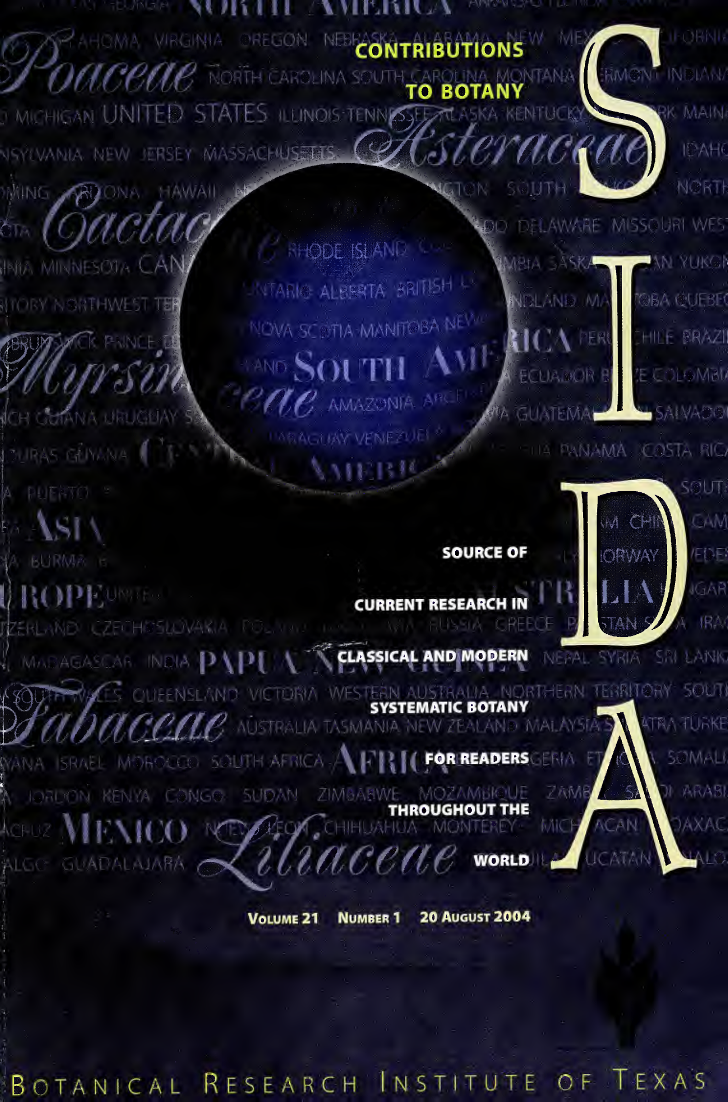


CONTRIBUTIONS
TO BOTANY

SIDA

SOURCE OF
CURRENT RESEARCH IN
CLASSICAL AND MODERN
SYSTEMATIC BOTANY
FOR READERS
THROUGHOUT THE
WORLD

VOLUME 21 NUMBER 1 20 AUGUST 2004

BOTANICAL RESEARCH INSTITUTE OF TEXAS

SIDA CONTRIBUTIONS TO BOTANY WAS FOUNDED BY LLOYD H. SHINNERS (LEFT) IN 1962. INHERITED BY WILLIAM F. MAHLER (RIGHT), DIRECTOR EMERITUS OF BRIT IN 1971, AND SINCE 1993, IT HAS BEEN PUBLISHED BY BRIT PRESS.

BARNEY L. LIPSCOMB, EDITOR
Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, USA
817 332-4441 / 817 332-4112 FAX
Electronic mail: sida@brit.org
Home page at the URL: http://www.brit.org/sida/

JOHN W. THIERET, ASSOCIATE EDITOR
Dept. of Biological Sciences
Northern Kentucky University
Highland Heights, KY 41099 USA

FÉLIX LLAMAS, CONTRIBUTING SPANISH EDITOR
Dpto. de Botánica, Facultad de Biologia
Universidad de León
E-2471 León, SPAIN

Guidelines for contributors are available upon request and on our SIDA home page as well as the last pages of each volume.

Subscriptions for year 2004:
$35. Individual
$60. USA Institutions
$70. Outside USA
numbers issued twice a year

BRIT
PRESS

VOLUME 21, NUMBER 1, PAGES 1–510.
20 AUGUST 2004

PRINTED IN THE UNITED STATES OF AMERICA
ISSN 0036-1488

Table of Contents

SYSTEMATICS

ETHNOBOTANY

BOTANICAL HISTORY

FLORISTICS AND ECOLOGY

Index to new names and new combinations in Sida 21(1), 2004

A NEW SPECIES OF *LEUCOPHYLLUM* (SCROPHULARIACEAE) AND COMMENTS ON RELATIONSHIPS OF THE GENUS

James Henrickson

Department of Biology
California State University
Los Angeles, California 90032, U.S.A.
henrickson@mail.utexas.edu

ABSTRACT

Leucophyllum coahuilensis is described from a gypsum area in central Coahuila, Mexico. It is characterized by small, sessile leaves, a vestiture of dendritic hairs with long, slender radii, and blue to violet corollas with white on the throat floor with orange maculations. It is unique within the genus in having only 2 ovules per ovary. Recent cytological and molecular data regarding relationships between the Scrophulariaceae and Myoporaceae are discussed.

RESUMEN

Se describe a ***Leucophyllum coahuilensis*** como una especie nueva de suelos yesosos del centro de Coahuila. Se caracteriza por presentar las hojas pequeñas y sésiles, un indumento de pelos dendríticos con radios largos y tenues, y las corolas de color violeta con la superficie interna abaxial de la garganta blancuzca o amarillenta con máculas anaranjadas. La nueva especie es la única del género que tiene dos óvulos por ovario. Se discuten datos citológicos recientes, y las relaciones del género con las familias Scrophulariaceae y Myoporaceae.

INTRODUCTION

Since the publication of the taxonomic monograph of *Leucophyllum* (Henrickson & Flyr 1985) two new taxa have been described (Nesom 1991, 1993) and a third new species is described herein. Additional information on chromosome numbers, anatomical features, and phylogenetic relationships have also been published and are summarized herein.

TAXONOMY

While traveling in central Coahuila on a recently paved highway from San Pedro de las Colonias to Laguna del Rey, I saw extensive, previously unexplored, outcroppings of gypsum. I drove to the slopes, parked my vehicle and within 50 feet found this distinctive new species of *Leucophyllum*.

Leucophyllum coahuilensis Henrickson, sp. nov. (**Figs 1, 2**). TYPE: MEXICO. COAHUILA: N end of Valley of Acatita, 15.1 road mi N of Rancho Acatita where NE-SW running spur (Sierra del Cuchilla) extends to highway, the ridge containing extensive areas of gypsum; collections from the N side of this ridge; 26° 39'N, 103°

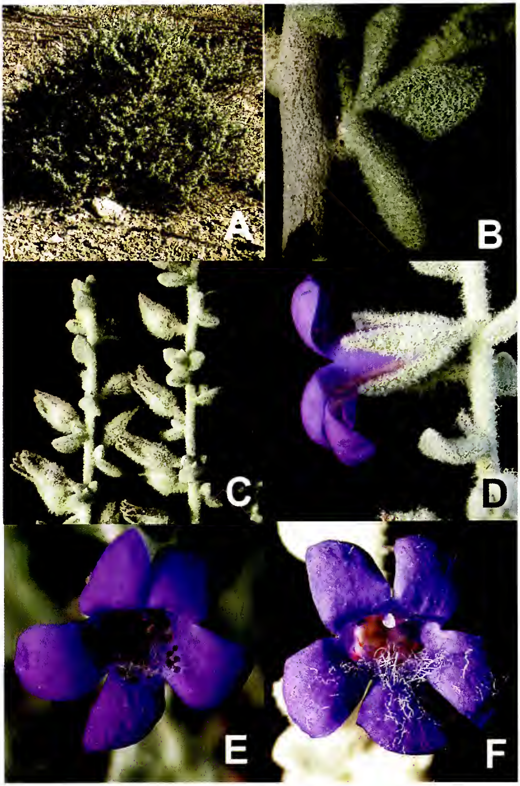


Fig. 1. *Leucophyllum coahuilensis*. **A.** Growth habit, the plant about 5 dm tall. **B.** Short shoot on young stem showing loose vestiture of dendritic hairs. **C.** Inflorescence showing post-flower calyces subtended by leaf-like bracts. **D.** Flower, lateral view, showing strongly vestitured calyx and spreading corolla lobes. **E.** Corolla, face view, showing posterior anthers and orange spots on the lower tube. Note hairs in lower throat and lower lobes. **F.** Corolla, face view, showing posterior stigma, internal spots and hairs on lobes and distal throat. B × 6; C × 1.3; D. × 3; E × 4; F × 4.

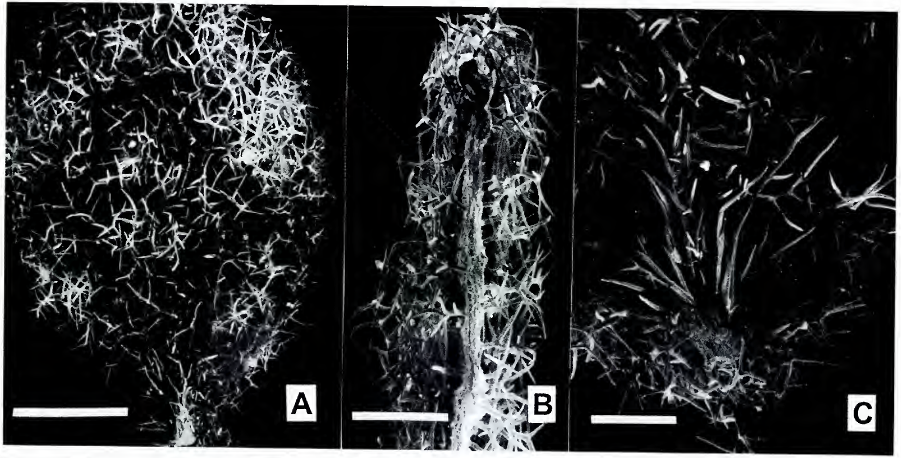


Fig. 2. Leaf vestiture of *Leucophyllum coahuilensis*. **A.** Small leaf 3 mm wide, adaxial surface, showing loose vestiture of moderately branched hairs. **B.** Transverse section of leaf showing thickness of the vestiture in relation to the leaf thickness. **C.** Larger leaf showing tuft of straight hairs in abaxial base. Magnifications: bars = 1.0 mm.

10'W, 1070–1200 m, 20 Sep 1999, *Henrickson 22601 with D. Riskind* (HOLOTYPE: TEX; ISOTYPES: MEXU, NY, GH, US).

Frutices globosi, rami divergentibus, solum profundum gypseum incoli. Folia ovata ad elliptica, parva, sessilis, vestimento dendritico (cum radiis longis gracilibusque), sub pilis dendritici stipitato-glandulosa; axillae foliorum cum caespitibus trichomatum indutae; corollae profunde caeruleo-purpureae coloratae, cum coloribus luteis basi faucum, cum maculae aurantiaceae ad medium faucum, 10–13 mm longae. Fructus cum solis duobus seminibus instructus (non cum seminibus numerosae in fructo quoque, ut in caeteris speciebus generis).

Divaricately branched, broadly globose, densely vestitured, whitish shrubs 3–6 dm tall, 4–8 dm wide, becoming rather thorny due to retention of old divergent stems; young stems with long-shoot internodes 3–13 mm long, the internodes densely white pannose with short dendritic hairs and an overstory of scattered, slender, longer dendritic hairs, with a shorter series of nearly sessile stipitate glands; understory dendritic hairs with 3–5 short nodes, each with 1–4 radii, 0.2–0.35 mm long, the longer scattered emergent hairs somewhat cylindrical with the central axis somewhat zig-zagged, 0.8–1.2 mm long, with 6–10 nodes, the internodes 0.1–0.15 mm long, the radii 1–2 per node, 0.2–0.3 mm long; with age the longer vestiture weathering away to form a closer pannose vestiture that eventually is replaced as older stems develop a light grayish, weathered bark. Leaves alternate on long shoots, and crowded on axillary fascicles; leaf blades ovate, ovate-elliptical, elliptical to obovate, (3.5–)5–9(–12) mm long, (2.2–)3–5 (–7.6) mm wide, obtuse to rounded, sometimes acute at the tip, broadly cuneate to rounded at sessile bases, entire, flat or somewhat saddle shaped, with a white, loose, uniformly dense vestiture on both surfaces, the hairs dendritic, 0.7–1.3 mm long, with zig-zagged rachies with 3–7 nodes, with internodes 0.1–0.16 mm long, the radii 1–2 per node, 0.15–0.4 mm long, ± 0.03 mm thick, the terminal arm often longest, the dendritic vestiture rather open, with the green leaf surface visible through the vestiture, with a close understory of stipitate glands 0.05–0.2 mm long, the basal adaxial surface leaves with a tuft of non-branched, white hairs 0.8–1.7 mm long. Flowers solitary in axils of the long-shoot leaves, on pedicels 1–4.7 mm long, ± 0.25 mm thick, with a dense dendritic vestiture as on the stems; calyces 6–9.5 mm long, the 5 sepals separate to within 0.5 mm of the base, the sepals lanceolate to linear-lanceolate, attenuate, 6–8.5 mm long, to 0.8–1 mm wide, broadest in the middle and narrowing below, strongly dendritically vestitured outside with hairs to 1.5 mm long and with an understory of stipitate glands 0.05–0.2 mm long, the vestiture longer and more dense at the sepal base, the inner sepal surfaces green, with only scattered stipitate glands 0.1–0.3 mm long or also with scattered unbranched hairs; corollas strong blue to violet, with white-yellow at the tube base, and white with scattered orange-brown dots on the throat floor, the orange spots ± 0.5 mm in diameter in several irregular series, the corollas 10–13 mm in total length (with lobes extended), the tube 7–8 mm long, to 4–4.5 mm wide at the distal throat, the 5 corolla lobes ± equal in size and shape and spread, ± oblong, broadly based, rounded at the tips, the upper 2 lobes (3.7–)4–5.5 mm long, 3.2–4.5 mm wide, the lower 3 lobes 4.2–6 mm long, 3–5.5 mm wide, the lobes spreading, often concavo-convex, the corollas moderately stipitate glandular outside with erect hairs to 0.1–0.3 mm long, the lower throat villous within with loosely arranged unbranched, wavy, white hairs 1-1.5 mm long that somewhat block the orifice to the throat; stamens 4, included, epipetalous; anthers white, each 2 lobed, the lower (anterior) 2 anthers 1.2–1.5 mm long (after anthesis), borne on free filaments 1–2 mm long, the adnate filament bases 3–5 mm long, the upper (posterior) anthers 1.7–1.8 mm long, borne on free filaments to 2–3 mm long, the adnate filament bases 3.2–6 mm long; ovary densely vestitured at the tip with erect, weakly branched hairs to ± 1 mm long, with the radii also erect; carpels and locules 2, ovules 1 per carpel produced in the distal fourth of the septa; styles 4.5–7.8 mm long, the stigmatic tip borne ± at the distal corolla tube throat, beyond the anthers, sparsely pubescent throughout with scattered non-branched hairs 0.2–0.3 mm long. Mature fruit and seeds unknown but ovoid immature seeds seen to 2 mm long, 1 mm wide.

Additional collections: **MEXICO. Coahuila:** ca. 31.5 rd mi S of Químicas del Rey on paved road south to San Pedro de las Colonias, area of steep gypsum on E side of rd near 26° 42'N, 103° 10'W, *Henrickson 20526* (TEX); N end of Valley of Acatita, 15.1 rd mi N of Rancho Acatita where NE-SW running spur (Sierra del Cuchilla) extends to highway, the ridge with extensive areas of gypsum, on solid gypsum interbedded with limestone, ± 26° 39'N, 103° 10'W, 20 Sep 1999, *Henrickson 22604 with D. Riskind* (TEX); W end of the Sierra de los Organos, 16 mi N of San Pedro (= Rancho Acatita) on Finisterre-Químicas del Rey highway, in gypsum-limestone area, near 26° 39N, 103° 09'W, ±1150 m, 24 Sep 2002, *Henrickson 23016* (TEX); same location, date, *Henrickson 23025*(TEX). All with duplicates to be distributed.

Leucophyllum coahuilensis is characterized by its small, sessile, ovate leaves, its dense, loose vestiture of dendritic hairs with moderately long rachis internodes (mostly 0.1–0.15 mm long) and few (1–2 per rachis node) thick radii mostly 0.2–0.3 mm long, 0.02–0.03 mm thick (Fig. 2). The sessile leaves also have a distinctive tuft of straight, unbranched hairs at the axil with the stem (Fig. 2C)–a feature not found elsewhere in the genus. All vestitured portions also have an understory of sessile or short-stipitate glands. This same vestiture also occurs on the pedicel and outer sepal surface. While the stems have a dense low understory vestiture that completely obscures the stem epidermis, the vestiture of the leaves is more open, with the green leaf surface clearly visible through the leaf vestiture, unlike some taxa, where the vestiture completely covers the leaf surface. The corollas are dark blue-violet with white marked with orange maculations in the lower throat; they are moderately short (10–13 mm in total length) and are stipitate glandular outside with a dense beard of wavy hairs on the basal throat within. The tip of the ovary has a dense beard of elongate branched hairs. Unlike all other species of *Leucophyllum*, ovules are only 2, one per carpel.

Within the genus *L. coahuilensis* is easily set apart by its two ovules per ovary, its distinctive vestiture, flower color, and sessile, ovate leaves with a basal tuft of unbranched hairs on the leaf axil. It appears most similar to *L. candidum* I.M.Johnston and *L. pruinosum* I.M.Johnston, both of which also have alternate leaves, orange maculations in the lower corolla throat, and vestitured ovary tips. The dendritic vestiture of *L. candidum*, however, has very short rachis internodes, with moderately long lower radii, and highly reduced upper radii, often not much longer than the width of the rachis internodes. As the terminal portions of the hairs fall away, the vestiture becomes very close and uniform (pannose), completely covering the leaf surface. *Leucophyllum candidum* also has petiolate, more broadly ovate, sometimes opposite leaves, and often larger flowers. It occurs from southern Big Bend Texas, eastern Chihuahua, through west-central Coahuila to northern Zacatecas and northeast Durango; its distribution surrounds that of *L. coahuilensis*, but *L. candidum* is not known from gypseous soils.

The new species is also somewhat similar to *L. pruinosum*, but the latter is distinguished by its vestiture that has longer, more slender radii (0.4–0.5 mm long, 0.01–0.015 mm in diameter); by petiolate, thinner, more orbicular leaves often with crisped margins; by more open, abruptly ampliate corolla throats; a preference for non-gypseous substrates; and a distribution around the confluence of the states of Tamaulipas, Nuevo León and San Luis Potosí (Henrickson & Flyr 1985).

The type locality of *L. coahuilensis* lies about one half kilometer east of the paved highway between Química del Rey and the loop highway northwest of San Pedro de la Colonias, about 30.5 miles (51 km) south of Química del Rey and 52 miles (84 km) north of the turnoff from the loop road east of Finisterre. It is part of Ejido Río Aguanaval. The type locality lies on the northern slopes of a northeast-southwest running spur from the range (locally called the Sierra de Cuchilla) that extends from the main range towards the highway. The area contains areas of mixed gypsum and clay, and other areas of nearly pure gypsum where the new species is common. Associates in the area include both obligate gypsophiles: *Fouquieria shrevei, Dyssodia gypsophila, Tiquilia gypsophila, Petalonyx crenulata, Dicranocarpus parviflorus, Nerisyrenia* sp., *Nama constancia, Haploesthes greggii, Euphorbia crepitata* var. *crepitata, Tiquilia gossipina, Selinocarpus purpusianus, Mentzelia mexicana, Drymaria elata*, etc. and non-gypsophils: *Grusonia braditiana, Jatropha dioica, Euphorbia antisiphilitica, Cordia parviflora, Castilleja lanata, Agave lecheguilla, Acacia neovernicosa, Allionia incarnata, Tiquilia greggii, Machaeranthera pinnatifida, Viguiera dentata, Tidestromia gemmata, Anulocaulis eriosolenus, Kallstromia grandiflora*, and *Larrea tridentata*.

On all trips to the site, the plants always produced a few flowers but no mature fruit. I have concluded that the plants were idling, i.e., just producing a few flowers at a time, but not maturing seeds. Perhaps after periods of strong rainfall, the plants will flower more strongly and have the resources to set seed.

RELATIONSHIPS AND MORPHOLOGY OF THE GENUS

Evidence of a close phylogenetic relationship between *Leucophyllum* and the Myoporaceae has been presented from a cpDNA-based molecular phylogenetic study by Olmstead et al. (2001). In this study the Scrophulariaceae is separated into three distinct clades. *Leucophyllum* remained in their Scroph I, or Scrophulariaceae *senso stricto* clade, showing a strongly supported relationship with Myoporaceae, with 100 percent bootstrap values and a high (44) decay value. Olmstead et al. (2001) suggested submersion of Myoporaceae into Scrophulariaceae s.s. along with the Loganiaceae. Robert Chinnock (pers. comm.), who has monographed *Eremophila* of the Myoporaceae, concurred and considered that Myoporaceae should be recognized as a subfamily of the Scrophulariaceae s.s.

In the monograph by Henrickson and Flyr (1985) the single chromosome count for *Leucophyllum* listed in Flyr's (1970) dissertation, obtained from pollen mother cells, was reported as both $n = 15$ and $n = 16$. The former number was a typographic error and the latter number may have been erroneous as well as Flyr (1970) indicated that he had difficulty in obtaining a clear chromosome spread. Read and Simpson (1989) reported $x = 17$ for *Leucophyllum* based on multiple root-tip counts from three species: *L. frutescens*, $2n = 34$; *L. minus*, $2n = 34$; and *L. candidum*, $2n = 68$, the first two diploid; the latter a tetraploid. Thus the base number for the genus appears to be $x = 17$.

Within the Scrophulariaceae, $x = 17$ has been reported from some members of the Tribe Gratioleae, namely *Bacopa* Aubl. ($2n = 68$; Chandron & Bhavanandan 1981), *Limnophila* R. Br. ($n = 17, 34$; Chandrum & Bhavanandran 1986; Subramanian & Pondmudan 1987) and *Picrorhiza* Royle in Benth. ($n = 17$; Jee et al. 1987). A base number of $x = 17$ also has been reported for *Veronica* L. (tribe Digitaleae) along with $x = 7, 8, 21, 32$. Within the Scrophulariaceae base numbers range from $x = 6$–20 and some genera, as *Veronica*, show wide variation in base numbers.

Within the Myoporaceae, Barlow (1971) provided chromosome counts for 58 of the 214 species of the large genus *Eremophila* (Chinnock pers. comm.). All species were $x = 18$, with diploids, tetraploids, and hexaploids occurring. Only two other counts have been published for *Myoporum* are $n = 54$, presumably triploid numbers for *M. laetum* and for *M. laetum* var. *decumbens* (Hair & Beuzenberg 1959), and $2n = 68$, a tetraploid based on $x = 17$, for *M. boninense* subsp. *boninense* by Ono and Masuda (1981). These are the only $x = 17$ counts recorded for the Myoporaceae thus far. Chinnock (pers. Comm..) considers the

Ono and Masuda (1981) count to be in error. A single count for *Bontia daphnoides* (Chinnock, pers. comm.) was *n* = 18. No counts are known for other genera of the family. The cytological data give little information of position of the genus.

Niezgoda and Tomb (1977) found that the Leucophylleae and Myoporaceae have tricolpate, diorate pollen grains of a distinct type not found elsewhere in the Sympetaleae. Karrfalt and Tomb (1983) further noted that the Myoporaceae are distinctive in having epithelium-lined secretory cavities in young stems and leaves. Their study showed that *Leucophyllum* has air cavities in the leaves that expand in a similar manner, although these lack epithelial linings and contents. They considered that the unlined air cavities of *Leucophyllum* may be homologous with the epithelial-lined secretory cavities in *Bontia* of the Myoporaceae. Lersten and Beaman (1998) found no support for the contention that air spaces in *Leucophyllum* were modified secretory cavities of the type found in Myoporaceae, however, they did find a single pair of epithelial-lined secretory cavities at the very leaf tips in three species of *Leucophyllum*. These did show a morphological similarity between *Leucophyllum* and Myoporaceae. Similar cavities are known from the genus *Capraria*, but its familial relationships are also under investigation (Lerston & Curtis 2001).

Carlquist and Hoekman (1986) studied wood anatomy of Myoporaceae and noted that certain xylem differences of *Leucophyllum* would exclude the genus from the Myoporaceae, but that there was a overall similarity of the woods of Myoporaceae and Scrophulariaceae as well as Gesneriaceae.

Comments on other species: Since publication of Henrickson and Flyr (1985) Guy Nesom has published two additional species of *Leucophyllum*. His *L. hintoniorum* Nesom from gypsum in the southeastern corner of Nuevo León, southeast of Aramberri (Nesom 1991) is distinctive in having a vestiture of three types of hairs: a very short understory of stellate-dendritic hairs that form a dense felty base layer; a larger series of stellate-dendritic hairs; and slender uniseriate gland-tipped hairs. With age the larger hairs fall alway leaving a closely pannose vestiture on both leaves and stems. The latter published *L. alejandrae* Nesom from a more arid gypsum area SW of Galeana, Nuevo León, about 68 km away, (Nesom 1993), has a similar vestiture, but narrower, more crowded leaves and smaller flowers. Subsequent collections of *L. hintoniorum* include specimens with much narrower, more crowded leaves, reducing the differences between the taxa. Unfortunately, *L. alejandrae* is known from only two collections, only one with flowers. More collections are needed of *L. alejandrae* in order to evaluate whether it should be considered separate from *L. hintoniorum*.

ACKNOWLEDGMENTS

I thank Neil Harriman for the Latin translation, Thomas Wendt for the Spanish abstract translation, David Riskind for his keen observation while in the field, and the Plant Resources Center for use of facilities.

REFERENCES

Barlow, B.A. 1971. Cytogeography of the genus *Eremophila.* Aust. J. Bot. 19:295–310.

Carlquist, S. and D.A. Hoekman. 1986. Wood anatomy of Myoporaceae: ecological and systematic considerations. Aliso 11:317–334.

Chandran, R. and K.V. Bhavanandan. 1981. In: Chromosome number reports LXXII. Taxon 30:698.

Chandran, R. and K.V. Bhavanandan. 1986. Cytological investigation of the family Scrophulariaceae 1. *Limnophila* R. Br. Cytologia 51:261–270.

Flyr, L.D. 1970. A systematic study of the tribe Leucophylleae (Scrophulariaceae). Ph.D. dissertation. University of Texas, Austin.

Hair, J.B. and E.J. Beuzenberg. 1959. Contributions to a chromosome atlas of the New Zealand Flora–2 Miscellaneous families. New Zealand J. Sci. 2:148–156.

Henrickson, J. and D.L. Flyr. 1985. Systematics of *Leucophyllum* and *Eremogeton* (Scrophulariaceae). Sida 11:107–172.

Jee, V., U. Dhar, and P. Kachroo. 1987. Addition to the cytological conspectus of alpine–subalpine flora of Kashmir Himalaya. CIS Chromosome Inform. Serv. 43:7–9.

Karrfalt, E.E. and A.S. Tomb. 1983. Air spaces, secretory cavities, and the relationship between Leucophylleae (Scrophulariaceae) and Myoporaceae. Syst. Bot. 8:29–32.

Lersten, N.R. and J.M. Beaman. 1998. First report of oil cavities in Scrophulariaceae and reinvestigation of air spaces in leaves of *Leucophyllum frutescens.* Amer. J. Bot. 85:1646–1649.

Lersten, N.R. and J.D. Curtis. 2001. Idioblasts and other unusual internal foliar secretory structures in Scrophulariaceae. Plant Syst. Evol. 227:63–73.

Nesom, G.L. 1991. A new species of *Leucophyllum* (Scrophulariaceae) from Nuevo León, México. Phytologia 71:337–339.

Nesom, G.L. 1993. *Leucophyllum alejandrae* (Scrophulariaceae), a new gypsophilic species from Nuevo León, México. Phytologia 74: 296–304.

Niezgoda, C.J. and A.S. Tomb. 1975. Systematic palynology of the tribe Leucophylleae (Scrophulariaceae) and selected Myoporaceae. Pollen et Spores 17:495–516.

Olmstead, R.G., C.W. dePamphilis, A.D. Wolfe, N.D. Young, W.J. Elisens, and P.A. Reeves. 2001. Disintegration of the Scrophulariaceae. Amer. J. Bot. 88:348–361.

Ono, M. and Y. Masuda. 1981. Chromosome numbers of some endemic species of the Bonin Islands II. Ogasawara Res. 4:1–24.

Read, J.C. and B.J. Simpson. 1989. Documented plant chromosome numbers 1989: 2. Chromosome counts of three species in the genus *Leucophyllum.* Sida. 13:369.

Subramanian, D. and R. Pondmudi. 1987. Cytotaxonomical studies of south Indian Scrophulariaceae. Cytologia 52:529–541.

BOOK REVIEW

GARY PAUL NABHAN and ANA GUADALUPE VALENZUELA-ZAPATA. 2004. **Tequila! A Natural and Cultural History.** (ISBN 0-8165-1937-4, pbk.). The University of Arizona Press, 355 S. Euclid, Ste. 103, Tucson, AZ 85719, U.S.A. (Orders: 520-621-1441, fax 520-621-8899, www.uapress.arizona.edu). $14.95 pbk., $29.95 hbk., 160 pp., 20 b/w, 5 1/2" × 9 1/4".

It is always a pleasure to share in someone else's passion. From the very beginning of this book, it is obvious that Ms. Valenzuela-Zapata and Mr. Nabham enjoy a passion for the agave plant. They bring us along when they gaze over vast hillsides of blue agave and when they compare varieties from all areas of Mexico. They require us to mourn with them how the over planting of one species has led to serious disease and infestation of the agave fields. They take us into the fields as the well trained agave harvesters, or jimadores, chop leaves off the agave to make the pineapple shaped cores that will be roasted and distilled into tequila.

Where the authors do not take us is out onto the patio to sip the finished product with them so we can learn about the different varieties and how to choose a good tequila. The Mexican government's descriptions of the four kinds of tequila are on page 52-3 and then a series of pictures shows the reader every stage of tequila production from planting propagules to the aging process of the finished liquor. Otherwise there is no tasting guide, as one might expect from a book called "Wine!" or "Vodka!"

Good information can be found throughout on cultivation, and there are four appendices ranging from a glossary of terms to species descriptions of agaves used in the tequila industry. There is also material on the cultural history of pulque, mescal and tequila. The main focus of the book to this reader remains the devastating effects of relying on one species of agave. Whether or not it was the authors' intention, the next time I take a sip of tequila I will be reminded of the "gangrene" epidemic in the fields, which is a bitter aftertaste to a favorite drink.—*Karen Hall, Library Volunteer, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

SIDA 21(1): 10. 2004

AMARANTHUS ACANTHOBRACTEATUS (AMARANTHACEAE)

James Henrickson

Department of Biology
California State University
Los Angeles, California 90032, U.S.A.
henrickson@mail.utexas.edu

ABSTRACT

Amaranthus acanthobracteatus is described as a new species from the sand dunes at Bilbao near Viesca in southern Coahuila, Mexico. It is a sister species to the dioecious *A. acanthochiton*, that has been recognized as a distinct genus *Acanthochiton*. Both species are psammophytic, dioecious annuals with large chartaceous, sharp-pointed pistillate bracts. The new taxon differs from *A. acanthochiton* in its longer, less cordate, distally recurved pistillate bracts, its larger seeds, larger pistillate inflorescences, and in many minor characteristics. The new species also is larger, with pistillate plants maturing as tumbleweeds.

RESUMEN

Se describe ***Amaranthus acanthobracteatus*** como especie nueva para la ciencia, de las dunas de arena de Bilbao, cerca de Viesca, en el sur de Coahuila, México. Representa una especie hermana de *A. acanthochiton*, especie dioica que ha sido segregada en un género distinto, *Acanthochiton*. Ambas especies son anuales, dioicas y psamófilas, y ambas presentan las brácteas pistiladas grandes, cartáceas y puntiagudas. El taxon nuevo se distingue de *A. acanthochiton* por las brácteas pistiladas más largas, menos cordadas, y recurvadas distalmente, por las semillas más grandes, por las inflorescencias pistiladas más grandes y por muchas características de índole menor. Además, las plantas de la especie nueva son más grandes y, al madurar y secarse, las plantas pistiladas son dispersadas por el viento.

INTRODUCTION

Dioecious *Amaranthus* species are native to North America. They initially were treated in the genera *Acnida* L. (with narrow pistillate bracts and 0–5 pistillate sepals) and *Acanthochiton* Torr. (with very large, conduplicate, chartaceous pistillate bracts) (Bentham & Hooker 1880; Standley 1917; Schinz 1934) until Sauer (1955) combined both genera with the monoecious *Amaranthus* species. Sauer (1957) noted that hybrids between the taxa previously in *Acnida* resulted in fertile offspring (Murray 1940), while hybrids between the *Acnida* group and monoecious *Amaranthus* species formed sterile hybrids, this implying that the *Acnida* taxa may represent a distinct phylad. However, Murray (1940) found that hybrids between species of monoecious *Amaranthus* often produced sterile hybrids as well. The relationship of *Acanthochiton* to the other dioecious taxa has not been specifically addressed. While some regional floras have continued to recognize *Acnida* and *Acanthochiton* as a distinct genera (Correll & Johnston 1970; Martin & Hutchins 1980) their combination with *Amaranthus* has been recognized in the Flora North America series (Mosyakin & Robinson 2003). While *Acanthochiton*, initially appears distinct from *Amaranthus*, Sauer (1955) points out that the differences are only quantitative and that the staminate plants of the taxon are very similar to those of *Acnida* species. Thus Sauer (1955) placed *Acanthochiton wrightii* Torr. into *Amaranthus*. Due to the existence of a previously published *Amaranthus wrightii* S. Wats., he made the combination *Amaranthus acanthochiton* (Torr.) Sauer.

In this paper, I present a second species related to *Amaranthus acanthochiton* from the Bilbao Dunes near the town of Viesca in southern Coahuila.

TAXONOMY AND DISCUSSION

Amaranthus acanthobracteatus Henrickson, sp. nov. (**Figs. 1, 2**). TYPE: MEXICO. COAHUILA: ca. 37 air mi ESE of Torreon on sand dunes at Bilbao, (8 mi NW of Viesca); dioecious; female plant 8 × 18 dm tall-wide with the stems dense, male plant 7 × 10 dm, with stems more erect and open; 25° 25'33.6'N, 102° 53'33.3'W, 3650 ft. elev., 13 Nov 2002, *Henrickson 23209* (HOLOTYPE: TEX; ISOTYPES: MEXU and to be distributed).

Amaranthus acanthochiton (Torr.) Sauer primo adspectu maxime simile, sed bracteis feminis ad maturitatem angustatis basin versus (non cordatis basi), spinis ad apicem bracteae recurvatis, non rectispinis, bracteis tenuibus, non incrassatis, sine reticulis lateribus, seminibus grandioribus 1.7–2.2 (versus 1.2–1.4) mm longis, et dichasiis magnioribus, et amplioribus magnitudinibus plantis differt.

Dioecious, depressed-globose, coarse annuals of sand-dune habitats. Pistillate plants densely branched, to 4–9 dm tall, 9–18 dm wide; central stems erect, to 20 mm in diameter at the base; internodes 3–13 cm long, branching alternately throughout; young stems 1–1.5 mm in diameter, striate, mottled green between the ± 10 yellowish ribs. Staminate plants 3.5–9 dm tall, 4–15 dm wide, with more vertical stems to 8 mm in diameter developed from basal decumbent stems. Leaves of pistillate and staminate plants similar; basal leaves linear-lanceolate, 5–8(–10) cm long, 5–8(–10) mm wide, ascending, obtuse to acute, apiculate at the tip, cuneate at the base; petioles 10–20(–30) mm long; upper-inflorescence leaves more linear, 1–5 cm long, 1–5 mm wide, the margins of all leaves strongly crisped, whitish, the primary-secondary veins whitish beneath. Pistillate plants with flowers axillary to the linear mid- upper-stem leaves, in irregular, dichasial inflorescences that eventually develop into an elongated cluster of ± overlapping bracts to 25 mm long, the inflorescences dichasial at the base, with the two axies usually not branching above, the large, ovate, strongly folded bracts obscuring the upper inflorescence arrangement, the lowest bracts smallest, to 5 mm long, 3 mm wide, the mid bracts largest, 10–16.5 mm long, to 10 mm wide, the distal, youngest bracts ± reduced, 8–12 mm long, the bracts thickened, V-shaped in transverse section, with the midvein straight or outwardly curved, with the sharp tips reflexed, the bracts rounded, cordate only with age at the base, broadest in the lower half, and tapering to the tip, the adaxial bract surface white throughout, the abaxial (outer) bract surface white along the base, the mid and distal portions green, not conspicuously veined,

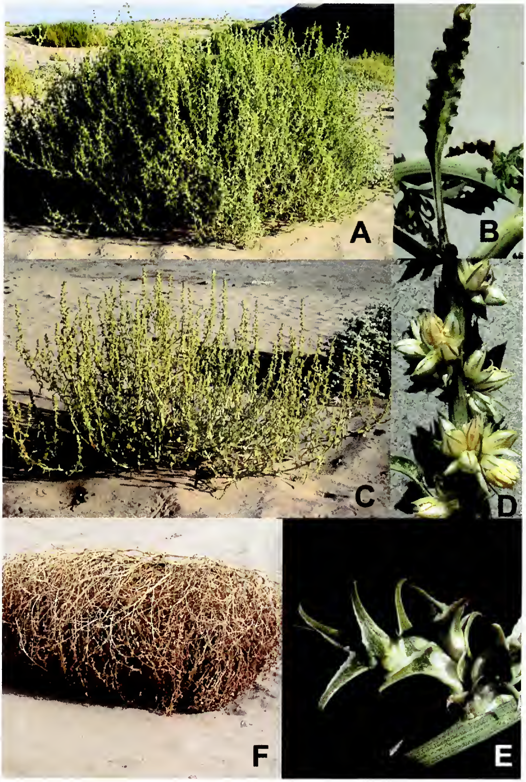


Fig. 1. *Amaranthus acanthobracteatus*. **A.** Pistillate plant, ca. 9 dm tall, 14 dm wide; note density of branching. **B.** Lower stem leaf, showing characteristic shape, long petiole, and strongly crisped blade margins. **C.** Staminate plant, ca. 8 dm tall, 1.2 dm wide; note open aspect of branching. **D.** Staminate globose dichasia with anthers. **E.** Pistillate inflorescence showing characteristic coloration and distal hook at the long bract tip. **F.** Post-mature pistillate plant, upside down—a tumbleweed.

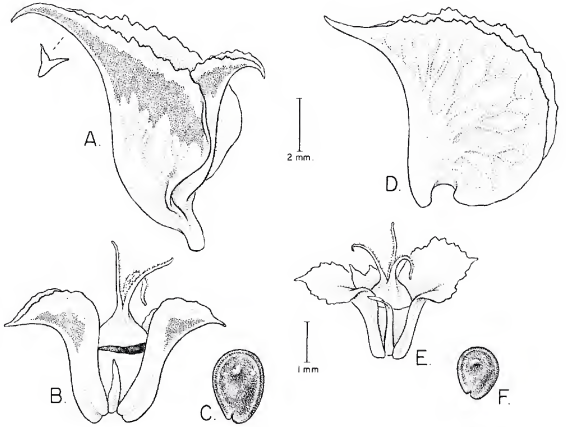


Fig. 2. Comparison of pistillate bracts, flowers, seeds of *Amaranthus acanthobracteatus* and *A. acanthochiton*. **A–C:** *A. acanthobracteatus*. Mature pistillate bracts, note narrow base, bract shape, and decurved tip. **B.** Mature fruit with associated perianth. **C.** Mature seed (all from *Henrickson 23209*). **D–F:** *A. acanthochiton*. **D.** Mature pistillate bract, note cordate base, folded reniform shape, and 6 straight terminal spine. Also note reticulate venation pattern on the bract side. **E.** Mature fruit with associated perianth. **F.** Mature seed (all from *Correll 26563*). The 2 mm scale is for mature pistillate bracts (A, D); the 1 mm scale is for B–C and E–F.

the outer margins thick membranous, white, entire or variously undulate to coarsely toothed, (0.3–)0.5–1.0 mm thick, the midvein white, with age the lower portion of the bracts becoming ± spongy and sometimes the mid portions and margins also becoming spongy at maturity. Pistillate flowers with 2–3 sepals, the two marginal sepals largest, 3–4.5 mm long, with one larger than the other, both swollen-spongy and truncate at the base, the midribs green, excurrent, the whitish margins broad along the claw, and much expanded in the ovate blade below the acute-obtuse tip, the third sepal (when present) oblong, 0.8–2.7 mm long, abaxial. Ovary compressed; styles 2–3, 1.5–2.2 mm long, stigmatic and pilose along their inner surfaces. Staminate plants producing dichasial glomerules of 7–20+ staminate flowers at 2–15(–30) mm intervals along the upper stems, the glomerules subtended by narrow, crisped-margined leaves; bracts 1.2–2(–3.8) mm long, sepal like in structure, white scarious except along the green, excurrent midvein; sepals 5, oblong-elliptical, concavo-convex, 3.3–4.3

mm long, 1.2–1.4 mm wide, scarious except along the slender green midveins, rounded to 2-toothed at the tips, the midveins excurrent for 0.4–0.9 mm, the sepals strongly spreading at anthesis exposing the anthers; anthers 5, oblong, 2–2.2 mm long, ± 0.7 mm wide (before anthesis), apiculate at the tip, yellow, post-anthesis anthers 1.5–1.7 mm long, the filaments initially 0.9 mm long, elongating to 2.0 mm at anthesis. Mature utricles compressed obovate, membranous, the body to 2.3 mm long, to 1.5 mm wide, with a visible circumscissile line of dehiscence in the distal third, the bottom portion smooth or rugose, the cap rugose or not, ± beaked below the filiform styles. Seeds compressed obovoid, smooth, shiny, reddish-brown to reddish-black, 1.7–2.2 mm long, 1.3–1.6 mm wide and 0.8–1.05 mm thick, the embryo radicle pointing downward. Figs. 1, 2.

Additional collections: **Mexico. Chihuahua:** 36 air mi ENE of Escalon along trail to Esmaralda in Bolsón de Mapimí region of CDR scrub; dioecious annual on sandy knoll, near 26° 57'N, 103° 52'W, 3500 ft, 19 Sep 1972, *Henrickson 7755* (RSA); Coahuila. Sand dunes near Bilbao, 6 mi via Hwy 91, S of Mex Hwy 40, robust annual to 5 dm tall, in active dunes, 25° 25'N, 102° 55'W, 12 Sep 1984, *J.E. Bowers 2930, with T.L Burgess, R.M. Turner* (ARIZ); ± 37 air mi ESE of Torreon, on the sand dunes at Bilbao, on Hwy 68, about 10 mi NW of Viesca, near 25° 25'N, 102° 53'W, ± 1000 m, 17 Oct 2002, *Henrickson 23171*, with *D. Riskind*; same locality, 13 Nov 2002; *Henrickson 23202; 23203, 23204, 23205, 23208; 23206, 23207*; all TEX and to be distributed

There is no question that the new taxon is related to *Amaranthus acanthochiton*. Both are branched dioecious annuals of dune systems or sandy soils. In both the leaf blades are crispate; both have broadened and thickened pistillate bracts that fold over flowers and fruit. Both have two large pistillate sepals and 1–3 smaller ones.

But *Amaranthus acanthochiton* differs from the new taxon in several features (Fig. 2). The bracts of *A. acanthochiton* are more reniform in two-dimensional outline, typically cordate at the base, the sharp tip is straight or only slightly curved (but not distinctly deflexed at the tip), the green, mid-bract becomes thickened, spongy and develops a conspicuous raised-reticulate venation pattern on the outer base surface at maurity, the outer membranous margins are more strongly erose-crenate, typically much narrower, (0.4–0.6 mm wide), and the mature pistillate inflorescences are smaller, with fewer flowers. Also, in *Amaranthus acanthochiton*, the pistillate flowers have two larger marginal, clawed sepals, and may have 1–3 smaller, oblong, membranous sepals, 1 on one side, and 0–2 on the other face, however, in the smallest bracts, the pistillate flowers may just have 5 small, oblong sepals. Overall the sepals in *A. acanthochiton* are similar to those of the new species. But in some collections the blades of the larger sepals can become strongly expanded and develop a branching network of veins and have denticulate margins (Fig. 2 E). The larger sepals may also develop thickened, spongy bases at maturity as in the new taxon. Seeds in both are similar in orientation, color and shape, but are smaller (1.2–1.4 mm long, 0.95–1.05 mm wide) in *A. acanthochiton*.

Amaranthus acanthochiton is known from sandy flats and dunes from eastern Arizona (Navajo, Greenlee cos.); western New Mexico (San Juan, Rio Arriba, McKinley, Valencia, Catron, Socorro, Otero, Doña Ana, Luna, and Hidalgo cos.); Texas (El Paso, Hudspeth and Jeff Davis cos.) and northern Mexico, Chihuahua (Samalayuca Dunes south of Cd. Juarez) (Sauer 1955). Reports by Turner et al. (2003) of the species in Brewster, Presidio and Webb cos. have not been substantiated.

In *Amaranthus acanthobracteatus*, staminate plants have a much more open habit than the pistillate plants as can be seen in Fig. 1 A–B. Staminate plants branch at the base and the vertical lateral stems have fewer lateral branches creating an open growth form that would appear to allow for air flow between the stems and outward dispersal of pollen from the plants (Fig. 1C). The pistillate plants, in contrast, are more densely branched at the base and above; the plants forming a dense broadly globose growth form with the main lateral branches curving upward. That would presumably cause entering pollen to slow down, perhaps increasing the possibility of finding a suitable stigmatic surface.

The plants are well known to the local public and in wet years are very common on the dunes where they occur nearly exclusively with *Tidestromea lanuginosa* (Nutt.) Standl. The plants, along with those of *Tidestromia lanuginosa*, are gathered for animal feed by local townfolk. The local name for the plant is "Torillo" or "Herba Voladora," the latter (flying herb) implying that the plants become tumbleweeds at maturity. The overall architecture of the pistillate plants is very similar to that of *Salsola*, (Chenopodiaceae) the Russian thistle, and a later trip to the type locality showed that mature plants indeed become tumbleweeds (Fig. 1F). However, unlike *Salsola*, where a distinct abscission layer forms at the stem-root junction, no distinct abscission layer forms between roots and stem. Rather, as the plants mature, their fleshy roots die, dry out, and eventually break away, leaving the broadly globose plants to tumble across the dunes dispersing the pistillate infructescences and seeds.

ACKNOWLEDGMENTS

I thank Neil Harriman for the Latin translation, Thomas Wendt and Fernando Chiang for the Spanish translation of the abstract, Bobbi Angell for Figure 2, ARIZ, and SRSC for loan of specimens, David Riskind for causing the initial visit the dunes at Bilbao, which I later hit at the peak of flower, and the Plant Resources Center of the University of Texas, Austin for use of facilities.

REFERENCES

Bentham, G. and J.D. Hooker. 1880. Amarantaceae. In: Genera plantarum. Vol 3. Reeves & Co., London. Pp. 20–43.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Martin, W.C. and C.R. Hutchins. 1980. A flora of New Mexico. 2 Vols. J. Cramer, Vaduz.

Mosyakin, S.L. and K.R. Robinson. 2003. Amaranthus. In: Fl. N. Amer. 4:410–435.

Murray, M.J. 1940. The genetics of sex determination in the family Amaranthaceae. Genetics 25:409–431

Sauer, J. 1955. Revision of the dioecious Amaranths. Madroño 13:5–46.

Sauer, J. 1957. Recent migration and evolution of the dioecious Amaranths. Evolution 11: 11–31.

Schinz, H. 1934. Amaranthaceae. In: A. Engler & K. Prantl. Die natürlichen pflanznfamilien 16c:7–85.

Standley, P.C. 1917. Amaranthaceae. In: N. Amer. fl. 21(2):95–169.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of vascular plants of Texas, Vol. 1., Sida, Bot. Misc. 24, Botanical Research Institute of Texas.

BOOK REVIEW

Benoît Dayrat. 2003. **Les botanistes et la flore de France: trois siècles de découvertes.** (ISBN 2-85653-548-8). Publications Scientifiques du Muséum national d'Histoire Naturelle, 57, rue Cuvier, 1-75005 Paris, FRANCE. (Orders: Tel. [33] (0) 1-40 79 3700; Fax [33] (0)1-40 79 3858; e-mail: diff.pub@mnhn.fr). Price not given, 690 pp., Illus., color plates, portraits, 6 1/2" × 9 1/2".

This massive work of scholarship is not, Dayrat declares, a history of botany in France but rather the history of the discovery of plants in France from 1753 to the early twentieth century. He details the lives of those authors of at least one species considered valid in current flora. The lives of the early doctors, pharmacists, members of the military and of the clergy, essentially amateurs, their explorations through the various regions of France, their personal triumphs and tragedies, the political and intellectual intrigues make fascinating reading. By their associations many additional botanists are cameoed in extensive footnotes, which also include bibliographical details of published works as well as references from many, often obscure resources, such as regional botanical journals. Each biography concludes with the valid species the author described; these species are again listed under the author's name in a separate section. Every person cited is indexed in one of two indices, the other being comprehensive.

Much botanical history is necessarily included in these biographies: the history of botanical investigations of such influential persons as Lamarck and Jussieu, of Candolle, of the eccentric Alexis Jordan; the first microphotography by Brébisson, and the development of the academic discipline of botany. There is also considerable history of the many botanical and Linnaean societies throughout France and the establishment of her numerous botanical gardens.

As a final word Dayrat, a post-doctoral student at the California Academy of sciences, reflecting on California plants,urges the documentation of the history of discoveries of fauna and flora throughout the world.

This is an important work and should be made accessible to all botanists and those in related sciences.—*Joann Karges, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

TAXONOMIC REEVALUATIONS IN NORTH AMERICAN *ERIGERON* (ASTERACEAE: ASTEREAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Four taxa of *Erigeron* are raised from varietal to specific rank: *E. breweri* var. *klamathensis* to **E. klamathensis** (Nesom) Nesom, comb. et stat. nov., *E. decumbens* var. *robustior* to **E. robustior** (Cronq.) Nesom, comb. et stat. nov., *E. engelmannii* var. *davisii* to **E. davisii** (Cronq.) Nesom, comb. et stat. nov., and *E. utahensis* var. *sparsifolius* is treated as *E. sparsifolius* Eastw. The morphological distinctions of these taxa are equivalent to those of other accepted species of *Erigeron*. **Erigeron poliospermus** var. **disciformis** (Cronq.) Nesom, comb. et stat. nov., is raised in rank from *E. poliospermus* forma *disciformis*. **Erigeron clokeyi** var. **pinzliae** Nesom, var. nov., occupies the major portion of the range of the species; the typical variety is restricted to Clark Co., Nevada. **Erigeron greenei** Nesom, nom. nov., representing a species endemic to California, replaces the later homonym *Erigeron angustatus* Greene. *Erigeron tracyi* Greene is an earlier name for *E. colomexicanus* A. Nels. Taxonomic clarifications are provided for *E. acris*, *E. uncialis* and *E. cavernensis*, and for the interrelated species *E. radicatus*, *E. ochroleucus*, *E. lackschewitzii*, and *E. parryi*. A lectotype is designated for *E. stenophyllus* var. *tetrapleurus*.

RESUMEN

Cuatro taxa de *Erigeron* se elevan del rango varietal al específico: *E. breweri* var. *klamathensis* a ***E. klamathensis*** (Nesom) Nesom, comb. et stat. nov., *E. decumbens* var. *robustior* a ***E. robustior*** (Cronq.) Nesom, comb. et stat. nov., *E. engelmannii* var. *davisii* a ***E. davisii*** (Cronq.) Nesom, comb. et stat. nov., y *E. utahensis* var. *sparsifolius* es tratado como *E. sparsifolius* Eastw. Las diferencias morfológicas de estos taxa son equivalentes a las de otras especies aceptadas de *Erigeron*. ***Erigeron poliospermus*** var. ***disciformis*** (Cronq.) Nesom, comb. et stat. nov., se eleva de rango desde *E. poliospermus* forma *disciformis*. ***Erigeron clokeyi*** var. ***pinzliae*** Nesom, var. nov., ocupa la mayor parte del área de la especie; la variedad típica está restringida a Clark Co., Nevada. ***Erigeron greenei*** Nesom, nom. nov., que representa una especie endémica de California, reemplaza al homónimo posterior *Erigeron angustatus* Greene. *Erigeron tracyi* Greene es un nombre más antiguo para *E. colomexicanus* A. Nels. Se ofrecen clarificaciones taxonómicas para *E. acris*, *E. uncialis* y *E. cavernensis*, y para las especies interrelacionadas *E. radicatus*, *E. ochroleucus*, *E. lackschewitzii*, y *E. parryi*. Se designa un lectotipo para *E. stenophyllus* var. *tetrapleurus*.

Taxonomic modifications are required for North American *Erigeron* L., preceding a treatment of the genus for the Flora of North America project. A new variety is described, a replacement name is provided for a species currently recognized by a later homonym, one taxon is raised from the rank of forma to variety, and four taxa previously recognized as varieties are treated at specific rank. Morphological distinctions of these former varieties are as significant as those separating many other species of *Erigeron*, and species rank is consistent

SIDA 21(1): 19–39. 2004

with current taxonomy within the genus. Clarifications of the taxonomic status of other taxa also are provided. Fuller morphological descriptions will be provided in the FNA treatment.

Erigeron breweri var. *klamathensis* at specific rank

Erigeron klamathensis (Nesom) Nesom, comb. et stat. nov. BASIONYM: *Erigeron breweri* A. Gray var. *klamathensis* Nesom, Phytologia 72:175. 1992. TYPE: U.S.A. CALIFORNIA. HUMBOLDT CO.: Trinity Summit, 2 mi SE of Devil's Hole, exposed rocky points in woods, westerly exposure, 26 Jul 1935, *J.P. Tracy 15515* (HOLOTYPE: UC!; ISOTYPES: JEPS!, MO!, TEX!).

Flowering Jun–Sep. Outcrops, ridges, crevices, rocky slopes, over shale, granite, serpentine, peridotite, chaparral, oak-pine, fir-oak, mixed evergreen woodlands; (450–)700–2150 m; California, Oregon.

Prior to the recognition of var. *klamathensis*, most previous identifications had referred these plants to the sympatric *Erigeron foliosus* Nutt. var. *confinis* (T.J. Howell) Jeps. I originally treated var. *klamathensis* within *E. breweri* A. Gray (Nesom 1992a) primarily because of similarities in vestiture and habit but here hypothesize that a closer relationship of var. *klamathensis* is more likely with *E. foliosus*. Recognition of *E. klamathensis* at specific rank emphasizes its geographic and morphological distinctions and its ambiguous evolutionary affinity.

Erigeron klamathensis occurs in the Klamath Ranges of Siskyou, Trinity, and Shasta counties, California, and adjacent Oregon (Nesom 1992a, Map 5). It is disjunct from *E. breweri*, which is distributed in the Sierra Nevada, southwestern California, and parts of the Great Basin province (Nesom 1992a, Maps 3 and 4) and is more similar in range and ecology to *E. foliosus*, which is primarily a species of coastal ranges (Nesom 1992a, Maps 6 and 7).

Erigeron klamathensis produces glandular phyllaries similar to those of *E. breweri* var. *breweri* and strongly lignescent bases like *E. breweri* var. *porphyreticus* (as well as *E. foliosus* var. *confinis*). The spreading-deflexed orientation of the stem vestiture in *E. klamathensis* is similar to that commonly found in *E. breweri*, but the sparsely pilose-hirsute vestiture of long, stiff hairs differs from the hirsutulous vestiture of *E. breweri*.

Cauline vestiture in *Erigeron foliosus* is consistently antrorsely strigose to nearly or completely absent, but the habit of *E. foliosus* Nutt. var. *confinis* is nearly identical to that of *E. klamathensis* and the phyllaries are similarly glandular. Their similarity in overall appearance, geography, and ecology has led to mixed collections: e.g., a collection from Josephine Co., Oregon (*Denton 2409*, HSC) has one plant of *E. klamathensis* and several stems of *E. foliosus* var. *confinis*, showing no intermediacy. Intermediates between the two are encountered but they are not common.

The rayless *Erigeron petrophilus* var. *viscidulus* (A. Gray) Nesom also is similar in habit to *E. klamathensis*, has similar involucral vestiture, and is partially sympatric with it (Nesom 1992a, Map 8). Var. *viscidulus* should considered among possible close relatives of *E. klamathensis.*

The radiate taxa under consideration can be identified by the following contrasts. *Erigeron breweri* is represented in the key by var. *breweri* because it is the only variety of *E. breweri* similar to *E. klamathensis* in its densely glandular phyllaries lacking non-glandular hairs.

1. Stems strigose to glabrate _____ **Erigeron foliosus**
1. Stems hirsute to hispid-hirsute or pilose-hirsute.
   2. Stems arising from slender, woody basal offsets, these from a strongly developed, woody root; hairs of stems 0.5–1 mm long; inner phyllaries with broad, white, thickened margins, lacking distinctly demarcated green apical areas _____ **Erigeron klamathensis**
   2. Stems arising from slender fibrous-rooted rhizome-like bases, without a strongly developed woody root; hairs of stems 0.1–0.4 mm long; inner phyllaries with green apical areas _____ **Erigeron breweri** var. **breweri**

In addition to the difference in vestiture, stems of *E. klamathensis* average considerably shorter than *E. foliosus* var. *confinis* [6–15(–20) cm tall vs. (10–)15–35 (–50) cm] and the root system usually is distinctly thicker and woodier than in var. *confinis.*

Erigeron decumbens var. *robustior* at specific rank

Erigeron robustior (Cronq.) Nesom, comb. et stat. nov. BASIONYM: *Erigeron decumbens* Nutt. subsp. *robustior* Cronq., Brittonia 6:174. 1947. *Erigeron decumbens* Nutt. var. *robustior* (Cronq.) Cronq., Vasc. Pl. Pacific Northwest 5:175. 1955. TYPE: U.S.A. CALIFORNIA. HUMBOLDT CO.: valley of South Yager Creek, 26 Jun 1932, *J.P. Tracy 10252* (HOLOTYPE: UC).

Erigeron robustior is known from Humboldt, Trinity, and Mendocino counties in northwestern California and is disjunct from *E. decumbens*, which is known from six counties of northwestern Oregon. The two taxa also are separated by consistent morphological differences (key below). It is possible that *E. decumbens* and *E. robustior* have an evolutionary sister relationship, but the magnitude of difference between them is consistent with other accepted species of *Erigeron*, particularly within the "*Erigeron eatonii* A. Gray group," of which they are a part.

1. Involucres (4.5–)5–6 mm high, 9–12 mm wide, phyllaries linear-lanceolate, apically linear-acuminate; disc corollas 3–3.5 mm long; cypselae 1.2–1.6 mm long; heavy soils in seasonally wet or dry upland prairie grasslands; 100–300 m elev. _____ **Erigeron decumbens**
1. Involucres 6–8.5 mm high, 12–18 mm wide, phyllaries narrowly oblanceolate to lanceolate, apically acute to acuminate; disc corollas 3.5–4.5 mm long; cypselae (1.8–)2–3.2 mm long; rocky or gravelly slopes, sometimes over serpentine, glades and meadows, sagebrush; 700–1500 m elev. _____ **Erigeron robustior**

Comments regarding the biology of *Erigeron decumbens* sensu stricto on the Center For Plant Conservation website (CPC 2003) note the following: "This rare species spreads vegetatively via rhizomes over very short distances [of] about 4 inches (<10 cm). Since plants often grow in clumps, it is often difficult to distinguish individuals." In the FNA treatment, these 'rhizomes' are described as 'rhizomiform caudex branches;' plants of *E. robustior* mostly grow singly, without similar vegetative reproduction, but the distinction is not absolute, because *E. robustior* also occasionally produces rhizomiform branches.

Three collections of plants of the *Erigeron eatonii* group from within the geographic range of *E. robustior* are smaller in stature and have smaller heads with elliptic-oblanceolate phyllaries, compared to *E. robustior*. They may represent an undescribed entity. Strother (1987) annotated these collections as "*E. decumbens* var. *robustior* vel aff.," indicating that their identity was uncertain.

Specimens examined: **CALIFORNIA. Humboldt Co.:** near Mad River Buttes, 4739 ft, meadow, 28 Jun 1980, *Baker 2479* (HSC), *Baker 2499* (HSC); Jack Rabbit Valley, along Swayback Ridge 4-wheel drive road 1 mi S of jct with Forest Service road, meadow, 4900 ft, 10 Jun 1980, *Nelson and Nelson 5395* (HSC). *Blankinship s.n.* (UC 87680, fide Strother), 1 Jul 1893, from "Mad River," may be the same entity.

Erigeron engelmannii var. *davisii* at specific rank

Erigeron davisii (Cronq.) Nesom, comb. et stat. nov. BASIONYM: *Erigeron engelmannii* A. Nels. subsp. *davisii* Cronq., Leafl. W. Bot. 3:167. 1942. *Erigeron engelmannii* A. Nels. var. *davisii* (Cronq.) Cronq., Vasc. Pl. Pacific Northwest 5:177. 1955. LECTOTYPE, selected here: U.S.A. IDAHO. IDAHO CO.: Whitebird summit, moist woods, range 2 east, township 29 north, 14 Jun 1941, *R.J. Davis 3254* (MIN; ISOLECTOTYPE: UC). Cronquist (1947) cited the two collections as type material, but he did not specify a holotype. The MIN sheet is annotated by Cronquist as 'type sheet' (fide A.C. Cholewa).

Flowering (Apr–)May–Jul. Bare, rocky ridges and slopes, basalt outcrops, sparsely vegetated woodland openings or edges, commonly with grasses; 1200–1800 m; Idaho, Oregon.

Erigeron davisii occurs in Idaho and eastern Oregon and is geographically disjunct from the range of *E. engelmannii*, which occurs over a wider area to the south and east (Fig. 1). The two are morphologically distinct (key below), and features of *E. davisii* indicate that it probably is equally or more closely related to *E. poliospermus* A. Gray, *E. disparipilus* Cronq., *E. nanus* Nutt., and others. These species are characterized by non-glandular stem hairs of markedly unequal lengths, petiole margins coarsely spreading-ciliate with thick-based hairs, coiling ray corollas, and a tendency for strigose-sericeous achenes. *Erigeron davisii* is distinct among these species primarily in its antrorsely appressed stem hairs; the orientation of the stem vestiture also probably is the reason that it has been hypothesized to be closely related to *E. engelmannii*.

Erigeron engelmannii is similar to *E. davisii* in habit, leaf morphology, coarsely ciliate petiole margins, and has cauline vestiture of nonglandular hairs of disparate length, but it is hypothesized here to be most closely related to *E. pumilus* Nutt. and *E. concinnus* (Hook. & Arn.) Torr. & A. Gray, in agreement

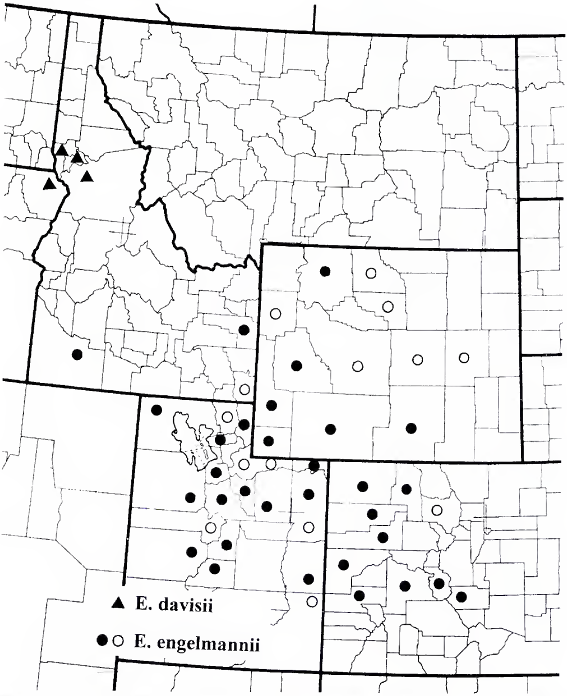


Fig. 1. Distribution of *Erigeron davisii* and *E. engelmannii*. Solid symbols are from collections at NY and BRIT. Open circles are from internet-posted maps (Rocky Mountain Herbarium 1998; Albee et al. 1988) and from Cronquist (1947).

with observations of Cronquist (1947), who noted close similarities among these taxa. All three have ray corollas very narrow (0.8–1.1 mm wide vs. 1.2–1.8 mm wide) and reflexing at the tube-lamina junction (vs. broader and coiling at the tips), disc corollas distinctly inflated and indurate above the tube (vs. not inflated or indurate), and achenes oblong (vs. narrowly obovate). *Erigeron* *engelmannii* shares with *E. concinnus* the unusual combination of densely short-hairy disc corollas and an outer pappus of narrow to broad scales.

In contrast to *E. pumilus* and *E. concinnus* and their other close relatives, the stems and leaves of *E. engelmannii* do not have dense, minute glandularity and ray corollas appear not only to reflex (as in the *E. pumilus* group) but also to coil at the tips (as in the *E. poliospermus* group). This apparent combination of ray behaviors in a single species is rare in *Erigeron*. In sum, *E. engelmannii* has features of both the *E. pumilus* group and the *E. poliospermus* group.

1. Involucres 3.5–5(–6) mm high; ray corollas 5–10 mm long, laminae 0.8–1.1 mm wide, apparently both coiling at the tips and reflexing at the tube-lamina junction; disc corollas inflated and indurate above the tube, puberulent; cypselae 1.4–1.8 mm long, oblong; outer pappus of narrow scales or setae _______ **Erigeron engelmannii**
1. Involucres 5–8 mm high; ray corollas 8–14 mm long, laminae 1.2–1.8 mm wide, coiling at the tips, not reflexing; disc corollas not inflated or indurate, glabrate; cypselae 2.1–2.5 mm long, obovate; outer pappus of setae _______ **Erigeron davisii**

Stems and involucres of *E. davisii* are more densely hairy than in *E. engelmannii*, easily seen with a collection of specimens of both; the difference is difficult to characterize in a key.

Erigeron poliospermus forma *disciformis* at varietal rank

Populations of discoid plants of *Erigeron poliospermus* from localities in central Oregon were originally treated by Cronquist at rank of forma. Geographically discrete discoid population systems, without other morphological differentiation, are generally recognized at varietal rank in other species of *Erigeron*.

Erigeron poliospermus A. Gray var. **disciformis** (Cronq.) Nesom, comb. et stat. nov. *Erigeron poliospermus* A. Gray forma *disciformis* Cronq., Brittonia 6:194. 1947. TYPE: U.S.A. OREGON. CROOK CO.: near camp on Hay Creek, rocky hillsides, 840 m, 12 Jun 1894, *J.B. Leiberg 212* (HOLOTYPE: NY; ISOTYPE: GH).

1. Stems branched at or below midstem, basal leaves and branches originating on elongate internodes from proximal 1–6 cm of primary stem; stems and involucres densely minutely glandular, without non-glandular hairs or sparsely hirsute _______ **Erigeron poliospermus** var. **cereus**
1. Stems unbranched, basal leaves and stems originating from compressed nodes at the caudex apex; stems and involucres sparsely minutely glandular and densely hirsute.
    2. Heads discoid, ray florets absent _______ **Erigeron poliospermus** var. **disciformis**
    2. Heads radiate, ray florets present and conspicuous _______ **Erigeron poliospermus** var. **poliospermus**

Erigeron utahensis var. *sparsifolius* at specific rank

Cronquist (1947, p. 273) observed that *Erigeron utahensis* A. Gray and *E. sparsifolius* Eastw. "intergrade so completely that specific recognition is scarcely possible" and treated them within a single species. He later noted (Cronquist 1994, p. 342) that "the species consists of two wholly intergradient varieties of

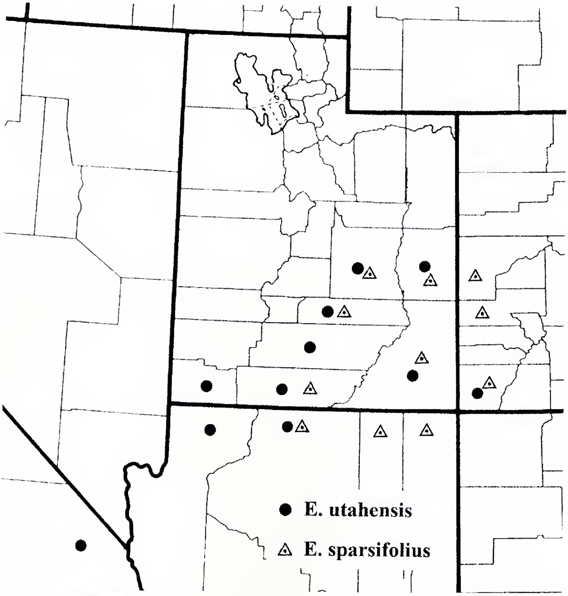


Fig. 2. Distribution of *Erigeron utahensis* and *E. sparsifolius*. Records are from collections at NY and BRIT, as well as several citations from Cronquist (1947).

strikingly different aspect." A large set of collections (NY) confirms the "strikingly different aspect" of these taxa and, in contrast to Cronquist's view, indicates that they are distinct in morphology as well as phenology. The two are sympatric over a significant area (Fig. 2) and are ecologically similar, but in Washington, Garfield, and western Kane counties, Utah, where *E. utahensis* is abundant, *E. sparsifolius* apparently does not occur. In San Juan Co., Utah, where both are common, apparent intermediacy in some collections may be evidence of hybridization, but more generally, *E. sparsifolius* has been identified consistently and it appears to be reproductively isolated from *E. utahensis*. The view that they are "wholly intergradient" is not corroborated by herbarium material. And apparently from field observations, A.H. Holmgren noted (label of *Holmgren 16229*, NY, San Juan Co.) that *E. sparsifolius* is "specifically distinct from *E. utahensis*." The two species can be identified by the following contrasts.

1. Cauline leaves linear, bracteate, relatively even-sized above midstem and continuing to immediately proximal to heads; heads (1–)3–10 from branches well above midstem; involucres 3–5 mm high, 5–8 mm wide; ray florets 10–14(–20), corollas 4–8 mm long; disc corollas viscid-puberulent with blunt-tipped hairs; flowering Jun–Sep ____ **Erigeron sparsifolius**
1. Cauline leaves gradually smaller distally, absent proximal to heads; heads 1–3(–5) from branches from midstem or above; involucres 5–7 mm high, (7–)12–15 mm wide; ray florets 28–40, corollas 10–18(–20) mm long; disc corollas sparsely strigose-villous with needle-like hairs; flowering mid Apr–Jun(–Jul) ____ **Erigeron utahensis**

Erigeron sparsifolius Eastw., Proc. Calif. Acad. Sci. 2, 6:297. 1896. *Erigeron utahensis* A. Gray var. *sparsifolius* (Eastw.) Cronq., Brittonia 6:273. 1947. TYPE: U.S.A. UTAH. SAN JUAN CO.: Willow Creek, 14 Jul 1895, *A. Eastwood 48* (HOLOTYPE: CAS; ISOTYPES: GH!, US!).

Wyomingia vivax A. Nels., Bot. Gaz. 56:70. 1913. TYPE: U.S.A. San Juan Co.: Geyser Canyon, [east slope of La Sal Mountains,] dry rocky hills, 9000 ft, 30 Jul 1912, *E.P. Walker 355* (HOLOTYPE: RM; ISOTYPE: GH!, US!).

Flowering Jun–Sep. Rocky or sandy soil, soil pockets and crevices in sandstone, canyon bottoms, stream terraces; 1100–1700 m; Arizona, Colorado, Utah.

Erigeron utahensis A. Gray, Proc. Amer. Acad. Arts 16:89. 1881. TYPE: U.S.A. UTAH. [KANE CO.:] Kanab, *Mrs. A.P. Thompson s.n.* (HOLOTYPE: GH!; internet image!).

Erigeron stenophyllus var. *tetrapleurus* A. Gray, Proc. Amer. Acad. Arts 8:650. 1873. *Erigeron tetrapleurus* (A. Gray) Heller, Bull. Torrey Bot. Club 25:628. 1898. *Erigeron utahensis* A. Gray var. *tetrapleurus* (A. Gray) Cronq., Brittonia 6:272. 1947. LECTOTYPE, designated here: U.S.A. Kane Co.: Kanab, *Mrs. A.P. Thompson s.n.* (GH!, internet image!). Gray also cited another Utah collection (*F.M. Bishop s.n.*, 1873)—this is mounted on the same sheet as the lectotype.

Flowering mid Apr–Jun(–Jul). Rocky slopes, cliff bases, ledges, and crevices, sandstone outcrops and terraces, sandy soil, gravelly limestone, shale, cottonwood floodplains, creosote bush, blackbrush, blackbrush-Joshua tree, warm desert shrub, salt desert shrub, mountain brush, pinyon-juniper, oak-maple-aspen; 800–2100(–2450) m; Arizona, California, Colorado, New Mexico, Utah. It seems likely that *E. utahensis* eventually will be discovered in southern Nevada.

A new variety within *Erigeron clokeyi*

Erigeron clokeyi is distinct in a number of features: a low, relatively caespitose habit; stems erect to basally decumbent-ascending and mostly monocephalous; minutely glandular stems, leaves, and phyllaries; nonglandular cauline hairs spreading-deflexed; leaves narrowly oblanceolate; and ray corollas reflexing at the tube/lamina junction. The species has been treated as a single unit (Cronquist 1947, 1994; Nesom 1992b), but two expressions of leaf vestiture exist within the species. Plants from the Charleston Mountains in Clark Co., Ne-

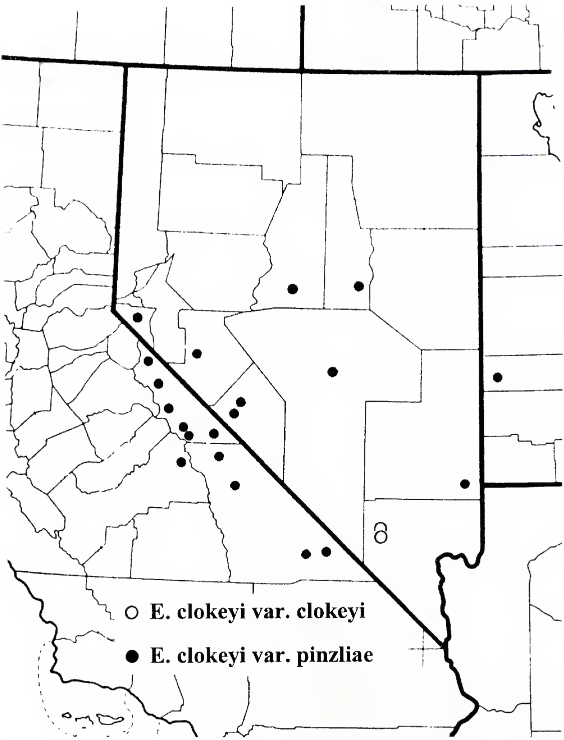


Fig. 3. Distribution of *Erigeron clokeyi*. Records are from collections at NY and BRIT, with additions from CalFlora (2004).

vada (the type locality), have hirsute-strigose leaves; those from other areas of the range (California, Nevada, west-central Utah), including most of the closest populations in southeastern Inyo Co., California, have hispidulous to hirsutulous leaves (Fig. 3). Some plants from Inyo Co. show a tendency toward strigose foliar vestiture. Cypsela size is slightly but consistently different, and the Clark Co. plants appear to have narrower leaves and a greater tendency for the stems to be decumbent-ascending. The two varieties are ecologically similar.

Erigeron clokeyi Cronq., Brittonia 6:214. 1947. TYPE: U.S.A. NEVADA. CLARK CO.: Charleston Mountains, Lee Canyon, brushy meadow, yellow pine belt, 2700 m, 12 Jul 1937, *I.W. Clokey 7742* (HOLOTYPE: NY!; ISOTYPES: LL!, MINN, MO!, NY!, PH, POM, RY, SMU! TEX!, UC, US!, VDB!, WS, WTU).

Erigeron clokeyi Cronq. var. **pinzliae** Nesom, var. nov. TYPE: U.S.A. NEVADA. MINERAL CO: Wassuk Range, road to Mt. Grant summit, 0.7 road mi below spring, T8N, R28E, NE 1/4 sect. 13, ca. 10,000 ft, 7 Sep 1995, *A. Pinzl 11733* (HOLOTYPE: BRIT; ISOTYPE: NSMC).

Differt a *E. clokeyi* sensu stricto vestimento foliorum hispidulo vel hirsutulo et cypselis minoribus.

Flowering Jun–Sep. Dry, rocky habitats, dry meadows, sometimes with sagebrush or mountain mahogany, treeless areas and often with yellow, bristlecone, or limber pines; 2200–3450 m; California, Nevada, Utah.

Differences between the two varieties are summarized here.

1. Leaves hirsute-strigose, hairs basally ascending, otherwise straight and distinctly antrorsely appressed; cypselae 2.2–2.5 mm; Charleston Mountains, Clark Co., Nevada __________ **Erigeron clokeyi** var. **clokeyi**
1. Leaves uniformly hispidulous to hirsutulous, hairs stiffly spreading to spreading-arching; cypselae 1.8–2 mm; east-central California, southern Nevada, west-central Utah __________ **Erigeron clokeyi** var. **pinzliae**

New name for a California species

Erigeron greenei Nesom, nom. nov. REPLACED SYNONYM: *Erigeron angustatus* Greene, Bull. Calif. Acad. Sci. 1(3):88. 1885 (non *Erigeron angustatus* Fries ex Nym., Consp. Fl. Europ. 2:389. 1879). TYPE: U.S.A. CALIFORNIA. NAPA CO.: dry hills on either side of Napa Valley, Jun-Oct, [Napa, 13 Aug 1874], *E.L. Greene 339* (not located with certainty, see comments in Nesom 1992; probable type material GH!).

The name *Erigeron angustatus* Greene has been used (Nesom 1992) for a discoid species now known to occur in Lake, Napa, Sonoma, Tehama, Trinity, Shasta, and Siskyou counties, California. Because *E. angustatus* Greene is a later homonym, it is replaced here. The new epithet commemorates Edward Lee Greene (1843–1915), whose perception of supraspecific natural groups and generic boundaries, in many instances, has proved to be remarkably close to modern concepts.

Status of *Erigeron cavernensis*

Erigeron cavernensis has been treated as a synonym of *E. uncialis* (Cronquist 1994, Nesom 1992b) but *E. uncialis* var. *conjugans*, which closely approaches *E. cavernensis* in its geographical range (Fig. 4), is markedly different from the latter and perhaps more similar to *E. cronquistii*. *Erigeron uncialis* var. *uncialis* and *E. uncialis* var. *conjugans* have features in common between themselves and contrast as a unit with *E. cavernensis*.

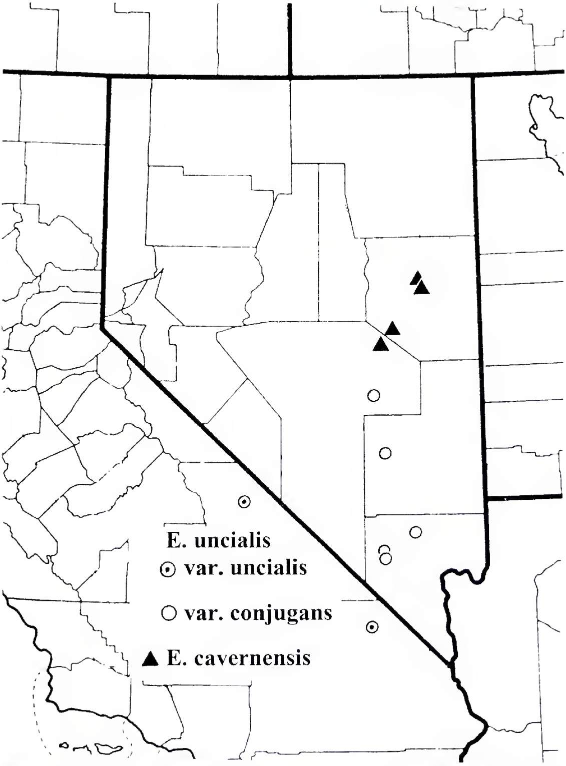


FIG. 4. Distribution of *Erigeron uncialis* and *E. cavernensis*. Records are from collections at NY, NSMC, and BRIT.

1. Phyllaries eglandular or sparsely glandular near the apices and along midregion; stems and leaves eglandular; leaves strigose to hirsute-villous, vestiture less dense on abaxial surfaces; cypselae 1.3–1.8 mm long ________________________ **Erigeron uncialis**

1. Phyllaries evenly densely glandular; stems and leaves glandular; leaves hirsute-canescent, equally hairy on both surfaces; cypselae 1–1.2 mm long _____ **Erigeron cavernensis**

Erigeron uncialis S.F. Blake, Proc. Biol. Soc. Wash. 47:173. 1934. TYPE: U.S.A. CALIFORNIA. SAN BERNADINO CO.: Clark Mountain, 7000 ft, Jun 1933, *E.C. Jaeger s.n.* (HOLOTYPE: POM; ISOTYPE: US!).

1. Stems 0.8–2.5 cm high, hirsute-villous; leaves 1–2 cm long, hirsute-villous to loosely strigose _____ **Erigeron uncialis** var. **uncialis**
1. Stems 3–7 cm high, loosely villous-strigose; leaves 2–4 cm long, sparsely and closely strigose _____ **Erigeron uncialis** var. **conjugans**

a. Erigeron uncialis S.F. Blake var. **uncialis.** Flowering May–Jul. Crevices, cliff bases, usually in limestone, pinyon-juniper, pine-fir; 1900–2600 m; California.

b. Erigeron uncialis S.F. Blake var. **conjugans** S.F. Blake, Proc. Biol. Soc. Wash. 47:174. 1934. *Erigeron uncialis* S.F. Blake subsp. *conjugans* (S.F. Blake) Cronq., Brittonia 6:211. 1947. TYPE: U.S.A. NEVADA. CLARK CO.: Charleston Mts., Kyle Canyon, Big Falls, crevices of vertical rock faces, 9000 ft, 3 Sep 1927, *C.L. Hitchcock s.n.* (HOLOTYPE: POM; ISOTYPE: US!).

Flowering May–Aug. Crevices in limestone cliffs and boulders, yellow pine or limber pine; 2200–2800 m; Nevada.

Erigeron cavernensis Welsh & Atwood, Great Basin Naturalist 48:495. 1988. TYPE: U.S.A. NEVADA. WHITE PINE CO.: Schell Creek Range, 25 air mi SE of Ely, ca. 2 km NE of summit of Cave Mountain, 3172–3233 m, limestone cliffs and rubble, *Pinus flexilis-P. longaeva* community, 18 Jul 1981, *B. Welsh, S. Goodrich, and E. Neese 910* (HOLOTYPE: BRY; ISOTYPES: NY!, POM, RM, UNLV, US!, UT).

Flowering Jun–Jul. Limestone ridges, outcrops, and cliffs, often with bristlecone pine, limber pine, spruce; 2100–3400 m; Nevada, known only from the White Pine Range of White Pine County and adjacent Nye County.

Status of *Erigeron radicatus* and *E. ochroleucus* var. *scribneri*

Confusion has existed in the distinction between *Erigeron radicatus* and *E. ochroleucus*, but the hypothesis is advanced here that they are distinct species sympatric over a significant area. In this view, *E. radicatus* has a wider geographic distribution (Fig. 5) than previously recognized and *E. ochroleucus* is more restricted in range (Fig. 6).

Small plants of *Erigeron ochroleucus*, often identified as *E. ochroleucus* var. *scribneri*, approach *E. radicatus* in aspect and many plants of *E. radicatus* have been identified as *E. ochroleucus* var. *scribneri*. *Erigeron radicatus* is distinctive in its branched caudex, short-villous cauline vestiture, smaller leaves with more reduced vestiture, smaller heads, involucral hairs usually with colored crosswalls, and fewer pappus bristles (see key couplet below). A thick taproot and unbranched caudex usually are contrasting features of *E. ochroleucus* and the phyllaries of *E. ochroleucus* often are apically linear-acuminate and loose, a feature not found in *E. radicatus*.

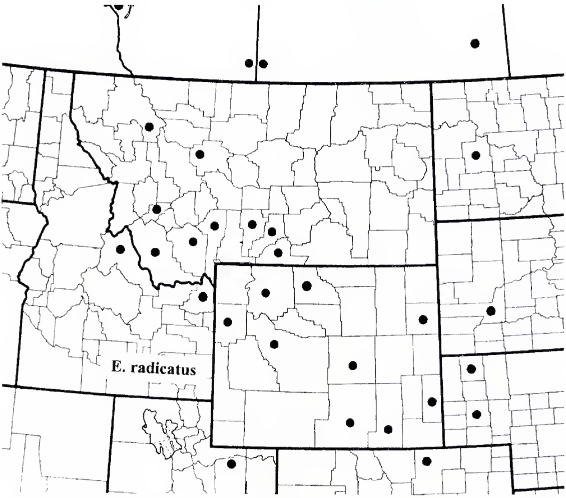


Fig. 5. Distribution of *Erigeron radicatus*. Records are from collections at NY and RM; Nebraska and South Dakota records are from KANU collections, fide Caleb Morse, using the present manuscript as basis for identification.

For the most part, *Erigeron radicatus* seems consistently distinct from *E. ochroleucus*, but I have identified as *E. radicatus* a few plants with involucral vestiture lacking colored crosswalls (eg., Carbon Co., Wyo.: *Dorn 3687*, RM; Fremont Co., Id.: *Moseley 835*, RM) and some plants as *E. ochroleucus* with involucral vestiture with colored crosswalls (e.g., Big Horn Co., Wyo.: *Hurd 208*, RM; Sheridan Co., Wyo.: *Nelson 6149*, RM; Johnson Co., Wyo.: *Nelson 5984*, RM). A few plants with an unbranched caudex are identified here as *E. radicatus* (e.g., Big Horn Co., Wyo.: *Williams 3221*, RM; Gallatin Co., Mont.: *Dorn 914*, RM). Some of these plants of apparently intermediate morphology may represent hybrids or introgressants. The chromosome number is reported as $2n = 36$ from Cheviot Mt., Alberta (Packer & Witkus 1982). A count of $2n = 18$ from Albany Co., Wyoming (Semple & Chmielewski 1987) was from *Erigeron simplex* Greene, the voucher misidentified by Nesom as *E. radicatus*.

Erigeron radicatus often is scapiform at relatively high elevations (2750–3350 m); more eastern populations in the Great Plains at lower elevations (1450–

2550 m) tend to have leafier stems. Plants of the collection from Weld Co. Colorado (rocky ridge ca. 3.4 mi N of Rockport, 6000 ft, *Dorn 8222*, RM), have slightly narrower phyllaries and involucral trichomes essentially without colored crosswalls, but in other respects they are similar to typical (but smallest) *E. radicatus*. Some of the low-elevation populations in Albany and Carbon cos., Wyoming, produce atypically short rays, and I initially regarded the eastern, low-elevation plants as taxonomically distinct. Finally, however, I was unable to find significant difference in other features. Even so, a species over such a wide range of elevation is unusual, both in the U.S.A. and in Canada, where *E. radicatus* occurs from montane sites in Alberta to localities at lower elevation in Saskatchewan. On the other hand, *E. ochroleucus*, one of its closest relatives, occurs over an equally wide elevational range.

Erigeron radicatus Hook., Fl. Bor.-Amer. 2:17, t. 123. 1834. Type: CANADA. Alberta. Mountains near Jasper's Lake, Rocky Mountains, *Drummond s.n.* (isotype, fide annotation in 1945 by Cronquist: NY!). The NY sheet does not have collection information other than a label noting "Erigeron divaricatum Hook., very rare, Hook., Am."

Erigeron macounii Greene, Pittonia 3:162. 1897. Type: CANADA. Alberta: Sheep Mountain, Waterton Lake, 28–31 Jul 1895, *J. Macoun 10858* (type material: NY!). Cited by Cronquist (1947) as a synonym of *Erigeron ochroleucus* var. *scribneri*; placed here as a synonym of *E. radicatus* because of its small (1.5–3 cm long) leaves and few (8) pappus bristles. The leaves, however, are linear-lanceolate and densely strigose and rays are bluish – features more consistently characteristic of *E. ochroleucus*.

Erigeron huberi Welsh & Atwood, Rhodora 103:71. 2001. Type: U.S.A. UTAH. Duchesne Co.: Uinta Mountains, Lake Fork Mtn., T2N R5W S16, NW1/4 of NE1/4, Uinta Base Meridian, plants growing along windswept ridge crest above limestone talus slopes, rocky soils, 10,900 ft, 21 Jul 1998, *A. Huber and C. Wedig 3825* (holotype: BRY; isotypes: MO!, NY!, US internet image!).

Flowering May–Aug. Rocky slopes, ridges, and summits, ledges and crevices, outcrops and talus, usually limestone, alpine tundra; (1450–)1600–2750(–3350)m; British Columbia, Alberta; Saskatchewan; Colorado, Idaho, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming.

1. Stems (1–)2–6(–12) cm high, usually arising from tips of short, thickened caudex branches; stems short-villous; leaves (0.5–)1–5(–8) cm long, sparsely loosely strigose adaxially, glabrous and shiny abaxially; involucres (3–)4–6(–8) mm high, hairs of involucre usually with colored crosswalls; pappus bristles (6–)7–11 _____ **Erigeron radicatus**
1. Stems (2–)8–18(–30) cm high, arising from a nearly common point near apex of thick taproot, caudex usually unbranched; stems loosely strigose; leaves (2–)4–9(–12) cm long, usually strigose on both surfaces at least on proximal 1/3–3/4 of blade, glabrous distally; involucres 5.5–7 mm high, hairs of involucre usually without colored crosswalls; pappus bristles 11–15 _____ **Erigeron ochroleucus**

Erigeron ochroleucus Nutt., Trans. Amer. Philos. Soc., 2, 7:309. 1840. Type: U.S.A. [probably central Wyoming, perhaps Natrona Co.]. "Plains of the Oregon" [Trail], [ca. Jun, 1834], *T. Nuttall s.n.* (GH!, PH, UC-photo and fragment).

Erigeron ochroleucus Nutt. var. *scribneri* (Canby ex Rydb.) Cronq., Brittonia 6:189. 1947. *Erigeron scribneri* Canby ex Rydb., Mem. New York Bot. Gard. 1:405. 1900. TYPE: U.S.A. MONTANA. [MEAGHER CO.:] Little Belt Mountains, 12 Aug 1883, *F.L. Scribner 77* (NY!). *Erigeron scribneri* Canby (Bot. Gaz. 15:150. 1890) was published as a "nomen provisorum."

Erigeron tweedyanus Canby & Rose, Bot. Gaz. 15:65. 1890. *Erigeron montanus* Rydb. [nom. nov.], Bull. Torrey Bot. Club 24:296. 1897. *Wyomingia tweedyana* (Canby & Rose) A. Nels., Man. Rocky Mt. Bot. 531. 1909. TYPE: U.S.A. MONTANA. PARK CO.: Jun 1889, *F. Tweedy s.n.* (NY- 2 sheets!).

Erigeron laetevirens Rydb., Bull. Torrey Bot. Club 28:506. 1901. TYPE: U.S.A. MONTANA. SHERIDAN CO.: Big Horn Mountains: Little Goose Creek, 8700 ft., Jul 1899, *F. Tweedy 2005* (NY!).

Flowering Jun–Aug. Rocky or sandy slopes, limestone outcrops and ridges, talus, sagebrush-grassland, juniper-mountain mahogany, ponderosa pine, limber pine, limber pine-Douglas fir, alpine tundra; 1100–3000(–3300) m. Alberta, British Columbia; Montana, Nebraska, South Dakota, Wyoming. The record for British Columbia is added from a report by Roemer (1996, as *E. ochroleucus* var. *scribneri*). Nesom and Murray (2004) report *E. ochroleucus* in arctic and boreal Alaska and immediately adjacent Yukon, long disjunct from the primary range in the western U.S.A. and adjacent Canada.

Plants of *Erigeron ochroleucus* are consistently relatively large in stature and white-rayed in northeastern and central Wyoming (Campbell, Converse, Crook, Fremont, Hot Springs, Natrona, Niobrara, and Weston cos.), where they occur at elevations of 1100–1900(–2400) and at similar elevations in the more montane areas of north-central Wyoming and adjacent Montana (Fig. 6). These plants match the type of the species. In the latter areas, however, at elevations characteristically about 2150–2750 m and ranging up to 3350 m, the plants are smaller and commonly blue-rayed, matching the type of *E. ochroleucus* var. *scribneri*, but such plants also commonly extend downward to 1600 m in these montane areas, and in the area of elevational overlap so much morphological variability exists that it seems impossible to distinguish var. *scribneri*. Smaller, blue-rayed plants also are occasionally encountered even in areas of predominantly larger, white-rayed ones. Reported chromosome numbers are $2n = 18$ from southern Alberta (Chinnappa & Chmielewski 1987) and Sheridan Co., Wyoming (Jones & Smogor 1984). A count of $2n = 54$ from Niobrara Co., Wyoming (Semple 1985) was from *Erigeron caespitosus* Nutt., the voucher misidentified by Nesom as *E. ochroleucus*.

Status of *Erigeron lackschewitzii*

Erigeron lackschewitzii was compared in its original description with *E. grandiflorus* Hook., but it instead is very similar and closely related to *E. ochroleucus*. Nesom (1989) treated it as a synonym of *E. ochroleucus*, but examination of additional collections confirms it as a distinct species. The distribution record for Glacier Co. (Fig. 6) is based on the citation in Lesica (2002). The record for Alberta (Waterton Lakes National Park) is added fide Joyce Gould (Alberta Natural Heritage Information Centre).

1. Involucres 5.5–7 mm high; phyllaries inconspicuously glandular, hairs of villous vestiture without colored crosswalls; ray corollas white or blue; disc corollas 2.8–3.6 mm; pappus bristles 12–15 ____ **Erigeron ochroleucus**
1. Involucres 6–8 mm high; phyllaries densely and conspicuously glandular, hairs of villous vestiture with dark purple crosswalls; ray corollas purple to lavender; disc corollas 3.5–4.3 mm; pappus bristles 15–24 ____ **Erigeron lackschewitzii**

Erigeron lackschewitzii Nesom & W.A. Weber, Madroño 30:245. 1983. TYPE: U.S.A. MONTANA. TETON CO.: Bob Marshall Wilderness Area, Flathead Range, summit of Headquarters Pass, 2365 m, large colony in small, dry meadow on the narrow saddle, 29 Jul 1978, *K. Lackschewitz 8487* (HOLOTYPE: MONTU!; ISOTYPES: COLO!, NY!).

Flowering Jul–Aug. Rocky slopes and ridges, terraces, talus, meadows, usually calcareous; 2250–2500 m; Alberta; Montana.

Status of *Erigeron parryi*

Cronquist (1947) maintained *Erigeron parryi*, noting (p. 190) that it probably is "merely an unusual form" of *E. ochroleucus*, but he later (1955) treated it (at least by implication) as a synonym of *E. ochroleucus*. Collections similar to the type, however, from the region of the type locality in southwestern Montana and adjacent Wyoming (Fig. 6) suggest that *E. parryi* is distinct. Leaves of *E. parryi* are equally hairy (hirsute to strigose-hirsute) on both surfaces, contrasted with the reduced vestiture (loosely strigose) on adaxial surfaces of *E. ochroleucus* leaves. Also, *E. parryi* tends to have smaller heads with fewer rays and the caudices sometimes are branched. The variation in orientation of vestiture is unusual, and as between *E. ochroleucus* and *E. radicatus*, the nature of the differentiation (or lack of differentiation) between *E. ochroleucus* and *E. parryi* is not clear.

1. Leaves 1–2.5 cm long, narrowly oblanceolate, equally hairy on both surfaces; caudices branched or not; involucres 4–6 mm high, 7–10 mm wide; ray florets 22–30 ____ **Erigeron parryi**
1. Leaves 2–6 cm long, linear to narrowly oblanceolate, strigose adaxially, less hairy to glabrous abaxially; caudices usually not branched; involucres 5.5–7 mm high, 10–15(–18) mm wide; ray florets 30–62 ____ **Erigeron ochroleucus**

Erigeron parryi Canby & Rose, Bot. Gaz. 15:65. 1890. TYPE: U.S.A. MONTANA. BEAVERHEAD CO.: Grasshopper Creek, dry hills, 7000 ft, Jul 1888, *F. Tweedy 15* (GH internet image!, NY!, US?). Canby and Rose cited only "*Frank Tweedy 15*" as the type.

Plants perennial, taprooted, caudices with or without short, thickened branches. **Stems** 1.5–5 cm, erect, short-hirsute to loosely strigose-villous, eglandular. **Leaves** basal and cauline, basal narrowly oblanceolate, 1–2.5 cm long, 0.8–2.5 mm wide, entire, cauline on proximal 1/2–2/3 of stem, gradually reduced distally, densely strigose to strigose-hirsute on both surfaces, eglandular, eciliate. **Heads** 1; involucres 4–6 mm high, 7–10 mm wide; phyllaries in (2–)3 equal to subequal series, filiform-attenuate and purplish at apex, sparsely to densely villous-strigose, basal cross-walls sometimes purple, sparsely minutely glandular. **Ray florets** 22–30, corollas 6–8 mm, laminae white to pink or bluish, not coiling or reflexing. **Disc florets:** corollas 2.4–3 mm, throat not indurate or inflated.

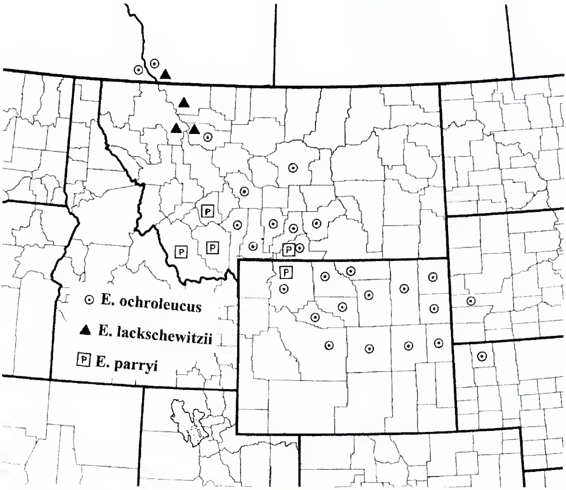


Fig. 6. Distribution of *Erigeron ochroleucus*, *E. lackschewitzii*, and *E. parryi*. Records are primarily from collections at NY and RM (see comments in text).

Cypselae 2–2.3 mm, 2-nerved, densely strigose; pappus bristles 12–15, readily deciduous, outer setae or scales prominent.

Flowering Jun–Aug. Open, rocky sites, limestone and quartzite; 1600–2250(–2600) m; endemic to southwestern Montana and adjacent Wyoming.

Additional collections examined: **U.S.A. MONTANA. Beaverhead Co.:** crest of Red Butte, ca. 8 mi NW of Lima, common, calcareous soil, with *Eriogonum mancum* and *Oxytropis besseyi*, T13S, R9W, Sec 10, 6200 ft, 6 Jul 1986, *Lesica 3928* (NY); exposed ridge crest 2 mi S of Grasshopper Creek, common in gravelly limestone and quartzite-derived soil, 6200 ft, with *Sphaeromeria capitata* and *Eriogonum mancum*, 22 Jun 2003, *Lesica 8657* (RM); Tendoy Mts., above Muddy Creek Rd, abundant on crest of ridge with *Lesquerella alpina*, *Penstemon aridus*, *Hymenopappus* sp., T13S, R10W, Sec 34, 7000 ft, 27 Jun 1987, *Lackschewitz 11307* (NY). **Carbon Co.:** N slopes above Lockheart Ranch, T8S, R28E, S13, *Poa* cover, 4400 ft, 9 Jun 1983, *Lichvar 5913* (RM); Big Pryor Mountain, gravelly soil, S slope, grassland, 8500 ft, 12 Jul 1926, *Williamson 28* (RM). **Jefferson Co.:** slopes of small hill at the head of Negro Hollow 6 mi NE of Caldwell, common in shallow limestone-derived soil, 5200 ft, with *Hymenoxys acaulis* and *Eritrichium howardii*, 17 Jun 2003, *Lesica 8630* (RM). Madison Co.: S end of Ruby Mts., 3 mi S and 3 mi W from Ruby Reservoir Dam, and SW of Mud Springs, common on small silty clay outcrop and occasional in immediately surrounding dry, rolling grassland, 5790 ft, with *Oryzopsis contracta*, *As-*

tragalus vexilliflexus, *Chrysothamnus nauseosus*, *Stipa comata*, *Aster scopulorum*, 4 Jul 1996, *Heidel and Cooper 1488* (RM); Highland Mountains, low ridge ca. 1 mi S of Victoria Mine W of Silver Star, locally common in shallow limestone-derived soil, 5250 ft, with *Cercocarpus ledifolius* and *Eriogonum mancum*, 18 Jun 2003, *Lesica 8640* (RM). WYOMING. Park Co.: Absaroka Mountains, North Fork Shoshone River drainage, ridge E of Pagoda Creek, ca. 1.5–2.5 mi S of US Hwy 14-16 & 20, open rocky areas with scattered Douglas fir and limber pine, 7200–8000 ft, 11 Jun 1986, *Evert 9860* (RM).

Leaves and stems of *Lesica 3928*, *8640*, and *8657* and *Williamson 28* are hirsute with stiffly spreading hairs, similar to those of the type collection; leaves of *Lackschewitz 11307*, *Lesica 8630*, *Lichvar 5913*, *Heidel and Cooper 1488*, and *Evert 9860* are hirsute-strigose with loosely appressed hairs. Although the vestiture of the latter six collections approaches the orientation of that of *E. ochroleucus*, the hairs are stiffer and slightly shorter than characteristic of *E. ochroleucus*.

Peter Lesica (submitted) has reached a similar conclusion regarding the distinction of *Erigeron parryi*, based on field experience, more numerous collections than recorded here, and a morphometric study. My conclusions were reached independently of his but were based on his collections, in significant part, at NY and RM. His concepts of *E. ochroleucus* and *E. radicatus* also are similar to those outlined here but not identical.

Erigeron tracyi an earlier name for *Erigeron colomexicanus*

I have been using *Erigeron colomexicanus* as the name for this species, but both *E. tracyi* and *E. commixtus* were published seven years earlier, simultaneously (immediate succession in the same paper: Greene 1902). Plants of the type collection of *E. tracyi*, as well as those of *E. commixtus*, are early season forms (essentially a basal rosette with a single, subscapiform, monocephalous stem) that had not yet produced runners characteristic of the species.

Erigeron tracyi Greene, Pittonia 5:59. 1902. TYPE: U.S.A. TEXAS. [JEFF DAVIS CO.:] Davis Mts., 28 Apr 1902, *S.M. Tracy* and *F.S. Earle 320* (HOLOTYPE: US!; ISOTYPES: GH!, NY!, OS!).

Erigeron commixtus Greene, Pittonia 5:58. 1902. TYPE: U.S.A. TEXAS. [JEFF DAVIS CO.:] Cañon of the Limpia, mountains of west Texas, 26 Apr 1902, *S.M. Tracy* and *F.S. Earle 279* (HOLOTYPE: US!, ISOTYPES: GH!, NY!, TAES!, TEX!).

Erigeron cinereus A. Gray, Mem. Amer. Acad. Arts n.s., 4[Pl. Fendler.]:68. 1849 (not Hook. & Arn. 1836). *Erigeron divergens* Torrey & A. Gray var. *cinereus* (A. Gray) A. Gray, Smithsonian Contr. Knowl. 3, Art. 5 [Pl. Wright.]:91. 1852. *Erigeron colomexicanus* A. Nels. [nom. nov.], Man. Bot. Rocky Mts., 529. 1909. TYPE: U.S.A. NEW MEXICO. [SANTA FE CO.:] near Santa Fe, 1847, *A. Fendler 374* (HOLOTYPE: GH!; ISOTYPES: GH, NY! UC-2 sheets!, US!).

Taxonomic status of *Erigeron acris* in North America

Erigeron acris L. (Sp. Pl. 653. 1753) has long been recognized as a species widespread in North America, but the nomenclature of these plants and an understanding of their relationship to expressions of the species in Europe and Asia still are unsettled. The type of *Erigeron acris* is a European plant. The taxonomic summary presented here is intended only as an overview.

Most names previously used at infraspecific rank for the American plants refer to Eurasian endemics: *Erigeron angulosus*, *E. asteroides*, *E. droebachiensis*, *E. elongatus*, and *E. politus* (Šída 1998; Tzvelev 2002) (see taxonomic summary below). The name *Erigeron acris* var. *kamtschaticus* was reserved by Hultén (1968a, 1968b) for a single North American collection made at "Junction Firth R. and Mancha Creek on the Alaska-Yukon boundary in August 1961;" he treated all others of the species in North America as *E. acris* subsp. *politus*. Entire-leaved plants, however, apparently are the common form of the species even in the Kamchatka area, and Gleason and Cronquist (1991) and Cronquist (1994) are followed here in using *E. acris* var. *kamtschaticus* as the correct name for the North American plants. Hara (1939) also viewed "the common form in Eastern Asia and North America ... [as] identical with *E. kamtschaticus* DC.," but he treated it as a variety of *E. angulosus*. Czerepanov (1995) and Šída (1998) have treated *E. kamtschaticus* and *E. acris* as separate species, as did deCandolle much earlier, in his original description of *E. kamtschaticus*.

Two other North American taxa closely related to *Erigeron acris* are treated at specific rank in the forthcoming Flora of North America (FNA) account of *Erigeron*: *E. nivalis* Nutt. (= *E. jucundus* Greene, *E. debilis* (A. Gray) Rydb.) and *E. elatus* (Hook.) Greene. *Erigeron nivalis* has often been treated at infraspecific rank within *E. acris*, but the two taxa are broadly sympatric without obvious intergrades in the northwestern U.S.A. and Canada. Both occur over a wide range of elevation and in similar habitats.

Erigeron acris L. var. **kamtschaticus** (DC.) Herder, Bull. Soc. Nat. Moscou Sect. Biol., Ser. 2. 38:392. 1865. *Erigeron kamtschaticus* DC., Prodr. 5:290. 1836. TYPE: "in Kamtschatka," (deCandolle noted "v. s. comm. ab ill. Acad. sc. Petrop.;" Cronquist (1994) noted "holotype at G!"). *Erigeron acris* L. subsp. *kamtschaticus* (DC.) H. Hara, J. Jap. Bot. 15:317. 1939. *Erigeron angulosus* Gaudin var. *kamtschaticus* (DC.) H. Hara, Rhodora 41:389. 1939. *Trimorpha acris* (L.) S.F. Gray var. *kamtschatica* (DC.) Nesom, Phytologia 67:64. 1989.

Erigeron yellowstonensis A. Nels., Bot. Gaz. (Coulter) 30:198. 1900. TYPE: U.S.A. WYOMING. Yellowstone National Park, near Yellowstone Lake, in loose sandy soil in the open pine woods, 6 Aug 1899, *A. Nelson 6348 with E. Nelson* (HOLOTYPE: RM; ISOTYPE: NY!). *Erigeron lapiluteus* A. Nels. [nom. illeg.], New Man. Bot. Centr. Rocky Mts. 530. 1909. *Erigeron lapiluteus* is an illegitimate replacement name for *E. yellowstonensis*.

Erigeron elongatus Ledeb. [nom. inval.], Icon. Pl. Fl. Ross. 1:9, tab. 31. 1829 (non *E. elongatus* Moench 1802). *Erigeron acris* var. *elongatus* (Ledeb.) Mela & Cajand., Suom. Kasv. 566. 1906.

Erigeron politus Fries (misapplied), Bot. Not. (Lund.) 1843:120. 1843. *Erigeron acris* L. subsp. *politus* (Fries) H. Lindb. f., Enum. Pl. Fennoscand. Orient. 56. 1901 (non Schinz & R. Keller 1909).

Erigeron asteroides Andrz. ex Besser (misapplied), Enum. Pl. Volhyn. 33. 1822 (non Roxb. 1814). *Erigeron acris* L. var. *asteroides* (Andrz. ex Besser) DC., Prodr. 5:290. 1836. *Trimorpha acris* (L.) S.F. Gray var *asteroides* (Andrz. ex Besser) Nesom, Phytologia 67:64. 1989. Listed by Tzvelev (2002) as a synonym of the Eurasian *E. podolicus* Besser.

Erigeron angulosus Gaudin (misapplied), Fl. Helv. 5:265. 1829. *Erigeron acris* L. var. *angulosus* (Gaudin) Vacc., Cat. Pl. Vall. Aoste 1:350. 1909.

Erigeron droebachiensis O. Mueller (misapplied), Fl. Dan. 5, 15:4, tab. 874. 1782. *Erigeron acris* L.

var. *droebachiensis* (O. Mueller) Blytt, Norges Fl. 1:562. 1861. *Erigeron acris* L. subsp. *droebachiensis* (O. Mueller) Arcang., Comp. Fl. Ital. 340. 1882.

ACKNOWLEDGMENTS

I am grateful to the staffs at GH, MO, and NY for help during visits there, HSC, NSMC, and RM for loans of specimens, Anita Cholewa (MIN) for observations regarding the type of *Erigeron davisii*, John L. Strother for observations on UC collections and editorial comments in review, Caleb Morse for observations on KANU collections, Peter Lesica for comments on *E. parryi* and relatives, Joyce Gould (Alberta Natural Heritage Information Centre) for information on *E. radicatus* and *E. lackschewitzii* in Canada, and John Semple for providing images of vouchers for previously published chromosome counts, and Dave Boufford for advice on lectotype selection for *E. stenophyllus* var. *tetrapleurus*.

REFERENCES

Albee, B.J., L.M. Shultz, and S. Goodrich. 1988. Atlas of the vascular plants of Utah. Utah Museum of Natural History. <http://www.gis.usu.edu/Geography-Department/utgeog/utvatlas/ut-vascatlas.html> Accessed Dec 2003.

CalFlora. 2004. Information on California plants for education, research and conservation. [web application]. Albany, California: The CalFlora Database [a non-profit organization]. Accessed Jan 2004.

Center For Plant Conservation (CPC). 2003. CPC national collection plant profile. <http://ridgwaydb.mobot.org/cpcweb/> Accessed Dec 2003.

Chinnappa, C.C. and J.G. Chmielewski. 1987. Documented plant chromosome numbers 1987: 1. Miscellaneous counts from western North America. Sida 12:409–417.

Cronquist, A. 1947. A revision of the North American species of *Erigeron*, north of Mexico. Brittonia 6:121–302.

Cronquist, A. 1955. Vascular plants of the Pacific Northwest, Part 5: Compositae. Univ. of Washington Press, Seattle.

Cronquist, A. 1994. Intermountain flora. Vol. 5, Asterales. New York Botanical Garden, Bronx.

Czerepanov, S.K. 1995. Vascular plants of Russia and adjacent states (the former USSR). Cambridge Univ. Press, Cambridge, England.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada (ed. 2). The New York Botanical Garden, Bronx, New York.

Greene, E.L. 1902. A fascicle of new Compositae. Pittonia 5:55–64.

Hara, H. 1939. Some notes on the botanical relationship between North America and Eastern Asia. Rhodora 41:385–392.

Hultén, E. 1968a. Comments on the flora of Alaska and Yukon. Arkiv Bot. n. ser. 7, 1:1–147.

Hultén, E. 1968b. Flora of Alaska and neighboring territories. Stanford Univ. Press, Stanford, California.

Jones, A.G. and R.A. Smogor. 1984. In: Chromosome number reports LXXXII. Taxon 33: 126–134.

Lesica, P. 2002. A flora of Glacier National Park, Montana. Oregon State University Press, Corvallis.

Lesica, P. Submitted. The resurrection of *Erigeron parryi* (Asteraceae: Astereae). Brittonia.

Nesom, G.L. 1989. Infrageneric taxonomy of New World *Erigeron* (Compositae: Astereae). Phytologia 67:67–93.

Nesom, G.L. 1992a. Revision of *Erigeron* sect. *Linearifolii* (Asteraceae: Astereae). Phytologia 72:157–208.

Nesom, G.L. 1992b. *Erigeron* and *Trimorpha* (Asteraceae: Astereae) in Nevada. Phytologia 73:203–219.

Nesom, G.L. 1993. *Erigeron* (50 species, 71 taxa). The Jepson manual: higher plants of California. J. Hickman (ed.). Univ. California Press, Berkeley.

Nesom, G.L. and D.F. Murray. 2004. Notes on North American arctic and boreal species of *Erigeron* (Asteraceae: Astereae). Sida 21:41–57.

Packer, J.G. and R. Witkus. 1982. In: IOPB chromososome number reports LXXV. Taxon 31: 363–364.

Rocky Mountain Herbarium. 1998. Atlas of the vascular plants of Wyoming. <http://www.esb.utexas.edu/tchumley/wyomap/atlas.htm> Accessed Dec 2003.

Roemer, H. 1996. Two plants new to the flora of British Columbia. Bot. Electronic News No. 148, 2 Nov 1996. <http://www.ou.edu/cas/botany-micro/ben/ben148.html> Accessed Dec 2003.

Semple, J.S. 1985. Chromosome number determinations in fam. Compositae tribe Astereae. Rhodora 87:517–527.

Semple, J.S. and J.G. Chmielewski. 1987. Chromosome number determinations in fam. Compositae tribe Astereae. II. Additional counts. Rhodora 89:319–325.

Šida, O. 1998. Taxonomic problems in *Erigeron* sect. *Trimorpha* (Compositae) in Eurasia. Preslia 70: 259–269.

Strother, J.L. and W.J. Ferlatte. 1988. Review of *Erigeron eatonii* and allied taxa (Compositae: Astereae). Madroño 35:77–91.

Tzvelev, N.N. (ed.). 2002. Flora of Russia: The European part and bordering regions. Vol. VII (English translation of 1994 original). A.A. Balkema, Rotterdam/Brookfield.

BOOK REVIEW

ESMOND HARRIS, JEANETTE HARRIS, and N.D.G. JAMES. 2003. **Oak: a British History.** (ISBN 0-9538630-8-5, pbk.). Windgather Press, Ltd., 29 Bishop Road, Bollington, Macclesfield, Cheshire SK10 5NX, UK. (Orders: Distributed by Central Books, 99 Wallis Road, London E9 5LN, UK). US $30.00, 208 p., 10 col., 49 b/w illus., 7 1/4" × 9 3/4".

This is not a book about the historical significance of oaks in Britain. This is not a study of the many and varied uses that oaks have supplied over the centuries. This is not a guide to the cultivation of oaks and the restoration of aged and historic woodlands. This is not about the myths and symbology that have surrounded the oak since time immortal. *The Oak: A British History* is all of these and more. Written in a easy to read manner which belies the authority behind the text, this will be a classic for years to come.

The oak has always held pride of place amongst trees in Britain. For centuries, its durability, strength and attractiveness have made it the timber of choice. When the British state was forged in the seventeenth and eighteenth centuries, these qualities made it a metaphor for the virtues of the nation. This book tells the story of man's use of this wonderful natural resource and argues that oak still has a rich future, both as material and as a key element in an ecologically rich countryside The authors are concerned with how people have managed and exploited oakwoods over time and with the uses to which oak timber has been put, in ships, furniture and buildings. As practicing foresters, they revisit with an expert's eye the silvicultural techniques of the past—the methods of propagating, raising, managing, coppicing and felling oak through the tree's life, from acorn to standard. They reveal the skills needed to work with oak timber, and tell the story of the great industries of iron-smelting and shipbuilding which relied on the tree. They also explore the myths, symbols and cultural associations that have connected people in Britain with the oak over hundreds of years. An appendix lists over 700 particularly significant oak trees, with notes on their location, present condition and historical connections. This book is a cultural history not only of a tree, but also of a timber. It reclaims the disappearing forestry and carpentry skills of our ancestors and shows how, in an era of climate change, oak can enrich our future as well as our past

Esmond Harris has spent a lifetime working as a forester, and is a Past Director of the Royal Forestry Society He wrote *The Guinness Book of Trees* (1981), *Trees*(1986), and *Arboles* (1998). Jeanette Harris is a farmer and author Together they wrote the best-selling *Reader's Digest Guide to the Trees and Shrubs of Britain* (1981) and *Wildlife Conservation in Managed Woodlands and Forests* (1997) They run a small farm in Cornwall, where their renovation of woodlands won the 2002 Duke of Cornwall's Award for Forestry and Conservation N D G. James, OBE, was President of the Royal Forestry Society and author of several tree books. He died in 1993, having laid the foundations for this book.—*Gary Jennings, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NOTES ON NORTH AMERICAN ARCTIC AND BOREAL SPECIES OF *ERIGERON* (ASTERACEAE: ASTEREAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

David F. Murray

University of Alaska Museum
907 Yukon Drive
Fairbanks, Alaska 99775-6960, U.S.A.

ABSTRACT

Erigeron grandiflorus is restricted to the western U.S.A. and southwestern Canada and is treated here to include widespread diploid populations (*E. simplex*) as well as triploids (*E. grandiflorus* sensu stricto). The distinction between *E. grandiflorus* and *E. simplex* has been made primarily on the basis of differences in size and ploidal level, but identifications based on morphology often are arbitrary because differences appear to be widely overlapping. Plants previously identified as *E. grandiflorus* var. *arcticus* Porsild are here treated as **Erigeron porsildii** Nesom & Murray, nom. nov. Distinctions are clarified among *E. grandiflorus* sensu stricto, *E. porsildii*, *E. muirii*, *E. yukonensis*, and the Asian *E. koraginensis*. *Erigeron hultenii* has not been relocated beyond the type collection and is tentatively regarded as an anomalous plant whose relationships are unknown. *Erigeron denalii* includes *E. purpuratus* var. *dilatatus* and *E. mexiae* and is contrasted with *E. pallens* (an endemic of southwestern Canada) and *E. purpuratus*. Recent collections document the occurrence of *E. ochroleucus* in arctic and boreal Alaska and immediately adjacent Yukon, disjunct more than 2800 kilometers from the closest localities in its main range to the south.

RESUMEN

Erigeron grandiflorus está restringido al oeste de Estados Unidos y suroeste de Canadá y es tratado aquí para incluir las poblaciones diploides extensas (*E. simplex*) así como a las triploides (*E. grandiflorus* sensu stricto). La distinción entre *E. grandiflorus* y *E. simplex* ha sido hecha en base a las diferencias de tamaño y nivel de ploidía, pero las identificaciones basadas en la morfología son a menudo arbitrarias porque las diferencias parecen estar ampliamente solapadas. Plantas identificadas previamente como *E. grandiflorus* var. *arcticus* Porsild se tratan aquí como ***Erigeron porsildii*** Nesom & Murray, nom. nov. Se clarifican las diferencias entre *E. grandiflorus* sensu stricto, *E. porsildii*, *E. muirii*, *E. yukonensis*, y la asiática *E. koraginensis*. *Erigeron hultenii* no ha sido vuelta a localizar después de la colección tipo y se trata como una planta anómala cuyas relaciones son desconocidas. *Erigeron denalii* incluye *E. purpuratus* var. *dilatatus* y *E. mexiae* y se contrasta con *E. pallens* (un endemismo del suroeste de Canadá) y *E. purpuratus*. Recientes colecciones documentan la existencia de *E. ochroleucus* en Alaska ártica y boreal y en Yukon, con una disyunción de más de 2800 kilómetros desde las localidades más próximas en su área principal en el sur.

Various taxonomic problems regarding alpine, arctic, and boreal *Erigeron* in North America have been brought into focus during preparation of a treatment of the genus for the Flora of North America (FNANM) volumes. Here we examine some of those problems in detail and provide explanation and documentation for new taxonomic interpretations.

Status of *Erigeron grandiflorus*

Erigeron grandiflorus Hook. was described from southern Alberta, Canada (see typification below), and has since been recognized as a species distributed in alpine regions of the western U.S.A. and adjacent Canada and disjunct northward into arctic Canada and Alaska. Specimen citations by Cronquist (1947) for *E. grandiflorus* were mostly from arctic collections and his descriptive measurements reflected this inclusive view. The arctic plants were recently segregated as *E. grandiflorus* subsp. *arcticus* Porsild and are here treated as a separate species (see topic below).

Erigeron simplex Greene, which has been recognized as a widely distributed species of alpine habitats in the western U.S.A., is very similar to *E. grandiflorus*. Cronquist found overlapping differences between these species in leaf shape and vestiture, number of pappus bristles, and outer pappus morphology. After separating the arctic plants from Cronquist's concept of *E. grandiflorus*, we find that features defining *E. grandiflorus* and *E. simplex* are even more strongly overlapping.

Since Cronquist's monograph (1947), and apart from Spongberg's dissertation study of arctic and alpine species (1971), *Erigeron grandiflorus* has been recognized in the conterminus U.S.A. only in Montana (Dorn 1984) and Colorado (Weber 1987, 1990; Weber and Wittman 1992). In these treatments, contrasts of *E. grandiflorus* with *E. simplex* largely repeated measurements from Cronquist's study. Both *E. grandiflorus* and *E. simplex* were included in the Alberta flora by Moss (1959), also using species descriptions essentially taken from Cronquist (1947). Scoggan (1979) included *E. simplex* as a questionable member of the Canadian flora, based on the sole record from Moss, but Packer's revision of the Alberta flora (Moss 1983) treated only *E. grandiflorus*, with no mention of *E. simplex*. *Erigeron grandiflorus* also has been recognized in British Columbia by Douglas et al. (1998), whose descriptive measurements gave broader ranges than Cronquist's.

Spongberg (1971) regarded *Erigeron grandiflorus* strictly as an apomictic triploid (compared with strictly diploid *E. simplex*) and documented its occurrence in Utah, Colorado, and Wyoming. At some localities, he found triploids "growing intermixed with plants of a larger population of *Erigeron simplex*" (e.g., Clear Creek/Grand Co. line, above Berthoud Pass, *Spongberg 67-243*, TEX). He did not provide a key, but from his comments and annotations, *E. grandiflorus* in southern Canada and the western United States differed only quantitatively in his concept from the more widespread *E. simplex*, with involucres and florets at the higher end of the ranges of size measurements. Spongberg (1971, p. 200) also noted that "because of the intergrading of morphological features of plants of *Erigeron grandiflorus* ... the single most important criterion indicative of this taxon is highly irregular [in shape] and greatly abortive pollen." These pollen features result from meiotic anomalies associated with the triploid condition.

We observe that triploids (including the largest-headed plants) appear to be consistently stipitate-glandular over the whole stem with glandular trichomes mostly 0.2–0.3 mm high, while the diploids (smaller-headed plants) commonly are essentially eglandular or stipitate-glandular with shorter trichomes only just beneath the heads. Many smaller-headed plants, however, are variably glandular, trichome sizes vary, and all collections of *Erigeron simplex* from Arizona and Utah appear to be stipitate-glandular. At least one collection of relatively small-headed plants was counted as triploid and identified by Spongberg as *E. grandiflorus* (*Spongberg 69-30*, TEX).

Spongberg hypothesized that the triploid plants (= *Erigeron grandiflorus* sensu stricto in his view) incorporate a genomic element from an ancestor other than *E. simplex*, but we find that morphological distinctions between the ploidal races are too arbitrary to allow consistent identification. Until more convincing evidence is at hand regarding the evolutionary divergence of these taxa, and until some way might be found to distinguish them with more precision, *E. grandiflorus* is treated here as including the plants generally identified as *E. simplex*.

Erigeron grandiflorus Hooker, Fl. Bor.-Amer. 2:18, plate 123. 1834. TYPE: CANADA. [ALBERTA]. "Summits of the Rocky Mountains," *Drummond s.n.* (GH!, KEW?). Non Nuttall 1834; non Hoppe ex DC. 1836; non Sessé & Mociño 1894. Drummond's collection apparently was made in June or July, 1826 (Drummond 1830), in the vicinity of Jasper or between Jasper and "Lac-la-Pierre," which is about 60 miles north of Jasper.

Erigeron simplex Greene, Fl. Francisc. 387. 1897. LECTOTYPE (Cronquist 1947): U.S.A. Colorado: no other data, 1875, *E.L. Greene s.n.* (ND-G).

Erigeron leucotrichus Rydb., Bull. Torrey Bot. Club 28:23. 1901. TYPE: U.S.A. WYOMING. Big Horn Mountains, 8000 ft, Jul 1899, *F. Tweedy 2003* (HOLOTYPE: NY!).

Plants perennial, from short, horizontal or erect, fibrous-rooted rhizomes, caudex essentially unbranched or with short, thick branches. Stems 2–25 cm high, erect to basally decumbent-ascending, sparsely to moderately pilose to villous-hirsute, variably stipitate-glandular over whole or part of stem, sometimes essentially eglandular. Leaves basal and cauline, basal persistent, oblanceolate to obovate or spatulate, apically rounded, 1–6(–9) cm long, 2–6(–14) mm wide, entire, cauline quickly or gradually reduced upward, not subclasping, sparsely hirsutulous or villous to sparsely strigose or glabrate, sometimes sparsely glandular. Heads 1; involucres 5–8(–10) mm high, 8–20 mm wide; phyllaries in 2–3 series, green or purplish, moderately to densely woolly-villous with flattened hairs, sometimes with reddish crosswalls, minutely glandular at least near the tips. Ray florets 50–130, corollas 7–11(–15) mm long, laminae blue to pink or purplish, rarely white, coiling. Disc corollas 2.4–4(–5) mm long, throat not indurate or inflated. Cypselae ca. 1.8–2.4 mm long, 2-nerved, strigose; pappus of (7–)10–18(–22) bristles, with an outer series of narrow scales. $2n$ = 18, 27 (Spongberg 1971; numerous diploid counts in literature as *Erigeron simplex*).

Flowering Jul–Aug (–Sep). Rocky sites, meadows, alpine or near timberline; 2900–4200 m. Canada (Alberta, British Columbia); U.S.A. (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Wyoming).

Status of *E. grandiflorus* sensu stricto and *E. grandiflorus* subsp. *arcticus*

The type collection of *Erigeron grandiflorus* and later collections from the same region (southwestern Alberta and adjacent British Columbia) are disjunct by more than 1500 kilometers from the more northern range of *E. grandiflorus* subsp. *arcticus* Porsild. The southern populations are located at the northern tip of the range of the species identified here as *E. grandiflorus* sensu stricto, including *E. simplex*. Porsild (1955) observed that *E. grandiflorus* comprised three "races": Rocky Mountain, arctic, and Alaskan. The 'Rocky Mountain' race corresponds to *E. grandiflorus* sensu stricto, while we are unable to separate the "arctic" and "Alaskan" races and regard them both as composing Porsild's subsp. *arcticus*. Our study of these two entities concludes that they are distinct by a number of nonoverlapping features and that both are appropriately treated at specific rank.

1. Basal leaves oblanceolate to obovate or spatulate, 2–6(–14) mm wide, apically rounded, cauline oblanceolate to narrowly lanceolate, never subclasping; villous involucral vestiture of glassy hairs, often with reddish crosswalls; ray corollas 7–11(–15) mm long; $2n = 18, 27$ ______ **Erigeron grandiflorus**
1. Basal leaves oblong-oblanceolate to narrowly obovate, (3–)5–14 mm wide, apically acute, cauline narrowly ovate to ovate-lanceolate or lanceolate, often subclasping; villous involucral vestiture of whitish hairs, without colored crosswalls; ray corollas 13–17 mm long; $2n = 36$ ______ **Erigeron porsildii**

Erigeron porsildii Nesom & Murray, nom. nov. *Erigeron grandiflorus* Hooker subsp. *arcticus* Porsild, Mus. Natl. Canada, Publ. Bot. (Ottawa) 4:67. 1975. TYPE: CANADA. NORTHWEST TERRITORIES: Victoria Island, SW coast, vicinity of Holman Island trading post, dry, gravelly slope, 8 Aug 1949, *A.E. Porsild 17342* (HOLOTYPE: CAN, color image!, photos in Porsild 1955!; ISOTYPE: ALA!). Non *Erigeron articus* Rouy, Fl. France 8:160. 1903. Rouy's epithet was a variant spelling applied to an "arctic" plant and precludes adoption at specific rank of the similar Porsild name, which denotes the same geography (ICBN, Art. 53, Ex. 9). In order to retain the original type designation, we have chosen to rename the taxon at specific rank. The replacement name honors A.E. Porsild (1901–1977), whose studies and publications over a 60 year period greatly advanced knowledge of the flora of arctic and boreal America.

Plants perennial, from a short, horizontal or erect, fibrous-rooted rhizome (sometimes appearing more like a taproot), sometimes with short caudex branches. Stems (2–)10–20(–25) cm high, erect, sparsely to moderately villous with hairs 0.5–1.6 mm long, usually stipitate-glandular over whole stem with hairs 0.05–0.4 mm long. Leaves basal and cauline, basal oblong-oblanceolate to narrowly obovate, 3–12 cm long, (3–)5–14 mm wide, entire, cauline oblong-lanceolate to lanceolate, often subclasping, gradually reduced upward or nearly equal-sized, densely hirsute to coarsely villous, sparsely stipitate-glandular to minutely glandular. Heads 1; involucres 6–10 mm high, 12–20 mm wide; phyllaries in ca. 2 series of equal length, narrowly lanceolate, apically acuminate, purple at least at the tips, densely hirsute, hirsute-villous, or villous with whitish hairs without colored cross-walls, sparsely stipitate-glandular to minutely glandular. Ray florets 65–110, corollas 13–17 mm long, laminae 1.2–1.7 mm wide, blue to purple or lavender, less commonly white, weakly coiling. Disc corollas 3.8–4.5 mm, puberulent with glandular hairs, throat not indurate or inflated. Cypselae 2–2.5 mm, 2-nerved, sparsely strigose; pappus of 14–20(–25) bristles, with a prominent outer series of setae or narrow scales. $2n = 36$ (Dawe & Murray 1981).

Flowering mid Jun–Aug(–Sep). Alpine ridges and slopes, rock outcrops, cliffs and talus (often calcareous) slopes, shaly gravel and scree, bluffs, grassy ravines, tundra, meadows; (150–)600–1600(–2100) m. Canada (N.W.T.: Districts of Franklin, Mackenzie; Yukon); U.S.A. (Alaska).

Additional collections examined. **Alaska**. Wrangell-St. Elias National Park and Preserve, McCarthy Quad, Wrangell Mts., vic. plateau W of Nizina River, above head of Nikolai Creek, SE-facing shaley scree near ridge crest, 1370 m, 24 Jul 1996, *Batten and Barker 96-66* (ALA); Mt. McKinley National Park, Cathedral Mountain, mile 36, 1–10 Jul 1964, *Hultén s.n.* (NY); Demarcation Point Quad, Kongakut river, 30 km S of Beaufort Sea coast, S-facing river bluff, dominant willow, 29 Jun 1984, *McCarthy s.n.* (ALA); Tetlin National Wildlife Refuge, Nabesna Quad, Mentasta Mts., vic. Nabesna River valley, '4940 Hill' site, alpine screes and seeps, 1506–1628 m, 25 Jul 1996, *Moran 45* (ALA); Mt. McKinley Quad, mountain slope along Stony Creek, 26 Jun 1941, *Murie s.n.* (ALA); Philip Smith Mountains Quad, Yukon River-Prudhoe Bay Haul Road, just E of Galbraith L, tundra slopes and conglomerate outcrops, 915–1220 m, 20 Jul 1976, *Murray 6119* and Johnson (ALA); Circle Quad, Yukon–Tanana Uplands, South Fork Birch Creek drainage, alpine ridges and slopes between Puzzle Gulch and Big Windy Creek, marble outcrops in mica-schist bedrock, lush, dry, S-facing herbaceous slope below outcrops, 1100–1220 m, 8 Jul 1996, *Parker et al. 6537* (ALA); Gates of the Arctic National Park and Preserve, Chandler Lake Quad, Arctic Foothills, Castle Mtn., northern ridge of summit area, 700-1070 m, alpine dryas heath, cliffs, scree and meadows along drainages, in lush herbaceous, N-facing meadow, 30 Jul 2002, *Parker et al. 12891* (ALA); Baird Mountains Quad, Noatak National Preserve, Central Noatak River valley, Grand Canyon, vic. of "Wolf control" cabin, ca. 7 km upriver from Mukachiak Cr. mouth, S-facing acidic bedrock bluffs above floodplain, dry mesic shrub and open shrub-herbaceous vegetation, growing in open, grassy slope, 140–200 m, 19 Jul 2003, *Parker et al. 14959* (ALA, BRIT); Baird Mountains Quad, Noatak National Preserve, Central Noatak R. valley, Sekuiak Bluff, vic. of upstream end of bluff and VABM Windy, N bank of river, 100–150 m, S-facing outcrops and scree, limestone-acidic contact zone, 27 Jul 2003, *Parker et al. 15264* (ALA, BRIT); Denali National Park and Preserve, Healy Quad, Alaska Range, S-facing slopes of main ridge NW of Riley Creek, 1 km SSW of VABM Riley, confined to turfy, graminoid-forb meadow-tundra area on steep, S-facing slope, 3700 ft, 18 Jun 1999, *Roland and Batten 3821* (ALA). **Yukon**. Kluane National Park and Preserve, Dezadeash Quad, St. Elias Mts., King's Throne, vic. Kathleen Lake and Haines Road, 24 Jul 2000, *Caswell 359* (ALA); Richardson Mts., fine broken stones and turf in saddle and adjacent slopes, 2000 ft, 13 Jul 1982, *Cody and Ginns 31788* (ALA); E end of Herschel Island, Mackenzie Bay, Beaufort Sea, slope above stream, 20 Jul 1975, *Cooper 75E* (NY), 14 Jul 1978, *Cooper 634D* (NY), 19 Jul 1975 *Cooper 54A* (NY); Herschel Island, 14 Jul 1906, *Lindstrom s.n.* (NY); Kluane Lake Quad, NW of Slims River, 4500–6300 ft, 9 Jul 1967, *Murray 933* (ALA).

Erigeron porsildii contrasted with *E. koraginensis*

A range of opinions regarding the definitions and distinctions (or lack of distinction) among *Erigeron grandiflorus*, *E. porsildii* (= *E. grandiflorus* subsp. *arcticus*), *E. muirii*, and the Asian species *E. koraginensis* is summarized in Elven et al. (2003, as related by Aiken et al. 2003). It has not been clear whether *E. koraginensis* occurs on the North America continent or whether it might be conspecific with an earlier-named American species, particularly *E. grandiflorus/porsildii*. *Erigeron koraginensis* and *E. porsildii* are the most similar among these species, but here, based on material housed at ALA, we conclude that *E. koraginensis* and *E. porsildii* are distinct and note that we have seen no collections of *E. koraginensis* from North America.

1. Leaves sparsely to moderately villous on both surfaces; villous involucral vestiture of whitish hairs, without colored crosswalls; ray florets 65–110, corollas 13–17 mm long; disc corollas 3.8–4.5 mm long; outer pappus a prominent series of long setae or scales __________ **Erigeron porsildii**
1. Leaves glabrous or essentially so on adaxial surfaces, villous abaxially; villous involucral vestiture of hairs with purple crosswalls; ray florets 45–73, corollas 9–13 mm long; disc corollas 3–3.9 mm long, outer pappus of a few minute setae and narrow scales __________ **Erigeron koraginensis**

Erigeron koraginensis (Komarov) Botschantzev, Not. Syst. Herb. Inst. Bot. Acad. Sci. URSS 16:391. 1954. *Aster koraginensis* Komarov, Fl. Penins. Kamtsch. 3:125. 1930. *Erigeron komarovii* Botschantzev var. *koraginensis* (Komarov) Voroshilov, Byull. Glavn. Bot. Sada (Moscow) 84:34. 1972.

Erigeron komarovii Botschantzev, Not. Syst. Herb. Inst. Bot. Acad. Sci. URSS 16:391. 1954. *Aster consanguineus* Ledeb., Fl. Ross. 2, 2:473. 1845. *Erigeron consanguineus* (Ledeb.) Novopokr., Bot. Mat. (Leningrad) 7:137. 1938 (non Cabrera 1937).

Plants perennial from lignescent thickened but elongate rhizomes 1–4 cm long. Stems erect, 4–25 cm high, sparsely to moderately villous, densely villous beneath the heads, hairs 0.5–1.5(–1.8) mm long, often with colored crosswalls, stipitate glands 0.1–0.3 mm high with colored cross walls. Leaves mostly basal or basal and cauline, basal oblanceolate to oblanceolate-spatulate with rounded to acute apices, 2–7 cm long, 2–10 mm wide, cauline oblanceolate to narrowly lanceolate, (if present) quickly or gradually reduced on lower 1/3–2/3 of stem, not clasping, sparsely villous and minutely and short-stipitate glandular abaxially, glabrous adaxially, margins ciliate and stipitate-glandular. Heads 1; involucres 6–9 mm high, 11–18 mm wide; phyllaries linear-lanceolate, usually purple, in 2 series of equal length, moderately to densely villous, hairs usually with purple crosswalls (at least in proximal cells), stipitate glandular. Ray florets 45–73, corollas 9–13 mm long, 1.2–2 mm wide, blue to white, coiling. Disc corollas 3–3.9 mm long, very sparsely villous, lobes narrowly triangular. Cypselae 2.2–2.6 mm long, narrowly oblong in outline, sparsely strigose-villous, 2-nerved; pappus bristles 19–23, of uneven thickness and length, outer series a few minute setae and narrow scales. Description drawn from nine ALA collections from northeastern Russia; it corresponds closely to the description of *E. komarovii* provided by Botschantzev (1959). $2n = 18$ (summary in Aiken et al. 2003).

The names *Erigeron koraginensis* and *E. komarovii* were proposed in 1954 on the same page of publication. *Erigeron komarovii* was a replacement name for the later homonym *E. consanguineus* (1938), which was based on *Aster consanguineus* (1845); *E. koraginensis* was based on *Aster koraginensis* (1930). We follow the observations of Dr. Kanchi Gandhi (pers. comm.) in recognizing the priority of *E. koraginensis* if *E. komarovii* and *E. koraginensis* are combined: "Although the priority of the type of *E. komarovii* starts from 1845, the priority of the epithet itself starts from 1954. In contrast, the priority of the type and of the epithet in *E. koraginensis* start from 1930."

Erigeron koraginensis is distributed in arctic and eastern Siberia, Wrangel Island, and the Kamchatka region (Botschantzev 1959; Tzelev 2002). Yurtsev et al. 1989 said explicitly that *E. komarovii* occurs on Wrangel Is. and replaced the name *E. muirii* erroneously used in prevous accounts. Czerepanov (1995) listed *E. koraginensis* as a synonym of *E. komarovii*; Botschantzev (1959) maintained them as separate species but by widely overlapping differences. The type of *E. koraginensis* was collected in Kamchatka; the type of *E. komarovii* was collected from Karaginskii Island, in the Bering Sea just off the coast of northeast Kamchatka.

Taxonomic status and distribution of *Erigeron muirii*

Hultén (1968) treated *Erigeron muirii* Gray as a subspecies of *E. grandiflorus* (*E. porsildii*, as identified here), noting that its densely lanate leaves and involucres distinguish it from the typical expression of the latter. Elven et al. (2003) also note that "The hairs of *E. muirii* are very thin, curly, and intermingled, and they are totally different from the stiffer and straighter hairs of *E. grandiflorus* and *E. koraginensis*." *Erigeron muirii* and *E. porsildii* occur sympatrically in northeastern Alaska, but *E. muirii* usually grows in exposed, rocky settings, whereas *E. porsildii* tends to favor meadows. Chromosome counts from Alaska show *E. muirii* to be diploid, *E. porsildii* tetraploid (Dawe & Murray 1981). Two unusual plants on a sheet with six others of typical *E. muirii* may be hybrids between *E. muirii* and *E. uniflorus var. eriocephalus* (J. Vahl) Boivin (Alaska: vicinity of Cape Thompson, 26 Jul 1976, *Roseneau s.n.*, ALA), but we have not seen evidence of hybridization or intergradation between *E. muirii* and *E. porsildii* and agree with Cronquist (1947), Porsild and Cody (1980), Cody (2000), and others in observing that *E. muirii* is appropriately treated at specific rank.

Erigeron muirii A. Gray, Proc. Amer. Acad. Arts 17:210. 1881. *Erigeron grandiflorus* Hook. subsp. *muirii* (A. Gray) Hultén, Ark. Bot. 7:132. 1968. TYPE: U.S.A. ALASKA. Cape Thompson, 1881, *J. Muir s.n.* (HOLOTYPE: GH!).

1. Stems and leaves moderately lanate, involucres densely lanate, all eglandular; cauline leaves narrowly elliptic-lanceolate, not subclasping ______ **Erigeron muirii**

1. Stems and leaves sparsely villous, involucres villous, all glandular to stipitate-glandular; cauline leaves narrowly ovate to ovate-lanceolate or lanceolate, often subclasping ________ **Erigeron porsildii**

Erigeron muirii has been regarded as an endemic of northern Alaska (Murray & Lipkin 1987, Lipkin and Murray 1997), but a herbarium sheet of *E. muirii* at US(!) bears the label "Wrangel Is., Dr. Ross, Corwin 1881." Hultén (1950) commented that personal communication from Soviet botanists led him to doubt the occurrence of *E. muirii* on Wrangel Island (in the Arctic Ocean, between the East Siberian Sea and the Chukchi Sea, off northeastern Russia) and to hypothesize that the specimen at US is incorrectly labeled. Nevertheless, he felt that this explanation needed confirmation.

Knowing of the specimen at US and lacking authentic material of *Erigeron muirii* at LE, V.V. Petrovsky compared the written descriptions and the photograph in Hultén (1950) of *E. muirii* with specimens of *E. komarovii* (= *E. koraginensis*, as recognized here, see section above) and concluded they were conspecific. Petrovsky (1987) therefore included *E. muirii* in the Arctic Flora USSR, under which he included *E. komarovii* Botsch. as a synonym (among many synonyms). Following exchanges of specimens between LE and ALA, it was possible for both sides to examine authentic *E. muirii* and *E. komarovii* and to determine that they are not the same. Yurtsev et al. (1989) removed *E. muirii* from their list of Wrangel Island plants.

The voyage in which Muir participated had numerous ports-of-call, including Cape Thompson (the type locality of *Erigeron muirii*, in northwestern Alaska) and Wrangel Island. In accounts of this voyage published by Muir (1883, 1917), plant lists for Wrangel Island do not include any species of *Erigeron*. It is reasonable to presume that a mistake was made during processing of the specimens and that a Wrangel Island label was assigned to an Alaskan collection, just as Hultén had earlier surmised.

Specimens from Herschel Island on the coast of the northwestern extreme of Canada very near the Alaskan border were included by Hultén (1968) in *Erigeron muirii* (as *E. grandiflorus* subsp. *muirii*). We have determined these specimens as *E. porsildii* and note that other collections from Herschel Island are cited above for *E. porsildii*. Collections of *E. muirii* from which our discussion is drawn are mostly at ALA.

The status of *Erigeron hultenii*

Erigeron hultenii was noted by its author to be "closely allied to the polymorphic arctic-alpine species *E. grandiflorus* W.J. Hooker" (Spongberg 1973, p. 116) and to have a "close morphological resemblance to some plants of *E. grandiflorus* from Alaska" [= *E. porsildii* in the present sense] (p. 119). Contrasts with *E. porsildii*, however (as in the couplet below), exclude it from that species. Despite additional exploration at and near the type locality, plants corresponding to *E. hultenii* have not been recollected and we do not find that *E. hultenii* fits with any other known Alaskan species. We continue to regard it as an anomalous plant of unknown relationships.

1. Leaves 1-veined; ray florets 65–110; disc corollas 3.8–4.5 mm long; achenes 2-nerved; outer pappus a prominent series of long setae or scales ______________ **Erigeron porsildii**
1. Leaves 3-veined; ray florets 20–45; disc corollas 2.5–3 mm long; achenes 4-nerved; outer pappus barely if at all evident ____________________________ **Erigeron hultenii**

Erigeron hultenii Spongberg, Rhodora 75:116. 1973. TYPE: U.S.A. ALASKA: Campbell Creek Valley, 11 mi N of Anchorage, 7 Aug 1965, *L. Strutz s.n.* (HOLOTYPE: S).

Taxonomic status of *Erigeron yukonensis*

Erigeron yukonensis was included within the "*E. grandiflorus* agg." by Polunin (1959), but Hultén (1950) hypothesized it to be closely related to *E. glabellus* Nutt. Later, Hultén formalized this (1967) by reducing *E. yukonensis* to varietal rank within *E. glabellus*. We agree with a number of recent botanists who find *E. yukonensis* to be a distinct species, although its evolutionary relationships are not clear—its eglandular vestiture, elongate basal leaves, and 1–4 heads are uncharacteristic of most of the arctic monocephalous *Erigeron* species. Plants of *E. porsildii* with elongate-lanceolate leaves sometimes approach single-headed *E. yukonensis* in aspect, but *E. porsildii* differs especially in its stipitate-glandular stems and its tendency for oblong-lanceolate to lanceolate, often subclasping cauline leaves.

Erigeron yukonensis Rydb., Bull. New York Bot. Gard. 2:185. 1901. TYPE: CANADA. YUKON: Dawson, 23 Jul 1899, *R.S. Williams s.n.* (HOLOTYPE: NY!). *Erigeron glabellus* Nutt. var. *yukonensis* (Rydb.) Hultén, Ark. Bot. 7(1):132. 1967.

Plants perennial, fibrous-rooted rhizome, sometimes appearing like a taproot, multicipital. Stems 10–30(–40) cm high, erect to basally ascending, often purplish at base, sparsely to moderately hirsute to villous-hirsute, eglandular. Leaves basal and cauline, lower narrowly oblanceolate, rarely oblanceolate-obovate, entire, (1–)4–16 cm x 2–8 mm, middle and upper reduced and narrowly lanceolate, not clasping, sparsely hirsute to glabrous, eglandular. Heads 1–2(–4) from branches at midstem; involucres 6–10 mm high, 12–19 mm wide; phyllaries in 2(–3) series, linear-lanceolate with linear-acuminate tips, sparsely to moderately woolly-villous with whitish, flattened hairs without colored cross-walls, eglandular to very sparsely minutely glandular. Ray florets 42–82, corollas 10–15 mm long, laminae white to pink or pink-purple, coiling. Disc corollas 3.8–5.2 mm long, throat not indurate or inflated. Cypselae 1.7–2 mm long, 2-nerved, strigose; pappus of 15–20 bristles, with an evident outer series of short bristles, squamellae, or scales.

Flowering (Jun–)Jul–Aug (–Sep). Rocky sites and meadows, near timberline and above; 2850–3150 m. Canada (N.W.T.: District of Mackenzie; Yukon); U.S.A. (Alaska).

Additional collections examined. Canada. **Yukon** S end of Lake Kluane, alpine, 24 Jul 1944, *Anderson 9472B* (NY); Moosehide Mountain, W-facing slope, open rocky slope, 20 Jun 1949, *Calder 3266* (NY); Lower Klondike, last half of Jun 1919, *Cockfield 64* (CAN-photo ALA!); near Collinson Head, E end of Herschel Island, Mackenzie Bay, Beaufort Sea, 16 Jul 1975, *Cooper 38A* (NY); Dawson, 30 Jun 1914, *Eastwood 454* (CAN-photo ALA!); Red Mountain near Fort Selkirk, shady slopes, 17 Jul 1899, *Gorman 1109* (NY); Ft. Selkirk, 1-9 Jul 1891, *Hayes s.n.* (NY); White Horse, Yukon River, 1 Sep 1902, *Macoun 78996* (NY, CAN-photo ALA!); Fort Selkirk, 18 Jul 1899, *Tarleton 141* (NY). **NWT**: Inuvik, damp rock ledges by Dolomite Lake in open sunlight, just above ledge with *Woodsia glabella* and *Cystopteris fragilis*, 7 Jul 1965, *Swales 522* (CAN-photo ALA!).

Cronquist (1947) cited a collection of *Erigeron yukonensis* from District of Mackenzie (Richards Island, 1896, *Stringer 16*, no herbarium cited). Wiggins and Thomas (1962) cited an Alaskan collection in AMES from north of the Brooks Range (Utukok River, 5 Jun–15 Jul 1947, *Thompson s.n.*), but the identity of this collection needs to be verified. Cody (2000, p. 581) noted that *E. yukonensis* occurs in "the Yukon Territory west of latitude 135 W, in northern District of Mackenzie east to Coronation Gulf and in Nahanni National Park." See also Map 1104 in Porsild and Cody (1980) and a map in McJannet et al. (1993, p. 38).

The *Erigeron purpuratus—E. pallens* group

Treatments of these species have varied considerably, but we recognize *Erigeron purpuratus* Greene, *E. denalii* A. Nels., and *E. pallens* Cronq. as distinct species. *Erigeron pallens* is rare and endemic of the high mountains of southeastern British Columbia and adjacent Alberta, while the other two are more common and occur in Alaska, Yukon, District of Mackenzie, N.W.T., and extreme northwestern British Columbia, long disjunct from the range of *E. pallens*. The erect, inrolled laminae of the ray florets (giving them a "filiform" aspect) of all three species distinguishes them from other species of *Erigeron* sect. *Tridactylia* Nutt., of which they are members. The leaf-lobing of *E. pallens*, however, is more similar to that of *E. vagus* Payson and *E. flabellifolius* Rydb. (also sect. *Tridactylia*) of the northwestern U.S.A., which are geographically closer to *E. pallens* than *E. denalii* and *E. purpuratus*.

Erigeron denalii has been treated as a synonym or a variety of *E. purpuratus* (e.g., Cronquist 1947, Hultén 1968, Boivin 1972). They are similar in many ways, including the characteristic purplish pappus bristles, and perhaps are most closely related to each other, but the two taxa appear to be partially sympatric and differences in vestiture and leaf morphology are constant. The habitat of *E. purpuratus*, sandy or gravelly alluvium, also is remarkably constant and distinct from that of *E. denalii*. Probably correlated with the loose sands and gravels of its habitat, plants of *E. purpuratus* almost always develop a long and relatively slender but woody taproot; taproots of *E. denalii* are less well defined and often do not show on collections, and the plants usually develop slender rhizome-like caudex branches, well adapted to the downslope instability of the screes typically inhabited by the species.

1. Leaves entire or shallowly 3-lobed at the obtuse to nearly flat apex; pappus tawny-white to yellowish ______ **Erigeron pallens**
1. Leaves entire or with 1–2 shallow lobes on the margins; pappus usually purplish.
   2. Stems 1–5 cm tall; leaves spatulate to oblanceolate-spatulate, 2–4(–5) mm wide, minutely glandular and moderately villous; involucres densely pilose ______ **Erigeron denalii**
   2. Stems (2–)3–9(–14) cm tall; leaves linear- to narrowly oblanceolate, 1–2.5(–3) mm wide, merely minutely glandular or also sparsely hirsute-villous; involucres sparsely pilose ______ **Erigeron purpuratus**

Erigeron purpuratus Greene, Pittonia 4:155. 1900. TYPE: CANADA. YUKON: Fort Selkirk, sandy river banks, 28 Jun 1899, *M.W. Gorman 1065* (ND-G!).

Plants perennial, taprooted, from a diffuse caudex divided into system of slender rhizome-like branches. Stems (2–)3–9(–14) cm high, minutely glandular, villous. Leaves mostly basal, linear- to narrowly oblanceolate, 1.5–3(–4.5) cm long, 1–2.5(–3) mm wide, entire or (mostly on early-produced leaves) with 1 or 2 shallow lateral lobes, minutely glandular, sparsely villous or without nonglandular hairs. Heads 1; involucres 6–9(–10) mm high, 9–15 mm wide; phyllaries in 2–3 series, minutely glandular, sparsely villous, hairs with colored crosswalls and up to 3 mm or without nonglandular hairs. Ray florets 40–90, 5–9 mm long, laminae filiform, 0.3–0.8 mm wide, erect, white to pink or purplish, not coiling or reflexing. Disc corollas 4–5 mm long, throat not indurate or inflated. Cypselae 1.8–2.7 mm long, 2-nerved, sparsely strigillose to glabrate; pappus of 28–40 pinkish to purplish bristles, without an evident outer series. 2*n* = 18 (Dawe & Murray 1979).

Flowering Jun–Aug. Sandy and gravelly stream banks, gravel bars, sandy beaches, gravelly slopes, alpine tundra; 150–1350 m; Canada (Yukon); U.S.A. (Alaska).

Erigeron denalii A. Nelson, Amer. J. Bot. 32:289. 1945. TYPE: U.S.A. ALASKA. Mt. McKinley National Park: Sable pass, at highest point of Park road, rocky slopes, ca. 4000 ft, 8 Aug 1939, *A. Nelson and R.A. Nelson 4058* (HOLOTYPE: RM!; ISOTYPE: US!).

Erigeron purpuratus Greene var. *dilatatus* Boivin, Phytologia 23:134. 1972. TYPE: CANADA. DISTRICT OF MACKENZIE: Redstone River Region, 4 July 1963, *Kvale & Haggard 131* (HOLOTYPE: DAO).

Erigeron mexiae K. Becker, Brittonia 28:144. 1976. TYPE: CANADA. YUKON: Dempster Highway, N of Dawson City, E-facing slope just W of Mile 41, in scree, 5000 ft, 8 Jul 1973, *C.W. Greene 481* (HOLOTYPE: NY!; ISOTYPE: UAC).

Plants perennial, taprooted, with a diffuse, slenderly branching caudex. Stems 1–5 cm high, villous, granular-glandular. Leaves basal and cauline, spatulate to oblanceolate, entire or shallowly 3-lobed at the apex, 1–2 cm long, 2–4 mm wide, mid-cauline larger than the basal and lower cauline, villous, granular-glandular. Heads 1; involucres (4–)5–7 mm high, 9–12 mm wide; phyllaries in 2(–3) series, densely lanate-villous, the hairs to 3 mm long, often with dark purple crosswalls, glandular. Ray florets 30–55, 4–8 mm long; laminae erect, rarely spreading, filiform to narrowly straplike, 0.3–1.2(–2) mm wide, white to lavender. Disc corollas 3.8–4.8 mm long, throat not indurate or inflated. Cypselae oblanceolate-oblong, 3–3.8 mm long, 2-nerved, strigillose to strigose-hirsute; pappus of 20–25 bristles, more or less purple-red tinged or sometimes whitish (variable within populations), without an evident outer series.

Flowering Jun–Aug. Open alpine and subalpine habitats, tundra slopes, openings in spruce-fir woods, gravelly and shaley scree, cut banks; 900–2150 m; Canada (N.W.T.: District of Mackenzie; Yukon; extreme northwestern British Columbia); U.S.A. (Alaska).

Plants of the type collection of *Erigeron mexiae* have ray corollas with relatively broad laminae (1.5–2 mm wide), but ray corolla width is variable in *E. denalii* and *E. mexiae* is here regarded as an extreme variant within the species—in other characters there appears to be no difference.

Erigeron pallens Cronquist, Brittonia 6:240. 1947. TYPE: CANADA. BRITISH COLUMBIA: Glacier, Mount McDonald, 7500 ft, 1 Aug 1913, *Butters and Holway 799* (HOLOTYPE: MINN).

Plants perennial, taprooted, caudex divided into system of slender, rhizome-like branches. Stems 2–4 cm high, sparsely hirsute-villous, minutely glandular. Leaves mostly basal, oblanceolate to spatulate, 1–2.5 cm long, 2–4 mm wide, entire or shallowly 3-lobed at the obtuse to nearly flat apex, sparsely villous, minutely glandular. Heads 1; involucres 6–8 mm high, 9–13 mm wide; phyllaries in 2–3 series, commonly purplish or purple at the tips, sparsely villous, the hairs often becoming tawny, without purple cross-walls, minutely glandular. Ray florets 50–65, corollas 4–5(–6) mm long, laminae white to pink or purplish, ca. 0.5–0.8 mm wide, erect. Disc corollas 3.5–4.4 mm long, throat not indurate or inflated. Cypselae length not observed, 2-nerved, sparsely strigose; pappus of 25–30 tawny to purplish bristles, with a few, short, outer setae. $2n = 18$ (Packer & Witkus 1982).

Flowering Jul–Aug. Alpine talus, shale slides, steep and sparsely vegetated slopes; ca. 2100–3200 m; Canada (Alberta, British Columbia).

A nomenclatural combination attributed to G.W. Douglas (*Erigeron purpuratus* Greene subsp. *pallens*, such as by Moss 1983 and Packer & Witkus 1982), apparently was never validated and is a nomen nudum.

Erigeron ochroleucus in Alaska

Previously undetermined collections at ALA document the occurrence of *Erigeron ochroleucus* Nutt. in arctic and boreal Alaska and immediately adjacent Yukon, disjunct more than 2800 kilometers from the closest localities in its main range, which runs from Nebraska and South Dakota through Wyoming and Montana into southern Alberta and British Columbia (see map in Nesom 2004). The arctic and boreal plants are unequivocally identified as *E. ochroleucus*, although they differ in some ways from those of the southern system: stem height ranges shorter (2–15 vs. (6–)8–18(–20, 30) cm), leaf length ranges shorter (2–7 vs. 4–9(–12) mm), leaves are consistently linear to linear-oblanceolate (vs. linear to narrowly oblanceolate, 1–4(–5) mm wide), hairs of the villous involucral vestiture often (vs. uncommonly) have red crosswalls, ray florets range fewer in number ((18–)30–50 vs. 30–62), and the disc florets range greater in length (3.5–4.5 mm vs. 2.8–3.6 mm). The Alaska and Yukon plants plants might be formally treated as a variety, emphasizing their geographic disjunction, but morphological differences are overlapping and plants from the western U.S.A. can be found that closely match the arctic plants. In the interpretation of Nesom (2004), no varieties are recognized in the southern population system of *E. ochroleucus*.

Erigeron ochroleucus, although very restricted in Alaska and Yukon, is nevertheless common along a section of the Porcupine River from Rampart House in Yukon, but near the International Boundary, downstream below the Lower Ramparts, some 80 kilometers total. The climate is hypercontinental and habitat for this species is at the base of arid slopes with an eastern to southern exposure and adjacent terraces. The vegetation is discontinuous and steppic in character: *Artemisia frigida*, *Bupleurum americanum*, *Calamagrostis purpurascens*, *Agropyron spicatum*, *Phlox hoodii*, and *Erigeron caespitosus* are prominent. Several species also restricted in Alaska and Yukon, and some are also disjunct from their main ranges: *Festuca lenensis*, *Carex filifolia*, *Carex duriuscula*, *Eriogonum flavum* var. *aquilinum*, *Alyssum americanum*, and *Townsendia hookeri*. The two arctic localities for *E. ochroleucus* are climatically very different from the Porcupine River, but edaphically similar: dry sands and gravels (Atqasuk) and well-drained soils (Kadleroshilik Pingo).

Collections examined. **U.S.A. Alaska:** Arctic Slope District, 70 air mi S of Point Barrow, near Eskimo village of Atkasook, 2.9 km SE of Meade River Camp, 15 m, 31 Jul 1975, *Komarkova 45* (ALA). Black River Quad: Arctic NWR, steep southeast-facing steppe slope on Porcupine River, 366 msm, 66° 58' 56"N, 142° 49' 46" W, 4 June 1996, *Murray, Emers, and Jorgenson 12,128* (ALA); Yukon Flats NWR, steep southeast-facing steppe slope on Porcupine River, 66° 59' 15" N, 142° 58' 20" W, 6 June 1996, *Murray, Emers, and Jorgenson 12,153* (ALA). Porcupine River, E of old archeology camp, 66° 59'N, 142° 49'W, S facing bluff, 20 m above river shore, 18 Jul 1995, *Reitz s.n.* (ALA and to be distributed). Porcupine River, 67° 20' N, 141° 18' W, 20 Jul 1980, *Thorson 7-20-80-4* (ALA). First bluff inside Alaskan border [with Yukon, Canada], on Porcupine River, 67° 21'N, 141° 17'W, 275 msm, 17 July 1981, *Viereck and Foote 4536* (ALA). Beechey Point Quad, Kadleroshilik Pingo (no. 41), Kadleroshilik study area, 70° 01'N, 147° 41'W, gravelly areas, 26–28 Jul 1986, *Walker 86-31* (ALA). **CANADA. Yukon:** Porcupine River, Rampart House, 11 July 1951, *Loan 568b* (DAO).

Because *Erigeron ochroleucus* has not been included in floristic accounts of arctic areas, a description is provided here, drawn from 25 plants of the collections cited below. A detailed comparison can be made by comparing this description with that for "southern" *E. ochroleucus* in the *Erigeron* treatment for the developing FNANM volumes (Nesom in prep.).

Plants perennial from a thick, woody taproot, caudex multicipital, unbranched or rarely with short branches. Stems basally ascending, 2–15 cm, loosely strigose to villous-strigose, eglandular or sparsely minutely glandular. Leaves mostly basal, linear to linear-oblanceolate, entire, 2–7 cm long, 1–1.8 mm wide, cauline quickly reduced upwards, sparsely and loosely strigose adaxially, abaxially glabrous at least on distal 1/4–1/2 of blade and strigose proximally, eglandular. Heads 1; involucres 6–8 mm high, 12–16 mm wide; phyllaries in 3–4 series, densely hirsute-villous, hairs whitish or with red-purple crosswalls, densely and minutely glandular. Ray florets (18–)30–50, corollas 8–12 mm, laminae mostly white, less commonly bluish, 1–2(–2.5) mm wide, coiling. Disc corollas 3.5–4.5 mm long, not indurate or inflated. Cypselae 2–2.5 mm, 2-nerved, strigose-villosulous; pappus bristles 12–15, with a conspicuous outer series of thick setae, scales, or squamellae.

The status of *Erigeron pumilus* in Yukon

Porsild (1975) noted the occurrence in southwestern Yukon of *Erigeron linearis* (Hook.) Piper, as the single collection, *H.M. and L.G. Raup 12918*, had been identified on the original label. Hultén (1967, 1968) referred to this collection as *E. pumilus* Nutt., as it has continued to be recognized (e.g., Cody 2000). With caveats as below, our identification of the three plants on this sheet is *E. caespitosus* Nutt. In *E. pumilus* (in contrast to *E. caespitosus*), the stems and involucres are hirsute to hispid-hirsute and glandular, the ray corollas are linear and reflexing, and the disc corollas have distinctly indurate and inflated throats.

CANADA. Yukon Territory: Alpine grassy-stony slope, rays lavender, mountain slope on east side of Big Arm, Kluane Lake, app. Lat. 61° 33'N, 138° 40'W, 20 Aug 1944, *H.M. and L.G. Raup 12918* (ALA).

Erigeron caespitosus has an extended geographic distribution, ranging from Arizona and New Mexico northward into Alaska; it is relatively common in southwestern Yukon (see map in Cody 2000). The Yukon plants in question have strigose cauline vestiture, which contrasts with the normally deflexed to spreading vestiture of *E. caespitosus*, but such variation exists sporadically in the species in other parts of its range, including Saskatchewan as well as various places in the western U.S.A, and the vestiture of *Raup 12918* is more characteristic of *E. caespitosus* for 5-10 mm under the heads. The plants of *12918* also have linear to linear-oblanceolate basal leaves, narrower than normal for *E. caespitosus*, but narrow-leaved plants more clearly identified as *E. caespitosus* also occur in the Kluane Lake area (Murray, pers. observ.). The plants of *12918* are atypical, but we conclude that latent populational tendencies are sporadically expressed in this species--at least a hypothesis of recent hybridization or genetic introgression is not supported, because hybridization with any other species in southwestern Yukon probably would have more conspicuously influenced the morphological features of *12918*.

ACKNOWLEDGMENTS

We are grateful to Barney Lipscomb (BRIT) for help with locating bibliographic material, to NY staff for help on a recent visit, to Kanchi Gandhi for observations and advice on nomenclatural problems, to Susan Aiken for her review comments and a color image of the holotype of *Erigeron grandiflorus* subsp. *arcticus*, to Robert Lipkin for review comments, and to ALA for a loan of specimens to Nesom at BRIT. We gratefully acknowledge the confidence gained by learning that Ron Hartman (RM) had earlier reached the same conclusion regarding the identity of the Alaskan-Yukon populations of *Erigeron ochroleucus*.

REFERENCES

Aiken, S.G., M.J. Dallwitz, L.L. Consaul, C.L. McJannet, L.J. Gillespie, R.L. Boles, G.W. Argus, J.M. Gillett, P.J. Scott, R. Elven, M.C. LeBlanc, A.K. Brysting, and H. Solstad. 2003 [1999 onwards]. Flora of the Canadian Arctic Archipelago: Descriptions, Illustrations, identification, and Information Retrieval. Version: 29th April 2003. <http://www.mun.ca/biology/delta/arcticf/> Accessed February 2004.

Boivin, B. 1972. Flora of the prairie provinces. Part III (continued). 113. Compositae. Phytologia 23:85–140.

Botschantzev, V.P. 1959. *Erigeron*. Flora U.R.S.S. 25:191–288.

Cody, W.J. 2000. Flora of the Yukon Territory (ed. 2). NRC.CNRC, NRC Research Press, Ottawa.

Cronquist, A. 1947. A revision of the North American species of Erigeron, north of Mexico. Brittonia 6: 121–302.

Dawe, J.G. and D.F. Murray. 1979. In IOPB chromososome number reports LXIII. Taxon 28: 265–268.

Dawe, J.C. and D.F. Murray. 1981. Chromosome numbers of selected Alaskan vascular plants. Canad. J. Bot. 59: 1373–1381.

Dorn, R.D. 1984. Vascular plants of Montana. Mountain West Publishing, Cheyenne, Wyoming.

Douglas, G.W., G.B. Straley, D. Meidinger, and J. Pojar. 1998. Illustrated flora of British Columbia. Vol. 1, Gymnosperms and Dicotyledons (Aceraceae through Asteraceae). British Columbia Ministry of Environment, Lands and Parks, Ministry of Forests. Victoria, British Columbia.

Drummond, T. 1830. Sketch of a journey to the Rocky Mountains and to the Columbia River in North America. Bot. Miscellany (W.J. Hooker) 1:178–219.

Elven, R., D.F. Murray, and B.A. Yurtsev. 2003. Checklist of the Panarctic Flora (PAF) Vascular Plants. Draft version, National Centre of Biosystematics, Natural History Museums and Botanic Garden. University of Oslo.

Hultén, E. 1950. Flora of Alaska and Yukon. Vol. X. C.W.K. Gleerup, Lund. .

Hultén, E. 1967. Comments on the flora of Alaska and Yukon. Ark. Bot., Bd. 7, 1:1–147.

Hultén, E. 1968. Flora of Alaska and neighboring territories. Stanford Univ. Press, Stanford, California.

Lipkin, R. and D. Murray. 1997. Alaska rare plant field guide. U.S. Dept. Interior, Washington, D.C. (loose leaf, without pagination)

McJannet, C., G. Argus, S. Edlund, and J. Cayouette. 1993. Rare vascular plants in the Canadian Arctic. Syllogeus no. 72. Canadian Museum of Nature.

Moss, E.H. 1959. Flora of Alberta. Univ. of Toronto Press, Toronto, Canada.

Moss, E.H. 1983. Flora of Alberta (ed. 2, rev. by J.G. Packer). Univ. of Toronto Press, Toronto, Canada.

Muir, J. 1883. Cruise of the Revenue-Steamer Corwin in Alaska and the N.W. Arctic Ocean in 1881. Notes and memoranda: medical and anthropological; botanical; ornithological. Govt. Print. Off., Washington.

Muir, J. 1917. The Cruise of the Corwin. Journal of the arctic expedition of 1881 in search of DeLong and the Jeannette. Houghton Mifflin Co., N.Y.

Murray, D.F. and R. Lipkin. 1987. Candidate threatened and endangered plants of Alaska with comments on other rare plants. Univ. Alaska Mus., Fairbanks.

Nesom, G.L. 2004. Taxonomic reevaluations in North American *Erigeron* (Asteraceae: Astereae). Sida 00:000–000.

Packer, J.G. and R. Witkus. 1982. In IOPB chromososome number reports LXXV. Taxon 31: 363–364.

Petrovsky, V.V. 1987. *Erigeron*. In: B.A. Yurtsev, ed. Arctic Flora USSR. Vol. X. Nauka, Leningrad. (in Russian)

Polunin, N. 1959. Circumpolar arctic flora. Oxford Univ. Press, Oxford at the Clarendon Press.

Porsild, A.E. 1955. The vascular plants of the western Canadian Arctic Archipelago. Natl. Mus. Canad. Bull. 135.

Porsild, A.E. 1974 [1975]. Materials for a flora of Central Yukon Territory. Natl. Mus. Canada, Publ. Botany 4:1–77.

Porsild A.E. and W.J. Cody. 1980. Vascular plants of the Continental Northwest Territories, Canada. National Museum of Canada, Ottawa.

Scoggan, H.J. 1979. The flora of Canada. Part 4–Dicotyledoneae (Loasaceae to Compositae). Natl. Mus. Nat. Sci. Publ. Bot. No. 7(4).

Spongberg, S.A. 1971. A systematic and evolutionary study of North American arctic and alpine monocephalous species of *Erigeron* (Compositae). Ph.D. diss., Univ. of North Carolina, Chapel Hill.

Spongberg, S.A. 1973. A new Alaskan species of *Erigeron* L. (Compositae). Rhodora 75: 116–119.

Tzvelev, N.N. (ed.). 2002. Flora of Russia: The European part and bordering regions. Vol. VII. A.A. Balkema, Rotterdam/Brookfield.

Weber, W.A. 1987. Colorado flora: Western slope. Colorado Associated University Press, Boulder.

Weber, W.A. 1990. Colorado flora: Eastern slope. University Press of Colorado, Niwot.

WEBER, W.A. and R.C. WITTMAN. 1992. Catalog of the Colorado flora: A biodiversity baseline. Univ. Press of Colorado, Boulder.

WIGGINS, I.L. and J.H. THOMAS. 1962. A flora of the Alaskan arctic slope. Univ. of Toronto Press, Toronto, Canada.

YURTSEV, B.A., T.G. POLOZOVA, and N.A. SEKRETAREVA. 1989. Additions and corrections to the list of vascular plants of Wrangel Island. Communication 2. Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol. 94:116–126. (in Russian)

BOOK NOTICE

Ben-Erik van Wyk and Michael Wink. 2004. **Medicinal Plants of the World.** (ISBN 0-88192-602-7, hbk.) Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 480 pp., 793 color photos, 3 tables, 137 diagrams, 6 1/2" × 9 1/2".

Medicinal Plants of the World is a comprehensive and scientifically accurate guide to the best known and most important medicinal plants, including those of special commercial or historical interest. This book is a *Photographic* guide including info on their botany, main traditional uses, active ingredients, pharmacological effects and evidence of efficacy (if known) in a compact, colorful, reference text. *Medicinal Plants* does a wonderful job of conceptualizing the more than 320 plants in the book. The regulatory status of each plant is also given—whether it is listed in one or more pharmacopoeias, including the German Commission E monographs, the new ESCOP monographs of the European Community and the World Health Organization's series of monographs (all species treated in the last-mentioned three works will be found in this book). In the back of the book, the authors do well to include "A Quick Guide to Commercialized Medicinal Plants" and a "Glossary of Chemical, Medical and Pharmaceutical Terms." The book seems to be geared toward the specialist and not the "average gardener." The guide is organized alphabetically by genus species, and common names in subtitles. Without some previous knowledge of botanical names, the user will be referencing the index frequently. Nine hundred plants are covered in the book, but 320 have comprehensive detail including: plant description, geographic origin, therapeutic category, historical and modern uses, active ingredients and pharmacological effects.—*Asha McElfish, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NOTES ON TYPIFICATION IN *PLUCHEA* (ASTERACEAE: PLUCHEAE)

Guy Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Formal nomenclature and typification are detailed for taxa of the *Pluchea odorata*—*Pluchea camphorata* group. Lectotypes are designated for *Pluchea glabrata* DC., *Conyza marilandica* Michx., *Gynema viscida* Raf., *Pluchea petiolata* Cass., and *Conyza camphorata* Pursh. *Pluchea* (*Conyza*) *marilandica* (Michx.) Cass., which is the type of the genus, is based on a Dillenius illustration that shows features anomalous for *Pluchea*. The identity of several other pertinent taxa also remains ambiguous, but none of them appears to have a bearing on currently accepted nomenclature.

RESUMEN

Se detalla la nomenclatura formal y la tipificación de taxa del grupo *Pluchea odorata*—*Pluchea camphorata*. Se designan lectotipos para *Pluchea glabrata* DC., *Conyza marilandica* Michx., *Gynema viscida* Raf., *Pluchea petiolata* Cass., y *Conyza camphorata* Pursh. *Pluchea* (*Conyza*) *marilandica* (Michx.) Cass., que es el tipo del género, está basada en una ilustración de Dillenius que muestra características anómalas para *Pluchea*. La identidad de otros varios taxa también queda ambigua, pero ninguno de ellos parece tener importancia en la nomenclatura normalmente aceptada.

In connection with production of a taxonomic treatment of *Pluchea* for the Flora of North America (FNA) volumes of Asteraceae, an attempt is made here to clarify typifications for various names associated with two, relatively widespread species of *Pluchea* with petiolate, non-clasping leaves.

Pluchea odorata (L.) Cass.

The typical form of *Pluchea odorata* occurs from northern South America through the West Indies (the type is from Jamaica) and Mexico and is widely distributed through the southern United States, from California and Nevada to Texas and Oklahoma and eastward to North Carolina and Virginia. A large-headed variety of this species, primarily occurring in the northeastern United States, is *P. odorata* var. *succulenta* (Fern.) Cronq. (Cronquist 1980; Khan & Jarvis 1989).

Pluchea odorata (L.) Cass. [var. **odorata**]. *Pluchea odorata* (L.) Cass., Dict. Sci. Nat. 42:3. 1826. *Placus odoratus* (L.) M. Gómez , Anales Soc. Esp. Hist. Nat. 19:273. 1890. *Pluchea odorata* (L.) DC. var. *normalis* Kuntze, Revis. Gen. Pl. 1:357. 1891 (nom. invalid; includes the type of the autonym). *Conyza odorata* L., Syst. Nat., ed. 10. 1213. 1759. Linnaeus cited "Sloan. jam. t. 152. f. 1. Plum. ic. 97." LECTOTYPE (Urb. ex R.K. Godfrey 1952:241–242, 245): JAMAICA. Sloane, Voy. Jamaica 1: plate 152(1). 1707.

The plant illustrated is in the Sloane Herbarium—no data regarding collector, locality, or date (BM, photo Gillis (1977)!, internet image <http://internt.nhm.ac.uk/cgi-bin/botany/sloane/detail.dsml?ID=24>!). Although Godfrey's acceptance of an earlier choice of type by Urban formalized the lectotypification of *P. odorata*, Godfrey misinterpreted the Sloane illustration as referring to the woody species now generally identified as *Pluchea carolinensis* (Jacq.) D. Don. Application of this latter name was clarified by Khan and Jarvis (1989). The herbaceous species treated by Godfrey as *P. purpurascens* is correctly identified as *P. odorata* (see Gillis 1977).

Pluchea purpurascens (Sw.) DC., Prodr. 5:452. 1836. *Placus purpurascens* (Sw.) M. Gómez, Anales Soc. Esp. Hist. Nat. 19:273. 1890. *Conyza purpurascens* Sw., Prodr. 112. 1788. TYPE: JAMAICA: Swartz cited "Conyza l. Brown. jam. 318." and "Conyza major odorata—Sloan. h. l. 258. t. 152. f. 1.." Browne's citation (1756) was "Conyza major odorata, &c. Slo. Cat. 124. & H. t. 152. f. 1." in reference to the same Sloane illustration, which is the same as the lectotype of *Conyza odorata* L. (above). LECTOTYPE (Howard 1989:589): JAMAICA. Sloane, Voy. Jamaica 1: plate 152(1). 1707. The plant illustrated is in the Sloane Herbarium, as cited above for *Pluchea odorata*.

Pluchea purpurascens (Sw.) DC. var. *glabrata* (DC.) Griseb., Cat. Pl. Cub. 150. 1866. *Placus purpurascens* (Sw.) M. Gómez var. *glabratus* (DC.) M. Gómez, Anales Soc. Esp. Hist. Nat. 19:273. 1890. *Pluchea glabrata* DC., Prodr. 5:452. 1836. TYPE: GUADELOUPE: de Candolle cited the following: "in Guadalupa legit olim cl. Badier et recentius Perrottet ad Pointe-à-Pitre." Of specimens identified as *Pluchea glabrata* in the de Candolle herbarium, one is labeled simply "Guadeloupe" and may be the Badier collection; another has more specific data—"Pte. à Pitre, 17 Juin 1824, Perrottet 1825." This plant also was collected on Guadaloupe, and (Urban 1902) indicates that Perrottet was there at least for a period during 1824. The Perrottet collection is designated here as the LECTOTYPE (G-DC fiche 905!).

Pluchea petiolata Cass., Dict. Sci. Nat. 42:2. 1826. TYPE: Details of the protologue are too abbreviated to establish the identity: "ses calathides sont petites, subglobuleuses, et disposées en corymbe terminal; ... ses squames sont ovales, aiguës, presque membraneuses, parsemées de glandes ..." The description of small heads with acute, membranous, sparsely glandular phyllaries suggest that it might be *Pluchea camphorata*, but the heads in a terminal corymb and ovate phyllaries are more like *Pluchea odorata*. Cassini noted that "Nous avons observé cette plante dans l'herbier de M. de Jussieu, ou elle étoit innommée," citing no further detail. One of two specimens in the Jussieu herbarium might have been the one observed by Cassini.

(1) **Cat. No. 8646** (P-Jussieu, fiche 634!)—identified as "*Conyza marylandica* Michx.," with no collection information. The plant has short-petiolate leaves and a terminal capitulescence and is *Pluchea odorata*.

(2) **Cat. No. 8662** (P-Jussieu, fiche 635!)—identified only as "Conyza vulgari accedens Fl. purpurasc.," apparently collected on Hispaniola ("St. Domingo"); this plant also has short-petiolate leaves and a terminal capitulescence and is a representative of *Pluchea odorata* var. *odorata*. This specimen is here designated as the LECTOTYPE of *Pluchea petiolata* Cass.

Pluchea camphorata (L.) DC. var. *angustifolia* Torr. & A. Gray, Fl. N. Amer. 2:261. 1842. *Conyza angustifolia* Nutt., J. Acad. Nat. Sci. Philadelphia 7:109. 1834 (non Roxburgh 1832). TYPE: USA. "In South Carolina, from whence it was received by Mr. Durand" (specimen not located). Torrey and Gray cited the Nuttall publication in full and apparently intended to recognize Nuttall's *Conyza angustifolia* at reduced rank, not realizing that the basionym published by Nuttall was a later homonym. Following Article 58 of the ICBN (Saint Louis Code 2000), the name at varietal rank can be attributed to Torrey and Gray as a nomen novum.

Pluchea odorata var. **succulenta** (Fern.) Cronq. *Pluchea purpurascens* (Sw.) DC. var. *succulenta* Fern., Rhodora 44:227. 1942. *Pluchea odorata* var. *succulenta* (Fern.) Cronq., Fl. Southeast. U.S. 1:175. 1980. TYPE: UNITED STATES. MASSACHUSETTS: Back Bay, Boston, ditch in old marsh, 17 Sep 1910, *E.F. Williams s.n.* (HOLOTYPE: GH!).

Pluchea marilandica (Michx.) Cass., Dict. Sci. Nat. 42:2. 1826. *Conyza marilandica* Michx., Fl. Bor. Amer. 2:126. 1803. TYPE: Michaux cited "DILL. Elth. t. 88. f. 104. nondum perfecte florida" and gave as possible synonyms "*Baccharis foetida*? Walt." and *Erigeron camphoratum*? Linn." He noted that the habitat was "a Pensylvania ad Carolinam." The LECTOTYPE, (designated here) must be the Dillenius illustration, the only element cited in the protologue by Michaux: Hortus elthamiensis 1: t. 88. f. 104. 1732. This plant is identified in the Hortus as "Conyza Marilandica, flore purpureo" and is shown with broadly lanceolate, sessile, serrate leaves and minutely pubescent stems (as illustrated), but the capitulescence is relatively elongate, broken into several subclusters borne on leafy branches and illustrated details show the heads as cylindric-campanulate with phyllaries in ca. 4–5 series and the bisexual florets as strongly goblet-shaped, features not characteristic of *Pluchea*. The specimen in the Sherardian Herbarium (OXF) upon which the drawing was based was identified as "Conyza marylandica" by Klinsmann (fide Druce and Vines 1907).

The voucher specimen at OXF, notated ".88 104 105," bears two branches and was annotated by James Reveal in 1982 as *Pluchea purpurascens* (= *P. odorata*). A digital image made available by Stephen Harris, Curator of Oxford University Herbaria, confirms that identity. An early annotation identifies it as "*Pluchea marylandica*." According to Dr. Harris (pers. comm), "This is the specimen that Druce placed into the Hortus sequence when he worked on the material with Vines in the early 1900s. However, the specimen appears to have been incorporated from the Sherardian Herbarium and bears a different polynomial from that given in the Hortus." Clokie (1964, p. 89) observed that "very few of the specimens that [Druce] did take out [of the Sherard Herbarium] can be identified as originals of the plants in the Hortus Elthamiensis" and she noted specifically that the voucher for t. 88, fig. 104 is 'not the original specimen." The original label on the OXF sheet identifies the collection first as "Baccharis mariana flora pulchra rubenta Acta Philos. No. 246. pag. 401. pl. 22 1690" (by Sherard), then as "Conyza mariana flora pulchra rubenta Mem. Ac. R. Sc. 1719. p. 299 n.s." (by Dillenius). Thus, the identity of this specimen is clear, but its status as a voucher for the subject of the Dillenius illustration is not. Because Cassini typified his new genus *Pluchea* by *Pluchea marilandica*, typification of the genus is ambiguous to the same extent.

In Cassini's establishment of the genus and transfer of *Conyza marilandica* to *Pluchea*, he noted "Cette plante habite l'Amerique septentrionale" and described "l'enchantillon que nous avons observé dans l'herbier de Michaux ... ." Two plants in the Michaux herbarium (P!, P-Michaux fiche 100!) are identified as *Conyza* '*marylandica*.' One is labeled simply "Conyza[,] Maryland," while the second plant is labeled "Conyza marylandica[,] Virgin. et Carol."—both specimens are representatives of *Pluchea camphorata*, although the morphological details included by Cassini (Dict. Sci. Nat. 42:2) do not clearly indicate that he was describing *P. camphorata* rather than *P. odorata*.

Pluchea camphorata (L.) DC.

Based on a photograph of the type of *Erigeron camphoratus* L. received at Harvard from the British Museum, Fernald (1939) made this assessment: "That it is a fragment from the summit of a plant of *P. petiolata* Cass. will be evident to those who know that plant" (p. 461, photo published on p. 459). Fernald's judgement has been accepted by those who have dealt with this common species (e.g. Godfrey 1952, Cronquist 1980, Nesom 1989, and various other floristicians) and is confirmed here. A color image of the Clayton specimen is currently internet-posted as part of the John Clayton Herbarium (The Natural History Museum 2000).

Pluchea camphorata (L.) DC., Prodr. 5:451. 1836. *Erigeron camphoratus* L., Sp. Pl. 864. 1753. Linnaeus cited "Hort. ups. 259" and "Gron. virg. 97. Habitat in Virginia." Gronovius (Flora Virginica, ed. 1, 1739, p. 96) provided a description and referred to "Clayt. n. 165." The description in Linnaeus's own Hortus Upsaliensis of 1748 was nearly identical to the later one of 1753 and also referred to "Gron. virg. 96." As observed by Fernald (1939, p. 460), "Linnaeus composed his diagnosis by adding a portion of Clayton's own description [on the specimen itself] of his plant to that of Gronovius." LECTOTYPE (Fernald 1939:459–461): UNITED STATES. VIRGINIA: without other data, *Clayton 165* (BM!, photo-GH!, photo-Fernald (1939)!, internet image <http://internt.nhm.ac.uk/cgi-bin/botany/clayton/ detail.dsml?RowID=234>!). Clayton's collections in Virginia were made mostly within "a modest-sized region south of the Rappahannock and north of the James River and west to the Blue Ridge" (Sterling 1997).

Pluchea viscida (Raf.) House, Amer. Midl. Naturalist 7:129. 1921. *Gynema viscida* Raf., Ann. Nat. 15. 1820. *Gynema dentata* Raf. ex DC. (in syn., sub *Pluchea foetida*), Prodr. 5:452. 1836. Type: Rafinesque noted that this is "A fine species not uncommon in Kentucky in fields and woods" but cited no specific collection. His description of the "flowers corymbose, terminal and axillary" is a good indication of the identity of the species, especially as only a single species of *Pluchea* is known to occur in Kentucky. Rafinesque (Ann. Nat. 1820) noted that he had previously identified it as *Gynema dentata*, apparently a manuscript name picked up and listed in synonymy by de Candolle. A specimen in the deCandolle herbarium from "Kentucky," without other collection data, is identified in the handwriting of Rafinesque as *Gynema viscida*; another annotation label, also in Rafinesque's hand, for the same plant identifies it as "*Gynema dentata* Raf. N. sp. and *Gynema balsamica* fl. ludov." This specimen serves to establish the identity of *Gynema viscida* (LECTOTYPE, designated here: G-DC, fiche 904!).

Pluchea camphorata (L.) DC. var *glabrescens* Kuntze (nom. nud. invalid.), Revis. Gen. Pl. 1.357. 1891. In the same short paragraph as the listing of *Pluchea camphorata* var. *pubescens* (see below), Kuntze noted "Die bis auf Blattnerven fast kahl werdende Form ist b *glabrescens* O. Ktze. = *Baccharis foetida* L. p.p." No pertinent herbarium material located (fide Fernald 1942; none at NY).

Pluchea camphorata (L.) DC. var. *pubescens* Kuntze (nom. nud. invalid.), Revis. Gen. Pl 1:357. 1891. Fernald (1942, p. 228) observed that "since Kuntze gave no word of description, the name cannot be taken up" (see 1998 ICBN Article 32.1). Kuntze cited only "U. St.: Hoboken [New Jersey], Cairo [Illinois], Miss. [Mississippi? or Missouri?]." A Kuntze collection filed with NY types is marked "b *pubescens*": Illinois, Cairo, 9 Aug 1874, *C.E.O. Kuntze 2886* (NY!).

Doubtful identity

Conyza camphorata Pursh, Fl. Amer. Sept. 2:523. 1814 (non *Erigeron camphoratus* L.). TYPE: Pursh cited only "Icon. Dill. elth. t. 89. f. 105," and this illustration pre-

> sumably must be taken as the LECTOTYPE, designated here: Hort. eltham. 1: t. 89. f. 105. 1732. The Dillenius plate is identified as "Conyza American frutescens, foetidissima Vaill." The indication of its 'foetid' nature supports its identification as *Pluchea*, but no details of florets or fruits were illustrated, and the large, sessile, coarsely serrate-dentate leaves, glabrous stems (as illustrated), axillary clusters of heads, and peculiar renditions of the heads (suggesting linear, equal-length phyllaries) do not support a firm identification even at generic rank.

As a synonym of *Conyza camphorata*, Pursh listed *Baccharis foetida* (in the sense of Willdenow and Walter), which is *Pluchea camphorata* in the sense of the present manuscript. Pursh included *Erigeron camphoratus* [L.] (sensu Willdenow) as a synonym in his treatment of *Conyza marylandica* Michx. Tenets of previous nomenclatural confusion between *Pluchea (Baccharis) foetida* (L.) DC. and the North American petiolate-leaved species of *Pluchea* were outlined by Godfrey (1952).

ACKNOWLEDGMENTS

I am grateful to the staffs of GH, BM, and P for help during recent visits there. Prior to my visit, Charlie Jarvis of the British Museum made critical and accurate observations on the type of *Pluchea (Erigeron) camphorata*. The staff of P also provided a digital image of the specimen cited here as lectotype of *Pluchea petiolata* Cass. Stephen Harris (OXF) made available a digital image of the voucher for the Dillenius illustration of *Conyza marilandica* and comments regarding its origin. James Macklin (PH) searched for the type of *Conyza angustifolia* Nutt. I am grateful to an anonymous reviewer and especially to K. Gandhi (GH) for his helpful comments in review.

REFERENCES

Browne, P. 1756. The civil and natural history of Jamaica. London [reprinted 1972, Arno Press, New York].

Clokie, H.N. 1964. An account of the Herbaria of the Department of Botany in the University of Oxford. Oxford University Press, Oxford.

Cronquist, A. 1980. Flora of the southeastern United States. Vol. 1. Asteraceae. Univ. of North Carolina Press, Chapel Hill.

Druce, G.C. and S.H. Vines. 1907. The Dillenian Herbaria. Clarendon Press, Oxford.

Fernald, M.L. 1939. The identity of *Pluchea camphorata*. Rhodora 41:459–461.

Fernald, M.L. 1942. *Pluchea purpurascens* (Sw.) DC., var. *succulenta*, var. nov. Rhodora 44: 227–228.

Gillis, W.T. 1977. *Pluchea* revisited. Taxon 26:587–591.

Godfrey, R.K. 1952. *Pluchea*, section *Stylimnus*, in North America. J. Elisha Mitchell Sci. Soc. 68:238–271.

Howard, R.A. 1989. Flora of the Lesser Antilles: Leeward and Windward Islands, vol. 6. Arnold Arboretum, Harvard University. Jamaica Plain, Mass.

Khan, R. and C.E. Jarvis. 1989. The correct name for the plant known as *Pluchea symphytifolia* (Miller) Gillis (Asteraceae). Taxon 38:659–662.

Nesom, G.L. 1989. New species, new sections, and a taxonomic overview of American *Pluchea* (Compositae: Inuleae). Phytologia 67:158–167.

Sterling, K.B. 1997. John Clayton. In: Sterling, K.B., R.P. Harmond, G.A. Cevasco, and L.F. Hammond. Biographical Dictionary of American and Canadian Naturalists and Environmentalists. Greenwood Press, Westport, Connecticut. Pp. 154–156.

The Natural History Museum. 2000. The John Clayton Herbarium. Dept. of Botany, The Natural History Museum, Cromwell Road, London, SW7 5BD, UK. <http://www.nhm.ac.uk/botany/clayton/>; accessed December 2000.

Urban, I. 1902. Notae biographicae peregrinatorum Indiae occidentalis botanicorum. Symb. Antill. 3:14–146.

A REVIEW OF *CRATAEGUS* SERIES *ROTUNDIFOLIAE* (ROSACEAE) IN WESTERN CANADA

J.B. Phipps

Dept. of Biology
The University of Western Ontario
London, Ontario, N6A 5B7, CANADA
jphipps@uwo.ca

R.J. O'Kennon

Botanical Research Institute of Texas
509 Pecan St.
Fort Worth, Texas, 76102-4060, U.S.A.
okennon@brit.org

ABSTRACT

This paper discusses the circumscription of *Crataegus* ser. *Rotundifoliae* and provides identificatory materials (full descriptions, line illustrations and specimen citations where not previously available) for the taxa of the series occurring in western Canada, defined for the purposes of this paper as British Columbia and Alberta. The variable, widespread and common species *C. chrysocarpa* is reviewed for this area and a local, rather distinct new variety, var. *vernonensis*, is recognized. In addition, one species new to science, *C. sheila-phippsiae* is described.

Key Words: *Crataegus*, Rosaceae, ser. *Rotundifoliae*, western Canada, *C. sheila-phippsiae* sp. nov., *C. chrysocarpa* var. *vernonensis* var. nov.

RESUMEN

Se discute la circunscripción de *Crataegus* ser. *Rotundifoliae* y se ofrecen materiales de identificación (descripciones completas, ilustraciones y citas de especímenes que no estaban disponibles previamente) para los taxa de la serie que se encuentran en el oeste de Canadá, definido a los efectos de este artículo como Columbia Británica y Alberta. La especie variable, muy difundida y común *C. chrysocarpa* es revisada para esta área y se reconoce una nueva variedad local bastante diferente, var. *vernonensis*. Además se describe una nueva especie para la ciencia, *C. sheila-phippsiae*.

Since the first author's review (Phipps 1997) of red-fruited *Crataegus* in western North America was prepared, intensive collecting, particularly in the British Columbia Okanagan, has revealed a number of new species, especially in ser. *Purpureofructi* J.B. Phipps & O'Kennon and ser. *Douglasianae* (Rehder ex C.K. Schneider) Rehder. Here, we deal with ser. *Rotundifoliae* (Eggl.) Rehder (1940) in western Canada, a very wide-ranging series of hawthorns. They occur from the Pacific Northwest of the USA and southern British Columbia in a broad band through southern Canada and the northern United States to Newfoundland and southern New England extending locally southward, in the Rocky Mountains to Colorado and in the Appalachians to northern North Carolina.

The series is a re-ranking of Eggleston's section *Rotundifoliae* (1908b) which in turn is a renaming of Sargent's (1905) 'natural group' *Coccineae* which Eggleston (1908b) considered to be improperly typified. If one follows Eggleston (op. cit.) in which *C. rotundifolia* Moench is divided into two varieties, var. *rotundifolia* (now *C. dodgei* Ashe) and var. *chrysocarpa* (Ashe) Eggl. (now *C.*

SIDA 21(1): 65–77. 2004

chrysocarpa Ashe), one might typify series *Rotundifoliae* with *C. dodgei*, which would seem plausible as *C. dodgei* possesses a round to broadly elliptic leaf and *C. chrysocarpa* normally possesses a ± rhombic leaf. Unfortunately, Moench's illustration (1785) shows a hawthorn with an elliptic leaf, pointed at both ends, nothing like the leaf-shape of *C. dodgei* and not much like that of *C. chrysocarpa* and, regrettably, completely at variance with the text of the protologue. The poor quality of Moench's protologue for *C. rotundifolia* was further compounded by the fact that his name was invalid, *C. rotundifolia* Lam. (1783) being an earlier name for a different species.

In this paper, we avoid the problems associated with typifying *C. rotundifolia*, by considering both *C. chrysocarpa* and *C. dodgei* (not in the area of this paper) to be members of series *Rotundifoliae*. Nevertheless, there is a serious argument for separating *C. dodgei* and immediate relatives from *C. chrysocarpa* and immediate relatives to create two series at which point the typification problem would need to be addressed. In western Canada, all members of series *Rotundifoliae* fall into the *C. chrysocarpa* group and there is considerable variation within it, some only recently recognized.

Inasmuch as the *C. dodgei* group does not occur in western Canada and is perhaps best treated as a different series as suggested above, the following characteristics of ser. *Rotundifoliae* may be understood as only applying to the western forms of the series, i.e. the non-*dodgei* group of species. Series *Rotundifoliae* in this restricted sense are among the smaller hawthorns, typically multi-stemmed bushes 2–4 m tall and very thorny. The leaves are ± rhombic to ± ovate in shape, 2–4 lobed per side with LII (leaf incision index; IFI in latin) 5–20 %, rather glandular on the margins and petiole and typically very hairy adaxially. Anthesis is early, inflorescences 5–18 flowered, with usually pubescent branches bearing caducous, linear-oblong, gland-margined bracteoles. Flowers are mid-sized, 13–18 mm diam.; hypanthium usually hairy; calyx-lobes quite strongly glandular but weakly serrate; stamens 10 or rarely 20; anthers ivory to cream or less commonly pink; styles 3–4. Fruit 8–12 mm diam., usually ±orbicular, hairy or not; calyx-lobes spreading else broken off; nutlets 3–4, sides smooth.

At least superficially, the most similar series in western Canada are *Macracanthae* (Loud.) Rehder with eglandular petioles and laterally eroded nutlets and *Purpureofructi*, which are much larger plants, have stout, shorter thorns and plum-red to purple-black ripe fruit with sides of nutlets ± eroded. Eggleston (1909) placed his *C. williamsii* in ser. *Rotundifoliae* but this species has laterally eroded nutlets, generally slightly larger leaves and is now placed in ser. *Purpureofructi*.

The region explicitly covered by this paper is British Columbia and Alberta although the descriptive text should also cover *C. chrysocarpa* in Saskatchewan and Manitoba.

TAXONOMIC TREATMENT

We recognize here two species of ser. *Rotundifoliae*: *C. chrysocarpa* and *C. sheila-phippsiae*, the former with three varieties. The last-named species is new to science and brings to five the number of *Crataegus* species endemic to the remarkable hawthorn-rich region of the northern Okanagan. The detailed locations cited may be found, more or less precisely, by reference to our sketch-map (Fig. 1).

KEY TO SPECIES

1. Stamens 20; inflorescences glabrous **1. C. sheila-phippsiae,** sp. nov.
1. Stamens 10; inflorescences normally ± hairy **2. C. chrysocarpa**

1. Crataegus sheila-phippsiae J.B. Phipps & O'Kennon, sp. nov. (**Fig. 2**) TYPE: CANADA: BRITISH COLUMBIA. Northern Okanagan, Spallumcheen Mun., McLeery Rd, 50° 20' 59" N, 110° 08' 40" W, roadside, edge of thicket, 1314 ft a.s.l., bush 4.5 m tall, 18 pale pink anthers, 16 May 2002, *J.B Phipps 8334* (HOLOTYPE: UWO; ISOTYPES: ALTA, CAN, DAO, TRT, UBC, UVIC, V).

Frutices, usiter arborescentes, 3–5 m alti; spinae 2.5–4 cm longae; ± tenues vel validae, rectae vel leviter recurvatae, annotinae nitenter atrobrunneae, veteriores atrocinereae; ramuli extendentes glabri, virides; annotini valde nitento-brunnei, veteriores atrocinerei. Folia decidua; petioli 10–20 mm longi, graciles, pubescentes, glandulis secundum sulcum paucis vel pluribus; laminae 4–5 cm longae, ± rhombeae in forma generali, apex acuminata, basis cuneata; 3–4 arguti lobi per latus, max. IFI ca. 20%; margines cum parvissimis acutis dentibus; superficies adaxiales scabro-pubescentes, abaxiales pilosae solo in venis principalibus et in axillis; venatio craspedodroma, 4–5 nervatae per latus. Inflorescentiae 8–18-florae; ramuli glabri, bracteolis caducis, linearibus, membranaceis, glandulo-marginatis. Flores 14–19 mm diam.; hypanthium glabrum extrinsecus; lobi calycis triangulares, glandulo-marginati sed vix serrati; petala alba, ± circularia; stamina 18–20, antheris pallide roseis (raro moderate roseis - *Jackson for Phipps 8407*); styli 4–5, exorientes a caespite parvo pilorum. Fructus 10–12 mm diam., subglobosi, clare carmineo-scarlatini in Augusto exeunte, in maturitate fortiter rubro-purparei; lobi calycis patentes; pyrenae 4–5, dorsaliter sulcatae, lateribus planis.

Shrub, usually somewhat tree-like, 3–5 m tall; thorns 2.5–4 cm long, moderately slender to a little stout, straight or slightly recurved, dark shiny blackish brown at 1 yr, older deep gray; extending twigs glabrous, green, at 1 yr rich shiny brown, older gray. Leaves deciduous; petioles 10–20 mm long, slender, with few to several glands along the sulcus, pubescent; blades 4–5 cm long, ± rhombic in general shape, tip acuminate, base cuneate, 3–4 sharp lobes per side; max LII ca. 20%; margins with very small sharp teeth; scabrous-pubescent adaxially, hairy in the axils and parts of the main veins abaxially; venation craspedodromous, ca. 5 veins/side. Inflorescences 8–18 flowered; branches glabrous bearing early caducous, linear, membranous, gland-margined bracteoles. Flowers 14–19 mm diam.; hypanthium externally glabrous; calyx-lobes triangular, gland-margined, barely serrate; petals white, ± circular; stamens 18–20, normally pale pink but occasionally medium-pink (*Jackson for Phipps 8407*) or puce (*Phipps & O'Kennon 6917*); styles 4–5, arising from a small tuft of hairs. Fruit 10–12 mm diam., subglobose, brilliant crimson-scarlet in late August deepening to a dark burgundy at full ripeness, sepals spreading; nutlets 4–5, dorsally grooved, sides plane.

Crataegus sheila-phippsiae is a relatively scarce species restricted to the northern Okanagan of British Columbia but in some localities rather common as, for instance, just north of the Indian Cemetery on hwy 97A about 2 km south of Enderby. It grows in relatively open and apparently rather dry sites and as such appears to be quite xeromorphic like other members of the same series.

Crataegus sheila-phippsiae is a typical rhombic-leaved member of ser. *Rotundifoliae*. It is easily differentiated from *C. chrysocarpa* var. *chrysocarpa*, to which it is most similar, by its ± glabrous nature, 20 stamens, usually pale pink anthers and greater single-trunk dominance. In the past difficulties have arisen differentiating *C. sheila-phippsiae* from *C. shuswapensis* (ser. *Douglasianae*) in flower in those rare cases where *C. shuswapensis* has 15–18 stamens but we believe that they are now most easily resolved at the flowering stage by the better development of abaxial tufts of hair in the vein axils of *C. sheila-phippsiae* whereas *C. shuswapensis* is usually glabrous there. When in fruit, however, *C. shuswapensis* is quite different from *C. sheila-phippsiae*. The authors now suspect that the attribution of 18 stamens to *C. shuswapensis* in Phipps & O'Kennon (2002) may refer to a plant of *C. sheila-phippsiae* with deeply colored anthers. Of course, the critical eye will also notice differences in leaf color and slight differences in shape, together with subtle habit differences, all difficult to put into words. Also anther color in *C. shuswapensis* is much more variable than in *C. sheila-phippsiae*, ranging from pink to puce.

Persons with the resources might investigate the possibility that *C. sheila-phippsiae* may be a diploid, sexual counterpart of *C. chrysocarpa*, like the *C. suksdorfii*/ *douglasii* pair so elegantly demonstrated by Dickinson et al. (1996).

The species epithet recognizes the important contribution to the study of hawthorns by Sheila Phipps, wife of the first author, which include the typing over the years of hundreds of pages of manuscript, help with proofing of printed text, tending to young *Crataegus* seedlings and assisting at the scene the year this species was recognized in the field with certainty for the first time.

Additional specimens examined: **CANADA: British Columbia.** Northern Okanagan. Mabel Lake Rd., 1.0 km E of centre of Shuswap R. bridge at Enderby, bush 3.5 m tall, fruit burgundy, 07 Sep 2001, *J.B. Phipps 8279 & R.J. O'Kennon* (BRIT, UWO); ca 1.2 mi E of Enderby on road to Mabel Lake, bush 3 m tall, fruit burgundy-red, 20 Aug 1994, *J.B. Phipps 7015a & R.J. O'Kennon* (UWO); ca. 1 mi S of Enderby, gravel driveway to NNE off hwy 97A at Indian Cemetery, bush 2.5 m tall, fruit deep blood red, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7003* (BRIT, UWO); same loc., bush 2.5 m tall, pink anthers, 16 May 2002, *J.B. Phipps 8335* (BRIT, UWO); same loc., bush 2.5 m tall, 20 pale pink anthers, 16 May 2002, *J.B. Phipps 8336* (BRIT, UWO). Same loc., bush 4 m tall, 20 pale pink anthers, 16 May 2002, *J.B. Phipps 8338* (BRIT, UWO); same loc., bush 2.5 tall, 20 pale pink anthers, 16 May 2002, *J.B. Phipps 8339* (BRIT, UWO); same loc., bush 3 m tall, 20 pale pink anthers, 16 May 2002, *J.B. Phipps 8340* (BRIT, UWO); same loc., bush 3 m tall, 20 pale pink anthers, 16 May 2002, *J.B. Phipps 8342* (BRIT, UWO). Same loc., bush 3 m tall, anthers 18, light pink, 22 May 2002, *R. Jackson for J.B. Phipps 8380* (BRIT, UWO); same

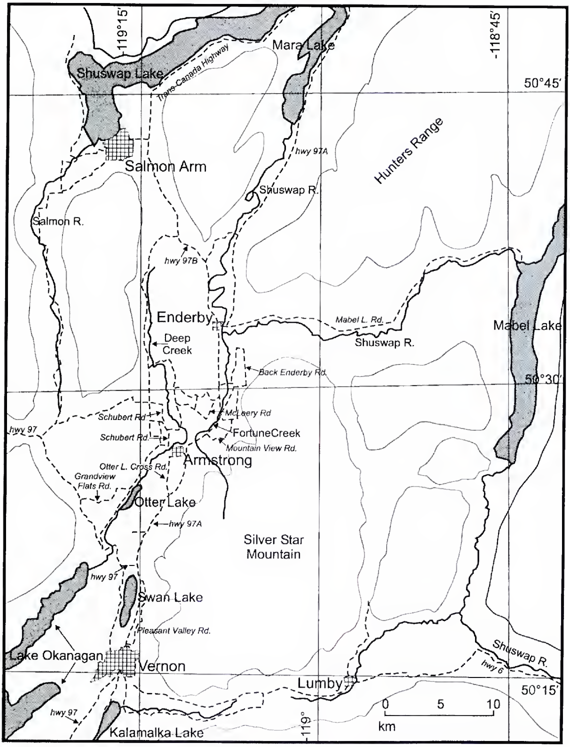


Fig. 1. Sketch-map of the Northern Okanagan-southwestern Shuswap drainage area.

loc., bush 2 m tall, 20 light pink anthers, 22 May 2002, *R. Jackson for J.B. Phipps* 8381 (BRIT, UWO); same loc., bush 3 m tall, 20 light pink anthers, 22 May 2002, *R. Jackson for J.B. Phipps* 8383 (BRIT, UWO); same loc., large bush, 20 light pink anthers, 22 May 2002, *R. Jackson for J.B. Phipps* 8384 (BRIT, UWO); same loc., fruit deep red, 25 Aug 2002, *R. Jackson for J.B. Phipps* 8458 (BRIT, UWO); same loc., fruit very dark red to deep purple, 22 Sep 2002, *R. Jackson for J.B. Phipps* 8475 (BRIT, UWO);

Spallumcheen Mun., Schubert Rd., bush 2 m tall, fruit reddish plum, 19 Aug 1995, *J.B. Phipps 7168* (BRIT, UWO); same loc., bush, 3.5 m tall, pale pink anthers, 18 May 2002, *J.B. Phipps 8362* (BRIT, UWO); Spallumcheen Mun., McLeery Rd., bush 3 m tall, fruit crimson-scarlet, 23 Aug 2000, *J.B Phipps with S.R. Phipps 8174* (BRIT, UWO); same loc., large bush, anthers 20, light pink, 20 May 2002, *R. Jackson for J.B. Phipps 8376* (BRIT, UWO); Spallumcheen Mun., Stepney Cross Rd., bush 4.5 m tall, fruit reddish-burgundy, 06 Sep 2001, *J.B. Phipps with R.J. O'Kennon 8270* (BRIT, UWO); Spallumcheen Mun., Otter Lake Rd., just N of Otter Lake Cross Rd., fruit very dark, 22 Sep 2002, *R. Jackson for J.B. Phipps 8476* (BRIT, UWO); same loc., 25 Aug 2002, *R. Jackson for J.B. Phipps 8461* (BRIT, UWO); Spallumcheen Mun., Otter Lake Cross Rd. between Hales Rd. and Crozier Rd., bush 2.5 m tall, fruit burgundy or darker, 20 stamens, 06 Sep 2001, *J.B. Phipps & R.J. O'Kennon 8269* (BRIT, UWO); same loc., bush, 3.5 m tall, pale pink anthers, 18 May 2002, *J.B. Phipps 8362* (BRIT, UWO); same loc., bush 1.5m tall, 10 May 2002, *J.B. Phipps 8311a* (BRIT, UWO); same loc., bush, 2 m tall, 20 stamens, pale pink anthers, 18 May 2002, *J.B. Phipps 8361* (BRIT, UWO); same loc., fruit deep red, 25 Aug 2002, *R. Jackson for J.B. Phipps 8462* (BRIT, UWO); some additional duplicates will be distributed later.

2. Crataegus chrysocarpa Ashe, 1900 (FIREBERRY HAWTHORN). *Crataegus rotundifolia* Moench, 1785, sens. auctt., non Lam., 1783. *Crataegus columbiana* Howell, 1898, sens. auctt. Amer. *Crataegus piperi* Britton, 1901. *Crataegus chrysocarpa* var. *piperi* (Britton) Kruschke (1965). *Crataegus columbiana* var. *chrysocarpa* (Ashe) Dorn, 1988. *Crataegus rotundifolia* var. *chrysocarpa* (Ashe) Eggl., 1908a. *Crataegus columbiana* var. *piperi* (Britt.) Eggl.,1908a. TYPE: U.S.A.: COLORADO. LARIMER CO.: foothills of Cache le Poudre Mountains, 6000 ft, 20 Aug 1899, *W.W. Ashe s.n.* (NY!).

Bushes 2–3.5 m tall, sometimes colonial; extending twigs usually appressed-pubescent; 1-year old branches usually dull yellowish-greenish brown or gray-brown to light tan in the east, rich tan but sometimes (as in MN and QU) shiny deep reddish- brown; thorns variable, 3–6 cm long, ± slender to ± stout, straight to slightly recurved, shiny, dark mahogany or blackish at 1 yr. Leaves deciduous; petioles 1–2.5 cm long, ± pubescent, usually narrowly winged distally, ± glandular at least initially; laminas 2–6 cm long, ± rhombic to broad-elliptic, very occasionally broad-ovate in general shape, 2–4 lobed, the lobes sharp to blunt, LII 5–20%; margins with numerous small teeth, these caducous gland-tipped; venation craspedodromous, about 5–6(–7) main lateral veins per side; usually appressed-short pubescent above and pubescent mainly on the veins beneath, variably glabrate later; autumn color yellow, or purplish in very dry spots. Inflorescence 5–10 flowered; branches densely to sparsely villous, bearing caducous, linear, membranous, gland-margined bracteoles; anthesis early. Flowers ca. 15–20 mm diam.; hypanthium villous; calyx-lobes ca. 4 mm long, triangular, margins glandular-serrate, pubescent abaxially; petals ± circular, white; stamens 10(–20), anthers only cream or ivory in the area covered by this paper, styles 3–4(–5). Fruit 8–10 mm diam., usually ± spherical, usually scarlet to deep red or darkened to burgundy if dried and shriveled, ± pubescent, calyx remnants present. Nutlets 3–4(–5), grooved dorsally, their faces plane.

Crataegus chrysocarpa is the second most wide-ranging of North American *Crataegus* species reaching from the landward side of the coastal ranges in

FIG. 2. Line drawing of *C. sheila-phippsiae* from *J.B. Phipps 8332* (UWO) *and J.B. Phipps & R. O'Kennon 6810* (UWO), flowering and flower details; *R. Jacksan for J.B. Phipps 8461* (UWO), fruiting and fruit detail. Scale bars = 1 cm. S. Laurie-Bourque del.

British Columbia, Washington and Oregon to the Atlantic. Its southern limit is Colorado, further north than the New Mexico and Arizona southern limit for *C. macracantha* which otherwise has a broadly similar but rather more southerly range. *Crataegus chrysocarpa* is abundant in the grasslands of the Canadian Prairie Provinces where it nearly always occurs in sunny areas in the bottoms of draws, seepage zone edges on slopes or along shallow ditches. It may also be found occasionally under aspen, generally at the edge of a stand or where the stand is thin and is found in similar habitats in valleys of the inter-mountain areas. *Crataegus chrysocarpa* is the most northerly and cold-adapted species of *Crataegus* in North America nearly reaching Hudson Bay in Ontario.

Crataegus chrysocarpa is a multi-stemmed bush, small for a hawthorn, usually 2–4 m high and, not surprisingly for so abundant a species, somewhat variable, although through most of its western range rather uniform. However a fairly well-marked regional variant, var. *piperi*, which is more thoroughly discussed in Phipps (1997) and which might be worth raising to subspecific rank, occurs west of the Rocky Mountains.

Crataegus piperi has also been synonymized with *C. columbiana* Howell but the first author showed that *C. columbiana* was based on two species and lectotypified it on the *C. douglasii* element (Phipps, 1995). The characteristic ripe fruit color of *Crataegus chrysocarpa* var. *chrysocarpa* in western Canada is bright red, in spite of the species epithet. However, about the third week of August it is a fairly bright orange, which ripens through orange-red to the final color. The fruit of a small percentage of specimens of *C. chrysocarpa* var. *chrysocarpa* observed in the Cypress Hills, Saskatchewan in late August 2001, however, were still golden-orange when most around were bright red. Also, in the same area and time, a lanate form of the type variety was found to have greenish-yellow fruit when congeners were bright red but its fully ripe color seems to occur later and is deep red. A few specimens from Saskatchewan, otherwise indistinguishable from the typical variety, have 20 stamens. See Phipps (1997) for citation of specimens, line illustration and distribution map.

We also take the opportunity here to describe as a variety new variety of *C. chrysocarpa*, the Okanagan endemic taxon, var. *vernonensis*.

The name *Crataegus rotundifolia* Moench has quite frequently been used for *C. chrysocarpa* Ashe, for instance by Packer (1983), though starting with Eggleston (1908a) as noted in the discussion of the series. However, as noted above, Eggleston's sense of *C. rotundifolia* var. *rotundifolia* was obviously *C. dodgei*, a different species.

KEY TO VARIETIES OF *C. CHRYSOCARPA* IN WESTERN CANADA

1. Anthers ivory to cream; ripe fruit usually bright red.
    2. Leaf-blades generally smaller (2–4 cm long) usually sharply but less deeply lobed (LII 5–15%); leaves ± glabrous abaxially ____________________ **2a.** var. **chrysocarpa**

2. Leaf-blades larger (4–6 cm long), sharply and quite deeply lobed (LII ≤ 20%), densely pubescent abaxially ______ **2b.** var. **piperi**

1. Anthers pale pink; ripe fruit usually deep claret-colored ______ **2c.** var. **vernonensis**, var. nov.

2a. Crataegus chrysocarpa var. **chrysocarpa.** TYPE: as species.

Characteristics as key. Variety *chrysocarpa* occurs practically throughout the range of the species and in western Canada in the valleys of southern intermountain British Columbia and the grassland biomes of Alberta, Saskatchewan and Manitoba where it is nearly the only hawthorn. The indumentum of the inflorescence is generally moderately pubescent but rare, densely lanate or ± glabrous forms also occur. A broad-leaved form originally described as *C. sheridana* A. Nels. from Colorado might be varietally distinct and should be looked out for in the area of this paper. Its nearest proven occurrence is in North Dakota. Overall the variation of the typical variety in western Canada is considerable and warrants further study.

2b. Crataegus chrysocarpa var. **piperi** (Britton) Kruschke, 1965. TYPE: U.S.A.: WASHINGTON: Pullman, Sep 1897, *C.V. Piper 1535* (NY!)

Characteristics as key. Widespread in the intermountain zone from Oregon to British Columbia and extending eastwards to Montana, var. *piperi* is the only variety at the western edge of the species' range. In western Montana intermediate forms occur while in the Okanagan when varieties *piperi* and *chrysocarpa* occur together they maintain their distinctness. The indumentum of the inflorescence is ± lanate.

2c. Crataegus chrysocarpa var. **vernonensis** J.B.Phipps & O'Kennon, var. nov. (**Fig. 3**) TYPE: CANADA: BRITISH COLUMBIA: Okanagan Valley, Okanagan I.R. no. 1, Westside Rd., 2 mi SW jct. Hwy 97, natural hedges, bush 3 m tall, habit very erect, fruit plum colored, flesh succulent-mushy, golden, 26 Aug 2000, *J.B. Phipps & S.R. Phipps 8178* (HOLOTYPE: UWO; ISOTYPES: BRIT, CAN, TRT, V).

Frutices, saepe multicaules; ramificatione pauca pro ratione, plerumque 2–3 m altae; spinae 3–4.5 cm longae, nitenter brunnescentes secundo anno exeunte, cinerascentes in maturitate; ramuli extendentes crispo-pilosi et rubi in juventute, glabrescentes; annotini ± nitenter brunnei, veteriores atrocinerei. Folia decidua; petioli 10–20 mm longi, primum ± dense-pubescentes, in maturitate pubescentes, aliquot glandulis secundum sulcum; laminae 3–6 cm longae, ovatae vel ovato-rhombeae in forma generali; apex obtusa vel subacuta; basis cuneata; lobi laterales 3–4/latus, acuti vel ± obtusi apice vix cuspidata, max IFl us. ca. 15%; margines dentibus minutissimis subacutis praeter basales; venatio craspedodroma, 3–4 principalibus nervis lateralibus per latus; superficies adaxiales appresso-scabro-pubescentes, persistentes; superficies abaxiales fere glabrae sed pilosae secundum venas; ± coriaceae in maturitate et saepe leviter convectae, olivaceae; color autumnalis flavus purpura saepe superposita. Inflorescentiae 5–14 -florae; rami lanati, ferentes caducas, anguste-oblongas, membranaceas, glanduli-marginatas, aliquantum brunneo-rubras bracteolas. Flores 18–20 mm diam.; hypanthium extrinsecus lanatum infra, glabrum supra; lobi calycis triangulares, minute glandulo-serrati; stamina 8–10, antheris plerumque pallide roseis; styli 4–5, exorientes a brevissimo caespite pilorum. Fructus 10–12 mm diam., subglobosi, ± pilosi, rubro-purpurei vel fere atri ultra maturitatem; caro aurea; lobi calycis semi-persistentes, erecto-patentes; pyrenae 4–5, sulcatae dorsaliter; lateribus planis.

Shrubs, often multistemmed with relatively little branching, us. 2–3 m tall; thorns 3–4.5 cm long, shiny brownish black at 2 yrs, graying with age, somewhat stout, straight to slightly recurved; extending twigs crisped hairy young, green tinged reddish young, glabrescent; at one year ± shiny brown; older dull gray. Leaves deciduous; petioles 10–20 mm long, ± dense-pubescent at first, largely persisting, with several glands along the margins of the sulcus; blades 3–6 cm long, ovate to ovate-rhombic in general shape, tip obtuse to ± acute, base cuneate; lateral lobes 3–4/side, acute (more likely in smaller or vegetative leaves) to somewhat rounded with a barely cuspidate tip, max. LII us. ca. 15%; margins with very small subacute teeth except near the entire base; venation craspedodromous with 3–4 principal lateral veins/side; adaxially appressed scabrous-pubescent, persisting; abaxially pilose on the veins, surfaces glabrous; rather coriaceous at maturity and often slightly convex, dull olive green; autumnal color yellow often overlayed with dull purple. Inflorescences 5–14-flowered; branches lanate, bearing caducous, narrow-oblong, membranous, somewhat brownish-red, gland-bordered bracteoles. Flowers 18–20 mm diam.; hypanthium externally lanate below, glabrous above; calyx-lobes triangular, minutely glandular-serrate; stamens 8–10, anthers generally pale pink; styles 4–5, arising from a very short tuft of hairs. Fruit 10–12 mm diam.; subglobose, ± hairy, burgundy or lake to nearly black when over-ripe; flesh golden; calyx-lobes semi-persistent, erecto-patent; nutlets 4–5, dorsally grooved, laterally smooth.

Crataegus chrysocarpa var. *vernonensis* is locally common in the northern Okanagan valley between the Vernon area and Salmon Arm. It occurs in the more xeric habitats in which hawthorns of the region are found, for instance, sometimes tolerating sandy soil. For this reason and its early ripening the fruits are apt to shrivel during September when the fruits of other hawthorns in the area are normally still plump. Perhaps for this reason it is under-collected. The particularly xeromorphic nature of var. *vernonensis* is such that it is seldom found growing among the larger, more mesomorphic hawthorns such as members of ser. *Purpureofructi* or *C. okennonii*. It is among the earliest to flower of the hawthorns of the area, typical for all ser. *Rotundifoliae*.

Crataegus chrysocarpa var. *vernonensis* is known from about 17 collection numbers and in diagnostic characteristics it is remarkably uniform. The multistemmed, relatively little-branching, erect habit is conspicuous in well-developed plants, as are the lanate inflorescences, pale pink anthers and fruit already ripe and burgundy-colored in late August. These characters help to distinguish the new species from other members of ser. *Rotundifoliae* while the tendency to blunt lobes in the leaf helps to distinguish it in midsummer from rare lanate forms of sympatric var. *chrysocarpa*.

Additional specimens examined. **CANADA: British Columbia:** Okanagan Valley, Okanagan Indian Reserve no. 1. Hawhola Rd., erect bush, 8 ft. tall, 11 May 2002, *J.B. Phipps & R.J. O'Kennon 8313* (UWO). Okanagan Indian Reserve no. 1, Westside Rd, N end, bush 4 ft. tall, fruit purple, 18 Aug 1994, *J.B.*

Fig. 3. Line drawing of *C. chrysocarpa* var. *vernonensis* from *J.B. Phipps 6889* (UWO) and *J.B Phipps 6883a* (UWO), flowering and flower details; *J.B. Phipps and R.J. O'Kennon 6989* (UWO) and *R. Jackson for J.B. Phipps 8460* (UWO), fruiting and fruit details. Scale bars = 1 cm. S. Laurie-Bourque del.

Phipps & R.J. O'Kennon 6985 (UWO); Spallumcheen Mun., top of ravine above Old Kamloops Rd., opposite Swan Lake, bush 3 ft. tall (=*JBP 6889*), 19 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6987* (BRIT, UWO); same loc., 3 May 1994, *J.B. Phipps 6889* (=JBP 6987) (UWO); same loc., both 24 September 1993, *J.B. Phipps & R.J. O'Kennon 6795* (UWO), 6796 (UWO); Spallumcheen Mun., Pleasant Valley Rd., N of Vernon, bush 1.5 m tall, 26 September 1993, *J.B. Phipps and R.J. O'Kennon 6816* (UWO); same loc., 26 September 1993, *J.B. Phipps and R.J. O'Kennon 6816a* (UWO); same loc., 26 September 1993, *J.B. Phipps & R.J. O'Kennon 6817* (UWO); same loc., bush, 5 ft. tall, 2 May 1994, *J.B. Phipps 6883a* (UWO Spallumcheen Mun., hwy 97, 1/2 mi W jct. Westside Rd, bush 2 m tall, 19 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6994* (BRIT, UWO); Spallumcheen Mun., eastern end L. & A. Cross Rd. (bank below hwy 97A), bush 1.3 m tall, 18 Aug 1995, *J.B. Phipps 7160* (UWO); same loc., bush 1.5 m tall, 12 May 2002, *J.B. Phipps & R.J. O'Kennon 8321* (BRIT, UWO); Spallumcheen Mun., Otter Lake Cross Rd., bush 2.5 m tall, 16 May 2002, *J.B. Phipps 8331* (UWO); Spallumcheen Mun., McLeery Rd., ca. 2 mi S Enderby, 25 Aug 2002, *R. Jackson for J.B. Phipps 8460* (BRIT, UWO). Enderby Indian Reserve no. 2, bush 3 m tall, 16 May 2002, *J.B. Phipps 8337* (BRIT, UWO); Salmon Arm, old municipal dump site, hawthorn thickets, bush 3.5 m tall, fruit red-burgundy, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7028* (UWO). Additional duplicates may be distributed later.

ACKNOWLEDGMENTS

Thanks are due to my colleague, Antony Littlewood, Dept. of Classical Studies, University of Western Ontario for critically checking my Latin diagnoses; to the Natural Sciences & Engineering Research Council of Canada for discovery award A1726 which supported the work; to Sheila Phipps who provided invaluable help as mentioned under the eponymous species and to Susan Laurie-Bourque who continues to provide exquisite illustrations.

REFERENCES

Ashe, W.W. 1900. *Crataegus chrysocarpa*. In: Some new species of the genus *Crataegus* and notes on some dichotomous *Panicums*. North Carolina Coll. Agric. Mech. Arts 175:110.

Bovin, B. 1967. *Crataegus*. In: Flora of the Prairie Provinces. Provancheria 2:51–52.

Britton, N.L. 1901. A new *Crataegus* from Washington. Torreya 1:55.

Dickinson, T.A., S. Belaousoff, R.M. Love and M. Muniyamma. 1996. North American black-fruited hawthorns. I. Folia Geobot. Phytotax. 31:355–371.

Dorn, R.D. 1988. Vascular plants of Wyoming. Mountain West Publishing, Cheyenne, WY.

Eggleston, W.W. 1908a. The *Crataegi* of the northeastern United States and adjacent Canada. Rhodora 10:73-84.

Eggleston, W.W. 1908b. *Crataegus* sect. *Rotundifoliae*. In: Robinson, B.L. & M.L. Fernald. Gray's New Manual of Botany, ed. 7. 467-469. American Book Co., New York, Cincinnati and Chicago.

Eggleston, W.W. 1909. New North American Crataegi. Bull. Torrey Bot. Club 36:639–642.

Harms, V.L. 2003. Checklist of the vascular plants of Saskatchewan. Univ. Saskatchewan Extension Press, Saskatoon, SK.

Howell, T.J. 1898. *Crataegus columbiana*. In: Flora of northwestern America 1:163. Published by author, Portland, OR.

Kruschke, E.L. 1965. Contributions to the taxonomy of *Crataegus*. Milwaukee Public Mus. Public. Bot. 3:1–273.

Lamarck, J.B.P. De M. 1783. *Crataegus rotundifolia.* In: Encyclopèdie Méthodique 1:84. Pantouche, Paris and Plonteaux, Liège.

Moench, C. 1785. *Crataegus rotundifolia.* In: Bäume und Stauden. J.G. Fleischerisch, Frankfurt & Leipzig.

Packer, J.G. 1983. Flora of Alberta, 2nd ed. Univ. Toronto Press, Toronto.

Phipps, J.B. 1995. The identity of *Crataegus columbiana* and its relationship to *C. piperi* (Rosaceae). Taxon 44:405–408.

Phipps, J.B. 1997. Introduction to the red-fruited hawthorns (*Crataegus*, Rosaceae) of western North America. Canad. J. Bot. 76:1863–1899.

Phipps, J.B. and R.J. O'Kennon. 2002. New taxa of *Crataegus* (Rosaceae) from the northern Okanagan-southwestern Shuswap diversity centre. Sida 20:115–144.

Rehder, A. 1940. Manual of cultivated trees and shrubs hardy in North America. 2nd ed. Macmillan, New York.

Sargent, C.S. 1905. Manual of the trees of North America. Houghton Mifflin, Boston and New York.

BOOK NOTICES

NEW YORK BOTANICAL GARDEN

ANDREW HENDERSON. 2002. **Evolution and Ecology of Palms.** (ISBN 0-89327-444-5, pbk.). The New York Botanical Garden Press, 200th Street & Kazimiroff Boulevard, Bronx, NY 10458-5126, U.S.A. (Orders: 718-817-8721, 718-817-5126 fax, http://www.nybg.org, nybgpress@nybg.org). $28.00, 198 pp., 38 b/w photos, 37 line drawings, 37 tables, glossary, bibliography, index, 7" × 10".

Publisher Comments: "Palms are among the most abundant, diverse, and economically important families of plants found in the tropical and subtropical regions of the world. Within the tropics, especially in lowland moist forests, palms are extremely abundant in terms of both numbers of species and individual, and are clearly an important part of the ecosystem. in addition, palms have a fascinating life history, much of it related to their morphology: they are not trees, yet they have woody stems and are not classified as herbaceous plants."

"Henderson brings together and analyzes the relevant literature and data in an attempt to understand something of the evolution and ecology of the palm family, and integrates this desparate knowledge into a cohesive whole."

HENRY A. GLEASON AND ARTHUR CRONQUIST. 2004. **Manual of Vascular Plants of Northeastern United States and Adjacent Canada, Second Edition, corrected.** (ISBN 0-89327-365-1, hbk.). The New York Botanical Garden Press, 200th Street & Kazimiroff Boulevard, Bronx, NY 10458-5126, U.S.A. (Orders: 718-817-8721, 718-817-5126 fax, http://www.nybg.org, nybgpress@nybg.org). $69.00, 862 pp., 6" × 9".

This is the 7th printing of the second edition; the first printing was in 1991. This new printing comes with corrections (suggested by users) to the good keys and descriptions, new information includes photographs and short biographies of Gleason and Cronquist, author abbreviations standardized, new and much more extensive indexes, and a new looking cover design.

CROTON BIGBENDENSIS (EUPHORBIACEAE), A NEW SPECIES FROM TRANS-PECOS, TEXAS

B.L. Turner

Plant Resources Center
University of Texas
Austin, Texas 78712-0471, U.S.A.

ABSTRACT

Croton bigbendensis B.L. Turner, sp. nov., is described from Trans-Pecos, Texas. It is closely related to *C. dioicus* Cav. and has passed for that species in most treatments of *Croton* for the Southwestern United States and Mexico. *Croton bigbendensis* is largely confined to the lower elevations of the Big Bend Region in Brewster, Presidio, and Hudspeth counties where it dominates sandy flats along the Rio Grande. It is readily distinguished in the field by its bushy habit, and elongate upper internodes, the latter having linear-lanceolate leaves. So far as known, it does not co-occur with *C. dioicus*, nor does it appear to intergrade with the latter in regions of near contact.

Key Words: *Croton*, *C. dioicus*, Euphorbiaceae, Texas

RESUMEN

Se describe ***Croton bigbendensis*** B.L. Turner, sp. nov., de Trans-Pecos, Texas. Está muy emparentada con *C. dioicus* Cav. y ha pasado por tal especie en la mayoría de los tratamientos de *Croton* para el suroeste de los Estados Unidos y México. *Croton bigbendensis* está confinado a las pequeñas elevaciones de la región de Big Bend en los condados de Brewster, Presidio y Hudspeth donde domina a lo largo de las llanuras arenosas del Río Grande. Se distingue fácilmente en el campo por su hábito arbustivo, e internudos superiores elongados, los últimos con hojas linear-lanceoladas. Por lo conocido hasta ahora no convive con *C. dioicus*, ni tampoco parece intergradarse con él en las regiones de contacto cercano.

Field work in the Trans-Pecos region over a several year period has convinced me that there exists an undescribed species of *Croton*, this long hidden within the taxonomic fabric of *C. dioicus*. Its description follows:

Croton bigbendensis B.L. Turner, sp. nov. **(Figs. 1,2,3)**. Type: U.S.A. TEXAS: Presidio Co.: ca. 20 mi W of Hwy. 90 along county road 2017 (dirt road to the Rio Grande), sandy flats along old flood plain of Rio Grande, 22 Aug 2002, *B.L. Turner 22-204A* (pistillate) and *22-204b* (staminate) (holotype: TEX; isotypes: MEXU, SRSC).

Similis *Croton dioico* Cav. sed herba suffruticosa aut suffrutex est ad 0.5 m altus, ramosissimus e basi caulibus super elongatis cum nodis foliis anguste lanceolatis pro parte maxima 1.5–3.0 plo longioribus.

Suffruticose perennial herbs or subshrubs mostly 40–60 cm high, the stems arising from lignescent tap roots. **Stems** densely pubescent with sessile peltate scales, the latter ca. 0.4 mm across. **Lower leaves** lanceolate; uppermost internodes elongate, bearing linear-lanceolate leaves 5–7 times as long as wide, pubescent like the stems. **Staminate flowers** with mostly (8–)9–12(–15) stamens;

SIDA 21(1): 79–85. 2004

filaments pilose, 1.5–2.0 mm long. **Pistillate flowers** with style branches ca. 1 mm long, fruits globose, ca. 5 mm long, 5 mm wide. Chromosome number, 2n = 28.

Representative Specimens: **UNITED STATES. TEXAS: Brewster Co.** Castalon Ranger Station, 17 Aug 1972, *Bacon & Hartman 1438* (LL); Big Bend Natl. Park, Chisos Mts., 26 Jun 1937, *Marsh 41* (TEX); flats N of Chisos Mts., 8 Jul 1932, *Muller s.n.* (TEX); near upper Tornillo Creek Bridge, "subshrub to 0.5 m high," 28 Apr 1984, *Powell & Powell 4329* (TEX); 24.9 mi S of Marathon, 16 Jun 2003, *Turner 23-152* (TEX); 25.7 mi along La Linda highway from highway 385, 16 Jun 2003, *Turner 23-155* (TEX); 4 mi S of highway 2627 along dirt road to Brushy Creek Canyon,17 Jun 2003, *Turner & Dodson 23-163* (TEX); between Todd Hill and Burro Mesa, yellow clay soils, 3200–3500 ft, 1 Aug 1955, *Warnock 12789* (LL, SRSC); Nine Point Mesa Ranch, 22 Apr 1998, *Webster & Westlund 32586* (TEX); near Rio Grande, creek bottoms, Compton Place, 30 Aug 1910, *Young s.n.* (TEX). **Hudspeth Co.:** ca. 5 mi S of Finley RR Station, along dirt road to IH 10, 3 Sep 2002, *Turner 22-226* (SRSC, TEX); 6 mi W of Fort Hancock, 7 Sep 1955, *Warnock 13767* (SRSC). **Presidio Co.:** Big Bend Ranch along Rio Grande, mouth of Canyon Colorado, 5 Oct 1975, *Butterwick & Lamb 1771* (TEX); 4.5 mi N of Ruidosa, 29 May 1941, *Hinckley 1541* (TEX); 3 mi N of Candelaria, 3 Sep 2000, *Billie & Matt Turner 20-508* (MEXU, NY, SRSC, TEX).

MEXICO: CHIHUAHUA. Mpio. Manuel Benavides, ca. 7 mi W of Providencia, silty desert plains, locally abundant, 10 Aug 1940, *I. M. Johnston & Muller 106* (LL).

The species is named for the Big Bend region of Texas and closely adjacent Mexico, to which it is largely restricted.

Altogether, 44 collections of *C. bigbendensis* were examined in this study (LL, SRSC, TEX): 22 from Brewster Co.; 18 from Presidio Co.; and two from Hudspeth Co. Only a single collection was examined from Mexico, this cited in the above.

Johnston (1959) provided a detailed treatment of the Texas species of *Croton*. In this he noted that *C. dioicus* is typified by material collected in the state of Hidalgo, Mexico. He further commented that it is a "widespread" (distributed from Texas to southern Mexico) and "somewhat weedy" taxon, occurring "in disturbed ground along roads and railroads." In spite of the fact that he knew the Trans-Pecos region quite well, he did not discern the species proposed herein.

Finally, it should be emphasized that, to my knowledge, the two species do not occur together, nor do they appear to intergrade in regions of near contact (cf. figs. 4 and 5), hence my recognition of *C. bigbendensis* as a good biological species. Such "cryptic species" are becoming increasingly common in Texas, even in regions that have been well studied: for example, the two new species of *Liatris* created out of the fabric of *Liatris punctata* Hook. (Nesom & O'Kennon 2001), and that of *Nemophila sayersensis* carved out of the previously well-studied *N. phacelioides* Nutt., Simpson et al. 2001).

Lectotypification

Johnston (1959) placed *C. neomexicanus* Muell. Arg. in synonymy with *C. dioicus*, having not seen type material, although he was aware that several early workers had taken up the name *C. neomexicanus* for what should have been called *C. dioicus*. Indeed, early on I thought the former name might apply to what I describe herein as *C. bigbendensis*. To resolve this issue I borrowed type

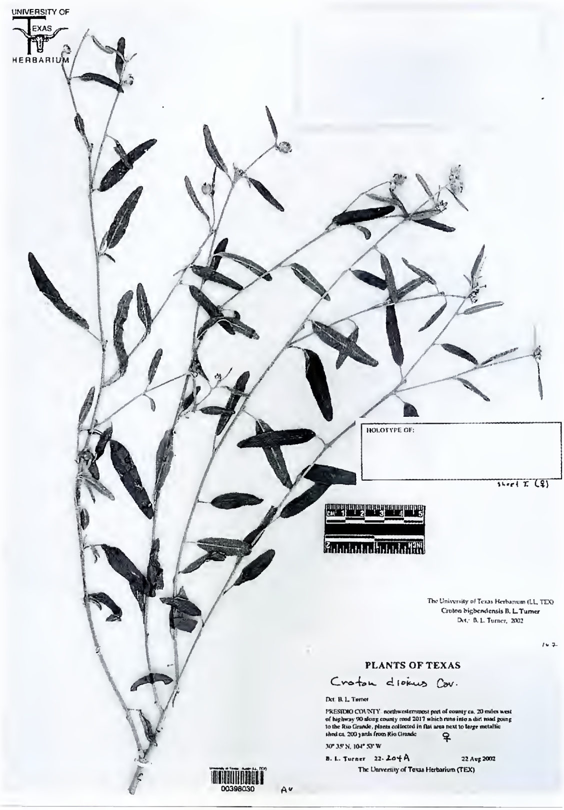
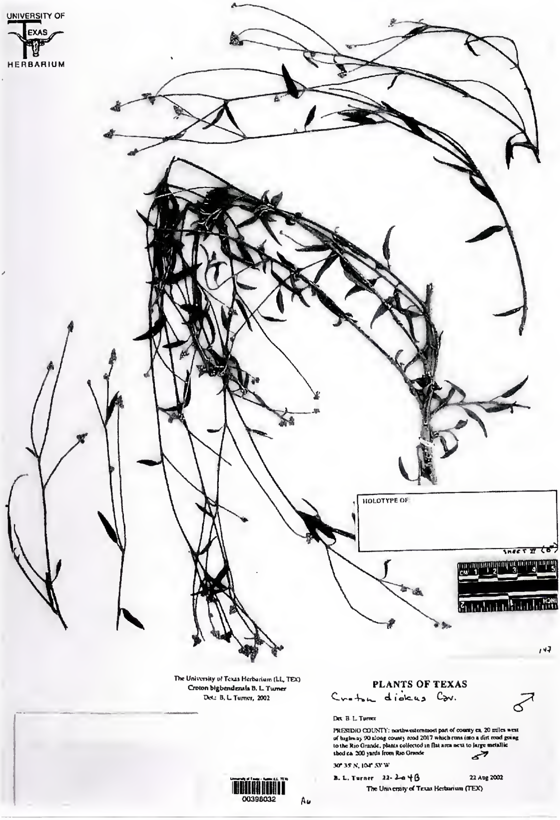


Fig. 1. *Croton bigbendensis;* holotype (*B.L. Turner 22-204A,* pistillate, TEX)



The University of Texas Herbarium (LL, TEX)
Croton bigbendensis B. L. Turner
Det.: B. L. Turner, 2002

PLANTS OF TEXAS

Croton dioicus Cav. ♂

Det. B. L. Turner

PRESIDIO COUNTY: northwesternmost part of county ca. 20 miles west of highway 90 along county road 2017 which runs into a dirt road going to the Rio Grande. plants collected in flat area next to large metallic shed ca. 200 yards from Rio Grande ♂

30° 35' N, 104° 53' W

B. L. Turner 22-204B 22 Aug 2002

The University of Texas Herbarium (TEX)

00398032

FIG. 2. *Croton bigbendensis;* holotype (*B.L. Turner 22-204b,* staminate, TEX)

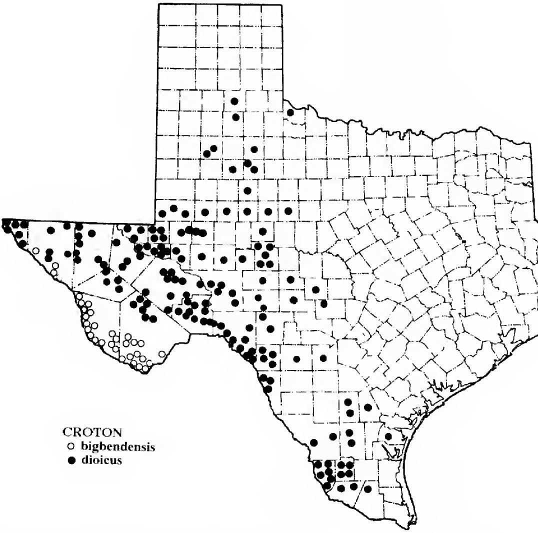


Fig. 3. Distribution of *Croton bigbendensis* and *C. dioicus* in Texas.

materials of *C. neomexicanus* from several institutions, the taxon itself typified by diverse collections, some of these said to have been collected by Charles Wright in the Trans-Pecos region of Texas. Clearly the name needed lectotypification, which follows.

In the protologue of *C. neomexicanus*, its author cited three collections: *Charles Wright 1800*, w/o locality, 1851–52; *Charles Wright 642* "Expedition from western Texas to El Paso, New Mexico, May-October, 1849;" and *Berlandier 3211*, Mexico: Nuevo Leon " in campsis," Jun 1844. Specimens of these several collections were borrowed from GH and NY. From among these *Wright 1800* (GH) was selected as a suitable lectotype; isolectotypes were also recorded at GH and NY. The lectotype has both male and female plants mounted on the same sheet, as does the GH isolectotype, the latter mounted on the same sheet with *Wright 642* (a paratype). All of the specimens concerned are quite similar, possessing the habit, upper nodes, and leaf shape of rather typical *C. dioicus*.

Fig. 4. Typical habit of *C. dioicus* (left); habit of living holotype of *Croton bigbendensis* (right).

Fig. 5. Typical aspect of early spring population of *Croton bigbendensis* (ca. 15 mi. NW of Presidio, Texas; note the bushy rounded habit of the plants concerned; individual in foreground is Bill Dodson, father of the sheriff of Brewster Co., Texas).

Chromosome numbers

Urbatsch et al. (1975) reported chromosome counts for 11 collections of *C. dioicus* (nine of these were diploid with 2n = 28, and two tetraploid with 2n = 56 pairs). Examination of the vouchers concerned (LL,TEX) revealed that only one of these (Brewster Co: *Bacon & Hartman 1438*) belonged to what is here described as *C. bigbendensis*. Since chromosome numbers of the *C. dioicus* collections included both diploids and tetraploids, chromosome number alone is not useful in distinguishing between the two taxa.

ACKNOWLEDGMENTS

My wife Gayle provided the Latin diagnosis. Grady Webster and Mike Powell reviewed a preliminary draft of the paper. The following herbaria provided loans of type materials: GH, NY, and US. Thanks to all for the kindness rendered.

REFERENCES

Johnston, M.C. 1959. The Texas species of *Croton* (Euphorbiaceae). SouthW. Naturalist 3: 175–203.

Nesom, G.L. and R.J. O'Kennon. 2001. Two new species of *Liatris* series Punctatae (Asteraceae: Eupatorieae) centered in north central Texas. Sida 19: 767–788.

Simpson, B.B., D.M. Helfgott, and J.L. Neff. 2001. A new cryptic species of *Nemophila* (Hydrophyllaceae) from Texas and the lectotypification of *N. phacelioides* Nuttall. Lundellia 4:30–36.

Urbatsch, L.E. et al. 1975. Chromosome numbers for North American Euphorbiaceae. Amer. J. Bot. 62:494–500.

BOOK NOTICE

DEBORAH P. DELMER, HANS J. BOHNERT, and SABEEHA MERCHANG (eds). 2003. **Annual Review of Plant Biology: Volume 54, 2003.** (ISBN 0-8243-0654-6, hbk; ISSN 1040-2519). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $165.00 (USA), $170.00 (Int'l.), 751 pp., 6" × 9".

Contents of Volume 54 of *Annual Review of Plant Biology*:

Conjectures, Refutations, and Extrapolations
Understanding the Functions of Plant Disease Resistance Proteins
Protein Phosphatases in Plants
Plant Peroxiredoxins
Nitric Oxide: The Versatility of an Extensive Signal Molecule
Biosynthesis and Metabolism of Brassinosteroids
The COP9 Signalosome: Regulating Plant Development Through the Control of Proteolysis
Iron Transport and Signaling in Plants
From Bacterial Glycogen to Starch: Understanding the Biogenesis of the Plant Starch Granule
The Plant Cell Cycle
Phospholipid-Based Signaling in Plants
Gibberellins and Flowering of Grasses and Cereals: Prizing Open the Lid of the "Florigen"
Photosynthesis of Overwintering Evergreen Plants
Structure of Linkage Disequilibrium in Plants
Single-Nucleotide Mutations for Plant Functional Genomics
How Do Cells Know What They Want To Be When They Grow Up? Lessons from Epidermal Patterning in *Arabidopsis*
Transfer Cells: Cells Specialized for a Special Purpose
Chloroplast Movement
Cryptochrome Structure and Signal Transduction
Membrane-Bound Diiron Carboxylate Proteins
Lignin Biosynthesis
Apomixis: A Developmental Perspective
Molecular Mechanisms and Regulation of K+ Transport in Higher Plants
Perception and Signal Transduction of Cytokinins
Functional Genomics of P450s
Metabolomics in Systems Biology
Remodeling the Cytoskelton for Growth and Form: An Overview with Some New Views

A NEW SPECIES OF *CENTAURIUM* (GENTIANACEAE) FROM TRANS-PECOS TEXAS

B.L. Turner

Plant Resources Center
The University of Texas
Austin, Texas 78712-0471, U.S.A.

ABSTRACT

Centaurium blumbergianum B.L. Turner, sp. nov., is described from near Ruidosa, Presidio Co., Texas. It is a perennial species with broad open, cymes having no obvious close relatives among the North American taxa described to date. It occurs only along saline streams and in seeps at the base of limestone walls in dead-end canyons where it grows with or near a number of other rare taxa such as the recently described localized endemic, *Arida mattturneri* and the equally rare *A. gypsitherma* (cf. Sida 20 [4]). Photographs of type material are presented, along with an account of its possible relationships to other taxa.

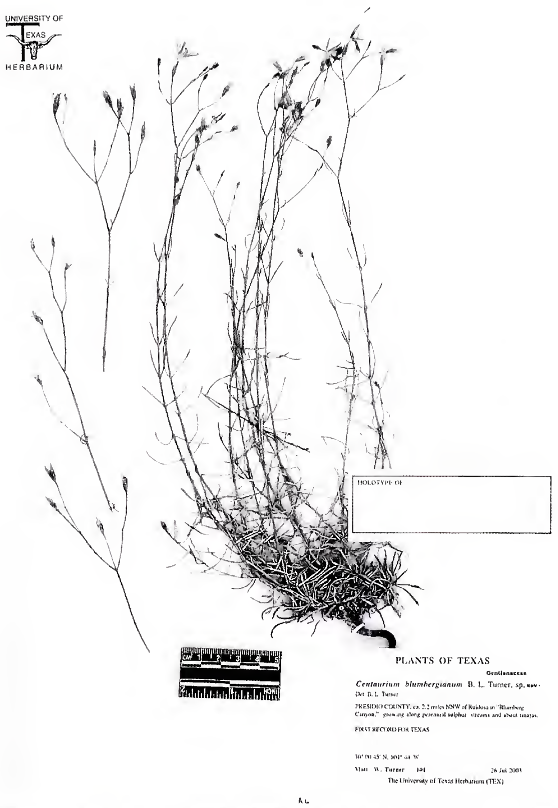
RESUMEN

Se describe ***Centaurium blumbergianum*** B.L. Turner, sp. nov., de cerca de Ruidosa, Presidio Co., Texas. Es una especie perenne con cimas abiertas anchas, que no tiene parientes próximos entre los taxa norteamericanos descritos hasta ahora. Ocurre solamente a lo largo de torrentes salinos y en filtrados de la base de paredones calcáreos de los finales ciegos de cañones donde crece junto o cerca de cierto número de otros taxa raros tales como el endemismo descrito recientemente, *Arida mattturneri* y la igualmente rara *A. gypsitherma* (cf. Sida 20 [4]). Se presentan fotografías del material tipo, junto con una relación de su posible parentesco con otros taxa.

Centaurium blumbergianum B.L. Turner, sp. nov. (**Figs. 1, 2**). TYPE: U.S.A. TEXAS: Presidio Co., ca. 2.2 mi NNW of Ruidosa in "Blumberg Canyon," growing along sulphur streams and about tinajas, 26 Jul 2003, *Matt W. Turner 101* (HOLOTYPE: TEX; ISOTYPES: MO, SRSC).

Simile *Centaurio tenuifolio* (Mart. & Gal.) B.L. Rob. sed habens petala parviora pallidaque et inflorescentiam expansiorum cum flores pauciores.

Perennial tufted herbs to 40 cm high. **Stems** 4-sided, 1–2 mm across, their edges adorned with minute, somewhat scabrous ridges, otherwise glabrous or nearly so. **Leaves** opposite throughout, linear, glabrous, those at mid-stem mostly 15–25 mm long, 0.4–0.6 mm wide. **Flowers** 3–15 per stem, forming an open cyme up to 20 cm across, the pedicels mostly 1.5–3.0 cm long. **Sepals** 5, linear-lanceolate, 7–10 mm long, united at their base for ca. 1 mm; apices slender and narrowly apiculate. **Corollas** pink; tubes 7–9 mm long, becoming transparent at maturity, constricted just below the 5 lobes, the latter 8–9 mm long, 3.5–4.5 mm wide. **Stamens** 5, exserted from tube for 2–3 mm, the anthers ca. 3 mm long at first, but 2–3 mm long and markedly helical at full anthesis. Style exserted from the tube for ca. 4 mm, the stigma somewhat bilobed, ca. 0.5 mm across. **Capsules**



HOLOTYPE OF

PLANTS OF TEXAS

Gentianaceae

Centaurium blumbergianum B. L. Turner, sp. nov.
Det. B. L. Turner

PRESIDIO COUNTY, ca. 2.2 miles NNW of Ruidosa in "Blumberg Canyon," growing along perennial sulphur streams and about tinajas.

FIRST RECORD FOR TEXAS

30° 00 45' N, 104° 44' W

Matt W. Turner 101 26 Jul 2003

The University of Texas Herbarium (TEX)

Fig. 1. *Centaurium blumbergianum*; holotype (*M.W. Turner 101*, TEX).

FIG. 2. *Centaurium blumbergianum*, type material (upper); close up of corolla (lower).

FIG. 3. James and Olivia Blumberg.

bivalvate, narrowly oval, 8–10 mm long, ca. 3 mm across; ovules numerous to each carpel. **Seeds** ovoid, brown, ca. 0.6 mm long, 0.4 mm wide, at maturity sculpted with a peanut-like raised reticulum.

Among the Texas species, *C. blumbergianum* has no close relatives, although an anonymous reviewer suggests that it might be compared favorably with *C.*

multicaule B.L. Rob., a rather small annual with broadly lanceolate to oblanceolate basal leaves. In contrast, *C. blumbergianum* is a relatively robust perennial with persistent linear basal leaves.

In her treatment of the Mexican and Central American species of *Centaurium* by Broome (1974), *C. blumbergianum* will key to or near *C. brachycalyx* Standl. & L.O. Williams, a species of southern Mexico and Central America. It differs from the latter in numerous characters, including habit, inflorescence, and leaf shape. Except for its small flowers and expanded inflorescence, *C. blumbergianum* would appear to be closest to *C. tenuifolium* (Mart. & Gal.) B.L. Rob., a taxon confined to the mountains of western Mexico (Nayarit to Guerrero).

Among the species of *Centaurium* in the U.S.A. it most closely approaches *Centaurium namophilum* Reveal, Broome & Beatley, a localized species of Nye Co., Nevada and closely adjacent California; *C. blumbergianum* differs in having a more robust perennial habit and much more diffuse inflorescence. *Centaurium namophilum* and the closely related *C. tricanthum* (Greisb.) B.L. Rob. (according to Reveal et al. 1974), are said to "occur near or along stream drainages, marshy places or on alkaline soil." Such habitats also house *C. blumbergianum*.

Etymology.—It is a pleasure to name this remarkable new species for Mr. James Blumberg and his wife Olivia (Fig. 3), residents of Ruidosa, Texas. They own the property concerned and Mr. Blumberg eagerly accompanied Matt Turner and myself in our efforts to collect type material.

ACKNOWLEDGMENTS

I am grateful to James Blumberg for permission to visit the site concerned and to my wife Gayle for the Latin diagnosis. A special thanks to Robert Harms for helping "upgrade" the picture of the Blumbergs. James Reveal and an anonymous reviewer made helpful suggestions.

REFERENCES

Broome, C.R. 1973. Systematics of *Centaurium* (Gentianaceae) of Mexico and Central America. Ph.D. Dissertation, Duke Univ., Durham, North Carolina, University Microfilms, Ann Arbor, Michigan.

Reveal, J.L., C.R. Broome, and J.C. Beatley. 1974. A new *Centaurium* (Gentianaceae) from the Death Valley region of Nevada and California. Bull. Torrey Bot. Club 100:353–356.

Turner, B.L. 1993. The Texas species of *Centaurium* (Gentianaceae). Phytologia 75:259–275.

BOOK NOTICE

DEBORAH P. DELMER and SABEEHA MERCHANG (eds). 2004. **Annual Review of Plant Biology: Volume 55, 2004.** (ISBN 0-8243-0655-4, hbk; ISSN 1543-5008). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $173.00 (USA), $178.00 (Int'l.), 659 pp., 6" × 9".

Contents of Volume 55 of *Annual Review of Plant Biology*:

Alternative NAD(P)H Dehydrogenases of Plant Mitochondria
An Unforeseen Voyage to the World of Phytochromes
Biosynthesis and Accumulation of Sterols
Decoding Ca2+ Signals Through Plant Protein Kinases
DNA Methylation and Epigenetics
Genetical Regulation of Time to Flower in *Arabidopsis thaliana*
How Do Crop Plants Tolerate Acid Soils? Mechanisms of Aluminum Tolerance and Phosphorous Efficiency
Metabolic Channeling in Plants
Molecular Mechanism of Gibberellin Signaling in Plants
Naturally Occurring Genetic Variation in *Arabidopsis thaliana*
Phosphoenolpyruvate Carboxylase: A New Era of Structural Biology
Phytoestrogens
Plastid Transformation in Higher Plants
Reactive Oxygen Species: Metabolism, Oxidative Stress, and Signal Transduction
Rhamnogalacturonan II: Structure and Function of a Borate Cross-Linked Cell Wall Pectic Polysaccharide
Rising Atmospheric Carbon Dioxide: Plants FACE the Future
Single-Cell C4 Photosynthesis Versus the Dual-Cell (Kranz) Paradigm
Symbioses of Grasses with Seedborne Fungal Endophytes
The Generation of Ca2+ Signals in Plants
The Ubiquitin 26S Proteasome Proteolytic Pathway
Transport Mechanisms for Organic Focus of Carbon and Nitrogen Between Source and Sink
VIGS Vectors for Gene Sliencing. Many Targets, Many Tools
Visualizing Chromosome Structure/Organization

A NEW COMBINATION IN *DENDROCALAMUS* (POACEAE: BAMBUSOIDEAE)

Muktesh Kumar & Remesh M.

Botany Division
Kerala Forest Research Institute
Peechi,680 653, Thrissur, Kerala, INDIA
muktesh@kfri.org

N. Unnikrishnan

Department of Botany
SVRNSS College, TP Puram, Vazhoor
Kottayam, INDIA

ABSTRACT

A new combination, *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan, is proposed to accommodate a widely occurring economically important bamboo in South and central India which was formerly described under *Oxytenanthera* Munro and *Pseudoxytenanthera* Soderstr. & R.P. Ellis.

RESUMEN

Se propone una nueva combinación, *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan, para acomodar un bambú de amplia distribución e importante económicamente del sur y centro de la India que fue descrito anteriormente en *Oxytenanthera* Munro y *Pseudoxytenanthera* Soderstr. & R.P. Ellis.

INTRODUCTION

During revisionary studies on some Indian bamboos, the authors undertook a detailed study on the delimitation of *Dendrocalamus* Nees, *Oxytenanthera* Munro, and *Pseudoxytenanthera* Soderstr. & R.P. Ellis. All of the species described in the above genera were critically examined using the specimens deposited in various herbaria including the type specimens. Field examination of the Indian species belonging to these genera was carried out. We found that *O. stocksii* Munro showed more affinity to the Genus *Dendrocalamus* in the vegetative and floral characters.

Oxytenanthera stocksii was first described by Munro (1868) based on the specimen collected by Stocks from the Concan area. This species is distributed in South India, along the Konkan coast up to Karwar. Subsequently, Talbot also collected it from the Coompta River in 1884 and Karwar in 1889. Munro's species was recognized by many later workers, e.g., Beddome (1873), Gamble (1896), Camus (1913), etc. It was, however, Holttum (1956) who asserted that the genus *Oxytenanthera* was truly represented by the African species *O. abyssinica* due to the peculiar nature of its ovary i.e. the ovary attenuate upwards very gradually into a more or less three angled hollow structure which bears the stigmas at its apex and the cavity of the style appears not to be continuous with the cavity which contains the ovule. He concluded that the rest of species described within this genus should be transferred to some other genera. Based on this analysis, Majumdar (1989) transferred this species to a new genus, *Pseudotenanthera* Majumdar. Unfortunately, *Pseudotenanthera* is nom. superfl. and illegitimate for *Pseudoxytenanthera* Soderstr. & Ellis (1988). Nguyen (1990) treated this taxon under the genus *Gigantochloa* but it could not be included under this genus due to the presence of stamens with free filaments. Therefore, Naithani (1991) transferred this species to *Pseudoxytenanthera* as *P. stocksii* (Munro) Naithani. *Pseudoxytenanthera* is characterized by the presence of straggling culms, inflorescence with spikelets of semiverticillate clusters, monadelphous stamens, and three plumose stigmas. *Pseudoxytenanthera stocksii* possesses erect culms, free stamens, and a single plumose style. Although the previous authors described this species with fused filaments, during the present study, it was observed that the anther filaments are short and do not show true monadelphous condition. A close examination from the young stamens to mature stamens revealed that the filaments are totally free. Owing to these characteristic features, it cannot be accommodated within the genus *Oxytenanthera* Munro either. *Oxytenanthera stocksii* differs from *O. abyssinica*, the type species, by having free stamens and monostigmatic ovary. In *O. abyssinica* the stamens are monadelphous and the style is divided into three stigmas.

The culms and branching patterns of *Oxytenanthera stocksii* also resemble those of species of *Dendrocalamus* Nees. As in the case of the type species (i.e., *D. strictus*), *O. stocksii* shows erect culms with short internodes, which have narrow lumen (solid). The inflorescence of *O. stocksii* is a large panicle of spicate heads. Even in *Dendrocalamus*, the inflorescence is composed of round congested globose heads. In both species, the spikelets are few-flowered and there are no lodicules. In *O. stocksii* and in *D. strictus*, the palea is keeled and ciliate on the keels and the paleas of the upper flowers are not keeled. The stamens have short-apiculate anthers and free filaments. Another important character is the vestiture of style and stigma. In both species, the style is sparsely ciliate and ends in a single feathery stigma. In *O. stocksii* and other species of the genus *Dendrocalamus* the basal nodes bear aerial roots.

Oxytenanthera stocksii can be easily separated from *Dendrocalamus strictus* by the distinct auricles and bristles in the culm sheath, comparatively large leaves (15–22 × 1.5–2.5 cm), slender spikelets, slightly apiculate anthers with short filaments, elongated ovary, and oblong caryopsis.

The above observations support the separation of *Oxytenanthera stocksii* from the genera *Oxytenanthera*, *Pseudoxytenanthera* and *Gigantochloa*, which justify its inclusion within the genus *Dendrocalamus*. Morphological characteristics of *D. stocksii* are compared with those of the type species of *Dendrocalamus*, *Oxytenanthera*, *Pseudoxytenanthera*, and *Gigantochloa* in Table 1.

While describing *Oxytenanthera stocksii*, Munro had also noticed its simi-

TABLE 1. Comparison of *Dendrocalamus stocksii* to *Dendrocalamus strictus, Oxytenanthera abyssinica, Pseudoxytenanthera monadelpha* and *Gigantochloa atter* (The type species of genera).

Characters	*D. strictus*	*D. stocksii*	*O. abyssinica*	*P. monadelpha*	*Gigantochoa atter*
Culm surface	matt, wax furry	glossy, wax thin	glossy, wax thin	glossy, wax thin	glossy, wax thin
Culm wall thickness	thick walled	thick walled	thick walled	moderately thick walled	moderately thick walled
Culm sheath auricle	small and rudimentary	well-developed with oral setae	small and rudimentary	well-developed with oral setae	well-developed with oral setae
Spikelets	2-3 flowered	2-3 flowered	1-3 flowered	1-3 flowered	3-4 flowered
Lemma	sparsely hairy	glabrous	sparsely hairy	glabrous	glabrous
Apex of anthers	slightly apiculate	slightly apiculate	perfectly apiculate	perfectly apiculate	perfectly apiculate
Filaments	free	free	United	united	united
Stigma	single	single	Three	three	single

larity to *Dendrocalamus strictus*. The type specimen of *O. stocksii*, housed at Kew (K), is annotated as *D. stocksii* Munro, and therefore it is evident that Munro had previously considered this species within *Dendrocalamus*. However, he treated the species within *Oxytenanthera* due to the presence of slightly apiculate anthers and striated membranous lower palea. The similarities between this species and *Dendrocalamus* were also mentioned by Gamble (1896) who pointed out that the narrow leaves, long petioles and culm sheath were similar to that of *D. strictus*. These similarities also led to the misidentification of this species by subsequent authors. All the previous studies including that of Munro and Gamble were merely based on herbarium specimens, and some of the field characters and floral characters such as the nature of filaments, ovary, palea etc., were omitted. Therefore, they did not observe the correct and distinct characteristics of the species. The field observation on the floral and vegetative characters confirm the present concept of the species and hence a new combination within *Dendrocalamus* is proposed.

This bamboo species, which is economically important, is widely cultivated throughout South India and is utilized for house construction, basket making, ladders, poles, and for several other purposes.

SYSTEMATIC TREATMENT

Dendrocalamus stocksii (Munro) M. Kumar, Remesh & Unnikrishnan, comb. nov. *Oxytenanthera stocksii* Munro, Trans. Linn. Soc. London 26:130. 1868. *Pseudotenanthera stocksii* (Munro) R.B. Majumdar, Fl. Ind. Enumerat.-Monocot. 280. 1989. *Gigantochloa stocksii* (Munro) Nguyen, Bot. Zhurn. Akad. NAUK. 75:224.

1990. *Psuedoxytenanthera stocksii* (Munro) Naithani, J. Bombay Nat. Hist. Soc. 87:440. 1991. *Pseudoxytenanthera stocksii* (Munro) T.Q. Nguyen, Bot. Zhurn. NAUK 76:993. 1991. TYPE: INDIA. SOUTH INDIA. Concan: *Stocks s.n.* (LECTOTYPE, here selected: K).

Vernacular names.—Uyi, Mula (Malayalam), Konda (Karnataka).

Distribution.—Endemic to Northern Western Ghats. South India; northern Kerala and Karnataka along Concan coast, Goa, Maharashtra.

Selected Specimens: **INDIA. Kerala: Kasaragod Dist.:** North Kasargod, *Bamboo Products Exports 140317* (DD); Kanchangad, 29 Oct 1999 *Raveendran 20637* (KFRI). **Thrissur Dist.:** Palapilly, 16 Dec 2000 *M. Remesh 20646* (KFRI); 26 Feb 2001 *Unnikrishnan 74039* (CALI). **Goa: South Goa Dist.:** Noowary, 3 Mar 1985, *H.B. Naithani 1189* (DD). **Karnataka: North Kanara Dist.:** Coompta, 1884, *W.A. Talbot 269* (BSI); Flora of North Kanara *W.A. Talbot 549974* (CAL).

ACKNOWLEDGMENTS

The authors wish to acknowledge J.K. Sharma, Director, Kerala Forest Research Institute, Peechi for his keen interest and encouragement and for providing the research facilities. Help rendered by S.A. Renvoize, Herbarium, Royal Botanic Garden, Kew for sending the cibachrome sheets of the type specimen deposited in K and the authorities of Indian Herbaria (CAL, CALI, DD, BSI, MH, and BLAT) for permission to consult specimens are gratefully acknowledged. The authors are also thankful to the Department of Science & Technology, Govt. of India, New Delhi, for the financial support to conduct this study.

REFERENCES

BEDDOME, R.H. 1873. The flora sylvatica for southern India. Madras 3:232–233.

CAMUS, E.G. 1913. Les Bambusees. Lechevalier, Paris. Pp.149.

GAMBLE, J.S. 1896. The *Bambuseae* of British India. Annals of the Royal Botanic Garden, Calcutta 7:75–76.

HOLTTUM, R.E. 1956. The classification of bamboos. Phytomorphology 6:73–90.

MUNRO, W. 1868. A monograph of *Bambuseae*. Trans. Linn. Soc. London 26:126–127.

MAJUMDAR, R.B. 1989. In: Karthikeyan, S. et al. Flora Indicae, ser. 4, 2(Enumeratio Monocotyledonae). Botanical Survey of India, Howrah, Calcutta. Pp. 274–283.

NAITHANI, H.B. 1991. Nomenclature of Indian species of *Oxytenanthera* Munro. J. Bombay Nat. Hist. Soc. 87:439–440.

NGUYEN, T.Q. 1990. New taxa of bamboos (Poaceae, Bambusoideae) from Vietnam. Bot. Zhurn. Akad. Nauk. 75(2):221–225.

UNA NUEVA ESPECIE DE *STRUTHANTHUS* (LORANTHACEAE) PARA COSTA RICA

Luis A. González and J. Francisco Morales

Instituto Nacional de Biodiversidad (INBio)
Apto 22-3100
Santo Domingo de Heredia, COSTA RICA

RESUMEN

Se describe una nueva especie de *Struthanthus* (Loranthaceae) para Costa Rica. Además se adjunta una clave para las especies del genero presentes en el país, incluyendo taxas no reportados aún, pero presentes en zonas cercanas de Nicaragua y Panamá.

ABSTRACT

A new species of *Struthanthus* from Costa Rica is described. A key to the species currently known for the country is given, including two species recorded from Panama and Nicaragua, but not reported from Costa Rica yet.

La familia Loranthaceae está ampliamente representada a lo largo del trópico, conteniendo alrededor de unos 60 géneros y 1000 especies (Kuijt 2001). En Costa Rica se han reportado hasta la fecha 6 géneros y unas 28 especies (Morales, en prep.). Este grupo de plantas está ampliamente distribuido y se encuentra en una amplia gama de habitads y ecosistemas, encontrándose desde el nivel del mar hasta los 3200 metros sobre el nivel del mar, tanto en bosques secos a muy húmedos o áreas semiparamosas o páramos. Su forma de crecimiento les ubica en una posición muy particular desde el punto de vista antrópico, ya que en cultivos frutales representa un problema que se refleja en la disminución de la producción al parasitar dichos cultivos, mientras que en el manejo de los bosques naturales son una fuente de alimento para varias especies silvestres, principalmente aves.

Struthanthus es un género neotropical constituido por unas 70 especies (Kuijt 2001), de las cuales se conocen para Costa Rica 13 especies. Dentro de la familia se puede confundir con *Panamanthus*, pero este último se distingue por tener inflorescencias con las flores solitarias, mientras que en *Struthanthus* las flores están dispuestas en diadas o tríadas. También se puede confundir con *Phthirusa*, cuyo carácter diferenciante radica en la presencia de flores usualmente bisexuales, en contraste con *Struthanthus* que posee flores funcionalmente unisexuales.

En los últimos 15 años, la exploración de regiones montañosas y prácticamente inexploradas del Valle de Candelaria en Acosta, San José y de la Vertiente Atlántica de la Cordillera de Talamanca, Limón, han producido la descripción de varios taxa (Hammel & Zamora 1990, 1993; Morales 1997, 1999), algunos de ellos localmente endémicos y restringidos a estas zonas geográficas. Durante la preparación del tratamiento de Loranthaceae para el Manual de la Flora de Costa Rica, se encontró una nueva especie de *Struthanthus*. Conocida hasta el momento de las áreas geográficas antes expuestas, se describe a continuación.

Struthanthus acostensis L.A. González & J.F. Morales, sp. nov. (**Fig. 1, 2**). TIPO. COSTA RICA. SAN JOSÉ: Acosta, Valle del Candelaria, Fila Zoncuano, 1000–1050 m, 20 Jul 1995 (fl), *Morales 4582* (HOLOTIPO: INB; ISOTIPO: MO).

A *S. burgeri* Kuijt cui affinis, corollae sessilis differt.

Epífita escandente, hemiparásita. Entrenudos de las hojas de 1.5–6.5 × 1.5–4.0 mm. Tallos teretes a subteretes, esparcidamente ferrugineo-lenticelados. Hojas opuestas a subopuestas, pecíolos de 3–8 mm de largo y 1.5–2.0 mm de ancho, con sus bordes continuos a los márgenes de la lamina; lamina de 8.0–12.5 cm de largo y 3.5–8.2 cm de ancho, ovada a elíptica, estrechándose gradualmente hacia el ápice, aguda, atenuada a cuneada basalmente, borde entero y ligeramente revoluto cuando seco, esencialmente glabra, venación pinnada, venas secundarias de 3-9 pares conspicuas, las terciarias conspicuas y a veces formando retículos. Inflorescencias 1 a 6 por axila, 0.7–4 cm, con 2–4 tríadas, subtendidas por bracteas de 0.7–2 mm, una por cada flor; pedúnculo 0.3–2.5 cm de largo, raquis de las tríadas 1.5–7.0 mm de largo; flores amarillentas, sésiles, unisexuales; las masculinas desconocidas, las pistiladas 4–5 mm de diámetro, corola ca. 3 mm, estaminodios fusionados con los pétalos, estilo apical, estigma capitado. Fruto 4.0 × 3.0 mm de diámetro, anaranjado al madurar, subgloboso, obtuso en la base, la superficie cubierta con numerosas y diminutas ranuras o cavidades.

Distribución. —esta especie se encuentra en bosques muy húmedos en la Fila Zoncuaco (Acosta) en el Valle del Candelaria, y en la Cordillera de Talamanca (Alto Urén), a elevaciones entre 700–1100 m. Floración y fructificación entre Julio y Agosto.

Struthanthus acostensis se reconoce con facilidad por sus inflorescencias con 2–4 tríadas pediceladas, flores y frutos sésiles y tallos teretes a subteretes. Anteriormente esta especie fue identificada como *Panamanthus panamensis* (Rizzini) Kuijt, pero este taxa se caracteriza por sus flores solitarias, contrastando con *Struthanthus acostensis* que posee flores en tríadas. También ha sido identificada como *S. burgeri* Kuijt; sin embargo, esta última especie se caracteriza por poseer inflorescencias con más de 4 tríadas y flores pediceladas, mientras que *S. acostensis* tiene flores sésiles dispuestas en inflorescencias de 2 a 4 tríadas. Por otro lado, se puede separar con facilidad de *S. oerstedii* (Oliv.) Standl. por sus hojas muchísimo más grandes, pecíolos más largos y desarrollados, así como por sus flores más grandes y distribución geográfica y preferencias ecológicas distintas.

La etimología de la especie hace referencia a la localidad tipo, zona de cuyas

INSTITUTO NACIONAL DE BIODIVERSIDAD
LORANTHACEAE
Struthanthus [illegible]

COSTA RICA
LORANTHACEAE dup.= 4
Struthanthus

Det.

LIMON: Cantón de Talamanca
Alto Urén. Siguiendo el camino entre
la Quebrada Chaho y Croriña.
9°20'50"N 82°59'00"W 700 m
Semiparásita. Flor amarillo tenue.
Frutos maduros anaranjados.

Gerardo Herrera 3326 [illegible] July [illegible]

HERBARIO NACIONAL DE COSTA RICA (CR)
INSTITUTO NACIONAL DE BIODIVERSIDAD/MISSOURI BOTANICAL GARDEN (MO)

Fig. 1. *Struthanthus acastensis* L.A. González & J.F. Morales (Paratipo, *Herrera 3326*, INB).

exploraciones botánicas en los últimos 10 años, han revelado una serie de novedades botánicas y nuevos reportes taxonómicos y que por largo tiempo han pasado inadvertidos, como consecuencia de la extensa deforestación prevaleciente desde hace más de 150 años.

Paratipos. Costa Rica. Limón: Talamanca, Alto Urén, 23 Jul 1989 (fl, fr), *Herrera 3326* (INB, MO)

A continuación se presenta una clave para las especies del género *Struthanthus* conocidas hasta el momento para Costa Rica. Dos especies adicionales, reportadas en zonas limítrofes de Panamá y Nicaragua que podrían encontrarse eventualmente en el país son incluidas.

1. Tríadas sésiles o subsésiles en la antesis, el pedúnculo ausente o inconspicuo, menos de 1.5 mm largo, algunas veces algunos elongados en fructificación (*Struthanthus orbicularis*), pero entonces los frutos más de 9 mm largo al madurar.
    2. Inflorescencias con numerosas brácteas basales papelosas, dispuestas justo en la articulación con las ramitas; tallos viejos (algunas veces los jóvenes y las inflorescencias) conspicuamente lenticelados, las lenticelas 1–2 mm diámetro ____ **S. leptostachyus** (Benth.) G. Don.
    2. Inflorescencias sin brácteas papelosas basalmente o si presentes, entonces inconspicuas o rápidamente deciduas antes de la antesis; tallos viejos sin lenticelas o si presentes, entonces muy pequeñas y menos de 1 mm de diámetro.
        3. Tallos nuevos conspicuamente cuadrangulares o angulados, los más viejos sin lenticelas; hojas nuevas prensiles; frutos 9–13 mm largo, anaranjado púrpura, azul-púrpura, púrpura a negro-púrpura al madurar ____ **S. orbicularis** (Kunth) Blume
        3. Tallos nuevos subteretes a muy obscuramente subangulados, los viejos con lenticelas menos 1 mm de diámetro o sin lenticelas; hojas nuevas no prensiles; frutos 4–5 mm largo, anaranjados a rojizo-anaranjados al madurar.
            4. Láminas anchamente agudas, redondeadas a obtusas apicalmente; tallos diminutamente lenticelados cuando viejos ____ **S. costaricensis** Standl.
            4. Láminas acuminadas a agudas apicalmente; tallos usualmente no lenticelados cuando viejos.
                5. Bosques húmedos de bajura de la Zona Norte & Vertiente Atlántica bajo los 500 m; venación conspicuamente impresa ____ **S. woodsonii** Cufod.
                5. Bosques húmedos de las Cordillera Central & de Talamanca sobre los 1000 m; venación inconspicuamente impresa ____ **S. cansjerifolius** (Oliv.) Eichler
1. Tríadas conspicuamente pedunculadas, algunas veces una pocas espigas subsésiles, pero predominando en el resto un pedúnculo obvio.
    6. Tallos más jóvenes usualmente irregularmente cuadrangulares o angulados.
        7. Láminas muy anchamente obovadas a suborbiculares ____ **S. hartwegii** (Benth.) Standl.
        7. Láminas elípticas, ovado-elípticas a ovadas o lanceoladas.
            8. Inflorescencias con numerosos tríadas, con al menos (5–)7 tríadas; áreas (900–)1500–3000m ____ **S. quercicola** (Schltdl. & Cham.) Blume
            8. Inflorescencias con 3 pares de tríadas; áreas alrededor 600–700 m ____ **S quadrangularis** Kuijt
    6. Tallos usualmente teretes a subteretes, nunca irregularmente cuadrangulares.
        9. Inflorescencias usualmente con 2–3(–4) tríadas.
            10. Láminas acuminadas apicalmente; tallos muy escazamente lenticelados ____ **S. subtilis** Kuijt

Fig. 2. *Struthanthus acostensis* L.A. González & J.F. Morales (*Morales 4582*, INB). **A.** Detalle de las inflorescencias.

10. Láminas agudas a obtusas apicalmente.
    11. Lámina 1.7–6(–8.5) × 0.7–3.3(–4) cm; peciolo 1.5–3 mm largo bosques; secos a bosques húmedos ________ **S. oerstedii** (Oliv.) Standl & Calderón
    11. Lámina 8.0–12.5 × 3.5–8.2 cm; peciolo 3–8 mm largo; bosques muy húmedos ________ **S. acostensis** L.A. González & J. F. Morales
9. Inflorescencias usualmente con más de (4–)5 tríadas; tallos sin lenticelas o esparcidamente lenticelados, las lenticelas no ferrugíneas.
    12. Lámina comúnmente obovada a elíptico-obovada, la venación conspicuamente impresa, los nervios secundarios más basales dando la sensación de una venación palmada; áreas de bosques secos de Guanacaste & Península de Nicoya, 0–600 m ________ **S. cassythoides** Millsp. ex Standl.
    12. Lámina elíptica, ovado-elíptica, anchamente-elíptica o elíptico-lanceolada, la venación inconspicua o levemente impresa, pero los nervios basales no pareciendo palmados, sino típicamente pinnados; áreas de bosques húmedos.
        13. Flores y frutos (todos) conspicuamente pedicelados ________ **S. burgeri** Kuijt
        13. Flores y frutos sésiles, usualmente algunas veces algunos frutos laterales pedicelados, pero siempre el resto sésil.
            14. Venación conspicuamente impresa en ambas caras de la hoja; bosques húmedos de bajura de la Zona Norte & Vertiente Atlántica bajo los 500 m ________ **S. woodsonii** Cufod.
            14. Venación inconspicuamente impresa en ambas caras de la hoja; Bosques húmedos de las Cordillera Central y de Talamanca sobre los 1000 m ________ **S. cansjerifolius** (Oliv.) Eichler

AGRADECIMIENTOS

Esta publicación fue financiada por la Asistencia Holandesa para el Desarrollo (NEDA) a través del proyecto "Desarrollo del Conocimiento de la Biodiversidad y Uso Sostenible en Costa Rica" conducido por el Instituto Nacional de Biodiversidad (INBio). Además, la investigación fue posible además gracias al convenio de cooperación entre el Ministerio de Ambiente y Energía (MINAE) e INBio con el fin de completar en Inventario Nacional de Biodiversidad.

REFERENCIAS

Kuijt, J. 2001. Loranthaceae. En: W. Stevens, C. Ulloa, A. Pool, y O. Montiel, eds. Flora de Nicaragua. Monogr. Syst. Bot. Missouri Bot. Gard. 85:1239–1246.

Hammel, B. and N. Zamora. 1990. *Nyssa talamancana* (Cornaceae), an addition to the remnant Laurasian tertiary flora of southern Central America. Brittonia 42:165–170.

Hammel, B. and N. Zamora. 1993. *Ruptiliocarpon* (Lepidobotryaceae): a new arborescent genus and tropical America link to Africa, with a reconsideration of the family. Novon 3:408–417.

Morales, J.F. 1997. Three new taxa for the flora of Costa Rica. Phytologia 81:361–364.

Morales, J.F. 1999. Seis nuevas especies de *Vriesea* section Xiphion (Bromeliaceae: Tillandsoideae) para Costa Rica. Novon 9:401–406.

THE *GONOLOBUS* COMPLEX (APOCYNACEAE: ASCLEPIADOIDEAE) IN THE SOUTHEASTERN UNITED STATES

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612
Alexander_Krings@ncsu.edu

(Jenny) Qiu-yun Xiang

Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612
Jenny_Xiang@ncsu.edu

ABSTRACT

Taxonomic limits of *Gonolobus* (Apocynaceae: Asclepiadoideae) in the southeastern United States have been controversial, with some authors recognizing two species and others only one. Over the past 30 years, most authors have tended toward recognition of a single species. However, the morphological variation within the taxon appears complicated and has not been analyzed using a quantitative approach. We analyzed the morphological variation within southeastern *Gonolobus*, based on 143 herbarium specimens from 13 southeastern states, using ANOVA, and mapped taxon distributions. Two distinct *Gonolobus* entities, based on differences in floral character states and geographic tendencies, appear to exist in the southeast, although questions regarding rank recognition remain.

RESUMEN

Los límites taxonómicos de *Gonolobus* (Apocynaceae: Asclepiadoideae) en el sureste de los Estados Unidos han sido controvertidos, con unos autores que reconocen dos especies y otros sólo una. En los últimos 30 años, la mayoría de los autores han tendido al reconocimiento de una sola especie. Sin embargo, la variación morfológica del taxon parece complicada y no ha sido analizada usando métodos cuantitativos. Hemos analizado la variación morfológica en los *Gonolobus* del sureste, en base a 143 especímenes de herbario de 13 estados del sureste, usando ANOVA, y distribuciones cartográficas del taxon. En el sureste parecen existir dos entidades distintas de *Gonolobus*, basadas en diferencias de los estados de carácter florales y las tendencias geográficas, aunque aún quedan cuestiones acerca del rango que merecen.

Climbing milkweeds (Apocynaceae: Asclepiadoideae and Periplocoideae) encompass at least two taxonomically difficult genera in the southeastern United States—*Matelea* and *Gonolobus* (Drapalik 1969; Sundell 1981; Rosatti 1989; Liede 1997). Two closely-related species of *Gonolobus* Michx. have until recently been recognized from the southeastern United States, although opinions over generic placement have differed. Woodson (1941) considered that the genus *Gonolobus* should contain plants characterized by only long, eglandular trichomes, dorsal anther appendages, and smooth, angled or winged follicles, whereas *Matelea* Aubl. should contain plants characterized by glandular and eglandular trichomes, anthers lacking dorsal appendages, and muricate follicles. Unconvinced that dorsal anther appendages should serve as a generic character and citing examples of smooth [but not angled or winged] fruits in *Matelea*, Shinners (1950) argued against Woodson's generic concept and transferred the southeastern

SIDA 21(1): 103 – 116. 2004

Gonolobus taxa to *Matelea*. Later, Shinners (1964) also included twelve of Woodson's (1941) *Gonolobus* combinations in *Matelea*. Drapalik (1969) maintained Shinners' generic view, although admitting to the characteristic differences of southeastern *Gonolobus* from southeastern *Matelea* species in bearing dorsal anther appendages and smooth, winged follicles. Taking a broader geographical perspective of generic morphology and citing the importance and development of anther appendages in the 150 some species of *Gonolobus* outside the southeastern United States, Rosatti (1989) argued for renewed placement of the southeastern taxon in *Gonolobus*. Most recently the concept of *Gonolobus* as characterized by short, capitate-glandular, short acicular, and long acicular trichomes, dorsal anther appendages (typically), and smooth, winged follicles has been used by Stevens (2001). The two *Gonolobus* species historically recognized from the southeastern United States—*Gonolobus suberosus* (L.) R. Br. and *Gonolobus gonocarpos*—have been distinguished primarily by the ratio of corolla lobe length to sepal lobe length and the presence or absence of pubescence on the adaxial corolla surface (Small 1933; Perry 1938; Fernald 1950; Gleason 1952; Radford et al. 1968). Most authors essentially followed Small (1933) in referring the taxon with glabrous corollas and lobes more than twice as long as the sepals to *G. gonocarpos* and the taxon with pubescent corollas and lobes twice as long or less than the sepals to *G. suberosus* (Perry 1938; Fernald 1950; Gleason 1952; Radford et al. 1968). In contrast, Drapalik (1969) considered the two taxa synonymous, having found "plants that would represent both [...] taxa and every conceivable intermediate." However, he stressed that in no manner should his decision be taken to acknowledge that the taxon was uniform throughout its range. Considering that *G. gonocarpos* is state listed as threatened in Florida (Florida Administrative Code Ch. 5B- 40.0055), this study seeks to re-examine the taxonomy of the southeastern *Gonolobus* complex by critically analyzing patterns of morphological variation and their geographical relationships using a quantitative approach.

METHODS

A total of 326 herbarium specimens (from nineteen herbaria) were examined from throughout the range of the southeastern *Gonolobus* complex (i.e., AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, and VA). We selected 143 herbarium specimens (the OTUs in the analysis) for our analyses—the rest were either too poor in condition or lacked some or all organs. Six characters (Table 1), three quantitative and three qualitative, showed variation within the group and were thus chosen for the analysis. Only mature flowers were chosen for scoring of floral characters.

Leaf shape/size and vestiture characters were not chosen for inclusion in the analysis. These characters were not rejected due to high variability, but due to lack of basic understanding regarding intra-individual variation. Leaf size and shape may be influenced by position on the stem (e.g., sun vs. shade leaves) and habitat (e.g., edge vs. forest interior) (Krings, pers. obs.). As collectors rarely indicate the stem position from which samples were taken, parallel comparisons of herbarium specimen leaf material (i.e., comparing sun leaves to sun leaves) is essentially impossible. Leaf pubescence characteristics were also considered uninformative with regard to southeastern *Gonolobus*. Our chi-square tests suggested no correlation between leaf pubescence and either floral character states or the environment (i.e., habitat), as might be expected (unpubl.).

Although inflorescence characters (type and number of flowers borne) have been useful in higher level analyses in the Asclepiadoideae (e.g., Liede 1996, 1997), inflorescence characters were not included in our study based on results of a preliminary analysis of 48 *Gonolobus* specimens chosen primarily from the extremes of the range (i.e., Florida and Texas). ANOVA results showed no significant difference ($F=0.865<F_{Crit}=4.05$) in the mean number of flowers per inflorescence between uniformly-colored and multi-colored specimens (Krings, unpubl.). In the preliminary analysis, flowers were counted for any inflorescence bearing at least one fully opened flower (i.e., corolla lobes completely extended). As flowers are produced sequentially over the life of the inflorescence, visible flower buds were included in the total count of flowers per inflorescence. Specimens chosen for inclusion were those most robust overall—a somewhat arbitrary judgment of the number of inflorescences available and their condition.

Due to the high similarity of fruits of *Gonolobus* in the southeast, collections of the same individuals in flower and fruit would be required to allow correlative evaluation of fruit character utility. Unfortunately, the extremely small number of such collections is inadequate for such an evaluation at this time.

A data matrix was produced by scoring the character states of five characters for all 143 OTUs (see below & Table 1). There were no gaps in the data matrix. A neighbor-joining tree was generated using PAUP 4.0 (Swofford 2002). Frequency distributions were also determined for selected floral character states and tested for significant differences using ANOVA.

Characters

1. *Floral color.*—Individuals of the southeastern *Gonolobus* complex exhibit flowers that are either uniformly green from corolla lobe base to apex or conspicuously dark at the base (variously described as maroon to brown) with lighter tips (typically green). Specimens bearing the former were scored as uniformly green (1) and specimens exhibiting the latter as multi-colored (0) for corolla lobe coloration. On senescing, greenish flowers tend to turn yellowish.

2. *Adaxial corolla vestiture.*—Adaxial corolla vestiture is an important character that has been used to recognize species in the southeastern *Gonolobus* complex (see Small 1933; Gleason 1952; Radford et al. 1968). Adaxial corolla lobe pubescence tends to be laterally distributed. Pubescence is generally concentrated on the right side of corolla lobes (from apex to base) and may extend longitudinally to various degrees across the lobe center to the left. The far left margins (from apex to base) tend to be glabrous in otherwise pubescent flowers. The same asymmetry was also evident in Caribbean species available to us for inspection and may be the case for all pubescent *Gonolobus* species—although such analysis was presently beyond our scope. Specimens were scored as pubescent (0) if pubescence to any degree was observed on the adaxial corolla lobes and glabrous (1) if no pubescence was evident.

3. *Corona.*—Corona characters have in the past been used to distinguish asclepiad genera (see Liede 1996), although caution must be employed if the true homology is not known (see Liede 1996; Liede & Täuber 2002). In our study, we evaluated only the shape of the corona lobes among members of the southeastern *Gonolobus* complex. All coronas in the complex are lobed. However, not all lobes are further lobed (i.e., emarginate at the apex). We scored corona lobes to be either lobed (i.e., emarginate at the apex)(0) or truncate (i.e., squared off at the apex) (1).

4–6. *Quantitative floral characters.*—Measurements of sepal and petal length were taken from between 1 to 5 flowers per specimen, depending on availability and measurability. Flowers with excessive contortion and folding of petals and sepals were avoided. In general, measurements were taken from different flowers, although in a few cases, when availability was poor and lobe length varied infraflorally, multiple corolla lobes were measured from a single flower. For generation of a nearest-neighbor tree, continuous sepal and corolla lobe lengths were coded into one of five range classes and treated as unordered in the analysis (Table 1). The ratio of mean corolla lobe length to mean sepal length was not used in the generation of the nearest-neighbor tree.

RESULTS

It appears that at least two distinct groupings of *Gonolobus* taxa exist in the southeastern United States. The clustering of taxa exhibits strong geographic tendencies (Fig. 1), although petal and sepal length intergrade among OTUs when graphed in a scatterplot (Fig. 2). Based on corolla coloration, taxa can be assigned to one of two groups: (1) a uniformly colored corolla group (UCCG) and a multi-colored corolla group (MCCG). The UCCG is considerably more widespread and exhibits a more western center of gravity relative to the MCCG (Fig. 1). Adaxial corolla pubescence is nearly invariable in the UCCG. Only 3.7% (3 of 81) of the examined individuals exhibit pubescent adaxial corolla surfaces (Fig. 3). Although individuals with uniformly colored petals have been collected in the far eastern states of Georgia, North Carolina, and Virginia, these tend to be rare collections disjunct from the main range of occurrence (Fig. 1).

Table 1. Floral characters and character states. Character 6 used in ANOVA only and not in generation of neighbor-joining tree due to lack of independence vis-á-vis characters 4 and 5.

Character	Character State	
1. Adaxial corolla coloration	Multi-colored (dark center, lighter tips) [0]	Uniformly green [1]
2. Adaxial corolla vestiture	Pubescent [0]	Glabrous [1]
3. Corona	Lobed [0]	Truncate [1]
4. Mean sepal length (mm)	1.5–2.5 [0], 2.51–3.5 [1], 3.51–4.5 [2], 4.51–5.5 [3]	
5. Mean corolla lobe length (mm)	2.01–4 [0], 4.01–6 [1], 6.01–8 [2], 8.01–10 [3], >10.01 [4]	
6. Ratio of Mean corolla lobe length: Mean sepal length	Continuous	

Adaxial corolla pubescence is much more frequent among members of the MCCG (Fig. 3). In fact, two thirds of the examined individuals in this group were pubescent (41 of 62). The MCCG appears to be restricted to a more narrowly defined southeastern range east of the Mississippi (Fig. 1).

Except for a few outliers (e.g., GA2, NC20, VA1, VA23), the geographic clustering is supported by the midpoint-rooted neighbor-joining tree (Fig. 4). Although bootstrapping yielded little support for any one branch of the tree (due to the small number of characters employed), the tree remains informative. Members of the MCCG and UCCG are grouped together—indicating greater within-group similarity across the five morphological characters than between groups.

Individuals of the UCCG exhibit longer mean corolla lobes (mean=7.68) and higher mean corolla lobe length to mean sepal length ratios (mean=2.48) than individuals of the MCCG (Table 2). Results of analyses of variation (ANOVA) indicate the differences in both mean corolla lobe length and corolla:sepal length ratio to be highly statistically significant between the two groups (Table 3).

It is interesting to note that the rare pubescent individuals of the predominantly glabrous UCCG appear to exhibit a similar frequency distribution of corolla lobe lengths and corolla:sepal ratios as pubescent members of the MCCG. ANOVA tests show no significant difference between pubescent UCCG and pubescent MCCG in both mean corolla lobe lengths ($F=0.042 < F_{Crit}=3.99$) and the ratio ($F=0.604 < F_{Crit}=3.99$)—although this may be a factor of the small sampling size of pubescent UCCG members (n=3). Glabrous members of the MCCG appear to exhibit corolla lobe lengths much larger than the more frequent (in terms of specimens examined) pubescent members of the MCCG (Fig. 5B). However, the difference in mean corolla lengths between glabrous and pubescent MCCG is not quite significant ($F=3.559 < F_{Crit}=3.96$). The difference in the

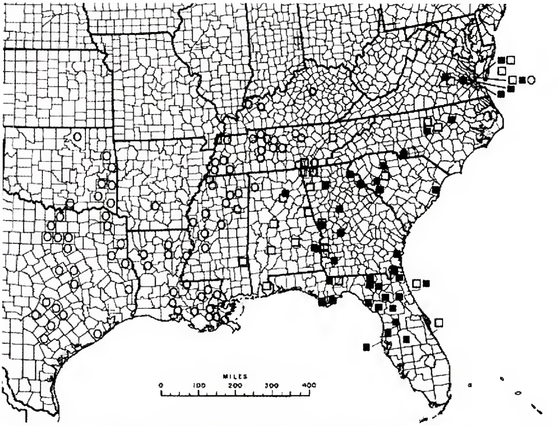


Fig. 1. Distribution map of southeastern United States *Gonolobus* entities. Circles represent individuals with uniformly green corollas—either glabrous adaxially (open circle) or pubescent (closed circle). Squares represent individuals with multi-colored corollas—either glabrous adaxially (open square) or pubescent (closed square).

corolla:sepal ratio between glabrous and pubescent MCCG members is also not quite significant ($F=3.746 < F_{Crit}=3.96$). Although the frequency peak for corolla:sepal ratios of glabrous MCCG members appears to graphically coincide with the peak of glabrous UCCG members (Fig. 5C & D), ANOVA results show a strong statistical difference between the two ($F=9.467 > F_{Crit}=3.93$).

DISCUSSION

The issue of whether more than one *Gonolobus* species should be recognized for the southeastern United States has long confronted taxonomists and has been additionally complicated by the nomenclatural confusion surrounding *Gonolobus suberosus* (L.) R.Br. (see Drapalik 1969; Reveal & Barrie 1992). Small (1933), and later Perry (1938), recognized two species of *Gonolobus* in the Southeast based on corolla pubescence and the ratio of corolla lobe length to sepal length. Small (1933) referred the taxon with glabrous corollas and lobes more than twice as long as the sepals to *G. gonocarpos* (*Vincetoxicum gonocarpos* sensu Small), whereas the taxon with pubescent corollas and lobes twice as long or less than the sepals was referred to *G. suberosus* (*V. suberosum* sensu Small).

Fig. 2. Scatterplot of sepal vs. petal length by flower color and adaxial petal vestiture for *Gonolobus* entities in the southeastern United States.

Fernald (1950) added some less than distinct characters to the mix, including flower bud ("abruptly acuminate" vs. "gradually acute or acuminate"), calyx pubescence ("practically glabrous" vs. "glabrous or ciliolate apically"), and corolla lobe shape ("broadly lanceolate" vs. "linear-lanceolate"), while basically maintaining Small's (1933) pubescence and ratio characters. Gleason (1952) treated only *G. gonocarpos*, stating that *G. suberosus* was "erroneously" accredited to the range of Britton and Brown's flora. However, in a footnote, Gleason (1952) maintained the distinction between the taxa based on adaxial corolla pubescence, forwarded by previous authors (Small 1933; Perry 1938; Fernald 1950). In light of the present analyses, these concepts of specific delimitation are untenable as stated.

Drapalik's (1969) findings of overlapping combinations of character states among *Gonolobus* taxa in the southeast are upheld by our study. However, overlapping character presence/absence combinations are insufficient argument against recognition of multiple taxa. Especially at the infraspecific level and in hybrid zones, some level of character overlap can be expected between individuals sharing some range continuity. Our data support the notion of previous workers (e.g., Small 1933; Perry 1938; Fernald 1950; Gleason 1952), that at least two *Gonolobus* entities occur in the Southeast that could be accorded for-

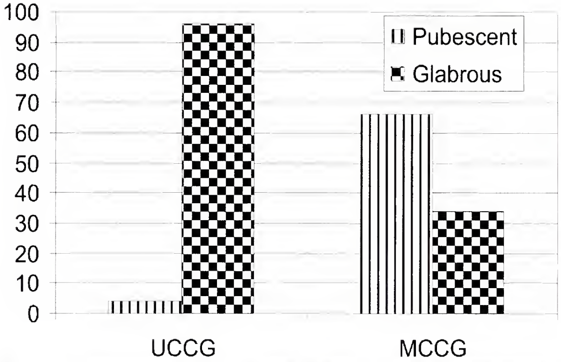


Fig. 3. Percentage of *Gonolobus* specimens exhibiting pubescent or glabrous adaxial corolla lobes in the respective uniformly colored corolla group (UCCG) and the multi-colored corolla group (MCCG).

mal rank. However, contrary to previous workers, we propose that the two groups respectively be defined by uniformly-green versus multi-colored corolla lobes, rather than by corolla/sepal length and adaxial corolla lobe pubescence. Although there are significant differences in mean corolla lobe lengths and the ratio of corolla lobe length to sepal length (Table 3), these character states can overlap at the individual level and cannot consistently separate the taxa. Similarly, adaxial corolla pubescence cannot consistently separate the taxa, being present in both members of the UCCG and the MCCG. However, distinct differences are apparent in the frequencies of the pubescence trait (Figs. 3 & 5). In addition, with respect to their geographic distribution, the frequency of glabrous, multi-colored flower collections increases conspicuously in the zones where the UCCG meets the MCCG (e.g., in Alabama). Similarly, the rare individuals bearing adaxially pubescent, uniformly green corollas occur well within the range of the MCCG. Thus, the respective changes in pubescence frequencies in the MCCG or occurrence of rare character states in the UCCG outside its primary range may be cautiously hypothesized to be an effect of genetic interchange between two taxa intergrading in distribution.

Unfortunately, frequency histograms of corolla lobe length and ratio of corolla lobe length:sepal length size classes within the UCCG and MCCG shed weak light on the matter of intergradation (Fig. 5). Although our analyses support the recognition of two *Gonolobus* entities in the Southeast, the question remains whether these should be recognized at the species level or below. Our

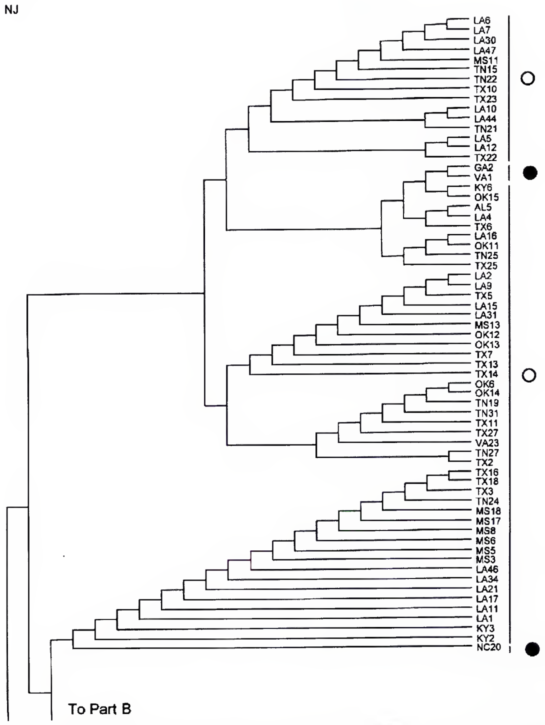


Fig. 4 (Part A). Midpoint-rooted neighbor-joining tree, based on five morphological characters. OTUs are individual specimens of *Gonolobus*. First two characters of alphanumeric code indicate state of origin by standard abbreviation. Second two characters are a unique, sequential number assigned to each specimen studied. Circles represent individuals with uniformly green corollas—either glabrous adaxially (open circle) or pubescent (closed circle). Squares represent individuals with multi-colored corollas—either glabrous adaxially (open square) or pubescent (closed square).

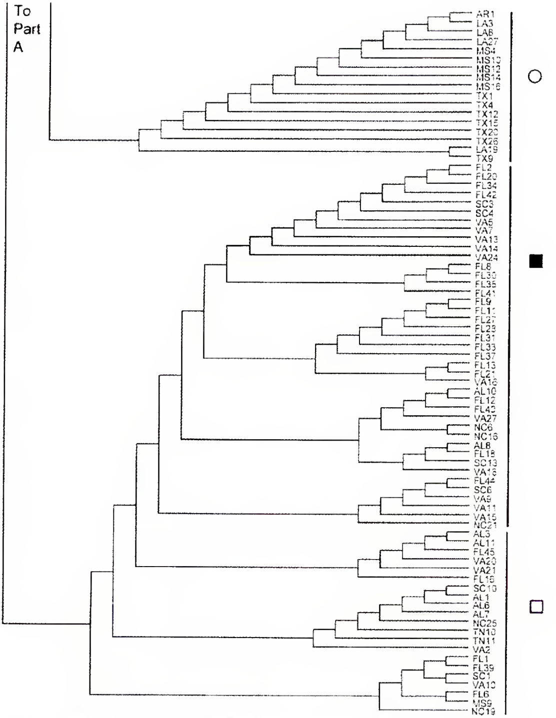


Fig. 4 (Part B).

data can be interpreted either way—two morphologically divergent species potentially hybridizing in overlapping zones, resulting in some morphological intergradation, or two diverging subspecies with morphological intergradation in zones of range overlap. The former interpretation could result from application of a quantitative or phenetic species concept, in which species are distinguished based on differences in means of variables. Although commonly

Table 2. Descriptive summary statistics for continuous floral characters of the uniformly colored corolla group (UCCG) and the multi-colored corolla group (MCCG).

	Mean sepal length	**Mean corolla lobe length**	**Mean ratio (corolla lobe length: sepal length)**
Uniformly colored	3.21 (SD=0.76)	7.68 (SD=1.47)	2.48 (SD=0.61)
Multi-colored	3.08 (SD=0.74)	5.59 (SD=1.73)	1.83 (SD=0.44)

Table 3. ANOVA results for floral character comparisons between the uniformly colored corolla group and the multi-colored corolla group. In both cases, the null hypothesis of no significant difference is rejected.

		Mean corolla lobe length				
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	153.1516	1	153.1516	61.08722	1.15E-12	3.908255
Within Groups	353.5008	141	2.507098			
Total	506.6524	142				

		Ratio of mean corolla lobe length: mean sepal length				
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	14.78613	1	14.78613	50.19068	6.1E-11	3.908255
Within Groups	41.53849	141	0.294599			
Total	56.32462	142				

applied, the underlying theory of this concept remains unclear (see Luckow 1995). In contrast, application of a phylogenetic species concept suggests two infraspecific taxa—populations exhibiting high frequencies of unique traits that may become 'fixed' in the future (Nixon & Wheeler 1990). However, a cladistic analysis that includes other congenerics is necessary to test this hypothesis (Nixon & Wheeler 1990). In the absence of additional data, we cautiously choose to follow (Drapalik 1969) in recognizing a single species until additional evidence is available. Interestingly, the overall biogeographic pattern exhibited by the two *Gonolobus* entities has been observed for other taxa (including fish!) in the Southeast (see Avise 1994) and may be the result of past environmental shifts such as the oceanic incursions and retreats that define today's southeastern Coastal Plain (Sorrie & Weakley 2001). To further elucidate both the question of rank and evolutionary history of the complex, we are conducting genetic analyses of southeastern *Gonolobus* populations using molecular markers and integrating phylogenetic data from Caribbean *Gonolobus* species—some of which have been suggested to be nearest relatives of the southeastern taxa (Scheele 1848).

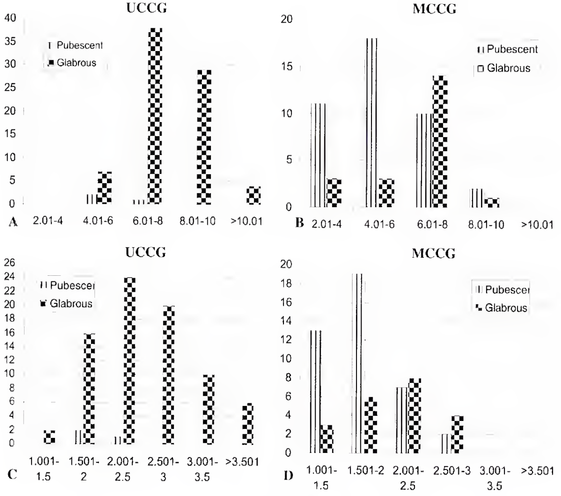


Fig. 5. Frequency histograms for floral characteristics in the uniformly colored corolla group (UCCG) and the multi-colored corolla group (MCCG) of southeastern *Gonolobus*—Corolla lobe length in mm ranges (A: UCCG; B: MCCG) and ratio of corolla lobe length to sepal length (C: UCCG; D: MCCG). Y axes represent number of individuals and X axes respective character state ranges.

Should workers choose to formally recognize the two entities, we provide a brief discussion regarding available names. For more detail regarding the particularly complicated history and nomenclature involved, readers are urged to see Reveal & Barrie (1992) and Krings (2001). In choosing a name for the taxon with uniformly colored petals, past names published for southeastern *Gonolobus* taxa were examined. Walter's type of *Gonolobus gonocarpos* (*Walter 687*, BM!) contains only leaves and roots. In addition, no mention regarding the pubescence of the corolla is made in his protologue (Walter 1788). Thus we cannot be certain to which species the plants that Walter based his description on belong. However, due to the rare occurrence of uniformly colored species in the Carolinas, we propose that his type be considered to belong to the multi-color group. Types for *Gonolobus macrophyllus* Michx. and *Gonolobus laevis* A. Gray, non Michx. are relegated to the multi-color group for the same reason. The protologue of *Gonolobus granulatus* Scheele (1848) is based on the only eligible type specimen collected west of the Mississippi (*Lindheimer s.n.*) and notes glabrous adaxial corolla lobes. Thus, the correct name for the uniformly green-flowered taxon should be based on *Gonolobus granulatus* Scheele and the name for the multi-color flowered taxon should be *Gonolobus suberosus* (L.) R.Br. Alternatively, if the two entities are recognized at the infraspecific level, the correct species name is *Gonolobus suberosus* (L.) R.Br.

ACKNOWLEDGMENTS

We thank the following institutions and their curators for assistance with specimen inquiries, providing photographs of material, and/or providing specimen loans: BM, BRIT, DUKE, FLAS, GA, KY, LL, MISS, MO, NCU, NO, OK, P, TENN, TEX, UNA, USCH, USF, WILLI. Helpful methodological and nomenclatural comments were provided by Tom Wentworth and Paul Fantz, respectively. David Thomas provided PAUP support. Eric Sundell and an anonymous reviewer provided thoughtful comments on a previous version of the manuscript.

REFERENCES

Avise, J.C. 1994. Molecular markers, natural history, and evolution. Chapman and Hall, New York.

Drapalik, D.J. 1969. A biosystematic study of the genus *Matelea* in the southeastern United States. Ph.D. Dissertation, University of North Carolina, Chapel Hill.

Ewan, J. 1939. Bibliographical miscellany. III. Publication dates of Asa Gray's "Botanical Contributions." Amer. Midl. Naturalist 22:218–222.

Fernald, M.L. 1950. Gray's Manual of Botany. American Book Company, Boston.

Forster, P.I. 1991. The correct publication dates for some genera and species of Asclepiadaceae described by Robert Brown. Asklepios 52:78–79.

Gleason, H.A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. New York Botanical Garden, Bronx.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett. 1990. Index Herbariorum. New York Botanical Garden, Bronx.

Krings, A. 2001. Neotypification of *Enslenia albida* and a new name in *Ampelamus* for *Cynanchum laeve* (Apocynaceae, Asclepiadoideae). Sida 19:925–929.

Liede, S. 1996. *Sarcostemma* (Asclepiadaceae) – a controversial generic circumscription reconsidered: Morphological evidence. Syst. Bot. 21:31–44.

Liede, S. 1997. American *Cynanchum* (Asclepiadaceae)—A preliminary infrageneric classification. Novon 7:172–181.

Liede, S. and A. Tauber. 2000. *Sarcostemma* R.Br. (Apocynaceae—Asclepiadoideae)—a controversial generic circumscription reconsidered: evidence from trnL-F spacers. Plant Syst. Evol. 225:133–140.

Luckow, M. 1995. Species concepts: assumptions, methods, and applications. Syst. Bot. 20:589–605.

Mabberley, J. 1985. Jupiter Botanicus—Robert Brown of the British Museum. J. Cramer, Braunschweig.

Nixon, K.C. and Q.D. Wheeler. 1990. An amplification of the phylogenetic species concept. Cladistics 6:211–223.

Perry, M.L. 1938. *Gonolobus* within the Gray's manual range. Rhodora 40:281–287.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill.

Reveal, J.L. and F.R. Barrie. 1992. *Matelea suberosa* (L.) Shinners (Asclepiadaceae)—once again. Bartonia 57:36–38.

Rosatti, T.J. 1989. The genera of suborder Apocynineae (*Apocynaceae* and *Asclepiadaceae*) in the southeastern United States. J. Arnold Arbor. 70:443–514.

Scheele, A. 1848. Beiträge zur flor von Texas. Linnaea 21:747–768.

Shinners, L.H. 1950. The species of *Matelea* (including *Gonolobus*) in North Central Texas (Asclepiadaceae). Field & Lab. 18:73–78.

Shinners, L.H. 1964. Texas Asclepiadaceae other than *Asclepias*. Sida 1:358–367.

Small, J.K. 1933. Manual of the southeastern flora. University of North Carolina Press, Chapel Hill.

Sorrie, B.A. and A.S. Weakley. 2001. Coastal Plain vascular plant endemics: Phytogeographic patterns. Castanea 66:50–82.

Stafleu, F.A. and R.S. Cowan. 1976. Taxonomic literature: a selective guide to botanical publications and collections with dates, commentaries and types, Vol. I: A–G. Bohn, Scheltema, and Holkema, Utrecht.

Stearn, W.T. 1960. An introduction to Robert Brown's "Prodromus florae novae hollandiae." Pp. V–LII in fascimile edition, Weinheim.

Stevens, W.D. 2001. Asclepiadaceae. Monogr. Syst. Bot. Missouri Bot. Gard. 85:234–270.

Sundell, E. 1981. The New World species of *Cynanchum* L. subgenus *Mellichampia* (A. Gray ex S. Wats.) Woods. (Asclepiadaceae). Evolutionary Monogr. 5:1–62.

Swofford, D.L. 2002. PAUP 4.0b10. Sinauer Associates, Sunderland.

Walter, T. 1788. Flora Caroliniana. Murray Printing Co. (Photolithographers), Cambridge.

Woodson, R.E. 1941. The North American Asclepiadaceae. Ann. Missouri Bot. Gard. 28: 193–244.

POLYPHYLY OF THE GENUS *ECHITES* (APOCYNACEAE: APOCYNOIDEAE: ECHITEAE): EVIDENCE BASED ON A MORPHOLOGICAL CLADISTIC ANALYSIS

Justin K. Williams

Department of Bioloigical Sciences
Sam Houston State University
Huntsville, Texas 77341-2116, U.S.A.

ABSTRACT

A cladistic analysis was performed to test the monophyly of *Echites* (Apocynaceae: Apocynoideae: Echiteae). For the analysis 40 morphological characters were coded for 42 ingroup taxa (22 genera) and three outgroup species (two genera). The results indicate that *Echites* as currently circumscribed is polyphyletic. However, species that fall within the original descriptions of the two subgenera described in *Echites* form monophyletic clades.

Key Words: *Echites*, *Prestonia*, *Thenardia*, and *Thevetia* Apocynaceae, cladistics, morphology, Neo-tropics

RESUMEN

Se realizó un análisis cladístico para comprobar la monofilia de *Echites* (Apocynaceae: Apocynoideae: Echiteae). Para el análisis se codificaron 40 caracteres morfológicos de 42 taxa del grupo (22 géneros) y tres especies como outgroup (dos géneros). Los resultados indican que *Echites* tal como se circunscribe normalmente es polifilético. Sin embargo, las especies que están en las descripciones originales de los dos subgéneros descritos en *Echites* forman clados monofiléticos.

Echites P. Browne was one of the first Neo-tropical Apocynaceae genera established. Consequently, it served as the focal point for the majority of species described in the Neo-tropics. Thus by the mid nineteen-hundreds there were about 375 species of *Echites* described. Woodson (1936) eventually cleared much of the nomenclatural confusion presented by the 300 plus names. In his monumental treatise, Woodson attributed the epithets to an appropriate genus (both newly described and preexisting) and or synonym, recognizing that the species of *Echites* sensu lato represented more than nine different genera. With a foundation established, Woodson (1936, 1938) defined *Echites* sensu Woodson by its twining habit, glabrous salverform corollas without corona, included anthers, and a solitary colleter opposite each of the five sepals. Woodson (ibid) ultimately recognized seven species in the genus that were placed into two subgenera.

Subgenus *Echites* is characterized by having corollas 5–8 cm long, oblique corolla lobes spreading at anthesis, and compact inflorescence with 3–7 flowers (Morales 1997; Williams 2002a). Today four species are recognized in subg.

SIDA 21(1): 117 – 131. 2004

Echites: *E. darienensis* J.F. Morales, *E. turrigera* Woodson, *E. umbellata* Jacq. and *E. yucatanensis* Millsp. (Morales 1997; Williams 2002a).

Subgenus *Psuedechites* Woodson is characterized by having corollas 1.25–2.5 m long, narrowly lanceolate corolla lobes that are reflexed at anthesis and a lax inflorescence with 8–20 flowers (Woodson 1936). Woodson included two species in the subgenus: *E. tuxtlensis* Standl. and *E. turbinata* Woodson. A third species of subg. *Pseudechites* was subsequently described by Monachino (1959): *Echites woodsoniana* Monac. This species would later come to have an intertwining history with *Prestonia* sect *Coalitae* (explained below).

Woodson (1936) divided *Prestonia* into four sections: *Coalitae* and *Acutifoliae*, (both characterized by having small and inconspicuous sepals similar to those of *Echites*); and *Annulares* and *Tomentosae* (both characterized by large foliaceous sepals). Woodson (1931, 1936) included *Prestonia agglutinata* (Jacq.) Woodson (=*Echites agglutinata* Jacq.) in *Prestonia* sect. *Coalitae*. Section *Coalitae* was distinguished from the other three sections of *Prestonia* by its lack of an annular corona at the mouth of the corolla. Woodson (1960) would later describe a second species in sect. *Coalitae* (*P. caudata* Woodson). Later, Gentry (1983) transferred *Echites woodsoniana* Monac. to *Prestonia* (*P. woodsoniana* (Monac.) Gentry) placing it as a member of sect. *Coalitae*. Because of the confusing nature of generic delimitation in the Apocynaceae, and the lack of an annular corona in *E. woodsoniana*, Gentry (ibid) was not confident of his transfer. J.K. Williams (1996) maintained *E. woodsoniana* in *Echites* because it lacked an annular corona at the mouth of the corolla. Morales (1997) would later include all species of *Prestonia* sect. *Coalitae* in *Echites* stating that the "narrowly elliptic to almost filiform corolla lobes [of the three species]... characterize *Echites* subg. *Pseudechites*".

The intermingling history of *Echites* subg. *Pseudechites* and *Prestonia* sect. *Coalitae* indicates the problems taxonomists have had in defining genera in the Apocynaceae. *Echites* subg. *Pseudechites* is a taxon that superficially resembles *Prestonia* section *Coalitae*, which make its placement within the family difficult.

A cladistic analysis using morphological characters was performed with two main objectives: 1) to assess the monophyly of *Echites* sensu Woodson and 2) to identify the placement and sister taxon of subg. *Pseudechites*.

MATERIALS AND METHODS

Taxa analyzed.—Included in this analysis are representative genera of Apocynoideae known from Mexico and Central America. In addition, Old World genera have been included in the study in order to expand the morphological variation and broad geographic range of the Apocynoideae. I did not intend to test the monophyly of the tribes recognized within the Apocynoideae, which is why a larger sampling of genera was not included. However, the genera that were selected represent four (Apocyneae, Echiteae, Mesechiteae, and Wrightieae) of the five tribes in the Apocynoideae recognized by Endress & Bruyns (2000).

Thevetia L. and *Cerbera* L. were selected as outgroups for the analysis. In previous cladistic studies (Endress et al. 1996; Sennblad & Bremer 1996; Sennblad et al. 1998; Potgieter & Albert 2001) *Thevetia* was indicated as one of the closer relatives to the Apocynoideae, and is appropriate for rooting the tree.

Selection of characters.—A total of 45 taxa, representing 25 genera, were included in the present study. Forty characters, representing 105 character states (Table 1), were scored for every taxon presented in this analysis. Character states were selected from those utilized in previous studies (Struwe et al. 1994; Endress et al. 1996; Sennblad et al. 1998; Potgieter & Albert, 2001; Williams 2002b). New characters not included in the above works, but uncovered during the course of this study were also included. Fifteen of the characters were vegetative and the other 25 were floral or reproductive. Analysis indicates that none of the characters are uninformative. The characters and their rationale are discussed in Appendix 1.

Sampling.—Character measurements and states for the data matrix (Table 2) were obtained from herbarium sheets (specimens and label data) and field observations for every representative species included in this study except *Tintinnabularia gratissima* J.F. Morales, and four species of *Parsonsia* R. Br. (*P. heterophylla*; *P. latifolia* (Benth.) S.T. Blake; *P. praeruptis* Heads & de Lange; *P. purpurascens* J.B. Williams). Data for *T. gratissima* was obtained from Morales (1996). The species of *Parsonsia* were included in the study in order to better represent the diversity of *Parsonsia* (a genus with many superficial similarities to *Thenardia* H.B.K.). Morphological data for the four species of *Parsonsia* were obtained from literature descriptions (J.B. Williams 1996; Heads & de Lange 1998).

With the exception of the species of *Parsonsia*, and *Tintinnabularia gratissima*, a representative specimen is deposited at the Plant Resources Center (TEX) for each of the species examined in the morphological cladistic analysis. Further observations and data were collected from material borrowed from or observed at the following herbaria: BM, BRIT, CHAPA, F, FLAS, G, GH, K, MA, METPEC, MEXU, MO, NY, P, SHST, TAMU, TEX, US, WIS.

The pollen of all genera was studied using a light microscope as well as a scanning electron microscope (Philips 515). All genera were examined and measured under the SEM at the Cell Research Center of the University of Texas at Austin.

Cladistic analysis.—The characters and character states (Table 2) used in the analysis were entered into a data matrix using MacClade 3.0 (Maddison & Maddison 1992). A phylogenetic analysis was then performed in PAUP 3.1 (Swofford 1993). A heuristic search by stepwise addition of random trees was performed with 100 replicates and the ACCTRAN, MULPARS and TBR options

TABLE 1. Characters and character states used in the cladistic analysis.

1. Latex
    - 0-milky
    - 1-watery
2. Predominate growth habit
    - 0-woody shrub
    - 1-liana
    - 2-suffruticose herb
    - 3-herb
3. Leaf arrangement
    - 0-opposite
    - 1-alternate
4. Colleters around the stem
    - 0-absent
    - 1-present
5. Colleters at base of upper leaf blade surface
    - 0-absent
    - 1-present
6. Colleters along the upper leaf blade surface
    - 0-absent
    - 1-present
7. Leaves with domatia
    - 0-absent
    - 1-present
8. Secondary venation of leaves
    - 0-visible
    - 1-obsure
9. Tertiary venation of leaves
    - 0-visible
    - 1-obsure
10. Calyx size
    - 0-minute (0-3 mm)
    - 1-foliaceous (5-15 mm)
11. Calycine colleters
    - 0-absent
    - 1-numerous and alternate with the sepals
    - 2-solitary and opposite the sepals
12. Aestivation
    - 0-sinistrorse
    - 1-dextrorse
    - 2-valvate
13. Corolla shape
    - 0-salverform
    - 1-urceolate
    - 2-infundibuliform
    - 3-rotate
14. Corolla color
    - 0-white
    - 1-yellow
    - 2-maroon
15. Corolla with epistaminal appendages
    - 0-absent
    - 1-reduced to a callused ridge
    - 2-extended into a linear protuberance resembling a filament
16. Corona between petal sinuses
    - 0-absent
    - 1-present
17. Infrastaminal appendages
    - 0-absent
    - 1- present
18. Corolla tube size
    - 0-minute (1–4 mm)
    - 1-small (6–10 mm)
    - 2-medium (11–20 mm)
    - 3-large (21–50 mm)
19. Filaments
    - 0-minute (0–1 mm)
    - 1-medium (3–6 mm) and running along the style
    - 2-long (10 mm and greater) and separate from the style
20. Anthers from ribs
    - 0-no
    - 1-yes
21. Stamen exposure
    - 0-included
    - 1-anther tips exserted
    - 2-stamens fully exserted
22. Anthers with apical appendages
    - 0-absent
    - 1-present
23. Anther dehiscence
    - 0-introrse
    - 1-latrorse
24. Anther morphology
    - 0- Connective enlarged, theca displaced laterally
    - 1- Connective not enlarged, theca not displaced, bases rounded and sterile
    - 2- Connective not enlarged, theca not displaced, bases forked sterile
    - 3- Connective not enlarged, theca not

displaced, bases rounded, anthers uniformly fertile

25. Anther-style head relationship
0-anthers free from style head
1-anthers fused to style head

26. Pistil head
0- Pistil head short, pentagonal; *Thevetia*-type
1- Pistil head elongated pentagonal; *Mandevilla*-type
2-Pistil head fusiform; *Echites*-type

27. Nectary
0-absent
1–5 free nectaries
2-nectaries fused into a cup, *Echites*-type
3-nectaries fused into a cup *Thevetia*-type

28. Inflorescence position
0-axillary
1-terminal

29. Inflorescence morphology
0-raceme
1-corymbose
2-reduced cyme

30. Inflorescence branching
0-absent
1-present

31. Fruit type
0-linear follicle (2–15 mm in diameter)
1-robust follicle (30–60 mm diameter)
2-drupe

32. Follicle orientation
0-Two follicles developing from one flower, both spreading
1-Two follicles developing from one flower, both fused only at the apical tips
2-Two follicles developing from one flower, both fused throughout entire length
3-One follicle developing from one flower

33. Follicles moniliform
0-no
1-yes

34. Follicle color
0-tan
1-red
2-black

35. Fruit texture
0-herbaceous
1- woody
2-leathery

36. Seeds with coma
0-absent
1-present and sessile
2-present and rostrate

37. Pollen apertures
0-tricolporate
1-triporate

38. Exine pattern
0-smooth
1-microreticulate

39. Pollen shape
0-spherical
1-triangular

40. Pollen diameter
0–20–35 μm
1–40–75 μm
2–75–110 μm

in effect. The option for maximum trees stored was set at 10,000. Taxa with multi-state characters were recognized as polymorphic for those characters. Characters were treated as unordered and of equal weight. At the end of the analysis the stored trees were rooted, with both the outgroup and ingroup directed as monophyletic. A strict consensus (Fig. 1) and a majority rule consensus (Fig. 2) tree of the stored trees were produced. Bootstrap values were calculated using 1,000 replicates with the PAUP settings at: full heuristic search, starting trees obtained via stepwise addition, random search set for additional sequences with 10 replicates, branches collapse if maximum branch length is zero, include groups compatible with 50% majority-rule consensus, include only informative characters. The majority rule tree (Fig. 2) is presented along with bootstrap values near or higher than 50%.

TABLE 2. Data matrix of the 40 informative characters used in the phylogenetic analysis[a,b] presented in this study.

Species	Character number and character states			
	0000000091	1111111112	2222222223	3333333334
	1234567890	1234567890	1234567890	1234567890
Adenium obesum	0010000000	112b010200	0102120110	000001000?
Angadenia berterii	0101000000	1121000200	0002122010	0100120001
Apocynum cannabinum	0300000000	0110010000	0002121111	0000010000
Cerbera odollam	0010000111	1000101201	0010203111	2—1201112
Echites agglutinata	1100000010	2101000100	0002121011	0110020000
Echites turbinata	1100000110	2101300110	0002121011	0110020000
Echites turrigera	0100000000	2100000200	0001121010	0100120001
Echites umbellate	0100000000	2100000200	0001122010	0000120001
Echites woodsoniana	1100000110	2101000100	0002121011	0110020000
Echites yucatanensis	0100000000	2100000200	0001122010	0000120001
Fernaldia pandurata	0100000000	2120000200	0001121010	0100120001
Forsteronia acouci	0100101000	1130000010	2001121111	0000110000
Forsteronia myriantha	0100101001	1130000020	2001121111	0000110000
Forsteronia peninsularis	0101001001	1130000020	2002121111	0000110000
Forsteronia spicata	0100100001	1130000020	2001121111	0200110000
Laubertia contorta	1100000000	0102310210	1002121010	0110010001
Mandevilla acutiloba	0101100000	1101000100	0003111000	0100010001
Mandevilla foliosa	0201100000	1101000100	0003111000	0110010001
Mandevilla hirsuta	0101110001	1121000200	0003111000	0110010002
Mandevilla subsagittata	0101110000	1101000200	0003111000	0110010002
Mesechites trifida	0101100000	1101000200	0003111011	0110010001
Nerium oleander	0000000000	112b010200	0102120110	0100010000
Odontadenia macrantha	0100000001	1121000200	0002121010	1300120001
Parsonsia latifolia	0101000000	3230000010	2002121111	02001100 00
Parsonsia heterophylla	1101000000	323a000000	0002121a11	0200111000
Parsonsia praeruptis	1001000110	3230000000	2002121a11	02001100 00
Parsonsia purpurascens	1101000000	3231000000	0002121111	02000100 00
Parsonsia straminae	1101000000	3231000000	1002121a11	02001100 0?
Pentalinon andrieuxii	0101000000	1121000200	0102122010	0100120001
Prestonia acutifolia	0101000000	2101210110	1002121011	0100110001
Prestonia mexicana	0101000001	2101310210	1002121011	1000110002
Prestonia tomentosa	0101000001	2101210210	1002121011	1000110001
Prestonia portobellensis	0101000001	2102210210	1002121011	0100110002
Rhabdadenia biflora	0100000001	0120000200	0001121020	0000110002
Strophanthus kombe	0100000000	1120010200	1002120111	000001000?
Telosiphonia brachysiphon	0200100001	1120000300	0003111120	0100010001
Thenardia chiapensis	1100000010	2130000010	2002121011	0210010000
Thenardia floribunda	1100000010	2130000010	2002121011	0210010001
Thoreauea paneroii	0100000000	2110010010	0002121011	0??0?10000
Thevetia ovata	0010000011	1021101201	0010203111	2—2201112
Thevetia ahouai	0010000111	1001101201	0010203111	2—1201112
Tintinnabularia mortonii	0101101001	1121000220	0103111011	0??0?10001

TABLE 2. (continued)

Species	Character number and character states			
	0000000091 1234567890	11111111112 1234567890	2222222223 1234567890	3333333334 1234567890
Tintinnabularia gratissima	0101101001	1121000200	0003111011	0110?1000?
Tintinnabularia mullaraensis	0101101000	1121000220	1103111011	0??0?10001
Trachelospermum difforme	0101000000	1100000100	0002121111	0000?10000

a Character numbers and character states correspond to those in Table 1.

b Polymorphic character states are represented by letters as follows: a=0,1; b=0,3; (within the data matrix character states for polymorphic characters were entered as 0/1 etc. Letters are used here for the convenience of aligning the table).

RESULTS

The data matrix (Table 2) of 45 taxa and 40 characters included no characters that were uninformative. Of the 1800 cells in the matrix 14 (.77%) were scored with a question mark for unknown character states. The data matrix included six characters coded as polymorphic constituting .33% of the entries.

The heuristic search yielded a total of 48 equally parsimonious trees of 159 steps and a consistency index (C.I.) of 0.434 and a retention index (R.I.) of .767. The low consistency index reflects the high level of homoplasy (Kitching et al.1998) within the characters selected. The high level of homoplasy probably also accounts for the lower bootstrap values in the basal branches (Fig. 2), thereby reducing stability in the basal clades. Stability is seen in the terminal branches, which is reflected by the higher bootstrap values (Fig. 2). The discrepancy in support for the basal clades versus the terminal clades is acceptable considering that the main focus of this study was to test the monophyly of genera in the Apocynaceae, in particular *Echites*.

The ingroup taxa formed two large clades. The first large clade, Clade I, is comprised of two clades. In the first of these, the Wrightieae clade is sister to two subclades: one is represented solely *Apocynum* (Apocyneae); the other, the *Prestonia* subclade, is comprised of three smaller subclades of genera from Echiteae, in which the genus *Thoreauea* is sister to the other two; one of these is a subclade composed of *Echites* subgen. *Pseudechites* and the two species of *Thenardia*; the other subclade is composed of *Laubertia* and *Prestonia*. The second group of clades in Clade I is comprised of the genus *Trachelospermum*, which is sister to two subclades: the *Forsteronia* subclade, and the *Parsonsia* subclade, which are comprised solely of these two genera, respectively, the first of which is in Apocyneae and the latter in Echiteae.

In Clade II, *Rhabdadenia* is sister to two clades. The first, the *Echites* clade, includes a subclade of *Angadenia* and *Pentalinon* (Echiteae) and *Odontadenia*

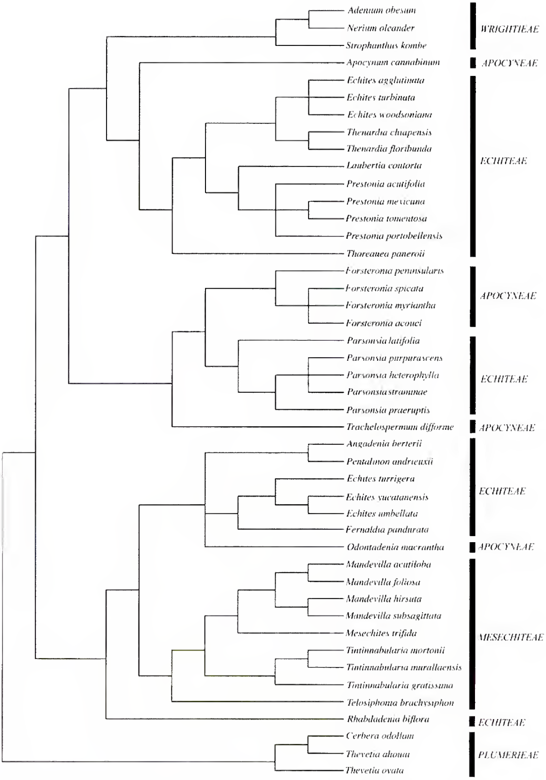


Fig. 1. Strict consensus tree. Taxa in capital letters and to the right of the cladogram indicate Tribes recognized in Endress & Bruyns (2000). Note: *Thoreauea* (Williams, 2002b) was described after Endress & Bruyns (2000) and therefore not included in their treatment. However, *Thoreauea*, as discussed in Williams (2002b), corresponds to the description of the Echiteae and is included in this tribe

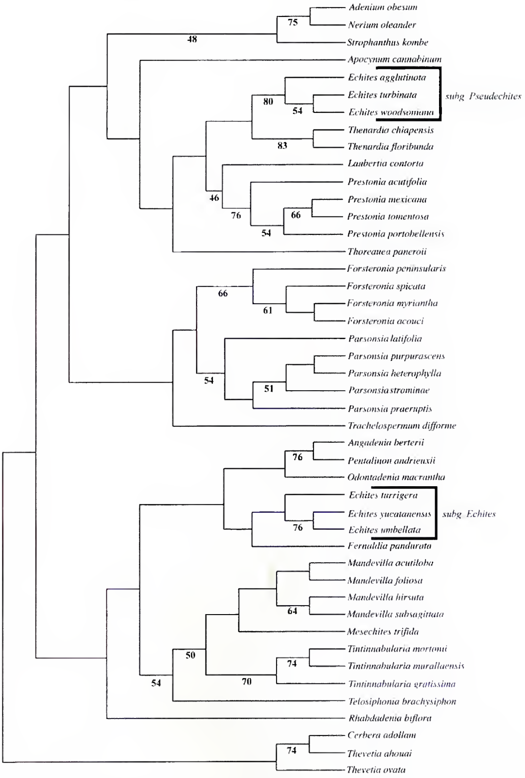


FIG. 2. Majority rule consensus tree calculated from 48 most parsimonious trees (length 165, CI =.434, RI=.767, RC = .333). Numbers below the branches are bootstrap values near or greater than 50%.

(Apocyneae), which is sister to a clade comprised of *Fernaldia* and *Echites* subgen. *Echites* (all Echiteae). The second main clade, the Mesechiteae clade, is composed of representatives of *Mandevilla*, *Mesechites*, *Tintinnabularia* and *Telosiphonia*. Comparing the results obtained here to the latest classification of the family by Endress and Bruyns (2000), the Wrightieae and Mesechiteae are supported as monophyletic, whereas the Apocyneae and Echiteae are polyphyletic.

DISCUSSION

Monophyly of Echites.—The results presented here indicate that *Echites*, as currently circumscribed, is not monophyletic. The placement of subg. *Pseudechites* in a clade both distant and distinct from subg. *Echites* renders *Echites* polyphyletic. This result was not unexpected, since the taxa of subg. *Pseudechites* are morphologically distinct from subg. *Echites* in at least thirteen observable characters (Table 3; three vegetative and 10 floral or reproductive). However, the species that fall within the original description of subg. *Pseudechites* form a well supported (bootstrap 80%) monophyletic clade.

Because of the polyphyletic nature of *Echites* sensu Woodson, based on the number of differences between subg. *Echites* and subg. *Pseudechites*, and the strongly supported monophyletic clade of subg. *Pseudechites*, it is suggested that the species of subg. *Pseudechites* be transferred to a genus separate from *Echites* sensu stricto The new genus and appropriate name combinations are proposed in Morales & Williams (2004).

Phylogeny of subg. Pseudechites.—Both the strict (Fig. 1) and the majority rule (Fig. 2) trees show subg. *Pseudechites* sister to *Thenardia*. A relationship between *Thenardia* and subg. *Pseudechites* was suggested in Williams (1998). The taxa share in common watery sap, leaves with inconspicuous secondary veins, and pollen of similar size. It should be noted however, that despite the similarities in morphology the bootstrap support for the clade comprising *Thenardia* and subg. *Pseudechites* is low (37%). Nevertheless, based on previous observations (Williams 1998) and the data presented here, the hypothesized relationship between *Thenardia* and subg. *Pseudechites* appears relatively sound.

Monophyly and phylogeny of subg. Echites.—Both the strict (Fig. 1) and the majority rule (Fig. 2) trees show subg. *Echites* sister to *Fernaldia* Woodson. There is only one major character difference between subg. *Echites* and *Fernaldia* (salverform vs. infundibuliform corollas; Table 3). It was hypothesized before the analysis that *Fernaldia* might branch with *E. turrigera* Woodson, due to their similar fruit types (follicles fused at the apex; character 32:1) rendering subg. *Echites* paraphyletic. Indeed, bootstrap support (Fig. 2) is 76% for the two subg. *Echites* species with spreading follicles (*E. umbellata* and *E. yucatanensis*) while support for the branch basal to the subg. *Echites* clade is below 50%. Regardless,

TABLE 3. Morphological comparisons of *Echites* subg. *Echites*, subg. *Pseudechites* and *Fernaldia*.

	subg. *Pseudechites*	**subg. *Echites***	***Fernaldia***
Latex	Watery	Milky	Milky
Secondary veins visible	No/yes	Yes	Yes
Tertiary veins visible	No	Yes	Yes
Inflorescence branched	1–3x	0–1x	0x
Corolla	Salverform	Salverform	Infundibuliform
Corolla length	4–9 mm	30–70 mm	35–50 mm
Corolla color	Yellow	White	White
Anther length	3–5 mm	5–9 mm	5–9 mm
Anther bases	Sagittate	Obtuse	Obtuse
Corolline corona behind the anthers	Yes/No	No	No
Follicles fused at apex	Yes	No/Yes	Yes
Pollen diameter	25–30 µm	45–50 µm	45–50 µm
Pollen aperture diameter	3–4.5 µm	5–8 µm	5–8 µm

as presented here both the strict and majority rule indicate subg. *Echites* to be monophyletic.

Tribal and other generic circumscriptions.—As stated in the "taxa analyzed" section it was not the intention of this study to test the monophyly of the tribes recognized by Endress & Bruyns (2000). However, the results presented in the strict consensus trees (Fig. 1) indicate that the tribes Mesechiteae and Wrightieae sensu Endress & Bruyns are monophyletic (each with bootstrap support near or over 50%; Fig. 2) and that the tribes Apocyneae and Echiteae sensu Endress & Bruyns are polyphyletic (Fig. 1). Furthermore the results presented suggest that *Thevetia* is not monophyletic, supporting Potgieter and Albert (2001). However, the results here show *Thevetia* to be paraphyletic, while Potgieter and Albert (ibid) show *Thevetia* to be polyphyletic. The discrepancy in results is due in large part to the much larger sampling of taxa in the Rauvolfiodeae by Potgieter and Albert (2001).

Despite the evidence indicating polyphyly in Apocyneae and Echiteae sensu Endress & Bruyns and paraphyly in *Thevetia*, tribal and generic reconstruction in these taxa is beyond the scope of the present paper and thus the discussion is left to further study and evaluation.

APPENDIX 1

Discussion of the characters utilized in the morphological cladistic analysis of the Apocynaceae. Characters in bold indicate newly uncovered and utilized characters during this study, and have lengthier discussions. The character number is given in parenthesis and corresponds to the character and character states in Table 1.

Latex (1). This character has not been utilized or discussed as a character for cladistic studies in the Apocynaceae. However, field observations of most of the genera ofEchiteae presented in this work indicate that some taxa consistently have watery sap, *Laubertia*, *Echites* subg. *Pseudechites*, and *Thenardia*, versus the typical milky sap typical of most Apocynaceae. *Parsonsia*, which has approximately 40 species, is polymorphic for this character.

Predominate growth habit and leaf arrangement (2–3, respectively). These two characters were utilized in three previous cladistic studies (Struwe et al. 1994; Endress et al. 1996; Potgieter and Albert, 2001). All of the genera of the Apocynoideae included in this study have opposite leaves (whorled in *Nerium*), except *Adenium*.

Colleters (4–6 & 11). Thomas and Dave (1991) provided a discussion of the systematic implications of colleters in the Apocynaceae that will not be repeated here. Endress et al. (1996) and Sennblad et al. (1998) utilized calycine colleters in their studies (character 12 here). I have expanded the use of colleters by including the presence or absence of colleters on other parts of the plant. Character 4, colleters around the stem, Character 5, colleters present on the apex of the leaf petiole of the upper leaf surface, appears to be convergent as it is shared by members of the "*Mandevilla*" clade and the distantly related *Forsteronia*. Character 6, colleters along the upper leaf midrib are only possessed by two species of *Mandevilla* studied here. This character is a synapomorphy which unites *M. subsagittata* and *M. hirsuta*.

Domatia (7). Domatia are only present in two of the genera studied here, *Tintinnabularia* and *Forsteronia*. This character appears convergent, haven arisen in two separate clades.

Venation (8 & 9). Distinctness of the secondary venation of leaves and tertiary venation of leaves has not been utilized in a morphological analysis. Observation in the field coupled with herbarium studies indicates that certain genera have inconspicuous lateral venation. The lack of secondary veins is a character uniting *Thevetia ahouai* with *Cerbera*. The lack of tertiary veins is a character that unites *Thenardia* and *Echites* subg. *Pseudechites*.

Calyx size (10). The majority of taxa in the Apocynoideae have sepals 1–3 mm long, a few have sepals much larger, 5–15 mm. Overall this character is highly variable with large sepals occurring randomly throughout the representative taxa. However, large sepals appear to unify a few of the species of *Prestonia*.

Aestivation (12). With the exception of *Parsonsia* (valvate), dextrorse aestivation is present in all of the taxa in the Apocynoideae included in this study. Aestivation type is one of the few synapomorphies that distinguishes the Apocynoideae from the Rauvolfioideae (sinistrorse aestivation).

Corolla shape ,**color and size**(13, **14**, **18**). Corolla shape was utilized by Endress et al. (1996), color and tube size are new characters. Most of the taxa presented in this work have yellow or white corollas. However, some have maroon corollas. Color was used because *Laubertia* and *Prestonia portobellensis* possess maroon corollas. Consequently the character was utilized to test if the species paired, thereby testing the monophyly of *Prestonia*. In addition, the two subgenera of *Echites* have different corolla colors. In this instance color was utilized to test the monophyly of *Echites*. Corolla tube size is added as an augment to the variability that exists in corolla shape. Utilization of tube size helps to emphasize that although both subg. of *Echites* have salverform corollas, there exists a considerable difference in the lengths of the corollas.

Corolla with epistaminal appendages, corona between petal sinuses, corolla with infrastaminal appendages (15, 16, 17). These three characters were utilized and discussed by Endress et al. (1996).

Filament length (19). An examination of the filaments of the taxa in this analysis indicates that filament length appears to be positively correlated with generic relationships. Short filaments are typical of the taxa in the subg. *Echites* clade (Fig. 1), while medium length filaments are consistent with the "*Prestonia*" clade (Fig. 1). Long filaments are only present in two of the three species of *Tintinnabularia*. In this instance the character was utilized to test the monophyly of *Tintinnabularia*.

Anthers from ribs, stamen exposure, and anther dehiscence (20, 21, 23). Anther ribs are only present in *Thevetia* and *Cerbera* and are used mainly to establish the monophyly of the outgroup. Anther exposure and dehiscence were utilized and discussed in Endress et al. (1996).

Apical appendages on anthers (22). It was presumed before the analysis was conducted that this character was highly convergent. However, it was included as a reference for testing the monophyly of *Tintinnabularia*, which has two species with and one species without elongate apical anther appendages.

Anther morphology, anther-pistil head relationship, pistil head type (24, 25, 26). At least five different types of anthers and pistil heads are exhibited in the Apocynaceae. The different anther and pistil head types have been discussed in Woodson (1930) and Fallen (1986). The important traits that characterize the different anther types are the connective, theca positioning and fertility and the base of the anther body. The union of the anthers and the pistil head is a synapomorphy that unifies the Apocynoideae.

Nectary (27). Several types of nectaries are exhibited by the Apocynaceae. Three different types are here recognized: five free nectaries, nectaries fused into a cup, and nectaries fused into a cup type two. Type two refers to the nectaries of *Thevetia* and *Cerbera*, that are twice as large and twice as wide as those found in the Apocynoideae.

Inflorescence position, inflorescence morphology, inflorescence branching (28, 29, 30). The structure of the inflorescence has not been used in a morphological cladistic analysis of the Apocynaceae. Woodson (1935) has provided a detailed account of the inflorescence types in the Apocynaceae that will not be repeated here. Within the taxa examined only the Wrightieae and Apocyneae (*Apocynum*) have terminal inflorescences, with all of the Echiteae possessing an axillary inflorescence. Inflorescence branching is one of the characters separating subg. *Echites* (not branched) from subg. *Pseudechites* (branched).

Fruit type, follicle orientation, follicles moniliform, follicle color, fruit dehiscence, **fruit texture** (31–36). Of the above characters, only fruit dehiscence has been utilized in a cladistic study (Endress et al. 1996). Fruits have been an underutilized resource in the systematics of the Apocynaceae. This is mainly due to the paucity of fruiting herbarium specimens. Collecting trips were made by the author specifically in the latter part of the flowering season, for the purpose of collecting fruits. From these observations, a pattern emerged. Many of the taxa with presumed relationships had similar fruit types. Characters observed were the union of the follicles, fused at apex, follicles spreading, or fused throughout. The fusion of the follicles, is a useful character in distinguishing species within genera (e.g. *Echites*), but overall the cladistic analysis indicated that follicle union is a convergent character, with spreading and fused follicles occurring throughout the Apocynoideae. In addition, follicle texture was noted. Some follicles were membranous while others were firm and woody. This character was useful in indicating *Echites* as polyphyletic (subg. *Echites* with woody follicles and subg. *Pseudechites* with herbaceous follicles). Lastly, it was noticed that some taxa had straight follicles and others were moniliform. Moniliform follicles occur more frequently in the "*Prestonia*" clade. Fruit color was used to test the monophyly of *Thevetia*. This character is a synapomorphy uniting *T. ahouai* and *Cerbera*, indicating that *Thevetia* as currently circumscribed is paraphyletic.

Seeds with coma (37). This character was utilized by Endress et al. (1996) and by Potgieter and Albert (2001) and subsequently discussed by them.

Pollen apertures, pollen exine pattern, **pollen shape, pollen size** (39–42). Pollen apertures and exine pattern were utilized in Endress et al (1996). The Rauvolfioideae and the Apocynoideae are distinguished by the apertures of the pollen, with tri-porate pollen as a synapomorphy uniting the Apocynoideae. In addition, the pollen of taxa in the Apocynoideae is consistently smooth vs. the Rauvolfioideae which has various exine patterning. Pollen shape, also helps to distinguish the Rauvolfioideae from the Apocynoideae. In general, the Rauvolfioideae have triangular-rounded pollen vs. the Apocynoideae that are consistently spherical. Pollen size was useful for determining intergeneric and intrageneric relationships. For instance, pollen size supports *Echites* as polyphyletic (subg. *Echites*, 45–60 µm vs. subg. *Pseudechites*, 23–35 µm). In addition, within *Mandevilla*, pollen size indicated *M. hirsuta* and *M. subsagittata* to be closely related.

ACKNOWLEDGMENTS

I thank the curators of the following herbaria for allowing me to study and borrow their specimens: BM, BRIT, CHAPA, F, FLAS, G, GH, K, MA, METPEC, MEXU, MO, NY, P, SHST, TAMU, TEX, US, WIS. I also thank B.B. Simpson for providing comments on the running and interpretation of the cladistic analysis, and most especially, I thank Mary Endress for her patience, support and superbly accurate and critical review of the article as well as contribution to the results section.

REFERENCES

Endress, M.E., B. Sennblad, S. Nilsson, L. Civeyrel, M. Chase, S. Huysmans, E. Grafstrom, and B. Bremer, 1996. A phylogenetic analysis of Apocynaceae s. str. and some related taxa in Gentianales: a multidisciplinary approach. Opera Bot. Belg. 7:59–102.

Endress, M.E. and P. Bruyns. 2000. A revised classification of the Apocynaceae s.l. Bot. Rev. 66:1–56.

Fallen, M. 1986. Floral structure in the Apocynaceae: Morphological, functional and evolutionary aspects. Bot. Jahrb. Syst. 106:245–286.

Gentry, A. 1983. A new combination for a problematic Central American Apocynaceae. Ann. Missouri Bot. Gard. 70:205–206.

Heads, M. J. and P.J. de Lange. 1998. *Parsonsia praeruptis* (Apocynaceae): a new threatened, ultramafic endemic from North Cape, New Zealand. New Zealand J. Bot. 37:1–6.

Kitching, I.J., P.L. Forey, C.J. Humphries, and D.M. Williams. 1998. Cladistics. Oxford University Press.

Maddison, W.P. and D.R. Maddison. 1992. MacClade: Analysis of phylogeny and character evolution. Version 3.0. Sinauer Associates, Sunderland, Massachusetts.

Monachino, J. 1959. A new *Echites* from Mexico. Bull. Torrey Bot. Club 86:245.

Morales, J.F. 1996. Una nueva especie de *Tintinnabularia* (Apocynaceae). Novon 6: 392–394.

Morales, J.F. 1997. A reevaluation of *Echites* and *Prestonia* sect. *Coalitae* (Apocynaceae). Brittonia 49:328–336.

Morales, J.F. and J.K. Williams. 2004. *Allotoonia*, a new neotropical genus of Apocynaceae based on a subgeneric segregate of *Echites*. Sida: 21:133–158.

Potgieter, K. and V. Albert. 2001. Phylogenetic relationships within Apocynaceae s.l. based on *trm*L intron and *trn*L-F spacer sequences and propagule characters. Ann. Missouri Bot. Gard. 88:523–549.

Sennblad, B. and B. Bremer. 1996. The familial and subfamilial relationships of Apocynaceae and Asclepiadaceae evaluated with rbcL data. Pl. Syst. Evol. 202:153–175.

Sennblad, B., M.E. Endress, and B. Bremer. 1998. Morphology and molecular data in phylogenetic fraternity: the tribe Wrightieae (Apocynaceae) revisited. Amer. J. Bot. 85: 1143–1158.

Struwe, L., V.A. Albert, and B. Bremer. 1994. Cladistics and family level classification of the Gentianales. Cladistics 10:175–206.

Swofford, D.L. 1993. PAUP: Phylogenetic Analysis Using Parsimony. Version 3.1.1. Computer program distributed by the Illinois Natural History Survey. Champaign, Illinois.

Thomas, V. and V. Dave. 1991. Comparative and phylogenetic significance of the colleters in the family Apocynaceae. Feddes Repertorium 102:177–182.

Williams, J.B. 1996. *Parsonsia*. In: Flora of Australia. Volume 28, Gentianales. Melbourne: CSIRO Australia. Pp. 154–189.

Williams, J.K. 1996. The Mexican genera of the Apocynaceae (sensu A. DC.), with key and additional taxonomic notes. Sida 17:197–214.

Williams, J.K. 1998. A revision of *Thenardia* H.B.K. (Apocynaceae, Apocynoideae). Lundellia 1:78–94.

Williams, J.K. 2002a. A further evaluation of *Echites* sect. Yucatanense (Apocynaceae) with additional notes on the genus. Brittonia 54:310–317.

Williams, J.K. 2002b. *Thoreauea* (Apocynaceae: Apocynoideae), a new genus from Oaxaca, Mexico. Lundellia 5:47–58.

Woodson, R.E., Jr. 1930. Studies in the Apocynaceae. I. A critical study of the Apocynoideae (with special references to the genus *Apocynum*). Ann. Missouri Bot. Gard. 17:1–212.

Woodson, R.E., Jr. 1931. New or otherwise noteworthy Apocynaceae of tropical America. Ann. Missouri Bot. Gard. 18:555.

Woodson, R.E., Jr. 1935. Observations on the inflorescence of Apocynaceae with special reference to the American genera of Echitoideae. Ann. Missouri Bot. Gard. 22:1–40.

Woodson, R.E., Jr. 1936. Studies in the Apocynaceae IV. The American genera of Echitoideae (concluded). Ann. Missouri Bot. Gard. 23:169–438.

Woodson, R.E., Jr. 1938. Apocynaceae. In: N.L. Britton et al. North Amer. Fl. 29:103–192.

Woodson, R.E., Jr. 1960. Loganiaceae, Apocynaceae, and Asclepiadaceae. In miscellanea taxonomica. II. Ann. Missouri Bot. Gard. 47:79.

BOOK NOTICE

Douglas J. Futuyma, H. Bradley Shaffer, and Daniel Simberloff (eds). 2003. **Annual Review of Ecology, Evolution, and Systematics: Volume 34, 2003.** (ISBN 0-8243-1434-4, hbk; ISSN 1543-592X). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $160.00 (USA), $165.00 (Int'l.), 716 pp., 6" × 9".

Volume 34 of *Annual Review of Ecology, Evolution, and Systematics* contains a 24 papers:

Effects of introduced bees on native ecosystems
Avian sexual dichromatism in relation to phylogeny and ecology
Paleobiogeography: the relevance of fossils to biogeography
The ecology of bird introductions
The effects of genetic and geographic structure on neutral variation
Data, models, and decisions in U.S. Marine fisheries management: lessons for ecologists
Partitioning of time as an ecological resource
Performance comparisons of co-occurring native and alien invasive plants: implications for conservation and restoration
Genetic variation in rare and common plants
The ecology and evolution of insect baculoviruses
Latitudinal gradients of biodiversity: pattern, process, scale, and synthesis
Recent advances in the (molecular) phylogeny of vertebrates
The role of reinforcement in speciation: theory and data
Extra-pair paternity in birds: causes, correlates, and conflict
Species-level paraphyly and polyphyly: frequency, causes, and consequences, with insights from animal mitochondrial DNA
Protective ant-plant interactions as model systems in ecological and evolutionary research
Functional matrix: a conceptual framework for predicting multiple plant effects on ecosystem processes
Effects of habitat fragmentation on biodiversity
Social organization and parasite risk in mammals: integrating theory and empirical studies
The community-level consequences of seed dispersal patterns
The ecology and evolution of seed dispersal: a theoretical perspective
Analysis of rates of morphologic evolution
Development and the genetics of evolutionary change within insect species
Flexibility and specificity in coral-algal symbiosis: diversity, ecology, and biogeography of *Symbiodinium*

ALLOTOONIA, A NEW NEOTROPICAL GENUS OF APOCYNACEAE BASED ON A SUBGENERIC SEGREGATE OF *ECHITES*

J. Francisco Morales
Instituto Nacional de Biodiversidad (INBio)
Apto 22-3100, Santo Domingo de Heredia
COSTA RICA

Justin K. Williams
Department of Biological Sciences
Sam Houston State University
Huntsville, Texas 77341-2116, U.S.A.

ABSTRACT

Allotoonia (Apocynaceae) a new neotropical genus segregated from *Echites* is described. In addition, a key to species, descriptions, distribution maps, illustrations and specimens examined are provided for all species.

Key Words. Apocynaceae, Apocynoideae, *Allotoonia*, Echiteae, *Echites*, Neotropics, Mesoamerica, Mexico

RESUMEN

Allotoonia (Apocynaceae), un nuevo género neotropical segregado de *Echites* es descrito. Se brinda una clave para todos los taxa, así como descripciones, mapas de distribución, ilustraciones y especímenes examinados para todas las especies.

In his monumental revision of *Echites* P. Browne, Woodson (1936) established two subgenera: *Echites* (*Euechites*) and subg. *Pseudechites* Woodson. Subgenus *Pseudechites* included the species *E. turbinata* Woodson and *E. tuxtlensis* Standl. and was distinguished from subgenus *Echites* by its smaller corollas (1.25–2.5 cm long vs. 5–8 cm long), lobes narrowly oblong and reflexed (vs. obliquely obovate and spreading), and its many flowered lax inflorescence (vs. compact and few flowered). A third species, *E. parviflora* Sessé & Moç. was subsequently added to subg. *Pseudechites* by Woodson (1938).

Echites went relatively unnoticed for close to 60 years, until Morales (1997) provided a synopsis of the genus. In his work, Morales described an additional species in subg. *Pseudechites* (*E. puntarenensis* J. F. Morales) as well as presented an argument for maintaining *Prestonia agglutinata* (Jacq.) Woodson in *Echites*, resurrecting the older name *Echites agglutinata*.

The morphological cladistic analysis of *Echites* s.l. and other genera of subfamily Apocynoideae presented in Williams (2004) indicates that *Echites* sensu Woodson is polyphyletic. Subgenus *Pseudechites* shows a stronger affinity to other genera of Echiteae sensu Endress and Bruyns (2000) (e.g., *Laubertia*, *Prestonia*, *Thenardia*) than it does to subg. *Echites*. Consequently, the authors have chosen to recognize the species in subg. *Pseudechites* as a distinct genus (*Allotoonia* described below) separate from *Echites* s.s. Table 1 documents the differences between *Allotoonia*, *Echites*, and other selected genera of New World Echiteae.

MORPHOLOGICAL CHARACTERS

Leaves.—The leaves are opposite and entire. Four of the five species have leaves with obscure secondary venation making them readily discernible from *Echites*. One species, however, *A. agglutinata*, has conspicuous secondary veins. *Allotoonia* also shares with others neotropical Apocynoideae, intra-petiolar colleters. All species have glabrous leaves. The leaves of *A. turbinata* are often two to three times longer and broader than those of the other four species. Field studies have shown that these characters are uniform and consistent within a population.

Inflorescence.—*Allotoonia* is readily distinguished from *Echites* by the inflorescence structure. The inflorescence of *Allotoonia* is a helicoid cyme once, twice to occasionally thrice branched, while in *Echites* the inflorescence is a modified dichasium, sometimes appearing racemose, and occasionally reduced to just one flower. The bracts are always inconspicuous and scarious.

Flowers.—The calyx is regular, pentamerous, and with a solitary opposite colleter on the adaxial surface of each sepal, as found in many others members of the Echiteae (e.g., *Prestonia*, *Thenardia*). The sepals are narrowly ovate and 1–3.5 mm long. The shape and dimensions of the sepals for each species corresponds to the shape and dimensions of the bracts subtending the pedicel.

The corolla is salverform, the tube glabrous without. The aestivation is dextrorse as are all other neotropical members of the Apocynoideae. The corolla lobes are very narrowly elliptic to almost filiform, acuminate to long-acuminate at the apex and conspicuously wavy and twisted distally. *Allotoonia* is the only neotropical Apocynaceae genus with wavy and twisted filiform lobes at the anthesis (Figs. 1–2). In *Echites*, the corolla lobes are obovate.

The stamens are included and the anthers are strongly attached at two levels to the spool shaped style head (Fig. 3). The anther shape differs between *Allotoonia* and *Echites* (Fig. 4). In *Allotoonia* an anther is more or less continuous (except for a slight dorsal protuberance), without a marginal rib. In *Echites* the anther has a conspicuous marginal rib that is extended from the basal projections along the entire length up to the apex (Fig. 1 B).

Fruit.—The fruits of *Allotoonia* are composed of two herbaceous, pendulous, follicles (Fig. 5) developing from two carpels postgenitally united at the apex, sometimes free at maturity. The follicles are continuous to obscurely moniliform. The fruits of *Echites* are woody and never moniliform.

Seeds.—The seeds of *Allotoonia* are glabrous, 6–20 per follicle, and rostrate, with the beak slender, narrowly and conspicuously elongate (Fig. 6), while in *Echites* the seeds are inconspicuous to moderately rostrate, with the beak short (sometimes somewhat elongate in *E. yucatanensis*) and gradually acuminate toward the micropylar end (Fig. 7).

Allotoonia J.F. Morales & J.K. Williams, gen. nov. TYPE. *Allotoonia agglutinata* (Jacq.) J.F. Morales & J.K. Williams

Herba volubilis, Forsteronieae, Laubertiae, Parsoniae, Prestonieae, Thenardiae et Thoreauiae affinis; folia opposita petiolata, membranacea, eglandulifera; inflorescentia lateralis pedunculata multiflora; corolla regularis 5-partita, hypocrateriforma, lobis filiformis, revolutis, tubo exappendiculata stamina inserta, glabra; fructus folliculis, seminibus rostrata.

Lactescent lianas, usually herbaceous, more rarely suffruticose, not woody. Stems terete to subterete, somewhat flattened at the nodes, glabrous, not lenticellate, with inconspicuous intrapetiolar colleters, the latex usually watery. Leaves opposite, entire, membranaceous, glabrous or glabrate, the secondary and tertiary veins usually inconspicuous or obscure, petiole with many, minute and filiform colleters in the axils. Inflorescence a helicoid cyme, axillary, glabrous, many-flowered, usually long-pedunculate, bracts scarious, inconspicuous. Flowers pentamerous, the sepals free or very slightly imbricate basally, scarious, bearing a solitary, episepalous entire to variously laciniate colleter within; corolla salverform, glabrous to very minutely and inconspicuously puberulent without, without corona lobes or annular corona, the tube usually longitudinally grooved, with an infrastaminal ribs present below each filament, the limb 5-parted, actinomorphic, dextrorsely convolute, the lobes very narrowly elliptic to almost filiform, acuminate, twisted and wavy distally; stamens 5, included, inserted in the upper part of the corolla tube near the mouth, anthers connivent and agglutinated to the style head, attached in two points to the style head, glabrous to glabrate, thecae with the base sagittate, 2-auriculate, auricles short, but conspicuous, short-acuminate, filaments short, puberulent to pilose, carpels 2, united at the apex by a common stylar shaft surmounted by the fusiform, spool-shaped style head, ovary glabrous, ovules numerous, multi-seriate, nectarines five, separated and distinct, rarely slightly connate basally. Follicles continuous and terete to subterete, or obscurely moniliform, slender and smooth, usually glabrous; seeds comose at the micropilar end, conspicuously rostrate, minutely rugose, numerous.

This genus comprises five species distributed from southern Mexico to northern Panama, and the West Indies. *Allotoonia* is named after Dr. Anthony Leeuwenberg, from the Wageningen University (WAG), The Netherlands, in recognition of his work in the Apocynaceae.

The genus *Allotoonia* is in the subfamily Apocynoideae, tribe *Echiteae* (Endress & Bruyns 2000), as evidenced by the following characters: anthers with the thecae connivent, agglutinated and strongly attached at two levels to the spool shaped style head.

TABLE 1. Morphological characters in *Allotoonia* and selected genera of the *Echiteae*

Genera Morphological Characters	Allotoonia	Echites	Forsteronia	Laubertia	Prestonia	Thenardia	Thoreauea
Latex	Clear	White	White	Clear	White	Clear	White
Secondary veins	Usually inconspicuous	Conspicuous	Conspicuous, rarely inconspicuous	Conspicuous	Conspicuous	Usually inconspicuous	Conspicuous
Inflorescence	Helicoid cyme	Modified dichasium	Thyrsiform	Scorpioid cyme, sometimes reduced and appearing simple or umbelliform subcorymbose	Racemose, subracemose, umbellate, subumbellate, corymbose or	Subumbellate cyme	Trichotomously branched Subumbellate cyme
Bracts	Scarious	Scarious	Scarious	Scarious	Foliaceous to scarious	Scarious	Scarious
Sepals	Scarious	Scarious	Scarious	Scarious	Foliaceous to scarious	Scarious	Scarious
Sepals colleters	Solitary and opposite	Solitary and opposite	Laterally or evenly disposed, rarely lacking	Lacking	Solitary and opposite	Solitary and opposite	Solitary and opposite
Corolla	Salverform	Infundibuliform	Salverform to rotate		Salverform	Salverform to rarely infundibuliform	Rotate Urceolate to campanulate
Corona	Absent	Absent	Absent	Present, continuous around the corolla mouth	Present, continuous around the corolla mouth	Absent	Present, dissected interior to corolla mouth

Genera Morphological Characters	Allotoonia	Echites	Forsteronia	Laubertia	Prestonia	Thenardia	Thoreauea
Lobes	Very narrowly elliptic to almost filiform, acuminate, twisted and wavy distally	Obovate	Oblong to lanceolate	Obovate	Obovate to ovate	Ovate	Ovate
Stamens insertion	included, inserted in the upper part, near the mouth	Included, inserted about midway the corolla tube	Included or variously exserted	Included or variously exserted	Included or apically exserted	Exserted	Apically exserted
Filaments	Free	Free	Free or connate	Free	Free or connate	Partially	Partially connate
Disk or nectaries	5, usually separated, rarely slightly connate basally	5, but usually connate basally	Usually (3–) 5-lobed basally	5, separated to irregularly connate in 5 nectaries	Annular, entire to 5-lobed or divided	5, separated	5, separated
Follicles	Slender, continuous and terete, or obscurely moniliform	Slender, continuous and terete	Slender, divaricate or, parallel, continuous to moniliform	Slender, moniliform, rarely continuous	Divaricate, fusiform, continuous or rarely moniliform	Slender, moniliform	Unknown
Coma seeds	Conspicuously rostrate	Inconspicuously to moderately rostrate	Truncate, sessile	Truncate, sessile	Truncate	Sessile	Unknown

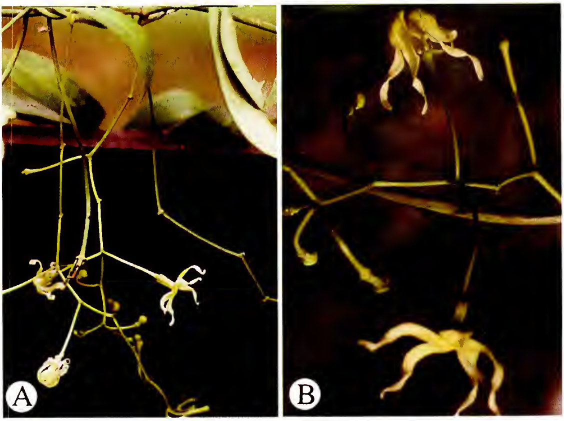


Fig. 1. ***Allotoonia caudata*. A.** **Habit and inflorescences (*Morales 8242*, INB). B. Close-up of the flowers, showing twisted and elongate corolla lobes (*Morales 8242*, INB).**

KEY TO THE SPECIES OF *ALLOTOONIA*

1. Corolla lobes (17–)20–27 mm long; corolla tube constricted below the insertion of the stamens; montane rain forest and related disturbed areas between 1500–2350 m ____ **A. turbinata**
1. Corolla lobes 4–14(–16) mm long; corolla tube straight or slightly constricted below the insertion of the stamens; tropical deciduous forest, premontane moist forest, gallery forest, and related disturbed areas, bewteen 0–1200(–1400) m.
  2. Secondary venation of leaves raised and conspicuous, tertiary venation of leaves obscure; corolla lobes glabrous; plants of the West Indies ____ **A. agglutinata**
  2. Secondary venation inconspicuous, not raised, tertiary venation usually inconspicuous; corolla lobes pubescent or glabrous; plants of Mexico and Central America.
    3. Corolla lobes shorter than tube, glabrous; bud pointed; tube 7–9 mm long, ca. 1 mm diam., constricted between middle to base of lobes ____ **A. tuxtlensis**
    3. Corolla lobes longer than tube, hirsute or glabrous; bud round, tube 4–6(–7) mm long, ca. 2 mm diam., straight, not constricted.
      4. Corolla orange to yellow-orange, the lobes hirsute; pedicels 2–9 mm; anthers 3.5–4 mm ____ **A. parviflora**
      4. Corolla white, creamish white to pinkish white, the lobes glabrous to glabrate; pedicels 11–24 mm; anthers (5–)6–8 mm ____ **A. caudata**

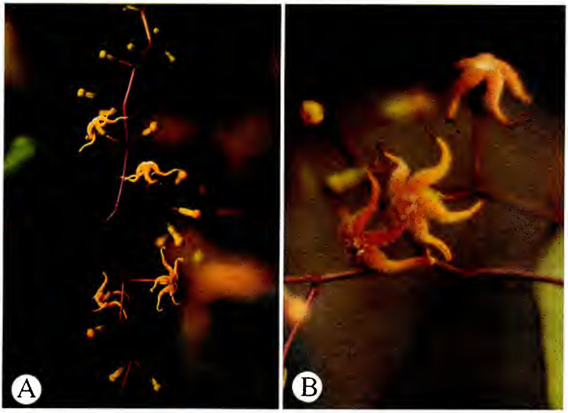


FIG. 2. ***Allotoonia parviflora*. A.** Habit and inflorescences (*Morales & Abarca 8810*, INB). **B.** Close-up of the flowers, showing twisted and elongate corolla lobes (*Morales & Abarca 8810*, INB).

1. **Allotoonia agglutinata** (Jacq.) J.F. Morales & J.K. Williams, comb. nov. (**Figs. 8, 9**). BASIONYM: *Echites agglutinata* Jacq., Enum. Syst. Pl. 13. 1760. *Anechites agglutinata* (Jacq.) Miers, Apocyn. S. Amer. 236. 1878. *Prestonia agglutinata* (Jacq.) Woodson, Ann. Missouri Bot. Gard. 18:552. 1931. TYPE. HAITI: Cap. Francais, Select Stirp. Am. Hist. 1763. (LECTOTYPE, here designated).

Echites circinalis Sw., Prodr. 52. 1788. *Haemadictyon circinalis* (Sw.) G. Don, Gen. Hist. 4:83. 1837. *Anechites circinalis* (Sw.) Miers, Apocyn. S. Amer. 236. 1878. TYPE: data lacking (fl), *Rohr 93* (LECTOTYPE, here designated: C, ISOLECTOTYPE: P-LA).

Echites sanguinolenta Tussac, Fl. Antill. 95, t. 11. *Haemadictyon nutans* (Anders.) A. DC. var. *sanguinolenta* (Tussac) A. DC., Prodr. 8:426. 1844. TYPE. HISPANIOLA: not located.

Echites circinalis Sw. var. *thomasiana* A. DC., Prodr. 466. 1844. *Anechites thomasiana* (A. DC.) Miers, Apocyn. S. Amer. 237. 1878. TYPE: ST. THOMAS: exact locality lacking, 1841 (fl), *Friedrichsthal 240* (HOLOTYPE: W).

Echites obtusifolia Sessé & Moc., Naturaleza (Mexico City), ser. 2, 2, app. 45. 1893. TYPE: PUERTO RICO: near Castellum del Morro, Oct., year lacking, *Sessé & Mocino 5075* (LECTOTYPE, here designated: MA).

Suffruticose to herbaceous liana, stem terete to subterete, glabrous to glabrate. Leaves: petioles 5–20 mm long, with minute pectinate colleters in the axils or sometimes eglandular, glabrous; blade 3–13.5 × 2–8.5 cm, membranaceous, el-

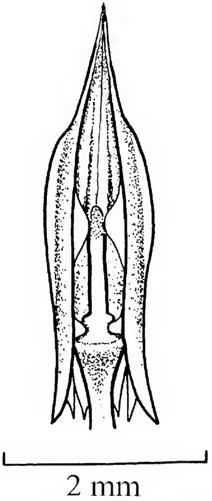


FIG. 3. *Allotoonia parviflora* style head and anthers, showing the two levels of attachment to the spool shaped style head. (*Morales & Abarca 8810*, INB).

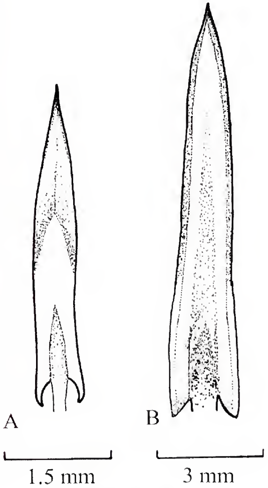


FIG. 4. *Allotoonia* and *Echites* anthers, dorsal view. **A.** *Allotoonia parviflora*. (*Morales 3139*, INB). **B.** *Echites umbellata*. (*Whiteford 8209*, INB).

liptic, narrowly elliptic to narrowly ovate, apex caudate to obtuse, base obtuse to somewhat attenuate basally, glabrous, midvein impressed on both surfaces, the secondary venation conspicuous on both sides. Inflorescence usually longer than the subtending leaves, lax, peduncle 1.5–7 cm, pedicels 2–5 mm, bracts 1–2 mm long, ovate, acute, scarious; sepals 1–1.5 × 0.5–1 mm, ovate, acuminate, glabrous, glabrate, or minutely and inconspicuously puberulent, colleter somewhat laciniate to deeply so; corolla salverform, white, creamish white to cream, glabrous without, tube 5–6 mm long, 1–1.5 mm diam, somewhat inflated at the attachment of the stamens, pubescent within near the mouth, lobes 4–6 × 1–2 mm, glabrous; stamens: filaments ca. 4 mm, glabrate to sparsely pubescent, anthers 4–5 mm, glabrous, auricles ca. 0.2 mm, ovary ca. 2 mm, glabrous, style head 1.5–2 mm long, nectaries 1–1.5 mm, entire and conspicuously separate. Follicles 11–31(–46) × 0.4–0.8 cm, continuous, smooth and glabrous, usually straight; seeds 6.5–10 × 1.5–2 mm, rugose, the tannish coma 2–4 cm.

Fig. 5. *Allotoonia parviflora*. Follicles

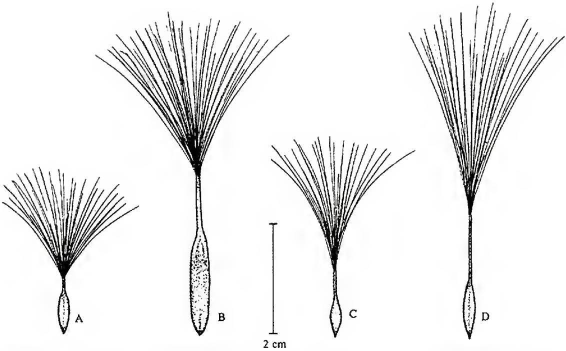


Fig. 6. *Allotoonia* seeds. **A.** *A. agglutinata* (*Axelrod & Axelrod 3091*, INB). **B.** *A. turbinata* (*Gómez-L. et al., 14142*, INB). **C.** *A. tuxtlensis* (*Arvigo et al. 536*, INB). **D.** *A. parviflora* (*Morales 3161*, INB).

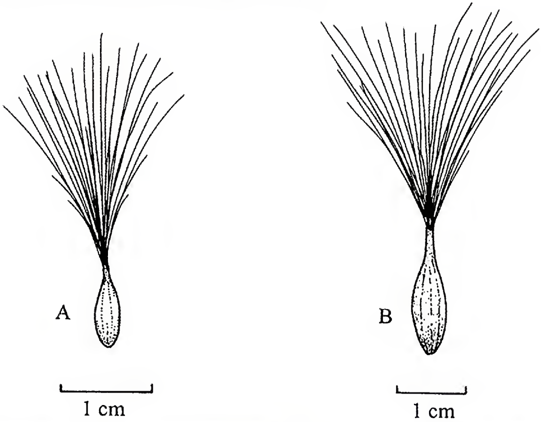


Fig. 7. *Echites* seeds. **A.** *E. umbellata* (*Trejo et al. 530*, INB). **B.** *E. yucatanensis* (*Magallanes 3137*, INB).

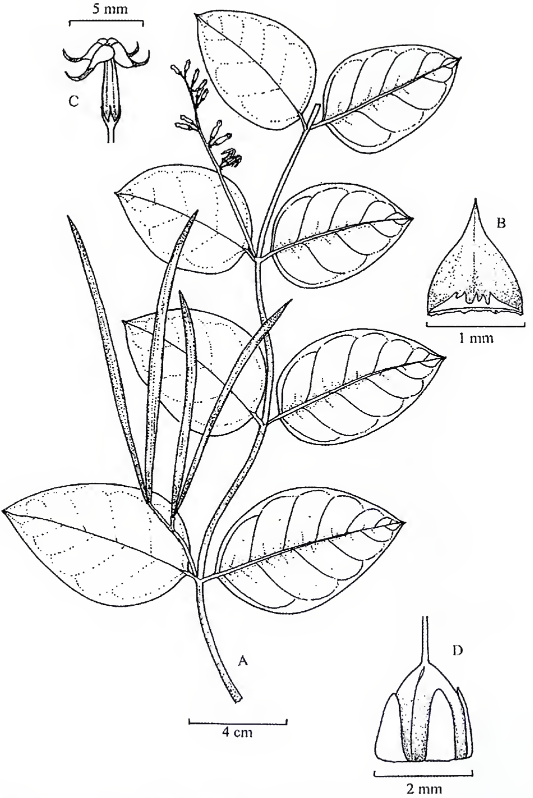


Fig. 8. *Allotoonia agglutinata* **A.** Fertile shoot, showing the inflorescence and fruits. **B.** Sepal and colleter. C. Corolla. D. Disk and ovary (*Zanoni et al. 47051*, INB).

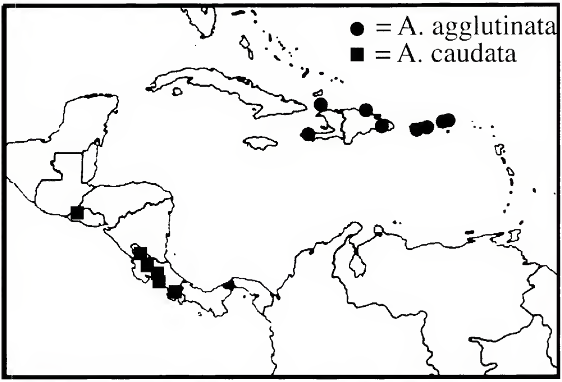


Fig. 9. Distribution of *A. agglutinata* and *A. caudata*.

Habitat and distribution.—Dry forest, gallery forest, shrubby vegetation, thickets, and disturbed areas in the West Indies (Hispaniola, Cuba, Puerto Rico, Jamaica, part of Greater Antilles), at elevations of 0–350 m. (Fig. 9). Associated species include *Abutilon* and *Plumeria*.

Phenology.—Flowering specimens have been collected in January, May–June and September–October. Fruiting collections have been made in January–February and September–October.

Local names.—abrazapalo (Dominican Republic); azufaifo, babeiro (Puerto Rico).

Allotoonia agglutinata is the only species of the genus with conspicuously raised secondary veins. In addition, it has glabrous corolla lobes that are longer than the tube and it is distributed throughout the West Indies. The corolla bud is contorted, similar to the bud of *A. tuxtlensis* (Fig. 10).

A complete list of synonyms for this species as presented by Woodson (1936) is provided here in order to indicate that an earlier generic name does not exist for any of the described species of *Allotoonia*. Although the types collection of *Echites sanguinolenta* Tussac and *E. circinalis* Sw. var. *thomasiana* A. DC. were not located, they are included in the synonymy based on their original descriptions, which matches the *Allotoonia agglutinata* concept used here. Within *Allotoonia*, *A. agglutinata* has the highest number of synonyms, and is the only

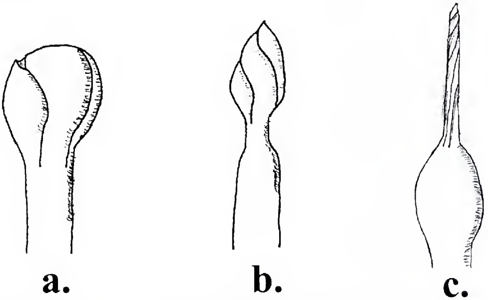


Fig. 10. Flower buds of the species of *Allotoonia*. A. *A. parviflora* (*Williams 96-88*, SHST). B. *A. turbinata* (*Breedlove 25058*, TEX). C. *A. tuxtlensis* (*Hernández 488*, TEX).

species that has been described in multiple genera. None of the genera listed above are legitimate alternatives to *Allotoonia*.

Observations of the Sessé & Mocino collections by the second author indicates that the specimen number *5075* is labeled *Echites obtusifolia*. The species name is written on the back of the herbarium sheet, which perhaps accounts for the specimen being overlooked. Consequently, specimen number *5075* of the Sessé and Mocino herbarium is here designated as the lectotype for *Echites obtusifolia*.

Selected specimens examined. **JAMAICA:** Data lacking: *Swartz 265* (BM). **PUERTO RICO:** Patillas, Guardarraya, Cerro Mala Pascua, 13 Oct 1991, *Axelrod & Axelrod 3091* (INB, UPRRP); Isla de Desecho, W of Puerto de los Botes, *Breckon 4994* (MAPR), *Breckon 5019* (MAPR); Sabana Grande, Susúa forest, 7 Nov 1990, *García & Caminero 3287* (MAPR. NY); Salinas, Camp Santiago, section Lima, date lacking, *Ross & Meletische 253* (MO); near Cayey, Pedro Avila, 22 Sep 1895, *Sintenis 2457* (S); Quebradillas, 24 Jun 1991, *Taylor & Gereau 10493* (MO); Guanica, 25 Jan 1886, *Urban 3565* (BM, P [2 sheets]); Punta Tuna, S of Yabacoa, 11 Oct 1968, *Wagner 1690* (INB). **DOMINICAN REPUBLIC:** Cabo Francés Viejo to Cabrera, 28 Sep 1969, *Liogier 16152* (INB, NY); La Romana: Río Cumayasa, road San Pedro de Macorí-La Romana, 29 Oct 1992, *Zanoni et al. 47051* (INB, JBSD). **HAITI:** La Hotte, Bras Gauche river, 8 Nov 1924, *Ekman 2431* (S); Totue Island, Basse-Terre, 28 Oct 1925, *Ekman 5131* (S, US). **TORTOLA:** Belmont Beach, 30 Oct 1965, *D'Arcy 292*^{d} (MO). **VIRGIN ISLANDS:** Francis Bay area, 6 Jun 1985, *Acevedo* et al. *902* (BM, NY); Coral Bay Quarter, road to Bordeaux, 7 Jan 1991, *Acevedo & Siaca 3819* (INB, US); Reef Bay, Dittlif point, 20 Jan 1991, *Acevedo & Siaca 3974* (MO).

2. Allotoonia caudata (Woodson) J.F. Morales, comb. nov. (**Figs. 1, 11**). BASIONYM: *Echites puntarenensis* J.F. Morales, Brittonia 49:332. 1997. nom. nov. *Prestonia caudata* Woodson, Ann. Missouri Bot. Gard. 47:79. 1960, non Blanco (1837). TYPE:

COSTA RICA: Puntarenas: vicinity of Cascajal, 25 km ESE of Puntarenas, 3 Jul 1949 (fl), *Holm & Iltis 243* (HOLOTYPE: MO; ISOTYPES: A, CR, G, GH, P).

Suffruticose lianas, stem terete to subterete, glabrous. Leaves: petioles 6–19 mm long, with minute pectinate colleters in the axils, glabrous; blade 6–14(–16) × 1.5–5 cm, membranaceous, elliptic to narrowly elliptic, more rarely narrowly obovate-elliptic, apex acuminate, base obtuse to cuneate, glabrous, midvein impressed on both surfaces, the secondary venation scarcely impressed or inconspicuous on both sides, veinlets usually inconspicuous. Inflorescence longer than the subtending leaves, lax, peduncle 4.5–11 cm, pedicels 11–24 mm, bracts ca. 1 mm long, ovate, acuminate, scarious; sepals 1 × 0.5–1 mm, ovate, acute, glabrous, the colleter entire to subentire; corolla salverform, white, creamish white, or pinkish white, glabrous without, tube 6–8 mm long, 2–2.5 mm diam, straight, glabrate around the stamens within, lobes 8–15 × 1.5–2 mm, glabrous to glabrate; stamens: filaments less than 0.5 mm, inconspicuous, anthers (5–)6–8 mm, glabrous, auricles ca. 0.8 mm; ovary 1.5–2 mm, glabrous, style head 1–2.5 mm long; nectaries 0.5–1 mm, entire. Follicles unknown.

Distribution.—Dry forest, savannas, and disturbed areas in northern Costa Rica, southern Nicaragua and El Salvador, 0–600(–1000) m. (Fig. 9). Associated species include *Curatella*, *Lonchocarpus*, *Plumeria*, and *Stemmadenia*.

Phenology.—Flowering specimens have been collected in February, April, June–July, September, and November–December.

Local names.—bejuco de Veneno (Costa Rica, Guanacaste, Nicoya).

Allotoonia caudata is very similar to *A. parviflora* and usually misidentified in herbarium specimens. However, the former taxon is easily distinguished by its white, creamish white, or pinkish white flowers (vs. orange to yellow-orange), with glabrous or glabrate corolla lobes (vs. densely hirsute). Morales (1997) recognized that *Prestonia caudata* Woodson should be treated in *Echites* but a new name was necessary, because the epithet was already occupied by several homonyms (*E. caudata* L., *E. caudata* Burman f., and *E. caudata* Blanco), thus, the name *E. puntarenensis* was proposed. With the transfer of this taxon to the new genus, the original basionym can be used according to article 58.3 of The Code. Therefore, the respective combination is made and *E. puntarenensis* is reduced to synonymy.

Specimens examined. **EL SALVADOR. Santa Ana:** Coatepeque, 3 Sep 1994, *Villacorta & Méndez 2181* (B, LAGU, MO). **NICARAGUA. Chontales:** 3 km N of St. Tomás, 6 Apr 1982, *Moreno 16081* (MO). **Rivas:** Isla Omotepe, Balgue, 28 Nov 1982, *Moreno 18888* (MO); Isla Ometepe, Balgue, 18 Jan 1983, *Moreno 19664* (BM, MO); Isla de Ometepe, 15 Sep 1983, *Moreno 22179* (MO); Isla Omotepe, Mérida, 11 Feb 1984, *Robleto 199* (MO); Isla Omotepe, Volcán Maderas, 18 Jun 1984, *Robleto 912* (MO), 16 Jan 1985, *Robleto 1701* (MO). **COSTA RICA. Guanacaste:** Pilas de Bejuco, 18 Nov 1994, *Estrada & Rodríguez 283* (CR, INB, MO); Cañas, Río Corobicí, 26 Jun 1942, *León 894* (F); Nicoya, 25 Jan 1985, *Poveda & Castro 3926* (CR, MO); scrub near Nicoya, May 1900, *Tonduz 13940* (MO). **Puntarenas:** Paquera a Playa Organos, 25 Dec 1993, *Hammel & Garita 19306* (CR, INB, MO). **San José:** San Juan de Mata, cabeceras Quebradas Yeguas y Paso Agres, 11 Nov 2001, *Morales 8242* (INB, MO).

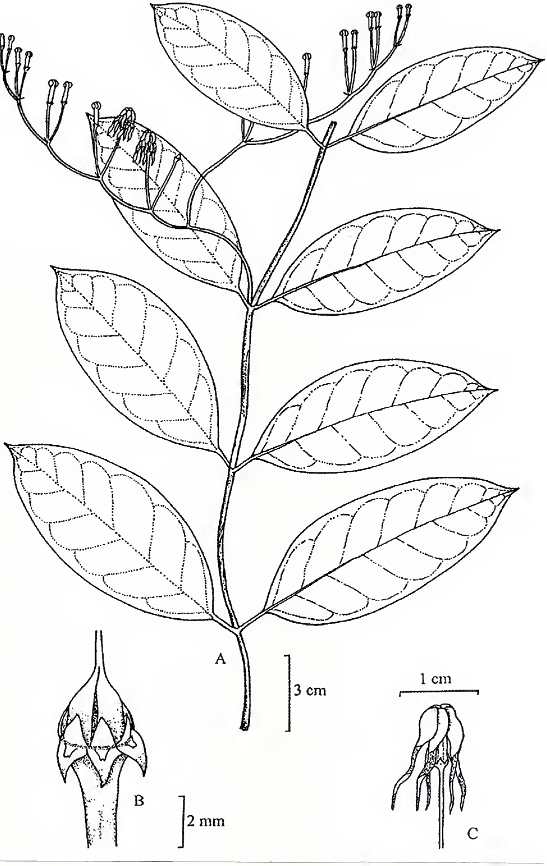


Fig. 11. *Allotoonia caudata* **A.** Flowering shoot. **B.** Sepals, colleters, nectaries, and ovary. **C.** Corolla (*Morales 8242*, INB).

3. **Allotoonia parviflora** (Sessé & Moc.) J.F. Morales & J.K. Williams, comb. nov. (**Figs. 2, 12, 13**) BASIONYM: *Echites parviflora* Sessé & Moç., Naturaleza (Mexico City), ser. 2, 1, app. 28. 1888, non Roxb (1832). TYPE: MEXICO. MICHOACÁN: Apatzingan, date lacking (fl), *Sessé & Moçiño 5068* (LECTOTYPE: fide Williams 2002, MA; ISOLECTOTYPE: F; photo F neg. 41238, INB ex MA).

Echites woodsoniana Monac., Bull. Torrey Bot. Club. 86:245–247, f. 1. 1959. *Prestonia woodsoniana* (Monac.) A.H. Gentry, Ann. Missouri Bot. Gard. 70:205. 1983. TYPE: MEXICO. MICHOACÁN: Apatzingan, 13 Oct 1939 (fl), *Hinton 15325* (HOLOTYPE: NY; ISOTYPES: GH, MO, NY, TEX, US [2 sheets]).

Suffruticose liana, stem subterete, glabrous. Leaves: petioles 3–15 mm long, with minute pectinate colleters in the axils, glabrous; blade 3.2–9.2(–11.4) × 0.9–3.6 cm, membranaceous to somewhat subchartaceous, elliptic, narrowly elliptic to narrowly ovate, apex acuminate, acute to acute-mucronate, base obtuse to cuneate, glabrous, midvein impressed on both surfaces, the secondary venation scarcely impressed or inconspicuous. Inflorescence longer than the subtending leaves, lax, peduncle 1.3–7 cm, pedicels 2–9 mm, bracts 1–1.5 mm long, almost linear, acuminate, scarious; sepals 1–1.5 × 0.5–1 mm, ovate to narrowly ovate, acute to acuminate, glabrous to glabrate, more rarely minutely and inconspicuously papillate, the colleter very slightly erose; corolla salverform, orange to yellow-orange, glabrous without, tube 3.5–6 mm long, ca. 1.5 mm diam, straight, puberulent within around the stamens, lobes 8–14(–16) × 1.5–2 mm, densely hirsute adaxially; stamens: filaments less than 0.5 mm, inconspicuous, anthers 3.5–4 mm, glabrous, auricles ca. 0.8 mm, ovary 1.5–2 mm, glabrous, style head 2–3 mm long, nectaries 0.5–1.5 mm, distinct to somewhat connate, entire. Follicles 30–40 × 0.4–0.5 cm, continuous to obscurely moniliform, smooth and glabrous, somewhat twisted distally; seeds 21–27 × 1–1.5 mm, rugose, the creamish coma 3.8–4.2 cm.

Distribution.—Dry forest, premontane moist forest, disturbed areas, savannas, semideciduos forest, rocky forested outcrops, and gallery forest in Mexico, Guatemala, Honduras, Nicaragua, and Costa Rica, at elevations of 0–1100(–1400) m. (Fig. 13). Associated species include *Anacardium*, *Astronium*, *Bursera*, *Enterolobium*, *Lonchocarpus*, *Ficus*, and *Plumeria*.

Phenology.—Flowering January, April–May, and July–December. Fruitng collections have been collected in January-April and November

Local names.—Bejuco de Sapo (Mexico, Guerrero, Zirándaro).

This species has a complicated taxonomic history having been treated repeatedly in *Prestonia*. The history of this species is well documented in Williams (2004).

Allotoonia parviflora is immediately distinguished by its rounded corolla bud (Fig. 10) and pubescent corolla lobes (Fig. 2 B). It is often confused with *A. tuxtlensis*, which has a pointed corolla bud (Fig. 10) and glabrous corolla lobes. Also, *Allotoonia parviflora* consistently has corolla lobes longer than the tube, while the corolla lobes in *A. tuxtlensis* are consistently shorter than the tube.

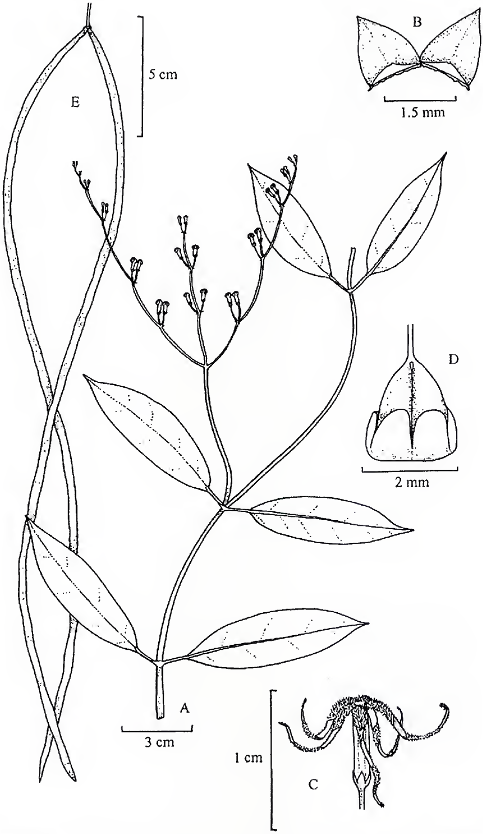


FIG. 12. *Allotoonia parviflora* (A–D from *Morales & Quirós 8241*, INB; E from *Morales 3139*, INB). **A.** Flowering shoot. **B.** Sepals and colleters. **C.** Corolla. **D.** Nectaries and ovary. **E.** Fruits.

The holotype of *E. woodsoniana* (=*Allotoonia parviflora*) at NY has corolla lobes 15–16 mm long, making it appear to be a specimen of *A. turbinata*. *Allotoonia turbinata* differs from *A. parviflora* by its flowering bud, which has the corolla lobes extended upwards rather than folded in (Fig. 10).

Although *Echites parviflora* Sessé & Moç. is a later homonym of *E. parviflora* Roxb., its use in the new combination *Allotoonia parviflora* (Sessé & Moç.) J.F. Morales & J.K. Williams is legitimate according to article 58.3 of The Code.

Monachino (1959) recognized that *Echites parviflora* Sessé & Moç. is a homonym of *E. parviflora* Roxb., and thus regarded its use by Woodson (1936) as illegitimate. Unfortunately, Monachino did not have access to the type of *E. parviflora* Sesse & Moç. and was therefore uncertain as to its true identity. Rather than proposing a new name for the species he decided to re-describe it as a new species, giving it the name *E. woodsoniana* Monach., as was exposed previously by Gentry (1983). Observations of the lectotype of *E. parviflora* at MA by the second author confirm that the specimen is conspecific with *E. woodsoniana*. *Echites woodsoniana* is here treated as a synonym of the new combination *Allotoonia parviflora*.

Specimens examined. **MEXICO. Guerrero:** Tario, Coyuca, 5 Apr 1935, *Hinton et al. 7589* (P, US); Tario, Coyuca, 4 Feb 1934, *Hinton 5863* (US); El Talamo, road Zirándaro-Guayamo, 6 Sep 1982, *Soto & Silva 4355* (INB, MEXU). **Jalisco:** Jilotlán de Los Dolores, Río Tepalcatepec, 21 Sep 1983, *Martínez et al. 4369* (INB, MEXU). **Michoacán:** 4 km e of Apatzingán along river, 3 Jan 1997, *Williams 96-88* (SHST, TEX); Arteaga, road to Playa Azul, 11 Nov 1977, *Koch et al. 77462* (US); Arteaga, road Arteaga to Nueva Italia, 27 Sep 1983, *Martínez & Stevens 4597* (INB, MEXU); along road to Infernillo, 15 Jan 1983, *Miller* et al. 456 (MO [2 sheets]). **Oaxaca:** Mpio. San Miguel Chimalapa, Río Escondido (Arroyo Baúl), W of the union with Río Portamonedas and Benito Juárez, ca. 38 km in a straight line to the N of San Pedro Tapanatepec, 8 Oct 1985, *Maya 2336* (TEX). **Quintana Roo:** N de Estero Franco, 30 Jul 1984, *Cabrera & Cabrera 6885* (MEXU, MO). **GUATEMALA. Chiquimula:** between Ramírez and Cumbre de Chiquimula, 15 Oct 1940, *Standley 74562* (F). **HONDURAS. Comayagua:** Comayagua Valley, 11 Sep 1974, *Hazlett s.n.* (MO); Quebrada Chicuas, cerca de El Agua Salada, 21 Jul 1962, *Molina 10996* (EAP, F, NY). **NICARAGUA. Chontales:** near Cuapa, 14 Jul 1976, *Neill 619* (DUKE, MO); N of Cuapa, 3 Sep 1977, *Neill 2488* (MO); N of Cuapa, 21 Jan 1978, *Stevens 6106* (BM, MO), ca. 2.8 km about Cuapa city, 30 Dec 1983, *Stevens 22695* (DUKE, MO, NY). **Rivas:** Isla Omotepe, 27 Apr 1984, *Robleto 396* (MO); 1 May 1984, *Robleto 537* (MO), 14 Dec 1984, *Robleto 1611* (MO); Volcán Maderas, 21 Sep 1984, *Robleto 1218* (MO). **COSTA RICA. Alajuela:** road to Upala, Hacienda Carbonal, 2 Nov 1985, *Gómez et al. 23879* (CR, F, MO). **Guanacaste:** Finca Tenorio, Las Cañas, 18 Jul 1965, *Croat 268* (MO); La Pacifica, 26 Jan 1969, *Gentry 307* (MO); Finca La Pacífica, Cañas, 21 Sep 1975, *Janzen 10148* (MO); Río Tenorio, near La Pacífica, 20 Nov 1972, *Opler 1567* (COL, CR, F, MO, NY). **Puntarenas:** Monteverde Biological Reserve, 27 Aug 1993, *Bello & Cruz 5278* (CR, INB, MO). **San José:** Acosta, Valle del Río Candelaria, near Puente, 15 Apr 1995, *Hammel 19760* (INB, MO); Acosta, Río Candelaria, 19 Nov 1994, *Morales 3139* (CR, INB [2 sheets], MO), *Morales 3161* (INB, MO); Cerros de Caraigres, Río La Meza, Ceiba Este, *Morales & Corrales 6033* (INB, MO); Río Jorco, Acosta, between Bajo Badilla and Bajo Cárdenas, 22 Aug 1998, *Morales 6481* (INB, MO); Río Candelaria, W of Resbalón, 3 Dec 2001, *Morales & Quirós 8241* (CR, INB, MO); Acosta, between Monterrey and Las Ceibas, 1 Dec 2002, *Morales & Abarca 8810* (INB).

4. Allotoonia turbinata (Woodson) J.F. Morales & J.K. Williams, comb. nov. (**Figs. 13, 14**). BASIONYM: *Echites turbinata* Woodson, Ann. Missouri Bot. Gard. 21:615.

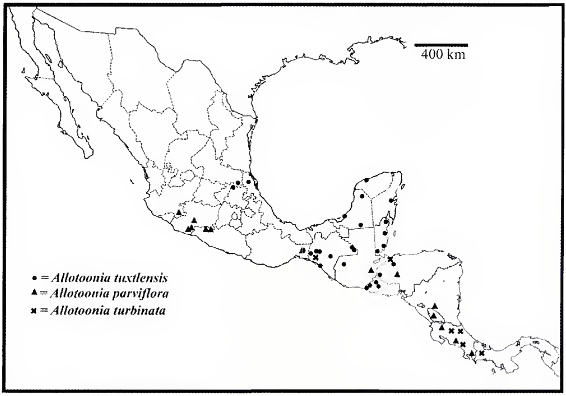


Fig. 13. Distribution of *A. parviflora*, *A. turbinata* and *A. tuxtlensis*.

1934. Type: COSTA RICA: Alajuela: Rancho Flores, 22 Feb 1890 (fl), *Tonduz 2147* (holotype: B [destroyed]; lectotype, here designated: US; isolectotypes: BR [2 sheets]).

Suffruticose liana, stem terete to subterete, glabrous. Leaves: petioles 7–21 mm long, without colleters in the axils, glabrous; blade 4.5–14.5(–17) × 2.1–8.7 cm, membranaceous, rarely subchartaceous, elliptic to narrowly elliptic, apex caudate-acuminate, rarely acuminate, base obtuse to cuneate, sometimes oblique, glabrous, midvein impressed on both surfaces, the secondary venation slightly impressed or inconspicuous. Inflorescence shorter than the subtending leaves, lax to somewhat agglomerate, peduncle 1.5–5.1(–5.4) cm, pedicels 4–15 mm, bracts 1–2.5 mm long, very narrowly elliptic to linear, acuminate, scarious; sepals 2–3.5 × 1–1.5 mm, ovate, long-acuminate, glabrous to glabrate, minutely rugose, the colleter irregularly fimbriate; corolla salverform, greenish yellow, glabrate to inconspicuously and sparsely puberulent without, tube 4–6 mm long, ca. 1.5 mm diam, inflated at the attachment of the stamens, puberulent to glabrate within around the stamens, lobes (17–)20–27 × 1 mm, glabrous to glabrate; stamens: filaments ca. 1 mm, glabrate, anthers 3–3.5 mm, glabrous, auricles 0.5–0.8 mm, ovary 1.5–2 mm, glabrate, style head 1–1.5 mm long, nectaries ca. 1.5 mm, entire. Follicles 20–31 × 0.4–0.6 cm, obscurely moniliform, smooth and glabrous; seeds 27–30 × 2–3 mm, rugose, the tannish coma 3–5.5 cm.

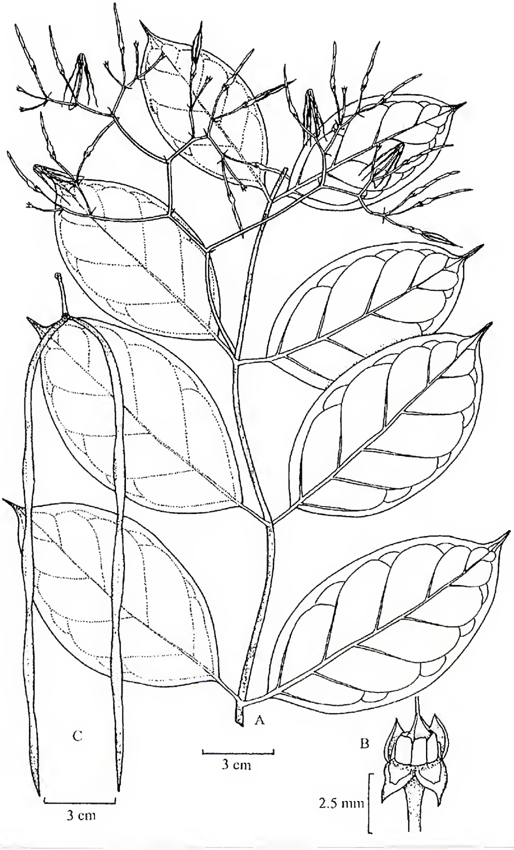


FIG. 14. *Allotoonia turbinata* (A–C from *Kupper 937*, M; D from *Gómez-L. et al., 12142*, INB). **A.** Flowering shoot. **B.** Sepals, colleters, nectaries, and ovary. **C.** Fruits.

Habitat and distribution.—Montane Rain forest and related disturbed areas in Mexico (Chiapas), Honduras, Costa Rica, and Panama, between 1500–2350 m. (Fig. 13). Associated species include *Clethra*, *Eugenia*, *Liquidamber*, *Pinus*, *Quercus*, and *Randia*.

Phenology.—Flowering specimens have been collected in January–May, June, and September. Fruiting collections are reported in January–February, and June.

Allotoonia turbinata is immediately distinguished by its corolla lobes 1.2–2.7 cm long. This species is similar to *A. parviflora* but differs in its corolla lobes which are longer and extended upwards in bud (vs. rounded in bud, Fig. 10).

The elevation range of this species (between 1500 m and 2350 m) is unique, considering that the other species in *Allotoonia* are found mostly at low elevations and the fact that in Mesoamerica very few apocynaceous lianas grow at 1500 m altitude. This species was originally considered endemic to Costa Rica (Rancho Flores, Cordillera Volcánica Central), but further collections have broadened of its known range.

Specimens examined. **MEXICO. Chiapas:** Mpio. Villa Corzo, E base of Cerro Tres Picos near Cerro Bola along a logging road SW of Colonia Agrónomos Mexicanos, 4 May 1972, *Breedlove 25058* (MO [2 sheets], TEX). **HONDURAS. Cortéz:** Montaña Idalfonso, N de Cofradía, 17 Apr 1957, *Molina 6203* (EAP, F). **COSTA RICA. Alajuela:** near Carrizal, 31 Jan 1992, *Gómez-L. et al. 12142* (INB, USJ); Poás, 27 Mar 1932, *Kupper 937* (M [2 sheets]). **Heredia:** Monte Barva, 1845–1848, *Oersted 15544* (C); Las Lajas de San Isidro, Sep 1900, *Pittier 14035* (US). **PANAMA. Chiriquí:** vicinity of Cerro Punta, 21 Jan 1939, *Allen 1524* (MO); Río Chiriquí Viejo Valley, between El Volcán and Cerro Punta, 15 Mar 1938, *White 6* (MO, US); vicinity of Casita Alta, Volcán de Chiriquí, 28 Jun 1938, *Woodson et al. 988* (GH, MO, NY).

5. Allotoonia tuxtlensis (Standl.) J.F. Morales & J.K. Williams, comb. nov. (**Figs. 14, 15**). BASIONYM: *Echites tuxtlensis* Standl., Contr. U.S. Natl. Herb. 23:1164. 1924. TYPE: MEXICO. CHIAPAS: near Tuxtla, 1 Sep 1895 (fl), *Nelson 3080* (HOLOTYPE: US).

Suffruticose liana, stems terete to subterete, glabrous. Leaves: petioles 3–11 mm long, with minute pectinate colleters in the axils, rarely eglandular, glabrous; blade 4.5–11 × 1.4–3.7(–4.8) cm, membranaceous, narrowly elliptic to narrowly ovate, apex acuminate, base obtuse to cuneate, midvein impressed on both surfaces, the secondary venation slightly impressed or inconspicuous. Inflorescence longer than the subtending leaves, lax, peduncle 2.6–8 cm, pedicels 8–19 mm, bracts 0.8–1.5 mm long, ovate, acuminate, scarious; sepals 1.5–1.8 × 1 mm, ovate, acuminate, glabrous, the colleter entire or somewhat laciniate; corolla salverform, yellow to creamish yellow, glabrous without, tube 8–10 mm long, 1.5–2 mm diam, inflated at the attachment of the stamens, puberulent within around the stamens, lobes 6–8 × 1–1.5 mm, glabrous; stamens: filaments inconspicuous, anthers ca. 4 mm, glabrous, auricles ca. 0.5 mm, ovary 1–1.5 mm, glabrous, style head 1.5–2 mm long, nectaries 0.5–1 mm, distinct to somewhat connate, entire. Follicles 13–15 × 0.3 cm, continuous, smooth and glabrous, sometimes somewhat twisted distally; seeds 11–13 × 1.5 mm, minutely and inconspicuously rugose, the creamish coma (2.3–)2.5–3.2 cm.

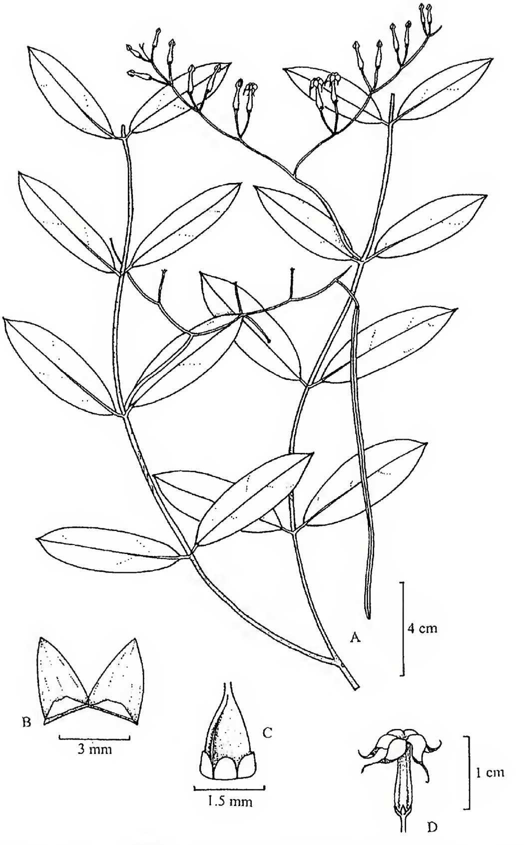


Fig. 15. *Allotoonia tuxtlensis* (A–C from *Arvigo et al. 536*, INB; D from *Renderos 378*, INB) **A.** Fertile shoot, showing the inflorescence and follicles. **B.** Sepals. **C.** Ovary and nectaries. **D.** Corolla.

Habitat and distribution.—Tropical deciduous forest and disturbed areas of Mexico (Chiapas, Campeche, Oaxaca, Quintana Roo, and Yucatán), Belize, Guatemala, Honduras, and disjunct into El Salvador, 100–1200 m. (Fig. 13). Associated species include *Aspidosperma*, *Bursera*, *Ficus*, *Pinus*, *Quercus*, and *Spondias*. This species is occasionally cultivated and it is suspected that the populations in Northern Mexico (San Luis Potosí, Querétaro, and Veracruz) are introduced rather than native.

Phenology.—Flowering all the year. Fruiting collections have been made in January and May.

Local names.—Tasnk'ub ts'aah (México, Huasteca); centipede vine (Mexico); bejuco lengua de culebra (El Salvador, Ahuacapán, San Benito); loroco de Culebra (El Salvador, Cuscatlán). The name Loroco is used for others Apocynaceous lianas in northern Mesoamerica [e.g., *Fernaldia pandurata* (A. DC.) Woodson].

Allotoonia tuxtlensis is readily distinguished from the other species of *Allotoonia* by its contorted and pointed corolla buds (Fig. 10) and its corolla lobes shorter than the tube. In both these respects, *A. tuxtlensis* resembles *A. agglutinata*. The main differences between the two taxa is the conspicuous secondary veins in the leaves of *A. agglutinata* and its restriction to the West Indies. At present no specimens with visible secondary veins in the Mexican and Central American collections of *A. tuxtlensis* have been observed.

This species was considered to be restricted to the Caribbean slopes in northern Mesoamerica (Morales 1997), but it was recently collected in the Cuscatlán Department, El Salvador Alcorn (1984) reported that this species is cultivated and protected in San Luis Potosí, Mexico. She reports that the leaves are used as a medicine in the cure of respiratory problems, including wheezing and difficulty in breathing. The leaves are boiled in a tea and drunk.

Specimens examined. **MEXICO. Campeche:** Calakmul, road to Dos Caminos, 14 Oct 1997, *Alvarez 401* (MEXU, MO); Santa María Xacabacab, 7 Mar 1982, *Cabrera et al. 2062* (INB, MEXU); Champotón, road to Escárcega, 23 Oct 1997, *Carnevali & May 4628* (CICY, MO); Calakmul, road Xpujil-Campeche road, 22 Nov 1997, *Lira et. al. 360*^{a} (MEXU, MO); Calakmul, 24 Nov 1997, *Martínez et. al. 29893* (MEXU, MO); Hopelchén, SE of Xpujil, 23 Jan 1996, *Pascual 150* (MO). **Chiapas:** between Piñola (Las Rosas) and Soyatitán, 27 Aug 1981, *Breedlove 52441* (MO [2 sheets]); Cintalapa, 14 Sep 1981, *Breedlove 52710* (MO); Ococingo, Río Usumacinta, 4 Dec 1984, *Martínez 8987* (INB, MEXU); Cerro Brujo, Ocozocuautla, 25 Oct 1985, *Martínez 14303* (MEXU, MO); NW of Boca Lacantum, 31 Oct 1985, *Martínez 14468* (MEXU, MO); Ococingo, road to Palenque, 4 Nov 1985, *Martínez 14883* (MEXU, MO); Ococingo, 10 Jan 1986, *Martínez 16205* (MEXU, MO); Ocosingo, road to Chapul, S of Boca Lacantum, 18 Apr 1986, *Martínez 18362* (MEXU, MO); Comitán, road to Tzimol, 20 Sep 1988, *Martínez & Stevens 23940* (INB, MEXU, MO); Tonala, Sep 1913, *Purpus 6825* (BM, GH); La Cueva, Tenejapa, 21 Feb 1984, *Shilom 7306* (INB, MEXU); E of Cintalapa, 19 Nov 1984, *Téllez et al. 8126* (INB, MEXU). **Oaxaca:** Santa María Chimalapa, Paso La Cueva, Río Corte, 9 Oct 1984, *Hernández 488* (MEXU, MO, TEX). **Querétaro:** Mpio. Lanad de Matamoros, W of Tilaco, road to Santa Ines, 6 Aug 1985, *Fernández 3121* (IEB). **Quintana Roo:** N of Estero Franco, road to Tomás Garrido, 30 Jul 1984, *Cabrera & Cabrera 6885* (MEXU, MO). **San Luis Potosí:** Mpio. San Antonio, San Pedro, 26 Oct 1978, *Alcorn 2102* (TEX). **Veracruz:** Mpio. Chicontepec, in the town of Tlacolula, 26 Feb 1980, *Calzada 5866* (F). **Yucatán:** Progreso, 1932, *Flores s.n.* (F). **GUATEMALA. Huehuetenango:** between Democracia and Santa Ana, Sierra de los Cuchumatanes, 25 Aug 1942, *Steyermark 51307* (F, MO). **HONDURAS. Morazán:** along Jicarito creek, 13 Aug 1947, *Molina 485* (EAP, F). **Ocotepeque:** road to Esquipulas, 29 Aug 1968, *Molina 22423* (F, NY). **BELIZE. Belize:** Belize Camp, 15 May 1991, *Arvigo* et al. *536* (INB, NY); Savanna, 2 Jun 1974, *Dwyer 12613* (MO). **Corazal:** High Ridge, 1931-1932, *Gentle 439* (BM, MO); Northern River, Dec 1933, *Gentle 1022* (MO, NY). **Toledo:** Columbia road, Dec 1946, *Gentle 6116* (F, MO, NY, TEX). **EL SALVADOR. Ahuachapán:** around Finca Santa Lina, S of Ahuachapán, 5 Dec 994, *Linares & Martínez 1953* (MO); San Francisco Menéndez, El Corozo, 13 Apr 2000, *Rosales 544* (B, LAGU, MO), 11 May 2000, *Rosales 702* (LAGU, MO), 19 Aug 2000, *Rosales 785* (LAGU, MO); San Benito, 15 Jun 1995, *Sandoval & Sandoval 27* (LAGU, MO). **Cuscatlán:** artificial lake near Cerrón Grande, 9 Dec 1997, *Renderos 378* (B, BM, BONN, INB, LAGU, MO). **Santa Ana:** S of Metapán, San Diego mountain, May 1995, *Linares & Martínez 2728* (MO).

APPENDIX 1: NUMERICAL LIST OF ACCEPTED TAXA

Allotoonia agglutinata (Jacq.) J.F. Morales & J.K. Williams
Allotoonia caudata (Woodson) J.F. Morales
Allotoonia parviflora (Sessé & Moc.) J.F. Morales & J.K. Williams
Allotoonia turbinata (Woodson) J.F. Morales & J.K. Williams
Allotoonia tuxtlensis (Standl.) J.F. Morales & J.K. Williams

APPENDIX 2: INDEX TO NAMES IN SYSTEMATIC TREATMENT

Allotoonia
agglutinata (Jacq.) J.F. Morales & J.K. Williams
caudata (Woodson) J.F. Morales
parviflora (Sessé & Moc.) J.F. Morales & J.K. Williams
turbinata (Woodson) J.F. Morales & J.K. Williams
tuxtlensis (Standl.) J.F. Morales & J.K. Williams
Anechites
agglutinata (Jacq.) Miers (= A. agglutinata)
circinalis (Sw.) Miers (= A. agglutinata)
circinalis Sw. var *thomasiana* A. DC. (= A. agglutinata)
thomasiana (A. DC.) Miers
Echites
agglutinata Jacq. (= A. agglutinata)
circinalis Sw. (= A. agglutinata)
obtusifolia Sessé & Moç. (= A. agglutinata)
puntarenensis J.F. Morales (= A. caudata)
sanguinolenta Tussac (= A. agglutinata)
turbinata Woodson (= A. turbinata)
tuxtlensis Standl. (= A. tuxtlensis)
woodsoniana Monac. (= A. parviflora)
Haemadictyon
circinalis (Sw.) G. Don (= A. agglutinata)
nutans (Anders.) A. DC. var. *sanguinolenta* (Tussac) (= A. agglutinata)
Prestonia
agglutinata (Jacq.) Woodson (= A. agglutinata)
caudata Woodson (= A. caudata)
woodsoniana (Monac.) A.H. Gentry (= A. parviflora)

APPENDIX 3: INDEX TO EXSICCATAE

Alcorn, J., 2102 (5).
Allen, P., 1524 (4).
Alvarez, D., 401 (5)
Arvigo, R. et al., 536 (5)
Axelrod, F. & B. Axelrod, 3091 (1).
Bello, E. & E. Cruz, 5278 (3).
Breckon, G., 4994 (1); 5019 (1).
Breedlove, D., 25058 (4); 52441 (5); 52710 (5).
Cabrera, E. & H. Cabrera, 6885 (5).
Cabrera, E. et al., 2062 (5).
Calzada, J., 5866 (5).
Carnevali, G. & F. May, 4628 (5).
Croat, T., 268 (3).
D'Arcy, W., 292a (1).
Dwyer, J., 12613 (5).
Ekman, E., 2431 (1); 5131 (1).
Estrada, A. & A. Rodríguez, 283 (2)
Fernández, R., 3121 (5).
Flores, R., (5).
Friedrichsthal, 240 (1).

García, R. & G. Caminero, 3287 (1).
Gentle, P., 439 (5); 1022 (5); 6116 (5).
Gentry, A., 307 (52).
Gómez-L., J. et al., 12142 (4).
Gómez, L. et al., 23879 (3).
Hammel, B., 19760 (3).
Hammel, B. & M. Garita, 19306 (2).
Hazlett, D., s.n. (3).
Hernández, H., 488 (5).
Hinton, G., 5863 (3); 15325 (3).
Hinton, G. et al., 7589 (3).
Holm, R. & H. Iltis, 243 (2).
Janzen, D., 10148 (3).
Koch, et al., 77462 (3).
Kupper, W., 937 (2).
Linares, J. & C. Martínez, 1953 (5); 2728 (5).
Liogier, B., 16152 (1).
Lira, E. et al., 360^{a} (5).
Martínez, E., 8987 (5); 14303 (5); 14883 (5); 16205 (5); 18362 (5).
Martínez, E. & W. Stevens, 4369 (3); 4597 (3); 23940 (5).
Martínez, E. et al., 29893 (5).
Maya, S., 2336 (3).
Miller J. et al., 456 (3).
Molina, A., 485 (5); 6203 (4); 10996 (3); 22423 (5).
Morales, J. F., 3139 (3); 3161 (3); 6481 (3); 8242 (2).
Morales, J.F. & R. Abarca, 8810 (3).
Morales, J.F. & J.F. Corrales, 6033 (3).
Morales, J.F. & T. Quirós, 8241 (3).
Moreno, P., 16081 (2); 18888 (2), 19664 (2); 22179 (2).
Neil, D., 619 (3); 2488 (3).
Nelson, E., 3080 (5).
Oersted, A., 15544 (4).
Opler, P., 1567 (3).
Pascual, A., 150 (5).
Pittier, H., 14035 (4).
Poveda, L. & V. Castro, 3926 (2).
Purpus, C., 6825 (5).
Renderos, M., 378 (5).
Robleto, W., 199 (2); 396 (3); 537 (3); 912 (2); 1218 (3); 1611 (3); 1701 (2).
Rohr, J., 93 (1).
Rosales, J., 544 (5); 702 (5); 785 (5).
Ross, R. & D. Meletische, 253 (1).
Sandoval, E. & M. Sandoval, 27 (5).
Sessé y Lacasta, M. & J. Moçiño. 5075 (1); 5068 (3).
Shilom, 7306 (5).
Sintenis, P., 2457 (1).
Soto J. & G. Silva, 4355 (3).
Standley, P., 74562 (3).
Stevens, D., 6106 (3); 22965 (3).
Steyermark, P., 51307 (5).
Swartz, O., 265 (1).
Taylor, C. & R. Gereau, 10493 (1).
Téllez, O., 8126 (5).
Tonduz, A., 2147 (4); 13940 (2).
Urban, I., 3565 (1).
Villacorta, R. & M. Méndez, 2181 (2).
Wagner, R., 1690 (1).
White, 6 (4).
Williams, J., 96-88 (3).
Woodson, R. et al., 988 (4).
Zanoni, T. et al., 47051 (1).

ACKNOWLEDGMENTS

We wish to thank the curators of A, B, BM, BR, BRIT, C, CAS, CGE, CICY, CIIDIR, CIMI, CM, COL, CR, DUKE, EAP, ENCB, F, FI, FI-W, G, GH, HAL, HBG, HUA, IEB, JAUM, JEPS, K, LAGU, LD, LE, M, MA, MEDEL, MEXU, MICH, MO, NY, O, P, PMA, TRIN, TEX, U, UC, UPS, US, USF, USJ, UVAL, W, WAG, WIS, XAL for providing specimens for examination. The senior author thanks Jorge León, for giving access to original references in his personal library. The second author thanks Mary Endress and the researches at the Plant Resources Center at the University of Texas in Austin. This research was financed in part by the Netherlands Development Agency (NEDA) through the project Development of Biodiversity Knowledge and Sustainable Use in Costa Rica conducted by the National Biodiversity Institute of Costa Rica (INBio). This research was also possible thanks to the Cooperation Agreement between the Ministry of Environment

and Energy (MINAE) and INBio in order to accomplish the National Biodiversity Inventory.

REFERENCES

Alcorn, J.B. 1984. Huasteca Mayan ethnobtoany. University of Texas press, Austin.

Endress, M.E. and Bruyns P. 2000. A revised classification of the Apocynaceae s.l. The Botanical Rev. 66:1–56.

Gentry, A.H. 1983. A new combination for a problematic Central American Apocynaceae. Ann. Missouri Bot. Gard. 70:205–206.

Monachino, J. 1959. A new *Echites* from Mexico. Bull. Torrey Bot. Club 86:245–247.

Morales, J.F. 1997. A reevaluation of *Echites* and *Prestonia* section *Coalitae* (Apocynaceae). Brittonia 49:328–336.

Williams, J.K. 2002. A further evaluation of *Echites* sect. Yucatanense (Apocynaceae) with additional notes on the genus. Brittonia 54:310–317.

Williams, J.K. 2004. Polyphyly of *Echites* (Apocynaceae: Echiteae) based on a morphological cladistic analysis. Sida 21:117–131.

Woodson, R.E. 1936. Studies in the Apocynaceae IV. The American Genera of Echitoideae. Ann. Missouri Bot. Gard. 23:169–438.

Woodson, R.E. 1938. (Asclepiadales) Apocynaceae. In: J.H. Barnhart, ed. N. Amer. Fl. 29(2):179–185. New York.

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES IV: NOTAS TAXONÓMICAS EN *PRESTONIA* (APOCYNOIDEAE, *ECHITEAE*) CON UNA NUEVA ESPECIE DE ECUADOR

J. Francisco Morales

Instituto Nacional de Biodiversidad (INBio)
Apartado Postal 22-3100
Santo Domingo, Heredia, COSTA RICA

RESUMEN

Se discute la utilidad taxonómica de los sépalos para delimitación de secciones dentro del género *Prestonia*. Asimismo, se describe e ilustra una nueva especie de Ecuador, *P. amabilis*, muy inusual por su cáliz campanulado.

ABSTRACT

The taxonomic use of the sepals features for intergeneric delimitation in *Prestonia* is discussed. *Prestonia amabilis* (Apocynaceae, Apocynoideae), a new species from Ecuador, is described and illustrated.

Durante la preparación de una monografía de *Prestonia* (Apocynaceae, Apocynoideae), un total de 55 especies han sido reconocidas, distribuidas desde México al N de Argentina y las Islas del Caribe (Morales, en prep.). Dado el alto número de especies de *Prestonia* originalmente descritas basadas en una sola colección (Woodson 1936), y la alta sinonimia prevaleciente en otros géneros, donde se han presentado situaciones similares (Morales 1999), ha sido necesaria la evaluación de varios caracteres tradicionalmente usados para separar especies (e.g., grado de laceración de los coléteres de los sépalos y de los nectarios o disco nectarífero), lo cual ha comprobado que algunos de ellos son muy inestables y no deben de ser usados como el carácter principal para el reconocimiento a nivel específico, tal y como fue demostrado por Morales (1997 b) para las especies mesoamericanas de la sección Tomentosae. Esto ha conllevado a la sinonimización de varios nombres. Las medidas aquí mencionadas están basadas en los resultados obtenidos durante la preparación de una nueva monografía del género.

La forma y consistencia de los sépalos fue un carácter clave usado por Woodson para separar secciones dentro de *Prestonia*. Sin embargo, dado que la utilidad de estos caracteres es cuestionable (para separar secciones) y junto con el descubrimiento de una nueva especie de Ecuador, con un cáliz bastante inusual, una explicación se brinda a continuación. Los sépalos en *Prestonia* son siempre libres longitudinalmente, estando únicamente ligados en forma basal al hipantio. Los sépalos pueden ser conspicuamente foliáceos o subfoliáceos (e.g., *P. portobellensis* (Beurl.) Woodson) a escariosos (e.g., *P. quinquangularis* (Jacq.) Spreng.). Woodson (1936) distinguió tres secciones basado en la consistencia de los sépalos. De esta manera, él separó la sección *Acutifoliae* de las secciones *Annulares* y *Tomentosae* por sus sépalos pequeños e inconspicuos, escariosos o levemente foliáceos y usualmente reflexos apicalmente (vs. grandes y conspicuos, foliáceos a subfoliáceos y no reflexos apicalmente). Sin embargo, estos caracteres no son totalmente confiables para la separación de estas secciones y la búsqueda de otros más consistentes debe prevalecer, debido a que son subjetivos y están supeditados al criterio de cada taxónomo. Primero, en las especies incluidas en la sección *Acutifoliae*, los sépalos no son consistentemente reflexos en el ápice, pudiéndose encontrar ápices reflexos o no reflexos. Luego, los términos foliáceo, subfoliáceo, o levemente foliáceo son totalmente subjetivos, si no son acompañados de medidas y otros caracteres adicionales, que definan claramente el concepto del monografiador. Por otro lado, algunas especies incluidas en las sección *Annulares* (e.g., *P. longifolia* (Sessé & Moc.) J. F. Morales) tienen sépalos escariosos a muy levemente subfoliáceos, de 3–6(–8) × 2–3 mm, no reflexos apicalmente, los cuales no difieren en gran medida de aquellos de otras especies incluidas en la sección *Acutifoliae* (e.g., *P. lagoensis* (Müll. Arg.) Woodson), con sépalos de 3–6 × 1.5–2 mm, reflexos o no reflexos apicalmente. Por lo tanto, se sugiere utilizar otros caracteres más consistentes, como el tipo y densidad del indumento de flores y frutos, presencia o ausencia de los lóbulos coronales en el interior de la corola, nivel de inserción de los lóbulos coronales (apicalmente exsertos o levemente incluidos, con los ápices casi al mismo nivel de la corona anular vs. profundamente incluidos, con los ápices por debajo de los ápices de las anteras) y textura de sépalos y hojas. Sin embargo, la definición definitiva de las secciones serán comentadas con detalle en la próxima monografía del género.

La última monografía del género *Prestonia* (Apocynaceae, Apocynoideae) fue hecha por Woodson (1936), quien aceptó 61 especies. Cinco especies fueron reportadas en ese entonces para Ecuador, *P. mollis* Kunth, *P. parvifolia* K. Schum. ex Woodson, *P. peregrina* Woodson, *P. rotundifolia* K. Schum. ex Woodson y *P. schumanniana* Woodson, cuatro de ellas endémicas y conocidas por menos de dos colecciones, con solo *P. mollis* reportada también en Perú. Desde 1936, el número de expediciones en Ecuador se han incrementado en forma notable, sobre todo en los últimos 30 años, lo que producido un aumento considerable en el número de colecciones de Apocynaceae disponibles hoy en día. Estos esfuerzos resultaron en la descripción de nuevas especies, algunas de ellas muy raras y endémicas (Morales 1997 a). El proceso de revisión de especímenes para una nueva monografía de *Prestonia* ha llevador a la necesidad de sinonimizar algunos taxa y elevado el número de especies conocidas para Ecuador a 15 (dos de ellas aún sin describir) y llevado a la necesidad de sinonimizar algunos taxa.

Una de estas especies inéditas es muy notable por tener los sépalos connados basalmente, conformando una base campanulada, algo bastante inusual dentro del género y que no fue reportado por Woodson (1936). Especies con sépalos connados a lo largo del tercio o mitad basal son muy raras y solamente otros dos taxas tienen la misma característica, *P. haughtii* Woodson (incluyendo *P. macrophylla* Woodson) y *P. rotundifolia* K. Schum. ex Woodson. Estas tres especies están restringidas a lo largo de los Andes desde la Cordillera Occidental en Colombia, a través de Ecuador hasta el N de Perú y en forma general son conocidas por muy pocas colecciones. Por lo tanto, esta nueva especie es descrita a continuación.

Prestonia amabilis J.F. Morales, sp. nov. (**Fig. 1**). TIPO. ECUADOR. PASTAZA: Hacienda San Antonio de Baron von Humboldt, 2 km NE de Mera, 27 Feb–19 Mar 1985 (fl, fr), *Neill et al.* 5975 (HOLOTIPO: INB; ISOTIPOS: MO, NY, USF, fotocopia en INB).

Suffruticosa volubilis, ramulis minutis puberulis maturitate sparseque puberulis vel glabratis; folia elliptica, 13–23 _ 6.5–13.5 cm, glabra, glabrata vel sparseque puberula, apice breviter acuminata, basi obtusa vel rotundata, petiolus 1–2 cm; inflorescentia corymbosa, lateralibus, bracteis 1–2 mm longis, calycis laciniis ovalis vel ovalis-elliptica, (10–)12–19 mm longis, minute puberulis, corolla salverformis, tubo extus glabro, 14–15 mm, lobis coronae inclusis vel paulo exsertis; folliculis 18–27.5 cm, glabratis.

Liana, ramitas diminutamente ferrugíneo-puberulentas cuando jóvenes, muy esparcidamente puberulentas a glabradas en la madurez, con secreción lechosa, inconspicuamente lenticeladas, coléteres interpeciolares inconspicuos, 0.5–1 mm de largo. Hojas: lámina 13–23 × 6.5–13.5 cm, elíptica, obtusa y abruptamente corta-acuminada o apiculada apicalmente, obtusa a redondeada basalmente, coriácea a subcoriácea, algunas veces algo revoluta marginalmente, glabra y usualmente brillante adaxialmente, inconspicuamente papilada-puberulenta a glabrada abaxialmente, venación secundaria y terciaria conspicuamente impresas, peciolo 1–2 cm. Inflorescencia corimbosa, axilar, usualmente más larga que las hojas adyacentes, con muchas flores, diminutamente y densa a esparcidamente ferrugíneo-puberulenta, pedúnculo 6.5–21 cm, pedicelos (1–) 1.7–2.8 cm, brácteas 1–2 × 0.5–1 mm, escariosas; base del cáliz conspicuamente campanulada, sépalos (10–)12–19 × (3–)4–6 mm, fusionados basalmente a lo largo de 1/3–1/2 de su longitud, coriáceos a subcoriáceos, angostamente ovados a angostamente ovado-elípticos, acuminados a cortamente acuminados, no reflexos apicalmente, diminuta y densamente ferrugíneo-puberulentos, raramente glabrados, foliáceos, coléteres 1–1.5 mm de largo, enteros, subenteros, o diminutamente erosos; corola hipocrateriforme, amarilla y moteada con rojo, glabra exteriormente, tubo 14–15 × 3–4 mm, recto, lóbulos coronales 1.5–2 mm, incluidos o apicalmente exsertos, corona anular entera, conspicua, lóbulos 9–11 × 7–9 mm, obovados; anteras 5 mm, glabras, los ápices conspicuamente exsertos, ovario 1–1.5 mm, glabro, cabeza estigmática ca. 1 mm, disco sobrepasando el ovario, usualmente profundamente y irregularmente pentalobado, eroso a algo lacerado. Folículos 18–27.5 × 0.8–1.2 cm, continuos a levemente moniliformes, esparcidamente lenticelados, glabrados; semillas 16–19 mm, glabras, la coma 3.5–4.8 cm, café oscuro.

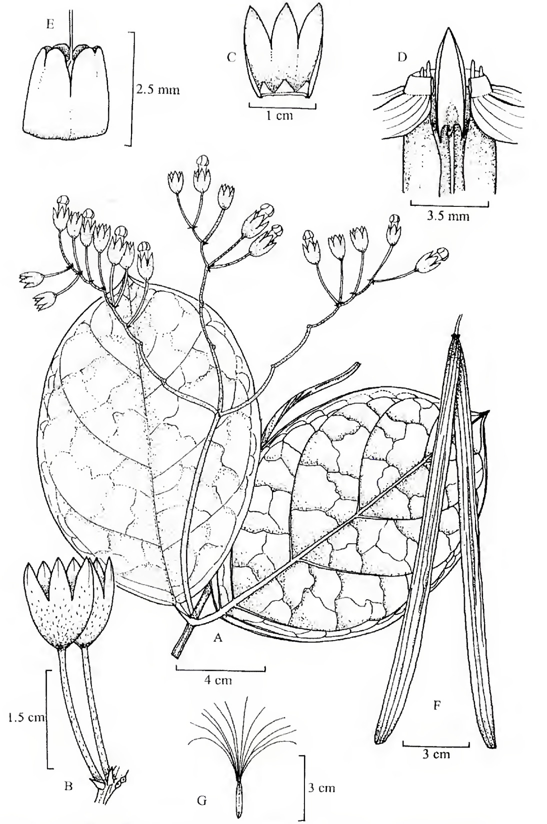


Fig. 1. *Prestania amabilis* (A-E de *Palacios 10102*, USF; F-G de *Brehm s.n.* (INB)). **A.** Ramita florífera. **B.** Cáliz, pedicelos, y brácteas. **C.** Cáliz abierto, mostrando la base cupuliforme y los sépalos fusionados. **D.** Tubo de la corola abierto, mostrando las anteras, corona anular, y lóbulos coronales apicalmente exsertos. **E.** Disco. **F.** Folículos. **G.** Semilla.

Distribución, hábitat, y ecología.—Restringida por el momento a Ecuador, donde crece en bosques muy húmedos y áreas de vegetación perturbada, en elevaciones de 300–1100 m. Especímenes con flores fueron colectados de Febrero hasta Junio, y de Agosto hasta Diciembre. Especímenes con frutos fueron colectados en Febrero, Marzo, y Noviembre.

Paratipos. **ECUADOR. Morona-Santiago:** Limón Indanza, cuenca del río Coangos, río Tsuirin, Oct 1999 (fl), *Ronquillo et al. 1018* (MO). **Napo:** carretera Coca-Loreto, cerca a río Pinguillo, 20 Oct 1988 (fl), *Cerón et al. 5331* (MO, USF); Shinguipino, entre ríos Napo y Tena, 30 Sep 1960 (fl), *Grubb et al. 1688* (K, NY); Tena, carretera Campococha-Chontapunta, 23 Ago 1997 (fl), *Nuñez & Tapuy 616* (MO); NNO de Coca, río Huashito, 27 Oct 1982 (fl), *Pennington 10637* (K, QCA). **Pastaza:** Arajuno, campamentos 11-12, 15-20 Sep 1998 (fl), *Freire et al. 3433* (MO); Puyo, Santa Cecilia, Villano, 1 May 1992 (fl), *Palacios 10102* (MO, QCNE, USF); Puyo, Los Vencedores, carretera Puyo-Macas, 8 Jun 1996 (fl), *Soejarto et al. 9651* (F); Pozo Villano, 3 Dic 1991 (fl), *Tipaz et al. 426* (MO, QCNE). **Zamora-Chinchipe:** Parque Nacional Podocarpus, 4 km al S de Zamora, 30 Nov 2000 (fl, fr), *Brehm s.n.* (INB); Nangaritza, Miazi, río Nangaritza, 28 Jul 1993 (st), *Gentry 80568* (MO).

Prestonia amabilis es similar a *P. haughtii* (incluyendo *P. macrophylla* Woodson) por tener sus sépalos connados basalmente y formando una conspicua base campanulada, pero difiere por su inflorescencia repetidamente ramificada, sépalos diminutamente ferrugíneo-puberulentos (vs. glabros o glabrados), anteras apicalmente exsertas (vs. incluidas) y lóbulos coronales levemente exsertos o al menos al nivel de la corona anular (vs. profundamente incluidos). Esta especie esta además algo relacionada a *P. annularis*, pero difiere por sus inflorescencias más grandes, sépalos ferrugíneo-puberulentos, base del cáliz campanulada, y frutos más gruesos y algo leñosos.

AGRADECIMIENTOS

Quiero agradecer a los herbarios K, MO, NY, QCA, US, USF por el envío de material en préstamo. Asimismo, se agradece al personal del Herbario de la Universidad de Antioquia (HUA), por las facilidades brindadas durante mis visitas a Medellín, Colombia. También deseo agradecer a Gunnar Brehm y Juergen Homeier, quienes suministraron fotografías, material preservado y duplicados de *Prestonia amabilis*.

REFERENCIAS

Morales, J.F. 1997 a. A synopsis of the genus *Allomarkgrafia* (Apocynaceae). Brittonia 49: 337–345.

Morales, J.F. 1997 b. A synopsis of the genus *Prestonia* section *Tomentosae* in Mesoamerica. Novon 7:59–66.

Morales, J.F. 1999. A synopsis of the genus *Odontadenia* (Apocynaceae), series of revisions of Apocynaceae XLV. Bull. Jard. Bot. Belg. 67:381–477.

Woodson, R.E. 1936. Studies in the Apocynaceae. IV. The American genera of Echitoideae. Ann. Missouri Bot. Gard. 23:276–436.

BOOK NOTICE

PAMELA A. MATSON, ASHOK GADGIL, and DANIEL M. KAMMEN (eds). 2003. **Annual Review of Environment and Resources: Volume 28, 2003**. (ISBN 0-8243-2328-9, hbk; ISSN 1543-5938). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $185.00 (USA), $190.00 (Int'l.), 648 pp., 6" × 9".

Contents of Volume 28 of *Annual Review of Environment and Resources*:

I. Earth's Life Support Systems
- Climate Change, Climate Modes, and Climate Impacts
- The Cleansing Capacity of the Atmosphere
- Evaluating Uncertainties in Regional Photochemical Air Quality Modeling
- Transport of Energy, Information, and Material Through the Biosphere
- Global State of Biodiversity and Loss
- Patterns and Mechanisms of the Forest Carbon Cycle

II. Human Use of Environment and Resources
- Dynamics of Land-Use and Land-Cover Change in Tropical Regions
- Urban Centers: An Assessment of Sustainability
- Water Use
- Meeting Cereal Demand While Protecting Natural Resources and Improving Environmental Quality
- State of the World's Fisheries
- Green Chemistry and Engineering: Drivers, Metrics, and Reduction to Practice

III. Management and Human Dimensions
- International Environmental Agreements: A Survey of Their Features, Formation, and Effects
- Tracking Multiple Pathways of Human Exposure to Persistent Multimedia Pollutants: Regional, Continental, and Global Scale Models
- Geographic Information Science and Systems for Environmental Management
- The Role of Carbon Cycle Observations and Knowledge in Carbon Management
- Characterizing and Measuring Sustainable Development
- Just Oil? The Distribution of Environmental and Social Impacts of Oil Production and Consumption

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES V: UNA NUEVA ESPECIE, NUEVOS REPORTES Y NUEVA SINONIMIA EN LAS APOCYNACEAE DE BOLIVIA

J. Francisco Morales

Instituto Nacional de Biodiversidad
Apartado 22-3100
Santo Domingo, Heredia, COSTA RICA

Alfredo Fuentes

Herbario del Oriente (USZ)
Museo de Historia Natural Noel Kempff Mercado
Universidad Autónoma Gabriel René Moreno
Casilla 2489, Santa Cruz, BOLIVIA

RESUMEN

Se describe e ilustra una nueva especie del género *Prestonia*, y sus relaciones con taxas relacionados son discutidas. Se brinda un total de 13 nuevas citas de Apocynaceae para Bolivia y se proponen nuevas sinonimias en los géneros *Himatanthus*, *Prestonia*, y *Tabernaemontana*.

ABSTRACT

A new species of *Prestonia* is described and illustrated, and its relationships with related taxa are discussed. In addition, 13 new records of Apocynaceae (subfamily Apocynoideae) are reported for Bolivia and new synonymy on *Himatanthus*, *Prestonia*, and *Tabernaemontana* are proposed

Bolivia es uno de los países menos explorados desde el punto de vista botánico en América del Sur. Hasta la fecha, no se ha realizado ningún tratamiento integral para su flora y prácticamente, la única referencia disponible es el trabajo de Foster (1958), el cual consiste en un catálogo basado en la información de trabajos monográficos previos. Al igual que casi todo el resto de la flora, no existen tratamientos para la familia Apocynaceae (subfamilia Apocynoideae) y las únicas referencias parciales son las monografías de varios géneros (e.g., Monachino 1943, 1945a; Morales 1999, 2002; Woodson 1933, 1936). El incremento de la actividad botánica en los últimos 20 años en el país, han provocado un notable aumento de nuevos reportes y novedades en la flora en general (e.g., Al-Shehbaz 1999; Fuentes 1998; Justiniano y Toledo 2001; Moraes 1996; Navarro 1997; Zuloaga et al. 1993). Como parte del proceso de elaboración de las Apocynaceae para el Catálogo de las Plantas Vasculares de Bolivia, una serie de novedades taxonómicas han sido encontradas. Estas incluyen géneros y especies anteriormente no citados (e.g., *Lacmellea*, *Stipecoma*), nuevas sinonimias (e.g., *Himatanthus*, *Prestonia*) y una nueva especie de *Prestonia*. Para el caso de nuevos reportes, solo se cita un especimen representativo por Departamento, y cuando el caso lo amerita, se brindan comentarios adicionales para cada especie o género. Asimismo, solo se citan géneros o especies que no hayan sido reportados anteriormente en el checklist de Foster (1958) o en los trabajos de Chávez de Michel (1993), Ezcurra (1981, 1984), Fallen (1983), Gensel (1969), Hansen (1985),

SIDA 21(1): 165–174. 2004

Killeen et al. (1998), Leeuwenberg (1994), Marcondes-Ferreira (1988), Meyer (1955), Monachino (1943, 1945a, 1945 b), Morales (1997, 1999, 2002, 2003), Plumel (1991), Rao (1956), Sakane y Sheperd (1987) y Woodson (1933, 1935, 1936, 1951). Para la determinación de la nueva sinonimia en *Prestonia*, todas las colecciones tipo fueron examinadas (a menos que se indique lo contrario) como parte del trabajo monográfico realizado por el primer autor para la serie Flora Neotrópica. Asimismo, las medidas de *P. lagoensis* (Müll. Arg.) Woodson y *Mandevilla scabra* (Hoffmans. ex Roem. & Schult.) K. Schum. utilizadas como referencia de comparación en la descripción de *P. boliviana* y *M. symphitocarpa*, fueron extraídas de las monografías de *Prestonia* y *Mandevilla* (Morales, en prep.), las cuales pueden diferir en alguna forma de los trabajos de Woodson (1933, 1936).

NUEVA ESPECIE

Prestonia boliviana J.F. Morales & A. Fuentes, sp. nov. (**Fig. 1**). TIPO: BOLIVIA. CHUQUISACA: valle del Río Limón, entre Padilla y Monteagudo, 13 Feb 1994 (fl), *Wood 7970* (HOLOTIPO: LPB; ISOTIPOS: INB, K).

Suffruticosa volubilis, ramulis glabris. Folia late ovalia, 8–9 × 4–5 cm, glabra, apice acuminata, basi obtusa vel rotundata, petiolus 1.5–2.5 cm. Inflorescentia racemosa, lateralibus, bracteis 1.5–2 mm longis, scariaceis, calycis laciniis anguste ovatis, 2.5–3 mm longis, glabris, corola salverformis, tubo extus glabro, 8–9 mm, appendicibus lobis coronae paulo exsertis. Folliculis ignotis.

Liana, ramitas glabras, con secreción acuosa, coléteres interpeciolares inconspicuos, menos de 0.5 mm de largo. Hojas: lámina 8–9 × 4–5 cm, anchamente ovada, acuminada apicalmente, obtusa a redondeada o cordada basalmente, delicadamente membranácea, no revoluta marginalmente, glabra, venas secundarias levemente impresas, venación terciaria casi inconspicua o inconspicua, peciolo 1.5–2.5 cm. Inflorescencia racemosa o corimbosa y dicotómicamente ramificada, pero ramificándose solo una vez cerca de la base y pareciendo subracemosa, axilar, usualmente más larga que las hojas adyacentes, laxa, con muchas flores, glabra a glabrada, pedúnculo 5–6.5 cm, pedicelos 2–3 cm, brácteas 1.5–2 × 0.5–1 mm, escariosas; base del cáliz corta e inconspicua, no campanulada, sépalos 2.5–3 × 1 mm, libres a lo largo de su entera longitud, delicadamente membranáceos, muy angostamente ovados, acuminados, los ápices algo reflexos apicalmente, glabros a glabrados, escariosos, coléteres 0.5–1 mm de largo, muy diminuta e inconspicuamente lacerados; corola hipocrateriforme, crema, glabra exteriormente, tubo 8–9 × 2.5 mm, recto, lóbulos coronales 2.5–3 mm, apicalmente exsertos, corona anular entera, conspicua, lóbulos 8–10 × 5 mm, obovados; anteras 4 mm, glabras, los ápices algo exsertos, ovario ca. 1.5 mm, glabro, cabeza estigmática ca. 2 mm, nectarios ca. 1 mm de largo, enteros a subenteros. Folículos desconocidos.

Distribución, hábitat y ecología. Endémica al departamento de Chuquisaca, Bolivia, donde crece en bosques estacionalmente húmedos y áreas de vegetación disturbada asociada de la formación Boliviano-Tucumana, en elevaciones

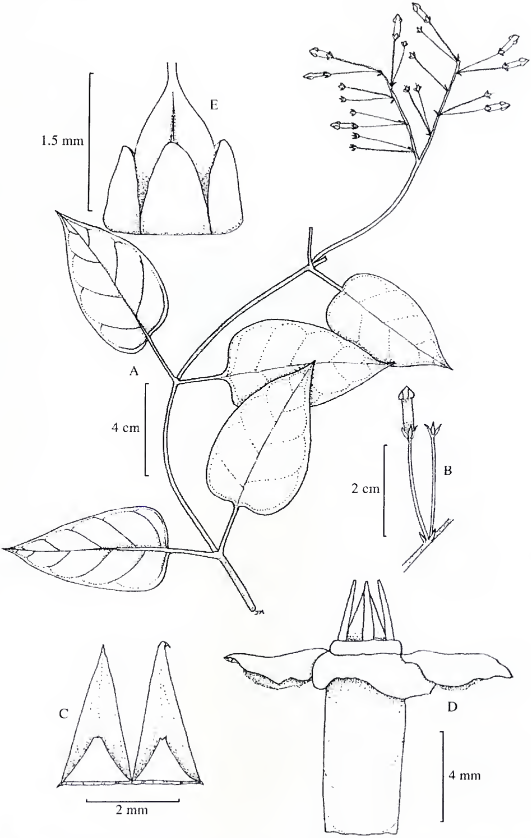


Fig. 1 *Prestonia boliviana* (*Wood 7970*, LPB). **A.** Ramita florífera. **B.** Cáliz, pedicelos, y brácteas. **C.** Sépalos y coléteres, vista adaxial. **D.** Corola, mostrando los lóbulos coronales y anteras apicalmente exsertas. **E.** Nectarios y ovario.

entre 1300–1500 m. Especímenes con flores han sido recolectados en Febrero y Mayo.

Paratipos. BOLIVIA. Chuquisaca: entre Padilla y Monteagudo, río Marcani, 1 Jun 2003 (fl), *Morales 9326* (LPB).

Prestonia boliviana pertenece a la sección *Acutifoliae* por sus flores glabras exteriormente y sépalos pequeños e inconspicuos (Woodson 1936). Esta especie está cercanamente relacionada con *P. lagoensis* (Müll. Arg.) Woodson, ya que vegetativamente son muy similares (e.g., textura y forma de las hojas, estructura de la inflorescencia) y ambas tienen flores con los lóbulos coronales conspicuamente exsertos apicalmente. Sin embargo, *P. boliviana* es fácilmente separada por sus flores con los sépalos 2.5–3 × 1 mm (vs. 3–6 × 1.5–2 mm), tubo de la corola más pequeño, 8–9 mm de largo, (vs. 13–20 mm) y pedicelos más largos, con 20–30 mm de longitud [vs. 8–14(–18) mm].

NUEVOS REPORTES

1. Couma macrocarpa Barb. Rodr., Vellozia (ed. 2) 1:32, pl. 1, f. b. 1891. Solo hemos visto un especimen estéril, pero que sin duda pertenece a esta especie. Debido a la escasez de colecciones suramericanas en la primera mitad del siglo XX, no fue reportada para Bolivia por Monachino (1943). El género *Couma* se reconoce fácilmente por sus hojas verticiladas, pecíolos con coléteres basales y frutos bayas carnosas, usualmente comestibles. El género está ampliamente distribuido en toda la cuenca amazónica, siendo *C. macrocarpa* la especie más común.

Especímenes representativos examinados: **BOLIVIA. Pando:** Federico Román, Río Negro, tributario del Abuná, *Vargas et al. 988* (LPB, USZ).

2. Forsteronia affinis Müll. Arg., Fl. Bras. 6(1):100, pl. 30. 1860. *Fosteronia* es un género mayormente Suramericano, con unas pocas especies presentes en las Islas del Caribe, México y Mesoamérica. Ampliamente distribuida en Colombia, Venezuela, Perú y Brasil, esta especie era desconocida en Bolivia (Hansen 1985), pero recientes colecciones en el Departamento de Santa Cruz, han confirmado su presencia en este país.

Especímenes representativos examinados: **BOLIVIA. Santa Cruz:** Parque Nacional Noel Kempff Mercardo, Campamento Las Gamas, *Foster et al. 476* (MO, USF, USZ).

3. Forsteronia australis Müll. Arg., Fl. Bras. 6(1):103. 1860. Esta especie es bastante rara y anteriormente era conocida solo en Brasil, donde se reportaba de localidades aisladas en los estados de Bahia, Ceará, Goiás, Minas Gerais, Rio de Janeiro y Sao Paulo (Hansen 1985). En Bolivia se conoce solamente en el departamento de Santa Cruz, de los bosques semideciduos chiquitanos.

Especímenes representativos examinados. **BOLIVIA. Santa Cruz:** Florida, Quebrada La Coca, al SO de Bermejo, *Nee 44409* (MO, NY, USF, USZ).

4. Forsteronia graciloides Woodson, Ann. Missouri Bot. Gard. 22:163–165. 1935.

Aunque anteriormente fue conocida solo de Perú y una colección disyunta de Colombia (Hansen 1985), especímenes adicionales han ampliado su rango de extensión a Ecuador y Bolivia, donde es reportada por primera vez. Esta especie se puede reconocer con facilidad por el relativamente pequeño tamaño de sus hojas, con las láminas obovadas y la presencia de domacios pubescentes a lo largo del nervio central abaxialmente.

Especímenes representativos examinados: **BOLIVIA. La Paz:** Abel Iturralde, Parque Nacional Maididi, río Tuichi, arroyo Rudidi, *Paniagua et al. 5099* (LPB, MO).

5. Galactophora calycina (Huber ex Ducke) Woodson, Ann. Missouri Bot. Gard. 19:50. 1932. *Galactophora* es un género de hierbas erectas típico de zonas abiertas y sabanas, restringido a Suramérica, donde ocurre desde la Amazonía colombiana hasta Brasil y Bolivia. Anteriormente era conocida solo en Colombia, Venezuela y Brasil. Aunque históricamente *G. calycina* se ha considerado como una especie distinta de *G. crassifolia* (Müll. Arg.) Woodson (Woodson 1936), es probable que representen una misma entidad, dado que la única diferencia permisible entre ambas es la presencia o ausencia de la pubescencia en hojas e inflorescencias y existen especímenes con un amplio grado de variación en relación a la densidad del indumento, situación que se repite en otros géneros de la tribus *Apocyneae* (e.g., *Odontadenia*) y *Mesechiteae* (e.g., *Mandevilla*). En todo caso, ambas especies son exactamente iguales en el resto de caracteres morfológicos.

Especímenes representativos examinados: **BOLIVIA. La Paz:** Iturralde, Luisita, *Haase 827* (LPB). **Santa Cruz:** Velasco, entre Florida y Bella Vista, *Guillén et al. 2545* (INB, MO, SCZ).

6. Lacmellea aculeata (Ducke) Monachino, Lloydia 7:292. 1944 [1945]. El género *Lacmellea* está confinado mayormente a Sur América, donde la mayor cantidad de especies están restringidas a la cuenca amazónica, aunque si bien, unas pocas especies están presentes en Mesoamérica (Morales 1998). La última monografía fue hecha por Monachino (1944), quién entonces no reportó ninguna especie para Bolivia. *Lacmellea aculeata* está ampliamente distribuida en la cuenca baja amazónica, desde Colombia y las Guyanas hasta Brasil y Bolivia. Una especie adicional, probablemente no descrita y cercanamente relacionada con este taxón, con hojas densamente pubescentes abaxialmente y conocida solo por colecciones con frutos del Departamento de Pando, se encuentra en Bolivia.

Especímenes representativos examinados: **BOLIVIA. Pando:** Rio Madeira, cerca de Abuna, *Prance et al. 8358* (NY, US).

7. Lacmellea arborescens (Müll. Arg.) Markgr. Notizbl. Bot. Gart. Berlin-Dahlem 15:626. 1941. La revisión de *Lacmellea* de Monachino (1944) reportó esta especie como endémica a Brasil, pero el proceso de elaboración de una nueva monografía del género (Morales, en prep.), ha extendido su rango hasta Perú y Bolivia. Esta especie está cercanamente relacionada a *L. ramosissima* (Müll. Arg.) Markgr. pero puede ser separada por sus hojas con nervios secundarios separados mayormente por 2 a 4 mm, lóbulos de la corola de 1–1.5 mm de longitud y frutos globosos a subglobosos, de 9 a 12 mm de diámetro. Otras especies relacionados a estos taxones por Monachino (1944), (e.g., *L. peruviana*) serán sinonimizadas en la próxima revisión del género (Morales, en prep.).

Especímenes representativos examinados: **BOLIVIA. Pando:** Federico Román, Río Abuná, Fortaleza, base naval Abuná, senda hacia la cachuela, *Vargas et al. 1066* (F, LPB, MO, USZ).

8. Mandevilla symphitocarpa (G. Meyer) Woodson, Ann. Missouri Bot. Gard. 19:70. 1932. Aunque originalmente fue conocida como restringida a las Guyanas y Trinidad (Woodson 1933), en el proceso de elaboración de una nueva monografía del género, se ha encontrado que *Mandevilla symphitocarpa* es una rara especie, distribuida ampliamente en toda la cuenca baja amazónica (Morales, en prep.). Este taxa puede ser confundida con la común *M. scabra* (Hoffmansegge ex Roemer & Schultes) K. Schumann, pero *M. symphitocarpa* se puede reconocer fácilmente por sus hojas, con la lámina foliar usualmente glabra (vs. variadamente pubescente a glabrada), flores con la parte inferior del tubo de la corola 4–5 mm de ancho (vs. 2–3 mm), folículos 25–32 cm de largo (vs. 9–23 cm) y semillas 13–16 mm de longitud (vs. 10–12 mm), con la coma 33–37 mm de largo (vs. 14–24 mm).

Especímenes representativos examinados: **BOLIVIA. Santa Cruz:** Serranía de Huanchaca, estación los Fierros, *Foster et al. 13733* (LPB, USZ).

9. Odontadenia anomala (Van Heurck & Müll. Arg.) J.F. Macbr., Field Mus. Nat. Hist., Bot. Ser. 11:35. 1931. Anteriormente reportada como endémica para Perú (Morales 1999), varias colecciones de esta especie fueron localizadas en varios herbarios bolivianos, lo que ahora amplia el rango de distribución hasta Bolivia. Una de las especies más distintivas en el género por sus hojas irregularmente verticiladas.

Especímenes representativos examinados. **BOLIVIA. Beni:** Vaca Diez, Río Beni, puerto de Florida, *Moraes 580* (LPB, USF). **Pando:** Puerto Candelaria, Río Madre de Dios, *Moraes 528* (LPB, MO, P, SI). **Santa Cruz:** Velasco, Campamento La Toledo, camino hacia Florida, *Guillén & Roca 2474* (USZ).

10. Prestonia lagoensis (Müll. Arg.) Woodson, Ann. Missouri Bot. Gard. 23:296. 1936. Esta especie fue conocida por mucho tiempo solo por la colección tipo, hecha por Warming en Lagoa Santa, Minas Gerais, Brasil. Sin embargo, con la futura sinonimización de *P. lindmanii* (Malme) Hoehne (Morales, en prep.), dentro de esta especie, su rango se extenderá notablemente. A pesar de ser relativamente común en Brasil y Paraguay, es conocida en Bolivia por menos de tres colecciones.

Especímenes representativos examinados: **BOLIVIA. Santa Cruz:** Velasco, Cerro Pelao, *Guillén & Surubi 1251* (MO, USZ).

11. Rauvolfia mollis S. Moore, Trans. Linn. Soc. London, Bot. Ser. 2, 4:393. 1895. *Rauvolfia mollis*, no reportada anteriormente para Bolivia (Rao 1956), es una especie cercanamente relacionada con *R. ligustrina* Willd. ex Roem. & Schult. y ambas especies pueden confundirse con facilidad, ya que los caracteres que las separan citados por Rao (1956) algunas veces tienden a traslaparse. En términos generales, *R. mollis* se reconoce de *R. ligustrina* por sus inflorescencias largamente pedunculadas y el indumento usualmente hirsuto de tallos e inflorescencias.

Especímenes representativos examinados: **BOLIVIA. Beni:** Mamoré, 104 km al N de Trinidad, camino a San Joaquín, *Moraes et al. 1521* (LPB). **Santa Cruz:** Velasco, San Juancito, 27 km al N de San Ignacio, *Seidel & Beck 379* (LPB, MO, SI).

12. Stipecoma peltigera (Stadelm.) Müll. Arg., Fl. Bras. 6(1):176. 1860. En la monografía de Woodson (1936), *Stipecoma* era conocido únicamente por menos de seis colecciones, de los estados de Bahia, Goiás, Minas Gerais en Brasil. Sin embargo, el incremento de la actividad botánica en dicho país en el último siglo ha incrementado notablemente el número de especímenes de esta especie. Anteriormente endémico para Brasil, es reportado por primera vez para Bolivia.

Especímenes representativos examinados: **BOLIVIA. Santa Cruz:** Chiquitos, La Mina, Motacuzal, Chochí, *Wood & Landivar 17548* (K, LPB).

13. Vinca major L., Sp. Pl. 1:209. 1753. Esta hierba de origen europeo ha sido introducida ampliamente en los trópicos y se puede encontrar en algunos sitios cercanos a la Paz creciendo escapada de cultivación.

Especímenes representativos examinados: **BOLIVIA. La Paz:** Murillo, Jardíon Botánico Municipal, *Solomon 15602* (LPB, MO).

NUEVA SINONIMIA

1. **Himatanthus sucuuba** (Spruce ex Müll. Arg.) Woodson, Ann. Missouri Bot. Gard. 25:198. 1938 [1937]. *Plumeria succuba* Spruce ex Müll. Arg., Fl. Bras. 6(1):40. 1860. TIPO: BRASIL. AMAZONAS: Manaus, Oct 1851 (fl), *Spruce 1848* (HOLOTIPO: K, ISOTIPOS: F, P).

Himatanthus tarapotensis (K. Schum. ex Markgr.) Plumel, Bradea 5(supl.):50. 1991. *Plumeria tarapotensis* K. Schum. ex Margr., Notizbl. Bot. Gart. Berlin-Dahlem 11: 339. 1932. TIPO: AMAZONAS: Remate dos Males, *Ducke 21607* (HOLOTIPO: RB; ISOTIPO: P).

El basiónimo de *Himatanthus tarapotensis* fue incluido anteriormente en la sinonimia de *H. succuba* por Woodson (1938), pero fue elevado al rango de especie por Plumel (1991). Sin embargo, las diferencias mencionadas por Plumel para distinguir ambas especies (hojas oblongas en *H. succuba* vs. hojas elípticas en *H. tarapotensis*) no son consistentes ni relevantes para mantener ambos taxas como entidades diferentes, pues corresponden a leves variantes morfológicas, sin ninguna discontinuidad evidente o aislada. Además, las colecciones tipo no difieren en el resto de caracteres morfológicos (e.g., inflorescencia, flores).

2. **Prestonia tomentosa** R. Br., Mem. Wern. Nat. Hist. Soc. 1:70. 1811. TIPO: BRASIL. RIO DE JANEIRO: Rio de Janeiro, s.d. (fl), *Banks 684* (HOLOTIPO: BM, foto en BM, INB, NY).

Prestonia cornutisepala Rusby, Mem. New York Bot. Gard. 7:329. 1927, **syn. nov.** *Prestonia cephalantha* Rusby, Mem. New York Bot. Gard. 7:330. 1927, **syn. nov.** Tipo: BOLIVIA. La Paz: Ixiamas, 17 Dic 1921 (fl), *Cardenas 1928* (holotipo: NY; isotipos: K, NY, n.v.).

Prestonia cornutisepala y *P. cephalanta* fueron descritas basadas en la misma colección tipo. *Prestonia cornutisepala*, descrita originalmente para Bolivia, no fue incluida en la monografía de Woodson (1936). La colección tipo no difiere en ninguna forma del tipo de *P. tomentosa*, y por lo tanto debe ser sinonimizada.

3. Tabernaemontana vanheurckii Müll. Arg., Observ. Bot. 168. 1871. Tipo: PERÚ. San Martín: cerca de Tarapoto, 1855–1856 (fl), *Spruce 4209* (holotipo: AWH; isotipos: BM, BP, BR, C, CGE, E, G, GH, GOET, K, L, MO, NY).

Tabernaemontana unguiculata Rusby Mem. New York Bot. Gard. 7:324. 1927, **syn. nov.** Tipo. BOLIVIA. La Paz: Huachi, cabeceras del Río Beni, 21 Ago 1921 (fl), *White 461* (holotipo: NY; isotipos: GH, US).

Tabernaemontana unguiculata fue incluida en la sinonimia de *T. heterophylla* por Leeuwenberg (1994). Sin embargo, despúes del estudio de las colecciones tipos de ambas especies, es claro que *T. unguiculata* es coespecífica con *T. vanheurckii* y por lo tanto, debe ser removida de la sinonimia de *T. heterophylla*, tal y como fue previamente propuesto por Killeen et al. (1993).

AGRADECIMIENTOS

Queremos agradecer a los curadores y directores de los siguientes herbarios B, BM, BOLV, C, CGE, E, F, G, G-DC, GH, K, M, MO, NY, LPB, P, US, USZ por el préstamo y uso de sus colecciones. El primer autor agradece al Missouri Botanical Garden (MO) por el generoso envio de material por regalo de identificación, así como a Stephan Beck (LPB) por la ayuda brindada en su estadía en Bolivia. También queremos agradecer a Mary Endress (Z), por ayudar a clarificar la identificación de las especies de *Malouetia* presentes en Bolivia.

REFERENCIAS

Al-Shehbaz, I. 1999. *Lepidium beckii* (Brassicaceae), a new species from Bolivia. Novon 9:5–7.

Chavez de Michel, R. 1993. Apocynaceae. En: T. Killeen, E. García, y S.G. Beck, eds. Guía de árboles de Bolivia. Herbario Nacional de Bolivia, La Paz, Bolivia y Missouri Botanical Garden, St Louis, USA.

Ezcurra, C. 1981. Revisión de las Apocináceas de Argentina. Darwiniana 23:367–484

Ezcurra, C. 1984. Apocynaceae. En: A.L. Cabrera, dir. Flora de la Provincia de Jujuy (Rep. Argentina) 8:84-117. Col. Cient. INTA, Buenos Aires.

Fallen, M.E. 1983. A taxonomic revision of *Condylocarpon* (Apocynaceae). Ann. Missouri Bot. Gard. 70:149–169.

Foster, R.B. 1958. A catalogue of the ferns and flowering plants of Bolivia. Contr. Gray Herb. 184:1–223

Fuentes, A. 1998. Contribución a la flora leñosa de los bosques de tierras bajas del este de Santa Cruz; adiciones a la guía de árboles de Bolivia. Revista Soc. Boliv. Bot. 2:46–59.

GENSEL, W.H. 1969. A revision of the genus *Thevetia* (Apocynaceae). Masters thesis. University of Connecticut [University Microfilms International, Ann. Arbor.]

GENTRY, A.H. 1974. Notes on Panamanian Apocynaceae. Ann. Missouri Bot. Gard. 61: 891–900.

GENTRY, A.H. 1984. New species and combinations in Apocynaceae from Peru and adjacent Amazonia. Ann. Missouri Bot. Gard. 71:1075–1081.

HANSEN. B. 1985. A monographic revision of *Forsteronia* (Apocynaceae). Ph.D. dissertation. University of South Florida. U.S.A. [University Microfilms International, Ann. Arbor.]

JUSTINIANO, J. & M. Toledo. 2001. Contribución de nuevos registros a la guía de árboles de Bolivia. Revista Soc. Boliv. Bot. 3:304–316

KILLEEN et al. 1998. Apéndice 1: Listado de plantas vasculares del Parque Nacional Noel Kempff Mercado y sus alrededores. En: T. Killeen y J. Schulenberg. A biological assessment of Parque Nacional Noel Kempff Mercado. RAP Working Papers 10. Washington DC.

LEEUWENBERG, A.J.M. 1994. A revision of *Tabernaemontana*. The New World species and *Stemmadenia*. The Royal Botanic Gardens, Kew, Richmond, England.

MARCONDES-FERREIRA, W. 1988. *Aspidosperma* Mart., nom. cons. (Apocynaceae): estudos taxonômicos. Ph D. thesis, Universidade Estadual de Campinas, Brasil.

MEYER, E. 1955. The genus *Vallesia*, a systematic study. Masters's Thesis, Washington University, St. Louis, Missouri. 1–46. [University Microfilms International, Ann. Arbor.]

MONACHINO, J. 1943. A revision of *Couma* and *Parahancornia* (Apocynaceae). Lloydia 6: 229–247.

MONACHINO, J. 1944. A revision of *Lacmellea* and the transfer of *Zschokkea* (Apocynaceae), Lloydia 7:275–302.

MONACHINO, J. 1945 a. A revision of *Hancornia* (Apocynaceae). Lilloa 11:19–48.

MONACHINO, J. 1945 b. A revision of *Macoubea* and the American species of *Landolphia* (Apocynaceae). Lloydia 8:291–317.

MORAES, M. 1996. Novelties of the genera *Parajubaea* and *Syagrus* (Palmae) from interandean valleys of Bolivia. Novon 6:85–92.

MORALES, J.F. 1997 [1998]. A synopsis of the genus *Macropharynx* (Apocynaceae). Rhodora 99:252–262.

MORALES, J.F. 1998. Synopsis del género *Lacmellea* (Apocynaceae) en Mesoamérica, con una nueva especie de Costa Rica. Novon 8:259–262.

MORALES, J.F. 1999. A synopsis of the genus *Odontadenia* (Apocynaceae) in A.J.M. Leeuwenberg (editor), Series of revisions of Apocynaceae XLV. Bull. Jard. Bot. Nat. Belg. 67:381–477.

MORALES, J.F. 2002. Studies in Neotropical Apocynaceae I: A revision of the genus *Laubertia* (Apocynaceae). Rhodora 104:170–185

MORALES, J.F. 2003. Studies in Neotropical Apocynaceae III: A revision of the genus *Secondatia*, with discussion of generic classification. Candollea 58:305–319.

NAVARRO, G. 1997. *Izozogia nellii* (Zygophyllaceae), nuevo género y especie del Gran Chaco de Santa Cruz. Novon 7:1–5.

Plumel, M. 1991. Le genre *Himatanthus* (Apocynaceae) Révision taxonomique. Bradea 5 (supl.):1–118.

Rao, A.S. 1956. A revision of *Rauvolfia* with particular reference to the American species. Ann. Missouri Bot. Gard. 43:253–355

Sakane, M. y G.J. Sheperd, 1987. Uma revisao do genero *Allamanda* L. (Apocynaceae). Rev. Brasil. Bot. 9:125–149.

Woodson, R.E. 1933. Studies in the Apocynaceae. IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 20:605–790.

Woodson, R.E. 1935. Studies in the Apocynaceae. IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 22:153–306.

Woodson, R.E. 1936. Studies in the Apocynaceae. IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 23:169–438.

Woodson, R.E. 1938. Studies in the Apocynaceae. VII. An evaluation of the genera *Plumeria* L. and *Himatanthus* Willd. Ann. Missouri Bot. Gard. 25:189–224.

Woodson, R.E. 1951. Studies in the Apocynaceae. VIII. An interim revision of the genus *Aspidosperma* Mart. & Zucc. Ann. Missouri Bot. Gard. 38:119–206.

Zuloaga, F., O. Morrone, y T. Killeen. 1993. *Gerritea*, a new genus of Paniceae (Poaceae: Panicoideae) from South America. Novon 3:213–219.

PSEUDOSTELLARIA OXYPHYLLA (CARYOPHYLLACEAE), A LONG OVERLOOKED SPECIES FROM NORTHERN IDAHO

Ronald L. Hartman

Rocky Mountain Herbarium
Department of Botany
University of Wyoming
Laramie, Wyoming 82071-3165, U.S.A.
rhartman@uwyo.edu

Richard K. Rabeler

University of Michigan Herbarium
3600 Varsity Drive
Ann Arbor, Michigan 48108-2287, U.S.A.
rabeler@umich.edu

ABSTRACT

Stellaria oxyphylla B.L. Rob. has been rediscovered in northern Idaho; a taxon rarely noted in the literature since its original description in 1898. Our study indicates that *Stellaria oxyphylla* is congeneric with *Pseudostellaria*, thus the new combination is provided. The three western North American members of *Pseudostellaria* have six capsular valves that dehisce by rolling back tightly 2 or 3 revolutions, forming a shallow dish, thus exposing the seeds. *Pseudostellaria oxyphylla* differs from *P. sierrae* Rabeler & R.L. Hartman and *P. jamesiana* (Torr.) W.A. Weber & R.L. Hartman in having internodal lines of hairs (0.5–5 mm wide) on the stems and branches of the inflorescences, but like the last taxon, the stems of *P. oxyphylla* are square in cross section. In general appearance, *P. oxyphylla* is most similar to *P. jamesiana*, the congener widely distributed in the western United States. *Pseudostellaria oxyphylla* and *P. sierrae* share a reduction in stamen number from 10 to 5 and seeds with elongate, rounded tubercles each with 5 to 12 or more minute stipitate glands or conical projections, respectively. *Pseudostellaria oxyphylla* is found along stream banks, often under and near conifers.

RESUMEN

Se ha redescubierto *Stellaria oxyphylla* B.L. Rob. en el norte de Idaho; un taxon raramente presente en la bibliografía desde que se describió en 1898. Nuestro estudio indica que *Stellaria oxyphylla* es congenérica con *Pseudostellaria*, por lo que se hace una nueva combinación. Los tres miembros del oeste de Estados Unidos de *Pseudostellaria* tienen seis valvas en su cápsula, que se abre enrollándose hacia atrás 2 ó 3 vueltas, formando un plato plano, exponiendo de este modo las semillas. *Pseudostellaria oxyphylla* difiere de *P. sierrae* Rabeler & R.L. Hartman y *P. jamesiana* (Torr.) W.A. Weber & R.L. Hartman por tener líneas de pelos internodales (0.5–5 mm de ancho) en los tallos y ramas de las inflorescencias, pero como el último taxon, los tallos de *P. oxyphylla* son cuadrados en sección transversal. En su aspecto general, *P. oxyphylla* es más semejante a *P. jamesiana*, el congénere ampliamente distribuido en el oeste de los Estados Unidos. *Pseudostellaria oxyphylla* y *P. sierrae* comparten una reducción en el número de estambres de 10 a 5, y semillas con tubérculos alargados y redondeados, cada uno con 5 a 12 o más glándulas estipitadas diminutas o proyecciones cónicas, respectivamente. *Pseudostellaria oxyphylla* se encuentra a lo largo de los bancos de torrentes, a menudo debajo y cerca de coníferas.

Stellaria oxyphylla B.L. Rob. has rarely appeared in the literature since it was described in 1898. Most recently, the taxon was relegated to synonymy under *Stellaria calycantha* (Ledeb.) Bong. as C.L. Hitchcock considered it "the robust extreme" of that taxon (Hitchcock et al. 1964). Rabeler (1986) considered *Stellaria oxyphylla* distinct from the *S. calycantha* complex and placed it tentatively under *Pseudostellaria jamesiana* (Torr.) W.A. Weber & R.L. Hartman. Our recent collaboration on the Caryophyllaceae for Flora of North America (Hartman & Rabeler in prep.), necessitates that we resolve the taxonomic status of this plant. Recent field work has provided new material and information on the geographic and ecological distribution of this taxon. Populations of *P. oxyphylla* appear restricted to stream margins in the St. Joe Mountains, Kootenai and Shoshone counties, Idaho, an area where *P. jamesiana* is absent. It likely represents a taxon of conservation concern but intensive field studies are warranted.

After studying the available material of *Stellaria oxyphylla* again, especially in light of our recent description of *Pseudostellaria sierrae* Rabeler & R.L. Hartman and its relationship to *P. jamesiana* (Rabeler & Hartman 2002), we conclude that these species are congeneric. We here make the following new combination, *Pseudostellaria oxyphylla* (B.L. Rob.) R.L. Hartman & Rabeler. The description, illustration (Fig. 1), and geographic and ecological notes supplement the only other published account of the species—the type description.

We investigated the relationship between the North American and Asian species of *Pseudostellaria* when *P. sierrae* was described (Rabeler & Hartman 2002); an overview of the genus can also be found in that article. At least one synapomorphy unites the western United States members of *Pseudostellaria*: six capsular valves that dehisce by rolling back tightly 2 or 3 revolutions, forming a shallow dish exposing the basal placentae with 1 or 2 seeds that may persist, at least briefly, prior to dispersal. In general appearance, *P. oxyphylla* is most similar to *P. jamesiana*. *Pseudostellaria oxyphylla* and *P. sierrae* share a reduction in stamen number from 10 to 5 and have seeds with elongate, rounded tubercles each having 5 to 12 minute stipitate glands or conical projections, respectively. All three taxa have rhizomes with occasional axillary buds, but unlike *P. oxyphylla*, *P. jamesiana* has tuberous thickenings of the rhizomes, while *P. sierrae* has tuberous, cigar-like thickened roots. Considerable excavation of the rhizomes of several plants of *P. oxyphylla* did not reveal additional perennating structures. Unfortunately, very few fully mature seeds are preserved for these taxa on herbarium specimens; this is especially true for *P. jamesiana*. Unlike *P. sierrae* (northern California) and *P. jamesiana* (widespread), with geographical ranges that overlap in part, *P. oxyphylla* appears to be disjunct from the latter taxon.

Pseudostellaria oxyphylla (B.L. Rob.) R.L. Hartman & Rabeler, comb. nov. (**Fig. 1**). BASIONYM: *Stellaria oxyphylla* B.L. Rob., Bot. Gaz. (Crawfordsville) 25:165, pl. 13, fig. 5, 1898. *Alsine oxyphylla* (B.L. Rob.) A. Heller, Cat. N. Amer. pl., ed. 2, p. 4. 1900. TYPE: U.S.A. IDAHO. KOOTENAI CO.: on St. Joseph's River [?], Wies[s]ner's Peak, *Sandberg, MacDougal, and Heller 608*, 8 Jul 1892 (fl), 1,800 m (HOLOTYPE: GH!; ISOTYPES: CAS!, NY!, PH!, POM!, US!).

Perennial, mostly glabrous herb, erect to sprawling, 20–25 cm tall, with stems arising singly, at varying intervals, along rhizomes. Roots vertical to spreading, filiform, 1–8 cm long or more; rhizomes often extensive, branched, whitish to

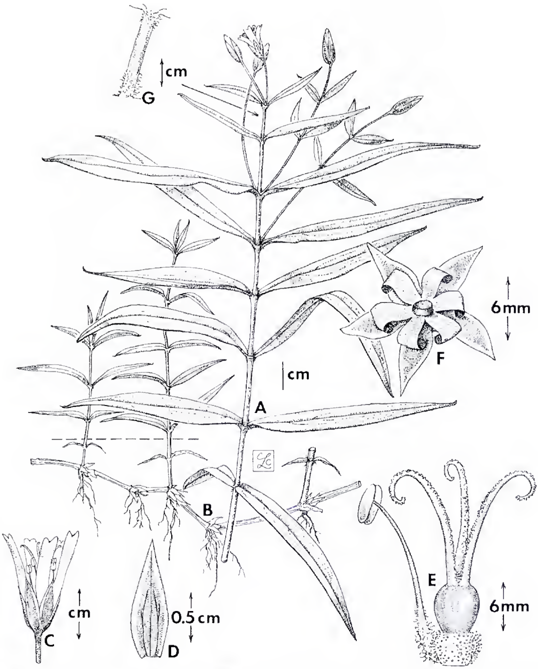


Fig. 1. *Pseudostellaria oxyphylla.* **A.** and **B.**, habit, the stem in A. detached from the base with rhizome, to the right in B. **C.** Flower. **D.** Sepal. **E.** Gynoecium with one stamen attached. **F.** Capsule, dehisced, with subtending calyx. **G.** Upper internode, side opposite the internodal line of pubescence.

tan, square in cross section to rounded with age, 0.5–1 mm in diameter, shiny, internodes 0.1–2 cm long or more, when internodes contracted achlorophyllous bracts often dense, overlapping, axillary buds 2-3 mm long. Stems mostly simple, square in cross section, internodes 1–5 cm long or more below, 1–2.5 cm long in inflorescence, glabrous except for a dense, internodal line of pubescence, 0.5–5 mm wide, trichomes straight to curly, most recurved, uniseriate of 5–9 elongate cells (possibly somewhat glutinous as evidenced by debris adhering to older material). Leaves opposite, sessile, the primary leaves 8–11 pairs on main stem, lanceolate to lance-elliptic, ascending to spreading, 6–12 × 0.7–1.2 cm, little reduced above, exstipulate, bases connate with transverse margin 0.3-0.6 mm wide, leaf surface flat, often pustulate (30×), margins often revolute, smooth to granular or sometimes papillate, sparsely ciliate proximally, midrib often sparsely pubescent adaxially, smooth, shiny, and often prominent abaxially. Inflorescence consisting of paired flowers, or one abortive, on pedicels often terminating secondary branches in the distal 3–7 axils, progressively reduced upward from pairs of normal leaves to scarious bracts, lanceolate to linear-lanceolate, 2–10 mm long; pedicels 1.5–4.5 mm long. Flowers perfect, chasmogamous, regular; sepals, inner lanceolate, outer narrowly ovate, 6.5–7 × 1.5–2.5 mm, glabrous, margins narrowly scarious, ciliolate in proximal half, midrib and lateral pair of nerves obscure, becoming evident in fruit, acute to acuminate, in fruit proximal 1/5 of sepals often with a thickened, elliptical patch; petals 5, white, strap-shaped, expanding to twice the width distally, 8–9 × 1.5–2 mm, broadly notched, notch 0.8–1 mm deep, the lobes rounded; stamens 5, each with a circular, thickened, basal gland 2–2.5 times the filament width, alternating with the petals, filaments 4–4.5 mm long, anthers yellow; ovary 3-carpellate, with 6–12 ovules; styles 3, 3.5–4 mm long, stigma terminal and adaxial, linear, minutely papillate (30×). Capsule ovoid, 4–4.5 mm long; valves 6, dehiscing by rolling back tightly 2–3 revolutions, forming a shallow dish exposing the basal placentae and plump funiculi. Seeds 1–2, reddish-brown, 2.5–2.6 mm long, circular, plump, radicle prominent, mature seeds with most tubercles broadly conical to elongate, rounded, interdigitating, each with 8–12 or more stipitate glands ca. 0.015 mm long or less (50×).

During the August visit to Pine Creek, most of the inflorescences were brown; most of the fruit aborted. This is likely a consequence of the dry summer. Similarly, it is very difficult to find fruiting material and seeds of *Pseudostellaria jamesiana*, in part because the fruits and seeds frequently abort or mature late in the fall and thus are seldom collected.

While this species has been known for over a century, to our knowledge it had been collected only twice, and never in fruit. The only collection subsequent to the type was gathered by J.H. Christ in 1940 (*Christ 10949*, NY). In August of 2000, Hartman relocated it and returned in June of 2001 to obtain additional material. The known geographic range appears restricted to the St. Joe Mountains and vicinity: extreme west-central Shoshone and southeastern Kootenai counties, Idaho.

Specimens examined: U.S.A. **Idaho. Kootenai Co.:** St. Joseph River [?], Wies[s]ner's Peak, 1,800 m., 8 Jul 1892, *Sandberg, MacDougal, & Heller 608* (HOLOTYPE: GH; ISOTYPES: CAS, NY, PH, POM, US); Pine Creek, just before Middle Fork Pine Creek, on jeep trail to Mount Wiessner, T47N R1E S15, 2,800 ft., 25 Aug 2000, *Hartman 70411* (MICH, MONT, RM); Pine Creek, 0.5 air mi NE of Middle Fork Pine Creek, T47N

R1E S12, 2,700 ft., 25 Aug 2000, *Hartman 70410* (MICH, RM), 12 Jun 2001, *Hartman 71073* (ID, MICH, NY, RM, UC, WTU). **Shoshone Co.:** cliffs along St. Joe River, 7 mi N of Calder, 19 May 1940, *Christ 10949* (NY).

The only floristic work that treats *Stellaria oxyphylla* as a recognized taxon is the unpublished "Manual of the Flora of Northern Idaho" by Carl Epling and Joseph Ewan dated 1941 (page 258 of 1121 page manuscript, original at MO; copies at RM, UC, provided by Alan Whittemore).

Several locations were visited along the St. Joseph River, including the segment in the vicinity of Christ's collecting site, but *Pseudostellaria oxyphylla* was not relocated. The habitat is given as "cliffs," perhaps at their bases. According to the late Douglass Henderson, "Christ's labels are to be viewed as "probably inaccurate"" (letter to Rabeler, Sep 1987).

After Hartman discovered populations of the taxon along Pine Creek, south of Pinehurst, he hiked the switchbacks from the southwest to the saddle, ca. 6,000 feet elevation, between Latour Peak (6,408 feet) and Mount Wiessner (6,185 feet). Neither suitable habitat for nor populations of *Pseudostellaria oxyphylla* was encountered on the slopes and drainages.

ECOLOGY

Pseudostellaria oxyphylla appears restricted to banks along perennial streams and rivers and adjacent moist sites; often under conifers or at the edge of coniferous forests. Due in part to an often extensive rhizome system, 20 to 100 or more flowering stems were found scattered in these sites that often dry out over the summer. On Pine Creek, the scattered populations were found over a 2.5 mile stretch of the creek valley.

ACKNOWLEDGMENTS

We wish to thank Carolyn Crawford for the illustration and the curators of CAS, GH, NY, PH, POM, and US for loans to Rabeler, ID, MONT, MONTU, WS for loans to Hartman, and CAS, MO, and UC for visits by Hartman and Rabeler.

REFERENCES

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1964. Vascular plants of the Pacific Northwest. Part 2. Univ. Wash. Publ. Bot. 17(2):1–597.

Rabeler, R.K. 1986. Revision of the *Stellaria calycantha* (Caryophyllaceae) complex and taxonomic notes on the genus. Ph.D diss., Michigan State Univ., East Lansing.

Rabeler, R.K. and R.L. Hartman. 2002. *Pseudostellaria sierrae* (Caryophyllaceae), a new species from California. Novon 12:82–86.

Robinson, B.L. 1898. New species and extended ranges of North American Caryophyllaceae. Bot. Gaz. (Crawfordsville) 25:165–171.

BOOK NOTICE

ROBERT K. WEBSTER, GEORGE BRUENING, WILLIAM O. DAWSON, and NEAL K. VAN ALFEN (eds). 2003. **Annual Review of Phytopathology: Volume 41, 2003.** (ISBN 0-8243-1341-0, hbk; ISSN 0066-4286). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $165.00 (USA), $170.00 (Int'l.), 704 pp., 6" × 9".

Contents of Volume 41 of *Annual Review of Phytopathology*:

Perspectives on Plant and Soil Nematology
James Gordon Horsfall: Nonconformist and Founding Father
Carl Freiherr von Tubeuf: Pioneer in Biological COntrol of Plant Diseases
Epidemiology and Management of Tomato Spotted Wilt in Peanut
Brome Mosaic Virus RNA Replication: Revealing the Role of the Host in RNA Virus Replication
Cultural and Genetic Approaches to Managing Mycotoxins in Maize
Regulation of Antibiotic Production in *Pseudomonas* spp. and Implications for Biological Control of, Plant Disease
The Threat of Plant Pathogens as Weapons against U.S. Crops
Gibberella from *A(venacea)* to *Z(eae)*
Evolution of Wheat Streak Mosaic Virus: Dynamics of Population Growth Within Plants May Explain Limited Variation
Molecular Basis of Pto-Mediated Resistance to Bacterial Speck Disease in Tomato
Parasitic Nematode Interactions with Mammals and Plants
Ecology of Mycorrhizae: A Conceptual Framework for Complex Interactions Among Plants and Fungi
Advances in Molecular-Based Diagnostics in Meeting Crop Biosecurity and Phytosanitary Issues
Development of Alternative Strategies for Management of Soilborne Plant Pathogens Currently, Controlled Through Methyl Bromide
Patterns of Pesticide Use in California and the Implications for Strategies for Reduction of Pesticides
Innovations In Plant Pathology Teaching
Of Smuts, Blasts, Mildews, and Blights: cAMP Signaling in Phytopathogenic Fungi
The Ecological Significance of Biofilm Formation by Plant-Associated Bacteria
Quorum Sensing in Plant-Pathogenic Bacteria
Spiroplasma citri, A Plant Pathogenic Mollicute: Relationships with its Two Hosts, the Plant and the, Leafhopper Vector
Pathogen Self-Defense: Mechanisms to Counteract Microbial Antagonism
Luteovirus-Aphid Interactions
Ecology and Epidemiology of Benyviruses and Plasmodiophorid Vectors
The Potential of Optical Canopy Measurement for Targeted Control of Field Crop Diseases
Engineering of Transgenic Plant Nematode Resistance
Establishment of Biotrophy by Parasitic Fungi and Reprogramming of Host Cells for Disease, Resistance

THE GENUS *PRENANTHES* (ASTERACEAE: LACTUCEAE) IN TEXAS

Jason R. Singhurst

Wildlife Diversity Program
Texas Parks and Wildlife Department
Austin, Texas 78704, U.S.A.

Robert J. O'Kennon

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

Walter C. Holmes

Department of Biology
Baylor University
Waco, Texas 76798-7388, U.S.A.

ABSTRACT

Three species of *Prenanthes* occur in Texas. *Prenanthes carrii* Singhurst, O'Kennon, & Holmes is described as a new species endemic to the Edwards Plateau vegetational region. *Prenanthes altissima* is known only from Jasper and Newton counties in extreme southeastern Texas. *Prenanthes barbata* is more widespread but rare in rich hardwood and pine-oak forests in the Pineywoods of eastern Texas, with one record in the Post Oak Savannah of Lamar County. A key to species, descriptions, distribution map, and lists of exsiccatae are included.

RESUMEN

En Texas hay tres especies de *Prenanthes*. Se describe *Prenanthes carrii* Singhurst, O'Kennon, & Holmes como especie nueva endémica de la región de vegetación de Edwards Plateau. *Prenanthes altissima* se conoce únicamente de los condados de Jasper y Newton en el extremo sureste de Texas. *Prenanthes barbata* es más frecuente pero raro en los bosques de madera dura y de pino-roble en los pinares del este de Texas, con una cita en la sabana de Post Oak del condado de Lamar. Se incluye una clave de especies, descripciones, mapas de distribución, y listas de exsicatas.

INTRODUCTION

Correll and Johnston (1970) recognized two species of *Prenanthes* L. in Texas. One, *P. altissima* L. was identified from three specimens all collected the same year from the same location in Newton County. *Prenanthes barbata* (T. & G.) Milstead ex Cronquist was identified from two specimens, one each from Jasper and Nacogdoches counties. By 1993 knowledge of the genus in Texas was based upon seven additional collections of *P. barbata* and two additional collections of *P. altissima*. In 1993 and 1994 Singhurst (1996) conducted a status survey of *P. barbata* in Texas that increased the understanding of its distribution and habitat restrictions. That survey prompted the present expanded study.

The purpose of the present paper is to (1) describe a new species of *Prenanthes* from the Edwards Plateau vegetational region of Texas, (2) report the additional information regarding the Texas distribution of *P. altissima* and *P. barbata*, (3) provide a key to distinguish the three species in Texas and (4)

SIDA 21(1): 181 – 191. 2004

remark on the rarity and abundance of all species treated. Field research and collections made between 1993 and 2003 form the primary basis of this study. The majority of specimens collected are deposited in the Baylor University Herbarium (BAYLU). Other specimens from ASTC, BRIT, LAMU, Rice University Herbarium, Houston Texas (hereafter cited as RICE), SBSC, TAES, TAMU, TEX-LL, US, and the personal herbarium of Steve Orzell and Edwin Bridges were examined and annotated.

Cultivation studies of both *P. barbata* (1993–1994) and *P. altissima* (1998) were conducted at the Stephen F. Austin Arboretum and Tucker Estate, Nacogdoches, Texas. The new species was cultivated in 2003 at the residence of O'Kennon in Fort Worth. Though limited, these cultivation studies provided growth form information that was otherwise unavailable.

TAXONOMIC TREATMENT

Prenanthes L., Sp. Pl. 797–798. 1753.

Nabalus Cass., Dict. Sc. Nat. 34:94. 1825.

Perennial herbs with milky juice and tuberous roots. Leaves alternate, simple and entire to toothed to few-lobed or deeply cleft, or lower ones sometimes several-foliate. Capitula mostly numerous in an elongate, erect and often nodding paniculiform capitulescence; flowers ligulate, perfect, 5–15 in number, white, yellow-white, to greenish-white; involucres cylindric, of 4–8 principal phyllaries, the outer phyllaries (bracts) much reduced; receptacles epaleate. Cypselae cylindric or nearly so, glabrous, mostly reddish-brown, multicostate; pappus of numerous deciduous capillary bristles.

Prenanthes is a genus of approximately 40 species (Rao & Datt 1996) with a predominantly north temperate distribution except for one species of south central Africa (Milstead 1964). Two subgenera are recognized. Subgenus *Nabalus* includes all species of North America and northeast Asia, while the European and African species are in subgenus *Prenanthes*. Classification of the genus is complicated by frequent hybridization and by extreme morphological variation (Cronquist 1980).

Plants of the genus are commonly known as rattlesnake root, cankerweed, or gall of the earth. The name *Prenanthes* is from Greek *prenes* (drooping) and *anthe* (flower). This name refers to the nodding habit of the capitula.

KEY TO THE SPECIES OF *PRENANTHES* IN TEXAS

1. Capitula 5–6 flowered; involucres with 5–6 principal phyllaries, glabrous ________ **P. altissima**
1. Capitula 10–15 flowered; involucre with 6–8 principal phyllaries, pubescent with long coarse hairs.
    2. Lower and midstem leaves shallowly or deeply pinnately lobed, the upper lanceolate to oblong; petioles usually shorter than the blades; capitulescence racemose to slightly paniculate ________ **P. barbata**

2. Lower and midstem leaves sagittiform, the upper ovate to triangular-deltate; petioles usually longer than the blades, capitulescense paniculate ______ **P. carrii**

Prenanthes altissima L., Sp. Pl. 797. 1753. *Nabalus altissimus* (L.) Hook., Fl. Bor. Amer. 1:294. 1833. Type: LINN; IDC microfiche 177.536.III.1.

Prenanthes altissima L. var. *cinnamomea* Fern., Rhodora 10:95. 1908. Type: U.S.A. MISSOURI Monteer, 5 Oct 1905, *Bush 3534* (holotype: GH).

Perennial herbs from a thick and knotty corm-like taproot. Stems erect to 200 cm tall, glabrous, striate, the upper portions not branched or rarely so, leafy towards the base and sparse to leafless in the immediate vicinity of the capitulescence. Leaves ovate to triangular, 3–5 lobed, 2–14 × 1.5–12 cm, the lower ones sometimes withered before anthesis but can also be present; venation pinnate, with 4–6 pairs of prominent secondary nerves separating from the midvein at an angle of ca. 45°, the nerves arcuate, tertiary and quartenary nerves reticulate, surfaces glabrous to villous; bases widely cordate to an obtuse insertion at the petioles, margins dentate, the teeth 0.5–1 cm distant, apices acute to acuminate; petioles 0.5–8.5 cm long, wingless throughout its length; upper leaves reduced in size; deltoid to reniform, shortly petiolate, margins slightly dentate. Capitulescene paniculate, heads disposed in loose axillary clusters in upper axils, 20–28 cm tall. Capitula slender, 12–15 mm long; peduncles to 2–3 mm long, puberulent; bracts (outer phyllaries) lanceolate to ovate, 1–2 mm long, apices acuminate, margins puberulent; primary phyllaries 5, 10–12 mm long, lanceolate, green to lilac, apices acuminate, glabrous. Florets white, 5–6 in number, 10–11 mm long, tubes ca. 6 mm long, ligules 5 mm long, 5-nerved, teeth 5, linear, sparingly glandular, surfaces glabrous, anthers 4 mm long; stigmatic surfaces densely hispid to setose. Cypselae obscurely 5-angled, 5 mm long, golden-brown. Pappus bristles ca. 40–50, yellow-brown, ca. 8–9 mm long, margins finely scabrid.

Distribution.—Known only from Jasper and Newton counties in extreme southeast Texas (Fig. 1); also Quebec to Maine, S to Georgia, Tennessee, Kentucky, Arkansas, and Louisiana.

Phenology.—Flowering from late August through October.

Specimens examined. **TEXAS. Jasper Co.:** Sally Withers Lake area, Autumn 1974, *Watson s.n.* (RICE). **Newton Co.:** FR 1414 about 3 mi SE of Burkeville, 23 Mar 1969, *Correll 36864* (TEX-LL); FR 1414 about 3 mi SE of Burkeville, 15 Oct 1969, *Correll 38172* (TEX-LL); FR 1414, about 3 mi SE of Burkeville, 29 Oct 1969, *Correll & Correll 38217* (TEX-LL); Scrappin Valley, 25 Oct 1974, *Watson s.n.*; Scrappin Valley Preserve, Temple Inland Property, 12 mi NNE of Burkeville, 2 Apr 1998, *Singhurst & Watson 6548* (BAYLU); jct. FM 645 and Hickman Creek, W on Hickman Creek 0.4 mi, 3 Apr 1998, *Singhurst & Watson 6559* (BAYLU); Canyon Rim Trail, Tex. Hwy 87, 0.5 mi N of Mayflower Community, 30 Sep 2001, *Holmes 11997 & Singhurst* (BAYLU); Louisiana Pacific Corp. Nature Trail, 4 mi N of jct. of Tex. Hwy 87 and R255 on Hwy 87, 23 Sep 2003, *Singhurst 12494* (BAYLU); Tex. Hwy 87, 2.1 mi S of jct. with Tex. Hwy 63, SE on Co. Rd. 2.7 mi to Simms Cemetery, Yellow Bayou bluffs and banks, 23 Sep 2003, *Singhurst 12494* (BAYLU).

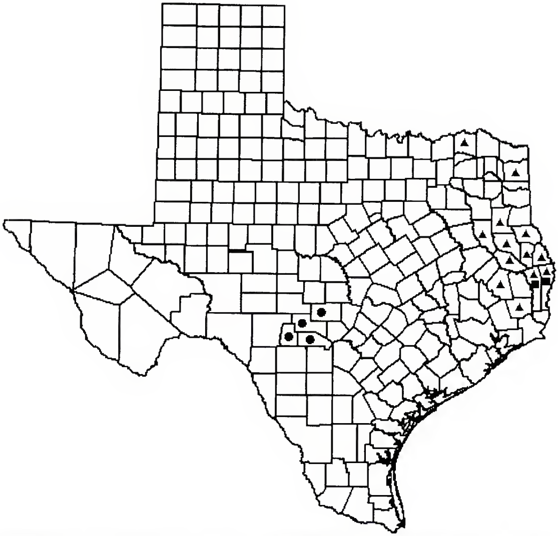


FIG. 1. Distribution map of the genus *Prenanthes* in Texas. *Prenanthes altissima* ■, *P. barbata* ▲, and *P. carrii* ●.

Prenanthes altissima is known from seven locations in the northern portion of Jasper and Newton counties. These locations are the southwestern limit of *P. altissima*'s distribution in Texas. Outside Texas, the nearest documented occurrences are approximately 120 km distant in Evangeline and Rapides parishes, Louisiana (Thomas & Allen 1996). The nearest Arkansas population (Smith 1979) is about 320 km distant. In Texas the species occurs on primary and secondary terraces along stream banks of small perennial spring-fed creeks and banks of larger streams with flood plains that support hardwood forests. *Prenanthes altissima* is associated with *Fagus grandifolia*, *Magnolia grandiflora*, *Acer barbatum*, *Quercus alba*, *Hamamelis virginiana*, *H. vernalis*, *Lindera benzoin*, *Lilium michauxii*, *Tipularia discolor*, *Sanguinaria canadensis*, *Polygonatum biflorum*, *Polystichum acrostichoides*, *Thelypteris hexagonoptera*, *Trillium gracile*, *Spigelia marilandica*, *Solidago auriculata*, and *S. caesia*.

Cronquist (1980) recognized two varieties of *Prenanthes altissima*, var. *altissima* with whitish to pale brown pappus, occupying the greatest part of the distribution of the species, and var. *cinnamomea* of Missouri, Arkansas, Louisiana, and, though not cited by Cronquist, presumably Texas. This variety is characterized by bright yellow-brown or almost orange pappus. Gandhi and Thomas (1989) used this varietal name to refer to the Louisiana forms of this taxon. However, Thomas and Allen (1996) merged var. *cinnamomea* with var. *altissima* in the *Atlas of the Vascular Flora of Louisiana*. Color variation of the pappus does not appear to justify recognition at the varietal level.

Prenanthes barbata (Torr. & A. Gray) W.L. Milstead ex A. Cronquist. Brittonia 29:223. 1977. *Nabalus fraseri* DC. var. *barbatus* Torr. & A. Gray, Fl. N. Amer. 2:481. 1843. *Prenanthes serpentaria* Pursh var. *barbata* (Torr. & A. Gray) A. Gray, Syn. Fl. N. Amer. 1(2): 434. 1886. *Nabalus barbatus* (Torr. & A. Gray) Heller, Muhlenbergia 1:8. 1900. *Nabalus serpentaria* Pursh var. *barbatus* (Torr. & A. Gray) Mohr, Contr. U.S. Natl. Herb. 6:755. 1901. TYPE: U.S.A. ALABAMA: *Buckley s.n.* (SYNTYPE: GH; ISOSYNTYPE: NY). The GH specimen is here designated as lectotype. The other syntype cited, *Macbride s.n.* from the Saluda Mountains of [Polk Co., North Carolina], was not located but from location seems to refer to *P. serpentaria* Pursh.

Perennial herbs from thick corm-like taproots, occasionally connected by slender rhizomes. Stems erect, 50–150 cm tall, simple below, glabrous, the upper portions often branched, glabrate to pilose to hispid to semiarachnose to villous, leafy except in the immediate vicinity of the capitulescence. Leaves oblanceolate to spatulate, 5–20 × 1.5–5 cm, the lower ones usually withered before anthesis, venation pinnate, with 4–6 pairs of prominent secondary nerves separating from the midvein at an angle of ca. 45 degrees, the nerves straight to arcuate, tertiary and quartenary nerves reticulate, surfaces glabrate to sparingly puberulent-pilose; bases attenuate, the lower to long winged petioles, margins entire to denticulate to dentate to lacerate-parted (especially lower leaves), the teeth 1–2 cm distant, apices acute to rounded; petioles 0.5–6.5 cm long, winged for most of its length; upper leaves reduced in size; elliptic to oblanceolate, sessile to shortly petiolate, margins mostly entire to denticulate to less commonly dentate to lacerate-lobed at the bases. Capitulescene racemose to paniculate, 5–36 cm tall. Capitula cylindric to semicampanulate; peduncles to ca. 1 cm long, glabrate to tomentose to villous; bracts (outer phyllaries) lanceolate to narrowly ovate, 2–5 mm long, apices acuminate, margins subentire, midribs with few to numerous coarse bristles; primary phyllaries 6–8, 13–16 mm long, linear-oblong to narrowly lanceolate, green to purplish, apices acute to rounded to an acute point, finely puberulent, occasionally with glandular hairs, margins entire, midribs with few to numerous coarse bristles. Florets white, 10–12 in number, 12–13 mm long, tubes ca. 5–6 mm long, ligules 5–6 mm long, 5-nerved, teeth 5, linear, sparingly glandular, surfaces glabrous, anthers 5–5.5 mm long; stigmatic surfaces setose-hispid. Cypselae obscurely 5-angled, 5–5.5 mm long, golden-brown. Pappus bristles ca. 50, white to yellow-brown, ca. 8 mm long, margins scabrid.

Distribution.—Eastern Texas from Hardin County north to Lamar County (Fig. 1); also Alabama, Arkansas, Georgia, Kentucky, Louisiana, and Tennessee.

Phenology.—Flowering from late August through November.

Specimens examined: **TEXAS. Angelina Co.:** Comp. 94, Angelina National Forest, ca. 0.7 mi S of junction of FS Rd 303 and FS Rd 302 on FS Rd 303, jct. of FS Rd 303 and Big Creek, 11 Nov 1994, *Singhurst 3609* (BAYLU). **Cass Co.:** ca. 0.4 air mi SW of jct. of Tex. Hwy 11 and Tex. Hwy 8 at Linden, 24 Oct 1994, *Singhurst 3404* (BAYLU). **Cherokee Co.:** ca. 0.5 air mi SE of jct. of U.S. Hwy 69 and FM 241, 17 Nov 1994, *Singhurst 3610* (BAYLU). **Hardin Co.:** W side of Silsbee near Mill Creek, Rd 327, 22 Sep 1971, *Watson 766, 767, & 768* (RICE); W of Silsbee on Tex. Hwy 327 near Mill Creek, 29 Sep 1971, *Amerson 806* (SMU). **Jasper Co.:** U.S. Hwy 96, ca. 2.0 mi S of Jasper, 10 Oct 1946, *Lundell & Lundell 14674* (TEX); ca. 3.5 mi SW of Jasper on FM 777, 4 Nov 1982, *Agilvsgi 8270* (TAMU); S of Walnut Run Creek on U.S. Hwy 96, 1.8 mi S of jct. U.S. Hwy 190 and 96 in Jasper, 29 Oct 1993, *Singhurst 3401* (BAYLU); roadside park ca. 1.6 mi S of U.S. Hwy 190 and 96 in Jasper, 13 Oct 1982, *Cheatham s.n.* (TEX). **Lamar Co.:** FM 906, 1.4 mi E of jct. of FM 906 and U.S. Hwy 271 at Mid City, 18 Oct 2002, *Singhurst & Harris 11345* (BAYLU). **Nacogdoches Co.:** ca. 8.0 mi NE of Nacogdoches, 4 Oct 1941, *Parks 1373* (TEX), *1372* (SMU); Tex. Hwy 21, 100 yards W of Loco Bayou, ca. 0.4 mi E of Co. Rd. 829, 21 Oct 1993, *Carr 13246* (TEX-LL); Little Loco Bayou, ca. 9.0 mi W of Nacogdoches on Tex. Hwy 21, ca 2.1 air mi ESE of Winter Hill, 1994, 14 Oct 1993, *Singhurst 3406* (BAYLU); ca. 1.95 mi W of jct. of FM 95 and FM 1878, 5 Sep 1994, *Singhurst 3407* (BAYLU), ca. 9.2 mi NNE of Nacogdoches on U.S. Hwy 59, 4.5 mi SSW of Garrison on U.S. Hwy 59, 1 Nov 1993, *Singhurst s.n.* (BAYLU); ca. 4.2 mi NE of jct. of Loop 224 and FM 1878 in Nacogdoches on FM 1878, Carrizo Estates, 5 Sep 1994, *Singhurst 3408* (BAYLU); ca. 6.9 mi NW from jct. of U.S. Hwy 59 and FM 343 on FM 343, ca. 0.9 air mi ESE of Winter Hill, 5 Sep 1994, *Singhurst 3601* (BAYLU); Nacogdoches, W end of Spring Valley Drive, 5 Sep 1994, *Singhurst 3602* (BAYLU); Branch entering into Barnes Lake, ca. 1.5 air mi SW of Barnes Lake Dam, 5 Sep 1994, *Singhurst 3405* (BAYLU). **Newton Co.:** jct. of Clear Creek and U.S. Hwy 190, 7 Mar 2002, *Singhurst 11202* (BAYLU). **Polk Co.:** Morgan Creek, FM 1988, 2.6 mi SW of jct. Tex. Hwy 146 and FM 1988, 27 Sep 1994, *Singhurst 3403* (BAYLU). **Rusk Co.:** ca. 2.5 air mi NNE of jct. of Tex. Hwy 322 and U.S. Hwy 259, N of Henderson, 24 Oct 1994, *Singhurst 3402* (BAYLU). **Sabine Co.:** Comp. 66, Sabine National Forest, Matlock Hills, ca. 4.4 mi NE of jct. of Tex. Hwy 21 and FM 3153,14 Aug 1994, *Singhurst 3606* (BAYLU); Comp. 69, Sabine National Forest, ca. 1.3 mi E of jct. of FS Rd 131 and FS Rd 131-A on FS Rd 131-A, ca. 2.1 air mi S of jct. of U.S. Hwy 87 and FS Rd 131, 14 Aug 1994, *Singhurst 3607* (BAYLU); Comp. 72, Sabine National Forest, ca. 3.4 mi from jct. of Tex. Hwy 21 and U.S. Hwy 87, ca. 0.5 air mi SW of Red Hills Lake, 14 Aug 1994, *Singhurst 3608* (BAYLU); Tex. Hwy 21, 5.9 road mi E of jct. FM 225 at Douglass, 12 Oct 1993, *Carr 13246* (TEX-LL). **San Augustine Co.:** Comp 65, Sabine National Forest, ca. 0.8 mi on FR that enters Comp. 65 from W, 14 Aug 1994, *Singhurst 3604* (BAYLU); ca. 3.5 air mi NNE of jct. of Attoyac River and Tex. Hwy 21, 14 Aug 1994, *Singhurst 3605* (BAYLU); Spring Ridge on Arenosa Creek, ca. 12 mi WNW of San Augustine, 29 Sep 2001, *Holmes & Singhurst 11970* (BAYLU). **Shelby Co.:** Sabine National Forest, Tenaha RD, Compartment 51, ca. 1.4 air mi NNW of jct. of FM 1279 and Tex. Hwy 147, 14 Aug 1994, *Singhurst 3400* (BAYLU); Comp. 51, Sabine National Forest, ca. 2.2 mi from jct. of FM 1279 and FM 147 on FM 147, 22 Apr 1987, *Orzell & Bridges 5126* (pers. herb.).

The distinctness of *Prenanthes barbata* was first recognized but never formalized by Milstead (1964). The name was subsequently adopted by Correll and Johnston (1970) and gained general acceptance; it was formalized by Cronquist in 1980.

The species was considered rare by Correll and Johnston (1970) because it was known only from Jasper and Nacogdoches counties. Turner et al. (2003) presented an expanded distribution in east central Texas that included six counties. Turner et al. also used the name to refer to plants of the Edwards Plateau which, in this study, are considered a distinct species. *Prenanthes barbata* occurs in mesic ravine slope forests that are dominated by *Fagus grandifolia-Quercus alba* series (Diamond et al. 1987) and on mesic hardwood sites with *Quercus shumardii*, *Q. muhlenbergii*, *Q. alba*, *Q. michauxii*, *Pinus taeda*, *Carya ovata*, and *C. myristicaeformis*.

Prenanthes carrii J.R. Singhurst, R.J. O'Kennon, & W.C. Holmes, sp. nov. (**Fig.2**). TYPE: U.S.A. TEXAS. BANDERA CO.: Lost Maples State Natural Area, above and below Upper Forks of Mystic Canyon Trail, 1 Sep 2003, *Singhurst & Singhurst 12496* (HOLOTYPE: BAYLU).

A *P. barbatae* similis sed foliis sagittiformibus differt.

Perennial herbs from tuberous tap roots with similar side roots. Stems simple, erect, occasionally rather long branched in area of inflorescence, 80–150 cm long, strigose to tomentose in upper half, scattered strigose to glabrous basally. Lower leaves sagittiform (ovate, ovate-deltate to broadly elliptic in general contour), 13–25 × 7–12 cm, light green, chartaceous, venation pinnate, with 3–5 pairs of prominent secondary nerves separating from the midvein at an angle of about 45 degrees, nerves straight to slightly antrorsely curved, tertiary and quartenary veins reticulate; surfaces glabrate to lightly puberulent-setose especially on nerves; bases attenuate, truncate to widely cordate, occasionally deeply pinnately divided at base near petioles, margins coarsely and irregularly dentate, mostly 1–2 cm distant, teeth subspinose-mucronate, apices acute to rounded; petioles 2.2–13 cm long, broadly winged for half or more of its length by the decurrent leaf bases; upper leaves reduced in size, elliptic, occasionally nearly sessile or with winged-decurrent petioles to about 1 cm long, otherwise similar to lower leaves; bracteal leaves reduced in size, less prominently dentate to occasionally subentire. Capitulescence paniculate, 20–50 cm tall; capitula cylindric to semicampanulate; peduncles, 4–9 mm long, tomentulose, with 5–12 or more linear-subulate to narrowly lanceolate hispid bracts (outer phyllaries) 2–4 mm long; primary phyllaries 8, 9–11 mm long, mostly lime green to pinkish-rose to lavender, linear-subulate to lanceolate, apices acuminate, outer surfaces glabrate except for the sparingly hispid midrib, apical margins minutely ciliate. Florets 9–11 per capitulum; 11.5–13.5 mm long, tubes 4–7 mm long, ligules ca. 7 mm long, 5-nerved, teeth 5, linear-oblong, 0.07–0.1 mm long, apical surfaces papillate; anthers ca. 5.5 mm long; stigmatic surfaces densely hispid-setose. Cypselae irregularly angled to more often terete, ca. 6.3 mm long, golden yellow to tan, prominently 12–15 costate. Pappus bristles white to tan to yellow, 7–8 mm long, 30–40, margins scabrid.

Fig. 2. *Prenanthes carrii*: **A.** habit, **B.** upper bracteal leaves, **C.** middle leaf, **D.** basal rosette leaf, **E.** florets, **F.** pappus, **G.** mature achene and **H.** immature achene with ligule/anther detail. Illustration by Linny Heagy 2004. Specimens used in illustration include a combination of *Singhurst & Singhurst 12496* (BAYLU) and *O'Kennon s.n.* (BAYLU).

Distribution.—Southwest Edwards Plateau (Bandera, Gillespie, Kerr, and Real counties) of Texas (Fig. 1.)

Phenology.—Flowering late August to November.

PARATYPES: TEXAS. **Bandera Co.:** Lost Maples State Natural Area, Upper Can Creek, 17 Nov 1999, *Singhurst 8533* (BAYLU); Love Creek Preserve, The Nature Conservancy of Texas, 2 Nov 2002, *Singhurst 11544* (HOLOTYPE: BAYLU). **Gillespie Co.:** 7 mi N of Harper in rich creek canyon off Threadgill Creek, Oct 1993, *O'Kennon 11914* (TEX-LL). **Kerr Co.:** along rocky spring branch, Lacey's Ranch, 3 Oct 1916, *Palmer 10893* (US); without specific location, 13 Oct 1940, *Parks s.n.* (TAES); 12 mi S of Kerrville along Lamb Creek, Oct 1993, *O'Kennon 11898* (TEX-LL); 5.3 mi N of jct. of Kerr/Bandera County line on Tex. Hwy 16, Upper Lamb Creek, 17 Nov 1999, *Singhurst 8534* (BAYLU); cultivated [propagules from Upper Lambs Creek], 18 Oct 2002, *O'Kennon s.n.* (BAYLU). **Real Co.:** Lost Maples State Natural Area, 27 Oct 2001, *Singhurst 11526* (BAYLU); upper reaches of Mill Creek, Grey Wolfe Ranch, 2 Nov 2002, *Singhurst 11554* (BAYLU).

Prenanthes carrii is morphologically similar to *P. crepidinea* Michx., *P. alata* (Hook.) D. Dietr., *P. sagittata*, (A. Gray) A. Nels., *P. bootii* (DC.) D. Dietr, and *P. barbata*. This group was proposed as a new subsection in Milstead's (1964) unpublished (thus never formalized) dissertation. The group is characterized by paniculate to racemose capitulescences, leaves at least short petiolate, flowers white to creamy and usually numbering 7–38 per capitulum, inner phyllaries 6–15, and outer phyllaries (bracts) mostly 7–13 per capitulum. Leaf characteristics of *P. carrii* resemble the sagittiform shaped leaves of *P. alata*, *P. crepidinea*, and *P. sagittata*. The new species appears to be most closely similar to *P. barbata*, particularly in the paniculate nature of the capitulescence. The two species may be distinguished by the characters referenced in the key. Additional traits distinguishing *P. carrii* from *P. barbata* include its taller height of 80–150 cm, strigose to tomentose vestiture, and primary phyllaries 9–11 mm long. *Prenanthes barbata* is usually 55–125 cm tall, has tomentulose to subarachnose vestiture, and has primary phyllaries 11–14 mm long.

Prenanthes carrii occurs primarily in rich soils in woodlands at the upper reaches of canyons where springs flow due to geologic contacts. Where these contacts occur, there is a vegetation transition between the species of *Quercus laceyi*, *Q. muhlenbergii*, *Q. texana*, and *Acer grandidentatum* and the creekside seepage shelves dominated by *Platanus occidentalis*, *Cephalanthus occidentalis*, *Adiantum capillus-veneris*, *Thelypteris kunthii*, and *Cladium mariscoides*. The species is normally associated with *Aristolochia serpentaria*, *Carex edwardsiana*, *C. planostachys*, *Lindera benzoin*, *Senecio obovatus*, and *Verbesina virginica*. Other central Texas endemics occurring with or near *P. carrii* include *Chaetopappa effusa*, *Clematis texensis*, *Matelea edwardsensis*, *Philadelphus texensis*, *Tragia nigricans*, *Tridens buckleyanus*, and *Styrax platanifolius* var. *stellatus*.

Etymology.—The species is named in honor of William F. Carr of The Nature Conservancy of Texas. Bill is deeply committed to preserving the botanical heritage of Texas and is currently one of the most active plant collectors in the state.

ACKNOWLEDGMENTS

We wish to thank the curators of the herbaria cited for access to the specimens used in this study. Special recognition is given to Geraldine Watson who accompanied the senior author to the sites where she had previously collected *Prenanthes*. Amber Swanson, Curatorial Assistant of the Harvard University Herbaria, provided a digital photograph of the designated lectotype of *Prenanthes barbata*. We thank Guy L. Nesom for his Latin translation and for reviewing the manuscript. Appreciation is also expressed to the landowners who graciously permitted access to their properties and to Bill Carr for his field assistance and access to Love Creek Preserve. We also give special thanks to David Riskind at Texas Parks and Wildlife Department who granted us access to Lost Maples State Natural Area and reviewed the preliminary manuscript. We also want to thank Larry Brown of Spring Branch Science Center Herbarium and Sandi Elsik and Warrens Pruess of Rice Herbarium for their assistance with specimen records. We also extend our deepest gratitude to Linny Heagy. Her amazing artistry exemplifies the details of the newly-described *Prenanthes carrii*.

REFERENCES

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Cronquist, A. 1980. Vascular flora of the southeast United States. Vol. 1. Asteraceae. Univ. North Carolina Press, Chapel Hill.

Diamond, D.D., D.H. Riskind, and S.L. Orzell. 1987. A framework for plant community classification and conservation in Texas. Texas J. Sci. 39:203–221.

Gandhi, K.N. and R.D. Thomas. 1989. Asteraceae of Louisiana. Sida, Bot. Misc. 4. Botanical Research Institute of Texas, Fort Worth.

Milstead, W.L. 1964. A revision of the North American species of *Prenanthes*. Unpub. dissertation, Purdue University.

Rao, R.R. and B. Datt. 1996. Diversity and phytogeography of Indian Compositae. In: D.J.N. Hind, ed.-in-chief, Composite: systematics. Proceeding of the international Compositae conference, Kew, 1994. Royal Botanic Gardens, Kew. Pp. 445–461.

Singhurst, J.R. 1996. The status of nine endangered plants of East Texas: historical, ecological and phytogeographical notes. Unpub. thesis, Stephen F. Austin University, Nacogdoches, Texas.

Smith, E.B. 1979. An atlas and annotated list of the vascular plants of Arkansas. Published by the author. Fayetteville.

Thomas, R.D. and C.A. Allen. 1996. Atlas of the vascular flora of Louisiana. Vol. II. Dicotyledons. Acanthaceae–Euphorbiaceae. Louisiana Department of Wildlife and Fisheries Natural Heritage Program, Baton Rouge.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Sida, Bot. Misc. 24. Botanical Research Institute of Texas, Fort Worth.

BOOKS RECEIVED

Slavoko Matić (Editor in Chief). 2003. **Obična Bukva (*Fagus sylvatica* L.) U Hrvatskoj (common beech, *Fagus sylvatica* L. in Croatia).** (ISBN 953098571-1-2, hbk.). Akademija Šumarskih Znanosti and co-published with Hrvatske Šume d.o.o. Grad Zabreb, Gradski ured za Poljoprivredu I Šumarstvo, Zagreb Croatia. Price not given, 855 pp., b/w photos, color photos, maps, drawings, graphs, tables, 6 1/2" × 9 1/2".

Joseph H. Kirkbride, Jr., Charles R. Gunn, and Anna L. Weitzman. 2003. **Fruits and Seeds of Genera in the Subfamily Faboideae (Fabaceae). Volume 1 and volume 2.** U.S.Department of Agriculture, Technical Bulletin No. 1890. U.S. Department of Agriculture, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, U.S.A. (Orders: 703-605-6000, 306-966-5567 fax). Price not given. 1212 pp., b/w photos, drawings, keys, descriptions, 8 1/2" × 11".

Richard "The Bugman" Fagerlund and Johnna Strange. 2004. **The Bugman on Bugs: Understanding Household Pests and the Environment.** (ISBN 0-8263-3363-X, pbk.). University of New Mexico Press, 1720 Lomas Blvd. NE, 1 University of New Mexico, Albuquerque, NM 87131-0001, U.S.A. (Orders: 800-249-7737, 505-277-9270 fax, unmpress.com). $14.95, 131 pp., 17 halftones and 30 b/w illus. 5 1/2" × 9".

Howard Scott Gentry. 2004. **Agaves of Continental North America**. (ISBN 0-8165-2395-9, pbk.). The University of Arizona Press, 355 S. Euclid, Ste. 103, Tucson, AZ 85719. (Orders: 520-621-1441, 520-621-8899 fax, www.uapress.arizona.edu). $49.95, 670 pp., 422 illustrations, 7" × 10".

Tracey Parker. 2003. **Manual of Dendrology Jamaica**. (ISBN 976-610-504-9 pbk.). Forestry Department, Ministry of Agriculture, 173 constatn Spring Road, Kingston 8, Jamaica (West Indies) (Orders: 876-924-2667, 876-924-2626 fax, www.forestry.gov.jm, email: forestrydepartment@forestry.gov.jm). 494 pp., 5 1/2" × 8".

TWO NEW SUBSPECIES OF *MICROSERIS LACINIATA* (ASTERACEAE) FROM THE SISKIYOU MOUNTAINS

Kenton L. Chambers

Dept. of Botany & Plant Pathology
Oregon State University
2082 Cordley Hall
Corvallis, Oregon 97331, U.S.A.
chamberk@science.oregonstate.edu

ABSTRACT

Microseris laciniata subsp. ***siskiyouensis*** and subsp. ***detlingii*** are described as endemics of the floristically "central" region of the Siskiyou Mountains of Oregon and adjacent California. These taxa have novel morphological features differentiating them from the related *Microseris laciniata* subsp. *laciniata* and subsp. *leptosepala* also found in this region. The populations are kept separate by allopatry and by adaptation to different edaphic conditions, and thus have different vegetation associations. Intermediate populations occur where pairs of taxa meet and the ecological differences are modified by habitat disturbance.

RESUMEN

Se describen ***Microseris laciniata*** subsp. ***siskiyouensis*** y subsp. ***detlingii*** como endemismos de la región florística "central" de las Montañas Siskiyou de Oregón y la adyacente California. Estos taxa tienen característica morfológicas que los diferencian de sus parientes *Microseris laciniata* subsp. *laciniata* y subsp. *leptosepala* que también se encuentran en esta región. Las poblaciones se mantienen separadas por alopatria y por adaptación a condiciones edáficas diferentes, y así tienen diferentes asociaciones de vegetación. Aparecen poblaciones intermedias donde contactan pares de taxa y las diferencias ecológicas se modifican por alteraciones del hábitat.

INTRODUCTION

The perennial species of *Microseris* subgen. *Scorzonella* were last reviewed taxonomically by Chambers (1957) in preparation for the generic treatment in Abrams and Ferris' *Illustrated Flora of the Pacific States* (Chambers 1960). An attempt was made to compartmentalize the extensive variation of *M. laciniata* into two subspecies, subsp. *laciniata* and subsp. *leptosepala*, based principally on the shape, width, and pubescence of the involucral phyllaries and on differences in distribution. The species ranges from western Washington south through Oregon to just north of San Francisco in California, principally west of the Cascade Range but extending east to Klamath and Lake Counties, Oregon, and Siskiyou, Lassen, and Modoc Counties, California. The subsp. *leptosepala* occurs in the more coastal parts of the Coast Range, especially in the Klamath Mountains region, but is also in northwestern Oregon including the lower Willamette Valley. The subsp. *laciniata* is more interior, being the common form from Pierce County, Washington south to Douglas County, Oregon and from southern Humboldt County to Sonoma County, California, as well as in the Great Basin part of the range. Intergradent forms are frequent, especially in the Willamette Valley and Curry County, Oregon, the northern California Coast Range, and in populations east of the Cascade Range.

In this earlier study, additional puzzling variation was found in the Siskiyou Mountains of southwestern Oregon and adjacent California, but it could not be resolved using the few available herbarium specimens from this rugged and poorly explored region. This variation was lumped into *Microseris howellii*, which we now know to be a narrowly endemic species which is limited to exposed serpentine sites in the Illinois River Valley of Oregon. Field research by the present author suggested that two additional forms of *M. laciniata* should be recognized taxonomically from the Siskiyou region, and their ranges have recently been mapped through the collecting efforts of a number of interested colleagues (see Acknowledgments section). These entities have been presented informally (Chambers 1993) but have not yet been validly published.

Some diagnostic features of these new entities were presented by Mauthe et al. (1982) and compared with 9 other samples of *Microseris laciniata* representing much of the species' range. Capitulum and fruit morphology was the principal object of this investigation. It was suggested that there was "a rather small number of unlinked genes allowing for a rather free recombination of character states" and that "the characters that distinguish these two groups of populations (subsp. *laciniata* and subsp. *leptosepala*) recombine freely" in some populations. Crossing experiments (Pires 1980) show that hybrids between taxa in the *M. laciniata* complex are no less pollen-fertile than intrataxon crosses. An important result of these and previous studies of *M. laciniata* (Bachmann and Price 1979) was the validation of pappus part number as a highly consistent morphological feature of these two named subspecies. In both, the number varies among cypselae of single heads but is always constrained from 5 to 10. Frequencies of average pappi numbers follow patterns of rather simple Poisson distributions between 5 and 10, as would result from the interaction of a minimum of two pairs of genes (Bachmann & Chambers 1978).

Both of the newly recognized subspecies have average pappi numbers that are above 10–up to 16.6 in subsp. *detlingii* and 20.3 in subsp. *siskiyouensis*. In other respects, these two new subspecies are very different in morphology and in edaphic and vegetation associations. The newly available suite of collections of these taxa shows that each has an area of intergradation with an adjacent subspecies of *M. laciniata*—subsp. *detlingii* with subsp. *laciniata*, and subsp. *siskiyouensis* with subsp. *leptosepala*. Hence they are parts of a single genetic complex and are best placed as subspecies rather than as separate species. Their addition to the flora of the Siskiyou Range means that this region is an unusually rich center of diversity for perennial *Microseris*, containing 5 recognized taxa. These taxa have defined distribution patterns and characteristic habitat preferences, which allow them to persist as separate populations in this limited geographic region.

Microseris laciniata (Hook.) Sch. Bip. subsp. **siskiyouensis** K.L. Chambers, subsp. nov. (**Figs. 1, 2, 3**). TYPE: U.S.A. CALIFORNIA. DEL NORTE CO.: Hwy. 199, 5.0 mi by road up the Smith R. from Patricks Ck. Guard Station, on a rocky diabase knob overlooking the river, in shallow soil covered by mosses, lichens, and *Selaginella* sp., with *Melica harfordii*, *Luina hypoleuca*, *Sedum* sp., 10 Jul 1964, *K.L. Chambers 2242* (HOLOTYPE: OSC; ISOTYPES: MO, NY, UC).

Microseride laciniato subsp. *leptosepalo* (Nutt.) K.L. Chambers similis a qua segmentis pappi numero 10–24 varians setis minute barbellatis differt; chromosomatum numerus $2n = 18$.

Perennial herbs with 1–3 fleshy biennial taproots; *stems* to 65 cm high, well-branched above, except on depauperate plants, leafy, the floral peduncles arising terminally and from leaf axils; *leaves* linear or narrowly lanceolate, attenuate, sometimes sparsely toothed or pinnatifid with narrow lobes; *involucres* 10–17 mm high, with a series of lanceolate inner phyllaries and a variable number of shorter outer ones ranging from linear to lanceolate-attenuate or deltoid-attenuate (Fig. 1B shows the narrowest type of outer phyllaries), both outer and inner series usually densely furfuraceous (that is, covered with the minute scaly trichomes that are a generic feature of *Microseris*), inner phyllaries usually lightly black-villous dorsally and minutely white-strigulose ventrally; *florets* 13–48+ in number, with yellow ligules 15–22 mm long; *cypselae* pale to dark brown, 3.5–5.5 mm long, 10-ribbed, the ribs usually smooth or lightly scabrous, often lightly hispid near the apex on outer fruits; *pappi* scales 10–24, 0.5–2.0 mm long, lanceolate to linear-lanceolate, white or brownish, bristles minutely barbellate, white.

In the region under discussion, subsp. *leptosepala* and subsp. *siskiyouensis* are practically indistinguishable in habit. Therefore, Figure 1 can represent either taxon. Cypsela and pappi are illustrated in Figure 2, with enlargements of the pappi to show the bristle differences from the scabrous-awned subsp. *leptosepala*, left, and the plumose-awned species *Microseris nutans* (Hook.) Sch. Bip. on the right. The bristle difference with subsp. *leptosepala* breaks down where the taxa are sympatric in western Curry Co., Oregon and Del Norte Co., California. Here both subspecies have barbellate bristles, and they are distinguished only by pappi number—5–10 per cypsela in subsp. *leptosepala*, 10–24 per cypsela in subsp. *siskiyouensis*.

Distribution.—*Microseris laciniata* subsp. *siskiyouensis* is limited to the Siskiyou Mountains in Del Norte and Siskiyou counties, California and Josephine and Jackson counties, Oregon. The most common habitat is in grassy openings of second growth woodlands, in non-serpentine soil or well-developed forest soil over serpentine bedrock. It also occurs on non-serpentine rock outcrops, as at the type locality. Frequently associated woodland species are *Pseudotsuga*

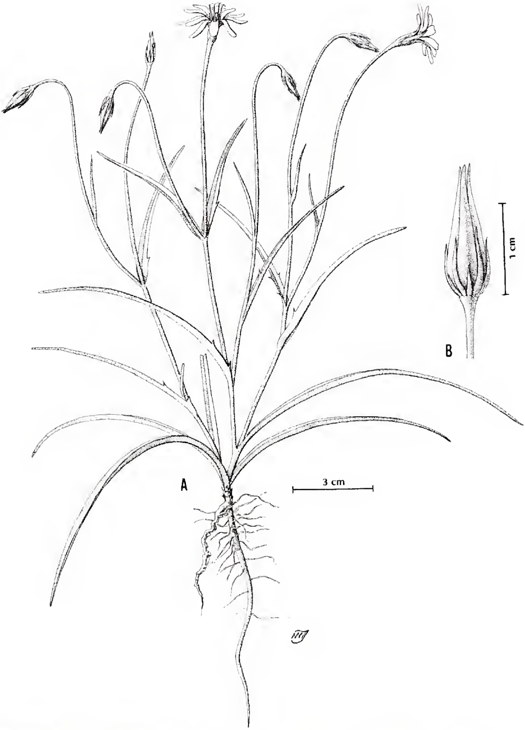


FIG. 1. *Microseris laciniata* subsp. *siskiyouensis*. **A.** Habit of plant at anthesis. **B.** Head with developing fruits.

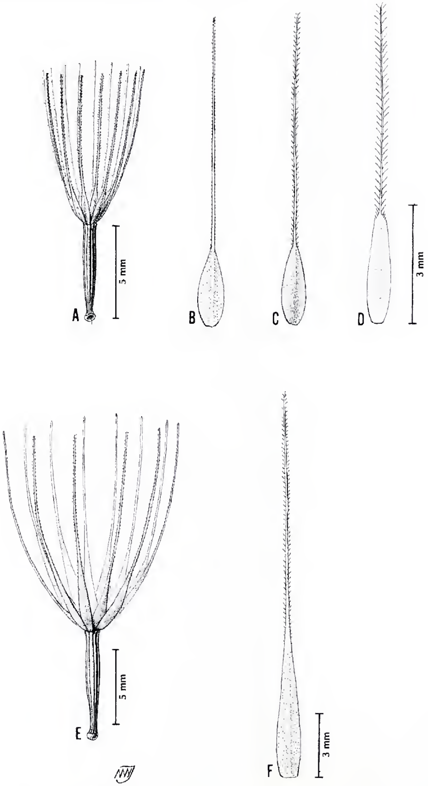


Fig. 2. Cypselae and pappi of various *Microseris* taxa. **A.** Cypsela of *M. laciniata* subsp. *siskiyouensis* bearing 15 pappus parts. **B.** Pappus part of *M. laciniata* subsp. *laciniata* or subsp. *leptosepala*, with scabrous bristle. **C.** Pappus part of *M. laciniata* subsp. *siskiyouensis*, with minutely barbellate bristle. **D.** Pappus part of *M. nutans*, with plumose bristle. **E.** Cypsela of *M. laciniata* subsp. *detlingii* bearing 12 pappus parts. **F.** Pappus part of *M. laciniata* subsp. *detlingii*, with minutely barbellate bristle.

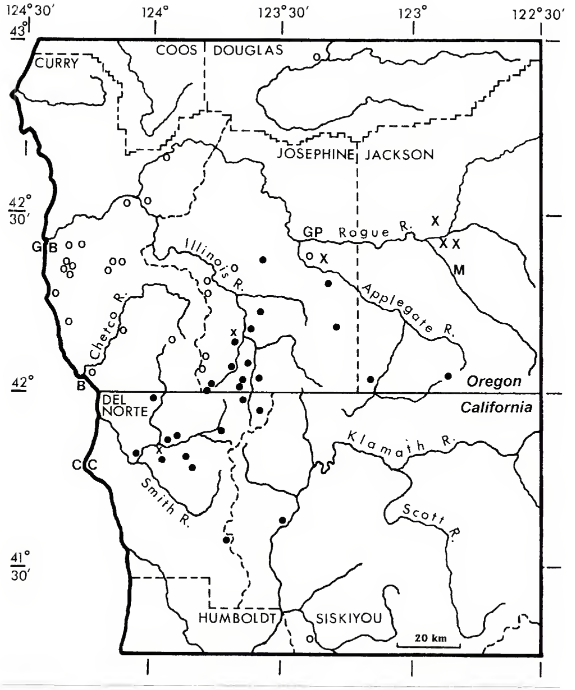


FIG. 3. Distribution of *Micraseris* taxa in the western Siskiyou Mountains. Black circles = *M. laciniata* subsp. *siskiyouensis*; open circles = *M. laciniata* subsp. *leptasepala*; small Xs = intergradent populations between these two taxa; large Xs = *M. laciniata* subsp. *laciniata*. Cities: B = Brookings; CC = Crescent City; GB = Gold Beach; GP = Grants Pass; M = Medford. *Microseris howellii* is omitted.

menziesii, *Pinus lambertiana*, *P. jeffreyi*, *Calocedrus decurrens*, *Quercus garryana*, *Q. kelloggii*, *Arbutus menziesii*, *Arctostaphylos canescens*, *Rhododendron macrophyllum*, and *Ceanothus integerrimus*. Elevations are 30–2100 m.

Flowering.—May–Jul, depending on habitat and elevation.

Figure 3 maps the known populations of subsp. *siskiyouensis*, represented by black circles, while the known localities for subsp. *leptosepala* in the Siskiyous are shown as open circles. The pattern of parapatry and the region of contact in western Josephine County are evident. Two sites have been identified, marked by small Xs, where intermediate populations are known, containing many plants with 10 or fewer pappus parts and others with average pappi numbers in the range of subsp. *siskiyouensis*. One such population, at Gasquet Flat, Del Norte County (see *Chambers 5168*, below) was well sampled by Mauthe et al. (1982), who reported the average numbers of pappi in a sample of 149 plants. The frequencies of plant averages, grouped by whole numbers, are as follows: 9–10: *56*; 10.1–11: *55*; 11.1–12: *15*; 12.1–13: *8*; 13.1–14: *8*; 14.1–15: *6*; 15.1–16: *1*. Although the genetics of pappi numbers are not known, one can speculate that this is a population of subsp. *leptosepala* showing a history of hybridization with subsp. *siskiyouensis*. The second site with an intermediate population, West Side Road in Josephine County (*Chambers 5522*, below), though not as well sampled, shows a similar range of pappi numbers between the two subspecies. For comparison, select plants in 10 populations of subsp. *siskiyouensis* more remote from subsp. *leptosepala* had the following average pappi numbers: 13.2, 15.0, 15.2, 15.5, 15.6, 16.8, 17.0, 17.3, 17.6, and 20.3. The large Xs in Figure 3 mark populations assignable to subsp. *laciniata*; these are discussed below under subsp. *detlingii*.

Collections of *Microseris laciniata* subsp. *siskiyouensis* mapped in Figure 3. **U.S.A. CALIFORNIA. Del Norte Co.:** Old Gasquet Toll Road by Middle Fork of Smith R., 1 Jun 1935, *Tracy 11223* (UC); State Line N of Monumental, 13 Jun 1936, *Tracy 15220* (UC); French Hill, 2 mi S of Gasquet, 20 Jun 1942, *Tracy 17191* (UC); intersection of Hayne's Flat Road, Coon Mtn., 27 Jun 1950, *Tracy 18991* (UC); head of Blue Ck. 1 mi E of Chimney Rock, 19 Jul 1950, *Tracy 19136* (UC); Smith R. on Hwy. 199, 9.7 mi NE of Hwy. 101, 5 Jul 1961, *Breedlove 680* (DS); Pine Flat, 26 Jun 1938, *VanDeventer 237* (JEPS); Old Gasquet Toll Road near Eighteenmile Ck., 26 Jun 1938, *VanDeventer 167* (JEPS); Gordon Mtn. N of Big Flat, 24 Jun 1952, *Munz 17729* (NY); Crazy Peak area on Road 49906-053, 1 Jun 1997, *Paetzel & Bell s.n.* (OSC); Rd. 40S03 S of Waldo, Six Rivers Natl. For. 1 mi S of border of Siskiyou Natl. Forest, 30 Jun 1973, *Denton 2916* (OSC, WTU); Old Gasquet Toll Road 2.7 mi up from Smith R. bridge at Gasquet, 11 Jul 1964, *Chambers 2246* (OSC); Old Gasquet Toll Road 4.7 mi up from Smith R. bridge at Gasquet, 11 Jul 1964, *Chambers 2247* (OSC). **Siskiyou Co.:** Klamath R. 2 mi N of Swillup Ck. Ranger Station, 1 Jun 1942, *Stebbins & Beetle 3273* (UC). **OREGON. Jackson Co.:** Collins Mtn. near Steamboat, 13 Jul 1950, *Whittaker 184* (WS); summit slopes of Big Red Mtn., 15 Jul 1950, *Whittaker s.n.* (WS). **Josephine Co.:** Old Gasquet-O'Brien Toll Road 10.1 mi NE of Patrick Ck. Road, 8 Jun 1962, *Breedlove 3193* (DS); northern city limits of Cave Junction, 9 Jun 1962, *Breedlove 3241* (DS); Waldo Junction, 18 May 1930, *Kildale & Kildale 9643* (DS); Takilma, 24 Jun 1918, *Peck 7955* (GH, WILLU); Murphy Ck. near Murphy, 12 Jul 1950, *Whittaker 155, 159* (WS); Illinois R. Valley SW of Cave Junction, to E of West Side Rd., 11 May 1989, *Brock 242* (OSC); valley of East Fork of Illinois R. by French Flat, 1 Jun 1988, *Kagan 6018801* (OSC); Illinois R. Valley, West Side Road S of Cave Junction, 4 Jun 1991, *Chambers 5609* (OSC); Illinois R. Valley, Rockydale Rd. 2.0 mi N of Waldo Rd. E of O'Brien, 15 Jun 1998, *Chambers 6113* (OSC); Waldo

Hill Lookout Rd. 1.6 mi S of Waldo, 15 Jun 1998, *Chambers 6123* (OSC); junction of Waldo Hill spur road with road to Sanger Pk., 3 Jul 1965, *Chambers 2364* (OSC).

Collections of *Microseris laciniata* subsp. *leptosepala* mapped in Figure 3. **U.S.A. CALIFORNIA. Del Norte Co.:** Gasquet Flat, alluvial flat in mixed evergreen woodland by the Smith R., T17N, R2E, S20, 24 Jun 1984, *Chambers 5168* (OSC). **OREGON. Curry Co.:** 10 mi N of Carpenterville, 7 Jul 1939, *Peck 20450* (WILLU); Brookings, 11 Jul 1919, *Peck 8790* (WILLU); Rogue River 5 mi below Mule Ck., 21 Jun 1917, *Peck 3502* (WILLU), Snow Camp Meadows, 3 Jul 1929, *Leach 2244* (ORE); Mine Cabin, Collier Trail, 28 Jun 1929, *Leach 2277* (ORE); near Agness, 25 Jun 1933, *Leach 4428* (ORE), Waldeens, 29 Jun 1934, *Leach 4700* (ORE); Pyramid Rock, 30 Jun 1934, *Leach 4701* (ORE); Vulcan Peak, T39S, R11W, S15, 23 Jun 1980, *Hess s.n.* (OSC); Agness road, 2 mi W of Illinois R. junction with Rogue R., 18 Jun 1984, *Stansell s.n* (OSC); Signal Buttes E of Gold Beach, 23 Jun 1982, *Stansell s.n.* (OSC); Pine Point Forest Camp, T37S, R13W, S18, 27 Jun 1974, *Hawk s.n.* (OSC); above Wren Cabin, T37S, R14W, S12, 28 Jun 1993, *Rittenhouse 1480* (OSC); 10 km S of Gold Beach, T37S, R14W, S24, 16 Jun 1980, *Sundberg 1098* (OSC); Fairview Meadow, T37S, R12W, S18, 11 Jul 1981, *Chambers 4872* (OSC); Gold Beach to Agness road 1.6 mi W of Illinois R. bridge, 23 Jun 1984, *Chambers 5162* (OSC). **Josephine Co.:** Eagle Gap, 11 mi W of Selma, 23 Jun 1930, *Leach 2897* (ORE, WILLU); 7 mi W of O'Brien, T40S, R10W, S26, 14 Jun 1990, *Kagan s.n.* (OSC); Illinois R. road, T37S, R9W, S32, 31 May 1988, *Kagan 5318801* (OSC); Illinois R. valley W of Selma, T37S, R9W, S23, 19 Jun 1969, *White/Lillico 266* (OSC); old road to Buckskin Pk., T40S, R10W, S24, 11 Jul 1989, *Rolle 256* (OSC); Bolt Mtn. 9 mi SW of Grants Pass near Applegate R., 9 Jul 1996, *Mazzu s.n.* (OSC).

Microseris laciniata (Hook.) Sch. Bip. subsp. **detlingii** K.L. Chambers, subsp. nov. **(Figs. 2, 4, 5).** TYPE: U.S.A. OREGON. JACKSON CO.: Siskiyou Pass, S side on the old highway where it joins Hwy. 5, 2.1 mi N of Hilt exit, grassy openings in *Quercus breweri/Amelanchier pallida* brushland, in heavy clay soil on slope above road, 22 Jun 1967, *K.L. Chambers 2868* (HOLOTYPE: OSC; ISOTYPES: BRIT-SMU, CAS, MO, NY, RSA, UC, US, WS, WTU).

Microseride laciniato subsp. *laciniato* similis a qua marginibus foliorum plerumque integris caule non ramoso radice longissimo segmentis pappi numeris 9–19 varians squamis 4–9 mm setis minute barbellatis differt; chromosomatum numerus $2n = 18$.

Perennial herbs with 1–2 much elongated fleshy biennial taproots; *stem* erect, to 55 cm high, usually simple, leafy near the base; *leaves* lanceolate or oblanceolate, acute to attenuate, tapering below to a clasping, winged petiole, glabrous, entire or rarely sparingly dentate or pinnatifid, margins often undulate; *head* single on a terminal, naked or bracteate peduncle, a second peduncle sometimes arising from the axil of a lower leaf; *involucres* 13–25 mm high, the inner series of phyllaries equal, lanceolate, often black-villous dorsally, the outer phyllaries imbricate in several series, broadly lanceolate to elliptic or round, cuspidate to acuminate, glabrous, sometimes purple-spotted, the outermost 3–7 mm wide; *florets* 18–85+, with yellow ligules 18–22 mm long, often purple-striped dorsally; *cypselae* 5–9 mm long, gray to brown, 10-ribbed, ribs smooth or hispid on outer fruits; *pappi* scales 9–19, 4–9 mm long, lanceolate, silvery (brownish on herbarium specimens), bristles minutely barbellate.

Distribution.—*Microseris laciniata* subsp. *detlingii* is endemic to a limited area east and south of Medford and Ashland, Jackson County, Oregon, extending north to near Butte Falls and south over Siskiyou Pass to the California state

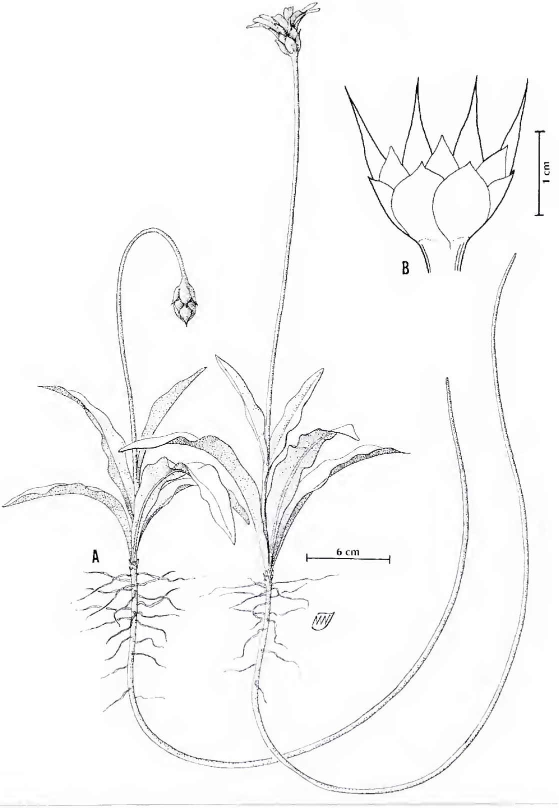


Fig. 4. *Microseris laciniata* subsp. *detlingii*. **A.** Habit of plant at anthesis. **B.** Pressed head showing phyllaries.

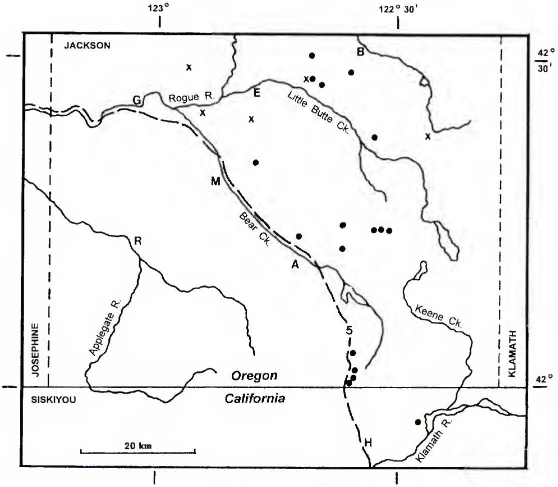


Fig. 5. Distribution of *Microseris* taxa in southern Jackson Co., OR and adjacent Siskiyou Co., CA. Black circles = *M. laciniata* subsp. *detlingii*; Xs = *M. laciniata* subsp. *laciniata*. Cities: A = Ashland; B = Butte Falls; E = Eagle Point; G = Gold Hill; H = Hornbrook; M = Medford; R = Ruch. Dashed line = Interstate Highway 5.

line (Fig. 5). One population has been found in adjacent Siskiyou County, California. The subspecies occurs only in montmorillonite clay soil, sticky when wet and hard and cracked when dry, on grassy slopes and openings in shrublands and forest edges. The geology of the type area, south of the summit of Siskiyou Pass, was included in the thesis of Richard Carlton (1972), who identified the underlying rocks at the type locality as fossil-bearing claystones and siltstones of the early Eocene Colestin Formation, lacustrine in origin and possessing clay minerals of the montmorillonite-mica type. Farther north, near Ashland and Medford, similar clay soil develops in younger Eocene deposits of volcanic-derived sedimentary rocks (McKnight 1971). The complex geology of this region also includes sandstones and volcanic lahar and ash-flow deposits. Adaptations of subsp. *detlingii* to this unusual substrate include an exceptionally deep, slender taproot (Fig. 4) and the ability to reproduce clonally by adventitious buds on the lateral rootlets. Colonies are often limited to patches of loose soil turned up by gophers or squirrels. Associated species are *Pinus jeffreyi*, *Quercus breweri*, *Q. garryana*, *Amelanchier pallida*, *Ceanothus cuneatus*, *Arctostaphylos viscida*, *Toxicodendron diversifolium*, *Festuca idahoensis*, *Achnatherum lemmonii*. Elevations are 600–1450 m. Flowering occurs May–Jun.

Etymology.—The name is in honor of Prof. LeRoy Detling, longtime curator of the University of Oregon herbarium, whose 1950 collection first alerted the author to the peculiar features of this plant.

Figure 5 shows the limited distribution of subsp. *detlingii*, as well as the nearby occurrence of populations, marked by Xs, which the author places in subsp. *laciniata*. The latter specimens, listed below, occur on substrates other than the "heavy clay soil" or "rocky clay soil" consistently mentioned on the labels of subsp. *detlingii* specimens. North of Medford, subsp. *laciniata* is found on rocky alluvium, as at the Agate Desert (*Chambers 3080*), and differs from subsp. *detlingii* in having pinnate leaves, multiple arched-ascending stems from the base, consistently 10 pappi, and lacking an unusually elongate taproot. However, the pappi scales are up to 4 mm long, nearly twice the usual range of subsp. *laciniata*, and are barbellulate. On Kanutchan Creek just north of Little Butte Creek, collections by Greenleaf (*1418, 1435*) contain both subsp. *detlingii* and plants with highly pinnatifid leaves and basal branching like that of subsp. *laciniata* at Agate Desert. The habitat is described as *Quercus garryana/Pinus ponderosa/Arbutus menziesii* woodland. We expect that more intergradation will be found between the two subspecies in this area, depending on soil type and disturbance, for example by erosion and cattle grazing. A pappus member of subsp. *detlingii* is shown in Figure 2B, where it is compared with both subsp. *siskiyouensis* and with the common type in subspp. *leptosepala* and *laciniata*.

Collections of *Microseris laciniata* subsp. *detlingii* mapped in Figure 5. **U.S.A. CALIFORNIA. Siskiyou Co.:** Copco Rd. W of Iron Gate Reservoir, 1.2 mi N of Klamath R. bridge at Iron Gate Dam, 16 Jun 1998, *Chambers 6132* (OSC, UC). **OREGON. Jackson Co.:** High hills opposite Ashland, Jun 1889, *Howell s.n.* (MIN, MSC, ORE, UC, US); slope of Grizzly Peak, 17 Jul 1913, *Peck 7667* (WILLU); Klamath Hwy. 7 mi SE of Ashland, 19 Jun 1927, *Peck 15000* (WILLU); S slope of Siskiyou Mtns. near California line, 12 Jun 1930, *Henderson 13256* (ORE); Siskiyou Pass, T41S, R2E, S8, 11 Jun 1950, *Detling 6635* (DS, ORE, UC, WTU); Dead Indian Memorial Rd. E of Ashland, T39S., R2E, S5, 23 May 1995, *Straw 3274* (SOC); Round Top RNA, T35S, R1E, S15, 25 Jun 1997, *Wineteer s.n.* (SOC); Kanutchan Ck., T35S., R1E, S27, 31 May 1983, *Greenleaf 1435* (OSC); Dead Indian Memorial Rd. E of Ashland, T38S, R2E, S24, 9 Jul 1982, *Kagan s.n.* (OSC); S of Butler Ck., hills N of Ashland, 9 May 1993, *Brock 486* (OSC); W slope of Roxy Ann Pk. E of Medford, 30 May 1993, *Brock 496* (OSC); Lick Ck., T36S, R1E, S1, *Brock 797* (OSC); Heppsie Mtn., T37S, R2E, S2, *Brock 807b* (OSC); Lick Ck., T35S, R2E, S29, 14 Jun 2001, *Knapp 614001* (OSC); Old Siskiyou Pass Rd.. 3.5 mi S of summit at junction with Hwy. 5, 29 May 1965, *Chambers 2348* (OSC); Old Siskiyou Pass Rd. 0.7 mi N of junction with Hwy. 5, 22 Jun 1967, *Chambers 2869* (OSC); Old Siskiyou Pass Rd. 2.7 mi N of junction with Hwy. 5, 22 Jun 1967, *Chambers 2870* (OSC); Siskiyou Pass summit on the old road, T40S, R2E, S32-33, 13 Jul 1978, *Chambers 4524* (OSC); Siskiyou Pass, S side, on abandoned stretch of old road ca. 0.25 mi N of California state line, 16 Jun 1998, *Chambers 6131* (OSC).

Collections of *Microseris laciniata* subsp. *laciniata* mapped in Figures 3 and 5. **U.S.A. OREGON. Jack-**

son Co.: Sam's Valley N of Medford, 4 May 1930, *Henderson 12388, 13253* (ORE); 5 mi W of Fish Lake, T36S, R3E, S35, 27 Jul 1989, *Rolle 280* (OSC); Kanutchan Ck. ca. 4 mi E of Eagle Point, 26 May 1983, *Greenleaf 1418* (OSC); Sam's Valley, T35S, R2W, S32, 6 May 1961, *Chambers 1601* (OSC); 2.5 mi E of Hwy 62, White City N of Medford, 16 May 1971, *Chambers 3044* (OSC); Agate Desert N of Medford, Kirtland Rd. 1 mi W of Table Rock Rd., 16 May 1971, *Chambers 3080* (OSC). **Josephine Co.:** Fish Hatchery Rd 0.7 mi W of New Hope Rd. S of Grants Pass, 14 Jun 1998, *Chambers 6105* (OSC).

DISCUSSION

The Klamath Region, including the Siskiyou Mountains, has long been recognized as an area of high endemism and as a center of floristic diversity (Whittaker 1961). Factors favoring this diversity, mentioned by Whittaker, include a steep climatic gradient from the coast inland, high rainfall and moderate temperatures, much-dissected topography, and diversity of bedrock, and hence of soil types. The complex geological history and origin of the varying substrates are described by Coleman and Kruckeberg (1999). Types of endemism and an analysis of the endemic flora were presented by Smith and Sawyer (1988). These authors list the two taxa newly described here, whose names were available on herbarium annotations, and also *Microseris howellii*, a previously named endemic of serpentine barrens in the Illinois River valley of Josephine County, Oregon. This species, and the other *Microseris* taxa mentioned above, illustrate very well the importance of edaphic and climatic factors in keeping separate the parapatric members of this complex.

Proceeding from west to east, *Microseris laciniata* subsp. *leptosepala* occupies the more coastal region of Curry County and is found on serpentine barrens as well as non-serpentine meadows and forest edges. The peculiar vegetation and characteristic flora on serpentine barrens in the Siskiyous are discussed in Coleman and Kruckeberg (1999). Examples of serpentine sites among the specimens of subsp. *leptosepala* cited above are Pine Point (*Hawk s.n.*), Gold Beach to Agness road (*Chambers 5162, Stansell s.n.*), Signal Buttes (*Stansell s.n.*), S of Gold Beach (*Sundberg 1098*), Buckskin Peak (*Rolle 256*), and 7 miles W of O'Brien (*Kagan s.n.*). Endemic to serpentine barrens farther east in the Illinois River valley is *M. howellii*, a close relative of *M. laciniata*, having 5–10 pappi but differing in its pappi scales 3–5 mm long. Parapatric in Oregon with *M. howellii* is *M. laciniata* subsp. *siskiyouensis*, which avoids open, rocky serpentine barrens but occurs in adjacent forested sites in loam soil. No hybrid populations have been noted between these two taxa. To the east, *M. laciniata* subsp. *laciniata* is on alluvial and deeper loam soils in grasslands and mixed oak woodlands near the Rogue River. Finally, *M. laciniata* subsp. *detlingii* is endemic to montmorillonite clay soils from 600–1450 m elevation in the Medford-Siskiyou Pass area.

The differentiation of *Microseris* taxa in the Siskiyous, and their maintenance as genetically separate populations, has involved both an adaptation to different substrates and a geographical separation into different climatic zones.

This has led to an unusual richness of species and subspecies in this limited region of southwestern Oregon and adjacent California, which is in line with the frequently mentioned floristic diversity of the Klamath-Siskiyou Mountains in general.

ACKNOWLEDGMENTS

The author gratefully acknowledges the help of the following colleagues in various aspects of this study: Konrad Bachmann, Richard Brock, Richard Carlton, John Dilles, Jimmy Kagan, Linda Mazzu, John Megahan, Bruce Rittenhouse, Wayne Rolle, Veva Stansell, and Richard Straw.

REFERENCES

Bachmann, K. and K.L. Chambers. 1978. Pappus part number in annual species of *Microseris* (Compositae, Cichoriaceae). Pl. Syst. Evol. 129:119–134.

Bachmann, K. and H.J. Price. 1979. Variability of the inflorescence of *Microseris laciniata* (Compositae: Cichorieae). Pl. Syst. Evol. 131:17–34.

Carlton, R.W. 1972. Stratigraphy, petrology, and mineralogy of the Colestin Formation in southwest Oregon and northern California. Ph.D. Thesis, Oregon State Univ., Corvallis.

Chambers, K.L. 1957. Taxonomic notes on some Compositae of the Western United States. Contr. Dudley Herb. 5:56–68.

Chambers, K.L. 1960. *Microseris*. In: Abrams, L.R. and R.S. Ferris, eds. Illustrated flora of the Pacific States. Vol. IV. Stanford Univ. Press, Stanford, CA. Pp. 554–562.

Chambers, K.L. 1993. *Microseris*. In: Hickman, J., ed. The Jepson manual: higher plants of California. Univ. California Press, Berkeley. Pp. 316–319.

Coleman, R.G. and A.R. Kruckeberg. 1999. Geology and plant life of the Klamath – Siskiyou Mountain region. Natural Areas J. 19:320–340.

McKnight, B.K. 1971. Petrology and sedimentation of Cretaceous and Eocene rocks in the Medford–Ashland region, south-eastern (sic!) Oregon. Ph.D. Thesis, Oregon State Univ., Corvallis.

Mauthe, S., K. Bachmann, K.L. Chambers, and H.J. Price. 1982. Variability of the inflorescence among populations of *Microseris laciniata* (Asteraceae, Lactuceae). Beitr. Biol. Pflanzen 56:25–52.

Pires, M.J.P. 1980. Morphogenetic studies of intraspecific hybrids of *Microseris laciniata* (Hook.) Sch. Bip. M.S. Thesis, Oregon State Univ., Corvallis.

Smith, J.P. Jr. and J.O. Sawyer. 1988. Endemic vascular plants of northwestern California and southwestern Oregon. Madroño 35:54–69.

Whittaker, R.H. 1961. Vegetation history of the Pacific Coast states and the "central" significance of the Klamath region. Madroño 16:5–23.

BOOKS RECEIVED

William A. Weber, F.L.S., (Ed). 2004. **The Valley of the Second Sons (Letters of Theodore Dru Alison Cockerell, a Young English Naturalist, Writing to His Sweetheart and Her Brother about His Life in West Cliff, Wet Mountain Valley, Colorado 1887-1890).** (ISBN 0-9710609-9-1, pbk.). Pilgrims Process, Inc., 4066 Niblick Drive, Longmont, CO 80503. (Orders: 303-554-6641, www.PilgrimsProcess.com). $39.95, 358 pp., 7 1/2" × 9".

Glafiro J. Alanís Flores and Diego González Alanís. 2003. **Flora Nativa Ornamental Para el área Metropolitana de Monterrey. Descripción Botanica y Requerimientos de las Especies para el Paisaje Urbano.** (ISBN 970-649-122-3 pbk.). Universidad Autonoma de Nuevo León R. Ayuntamiento de Monterrey, 2000-2003. (Orders: Email: galaris@ccr.dsi.uani.mx). Price not given, 127 pp., color photos, 8 1/4" × 8 1/4".

Joseph Felsensteiin. 2004. **Inferring Phylogenies.** (ISBN 0-8893-728-5, pbk.). Sinauer Associates, Inc. Publishers, 23 Plumtree Road, Sunderland, MA 01375, U.S.A. (Orders: fax 413-549-1118, orders@sinauer.com, www.sinauer.com). $59.95, 664 pp., b/w photos, graphs, 7" × 9".

The book is divided into 35 chapters: **1)** Parsimony methods. **2)** Counting evolutionary changes. **3)** How many trees are there? **4)** Finding the best tree by heuristic search. **5)** Find the best tree by branch and bound. **6)** Ancestral states and branch lengths. **7)** Variants of parsimony. **8)** Compatibility. **9)** Statistical properties of parsimony. **10)** A digression on history and philosophy. **11)** Distance matrix methods. **12)** Quartets of species. **13)** Models of DNA evolution. **14)** Models of protein evolution. **15)** Restriction sites, RAPDs, AFLPs, and microsatellites. **16)** Likelihood methods. **17)** Hadamard methods. **18)** Bayesian inference of phylogenies. **19)** Testing models, trees, and clocks. **20)** Bootstrap, jackknife, and permutation tests. **21)** Paired-sites tests. **22)** Invariants. **23)** Brownian motion and gene frequencies. **24)** Quantitative characters. **25)** Comparative methods. **26)** Coalescent trees. **27)** Likelihood calculations on coalescents. **28)** Coalescents and species trees. **29)** Alignment, gene families, and genomics. **30)** Consensus trees and distances between trees. **31)** Biogeography, hosts, and parasites. **32)** Phylogenies and paleontology. **33)** Tests based on tree shape. **34)** Drawing trees. **35)** Phylogeny software.

NEW TAXA AND NEW COMBINATIONS IN NORTH AMERICAN *CIRSIUM* (ASTERACEAE: CARDUEAE)

David J. Keil

Biological Sciences Department
California Polytechnic State University
San Luis Obispo, California 93407, U.S.A.
dkeil@calpoly.edu

ABSTRACT

Six new varieties are proposed in North American *Cirsium* (Asteraceae: Cardueae): **C. arizonicum** (A. Gray) Petrak var. **tenuisectum** D.J. Keil var. nov., **C. eatonii** (A. Gray) B.L. Rob. var. **viperinum** D.J. Keil, var. nov., **C. edule** Nutt. var. **wenatchense** D.J. Keil, var. nov., **C. occidentale** (Nutt.) Jeps. var. **lucianum** D.J. Keil, var. nov., **C. scariosum** Nutt. var. **robustum** D.J. Keil, var. nov., **C. scariosum** Nutt. var. **toiyabense** D.J. Keil, var. nov. Additionally, twenty new combinations are presented: **C. arizonicum** (A. Gray) Petrak var. **bipinnatum** (Eastw.) D.J. Keil, comb. nov., **C. arizonicum** (A. Gray) Petrak var. **chellyense** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov., **C. arizonicum** (A. Gray) Petrak var. **rothrockii** (A. Gray) D.J. Keil, comb. et stat. nov., **C. clavatum** (M.E. Jones) Petrak var. **americanum** (A. Gray) D.J. Keil, comb. nov., **C. clavatum** (M.E. Jones) Petrak var. **osterhoutii** (Rydb.) D.J. Keil, comb. et stat. nov., **C. cymosum** (Greene) J.T. Howell var. **canovirens** (Rydb.) D.J. Keil, comb. et stat. nov., **C. eatonii** (A. Gray) B.L. Rob. var. **eriocephalum** (A. Nelson) D.J. Keil, comb. nov., **C. eatonii** (A. Gray) B.L. Rob. var. **hesperium** (Eastw.) D.J. Keil, comb. et stat. nov., **C. eatonii** (A. Gray) B.L. Rob. var. **peckii** (L.F. Hend.) D.J. Keil, comb. et stat. nov., **C. eatonii** (A. Gray) B.L. Rob. var. var. **clokeyi** (S.F. Blake) D.J. Keil, comb. et stat. nov., **C. edule** Nutt. var. **macounii** (Greene) D.J. Keil, comb. et stat. nov., **C. horridulum** Michx. var. **megacanthum** (Nutt.) D.J. Keil, comb. et stat. nov., **C. inamoenum** (Greene) D.J. Keil, comb. nov., **C. inamoenum** (Greene) D.J. Keil var. **davisii** (Cronquist) D.J. Keil, comb. et stat. nov., **C. ochrocentrum** A. Gray var. **martinii** (P. Barlow-Irick) D.J. Keil, comb. et stat. nov., **C. pulcherrimum** (Rydb.) K. Schum. var. **aridum** (R.D. Dorn) D.J. Keil, comb. et stat. nov. **C. scariosum** Nutt. var. **americanum** (A. Gray) D.J. Keil, comb. nov., **C. scariosum** Nutt. var. **citrinum** (Petrak) D.J. Keil, comb. nov., **C. scariosum** Nutt. var. **coloradense** (Rydb.) D.J. Keil, comb. et stat. nov., **C. scariosum** Nutt. var. **congdonii** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov. Lectotypes are designated for several of these taxa.

RESUMEN

Se proponen seis variedades nuevas en *Cirsium* (Asteraceae: Cardueae) de Norteamérica: ***C. arizonicum*** (A. Gray) Petrak var. ***tenuisectum*** D.J. Keil var. nov., ***C. eatonii*** (A. Gray) B.L. Rob. var. ***viperinum*** D.J. Keil, var. nov., ***C. edule*** Nutt. var. ***wenatchense*** D.J. Keil, var. nov., ***C. occidentale*** (Nutt.) Jeps. var. ***lucianum*** D.J. Keil, var. nov., ***C. scariosum*** Nutt. var. ***robustum*** D.J. Keil, var. nov., ***C. scariosum*** Nutt. var. ***toiyabense*** D.J. Keil, var. nov. Se presentan además veinte combinaciones nuevas: ***C. arizonicum*** (A. Gray) Petrak var. ***bipinnatum*** (Eastw.) D.J. Keil, comb. nov., ***C. arizonicum*** (A. Gray) Petrak var. ***chellyense*** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov., ***C. arizonicum*** (A. Gray) Petrak var. ***rothrockii*** (A. Gray) D.J. Keil, comb. et stat. nov., ***C. clavatum*** (M.E. Jones) Petrak var. ***americanum*** (A. Gray) D.J. Keil, comb. nov., ***C. clavatum*** (M.E. Jones) Petrak var. ***osterhoutii*** (Rydb.) D.J. Keil, comb. et stat. nov., ***C. cymosum*** (Greene) J.T. Howell var. ***canovirens*** (Rydb.) D.J. Keil, comb. et stat. nov., ***C. eatonii*** (A. Gray) B.L. Rob. var. ***eriocephalum*** (A. Nelson) D.J. Keil, comb. nov., ***C. eatonii*** (A. Gray) B.L. Rob. var. ***hesperium*** (Eastw.) D.J. Keil, comb. et stat. nov., ***C. eatonii*** (A. Gray) B.L. Rob. var. ***peckii*** (L.F. Hend.) D.J. Keil, comb. et stat. nov., ***C. eatonii*** (A. Gray) B.L. Rob. var. var. ***clokeyi*** (S.F. Blake) D.J. Keil, comb. et stat. nov., ***C. edule*** Nutt. var.

SIDA 21(1): 207–219. 2004

macounii (Greene) D.J. Keil, comb. et stat. nov., ***C. horridulum*** Michx. var. ***megacanthum*** (Nutt.) D.J. Keil, comb. et stat. nov., ***C. inamoenum*** (Greene) D.J. Keil, comb. nov., ***C. inamoenum*** (Greene) D.J. Keil var. ***davisii*** (Cronquist) D.J. Keil, comb. et stat. nov., ***C. ochrocentrum*** A. Gray var ***martinii*** (P. Barlow-Irick) D.J. Keil, comb. et stat. nov., ***C. pulcherrimum*** (Rydb.) K. Schum. var ***aridum*** (R.D. Dorn) D.J. Keil, comb. et stat. nov., ***C. scariosum*** Nutt. var ***americanum*** (A. Gray) D.J. Keil, comb. nov., ***C. scariosum*** Nutt. var. ***citrinum*** (Petrak) D.J. Keil, comb. nov., ***C. scariosum*** Nutt. var. ***coloradense*** (Rydb.) D.J. Keil, comb. et stat. nov., ***C. scariosum*** Nutt. var. ***congdonii*** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov., También se designan lectótipos de varios de estos taxa.

Preparation of a taxonomic treatment of *Cirsium* Mill. (Asteraceae: Cardueae) for the upcoming Asteraceae volumes of the Flora of North America has entailed a reevaluation of many of the published taxa. The only comprehensive treatment of North American *Cirsium* species (Petrak 1912, 1917) is long out of date. Revisions or cytotaxonomic studies have been published for several species groups (Frankton & Moore 1961, 1963; Moore & Frankton 1962, 1964, 1965, 1966, 1969, 1974; Ownbey 1952; Ownbey & Hsi 1963, 1969; Ownbey & Olson 1969; Ownbey et al. 1975), and many of the species have been included in state or regional floristic treatments (e.g., Cronquist 1955, 1994; Dorn 1992; Gardner 1974; Howell 1960; Keil & Turner 1993; Munz & Keck 1959; Munz 1974; Weber 1996; Weber & Wittmann 1987; Welsh 1983; Welsh et al. 1993), but these treatments have been uneven and limited in scope. Political boundaries often mark the application of differing taxonomic constructs. In my investigations I have examined North American *Cirsium* as a whole and across the breadth of its geographic range.

Cirsium well deserves its reputation as a taxonomically difficult genus. One of the most challenging aspects for a taxonomist studying New World *Cirsium* is the presence of species complexes that are apparently evolutionary works in progress. Some of the thistles, especially in the mountainous western part of North America, are frustratingly polymorphic with mosaic and overlapping patterns of variation and intergradation of characters. Early taxonomists, basing their work on a limited sampling of the morphological diversity, named many of the forms as species, and the literature is robust with species names. The infilling that results from more collectors visiting more localities within the ranges of these complexes has blurred the boundaries between many of the proposed species and often added forms that do not "fit" the characters of named species. As I faced the challenges of preparing the FNA treatment I recognized that maintaining some of the named entities as species would for consistency require a further proliferation of species names.

I have chosen to go the other way. Instead continuing the proliferation of ill-defined microspecies I treat the plants in question as rapidly evolving, only partially differentiated assemblages of races that have not reached the level of stability that is usually associated with the concept of species. In a molecular phylogenetic investigation Kelch and Baldwin (2003) found unusually low rates of molecular divergence relative to the ecological diversity of New World *Cirsium* and suggested that the genus has undergone a rapid ecological diversification on a continental scale. Certainly there is much variation within these groups that deserves a level of taxonomic recognition, or that at least should be mentioned, but I think it much more prudent to recognize these as infraspecific taxa—entities that may be expected to freely intergrade—than species. I view species as entities that should be consistently recognizable. Within a large genus such as *Cirsium* the amount of infraspecific variation and the degree of geographical separation among races varies from species to species and from geographical race to geographical race. Races occupying contiguous habitats often intergrade freely in zones of contact whereas races currently isolated by geographic or habitat barriers often have more discrete variation patterns. Both situations may occur in a single species.

Infraspecific taxa in *Cirsium* have been recognized in various taxa at the rank of form, variety, and subspecies. In the Flora of North America (Flora of North America Editorial Committee 1996) the trivial rank of form, representing sporadic variants without a geographic range, is not used. Some *Cirsium* variants recognized in the past as varieties are the equivalent of forms. In *Cirsium* both variety and subspecies have been used in the context of morphologically distinguishable geographical races. The rank of variety has been used more widely. The Flora of North America Guide for Contributors (Flora of North America Editorial Committee 1996) stipulates that only one infraspecific rank (subspecies or variety) be recognized within a genus. As used by most workers in *Cirsium* taxonomy the choice of rank has been a matter of preference, and I view them as equivalent. I have chosen to use variety rather than subspecies because only one change from subspecies to variety has to be made to follow the Flora of North America Guidelines whereas the use of subspecies as the infraspecific rank for formally recognized geographical races would require many more nomenclatural innovations.

The overall product of my studies will be detailed in the FNA treatment (Keil, in press). Presented below are six newly proposed varieties and validation of twenty new combinations for North American *Cirsium.*

Cirsium arizonicum (A. Gray) Petrak var. **bipinnatum** (Eastw.) D.J. Keil, comb. nov. BASIONYM: *Cnicus drummondii* Torr. & A. Gray var. *bipinnatus* Eastw., Zoe 4:8. 1893. TYPE: COLORADO: Johnston Cañon near where it joins Mancos River, Sep 1892, *Eastwood s.n.* (HOLOTYPE: CAS; ISOTYPE: MIN).

Cirsium arizonicum (A. Gray) Petrak var. **chellyense** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov. BASIONYM: *Cirsium chellyense* R.J. Moore & Frankton, Canad. J. Bot. 52:547. 1974. TYPE: ARIZONA. Apache Co.: Canyon de Chelly, 1 Jul 1961, *Norman 680* (HOLOTYPE: DAO).

Cirsium arizonicum (A. Gray) Petrak var. **rothrockii** (A. Gray) D.J. Keil, comb. et stat. nov. Basionym: *Cnicus rothrockii* A. Gray, Proc. Amer. Acad. Arts 17:220. 1882. Type: ARIZONA: Rocky Canyon, 1874, *Rothrock 289* (lectotype, here chosen from syntypes, GH). Gray (1882) described *Cnicus rothrockii* based upon two collections (*Rothrock 289* and *Lemmon 2794*).

Moore and Frankton (1974) selected *Rothrock 289* as the lectotype collection of *Cnicus rothrockii*. However, they cited as lectotype specimens of this gathering from both GH and US. According to Article 9.2 of the International Code of Botanical Nomenclature (Greuter et al. 2000) "a lectotype is a specimen or illustration designated from the original material as the nomenclatural type." Moore and Frankton's designation of two specimens at different institutions as lectotype fails the requirement that a single specimen serve in that role. I agree with their designation of *Rothrock 289* as the lectotype collection and here choose the GH specimen as lectotype for the taxon.

Cirsium arizonicum (A. Gray) Petrak var. **tenuisectum** D.J. Keil, var. nov. Type: CALIFORNIA. San Bernardino Co.: New York Mountains, Keystone Canyon, 2.1 road mi from Ivanpah Road, ca. 1670 m, *Pinus monophylla-Juniperus osteosperma* woodland; scattered in rocky wash channel; associates: *Fallugia paradoxa, Prunus fasciculata, Gutierrezia sarothrae, Atriplex canescens, Eriodictyon angustifolium, Yucca brevifolia, Opuntia echinocarpa, Menodora scabra, Ephedra nevadensis, Penstemon* sp., *Machaeranthera canescens, Purshia mexicana, Muhlenbergia porteri, Ericameria linearifolia, Salvia dorrii, Lycium cooperi, Yucca baccata, Berberis* sp., *Rhus trilobata, Sphaeralcea* sp., *Ipomopsis agregata, Datura wrightii, Artemisia dracunculus*, and *Achnatherum hymenoides*, 5 Nov 1999, *Keil 28401* (holotype—flowering stem of plant D, OBI; isotypes [the letter in parentheses represents the individual], ASU (A), BRY (C), CAS (B), CDA (C), DAO (D), GH (D), MIN (D), MO (C), NY (C), OBI (A, C), RSA (A), TEX (D), UC (B), US (D)).

Caulibus et costis abaxialibus glabris ad tomentosis trichomatibus tenuibus non-septatis, spinis principalibus foliorum 5–30 mm longis, et corollis rubellopurpureis distinguatur.

Stems thinly arachnoid tomentose, ± glabrate, without septate trichomes. Leaves deeply divided, often nearly to the midvein, abaxially arachnoid tomentose or sometimes glabrate, without septate trichomes, adaxially thinly arachnoid or glabrate; principal marginal spines 5–30 mm, often stout; cauline leaves narrowed at base to truncate or ± clasping, but not or only slightly decurrent. Involucres cylindric to campanulate; phyllary spines 5–25 mm, stout. Corollas reddish purple, 25–35 mm, the tube 10–13, throat 5–8 mm, lobes 10–13.5 mm; style tips 1–2 mm.

Paratypes: **CALIFORNIA. San Bernardino Co.:** New York Mountains, Carruthers Canyon, 1615–1645 m, 6 Nov 1999, *Keil 28402* (NMC, OBI, OSC); New York Mountains, Keystone Spring, 1585 m, 13 Oct 1935, *Munz 13862* (UC). Nevada. Clark Co.: SW slope of NW Spring Mts., upper Clark Canyon, yellow pine vegetation, 7000-7600 ft, 9 Jul 1970, *Beatley 11355* (UNLV); Charleston Mts., Charleston Peak, gravelly wash, with *Pinus scopulorum*, 2270 m, 18 Jul 1938, *Clokey 8182* (PH, UC, UTC(2), WTU(2)), Charleston Mts., Kyle Canyon at bridge, wash with aspens, 2300 m, 3 Aug 1935, *Clokey 5609* (UC), Charleston Mts., Charleston Park, gravelly wash, yellow pine belt, 2300 m, 25 Jul 1936, *Clokey 5609*

(UC, UTC, WTU); Charleston Mts., Lee Cañon, in limestone, 8000 ft, 4 Aug 1913, *Heller 11057* (PH, UC); Charleston Mts., Pine Cr., 6700 ft, 4 Sep 1927, *Jaeger 2202* (UC); Charleston Mts., near Charleston park resort, plentiful, 8000 ft, 12 Sep 1925, *Jaeger s.n.* (UC); Spring Range, Toiyabe National Forest, Kyle Canyon Rd. (Nevada Rte. 157) just W of junction with Nevada Rte. 157, Ponderosa pine forest, 6930 ft, 17 Aug 2002, *Keil 29112* (OBI); Spring Mountains, Toiyabe National Forest, Las Vegas Ski and Snowboard area in Upper Lee Canyon, 36.299°N, 115.696°W, subalpine forest with limber pine, bristlecone pine, white fir, quaking aspen, wax currant, and common juniper, 9200 ft, 17 Aug 2002, *Keil 29114* (OBI); Red Rock Canyon Recreation Lands, Mouth of Velvet Canyon, with *Celtis reticulata*, *Quercus turbinella*, and *Chrysothamnus paniculatus*, 4400 ft, 6 Jun 1990, *Leary et al. 4006* (UNLV); Spring Range, NW of Las Vegas, upper Lee Canyon between ski area and saddle at head of Wallace Canyon, conifer forest with *Pinus flexilis*, *P. longaeva*, *Abies concolor*, and *Populus tremuloides* on steep limestone slopes and canyon bottom, 8700–9900 ft, 31 Aug 1986, *Sanders et al. 6881* (OBI).

The *Cirsium arizonicum* complex is a group of closely related taxa of the southwestern United States and northwestern Mexico. This species complex was revised by Moore and Frankton (1974), who recognized eight species, three of them newly described. In Moore and Frankton's key to species of the *C. arizonicum* complex, var. *tenuisectum* keys to *Cirsium nidulum* (M.E. Jones) Petrak, and these authors cited a chromosome count from the Spring Mountains population of var. *tenuisectum* as *C. nidulum*. Moore and Frankton's rather imprecise range map does not include the New York Mountains for *C. nidulum* or any other member of the *C. arizonicum* complex, and there is no indication that Moore and Frankton were aware of the thistles from this mountain range. *Cirsium nidulum* is the name that has been used for the New York Mountains thistle in various floras (Howell 1960; Munz and Keck 1959; Munz 1974; Keil and Turner 1993, 2002). As a part of my research on *Cirsium* for the Flora of North America project, I have examined many specimens, including types, from throughout the range of the various members of the *Cirsium arizonicum* complex, and I have concluded that the *C. arizonicum* complex should be treated as a single polymorphic species. It has become evident that the name *Cirsium nidulum* has been widely misapplied; the type is a very spiny plant of var. *arizonicum*. The plants from the Spring Mountains and New York Mountains represent a previously unnamed variety.

Cirsium clavatum (M.E. Jones) Petrak var. **americanum** (A. Gray) D.J. Keil, comb. nov. BASIONYM: *Cnicus carlinoides* Schrank var. *americanus* A. Gray, Proc. Amer. Acad. Arts 10:48. 1874. TYPE: COLORADO: Rocky Mts., lat. 39–41°, *Hall and Harbour 339* (LECTOTYPE, here chosen from syntypes, GH).

The varietal epithet *americanum* was based upon syntypes from both Colorado and California. The latter are referable to *Cirsium remotifolium* (Hook.) DC. Gray (1874) cited two Colorado collections, *Greene s.n.* and *Hall and Harbour 342*. Cronquist (1994) stated that "*Hall & Harbour 342*, Rocky Mts., Colo., is the first collection cited and has been taken to be the type; original at GH!" I agree with the choice of *Hall and Harbour 342* and am validating its designation as lectotype.

Cirsium clavatum (M.E. Jones) Petrak var. **osterhoutii** (Rydb.) D.J. Keil, comb. et stat. nov. BASIONYM: *Carduus osterhoutii* Rydb., Bull. Torrey Bot. Club 32:131. 1905. TYPE: COLORADO. EAGLE CO.: Red Cliff, 1902, *Osterhout 2706* (HOLOTYPE: NY; ISOTYPE: RM).

Cirsium cymosum (Greene) J.T. Howell var. **canovirens** (Rydb.) D.J. Keil, comb. et stat. nov. BASIONYM: *Carduus canovirens* Rydb., Mem. N.Y. Bot. Gard. 1:450. 1910. TYPE: MONTANA. MADISON CO.: Jack Creek Cañon, 7000 ft, 15 Jul 1897, *Rydberg and Bessey 5213* (HOLOTYPE: NY).

Cirsium eatonii (A. Gray) B.L. Rob. var. **eriocephalum** (A. Nelson) D.J. Keil, comb. nov. BASIONYM: *Cirsium eriocephalum* A. Gray, nom. illeg.; *Carduus hookerianus* Nutt. [var.] *eriocephalus* A. Nelson, in J.M. Coult. & A. Nelson, Man. Bot. Rocky Mts. 585. 1909. TYPE: COLORADO: headwaters of Clear Creek and the alpine ridges lying E of Middle Park, 1861, *Parry s.n.* (LECTOTYPE, here chosen from syntypes, GH).

This taxon was originally named *Cirsium eriocephalum* by Gray (1863), but this name was a later homonym. Because of the illegitimate status of *C. eriocephalum*, a priorable autonym was not created by publication of *Cirsium eriocephalum* A. Gray var. *leiocephalum* D.C. Eaton (1871). However, Nelson's recognition of *Carduus hookerianus* var. *eriocephalus* established this epithet at the varietal level with Nelson as the author of the epithet, not Gray [ICBN Art. 58]. Nelson did not cite rank for infraspecific taxa but his trinomial combinations are to be treated as varieties (ICBN Art. 35.4).

Cirsium eatonii (A. Gray) B.L. Rob. var. **hesperium** (Eastw.) D.J. Keil, comb. et stat. nov. BASIONYM: *Cnicus hesperius* Eastw., Bull. Calif. Acad. Sci. ser. 3, 1:122. 1898. TYPE: COLORADO: La Plata Mts., Mt. Hesperus on Bear Creek Divide, Aug 1892, *Eastwood s.n.* (HOLOTYPE: CAS).

Cirsium eatonii (A. Gray) B.L. Rob. var. **peckii** (L.F. Hend.) D.J. Keil, comb. et stat. nov. BASIONYM: *Cirsium peckii* L.F. Hend., Madroño 5:97. 1939. TYPE: OREGON. HARNEY CO.: Alvord Ranch, E base of Steens Mt., 6 Jun 1927, *Henderson 8521* (HOLOTYPE: ORE).

Cirsium eatonii (A. Gray) B.L. Rob. var. **clokeyi** (S.F. Blake) D.J. Keil, comb. et stat. nov. BASIONYM: *Cirsium clokeyi* S.F. Blake, Proc. Biol. Soc. Washington 51:8. 1938. TYPE: NEVADA. CLARK CO.: Charleston Mts., 6 Aug 1937, *Clokey 7456* (HOLOTYPE: US; ISOTYPES: BRY, DAO, GA, MO, PENN, PH, RM, UC).

Cirsium eatonii (A. Gray) B.L. Rob. var. **viperinum** D.J. Keil, var. nov. TYPE: NEVADA. WHITE PINE CO.: Snake Range, Humboldt National Forest, Snake Creek Canyon, above Johnson Lake, steep rocky slope, granite, common, 11,000 ft [3353 m], 10 Aug 1964, *Holmgren and Reveal 1588* (HOLOTYPE: UTC; ISOTYPES: WTU, MIN).

Capitulis rare arachnoideis trichomatibus non-septatis, corollas lavandulis ad purpureis, 29–35 mm longis, setis longissimis pappi 20–25 mm distinguatur.

Plants erect, 2.5–4 dm. Leaves glabrous or nearly so on both surfaces. Capitula 1–5, subsessile or short-peduncled, in raceme-like or corymbiform capitulescence. Involucres 3–5 cm, thinly arachnoid with non-septate trichomes; outer phyllaries with numerous lateral spines; spine tips of phyllaries stout. Corollas lavender to purple, 29–35 mm, the tube 9–12.5 mm, the throat 9–12 mm, the lobes 9–11 mm. Longest pappus bristles 20–25 mm.

PARATYPES: **NEVADA. White Pine Co.:** Snake Range, Mt. Washington, bristlecone pine forest just S of the peak, T12N, R68E, Sect. 11, plants growing with *Pinus* on limestone gravel slopes, 11,300 ft [3444 m], 9 Aug 1985, *Tiehm 10107* (CAS, COLO, MIN, OSC, UNLV); Mount Moriah, N end of Snake Range, moist limestone derived sandy to rocky soil, on S-facing slope with *Phlox*, *Aquilegia*, *Crepis nana*, *Allium*, and *Erigeron*, T18N, R69E, Sect. 10, 11840 ft (3500 m), 2 Aug 1999, *Niles et al. 5818* (UNLV); 12 mi SW of Baker, Humboldt National Forest, Snake Range, N side of Mt. Washington, T12N, R68E, E 1.2 of Sect. 11, with scattered bristlecone pine, 11,000 ft, 12 Sep 1983, *Goodrich et al. 20063* (BRY); 13 mi SW of Baker, Snake Range, S slopes of Mt. Washington, T12N, R68E, N 1/2 of Sect. 14. upper edge of bristlecone pine-limber pine forest, 11,000 ft, 12 Sep 1983, *S. Goodrich et al. 20063* (BRY).

Cirsium eatonii var. *viperinum* is apparently endemic to upper elevations of the Snake Range of White Pine County, Nevada. Capitula of var. *viperinum* are similar in size to those of var. *clokeyi*. However, var. *viperinum* is a shorter plant (2–4 dm vs. 4–15 dm) with longer corolla tubes (9–12 mm vs. 3.5–7 mm), and longer pappus bristles (longest bristles 20–25 mm vs. 16–18 mm). Ranges of the two varieties are separated by about 340 km. Putative hybrids between *C. inamoenum* and *C. eatonii* var. *viperinum* are known from the Snake Range.

Cirsium edule Nutt. var. **macounii** (Greene) D.J. Keil, comb. et stat. nov. BASIONYM: *Carduus macounii* Greene, Ottawa Naturalist 16:38. 1902. TYPE: BRITISH COLUMBIA: Chilliwack Valley, 13 Jun 1901, *Macoun 26451* (LECTOTYPE, here chosen from syntypes, NDG).

Cirsium edule Nutt. var. **wenatchense** D.J. Keil, var. nov. TYPE: WASHINGTON. CHELAN CO.: Nason Creek, banks of streams, 660 m, 30 Jul 1893, *Sandberg and Leibgerg 626* (HOLOTYPE: ORE; ISOTYPES: CAS, UC).

Capitulis generaliter solitariis, in pedunculis 10–30 cm portatis et involucris 3–4 cm altis et 4–5 cm diametro distinguatur.

Capitula mostly solitary; peduncles 10–30 cm. Involucres 3–4 cm, 4–5 cm diam., moderately arachnoid; phyllary apices long-acicular, widely spreading, spine tips 5–15 mm. Corollas 29–33 mm, the tube 9–11 mm, the throat 8–12 mm, the lobes 9–10 mm. Style tips 3–4 mm. Cypselae 4.5–6 mm, dark brown; longest pappus bristles 20–25 mm.

PARATYPES: **WASHINGTON. Chelan Co.:** Wenatchee Mts., trail to Snow Lakes, rocky granitic alpine slopes, 11 Aug 1952, 4000 ft, *Thompson 17135* (WTU); Yakima Region, 1883, *Brandegee 922* (UC); Nason City, 2000–3000 ft., Jul 1893, *Sandberg and Leiberg s.n.* (MIN); Yakima Region, Wenatchie, Aug 1883, 6500 ft, *Tweedy s.n.* (YU). **Kittitas Co.:** Mt. Stuart, Cascades, Aug 1898, *Elmer 1217* (MIN).

Cirsium edule var. *wenatchense* is apparently endemic to the Wenatchee Mountains, in the eastern Cascade Range of central Washington. Little is known of its variation or habitat. Because none of the specimens are complete individuals, the overall stature of the plant is unknown. I am not aware of any recent collections of this taxon.

Cirsium horridulum Michx. var. **megacanthum** (Nutt.) D.J. Keil, comb. et stat. nov. Basionym: *Cirsium megacanthum* Nutt., Trans. Amer. Phil. Soc. 2nd ser., 7:421. 1841. Type: LOUISIANA: banks of Mississippi near New Orleans, *Little s.n.* (lectotype, here chosen from syntypes, PH).

Cirsium inamoenum (Greene) D.J. Keil, comb. nov. Basionym: *Carduus inamoenus* E.L. Greene Fl. Fran. 479. 1897; *Carduus undulatus* Nutt. var. *nevadensis* Greene, Proc. Acad. Nat. Sci. Philad. 44(1892):361. 1893 (homotypic synonym of *C. inamoenus*). Type: CALIFORNIA: E of Truckee or near that place, Aug 1883, *Greene s.n.* (lectotype, here chosen from syntypes, ND-G).

Cirsium inamoenum (Greene) D.J. Keil var. **davisii** (Cronquist) D.J. Keil, comb. et stat. nov. Basionym: *Cirsium davisii* Cronquist, Leafl. W. Bot. 6:46. 1950. Type: IDAHO. Bannock Co.: University of Idaho farm, Pocatello, 8 Jun 1931, *Davis s.n.* (holotype: WS).

Cirsium occidentale (Nutt.) Jeps. var. **lucianum** D.J. Keil, var. nov. Type: CALIFORNIA. San Luis Obispo Co.: Cuesta Ridge, along main road (USFS Rd. 29S11.3) 1.3 mi W of E boundary sign for Cuesta Ridge Botanical Area, ca. 4.3 mi W of Hwy. 101, scattered along disturbed roadside, serpentine, 2460 ft, 22 Jun 1989, *Junak and Ayers 4073* (holotype: SBBG; isotype: OBI).

Habitu erecto, capitulis conspicue pedunculatis, involucris 2–4 cm diametro, atropurpureis, floccoso-arachnoideis, et corollas purpureo-atrorubens 20–24 mm distinguatur.

Plants erect, 3–20 dm. Capitula long-peduncled, elevated well above lower leaves; involucres 2–4 cm diameter, dark purple, floccose-arachnoid; middle phyllary tips generally 5–8 mm, 1–3 mm wide, straight or upwardly curved, ascending to spreading. Corollas 20–24 mm, dark purplish red.

Paratypes: **CALIFORNIA. San Luis Obispo Co.:** Los Padres National Forest, W-facing cleared slope below TV towers just E of West Cuesta Ridge Rd. at eastern botanical area boundary sign, ca. 3 mi W of Hwy. 101, 22 Jun 1989, *Ayers and Junak 754A* (OBI, SBBG); 0.3 mi from hwy 101 along West Cuesta Ridge Rd., chaparral, S-facing slope, roadside, ca. 1540 ft, 4 Jun 2000, *Bushakra and Bushakra 35* (OBI), *36* (UC), *37* (MIN), *38* (ASU); Cerro Alto, 13 May 1958, *Hardham 3288* (SBBG); near summit of ridge W of upper Lopez Canyon, open W-facing slope, 5 Jun 1964, *Hoover 8932* (OBI); ridge NW of Cuesta Pass, serpentine area, disturbed roadside, 17 Jun 1965, *Hoover 9430* (OBI); Black Butte Research Natural Area, SE base of Peak 3, steep rocky opening at edge of *Quercus agrifolia* woodland at margin of unburned area, 2 May 1995, *Hrusa 12258* (CDA, OBI); Cuesta Ridge Botanical Area, N of main road, just S of KSBY television towers, ca. 2.7 mi W of Hwy. 101, 28 Jun 1989, *Junak and Ayers 4098* (SBBGG); Cuesta East in area burned by Gay Mt. and Las Pilitas fires, fire succession area in chaparral, 17 May 1987, *Keil et al. 20162* (OBI); San Luis Obispo, 187_, *Lemmon 41* (PH); along road to cypress forest below summit of TV peak, W of Cuesta Grade and Hwy. 101, 28 Jun 1968, *Smith 10095* (SBBG); S entrance to Cuesta Botanical Area, serpentine soil, 7 Jun 1971, 2500 ft, *Wiese 97* (OBI).

Cirsium occidentale var. *lucianum* is restricted to San Luis Obispo County, California where it occupies a narrow corridor along and adjacent to the main ridge of the southern Santa Lucia Mountains. In *The Jepson Manual* Keil and Turner (1993) treated these plants as an atypical race of *C. occidentale* var. *californicum*. They resemble small-headed plants of var. *californicum* but differ in their dark, reddish purple corollas and darkly pigmented involucres. They approach the ranges of var. *californicum* and var. *venustum* but are not known to grow with either of these varieties. Wells (1983) and Keil and Turner (1992) reported the occurrence of hybrid swarms between these taxa in which emergent phenotypes differing from either parent have been observed. *Cirsium occidentale* var. *lucianum* may represent a stabilized emergent form derived by prehistoric hybridization between var. *californicum* and var. *venustum*.

Cirsium ochrocentrum A. Gray var. **martinii** (P. Barlow-Irick) D.J. Keil, comb. et stat. nov. BASIONYM: *Cirsium ochrocentrum* A. Gray subsp. *martinii* P. Barlow-Irick, Novon 9:320. 1999. TYPE: NEW MEXICO. CATRON CO.: NM Hwy. 12, 5 mi E of San Francisco River bridge at Reserve, 5800 ft. elev., 28 Jul 1997, *Barlow 97-8* (HOLOTYPE: US; ISOTYPES: ASU, MO, NMC, UNM).

Hsi (1960) in an unpublished dissertation proposed recognition of this taxon as a species, noting its resemblance to *C. ochrocentrum*. Barlow-Irick (1999) formally described it as a subspecies of *C. ochrocentrum*, demonstrating its intergradation with typical *C. ochrocentrum*. As indicated above I have chosen to recognize varieties rather than subspecies in my FNA treatment of *Cirsium*, and I make the change from subspecies to variety in deference to the FNA Guide for Contributors.

Cirsium pulcherrimum (Rydb.) K. Schum. var. **aridum** (R.D. Dorn) D.J. Keil, comb. et stat. nov. BASIONYM: *Cirsium aridum* R.D. Dorn, Vasc. Pl. Wyoming, 2nd ed. 304. 1992. TYPE: WYOMING. FREMONT CO.: ca. 6 mi N of Sweetwater Station, barren chalky hills, 6700 ft, 26 Jul 1990, *Dorn 5105* (HOLOTYPE: RM).

Cirsium scariosum Nutt. var. **americanum** (A. Gray) D.J. Keil, comb. nov. BASIONYM: *Cirsium acaule* Allioni var. *americanum* A. Gray, Proc. Philad. Acad. Nat. Sci. 1863:68. 1863. TYPE: COLORADO: Rocky Mts., lat. 39–41, *Hall and Harbour 339* (HOLOTYPE: GH).

Cirsium scariosum Nutt. var. **citrinum** (Petrak) D.J. Keil, comb. nov. BASIONYM: *Cirsium quercetorum* (A. Gray) Jeps. var. *citrinum* Petrak, Bieh. Bot. Centralbl. 35:363. 1917. TYPE: CALIFORNIA. SAN DIEGO CO.: Warner's Hot Springs, 10 Apr 1913, *Eastwood 2629* (HOLOTYPE: CAS).

Cirsium scariosum Nutt. var. **coloradense** (Rydb.) D.J. Keil, comb. et stat. nov. BASIONYM: *Carduus coloradensis* Rydb., Bull. Torrey Bot. Club 32:132. 1905. TYPE: COLORADO: Pagosa Springs, 28 Jul 1899, *Baker 644* (HOLOTYPE: NY; ISOTYPES: MO, ND-G, POM).

Cirsium scariosum Nutt. var. **congdonii** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov. BASIONYM: *Cirsium congdonii* R.J. Moore & Frankton, Canad. J. Bot. 45:1738. 1967. TYPE: CALIFORNIA. MONO CO.: Bridgeport Valley, 3.5 mi NW of Bridgeport along U.S. Hwy. 395, edges of winter overflow of Buckeye Creek, 6505 ft, *Bacigalupi et al. 8015* (HOLOTYPE: DAO).

Cirsium scariosum Nutt. var. **robustum** D.J. Keil, var. nov. TYPE: CALIFORNIA. SISKIYOU CO.: N side of Stateline Rd., Hwy 161 to Tulelake, 5.2 km E of Hwy 97, 10.5

km NE of Dorris, T48N, R1E, sect. 16, 14 Jun 1977, *Fuller 20216* (HOLOTYPE: mounted on 3 sheets, CDA; ISOTYPE: CDA).

Habitu caulescente caulibus proximale ramosis, capitulis evidenter pedunculatis, apicibus phyllariorum interiorum expansis scariosis erosodentatis, et corollas albidis distinguatur.

Plants caulescent, 2.5–7 dm. Stems solitary from base, often very stout, proximally simple and distally branched or branched throughout, leafy, glabrous, villous with septate trichomes, or arachnoid-tomentose. Leaves oblanceolate to elliptic, deeply pinnately lobed, villous with septate trichomes or thinly arachnoid-tomentose, abaxially thinly to densely arachnoid-tomentose, villous with septate trichomes along the midvein. Capitula 3–many, evidently peduncled at stem tips (in age clustered axillary capitula sometimes developing), subtended and ± overtopped by upper leaves or these ± reduced. Involucres 2.5–4 cm; outer and middle phyllaries lanceolate to ovate, the spine tips 1–6 mm, slender to ± broad and flat; tips of inner phyllaries linear-acuminate or more commonly expanded as a scarious, erose-toothed appendage, often contorted. Corollas white, 30–36 mm, the tubes 14–22 mm, the throats 7–12 mm, the lobes 5–10 mm; style tips 6–8 mm. Cypselae 4–6.5 mm; pappi 22–32 mm.

PARATYPES: **CALIFORNIA. Siskiyou Co.:** Gazelle, moist meadows, 20 Jun 1905, *Heller 8077* (PH); Butte Valley W of Dorris, occurring in large patches, 16 Jul 1982, *Shaw s.n* (CDA); E of McCloud along Hwy. 89, 7.7 mi W of Shasta Co. line, roadside drainage in lodgepole pine forest, 24 Jul 1992, *Keil and Keil 23571* (OBI); 5 mi N of Gazelle, 14 Jul 1948, *Pryor 3704* (CDA); 4 mi N of Gazelle, 26 Jul 1950, *Pryor s.n.* (CDA); without locality, 22 Jul 1954, *Huse s.n.* (CDA); Hwy 99, 2 mi S of Gazelle, T42N, R6W, roadside meadow, 9 Jul 1959, *Fuller 2738* (CDA). **OREGON. Klamath Co.:** Keno, bank of Klamath River, 6 Jul 1920, *Peck 9279* (DS); 15 mi S of Diamond Lake, moist ground, 7 Jun 1937, *Peck 19736* (WILLU). **Lake Co.:** 9 mi S of Summer Lake P.O., swampy meadow, 19 Jun 1941, *Peck 20809* (UC, WILLU); along Johnson Creek, Summer Lake, 12 Jul 1928, *Constance 9478* (ORE); 6 mi NE of Lakeview, 29 Jun 1937, *Peck 19624* (WILLU).

Cirsium scariosum var. *robustum* is known only from northern California (Siskiyou County) and south-central Oregon (Klamath and Lake counties).

Cirsium scariosum Nutt. var. **toiyabense** D.J. Keil, var. nov. TYPE: NEVADA. LANDER CO.: N of Toiyabe Range, Silver Creek, 10.5 mi E of Nevada 8A, 12 airline mi N of Austin, T21N, R44E, Sect. 22, edge of wet meadow, 17 Jul 1970, 7000 ft, *Holmgren and Holmgren 4476* (HOLOTYPE: MIN; ISOTYPES: ASU, WTU).

Habitu caulescente corollas purpureis lobis 5.5–8 mm longis distinguatur.

Plants subacaulescent to erect, 0.5–5.5 dm. Stems usually simple, leafy, glabrous to villous or tomentose with septate trichomes, sometimes thinly arachnoid tomentose. Leaves oblong to oblanceolate or elliptic, pinnately lobed or often unlobed, adaxially green, glabrous or villous with septate trichomes, abaxially green and ± glabrous to white-tomentose. Capitula 1–10+, sessile or short-peduncled, crowded at stem tips, usually subtended and ± overtopped by upper leaves. Involucres 2–3 cm; outer and middle phyllaries lanceolate to ovate, the spine tips 2–4 mm, slender; tips of inner phyllaries acuminate and entire or abruptly expanded into a scarious, erose-toothed appendage. Corollas rose-purple, 23–31 mm, the tubes 11–16 mm, the throats 4.5–8.5 mm, the lobes 5.5–8.5 mm; style tips 3.5–4.5 mm. Cypselae 4–6 mm; longest pappus bristles 22–25 mm.

Paratypes: **NEVADA. Humboldt Co.:** Paradise Valley, NE of Winnemucca, T42N, R39E, Sect.14, irrigated meadow, 24 Jun 1967, 4700 ft, *Gentry and Davidse 1627* (ASU, DS, KANU, WTU); Virgin Valley, Virgin Valley campground, banks of pond, 16 Jun 1978, 4820 ft, *Tiehm and Rogers 4457* (CAS); Buckskin Mt.-Hinkey Summit road 2 mi from Buckskin Mt. summit, wet meadow, 1 Jul 1978, *Grimes and Packard 1183* (COLO); Kings River, Disaster Peak Range, 28 Jun 1924, *Archer 123* (ASU). **Lander Co.:** Toiyabe Range, hills around Austin, 22–25 Jul 1913, *Kennedy 4400* (PH, UC); Reese River, ca. 10 mi W of Austin, moist pasture, 31 Jul 1939, 5400 ft, *Hitchcock and Martin 5580* (UC, WTU); Toiyabe Mts., Jul 1868, 6000 ft, *S. Watson 689* (YU). **Nye Co.:** Millett, 4 Jul 1931, 5500 ft, *Linsdale and Linsdale 637* (CAS). **Washoe Co.:** near Glendale, Truckee meadows, 18 Jul 1913, 4500 ft, *Kennedy 3054* (PH, UC); White Pine, Steptoe Valley, Monte Neva Hot Springs, 21 mi N of McGill, white salt-crusted loam around spring, 4 Jul 1966, 6000 ft, *Holmgren and Reveal 2810* (WTU). **OREGON. Harney Co.:** Sod House School S of Malheur Lake, in marsh with *Typha*, 21 Jun 1958, *Raven and Solbrig 13368* (CAS); McDermitt Canyon, wet meadow, 4 Jul 1927, *Henderson 8522* (CAS); vicinity of Malheur Field Station, ca. 1/4 mi E of North Butte, edge of marsh with invading weeds, 11 Aug 2000, 4080 ft, *Keil 29092A, B* (OBI).

Cirsium scariosum var. *toiyabense* occurs from northern Nevada to southeastern Oregon and southern Idaho.

ACKNOWLEDGMENTS

I gratefully thank the curators of the various herbaria who have made specimens available to me for this project and patiently waited for me to return the loans.

REFERENCES

Barlow-Irick, P. 1999. *Cirsium ochrocentrum* subsp. *martinii* (Asteraceae), a new subspecies of the Santa Fe thistle from the Gila River region of Arizona and New Mexico. Novon 9:318–322.

Cronquist, A. 1955. Part 5: Compositae. In: C.L. Hitchcock, A. Cronquist, M. Ownbey, and J.W. Thompson. Vascular plants of the Pacific Northwest. University of Washington Press, Seattle and London.

Cronquist, A. 1994. Vol. 5. Asterales. In A. Cronquist, A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren, Intermountain flora. Vascular plants of the Intermountain West. The New York Botanical Garden, Bronx, N.Y.

Dorn, R.D. 1992. Vascular plants of Wyoming, 2nd ed. Mountain West Publishing, Cheyenne, WY.

Eaton, D.C. 1871. The Compositae. In: S. Watson, aided by D.C. Eaton et al., Botany. United States geological exploration of the fortieth parallel. Clarence King, Geologist in charge. Government Printing Office, Washington, D.C. Pp. 136–208.

Flora of North America Editorial Committee. 1996. Flora of North America north of Mexico guide for contributors. Compositae version. Flora of North America Organizational Center, Missouri Botanical Garden, St. Louis.

Frankton, C. and R.J. Moore. 1961. Cytotaxonomy, phylogeny and Canadian distribution of *Cirsium undulatum* and *Cirsium flodmanii*. Canad. J. Bot. 39:21–33.

Frankton, C. and R.J. Moore. 1963. Cytotaxonomy of *Cirsium muticum, Cirsium discolor,* and *Cirsium altissimum*. Canad. J. Bot. 41:73–84.

Gardner, R.C. 1974. Systematics of *Cirsium* (Compositae) in Wyoming. Madroño 22: 239–265.

Gray, A. 1863. Contributions to the botany of North America. I. A synopsis of North American thistles. Proc. Amer. Acad. Arts 10:39–48.

Gray, A. 1874. A synopsis of North American thistles. Proc. Amer. Acad. Arts 10:39–49.

Greuter, W., J. McNeill, F.R. Barrie, H.M. Burdet, V. Demoulin, T.S. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth (editors & compilers): International code of botanical nomenclature (Saint Louis code) adopted by the Sixteenth International Botanical Congress St. Louis, Missouri, July - August 1999. Regnum Veg. 138. Koeltz Scientific Books, Königstein, Germany.

Howell, J.T. 1960. *Cirsium*. In: L. Abrams and R.S. Ferris, Illustrated flora of the Pacific States, Washington, Oregon, and California. Vol. 4: Bignoniaceae to Compositae, bignonias to sunflowers. Stanford University Press, Stanford, California. Pp. 514–538.

Hsi, Y.-T. 1960. Taxonomy, distribution and relationships of the species of *Cirsium* belonging to the series *Undulata*. Ph.D. dissertation, University of Minnesota.

Keil, D.J. (in press). *Cirsium* P. Miller. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico Vol. 19. Asterales: Asteraceae.

Keil, D.J. and C.E. Turner. 1992. Taxonomic notes on California species of *Cirsium* (Asteraceae: Cardueae). Phytologia 73:312–317.

Keil, D.J. and C.E. Turner. 1993. *Cirsium*. In: J.C. Hickman, ed. The Jepson manual: higher plants of California. University of California Press, Berkeley & Los Angeles. Pp. 232–239.

Keil, D.J. and C.E. Turner. 2002. *Cirsium*. In: B.G. Baldwin, S. Boyd, B.J. Ertter, R.W. Patterson, T.J. Rosatti, and D.H. Wilken, eds. and M. Wetherwax, managing ed. The Jepson desert manual. University of California Press, Berkeley, Los Angeles, and London. Pp. 134–136.

Kelch, D.G. and B.G. Baldwin. 2003. Phylogeny and ecological radiation of New World thistles (*Cirsium*, Cardueae—Compositae) based on ITS and ETS rDNA sequence data. Molecular Ecology 12:141–151.

Moore, R.J. and C. Frankton. 1962. Cytotaxonomy and Canadian distribution of *Cirsium edule* and *Cirsium brevistylum*. Canad. J. Bot. 40:1187–1196.

Moore, R.J. and C. Frankton. 1964. A clarification of *Cirsium foliosum* and *Cirsium drummondii*. Canad. J. Bot. 42:451–461.

Moore, R.J. and C. Frankton. 1965. Cytotaxonomy of *Cirsium hookerianum* and related species. Canad. J. Bot. 43:597–613.

Moore, R.J. and C. Frankton. 1966. An evaluation of the status of *Cirsium pumilum* and *Cirsium hillii*. Canad. J. Bot. 44:581–595.

Moore, R.J. and C. Frankton. 1967. The thistles of Canada. Research Branch, Canada Department of Agriculture Monograph 10.

Moore, R.J. and C. Frankton. 1969. Cytotaxonomy of some *Cirsium* species of the eastern United States, with a key to eastern species. Canad. J. Bot. 47:1257–1275.

Moore, R.J. and C. Frankton. 1974. The *Cirsium arizonicum* complex of the southwestern United States. Canad. J. Bot. 52:543–551.

Munz, P.A. 1974. A flora of southern California. University of California Press, Berkeley. Los Angeles, and London.

Munz, P.A. and D.D. Keck. 1959. A California flora. University of California Press, Berkeley, Los Angeles, and London.

Ownbey, G.B. 1952. Nuttall's Great Plains species of *Cirsium*: *C. undulatum* and *C. canescens*. Rhodora 54:29–35.

Ownbey, G.B. and Hsi, Y.-T. 1963. Chromosome numbers in some North American species of the genus *Cirsium*. Rhodora 65:339–354.

Ownbey, G.B. and Hsi, Y.-T. 1969. Chromosome numbers in some North American species of the genus *Cirsium*. II. Western United States. Madroño 20:225–228.

Ownbey, G.B. and W.A. Olson. 1969. Cytotaxonomic notes on the species of *Cirsium* native to the southeastern United States. Rhodora 71:285–296.

Ownbey, G.B., P.H. Raven, and D.W. Kyhos. 1975. Chromosome numbers in some North American species of the genus *Cirsium*. III. Western United States, Mexico, and Guatemala. Brittonia 27:297–304.

Petrak, F. 1912. Beiträge zur kenntnis der mexikanischen und zentral-amerikanischen *Cirsium*. Bot. Tidsskr. 31:57–72.

Petrak, F. 1917. Die nordamerikanischen arten der gattung *Cirsium*. Bieh. Bot. Centralbl. 35 (Abt. 2):223–567.

Weber, W.A. 1987. Colorado flora: western slope. Colorado Associated University Press, Boulder.

Weber, W.A., and R.C. Wittmann. 1996. Colorado flora: eastern slope. University Press of Colorado.

Wells, H. 1983. Hybridization and genetic recombination of *Cirsium californicum* and *C. occidentale* (Asteraceae: Carduaceae). Madroño 30:12–30.

Welsh, S.L. 1983. Utah flora: Compositae (Asteraceae). Great Basin Naturalist 43:179–357.

Welsh, S.L., N.D. Atwood, S. Goodwin, and L.C. Higgins (eds.). 1993. A Utah flora. Print Services, Brigham Young University, Provo, Utah.

BOOK NOTICES

TOD F. STUESSY, VERONIKA MAYER, and ELVIRA HORANDL (eds.). 2003. **Deep Morphology: Toward a Renaissance of Morphology in Plant Systematics.** (ISBN 3-906166-07-4, hbk.; ISSN 0080-0694). International Association for Plant Taxonomy, Institute of Botany, University of Vienna, Rennweg 14, A-1030 Vienna, Austria. (Orders: Koeltz Scientific Books, P.O. Box 1360, D-61453, Koenigstein, Germany; www.koeltz.com, koeltz@t-online.de, 49-0-617493720, 49-0-6174937240 fax). EUR 78.00, 326 pp., illustrated, 7" × 9".

Review forthcoming in volume 21, no. 2.

DONALD MACE WILLIAMS. 2003. **Timberline U.S.A.: High-Country Encounters from California to Maine.** (ISBN 0-87421-571-4, pbk.). Utah State University Press, 7800 Old Man Hill, 1151 East 700 North, Logan, UT 84322-7800, U.S.A. (Orders: 435-797-1362, 435-797-0313 fax). $17.95, 225 pp., 5 1/2" × 8".

KEY WORDS: Nature, mountains, sports, recreation and hiking. This book is about timberline adventures and the various people who adventure there as well as some scientists who study those areas. According to the author, "My main hope in writing this book, I suppose, was to show what it is about the treeless parts of high mountains that awes, attracts, and frightens me and millions of other hikers. Also, I wanted to see how, in each of the major ranges of the lower forty-eight states that get above timberline—the Rockies **[Part I]**, the Sierra Nevada **[Part II]**, the Cascades **[Part III]**, and the northern Appalachians **[Part IV]**—the high country is different form that of the other three ranges. For both purposes, I hiked."

ANDREW PARKER. 2003. **In the Blink of An Eye: How Vision Sparked the Big Bang of Evolution.** (ISBN 0-465-05438-2, pbk.). Basic Books, A Member of the Perseus Books Group, 387 Park Avenue South, New York, NY 10016, U.S.A. (Orders: 212-340-8100, 212-340-8115 fax, www.basicbooks.com). $15.00, 316 pp., b/w photos, line drawings, 5" × 8".

Author Comments: "The big Bank in animal evolution was perhaps the most dramatic event in the history of life on Earth. During this blink of an eye in such history, all the major animal groups found today evolved hard parts and became distinct shapes, simultaneously and for the first time. This happened precisely 543 million years ago, at the beginning of a period in geological history called the Cambrian, and so has become known as the 'Cambrian explosion'. But what lit the Cambrian fuse? "... In short, we know very well *what* happened during evolution's Big Bang, indeed numerous books have already been written on this question, but we don't know *why* it happened. *Why* it happened is the puzzle this books sets out to solve."

The book attempts to solve the 543 million year old puzzle in 316 pages in ten chapters: **1)** Evolution's Big Bang. **2)** The Virtual Life of Fossils. **3)** The Infusion of Light. **4)** When Darkness Descends. **5)** Light, Time and Evolution. **6)** Colour in the Cambrian? **7)** The Making of a Sense. **8)** The Killer Instinct. **9)** The Solution. **10)** End of Story?

A NEW NAME AND A NEW COMBINATION IN *SOLIDAGO* SUBSECT. *GLOMERULIFLORAE* (ASTERACEAE: ASTEREAE)

Rachel E. Cook[1] and John C. Semple

Department of Biology
University of Waterloo
Waterloo, Ontario, CANADA N2L 3G1
jcsemple@sciborg.uwaterloo.ca

ABSTRACT

The following new name and new combination are proposed: *Solidago caesia* var. *zedia*, *Solidago curtisii* var. *flaccidifolia*.

RESUMEN

Se proponen el siguiente nombre y combinación nueva: *Solidago caesia* var. *zedia*, *Solidago curtisii* var. *flaccidifolia*.

The following new name and new combination are presented in order to have them available for use in our treatment of *Solidago* L. for the Flora North America project (Semple & Cook, submitted). Cook (2002, Ph.D. thesis) revised *Solidago* subsect. *Glomeruliflorae* (Torrey & A. Gray) Nesom, including cytogeography and multivariate morphometric analyses. Detailed papers on the taxonomy and biosystematics of subsect. *Glomeruliflorae* are in preparation.

Solidago caesia L. var. **zedia** R.E. Cook & Semple, var. nov. (**Fig. 1**). TYPE: U.S.A. LOUISIANA. EAST FELICIANA PARISH: LA-67, 2.5 km S of Felps (LA-422), vicinity of small creek, 13 Oct 1991, *J.C. Semple & B.A. Suripto 10108* (HOLOTYPE: WAT; ISOTYPES: BRIT, MO).

Differt a Solidago caesia var. caesia foliis caulinis rhombico-ovatis.

Perennial from woody caudex-like rhizomes. Stems one to many, arching (27.7–)31.6–54.1–76.6(–99.1) cm tall occasionally with one to several elongated lateral branches, glaucous, usually blue to purple anthocyanin colored, glabrous to slightly pubescent in the inflorescence (0.0–)0.6–6.2–11.8(–17.0) hairs/mm^2. Basal leaves absent at flowering time. Lower stem leaves lanceolate to rhombic, sessile, (47.3–)57.0–70.0–83.1(–91.8) mm long, (13.0–)14.4–17.7–21.1(–24.0) mm wide, sparsely pubescent above (0.0–)0.0–1.1–2.2(–3.6) hairs/mm^2, (0.2–)1.6–3.3–5.0(–6.0) hairs/mm along the vein, glabrous to sparsely pubescent below (0.0–)0.0–0.2–0.9(–2.7) hairs/mm^2, (0.0–)0.1–2.5–4.9(–8.0) hairs/mm along the vein, leaf apices acuminate, margins with (4.0–)5.0–6.9–8.7(–9.3) serrations. Upper stem leaves lanceolate to rhombic, sessile, (23.0–)32.4–43.0–53.6(–60.3) mm long,

---

[1] Current Address: Chicago Botanic Garden, Conservation Science, 1000 Lake Cook Rd., Glencoe, Illinois 60022, U.S.A., rcook@chicagobotanic.org

Fig. 1. Holotype of *Solidago caesia* var. *zedia*: *Semple & Suripto 10108* WAT, scale bar = 10 cm in total. Insert. A. Upper stem leaves, scale bar = 1 cm.

(5.6–)6.7–9.1–11.6(–13.9) mm wide, glabrous to sparsely pubescent above (0.0–)0.1–1.1–2.2(–3.0) hairs/mm^2, (0.8–)1.6–3.8–5.9(–8.6) hairs/mm along the vein, glabrous to sparsely pubescent below (0.0–)0.0–0.2–0.9(–2.0) hairs/mm^2, (0.0) 0.4–2.6–4.9(–7.5) hairs/mm along the vein, margins entire to slightly serrate with (0.0–)0.0–1.8–3.6(–7.0) serrations. Capitulescence short axillary and terminal racemiform-paniculiform clusters, inflorescence (8.9–)11.4–20.8–30.2(–38.7) cm long with heads secund. Involucres (4.8–)5.4–6.1–6.8(–7.2) mm high, (3.1–)3.1–3.9–4.7(–6.3) mm wide; phyllaries in several unequal series, outermost phyllaries (0.9–)1.0–1.1–1.2(–1.3) mm long, lanceolate, acute; innermost phyllaries (2.5–)2.8–3.3–3.7(–4.1) mm long, linear-oblong, obtuse to acute, single nerved. Ray florets (1.0–)1.9–2.7–3.5(–4.0), strap yellow, (1.5–)1.8–2.3–2.7(–3.4) mm long; corolla (1.3–)1.5–1.7–1.9(–2.0) mm long; achenes (1.1–)1.3–1.7–2.1(–2.6) mm long, sparsely to moderately pubescent; pappus (1.6–)2.2–2.6–3.1(–3.4) mm long. Disc florets (3.0–)3.8–5.2–6.6(–7.0), yellow; corolla (2.0–)2.1–2.5–3.0(–3.7) mm long; corolla lobe (0.9–)1.1–1.3–1.4(–1.6) mm long; achenes (1.2–)1.4–1.7–2.0(–2.2) mm long, moderately to densely pubescent; pappus (2.4–)2.6–3.0–3.4(–3.6) mm long. Chromosome number: $2n=18$.

Solidago caesia var. *zedia* is distinguished by its shorter, broadly lanceolate to rhombic leaves (Fig 1). Variety *zedia* is found in the wet, lowland areas of southern Arkansas, Mississippi, Louisiana, Alabama, Georgia and into northwestern Florida.

Etymology.—The varietal name is an alphabetical reference to it being the last taxon recognized during work by our Canadian laboratory, eh.

KEY TO THE TWO VARIETIES OF *SOLIDAGO CAESIA*

1. Lower midstem leaves long and narrowly lanceolate, 5–15 cm long, 0.8–3 cm wide; stems strongly arching; Nova Scotia to Wisconsin south to Florida and Texas ____ **S. caesia** var. **caesia**
1. Lower midstem leaves shorter and broadly lanceolate, 5–9 cm long, 1.3–2.4 cm wide; stems weakly arching; restricted to the wet, lowlands of Arkansas, Mississippi, Alabama, Georgia, and Florida ____ **S. caesia** var. **zedia**

Solidago curtisii Torrey & A. Gray var. **flaccidifolia** (Small) R.E. Cook & Semple, comb. et stat. nov. BASYONYM: *Solidago flaccidifolia* Small, Bull. Torrey Bot. Club 25:477. 1898. TYPE: U.S.A. GEORGIA: Rome, 1872, *Chapman s.n.* (HOLOTYPE: NY!)

The var. *flaccidifolia* is distinguished by its leaves being more elliptical and more pubescent than those of var. *curtisii*. The range of var. *flaccidifolia* includes the mountains of Tennessee, Kentucky, Virginia, North Carolina, and Georgia, as well as lowland areas in southern Georgia, Alabama and Mississippi. It can be found at low to moderate elevations in shaded woods and thickets. This variety has been found to be tetraploid and hexaploid. A complete discussion of the taxon will be presented in a paper, now in preparation by R.E. Cook.

ACKNOWLEDGMENTS

This research was supported by Natural Sciences and Engineering Council of Canada Research and Discovery Grants to J.C.S., a Natural Sciences and Engineering Council of Canada Post Graduate Scholarship and an Ontario Graduate Scholarship to R.E.C.

REFERENCES

Cook, R.E. 2002. A biosystematic study of *Solidago* subsection *Glomeruliflorae* (Torr. & Gray) Nesom. (Asteraceae: Astereae) in Eastern North America. Ph.D. Dissertation. University of Waterloo. Waterloo, Ontario.

Semple, J.C. and R.E. Cook. Submitted. *Solidago*. In: Flora North America Editorial Committee, eds. Flora of North America. Vol. 20. *Asteraceae*. Oxford University Press.

TAXONOMIC NOTES ON *KRIGIA* (ASTERACEAE)

Kenton L. Chambers

Department of Botany and Plant Pathology
Oregon State University
2082 Cordley Hall
Corvallis, Oregon 97331-2902, U.S.A.

ABSTRACT

The new combination *Krigia cespitosa* (Raf.) K.L. Chambers var. *gracilis*, based on *Apogon gracilis* DC., is proposed, and a lectotypification of the basionym is given. A neotype is created for *Serinia cespitosa* Raf. The hexaploid hybrid *Krigia* × *shinnersiana* is described from the Blue Ridge Parkway, North Carolina, representing an allopolyploid of the cross *Krigia biflora* (Walter) S.F. Blake × *Krigia montana* (Michx.) Nutt.

RESUMEN

Se propone la nueva combinación *Krigia cespitosa* (Raf.) K.L. Chambers var. *gracilis*, basada en *Apogon gracilis* DC., y se hace una lectotipificación del basiónimo. Se crea un neotipo para *Serinia cespitosa* Raf. El híbrido hexaploide *Krigia* × *shinnersiana* se describe del Blue Ridge Parkway, North Carolina, y representa un alopoliploide del cruce *Krigia biflora* (Walter) S.F. Blake × *Krigia montana* (Michx.) Nutt.

THE VARIETIES OF *KRIGIA CESPITOSA*

Krigia Schreb., *Nomen Conservandum*[1], has a large synonymy, considering its rather modest number of species. Shinners (1947) recognized only seven species but listed eight synonymous generic names. This excess of names may have resulted from the various authors' overemphasis on pappi differences and the contrast between annual and perennial habit within the genus. One species, as recognized here, consistently lacks pappi and, on this basis, was segregated as *Serinia* Raf. (Rafinesque 1817) and *Apogon* Elliott (Elliott 1823). DeCandolle (1838:261) placed *Serinia* in his Compositae Incertae Sedis but recognized *Apogon humilis* Elliott and added a second species, *Apogon gracilis* DC. These two species were again recognized by Gray (1884), and a third species, *A. wrightii* A. Gray, was described, differing from the others by the possession of "an obscure vestige of pappus." The final union of *Apogon* and *Serinia* with *Krigia* was done by Shinners (1947), who included *Krigia gracilis* (DC.) Shinners and *Krigia oppositifolia* Raf. (=*Krigia cespitosa* (Raf.) K.L. Chambers, formerly *Apogon humilis*) but placed *Apogon wrightii* Gray in synonymy under the latter species.

---

[1] As explained by Kim and Turner (1992), the International Code of Botanical Nomenclature (Greuter et al. 1988) erroneous stated that the basionym of the conserved type species, *Krigia virginica* (L.) Willd., is *Tragopogon virginicus* L., whereas it should be *Hyoseris virginica* L. This mistake is perpetuated in the current Saint Louis Code (Greuter et al. 2000). I second the proposal by Kim and Turner that this be corrected in the next edition of the Code.

We now know much more about this cluster of taxa, from chromosome studies and the detailed molecular analyses by Kim and co-workers (Kim & Mabry 1991; Kim et al. 1992; Kim & Jansen 1994). *Krigia gracilis* and *K. cespitosa* both are diploid annuals with $n = 4$ and have similar epappose, fusiform cypselae. They are practically indistinguishable in the chloroplast cDNA and nuclear rDNA traits studied (summarized in Kim & Turner 1992). *Krigia wrightii* (A. Gray) K.L. Chambers ex K.-J. Kim is annual and tetraploid, with $n = 9$, and has more barrel-shaped cypselae often with a pappus of vestigial scales (figured in Kim & Turner 1992:180). In a cladistic analysis of cDNA and rDNA data, a 100% bootstrap value provided by 51 synapomorphies separated it from the cluster that includes *K. cespitosa* and the related *K. occidentalis* Nutt. It is probably an ancient allopolyploid between a *K. cespitosa*-like species and one of the pappus-bearing annual species of the genus (Kim & Turner 1992).

Prior to the work of Kim and Turner, systematists in Texas recognized *Krigia gracilis* and *K. cespitosa* as different species (Shinners 1958; Correll & Johnston 1970). Their emphasis was on morphological traits, especially the difference in size of heads and florets (corollas 5–10 mm long, involucres 5.3–8.5 mm high in flower, 6.2–8.5 mm high in fruit in *K. gracilis*, versus corollas 2–4 mm long, involucres 3–4.3 mm high in flower, 3.3–5.3 mm high in fruit in *K. cespitosa*). To these authors, *K. gracilis* was endemic to central and south-central Texas in the Blackland Prairie, occasionally west to the Llano region, mostly in clay-loam soil but also in adjacent regions of sandy soil, even becoming weedy in fields and disturbed ground (Shinners 1947). *Krigia cespitosa* is much more widespread, extending from central Texas east to Florida, the Carolinas, and Virginia, and north to Kansas, Missouri, and Tennessee. In herbarium studies done much earlier by the present author, the area of overlap between the varieties in Texas formed a north-south band, from Denton and Tarrant Cos. east to Hunt Co. in the north, and from Travis and Hays Cos. east to Harris Co. in the south, with an extension east to Polk and Angelina Cos. Kim and Turner (1992) took a different view of these taxa. Based on their field and herbarium studies, they extended the range of *K. gracilis* from eastern Texas to "adjacent Oklahoma, Arkansas, and Louisiana," and they noted the presence of populations intermediate in head and flower size. Due to this pattern of intergradation and to the high similarity revealed by their DNA analysis, they proposed that the large-flowered types be reduced to the rank of *K. cespitosa* forma *gracilis* (DC.) K.-J. Kim (Kim & Turner 1992:196; Diggs et al. 1999).

My purpose here is to make a different proposal for these taxa, based on several considerations. The first is the geographical pattern, in which a widespread small-flowered type intergrades at the western edge of its range with a morphologically distinctive and geographically limited large-flowered type. Geographical races marked by interbreeding in the area of overlap are more often accorded the rank of variety than of forma. Weight must also be given to the nature of the morphological differences, as they represent a developmentally coordinated syndrome of variation in the reproductive organs. The large-flowered race may differ in breeding system, through pollinator attraction, an increased frequency of outcrossing, and genetic mixing in the otherwise self-pollinating reproductive mode exhibited by the two varieties (Kim & Turner 1992). Intraspecific differences in reproduction associated with conspicuous floral-size differences have been noted in other genera of Cichorieae and have been accorded varietal status. Examples known to the author are *Agoseris heterophylla* (Nutt.) Raf. var. *californica* (Nutt.) Jeps. (Chambers 1963), and *Glyptopleura marginata* D.C. Eaton var. *setulosa* (A. Gray) Jeps. (Jepson 1925), both of which are large-flowered races in typically smaller-flowered species.

To allow the recognition of this morphologically distinctive geographic race at a higher taxonomic level than forma, the following combination is proposed:

Krigia cespitosa (Raf.) K.L. Chambers var. **gracilis** (DC.) K.L. Chambers, stat. nov. (**Fig. 1**). *Apogon gracilis* DC., Prod. 7:79. 1838. *Krigia gracilis* (DC.) Shinners, Wrightia 1:205. 1947. *Krigia cespitosa* (Raf.) K.L. Chambers forma *gracilis* (DC.) K.-J. Kim, Brittonia 44:196. 1992. TYPE: [TEXAS] "de Bejar a Austin, Avril 1828, *Berlandier No. 1637*" (LECTOTYPE: G-DC, the larger left-hand plant of 3 on the sheet; ISOLECTOTYPES: G, GH, US).

The need for lectotypification of the basionym was first suggested by the wording of DeCandolle's description, which includes the phrase "*achaeniis scabris brevissime papposis.*" Since *Krigia gracilis*, as the name has been used by American botanists, totally lacks pappus, I became concerned that DeCandolle was dealing with a mixed collection, perhaps including *K. wrightii* or *K. occidentalis*. With the kind assistance of Dr. F. Jacquemoud and Dr. L. Gautier of the Herbarium, Conservatoire et Jardin botaniques de la Ville de Geneve, it has been determined that the Berlandier type sheet is a mixed collection, the left-hand plant possessing epappose cypselae and the right-hand plant having vestigial pappus resembling the illustration of *K. wrightii* published by Kim and Turner (1992:180). To maintain the present usage of the epithet *gracilis*, I have designated the left-hand plant as the lectotype. The isolectotype at GH studied by Shinners and Kim consists only of *gracilis*-type plants that lack pappi. Another duplicate in the general herbarium at Geneva, ex Herbier Moricand, clearly shows two *gracilis*-type plants and two of the pappus-bearing species. My notes from 1965 on the isolectotype at US, "ex Herb. Musei Britannici," state that it has 2 plants of the *gracilis*-type and 4 plants with muticous pappi. Whether the second species in Berlandier's collection is *K. wrightii* or a muticous form of *K. occidentalis* is not clear, although a photograph of the Herbier Moricand sheet strongly suggests the latter.

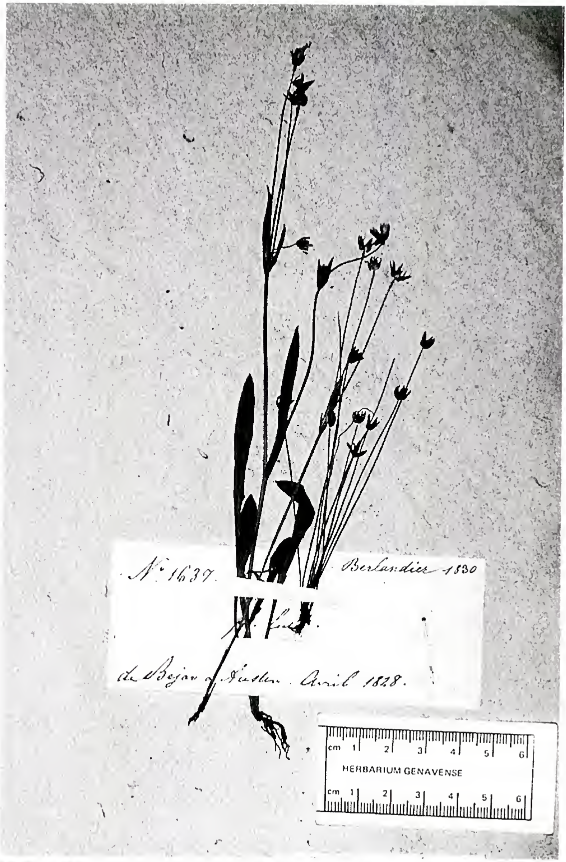


Fig. 1. Type sheet of *Apogon gracilis*, G-DC; lectotype plant is the tall specimen at the left.

Krigia cespitosa (Raf.) K.L. Chambers var. **cespitosa.** *Serinia cespitosa* Raf., Fl. ludov. 149. 1817. *Krigia ? oppositifolia* Raf., op. cit. 57, nom. invalid. *Krigia cespitosa* (Raf.) K.L. Chambers, J. Arnold Arbor. 54:52–53. 1973. *Krigia cespitosa* (Raf.) K.L. Chambers forma *cespitosa* in K.-J. Kim, Brittonia 44:196. 1992. TYPE: LOUISIANA: Natchitoches, open ground, 15 Apr 1915. *E.J. Palmer 7220* (NEOTYPE: MO! ISONETOTYPE: NY!)

As is well known, Rafinesque's *Florula Ludoviciana* (1817) was a translation of part of the French traveler C.C. Robin's publication describing his voyages to Louisiana, Florida, and the West Indies, in which Rafinesque proposed many new species and genera. Collections by Robin have never been located. The above species was described first on page 57 as *Krigia? oppositifolia*, but that name was rejected by the author on page 149 of the "Additions," and *Serinia cespitosa* was substituted (Chambers 1973). American authors have been in agreement as to what species Rafinesque was referring, but its name has not before been typified.

A HYBRID *KRIGIA* FROM THE MOUNTAINS OF NORTH CAROLINA

It was long ago reported that a hexaploid hybrid population of *Krigia* occurs on the Blue Ridge Parkway northeast of Ashville, North Carolina (Chambers 1965; Vuilleumier 1973), but its formal taxonomic recognition has been delayed until the present. The parental taxa are *K. montana* (Michx.) Nutt. ($n = 10$) and *K. biflora* (Walter) S.F. Blake ($n = 5$), whose area of sympatry is limited to the southern Appalachian Mountains. *Krigia montana* is endemic to this region (Shinners 1947; Wiser 1994), occurring mainly on granitic balds, cliffs, talus, and roadbanks, principally in North Carolina but extending into South Carolina, Georgia, and Tennessee in similar habitats. It is consistently tetraploid (Tomb et al. 1978). *Krigia biflora* is much more widespread, occurring in woodlands and low prairies throughout the northeastern United States and parts of southern Canada, ranging south to Georgia, Alabama, and Arkansas, with disjunct populations in Colorado, New Mexico, and Arizona (Kim & Turner 1992). In the Blue Ridge of North Carolina it is found principally in the shrub bald community (Ramseur 1960), and both diploid ($n = 5$) and tetraploid ($n = 10$) populations are known.

At Craggy Gardens on the Blue Ridge Parkway, ca. 12 air line km northeast of Asheville, Buncombe County, hexaploid plants were found that were intermediate in various respects between the two above species. Their population will be described below. Samples from this site, along with samples of *K. montana* and of diploid and tetraploid *K. biflora* were contributed to the research of K.-J. Kim, University of Texas, and are mentioned in his various publications. His biochemical studies involved the whole genus and included both chloroplast DNA, examined through restriction site analysis, and nuclear rDNA, for which restriction sites and ITS sequences were utilized. Because the chloroplast genome is inherited maternally, it was expected that the hybrid's chloroplasts would resemble one parent more than the other. In the cladistic analysis, the maternal parent proved to be diploid *K. biflora* (Kim et al. 1992). In the ITS sequence study, the hybrid did not associate closely with either parent but instead, in the strict consensus tree, formed an unresolved branch at the node basal to the two parents (Kim & Jansen 1994). However, a relationship of the hybrid with *K. montana* was shown in the analysis based on rDNA restriction sites (Kim and Mabry 1991). The hexaploid "exhibited combined length polymorphism patterns of the diploid *K. biflora* and the tetraploid *K. montana*." These studies leave no doubt that the Craggy Gardens plants are indeed the allopolyploid hybrid of *K. biflora* × *K. montana*.

In order to call attention to this hybrid and to provide a name for use by those interested in studying it further, the following taxon is here described:

Krigia × shinnersiana K.L. Chambers, hybrid nov. (**Fig. 2**). TYPE: U.S.A. NORTH CAROLINA. BUNCOMBE CO.: Craggy Gardens, Blue Ridge Parkway 18.6 mi N of junction with Hwy. 70 E of Asheville, at the observation hut on grassy bald above the parking lot, elev. 5340 ft, grassy turf over granite substrate, 21 Jul 1968, *K.L. Chambers 2880* (HOLOTYPE: OSC; ISOTYPES: GH, MO, NY, OSC, US).

Hybrida inter *Krigiam bifloram* et *K. montanam* intermedia caule inferne et superne ramoso foliato ramis superne folia redacta ferens ab capitulis longi-pedunculatis 1–3 simul terminatis, cypselis 3.5 mm longis, floribus aurantiaco-luteis, chromosomatum numerus $2n = 60$.

Perennial herb with short rhizome, propagating by adventitious buds from the rootlets, stems decumbent or erect, to 65 cm tall, leaves of the basal rosette 8–30 cm long, oblanceolate, tapering to a narrowly winged petiole, acute, entire or dentate to pinnatifid with remote, straight or arcuate, acute lobes, lower cauline leaves similar, 14–25 cm long, upper leaves reduced, lanceolate with broad, clasping petiole, peduncles 14–28(–30) cm long, glandular-villous towards apex, involucre 7–10 mm high in flower, 8–13 mm high in fruit, phyllaries 11–13, equal, lanceolate, attenuate, green, glabrous or lightly glandular-villous, florets 20–23 mm long. The name honors Lloyd H. Shinners, whose valuable monograph (1947) forms the basis for studies of the genus.

Additional collections: **U.S.A. NORTH CAROLINA. Buncombe Co.:** Blue Ridge Parkway, mile 364.4 R., Craggy Flats, in bald near trail shelter on Craggy Gardens nature trail, 14 Jul 1977, *T. Govus 231 and Dan Pittillo* (WCUH). **Buncombe Co.:** Scattered in grassy bald, top of Craggie Mt., 15 Jul 1935, *H.J. Oosting 35453* (DUKE).

A comparison of habit and flower color in *Krigia × shinnersiana* and its two parents is given in Table 1. Differences in the cypselae also were noted (Fig. 3). Fruits of the hybrid were consistently longer, at 3.5 mm, than in either *K. biflora* (3.0 mm) or *K. montana* (2.5–3.0 mm). In *K. biflora* the ribs of the cypselae are low and of equal prominence nearly to the base, whereas in *K. montana*, 3 ribs are usually more prominent than the others in adaxial view, some other ribs being suppressed. In *K. × shinnersiana* the ribs in adaxial view arise at the base in groups of 3, with the central rib being more prominent to near the cypsela

HOLOTYPE

KRIGIA X SHINNERSIANA K. L. Chambers

Annotated: K. L. Chambers 2/4/2004

Hybrid between Montana x biflora

UNIVERSITY OF TEXAS HERBARIUM (LL,TEX)

Krigia montana (Michx.) Nutt

Det., Ki-Joong Kim, 1989

PLANTS of NORTH CAROLINA

KRIGIA

BUNCOMBE CO.: Craggy Gardens, on the Blue Ridge Pkwy. 18.6 mi. north of junction with Hwy. 70 east of Asheville. At the observation hut on grassy bald above the parking lot. Elev. 5340 feet. Grassy tur over granite substrate. [Coll. 10/20/67; transplants flowered and coll. July 21, 1968 in garden at Kensington, Md.]

K. L. Chambers (2880-3) 2n=30

HERBARIUM

179923

OREGON STATE UNIVERSITY

Fig. 2. Holotype of *Krigia* × *shinnersiana*, OSC.

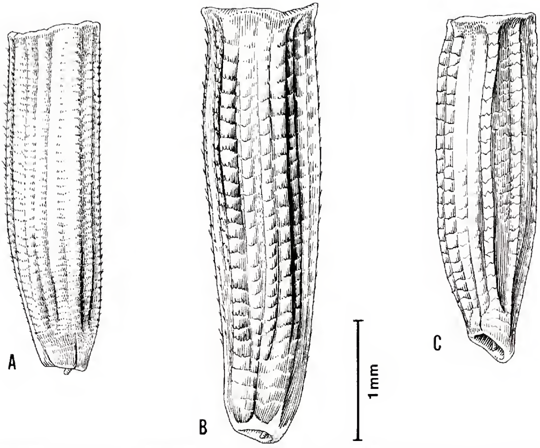


Fig. 3. Cypselae of *Krigia* × *shinnersiana* and its parental taxa. A. *Krigia biflora* (*Chambers 1404*), B. *K.* × *shinnersiana* (*Chambers 1362*), C. *K. montana* (*Chambers 1360*). Pappi not shown.

apex. The number of bristles per cypsela was compared, using mature heads collected in glass vials to avoid shattering the delicate pappi (Table 2). Bristle numbers in *K. biflora* are distinctly greater than in *K. montana*, while the hybrid numbers vary from those of *K. montana* up to an approximately intermediate number. If bristle number is assumed to have a genetic component, the range of numbers in the hybrid, sampled at different times from the type locality, suggests that two or more different genotypes are present.

The type locality is reached by a trail heading south 0.5 km from the Visitors Center at the Craggy Gardens parking area, to a hikers' shelter constructed of weathered chestnut beams. The grass bald south of the shelter is being invaded by small shrubs of *Rhododendron catawbiense* from the surrounding heath bald community (Ramseur 1960:90). *Krigia montana* is common on Craggy Pinnacle north of the parking area but was not seen in the heath or grass bald communities along the south trail. *Krigia biflora* was never noted in this vicinity during my field studies. Observations made in 1995 found the hybrid to be abundant in two areas of the bald, forming colonies near small shrubs of *Rhododendron* and *Vaccinium*. The absence of variation in transplants from

Table 1. Comparison of habit and flower color of *Krigia biflora, K. montana*, and *K.* × *shinnersiana*. *Measured by means of Nickerson Color Fan (Munsell Color Co., Baltimore, MD). Floral pigments of *Krigia* spp. identified as carotenoids by Harborne (1997).

Krigia biflora	***Krigia* × *shinnersiana***	***Krigia montana***
Stems naked below or with one large leaf low-down; modified clasping leaf higher up.	Same as *K. montana*	Cauline leaves well-developed, with axillary branches above basal leaf rosette.
Main stem ending in umbellate cluster of 2–6 naked floral peduncles.	Main stem ending in cluster of 1–3 naked floral peduncles.	Main stem usually terminated by a single naked floral peduncle.
Terminal cluster of peduncles subtended by 1–3 bracts up to 3(–5) cm long.	Terminal peduncles subtended by 1–3 bract-like leaves up to 9(–11) cm long.	Terminal peduncle subtended by 1–2 leaves up to 18 cm long.
Later inflorescences may arise in axils of clasping upper leaf and lower stem leaf.	Same as *K. montana*	Later inflorescence branches arise in axils of stem leaves and leaves subtending terminal peduncle.
First floral peduncle not arising singly from basal leaf rosette.	Same as *K. biflora*	First floral peduncle may arise singly near basal leaf rosette.
Flower color Munsell Hue 10YR 8/10 moderate orange yellow.*	Flower color Munsell Hue 5Y 8/12, vivid yellow.	Flower color Munsell Hue 7.5Y 8/12, vivid greenish yellow.

Table 2. Mean number of pappi bristles per cypsela in plants of *Krigia biflora, K. montana*, and *K.* × *shinnersiana*. Collections of the latter taxon were made at Craggy Gardens at various times. The standard deviation, range, and number of cypselae sampled are given. See Appendix for other locality information.

Collection	**Mean**	**S.D.**	**Range**	**Number**
1207 biflora 2x	36.86	2.97	30–42	28
1404 biflora 4x	31.88	3.15	26–39	24
2894 montana	15.38	1.36	13–18	16
2881 montana	18.67	1.36	16–22	27
2887 montana	21.13	1.46	20–23	8
2889 montana	21.88	1.45	19–25	16
2888-1 shinnersiana	18.49	1.64	14–22	38
2880 shinnersiana	19.48	1.35	16–22	29
2888-2 shinnersiana	20.74	1.95	18–23	50
2879-2 shinnersiana	21.16	2.41	17–26	76
1362 shinnersiana	24.17	2.17	21–28	12
2879-5 shinnersiana	24.80	2.07	20–28	20
2879-3 shinnersiana	27.70	1.52	25–30	20

each colony suggests that reproduction is largely clonal. One such colony was located 31 m southeast of the shelter, just east of an incised walking trail, while another was found 28 m southwest of the shelter, west of a second trail. The two colonies differ in leaf shape (nearly entire vs. sharply pinnately lobed) and probably represent different genotypes. Fruit-set is high when hybrid plants are cross-pollinated experimentally, but seedling establishment may be infrequent in the dense stand of *Carex* and grasses of the bald.

As discussed by Wiser and White (1999), grass balds of the Southern Appalachians were used as summer grazing pastures until around 1930, but they are not maintained by current natural processes and are subject to woody plant invasion. The bald at the type locality, under the name Craggy Flats, was described by Pittillo and Govus (1978), who included a brief list of the herbaceous flora. *Krigia* × *shinnersiana* was mentioned in this list under the name *K. biflora* (voucher checked by the author). It is tempting to speculate that the hybrid originated over 70 years ago, in the period of cattle grazing, when habitat disturbance was greater than now and open ground was more available for hybrid seedling establishment. The two parental species must have been in genetic contact over a long period of time in this mountainous region, and we can expect to find the products of their hybridization at other sites as well. Evidence of this is the discovery of pentaploid plants referable to *Krigia biflora* at two sites along the trail up Mt. Pisgah from the Blue Ridge Parkway, Haywood County, NC (*Chambers 2891, 2893*). The habitat was trail-side in a shrub bald about 50 m below the summit communications tower, in very different conditions than the grass bald at Craggy Flat. Morphology of the plants suggests a contribution of *K. montana* to their origin. It is hoped that this report will stimulate interest and further study by persons to whom these sites on the Blue Ridge Parkway are readily accessible.

APPENDIX: COLLECTIONS CITED

***Krigia biflora*.**—**NEW JERSEY. Atlantic Co.:** Nesco, 21 May 1957, *Chambers 1207*. **WEST VIRGINIA. Nicholas Co.:** 7.7 mi N of Mt. Nebo, 30 Aug 1958, *Chambers 1404*. **NORTH CAROLINA. Heywood Co.:** trail up Mt. Pisgah, where vegetation changes to *Kalmia* scrub with oaks, 21 Jun 1968, *Chambers 2891*; same, 50 yards down trail from summit tower, *Chambers 2893*

***Krigia montana*.**—**NORTH CAROLINA. Rutherford Co.:** Chimney Rock Park, 7 Jun 1958, *Chambers 1360*. **Buncombe Co.:** Blue Ridge Parkway, Craggy Pinnacle, 20 Oct 1967, *Chambers 2881*; same, nature trail by Craggy Gardens parking lot, 20 Jun 1968, *Chambers 2887*. **Buncombe Co.:** Blue Ridge Parkway, Balsam Gap, 6.5 mi NE of Craggy Gardens, 20 Jun 1968, *Chambers 2889*. **SOUTH CAROLINA. Greeneville Co.:** Caesar's Head, 22 Jun 1968, *Chambers 2894*.

***Krigia* × *shinnersiana*.**—**NORTH CAROLINA. Buncombe Co.:** grassy bald at observation hut on trail S of Craggy Gardens parking lot, 8 Jun 1958, *Chambers 1362*; same, 20 Oct 1967, *Chambers 2879, 2880*; same, 20 Jun 1968, *Chambers 2888*.

ACKNOWLEDGMENTS

I am pleased to acknowledge the help of the following persons during the course of these studies: David Boufford, Henrietta Chambers, Kanchi Gandhi, Laurent Gautier, Bonnie Hall, F. Jacquemoud, Aaron Liston, John Nelson, J. Dan Pittillo, Beryl Simpson, Rena Schlachter, Chris Tanner, and Carroll Wood. I appreciate Guy Nesom and an anonymous reviewer for carefully reviewing the manuscript.

REFERENCES

Chambers, K.L. 1963. Amphitropical species pairs in *Microseris* and *Agoseris* (Compositae: Cichorieae). Quart. Rev. Biol. 38:124–140.

Chambers, K.L. 1973. *Krigia cespitosa*. In: B.S. Vuilleumier, The genera of Lactuceae (Compositae) in the Southeastern United States. J. Arnold Arbor. 54:52–53.

Chambers, K.L. 1965. An allopolyploid *Krigia* from the southern Appalachians. Amer. J. Bot. (Abstr.) 52:658.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

DeCandolle, A.P. 1838. Prodromus systematis naturalis regni vegetabilis. Pars 7. Treuttel & Wurtz, Paris.

Diggs Jr., G.M., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners & Mahler's illustrated flora of north central Texas. Botanical Research Institute of Texas, Fort Worth.

Elliott, S. 1824. A. sketch of the botany of South-Carolina and Georgia. Facsimile ed. 1971, Hafner Publ. Co., New York.

Gray, A. 1884. Synoptical flora of North America. Vol. I, Part II. Ivison, Blakeman, Taylor & Co., New York.

Greuter, W. et al. 1988. International code of botanical nomenclature. Regnum Veg. 118. Koeltz Scientific Books, Koenigstein.

Greuter, W. et al. 2000. International code of botanical nomenclature. Regnum Veg. 138. Koeltz Scientific Books, Koenigstein.

Harborne, J.B. 1977. Variations in pigment patterns in *Pyrrhopappus* and related taxa of the Cichorieae. Phytochem. 16:927–928.

Jepson, W.L. 1925. A manual of the flowering plants of California. Univ. of California, Berkeley.

Kim, K.-J. and T.J. Mabry. 1991. Phylogenetic and evolutionary implications of nuclear ribosomal DNA variation in dwarf dandelions (*Krigia*, Lactuceae, Asteraceae). Pl. Syst. Evol. 177:53–69.

Kim, K.-J. and B.L. Turner. 1992. Systematic overview of *Krigia* (Asteraceae—Lactuceae). Brittonia 44:173–198.

Kim, K.-J., B.L. Turner, and R.K. Jansen. 1992. Phylogenetic and evolutionary implications of interspecific chloroplast DNA variation in *Krigia* (Asteraceae–Lactuceae). Syst. Bot. 17:449–469.

Kim, K.-J. and R.K. Jansen. 1994. Comparisons of phylogenetic hypotheses among different data sets in dwarf dandelions (*Krigia*, Asteraceae): additional information from internal transcribed spacer sequences of nuclear ribosomal DNA. Pl. Syst. Evol. 190:157–185.

Pittillo, J.D. and T.E. Govus. 1978. Important plant habitats of the Blue Ridge Parkway from the Great Smoky Mountain National Park to Roanoke, Virginia. Southeast Regional Office, National Park Service.

Rafinesque, C.S. 1817. Florula ludoviciana. C. Wiley & Co., New York.

Ramseur, G.S. 1960. The vascular flora of high mountain communities of the southern Appalachians. J. Elisha Mitchell Sci. Soc. 76:82–112.

Shinners, L.H. 1958. Spring flora of the Dallas-Fort Worth area, Texas. Lloyd H. Shinners, Dallas.

Shinners, L.H. 1947. Revision of the genus *Krigia* Schreber. Wrightia 1:187–206.

Tomb, A.S., K.L. Chambers, D.W. Kyhos, A.M. Powell, and P.H. Raven. 1978. Chromosome numbers in the Compositae. XIV. Lactuceae. Amer. J. Bot. 65:717–721.

Vuilleumier, B.S. 1973. The genera of Lactuceae (Compositae) in the southeastern United States. J. Arnold Arbor. 54:42–93.

Wiser, S.K. 1994. High-elevation cliffs and outcrops of the southern Appalachians: vascular plants and biogeography. Castanea 59:85–116.

Wiser, S.K. and P.S. White. 1999. High-elevation outcrops and barrens of the southern Appalachian Mountains. Pp. 119–132. In: R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds. Savannas, barrens, and rock outcrop plant communities of North America. Cambridge Univ. Press.

NEW COMBINATIONS IN NORTH AMERICA *EREMOGONE* (CARYOPHYLLACEAE)

Ronald L. Hartman
Rocky Mountain Herbarium
Department of Botany
University of Wyoming
Laramie, Wyoming 82071-3165, U.S.A.
rhartman@uwyo.edu

Richard K. Rabeler
University of Michigan Herbarium
3600 Varsity Drive
Ann Arbor, Michigan 48108-2287, U.S.A.
rabeler@umich.edu

ABSTRACT

The following 18 new combinations in *Eremogone* are proposed: *Eremogone capillaris* var. *americana*, *E. congesta* var. *cephaloidea*, *E. congesta* var. *charlestonensis*, *E. congesta* var. *crassula*, *E. congesta* var. *glandulifera*, *E. congesta* var. *prolifera*, *E. congesta* var. *simulans*, *E. congesta* var. *subcongesta*, *E. congesta* var. *suffrutescens*, *E. congesta* var. *wheelerensis*, *E. eastwoodiae* var. *adenophora*, *E. franklinii*, *E. franklinii* var. *thompsonii*, *E. kingii* var. *plateauensis*, *E. kingii* var. *rosea*, *E. macradenia* var. *arcuifolia*, *E. macradenia* var. *ferrisiae*, and *E. macradenia* var. *kuschei*.

RESUMEN

Se proponen las siguientes dieciocho combinaciones nuevas en *Eremogone*: *Eremogone capillaris* var. *americana*, *E. congesta* var. *cephaloidea*, *E. congesta* var. *charlestonensis*, *E. congesta* var. *crassula*, *E. congesta* var. *glandulifera*, *E. congesta* var. *prolifera*, *E. congesta* var. *simulans*, *E. congesta* var. *subcongesta*, *E. congesta* var. *suffrutescens*, *E. congesta* var *wheelerensis*, *E. eastwoodiae* var. *adenophora*, *E. franklinii*, *E. franklinii* var. *thompsonii*, *E. kingii* var. *plateauensis*, *E. kingii* var. *rosea*, *E. macradenia* var. *arcuifolia*, *E. macradenia* var. *ferrisiae*, y *E. macradenia* var. *kuschei*.

During preparation of the treatment of the Caryophyllaceae for *Flora North America* (Rabeler and Hartman, editors, in prep), the decision was made to recognize the genus *Eremogone* Fenzl (= *Arenaria* subgenera *Eremogone* (Fenzl) Fenzl and *Eremogoneastrum* F. Williams sensu McNeill 1962).

Nepokroeff and Wagner (pers. comm.; see also Nepokroeff et al. 2001) conducted a DNA survey of the Caryophyllaceae, using sequence data from matK and the rps16 intron. Over 79 species constituting 38 genera were included, with emphasis on the subfamily Alsinoideae. The phylogeny illustrated *Arenaria* (*sensu* McNeill (1962), excl. *Minuartia* and *Moehringia*) to be polyphyletic, with two major, distinct clades. While one clade includes members of four of McNeill's subgenera, including *Arenaria serpyllifolia* L., the type of *Arenaria*, and the genus *Moehringia*, the second clade includes seven species (five from subgenus *Eremogone*, three North American and two Asian, and two Asian members of subgenus *Eremogoneastrum*). Within that clade, *Arenaria bryophylla* Fern. (subg. *Eremogoneastrum* from Asia) clusters closely with *A. aculeata* S. Watson and *A. kingii* (S. Watson) M.E. Jones (subg. *Eremogone* from North America), suggesting that the relationships between the subgenera may also need examination. The results indicated that the *Eremogone* group, including both subgenera, is strongly supported as monophyletic.

Eremogone was treated by McNeill (1962) as a subgenus of *Arenaria* containing eight sections (64 species, our compilation; ca. 70 species (Zhengyi et al. 2001)) closely allied with subgenus *Eremogoneastrum* (ca. 22 species). Members of subgenus *Eremogone* are found from western Europe through Asia, east to southern Alaska and northwestern Canada, disjunct to southwestern Canada and the western United States. The composition of *Eremogone* sensu Ikonnikov (1990) excludes McNeill's monotypic section *Monogone* Maxim. (the Tien Shan Mountains and the Altai Region), two of the species from his section *Scariosae* (northern Iran and Turkish Armenia), and his sect. *Pungentes* (two species, Spain and North Africa).

As outlined by McNeill (1962), *Arenaria* subgenus *Eremogoneastrum* is confined to three centers with two species (*Arenaria hookeri* Nutt. and *A. franklinii* Dougl. ex Hook.; a third, *A. pinetorum* A. Nelson is a variety of the former) in western North America, the type, *A. festucoides* Benth., known from India, Pakistan, and China, and the remainder (ca. 6 species) Sino-Himalayan in distribution. Seventeen species are now known from China (Zhengyi et al. 2001); most are Sino-Himalayan, nine were published since 1979. Ikonnikov makes no mention of *Arenaria* subgenus *Eremogoneastrum* in either of his synopses of *Eremogone* (1973, 1990).

In North America, both Maguire (1947, 1951; treated in Maguire (1951) as *Arenaria* sect. *Pentadenaria* Williams) and Hickman (1971) recognized a broader concept of *Arenaria* section *Eremogone*, including the two western American members of subgenus *Eremogoneastrum* (*A. hookeri* and *A. franklinii*). Maguire treated those species as related to but of uncertain placement, while Hickman considered them to be intermediate between sections *Eremogone* and *Alsine* (= *Minuartia*). *Eremogone* as presented here is currently accepted in floras of Colorado (Weber & Wittmann 1992 and subsequent updates at *http://cumuseum.colorado.edu/*) and Wyoming (Dorn 2001).

Morphologically, *Eremogone* consists of woody based perennials with a cespitose or matted habitat, filiform to subulate leaves with scarious bases, stiffly erect or ascending flowering stems, and cymes that are open to congested or umbellate. This is contrasted with the remaining North American (north of Mexico) members of *Arenaria* (ca. 9 species), that are annuals or perennials with either a caespitose habit or ascending to trailing stems, broader (ovate to lanceolate, sometimes narrowly so) leaves, and flowers often solitary or in few-flowered, open cymes.

Ikonnikov (1973) and Holub (1974) both noted that a base chromosome number of $x = 11$ also distinguished *Eremogone* from *Arenaria* ($x = 10$). Of the approximately 30 species of *Eremogone*, as here defined, which have been counted, only three counts (including two for *E. fendleri* that appear not to have been vouchered; that taxon was counted by Hartman (1971) as 2n = 44) are not based on $x = 11$. Contrary to their notion, *Arenaria* s.s. is cytologically more diverse; while many counts are based on $x = 10$, counts based on $x = 11$ are known in two subgenera as well as five sections of subg. *Arenaria* (Rabeler, pers. compilation from standard chromosome atlases).

Most of the nomenclatural combinations for the 13 North American species of *Arenaria* to be included in *Eremogone* are available (Ikonnikov 1973, 1974; Weber et al. 1981); by contrast, only a few of the infraspecific taxa have the appropriate combinations (Weber et al. 1981; Dorn 2001).

The following combinations are needed for the genus *Eremogone* in North America in anticipation of the *Flora North America* treatment (Hartman, Rabeler and Utech, in prep).

Eremogone capillaris (Poir.) Fenzl var. **americana** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria capillaris* Poir. subsp. *americana* Maguire, Bull. Torrey Bot. Club 74:41. 1947. *Arenaria capillaris* var. *americana* (Maguire) R.J. Davis, Madroño 11:144. 1951. *Eremogone americana* (Maguire) Ikonn., Novosti Sist. Vyssh. Rast. 11:174. 1974.

Eremogone congesta (Nutt.) Ikonn. var. **cephaloidea** (Rydb.) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria cephaloidea* Rydb., Bull. Torrey Bot. Club 39:316. 1912. *Arenaria congesta* Nutt. var. *cephaloidea* (Rydb.) Maguire, Bull. Torrey Bot. Club 74:46. 1947.

Eremogone congesta (Nutt.) Ikonn. var. **charlestonensis** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria congesta* Nutt. var. *charlestonensis* Maguire, Bull. Torrey Bot. Club 73:326. 1946.

Eremogone congesta (Nutt.) Ikonn. var. **crassula** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria congesta* Nutt. var. *crassula* Maguire, Bull. Torrey Bot. Club 74:45. 1947.

Eremogone congesta (Nutt.) Ikonn. var. **glandulifera** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria congesta* Nutt. var. *glandulifera* Maguire, Amer. Midl. Naturalist 46:501. 1951.

Eremogone congesta (Nutt.) Ikonn. var. **prolifera** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria congesta* Nutt. var. *prolifera* Maguire, Bull. Torrey Bot. Club 74:47. 1947.

Eremogone congesta (Nutt.) Ikonn. var. **simulans** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria congesta* Nutt. var. *simulans* Maguire, Bull. Torrey Bot. Club 74:48. 1947.

Eremogone congesta (Nutt.) Ikonn. var. **subcongesta** (S. Watson) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria fendleri* A. Gray var. *subcongesta* S. Watson, Botany [Fortieth Parallel]. 5:40. 1871. *Arenaria congesta* Nutt. var. *subcongesta* (S. Watson) S. Watson, Bot. Calif. 1:69. 1885. *Arenaria subcongesta* (S.Watson) Rydb., Bull. Torrey Bot. Club 24:244. 1897. *Arenaria burkei* Howell, Fl. N.W. Amer. 1:85. 1897.

Eremogone congesta (Nutt.) Ikonn. var. **suffrutescens** (A. Gray) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Brewerina suffrutescens* A. Gray, Proc. Amer. Acad.

8:620. 1873. *Arenaria congesta* Nutt. var. *suffrutescens* (A. Gray) B.L. Rob., Proc. Amer. Acad. Arts 29:295. 1894. *Arenaria suffrutescens* (A. Gray) A. Heller, Muhlenbergia 6:96. 1910.

Eremogone congesta (Nutt.) Ikonn. var. **wheelerensis** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria congesta* Nutt. var. *wheelerensis* Maguire, Bull. Torrey Bot. Club 74:48. 1947.

Eremogone eastwoodiae (Rydb.) Ikonn. var. **adenophora** (Kearney & Peebles) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria eastwoodiae* Rydb. var. *adenophora* Kearney & Peebles, J. Wash. Acad. Sci. 29:475. 1939.

Eremogone franklinii (Dougl. ex Hook.) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria franklinii* Dougl. ex Hook., Fl. Bor. Amer. 1:101. 1831.

Eremogone franklinii (Dougl. ex Hook.) R.L. Hartman & Rabeler var. **thompsonii** (M. Peck) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria franklinii* Dougl. ex Hook. var. *thompsonii* M. Peck, Torreya 32:149. 1932 ('*Thompsoni*').

Eremogone kingii (S. Watson) Ikonn. var. **plateauensis** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria kingii* (S. Watson) M.E. Jones subsp. *plateauensis* Maguire, Bull. Torrey Bot. Club 74:54. 1947. *Arenaria kingii* var. *plateauensis* (Maguire) Reveal, Great Basin Naturalist 35:344. 1975.

Eremogone kingii (S. Watson) Ikonn. var. **rosea** (Maguire) R.L. Hartman & Rabeler, comb. et stat. nov. BASIONYM: *Arenaria kingii* (S. Watson) M.E. Jones subsp. *rosea* Maguire, Bull. Torrey Bot. Club 73:326. 1946.

Eremogone macradenia (S. Watson) Ikonn. var. **arcuifolia** (Maguire) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria macradenia* S. Watson var. *arcuifolia* Maguire, Bull. Torrey Bot. Club 74:51. 1947.

Eremogone macradenia (S. Watson) Ikonn. var. **ferrisiae** (Abrams) R.L. Hartman & Rabeler, comb. et stat. nov. BASIONYM: *Arenaria macradenia* S. Watson subsp. *ferrisiae* Abrams, Ill. Fl. Pacif. States 2:151. 1944.

Eremogone macradenia (S. Watson) Ikonn. var. **kuschei** (Eastw.) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria kuschei* Eastw., Proc. Calif. Acad. IV. 20:140. 1931. *Arenaria macradenia* S. Watson var. *kuschei* (Eastw.) Maguire, Bull. Torrey Bot. Club 74:51. 1947.

ACKNOWLEDGMENTS

We wish to thank Kanchi Gandhi (GH) for nomenclatural advice and Molly Nepokroeff (SDU) and Warren L. Wagner (US) for sharing with us results of their molecular work on the Caryophyllaceae.

REFERENCES

DORN, R.D. 2001. Vascular plants of Wyoming. Third Ed. Mountain West Publishing.

HARTMAN, R.L. 1971. Chromosome numbers in Caryophyllaceae from Wyoming and adjacent states. Bull. Torrey Bot. Club 98:276–280.

HICKMAN, J.C. 1971. *Arenaria*, Section *Eremogone*, (Caryophyllaceae in the Pacific Northwest: a key and discussion. Madroño 21:201–207.

HOLUB, J. 1974. New names in *Phanerogamae* 3. Folia Geobot. Phytotax. 9:261–275.

Holub, J. 1977. New names in *Phanerogamae* 6. Folia Geobot. Phytotax. 12:417–432.

Ikonnikov, S.S. 1973. Notae de Caryophyllaceis, 1. Novosti Sist. Vyssh. Rast. 10:136–142.

Ikonnikov, S.S. 1974. Notula de speciebus Americanis generis *Eremogone* Fenzl (fam. Caryophyllaceae). Novosti Sist. Vyssh. Rast. 11:174–175.

Ikonnikov, S.S. 1990. Notae de Caryophyllaceis, 9. Novosti Sist. Vyssh. Rast. 27:63–65.

Maguire, B. 1947. Studies in the Caryophyllaceae—III. A synopsis of the North American species of *Arenaria*, sect. *Eremogone* Fenzl. Bull. Torrey Bot. Club 74:38–56.

Maguire, B. 1951. Studies in the Caryophyllaceae—V. *Arenaria* in America North of Mexico. A Conspectus. Amer. Midland Nat. 46:493–511.

McNeill, J. 1962. Taxonomic studies in the Alsinoideae: I. Generic and infra-generic groups. Notes Roy. Bot. Gard. Edinburgh 24:79–155.

Nepokroeff, M., W.L. Wagner, E.A. Zimmer, S.G. Weller, A.K. Sakai, and R.K. Rabeler. 2001. Origin of the Hawaiian subfam. Alsinoideae and preliminary relationships in Caryophyllaceae inferred from *mat*K and *trn*L C-F sequence data. Botany 2001 Abstracts: 130. Bot. Soc. of America, Columbus, Ohio. (Also posted at http://www.botany2001.org)

Weber, W.A., B.C. Johnston, and R. Wittmann. 1981. Additions to the flora of Colorado–VII. Brittonia 33:325–331.

Weber, W.A and R.C. Wittmann. 1992. Catalog of the Colorado flora: a Biodiversity Baseline. Univ. Press of Colorado, Boulder.

Zhengyi, W., Z. Lihua, and W.L. Wagner. 2001. 19. *Arenaria*. In: Zhengyi, W., P.H. Raven, and H. Deyuan, eds. Flora of China 6:40–66.

BOOK NOTICES

FLORAS AND CHECKLISTS

PHILIP A. MUNZ (Edited by Dianne Lake and Phyllis M. Faber). 2003. **Introduction To Shore Wildflowers of California, Oregon, and Washington. Revised Edition.** (ISBN 0-520-23639-4, pbk.). University of California Press, California/Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A. (Orders: 609-883-1759, 609-883-7413 fax). $16.95, 234 pp., color photos, 5" × 7 1/2".

Review forthcoming in volume 21, no. 2.

LINDA H. BEIDLEMAN and EUGENE N. KOZLOFF. 2003. **Plants of the San Francisco Bay Region: Mendocino to Monterey. Revised Edition.** (ISBN 0-520-23173-2, pbk.). University of California Press, California/Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A. (Orders: 609-883-1759, 609-883-7413 fax). $29.95, 504 pp., 227 line drawings, 457 color photos, 7" × 10".

This revised edition accounts for more than 2,000 species of wildflowers, trees, shrubs, weeds, and ferns in the San Francisco Bay Region. The introduction includes discussion on scientific names, common names, and geographic ranges of plants, measurements, how to use a key, conservation issues, using native plants, and general references. A full chapter is devoted to San Francisco Bay Region's plant communities and their environments. Keys for identification of the major groups of plants are followed by an alphabetical listing of families for ferns, fern allies, gymnosperms, dicots and monocots. There is a brief description of the family followed by a key to the various taxa in the family with line drawings for selected taxa following the keys. An impressive section of the book is the color plate part in which almost one quarter of the taxa are illustrated with a nice color photograph.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 761202-4060, U.S.A.*

VERNON L. HARMS. 2003. **Checklist of the Vascular Plants of Saskatchewan and the Provincially and Nationally Rare Native Plants in Saskatchewan.** (ISBN 0-88880-471-7, pbk.). University of Saskatchewan, Extension Division, Kirk Hall Room 125, 117 Science Place, Saskatoon, SK 57N 5C8 CANADA. (Orders: 306-966-5565, 306-966-5567 fax). $39.95cd, 328 pp., 6" × 9".

"The *Checklist of the Saskatchewan Vascular Plants* is a compilation of all native and naturalized vascular plants that occur in Saskatchewan." The checklist provides users with relatively comprehensive nomenclatural synonymies. A common names index is included following a scientific names index.

NEW COMBINATIONS IN THE GENUS *GUNDLACHIA* AND FOUR NEW GENERA OF ASTEREAE (ASTERACEAE) FROM NORTHERN MEXICO AND THE SOUTHERN UNITED STATES

Lowell E. Urbatsch

Department of Biological Sciences
Louisiana State University
Baton Rouge, Louisiana 70803, U.S.A.

Roland P. Roberts

Department of Biological Sciences
Towson University
Towson, Maryland 21252-0001, U.S.A.

ABSTRACT

New combinations and new genera for species in *Xylothamia* are provided, reflective of recent phylogenetic data indicating the polyphyletic nature of that genus and the need to revise its taxonomy. Four species of *Xylothamia* are subsumed under the genus *Gundlachia*, necessitating the following new combinations: ***G. diffusa, G. riskindii, G. triantha*** (the type for *Xylothamia*), and ***G. truncata***. Four new genera are recognized for lineages without available generic names. ***Neonesomia*** includes ***N. johnstonii*** and ***N. palmeri***. Each of the other three genera are monotypic, ***Chihuahuana, Medranoa***, and ***Xylovirgata***, and they accommodate ***C. purpusii, M. parrasana***, and ***X. pseudobaccharis***, respectively.

Key Words: Asteraceae, Astereae, *Xylothamia, Chihuahuana, Gundlachia, Medranoa, Neonesomia*, and *Xylovirgata*, Chihuahuan Desert, Sonoran Desert, Caribbean plants

RESUMEN

Las nuevas combinaciones y los nuevos géneros que se ofrecen para las especies en *Xylothamia* son el reflejo de los datos filogenéticos recientes que indican la naturaleza polifilética de ese género y de la necesidad de revisar su taxonomía. Cuatro especies de *Xylothamia* se incluyen en el género *Gundlachia* que hace necesarias las nuevas combinaciones siguientes: ***G. diffusa, G. riskindii, G. triantha***, (la tipo para *Xylothamia*), y ***G. truncata***. Se reconocen cuatro nuevos géneros para los linajes sin nombres genéricos disponibles. ***Neonesomia*** incluye ***N. johnstonii*** y ***N. palmeri***. Cada uno de los otros tres géneros es monotípico, ***Chihuahuana, Medranoa***, y ***Xylovirgata***, e incluyen a ***C. purpusii***, ***M. parrasana***, y ***X. pseudobaccharis***, respectivamente.

INTRODUCTION

Xylothamia, a genus of nine shrubby species from northern Mexico, Baja California, and southern Texas, was proposed by Nesom et al. (1990) to accommodate certain species of *Haplopappus* (sensu Hall 1928) and certain *Ericameria* (sensu Urbatsch 1978), plus similar and more recently described taxa. Studies designed to evaluate relationships among North American Astereae using parsimony analysis of external (ETS) and internal transcribed (ITS) DNA sequence data has shown *Xylothamia* to be polyphyletic (Urbatsch et al. 2003). Four of the nine species in *Xylothamia* and *Gundlachia* formed a robustly supported clade in this sequence-based study. The other five species were, in general, unresolved in a clade that also contained species in the genera *Amphiachyris, Bigelowia, Euthamia, Gutierrezia, Gymnosperma*, and *Thurovia* (Urbatsch et al.

2003). Figure 1 summarizes the phylogenetic relationships among taxa treated in the present study and those related. The tree is derived from figure 4 published in Urbatsch et al. (2003) where additional, explanatory information may be found. The purpose of this paper is to provide names for species of *Xylothamia* reflective of their phylogenetic placement in this sequence based study with consideration for their morphological and cytological variation as well.

Gundlachia, according to Lane (1996), who last considered its taxonomy, is restricted to the Caribbean region and consists of two species, *G. domingensis* and *G. corymbosa*. The former is known from the Bahamas, Cuba, and the Dominican Republic, while the latter consists of six varieties, and ranges from coastal Venezuela northward through the Greater and Lesser Antilles to the Bahamas and Cuba (Lane 1996). Although *Gundlachia* had not been included in their cpDNA-based study, Lane et al. (1996) and Nesom (1991, 1993) were in general agreement on its placement within the *Gutierrezia* lineage sensu Nesom (1993). *Gundlachia* is expanded herein to accommodate *X. diffusa*, *X. riskindii*, *X. triantha*, and *X. truncata*. *Gundlachia* now encompasses six species. Its geographic range is expanded from the Caribbean and nothern South America to include parts of mainland Mexico, the Baja California peninsula, and southwestern Texas. Formal nomenclatural combinations for these *Xylothamia* are made in keeping with the botanical code (Greuter et al. 2000). Generic synonymy for *Gundlachia* as treated herein is also updated because it encompases *X. triantha*, the type for *Xylothamia*.

With regard to the other five species of *Xylothamia*, *X. johnstonii*, and *X. palmeri* constitute a robustly supported clade (Urbatsch et al. 2003) that is herein proposed as the new genus *Neonesomia*. The three remaining species of *Xylothamia* are each treated as monotypic genera because they are not unambiguously supported as monophyletic or placed within existing genera based on DNA sequence data (Urbatsch et al. 2003), and they are each morphologically unique. *Chihuahuana*, *Medranoa*, and *Xylovirgata* are the generic names proposed for each of the three taxa.

Gundlachia as reconstituted in this study and its sister clade containing the five former species of *Xylothamia* plus *Amphiachyris*, *Bigelowia*, *Euthamia*, *Gutierrezia*, *Gymnosperma*, and *Thurovia* are supported as a monophyletic lineage based on ITS/ETS sequences (Urbatsch et al. 2003) and approximates what Nesom (1991) called the *Gutierrezia* group. Nesom (1991) credited the cpDNA enzyme restriction studies of Suh (1989) and Suh and Simpson (1990) for initially helping to define this group as monophyletic. Although *Gundlachia* had not been part of the aforementioned DNA investigations, Nesom (1991) aligned it with this group because of its sharing several anatomical and morphological features discussed in part by Anderson and Creech (1975). *Chrysoma* and *Sericocarpus* were subsequently aligned with the former ten genera of the *Gutierrezia* lineage (Nesom 1993) which Nesom subdivided into two groups. *Amphiachyris*, *Gutierrezia*, *Gymnosperma*, and *Thurovia* were assigned to the redefined *Gutierrezia* group. Features shared by most taxa in this group are reduced pappus, short disc corolla lobes, annual life cycle in certain species, and base chromosome numbers of x = 4, 5 (Nesom 1993). The remaining six genera were designated the *Euthamia* group (Nesom 1993) that are typically perennial herbs or shrubs with pappus of capillary bristles and a base chromosome number of $x = 9$.

Chrysoma and *Sericocarpus* in the ETS + ITS sequence based phylogenies were placed more closely to *Solidago* and allies (Urbatsch et al. 2003) and not part of the *Gutierrezia* lineage sensu Nesom (1993). Results by Noyes and Rieseberg (1999) for *Sericocarpus* were similar while *Chrysoma* was not included in their study. Lane et al. (1996), based on cpDNA restriction site data, provided support for a clade containing six of the ten genera of the *Gutierrezia* lineage. *Chrysoma*, *Gundlachia*, and *Sericocarpus* were not investigated and *Xylothamia* constituted part of their *Ericameria* lineage (Lane et al. 1996). Branch support and decay index scores for *Xylothamia*'s inclusion in the *Ericameria* lineage ranged from one to zero (Lane et al. 1996).

Sequence support for the *Gutierrezia* group within the *Gutierrezia* lineage (sensu Nesom 1993) is equivocal based investigations of Urbatsch et al. (2003), depending on optimality criteria and databases analyzed. *Amphiachyris*, *Gutierrezia*, and *Gymnosperma* constitute a robustly supported lineage in the Bayesian ITS + ETS tree. However, *Thurovia* appears as an unstable member of the *Gutierrezia* group sensu Nesom (1993). Only when this data set is analyzed with PAUP* ratchet are *Thurovia* and *Amphiachyris* sisters (Urbatsch et al. 2003). Otherwise *Thurovia* was not affiliated with the *Gutierrezia* group. It was sister to *Bigelowia* in PAUP* ratchet of the combined ITS + ETS + indels and to *Neonesomia* in the Bayesian tree resulting from the combined ITS + ETS. Sequence data offered no support for the *Euthamia* group of the *Gutierrezia* lineage sensu Nesom (1993).

Characters that support and diagnose the *Gutierrezia* lineage as delineated in Urbatsch et al. (2003) i.e., without *Chrysoma* and *Sericocarpus*, include leaves showing xerophytic adaptations such as often being filiform or otherwise reduced in size, somewhat coriaceous in some taxa, usually punctate and resin coated, and often supporting a variety and abundance of trichomes; capitula generally small, borne in sessile clusters or on short peduncles; phyllaries basally indurate with a thickened apical patch; stamen insertion below the apex of disk corolla tube; cypselae small, cylindrical to turbinate, and often sericeous.

NOMENCLATURAL TREATMENT

1. Chihuahuana Urbatsch & R.P. Roberts, gen. nov. TYPE: *Ericameria purpusii* Brandegee, Univ. Calif. Publ. Bot. 4:191. 1911. = *Chihuahuana purpusii* (Brandegee) Urbatsch & R.P. Roberts, combination made herein].

Fruticulus ramosus, folia lineari-lanceolata ca. 2 mm longa acuminata in axillis filiorum 3–10 mm longorum linearium acuminatorum decurrentium demum cinereorum spinescentium fasciculatis; capitula ramos terminantibus 6–7 mm alta fere sessilia discoidea; corollae 8–10, luteola in lobos ovato-lanceolata inaequaliter sectis.

Densely branching shrubs to 30 cm tall; stems mostly concealed by the persistent closely spaced leaves with small axillary clusters; leaves sessile, acicular, narrowly triangular with a thickened midrib composed mainly of a large bundle of fibers, erect, 3–10 mm long, ca. 1 mm broad at base, hirtellous due to a dense covering of uniseriate conic trichomes, bases somewhat decurrent, apices sharply acute; capitula discoid, solitary, campanulate, 4–5 mm wide; phyllaries graduated, the inner 5–6 mm long; eradiate; disk flowers 8–10, corollas hairy 4.2–5.0 mm long; cypselae densely sericeous; $x = 9$.

Prominent features, distribution, and relationships.—*Chihuahuana*'s needle-like, non-resinous, hirtellous leaves with a large midvein consisting of a bundle of fibers is unique in the *Gutierrezia* clade where its relationships are not fully resolved (Urbatsch 1975; Urbatsch et al. 2003).

Etymology.—The generic name was selected because it is a member of the Chihuahuan Desert flora.

1a. Chihuahuana purpusii (Brandegee) Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Ericameria purpusii* Brandegee, Univ. Calif. Publ. Bot. 4:191. 1911. *Haplopappus* [*Aplopappus*] *purpusii* (Brandegee) S.F. Blake. Contr. U.S. Natl. Herb. 23:1491. 1926. *Xylothamia purpusii* (Brandegee) G.L. Nesom, Sida 14:112 1990. TYPE: MEXICO. COAHUILA: Cerro de Macho, Jun 1910, *Purpus 4479* (HOLOTYPE: UC!).

Distribution, ecology, and relationship.—Chihuahuan Desert region in southwestern Coahuila and adjacent locales in Chihuahua and Durango, rocky hills in gypseous or limestone soils (Nesom et al. 1990). Detailed descriptive information and distributional data for this species (as *X. purpusii*) are provided in Nesom et al. (1990).

Chihuahuana purpusii was originally described in *Ericameria* then transferred to *Haplopappus* by Blake (1926). Hall (1928) placed the species in *Haplopappus* section *Asiris* with five other species mostly of Great Basin distribution. This species was then reinstated in *Ericameria* (Urbatsch 1978) and subsequently placed in the newly created genus *Xylothamia* (Nesom et al. 1990). Foliar anatomy, morphology, and flavonoid profiles for *C. purpusii* are unique (Urbatsch 1978; Urbatsch et al. 2003). ETS/ITS sequence-based phylogenies indicate the affinities of *C. purpusii* are with the *Gutierrezia* clade rather than with species in section *Asiris* (Urbatsch et al. 2003).

2. Gundlachia A. Gray, Proc. Amer. Acad. Arts 16:100. 1880. TYPE: *Solidago domingensis* Spreng., Syst. Veg. 3:539. 1826].

Xylothamia G.L. Nesom, Y.B. Suh, D.R. Morgan & B.B. Simpson, Sida 14:106. 1990. TYPE: *Aplopappus trianthus* S.F. Blake, J. Wash. Acad. Sci. 28:485. 1938 *Gundlachia triantha* (S.F. Blake) Urbatsch & R.P. Roberts.

Evergreen shrubs to 2.0 m tall, stems unbranched to abundantly branching, angular to minutely ridged; leaves usually evenly spaced along the stems, spreading to occasionally appressed, sessile to short petiolate, narrowly to broadly linear to obovate, flat to involute-terete, punctate, resinous; capitula usually clustered at branch tip, clusters few and sometimes hidden by the subtending leaves or numerous and organized into racemes or paniculate to corymbiform capitulescences; involucres cylindric, turbinate, or narrowly obconic, phyllaries 2–5 seriate, linear-lanceolate to ovate with an apical resin pocket, basally chartaceous, indurate, margins translucent; ray flowers 0–13, corollas 1–6.5 mm long, white to yellow; disk flowers 3–50, corollas 4.0–5.5 mm long, white to yellow, lobes 1.0–2.5 mm long, slightly irregular, usually laxly recurved, style branches 1.0–2.2 mm long, linear lanceolate to ovate, ratio of appendage/stigmatic length variable with different species; cypselae turbinate to cylindrical, 1.0–2.5 mm long sparsely to densely pilose to sericeous; pappus of ca. 40, slender, flattened, barbellate bristles, 3.5–5.0 mm long; $x = 9$

Prominent features, distribution, and relationships.—*Gundlachia* as treated in this study consists of six species known from the Caribbean, northern South America, northern Mexico, Baja California, and southwestern Texas. Its monophyly was robustly supported by DNA sequence data as a lineage sister to one consisting of several other taxa primarily from western North America. All taxa in this genus are shrubs usually with resinous, punctate leaves that are linear lanceolate to spatulate in three species, *G. corymbosa, G. domingensis,* and *G. riskindii* and filiform in the other three. Capitulescences are often large, corymbose to paniculate in *G. corymbosa, G. domingensis,* and *G. diffusa*; they are more reduced and cymose in *X. triantha. Gundlachia riskindii* has solitary capitula whereas *G. truncata* has two or three capitula clustered at their twig apices. Phyllaries in *Gundlachia* are resinous to glutinous and basally indurate.

All species are xeropytes. *Gundlachia corymbosa* and *G. domingensis* inhabit mainly sandy or stony soils in or near coastal habitats of various Caribbean islands, while *G. diffusa* occupies similar habitats of the Gulf of California region of Sonora and Baja California. *Gundlachia riskindii* appears to be restricted to exposed limestone areas in pine-oak woodland at around 2100 m in Coahuila and adjacent Nuevo León, Mexico. The other two species occur in the Chihuahuan Desert region associated with elements more typical of that flora such as *Atriplex, Larrea, Prosopis, Suaeda,* etc. Specific descriptions, distributional data, and supporting documentation for the species of *Xylothamia* here considered as *Gundlachia* are provided in Nesom et al. (1990). Similar data for *Gundlachia truncata* as a species of *Xylothamia* can be found Nesom (1992). Lane (1996) provided detailed species descriptions, distributional data, other pertinent information, and keys to varieties of *G. corymbosa.*

There is no indication whether the *Gundlachia* clade first evolved in the Caribbean, in Mexico, or elsewhere since species relationships within it are not well-resolved (Urbatsch et al. 2003). The clade sister to *Gundlachia* consists of North American taxa. These two clades taken together also appear to be related to North American species, although few Central and South American species have been investigated (Urbatsch et al. 2003). Regardless of where the *Gundlachia* clade first appeared, dispersal rather than plate tectonics must have been a factor in its evolution since the approximate present position of the Caribbean islands relative to North and South America predates the estimated age of the Asteraceae (Graham et al. 2000; Bohm & Stuessy 2001).

KEY TO SPECIES OF *GUNDLACHIA*

1. Leaves linear-lanceolate to spatulate, laminar, more than 2 mm wide.
  2. Capitula typically solitary at branch tips; plants of Coahuila and Nuevo León, Mexico ____ **G. riskindii**
  2. Capitula generally in large, dense, corymbose or paniculate clusters several cm broad; plants of the Caribbean.
    3. Capitula in corymbose clusters; involucres cylindric; ray corollas <4 mm long; Bahamas, Greater and Lesser Antilles ____ **G. corymbosa**
    3. Capitula in paniculate clusters; involucres obconic or turbinate; ray corollas >4 mm long; plants of northern Bahamas, Cuba, and Hispaniola ____ **G. domingensis**
1. Leaves filiform, less than 2 mm wide, nearly as thick as broad
  4. Leaves densely clustered along the terminal 2–3 cm of the branches, surfaces glutinous, not evidently punctate; capitula eradiate, in clusters of 2–3, mostly concealed by foliage; disk flowers 3–5; Coahuila, Mexico, Cuatro Cienegas basin ____ **G. truncata**
  4. Leaves more widely spaced on stems, internodes generally much >2 mm long, surfaces resinous, somewhat punctate; capitula eradiate or rays 1–3, rays mostly concealed by the involucre; disk flowers 3–7.
    5. Stems glabrous; ray flowers 0–3; coastal habitats of the Gulf of California region, Baja California and Sonora, Mexico ____ **G. diffusa**
    5. Stems papillate, scabrous; rays absent; disk flowers 3(–7); widespread in the Chihuahuan Desert of southwestern Texas, Chihuahua, Coahuila, Durango, and Nuevo León, Mexico ____ **G. triantha**

New specific combinations in *Gundlachia*

2a. Gundlachia triantha (S.F. Blake) Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Aplopappus[Haplopappus] trianthus* S.F. Blake, J. Wash. Acad. Sci. 28:485. 1938. *Ericameria triantha* (S.F. Blake) Shinners, Field & Lab. 19:133. 1951. *Xylothamia triantha* (S.F. Blake) G.L. Nesom, Sida 14:113. 1990. TYPE: UNITED STATES. TEXAS. BREWSTER CO.: Chisos Mountains area, along road from Study Butte to Terlingua, 31 Aug 1937, *B.H. Warnock 1126*, (HOLOTYPE: US!; ISOTYPE: LL!).

Distribution, ecology, and relationships.—This species is widespread in the Chihuahuan Desert region ranging from Brewster County, Texas, to eastern Chihuahua, Coahuila, northeastern Durango, and west central Nuevo León, Mexico. It grows on gyp-seous, calcareous, igneous, or saline soil substrates on slopes or desert flats generally associated with *Atriplex*, *Prosopis*, *Larrea*, *Suaeda*, and various desert species at elevations 700–1500 m. Flowering normally occurs from July to October which undoubtedly depends on the timing and abundance of rainfall. Its resinous, adi-axially caniculate, filiform leaves, and often three-flowered capitula are diagnostic.

Based on sequence data *G. triantha* and *G. truncata* are strongly supported as sisters (Urbatsch et al. 2003) (see Fig. 1). Nesom (1992) indicated that the two are similar in having linear, involute leaves, eradiate, few-flowered capitula, and similar style appendages. *Gundlachia diffusa* receives moderate support as the sister to this clade in most analyses except for parsimony analysis of the ETS + ITS data sets where it is sister to *G. domingensis* (Urbatsch et al. 2003). When describing *G. triantha* Blake, (1938) discussed its morphological similarity to *G. diffusa*. Urbatsch (1978) noted the similarity in flavonoid profiles between these two taxa. At the time these studies were made *G. truncata* was unknown. Nesom et al. (1990) commented on the *Euthamia*-like inflorescences of *G. triantha* and *G. diffusa*. Sequence data show that *Euthamia* is but distantly related to these taxa, indicating possible convergence in this feature (Fig. 1).

2b. Gundlachia diffusa (Benth.) Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Ericameria diffusa* Benth., Bot. Voyage H.M.S. Sulphur 2:23. 1844. non *Aplopappus diffusus* DC. 1836. *Solidago diffusa* (Benth.) A. Gray, Proc. Amer. Acad. Arts 5:159. 1861. *Bigelovia diffusa* (Benth.) A. Gray, Proc. Amer. Acad. Arts 8:640. 1873. *Chrysoma diffusa* (Benth.) E. Greene, Erythea 3:10. 1895. *Xylothamia diffusa* (Benth.) G.L. Nesom, Sida 14:109. 1990. TYPE: MEXICO. BAJA CALIFORNIA SUR: Magdalena Bay, 1839, *R. Barclay & B. Hinds s.n.* (HOLOTYPE: BM?).

Linosyris sonoriensis A. Gray, Proc. Amer. Acad. Arts 8:291. 1870. Basionym: *Haplopappus* [*Aplopappus*] *sonoriensis* (A. Gray) S.F. Blake, Contr. U.S. Natl. Herb. 23:1490. 1926. *Aster sonoriensis* (A. Gray) Kuntze, Rev. 1:317. 1891. TYPE: MEXICO. SONORA: District of the Yaqui River, 1869, *E. Palmer s.n.* (HOLOTYPE: GH!).

Distribution, ecology, and relationships.—*Gundlachia diffusa* occurs in Baja California Sur and coastal regions of Sonora, Mexico, where it inhabits various soil types including coastal sand dunes, gravel plains, and salt flats from near sea level to around 100 m. Its habitat preferences appear to be similar to the two species of *Gundlachia* from the Caribbean. Based on leaf morphology the species resembles the two Chihuahuan Desert species in this genus. When well-developed, its inflorescences can be large and paniculate and appear similar to those in *G. corymbosa*. Its species relationships are somewhat equivocal but appear to be closest to *G. triantha* and *G. truncata* and are discussed under to the former.

2c. Gundlachia riskindii (B.L. Turner & Langford) Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Ericameria riskindii* B.L. Turner and Langford, Madroño 29:234. 1982. *Xylothamia riskindii* (B.L. Turner and Langford) G.L. Nesom, Sida 14:113. 1990. TYPE: MEXICO. COAHUILA: ca. 24 km E of Saltillo, S side of Sierra La Viga, ca. 6.5 km E of Jamé along wood cutter's road, 10,00 ft, 15 May 1977, *Henrickson et al 16156b* (HOLOTYPE: TEX!; ISOTYPE: MEXU, RSA).

Distribution, ecology, and relationships.—This apparently rare species is known from southeastern Coahuila and adjacent Nuevo León where it occurs on exposed limestone areas and in gypseous soils in pine-fir-oak woodlands at 2100–3000 m elevation. It is distinctive in having small spatulate leaves and radiate capitula with a large number of disk and ray florets. Originally, *G. riskindii* was described as *Ericameria* but then transferred to *Xylothamia*. Concerning its sister taxon relationships, results differ depending optimality criteria used in DNA sequence analysis. In the PAUP ratchet analysis of the combined ITS/ETS sequences support is provided for its basal position in the *Gundlachia* clade. In the parsimony derived trees that included indels, the Caribbean and Mexican species are resolved as sister lineages, where it is basal to the latter (Urbatsch et al. 2003). When indels were excluded, the species is basal in the *Gundlachia* clade (Fig. 1). Flagelliform trichomes having a subterminal appendage attachment characterize the Caribbean species and similar trichomes are seen in *G. riskindii*. This unusual trichome type, along with spatulate leaves and certain DNA evidence suggest that *G. riskindii* may represent the ancestral state for *Gundlachia* or may be a link connecting the Caribbean and the Mexican species.

2d. Gundlachia truncata (G.L. Nesom) Urbatsch & R.P. Roberts, comb. nov. Basionym: *Xylothamia truncata* G.L. Nesom, Phytologia 73:318. 1992. Type: MEXICO. Coahuila: Mpio. Cuatro Cienegas, ca. 2 km W of town of Cuatro Cienegas, along dirt road paralleling railroad, hard packed gypseous sand, 18 Oct 1985, *Nesom 5254* (holotype: TEX!).

This rare species is know only from the Cuatro Cienegas basin in Coahuila, Mexico, where it was collected on alluvial, gypseous sands. It is readily recognized by its involute linear leaves crowded near the branch apices that largely concealing its flowering capitula (Nesom 1992). The nearly identical ITS/ETS sequences of *G. truncata* and *G. triantha* robustly support their sister relationship despite their distinctive morphologies. Nesom (1992) had suggested the possibility of *G. truncata* being an abnormal growth form of the later, but field observations offered no evidence supporting this hypothesis.

Distribution, ecology, and relationships.—Both *Gundlachia corymbosa* and *G. domingensis* grow in the Caribbean region. The former occurs in eastern Cuba, the Bahamas, the Greater and Lesser Antilles, and northern Venezuela. It is distinguished from its counterpart by its corymbose capitulescences, cylindric involucres, ovate phyllaries, and ray corollas shorter than 4 mm. Six varieties are recognized within the species. Three of these, *G. corymobsa* varieties *apiculata*, *cubana*, and *foliosa*, have corymbs reduced to a few capitula concealed by the leaves, which is a feature seen in two species in Mexico, *G. riskindii* and *G. truncata*. The leaves of *G. corymbosa* var. *apiculata*, a taxon from the mountains of eastern Cuba, are similar in form to those of *G. riskindii* but larger. *Gundlachia domingensis* is known from the northern Bahamas, Cuba, and Hispaniola and is distinguished by its paniculate capitulescences, turbinate involucres, linear-lanceolate phyllaries, and ray corollas about 5.0 mm long. Both species appear to grow on well-drained sandy and stony substrates from near

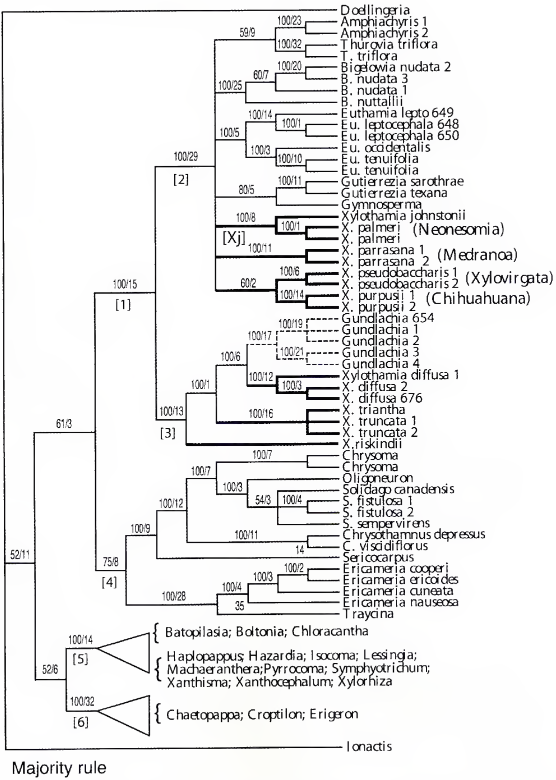


FIG. 1. 50% majority rule consensus tree derived from PAUP* ratchet analysis of the combined ETS + ITS data sets without indels and based on Fig. 4 published in Urbatsch et al. (2003). Fractional numbers designate branch support/branch length. Branches in bold highlight taxa traditionally treated as *Xylothamia*. Dash line branches highlight taxa traditionally treated as *Gundlachia*. Generic names proposed in the present study are indicated parenthetically. Taxa of the lower most clades not immediately relevant to the present study are merely listed for each major lineage.

sea level to 2500 m elevation. Greater details for these two species are provided in Lane (1996).

3. Neonesomia Urbatsch & R.P. Roberts, gen. nov. Type: *Aster palmeri* A. Gray, Proc. Amer. Acad. Arts 17:209. 1882. ≡ *Neonesomia palmeri* (A. Gray) Urbatsch & R.P. Roberts.

Frutices ad 3 m alta; caules ramosissimi aliquantum aromatici, ramunculis foliosis valde porcatis; folia 1–4 cm longa 1–2(–5) mm lata linearia elliptica ad anguste oblanceolata, laminis complanatis cum costis elevatis abaxialibus; capitula radiata solitaria vel in cymis fasciculatis ad apices ramulorum, paniculis laxis; involucra plerumque turbinata 4–6 mm longa; phyllaria valde gradata linaria; flosculi radii 5–15, corollae ca. 2–5 mm longa alba ad flava; flosculi disci 8–20, corollae 3.5–5 mm longa alba ad flava, limba aliquantum asymmetrice 5-lobata; pappi setosi; cypselae ca. 1.5 mm longae dense strigosae ad sericeas.

Shrubs to 3 m tall; much-branched, somewhat aromatic, leafy twigs strongly ridged, internodes 2–10 mm long; leaves 1–4 cm long, 1–2(–5) mm broad, linear, elliptic to narrowly oblanceolate, blades flat with conspicuously raised midvein abaxially, pubescent with flagelliform trichomes, margins entire to minutely ciliate; capitula solitary or in cymose clusters at branch tips these arranged in loose panicles; involucres usually turbinate, 4–6 mm long; phyllaries strongly graduated, linear, blunt to somewhat acute, thick, firm, resinous, mostly stramineous but with an apical glandular patch occupying much of the tip region; rays flowers 5–15 corollas ca. 2–5 mm long, white, pale yellow, or yellow; disk flowers 8–20, corollas 3.5–5 mm long, with a tube 1–1.8 mm long and poorly differentiated from the asymmetrical 5-lobed limb, shorter lobes 0.9–1.5 mm long, longest up to 3.3 mm long; pappus of setose bristles; cypselae ca. 1.5 mm long, densely strigose to sericeous; $x = 9$.

Prominent features, distribution, and relationships.—*Neonesomia* contains two species, *N. palmeri* from Nuevo León, Tamaulipas, and southern Texas and *N. johnstonii* from San Luis Potosí, which grow on rocky hillsides, brushy shrublands, and coastal dunes (Johnston 1970; Nesom et al. 1990). Species in this genus are characterized by their shrubby habit, ridged twigs, flat leaf blades with prominent midveins, small radiate capitula, and white to yellow corollas with somewhat zygomorphic disc corollas. They resemble the herbaceous perennials in *Euthamia* in leaf and growth form, but differ in being non-rhizomatous shrubs with deeply lobed, somewhat zygomorphic disc corollas.

Etymology.—*Neonesomia* commemorates Guy Nesom, Botanical Research Institute of Texas, zealous student of the Astereae and other Asteraceae who has significantly contributed to understanding their systematics. Additional information for these taxa is found in Nesom's treatment of *Xylothamia* (Nesom et al. 1990).

The genus *Neonesomia* is strongly supported as a clade in the gene-based phylogenies of Urbatsch et al. (2003). Based on parsimony analyses of ITS +ETS + INDEL data it is basal to a clade consisting of several xerophytic, mainly western North American taxa, including *Amphiachyris, Bigelowia, Chihuahuana,* *Euthamia, Gutierrezia, Gymnosperma, Medranoa, Thurovia,* and *Xylovirgata* (Urbatsch et al. 2003). Weak support for its sister relationship to *Thurvoia* was seen in the ITS/ETS Bayesian tree derived in that study. Otherwise its sister relationship was unresolved (Fig. 1) and kinship among the above cited genera is uncertain (Urbatsch et al. 2003).

KEY TO SPECIES OF *NEONESOMIA*

1. Ray and disk flowers 12–15 and 15–20, respectively; corollas yellow; flowering May to June; San Luis Potosí, Mexico ______ **N. johnstonii**
1. Ray and disk flowers 5–11 and 9–14, respectively; corollas white to very pale yellow; mainly flowering August to October; southern Texas and Nuevo León and Tamaulipas ______ **N. palmeri**

New combinations in *Neosomia*

3a. Neonesomia palmeri (A. Gray) Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Aster palmeri* A. Gray, Proc. Amer. Acad. Arts 17:209. 1882. TYPE: UNITED STATES. TEXAS. MAVERICK CO.: Eagle Pass on the Rio Grande, Sep–Oct, 1879. *E. Palmer 516* (LECTOTYPE: GH!; ISOLECTOTYPES: PH, US; Johnston 1967). *Isocoma palmeri* (A. Gray) Shinners, Field & Lab. 18:2. 1950. *Ericameria austrotexana* M.C. Johnston, nom. nov., SouthW. Naturalist 12:106. 1967, non *E. palmeri* (A. Gray) H.M. Hall. *Xylothamia palmeri* (A. Gray) G.L. Nesom, Sida 14:110. 1990, non *X. palmeri* var. *pachylepis* (H.M. Hall) G.L. Nesom ex M.A. Lane & R.L. Hartman, Amer. J. Bot. 83:364. 1996

Distribution, ecology, and relationships.—This species is known from most counties in southern Texas, i.e., Atascosa, LaSalle, and San Patricio cos. southward into the states of Nuevo León and Tamaulipas, Mexico, mostly of open, brushy habitats on or near the Gulf Coast in sandy or saline soils from near sea level to 600 m. *Neonesomia palmeri* is distinguished from its sister species in having fewer flowers per capitula and paler yellow corollas. Its ITS/ETS sequences showed little differentiation from *N. johnstonii* in Urbatsch et al. (2003). *Neonesomia palmeri* was first described as a species of *Aster* and subsequently placed in various other genera including *Isocoma* (Shinners 1950), *Ericameria* (Johnston 1967), and *Xylothamia* (Nesom et al. 1990). Nesom et al. (1990) proposed a close relationship of *N. palmeri* to *Medranoa* (*Xylothamia*) *parrasana* and *Xylovirgata* (*Xylothamia*) *pseudobaccharis,* a hypothesis not robustly supported by analyses of DNA sequences.

3b. Neonesomia johnstonii (G.L. Nesom) Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Xylothamia johnstonii* G.L. Nesom, Sida 14:110. 1990. TYPE: MEXICO. SAN LUIS POTOSÍ: Bagre, Minas de San Rafael, May 1911, *C.A. Purpus 5021* (HOLOTYPE: GH!; ISOTYPE: US).

Distribution, ecology, and relationships.—This taxon is known from central San Luis Potosí, Mexico where it apparently grows on steep slopes at elevations of 120–1500 m. In addition to the diagnostic features presented under *N. palmeri,* flowering times also differ with *N. johnstonii* blooming in the spring and *N.*

palmeri in the fall. Habitat preferences for the two taxa differ: *N. johnstonii* grows on steep hillsides at higher elevations than *N. palmeri*, which inhabits the Gulf coastal plain often on sand dunes near the water. Based on sequence data *N. johnstonii* and *N. palmeri* form a robustly supported clade, but the two taxa differ little from one another in sequence data indicating their close affinity (Urbatsch et al. 2003).

4. **Medranoa** Urbatsch & Roberts, gen. nov. Type: *Ericameria parrasana* S.F. Blake, Contr. Gray Herb. 52:26. 1917. ≡ *Medranoa parrasana* (S.F. Blake) Urbatsch & R.P. Roberts.

Frutex ramosus caule tenui cortice griseo glabro donato, ramulis uventate viridibus dense papilloso-glandulosis viscosis non puberulis dense foliosis; folia linearia mucronulata ut ramuli punctata et viscose complanata supra suplana vel paullum concave sutus subconvexa; involucri 3-seriati paullulum gradati 3.5–4 mm alti praecipue supra glandulari-viscosa ceterum subglabra infra valde indurate coriacea albida apice appendice appressa subherbacea lanceolata munita.

Shrubs to 2 m tall, much branched; branches ascending, mostly terete or remotely ribbed, bark smooth, becoming slightly fissured, tan becoming dark gray; twigs numerous, to 8 cm long, internodes smooth to obscurely sulcate, 1–4 mm long, green resinous, scabridulous; leaves evergreen, sessile, crowded, 5–12 mm long ≤ 1.5 mm wide, narrowly elliptic-oblanceolate, flat to canaliculate, decurrent on stem, surfaces resinous, punctate; capitulescence somewhat corymbiform, capitula solitary or cymose at branch tips; involucres 2–3 seriate, campanulate, 3–5 mm high, 4–7 mm wide; phyllaries imbricate, moderately graduated, mostly chartaceous, 2.5–4 mm long; capitula radiate, with ca 30 flowers, ray flowers 5–11, pappus bristles ca. 80, setose, subequal, 2.5–4 mm long, silvery tan, corollas 5–8 mm long, ligules elliptic, 3–7 mm long, 1–2 mm wide; disk flowers ca 20, corollas pale yellow, 4–5 mm long, lobes spreading to recurved, unequal in length, shortest 0.8–1.2 mm long, longest 1.5–2.2 mm long, style branches 2–3 mm long, appendages narrowly linear, apices acute, 1.5–1.8 mm long, pappus same as on ray flowers; cypselae turbinate, ca. 2 mm long, pilose; $x = 9$.

Prominent features, distribution, and relationships.—*Medranoa* is unispecific with its only species occurring in the Sierra de Parras region of Coahuila and Zacatecas. Shrubby habit, deeply pitted, resin coated leaves, relatively large capitula, and thickened style branches are features diagnostic for this taxon. Sequence based data robustly support its placement in the *Amphiachyris/Gutierrezia* clade (Urbatsch et al. 2003). Weak support is provided in that study for a sister relationship with *Chihuahuana* (*X. purpusii*) or with a clade composed of *Chihuahuana* plus *Xylovirgata* (*Xylothamia pseudobaccharis*).

Etymology.—The generic name *Medranoa* is in honor of Francisco Gonzlez Medrano, MEXU. He has worked for many years on desert and dryland floras of Mexico—mostly Tamaulipas and Tehuacan, and has trained several young botanists. Additional information about this taxon can be found in the treatment of *Xylothamia* by Nesom et al. (1990).

4a. Medranoa parrasana (S.F. Blake) Urbatsch & R.P. Roberts, comb. nov. [BASIONYM: *Ericameria parrasana* S.F. Blake, Contr. Gray Herb.52:26. 1917]. *Haplopappus parrasanus* (S.F. Blake) S.F. Blake, Contr. U.S. Natl. Herb. 23:1490. 1926. *Xylothamia parrasana* (S.F. Blake) G.L. Nesom, Sida 14:111. 1990. TYPE: MEXICO. COAHUILA: Sierra de Parras, rocky slopes, Mar 1905, *Purpus 1005* (HOLOTYPE: GH!).

Distribution, ecology, and relationships.—The single species in this genus grows on rocky slopes in the Sierra de Parras region of southern Coahuila and northern Zacatecas. Originally it was described in *Ericameria* by Blake (1917) who later transferred it to *Haplopappus* (Blake, 1926). Subsequently, it was placed in *Xylothamia* (Nesom et al. 1990). In the DNA sequence-based trees, it is placed in the clade composed of *Amphiachyris, Bigelowia, Chihuahuana, Euthamia, Gutierrezia, Gymnosperma, Neonesomia,* and *Thurovia* (Urbatsch et al. 2003). *Medranoa* is basal to a clade of *X. pseudobaccharis* and *Chihuahuana purpusii* in parsimony analyses of the ETS/ITS/INDEL data set place. It is a weakly supported sister of *Chihuahua purpusii* in the Bayesian analysis (Urbatsch et al. 2003).

Medranoa parrasana is distinguishable from other taxa in the *Amphiachyris/Gutierrezia* clade by the combination of its shrubby habit, narrowly elliptic-oblanceolate, flat-canaliculate, resin-covered leaves with numerous, well-organized depressions, and its campanulate capitula bearing 5–11 ray and 15–22 disk flowers. The thickened style branches wherein the vascular trace bifurcates or expands in size distally in each branch is unique among taxa in this clade. Additional information about this taxon can be found in the treatment of *Xylothamia* by Nesom et al. (1990).

5. Xylovirgata Urbatsch & R.P. Roberts, gen. nov. TYPE: *Haplopapus pseudobaccharis* S.F. Blake, J. Wash. Acad. Sci. 40:47. 1950. ≡ *Xylovirgata pseudobaccharis* (S.F. Blake) Urbatsch & R.P. Roberts.

Frutex scoparium metralis glaberrimus modice resinosus, ramis et ramulis multis erectis pallide viridibus striato-angulatus; folia anguste linearia integerrima plano paullum incrassata omnino non vel solum supra obscurissime punctata usque ad 1.4 cm longa 1 mm lata.

Intricately branched, broomlike shrubs to 1 m tall; stems slender, bark becoming whitish with age; branches and twigs strongly ridged and angled; leaves present mainly on present years growth, widely spaced, somewhat erect, blades 2–15 mm long, ≤1 mm wide; capitula radiate solitary at branch apices arranged in loose racemes; involucres campanulate to turbinate, 3–4 mm wide, phyllaries graduated, the inner 3–5 mm long, thickened subapical glandular structure present; ray flowers 3–6, ligules apically 2–3 denticulate, 2.3–3.0 mm long, ca. 1 mm wide; disk flowers 7–14, corollas 4.0–4.5 mm long unequally 5 lobed, shorter lobes ca. 1.3 mm long, longer lobes ca. 2.3 mm long; cypselae ca. 1.3 mm long, sericeous; pappus similar on disk and ray cypselae, ca. 30 subequal setose bristles; $x = 9$.

Prominent features, distribution, and relationships.—*Xylovirgata* is unispecific and known only from western Coahuila, Mexico. It is recognized by its broom-like appearance due to its woody, erect, intricately branched habit, as referenced by its generic name, and its conspicuously ridged stems, reduced, widely spaced, inconspicuous leaves. This entity is clearly related to taxa in the *Amphiachyris/Gutierrezia* clade, where there is weak support for its sister relationship to *Chihuahuana* in trees resulting from parsimony analysis of ETS/ ITS sequence data (Urbatsch et al. 2003). When indel data were added to the data set support for this relationship is supported more robustly. Bayesian and bootstrap analyses resulted in its placement as one of several unresolved basal elements in the *Amphiachyris/Gutierrezia* clade (Urbatsch et al. 2003). Additional descriptive data for this taxon can be found in Nesom et al. (1990).

5a. Xylovirgata pseudobaccharis (S.F. Blake) Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Haplopapus pseudobaccharis* S.F. Blake. J. Wash. Acad. Sci. 40:47. 1950. *Ericameria pseudobaccharis* (S.F. Blake) Urbatsch, Sida 7:299. 1978. *Xylothamia pseudobaccharis* (S.F. Blake) G.L. Nesom, Sida 14:112. 1990. TYPE: MEXICO. COAHUILA: arid limestone hills of Sierra Paila, Valle Seco, General Cepeda, 1700 m, 4 Jul 1944, *J.C. Hinton (G.B. Hinton et al.) 16546* (HOLOTYPE: US!; ISOTYPES: GH!, NY!).

Distribution, ecology, and relationships.—*Xylovirgata pseudobaccharis* is known only from western Coahuila, Mexico, where it grows on limestone or gypsum slopes. Its suggested relationships to *Neonesomia* (*Xylothamia palmeri, X. johnstonii*), *Medranoa* (*X. parrasana*), and *Gundlachia riskindii* (*X. riskindii*) (Nesom et al. 1990) are not supported by sequence-derived phylogenies (Urbatsch et al. 2003). Sequence data provides some support for its sister relationship with *Chihuahuana purpusii*. Additional descriptive and distributional data for this taxon as *Xylothamia pseudobaccharis* are presented in Nesom et al. (1990).

ACKNOWLEDGMENTS

We thank Kurt Neubig for providing the Latin diagnoses, Tom Wendt (LL, TEX) for his assistance in providing materials for DNA extraction and other herbarium matters, and to herbarium curators at BRIT, GH, MICH, MO, NY, UC, and US for their assistance. We appreciate Guy Nesom reviewing the manuscript.

REFERENCES

ANDERSON, L.C. and J.B. CREECH. 1975. Comparative leaf anatomy of *Solidago* and related Asteraceae. Amer. J. Bot. 62:486–493.

BLAKE, S.F. 1917. New and noteworthy Compositae, chiefly Mexican. Contr. Gray Herb. 52: 16–59.

BLAKE, S.F. 1926. In: P.C. Standley. Trees and shrubs of Mexico. Contr. U.S. Natl. Herb. 23: 1313–1721.

BLAKE, S.F. 1938. Eleven new American Asteraceae. J. Wash. Acad. Sci. 28:478–492.

BOHM, B.B and T.F. STUESSY. 2001. Flavonoids of the sunflower family (Asteraceae). Springer-Verlag, Vienna, Austria.

Graham, A., D. Cozadd, A. Areces-Mallea, and N.O. Frederiksen. 2000. Studies in Neotropical paleobotany. XIV. A palynoflora from the middle Eocene Saramaguacán Formation of Cuba. Amer. J. Bot. 87:1526–1539.

Greuter, W., Chairman of the Editorial Committee, et al. 2000. International code of botanical nomenclature (St. Louis Code). Regnum Veg. 138. Koeltz Scientific Books, Königstein.

Hall, H.M. 1928. The genus *Haplopappus*: a phylogenetic study in the Compositae. Carnegie Inst. Wash. Publ. 326:i–viii, 1–391.

Johnston, M.C. 1967. *Ericameria austrotexana* M.C. Johnston (Compositae), nomen novum. SouthW. Naturalist 12:106–109.

Johnston, M.C. 1970. *Ericameria*. In: Correll, D.S. and M.C. Johnston. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, Texas. Pp. 1577–1578.

Lane, M.A. 1996. Taxonomy of *Gundlachia* (Compositae: Astereae). Brittonia 48:532–541.

Lane, M.A., D.R. Morgan, Y. Suh, B.B. Simpson, and R.K. Jansen. 1996. Relationships of North American genera of Astereae, based on chloroplast DNA restriction site data. In: D.J.N. Hind and H.J. Beentje, eds. Compositae: systematics—Proc. Int. Compositae Conf., Kew, 1994. Royal Botanic Gardens, Kew, UK. Vol. 1:49–77

Nesom, G.L. 1991. Morphological definition of the *Gutierrezia* group (Asteraceae: Astereae). Phytologia 71:252–262.

Nesom, G.L. 1992. A new gypsophilic species of *Xylothamia* (Asteraceae: Astereae) from the Cuatro Cienegas area of Coahuila, Mexico. Phytologia 73:318–320.

Nesom, G.L. 1993. Taxonomic infrastructure of *Solidago* and *Oligoneuron* (Asteraceae: Astereae) and observations on their phylogenetic position. Phytologia 75:1–44.

Nesom, G.L., Y. Suh, D.R. Morgan, and B.B. Simpson. 1990. *Xylothamia* (Asteraceae: Astereae), a new genus related to *Euthamia*. Sida 14:101–116.

Noyes, R.D. and L.H. Rieseberg. 1999. ITS sequence data support a single origin for North American Astereae (Asteraceae) and reflect deep geographic divisions in *Aster s.l.* Amer. J. Bot. 86:398–412.

Shinners, L. H. 1950. Notes on Texas Compositae–IV. Field & Lab. 18:25–32.

Suh, Y. 1989. Phylogenetic analysis of chloroplast DNA in North American Astereae (Asteraceae) based on chloroplast DNA. Ph.D. dissertation, University of Texas, Austin, Texas, USA.

Suh, Y and B.B. Simpson. 1990. Phylogenetic analysis of chloroplast DNA in North American *Gutierrezia* and related genera (Asteraceae: Astereae). Syst. Bot. 15:660–670.

Urbatsch, L.E. 1975. First chromosome number reports for some Compositae. SouthW. Naturalist 20:271–287.

Urbatsch, L.E. 1978. The Chihuahuan Desert species of *Ericameria* (Compositae: Astereae). Sida 7:298–303.

Urbatsch, L.E., R.P. Roberts, and V. Karaman. 2003. Phylogenetic evaluation of *Xylothamia, Gundlachia*, and related genera (Asteraceae, Astereae) based on ETS and ITS nrDNA sequence data. Amer. J. Bot. 90:634–649.

BOOK NOTICES

FLORAS AND CHECKLISTS

NATHAN SMITH, SCOTT A. MORI, ANDREW HENDERSON, DENNIS WM. STEVENSON and SCOTT HEALD (eds.) 2004. **Flowering Plants of the Neotropics.** (ISBN 0-691-11694-6, hbk.). Princeton University Press, 41 William Street, Princeton, NJ 08540, U.S.A. (Orders: 609-258-5714, 609-258-1335 fax). $75.00, 616 pp., 307 color photos, 258 line illus., 6 tables, 8 1/2" × 11".

The American tropics is one of the great hotspots of biological diversity, harboring 35% of the world's flowering plants. This magnificent new book from Princeton University Press provides standard treatments for more than 280 families of flowering plants that occur in this region, and is the culmination of the work of 150 botanists from around the world. The goal of the editors was to provide an authoritative reference to plant families that are known to occur in tropical America. They have accomplished their goal, as this book will be an essential reference guide for anyone interested in learning about the rich diversity of the neotropical flora. The text describes features of each family, the diversity of genera and species, classification, geography, ecology, natural history, and important uses. Students learning tropical flowering plant families and their characteristics will find the family features and descriptions especially useful. The excellent identification key to the families treated in the book and the *Aids to Identification* in Appendix V will be of special interest to anyone who wishes to learn to identify neotropical flowering plant families. The editors also provide other useful reference tools, such as a comprehensive botanical glossary, and comparisons of family concepts across the various classification systems, including Cronquist, Dahlgren, and Judd et al. More than 300 color photographs and 250 botanical line drawings provide expert visual aids for identifying and learning about the families.—*John Janovec, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

R.J. PETHERAM and B. KOK. Photography by E. Bartlett-Torr. 2003. **Plants of the Kimberley Region of Western Australia. Revised Edition.** (ISBN 1-920694-04-8, pbk.) University of Western Australia Press. (Orders: International Specialized Book Services, 920 NE 58th Avenue, Ste. 300, Portland, OR 97213-3786, U.S.A., 503-287-3093, 503-280-8832 fax, www.isbs.com, email: info@isbs.com). $40.50, 553 pp., color photos, 6" × 8 1/2".

Publisher Comments: "For many years *Plants of the Kimberley Region of Western Australia* has been an important resource for pastoral managers and rangeland advisors in managing vegetation and land-use issues. This revised edition includes changes to 50 plant names, and also updates the introductory sections about the Kimberley region and the principles of rangeland management. The 240 species covered in the book are organised in three sections: grasses and herbs (110), shrubs (40) and trees (90), and constitute a unique flora not dealt with in any other single volume."

"With its straightforward text and excellent photographs, this book will also be a valuable reference for students of ecology and range science, as well as appealing to nature-lovers, conservationists and travellers in the Kimberley region."

CHARLES M. ALLEN, DAWN ALLEN NEWMAN, and HARRY WINTERS. 2004. **Grasses of Louisiana. Third Edition.** (ISBN 0-9718625-1-6, pbk.). Allen's Native Ventures, LLC, 5070 Hwy 399, Pitkin, LA 70656, U.S.A. (Orders: 337-328-2252, www.nativeventures.net, email: native@camtel.net). $20.00, 374 pp., 3 maps, b/w line drawings, 7" × 10".

A NEW SPECIES OF *CALYCADENIA* (ASTERACEAE) FROM NORTH CENTRAL CALIFORNIA

Robert L. Carr

Department of Biology
Eastern Washington University
Cheney, Washington 99004, U.S.A.
rcarr@ewu.edu

Gerald D. Carr

Department of Botany
University of Hawaii
3190 Maile Way
Honolulu, Hawaii 96822, U.S.A.
gerry@hawaii.edu

ABSTRACT

An unusual form of *Calycadenia* from north central California was studied in greenhouse culture and confirmed to be self-compatible, a condition rare in *Calycadenia*. Based on the distinctive morphology and breeding system of this taxon, it is described and illustrated as a new species, *Calycadenia micrantha*. Although clearly related to *C. truncata* and apparently included in *C. truncata* DC. subsp. *microcephala* H.M. Hall ex D.D. Keck, this name was rejected as a basionym for the new species because of ambiguities regarding the type, the original description, and specimens cited and/or annotated by Keck.

RESUMEN

Se estudió una forma inusual de *Calycadenia* del centro-norte de California en cultivo de invernadero y se confirmó que es autocompatible, una característica rara en *Calycadenia*. Se describe e ilustra como una nueva especie basada en la diferente morfología y sistema reproductor de este taxon, *Calycadenia micrantha*. Aunque claramente emparentada con *C. truncata* y aparentemente incluida en *C. truncata* DC. subsp. *microcephala* H.M. Hall ex D.D. Keck, este nombre fue rechazado como basiónimo para la nueva especie por algunas ambigüedades relacionadas con el tipo, la descripción original, y los especímenes citados y/o anotados por Keck.

INTRODUCTION

For some years we have been aware of a unique population of plants related to *Calycadenia truncata* and growing on Elk Mountain in Lake County, California. In 1990 we received a similar specimen from David W. Isle, Forest Botanist for the Mendocino National Forest in California. The plant had been collected near the Wilson Camp area of southern Colusa County. Morphologically, the plant was clearly related to *Calycadenia truncata*. However, like the Elk Mountain specimens, Isle's plant was shorter and more slender than most and had very tiny heads with only 1 or 2 obscure, tiny ray flowers and 1 or 2 disk flowers.

Subsequently, several additional populations of this taxon were located in adjacent Lake County. The heads and rays suggested the possibility of self-compatibility, a condition rare in *Calycadenia*. In conjunction with ongoing biosystematic research on *Calycadenia*, a number of populations of this taxon were studied in greenhouse culture. All individuals were self-compatible, a condition known to exist in only one other species of *Calycadenia*, *C. hooveri* G.D.

SIDA 21(1): 259 – 265. 2004

Carr. In addition, although dozens of reciprocal crosses of these populations with self-incompatible forms of *Calycadenia truncata* have been made, cypselae with embryos were generated only when the self-compatible form served as the female parent. Carr (1975) noted the same phenomenon in *C. hooveri* and suggested that it may be the result of unilateral interspecific incompatibility, as discussed in Lewis and Crowe (1958).

The investigation of these unique plants led to re-evaluation of a previously described taxon, *Calycadenia truncata* DC. subsp. *microcephala* H.M. Hall ex D.D. Keck. According to Keck (1946), "This subspecies is separated from *Calycadenia truncata* subsp. *scabrella* (Drew) Keck, to which it is most nearly related, by the reduced number of disk-florets (3 or 4 instead of the usual 8 to 15) and the smaller heads." Additionally, he recognized the existence of intergradation between these subspecies. It appears from Keck's description and discussion that his small-headed taxon clearly includes the tiny-rayed self-compatible taxon described here but also includes other small-headed *C. truncata* populations.

Keck (1946) listed a number of specimens, and subsequently annotated numerous additional specimens, representing *C. truncata* subsp. *microcephala*, including locations from southern Trinity County to Lake County and in the Santa Lucia mountains of Monterey County. Some of these specimens are representative of a small-headed, self-compatible taxon but others represent populations of self-incompatible *C. truncata* plants with somewhat larger heads and rays. Depauperate individuals are common in populations of annual plants, especially in harsh years. Specimens of *C. truncata* prepared from such depauperate plants, especially those poorly pressed or without flowering heads at anthesis, could easily be confused with the new, small-headed, self-compatible taxon proposed herein.

To better understand his concept of *C. truncata* subsp. *microcephala*, attempts were made to field-verify all collections referred to this taxon by Keck in his original publication (1946) and subsequent specimen annotations. This was difficult as most collections cited, including the type locality, have not been re-located. Additionally, the type locality cited (*H.M. Hall 9602*, Mill Creek Canyon about 8 miles eastward from Ukiah, Mendocino Co., CA.) has no habitat that would support *Calycadenia* within ca. 3–4 miles. Hall may have accidentally written down the wrong mileage or possibly transposed a 3 with an 8. Regardless, there is very little likelihood that the type specimen was collected near the suggested location. There are sites 2–4 miles east of Ukiah with habitat that may have supported *Calycadenia* in the past but these sites are now largely occupied by agriculture. In any case, there appears to be no way to relate the type specimen to an extant population in the field.

After careful consideration, and for a variety of reasons, we believe the circumscription of Keck's *C. truncata* subsp. *microcephala* is not the same as the new species proposed herein. The questionable nature of the type, the ambiguity in the description and cited specimens, and the likelihood that Keck had no knowledge of the derived breeding system of the new taxon described below, lead us to conclude that use of the epithet "*microcephala*" for this new species is untenable.

RESULTS AND DISCUSSION

Calycadenia micrantha R.L. Carr & G.D. Carr, sp. nov. (**Fig. 1**). TYPE: U.S.A. CALIFORNIA. TRINITY CO.: ca. 1 mi N of Mad River Rock on rd. to Mad River Rock from Low Gap, S of the Mad River Ranger Station, 40°23'10"N, 123°29'01"W, 1340 m, 22 Aug 2003, *R.L. Carr 3801* (HOLOTYPE: UC; ISOTYPES: OSC, US).

Herba annua. Caules graciles 1–5 dm ramorum saepe multis glabris curvatis ascendentibusve. Folia basalia 2–5 cm × 2–3 mm proximaliter rosulata distaliter deminuta linearia. Bracteae pedunculares 2–4 mm hispidulae plus minusve pectinato-fimbriatae glande una grandi capitata terminali. Capitula 1(–3) in quoque nodo; phyllariis 1–2, 4–5 mm; paleis 2–3, 5–6 mm hispidulis villosulis ad marginem superum interdum cum glande una parva capitata terminali; flosculis radialibus 1–3 lamina 2–2.5(–3.5) mm sinu 0.5(–1) mm; flosculis disci 1–3; cypselis radialibus aspero-rugosis glabris epapposis; cypselis disci plerumque abortivis glabris epapposis.

Annual herbs. **Stems** 1–5 dm, slender, generally less than 2(–3) mm diameter at the base, branches often many, generally beginning near mid-stem, arcuate to ascending; glabrous, often purplish, especially distally. **Leaves** in basal rosette 2–5 cm long, 2–3 mm wide, sessile by a widened base, becoming more remote and reduced distally, linear, hispidulous adaxially and along the margins, often with longer, hispid hairs adaxially; leaves of the inflorescence 5–20 mm long, linear with a widened base, hispidulous, sometimes with a few awn-like bristles along the margin. **Heads** 1(–3) per node, sessile or nearly so. **Peduncular bracts** 2–4 mm, these and associated reduced leaves terete to strongly flattened, glabrous to hispidulous, commonly also with 1–8 long, pectinate bristles on the margins; apex bearing 1 large tack-shaped gland. **Phyllaries** 1–3(–6); 4–5 mm, each partly enfolding a ray cypsela, the abaxial surface glabrous to more or less hispidulous, especially toward the tip, sometimes bearing a few scattered, stout bristles; distal margins with shaggy hairs; apex occasionally with a single small tack-shaped gland. **Receptacle paleae** 2–3; 4–6 mm, each associated with a disk cypsela, the abaxial surface glabrous to more or less hispidulous, especially toward the tip, sometimes bearing a few scattered, stout bristles, distal margins with shaggy hairs; apex occasionally with a single, small, tack-shaped gland. **Ray florets** 1–3(–6); fertile, corolla bright yellow, laminae 2–2.5(–3.5) mm long by 2–4 mm wide, 3(–4)-lobed, sinuses ca. 0.5 mm, the middle lobe(s) smallest, symmetric, oblong to narrowly triangular, the outer lobes asymmetric, basically oblong to obovate but excursion of outer margin from midline greater than that of the inner margin, the tube 1–1.5 mm. **Disk florets** 1–3, 3–4 mm, yellowish. **Ray cypselae** ca. 3 mm long, ca. 2 mm wide, more or less triangular, rough-wrinkled, glabrous, pappi none. **Disk cypselae** ca. 3 mm long, mostly abortive,

Fig. 1. *Calycadenia micrantha.* **A.** Habit. **B.** Capitulum, lateral view. **C.** Capitulum from above. **D.** Peduncular bract (appressed to capitulum). **E.** Ray cypselae. **F.** Peduncular bract tip with tack-shaped gland. Photos of Holotype, *R.L. Carr 3801* (UC).

terete when developed and tapered toward the base, smooth to very slightly ridged, glabrous, pappi none. Self-compatible. $2n = 14$ (Carr 1977).

Flowering (Jun–)Jul–fall.

Paratypes: **U.S.A. CALIFORNIA. Colusa Co.:** Wilson Camp SW of Stonyford, near the Colusa/Lake Co. line, ca. 3 air mi SE of Goat Mtn., 1400 m, 23 Sep 1994, *R.L. Carr 2656* (UC). **Lake Co.:** 0.4 mi S of Elk Mtn. summit along Elk Mtn. Rd., 1140 m, 10 Aug 1974, *G.D. Carr 771* (UC); S side of Elk Mtn. along Elk Mtn. Rd., 0.45 mi N of 14 mi marker, N of Upper Lake, 1150 m, 30 Sep 1986, *R.L. Carr 2258* (UC), 0.7 mi NE of Pinnacle Rock Rd. on Bartlett Springs Rd., 2.1 mi NE of Lakeview Campground, 6.8 mi from jct. with Hwy. 20, 1150 m, 23 Sep 1994, *R.L. Carr 2658* (UC); S facing slope on Elk Mtn., Elk Mtn. Rd. to Upper Lake at jct. with forest rd. (17N28), ca. mile post 16.6 on rd., 1100 m, 23 Sep 1994, *R.L. Carr 2660* (UC); S facing slope of Elk Mtn., 3.3 mi N of the entrance to Middle Creek Campground on rd. from Upper Lake to Elk Mtn., ca. 1100 m, 23 Sep 1994, *R.L. Carr 2661* (UC); E of Elk Mtn. Rd. on Deer Valley Campground Rd. (16N01), 1.3 mi W of Deer Valley Campground, 1005 m, 18 Jul 1997, *R.L. Carr 3353* (UC); rd. to Bear Creek (16N01) ca. 2.1 mi E of Deer Valley Campground, 0.8 mi W of Dry Oak Campground, 1130 m, 18 Jul 1997, *R.L. Carr 3354* (UC); ca. 200 yds SW of Little Pinnacle Rock Peak, on forest

Fig. 2. Capitulae from greenhouse-grown plants. A. *Calycadenia truncata, R.L. Carr 2224.* **B.** *Calycadenia micrantha, G.D. Carr 771.*

rd. 16N01 ca. 1.9 mi W of its jct. with rd. to Bartlett Springs, 1350 m, 07 Oct 1997, *R.L. Carr 3395* (UC); above Old Rd. to Witter Springs, ca. 0.2 mi E of Witter Springs site N of Lakeport, 39°11'29"N, 122°59'30"W, 500 m, 23 Aug 2003, *R.L. Carr 3802* (UC); along Hwy. 175, W of Lakeport, ca. 2.5 mi W of jct. with Hwy 29, 38°59'43"N, 122°55'48"W, 500 m, 23 Aug 2003, *R.L. Carr 3803* (UC). **Monterey Co.:** Fort Hunter Liggett boundary, ridge crest near South Coast Ridge Rd., ca. 12.9–13 rd. mi S of jct. with Nacimiento-Fergusson Rd. and ca. 0.3 mi S of jct. with Burma Rd., 1000 m, 15 Jun 1998, *E. Painter & E. Neese (s.n.)* (SBBG); Fort Hunter Liggett (Training Area 17), near Burro Rd., ca. 2.0 km N of Three Peaks, ca. 3.25 km W of Burro Mtn., 700 m, 15 Jun 1995, *E. Neese & E. Painter HL1902* (SBBG); Fort Hunter Liggett (Training Area 17), near Burro Rd., ca. 2.0 km N of Three Peaks, ca. 3.25 km W of Burro Mtn., 700 m, *E. Painter, E. Neese & A. Hazebrook HL3005* (SBBG). **Trinity Co.:** Threeforks of the Mad River, ca. 0.2 mi E of end of county rd. across Mad River, 40°09'48"N, 123°13'21"W, 899 m, 21 Aug 2003, *R.L. Carr 3800* (UC).

Distribution and ecology.—Dry, open, rocky ridges, hillsides and talus; 500–1,500 m; Colusa, Lake, Trinity and Monterey counties, California. This species grows only in areas of low plant density, in or closely associated with exposed rocky areas or areas of packed mineral materials. For this reason and because survivorship is low, populations are generally small with few individuals. The species is surviving in an extremely limited and very fragile habitat.

Etymology.—Name Gr., *micr*, small; *anth*, a flower. Referring to the reduced ray flowers compared to most other species of *Calycadenia*.

Compared to some other taxa of *Calycadenia*, *C. micrantha* is remarkably uniform morphologically. The variation that is seen between populations is

Table 1. Comparison of selected features of *Calycadenia micrantha* and *C. truncata*.

Character	Calycadenia micrantha	Calycadenia truncata
Stem height	1–5 dm	2–12 dm
Leaf length	2–5 cm	2–10 cm
Peduncular bract length	2–4 mm	1–12 mm
Phyllary length	4–5 mm	5–10 mm
Ray floret number	1–3(–6)	3–6
Ray corolla lamina length	2–2.5(–3.5) mm	(4–)5–12 mm
Disk floret number	1–3	3–25
Disk floret length	3–4 mm	4–6 mm
Breeding system	Self-compatible	Self-incompatible

about that seen within populations. The overall size, branching and coloration of the plants, the overall size and position of the heads, the number, size, and position of the peduncular bracts, involucral bracts, ray ligules, ray achenes, receptacular bracts, disk flowers, and disk cypselae is very constant. The major variation seen is in the vestiture of the basal/proximal cauline leaves and that of the leaves associated with heads and the peduncular, involucral, and receptacular bracts. The basal and proximal cauline leaves are nearly always hispidulous but the presence of longer, stiff, bristly hairs ranges from sparse to rather dense. The leaves and bracts of the inflorescence are nearly always more or less hispidulous but the presence of pectinate hairs and other bristles varies considerably, as does the presence of hairs on or near the tips of the involucral and receptacular bracts. Additionally, the presence of the smaller tack-shaped gland on the tips of the involucral or receptacular bracts is variable, although uncommon overall.

As discussed above, the populations treated here as *Calycadenia micrantha* have previously been considered conspecific with *C. truncata*. Salient features that help distinguish the two species as circumscribed here are presented in Table 1. Some of the most striking differences relate to the reduced capitulum associated with the self-compatible breeding system found in *C. micrantha* (Fig. 2).

In greenhouse cultivation of *C. micrantha*, we have noted that the middle lobe of ray flower laminae is commonly subdivided, yielding a 4-lobed lamina with two small symmetric central lobes and two larger, asymmetric outer lobes. Heads may contain a mixture of ray flowers with 'normal' and 'aberrant' laminae. It is not known to what extent this phenomenon occurs in natural populations. We have noted the same phenomenon at very low frequencies in other species or hybrids of *Calycadenia* in cultivation.

ACKNOWLEDGMENTS

We are grateful to Kenton L. Chambers, emeritus professor of botany, Oregon State University, for preparation of the Latin diagnosis. We also thank the curators at UC and SBBG for making specimens available to the first author. We thank Bruce G. Baldwin (UC) and an anonymous reviewer for reviewing the manuscript.

REFERENCES

Carr, G.D. 1975. *Calycadenia hooveri* (Asteraceae), a new tarweed from California. Brittonia 27:136–141.

Carr, G.D. 1977. A cytological conspectus of the genus *Calycadenia* (Asteraceae): an example of contrasting modes of evolution. Amer. J. Bot. 64:694–703.

Lewis, D. and L.K. Crowe. 1958. Unilateral interspecific incompatibility in flowering plants. Heredity 12:233–256.

Keck, D.D. 1946. A new subspecies of *Calycadenia truncata* from the Coast Ranges of California. Leafl. W. Bot. 4:259–260.

BOOK NOTICES

Oxford University Press

Ted J. Case, Martin L. Cody and Exequiel Ezcurra. (eds.). 2002. **A New Island Biogeography of the Sea of Cortés.** (ISBN 0-19-513346-3, hbk.). Oxford University Press. (Orders: Oxford University Press, 2001 Evans Road, Cary, NC 27513, U.S.A., 800-451-7556, 919-677-1303 fax, www.oup.com). $95.00, 652 pp., figures, maps, graphs, tables, 6 1/2" × 9 1/2".

Publisher Comments: "This updated and expanded *A New Island Biogeography of the Sea of Cortés*, first published nearly 20 years ago, integrates new and broader studies encompassing more taxa and more complete island coverage. The present synthesis provides a basis for further research and exploration in upcoming years of the biologically fascinating Sea of Cortés region."

"The new *Biogeography* includes a section on the conservation issues in the Sea of Cortés, past accomplishments, and conservation needs as yet outstanding."

Donald G. Crosby. 2004. **The Poisoned Weed, Plants Toxic to Skin** (ISBN 0-19-515548-3, hbk.). Oxford University Press. (Orders: Oxford University Press, 2001 Evans Road, Cary, NC 27513, U.S.A., 800-451-7556, 919-677-1303 fax, www.oup.com). $59.95, 214 pp., figures, graphs, 24 color figures, 6 1/2" × 9 1/2".

Publisher Comments: "Toxic plants affect the skin of almost everyone on earth. Many such "dermatotoxic" species were well known to the Ancients and later generated centuries of medical research, but The Poisoned Weed is the first comprehensive book specifically about this topic. Crosby covers a wide range of these plants."

Poison ivy and relatives (Anacardiaceae) are not the only culprits included in the book.

James F. Hancock. 2004. **Plant Evolution and the Origin of Crop Species. Second Edition.** (ISBN 0-85199-685-X, hbk.) CABI Publishing, Wallingford, Oxon OX10 8DE, UK and 8756 Massachusetts Avenue, 7th Floor, Cambridge, MA 02139, U.S.A. (Orders: www.cabi-publishing.org, Oxford University Press, 2001 Evans Road, Cary, NC 27513, U.S.A., 800-451-7556, 919-677-1303 fax, www.oup.com). $100.00, 313 pp., graphs, b/w photos, line drawings, 6 1/4" × 91/4".

Publisher Comments: "This book is probably the only current volume to combine discussion of plant evolution with that of crop origins. The first edition was published in 1992 by Prentice-Hall, and has now been fully revised to reflect recent advances. The key features include a description of the process of evolution in native and cultivated populations of plants, a review of when and where major crops where domesticated, and a discussion of the subsequent development of crops over time. There is also greater integration of the information on evolution and crop origins compared with the first edition."

TWO NEW VARIETIES OF *AGOSERIS* (ASTERACEAE: LACTUCEAE)

Gary I. Baird

Department of Biology
Brigham Young University–Idaho
525 South Center St.
Rexburg, Idaho, U.S.A. 83460-1100, U.S.A.
bairdg@byui.edu

ABSTRACT

Agoseris grandiflora var. *leptophylla* occurs predominately west of the Cascade Mountains from southwestern British Columbia to western Oregon and is morphologically and geographically distinct from *A. grandiflora* var. *grandiflora*. The two varieties are parapatric and intermediate forms are found where they occur together. *Agoseris heterophylla* var. *quentinii* is known from Sonoran Desert regions of Arizona and New Mexico and is geographically isolated and morphologically distinct.

RESUMEN

Agoseris grandiflora var. *leptophylla* está predominantemente al oeste de las Montañas de las Cascadas desde el suroeste de la Columbia Británica hasta el oeste de Oregón y es morfológica y geográficamente distinta de *A. grandiflora* var. *grandiflora*. Las dos variedades son parapátricas y se encuentran formas intermedias allí donde conviven. *Agoseris heterophylla* var. *quentinii* es conocida de las regiones del desierto de Sonora en Arizona y Nuevo México, está aislada geográficamente y es diferente morfológicamente.

INTRODUCTION

Agoseris Raf. is a genus of perennial, lactucoid herbs that are found throughout western North America. One species is known from temperate regions of southern South America. Some *Agoseris* are considered taxonomically challenging. This is due, in part, to similar or overlapping morphologies between certain species and/or the formation of occasional hybrids between sympatric species. In addition, most members of the genus are very widespread and often contain local forms or regional phases that can appear quite distinct. Past attempts to formally recognize these forms or phases have largely failed as they either occur as sporadic populations or they form broad clines, thus their separation becomes arbitrary. Despite these challenges, in a recent review of *Agoseris* (Baird 1996) two variants were discovered that were geographically and morphologically distinct enough to merit nomenclatural recognition.

Agoseris grandiflora (Nutt.) Greene var. **leptophylla** G.I. Baird, var. nov. TYPE: U.S.A. WASHINGTON: PIERCE or LEWIS CO.: "dry open ground, upper valley of the Nisqually River," 19 Jul 1896, *Allen 225* (HOLOTYPE: GH; ISOTYPES: CAS!, DS!, K!, NY! [2 sheets], UC!, WS!).

Varietas haec ab var. grandiflora differt capitulis minoribus et flosculis paucioribus, plerumque 40–60+, phyllariis involucri saepe cum maculis purpureis, foliis et lobis perangustis, plerumque ca. 2–4 mm latis, magis saepe in habitationibus humidis vel sylvaticis vel umbriosis.

Perennial herbs, ± acaulescent; **leaves** linear-filiform to narrowly oblanceolate, 10–25(–36) cm × 1–4(–8) mm (excluding lobes), toothed (rarely) to laciniately lobed or pinnatifid, sub-glabrous to villous; lobes mostly in 3–5 opposite to sub-opposite pairs, linear to filiform, spreading to antrorse, often with a reduced secondary tooth or lobe on distal side of base of each primary lobe; **heads** borne singly, erect, scapiform; peduncles 15–40 cm tall at anthesis, 25–75(–96) cm tall at maturity, mostly 2–4 leaf lengths when mature, 3–4 mm in diameter, proximally glabrate, distally villous to tomentose, non-glandular; **involucres** campanulate, 2–4 cm tall at maturity; phyllaries ± ovate-attenuate, in 4–5 series, subequal at anthesis, unequal at maturity, usually entire, rarely dentate, herbaceous, often purple spotted and/or with a rosy-purple medial stripe, adaxially sub-glabrous to tomentose, abaxially glabrous or villous, margins ± ciliate; hairs whitish-opaque or translucent, non-glandular; outer phyllaries apically spreading to squarrose, not overtopping the inner series at anthesis; inner phyllaries erect, elongating, exceeding the outer at maturity; receptacles naked; **florets** 40–60+; corollas equal to or just exceeding phyllaries at anthesis, yellow, often with an abaxial purplish stripe on the outermost; tubes 4–5 mm; ligules 3–5 × 1 mm; anthers ca. 1 mm; **cypselae** pale brown to whitish, 15–24 mm long, 10-ribbed, beaked, glabrous or slightly scabrous, homogenous or outermost slightly different; bodies fusiform, 3–6 mm, abruptly contracted to their beaks; ribs ridged to sub-alate, straight; beaks 11–18 mm long, filiform, mostly 3–4 lengths of cypsela bodies; **pappi** of capillary bristles in 2–3 series, 7–15 mm long, white; $n = 9$ (Tomb et al. 1978, voucher: *Chambers 2238* (OSC-143201), reported as *Agoseris apargioides* subsp. *maritima*).

Common name.—Puget Sound agoseris.

Agoseris grandiflora var. *leptophylla* occurs primarily west of the Cascade Mountains from Vancouver Island and southwestern British Columbia, south throughout the Puget Sound trough and Willamette Valley to southwestern Oregon and northwestern California (see Fig. 1). It also occurs eastward through the Columbia River gorge and sporadically on the eastern slopes of the Cascade Mountains in Washington and Oregon. Some specimens from the moist, western slopes of the Rocky Mountains of British Columbia and northern Idaho (panhandle region) are assignable to var. *leptophylla*. Ecological notes on specimen labels suggest that var. *leptophylla* occurs most commonly in lowland prairies or open forest habitats within the region outlined.

As a whole, *A. grandiflora* manifests two or three geographic phases that grade together and cannot be satisfactorily or consistently separated. Conversely, var. *leptophylla* represents what is arguably the most distinct phase of the species, with the specimens of var. *leptophylla* from the Puget Sound region

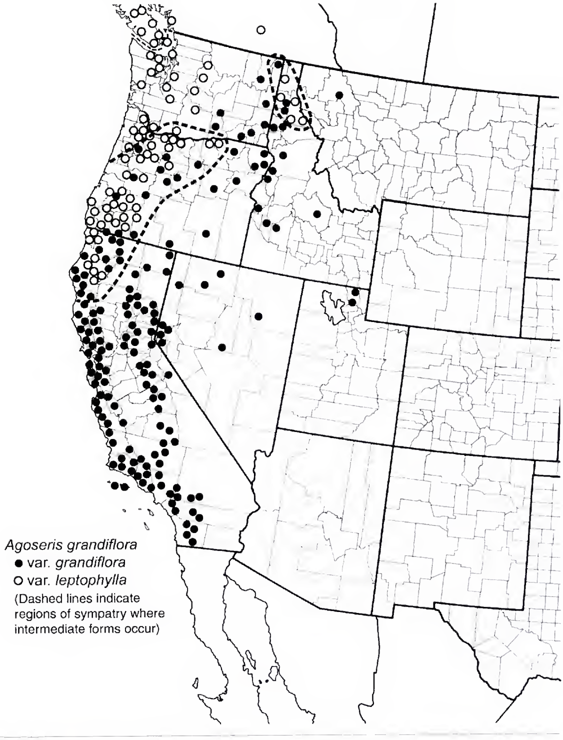


FIG. 1. Approximate distribution of *Agoseris grandiflora* in western North America. The two accepted varieties transition primarily within the regions indicated by the dashed lines (intermediate specimens not mapped).

morphologically the most distinct from var. *grandiflora*. Within this region var. *leptophylla* appears to completely supplant var. *grandiflora*. Jones (1954) felt this was only the "expressions of different environmental regimens" and that the morphological overlap and geographical transition between this variant and the remainder of the species was too great to justify recognition of intraspecific taxa. The separation and transition between the two varieties of *A. grandiflora*, however, are no different than that found between other well-accepted varietal pairs within *Agoseris* (e.g., *A. aurantiaca* var. *aurantiaca* and var. *purpurea*, or *A. glauca* var. *glauca* and var. *dasycephala*). In the Columbia River gorge and southern Willamette Valley, extending into northern California, and in the panhandle region of northern Idaho, the two varieties do intermingle and intergrade such that the distinction between them falters and not all specimens are clearly assignable to one or the other variety. In general, var. *leptophylla* differs from var. *grandiflora* by its more diminutive size, slender, laciniately lobed leaves, slender peduncles, smaller heads with fewer florets, and outer phyllaries subequal to (rather than longer than) inner phyllaries at anthesis. The following couplet will assist in separating the two varieties:

1. Leaves ± entire, toothed, or pinnatifid, mostly 10–35 mm wide (excluding lobes), rarely less, lobes lanceolate to oblanceolate; involucres 3.0–5.5 cm tall at maturity, florets mostly 150–500+, rarely fewer; outer phyllaries often with a purplish medial stripe, usually not spotted ____ var. **grandiflora**
1. Leaves mostly laciniately pinnatifid, mostly 2–4 mm wide (excluding lobes), rarely wider, lobes filiform to narrowly lanceolate; involucres 2.0–4.0 cm tall at maturity, florets mostly 40–60, rarely more; outer phyllaries occasionally with a purplish medial stripe but often purple spotted ____ var. **leptophylla**

Specimens assigned here to var. *leptophylla* have often been identified as *Agoseris laciniata* (Nuttall) Greene or *A. grandiflora* var. *laciniata* (Nuttall) Jepson, names based on *Stylopappus laciniatus* Nuttall. In 1834–1835, Thomas Nuttall collected the types of four *Agoseris* taxa from the Willamette Valley of western Oregon, all of which he placed in *Stylopappus*. Three (*Stylopappus elatus*, *S. laciniatus*, and *S. laciniatus* var. *longifolius*) were collected at the mouth of the Willamette River and belong to the enigmatic *Agoseris* ×*elata* (Nuttall) Greene (Jones 1954; Baird 1996). The fourth (*Stylopappus grandiflorus*) was collected on the "high plains" or "hills" of the Willamette (the exact location is not known but possibly in present-day Marion or Polk Counties; see Ewan, 1971) and is the type of *Agoseris grandiflora*; the specimen is teratological but is clearly assignable to *A. grandiflora*. The type description of *S. laciniatus* seems to describe *A. grandiflora* var. *leptophylla* and applying the name "*laciniatus*" to this variant of *A. grandiflora* seems an appropriate course of action. However, the lectotype (Nuttall's original gathering at BM) of *S. laciniatus* appears to be part of the *A.* ×*elata* hybrid complex and is therefore excluded from *A. grandiflora* (Jones 1954; Baird 1996). The lectotype of *S. laciniatus* var. *longifolius* (also teratological) is more clearly of hybrid origin, with *A. grandiflora* var. *leptophylla* as one of the putative parents.

Representative collections of *Agoseris grandiflora* var. *leptophylla*. **CANADA. BRITISH COLUMBIA: Alberni–Clayquot R.D.:** Alberni region, 26 Jun 1907, *Rosendahl 1969* (GH, MO, NY, UC). **Capital R.D.:**

Near Victoria, 21 Apr 1885, *Fletcher s.n.* (GH, US); vicinity of Victoria, 31 May 1893, *J. Macoun 573* (GH, MO); Goldstream, Vancouver Island, 12 Jun 1939, *Eastham s.n.* (UBC); Maxwell Mt., Salt Spring Island, 7 Aug 1955, *Ashlee s.n.* (UBC). **Central Kootenay R.D.:** Longbeach, Nelson, 12 Jul 1937, *Eastham s.n.* (UBC); Gray Creek, Kootenay Lake, 12 Jul 1941, *Eastham s.n.* (UBC). **Cowichan Valley R.D.:** Cowichan Lake, 30 Jun 1939, *Buckland 44* (UBC). **Greater Vancouver R.D.:** South Face of Black Mt., 15 Jun 1912, *Davidson s.n.* (UBC). **Nanaimo R.D.:** Cameron Lake, 14 Jul 1917, *Carter s.n.* (GH); First Lake, Nanaimo River Valley, 25 Jul 1955, *Mueller-Dombois 61-3* (UBC); Parksville, 13 Jul 1961, *Taylor 3098* (UBC). **U.S.A. CALIFORNIA: Del Norte Co.:** On road to Bear Basin, 1 mi. W of Doe Flat, 2 Aug 1955, *Van Deventer 1003* (JEPS). **Humboldt Co.:** Mackay Prairie, Trinity Summit, 25 Jul 1935, *Tracy 14234* (UBC); Garberville, at N end of town, 18 Jul 1942, *Tracy 17275* (UBC); Gravelly place at summit of ridge near "Clear Lake," 31 Jul 1950, *Tracy 19233* (UC). **Mendocino Co.:** South Fork of Eel River, near the Mendocino Co. line, 6 Jul 1918, *Tracy 5074* (UC). **Trinity Co.:** Two mi W of Hayfork, 23 Jun 1943, *Pitelka 256* (UC); Trinity Centre, 27 Jun 1982, *Straley 2341* (UBC). **IDAHO: Clearwater Co.:** One mile S of Weipe, 26 Jun 1941, *Davis 3592* (UC). **Idaho Co.:** Above Little Granite Creek, 13–30 Jun 1937, *Packard 265* (UC). **Kootenai Co.:** Coeur d'Alene, E slope of Tubb's Hill, 28 Jun 1913, *Rust 316* (US). **Shoshone Co.:** Coeur d'Alene Mountains, between Old Mission and Wardner, 30 Jul 1895, *Leiberg 1413* (GH, US); Roundtop Ranger Station, on the road to Avery, 4 Aug 1941, *Wilson 488* (GH, UC). **OREGON: Benton Co.:** Corvallis, 12 Jun 1916, *Gilbert 26* (OSC). **Clackamas Co.:** Boring, 18 Aug 1918, *Diehm and Gorman 4339* (ORE). **Curry Co.:** Brookings, 11 Jul 1919, *Peck 8784* (WILLU); Trail above Agness, Rogue River, 8 Jul 1929, *Henderson 11386* (UC). **Douglas Co.:** Roseburg, 21 Jun 1916, *Peck 2447* (WILLU); Umpqua National Forest, Bear Creek Road No. 2735, 21 Sep 1975, *Williams s.n.* (ORE). **Hood River Co.:** Bonneville, 6 Aug 1895, *Canby s.n.* (US); Hood River, 23 Jun 1911, *Peck 2453* (WILLU). **Jackson Co.:** Ashland, 19 Jun 1927, *Peck 14999* (WILLU); 4 mi E of Central Point, 22 May 1948, *Peck 24856* (WILLU). **Jefferson Co.:** Bank of Suttle Lake, 19 Jul 1925, *Peck 14426* (WILLU). **Josephine Co.:** Grants Pass, 28 Jul 1913, *Peck 2457* (WILLU); Takilma, 24 Jun 1918, *Peck 7953* (WILLU). **Klamath Co.:** Klamath Falls, 28 Aug 1916, *Peck 2446* (WILLU). **Lane Co.:** Amazon Slough, W of Eugene, 31 May 1925, *Constance s.n.* (UC); Spencer's Butte, 11 Jul 1933, *Brown 229* (ORE). **Lincoln Co.:** Yachats, bluff above the sea, 25 Aug 1921, *Peck 10612* (WILLU). **Linn Co.:** Cascade Mtns., vicinity of Tombstone Pass, Iron Mtn., Cone Peak, Tombstone Prairie, by Hwy. 20, 16 Aug 1983, *Chambers and Ross 8378* (OSC). **Multnomah Co.:** Dry hills in Portland, 25 Jun 1886, *Henderson 584* (US); St. Johns, 28 Jul 1902, *Sheldon 11021* (US). **Tillamook Co.:** Neahkahnie, 3 Jul 1924, *Peck 13313* (WILLU). **Wasco Co.:** The Dalles, 7 Jun 1869, *Kellogg and Harford 604* (US). **WASHINGTON: Clallam Co.:** Mt. Angleles, 21 Jul 1931, *Howell 7429* (CAS). **Clark Co.:** East Mill Plain, 27 Jun 1925, English 452 (US). **Chelan Co.:** Nason Creek, 30 Jul 1893, *Sandberg and Leiberg 612* (GH, UC, US). **Grays Harbor Co.:** near Montesano, 27 Jun 1898, *Heller and Heller 3964* (MO, NY, PH, US). **Island Co.:** Whidby Island, Deception Pass Park, Goose Rock, 8 Jul 1937, *Smith 2113* (DS). **Jefferson Co.:** Evergreen, 13 Jul 1902, *Conrad 326* (PH, US). **King Co.:** Seattle, 19 Jun 1889, *Smith s.n.* (US). **Klickitat Co.:** Bingen Mountain, 16 Jul 1907, *Suksdorf 6007* (GH). **Mason Co.:** Olympic National Park, Lincoln Ranger Station, road shoulder, 10 Jul 1941, *Rogers 860* (UC). **Pierce Co.:** Tacoma, edge of forest prairies, 13 Jun 1908, *Flett 3390* (UC). **San Juan Co.:** Friday Harbor, 25 Jun–1 Aug 1917, *Zeller and Zeller 857* (GH, US).

Agoseris heterophylla (Nutt.) Greene var. **quentinii** G.I. Baird, var. nov. TYPE: U.S.A. ARIZONA: Pima Co.: "On gravelly slopes in scrub oak – mesquite openings; altitude 4000 ft., Sawmill Canyon, near upper well, Santa Rita Mountains," 26 Mar 1945, *Gould and Haskell 3045* (HOLOTYPE: LL; ISOTYPES: ARIZ!, CAS!, DS!, GH!, NY!, UC!).

Varietas haec aliis differt forma valde acauli, foliis saepe decumbentibus lobatis et abaxialiter glabris sed adaxialiter pubescentibus, lobis rotundatis vel obtusatis raro foliis dentatis vel integris, scapis tomentosis prope apicem, involucris floriferis sessilibus vel his aliquanto longioribus sed foliis scapum superantibus, acheniis costatis vel porcatis, sine variatione varietatum ceterarum.

Annual (winter annual?) herbs, acaulescent; **leaves** oblanceolate to spathulate, 2–12 cm × 3–9(–12) mm, spreading to prostrate, adaxially pubescent, abaxially glabrous, mostly lobed, rarely toothed; lobes in 2–3 pairs, rounded to blunt, lacking secondary denticulations; **heads** borne singly, erect, ± sessile to scapiform; peduncles to 26 mm tall at maturity, mostly less than 0.5 leaf lengths at anthesis (rarely longer), 0.5– 3 leaf lengths at maturity, villous to tomentose, proximally ± glabrate, distally tomentose; **involucres** campanulate to hemispheric, 1–2 cm tall at maturity, sometimes proximally pubescent, hairs yellowish-translucent, glandular; phyllaries lanceolate, in 2–3 series, subequal at anthesis, unequal at maturity, entire, herbaceous, often with a purplish medial stripe, adaxially lanate, hairs whitish-opaque, abaxially ± glandular-villous, hairs purple-septate, translucent (intermixed with whitish-opaque hairs), marginally ± ciliate to lanate; outer phyllaries erect to squarrose, not elongating at maturity; inner phyllaries erect, ± elongating at maturity; receptacles naked; **corollas** ± equal to phyllaries at anthesis, yellow, outermost often with an abaxial purplish stripe; tubes 2–3 mm; ligules 2–3 × 0.8–1.5 mm; anthers 1 mm or less; **cypselae** pale brown to whitish, 9–10 mm, ca. 10-ribbed, beaked, ± glabrous, ± homogenous; bodies fusiform, 3–4 mm, gradually tapering to abruptly narrowing to their beaks; ribs ridged, straight, not diminishing proximally; beaks 5.0–6.5 mm long, 1.5–2.5 lengths of cypsela bodies; **pappi** of capillary bristles in 2–3 series, 4–9 mm, whitish.

Common name.—Arizona agoseris.

Agoseris heterophylla var. *quentinii* is known from Arizona and New Mexico (see Fig. 2). It most commonly occurs in desert grasslands, scrublands, and open woodlands between 1200 and 2000 m. It is found on various mountain ranges from the vicinity of the San Francisco Peaks southeastward to southeastern Arizona and southwestern New Mexico. It has not yet been reported from Mexico, although it has been found not far from the border in the Baboquivari and Huachuca mountains of Arizona and the Peloncillo Mountains of New Mexico.

The principle features that distinguish var. *quentinii* from the other two varieties of *A. heterophylla* are its strongly acaulescent form, leaves adaxially pubescent and abaxially glabrous, peduncles apically tomentose and typically much shorter than the leaves at anthesis, and homogenous cypselae that lack the morphological variation and heterogeneity typical of this species. The three varieties of *A. heterophylla* accepted here may be separated using the following key:

1. Corolla ligules 2–4 mm long, ± equaling phyllaries; anthers less than 1.5 mm long; leaves entire, toothed, or lobed, the lobes mostly 2–3 paired; found in California and/or elsewhere.
    2. Peduncles mostly 1.5–4.5 leaf lengths at anthesis, proximally glabrous or glabrate, distally glabrous or ± pubescent; leaves glabrous or uniformly pubescent; wide-

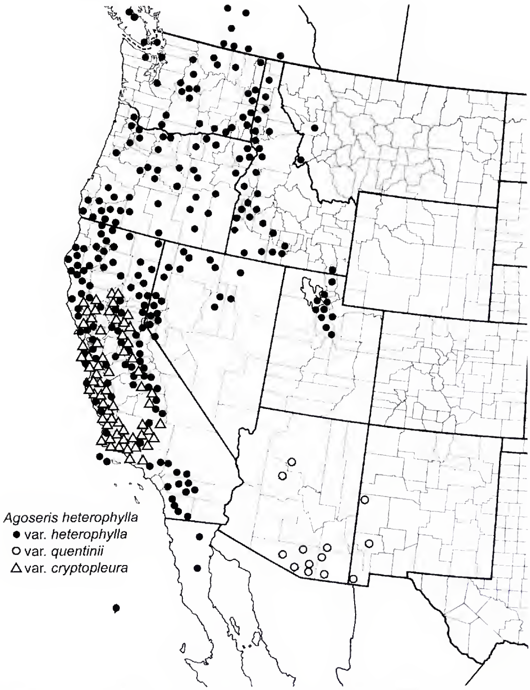


Fig. 2. Approximate distribution of *Agoseris heterophylla* in western North America.

spread in western North America but not known from Arizona or New Mexico ________ var. **heterophylla**

2. Peduncles 0–1 leaf length at anthesis, proximally glabrous or glabrate, distally tomentose; leaves adaxially pubescent, abaxially glabrous; desert regions of southern Arizona and New Mexico ________ var. **quentinii**

1. Corolla ligules 10–15 mm long, much exceeding phyllaries; anthers 2–4 mm long; leaves toothed to lobed, the lobes mostly 3–5 paired; coast ranges and foothills of central California ________ var. **cryptopleura**

Agoseris heterophylla var. *quentinii* is named in honor of Quentin Jones, Ph.D., who monographed *Agoseris* for his doctoral thesis (Jones 1954). His work was instrumental in stabilizing and establishing much of the current nomenclature within the genus. He was the first to recognize that specimens of *A. heterophylla* from Arizona and New Mexico are distinct from the remainder of the species. His manuscript name was never published.

Observed collections of *Agoseris heterophylla* var. *quentinii* **U.S.A. ARIZONA: Cochise Co.:** Three mi N of Mescal, 17 Mar 1945, *Pultz and Phillips 1571* (ARIZ); Galiuro Mountains, Bass Canyon on Muleshoe Ranch, ca. 25 mi NW of Willcox, T12S, R21E, 14 May 1983, *Daniel and Butterwick 2863* (ASU, NY). **Coconino Co.:** Sedona, 25 May 1941, *Stitt and McLellan s.n.* (ASU). **Gila Co.:** Pinal Mountains, Six Shooter Canyon, 2 May 1968, *Pase 1797* (ASU); Pinal Mountains, Russell Gulch, 2.7 mi below intersection of forest roads 55 and 55A, 24 Apr 1970, *Keil, McLeod, Lamb, and Lehto 16792* (ASU). **Navajo Co.:** White Mountain Indian Reservation, on grassy flats around Kinishba Ruin, 31 Apr 1947, *Lane 1946* (ASU). **Pima Co.:** Plains near Arivaca, 6 Apr 1884, *Pringle s.n.* (PH-2, NY-2); Santa Rita Mountains, Stone Cabin Canyon, 17 Apr 1903, *Thornber 374* (ARIZ-2, NY); Santa Rita Mountains, Stone Cabin Canyon, 5 May 1905, *Thornber s.n.* (ARIZ-2); Santa Rita Mountains, " Rozemont" (Rosemont?), 12 Apr 1907, *Thornber s.n.* (ARIZ); Santa Catalina Mountains, 16.1 mi S of Oracle on road to Mt. Lemmon and 0.4 mi E on ranch road, 27 Apr 1973, *Lehto, Hansel, and Pinkava 10848* (ASU). **Santa Cruz Co.:** Santa Rita Mountains, McCleary's, base of Old Baldy, Apr 1901, *Griffiths 2671* (NY). **Yavapai Co.:** 1.6 mi N of Skull Valley, 8 May 1967, *Keil, Pinkava, and Lehto 8147* (ASU); Weaver Mountains, Arrastre Creek, 18 May 1980, *Butterwick and Hillyard 6439* (ARIZ, ASU); Finch Wash, E of Skull Valley, near National Forest boundary, 2 Jun 1980, *Butterwick and Hillyard 6697* (ASU); Woodchute Wilderness Area, NW base of Woodchute Mountain, ca. 9 km WNW of Jerome, 12 May 1992, *Baker 9086* (ASU). **NEW MEXICO: Catron Co.:** Base of Mogollon Mountains, Sheridan Gulch trail ca. 6 mi SE of Glenwood, 4 mi from Hwy. 180, 21 May 1983, *Soreng and Ward 2130C* (NMC). **Grant Co.:** Mangas Spring, 27 May 1941, without collector (NMC). **Hidalgo Co.:** Peloncillo Mountains, Coronado National Forest, about one mile NW of Pendleton Ranch House along Cloverdale Creek, T33S, R21W, S5, 20 Apr 1986, *Worthington 14026.5* (NMC, NY). **Location Uncertain:** Mexican Boundary Survey (without location, date, or collector; NY); *Griffiths 2671* (without location or date; ARIZ); Arizona, " Toros Canyon," 28 Mar 1927, *Peebles, Harrison, and Kearney 3769* (ARIZ)

ACKNOWLEDGMENTS

I thank the curators and staff members at ARIZ, ASU, CAS, DS, GH, JEPS, K, LL, MO, NMC, NY, ORE, OSC, UBC, UC, US, WILLU, WS, and WTU for their assistance in locating information and for the loan of specimens.

REFERENCES

Baird, G.I. 1996. The systematics of *Agoseris* (Asteraceae: Lactuceae). Ph.D. dissertation, University of Texas, Austin.

Ewan, J. 1971. Classica Botanica Americana, Vol. 7: Thomas Nuttall, Genera of North American Plants. New York.

Jones, Q. 1954. Monograph of *Agoseris*, tribe Cichorieae. Ph.D. dissertation, Harvard University, Cambridge.

Tomb, A.S., K.L. Chambers, D.W. Kyhos, A.M. Powell, and P.H. Raven. 1978. Chromosome numbers in the Compositae. XIV. Lactuceae. Amer. J. Bot. 65:717–721.

LECTOTYPIFICATION OF *PASSIFLORA AFFINIS* (PASSIFLORACEAE) AND DISCUSSION OF ITS GEOGRAPHIC RANGE WITHIN THE UNITED STATES

Douglas H. Goldman

Harvard University Herbaria
22 Divinity Avenue
Cambridge, Massachusetts 02138, U.S.A.
dgoldman@fas.harvard.edu

ABSTRACT

George Engelmann, in his description of *Passiflora affinis*, never designated a holotype for the species, nor has a lectotype been designated in subsequent literature addressing Engelmann's work or North American *Passiflora*. A lectoype is designated here and a discussion and clarification of the geographic range of this species in the United States is provided.

Key Words: *Passiflora affinis*, lectotypification, geographic distribution, Ferdinand Lindheimer, George Engelmann, Charles Wright, Charles Parry, Benno Matthes

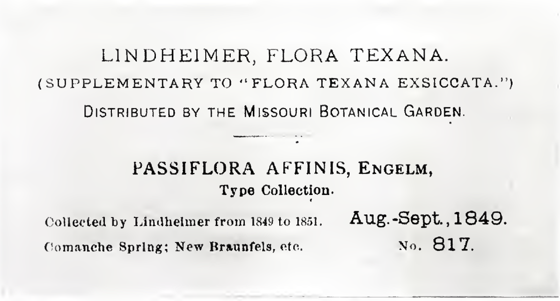
RESUMEN

George Engelmann, en su descripción de *Passiflora affinis*, nunca designó un holotipo para la especie, ni tampoco se ha designado un lectotipo en la literatura subsiguiente que trata el trabajo de Engelmann o las *Passiflora* norteamericanas. En este trabajo se designa un lectotipo, y además se hace una discusión y clarificación de la distribución geográfica de la especie en los Estados Unidos

INTRODUCTION

Passiflora affinis Engelm. is a warm-temperate and subtropical species of oak-juniper savannas and mesic woodlands from central Texas and northeastern Mexico (Schulz 1922; Killip 1938; Correll & Johnston 1970; Diggs et al. 1999). The type collection was made by Ferdinand Lindheimer in August to September 1849 at Comanche Spring, Bexar County, Texas. The type series was distributed in 1907 by the Missouri Botanical Garden as a part of a long-forgotten portion of the Flora Texana Exsiccata (Blankinship 1907), although it was originally described several decades earlier (Engelmann 1850a).

The labels distributed with the type series in 1907 (Fig. 1) are potentially misleading, presenting the type locality as "Comanche Spring; New Braunfels, etc.," Comanche Spring and New Braunfels occurring perhaps 30 miles apart. However, Engelmann (1850b), Blankinship (1907), Killip (1938) and Lindheimer correspondence with George Engelmann, found in the archives of the Missouri Botanical Garden, make clear that it was collected at Comanche Spring alone. Lindheimer spent the majority of the growing season of 1849 at that site, returning to New Braunfels only at the end of that year (Engelmann 1850b;



LINDHEIMER, FLORA TEXANA.
(SUPPLEMENTARY TO "FLORA TEXANA EXSICCATA.")
DISTRIBUTED BY THE MISSOURI BOTANICAL GARDEN.

PASSIFLORA AFFINIS, ENGELM,
Type Collection.

Collected by Lindheimer from 1849 to 1851. Aug.-Sept., 1849.
Comanche Spring; New Braunfels, etc. No. 817.

Fig. 1. The collection label found on specimens of the type series of *Passiflora affinis* distributed in 1907 (see Blankinship 1907), this label from a duplicate at GH.

Blankinship 1907). Comanche Spring was on the property of a friend of Lindheimer's, Baron Ottfried Hans von ("John O.") Meusebach, an early settler and founder of several communities in central Texas (King 1967). The spring was probably very close to Meusebach's house near the headwaters of Salado Creek, in what is now the Camp Bullis Military Reservation (Ivey 1979).

Although Englemann (1850a) did clearly state the type locality in the protologue, he did not designate a holotype, and neither Blankinship (1907) nor Killip (1938) later designated a lectotype from the *P. affinis* type series.

Passiflora affinis Engelm., Bost. J. Nat. Hist. 6:233. 1850. (**Fig. 2**). Type: TEXAS: [Bexar Co.:] Comanche Spring, Aug–Sep 1849, *F. Lindheimer 174* (lectotype, here selected: GH!; isolectotypes: ARIZ!, BM!, BR!, BRIT-SMU!, C!, CAN!, G! (2), GH!, K!, MEXU, MO!, NY!, P!, PH!, TEX!, UC!, US!, W!).

Liana, often suckering from roots, stems terete, glabrous, minutely puberulent to scabrous when young; tendrils glabrous; stipules linear-setaceous, erect, glabrous, 0.1–0.2 cm; petioles glabrous, glandless, 0.4–4.5 cm; leaves glabrous, entire, shallowly to deeply 3(–5)-lobed, broadly ovate in general outline, basally cordate, truncate, to cuneate, 1–8(–10) cm long by 1.5–10(–14) cm wide, lobes ovate to obovate, rounded to truncate, entire to apiculate, often basally narrowed, laminar nectaries round, often in two obscure lines, each running from base of leaf near petiole apex toward the larger sinuses; inflorescence of two or rarely one flower per node, flowers fragrant, erect, stipe + pedicel 1.0–3.5 cm, slightly elongating in fruit; floral bracts glabrous, 3, occasionally deciduous, green to purple, linear-subulate to rarely ovate, 0.1–0.3 cm; flowers 3–5 cm in diameter; sepals moderately reflexed, lanceolate to linear-lanceolate, rounded

Fig. 2. The lectotype of *Passiflora affinis* at GH.

to acute, pale green to white, 1.0–1.6 cm long, 0.2–0.4 cm wide; petals moderately reflexed, linear-lanceolate, subulate, acute, pale green to white, 0.6–1.3 cm long, 0.1–0.2 cm wide; corona of 2 series of filaments, outer series linear-filiform, sinuous, weakly reflexed or not, tapering distally and terminating in a clavate apex, basally purple, apically green, white in between, 0.9–1.8 cm long, inner series filiform, erect, clavate, pale purple with green basally, 0.15–0.3 cm long; floral tube shallowly convex to nearly flat, operculum erect, incurved, plicate, pale purple to white, 0.1–0.2 cm long, nectar ring absent, limen erect, incurved, white, 0.1 cm wide; androgynophore 0.7–1.0 cm long, terete, pale purple; stamen filaments green with purple, 0.4–0.6 cm long; anthers green with purple margins, 0.25–0.4 cm long; ovary globose to subovoid, glabrous, styles purple, filiform, glabrous, 0.5–0.7 cm long, stigmas broadly expanded, round, 0.1–0.2 cm wide; berry, purple-black, ovoid, globose, to dorsiventrally compressed, 1.0–1.5 cm long, 1.0 cm wide; seeds dark brown to black, flattened, obovoid, acute, transversely sulcate, 0.25–0.35 cm long, 0.2–0.3 cm wide, with white arillate swelling to one side; germination epigeal.

It would be anticipated that a specimen chosen as the lectotype of an Engelmann name at the rank of species or below would be at the Missouri Botanical Garden where many of his collections reside, St. Louis, Missouri, being Engelmann's home from the early 1830s until his death in 1884 (White 1896; Yatskievych 1999). However, the protologue describes both flowering and fruiting material and none of the examined duplicates of this collection have flowers and fruit except for the specimen chosen as the lectotype at GH (Fig. 2). Most duplicates seen are sterile or have few fruit, the only other flowering specimen being at BRIT-SMU. All of the duplicates distributed in 1907 have mass-produced labels numbered *817*, whereas one of the two GH specimens, the one with flowers, has a much older, mostly hand-written label, numbered *174*. Lindheimer had his own field numbers, whereas Englemann used separate numbers based on the distribution order of the Flora Texana Exsiccata following the Bentham and Hooker sequence (Blankinship 1907). Blankinship does note (p. 170) that *174* is the Lindheimer number, which corresponds to the Engelmann number *817*, therefore these numbers refer to the same collection. The handwriting on the label of the now-lectotype is almost entirely Engelmann's, identifying the plant as *Passiflora triloba*. Elsewhere on the label and in the lower right-hand corner of the specimen is written "affinis" in what is probably Asa Gray's handwriting. In addition, this is the only specimen of the type series that indicates habitat information as it is cited in the protologue, stating that the plant was growing in "shady places" and "climbing high over trees." None of the series distributed in 1907 gives habitat details. The only detail in the label of the lectotype that differs from the protologue and the 1907 labels is the date, the older label stating "Sept 1849" whereas the protologue and newer labels state "Aug.-Sept. 1849" (Fig. 1). However, this does not make the older label incongruent with the protologue, and because of the other information on it and the presence of flowers on this specimen alone it is the best choice for the lectotype.

GEOGRAPHIC DISTRIBUTION

In Texas *P. affinis* is typicallyfound growing over Cretaceous limestone or much less commonly over Precambrian igneous rock or late Tertiary sandstone and clay (Sellards et al. 1932; Spearing 1991). In northeastern Mexico (see specimens examined) it grows over Cretaceous limestone, shale and sandstone (Dirección General de Geografía del Territorio Nacional 1981a, b; Padilla y Sanchez & Aceves-Quesada 1992). The currently known distribution of *Passiflora affinis* in Texas is shown in Fig. 3, based on herbarium and literature surveys, indicating that it is nearly restricted to the southern Edwards Plateau and Lampasas Cut Plains (Diggs et al. 1999; Turner et al. 2003).

A population was once collected in Fayette County, Texas, by Benno Matthes (see specimens examined), representing the eastern range-limit of the species in the United States and in an area with different geology than where this species occurs elsewhere in Texas. Matthes, a German settler and naturalist in Fayette County, lived for a short period in the town of Round Top, where he collected several plant specimens from late 1853 until mid-1854 (Geiser 1941). In this area he apparently collected *P. affinis* (=*Matthes 274*), with specimens deposited at the Muséum National d'Histoire Naturelle, Paris and the Naturhistorisches Museum, Vienna (Killip 1938). This specimen still exists at P, but it was not found at W in a recent search, although W does have a fragmentary Matthes specimen of *P. lutea* labeled "bei No. 274," suggesting that the two species were probably growing together. Matthes initially outlined his botanical discoveries in this area, although without mentioning *Passiflora* (Matthes 1855a). He later provided a more detailed field account (Matthes 1861) where he mentioned finding at the upper margin of a riparian forest "*Passiflora triloba*" with "*Clematis coccinea*" and *Cornus florida*. This may have been to the southwest of Round Top near Cummins ("Cummings") Creek, along which he had been known to collect (Matthes 1855b, 1861). Although mesic forest edges are appropriate habitat for both *P. affinis* and *P. lutea*, such a habitat at the inner edge of the coastal plain may seem more appropriate for the latter species (e.g. Cooperrider 1995; Alford 2000) versus those of *P. affinis* on the Edwards Plateau and associated uplift. However, much of Fayette County, including the Round Top area, is underlain by sandstone and clay of the Catahoula and Oakville formations, both which can contain calcareous portions, particularly the latter (Sellards et al. 1932; Proctor et al. 1974). Furthermore, the springs in Fayette County are also known to be alkaline (Brune 1981). This suggests that much of Fayette County can provide habitats consistent with the primarily calciphilic preferences of *P. affinis*.

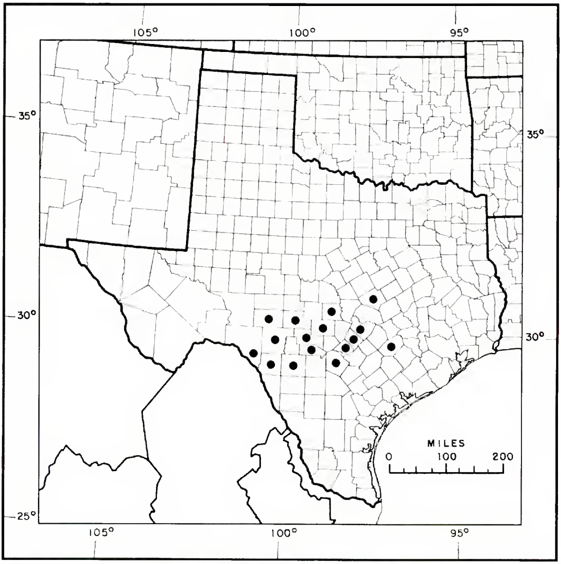


Fig. 3. Geographic distribution of *Passiflora affinis* in the United States based on herbarium surveys and floristic summaries (Diggs et al. 1999; Turner et al. 2003).

Killip (1938) reported the presence of *P. affinis* in New Mexico, citing a Parry specimen at US from Doña Ana county, labeled "chiefly in the valley of the Rio Grande, below Donana." This specimen was collected by the botanical survey party attached to the United States and Mexican Boundary Survey, consisting of John Bigelow, Charles Parry, Arthur Schott and Charles Wright (listed on the collection label as "C.C. Parry, J.M. Bigelow, C. Wright, & A. Schott"; see specimens examined). However, the only *P. affinis* collection cited in the botanical report of the Boundary Survey is by Bigelow in October (but with no year given) along the Devils River (Torrey 1859) in what is now Val Verde County, Texas, perhaps 350 miles from Doña Ana County, New Mexico. The Boundary Survey travelled within close proximity to the Rio Grande for several hundred miles south and west of Doña Ana County after the Treaty of Guadalupe Hidalgo was signed with Mexico in 1848, following the end of the Mexican-American War (Emory 1857). Therefore it should not have been assumed that this specimen was collected within the present boundaries of New Mexico.

In contrast, Killip (1938) did not similarly interpret the vague labels of *P. affinis* specimens collected by Charles Wright to suggest that this species occurred in New Mexico. Three collections could have been interpreted as such, one at GH (*Wright 217*) labeled "from Western Texas to El Paso, New Mexico, May to October 1849," another at GH and US with the same information but numbered *218*, and another with no number at NY and PH labeled "N. Mexico, 1851" (see specimens examined). It is surprising that they were not, with El Paso attributed to New Mexico in two of these three collections and "N. Mexico" also potentially interpreted in the same way, or as "northern Mexico."

Wright's number *217* is actually a distribution number given by Asa Gray for his Plantae Wrightianae part I (1852), whereas Wright's field number corresponding to *217* was *404*, collected on the 9th of June, 1849. His travel route (Geiser 1935) and his field notes, summarized in Shaw (1987) and available in the Gray Herbarium archives at Harvard University, indicate that *217/404* was collected "on the banks of the Leona" close to present-day town of Uvalde, Texas. Wright *218* was the distribution number for Wright's field number *734*, collected on the 25th of July 1849, among the "hills of the Devil's River" in present-day Val Verde County, Texas, although Gray (1852) consistently referred to the Devils River as the "San Pedro River", following the geographic names used by French (1850; Shaw 1987). Wright's "N. Mexico, 1851" may be the same as that referred to by Gray (1853), collected "on the Sabinal, western Texas, July," in what is now Uvalde County. However, Gray (1853) gives no distribution number for this specimen. In Wright's 1851 field notes in the GH archives *Passiflora* is entered only twice, once having been found on Chicon Creek (in modern Zavala County, Texas) in May 1851 and another time found in the "mountains near Santa Cruz, climbing among rocks," in Sonora, Mexico, July 1851, with no mention of the genus in his 1852 notes. The Chicon Creek *Passiflora* matches the entry in Gray (1853) for *P. tenuiloba* and the Santa Cruz specimen matches the entry (and protologue) for *P. inamoena* (=*P. bryonioides* Kunth). In July 1851 Wright was hundreds of miles away from the Sabinal River, in the vicinity of El Paso and southwestern New Mexico (Shaw 1987). It is possible that he collected this *P. affinis* specimen in this area, but without entering it into his field book, although that seems unlikely because he was a fastidious note-taker during his explorations of the border region. The only time he appeared to relax his note-taking was at the end of his travels in 1852, on his return to San Antonio, when on July 2nd he records his final collection in what is now western Crockett County, Texas (Shaw 1987), over 100 miles to the northwest of the Sabinal River in Uvalde County. It seems probable that Wright collected this specimen not in 1851 but in 1852, east of Crockett County on his return to San Antonio, which would have taken him through present-day Uvalde County. Shaw (1987) mentions that these post-July 2, 1852 notes tend to be folded-up in the fragment folders of the specimens themselves. Such notes tend to be only with GH specimens because of Wright's professional association with Gray. No duplicate of this specimen exists at GH so such information is probably lost. Furthermore, Gray often cut up notes and correspondence to make into fragment folders (W. Kittredge, pers. comm.). Thus if these notes still exist at GH they may form a packet on one of the over five million specimens in the herbarium.

These three Wright collections and the single Parry collection were obtained within what is currently west-central Texas, some of this area having been included in a southeastward extension of the Mexican province of New Mexico prior to the signing of the Treaty of Guadalupe Hidalgo (Commons 1990). Thereafter, all that is presently part of modern Texas was considered to be within the United States, Texas having claimed most of what is now modern New Mexico, northward through parts of Colorado and Kansas, into Wyoming, this land later purchased from Texas by the United States in the Compromise of 1850 (Stephens & Holmes 1988; Beck & Haase 1989). With these Parry and Wright collections made after Guadalupe Hidalgo in an area that has subsequently been considered to be part of Texas only, any interpretations in herbarium labels or in the literature of these collections having come from New Mexico or northern Mexico are in error.

Despite the potentially misleading labels on these specimens, *P. affinis* has never been reported from modern New Mexico in any floras of that state, which is fortuitous because a similar situation with vague herbarium labels may have led to the potential misreporting of *P. tenuiloba* for New Mexico (Martin & Hutchins 1981). Therefore, it can be assumed that the geographic range of *P. affinis* is restricted only to central Texas, with scattered populations in northeastern Mexico. The potential confusion created by old, vague labels, can lead to floristic uncertainty and this alone should be an inspiration to all botanists to be extremely thorough in making their collection labels.

Specimens examined: **MEXICO. Nuevo Leon. Mcpo. Lampazas de Naranjo:** Rancho Resendez, Lampazas, 22 Jun 1937, *M.T. Edwards 298* (GH). **Mcpo. Monterrey:** Monterrey, Sierra Madre Oriental, 23 Jul 1933, *C.H. Mueller & M.T. Mueller 100* (GH). **Mcpo. Santiago:** trail between Potrero Redondo & Las Ajuntas, 24 Aug 1939, *C.H. Muller 2955* (GH). **Tamaulipas Mcpo. Cruillas:** Vic. of El Milagro, Cerro Zamora, 22 Aug 1930, *H.H. Bartlett 11094* (GH) **Mcpo. Victoria:** 12mi W of Victoria, 28 Aug 1948, *Kenoyer & Crum 3366* (GH).

U.S.A. TEXAS: Bexar Co.: Comanche Spring, New Braunfels, etc., Aug–Sep, 1849, *F. Lindheimer 817* [=*174*] (ARIZ, BM, BR, BRIT-SMU, C, CAN, G [2], GH [2], K, MO, NY, P, PH, TEX, UC, US, W); San Antonio, 17 Oct 1920, E.D. *Schulz 401* (US). **Edwards Co.:** Devil's Sink Hole, 29 Sep 1940, *V.L. Cory 35652* (GH); 39mi S. of Sonora, 16 Aug 1941, *V.L. Cory 38039* (GH); Devil's Sink Hole, 10mi E. of Rock Springs, 24 Jul 1946, *D.S. Correll 13412* (BRIT, NY), 10mi SE of Carta Valley, 7 Aug 1965, *D.S. Correll 31537* (GH). **Fayette Co.:** no locality, no date, *B. Matthes 274* (P). **Gillespie Co.:** 3mi E. of farm road, 1mi S. of county line off rt. 16, 20 Jul 1967, *D.S. Correll & H.B. Correll 34292* (GH). **Hays Co.:** San Marcos and vicinity, Jul 1897, *S.W. Stanfield s.n.* (NY); lake bank, San Marcos, 25 Jul 1941, *B.C. Tharp s.n.* (BRIT, GH, NY, PH, US). **Kerr Co.:** Hunt, shores of Guadalupe River, 4 Aug 1969, *P. Fryxell 1099* (NY). **Kimble Co.:** Telegraph, 8 Oct 1916, *E.J. Palmer 10942* (US); along Llano River at Junction, 6 Sep 1965, *D.S. Correll 31527* (GH). **Kinney Co.:** Ft. Clark, 10 May 1893, *E.A. Mearns 1439* (US); 10 3/4mi W of Laguna, 24 Sep 1939, *V.L. Cory 33461* (GH). **Llano Co.:** Enchanted Mt., Fredricksburg, 26 Jun 1932, *C.C. Albers s.n.* (BRIT); Enchanted Rock, 1 Aug 1938, *B.C. Tharp s.n.* (NY). **Sutton Co.:** 3/4mi SW of Ft. Terrett, 20 Aug 1937, *V.L. Cory 24090* (GH). **Travis Co.:** above Zilker Park, Austin, 10 Oct 1945, *B.C. Tharp 45-49* (GH, NY); Hamilton Pool, 8 Jul 1966, *J.R. Crutchfield 1802* (NY); Austin, 27 Aug 1978, *J.M. MacDougal 448* (US). **Uvalde Co.:** from Western Texas to El Paso, New Mexico, May–Oct 1849, *C. Wright 217* (GH [2]); N. Mexico, 1851, *C. Wright s.n.* (NY, PH). **Val Verde Co.:** chiefly in the valley of the Rio Grande, below Doñana, no date, *C.C. Parry, J.M. Bigelow, C. Wright, & A. Schott s.n.* (US); from Western Texas to El Paso, New Mexico, May–Oct 1849, *C. Wright 218* (GH [2], US). **Undetermined locality:** Nueces, 1880s, *V. Havard s.n.* (US). **CULTIVATED:** Cornell University, originally from U. Texas, San Antonio, 17 Jun 2001, *D. Goldman 1769* (BH); Cornell University, originally from U. Texas, San Antonio, 10 Aug 2001, *D. Goldman 1819* (BH), Cornell University, originally from U. Texas, San Antonio, 9 Sep 2001, *D. Goldman 2126* (BH); Cornell University, originally from Edwards Co., TX, 9 Sep 2001, *D. Goldman 2127* (BH); Cornell University, originally from U. Texas, San Antonio, 28 Sep 2001, *D. Goldman 2160* (BH); Cornell University, originally from U. Texas, San Antonio, 2 Nov 2001, *D. Goldman 2161* (BH); Cornell University, originally from U. Texas, San Antonio, 2 Nov 2001, *D. Goldman 2162* (BH).

ACKNOWLEDGMENTS

Thanks is given to Lisa DeCesare, Gretchen Wade and Judy Warnement for library and archives assistance; Ken Cameron, Kanchi Gandhi, Walter Kittredge, Scott "M" LaGreca, Barney Lipscomb and Tanya Livshultz for valuable discussions or assistance; John MacDougal and Kristen Porter-Utley for reviewing this manuscript and other related discussions; the staff at ARIZ, BM, BR, BRIT-SMU, C, CAN, G, GH, K, MO, NY, P, PH, TEX, UC and US for sending loans and/or making digital images of specimens available; Alain Changy (P), Jochen Heinrichs (GOET) and Bruno Wallnöfer (W) for assistance with finding Matthes specimens; Bob Dirig, Kevin Nixon and Sherry Vance (BH), and Richard Zander (BUF) for receiving loans on my behalf; Marshall Enquist and Larry Gilbert (TEX) for sending live material for cultivation; Carol Bader, Paul Cooper, Jerry David, Kim Goodwin, Andy Leed and Melissa Lucknow for the facilitation of space and cultivation assistance at Cornell University; Andrew Colligan for assistance with the archives of the Missouri Botanical Garden; Renate Hellmiss and Daniel Schott for translations of Matthes manuscripts; Dan Fulop for the Spanish translation of the abstract and Hobbes Goldman for general support throughout.

REFERENCES

Alford, M.H. 2000. The vascular flora of Amite County, Mississippi. Sida 19:645–699.

Beck, W.A., and Y.D. Haase. 1989. Historical atlas of the American West. University of Oklahoma Press, Norman, Oklahoma.

Blankinship, J.W. 1907. Plantae Lindheimerianae part III. 18th Ann. Rep. Missouri Bot. Gard. Pp. 123–223.

Brune, G. 1981. Springs of Texas. Vol. I. Branch-Smith, Ft. Worth, Texas.

Commons, A. 1990. Divisiones territoriales, historia de las divisiones político-adminstrativas. II.5.2. (1524–1776), II.5.3 (1776-1821), II.5.4 (1810-1990). In: Atlas Nacional de México, Vol I, Universidad Nacional Autonóma de México, D.F., Mexico.

Cooperrider, T.S. The Dicotyledonae of Ohio. Part 2, Linaceae through Campanulaceae. Ohio State University Press, Columbus.

Correll, D.S., and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, Texas.

Diggs, G.M., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinner and Mahler's illustrated flora of north central Texas. Sida, Bot. Misc. 16. Botanical Research Institute of Texas, Fort Worth, Texas.

Dirección General de Geografía del Territorio Nacional. 1981a. Carta Geológica, 1:1,000,000. Monterrey. Estados Unidos Mexicanos, Secretaría de Programación y Presupuesto.

Dirección General de Geografía del Territorio Nacional. 1981b. Carta Geológica, 1:1,000,000. México. Estados Unidos Mexicanos, Secretaría de Programación y Presupuesto.

Emory, W.H. 1857. Report on the United States and Mexican Boundary Survey, Vol. 1. A.O.P. Nicholson, Washington, D.C.

Engelmann, G. 1850a. *Passiflora affinis*. P. 233. In A. Gray, ed., Plantae Lindheimeianae Part II. Boston J. Nat. Hist. 6.

Engelmann, G. 1850b. "Subjoined preface." Pp. 234-240. In A. Gray, ed., Plantae Lindheimeianae Part II. Boston J. Nat. Hist. 6.

French, S.G. 1850. A report in relation to the route over which the government train moved from San Antonio to El Paso del Norte. In: Reports of the Secretary of War: with reconnaissance of routes from San Antonio to El Paso. Senate, 31st Congress, 1st Session, Ex. Doc. No. 64. Union Office, Washington, D.C. Pp. 40–54.

Geiser, S.W. 1935. Charles Wright's 1849 botanical collecting trip from San Antonio to El Paso; with type localities for new species. Field & Lab. 4:23–32.

Geiser, S.W. 1941. Dr. Benno Matthes: an early Texas herpetologist. Field & Lab. 9:37–45.

Gray, A. 1852. Plantae Wrightianae Texano-Neomexicanae Part I: An account of a collection of plants made by Charles Wright, A.M., in an expedition from Texas to New Mexico in the summer and autumn of 1849, with critical notices and characters of other new or interesting plants from adjacent regions, etc. Smithsonian Institution, Washington, D.C.

Gray, A. 1853. Plantae Wrightianae Texano-Neomexicanae Part II: An account of a collection of plants made by Charles Wright, A.M., in western Texas, New Mexico and Sonora in the years 1851 and 1852. Smithsonian Institution, Washington, D.C.

Ivey, J.E. 1979. The Comanche Spring site. La Tierra 6:16–21.

Killip, E.P. 1938. The American species of Passifloraceae. Publ. Field Mus. Nat. Hist., Bot. Ser. 19:1–613.

King, I.M. 1967. John O. Meusebach, German colonizer in Texas. University of Texas Press, Austin, Texas.

Martin, W.C., and C.R. Hutchins. 1981. A flora of New Mexico. J. Cramer, Vaduz, Liechtenstein.

Matthes, B. 1855a. Excursion von New-Orleans nach dem Urwald am Rio Colorado in Texas.

Allgemeine deutsche Naturhistorische Zeitung, Band I, No. 4:152–162. R. Kuntze, Hamburg, Germany.

Matthes, B. 1855b. Die Hemibatrachier im Allgemeinen und die Hemibatrachier von Nord-America im Speciellen. Allgemeine deutsche Naturhistorische Zeitung, Band I, No. 7:249–280. R. Kuntze, Hamburg, Germany.

Matthes, B. 1861. Reise-Bilder. Bilder aus Texas. H.J. Zeh, Dresden, Germany.

Padilla y Sanchez, R.J., and J.F. Aceves-Quesada. 1992. Geológica, IV.1.1. In Atlas Nacional de México, Vol II, Universidad Nacional Autonóma de México, D.F., Mexico.

Proctor, C.V., T.E. Brown, J.H. McGowen, and N.B. Waechter. 1974. Geological atlas of Texas. Austin sheet. Bureau of Economic Geology, University of Texas, Austin.

Schulz, E.D. 1922. 500 wild flowers of San Antonio and vicinity. Published by the author, San Antonio, Texas.

Sellards, E.H., W.S. Adkins, and F.B. Plummer. 1932. The geology of Texas. Volume 1, stratigraphy. University of Texas Bull. 3232. Austin.

Shaw, E.A. 1987. Charles Wright on the boundary, 1849-1852, or Plantae Wrightianae revisited. Meckler Publishing Corp., Westport, Connecticut.

Spearing, D. 1991. Roadside geology of Texas. Mountain Press, Missoula, Montana.

Stephens, A.R., and W.M. Holmes. 1988. Historical atlas of Texas. University of Oklahoma Press, Norman.

Torrey, J. 1859. Botany of the Boundary. In: W.H. Emory, ed. Report on the United States and Mexican Boundary Survey, Vol. 2, part 1. A.O.P. Nicholson, Washington, D.C. Pp. 27–270.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Introduction, dicots. Sida, Bot. Misc. 24. Botanical Research Institute of Texas, Fort Worth, Texas.

White, C.A. 1896. Memoir of George Engelmann, M.D., 1809–1884. Extract from Biog. Mem. Nat. Acad. Sci. 4. Judd & Detweiler, Washington, D.C.

Yatskievych, G.A. 1999. Steyermark's flora of Missouri. Missouri Department of Conservation, with Missouri Botanical Garden Press, Jefferson City.

BOOK NOTICES

Timber Press

MARK F. LARGE and JOHN E. BRAGGINS. 2004. **Tree Ferns.** (ISBN 0-88192-630-2, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 360 pp., 131 color photos, 3 tables, 12 line drawings and 15 maps, 7 3/8" × 10 3/8".

This book is about ferns that look like trees. Tree ferns are true ferns and reproduce as other ferns by production of spores. Some of the species are beautifully displayed in the many color photographs provided in the book. The dust jacket says, "This volume is *the* source of information on the living tree ferns. It surveys all the families, genera, and species, including those that are suitable for the home garden. It offers up-to-date taxonomy and detailed descriptions as well as in-depth coverage of everything from tree fern use to conservation. In recognition of the horticultural importance of tree ferns, the authors provide extensive cultivation information, including propagation and diseases and pests."—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 761202-4060, U.S.A.*

DAVID E. ALLEN and GABRIELLE HATFIELD. 2004. **Medicinal Plants in Folk Tradition, an Ethnobotany of Britain and Ireland.** (ISBN 0-88192-638-8, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 432 pp., 31 color photos, 57 b/w illustrations and 1 map, 6" × 9".

Publisher Comments. This book provides the first comprehensive account of medicinal uses of wild plants by the country folk of Britain and Ireland. Two of Britain's foremost ethnobotanical scholars mined nearly 300 published and unpublished sources, including information gathered by the Irish Folklore Commission in more than 1000 manuscript volumes, to chronicle the fascinating uses of more than 400 plant species."

"Among the many kinds of plants recorded here are a seaweed used in Scotland against 'all maladies except the Black Death', a mushroom stewed in milk in Norfolk to soothe cancer of the throat, a fern identified in Ireland as a 'herb of the seven gilts' for its reputed ability to cure diseases, and the remarkable range of benefits attributed to nettles. Such information, in addition to being interesting in and of itself, offers a starting point for phytochemical and pharmacological investigations of plants whose utility may have been overlooked. An appendix of veterinary uses is provided Illustrations include 57 carefully chosen drawings and 31 colour photographs by Deni Bown."

THYMOPHYLLA SETIFOLIA VAR. *GREGGII* (COMPOSITAE)

John L. Strother

University Herbarium
1001 Valley Life Sciences Bldg.
University of California
Berkeley, California 94720-2465, U.S.A.
strother@uclink4.berkeley.edu

The types of the names *Thymophylla greggii* and *T. greggii* var. *radiata* have been treated as convarietal within *Dyssodia setifolia* (Lagasca) Robinson or *Thymophylla setifolia* Lagasca; (e.g., M.C. Johnston, Field & Lab. 24:67. 1956; J.L. Strother, Univ. Calif. Publ. Bot. 48:65–66. 1969; J.L. Strother, Sida 11:378. 1986).

I have used the name *Thymophylla setifolia* Lagasca var. *radiata* (A. Gray) Strother. That name is illegitimate under Article 11.6 of the International Code of Botanical Nomenclature (W. Greuter et al., 2000. Regnum Veg. 138:i–xviii, 1–474). For treatment of the variety in forthcoming *Flora of North America north of Mexico*, a new combination is required:

Thymophylla setifolia Lagasca var. **greggii** (A. Gray) Strother, comb. nov. BASIONYM: *Thymophylla greggii* A. Gray var. *greggii*, established by *Thymophylla greggii* A. Gray var. *radiata* A. Gray, Smithsonian Contr. Knowl. 3(5):119. 1852.

BOOK NOTICES

Timber Press

JENNIFER TREHANE. 2004. **Royal Horticultural Society Plant Collector Guide Blueberries, Cranberries and Other Vacciniums.** (ISBN 0-88192-615-9, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 272 pp., 66 color photos, 7" × 9".

Publisher Comments: "This book clarifies the *Vaccinium* story for any reader, whether an enthusiastic gardener or someone who is simply curious about blueberries and cranberries and would like to widen the picture and maybe even learn a little about some of the lesser known vacciniums. It will inform and inspire those who have either never grown *Vaccinium* plants before or have put just a tentative toe in the water and would now like to go in a little deeper. The book contains a wealth of information to get a reader started on growing blueberries, cranberries and even lingonberries."

LEE REICH (Illustrations by Vicki Herzfeld Arlein). 2004. **Uncommon Fruits for Every Garden.** (ISBN 0-88192-602-7, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 308 pp., 51 color photos, 29 line drawings, 1 map, 6" × 9".

Publisher Comments: "Lee Reich provides a valuable guide to fruits and berries that add an adventurous flavor to any garden. Though names like jujube, juneberry, maypop, and shipova may seem exotic at first glance, these fruits offer delectable rewards to the gardener willing to go only slightly off the beaten path at local nurseries. Reliable in the toughest garden situations, cold-hardy and pest-resistant, they are as enticing to the beginning as to the advanced gardener. This expanded sequel to the author's celebrated *Uncommon Fruits Worthy of Attention* offers new fruits, new varieties, and new photos and illustrations to entice the reader into an exciting world of garden pleasure."

SIDA 21(1): 288. 2004

TWO NEW COMBINATIONS
IN THE GENUS *PACKERA* (ASTERACEAE)

Debra K. Trock

Herbarium, Department of Plant Biology
Michigan State University
East Lansing, Michigan 48824-1312, U.S.A.

ABSTRACT

Two new varietal combinations in *Packera* (Asteraceae: Senecioneae) are made based on work completed for the *Flora of North America north of Mexico* project.

RESUMEN

Se hacen dos nuevas combinaciones varietales en *Packera* (Asteraceae: Senecioneae) en base al trabajo completado para el proyecto *Flora of North America north of Mexico.*

Packera is a relatively recent North American segregate of the much larger cosmopolitan genus *Senecio.* Áskell and Doris Löve first proposed the recognition of *Packera* as a distinct genus based on chromosome numbers and morphological trends (Löve & Löve 1975). They initially transferred eight species of arctic plants to this genus. Subsequently other authors have transferred most of the remaining taxa (Weber & Löve 1981; Jeffrey 1992; Trock & Barkley 1998; Bain 1999; Kartesz 1999).

Preparation of a treatment of *Packera* for the forthcoming *Flora of North America north of Mexico* has brought to light the need for two additional nomenclatural combinations.

Packera streptanthifolia (Greene) W.A. Weber & A.Löve var. **borealis** (Torr. & A. Gray) D.K. Trock, comb. nov. BASIONYM: *Senecio aureus* L. var. *borealis* Torr. & A. Gray, Fl. N. Amer. 2:442. 1843. *Senecio cymbalarioides* Nutt. var. *borealis* (Torr. & A. Gray) Greenm., Ann. Missouri Bot. Gard. 3:117. 1916. *Senecio streptanthifolius* Greene var. *borealis* (Torr. & A. Gray) J.F. Bain, Rhodora 90:293. 1988.

Packera subnuda (DC.) Trock & T.M. Barkley var. **moresbiensis** (J.A. Calder & R.L. Taylor) D.K. Trock, comb. nov. BASIONYM: *Senecio cymbalarioides* Nutt. subsp. *moresbiensis* J.A. Calder & Taylor, Canad. J. Bot. 43:1399. 1965. *Senecio moresbiensis* (J.A. Calder & R.L. Taylor) G.W. Douglas & G. Ruyle-Douglas, Canad. J. Bot. 56:1710. 1978. *Packera moresbiensis* (J.A. Calder & Taylor) J.F. Bain, Novon 9:457. 1999.

ACKNOWLEDGMENTS

I am grateful to Luc Brouillet and Guy Nesom for reviewing this manuscript, and to Alan Prather and Ted Barkley for providing helpful comments. I would also like to thank the curators of the following herbaria for their loan of specimens: ALA, CAN, COLO, DAO, MICH, MONT, MSC, NY, OSC, V, WTU.

REFERENCES

BAIN, J.F. 1999. New combinations in *Packera* (Asteraceae) and lectotypification of *Packera ovina*. Novon 9:457-459.

JEFFREY, C. 1992. The tribe *Senecioneae* (Compositae) in the Mascarene Islands with an annotated world check-list of the genera of the tribe. Notes on *Compositae*: VI. Kew Bull. 47:49–109.

KARTESZ, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T. and C.A. Meacham. Synthesis of the North American flora, Version 1.0, North Carolina Botanical Garden, Chapel Hill, NC.

LÖVE , Á. and D. LÖVE. 1975. Nomenclatural notes on arctic plants. Bot. Not. 128:497–523.

TROCK, D.K. and T.M. BARKLEY. 1998. Seven new nomenclatural combinations and a new name in *Packera* (Asteraceae: Senecioneae). Sida 18:385–387.

WEBER, W.A. and Á. LÖVE. 1981. New combinations in the genus *Packera* (Asteraceae). Phytologia 49:44–50.

A NEW COMBINATION IN *PERSICARIA* (POLYGONACEAE)

Craig C. Freeman

R. L. McGregor Herbarium, Division of Botany
Natural History Museum and Biodiversity Research Center
University of Kansas, 2045 Constant Avenue
Lawrence, Kansas 66047-3729, U.S.A.
ccfree@ku.edu

ABSTRACT

The following new combination in *Persicaria* is made: *Persicaria meisneriana* (Cham. & Schltdl.) M. Gómez var. *beyrichiana* (Cham. & Schltdl.) C.C. Freeman.

RESUMEN

Se hace la siguiente combinación nueva en *Persicaria*: *Persicaria meisneriana* (Cham. & Schltdl.) M. Gómez var. *beyrichiana* (Cham. & Schltdl.) C.C. Freeman.

Persicaria Mill. sect. *Echinocaulon* (Meisn.) H. Gross is represented by five species in North America north of Mexico. Park (1988) monographed the section as part of *Polygonum* L. Following evidence from morphological (Haraldson 1978; Ronse Decraene & Akeroyd 1988; Ronse Decraene et al. 2000) and molecular studies (Lamb Frye & Kron 2003), sect. *Echinocaulon* will be included in *Persicaria* Mill. in the forthcoming treatment of Polygonaceae in the Flora of North America. Consequently, the following new combination is required.

Persicaria meisneriana (Cham. & Schltdl.) M. Gómez var. **beyrichiana** (Cham. & Schltdl.) C.C. Freeman, comb. nov. Basionym: *Polygonum beyrichianum* Cham. & Schltdl., Linnaea 3:42. 1828. *Polygonum meisnerianum* Cham. & Schltdl. var. *beyrichianum* (Cham. & Schltdl.) Meisn., Fl. Bras. 5:19. 1855. *Tracaulon beyrichianum* (Cham. & Schltdl.) Small, Fl. S.E. U.S., 380, 1330. 1903. Type: n.v., see Park (1986).

ACKNOWLEDGMENTS

I thank Kanchi Gandhi for his assistance verifying the nomenclature. Jim Zarucchi, Caleb Morse, Guy Nesom, and Mihai Costea provided valuable comments.

REFERENCES

Haraldson, K. 1978. Anatomy and taxonomy in Polygonaceae subfam. Polygonoideae Meisn. emend. Jaretzky. Symb. Bot. Upsal. 22:1–93.

Lamb Frye, A.S. and K.A. Kron. 2003. *rbcL* phylogeny and character evolution in Polygonaceae. Syst. Bot. 28:326–332.

SIDA 21(1): 291 – 292. 2004

Park, C.-W. 1986. Nomenclatural typifications in *Polygonum* section *Echinocaulon* (Polygonaceae). Brittonia 38:394–406.

Park, C.-W. 1988. Taxonomy of *Polygonum* section *Echinocaulon* (Polygonaceae). Mem. New York Bot. Gard. 47:1–82.

Ronse Decraene, L.P. and J.R. Akeroyd. 1988. Generic limits in *Polygonum* and related genera (Polygonaceae) on the basis of flora characters. Bot. J. Linn. Soc. 98:321–371.

Ronse Decraene, L.P., S.-P. Hong, and E. Smets. 2000. Systematic significance of fruit morphology and anatomy in tribes Persicarieae and Polygoneae (Polygonaceae). Bot. J. Linn. Soc. 134:301–337.

AN EVALUATION OF *ANTHENANTIA* (POACEAE)

Robert Kral

Botanical Research Institute of Texas and
Vanderbilt University (VDB)
509 Pecan Street
Fort Worth, Texas, 76102-4060, U.S.A.

ABSTRACT

Anthenantia, a small Panicoid grass genus of the southeastern U.S.A. is evaluated morphologically. The two previously known taxa, *A. rufa* (Elliott) Schultes, and *A. villosa* (Michx.) Beauv., together with a proposed new species, *A. texana*, are described, compared, and illustrated, and their relationships are discussed.

RESUMEN

Se evalúa morfológicamente *Anthenantia*, un pequeño género de gramínea panicoide del sureste de Estados Unidos. Los dos taxa conocidos previamente, *A. rufa* (Elliott) Schultes, y *A. villosa* (Michx.) Beauv., junto con la nueva especie propuesta, *A. texana*, se describen, comparan, e ilustran, y se discuten sus relaciones.

Anthenantia Beauvois is treated in most recent floras (Small 1903 1933; Hitchcock 1951; Radford et al. 1968; Correll & Johnston 1970; Gould 1975; Hatch et al. 2001; Barkworth et al. 2003), as a panicoid grass genus of two species, these confined to the Coastal Plain Physiographic Province and adjacent physiography within the southeastern United States from eastern North Carolina to Florida, westward (exclusive of the Mississippi Embayment) to Arkansas and eastern Texas. The genus was named by Palisot de Beauvois (Ess. Agrost. 48, 151, pl. 10, f.7, 1812) and based upon *Phalaris villosa* Michx. (Fl. Bor. Amer. 1:43. 1803). A second species, *Aulaxanthus rufus* Elliott (Bot. S.C. & Ga. 1:103. 1821), was incorporated by Schultes (Mantiss. 2:258. 1824), thus becoming *A. rufa* (Elliott) Schultes and forming a bitypic genus. So far as southeastern U.S.A. floristics are concerned, the only supplemental descriptive information appears to have come from G.V. Nash, who noted some extra-typical *A. rufa* in populations of that species from South Carolina westward, these mentioned in J.K. Small's Flora (1903, p. 79), as "A form, *A. rufa scabra* Nash."

Lately I have had some questions on the genus, the provocation being first from trying to fit the two previously known species into my "Guide to the Flora of Alabama and Middle Tennessee" (in prep.), second from trying to understand the patterns of morphological variation over the known range of the genus. Trips to and from Fort Worth, Texas across the Gulf South in recent years, together with fieldwork over much of the southeastern U.S.A. over the past four decades and study of collections in the herbaria BRIT/SMU, DUKE, MISSA, NO,

SIDA 21(1): 293 – 310. 2004

TAES, TENN, TEX/LL, and USF have allowed me to form concepts regarding these taxa. As a result, a third taxon has been discovered.

In this study the sequence will be 1) detailed discussion of *Anthenantia* as a genus, presented in standard descriptive sequence; 2) a descriptive key, including the new species; 3) technical descriptions of the three, each followed by some discussion of habitat and distribution; 4) illustrations, the first three being figures of the species, the fourth a plate with additional morphological detail.

Anthenantia Beauv., Ess. Agrost. 48, 151, pl. 10, f. 7. 1812. TYPE SPECIES: *A. villosa* (Michx.) Beauv. [= *Phalaris villosa* Michx.].

Habit loosely caespitose, slender perennials, perennating by shallow, concavely-arching, scaly rhizomes spreading as axillary branches from older shoot bases. **Roots** fibrous, shallow; adventitious roots not observed. **Culms** wandlike, mostly 70–120 cm tall, terete, finely multicostate, smooth, leafiest at and toward base. **Leaves** lowermost transitional to rhizomal scales, almost entirely multicostate, firm, scale, just upculm transitional to short, then longer, bladed members, then to uppermost ones, most distant and with long, tubular-conduplicate sheaths and short, erect blades; lower (basal) sheaths often open, either angled- or rounded-concave; upper sheaths progressively more rounded-conduplicate, tubular: leaf blades linear or lance-linear to linear-spathulate or linear-gladiate, flat to strongly involute or flattened-conduplicate, the margins variously hirsute or pilose-ciliate, scabro-ciliate, scaberulous, or entire, the apices mostly asymmetrically broadly acute, scabro-serrulate, often with midrib exsert as a mucronula; surfaces strongly multicostate, abaxially smooth, adaxially with strongest costae, these and their intervals smooth to variously scaberulous or papillate, sometimes with rounded microhairs, and in one species with erect, pilose intercostal hairs to 2 mm. Ligule present as a narrow, transverse, purplish or brownish, often sinuous zone, this elevated as a low, erect to antrorse ridge or scale crested with minute to elongate papillae, ciliae, tubercles or scales, or erose. Note! Measures and character of ligules are taken from lower culm leaves; ligules of median and upper leaves can sometimes have longer hairs or scales than given here! **Inflorescence** paniculate, the upper scape a slender, naked peduncle above the short, erect blade of the elongate-sheathed upper leaf, mostly narrowly oblong to elliptic, lanceolate or ovate in outline, compact or loose, mostly 10–20 cm, the lowest nodes with primary branches whorled and usually longest, the internodes progressively closer, with progressively shorter primary branches, ultimate branching and rebranching sinuous, bending upward, terminating in cupuliform receptacles. **Spikelets** erect on cuplike receptacle, at maturity broadly obovoid or ellipsoid, slightly compressed dorsiventrally, 3–4 mm long, exposed surfaces greenish and/or reddish, and at maturity densely cloaked with narrow, longitudinal bands of reddish, pinkish or pale, sharp, straight trichomes 1–2 mm long, lending a fuzzy look to the whole inflorescence; first glume lacking; second glume and lower lemma broadly obovate, obovate or elliptic, cupuliform, slightly longer than all other spikelet parts, abruptly acuminate, 5-nerved with broad, hyaline, entire borders, the opposing lemma slightly narrower, less convex, both with strong bands of trichomes alternating with the median nerves, but the outermost (lateral) nerves narrowest, surmounted by waxy-papillose zones with protruding trichomes, the second glume with its thin border lapping over the edges of the opposing lemma. Lower (first) lemma and its palea sterile or male, rarely with a bisexual floret, the palea hyaline, oblong- oblong-ovate or oblong, mostly apically two-toothed, shallowly two-keeled, two-nerved, or nerves lacking, entire 'with broad involute borders. Second lemma and its palea enclosing a perfect flower, cartilaginous, narrowly ovoid or lance-ovoid, plano-convex, at maturity brown to deep red-brown or appearing nearly black, with hyaline borders broadening toward scale apex, those of lemma finely ciliate, both with acuminate, incurved, crisped-bordered tips, at anthesis looking like a slightly opened bird's beak, the lemma back strongly rounded proximally, the palea slightly rounded apically, medially and distally two-nerved, shallowly two-keeled, plane or slightly concave between the nerves. **Florets** those of the lowest (first) lemma either male or sterile; those of the upper (second) lemma bisexual. Perianth of two, asymmetrically flabellate, bilobed lodicules. Stamens 3, anthers oblong-linear to elliptic-linear, extrorse, 1.5–2.5 mm long, the very accrescent filaments attaching to anther adaxially at a very short connective, shoving the anthers out of the floret apex as they reach lengths of 4 mm or more. Ovary at anthesis with uneven dorsiventral symmetry, looking much like an ovoid-bodied, small-headed insect, the arched abaxial and convex side with two short, broad, lateral grooves, the more level, adaxial side with a broad, shallow, concave surface, the small "head" with two lateral, narrowly subulate-terete branches, these bent outward, proximally, then upward, narrowing distally, ca. 2.5 mm long, each abruptly thickening to become the axis of a dark, dense stigmatic "brush" ca. 2.5 mm, these shoved out laterally as the floret opens. **Caryopses** broadly and tumidly obovoid, 1–1.8 mm long, yellow-brown, the bulbous apex apiculate, the oblique base dorsiventrally narrowed and oblique, the hilum an oblong depression on the palea side, the embryo under a large, rimmed disc on the lemma side.

Distribution.—Three species in North America, Atlantic and Gulf Coastal Plain and contiguous physiography exclusive of the Mississippi Embayment, North Carolina south to peninsular Florida, west to southern Arkansas and eastern Texas.

Phenology.—Typically flowering from mid-July through October.

KEY TO THE SPECIES

1. Adaxial surface of leaf blade with erect or variously directed, strumose pilosity, these hairs arising from intercostal sulcae; principal leaves with blades shallowly auricled, slightly bent outward from sheath; longer primary panicle branches 1/3–1/2 as long as whole panicle, these usually naked-based and widely ascending (to 45° or slightly more) giving panicle an ovate or broadly elliptic outline; glume and lower (outer) lemma surfaces often with longitudinal broad, reddish bands; spikelet trichomes commonly reddish, or pale with red or pink tips; ligule base reddish, its edge ascending-ciliate, the pale hairs to 1(–1.5) mm ______ **1. A. texana**
1. Adaxial surface of leaf blade lacking trichomes of any sort (save for occasional papillae or microhairs), sometimes scabrid; principal leaves with blades either strongly auricled and bent outward from their sheathes, or lacking auricles and erect to gradually bowed outward with no geniculation; longer primary branches of panicle either less than 1/3 panicle length or branching near base, seldom (save in a few extremes of no. 3) widely ascending, and generally with a narrower outline and a denser look; glume and lower lemma with or lacking red pigmented longitudinal bands; ligule base with edge ranging from papillate-tuberculate to variously ciliolate or ciliate or with a line of narrowly triangular scales.
   2. Principal (lower) leaves strongly auriculate at junction of blade and sheath, thus blades of lower culm leaves "breaking" away from sheaths at narrow to wide angles, these same ciliate at least proximally, with spreading to ascending strumose-hirsute cilia; pigmentation of leaves, spikelets and their trichomes usually with little or any red; fertile lemma and palea lustrous brown; anthers at anthesis brown; ligule rim of lower principal leaves minutely erose or lacerate-ciliolate or with a line of irregular, flat-based cilia mostly under 1 mm ______ **2. A. villosa**
   2. Principal (lower, bladed) leaves weakly, if at all, auriculate at junction of blade and sheath, thus this zone, if viewed from side, usually showing but a slight projection and a few pilose hairs, sometimes ascending-pilose-ciliate at blade base, or lacking hairs entirely; blades not perceptibly "breaking" away (geniculate) but flowing into their sheaths., suberect or slightly excurved; pigmentation of leaves, spikelets and their trichomes variously reddish or purplish, thus the foliage, scapes and spikelets darker; fertile lemma and palea similarly lustrous but a darker, red-brown to near black; anthers at anthesis dark brown; ligule rim of lower principal leaves nearly perpendicular, its edge commonly papillose- tubercular, minutely ciliolate, finely erose, or with a line of short narrowly-triangular-based pale cilia ______ **3. A. rufa**

1. Anthenantia texana R. Kral, sp. nov. (**Figs. 1, 4**). U.S.A. TEXAS. HOUSTON CO.: 2.5 mi W of Kennard city limit by TX Hwy 7, in Sam Houston National Forest; sandy clay loam of clearings in and edges of pine (*Pinus taeda, P. echinata*) and hardwood flats, 30 Sep 2002, *R. Kral 92270* (HOLOTYPE: VDB; ISOTYPES: AUA, BM, BAYLU, CLEMS, DOV, DUKE, FLAS, FSU, GH, ILLS, JSU, K, KANU, M, MICH, MO, MU, NCSC, NLU, OSC, P, TEX, U, UAM, UNA, USCH, US, VPI, VSC, WILLI).

Planta perennis, gracilis. laxe caespitose, squami-rhizomatosa, (40–)50–100(–120) cm alta. Folia principalia vulgo suberecta vel leviter excurvata, 15–50 cm longa, leviter auriculata, leviter geniculata, ad basim culmorum approximate, sursum remota; ligula albociliata, ciliis (0.5–)1(–1.5) mm longis; laminae foliorm adaxialiter strumoso-pilosae, pilis erectes vel ascendentibus, ad 2 mm longis. Squamae exteriores spicularum alterne longitudine rubrae et virides. Lemma et palea secunda coriacea, atrocastanea. Antherae maturae atroferrugineae, ca. 2 mm longae.

Perennial (45–)60–100(–120 cm high, loosely caespitose, the shoot bases connected by short (–7 cm) concavely arching, shallow scaly rhizomes 2–4 mm thick. Culms slender, wand-like, leafiest at and toward base, the lowermost leaves mere ribbed yellowish scales 5–15 mm, soon grading to bladed members. Principal leaves (15–)20–40(–60) cm, ascending, the longest with blades several times longer than their open but somewhat "V"-shaped or rounded sheaths., grading to the uppermost, this with its erect blade much shorter than its convolute-tubular slender sheath; sheath summit with two low but evident, usually cartilaginous, pilose-edged auricles, the transverse narrow, usually purple, ligular scale projecting forward at an angle, its edge a band of pale ciliae (5–)1(–1.5 mm; blade lance-linear to linear, mostly 4–7(–10) mm wide, base thickened at rounded auricle area, there often ascending-pilose, here breaking from the sheath, distally narrowing, often flattened or "v"-troughed to plane or variably deeply concave or almost conduplicate, abruptly narrowed to a broadly and obliquely angled apiculate tip, abaxial surfaces of sheath pale to green tinged with red, those of blades mostly deep green; adaxial surface of blades pilose with pale, erect or ascending, pustular-based trichomes to 2 mm arising from deep intercostal sulcae. Panicle outline ovate to elliptic or broadly lanceolate, 7–15(–20) cm, the lowest group most distant, the primary branches ascending, sometimes to 45° or slightly more, the longest of a whorl also naked-based and mostly 1/3–1/2 or more the total length of the panicle, the whole with secondary branching progressively more and shorter toward branch ends, giving the wide panicle base a much more open look. Spikelets turgidly obovoid or ellipsoid, 3–4 mm, at flowering time with longitudinal smooth zones of second glume and outer palea reddish alternating with green, the alternating rows of pustular-based trichomes red to pale pink or purple. First palea hyaline, 2-keeled, bifid, hairless, slightly shorter than the opposing lemma, tristaminate or stamens lacking. Second lemma and palea about equaling subtending second glume, a deep, lustrous red-brown or near black, the hyaline margins gradually widening, ciliolate, to a crisped, ciliate apical border; flower usually perfect simply pistillate. Caryopses 1.5–1.8 mm long.

Distribution.—Sands, sandy clay loam, sandy peat or silts of pine flatwoods, pine-oak barrens, bog edges, ditchbanks, clearings, Gulf Coastal Plain and contiguous physiography west of the Mississippi delta, southern Arkansas, Louisiana and eastern Texas.

Phenology.—Flowering mid-July through October.

PARATYPES. **U.S.A. LOUISIANA: Beauregard Parish:** by US 171, 2.8 mi N of Ragley & jct. US 190E (with *A. villosa*) 14 Oct 2001, *R. Kral* 91997 (TROY, VDB, VSC); ca. 17 mi W of DeRidder by US 190, 30 Sep 2002, *R. Kral* 93287 (BM, BAYLU, CONN, CTB, EKY, FSU, GH, JSU, KANU, KNK, MICH, MISSA, MO, MSC, MU, NCSC, NY, OSH, PH, RM, TENN, U, UNA, USCH,US, VDB, VPI, VSC, WAT, WILLI.

Specimens examined (cited by county, collector and collector's number): **ARKANSAS: Bradley Co.:** *Sundell & McIntyre 2788* (VDB). **Calhoun Co.:** *Sundell, Amason & Etheridge* 7876 (BRIT); *Orzell*

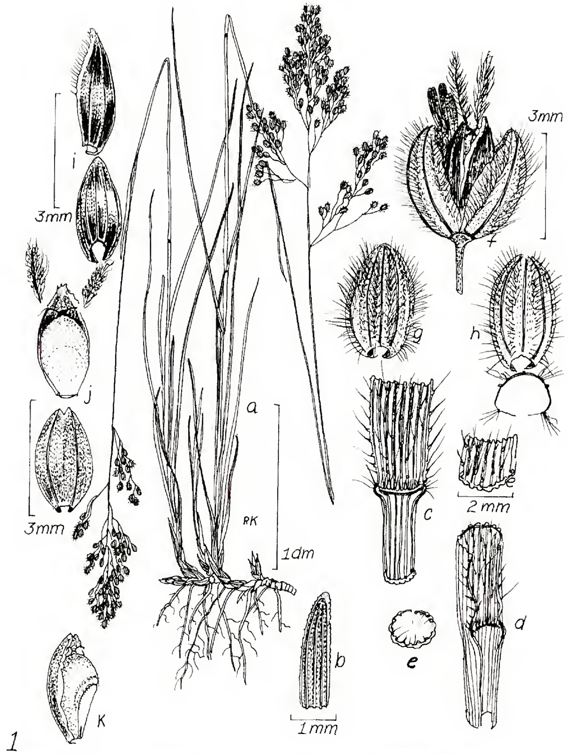


Fig. 1. *Anthenantia texana* (from the type, *Kral 92270)*. **A.** Habit sketch. **B.** Leaf apex. **C.** Leaf sheath/blade junction, adaxial side (left), sector of leaf blade, adaxial side (right). **D.** Leaf sheath/blade junction, oblique view. **E.** Idealized cross- section of involute leaf blade. **F.** Spikelet at anthesis. **G.** Abaxial side of glume. **H.** Abaxial side of first (lower) lemma (above); idealized cross section of same (below). **J.** Fruit, approaching maturity, two abcissed stigma brushes (above); abaxial side of fertile (upper) palea (below). **K.** Side view of fruit.

& Bridges 3058 (SMU). **Ouachita Co.:** *Thomas & Doffitt 171881 & 669* (BRIT, NLU). **LOUISIANA: Allen Parish:** *Shinners 22102* (SMU). **Beauregard Parish:** *Shinners 21554* (NCSC, SMU). **Grant Parish:** *Thomas, Barrett, Jones 1105* (VDB); *Thomas et al. 12231, 12565* (VDB). **Jefferson Davis Parish:** *Shinners 21469* (SMU). **Natchitoches Parish:** *B.R. & H.M. MacRoberts 1202, 1550, MacRoberts 1198* (VDB); *Thomas et al. 171,947* (BRIT). **Winn Parish:** *Shinners 21940* (SMU). **TEXAS: Angelina Co.:** 13 Oct 1979, *Fritz s.n.* (SMU). **Aransas Co.:** *Blakey 45140* (TEX). **Austin Co.:** 15 Oct 1939, *Tharp s.n.* (TEX). **Calhoun Co.:** 1 Dec 1928, *Tharp, s.n.* (TAES, TEX). **Freestone Co.:** *Kral 154* (SMU). **Hardin Co.:** *Gould 11030* (SMU, VDB); *Parks and Cory 19901* (TAES). **Harris Co.:** *Fisher 10178*. **Houston Co.:** *Kral 93270* (VDB-Type!). **Jackson Co.:** *Silveus 371* (BRIT, TEX). **Jasper Co.:** *Correll 38165* (SMU); *Silveus 840* (TEX) **Liberty Co.:** *Gould 5419* (SMU, TAES). **Newton Co.:** *Mahler 5199 with Weaver* (SMU). **Nueces Co.:** *Tharp 7918* (TEX). **Robertson Co.:** *Lonard 2460 et al.* (SMU); 2 Oct 1948, *Parks s.n.* (TAES); *Trew, Jr. 97* (TAES). **Tyler Co.:** *Brown 3425* (TEX); *Cory 49972* (SMU).

This species has in the past been identified as *A. villosa*, particularly the broader and more distinctively auriculate-leaved, paler-haired examples (i.e. Texas specimens, Calhoun Co., 1 Dec 1928, B.C. Tharp [TEX]; Nueces Co., 25 Oct 1931, B.C. Tharp [TEX]). Many, because of their darker green or reddish pigmentation of foliage, darker spikelet pubescence, narrow, more erect leaves, have been identified as *A. rufa* (a large majority of east Texas examples, all Arkansas examples, most examples from western Louisiana. The "*villosa*" morphs of the species from southeast Texas may suggest a genetic influence of that species, since *A. villosa* is the only other Texas native, it and *A. texana* often mingling where ecotones are obliterated by disturbance. But, in such instances, the two appear to retain most, if not all, distinguishing features. In Beauregard Parish, western Louisiana, both west and east of DeRidder, I observed many hundreds of the two in recently logged areas of pine savanna. In each site *A. villosa* (*Kral 91997B, 93286*) occupied sandier small rises but often would be within a few feet of clumps of *A. texana Kral 91997A, 93287*), which would be on slightly moister substrate. In those sites I had no trouble distinguishing the two, the former with broader leaf blades distinctly "breaking" away and with paler spikelets in narrower, denser inflorescences, the latter with narrower, geniculate, but less evidently so, and with darker spikelets in broader, more diffuse inflorescences. I plan further fieldwork in western Louisiana so as to see if there are examples there of mixed populations of *A. texana* and *A. rufa* and will prepare a report on that situation. Should there be such mixtures, from what information I have so far, all the *A. rufa* would be predicted to be forma *scabra*, while *A. texana* should show no scabrosity and a consistently geniculate leaf blade, together with a longer ligule. So, while there are distinct overlaps in regard to given characters for the three taxa, the pale, intercostal pilosity of strumose-based hairs is unique to *A. texana*.

2. Anthenantia villosa (Michx.) Beauv., Ess. Agrost. 48, 151, t. 10, f. 7. 1812. (**Figs. 2, 4**). BASIONYM: *Phalaris villosa* Michx., Fl. Bor. Amer. 1:43. 1803. TYPE: U.S.A. "In sabulosis Carolinae," *Michx. s.n.* (HOLOTYPE: P!).

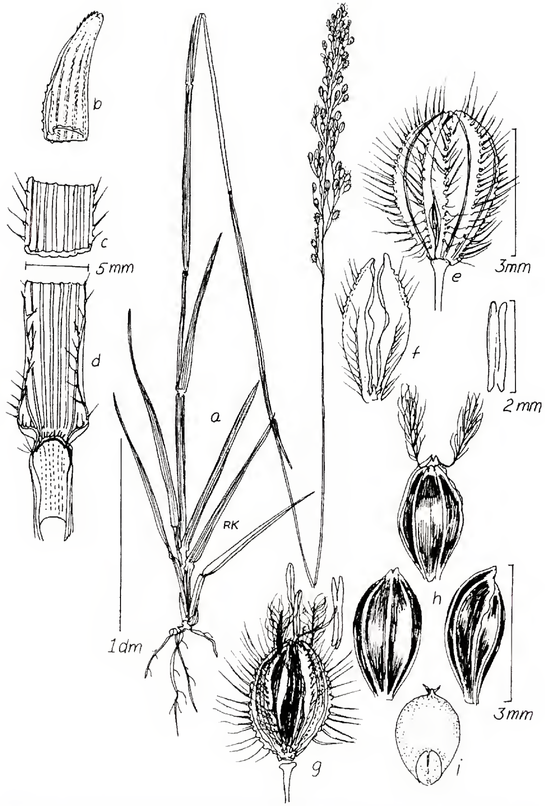


Fig. 2. *Anthenantia villosa* (Michx.) Beauv. (from *Kral 90571*). **A.** Habit sketch. **B.** Leaf apex, side view. **C.** Sector of lower leaf blade, adaxial viewed. Adaxial view of leaf/sheath junction. **E.** Side view of spikelet. **F.** An anomalous "extra" floret (left); anther (right). **G.** Spikelet at anthesis. **H.** Three views of fertile (upper) floret, abaxial (palea side) view, stigma brushes protruding (above), abaxial view (below, left); side view (below, right). **I.** Mature caryopsis (Hilum side).

Aulaxanthus ciliatus Elliott, Sketch Bot. S. Carolina 1:102. 1816. *Aulaxia ciliata* (Elliott) Nutt., Gen. Pl. 1:47. 1818. TYPE: "in dry pine barrens, flowers September – October," (HOLOTYPE: CHARL "BY-3965"!).

Elliott suggested the possibility that his *A. ciliatus* might be the same as *Phalaris villosus* Michx., noting "*Phalaris villosa*? Mich. 1. p. 43." To be sure of Elliott's concepts, I visited the Charleston Museum in December 2003 to examine the type material. Thanks to the consideration of Albert Sanders, curator of the Elliott Herbarium, I was quickly shown the Elliott types of *Aulaxanthus ciliatus* and *Aulaxanthus rufus*, both mounted on a single sheet and in good shape. The right hand specimen is a small but readily identifiable specimen (CHARL "BY-3965") of *Anthenantia villosa*, marked by Weatherby as the type of *Aulaxanthus ciliatus* Elliott by Weatherby in 1941. To be absolutely sure of the identity of Michaux's *Phalaris villosa*, At my request, Barney Lipscomb (BRIT) made photocopies of my plates of *A. villosa* and *A. rufa* and sent them unlabelled to Porter Lowry (P). The Michaux type clearly matched my unlabelled plate of *Anthenantia villosa*.

Panicum erianthum Poir., Encycl. Sup. 4:284. 1816.

Panicum hirticalycinum Bosc. ex Roemer & Schultes, Syst. Veg. 2:468. 1817.

Perennial (50–)60–130 cm high, loosely caespitose, perennating by short, scaly rhizomes from older shoot bases, Culms slender, wand-like, leafiest at or toward base. Lowest leaves imbricate, yellowish, multicostate scales, grading to long-bladed principal leaves 15–40 cm, the sheaths rounded-conduplicate, opening distally, there with a narrow, wavy-transverse ligule, each edge terminating at a prominent thickened auricle., there with a tuft of pilose hairs, the ligule base ascending at a wide angle from the leaf surface, or even an erect, low wall of tissue, its edge variously short-ciliate (mostly not over 0.5 mm), or irregularly papillate-erose or with short, narrowly triangular squamellae; blades mostly lance-linear, lower ones distinctly breaking away from sheaths at various angles sometimes nearly 90°, 4–9(–15) mm wide, plane or inrolled, margins strumose-hirsute-ciliate, often also strongly papillose at least proximally, apex flat, triquetrous to rounded-conduplicate, or compressed-conduplicate, usually obliquely acute, scabro-ciliolate. Upper culm exserted 1–2 dm above the-erect, short-linear upper leaf blade as a slender peduncle terminating at a mostly narrowly elliptic to cylindric or lanceoloid panicle, this (5–)10–20(–25) cm, the whorls of primary branches ascending to erect, mostly closely rebranching to produce a generally dense, rarely interrupted inflorescence of yellowish to silvery-green spikelets. Spikelets obovoid to ellipsoid, 3–4 mm long, the rows of pustular-based trichomes typically silvery or pale, the outer scales with mostly green or pale green surfaces, the hyaline first palea slightly shorter than its lemma, often with a line of ascending clear trichomes lateral to each keel, the floret either sterile or staminate; second lemma and palea coriaceous with distal edges hyaline-ciliate, surface brown to dark brown, this floret typically perfect. Anthers at maturity narrowly oblong-linear, ca. 2.5 mm, yellowish-brown. Fruit ca. 2 mm long, yellow-brown.

Distribution.—Sands, sandy clay, sandy loams, moist to rather dry sites, mainly pinelands, particularly the longleaf pine-turkey oak system, oak-pine barrens and flatwoods, upper edges of bogs, ditchbanks, sandy clearings, Atlantic and Gulf Coastal Plain and contiguous physiography from North Carolina south to South Florida and west, except for the Mississippi Embayment, into eastern Texas.

Phenology.—Flowering mid-July through October (or November in southern range).

Specimens examined: **ALABAMA. Autauga Co.:** *Kral 33566* (VDB); *Harper 4464* (UNA, VDB); *McDaniel 7002* (MISSA, VDB). **Baldwin Co.:** *Kral 29795* (VDB); *Kral 29847* (SMU, VDB); *Pennell 4551* (DUKE); *Shinners 28901* (SMU); *Tracy 8025* (TAES). **Barbour Co.:** *Kral 28004* (SMU, VDB) **Bibb Co.:** *Kral 52265 & 69548* **Choctaw Co.:** *Kral 67840*. **Conecuh Co.:** *Kral 40972* (BRIT, VDB). **Covington Co.:** *Kral 33668, 38107, 36804, 33688, 44692* (VDB). **Crenshaw Co.:** *Kral 21993, 33722* (VDB). **Escambia Co.:** *Kral 32477, 33873* (VDB). **Geneva Co.:** *MacDonald 12225* (VDB). **Houston Co.:** *MacDonald 3030* (VDB) **Mobile Co.:** *Kral 29701* (VDB), *29717* (SMU, VDB); *Silveus 1021* (BRIT, TEX). **Monroe Co.:** *Kral 69707, 85370* (VDB). **Russell Co.:** *Kral 44210* (VDB). **Washington Co.:** *Kral 37263* (VDB); *McDaniel 9913* (VDB). **FLORIDA. Calhoun Co.:** *Godfrey 55581* (FSU, NCU, VDB), *Godfrey & Kral 54160* (DUKE). **Duval Co.:** *Curtiss 6258* (NCU). **Escambia Co.:** *Silveus 5622* (TEX). **Franklin Co.:** *Godfrey* (FSU, VDB). **Gadsden Co.:** *Godfrey 53585* (DUKE, FSU). **Hernando Co.:** *Ray 9484* (FSU, USF, VDB). **Hillsboro Co.:** *Lakela 23376* (USF), *25374* (SMU, USF, VDB). **Jackson Go.:** *Godfrey 54264* (FSU), *54383* (DUKE, FSU, USF, VDB); *Tacy 3850* (TAES). **Leon Co.:** *Clewell 793* (VDB), *Godfrey 56111* (FSU, USF, VDB); *Kral 1789* (FSU, SMU, NCSG). *Reese 640* (NCU) **Levy Co.:** *Kral 15269* (VDB). **Liberty Co.:** *Thorne & Davidson 16834*, possible hybrid! (FSU). **Madison Co.:** *Kral 6178* (FSU, VDB). **Okaloosa Co.:** *Godfrey 57669* (FSU); 27 Sep 1950, *West s.n.* **Santa Rosa Co.:** *Ford 5375* (NCU), *Godfrey & Houk 62551* (SMU, VDB). **Wakulla Co.:** *Kurz 169* (FSU). **Walton Co.:** *Godfrey 57630* (FSU); *Tyson 358* (USF). **Washington Co.:** *Godfrey 55238* (FSU, NCSC). **GEORGIA. Baker Co.:** *Thorne 6416* (Emory U.). **Bryan Co.:** *Eyles 6814* (Emory U.) **Charlton Co.:** *Kral 64651* (VDB); *Jones 7290 with Carter* (VDB, VSC). **Early Co.:** *Kral 90344* (VDB); *Thorne 6628 (Emory U.)*. **Emanuel Co.:** *Kral 85477* (VDB); *Wilbur 2910* (FSU, NCSC, SMU) **Taylor Co.:** *D.S. & H. Correll 8401* (DUKE); *Kral 85477* (VDB) **Ware Co.:** *Silveus 5370A* (TEX). **LOUISIANA. Beauregard Parish:** *Shinners 22218* (NCSC, SMU, TEX), *Kral 91997B* (VDB); *Kral 92286* (VDB). **Grant Parish:** *Thomas et al. 3062* (VDB), *12565* (BRIT). **LaSalle Parish:** *Laird 1069* (BRIT). **Natchitoches Parish:** *Kral 16207* (VDB). **Rapides Parish:** *Duncan 56031* (SMU, TAES, TEX), and *56041* (SMU, TAES). **St. Tammany Parish:** *Bro. Arsene et al. 11251* (SMU). **Vernon Parish:** *Thomas & DePoe 273* (VDB), *Kral 93319* (VDB). **Washington Parish:** *Allen 8684* (VDB) **MISSISSIPPI. Forrest Co.:** *K.E. & L. Rogers 42011* (SMU); *Weddle s.n.* 9/10/40 (MISSA). **Greene Co.:** *Rogers 1747-A* (SMU **Harrison Co.:** *Tracy 3848* (NCU, TAES). **Jackson Co.:** *A.B & A.C Seymour 178* (DUKE, NCU); 3 Aug 1889, *Earle s.n.* (DUKE); *Weaver & Rushing 0186* (VDB). **Jones Co.:** *Morgan 1439* (VDB). **Lauderdale Co.:** *McDaniel & Clarke 14601* (VDB). **Pearl River Co.:** *Jones & Sargent 13694* (VDB), *8432* (SMU); *Reed 53* (FSU). **Stone Co.:** *Shinners 28826* (SMU). **NORTH CAROLINA. Bladen Co.:** *Blomquist 13622* (DUKE) **Brunswick Co.:** *Blomquist 439* (FSU, NCSC). **Cumberland Co.:** *Carter 2974* (VDB); *Ahles & Leisner 33466* (NCU) **Columbus Co.:** *Blomquist 14785* (DUKE). **Duplin Co.:** *Ahles 33183 with Leisner* (NCU, VDB). **Harnett Co.:** *Godfrey 5685* (DUKE); *Radford 8758* (NCU). **Hoke Co.:** *Kral et al. 82990* (VDB); *Ahles 36383* (NCU). **Johnston Co.:** *Radford 29292* (NCU, SMU). **Moore Co.:** 10 Apr 1931, *Blomquist s.n.* (DUKE) **Richmond Co.:** *Correll 7139* (DUKE); *Radford 19232* (NCU). **Scotland Co.:** *Ahles with Leisner 32863* (NCU). **SOUTH CAROLINA. Allendale Co.:** *Ahles with Bell 18423* (NCU). **Bamberg Co.:** *Ahles 37657* (NCU) **Barnwell Co.:** *Batson, s.n.* 27 Oct 1953 (NCU, USCH) **Calhoun Co.:** *Ahles 35363* (NCU, VDB). **Chesterfield Co.:** *Godfrey 8086* (DUKE); *Radford 18646* (NCU). **Colleton Co.:** *Ahles with Bell 15431* (DUKE. NCU). **Darlington Co.:** 22 Aug 1908, *Coker s.n.* (NCU). **Edgefield Co.:** *Radford 30195* (NCU) **Georgetown Co.:** *Godfrey 8109* (DUKE). **Kershaw Co.:** *Radford 29984* (NCU). **Lee Co.:** *Radford 29340* (NCU). **Lexington Co.:** *Radford 29856* (NCU). **Marion Co.:** *Bell 11012* (NCU). **Orangeburg Co.:** *Ahles 35131* (NCU) **Richland Co.:** *Godfrey 50758* (DUKE, NCSC). **Sumter Co.:** *Freeman 57880* (NCU). **TEXAS. Hardin Co.:** *Parks & Cory 11145, 19900, 19902, 19903* (TAES). **Jasper Co.:** *Correll 38164* (SMU); 22 Aug 1941, *Tharp s.n.* (TAES). **Newton Co.:** 16 Sep 1947, *Lay s.n.* (TEX); *Cory 49807* (SMU).

I have not yet seen the three *Anthenantia* in one place, although this might be possible in western Louisiana or even eastern Texas. But were such to happen, *A. villosa* would be distinguishable at a glance. It is the most robust of the three, has the least rusty pigmentation in leaf and culm (save sometimes for pinkish internodes and spikelet hairs), has generally paler vesture, the plants therefore giving the overall effect of pale green. The lower culm leaves are more visibly auriculate and tend to spread more, and the blade margins are more coarsely and conspicuously strumose-hirsute-ciliate. Pigmentation of anthers and of the coriaceous lemma and palea is paler. The hyaline palea of the lower (first) floret is unique, since it usually has rows of ascending, long, stiff, pale trichomes parallelling and external to each of the two keels (see fig. 4). On the other hand, in character of culm, in pigmentation, character and orientation of leaves and in character, shape, and indumentum of inflorescence, it is easy to see why the other two have traveled under the same epithet for such a long time. This will be discussed under *A. rufa*.

Anthenantia villosa occupies the driest habitats of the three. It extends further up sides of sandhills, is in higher zones within ecotones between uplands and low, and is in the higher spots in flatwoods and savannas. It is the most frequent associate of *Aristida stricta* in Longleaf pine sandhills. Future studies probably will show that there is genetic exchange between it and *A. rufa* and *A. texana*, particularly where ecotones have been broadened through disturbance.

3. Anthenantia rufa (Elliott) Schultes, Mant. 2:258. 1824. (**Figs. 3, 4**). BASIONYM: *Aulaxanthus rufus* Elliott, Sketch bot. S. Carolina 1:103. 1816. *Aulaxia rufa* (Elliott) Nutt., Gen. Pl. 1:47. 1818. *Panicum rufum* (Elliott) Kunth, Revis. Gramin. 1:35. *Monachne rufa* (Elliott) Bertolini, Mem. Reale Accad. Sci. Inst. Bologna 2:596, t. 41, f. 1. 1850. TYPE: [SOUTH CAROLINA] "in savannas, and damp soils in the pine barrens, midway between Saltcatcher bridge and Murphy's on the Edisto," *Elliott 523* (number assigned by Muhlenberg) (HOLOTYPE: CHARL!).

Leptocoryphium drummondii Müll. Berol., Bot. Zeitung (Berlin) 19:314. 1861. TYPE: U.S.A. LOUISIANA: [1831–1832?] *T. Drummond.*

Perennial (50–)60–125 cm high, loosely caespitose, perennating by short, scaly rhizomes from older shoot bases. Culms slender, wand-like, leafiest at or toward base. Lowest leaves mere scales, transitional to principal leaves 12–60 cm, with blades much longer than sheath; sheaths often red-brown or purple tinged, variously folded conduplicately, narrowing gradually to similarly folded blade, the connecting auricle minute or not evident save as a few pilose spreading hairs at ligule ends or even these lacking; ligule wavy-transverse, usually a narrow, erect ridge 0.2–0.4 mm high, typically purplish, its upper edge papillate, minutely lacerate, rarely ciliolate with cilia at most 0.5 mm (uppermost leaves

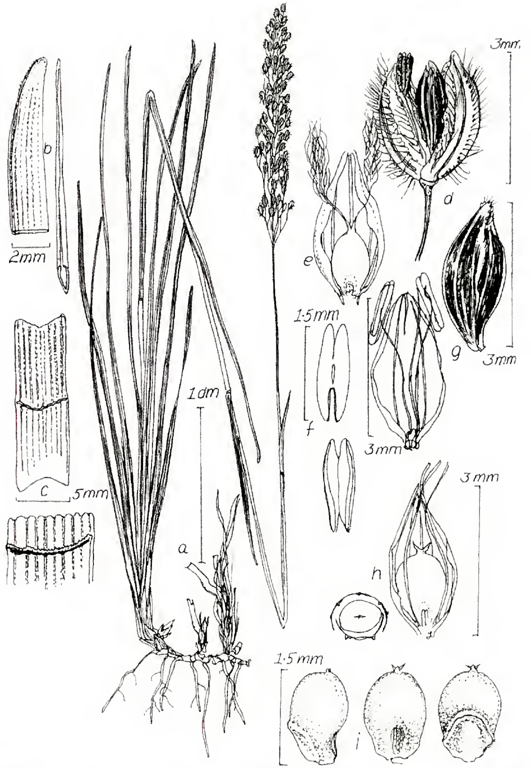
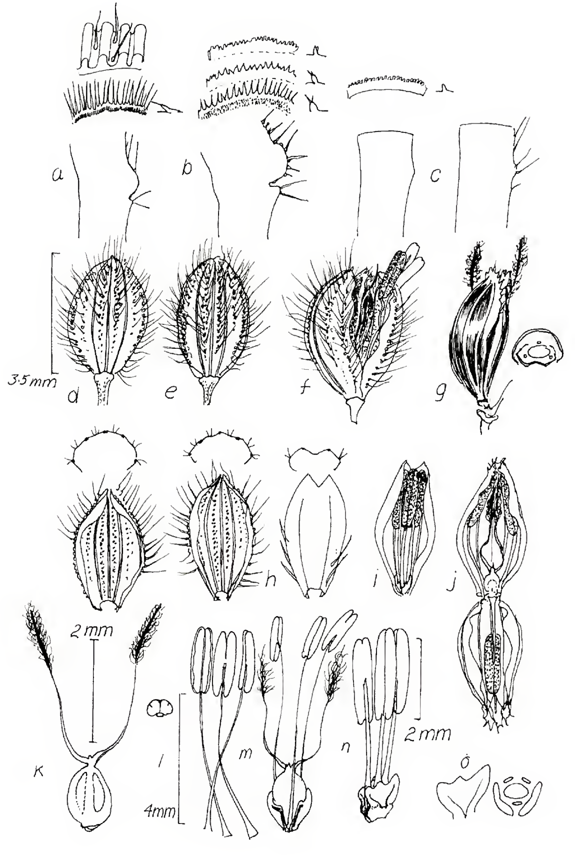


Fig. 3. *Anthenantia rufa* (Ell.) Schult. (from *Kral 90519*). **A.** Habit sketch. **B.** leaf apex, side view (left), adaxial edge (right). **C.** Leaf blade/sheath junction, lower leaf, adaxial view (above); leaf blade/ sheath junction, adaxial view, ligule. **D.** Spikelet at anthesis. **E.** "Cleared" fertile lemma with young developing fruit. **F.** Adaxial view of anther. **G.** Adaxial view of first (lower) palea at anthesis (below left); side view of upper (second) lemma and palea (above right). **H.** Perfect floret, with ripening fruit (right); idealized cross-section of perfect floret, including lemma (left). **I.** Three views of ripe fruit, side view (left), hilum side (middle), embryo side (right).

often with distinctly longer cilia!); blades mostly erect to ascending-excurved, continuous with sheath apex, not at all geniculate, linear to linear-gladiate or linear-spathulate, (3–)4–8(–10) mm wide, flat to rounded-involute or variously folded-conduplicate, margins entire,- or sparsely pilose-ciliate proximally, or scabrid, the surfaces pale to deep green, or purple-tinged, smooth to papillate or scaberulous on the costae, apex mostly conduplicately sharply folded, or open at a wide angle, obliquely broadly acute, apiculate. Panicles ovoid to lanceoloid, ellipsoid, or cylindric, (8–)10–20(–25) cm, branching mostly strongly ascending to nearly erect, the lowest whorl often with some primary branches 1/3 the total panicle length or more, but mostly floriferous to near base, thus the inflorescence mostly dense. Spikelets mostly broadly ellipsoid to obovoid, 3–4 mm, with exposed outer surfaces alternating with longitudinal bands of green and red, the bands of trichomes reddish to deep purple, rarely pinkish, very rarely pale. Lower floret usually staminate, often sterile, sometimes perfect; upper floret with coriaceous lemma and palea deep red-brown or castaneous, appearing nearly black, the hyaline borders broadening distally, there ciliate, often crisped and finely ciliate apically, their flower usually perfect. Anthers at anthesis narrowly oblong, ca. 2–2.5 mm, deep purple-brown, appearing black. Ripe caryopses 1.5–2 mm, yellowish-brown.

Distribution.—Sands, sandy peats, silts and sandy clay of pine flatwoods and bogs, edges of bogs, acidic seeps and seep slopes, and pine savanna, Coastal Plain and contiguous geology, North Carolina south to peninsular Florida, west into Louisiana, possibly eastern Texas.

Specimens examined.—Note! In Small's *Flora of the Southeastern United States* (1903, p. 97) appears the citation., under *Anthenantia rufa* "A form, *A. rufa scabra* Nash, differing from the above in having the sheaths and blades scabrous, occurs in similar situations in South Carolina, but mainly from Alabama to Louisiana. Fall." This information appears in some present-day reference sources, but inconsistently, sometimes the taxon being given as a variety, in other instances as a "form" (as per Small). Since Nash and Small were colleagues at the New York Botanical Garden, and since Small passed along the characteristics in 1903 for what he referred to as a form, it must be assumed that the name received no further published attention. I have been unable to find any actual formal presentation. and Small appears to have let the matter lapse as of 1903; certainly it did not carry forward to his 1933 "Manual." Whatever the case, Nash should be credited for his observations. It is true that there are populations of scabrid *A. rufa* from the Carolinas west to Louisiana, and there are associated characters such as the presence (usually) of a tuft of pilose hairs at a small triangular projection where ligule meets margin, this often accompanied by a short line of slender pilose cilia above and below along contiguous margin. However, these latter characters tend to vary independently, as does the degree of scabrosity of leaf blades and sheaths. My own conclusion is


a
b
c
3.5mm
d
e
f
g
h
i
j
2mm
k
l
4mm
m
n
2mm
o

to leave the situation as Small had it. "*Scabra*" morphs show a gradation westward, particularly in the increase of scabrosity and hairs at and around the ligular edge, mostly from Alabama and panhandle Florida west into 'Louisiana. Regrettably, large loans from DUKE and NCU were annotated *A. rufa* without checking "scabra" characters. They are entered with an asterisk so as to provide an idea of distribution of *A. rufa* in the Carolinas, and a more careful check for the few, if any, "scabra" morphs will be made.

Anthenantia rufa (Elliott) Schultes forma **rufa**

ALABAMA. Baldwin Co.: *Kral 79274* (VDB). **Butler Co.:** *Kral 62998* (VDB). **Conecuh Co.:** *Kral 83306* (VDB); *Kral 52367* (VDB). **Geneva Co.:** *McDaniel 7958* (VDB); *Kral 52367* (VDB). **Houston Co.:** *MacDonald 11801* (VDB); *MacDonald 3686* (VDB). **Mobile Co.:** *John & Connie Taylor 15260* (BRIT). **FLORIDA.** no county but suspect Duval, 1883, *A.H. Curtiss* (TAES). **Bay Co.:** *Kral 52190* (VDB); *Godfrey & Houk 61532* (SMU). **Gadsden Co.:** *Kral 64456B* (VDB). **Liberty Co.:** *Godfrey 84413* (BRIT, FSU). **Wakulla Co.:** *Henderson 63-1379* (SMU). **Walton Co.:** *Ward 7417 with Hunter* (VDB). **Washington Co.:** *Kral with Godfrey 5976* (DUKE, FSU, VDB). **GEORGIA. Baker Co.:** *Kral 56732* (VDB). **Coffee Co.:** *Kral 83766* (VDB). **Long Co.:** *Kral 18864* (VDB). **Pierce Co.:** *Kral 79975* (VDB). **Turner Co.:** *Kral with Carter 84177* (VDB). **Wayne Co.:** *Duncan 7670* (SMU). **Worth Co.:** *Kral 81802* (VDB). **LOUISIANA. St. Tammany Parish:** 17 Nov 1936, *Penfound s.n.* (NO). **MISSISSIPPI. Hancock Co.:** *Clarke 5890* (BRIT). **Harrison Co.:** *Tracy 3819 & 8590* (TAES). **Jackson Co.:** *Tracy 82* (TAES), *Earle 239A*. **NORTH CAROLINA. Bladen Co.:** *Ahles with Leisner 33368; Ahles 37509** (NCU) **Brunswick Co.:** *Blomquist 436* (NCSC, SMU). **Craven Co.:** *Brown 2332* (TEX). **Duplin Co.:** *Ahles 35796A**. **Pender Co.:** *Blomquist 10075, 10076* (TEX), *Ahles 36235* (NCU, 5-MU). **SOUTH CAROLINA. Bamberg Co.:** *Ahles 37755* (NCU). **Chesterfield Co.:** *Radford 18760** (NCU). **Georgetown Co.:** *Radford 31389** (NCU).

Anthenantia-rufa (Elliott) Schultes forma **scabra** Nash

ALABAMA. Baldwin Co.: *Wilhelm 1188* (VDB); *Kral 78172, 89038* (VDB) **Covington Co.:** *Duncan et al. 14181* (SMU); *Kral 41655, 80081D, 86880* (VDB). **Escambia Co.:** *Kral 33829, 44787, 44885* (VDB). **Geneva Co.:** *Kral 90294* (VDB). **Mobile Co.:** *Kral 26949, 93368* (VDB). **Monroe Co.:** *Kral 44380, 69624, 90519, 90572* (VDB). **Washington Co.:** *LeLong 6818* (VDB); *Kral 25901, 90526, 90527* (this last one first identified as *A. villosa* because of pale spikelets, a large set to be distributed, (VDB). **FLORIDA. Alachua Co.:** *Silveus 6742* (TEX). **Baker Co.:** *Godfrey* 74696 (VDB). **Bay Co.:** 24 Oct 1980, *Athey s.n.* (VDB) **GEORGIA. Tift Co.:** *Shepherd 237* (TAES). **Ware Co.:** *Silveus 5345* (TEX). **Worth Co.:** *Kral 51569* (VDB). **LOUISIANA. St. Tammany Parish:** 17 Nov 1938, *Penfound s.n.* (NO). **Vernon Parish:** *Thomas & Allen*

Fig. 4. Idealized sketches of floral and vegetative parts, *Anthenantia*. **A.** *A. texana* lower leaf, small sector adaxial side of blade (above); sector of ligule, adaxial side of leaf (middle); side view of leaf sheath/blade junction, showing trichomes at blade base and on auricle. **B.** Three ligular types, idealized for *A. villosa*, with three cross-sections (top); side view of leaf/sheath junction, *A. villosa* (below). **C.** *A. rufa,* lower leaf, sector of ligule and cross-section at right (above)-, side view of leaf/sheath junction, *A.* rufa forma *rufa* (below left) and forma scabra (below right). **D.** *A. texana* glume, abaxial side (top), cross-section (middle; dots for nerves, lines for hairs); adaxial view (bottom). **E.** Opposing lemma, abaxial side (top); cross-sectional ideogram (middle); adaxial side (bottom). **F.** Side view of *A. rufa* spikelet, lower (staminate) flower at anthesis. **G.** Side view of *A. rufa* "upper" floret at anthesis, stigmas exserted (left); ideogram of cross- section of same (right). **H.** Abaxial view of first (lower) palea, *A. villosa* (below), ideogram of cross section of same. **I.** Adaxial view, *A. texana* staminate flower and its palea just prior to anthesis. **J.** A cleared second (upper) floret of *A. rufa* opened 180 degrees, the perfect flower just prior to anthesis. **K.** Idealized view of young gynoecium, abaxial side. **L.** Three *A. rufa* stamens at anthesis. **M.** Perfect floret, *Anthenantia*. **N.** Side view of lower (staminate) flower, *A. villosa*, just prior to anthesis. **O.** Side view of lodicule, *A. texana* showing the typical nervation (left); ideogram of position of flower parts, the two lodicules, the three stamens and the ovary at center.

98029 (NLU, VDB); *Thomas 5568* (VDB). **Washington Parish:** *Kral 83043* (VDB). **MISSISSIPPI. Hancock Co.:** *Jones 20345* (VDB); *Sargent 9007* (SMU); *Clarke 5887* (BRIT). **Harrison Co.:** *Tracy 3819* (TAES). **Stone Co.:** *Kral 93351* (VDB). **NORTH CAROLINA.** *Hitchcock 290* (LL).

CONCLUSIONS

My study of *Anthenantia* has been based on field observation along with careful artwork and morphologic evaluation. Such foci allow the following:

1. *Anthenantia*, so far as the North American flora is considered, is a distinct genus of panicoid grasses. It is the only genus in our area to combine (1) a scaly-rhizomatous, loosely caespitose habit (2) a paniculate inflorescence, with (3) spikelets similar to those of *Panicum* but lacking a first glume, (4) the second glume and first lemma 5-nerved, with at least the median three flanked by narrow longitudinal rows of elongate, often papillose-base (strumose) trichomes, and (5) two florets, the lower "glumelike" lemma with its hyaline, bicarinate palea enclosing a male floret or sterile, the second (or upper) lemma and palea coriaceous, enclosing a (usually) perfect floret.

2. A third "species-level" taxon, *Anthenantia texana*, exists west of the Mississippi Embayment, where it may share area, if not exact habitat, with *A. villosa* and possibly also *A. rufa* in eastern Texas and western Louisiana. *Anthenantia texana* may actually be the only species to be found in Arkansas.

3. An examination of the synonymy and taxonomic dispositions in *Anthenantia* and morphologically adjacent genera seems (to me) to show a definitely confused set of concepts. Since the whole tribe, for that matter the whole family, is having a vigorous and very controversial "shakedown," it is useful to point out two genera with strong resemblance to *Anthenantia*, namely *Leptocoryphium* Nees and *Melinis* P. Beauv. *Leptocoryphium* has two species: *L. lanatum* (Kunth) Nees ranges from Argentina north into Mexico and the Anti'lles, in the north of its range frequenting pine savanna, oak-pine land, open savanna, and pasturage within these systems. In short, it has an "*Anthenantia*-type" habitat. My first encounter with the species was in Nicaragua ("Zeylaya, burnt savanna by road to Limbaika, ca. 1 km e of jct. rd to Limbaika, 10 July 1982, *R. Kral 64344*"). I did not identify the plant but did note its strong resemblance to *Anthenantia*. From my recent examination of herbarium material and from excellent descriptions by Pohl for Flora Meso-america (1994) and Flora Nicaragua (2001), I am further intrigued. The species is described as having a cormose, fibrillose base but otherwise seems to differ vegetatively from *Anthenantia* in no significant way. The inflorescence is paniculate, sinuously branched, the spikelets are similar in design, the lower glume is lacking, the second glume and lower palea have the same nervation, with trichomes elongate and in longitudinal rows. The only significantly different character state in the spikelet seems to be in the lower floret, which has no palea and which is sterile. The upper floret in character and dimensions of lemma and palea and in perianth, stamens, and gynoecium is very similar. The fruits are similar. I suggest that if a tight description of *Leptocoryphium* were spaced so that a similar one of *Anthenantia* were laid in on alternate lines, there would be a strong agreement. It is significant that one of the most excellent of observers, George Bentham, treated *L. lanatum* as *Anthenantia lanata* (Kunth) Benth.

Melinis P. Beauv., an African genus of 22 species, also is similar to *Anthenantia* but appears to be a more distant relative and is in fact placed in subtribe Melinidinae by current authors, while *Anthenantia* and *Leptocoryphium* are morphologically aligned with subtribe Digitariinae. The two species of *Melinis* in the Americas are the weedy invasives *M. repens* (Willd.) Zizka ssp. *repens* (*Rhyncheletrum repens* [Willd.] C.E. Hubb. = *R. roseum* (Nees) Stapf & C.E. Hubb.) and *M. minutiflora* P. Beauv., which are rapidly occupying disturbed sandy or gravelly areas (overfarmed situations, fields, railroad rights-of-way, etc.). The former has gotten into the range (if not the habitat) of *Anthenantia* in northern Florida, south Georgia, and Texas. The latter is so far confined to Florida. A quick scan of a living *M. repens* makes one note the strong resemblance to *A. villosa*. The general dimensions of culm, leaf (shape, surfaces, ciliate blade margins, the geniculate "bend," the character of ligule and auricle) and the feathery panicle of pinkish to silvery-white hairy spikelets, all are deceptively similar. However, a closer look reveals a different plant base, namely caespitose but not rhizomatous, the culms often short-decumbent, themselves geniculate at base and with adventitious roots. In the panicle the spikelets, at first appressed-silky-pubescent, later "fuzzy" with elongate spreading trichomes, are superficially similar to *Anthenantia*, but a closer inspection reveals (a) lateral compression rather than dorsiventral, (b) two glumes, both keeled apically and aristate, and (c) second glume and lower lemma about equal in length with lower half gibbous, the rounded backs prominently pustular-papillose, the hairs liberally interspersed, not in longitudinal rows, the upper half abruptly narrowed to a strongly-laterally compressed, keeled, aristate (in the glume) beak. Finally, while the two florets are similar in composition to *Anthenantia* (lower floret with a hyaline, 2-keeled palea and tristaminate flower, the upper one typically perfect and navicular) the lemma and palea are chartaceous rather than coriaceous and show a slight lateral compression. The caryopses, while slightly similar, also show bilateral symmetry and an eccentric style base.

Thus, I have the impression that *Leptocoryphium*, having so many characters in common, could indeed be merged with *Anthenantia*, an opinion already given by George Bentham. For *Melinis*, on the other hand, the symmetry of spikelet, the presence of two awned glumes, the disposition of hairs and papillae on the laterally (rather than dorsiventrally) compressed scales or their tips, and the chartaceous, rather than coriaceous, laterally compressed upper floret constitute a significant set of differences and suggest a different evolutionary alliance.

ACKNOWLEDGMENTS

The help of curatorial and management staffs of all is hereby gratefully acknowledged as well as for careful editorial suggestions by agrostologist Victoria Hollowell (MO). The invaluable help of Barney Lipscomb and that of Porter Lowry (P) is greatly appreciated. Barney made digital images of my drawings of *A. rufa* and of *A. villosa* and sent them to Porter, who compared them with Michaux's type collection of *Anthenantia villosa*. The kindness of these two gentlemen is gratefully acknowledged!

REFERENCES

Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep (eds.). 2003. Magnoliphyta: Commelinidae: Poaceae part 2. Flora of North America: North America north of Mexico. Oxford University Press. New York. Vol. 25.

Palisot de Beauvois, A.M.F.J. 1812. Essai d'une nouvell agrostographie…de Fain, Paris, France.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Elliott, S. 1821. A sketch of the botany of South Carolina and Georgia /(Facsimile of 1816-1824 edition) Hafner Publishing Company, New York. Vol. 1.

Gould, F.W. 1975. The grasses of Texas. Texas A&M University Press, College Station.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 2001. Checklist of the vascular plants of Texas. Agric. Exp. Sta. Misc. Publ. No. 1655.

Hitchcock, A.S. 1951. Manual of the grasses of the United States. Second Edition edited by A. Chase. Dover Publications, Inc. New York.

Michaux, A. 1803. Flora Boreali-Americana…Parisii & Argentorati, France. Vol. 1:43.

Nash, G.V. 1903. *Anthenantia*. In: Small, J.K., Flora of the southeastern United States. *(Anthenantia rufa* forma scabra Nash). P. 79.

Pohl, R.W. 1994. *Leptocoryphium*. In: G. Davidse, M. Sousa S., A.O. Chater, eds. Flora Mesoamerica: Alistmataceae a Cyperaceae. Universidad Nacional Autónoma de México, Missouri Botanical Garden, and Natural History Museum (London). Vol. 6: 371.

Pohl, R.W. 2001 *Leptocoryphium*. In: W.D. Stevens, C. Ulloa Ulloa, A. Pool, O.M. Montiel, eds. Flora Nicaragua: Angiosperms (Pandanaceae–Zygophyllaceae). Monogr. Syst. Bot. Missouri Bot. Gard. 85(3):2071.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The Univ. of North Carolina Press, Chapel Hill.

Small, J.K. 1903. Manual of the southeastern flora. The Science Press, Lancaster, Pennsylvania.

Small, J.K. 1933. Manual of the southeastern flora. John Kunkel Small, New York.

CALAMAGROSTIS COAHUILENSIS AND *C. DIVARICATA* (POACEAE: POOIDEAE: AGROSTIDINAE), TWO NEW SPECIES FROM MÉXICO

Paul M. Peterson and Robert J. Soreng

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, District of Columbia 20013-7012, U.S.A.
peterson.paul@nmnh.si.edu; soreng.rob@nmnh.si.edu

Jesus Valdés-Reyna

Departamento de Botánica
Univerisidad Autonoma Agraria "Antonio Narro"
Buenavista, Saltillo
Coahuila 25315, MÉXICO
jvaldes@narro.uaaan.mx

ABSTRACT

Calamagrostis coahuilensis P.M. Peterson, Soreng & Valdés-Reyna, sp. nov., and ***Calamagrostis divaricata*** P. M. Peterson & Soreng, sp. nov., from México are described and illustrated. *Calamagrostis coahuilensis* occurs on calcareous slopes in the mountains of southeastern Coahuila and southwestern Nuevo León; and *C. divaricata* occurs on moist slopes and mossy cliffs of southwestern Durango. *Calamagrostis coahuilensis* is morphologically similar to *C. purpurascens* but differs by having shorter anthers (1–1.2 mm long), nearly smooth ligules, scaberulous rachises, glabrous or minutely antrorsely scabrous sheath summits, and somewhat dense but not spikelike, greenish panicles. *Calamagrostis divaricata* seems morphologically allied to *C. pringlei* but differs by having wider panicles (4–10 cm) with branches reflexed spreading and divaricate, shorter spikelets (3.4–4.3 mm long), shorter glumes (3.4–4.3 mm long) that are both 1-veined, and shorter lemmas (3.8–4.3 mm long) with an awn inserted on upper 1/4 to 1/3.

RESUMEN

Se describen y se ilustran para México ***Calamagrostis coahuilensis*** P.M. Peterson, Soreng & Valdés-Reyna, sp. nov., y ***Calamagrostis divaricata*** P.M. Peterson & Soreng, sp. nov. *Calamagrostis coahuilensis* se encuentra en laderas calcáreas en las montañas del sureste del estado de Coahuila y suroeste del estado Nuevo León; y *C. divaricata* se encuentra en laderas húmedas y riscos musgosos del suroeste del estado de Durango. *Calamagrostis coahuilensis* es morfologicamente similar a *C. purpurascens* pero difiere en poseer anteras más cortas (1–1.2 mm largo), lígulas casi lisas, raquis escaberuloso, ápices de las vainas glabros o escasamente con escabrosidad antrosa, y panículas densas pero no espigadas, de color verdusco. *Calamagrostis divaricata* parece morfologicamente relacionado a *C. pringlei* pero difiere en poseer panículas mas amplias (4–10 cm) con ramificaciones reflexas, extendidas y divaricadas, espiguillas mas cortas (3.4–4.3 mm largo), glumas más cortas (3.4–4.3 mm largo) ambas uninervadas, y lemas mas cortas (3.8–4.3 mm largo) con una arista insertada desde 1/4 hasta 1/3 arriba de la mitad.

Calamagrostis is characterized as having single-flowered spikelets, one or three-veined glumes as long or exceeding the floret in length (rarely slightly shorter), non-keeled lemmas that are membranous or cartilaginous (infrequently hyaline), usually with a single dorsally attached awn (rarely awnless), a callus with a crown of hairs, caryopses with short hilums and without apical hairs, and lodicules that are apically membranous (Clayton & Renvoize 1986; Watson &

Dallwitz 1992). Worldwide, *Calamagrostis* includes between 230 (Watson & Dallwitz 1992) and 263 (reported by D. Clayton & B. Simon, pers. comm. 2004) species. In North, Central, and South America 131 species are reported in Soreng et al. (2003). In México the following 11 species of *Calamagrostis* are recognized: *C. erectifolia* Hitchc., *C. eriantha* (Kunth) Steud., *C. guatemalensis* Hitchc., *C. intermedia* (J. Presl) Steud., *C. oridzabae* (Rupr. ex E. Fourn.) Beal, *C. pringlei* Scribn. ex Beal, *C. purpurascens* R. Br., *C. rigescens* (J. Presl) Scribn., *C. tolucensis* (Kunth) Trin. ex Steud., *C. valida* Sohns [syn.=*C. mcvaughei* Sohns; McVaugh (1983) was the first to select this name as a synonym, see Article 11.5 for equally published species in the Code of Botanical Nomenclature (Greuter et al. 2000)], and *C. vulcanica* Swallen (Chimal 1987; Espejo-Serna et al. 2000).

While collecting grasses and specifically searching for unique forms of *Trisetum* in Durango, México (Finot et al. 2004) in the fall of 2003 the first author gathered a specimen that seemed to be an undescribed species. At first glance this specimen appeared to be two or more flowered but upon closer inspection and under magnification all spikelets contained a single floret. After studying morphologically similar material from México collected by the first author, an additional undescribed species was found in Coahuila. The two new species are clearly members of subfamily Pooideae, tribe Poeae, subtribe Agrostidinae (Soreng et al. 2003, 2004). We describe these two specimens as new species of *Calamagrostis*.

Calamagrostis coahuilensis P.M. Peterson, Soreng & Valdés-Reyna, sp. nov. (**Figs. 1, 2**). TYPE: MÉXICO. COAHUILA. Sierra Madre Oriental, 32 mi SE of Saltillo and 8 mi SE of Jame on road to Sierra La Viga, 3240 m, 29 Sep 1990, *P.M. Peterson, C.R. Annable & J. Valdés-Reyna 10051b* (HOLOTYPE: US!).

A *Calamagrosti purpurascenti* R.Br. antheris 1–1.2 mm longis. ligulis fere laevigatis, rhachibus scaberulis, vagina apicali glabra vel scabrella antrorse, paniculis aliquantum densis sed non spicae similibus, viridis, recedit.

Caespitose perennial with intravaginal and extravaginal shoot initiation. Culms (22–)40–100 cm tall, erect, glabrous; internodes glabrous. Sheaths 6–28 cm long, shorter than the internodes, glabrous, often fibrous below with age; margins smooth; cataphylls and lower sheaths glabrous; summit glabrous or minutely antrorsely scabrous. Ligules 5–8 mm long, membranous often lacerate, firmer below, nearly smooth, apex obtuse to acute. Blades 8–20 cm long, 2–4 mm wide, flat, apically acuminate, glabrous, scabrous above. Panicles (7–)9–20 cm long, 0.5–1.2 cm wide, contracted, somewhat dense but not spike-like, greenish; rachis scaberulous; inflorescence branches mostly 2–10 cm long below, the branches, ascending and tightly appressed, mostly floriferous near base, one or two per node. Spikelets 5.8–7.2 mm long, 1-flowered, tightly appressed to the branches, dark greenish; pedicels 0.6–4 mm long, ascending, scaberulous; rachilla 2.4–3 mm long, covered with stiff hairs, the hairs 0.5–1 mm long. Glumes 5.8–7.2 mm long, lanceolate, about equal or subequal in length, longer than the

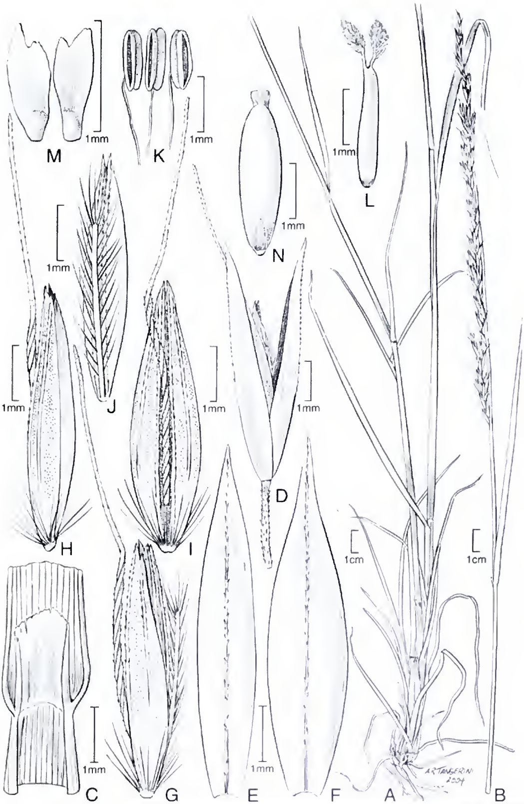


Fig. 1. *Calamagrostis coahuilensis* (*Peterson, Annable & Valdés-Reyna 10051b*). **A.** Habit. **B.** Inflorescence. **C.** Sheath, ligule, and blade. **D.** Spikelet. **E.** Lower glume, dorsal view. **F.** Upper glume, dorsal view. **G.** Floret, lateral view. **H.** Lemma, lateral view. **I.** Lemma, dorsal view. **J.** Palea with rachilla, dorsal view. **K.** Stamens. **L.** Pistil. **M.** Lodicules. **N.** Caryopsis, dorsal view.

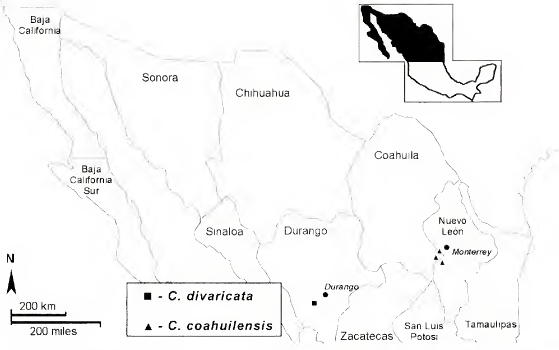


Fig. 2. Distribution of *Calamagrostis coahuilensis* and *C. divaricata* in México.

floret, membranous, 1-veined, scaberulous along vein; margins hyaline; apex acute. Lemmas 5–5.7 mm long, lanceolate, membranous, yellowish-green, conspicuously 5-veined near base, scaberulous, awned; apex acute, entire or bifid; awn 8–10 mm long, golden below and purplish above, borne near the base on the lower 1/6, inserted in a groove below and twisted and once-geniculate above; callus obtuse with white hairs, the hairs 0.8–1.8 mm long. Paleas 5–5.6 mm long, about as long as the lemma, hyaline, 2-veined, the veins scaberulous, green; apex acute, entire. Lodicules ca. 1 mm long, lanceolate, lobed, glabrous. Stamens 3; anthers 1–1.2 mm long, purple. Ovary ca. 0.2 mm long, glabrous; styles 2, separate; stigmas 2, feathery, whitish. Caryopses 2–2.5 mm long, fusiform, light greenish.

Phenology.—Flowering in late August, September, and early October.

Distribution.—*Calamagrostis coahuilensis* is known from the mountains of Coahuila and Nuevo León growing on calcareous slopes with *Abies mexicana* Martínez, *Pinus culminicola* Andresen & Beaman, *P. hartwegii* Lindl., *Hesperostipa spartea* (Trin.) Barkworth, *Poa ruprechtii* Peyr, *Holodiscus discolor* (Pursh) Maxim., *Quercus greggii* (A. DC.) Trel., and scattered *Populus tremuloides* Michx.

Additional specimens examined (PARATYPES): **MEXICO. Coahuila:** municipio de Arteaga, near summit of Coahuilon, SE of San Antonio de Las Alazanas and SE of Saltillo, 3120 m, 17 Oct 1989, *P.M. Peterson, J. Valdés-Reyna & J.A. Villareal* 8399 (ANSM, US); 29 Aug 1986, *J.A. McDonald* (TEX). **Nuevo León:** municipio de Galeana, Cerro el Potosí, 3600 m, 3 Aug 1989, *A. García-Arévalo* 66 (ANSM, CIIDIR); cumbre de Cerro Potosí, ca. Galeana, 29 Aug 1986, *J.A. McDonald* (TEX); Ladera S, 26 Jul 1985, *J.A. McDonald* (TEX); *J. Ochoa-Guillemard* 983 (COCA).

Calamagrostis divaricata P.M. Peterson & Soreng, sp. nov. (**Figs. 2, 3**). TYPE: MÉXICO. DURANGO. Sierra Madre Occidental, ca. 3 mi S of Hwy 40 at Mexiquillo, Arroyo Paso Resbaloso (23°42'46.2"N-105°39'45.1"W), 2520 m, 14 Sep 2003, *P.M. Peterson, M.S. González-Elizondo & G. Teña-González 17774* (HOLOTYPE: US!; ISOTYPES: ANSM!, CIIDIR!, MO!, RSA!, US!).

A *Calamagrosti pringlei* Scribn. ex Beal paniculis 4–10 cm latis, ramis reflexis, effusis et divaricatis, spiculis 3.4–4.3 mm longis, glumis 3.4–4.3 mm longis, univenis, lemmatibus 3.8–4.3 mm longis, arista inserta supera 1/4–1/3, recedit.

Loosely caespitose perennial with short rhizomes and extravaginal shoot initiation. Culms 52–96 cm tall, erect to slightly decumbent near base, glabrous; internodes glabrous. Sheaths 8–20 cm long, shorter or longer than the internodes, glabrous; margins smooth; cataphylls and lower sheaths glabrous; summit glabrous. Ligules 2–3.6 mm long, membranous often lacerate, decurrent below; apex truncate, ciliolate. Blades 15–60 cm long, 1–3 mm wide, flat or involute, apically acuminate, glabrous, scabrous above. Panicles 9–16 cm long, 4–10 cm wide, ovate, open, lax, sparsely flowered, greenish; rachis scaberulous; inflorescence branches mostly 2–8 cm long below, the branches delicate, ascending and spreading, naked near base, whorled; lower inflorescence nodes with 3–6 branches. Spikelets 3.4–4.3 mm long, 1-flowered, spreading from the branches, yellowish-green; pedicels 1–5 mm long, ascending to reflexed and spreading, scaberulous; rachilla 1.6–1.9 mm long, covered with stiff hairs, the hairs up to 1.5 mm long. Glumes 3.4–4.3 mm long, lanceolate, about equal in length, shorter or longer than the floret, membranous, 1-veined, scaberulous along vein; margins hyaline; apex acute to acuminate. Lemmas 3.8–4.3 mm long, lanceolate, membranous, yellowish-green, 5-veined, scaberulous, awned; apex acute, entire; awn 4–6 mm long, yellowish, borne on the upper 1/3 or 1/4, straight or twisted and once-geniculate; callus obtuse with short white hairs, the hairs 0.2–1 mm long. Paleas 3.8–4.4 mm long, as long or slightly longer than the lemma, hyaline, 2-veined, the veins scaberulous, green; apex acute, entire. Lodicules 0.7–0.8 mm long, lanceolate, lobed, glabrous. Stamens 3; anthers 1.8–2.2 mm long, yellow. Ovary 0.2–0.4 mm long, glabrous; styles 2, separate; stigmas 2, feathery, whitish. Caryopses 1.8–2.5 mm long, fusiform, light brownish.

Phenology.—Flowering in September.

Distribution.—*Calamagrostis divaricata* is known only from the type locality growing on moist slopes and mossy cliffs with *Pinus cooperi* C.E. Blanco, *P. durangensis* Martínez, *P. ayacahuite* C. Ehrenb. ex Schltdl., *Quercus sideroxyla* Bonpl., *Arbutus occidentalis* McVaugh & Rosatti, *Cupressus arizonica* Greene, and *Muhlenbergia alamosae* Vasey.

DISCUSSION

Calamagrostis coahuilensis remained undetected by biologists for almost 19 years. The first collections of this species were apparently made by McDonald

Fig. 3. *Calamagrostis divaricata* (*Peterson, González-Elizondo & Teña-González 17774*). **A.** Habit. **B.** Inflorescence. **C.** Sheath, ligule, and blade. **D.** Spikelet. **E.** Lower glume, dorsal view. **F.** Upper Glume, dorsal view. **G.** Lemma, dorsal view. **H.** Lemma, ventral view. **I.** Palea with rachilla, dorsal view. **J.** Palea, dorsal view. **K.** Stamens and pistil. **L.** Gynoecium, mature. **M.** Lodicules.

in 1985 from the Cumbre de Cerro Potosí. All specimens that we have seen from Coahuila and Nuevo León that were previously determined as *C. purpurascens* or *C. pringlei* are *C. coahuilensis*. Therefore, *C. purpurascens* is not found in México. *Calamagrostis coahuilensis* is morphologically similar to *C. purpurascens*, but can be separated from the latter by having anthers that are shorter (1–1.2 mm long), ligules that are nearly smooth, a scaberulous rachis, sheath summits that are glabrous or minutely antrorsely scabrous, and greenish panicles that are somewhat dense but not spikelike (Table 1). Populations of *C. coahuilensis* are separated from the closest known locality of *C. purpurascens* in the Sangre de Cristo Mountains, Taos County, New México (Allred 1993) by over 800 mi. McDonald (1990) and Garcia-Arevalo and González-Elizondo (1991) first reported *C. purpurascens* from Coahuila and Nuevo León, México. Apparently, Manuel González-Ledesma, John Reeder, and Charlotte Reeder identified the grasses for McDonald (1990) since they appear in the acknowledgments for having reviewed that family. This is not surprising since in most characteristics the range of variation in *C. coahuilensis* overlaps that of *C. purpurascens*. An adequate illustration (*Ochoa 983*) of the new species appears in Beetle's (1987) treatment of the grasses of México, although he referred to it as *C. pringlei*.

It is surprising that *C. divaricata* is known only from a single, recent collection since it occurs near a rather heavily used tourist destination. *Calamagrostis divaricata* seems morphologically allied to *C. pringlei* and can be differentiated from the latter by having wider panicles (4–10 cm) with branches reflexed spreading and divaricate, shorter spikelets (3.4–4.3 mm long), shorter glumes (3.4–4.3 mm long) that are both 1-veined, and shorter lemmas (3.8–4.3 mm long) with an awn inserted on upper 1/4 to 1/3 (Table 1.).

The infrageneric classification of *Calamagrostis* has not been critically tested, and it is not usually discussed for the New World, other than the acceptance of the segregate genus *Deyeuxia* by some South American taxonomists (Rúgolo de Agrasar 1978, 1998; Villavicencio 1995). The genus (including *Deyeuxia*) is divided into at least four subgenera with many sections, subsections, and series (Rozhevits & Shishkin 1963; Tzvelev 1976; Wasiljew 1960). All of these Russian agrostologists placed *C. purpurascens* in *Calamagrostis* sect. *Deyeuxia* (Clarion ex P. Beauv) Rchb., and Wasiljew (whose classification was world-wide in scope) placed *C. pringlei* in the same section. Several infrageneric taxa were accepted for the New World (Soreng et al. 2003). Based on callus hair length (1/2 or less the lemma length), lemmas membranous, and presence of a well-developed rachilla extention, both of the new species appear to belong in *Calamagrostis* subgen. *Deyeuxia* sect. *Deyeuxia*. A key for separating the two new species from other species of *Calamagrostis* in northern México (Chihuahua, Coahuila, Durango, Nuevo León, Sinaloa, and Tamaulipas) follows.

Table 1. Salient features comparing *Calamagrostis coahuilensis*, *C. divaricata*, *C. pringlei*, *C. purpurascens*, and *C. valida*.

Characters	***C. coahuilensis***	***C. divaricata***	***C. pringle***	***C. purpurascens***	***C. valida***
Cataphylls & lower leaf sheath abaxial surface	glabrous	glabrous	densely hirtellous	glabrous or scaberulous	glabrous
Leaf sheath summit abaxial surface	glabrous or minutely antrorsely scabrous	glabrous	glabrous	glabrous or minutely retrorse-Strigulose	Densely hirtellous
Leaf blade & ligule adaxial surface	glabrous or nearly smooth	glabrous	glabrous	scabrous	sparsely hirtellous
Inflorescence width	0.5–1.2 cm	4–10 cm	2–4 cm	0.8–1.5 cm	(1.5–)4–10 cm
Inflorescence branches, arrangement & spikelet placement	ascending and closely appressed; ±floriferous to base	ascending, reflexed spreading to divaricate; not floriferous to base	ascending, loosely appressed or spreading; not floriferous to base	ascending and closely appressed, spike-like; +floriferous to base	ascending, appressed to base spreading; ± floriferous to base
Spikelet length	5.8–7.2 mm	3.4–4.3 mm	(4.5–)5–5.8 mm	5–9 mm	4–6.5 mm
Spikelet color	greenish	yellowish-green	pale green to purplish	yellowish-purple	yellowish-purple
rachilla length	2.4–3 mm	1.6–1.9 mm	1.5–2 mm	1.8–3 mm	1.5–2 mm
rachilla hair length	0.5–1 mm	0.8–1.5 mm	1–2 mm	1–2 mm	2–3 mm
Glumes length	5.8–7.2 mm	3.4–4.3 mm	(4.5–)5–5.8 mm	5–9 mm	3.4–6.5 mm
Upper glume, number of veins	one	one	three	one	(one) three
Lemma length	5–5.7 mm	3.8–4.3 mm	4.5–5 mm	4–7 mm	3.4–5 mm
Lemma surface	smooth	scaberulous	scaberulous	scaberulous	smooth
Lemma veins, aspect	conspicuous	inconspicuous	inconspicuous	inconspicuous	inconsp./conspicuous
Lemmatal awn insertion	base, lower 1/6	upper 1/4 to 1/3	lower 1/3 to middle	lower 1/6 to 1/3	near middle
Lemma apex	entire or bifid with age	entire	entire	bifid	two or four setae or teeth (prolongation of veins)
Callus hair length	0.8–1.8 mm	0.2–1 mm	0.2–1 mm	0.7–2 mm, occasionally absent	1.3–2.8(–3.5) mm
Anther length	1–1.2 mm	1.8–2.2 mm	2.2–2.4 mm	1.5–3.5 mm	1.4–2.2 mm
Anther color	purple	yellow	yellowish-purple	purple or yellow	yellow or purple

KEY TO THE SPECIES OF *CALAMAGROSTIS* IN NORTHERN MÉXICO

1. Panicles 0.5–1.5 cm wide, contracted, densely flowered; lemma awn inserted at base or on lower 1/6 to near lower 1/4; anthers 1–1.2 mm long _____ **Calamagrostis coahuilensis**
1. Panicles 1.5–10 cm wide, narrow to open and loosely flowered; lemma awn inserted from lower 1/3, middle, and upper 1/4; anthers 1.4–2.4 mm long.
    2. Lemma apex with two or four setae or teeth (prolongation of veins); callus hairs 1.3–2.8 mm long; rachilla hairs 2–3 mm long; leaf blade, ligule, and summit of sheath sparsely hirtellous _____ **Calamagrostis valida**
    2. Lemma apex entire and without setae or teeth; callus hairs 0.2–1 mm long; rachilla hairs 0.8–2 mm long; leaf blade, ligule, and summit of sheath glabrous.
        3. Upper glume 3-veined; spikelets (4.5) 5–5.8 mm long; lemmas 4.5–5 mm long, awn inserted on lower 1/3 to middle; panicles 2–4 cm wide, the branches loosely appressed or spreading but not divaricate _____ **Calamagrostis pringlei**
        3. Upper glume 1-veined; spikelets 3.4–4.3 mm long; lemmas 3.8–4.3 mm long, awn inserted on upper 1/3 to 1/4; panicles 4–10 cm wide, the branches reflexed spreading, divaricate _____ **Calamagrostis divaricata**

ACKNOWLEDGMENTS

We wish to thank the Smithsonian Institutions, National Museum of Natural History, Biodiversity and Inventory Program, and Research Opportunities Fund for supporting the fieldwork. Appreciation is extended to Alice R. Tangerini for providing the illustrations; Susan J. Pennington for preparing the distribution map; Alain Touwaide and Dan Nicolson for correcting the Latin diagnoses; Kelly Allred and Rich Spellenberg for checking the distribution records in New Mexico; and Teresa Mejia-Saulés for finding inconsistencies in the manuscript.

REFERENCES

Allred, K.W. 1993. A field guide to the grasses of New Mexico. Department of Agricultural Communications, College of Agriculture and Home Economics, New Mexico State University, Las Cruces.

Beetle, A.A., E. Manrique Forceck, C.V. Jaramillo Luque, M.P. Guerrero Sanchez, J.A. Miranda Sánchez, C.I. Nuñez Tancredi, y C.A. Chimal Hernández. 1987. Las Gramineas de México, Tomo II. 344 p. COTECOCA, S.A.R.H., México, D.F., México.

Chimal Hernández, C.A. 1987. *Calamagrostis* Adans. In: A.A. Beetle, E. Manrique Forcek., C.V. Jaramillo Luque., M.P. Guerrero Sánchez., J.A. Miranda Sánchez., C.I. Núñez Tancredi, y C.A. Chimal Hernández. 1987. Las Gramíneas de México. Tomo II. COTECOCA, S.A.R.H. México, D.F. Pp. 161–172.

Clayton, W.D. and S.A. Renvoize. 1986. Genera graminum: grasses of the World. Her Majesty's Stationary Office, London.

Espejo-Serna, A., A.R. López-Ferrari, and J. Valdés-Reyna. 2000. *Poaceae*. In: A. Espejo Serna and A.R. López-Ferrari, eds. Las Monocotylidóneas Mexicanas: una sinopsis florística, Partes IX–XI. Consejo Nacional de la Flora de México, A.C., Universidad Autónoma Metropolitana-Izapalapa, y Comisión Nacional para el conocimiento y uso de la Biodiversidad, México, D.F. Pp. 10:7–236.

FINOT, V.L., P.M. PETERSON, R.J. SORENG, and F.O. ZULOAGA. 2004. A revision of *Trisetum*, *Peyritschia*, and *Sphenopholis* (Poaceae: Pooideae: Aveninae) in México and Central America. Ann. Missouri Bot. Gard. 91:1–30.

GARCIA-AREVALO, A. and S. GONZÁLEZ-ELIZONDO. 1991. Flora y vegetacion de la cima del Cerro Potosí, Nuevo León, México. Acta Bot. Mex. 13:53–74.

GREUTER, W.J. MCNEILL, F.R. BARRIE, H.M. BURDET, V. DEMOULIN, T.S. FILGUEIRAS, D.H. NICOLSON, P.C. SILVA, J.E. SKOG, P. TREHANE, N.J. TURLAND, and D.L. HAWKSWORTH. 2000. International code of botanical nomenclature (Saint Luis Code). Koeltz Scientific Books, Königstein, Germany.

MCDONALD, J.A. 1990. The alpine-subalpine flora of northeastern México. Sida 14:21–28.

MCVAUGH, R. 1983. Flora Novo-Galiciana. A descriptive account of the vascular plants of western México. Gramineae. 14: 1–436. University of Michigan Press, Ann Arbor.

ROZHEVITS, R.YU. and B.K. SHISHKIN. 1963 (1934). Flora of the U.S.S.R. vol. II, XXIV. Gramineae Juss. National Science Foundation, Washington, D.C. Pp. 152–184.

RÚGOLO DE AGRASAR, Z.E. 1978. Las especies patagónicas del genero *Deyeuxia* Clar. (Gramineae) de la Argentina y de Chile. Darwiniana 21:417–453.

RÚGOLO DE AGRASAR, Z.E. 1998. *Deyeuxia.* In: S.A. Renvoize, Gramíneas de Bolivia. The Royal Botanic Gardens, Kew. Pp. 181–235.

SORENG, R.J., P.M. PETERSON, G. DAVIDSE, E.J. JUDZIEWICZ, F.O. ZULOAGA, T.S. FILGUEIRAS, and O. MORRONE. 2003. Catalogue of New World grasses (Poaceae): IV: subfamily Pooideae. Contr. U.S. Natl. Herb. 48:1–730.

SORENG, R.J., G. DAVIDSE, P.M. PETERSON, F.O. ZULOAGA, E.J. JUDZIEWICZ, T.S. FILGUEIRAS, and O. MORRONE. 2004. Catalogue of New World grasses (Poaceae). http://mobot.mobot.orgW3T/Search/nwgc.html and Classification of New World Grasses. http://mobot.mobot.org/W3T/Search/nwgclass.html

TZVELEV, N.N. 1983 (1976). Grasses of the Soviet Union (Zlaki SSSR), part II. Oxonian Press, New Delhi, India.

VILLAVICENCIO, X. 1995. Revision der gattung *Deyeuxia* in Bolivien. 1–304. Ph.D. Thesis, Freien Universität Berlin, Berlin.

WASILJEW, W.N. 1960. Das system der gattung *Calamagrostis* Roth. Feddes Repert. 63(31): 229–251.

WATSON, L. and M.J. DALLWITZ. 1992. The grass genera of the World. C.A.B. International, Wallingford, U.K.

ETHNOBOTANY OF *RHODIOLA ROSEA* (CRASSULACEAE) IN NORWAY

Torbjørn Alm

Department of Botany
Tromsø Museum
University of Tromsø
N-9037 Tromsø, NORWAY

ABSTRACT

Rhodiola rosea is a widespread species in Norway. It is well known in Norwegian folk tradition, with a variety of vernacular names, of which many reflect its traditional uses. Past use as a cure for scurvy in cattle may explain names with the prefix *kalv-* ("calf"). Its widespread use as a hair wash is also reflected in vernacular names. In the past, *Rhodiola* was planted on turf roofs to protect them from fire, i.e. as an apotropaic (supposedly averting evil forces); this tradition is documented as early as the 13th century.

SAMMENDRAG

Rosenrot *Rhodiola rosea* er en vanlig og vidt utbredt art i Norge. Den er vel kjent i folketradisjonen, med en lang rekke folkelige navn. En god del av disse gjenspeiler artens tradisjonelle bruksområder. Bruk som et botemiddel mot skjørbuk hos kyr kan forklare de mange navnene på *kalv*. Den flittige bruken til hårvask går likeens igjen i mange lokale navn. Tidligere ble rosenrot ofte plantet på tovtak for å beskytte dem mot brann, dvs. som er verneråd; denne tradisjonen er dokumentert allerede på 1200-tallet.

INTRODUCTION

Rhodiola rosea L. (Crassulaceae) (syn. *Sedum rosea* (L.) Scop., *S. rhodiola* DC.) is a common species in the mountains and coastal districts of Norway, occurring abundantly both on coastal cliffs and in alpine habitats, from sea level to 2280 m a.s.l. in the mountains of Central Norway (Elven 1994). The lowland plants belong to subsp. *rosea*, whereas those of high mountain habitats are similar to the arctic subsp. *arctica* (Boriss.) Á. & D. Löve (Elven 1994). The species as such is easily recognizable.

The genus *Rhodiola*, formerly often included in *Sedum*, comprises about 50 species, centered on the mountains of East Asia (Springate 1995). Whereas *Sedum* has hermaphroditic flowers, many *Rhodiola* species, including *R. rosea*, are dioecious (Lippert 1995). *Rhodiola rosea* is a hemicryptophyte with thick rhizomes. The annual shoots are unbranched, and densely clad with flat, fleshy leaves. *Rhodiola rosea* has a circumpolar-montane/alpine distribution (Hultén & Fries 1986; Lippert 1995). Hultén (1958) considered *R. rosea* "A collective species consisting of numerous races differing chiefly in size, form and dentation of the leaves and in the colour of the flowers."

Rhodiola rosea has received increased attention during the last few years, not least due to its alleged medical properties, e.g. as an adaptogen, supposedly enhancing memory, stress mastering, etc.; some of these effects have been confirmed by recent studies (Boon-Niermeijer et al. 2000; Spasov et al. 2000). Germano & Ramazanov (1999) provide extensive references to Russian literature on its medical properties. For a review of current knowledge, see Brown et al. (2002).

Folk tradition claiming positive health effects derives largely from Asia (eastern Russia, Mongolia, China). Norwegian tradition is less inclined to claim "wondrous" properties, but may provide valuable information of potential uses. Both the rhizomes and flowering stems of *R. rosea* have found a number of uses in folk tradition in Norway. The present paper aims at a comprehensive review of the ethnobotany of *R. rosea* in Norway, including vernacular names, medicinal uses and other traditions. Unless otherwise stated, all citations have been translated from Norwegian.

Sources

Høeg (1974) assembled a vast body of information on plant names and uses in Norway, including a three-page chapter on *Rhodiola rosea*. It is largely based on his own data, and fails to incorporate more than a fraction of existing literature, e.g. the interesting note of Søreide (1952). Nordhagen (1934) studied the old tradition of planting *R. rosea* on house roofs in Norway. Alm (1996a) discussed its past use as a cure for scurvy. Recently, Dragland (2001) reviewed data on *R. rosea* as part of a project aimed at commercial cultivation in Norway. His report includes some ethnobotanical data, but these are largely culled from Høeg (1974) and some secondary sources.

Scattered notes on *R. rosea* and its uses in Norway occur in numerous other publications on folk medicine and other traditions. In addition to these, I have incorporated some data from archival sources, mainly NFS (Norsk folkeminnesamling/Norwegian folklore collection) and NOS (Norsk ordbok, seddelarkivet/Norwegian dictionary, card archive). Furthermore, some data have been excerpted from my own ethnobotanical field work in North Norway; these are referred to as "interview + year." Informants are not identified here; transcripts and some recordings of the original interviews are stored at the Department of Botany, Tromsø Museum (TROM).

Vernacular Names

In Norwegian folk tradition, widespread and well-known plants are usually known either under a single, ubiquitous vernacular name (e.g. *blåbær*, "blue berries" for *Vaccinium myrtillus* L.), or display a substantial array of widely different names (e.g. more than 100 names for *Dactylorhiza maculata* (L.) Soó, see Alm 2000). With more than a half-hundred Norwegian vernacular names recorded so far, *Rhodiola rosea* belongs to the latter group. No record of its Norse name (or names) seems to have survived (Heizmann 1993); the oldest names included in the present paper date back to 1599. A compilation of Norwegian and Sámi names is found in Table 1. Some are of local use, and may be confined to a single village; others are widespread. A couple of name-groups (see Fig. 1) are of particular interest:

a) In Western Norway, *R. rosea* has a set of names with the prefix *syste*—or *syster, systre, søster* and similar terms (Høeg 1974; Lagerberg et al. 1955; Lid 1941; Nordhagen 1934; Søreide 1952; Strøm 1762), e.g. *systegras* ("-gras"), *systelykjil* ("-key"), *systerøter* ("-roots"). Nordhagen (1934) noted only a deviant form, *systergras* ("-grass"), and suggested that *syster* (interpreted as meaning "sister") might refer to the occurrence of separate male and female plants—perhaps a rather too botanical explanation, though Høeg (1974) noted that people at least locally had noticed that there were two different kinds of plants. The latter author recorded a number of similar names, partly with *syste-* and partly with *syster-*. He suggested the latter to be correct, perhaps influenced by the linguist Ivar Aasen's record of *søstregras* ("sisters grass") at Sunnmøre in the 1830s (see Lid 1941). Evidently, Høeg was not aware of the discussion in Søreide (1952), who argued convincingly that the prefix was related to the verb *syste* or *syfte*, "clean" or "purify." *Syftesok* is an old calendar term for July 2, at which date apotropaic plants (e.g. twigs of *Alnus* sp. and *Juniperus communis* L.) were placed in the fields to ward off vermin (Bugge 1921; Riste 1916; Søreide 1952; Wille 1786). Thus, *systegras* and similar names may suggest that folk tradition ascribed *Rhodiola rosea* abilities to ward off evil. This is confirmed by the widespread belief in the plant's ability to protect against fire (see below). The prefix *syster-* (and *søster-*), i.e. "sister," is probably a younger re-interpretation of an old name.

b) In most of North Norway, *R. rosea* is known under names with the prefix *kalv-* or *kalve-* ("calf"), e.g. *kalvegress* ("calf grass"), *kalvedans* ("calf dance"), and others (Alm 1996a; Elvebakk 1979; Heltzen 1834; Høeg 1974; Lagerberg et al. 1955; Mørkved 1996; Øksendal 1977; Qvigstad 1901; Strompdal 1929; NOS). *Kalverot* ("calf root") is also mentioned from the Bergen area in 1599 (Bring 1758; Holmboe 1953; Lagerberg et al. 1955; Rørdam 1873). The name may well derive from North Norway, which was the source of most of the fish exported from the major trade port of Bergen. The origin of the prefix *kalv-* is unclear. Alm (1996a) suggested that it might be due to the past use of *R. rosea* as cattle fodder, potentially an important cure for scurvy (see below). An alternative explanation is a relation to the old Norse term for the thick muscle on the hind side of the leg (Lagerberg et al. 1955), still known (by a Norse loan-word) as *calf* in English. If so, *kalv-* might refer to *R. rosea*'s thick leaves. At least some of the associated suffixes support the former interpretation, e.g. *kalvegror* ("calf growth") and perhaps the widespread *kalvedans* ("calf dance"); an unlikely acitivity for starving cattle. Reichborn-Kjennerud (1922) suggested that *kalvedans* could refer to the plant's dancing and nodding behaviour in wind, but this leaves the

Table 1. Norwegian and Sámi vernacular names for *Rhodiola rosea* in Norway. Names are given with modern Norwegian and North Sámi spellings; deviant spellings used in the original sources are indicated. "Interview" refer to ethnobotanical records made by the author. As far as possible, geographic origin is indicated, using present-day administrative units (counties and municipalities). English translations are literal, but note that some may be folk re-interpretations of older names (see text). A few terms cannot be translated, e.g. the suffix *tort*, otherwise a frequent vernacular name for *Cicerbita alpina* (L.) Wallr., and *mo/mosott*, which are widespread Norwegian terms for a somewhat diffuse disease.

Vernacular name	English translation	Area and source
Norwegian		
Baldans	*Bal* dance	North Norway: Nordland: Leirfjord (Jenssen 1982:43)
Bergakonge	Rock king	Western Norway: Hordaland: Hardanger, interior area (Høeg 1974:597)
Bergbukk	Rock buck	Southern Norway: Aust-Agder: Bygland; Central Norway: Nord-Trøndelag: Verdal (Høeg 1974:596)
Bergebruse	Rock buzz	Southern Norway: Aust-Agder: Bykle; Bygland; Valle (Høeg 1974:596)
Bergebukk	Rock buck	Southern Norway: Aust-Agder: Valle (Høeg 1974:596)
Berggull	Rock gold	Northern Norway: Nordland: Beiarn (Vreim 1943:50, footnote, as bergull)
Bergkrans	Rock wreath	Central Norway: Sør-Trøndelag: Oppdal (Donali 1988:587, as bærjkrans; Høeg 1974:597)
Berjebruse	Rock buzz	Western Norway: Møre og Romsdal: Surnadal (Høeg 1974:596-597, as bærjebruse)
Bukkablom	Buck flower	Western Norway: Rogaland: Forsand (Høeg 1974:597)
Bukkebruse	Buck buzz	Nordland: Vesterålen; Troms: Senja (Ross 1895:66, 71)
Feitbokk	Fat buck	Central Norway: Nord-Trøndelag: Lierne (Sørli); Namdalseid (Høeg 1974:596)
Fjellbruse	Mountain buzz	Møre og Romsdal: Nordmøre (Ross 1895:66)
Fjellbu	Mountain plant	North Norway: Nordland: Sørfold (Engan 2002:56)
Fjellkaur	Mountain curl	Norway: Nordland (Høeg 1974:597; Nordhagen 1934:124); Saltdal (Nordhagen 1934:124); Skjerstad (Høeg 1974:597; NOS); Beiarn (Vegusdal 1979:159, as *fjelljkaur*; Vreim 1943:50; NOS)
Fjellknesk(e)	Mountain squeak	North Norway: Nordland: Bodø (Høeg 1974:597)
Fjellknirke	Mountain squeak	North Norway: Finnmark: Nordkapp (Høeg 1974:597)
Fjellkrans	Mountain wreath	Central Norway: Sør-Trøndelag: Midtre Gauldal (Haukdal 1961:141-142); Soknedal (Høeg 1974:597)

TABLE 1. continued

Vernacular name	English translation	Area and source
Norwegian		
Gnagblomst	Itch (squeak?) flower	North Norway: Nordland: Værøy (Høeg 1974:597)
Hårblomster	Hair flowers	Central Norway: Sør-Trøndelag: Bjugn: Stjørna (Høeg 1974:596)
Hårkjeks	Hair "biscuit" (plant)	Western Norway: Hordaland: Fusa (Høeg 1974:596)
Hårvekster	Hair growth	Western Norway: Sogn og Fjordane: Nordfjord (Krogh 1813:266, 282, as Haarwæxter); Møre og Romsdal area (Gunnerus 1766:49, as Haarvæxter); Central Norway: Sør-Trøndelag: Bjugn; Stjørna (Høeg 1974:596)
Hårvokst	Hair growth	Eastern Norway: Oppland: Dovre; Lesja; Lom (Høeg 1974:596), Nord-Fron: Sikkilsdalen (Nordhagen 1934:124, footnote); Gudbrandsdalen area (Nordhagen 1934:123); Western Norway: Møre og Romsdal: Romsdalen area (Nordhagen 1934:123); Central Norway: Sør-Trøndelag: Oppdal (Donali 1988:587; Rise 1947:56)
Hårvokster	Hair growth	Norway, unspecified (Schübeler 1888:268, as Haarvokster); Eastern Norway: Gudbrandsdalen area (Nordhagen 1934:123); Oppland: Lom (Høeg 1974:596); Western Norway: Møre og Romsdal (Gunnerus 1766:49; Hukkelberg 1952:37), Romsdalen area (Nordhagen 1934:123); Sunnmøre area (Strøm 1762:119, as Haar-Voxter); Nesset: Eresfjorden (Høeg 1974:596); Volda (Høeg 1974:596); Fræna (Høeg 1974:596); Halsa (Høeg 1974:596); Surnadal (Høeg 1974:596; NOS, as hårvåkkster); Sunndal: Ålvundeid (Høeg 1974:596); Central Norway: Grøten—Vedøy (Dahl 1896:70, 1899:8, 58, as Haar-Voxter); Sør-Trøndelag: Oppdal (Donali 1988:587; Rise 1947:50, 56); Roan (Høeg 1974:596); Nord-Trøndelag: Meråker (Høeg 1974:596); Stjørdal/Meråker (Leirfall 1968:510)
Hedlekaure	Heal-curl ?	Western Norway: Hordaland: Hardanger area (Reichborn-Kjennerud 1922:57); Kvam (NFS Gade-Grøn 149)
Heilkaur	Heal-curl	North Norway: Nordland: Rana (unpublished note by Axel Blytt, 1870)
Heilkaure	Heal-curl	Norway, unspecified (Nordhagen 1947:39); North Norway: Nordland: Helgeland? (Reichborn-Kjennerud 1922:57)

Table 1. continued

Vernacular name	English translation	Area and source
Norwegian		
Helkaure	Heal-curl	North Norway: Nordland: Rana (unpublished diary by Axel Blytt, 1870-1875; NOS)
Huskall	House man	Central Norway: Nord-Trøndelag: Lierne: Nordli (Høeg 1974:595, 597)
Kalvdans	Calf dance	Central Norway: Nord-Trøndelag: Vikna (Høeg 1974:596-597); North Norway: Nordland: Hattfjelldal (NFS O.A. Høeg 572); Vevelstad (NFS O.A. Høeg 425); Brønnøy (Strompdal 1929:85, NFS O.A. Høeg 415; NOS); Vefsn (Øksendal 1977:99; NFS O.A. Høeg 88, 445, 719); Rana (NOS, note by Hallfrid Christiansen); Leirfjord (Jenssen 1982:43); Rødøy (NFS O.A. Høeg 36); Flakstad (Mørkved 1996:18); Troms: Harstad; Ibestad; Tromsø: Hillesøy (Høeg 1974:597); Finnmark: Lebesby (Høeg 1974:597)
Kalveblomst	Calf flower	North Norway: Troms: Harstad; Skjervøy (Høeg 1974:597); Kvænangen (interview 2004)
Kalveblomster	Calf flowers	North Norway (Elvebakk 1979:47)
Kalvedans	Calf dance	Central Norway: Nord-Trøndelag: Vikna (Høeg 1974:597); North Norway (Elvebakk 1979:47, as kalvedainjs); Nordland: Vefsn (NFS O.A. Høeg 145); Dønna (NFS O.A. Høeg 145); Brønnøy (Høeg 1974:597); Troms: Harstad (Høeg 1974:597); Ibestad (Høeg 1974:597); Tromsø (Høeg 1974:597; NOS; interview 2001); Kvænangen (interview 1988, 2003); Finnmark: Hammerfest (Qvigstad 1901:311; interview 1998); Kvalsund (interview 2003), Lebesby (Høeg 1974:597), Gamvik (interview 1998); Berlevåg (interview 2003); Båtsfjord (interview 1988)
Kalvedaude	Calf death	North Norway: Nordland: Bindal (Høeg 1974:597)
Kalvegras/kalvgras	Calf grass	North Norway: Nordland: Lurøy; Rødøy; Ofoten area, Troms: Karlsøy (Høeg 1974:597)
Kalvegress	Calf grass	North Norway: Nordland: Rana (Heltzen 1834:8, as Kalvegræs)
Kalvegror	Calf growth	North Norway: Nordland: Vågan (Mørkved 1996:18); Langøya area (Mørkved 1996:18); Narvik (NOS, note by Hallfrid Christiansen); Troms: Tromsø (NOS)
Kalvekål	Calf cabbage	North Norway: Nordland: Rana (Høeg 1974:597)
Kalveknark	Calf squeak (?)	North Norway: Troms: Bjarkøy (Høeg 1974:597)
Kalverompe	Calf tail	North Norway: Troms: Salangen; Tranøy (Høeg 1974:597)

Table 1. continued

Vernacular name	English translation	Area and source
Norwegian		
Kalverot	Calf root	Western Norway: Hordaland: Bergen (Bring 1758:64: Holmboe 1953:9-10; Rørdam 1873:405, diary note of Sivert Grubbe July 5, 1599, as Kalfweroed)
Kalvespreng	Calf burst	North Norway: Nordland: Brønnøy (Høeg 1974:597)
Kalvestolpe	Calf post	North Norway: Nordland: Herøy (Høeg 1974:597)
Kalvgras	Calf grass	North Norway: Nordland: Lurøy (NFS O.A. Høeg 159); Rødøy (NFS O.A. Høeg 36)
Kalvgress	Calf grass	North Norway: Nordland: Lurøy (unpublished note by Hallfrid Christiansen); Vestvågøy (Mørkved 1996:18)
Kalvgror	Calf growth	North Norway: Nordland: Vestvågøy (Mørkved 1996:18); Bø (NFS O.A. Høeg 496); Sortland (NFS O.A. Høeg 715); Langøya (Mørkved 1996:18)
Kalvkaur	Calf curl	Southeast Norway: Vestfold: Sandefjord (NFS O.A. Høeg 603); North Norway: Nordland: Rana (Høeg 1974:597)
Kalvkål	Calf cabbage	North Norway: Nordland: Sortland (NFS O.A. Høeg 346)
Kalvlyng	Calf heather	North Norway: Nordland: Hadsel (Høeg 1974:597)
Kalvtort	Calf *tort*	North Norway: Nordland: Hadsel (Høeg 1974:597)
Knerke	"Squeek"	North Norway: Finnmark: Hammerfest (Høeg 1974:597; interview 2002)
Långrot	Long (?) root	Central Norway: Sør-Trøndelag: Melhus: Hølonda; Midtre Gauldal: Singsås; Holtålen: Ålen (Høeg 1974:597)
Longrot	Long (?) root	Central Norway: Sør-Trøndelag: Melhus: Hølonda; Midtre Gauldal: Singsås; Holtålen: Ålen (Høeg 1974:597)
Lungerot	Lung root	Eastern Norway: Hedmark: Alvdal; Tynset (Høeg 1974:596-597)
Morot	*Mo* root	Central Norway: Nord-Trøndelag: Snåsa (Høeg 1974:597)
Mosottrot	*Mosott* root	Central Norway: Nord-Trøndelag: Snåsa (Høeg 1974:597)
Oksfot	Ox foot	Central Norway: Nord-Trøndelag: Nærøy: Foldereid; Grong: Harran; Høylandet; Snåsa (Høeg 1974:597)
Oksstut	Ox bull	Central Norway: Nord-Trøndelag: Nærøy: Foldereid (Høeg 1974:597)

Table 1. continued

Vernacular name	English translation	Area and source
Norwegian		
Smærbukk	Butter buck	Eastern Norway: Telemark: Vinje (Halvorsen 1988:197)
Smørbukk	Butter buck	Norway, unspecified (Schübeler 1888:268); Eastern Norway: Oppland: Land (NOS); Vestre Slidre (NOS, unpublished notes by G. Kirkevoll and A. Ødegaard); Valdres area (Kirkevoll 1940:173); Western Norway: Hordaland: Fusa; Granvin; Vaksdal; Voss; and several other municipalities (NOS, unpublished notes by T. Hannaas and N. Lid); Møre og Romsdal (NOS); Romsdal area (Gunnerus 1766:49, as Smørbuk, cf. Nordhagen 1934:124)
Smørbukk/smørbokk	Butter buck	Western Norway: Møre og Romsdal: Fræna; Halsa; Nesset: Eresfjord; Sunndal: Ålvundeid; Surnadal; Volda; Central Norway: Sør-Trøndelag: Roan; Nord-Trøndelag: Meråker (Høeg 1974:596)
Smørstakk	Butter skirt	Norway, unspecified (Schübeler 1888:268, as Smørstak; cf. Nordhagen 1934:124)
Søsteløkjel	Purifying key	Western Norway: Sogn og Fjordane: Jølster (Høeg 1974:597)
Søsteløkla	Purifying keys	Western Norway: Sogn og Fjordane: Jølster (Høeg 1974:597)
Søsteløklar	Purifying keys	Western Norway: Sogn og Fjordane: Jølster (Høeg 1974:597)
Søstergras	Sister grass	Møre og Romsdal (Hukkelberg 1952:37); Halsa (NFS Maurit Fugelsøy III:7)
Søstergress	Sister grass	Western Norway: Sogn og Fjordane: Nordfjord (Krogh 1813:266, as Søstergræs); Møre og Romsdal: Sunnmøre area (Strøm 1762, as Søster-Græs; Gunnerus 1766:49, as Søster-græs)
Søsterløk	Sister onion	Western Norway: Sogn og Fjordane: Jølster (Høeg 1974:597)
Søstregras	Sisters grass	Western Norway: Møre og Romsdal: Sunnmøre area (Lid 1941:75, annotation on a specimen in Ivar Aasen's herbarium from 1837 – 39)
Stubberot	Stump root	Norway (Bring 1758:40)—recorded by Sivert Grubbe (as Stubberod) in 1599
Systegras	Purifying grass	Western Norway: Sogn og Fjordane: Bremanger: Davik (Høeg 1974:595), Eid (Høeg 1974:595, 597; Søreide 1952:29); Gloppen; Stryn: Innvik (Høeg 1974:597); Møre og Romsdal: Rauma (Søreide 1952:29)
Systelykjel	Purifying key	Western Norway: Sogn og Fjordane: Naustdal (Søreide 1952:29)

Table 1. continued

Vernacular name	English translation	Area and source
Norwegian		
Systelykla	Purifying keys	Western Norway: Sogn og Fjordane: Naustdal (Høeg 1974:597)
Systergras	Sister grass	Norway (Schübeler 1888:268; Reichborn-Kjennerud 1922:57); Sogn og Fjordane: Lærdal: Borgund; Gloppen; Jølster (Høeg 1974:579); Hornindal (Melheim 1953:49); Møre og Romsdal: Volda; Ørsta (Høeg 1974:597)
Systerlykkjel'e	Sister keys	Western Norway: Sogn og Fjordane: Førde (Høeg 1974:597)
Systerlykla	Sister keys	Western Norway: Sogn og Fjordane: Gaular (Høeg 1974:597)
Systerlyklar	Sister keys	Western Norway: Sogn og Fjordane: Førde; Gaular; Jølster (Høeg 1974:597)
Systerose	Purifying rose	Western Norway: Møre og Romsdal: Vanylven: Syvde (Høeg 1974:597)
Systerøter	Puryifying roots	Western Norway: Sogn og Fjordane: Selje (Søreide 1952:29)
Systerrot	Sister root	Western Norway: Hordaland: Lindås: Alversund (Høeg 1974:596-597); Sogn og Fjordane: Fjaler (NOS, unpublished note by H. Tveit); Møre og Romsdal: Vanylven: Syvde (Høeg 1974:597)
Systregras	Sisters grass	Western Norway: Sogn og Fjordane: Lærdal: Borgund; Møre og Romsdal: Stranda: Sunnylven (Høeg 1974:597)
Takbruse	Roof buzz	Western Norway: Møre og Romsdal: Rindal (Høeg 1974:597; Mo 1925:84); Surnadal (Høeg 1974:597)
Takdupp	Roof-nod	Central Norway: Sør-Trøndelag: Meldal (Høeg 1974:597)
Takgull	Roof gold	Central Norway: Nord-Trøndelag: Nærøy (Høeg 1974:597)
Takkrans	Roof wreath	Central Norway: Sør-Trøndelag: Meldal (Høeg 1974:597)
Taklauk	Roof onion	North Norway: Nordland: Beiarn (Vegusdal 1979:159)
Tjukke-Nils	Fat Nils	Western Norway: Rogaland: Kvitsøy (Høeg 1974:597)
Trappakall	Staircase man	Central Norway: Sør-Trøndelag: Åfjord: Stokksund (Høeg 1974:597)
Trappkall	Staircase man	Central Norway: Sør-Trøndelag: Roan (Høeg 1974:597)
Trappros	Staircase rose	Central Norway: Sør-Trøndelag: Roan (Høeg 1974:597)
Gálbberáhta	Calf sprout	North Norway: Finnmark: Alta (interview 1998)

TABLE 1. continued

Vernacular name	English translation	Area and source
North Sámi		
Gálbberássi	Calf grass	North Norway: Troms: Lavangen (Qvigstad 1901:311, as galbe-rasse); Finnmark: Deatnu/Tana (interview 1996)
Gálbberássit	Calf grasses	North Norway: Troms: Lyngen (Qvigstad 1932:78, as galberaset)

prefix unexplained. The few Sámi names recorded so far, *galbberáhta* ("calf sprout") and *galbberássi* ("calf grass"), belong to the same name complex.

c) Vernacular names with the prefix *hår-* ("hair") occur in parts of southern Norway (Dahl 1898; Donali 1988:587; Høeg 1974; Lagerberg et al. 1955; Nordhagen 1934; Reichborn-Kjennerud 1941; Rise 1947; Schübeler 1888; NOS). They obviously reflect the use of a decoction of *R. rosea* as a hair wash. Vernacular names incorporating the term *kaur* or *kaure*, meaning something curly, may also refer to such use (Nordhagen 1934, 1947).

d) *R. rosea* has sometimes appropriated vernacular names more frequently used for other species, e.g. *smørbukk* ("butter buck"), more frequently a name for *Hylotelephium telephium* (L.) Ohba (syn. *Sedum telephium* L.), e.g. in inland areas adjacent to the latter's mainly coastal distribution (Halvorsen 1988; Kirkevoll 1940), and *taklauk* ("roof onion"), normally *Sempervivum tectorum* L., at a few stations (Vegusdal 1979).

e) A deviant name, *knerke*, was recorded from Hammerfest, Finnmark by Høeg (1974); two informants both explained it as an onematopoeticon: "it squeaks when the flowers are touched"; "if the leaves are touched, one hears a squeaking sound" (translated from Norwegian). This seems to be a well-known tradition in parts of Finnmark; one of my own informants knew the name *kalvedans* from the same area, but suggested *knerke* as an alternative name: "That sound when you touch them, it says [knerke]... I think it was a sound-like name we had." (interviews 1998 & 2002). A few other, sound-based vernacular names are known from North Norway (Table 1).

Rosenrot ("rose root"), the "official" Norwegian name of *R. rosea*, has been introduced through floras. It was first used in the Danish herbal of Paulli (1648), probably based on the German *Rosenwurz*, and has no root in Norwegian folk tradition (Høeg 1974; Nordhagen 1934).

Only two Sámi names for *R. rosea* have been recorded in Norway: *gálbberássi* both in Troms and Finnmark, and *gálbberáhta* in the latter county. *Gálbberássi* is obviously a Norwegian loan-word, identical to "kalvegras." Qvigstad (1901, 1932) noted it from Lavangen and Lyngen, Troms. It is still used, and was re-

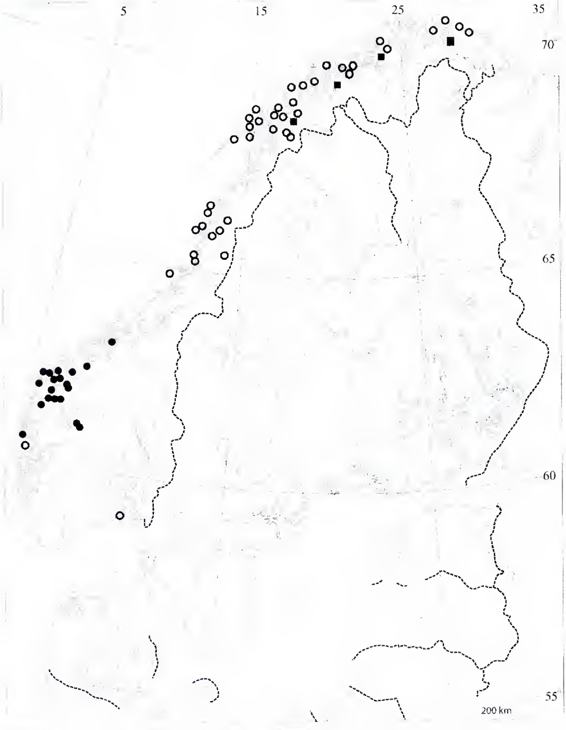


Fig. 1. Geographical distribution of two major groups of vernacular names for *Rhodiola rosea* in Norway. **A.** Norwegian names with prefix of the *syste(r)/søster* type, based on the verb *syfte* or *syste*, "protect" (dots). **B.** Names with a prefix meaning "calf": Norwegian *kalv-/kalve-* (open circles) and North Sámi *gálbbe-* (squares).

corded in the Deatnu/Tana area of Finnmark in the 1990s (Alm & Iversen, unpublished data).

Rhodiola rosea as a Cure for Scurvy

Nordal (1939) studied the contents of vitamine C in various plants species traditionally used to treat scurvy in Norway. Scurvy-grass *Cochlearia officinalis* L. and cloudberries *Rubus chamaemorus* L. may have been the most important of these, at least for human use (Alm 1995, 1996b; Eckblad 1989). *Rhodiola rosea* contains less vitamine C; 12 mg/g (rhizome) and 33 mg/g (fresh leaves) according to Nordal (1939, 1946). Still, it may have been an important source, in particular for livestock (Alm 1996a). Insufficient feeding of cattle during the winter was an established tradition in Norway, and if spring was late, livestock could be heavily affected by scurvy. Cloudberries (and, perhaps less so, scurvy-grass) were reserved for human consumption, but *Rhodiola rosea* was not. Secondly, due to its preference for cliff habitats, the rhizomes could be collected even in late winter. It is also one of the first plants to sprout in spring, and both rhizomes and fresh shoots may thus have served as an important remedy for scurvy in livestock. Records in Elvebakk (1979) and Høeg (1974) confirm that *R. rosea* was usually collected during the period of fodder shortage in late spring. As noted above, such use is a likely explanation for the wide-spread vernacular names with *kalv-* as a prefix, which may thus reflect the species' importance for making cattle (and calves) survive (Alm 1996a; Høeg 1974).

A letter to Olaf I. Rønning, then curator at Tromsø museum, was sent as a response to his popular account (Rønning 1959) of *R. rosea* and its uses. The comment, based on tradition at the west coast of Senja island, Troms county, confirms the use as cattle fodder:

> "In my childhood, about the turn of the century [1900], we [as] children were frequently told to collect *kalvegror*, i.e., *rosenrot* [*Rhodiola rosea*]. It was used as fodder for calves, [which had been] born during the winter, in spring. As it was almost always a shortage of fodder [at this time], the *kalvegror* was a welcome food for the calves (and a vitamine source). The *kalvegror* sprouted earlier than other plants (in our area of southern Berg, and the islets) and was easy to get hold of" (letter from Paul Hay, Gryllefjord, dated January 20, 1960).

Some early data on *R. rosea* ethnobotany, including its use as an antiscorbutic, were recorded during the Danish-Norwegian king Christian IV's naval expedition to the northern outposts of his kingdom in 1599 (Alm 1996a; Nielsen 1873). At least two of the Danes participating (Sivert Grubbe and Jonas Charisius) wrote diaries. A comparison of the two leaves no doubt that Grubbe was the better botanist; his diary (Bring 1758; Rørdam 1873) contains scattered notes on plants seen during the voyage. Despite this, Charisius (1773-76) is more frequently cited, often from an 18th century transcript by Hans Paus (extracts e.g. in Hansen & Schmidt 1985).

Although the most interesting comment on *R. rosea* was made during a visit to the NW Kola peninsula, now on Russian territory (but also claimed as belonging to the king's territory), it is worth recording here: "On this island Kildin there is found a kind of herb at the shore, which the Sámi and Russians call orpin, and [which] is very remarkable to use for scurvy, the root smells of rose, and tastes well in beer" (Charisius 1773-76:74; Hansen & Schmidt 1985:191, translated from Danish).

Qvigstad (1901), in his survey of Sámi plant names, accepted *orpin* as an East Sámi term. It is not, however, included in a dictionary of East Sámi as used in the Kola Peninsula (Genetz 1891). As noted by Alm (1996a), *orpin* is the French name of *R. rosea*, and it is highly unlikely that a similar name should occur in both East Sámi and Russian. The suggestion that it was termed thus by the Sámi is obviously wrong; educated Russians could perhaps have known this name. Qvigstad (1901) couples *orpin* with the Norwegian term *Stubberod*, seemingly as a translation. The latter name is mentioned in Grubbe's Latin diary, in the entry for May 18, 1599:

> "Collegimus in isto monte herbas, quas angli vocant orpin, Norvegi *Stubberod*, præsentissimum remedium contra scorbutum, in illis locis valde familiare. Capitaneus noster usus est illius herbæ foliis loco acetarii." (Bring 1758:40–41)—"In this mountain we collected some herbs, which the English call *orpin*, the Norwegians *stubberod*, an excellent remedy for scurvy, and very frequent in these places. Our captain [king Christian IV] used the leaves of this plant as a salad."

Thus, Grubbe certainly did not record *orpin* as a local name (though it was hardly an English term either, as he believed). *Stubberod* (*stubberot* in present-day Norwegian) is clearly identified as a Norwegian name, otherwise unknown, but easily comprehensible; its meaning ("stump root") is a descriptive term for the rhizomes in their early spring state, i.e., just at the time they were presumably gathered as a cure for scurvy.

Pontoppidan (1752) also noted that *R. rosea* had "en herlig Kraft mod Skiørbug"—"a splendid force against scurvy." Gunnerus (1766) mentioned that "Radix scorbuticis salutaris"—"the root heals scurvy"; this seems to be the last suggestion of human use as an antiscorbutic in Norway.

Rhodiola rosea as Food

Both the rhizomes and green parts of *Rhodiola rosea* are edible. Human consumption is well known from other areas, e.g. Siberia, but seems to have been rare in Norway—at least according to our present knowledge. Ruge (1762), vicar in Valdres, advocated plantations of *R. rosea* as food in times of need, but it is unlikely that this idea was based on local tradition. On the contrary, he referred to Egede (1741), who had noted that the rhizomes were eaten in Greenland. Ruge added that "I have eaten it myself, both fried and roasted as well as cooked, and neither in taste nor effect have I found it unpleasant." (Ruge 1762:286).

Høeg (1974) recorded a single, modern instance of *R. rosea* consumption in western Norway; an informant from Uvdal (Buskerud, SE Norway) claimed that the leaves had been ground and mixed in dough. In addition, children could eat the fresh leaves.

According to Engan (2002), people at Sørfold in North Norway used ground bark of birch (*Betula pubescens* Ehrh.) as a flour substitute during times of need. The resulting flour was coarse and hardly suited for dough. In order to improve it, an unidentified alpine herb called *fjellbu* ("mountain plant") was added. The brief description included fits *Rhodiola rosea*, and hardly anything else, suggesting that it may have had some tradition as an emergency food. No information is given on the plant part used, only that it was boiled before being added to the flour.

Rhodiola rosea as Hair Wash

A decoction of *R. rosea* has been widely used as a hair-wash in Norway, e.g. along the western coast northwards at least to Nordland (Donali 1988:587; Gunnerus 1766; Høeg 1974; Hukkelberg 1952; Lagerberg et al. 1955; Reichborn-Kjennerud 1922, 1941; Rise 1947; Strøm 1762; NOS). This is frequently indicated by its vernacular names (see above), as noted e.g. by the latter author: "In the fjords, it is called Søster-Græs [i.e. sister grass], but otherwise everywhere [at Sunnmøre, western Norway] Haar-Voxter [hair growth], because one boils it in water and washes the hair with it, in the belief, that it will grow well thereafter" (Strøm 1762:119). Two hundred years later, folk tradition in Møre og Romsdal remained unchanged: "*Søstergras* [sister gras] is also called *hårvokster* [hair growth] because if one boiled it in water and washed the hair with it, the hair would grow much better afterwards" (Hukkelberg 1952:37).

The motivation for using *R. rosea* as a hair-wash, according to folk tradition, varies slightly. Some claimed that it prevented hair loss (Donali 1988; Rise 1947), and ensured a long, fine hair, others that it stimulated hair growth or healed various complaints affecting the hair, e.g. dandruff. An undated archival note, again from Møre og Romsdal, adds a piece of folk etymology: "Women who were about to loose their hair made a kind of hair oil from *rosenrot* which made the hair grow well—for this reason [it was] called *søstergras* [sister grass]." (NFS Maurits Fugelsøy III:7).

At Narvik in Nordland, North Norway, folk tradition claimed that plants for use as hair wash should be collected in spring or early summer:

> "If you manage to collect *kalvegrot* before the cuckoo [*Cuculus canorus*] cries, and then boils a decoction from it, it is good for washing the hair." (NOS, unpublished 1940s note by Hallfrid Christiansen).

Other Medical Uses

Apart from its use a an antiscorbutic and as a hair-wash, *Rhodiola rosea* has found little use in Norwegian folk medicine. Høeg (1974) noted that it had been used as a remedy for lung diseases at Volda, W Norway, but also that this might be inspired by its local vernacular name, *lungerot* ("lung root"). From the Nordfjord area of W Norway, Krogh (1813) merely noted that the rhizome was sometimes used as a medicine, and considered an adstringent. According to Kirkevoll (1940), *R. rosea* was "much used as an ointment for wounds" in the

Valdres area of interior SE Norway. In Sunnfjord, W Norway, a poultice of *R. rosea* and ground oats *Avena sativa* L. was used to treat wrenched or swollen limbs (Reichborn-Kjennerud 1922; NFS Gade-Grøn 149). The vernacular name *mosottrot*, used in Snåsa, Nord-Trøndelag (Høeg 1974), also implies a medical use. In folk medicine, *mosott* was a frequently diagnosed, if rather ill-defined disease, usually treated with magical means, in particular "measuring" the patient's body with a woolen tread.

In Lyngen (Troms, North Norway), Sámi folk medicine used a decoction to treat urinary disorder (Qvigstad 1932; Steen 1961): "A decoction of *Rhodiola rosea* (...) is drunk, and the softened roots [rhizomes] are rubbed at both sides of the joint. When the urine starts to drip, another mouthful is consumed." (Qvigstad 1932:78; translated from German).

In his late 17th century topographical description of Finnmark, district govenor Hans H. Lilienskiold mentioned that the Sámi of Finnmark used rose water to treat eye diseases (Qvigstad 1932). No further details are given. *Rosa majalis* J. Herrmann is the only species of the genus occurring in Finnmark, but it is very rare, and it it thus possible that the cure was a decoction of *Rhodiola rosea*, with its characteristic, rose-like odour.

Folk Veterinary Medicine

Apart from its use to heal (or prevent) scurvy, there are few records of *Rhodiola rosea* being used in folk veterinary medicine in Norway. Høeg (1974) noted that people at Hølonda (Sør-Trøndelag, Central Norway) had used it as a "horse medicine, long ago"—which does not exclude the possibility that even this was as a cure for scurvy.

In Hardanger, W Norway, a decoction was given to cattle to treat many kinds of disease, in particular intestinal parasites (Reichborn-Kjennerud 1922). The original record, by Lars T. Steine, dated 1920, is found in the NFS archives:

> "*Hedlekaure* is the name of a plant that grows preferably in the shade (...) It was used for all kinds of animals; it was boiled and given in drink; it was good for many kinds of livestock diseases in particular intestinal parasites" (NFS Gade-Grøn 148).

***Rhodiola* on House Roofs**

Rhodiola rosea was formerly a frequent sight on turf roofs in Norway. According to a widespread tradition, its presence there should protect against fire, e.g. caused by lightning (Fægri 1944; Haukdal 1961; Høeg 1974; Lagerberg et al. 1955; Nordhagen 1934; Vegusdal 1979). A similar tradition related to *Sempervivum tectorum* L. is widespread in Europe. *S. tectorum* is not an indigenous species in Norway, but has a long history of cultivation, and is naturalized at scattered stations in southernmost Norway (Elven 1994; Nordhagen 1941). Both living plants and the associated traditions are likely to have been imported from Central Europe during the middle ages. Further north in Norway, in areas where *S. tectorum* does not thrive, *Rhodiola rosea* has acquired a similar reputation of protecting roofs from fire. According to folk tradition in Gauldal, Central Norway, its purpose was to avert the anger of Tor, the Norse god who controlled thunder and lightning:

> "It was the god Tor who was to be appeased by planting *fjellkransen* on the roof. When he saw the yellow flower on the roof, he passed by without striking it with fire." (Haukdal 1971:141).

The occurrence of an unidentified herb "on everyone"s house roof" in Bergen in the early 13th century is mentioned in the saga of the Norwegian king Håkon Håkonssøn. Nordhagen (1934) argued convincingly that the unnamed plant had to be *R. rosea*. Its use on house roofs is also mentioned in a 16th century description of Bergen (Nordhagen 1934, 1941), and remained well-known as long as turf roofs were common, i.e. well into the early 20th century. This practice is documented from much of southern Norway, especially along the west coast, northwards to the Salten area of Nordland, North Norway (Donali 1988; Grue 1943; Haukdal 1961; Høeg 1974; Kirkevoll 1940; Leirfall 1968; Nordhagen 1934; Søreide 1952; Strompdal 1929; Vegusdal 1979; Vreim 1943). In Beiarn, Nordland, people believed that the custom had been introduced from Bergen (Vegusdal 1979).

Melheim (1953) studied the flora of turf roofs in Hornindal, W Norway in the early 1930s. *Rhodiola rosea* was still frequent, and always planted if found on house roofs, but people could not any longer give any traditional reason for this practice: "Some said it was because the plant was so beautiful, others because great-grandpa had wished it, others because their neighbours had it like that." (Melheim 1953:49).

Norman (1894), in his flora of Norway north of the Polar Circle, recorded numerous stations of *R. rosea* on house roofs, noting for one of these that it was "som sedvanlig plantet"—"as usual planted." Nordhagen (1934) saw several roofs with planted *R. rosea* in Nordland in the 1930s, and recorded vestiges of an oral tradition related to such use. Vreim (1943:50) noted that he had seen "whole roofs of" *R. rosea* in Beiarn, Nordland. Vegusdal (1979:142) recorded a fading tradition in the same area: "Old superstition said that *fjelljkauren* [*R. rosea*] on the roof had power to protect from fire. Lately, some have retained the custom to keep up the old tradition at the farm, or because they found it decorative. In the past, there were few turf roofs, at least at Øynes, on which *fjelljkaur* had not been planted, and they grew well." This tradition may have been known further north as well, as indicated by the following note from Alta, Finnmark: "In Sámi, we call it *gálbberahttá*. And it used to grow on old turf roofs." (interview 1998).

Sempervivum tectorum may form dense mats of leaf rosettes, which may to some extent protect turf and straw roofs from fire (Fægri 1944). *Rhodiola* does not, and there is not much reason to believe that the plants as such had any real protective value. However, the belief may have some ecological justification. In Central Europe, *Sempervivum tectorum* thrives on old turf roofs, since these provide more humid conditions—and would thus less easily burn—than young or new roofs, which are much drier, just as *R. rosea* in Norway is often found on old turf roofs. Still, the Norwegian tradition of planting *Rhodiola* on turf roofs is likely to have been inspired by similar use of *Sempervivum tectorum* in areas further south, with *Rhodiola rosea* serving mostly as an apotropaic. Old photographs (e.g. in Nordhagen 1934 and Fægri 1944) frequently show only a single or a few plants placed along the ridge of the roof. On the other hand, Vreim (1943), in a booklet on timber houses and turf roofs, considered this as a useful practice, offering protection of the weakest part of the turf cover. In some cases, e.g. at Meråker (Nord-Trøndelag, Central Norway), *R. rosea* was placed over the door (Høeg 1974), reflecting a widespread European tradition of plants used as apotropaics to guard the house entrance.

The use of *R. rosea* on house roofs is probably rare by now, although many turf roofs still exist. A late 2002 search of the digital photo database at Tromsø museum yielded 908 photographs of turf roofs all over Norway, but not a single one with visible *R. rosea* stands.

People's belief in *R. rosea* as an apotropaic, protecting houses from fire, may be the reason for its celebrated mention in the saga of king Håkon Håkonssøn. In 1218, his mother, Inga of Varteig, was challenged to prove the royal parentage of her son by an ordeal of carrying hot iron. Prior to the task, Sigarr of Brabant, an employe of Earl Skule, suggested to one of her friends that she could protect herself from burns by salving her hands with the juice of a plant. When questioned where to find this wondrous herb, Sigarr answered "þat vex á þínum húsum ok hver manns hér i Bjorgyn"—"it grows on everyone"s house roof here in Bergen." As noted by Nordhagen (1934), *R. rosea* is the only likely candidate. Nordhagen, however, fails to note that the offer was refused; Earl Skule was one of Inga's enemies, and she may have had reason to consider the suggestion as an attempt at foul play (Hertzberg 1912)—perhaps as a means of persuading her that she had nothing to fear from the ordeal, and thus agree to it. If so, the plan failed. The ordeal was successfully completed, as far as the historical sources can tell without resorting to the protective powers of *R. rosea*, and Inga's son Håkon Håkonssøn went on to become one of the most illustrious Norwegian kings.

DISCUSSION

The uses recorded for *Rhodiola rosea* in Norway are closely reflected in other areas settled by people of Norse origin. Debes (1673) noted that a decoction was used as a kind of "rose water" in the Faroes, presumably as a hair wash; an ointment was used on wounds (Nordhagen 1934). An unpublished Faroese dictionary from about 1670 lists *R. rosea* as *hjalpirót* ("help root"), suggesting some kind of medicinal use, e.g. to improve hair growth (Lange 1960). In Iceland, a decoction of the fresh rhizome was used to wash the head as a cure for headache (Nordhagen 1934); such use was a part of older school medicine. *Rhodiola rosea* was also dried, mixed with butter, and used as an ointment on old wounds (Hallgrímson 1964; Mohr 1786).

In Greenland, the rhizomes of *R. rosea* were eaten by the Eskimos or Inuits (Birket-Smith 1928; Egede 1741; Høygaard 1941; Hughes 1960; Schübeler 1888); leaves and shoots were also consumed. It was also eaten by the Eskimos of North America. In Alaska, both the rhizomes, stems and leaves were eaten, partly fresh (Porsild 1953), fermented or frozen (Moerman 1998). The Eskimos of Nunivak Island, Alaska, prepared a tea from the flowers (Griffin 2001).

The former use of *R. rosea* to treat (or avoid) scurvy is in accordance with its rather high contents of vitamine C. Høygaard (1941, table D) found it to be the richest terrestrial plant source of vitamine C available to the Eskimos in his study area at East Greenland.

Rhodiola rosea is also found in the mountains of Central Europe, and had acquired some reputation as a medicinal plant in this area as well. It is included in several early herbals, e.g. Fuchs (1543) and Bock (1551), and the rhizomes (Radix rosea) were sold in pharmacies. The comments in the major Danish herbal of Paulli (1648) seems to be based mainly on Central European tradition. *Rhodiola rosea* does not occur in Denmark, and its use here was based on cultivated plants—Paulli noted that it was found in some "noble gardens"—possibly supplemented by plant material imported from Norway. Both in Denmark and in Central Europe, *R. rosea* was used to cure head-ache (Paulli 1648, Lippert 1995). The German-speaking farmers of South Tyrol (Italy) believed that a decoction in milk promoted pregnancy (Marzell 1979).

In terms of medical properties, the peoples of eastern Asia have found a much wider use of *Rhodiola* species than that of *R. rosea* in Norway and other parts of Europe. In Russian Siberia, *R. rosea* was considered an aphrodisiac, and supposed to ensure a long life. In Mongolia, it was used to treat cancer and tuberculosis. In China, both *R. rosea* (imported) and other *Rhodiola* species were prized for their medical qualities (Germano & Ramazanov 1999). As a cure for tuberculosis, *R. rosea* was also used by the western Eskimos of North America; the disease was treated with raw flowers (Lantis 1959). The Eskimos of Nelson Island, Alaska, used *R. rosea* to treat sores (Ager & Ager 1980).

Rhodiola species, e.g. *R. quadrifida* (Pall.) Fisch. & Mey., *R. rosea*, and *R. sacra* (Prain ex Hamet) S.H. Fu, are currently the focus of substantial interest in terms of medical and pharmacological properties. Studies of Asiatic species have revealed a vast array of chemical compounds (see Brown et al. 2002, Kurkin & Zapesochnaya 1986, Yoshikawa et al. 1995, 1996, 1997), including some with promising antiallergenic effects. The only biochemical study of Norwegian *R. rosea* so far, by Rohloff (2002), identified various terpenes and volatiles, but failed to identify some constituents (rosiridin, rosiridol) reported from Russian material of *R. rosea* (Kurkin et al. 1995), and found only neglible amounts of octadecadienoic acid, heptanol derivates and hexadecanoic acid, claimed by Belov et al. (1994) to be some of the main constituents. Thus, the biochemical characteristics of *R. rosea* may vary according to geographical origin, and Norwegian plants could differ from those found in Asia in terms of pharmacological properties—which would be in accordance with folk tradition in the two areas. Alternatively, its potential qualities were undetected in Norwegian tradition, or other plants were considered more effective. Norwegian *R. rosea* is rich in the phenylpropanoid rosavin (S. Dragland, pers. comm.), specific to *R. rosea* and now considered to be one the most important constituents in terms of medical activity (Brown et al. 2002), which might support the latter hypothesis. The sparse or absent use of *R. rosea* as food in Norway may also have a biochemical explanation; according to Høygaard (1941), Norwegian *R. rosea* has a much sharper taste than the plants found in Greenland.

At present, the old traditions related to *R. rosea* in Norway are probably fading away, e.g. its former use as an apotropaic on house roofs. The vernacular names are more likely to survive, at least as long as *R. rosea* remains a well known and popular ornamental, especially in rock gardens.

ACKNOWLEDGMENTS

The referees (Joachim Thiede and U. Eggli), Steinar Dragland, and *Sida* editor Barney Lipscomb provided useful comments. Ernst Høgtun prepared the map.

ARCHIVAL SOURCES

NFS (Norsk folkeminnesamling/Norwegian folklore collection): (a) Gade-Grøn, questionaires on Norwegian folk medicine, distributed 1911; (b) original material of O.A. Høeg; (c) undated notes by Maurits Fugelsøy; NOS (Norsk ordbok, seddelarkivet/Norwegian dictionary, card archive).

REFERENCES

Aasen, I. 1860. Norske Plantenavne. Budstikken 2:9–37.

Ager, T.A. and L.P. Ager. 1980. Ethnobotany of the Eskimos of Nelson Island, Alaska. Arctic Anthropol. 17:27–48.

Alm, T. 1995. Multer i folketradisjonen—navn og bruk. Ottar 206:7–12.

Alm, T. 1996a. Bruk av rosenrot (*Rhodiola rosea*) mot skjørbuk. Polarflokken 20:29–32.

Alm, T. 1996b. Bruk av skjørbuksurt (*Cochlearia officinalis*) i Nord-Norge. Blyttia 54: 185–192.

Alm, T. 2000. *Dactylorhiza maculata* (L.) Soó—Norwegian and Sámi ethnobotany of a magical orchid. J. Eur. Orch. 32:189–221.

Belov, V.N., T.V. Lavrova, N.G. Vashkevich, and A.Y. Mikhailov. 1994. Extraction of essential oils from plant raw material by steam distillation. Russ. J. Appl. Chem. 67:154–156.

Birket-Smith, H. 1928. The Greenlanders of the present day. In: M. Vahl, G.C. Amdrup, L. Bobe, and A.S. Jensen, eds. Greenland. Vol. 2. The past and present population of Greenland.

C.A. Reitzel, Copenhagen—Humphrey Milford/Oxford University Press, London. Pp. 1–208.

Bock, H. 1551. New Kreuterbuch. Strassbourg.

Boon-Niermeijer, E.K., A. van der Berg, G. Wikman, and F.A.C. Wiegant. 2000. Phyto-adaptogens protect against environmental stress-induced death of embryos from the freshwater snail *Lymnaea stagnalis*. Phytomedicine 7:1–11.

Bring, S. 1758. Samling Af åtskilliga Handlingar och Påminnelser, Som Förmodligen kunna gifwa Lius i Swänska Historien. III. Lund.

Brown, R.P., P.L. Gerbarg, and Z. Ramazanov 2002: *Rhodiola rosea:* A phytomedicinal overview. HerbalGram 56:40—52.

Bugge, K. 1921. Eneren (*Juniperus communis*) i norsk folketro og skik. Tidssk. Hist. Bot. 1: 141–170.

Charisius, J. 1773–76. Kong Christian den Fierdes Reise til Norge og Vardøhus i Findmarken. In: Samlung zur Dänischen Geschichte, Münzkenntniss, Ökonomie und Sprache durch Johann Heinrich Schlegel. Kopenhagen. Pp. 55–90.

Dahl, O. 1896. Biskop Gunnerus' virksomhed fornemmelig som botaniker tilligemed en oversigt over botanikens tilstand i Danmark og Norge indtil hans død. III. Johan Ernst Gunnerus. Tillæg II: Uddrag af Gunnerus' brevveksling, særlig til belysning af hans videnskabelige sysler. Hefte 1. Kongel. Norske Vidensk. Selsk. Skrifter 1895 (3):11–224.

Dahl, O. 1898. Biskop Gunnerus' virksomhed fornemmelig som botaniker tilligemed en oversigt over botanikens tilstand i Danmark og Norge indtil hans død. III. Johan Ernst Gunnerus. Tillæg II: Uddrag af Gunnerus' brevveksling, særlig til belysning af hans videnskabelige sysler. Hefte 4. F. Breve til Gunnerus. Kongel. Norske Vidensk. Selsk. Skr. 1898 (4):1–83.

Dahl, O. 1899. Biskop Gunnerus' virksomhed fornemmelig som botaniker tilligemed en oversigt over botanikens tilstand i Danmark og Norge indtil hans død. III. Johan Ernst Gunnerus. Tillæg II: Uddrag af Gunnerus' brevveksling, særlig til belysning af hans videnskabelige sysler. Hefte 5. Kongel. Norske Vidensk. Selsk. Skr. 1899 (4):1–164.

Debes, L. 1673. Faeroae et Faeroa reserata. Kjøbenhavn.

Donali, I. (ed.) 1988. Oppdaling. Ord og uttrykk. (Oppdalsboka, vol. 3). Strindheim trykkeris forlag, Trondheim.

Dragland, S. 2001. Rosenrot, botanikk, innholdsstoff, dyrking og bruk. En litteraturoversikt. Planteforsk Grønn forskning 2001 (9):1–28 + 14 pp.

Eckblad, F.-E. 1989. Molter som skjørbuksmiddel i skriftlige kilder. Blyttia 46:177–181.

Egede, H. 1741. Det gamle Grønlands nye Perlustration. Kiøbenhavn.

Elvebakk, A. 1979. Smakebitar frå nord-norsk folkebotanikk med glimt frå Trøndelag og Nordmøre. Polarflokken 3:42–60.

Elven, R. 1994. Johannes Lid & Dagny Tande Lid: Norsk flora. Ed. 6. Det norske samlaget, Oslo.

Engan, H. 2002. Fra barkebrødstider. Årbok for Sørfold 2002:56.

Fægri, K. 1944. Planteverdenen i folketroen. In: S. Solheim, K. Fægri, P. Hovda, and S. Johnsen, eds. Folketru og folkeliv. J.W. Cappelens forlag, Oslo. Pp. 41-55.

Fuchs, L. 1543. New Kreuterbuch.

Genetz, A. 1891. Kuollan lapin murteiden sanakirja ynnä kielennäytteitä. / Wörterbuch der Kola-lappischen Dialekte nebst Sprachproben. Bidrag till kännedom af Finlands natur och folk 50:I–XLVI, 1–291.

Germano, C. and Z. Ramazanov. 1999. Arctic root (*Rhodiola rosea*). The powerful new ginseng alternative. Kensington Publishing, New York.

Griffin, D. 2001. Contributions to the ethnobotany of the *Cup'it* Eskimo, Nunivak Island, Alaska. J. Ethnobiol. 21:91–127.

Grue, T. 1943. Os i Østerdalene. Østgårds trykkeri, Røros.

Gunnerus, J. E. 1766. Flora norvegica. Pars prior. Nidrosiæ (Trondheim).

Hallgrímson, H. 1964. De rhodiolae. Flóra. Tímarit um íslenzka grasafræði 2:77-82.

Halvorsen, R. 1988. En del av kulturarven. Plantenavn i Vinje-dialekten. Blyttia 46:195–198.

Hansen, L.I. and T. Schmidt. 1985. Major Peter Schnitlers grenseeksaminasjonsprotokoller 1742–1745. Vol. 3. Norsk historisk kjeldeskrift-institutt, Oslo.

Haukdal, J. 1961. I skreddartimen. Folkeminne frå Gauldalsbygdene. Norsk folkeminnelags Skr. 87:1-169.

Heizmann, W. 1993. Wörterbuch der Pflanzennamen im Altwestnordischen. (Reallexikon der germanischen Altertumskunde, Ergänzungsbände, Band 7). Walter de Gruyter, Berlin - New York.

Heltzen, I.A. 1834. Ranens beskrivelse. Manuscript, printed as: Ranens Beskrivelse 1834. Rana museums- og historielag/Lofotboka.

Hertzberg, E. 1912. Inga af Varteig og hendes ættlegg. Hist. Tidsskr. 5. Rk. 1:1–28.

Høeg, O.A. 1974. Planter og tradisjon. Floraen i levende tale og tradisjon i Norge 1925–1973. Universitetsforlaget, Oslo—Bergen—Tromsø.

Holmboe, J. 1953. Tidligere undersøkelser over Bergenstraktens plantevekst. Utgitt ved av Knut Fægri. Bergens Hist. For. Skr. 59:1–32.

Høygaard, A. 1941. Studies on the nutrition and physio-pathology of Eskimos, undertaken at Angmagssalik, East-Greenland 1936-1937. Norske Vidensk.-Akad. Oslo, Skr. Mat.-Naturv. Kl. 1940(9):1-176.

Hughes, C.C. 1960. An Eskimo village in the modern world. Cornell University Press, Ithaca, New York.

Hukkelberg, M. 1952. Helsestell og sjukdomar. Årsskr. Romsdal sogelag 1952:33–38.

Hultén, E. 1958. The amphi-atlantic plants and their phytogeographical connections. Kungl. Sv. Vetensk.-Akad. Handl. 4. Series 7(1):1–340.

Hultén, E. and M. Fries. 1986. Atlas of North European vascular plants north of the Tropic of Cancer. Koeltz Scientific Books, Königstein.

Jenssen, Ø. 1982. Leirfjord bygdebok. Særbind I. Helgelandsmålet i Leirfjord. Språk og språkkultur der Vefsn og Rana møter Øyan. Leirfjord bygdeboknemnd.

Kirkevoll, G. 1940. Plantor og plantenamn frå Valdres, serleg frå Vestre Slidre. Tidsskr. Valdres historielag 4(3):165-176.

Krogh, J.A. 1813. Efterretninger om Provstiet Nordfjord i Bergens Stift i Norge. Topogr.-Stat. Saml. Kongel. Selsk. Norges Vel 2(1):1–291.

Kurkin, V.A. and G.G. Zapesochnaya. 1986. The chemical composition and pharmacological properties of *Rhodiola* plants. Khim.-farm. Zhurn. 20:1231-1244.

Kurkin, V.A., G.G. Zapesochnaya, and A.N. Shchavlinskii. 1985. Terpenoids of *Rhodiola rosea* rhizomes. Khim. Prir. Soedin. 5:632–636.

Lagerberg, T., J. Holmboe, and R. Nordhagen. 1955. Våre ville planter. Vol. 3. Johan Grundt Tanum, Oslo.

Lange, J. 1960. Ordbog over Danmarks plantenavne. Vol. II. Munksgaard, København.

Lantis, M. 1959. Folk medicine and hygiene. Anthropol. Papers Univ. Alaska 8:1–75.

Leirfall, J. 1968. Liv og lagnad i Stjørdalsbygdene II. Stjørdalsboka, vol. I, part III. Stjørdal og Meråker kommuner.

Lid, J. 1941. Ivar Aasens herbarium. Nytt Mag. Naturvidensk. 81:57–80.

Lippert, W. 1995. Familie Crassulaceae Dickblattgewächse. In: H.E. Weber, ed. Gustav Hegi. Illustrierte flora von Mitteleuropa. Band IV. Teil 2A. Blackwell Wissenschafts-Verlag, Berlin. Pp. 69-129.

Marzell, H. 1979. Wörterbuch der deutschen Pflanzennamen. Vierter Band. Sabadilla—Zygophyllum. Anhang: Abies—Zygocactus. Schrifttum, Berichtigungen. S. Hirzel Verlag, Stuttgart—Franz Steiner Verlag, Wiesbaden.

Melheim, A. 1953. Om floraen på hustak i Hornindal. Blyttia 11:33–61.

Mo, E. 1925. Rindalske namn på dyr og vokstrar. Aarskr. Nordmør historielag 1925:75–86.

Moerman, D.E. 1998. Native American ethnobotany. Timber press, Portland, Oregon.

Mohr, N. 1786. Forsøg til en Islandsk Naturhistorie. Kjøbenhavn.

Mørkved, B. 1996. "Vårknipa" i nordnorsk tradisjon, med hovedvekt på forholdene i Troms og Lofoten/Vesterålen. Polarflokken 20:9–18.

Nielsen, Y. 1873. Kristian IV's Reise til Finmarken 1599. Kristiania.

Nordal, A. 1939. Über einige norwegische volksmedizinische Skorbut-Pflanzen, und ihren Vitamin-C-Gehalt. Nytt Mag. Naturvidensk. 79:193–231, 81:117–142.

Nordal, A. 1946. A pharmacognostical study of *Sedum acre* L. including a comparison with some other Crassulaceae. Johan Grundt Tanum, Oslo.

Nordhagen, R. 1934. Taklauk og fjellkaur. Maal og minne 1934:101–128.

Nordhagen, R. 1941. De gamle klosterhager. Foreningen til norske fortidsminnesmerkers bevaring. Årsberetn. 1939:55–94.

Nordhagen, R. 1947. Kappilaup, kobbeloppe og kappegullkåre: norske dialektnavn på løvetann. Mål og minne 1947:27-69.

Norman, J.M. 1894. Norges arktiske flora. I. Speciel plantetopografi. Part 1. Kristiania.

Øksendal, K. 1977. Plantenamn frå Vefsn. Årbok for Helgeland 1977:94–102.

Paulli, S. 1648. Flora Danica. Det er: Dansk urtebog.

Pontoppidan, E. 1752. Det første Forsøg paa Norges Naturlige Historie. Første Deel. Kiøbenhavn.

Porsild, A.E. 1953. Edible plants of the Arctic. Arctic 6:15–34.

Qvigstad, J. 1901. Lappiske Plantenavne. Nyt Mag. Naturvidensk. 39:303–326.

Qvigstad, J. 1932. Lappische Heilkunde. Inst. Sammenl. Kulturforskn., Serie B, Skr. 20:1–270.

Reichborn-Kjennerud, I. 1922. Våre folkemedisinske lægeurter. Kristiania.

Reichborn-Kjennerud, I. 1941. Vår gamle trolldomsmedisin. III. Vidensk.-Akad. Oslo. II. Hist.-fil. Kl., Skr. 1940 (1):1–221.

Rise, O.J. 1947. Oppdalsboka. Historie og folkeminne. I. Johan Grundt Tanum, Oslo.

Riste, O. 1916. Primstaven. Nyaars- og tids-rekning, primstav- og "ring"stav. Syn og segn 22:13–22.

Rohloff, J. 2002. Volatiles from rhizomes of *Rhodiola rosea* L. Phytochemistry 59:655–661.

Rønning, O.I. 1959. Rosenrot. Ottar 21:22-24.

Rørdam, H.F. 1873. Sivert Grubbes dagbog. Danske Mag. 4 Rk. 2:361–406.

Ross, H. 1895. Norsk ordbog. Tillæg til "Norsk Ordbog" af Ivar Aasen. Christiania.

Ruge, H. 1762. Forslag Om Plandteringer til at lætte Hungers Nød. Maanedlige Afhandlinger til en og anden Forbedring i Huusholdningen 1762:259–288.

Schübeler, F.C. 1888. Viridarium norvegicum. Norges Væxtrige. Vol. 2. Universitetsprogram, Christiania.

Søreide, L. 1952. Systegras—Syftesoke. Folkeminne ved Samuel Roti. Årbok for Nordfjord 1952:29–31.

Spasov, A.A., G.K. Wikman, V.B. Mandrikov, I.A. Mironova and V.V. Neumoin. 2000. A double-blind, placebo-controlled pilot study of the stimulating and adaptogenic effect of *Rhodiola rosea* SHR-5 extract on the fatigue of students caused by stress during examination period with a repeated low-dose regimen. Phytomedicine 7:85–89.

Springate, L. 1995. *Rhodiola*. In: J. Cullen, J.C.M. Alexander, A. Brady, C.D. Brickell, P.S. Green, V.H. Heywood, P.-M. Jørgensen, S.L. Jury, S.G. Knees, A.C. Leslie, V.A. Matthews, N.K.B. Robson, S.M. Walters, D.O. Wijnands, and P.F. Yeo, eds. The European garden flora. Vol. 4. Cambridge University Press. Pp. 200—203.

Steen, A. 1961. Samenes folkemedisin. Samiske Saml. 5(2):1–62.

Strøm, H. 1762. Physisk og Oeconomisk Beskrivelse over Fogderiet Søndmør, beliggende i Bergens Stift i Norge. Første Part. Sorøe.

Strompdal, K. 1929. Gamalt frå Helgeland. Norsk Folkeminnelags Skr. 19:1–171.

Vegusdal, E. 1979. Gamalt or Beiara. Folkeminne fra Beiarn III. Norsk Folkeminnelags Skr. 119:1–179.

Vreim, H. 1943. Laftehus. Tømring og torvtekking. Ed. 3. Norske arkitekters landsforening, Oslo.

Wille, H.J. 1786. Beskrivelse over Sillejords Præstegield i Øvre-Tellemarken i Norge tilligemed et geographisk Chart over samme. Gyldendal, København.

Yoshikawa, M., H. Shimada, H. Shimoda, H. Matsuda, J. Yamahara, and N. Murakami 1995. Rhodiocyanoside-A and rhodiocyanoside B, new antiallergic cyanoglycosides from Chinese natural medicine si-li-hong-jing-tian, the underground part of *Rhodiola quadrifida* (Pall.) Fisch. et Mey. Chem. Pharm. Bull. 43(7):1245–1247.

Yoshikawa, M., H. Shimada, H. Shimoda, N. Murakami, J. Yamahara, and H. Matsuda 1996. Bioactive constituents of Chinese natural medicines. II. Rhodiolae Radix (1): Chemical structures and antiallergic activity of rhodiocyanosides A and B from the underground part of *Rhodiola quadrifida* (Pall.) Fisch. et Mey. (Crassulaceae). Chem. Pharm. Bull. 44(11): 2086–2091.

Yoshikawa, M., H. Shimada, S. Horikawa, T. Murakami, H. Shimoda, J. Yamahara, and H. Matsuda 1997. Bioactive constituents of Chinese natural medicines. IV. Rhodiolae Radix (2): On the histamine release inhibitors from the underground part of *Rhodiola sacra* (Prain ex Hamet) S.H. Fu (Crassulaceae). Chemical structures of rhodiocyanoside D and sacranosides A and B. Chem. Pharm. Bull. 45(9):1498–1503.

NOTES ON "COFFEE" FROM THE KENTUCKY COFFEETREE (*GYMNOCLADUS DIOICUS*, FABACEAE)

John P. Spaeth and John W. Thieret

Department of Biological Sciences
Northern Kentucky University
Highland Heights, Kentucky 41099, U.S.A.

ABSTRACT

The roasted/ground seeds of the Kentucky coffeetree (*Gymnocladus dioicus*, Fabaceae) were sparingly used in pioneer times as a substitute for arabica coffee. Preparation of the beverage, opinions on its smell and taste, toxicity of the plant, and history and present-day status of this use of the seeds are discussed.

RESUMEN

Las semillas del café de Kentucky (*Gymnocladus dioicus*, Fabaceae) se usaron en los tiempos de los pioneros como un sustituto del café. Se discute la preparación de la bebida, opiniones sobre su olor y sabor, toxicidad de la planta, historia y estatus actual del uso de las semillas.

INTRODUCTION

The assertion that the roasted and ground seeds of the Kentucky coffeetree (*Gymnocladus dioicus* (L.) K. Koch; Fabaceae) (hereafter KCT) can be brewed into a coffee-like beverage and that the Kentucky and Tennessee pioneers made such a beverage from them is repeated frequently in American and even European literature on New World edible wild plants (e.g., Allen & Allen 1981; Bean 1973; Browne 1857; Fernald & Kinsey 1958; Loudon 1838; Loz 1890; Nicholson 1883; Peterson 1978; Rogers 1905; Sargent 1889; Saunders 1920; Vannorsdall 1958; Wampler 2000). Most of the reports are quite definite concerning the pioneers: yes, the seeds were indeed so used by them. Some, though, are a bit uncertain, e.g., "Pioneers may have made a coffee substitute from [the] seeds" (Stacy 1992). Braun (1961) noted that the making of "coffee" from the seeds in Kentucky was in the Bluegrass region, where the tree is as common as or even more common than in most other places.

The Kentucky coffeetree ranges from New York to South Dakota, south to Virginia, and Oklahoma (Little 1977 [range map]; Spaeth n.d.). Its seeds (Fig. 1) are borne in large, woody, brown pods (legumes) (4.3)12–16.5(25?) cm long, 4–5 cm wide, and 1–2 cm thick. The pods remain on the tree throughout much of the winter; at a distance the tree appears to have a flock of birds among its leafless branches. Each pod contains a fleshy pulp in which are embedded 1–9 dark olive brown, hard seeds 1.1–2 cm long and wide and 0.6–1.3 cm thick. The seeds are rock hard—"adamantine," as Rogers (1905), with but slight hyperbole, well

Fig. 1. Kentucky coffeetree (*Gymnocladus dioicus*). Left, pods. Lower right, seeds (a U.S. penny included for size comparison). Upper right, ground seeds, the "coffee."

described them. Later, Rogers (1917) wrote: "How the pioneers ever crushed [the seeds] is a puzzle to all who have tried to break one with a nutcracker."

Living in the Bluegrass region and having access to an ample supply of the seeds, we decided to experiment by preparing a potable drink from them. Next we investigated the matter of toxicity of KCT and the history of beverage use of the seeds. Results of our trials and studies are reported here.

THE "COFFEE"

We found only four recipes for roasting the seeds. One internet site suggested roasting a cup of seeds, one layer thick, in an oven for 30 minutes (Rolen 2001). No temperature was specified, and 30 minutes did not seem to us long enough for any toxins possibly present in the seeds to dissipate (see "Toxicity" below). Another source, which we followed, gave more details: Brill and Dean (1994) suggested a "safe" way to make KCT coffee: bake the seeds in a "covered roasting pan" at 300° F for 3 hours (similar instructions are in Brill [2002] and Phillips [1998], although Phillips suggested 350° F).

On 5 Aug 2003, we put 30 seeds into each of four Pyrex jars labeled 1, 2, 3, and 4, respectively. One layer of seeds covered the bottom of each jar. The jars were roasted at 150° C (≅300° F). During the roasting, the room had at first an aroma of peanut butter. Jar 1 was removed after 2.0 hours, jar 2 after 2.5 hours, and jar 3 after 3.0 hours by which time four of the seeds had burst ("popped"). By the time jar 4 was removed (3.5 hours), the room had an aroma of something burning; 11 seeds had popped.

The next step was to establish a method of breaking the seeds, which were still rock hard. Without a corn grinder available (and fear that if we did have one, the seeds would break the grinder), we used pliers and a mortar and pestle. The seeds were first cracked open one-by-one with the pliers over the mortar. As they were cracked, most shattered or exploded so the cracking was done under a cloth that covered the mortar. They were then coarse-ground with the pestle, pulverized (Fig. 1) in a coffee grinder, and placed back into their respective jars, which were covered in plastic wrap to retain freshness. There appeared to be no relationship between the ease of cracking the seeds and the roasting times.

To make the "coffee," one heaping teaspoonful of ground seeds was placed in $^{3}/_{4}$ of a cup (≅175 ml) of boiling water. (This probably would have been the method used by pioneers.) The grounds were stirred and allowed to settle to the bottom. Twenty people were granted the opportunity to smell and taste this historical drink; their responses are listed in Table 1. No one claimed to enjoy the taste or the experience. All agreed that an overpowering and persistent aftertaste remained.

When the "coffee" was sweetened with sugar, the brew became "more palatable." The four participants who tasted it rated it as "acceptable," "like sweetened tea," "still rather unpleasant," and "could get used to it." The general consensus was that KCT "coffee" is not destined for supermarket shelves. A lot of work, with little pay-off, goes into roasting and grinding the seeds; this may be why some literature rates the brew as a poor substitute for coffee. The second author of the present paper drank about 1/3 cup of sweetened KCT "coffee" every day for 2 weeks, hoping that, with familiarity, the flavor might improve for him; it did not.

Yet, in contrast, some individuals rate the beverage more highly. Brill (2002) called it "the world's best caffeine-free coffee substitute"; his wife, too, likes the drink (Brill, pers. comm., Oct 2003). Phillips (1998) wrote that the beans make "a decent cup of caffeine-free coffee." The brew has been described also as "palatable and wholesome" (Thwaites 1905).

TOXICITY

Anyone wishing to prepare "coffee" from KCT seeds will probably have some interest in reports of the plant's toxicity to various organisms. KCT has long

TABLE 1. Opinions of the taste and smell of "coffee" brewed from ground, roasted seeds of Kentucky coffeetree in a 20-person taste/smell test, October/November 2003, Northern Kentucky University. Identical opinions were expressed by

several participants.

Taste	Smell
Akin to mud	Earthy
Horrible	Chocolaty
Fruity	Stale coffee
A little bit like coffee	Hint of mocha
Why bother?	Chocolate coffee
Like coffee with a touch of chocolate	Low-quality coffee
Like espresso	Like bakers chocolate
Bitter	
Like mocha	
Like bargain coffee	
Three-day-old brewed coffee	
Not worth the effort	
Hint of sour	
Really bad	
Bad after taste	
Pungent	
Not at all like coffee	

been known to possess poisonous properties, both for livestock and humans, though it is by no means a toxic plant of major significance (Kingsbury 1964). The toxin appears to be water soluble; intoxication of livestock has been reported after the animals drank water into which KCT pods had fallen. An extract from the leaves is said to poison flies (Bronaugh 1991; Chesnut 1898; Millspaugh 1887), a report that should be investigated. Toxins are found in all parts of the plant, especially fresh growth, and can cause "stomach and intestinal disorders with diarrhea, vomiting, irregular pulse, and coma" (Hardin & Arena 1974). For over a century, this poisoning has been attributed to the alkaloid cytisine (e.g., Chesnut 1898), but the presence of this compound has never been confirmed in KCT. Unusual amino acids and an alkaloid are reported from the seeds (Southon 1994), but these compounds are not likely to be of toxicologic significance (Burrows & Tyrl 2001).

One's desire to try making "coffee" from the seeds would probably be tempered by statements such as the following: "Only a few cases of human poisoning have been reported from eating the seeds or using them to make a coffee substitute" (Stephens 1980). ". . . chewing one or two [seeds] would not be expected to produce toxic effects" (Lampe & McCann 1985). "Eating the seeds" or "chewing one or two" would, of course, be most unwise because they are so hard; chewing them would be like chewing small rocks.

It appears, though, that there is probably little to worry about with the "coffee." "The toxin is heat labile" and "[the seeds] are not toxic when parched" (Burrows & Tyrl 2001). Nevertheless we do not recommend the "coffee" until more is known about the poisonous compounds in the seeds.

HISTORY

Pioneer times

The earliest appearance of the name *Kentucky* [italics ours] coffeetree—as opposed to simply coffeetree—we have noted is in an April 1785 entry in one of the diaries of George Washington: "Planted ... eight nuts from a tree called the Kentucke [sic] coffee tree . ..." (Jackson & Twohig 1978). According to Hill and Fountain (2003), the Kentucky coffeetree was

> promoted by early land developers who wanted to get settlers out to the "far west" (which included Kentucky at that time). Coffee, a popular beverage, was expensive and hard to find away from coastal ports. Land developers advertised Kentucky as a place where a tree grew with beans that could be roasted and brewed to make a fine coffee substitute. Although drinkable, the beverage was no substitute for coffee, and the early settlers quickly dropped it as soon as the real thing became available.

We were unable to verify this account in spite of extensive searching of literature and internet.

The earliest link we have found between KCT seeds and the "coffee" is in John Filson's *The discovery, settlement and present state of Kentucke* [sic] (Filson 1784): "The coffee-tree greatly resembles the black oak, grows large, and also bears a pod, in which is enclosed good coffee." This statement, however, does not inspire confidence that the author actually partook of the "good coffee" "enclosed" in the pods or that he knew of the *seeds* being the basis for the drink.

In *Pioneer life in Kentucky 1785–1800* (Horine 1948) a letter is quoted from Kentucky pioneer Daniel Drake to his adopted daughter that is definite on the use of the seeds for a beverage: "[We gathered] those wild fruits which were so precious to us in the absence of the cultivated. Some of them were for immediate use, or little thought of except by the children; others had a more permanent value, and were stored for winter . ... Among the latter, grapes, nuts, crab apples, and occasionally the hard seeds of the coffee tree, ... of which, by way of change from Bohea tea [*Camellia sinensis*), we made a substitute for coffee." This report, even in the absence of any other, would seem to verify the pre-1800 use of a beverage made from the seeds of KCT.

Bakeless (1965) wrote about the complaints of a man who, during the 1780's, was a guest at one of the "dreadful" hovels providing food, drink, and bed to Kentucky travellers:

> Nothing to eat but bear meat and 'corn-meal dodgers.' And nothing to drink but whisky ... and coffee 'composed of an article that grew some eight hundred or one thousand miles north of where coffee tree [*Coffea arabica*] ever did grow.' This beverage was brewed from the pod [sic] of the Kentucky 'coffee tree.' The resulting fluid was described by a charitable geographer of the period as 'not unlike coffee.' Another traveler, still more charitable, described it as 'a pod in which is good coffee-seed.'

Michaux (1817; French version 1812) wrote that "the name of coffee tree was given to this vegetable by the early emigrants to Kentucky and Tennessee, who hoped to find in its seeds a substitute for coffee: but the small number of persons who made the experiment abandoned it, as soon as it became easy to obtain from the sea ports the Coffee of the West Indies" (see also Keeler 1900). This, too, has the ring of a reliable report.

The extent of use of the seeds for a beverage recorded by Michaux differs much from that given by others. Saunders (1920) wrote that "a century ago such use of them was quite prevalent in what was then the western wilderness, and travelers' diaries of the time make frequent mention of the practice." Medsger (1972) wrote that "the pioneers apparently made much use of the seeds of this tree, which were roasted and ground, then used as a substitute for coffee." According to Clute (1943), KCT "coffee" was "often" resorted to when the supply of arabica coffee was exhausted. We have made a wide search through the literature—literally many hundreds of sources—and have found nothing that corroborates these statements. Michaux, we believe, was right in his assessment of the frequency of use.

It is perhaps indicative of the *infrequency* of use of KCT "coffee" that Porcher (1863), in his Civil War era *Resources of the southern fields and forests*, did not mention *G. dioicus* even though he listed various coffee substitutes. The tree's range does extend into the far northern part of the area covered in the book (Little 1977; Spaeth n.d.). Perhaps, too, arabica coffee, in spite of war-induced scarcity, was sufficiently available so that substitutes were generally not important; Dick (1974), in his book on the "southern frontier," mentioned that "by 1840 black coffee was coming into use as a beverage." Loudon (1838) noted that the use of KCT seeds for "coffee" had long since been discontinued. Wilson (1905) noted that the "coffee" use had "long since ceased." A 1902 paper on KCT did not mention the "coffee" even though it considered "economic uses" (Anonymous 1902). Gibson (1913), describing the "coffee" as black and bitter and noting that "a little of it would go a long way with a modern coffee drinker," wrote that "when the Kentuckians were able to procure coffee they let the wild substitute alone."

Kentucky and Tennessee were not the only places where this beverage was tried. Thomas Nuttall (1821) apparently had drunk the "coffee": in early 1819 he wrote in the record of his journey into the Arkansas Territory, "Among the trees, we still continue to observe the coffee-bean (*Gymnocladus canadensis*), now loaded with legumes, the seeds of which, when parched . . . produce a substitute for coffee greatly inferior to the *Cichorium* [chicory]." At that writing, he was near the confluence of the Ohio and Mississippi rivers. And in southwestern Iowa during the winter of 1819–1820, KCT "coffee" was drunk by members of S.H. Long's expedition to the Rocky Mountains (Thwaites 1905).

Seeds of KCT were not the only coffee substitute used in early Kentucky.

Another report on the pioneers (Goode 1989), from an area of the state in which KCT is lacking or exceedingly rare (Little 1977), stated that ground parched corn sweetened with honey made a "reasonably tasty substitute for coffee." Other substitutes included parched "tubers," rye, wheat, acorns, beans, chestnuts, chicory, chinquapins, cotton, grapes, peanuts, English peas, persimmons, okra, sorghum, sugar cane, "Irish" and sweet potatoes, and dandelion—and even, in desperation, wood shavings (Anonymous n.d.; Howard 1975; March 2000; Mitchell 1991).

Writing about pioneer Kentucky, Cotterill (1917) mentioned that "Tea and coffee were reserved for the sick and were considered as a mark of effeminacy if taken by people in good health." Was this, in addition to the scarcity of arabica coffee in those early times, maybe one reason to seek a coffee substitute?

One might wonder where the pioneers got the idea of preparing a beverage from these seeds, which seem to us to be a most unlikely source. The seeds certainly do not look like the "beans" of arabica coffee, and the task of preparing them for brewing is daunting. The pioneers might have learned the process from Native Americans; Smith (1928) reported that the Meskwaki Indians cooked the seeds and then ground them and boiled them to make "coffee." These Indians, however, were in Wisconsin, not Kentucky. But perhaps some Kentucky tribes knew of the use and shared the information with the pioneers. Indians of the Missouri River region (Gilmore 1991; Moerman 1998) knew of KCT but apparently did not make a beverage from the seeds although they roasted and ate the seeds and prepared a "food" from the pounded seeds. According to Phillips (1998), "the roasted beans are a reasonably good nut, especially when salted or soaked in salted water and re-baked." We infer that the roasting time, though not stated, is about $^1/2$ to 1 hour.

It is also possible that some pioneers familiar with arabica coffee but suffering coffee deprivation simply tried to make a beverage from KCT seeds, producing a brew that they liked and about which they spread the word.

KCT "coffee" during the Civil War

During the early days of November 2003 we were told by a Civil War history buff (who wishes to remain anonymous) that he had heard from a Civil War re-enactor that, during that war, quite limited use was made of KCT seeds as "coffee." The taste of the "coffee" was reportedly so bad that it made hardtack—those plain flour-and-water biscuits that were often moldy or infested with maggots and weevils (Billings 1887)—seem good by comparison. In her *Civil War plants and herbs*, Mitchell (1996) noted that the seeds are the basis for a "coffee," a report apparently based on Anonymous (1995). But she gave no indication that they were actually *used* for that purpose during the war although, of course, they could well have been. Arabica coffee was apparently a favorite non-alcoholic beverage of soldiers ("how delicious the aroma of it, and how readily each man disposed of a quart" [McCarthy 1882]). Although arabica coffee was available at least some of the time (Locke 1870), its supply in the south was sometimes uncertain because of the vicissitudes of war on land and the Lincoln-ordered blockade of southern ports from Virginia to Texas.

The George Rogers Clark connection

In going through hundreds of KCT websites we came upon one from Storm Lake, Iowa, a city that has a "tree museum" in which various "historic" trees are planted (Anonymous 2003b), among them a "George Rogers Clark Kentucky Coffee tree." The text concerning the tree is as follows: "During the Civil War, George Rogers Clark attempted to develop a coffee bean tree to replace regular coffee which was unavailable during that time. However, since the coffee was not pleasant to the taste, the project failed." Is this statement credible? Certainly not in the timing of Clark's posthumous interest; he died in 1818. One wonders, too, how one could "develop" a tree during the short time span of the Civil War. But we decided to investigate further.

We directed a query to Storm Lake, hoping to learn the source of their KCT. We were given the name of an individual in Louisville; later checking showed that he and another person were involved in a heritage tree program and that one of them is deceased. Two letters to the first man have gone unanswered; we suspect that he, too, has died.

We learned that Clark did send KCT seeds to Thomas Jefferson at Monticello. Indeed, in the Kentucky legislation (Anonymous 2003a) that established *G. dioicus* as the state tree of Kentucky (S.B. 150, approved 8 Mar 1976; later rescinded), one of the "whereas's" is this: "WHEREAS, in 1783 General George Rogers Clark did send seeds of the Kentucky coffeetree to Thomas Jefferson at Monticello and which seeds produces [sic] trees still gracing the grounds of Monticello." In a letter dated 4 Dec 1783 Jefferson wrote to Clark: "We received here about a week ago your obliging letter of Oct. 12. 1783, with the shells and seeds for which we return you many thanks" (Jefferson 2003). One can but assume that among the included seeds were those of KCT. (As an aside, this letter is the one in which Jefferson asked Clark if he would like to lead [an exploration party] into the country from the Mississippi to California.)

We found a brief quote said to be from Clark's October 1783 letter to Jefferson: speaking of KCT, Clark wrote "It makes beautiful shade and we think it will flourish with you" (Anonymous 2003a). Did Clark also mention in the letter the "coffee" use of the seeds of the tree? Inquiries to the Jefferson collection at the Princeton University Library (Linda Monaco, pers. comm., 16 Oct 2003) and to the Monticello Library (Bryan Craig, pers. comm., 16 Oct 2003) elicited the response that the letter is apparently lost.

Finally, we were referred to a person said to be knowledgeable about GRC's correspondence: Julia Parke, former director at Locust Grove, Clark's Louisville home. In an October 2003 telephone conversation with her, the second author was told that she had known of the 12 Oct 1783 letter and that yes, GRC did mention in the letter not only the horticultural possibilities of the tree but also the use of Kentucky coffeetree seeds for "coffee." Thus the Storm Lake report of Clark's interest in KCT had been somewhat exonerated.

CURRENT USE OF KCT "COFFEE"

In an article on various wild-growing substitutes for arabica coffee, Serlin (1977) wrote, "All last winter, along the Ramble in New York City's Central Park, I've seen people pinching coffee costs by scuffing through fallen leaves for precious pods under a stand of Kentucky Coffee Trees." In October 2003, wondering about the frequency of such foraging by New Yorkers, we telephoned Steven Brill, well-known author and educator on the subject of wild edible plants. He told us that, in his years of visiting Central Park, the only foragers he had seen were those accompanying him on his field trips.

According to some of these foragers, the seeds apparently can be used as a chocolaty seasoning in cakes and cookies (Brill & Dean 1994). One seed added to carob-flavored ice cream can make the product "taste more like chocolate than ever" (Brill 2002).

We checked with several more people knowledgeable about the subject of edible wild plants. None knew of anyone who had prepared a drink from KCT seeds.

Other than the reports of Brill (2002), Brill & Dean (1994), Phillips (1998), and Serlin (1977) and the recent brewing of "coffee" from KCT seeds here at Northern Kentucky University, we have located no evidence of significant extant use of the beverage. Even if current edible-plant books mention the use, we suggest that KCT "coffee" is mostly a curiosity from a time now past, being indulged in only by an occasional one of those individuals who eat their way through the landscape (often with tasty rewards). It poses no serious threat to Maxwell House or Starbucks.

CONCLUSION

Limited use of KCT seeds as a coffee substitute was made in pioneer Kentucky and elsewhere. It would appear that the many post-pioneer reports of a KCT-seed-based beverage derive ultimately from a few early accounts; Drake's, Long's, Michaux's, Nuttall's, and possibly Clark's. The Kentucky coffeetree is of essentially no present-day concern as a beverage plant.

ACKNOWLEDGMENTS

We thank the following for help: David M. Brandenburg, The Dawes Arboretum, Newark, OH; Steve "Wildman" Brill, Mamaronech, NY; Kenneth C. Carstens, Murray State University, Murray, KY; Bryan Craig, Library, Monticello, Charlottesville, VA; James Duvall, Boone County (Kentucky) Public Library; Jennifer Gregory, Archives, Steely Library, Northern Kentucky University, Highland Heights, KY; Miriam Steinitz Kannan, Biological Sciences, Northern Kentucky University, Highland Heights, KY; The Lloyd Library, Cincinnati, OH; Patricia B. Mitchell, Chatham, VA; Linda Monaco, The Papers of Thomas Jefferson, Princeton University Library, Princeton, NJ; Julia Parke, Louisville, KY; Maggie Whitson, Northern Kentucky University, Highland Heights, KY; Dennis Worthen, Lloyd Library, Cincinnati, OH; and the 20 brave individuals who took part in our taste/smell tests.

REFERENCES

Allen, O.N. and E.K. Allen. 1981. The Leguminosae. A source book of characteristics, uses, and nodulation. University of Wisconsin Press, Madison.

Anonymous. n.d. The CWi Civil War cookbook. Http://www.civilwarinteractive.com/cookbooknonalcoholic.htm. Accessed 10 Sep 2003.

Anonymous. 1902. Coffeetree (*Gymnocladus dioicus*). U.S.D.A. Forest Serv. Circ. 91.

Anonymous. 1995. Coffee substitutes. Herb Quart. 65 (spring):10.

Anonymous. 2003a. S.B. 150. Kentucky's state tree. http://www.kdla.net/statelib/KYtree.htm. Accessed 10 Sep 2003.

Anonymous. 2003b. Storm Lake [Iowa] Tree Museum. http://www.stormlake.org/city/pages/treemuseum.htm. Accessed 15 Sep 2003.

Bakeless, J. 1965. Daniel Boone. Stackpole Company, Harrisburg, PA.

Bean, W.J. 1973. Trees and shrubs hardy in the British Isles. Volume 2:D–M. John Murray, London.

Billings, J.D. 1887. Hardtack and coffee or the unwritten story of army life. George M. Smith & Company, Boston.

Braun, E.L. 1961. Woody plants of Ohio. Ohio State University Press, Columbus.

Brill, S. and E. Dean. 1994. Identifying and harvesting edible and medicinal plants in wild (and not so wild) places. Hearst Books, New York.

Brill, S. 2002. The wild vegetarian cookbook. Harvard Common Press, Boston.

Bronaugh, W. 1991. The biggest coffeetree. Amer. Forests (May/June):35.

Browne, D.J. 1857. The trees of America; native and foreign. Harper and Brothers, New York.

Buurrows, G.E. and R.J. Tyrl. 2001. Toxic plants of North America. Iowa State Univ. Press, Ames.

Chesnut, V.K. 1898. Principal poisonous plants of the United States. U.S.D.A. Div. Bot. Bull. 20.

Clute, W.N. 1943. Coffee from Kentucky. Amer. Bot. 49:52–53.

Cotterill, R.S. 1917. History of Kentucky. Johnson and Hardin, Cincinnati.

Dick, E. 1974. The Dixie frontier: a social history of the southern frontier from the first transmontane beginnings to the Civil War. Octagon Press, New York.

Fernald, M.L. and A.C. Kinsey. 1958. Edible wild plants of eastern North America. Revised by R.C. Rollins. Harper and row, New York.

Filson, J. 1784. The discovery, settlement and present state of Kentucke. Printed by James Adams, Wilmington, DE.

Gibson, H. 1913. American forest trees. Hardwood Record, Chicago.

Gilmore, M.R. 1991. Uses of plants by the Indians of the Missouri River region. Univ. Nebraska Press, Lincoln. [Work first published in 1919.]

Goode, C.E. 1989. Southern Kentuckians. Historical sketches of Barren and surrounding counties in Kentucky. Published by the author, Glasgow, KY.

Hardin, J.W. and J.M. Arena. 1974. Human poisoning from native and cultivated plants. Duke Univ. Press, Durham, NC.

Hill, D.B. and W.M. Fountain. 2003. Kentucky coffeetree: the state tree of Kentucky. http://www.ca.uky.edu/agc/pubs/for/for8/for8.htm. Accessed 1 Dec 2003.

Howard, M. 1975. Recollections of a Maryland confederate soldier and staff officer under Johnston, Jackson and Lee. Morningside Bookshop, Dayton, OH. [Work first published in 1914.]

Horine, E.F. 1948. Pioneer life in Kentucky 1785–1800. Henry Schuman, New York.

Jackson, D. and D. Twohig. 1978. The diaries of George Washington. Volume 4. http://memory.loc.gov/cgi-bin/query/r?ammem/mgw:@field[DOCID+@lit[wd0414]]. Accessed 1 Dec 2003.

Jefferson, T. 2003. The letters of Thomas Jefferson. The Avalon Project at Yale Law School. http://www.yale.edu/lawweb/avalon/jefflett/let21.htm. Accessed 20 Sep 2003.

Keeler, H.L. 1900. Our native trees. Charles Scribner's Sons, New York.

Kingsbury, J.M. 1964. Poisonous plants of the United States and Canada. Prentice-Hall, Englewood Cliffs, NJ.

Lampe, K.F. and M.A. McCann. 1985. AMA handbook of poisonous and injurious plants. American Medical Association, Chicago.

Little, E.L., Jr. 1977. Atlas of United States trees. U.S.D.A. Misc. Publ. 1342.

Locke, E.W. 1870. Three years in camp and hospital. Geo. D. Russell and Company, Boston.

Loudon, J.C. 1838. Arboretum et fruticetum britannicum. Volume 2. Printed for the author, London.

Loz, M.J. 1890. Le gymnoclade du Canada. Rev. Sci. Nat. Appl. 37:487–488.

March, W.C. 2000. Food and rations in the Civil War. http://users.aol.com/cinticwrt/food.html. Accessed 10 Sep 2003.

McCarthy, C. 1882. Detailed minutiae of soldier life in the army of northern Virginia 1861–1865. Carlton McCarthy and Company, Richmond, VA.

Medsger, O.P. 1972. Edible wild plants. Collier Books, a Division of Macmillan Publishing Company, New York.

Michaux, F.A. 1812. Histoire des arbres forestiers de l'Amérique septentrionale. Tome II. L. Haussmann, Paris.

Michaux, F.A. 1817. The North American sylva, or a description of the forest trees of the United States, Canada and Nova Scotia. Thomas Dobson-Solomon Conrad, Philadelphia.

Millspaugh, C.F. 1887. American medicinal plants. Boericke and Tafel, New York.

Mitchell, P.B. 1991. Desert Storm recalls Civil War food woes. Http://www.foodhistory.com/foodnotes/leftovers/dstorm.htm. Accessed 10 Sep 2003.

Mitchell, P.B. 1996. Civil War plants and herbs. P.B. Mitchell, Chatham, VA.

Moerman, D.E. 1998. Native American ethnobotany. Timber Press, Portland, OR.

Nicholson, G. 1883. The Kentucky coffee tree. Garden 24:29–30.

Nuttall, T. 1821. A journal of travels into the Arkansa [sic] Territory during the year 1819. T.M. Palmer, Philadelphia.

Peterson, L. 1978. A field guide to edible wild plants. Houghton Mifflin Company, Boston.

Phillips, J. 1998. Wild edibles of Missouri. Missouri Department of Conservation, [Jefferson City].

Porcher, F.P. 1863. Resources of the southern fields and forests. West and Johnston, Richmond, VA.

Rogers, J.E. 1905. The tree book. Doubleday, Page & Company, New York.

Rogers, J.E. 1917. Trees worth knowing. Doubleday, Page and Company, Garden City, NY.

Rolen, M. 2001. Kentucky Coffeetree Gymnocladus dioicus www.schools.1th5.k12.il.us/bths-e/2001/kentuckycoffee.html. Accessed 8 Aug 2003.

Sargent, C.S. 1889. The Kentucky coffee-tree. Garden & Forest 11:75–76.

Saunders, C.F. 1920. Useful wild plants of the United States and Canada. Robert M. McBride and Company, New York.

Serlin, K. 1977. My old Kentucky home-made coffee tree. Flower and Garden 21(10):14–15, 42, 47.

Smith, H.H. 1928. Ethnobotany of the Meskwaki Indians. Bull. Milwaukee Public Mus. 4:175–326, plates 37–46.

Southon, I.W. 1994. Phytochemical dictionary of the Leguminosae. Volume 1. Plants and their constituents. Chapman and Hall, London.

Spaeth, J. n.d. *Gymnocladus*. Flora of North America. In preparation.

Stacy, H.P. 1992. Kentucky Coffeetree. Page 493 in J.E. Kleber (editor in chief). The Kentucky encyclopedia. Univ. Press of Kentucky, Lexington.

Stephens, H.A. 1980. Poisonous plants of the central United States. Univ. Press of Kansas, Lawrence.

Thwaites, R.G. (ed.). 1905. Account of an expedition from Pittsburgh to the Rocky Mountains performed in the years 1819, 1820 … under the command of Maj. S.H. Long. 4 vols. Arthur H. Clark Company, Cleveland. (1:265.]

Vannorsdall, H.H. 1958. Trees of Ohio. Privately published, Wilmington, OH.

Wampler, F. 2000. Trees of Indiana. Indiana University Press, Bloomington.

Wilson, E.H. 1905. *Gymnocladus canadensis*—the American coffee-tree. Fl. & Sylva 3: 313–315.

REFLECTIONS ON THE TAXONOMY AND DISTRIBUTION OF MEDICINAL FLOWERS OF PAKISTAN

Mohammad Athar[1]

California Department of Food and Agriculture
2014 Capitol Avenue
Sacramento, CA 95814, U.S.A.
atariq@cdfa.ca.gov

M. Akmal Siddiqi[1]

Clinical Research Center
Marshfield Clinic Research Foundation
1000 North Oak Avenue
Marshfield, WI 54449, U.S.A.
siddiqi.muhammad@mcrf.mfldclin.edu

ABSTRACT

A literature search was conducted to determine the medicinal flowering plants found in Pakistan and used as remedies for various disorders or diseases. The taxonomic position, distribution and flowering period of these plants are described to facilitate their collection at blooming. There are 95 species belonging to 85 genera and 43 plant families. Most of the species belong to Fabaceae and Asteraceae (17 and 13 species respectively), followed by Malvaceae (7 species), Lamiaceae (6 species) and Boraginaceae (4 species). Apocynaceae and Rosaceae contained 3 species each. It is important for the sustainability of Pakistani medicinal plant industry to consolidate the plant-resource database and explore the national and international markets for its medicinal flora. It is imperative that large scale cultivation projects be implemented and that priority species of the medicinal plants be salvaged. Pakistan also needs expanded research efforts into cultivation, production and conservation of medicinal plants. Institutional linkages are urgently needed between all the Pakistani research and development organizations dealing with medicinal and aromatic plants.

RESUMEN

Se realizó una exhaustiva búsqueda bibliográfica acerca de las angiospermas medicinales de Pakistán utilizadas como remedios contra enfermedades de diversa naturaleza. Se preparó una lista de las especies encontradas con referencia a su posición taxonómica. Se incluye su distribución y período fenológico para facilitar su recolección en el momento óptimo de la floración. El listado comprende un total de 85 géneros y 95 especies pertenecientes a 43 familias. La mayoría de las especies pertenecen a las familias Fabaceae y Asteraceae (17 y 13 especies respectivamente) seguidas de Malvaceae (7 especies), Lamiaceae (5 especies) y Boraginaceae (4 especies); Apocynaceae y Rosaceae presentan 3 especies cada una. Resulta importante para la industria sostenible pakistaní de plantas medicinales consolidar el banco de datos disponibles y explorar los mercados nacionales e internacionales que atañen a su flora medicinal. Es imperativo aumentar los proyectos de cultivos a gran escala y preservar la prioridad de las plantas medicinales. Pakistán necesita también extender los esfuerzos de investigación a los problemas sobre cultivo, producción y conservación de plantas medicinales. Destacamos asimismo la imperiosa necesidad de desarrollar un sistema de transferencia institucional entre la investigación y las organizaciones de desarrollo que intervienen en los procesos industriales de plantas medicinales y aromáticas en Pakistán

---

[1] Disclaimer. The views expressed in this article are those of authors and do not necessarily represent those of their respective departments. The publication of this article does not constitute a recommendation or endorsement of the use of these flowers as herbal medicine. The authors or their departments make no warranty, expressed or implied, and assume no legal liability for the use of these flowers for medical purposes.

SIDA 21(1): 357 – 368. 2004

INTRODUCTION

The flora of Pakistan is very rich due to the diverse climatic and soil conditions in its different ecological regions. The country has around 6000 species of wild plants; about 400–600 are considered to be of medicinal importance. Pakistan has considerable significance from the point of view of medicinal plants (Nasir et al. 1972) and has been correctly called as the floral emporium of medicinal plants (Rizvi 1998). An estimated 80% of the rural population in Pakistan depends on traditional medicines for their primary healthcare needs, the majority of that are plants or their active principles (Shinwari & Khan 1998).

The sustainable harvesting of medicinal plants has great economic potential. Although some medicinal plants, such as *Carthamus tinctorius*, *Crocus sativus* and *Passiflora edulis*, are locally grown but require knowledge about the proper collection and preservation of these important medicinal plants (Rizvi 1998; William & Ahmad 1999). However, medicinal plants are used both in the indigenous medicinal system and by pharmaceutical industries (Shaheen et al. 2003).

Many different flowering species, such as *Artemisia absinthium*, (Gul-e-afsantee), *Matricaria chamomilla* (Gul-e-babuna), *Viola odorata* (Gul-e-banafsha), *Rosa damascena* (Gul-e-surkh), and *Crocus sativus* (Gul-e-zafran), are known as potential sources for curing various liver diseases (Bach 1994; Bisset 1994; Duke 1986; Khan et al. 1996). Safflower (*Carthamus tinctorius*) has been used for centuries in Europe and Asia as a laxative and diuretic (Keville 1995). Passionflower (*Passiflora edulis*) is reputed to have anti-spasmodic and sedative properties and used widely as an ingredient in herbal remedies (Reynold et al. 1994). The aqueous extract prepared from the calyx of *Hibiscus sabdariffa* is reported to possess cathartic activity (Haruna 1997).

Classification of medicinal plants is organized in different ways depending on the criteria used. In general, medicinal plants are arranged according to their active principles in their storage organs of plants, particularly roots, leaves, flowers, seeds and other parts of plant (Shaheen et al. 2003). These principles are valuable to mankind in the treatment of diseases (Shaheen et al. 2003; Shinwari & Khan 1998). According to the literature there are many Pakistani medicinal plants (Bach 1994; Nasir & Ali 1972; Rizvi 1998; Shinwari & Khan 1998) that could be used for remedies, medicinal preparations and future utilization (Bach 1994; Bugti 1998; Mahmood et al. 1996; Nasir & Rafiq 1995; Shinwari & Khan 1998; Zaman & Khan 1970). This paper presents the taxonomy of Pakistani medicinal flowering plants, their regional distribution, and flowering periods.

MATERIALS AND METHODS

A literature search was conducted to find out which Pakistani plants are used as remedies for various disorders or diseases (Bach 1994; Bugti 1998; Duke 1986;

Mahmood et al. 1996; Malik & Farooq 1984; Nasir & Ali 1972; Nasir & Rafiq 1995; Rizvi 1998; Shaheen et al. 2003; Shinwari & Khan 1998; Zaman & Khan 1970). The taxonomic position of species with medicinal properties was determined. Their distribution and flowering period was also noted to facilitate their collection at blooming. The plants included herbs, shrubs, vines and trees. The genera were arranged alphabetically within each family. The nomenclature and classification followed Nasir and Ali (1972), and author citations followed Brummitt and Powell (1992).

RESULTS AND DISCUSSION

Ninety-five Pakistani species distributed among 85 genera and 43 plant families were found to have medicinal properties (Table 1). The largest numbers of species were found in Fabaceae and Asteraceae (17 and 13 species respectively), followed by Malvaceae (7 species), Lamiaceae (5 species) and Boraginaceae (4 species). Apocynaceae and Rosaceae each contained 3 species of medicinal plants. Other families contained only one or two species of medicinal plants (Table 1). Their flowering period and distribution were also worked out and presented in Table 1. The medicinal plants that are commercially exploited in large quantities occur mainly in four ecological regions of Pakistan: alpine and high altitude; temperate mountain forests; sub-tropical foothill forests; and arid and semi-arid scrubs (Ali & Qaiser 1986; Shaheen et al. 2003; William & Ahmad 1999).

A number of medicinally important Pakistani plants are found in the moist alpine and high altitude areas, especially in the northwestern valleys (Nasir & Ali 1972; Shaheen et al. 2003; William & Ahmad 1999). Most plants of these areas are slow growing perennial species, which require several years of vegetative growth before reproduction by seed (Shaheen et al. 2003). Some of the species are classified as threatened or vulnerable if the current rate of collection continues. Endangered plant species of this area includes *Podophyllum hexandrum, Saussaurea costus, Picrorrhiza kurrooa, Aconitum heterphyllum,* and *Corydalis* sp. (Shaheen et al. 2003). Care should be taken in the conservation of plants with medicinal flowers so that their existence is not threatened.

The origin of Unani (Greek) medicines goes back to the material medica of numerous early civilizations. Unani medicine traces its origin to Greek medicine, which was adopted by the Arabs and thereafter spread to both Europe and Indo-Pak subcontinent (William & Ahmad 1999). There are about 27 large, Pakistani herbal-manufacturing companies, which produce Unani medicines on a commercial scale (Shaheen et al. 2003). The number of herbal-medicine manufacturers in the non-organized sector runs into the hundreds. The annual gross income of some large herbal manufacturers is comparable to that of multinational companies in Pakistan. About 50,000 traditional healers, including homeopaths, are serving about 60% of the population, especially those living in rural areas (Shaheen et al. 2003; William & Ahmad 1999).

TABLE 1. The taxonomy, distribution, and flowering period of some of the medicinal flowers of Pakistan.

Species	Flowering period	Distribution	Medicinal Remedies
MONOCOTYLEDONS			
Poaceae			
Cymbopogon jwarancusa (Jones) Schult.	Jul–Oct	Found in Karachi, Multan, Chitral, NWFP, Quetta, Gilgit	Detoxifier, astringent and tonic
Zea mays L.	Feb–May	Cultivated in Sindh, Punjab, NWFP	Astringent, chloretic, diuretic and remedy for urinary infection
DICOTYLEDONS			
Acanthaceae			
Adhatoda vasica Nees = *Justicia adhatoda* L.	Feb–Apr	Planted in Karachi, Sindh	Asthma, bronchitis, gonorrhea, highgrade fever and conjunctivitis
Amaranthaceae			
Achyranthes aspera L.	Sep–Apr	Found in Gilgit, Karachi, Punjab, Baluchistan	Anti-hemorrhoidal
Celosia cristata L. = *Celosia argentea* L. var. *cristata* (L.) Kuntze	Oct–Dec	Grown in gardens	Astringent, anti-diarrheal and for irregularity of menstrual cycle
Anacardiaceae			
Mangifera indica L.	Jan–Mar	Grown in Punjab and Sindh	Astringent, urinary infection, catarrh, anti-diarrheal, anti-dysentery, veneral diseases
Apocynaceae			
Catharanthus roseus (L.) G. Don.	Throughout out the year	Cultivated and naturalized in the tropics	Asthma, anti-leukemia, eyes salve and flatulence
Pergularia extensa Jacq. = *Pergularia daemia* (Forssk.) Chiov. var. *daemia*	Sep–Apr	Found in Karachi, Sindh, Lasbella, Peshawar, Rawalpindi	Anthelmintic, emetic, expectorant
Vinca major L.	Dec–Mar	Found in Parochial, Abbottabad, More hills	Fresh flowers are purgative
Asclepiadaceae			
Calotropis procera (Aiton) W.T. Aiton	Throughout the year	Widely distributed in deserts throughout Pakistan	Asthma, catarrh, cold, cough, cholera, and for dyspepsia
Asteraceae			
Achillea millefolium L.	Aug–Mar	Occurs in Gilgit, Swat, Murree, Poonch, Baluchistan, Chagia	Hypotensive, haemostatic to arrest bleeding
Artemisia absinthium L.	Aug–Sep	Grows in Thandiani	Anthelmintic, anti-scorpion venom and anti-snake venom

TABLE 1. continued

Species	Flowering period	Distribution	Medicinal Remedies
Artemisia maritima L.	Aug–Sep	Found in Astor, Baluchistan, Chitral, Swat	Dyspepsia, tonic and anti-helminthic
Calendula officinalis L.	Dec–Apr	Cultivated in many parks and gardens of Pakistan	Duodenal-gastric ulcers, hypotensive, emmenagogue and cures skin diseases
Carthamus tinctorius L.	Apr–Jul	Distributed NWFP, Baluchistan, (Harnai), Punjab	Emmenagogue, laxative, sedative, stimulant
Chrysanthemum cinerariifolium (Trevir.) Vis.=*Tanacetum cinerariifolium* (Trevir.) Sch. Bip.	Mar–Jul	Cultivated in Peshawar, Abbottabad	Aperient, conjunctivitis and dyspepsia
Helianthus annuus L.	Jul–Sep	Widely cultivated in Pakistan	Anti-diarrheal, anti-inflammatory carminative, diuretic
Matricaria chamomilla L. = *Matricaria recutita* L.	Jul–Jan	Found in plains of Punjab, Pishin	Analgesic, antiseptic, carminative, anti-convulsant, diuretic, liver diseases, dyspepsia
Silybum marianum (L.) Gaertn.	Mar–Apr	Found in Lahore, Peshawar, Saidu Sharif, Abbottabad, Mirpur, Rawalpindi	Flower heads are consumed for diabetes control
Tagetes erecta L.	Jun–Nov	Grown in gardens of Pakistan	Anti-dote against wasp stings, cure for eczema, diuretic
Tanacetum gracile Hook.f. & Thomson	Jun–Aug	Found in Hunza, Baluchistan	Anti-helminthic
Taraxacum officinale F. H. Wigg. Group	Feb–Apr	Widely distributed throughout Baluchistan	Aperient, diuretic, stimulant, stomachic, tonic, detoxicant
Xanthium strumarium L.	Jul–Aug	Found in Karachi, Gilgit, Chitral, Baluchistan, Swat, NWFP, Hazara	Flowers useful for tooth-ache
Balsaminaceae			
Impatiens balsamina L.	Jul–Oct	Cultivated in Karachi, Chitral, Murree	Antibiotic activity, inter-costal neuralgia and useful in lumbago
Bignoniaceae			
Millingtonia hortensis L.f.	Nov–Mar	Cultivated in Sindh, Punjab	Cures asthma
Stereospermum suaveolens DC. = *Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb.	May–Jun	Occurs in Rawalpindi District	Aphrodisiac, hiccoughs

TABLE 1. continued

Species	Flowering period	Distribution	Medicinal Remedies
Bombacaceae			
Bombax ceiba L.	Dec–Mar	Cultivated as roadside and garden plant in Pakistan	Diuretic and laxative
Boraginaceae			
Arnebia benthamii (Wall. ex G. Don) I.M. Johnst.	Oct–Nov	Found in Makran, Kaghan, Poonch	Angina, fever, pharyngitis
Borago officinalis L.	Jan–Feb	Reproduced from seeds at Karachi	Anti-cancer agent (breast or face), corns, sclerosis and tumors
Onosma hispidum Wall. & G. Don	Mar–Jul	Found in Pishin, common in Landikotal, Swat, Chitral, Kaghan	Cardiac tonic, stimulant
Trichodesma indicum (L.) Sm.	Aug–Oct	Occurs in Mangopir	Flowers used as emullient and diuretic
Brassicaceae			
Cheiranthus cheiri L. *Erysimum cheiri* (L.) Crantz	Mar–May	Cultivated in gardens	Cardiac disorders, emmenagogue, remedy for impotence and paralysis
Byttneriaceae			
Pterospermum acerifolium (L.) Willd.	Dec–Jul	Cultivated in Islamabad, Peshawar as an introduced tree	Dehydration, otalgia, haematuria, massage
Cannabaceae			
Humulus lupulus L.	Jul–Aug	Found in Pangi on the upper Chenab	Anti-septic, female inflorescence used as diuretic, emmenagogue, dyspepsia
Caprifoliaceae			
Sambucus nigra L.	Mar–Apr	Occurs in Parachinar, Nathiagali, Hazara	Laxative, anti-pruritic and stimulant of blood circulation
Cucurbitaceae			
Trichosanthes dioica Roxb.	Jun–Oct	Found in Punjab, Ravi, Chenab,Doab, Rawalpindi District	Lowers total cholestrol and blood sugar
Fabaceae (***Caesalpinioideae***)			
Bauhinia purpurea L.	Sep–Nov	Cultivated in Punjab, NWFP, Rawalpindi	Flowers are used as purgative
Bauhinia variegata L.	Feb–Apr	Cultivated in Pakistan	Flowers are aperient
Caesalpinia pulcherrima (L.) Sw.	Apr–Sep	Cultivated in gardens of Pakistan	Asthma, bronchitis, anti-pyretic, expectorant, anti-malarial
Cassia alata L. = *Senna alata* (L.) Roxb.	Oct–Dec	Sometimes cultivated in Pakistan	Laxative. Useful in skin texture

TABLE 1. continued

Species	Flowering period	Distribution	Medicinal Remedies
Cassia fistula L.	Apr–May	Naturalized throughout Pakistan. Cultivated in Karachi, Punjab	Cough, diphtheria, laxative, edema
Cassia siamea Lamk. = *Senna siamea* (Lam.) H. S. Irwin & Barneby	Oct–Dec	Cultivated in Karachi, Sindh	Anthelmintic, anti-hypertensive, asthma, dandruff, insomnia, laxative, tranquilizer, sedative
Delonix regia (Bojer ex Hook.) Raf.	May–Jun	Planted in Karachi, Hyderabad, Lahore	Anthelmintic
Tamarindus indica L.	Feb–Apr	Grown in Sindh, Punjab, Jehlum, Karachi	Anti-viral against New Castle disease virus, astringent and sedative
Fabaceae (*Mimosoideae*)			
Acacia nilotica (L.) Delile	May–Jun	Found cultivated or wild in Sindh, Punjab, Baluchistan, NWFP	Useful in jaundice and palpitations
Albizia lebbeck (L.) Benth	Jul–Oct	Grows in Sialkot to Hajara, Bajaur, Malakand	Aperient, boils, carbuncle, antibacterial
Prosopis cineraria (L.) Druce	Apr–Jul	Found in Sindh, Baluchistan, Punjab (in Thal and Cholistan deserts)	Beneficial against miscarriage
Fabaceae (*Papilionoideae*)			
Butea frondosa Roxb. = *Butea monosperma* (Lam.) Taub.	Mar–Apr	Cultivated in Punjab, NWFP	Anti-pyretic, appetizer, aphrodisiac, blood purifier, diuretic, tonic, viral hepatitis
Butea monosperma (Lam.) Taub.	Mar–Apr	Cultivated in Punjab, NWFP	Astringent, aphrodisiac, boil depurative, diuretic, gout, anti-leprosy agent
Pongamia pinnata L. = *Millettia pinnata* (L.) Panigrahi	Apr–May	Cultivated in Sindh, Punjab	Flowers are used in diabetes
Sesbania grandiflora (L.) Pers.	Aug–Mar	Planted in Karachi, Kutch, Sindh, Punjab	Flower juice improves vision (as eye drops)
Sesbania sesban (L.) Merr.	Apr–Nov	Found cultivated and wild in Sindh, Punjab	Anti-fertility activity reported
Trifolium pratense L.	Feb–Apr	Occurs in Chitral, Astor, Swat, Hazara	Anti-asthmatic, anti-spasmodic, bronchitis and expectorant
Iridaceae			
Crocus sativus L.	Oct	Propagated by bulb in Baluchistan	Beneficial for liver, brain, heart, regulates the menstrual function

TABLE 1. continued

Species	Flowering period	Distribution	Medicinal Remedies
Lamiaceae			
Hyssopus officinalis L.	Jun–Sep	Cultivated in Kashmir, Pangi, Upper Chenab	Used for chest congestion, flower tea is expectorant
Leucas aspera (Willd.) Link	Aug–Feb	Found in Jammu, Ghat, Ravi, Chenab, Doab	Anti-tussive, decongestant for children
Mentha longifolia (L.) Huds.	Feb–May	Common in home gardens	Carminative and stimulant
Ocimum basilicum L.	Nov–Apr	Cultivated in Karachi, Baluchistan, Punjab	Decongestant
Pervoskia abrotanoides Kar.	Sep–Oct	Occurs in Baluchistan, Chitral, Gilgit, Hunza, Quetta, Ziarat	Anti-pyretic
Linaceae			
Linum usitatissimum L.	Feb–Apr	Cultivated in Karachi	Cardiac and nerve tonic
Lythraceae			
Lawsonia inermis L.	Jun	Found in Sindh, Baluchistan, Punjab	Anti-pyretic, sedative, soporific
Magnoliaceae			
Michelia champaca L.	Throughout the year	Cultivated in Punjab, NWFP	Used in dyspepsia, anti-pyretic, anti-emetic
Malvaceae			
Abutilon indicum (L.) Sweet	Feb–Mar	Widely distributed in Karachi, Sindh, lower hills of Punjab	Anti-diarrheal, demulcent, anti-hemoptysis, sedative and decongestant
Althaea officinalis L.	Jul–Oct	Grows in Azad Kashmir, Peshawar, Rawalpindi	Emollient, demulcent, diuretic, bronchial catarrh and rheumatism
Gossypium herbaceum L.	May–Jul	Cultivated as a crop in Punjab and Sindh	Extracted flowers used as abortificient and for inducing menstrual flow
Hibiscus cannabinus L.	Autumn–Winter	Cultivated in Sindh, Karachi, Swat, Punjab, Chitral	Gastritis and popular laxative
Hibiscus rosa-sinensis L.	Apr–Sep	Grown as ornamental plant in Punjab, Sindh	Cardiac tonic, expectorant, anti-pyretic, anti-tussive, decongestant
Hibiscus sabdariffa L.	Aug–Sep	Cultivated in Karachi	Cathartic activity
Urena lobata L.	Sep–Dec	Occurs in Lahore, Jehlum, Changa Manga	Aphthosis, expectorant, decongestant
Meliaceae			
Azadirachta indica A. Juss	Mar–Apr	Found in Sindh, southern Punjab, lower Baluchistan	Adrenalgic stimulant, dyspepsia, also used in skin diseases
Melia azedarach L.	Mar–May	Found in Sindh and Punjab	Poultice to relieve headache, nervousness

Table 1. continued

Species	Flowering period	Distribution	Medicinal Remedies
Moringaceae			
Moringa oleifera Lam.	Feb–Apr	Cultivated in Rawalpindi, planted in Sindh	Cholagogue, diuretic tonic
Musaceae			
Musa sapientum L. = *Musa ×paradisiaca* L.	Feb–Sep	Cultivated in Sindh, Punjab, NWFP	Anti-hypoglycemic
Myrtaceae			
Myrtus communis L.	Apr–Jun	Wild in Baluchistan, NWFP	As anti-septic, disinfectant
Nyctaginaceae			
Mirabilis jalapa L.	Nov–Jan	Found in Karachi, NWFP, Hunza, Gilgit	Anti-hemorrhoidal
Nymphaeaceae			
Nelumbo nucifera Gaertn.	May–Jul	Found in Charsada, Multan, Shahdara	Cardiac tonic, diuretic, anti-pyretic
Oleaceae			
Jasminum grandiflorum L.	Warm season	Occurs in Peshawar, Karachi	Aphrodisiac, astringent, carminative, dysentery, hepatitis, suppress excess lactation
Jasminum sambac (L.) Aiton	Jul–Oct	Occurs in Karachi, Lahore, Islamabad	Anti-pyretic, cardiac tonic, lactifuge
Paeoniaceae			
Paeonia emodi Wall. ex Royle	May–Jun	Common in moist ground. Kaghan, Thandiani, Chitral, Bahrin, Poonch	Anti-diarrheal
Papaveraceae			
Papaver rhoeas L.	Jun–Sep	Cultivated in gardens	Bronchitis, hoarseness, sedative, sudorific
Passifloraceae			
Passiflora incarnata L.	Jul–Sep	Cultivated in Karachi	Asthma, dysentery, insomnia, whooping cough
Pontederiaceae			
Eichhorina crassipes (Mart.) Solms	Apr–Jul	Occasionally found filling ponds in plains	Arthritis and gout
Punicaceae			
Punica granatum L.	May–Jun	Commonly grown in Quetta, Sibbi, Karachi, Punjab, NWFP	Anti-diarrheal, dysentery, bronchitis

Table 1. continued

Species	Flowering period	Distribution	Medicinal Remedies
Rosaceae			
Eriobotrya japonica (Thunb.) Lindl.	Jul–Aug	Cultivated in sub-Himalayan zone	Flowers are expectorant
Rosa ×damascena Mill.	Jan–Jul	Cultivated in gardens of Pakistan	Anti-HIV, aperient, cardio-active, liver protector
Rosa foetida Herrm.	Jan–Jul	Found in Baluchistan, Kurrum, Quetta, Ziarat	Anti-diarrheal
Sapotaceae			
Bassia latifolia Roxb. = *Madhuca longifolia* (L.) J.F. Macbr.	Jul–Aug	Cultivated in Sindh, Punjab	Regarded as bronchitis, cooling, cold, anti-tussive, demulcent and tonic
Scruphulariaceae			
Verbascum thapsus L.	Jun–Aug	Common in Chitral, Mansehra	Coughs, diarrhea, febrifuge, stimulant, pharyngitis
Solanaceae			
Datura metel L.	May–Jun	Weedy places, Karachi	Smoke as anti-asthma
Solanum surattense Burm. f. = *Solanum virginianum* L.	Jun–Nov	Throughout Pakistan	Paresthesia, carminative
Rubiaceae			
Ixora coccinea L.	Jul–Jan	Cultivated in Karachi	Cure sores, relieve blood, ulcers
Tropaeolaceae			
Tropaeolum magus L.	Dec–Feb	Cultivated in Karachi	Natural anti-biotic
Verbenaceae			
Nyctanthes arbor-tristis L.	Aug–Oct	Naturalized in Punjab, Rawalpindi, NWFP, Mardan	Anti-pyretic, faintness, anti-vertiginous
Vitex negundo L.	Mar-Jun	Cultivated in Thai, Swat, Mirpur	Cardio tonic, cholera, diarrhea, useful for liver disorders
Violaceae			
Viola odorata L.	Mar–May	Naturalized in Nathia gali, Hazara, Kaghan, Swat, Chital	Liver protector, decongestant

Pakistan has the potential for sustainable utilization of its medicinal flora. Basic infrastructure also exists to carry out research and development activities in this field. However, more attention needs to be paid to the systematic propagation, collection and conservation of medicinal plants. It is important that the country consolidates its plant-resource database, explores the international and national markets for its medicinal flora, and implements large scale cultivation projects and salvage projects for its more important medicinal-plant species. Pakistan needs an expansion of research efforts into cultivation, production and conservation of medicinal plants. There is also a dire need to develop a system of institutional linkages among all the research and development organizations dealing with the Pakistani medicinal and aromatic plant industry.

ACKNOWLEDGMENTS

Special gratitude is expressed to Joseph H. Kirkbride, USDA, Agricultural Research Service, Beltville, MD, for his help in checking the nomenclature and taxonomy of the plants and Mohammad Nawaz, California Department of Health Services, Sacramento, CA, for valuable suggestions and helpful criticism on the manuscript. The authors are also grateful to Zahoor Ahmad, Pakistan Agricultural Research Council, Islamabad, and Prof. M. Iqbal Choudhary, H.E.J. Research Institute of Chemistry, University of Karachi, Karachi, Pakistan for providing many original reprints used in the preparation of this paper.

REFERENCES

Ali, S.I. and M. Qaiser. 1986. Phytogeopraphic analysis of phanerogams of Pakistan and Kashmir. Proc. Roy. Soc. Edinburgh. B89:89–101.

Bach, E. 1994. Flower remedies. Alternat. Med. 232–243.

Bisset, N.G. 1994. Herbal drugs and phytopharmaceuticals. CRC Press, Boca Raton, Florida, U.S.A.

Brummitt, K.R. and C.E. Powell (eds.). 1992. Authors of plant names. Royal Botanic Gardens, Kew, U.K.

Bugti, R.A. 1998. Prospectus and potentials of saffron (*Crocus sativus* Linn.) cultivation in Baluchistan. In: N. Haq, K. Anthony, M. Sarwar and Z. Ahmad, eds. Proceeding of Symposium on under Utilized Crops of Pakistan. Plant Genetic Resources Instititute, National Agricultural Research Center, and ICUC, Agha Jee Printers, Islamabad, Pakistan. Pp. 101–103.

Duke, J.A. 1986. CRC Handbook of medicinal herbs. CRC Press, Boca Raton, Florida, U.S.A.

Haruna, A.K. 1997. Cathartic activity of soborodo; the aqueous extract of calyx of *Hibiscus sabdariffa* L. Phytother. Res. 9:307–308.

Keville, K. 1995. Herbs an illustrated encyclopedia. Michael Friedman Publishing Group, U.K.

Khan, H.A., T.O. Siddiqui, and J. Ahmad. 1996. Medicinal plants and herbs as potential source of drugs for liver diseases: ethnic and traditional approaches. In: Hakim M. Said, M. Attaur Rahman, M. Abdulla, S.B. Vohra, and M. Athar, eds. Elements and Liver, Proceedings of International Symposium on Trace Elements and Liver Diseases, Hamdard Foundation Pakistan, Karachi, Pakistan. Pp. 128–141.

Mahmood, N., S. Piacente, C. Pizza, A. Broke, A.I. Khan, and A.J. Hay. 1996. The Anti-HIV activity and mechanism of action of pure compounds isolated from *Rosa damascena*. Biochem. Biophys. Res. Commun. 229:73–79.

Malik, S. and S. Farooq. 1984. Cultivated trees, shrub and climbers of gardens of Pakistan. Taxonomic studies. PCSIR, Peshawar Laboratory, Peshawar, Pakistan.

Nasir, E. and S.I. Ali. 1972. An annotated flora of West Pakistan. Stewart Herbarium Gordon College, Rawalpindi, and Department of Botany, University of Karachi, Pakistan.

Nasir, Y.J. and R.A. Rafiq. 1995. Wild flowers of Pakistan. Elite Publishers Ltd., Islamabad, Pakistan.

Reynold, J.E.F., K. Parfitt, A.V. Parsons, and S.C. Sweetman. 1994. Martidale: the extra pharmacopoeia. Info Access and Distribution, Singapore.

Rizvi, M.A. 1998. Medicinal flowers of Pakistan, Part-III. Horticultural Society of Pakistan, Karachi, Pakistan. Pp.48–52.

Shaheen, F., M. Attaur Rahman, K. Vasisht, and M. Iqbal Choudhary. 2003. The status of medicinal and aromatic plants in Pakistan, In: Medicinal plants and their utilization, UNIDO. Pp. 77–87.

Shinwari, M.I. and M.A. Khan. 1998. Ethonobotany of Margalla Hills National Park of Islamabad. Department of Biological Sciences, Quaid-i-Azam University, Islamabad, and PASTIC Press, Pakistan.

William, J.T. and Z. Ahmad. 1999. Priorities for medicinal plants research and development in Pakistan. Published by MAPPA, India, and IDRC, Canada.

Zaman, M.B. and M.S. Khan. 1970. Hundred drug plants of West Pakistan. Pakistan Forest Institute, Peshawar, and Ferozsons Ltd., Lahore, Pakistan.

CUSCUTA (CONVOLVULACEAE)—THE STRENGTH OF WEAKNESS: A HISTORY OF ITS NAME, USES AND PARASITISM CONCEPT DURING ANCIENT AND MEDIEVAL TIMES

Mihai Costea[1]
Department of Plant Agriculture
University of Guelph
Guelph, Ontario, N1G 2W1, CANADA
coste_amihai@hotmail.com

François J. Tardif
Department of Plant Agriculture
University of Guelph
Guelph, Ontario, N1G 2W1, CANADA
ftardif@uoguelph.ca

ABSTRACT

We examine the etymology and the first names of *Cuscuta*, as well as some unexplored aspects in the early history of parasitism concept. The name "Orobanche" was used for the first time by Theophrastus possibly for *Cuscuta*, however for sure not for the today's broomrapes. The etymology of the generic name is neither Arab nor Greek, as commonly thought, but Aramaic and/or Hebrew. The ideas of parasitism from medieval ages are merely a regression of the Greek ancient concept. Whereas the ancient Greeks view the parasites as originating from their own seeds, during the medieval times and as late as the 17th century, *Cuscuta* plants were literally believed to arise from their hosts. Several lesser known uses of these plants during ancient and medieval times are explored in the Old as well as in the New World.

RESUMEN

Se examinó la etimología de los primeros nombres de *Cuscuta*, así como, aspectos no explorados en la historia del concepto de parasitismo. El nombre "Orobanche," fue utilizado por la primera vez por Teofrasto, posiblemente refiriéndose a *Cuscuta*, sin embargo, seguramente no para los actuales "jopos de lobo." La etimología del nombre genérico no es ni árabe ni griega, como se creía comúnmente, aunque puede ser arameo y/o hebreo. El concepto con respecto a las plantas parásitas desde la edad media es solamente una regresión al antiguo concepto griego. Mientras que, el punto de vista de los antiguos griegos era que las plantas parásitas se originaban de sus propias semillas, en la Edad Media, a finales del siglo XVII, las plantas de *Cuscuta* se consideraron que literalmente surgían de sus hospedadores. Los usos de estas plantas en los tiempos antiguos y en la Edad Media son prácticamente desconocidos, por lo que éstos se están explorando en el Viejo y el Nuevo Mundo.

INTRODUCTION

Cuscuta is a worldwide distributed genus, that comprises about 150 species of parasitic plants (dodders) (Yuncker 1932). The etymology of the generic name is not clear since it has commonly been said to be either Greek (e.g. Dawson et al. 1994) or Arabic (Austin 1980). The history of these intriguing plants, and of parasitic plants in general, has been traced back to antiquity (Mirande 1900; Kuijt 1969). Such plants must have drawn the attention of both early scholars

---

[1] Corresponding author.

SIDA 21(1): 369 – 378. 2004

and farmers. As Theophrastus wrote: "the oddity is that a plant grows exclusively on another plant, and not on the ground. ..." (De causis plantarum 2:17.5, 1976). Since then, the concept of parasitism has evolved slowly. The early history of parasitism in plants is particularly poorly known. We examine the first names of *Cuscuta*, some unexplored aspects in the history of parasitism concept, and several less known uses of these plants.

Was Orobanche one of the first names of *Cuscuta*?

Theophrastus referred to a plant called "*ὀροβάγχη*" ("vetch strangler" from "orobos" - vetch - *Vicia ervilia* (L.) Willd.?, and "anchone" - to strangle) because "it overspreads the whole plant (of vetch) and holds it fast as if it were in coils, for it is thus that (vetch-strangler) strangles the plant" (Inquiry into plants 8.8.4, 1916). It is certain that, when using this name, Theophrastus did not have in mind the broomrapes (today's *Orobanche*), because he apparently spoke about these in the next paragraph, under a different name. Thus, he mentioned *αἱμόδωρον*, which is said to be like another unnamed plant that "springs straight from the roots of cummin" (*Cuminum cyminum* L.), and both these plants are "somewhat more peculiar in their habits." This *αἱμόδωρον* attaches itself to fenugreek" (*Trigonella foenum-graecum* L.) and its "root is more or less round" (Theophrastus, Inquiry into plants 8.8.5, 1916). Both these latter plants are probably the actual *Orobanche*, which cannot be the *ὀροβάγχη*, the "vetch-strangler." It would be tempting to assume that "*ὀροβάγχη*" (the vetch-strangler) is *Cuscuta*. This would mean that one of the first names of *Cuscuta* was *Orobanche*. In support of this hypothesis are the habit of the plant and the chapter about weeds in which Theophrastus mentioned it (Inquiry into plants 8.8.3–5, 1916). Unfortunately, the "vetch-strangler" was not further described or mentioned elsewhere by Theophrastus, and Pliny the Elder did not carry on this name.

The Labyrinth of names and languages

Theophrastus also spoke about the "small Syrian weed kasytas (*κασύταζ*) that grows on trees, thorn-bushes and certain other plants" (De causis plantarum 2:17.3, 1976). Mirande (1900) argued that "kasytas" is probably not *Cuscuta*. He suggested that since Pliny's subsequent reference to this plant ("cadytas") allegedly alludes to some aromatic properties, this plant may be *Cassytha* spp., a coastal plant from Lauraceae resembling *Cuscuta* in the parasitic habit. It must be noted that Pliny in his description (Natural History 13:129, 1951) amalgamated "kasytas" with other, unnamed plant from the account of Theophrastus. About this unnamed plant, Theophrastus said that is "sown in the dog days on the thorn-bushes in Babylonia that sprouts the same day and then speedily envelopes the bush" (De causis plantarum 2:17.3, 1976). Pliny referred to these two plants as if they were a single one, and added that this plant "is used in making spiced wine and it is cultivated for this purpose" (Natural History 13:129, 1951). An even earlier indication to the preparation of a drink can be found in the

Talmud: "Why are not sufferers from ra'athan in Babylon? Because they ... drink beer containing *Cuscuta* (growing on) the hizme shrub" (Kethuboth 77b; see Epstein 1961). Epstein (1961) indicated that the "hizme shrub" is "Spira (Spina?) Regia." We could not determine what this spiny shrub was: *Tragacantha* (*Astragalus tragacantha* L.), *Rhamnus* spp., *Paliurus* spp., *Berberis* spp., *Zizyphus*? Therefore, Theophrastus' "kasytas" may be either *Cuscuta* or *Cassytha*, and the etymology of the two names is probably the same. Even in the 16th century, Fuchs (1542) used the name "*Cassutha*" for a dodder (Fig. 1) that, judging by its mentioned host, was apparently *Cuscuta epilinum* Weihe.

Several authors mentioned that the name has Greek origin (e.g. Dawson et al. 1994). But "kasytas" does not have any meaning in Greek and it would be more logical to assume that the name was introduced. Although Austin (1979) initially suggested that that the name comes from Aramaic, he mentioned later that the name has an Arabic origin (Austin 1980). However, apparently "kushkuut," "kashuut" or "koshoût" as Arabic names of *Cuscuta* are early Aramaic neologisms (Fraenkel 1886; Nakhle Al-Yassu'i 1986). Many ancient Arabic words, especially related to agriculture were introduced from Aramaic (Nakhle Al-Yassu'i 1986). Based on the new root "k-sh-w-th," the word "kushsha" meaning in Arabic "a lock of hair" was probably derived (David Mehall, pers. comm). Since Theophrastus mentioned Babylonia (Assyria) as a place of origin for "kasytas," this was probably from the geographical source of the name as well. Indeed, the etymology can be retraced in Syriac Aramaic and Hebrew (ksutha and ksuth, respectively), two closely related Semitic languages. The triradical root of the verb K-S-Y (Kaph, Shin, Yodh) means "to cover." Based on this root, a verbal noun that signifies "cover," "clothing" or "garment" is constructed in both languages: K-S-W-T (in Hebrew) and K-S-W-T-A (Kaph, Shin, Waw, Tav, Aleph) in Aramaic (Yona Sabar, pers. comm.; Paul Flesher, pers. comm; Sokoloff 1990). "Ksutha" is often mentioned in the Talmud (see Epstein 1961) and other Jewish-Aramaic texts such as the Targums (Jastrow 1950; Bowker 1969; Sokoloff 1990). The word was introduced into Arabic, Persian and Greek, creating a bridge between these fundamentally different languages and cultures.

Before Pliny, Dioscorides said that "Epithumon ... is ye flower of ye harder Thyme, & like to Satureja" (4:179, see Gunther 1959). Pliny mentioned two types of Epithymum: "one which is like the flowers of the thyme and satureia" ("*qui est flos e thymo satureiae simili*") and another one "that grows without a root, has slender a head like a long mantle, is red in color and is dried in the shade" ("*sine radice nasci, capite tenui similitudine pallioli, ruben, siccari in umbra*") (26:55–56). The recognition of these two "types" persisted until medieval age, when Tragus (1552) and Parkinson (1640) considered that they belong to "one kind growing on different herbs." Between the 16th and 17th centuries, dodders were called differently depending on the author. For example, Casper Bauhin (1623) used both "Epithymum" and *Cuscuta*. A common practice during that

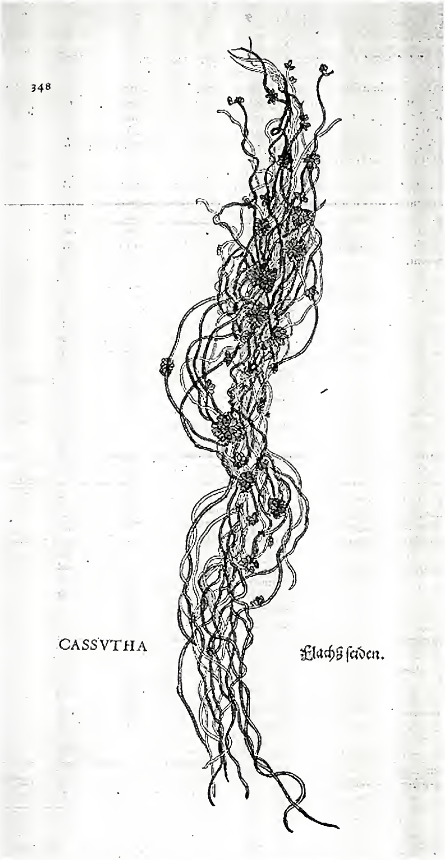


Fig. 1. *Cuscuta* spp. (probably *C. epilinum*). Fuchs, 1542.

time was to create a Latin name based on the hosts the dodders are growing upon, e.g. "Epithymum" (on *Thymus* spp.), "Epilinum" (on *Linum* spp.), "Epimajorana" (on Majoran), "Epistoebe" (on Stoebe - *Vicia* spp.), "Epiurtica" (on *Urtica* spp.) (e.g. Gerard 1633; Parkinson 1640). Apparently, Ray (1682) and Tournefort (1694–1695) were the first to retain only *Cuscuta*, which was later officially endorsed by Linnaeus (Sp. Pl. 124. 1753).

The parasite, "a spontaneous act of nature"

Kuijit (1969) suggested that the earliest reference to parasitic plants belongs to Theophrastus. However, an even earlier record can be found in Aristotle: "for even among land-plants there are some that are independent of the soil, and that spring up and grow, either parasitically upon other plants, or even entirely free (De partibus animalium 4:681b, 2001). Ancient Greeks were well-aware of the parasitic phenomenon. Even rooted, green lianas, like the ivy (*Hedera helix* L.) were regarded as "taking the food that belongs to the tree" (Theophrastus, De causis plantarum 2:17.4, 1976). And approximately three centuries latter, Pliny wrote: "it is a well-known fact that trees are killed by ivy" ("*hedera necari arbores certum est*") (Natural History 16:243, 1951).

The animal-oriented biological treaties of Aristotle have influenced our understanding of plant parasitism for almost 2000 years. Theophrastus was Aristotle's student and he developed many of the ideas of his teacher. "It may perhaps be that like animals, plants are fond of one another and live together" (Theophrastus, De causis plantarum 2:17.5, 1976). Or, that "some (plants) come from seed as through by a spontaneous act of nature. The latter come from rotting earth or from rotting parts of plants: for some are not constituted separately by themselves but are produced on trees, for example the mistletoe" (Aristotle, De generatione animalium 1:715b. 25–30, 1965). Following this idea, Theophrastus observed that maybe some plants "came from a corruption of something in the host" similarly to "some animals that can arise from other animals" (De causis plantarum 2:17.5, 1976). For example, like "those insects (such as lice and bed bugs) that ... live on the flavors of living flesh ... (and are produced) from the moisture from animals" (Aristotle, De partibus animalium 31:556b. 21–28, 2001; also De generatione animalium 1:715b. 5, 1965). But it must be emphasized that the Greek spontaneous concept does not preclude the origin of the parasite from seeds: "birds eat its fruit and let their droppings fall on the host tree." (Theophrastus, De causis plantarum 2:17.6, 1976). The wonder of ancient Greeks came from their belief that since plants "absorb the food already prepared from earth with their roots" they don't need a stomach, and they don't produce excrement (Aristotle, De partibus animalium 2.10, 2001). This is why plants "not growing on the ground at all is astonishing" (Theophrastus, De causis plantarum 2:17.5, 1976). In the Babylonian Talmud, the parasite was explicitly depicted as an integral part of its host: "if one plucks *Cuscuta* from shrubs and thorns ... one is culpable as if it inserts his hand in an animal's bowels and detaches an embryo" (Shabbath 107b; see Epstein 1961).

Later, Arabians were inspired by Greek science and introduced it into Europe. The ancient meaning of the "spontaneous act" degraded and the parasite was literally viewed as arising from its host. For instance, Francis Bacon, in the England of the early 17th century, believed that mistletoes were an exudation (sap) "that the tree doth excern and cannot assimilate," and that the idea of birds spreading its seeds is merely a "fable" or a "tale" (Sylua Syluarum 556–557, 1626). This misconception was reflected in the "Uva Barbata" or "Le Raisin Barbu," a *Cuscuta* spp. parasitizing *Vitis vinifera* L., and considered together with its host either as an entirely different species of grape wine (Tabernaemontanus 1588–1591), or a "monstrosity," a metamorphosis of the normal species (Jean Bauhin 1591). As late as 1831 such a blemish was connected to the appearance of the comet in the previous year (Kuijt 1969). In conclusion, the "spontaneous" concept regarding the origin of parasitic plants from medieval ages was merely a regression of the ancient Greek concept.

Rufinus, a forgotten botanist of the 13th century, was probably the first to observe that "*Cuscuta* ... is born in meadows and it ties to other plants, which it kills" ("*Cuscute ... nascitur in pratis et ligat alis herbas et necat eas*") (Rufinus approx. 1300 A.D.; see Thorndike 1946). His short note passed unobserved by all botanists and herbalists, and about three centuries later, Parkinson (1640) rediscovered that dodders "spring from their owne seede." He emphasized the discovery several times to "let all others understand": ... it may appeare plainely to any that neither Tyme, Savory, or any other herbe, doe naturally of their owne seede bring these strings or laeces but that they spring from their owne seede, either shed or scattered of themselves upon ground, or coming among the seedes of other hearbs that are sowne" (Parkinson 1640).

Cuscuta, the strength of weakness

Theophrastus compared parasitic plants with grafted shoots and buds that "get food that is more readily available and that has been prepared and practically concocted" (De causis plantarum 2:17.6, 1976). A good understanding of the parasitic phenomenon can be also encountered in the Babylonian Talmud, at approximately 100 BC. Although apparently it takes its food "from air ... *Cuscuta* derives its nourishment from soil (through its host); for we may observe that when the shrub (on which *Cuscuta* grows as a parasite) is cut off, *Cuscuta* dies" (Erubin 28b; see Epstein 1961). But "a plant seeking such food would be weak in its nature" (Theophrastus, De causis plantarum 2:17.6, 1976). Furthermore, such plants must be weaklings since they don't sprout and grow by themselves (Theophrastus, De causis plantarum 2:17.6, 1976). The same idea of helplessness, exemplified with "cadytas" and "viscum," can be found at Pliny: "because they have no abode of their own and consequently live in that of others" (“*namque cum suam sedem habeant, in aliena vivunt*,” Natural History 16:39. 243–244, 1951). In a sense this is true; today we know that during the parasitizing stage, *Cuscuta* depends entirely on the nutrients provided by its host (Dawson et al. 1994). Nonetheless, gradually the harmful effect of dodders on their hosts outweighed other considerations. Fuchs (1542) noted that *Cuscuta epilinum* “grows ... over plants, quite often entangling them so thickly with its web that shuts off the sun like a tent. ... It forces out growth from the host plant, and strangles it with its filamentous stems, or, by continuous sucking of the mother’s (host’s) sap, reduces it to exhaustion” (Historia Stirpium:347). Even today, it is intuitively seductive and deeply rooted in our unconscious fears to imagine plant parasitism in terms of animal parasitology.

The hot or cold character of dodders and several old uses

Quoting Phoenicians and Arabs, Fuchs and other medieval herbalists (Ruellius 1529; Gerald 1633; Parkinson 1640; Culpeper 1652) believed that the curative powers of dodders depend on the “character of the parent (host): if it invades a warm plant, it strengthens its heating nature, and if it clings to a cold one, it will acquire the cold strength” (Fuchs, Historia Stirpium:349, 1542). This is why during medieval times, dodders were named according to the host they are growing upon (see above) (e.g. Gerard 1633; Parkinson 1640). Among these, “Epithymum” was said to have the best therapeutic properties because *Thymus*, its host, is dry and hot in the third degree, as indicated by Galen (Tragus 1552; Gerard 1633; Parkinson 1640; Culpeper 1652). “Physitians crying up Epithymum, (most of which comes from Hymettus in Greece, or Hybla in Sicilia, becaus those Mountains abound with Time) he is a Physitian indeed that hath wit enough to chuse his Dodder according to Nature of the Diseas and Humor peccant” (Culpeper 1652).

“That dodder growing upon Tares (*Vicia* spp.), being the most frequent in London, and wherewith our markets are onely in a manner furnished and Apothaecaries shoppes stored from thence ... can have no effectual quality comparable to Epithymum for ... Tares are hard of digestion and binde the bellye and the nourishement of them engendereth thicke blood apt to turn into melancholie” (Parkinson 1640). Today we know that, indeed, the parasite forms a biochemical continuum with its host, and that its chemical makeup may depend on the latter. Primary metabolic compounds, minerals, xenobiotics, secondary products (e.g. alkaloids and cardenolides), herbicides, viruses, and mycoplasmas are translocated from the phloem of the host via the haustoria to the parasite (Dawson et al. 1994). “You are what you eat” couldn’t be more true for these plants.

Dioscorides, and later Pliny, recommended “Epythimum” as a purgative, as well as “for melancholicall, & ye puffed up with wind, ye quantity of an acetabulum to ye quantity of 4 dragms with honey & salt, and a little Acetum

(4:179, see Gunther 1959; also Pliny the Elder, Natural History 26:55). In an Arabic text dated before 1000 AD it is written: "If you put an euquia of blood (of the black dog) with a mithqal[2] of grounded *Cuscuta*; who will take this will never be reached by the spirits which causes enchantment. The meat (of black dog) in food with salt, is good a antidote against infantile epilepsy" (Alfonso-Goldfarb 1999). Other Arabic uses of *Cuscuta* have been reviewed by Guigues (1909), Hamarneh (1973) and Levey (1966). These were the main uses of dodders, which were later retained by all medieval herbalists. For example, Gilbertus Anglicus, around 1250 endorsed "Epithymum" as a remedy in a mixture of plants that "purge the head of evil humors" (Getz 1991). Culpeper (1652) noted that it is also good "to purge black or burnt Choller, which is the cause of many Diseases of the Head and Brains, as also for the trembling of the Heart, faintings, and swounings." Since dodders are under the sign of Saturn, "this helps by Sympathy, & strengthens al the parts of the Body he rules: Melancholy, Addust Choller, Trembling, fainting, swooning, Spleen, Hypochondria, Obstructions, Gall, Jaundice, Liver, Disury" (Culpeper 1652).

ACKNOWLEDGMENTS

Many thanks are due to Guy Nesom, Ovidiu Constantinescu and Daniel Austin who reviewed the manuscript and made interesting observations. Numerous linguists kindly helped in our search for meanings and possible etymologies of *Cuscuta*: Paul Flesher, Yona Sabar, and Michal Sokoloff with the Hebrew and/or Aramaic, and Safa Jubran, David Mehall, Hanita Brand, Irfan Shadid and Binyamin Abrahamov with the Arabic. Safa Jubran sent us the book she translated with Ana Maria Alfonso-Goldfarb. Sawsan Oran and Mohammed Sawaie gave us names of *Cuscuta* from Northern Africa. Rabbi Nissan oriented our search toward the Talmud. Yolanda Camacho translated the Spanish abstract.

REFERENCES

Alfonso-Goldfarb, A.M. 1999. Livro do tesouro de Alexandre. Translated by S. Jubran and A.M. Alfonso-Goldfarb. Editora Vozes, Petrópolis, Brazil.

Aristotle (384–322BC). 1965. De generatione animalium. Recognovit Brevique Adnotatione Critica Instruxit H.J. Drossaart Lulofs. Oxonii, E Typographeo Clarendoniano.

Aristotle (384–322 BC). 2001. De partibus animalium. Clarendon Press, Oxford University Press, Oxford, NY.

Austin, D.F. 1979. Plants without beginning or end. Fairchild Trop. Gard. Bull. 34:17–19.

Austin, D.F. 1980. Studies of the Florida Convolvulaceae—III. *Cuscuta*. Florida Sci. 43: 294–302.

Bacon, F. 1626. Sylua syluarum: or A naturall historie: In ten centuries. Written by the Right

---

[2] euquia = 32 76g; 1 mithgal = 3.9g (Safa Jubran, pers. comm.)

Honourable Francis Lo. Verulam Viscount St. Alban. Published after the authors' death, by William Rawley Doctor of Diuinitie, late his Lordships chaplaine. London.

Bauhin, C. 1623. Pinax theatri botanici, sive index in Theophrasti Dioscoridis, Plinii et Botanicorum qui a saeculo scripserunt opera. Basileae Helvet. Subtibus & Typis Ludovici Regis.

Bauhin, J. 1591. De plantis à Divis Sanctis. Additae sunt Conradi Gesneri Medici Clariss. Epistolae à Casparo Bauhino. Basileae Apud Conrad. Waldrich.

Bowker, J.W. 1969. The targums and rabbinic literature: an introduction to Jewish interpretations of scripture. Cambridge University Press, Cambridge, UK.

Culpeper, N. 1652. *The English physitian: or an astrologo-physical discourse of the vulgar herbs of this nation*, Peter Cole, London.

Dawson, J.H., L.J. Musselman, P. Wolswinkel, and I. Dörr 1994. Biology and control of *Cuscuta*. Rev. Weed Sci. 6:265–317.

Epstein, I. (Editor and translator). 1961. The Babylonian talmud. Soncino Press, London.

Fraenkel, S. 1886. Die Aramaeischen Fremdwoerter im Arabischen, Leiden.

Fuchs, L. (1542). 1999. The great herbal of Leonhart Fuchs. De historia stirpium commentarii insignes. G. Meyer, E.E. Trueblood, and J.L. Heller, eds. Vol. 2. Stanford University Press, Stanford, CA.

Gerard, J. (1542–1612). 1633. (republished in 1975). *The herbal or general history of plants.* Dover Publications, New York.

Getz, F.M. 1991. Healing and society in medieval England: A middle English translation of the pharmaceutical writings of Gilbertus Anglicus. University of Wisconsin Press, Madison.

Guigues, P. 1909. Les noms arabes dans Sèrapion, "Liber simplici medicina." Journale Asiatique 10:473–546.

Gunther, R.T. 1959. The Greek herbal of Dioscorides. Hafner Publishing Co. New York.

Hamarneh, S.K. 1973. Al-Birundi's book on pharmacy and materia medica. Karachi, Hambard National Foundation, Pakistan.

Jastrow, M. 1950. A dictionary of the Targumim, the Talmud Babli and Yerushalmi, and the Midrashic literature, Pardes Publishing house Inc., New York.

Kuijt, J. 1969. The biology of parasitic flowering plants. University of California Press, Berkeley, CA.

Levey, M. 1966. The medical formulary of Aqrābādhín of Al-Kindí. The University of Wisconsin Press, Madison.

Mirande, M. 1900. Recherches physiologiques et anatomiques sur les Cuscutacées. Thesis, fac. Sci. Paris.

Nakhle Al-Yassu'i, R. 1986. *Ghraai'b al-lughah al-arabiyya (*Strange things in the Arabic language). Dara El-Mashreq, Lebanon.

Parkinson, J. (1567–1650). 1640. Theatrum botanicum or an herbal of a large extent. Printed by T. Cotes, London.

Pliny the Elder. (ca. 23–79 A.D.). 1951. Natural History, Vol. IV (Libri II–XVI) and Vol. VII (Libri

XXIV and XXVII) translated by W.H.S. Jones and D. Litt. The Loeb Classical Library, Cambridge, Massachusetts and Harvard University Press, London.

Ray, J. 1682. (reprinted 1962). Methodus plantarum. Wheldon & Wesley, Ltd. and Hafner Publishing Co., New York.

Ruellius, J (1529). 1537. De natura stirpium libri tres. Froben, Hieronymus & Nic, Bazel.

Sokoloff, M. 1990. A dictionary of Jewish Palestinian Aramaic of the Byzantine period. Bar Ilan University Press, Ramat-Gan, Israel.

Tabernaemontanus, J.T. 1588–1591. Neuw Kreuterbuch. Mit schönen künstlichen und leblichen Figuren unnd Conterfeyten. Neuw und volkommentlich Kreuterbuch. Das Ander Theyl. Das dritte Theil des Kreuterbuchs. Nikolaus Basse, Frankfurt.

Theophrastus (ca. 371–ca. 287 B.C.). 1916. Inquiry into plants and minor works on odors and weather signs. Vol. I, II. English translation by A. Hort. The Loeb Classical Library, Heinemann, London.

Theophrastus (ca. 371–ca. 287 B.C.). 1976. De causis plantarum. Vol. I–III. English translation by B. Einarson and G.K.K. Link. The Loeb Classical Library, Heinemann, Harvard University Press, London.

Thorndike, L. 1946. The herbal of Rufinus. University of Chicago Press, Chicago.

Tournefort, J.P. 1694–1695. Elemens de botanique ou methode pour connoitre les plantes. L'Imprimerie Royale, Paris,

Tragus (Bock Hieronymus). 1552. De stirpium, maxime earum quae in Germania nostra nascuntur, usitatis, nomenclaturis, propriisque diferentiis neque non temperaturis ac facultatibus Commentariorum libri tres … interprete Davide Kybero … His accesserunt praefationes duae :altera Conradi Gesneri … adjectus est Benedicti Textoris Segusiani de Stirpium differentiis, ex Dioscoride secundum locos communes. Argentinae, Wendel Rihel.

Yuncker, T.G. 1932. The genus *Cuscuta*. Mem. Torrey Bot. Club. 18:113–331.

HISTORY AND EPONYMY OF THE GENUS NAME *AMSONIA* (APOCYNACEAE)

James S. Pringle

Royal Botanical Gardens
P.O. Box 399
Hamilton, Ontario, Canada L8N 3H8
jpringle@rbg.ca

ABSTRACT

The genus *Amsonia* was named for Dr John Amson, a physician in Williamsburg, Virginia, in the mid-nineteenth century.

RESUMEN

El genero *Amsonia* fue nombrado por Dr. John Amson, un médico de Williamsburg, Virginia, en la mitad del siglo diez y nueve.

Amsonia Walter is a genus of about twenty species native to North America and eastern Asia, of which the best known is *A. tabernaemontana* Walter, the eastern bluestar. The name *Amsonia* was first applied to that species by John Clayton of Gloucester, in colonial Virginia, in the 1750s, and ever since that time uncertainty has persisted and statements have differed as to its derivation or eponymy.

Clayton did not include the name *Amsonia* in the manuscript that he sent to the Dutch botanist Johan Frederik Gronovius, much of which Gronovius (1739) incorporated into his *Flora Virginica*. At that time Clayton thought that the bluestar might be considered a species of *Nerium* (oleander), and designated it "*Anonymus Suffrutex foliis Salicis alternis...Nerii species.*" He gave it the name *Amsonia* in the later manuscript (not extant) on the plants of Virginia that he sent to Peter Collinson in England in 1757, but that work was never published. He also included the name *Amsonia* with specimens and seeds that he sent to British and European botanists. Still later Clayton proposed a different name for the eastern bluestar, based on the form of the seeds, but that name likewise remained unpublished. By then, the name *Amsonia* had become inseparably associated with this species, which had quickly become popular in British horticulture following its introduction as *Amsonia* by Philip Miller in 1759 (Smith 1819; Berkeley & Berkeley 1963, 1982).

Linnaeus received a description of the eastern bluestar from his former student Daniel C. Solander in 1761. Solander, who was living in London at the time, had based this description on plants he had seen in the gardens of Peter

---

[1]Contribution No. 112 from the Royal Botanical Gardens, Hamilton, Ontario, Canada.

Collinson and James Gordon, supplemented with information from Clayton's manuscript. He informed Linnaeus that Clayton had called the species *Amsonia*, but added that "whence the name was taken I know not," nor did any of the botanists in London and vicinity of whom he had inquired; they believed "that Clayton named it for someone in North America" (letter from Solander to Linnaeus 16 November 1761, excerpted by Berkeley & Berkeley 1963). In 1762 Linnaeus received a sketch and information on the eastern bluestar from the botanical artist Georg Dionysius Ehret, with a promise of specimens to be sent via Solander (Calmann 1977). Ehret had been approached with regard to illustrating the work that Clayton had sent to Collinson, and had studied specimens collected by Clayton. Later that year Linnaeus (1762) named the species *Tabernaemontana Amsonia*.

The "*Anonymus Suffrutex*" was designated *Clayton 306* by Gronovius, but no such specimen is in the Clayton herbarium now at BM. The Linnaean herbarium at the Natural History Museum in Stockholm (S-LINN) contains a specimen of the eastern bluestar from the herbarium of Clas Alströmer, who had acquired it from Andreas Dahl. It is labeled "Tabernaemontana Amsonia" and "Dahl a Linné P" in Dahl's handwriting, indicating that Dahl had received it from Linnaeus himself (Lindman 1908). It was perhaps part of a collection made by Clayton and given to Linnaeus by Ehret or Gronovius, or it may have been obtained by Solander from a cultivated plant.

Amsonia was published as a genus name by Thomas Walter in 1788. The name of the type species, *Amsonia Tabernaemontana* Walter, was based on *Tabernaemontana Amsonia* L. Walter gave no derivation or eponymy for the name.

Many recent references state that *Amsonia* was named for "Charles Amson." The earliest association of the forename Charles with *Amsonia* that I have found was by Loudon (1830), according to whom the genus was named for "Charles Amason [sic], an American traveller." This eponymy for *Amsonia* was soon adopted in other British and Continental European references. The surname was altered to "Amson" by Paxton (1840), who identified Charles Amson as "a traveller in America." Nicholson (1884), whose wording has been retained in the successive editions of the *Royal Horticultural Society Dictionary of Gardening*, identified Charles Amson as a "scientific traveller in America."

It may be pertinent to the credibility of this eponymy that Loudon almost certainly would have seen Smith's (1819) account of the Neotropical genus *Amasonia* L.f. (Verbenaceae). As noted by Smith, Linnaeus filius had stated that *Amasonia* was named "in memory of Amason, a traveller in America" (translation), whom, according to Smith, "M. [Alexandre] De Thies [had] baptized Thomas." Smith was skeptical, because he had "never been able to learn any tidings of such a person." Linnaeus filius provided no forename or further information, and may merely have assumed that South America's largest river, the name of which is spelled "Amason" in Swedish and some other European languages, was named for an explorer. Loudon, however, having seen statements that *Amasonia* was named for Thomas Amason, may have followed De Thies's alleged precedent a step further and arbitrarily coined the name Charles Amason, and designated that imaginary person, like Thomas Amason, "an American traveller."

Of *Amsonia*, Smith (1819) said that "no positive account of the meaning or origin" of the name could be given, noting only that it had originally been bestowed by Clayton. He speculated that the spelling of the names *Amasonia* and *Amsonia* might represent an error, and that both genera might have been named for the British Admiral George Anson, Baron Anson of Soberton. Rafinesque (1838, 1840) accepted this eponymy with none of Smith's uncertainty and "corrected" the spelling to "*Ansonia*," but no others have done so.

The eponymy given by Loudon and Paxton was probably the basis for Gray's (1856) statement, in the second edition of his *Manual*, that *Amsonia* was "said to be named for a Mr. Charles Amson." That uncertain wording was retained through the sixth edition of *Gray's Manual*. Wood (1861) expanded it to "Dedicated to Charles Amson, of S. Carolina?" The speculative addition was not explained, but may have been made because the genus name was published by Walter, whose botanical activity had been confined to South Carolina. Britton and Brown (1896) stated with no such reservation that the genus was named "for Charles Amson of South Carolina." That wording was soon adopted in other American publications.

Woodson (1928) was skeptical about references to "Charles Amson." He consulted encyclopedic and historical references and made inquiries of historical societies in Virginia and the Carolinas, and found no evidence that any Charles Amson had lived or traveled in Virginia or the Carolinas during the colonial period or contributed to the knowledge of their natural history. Likewise, using more recent biographical references and publications from that history-conscious region, as well as Internet search engines, I found no record of any Charles Amson in those colonies during the 18th century (except as the supposed eponym of *Amsonia*). Nor have I found any mention of either of Loudon's "travellers" in any other context. Consequently, I share Smith's, Gray's, and Woodson's skepticism about their having existed. Had they lived and explored the wilds of the Americas, it seems unlikely that they could so greatly have impressed Clayton and Linnaeus filius, and at least have been known to Loudon, yet so completely have escaped the attention of historians and biographers. A thorough search would be complicated by the apparently independent origins of the surname Amason in England and Scandinavia. Even if these Amasons existed, however, there is ample evidence, presented below, that the apocynaceous genus *Amsonia* was not named for either of them.

The earliest extant indication that *Amsonia* was named for a physician is in a letter written 30 December 1759 by Ehret (Berkeley & Berkeley 1963), who had probably seen words to that effect in Clayton's manuscript or correspondence. Apparently not distinguishing between Carolina and Virginia as Clayton's place of residence, he wrote that *Amsonia* had been named "perhaps for a doctor in Carolina."

An indication of the eponymy of *Amsonia* by Clayton himself appears in a letter from him to the Philadelphia botanist John Bartram dated 1 September 1760, in which he said that he had previously proposed that the plant be named *Amsonia* "for a doctor, here" (William and Mary College Quart. Hist. Mag., ser. 3, 6: 319. 1926; Woodson 1928). Woodson inferred from Clayton's use of "here" that *Amsonia* had been named for "a physician of Gloucester County, Virginia." He added that "regarding his complete name, or the positive spelling of his family name, doubt still remains." The same letter was probably the basis for the statements by Robinson and Fernald (1908) and Fernald (1950), in the seventh and eighth editions of *Gray's Manual*, that *Amsonia* was "Named for Dr. Amson, physician of Gloucester, Virginia, in 1760, and friend of John Clayton." Combinations of "Charles Amson," from Loudon, Paxton, Gray, and Britton and Brown, and "physician" and "Virginia," from Robinson, Fernald, and Woodson, have come to prevail in recent publications.

Berkeley and Berkeley (1963, 1982) found from a source on Virginia medical history (Blanton 1931) that Dr. John Amson had been practicing in Williamsburg, Virginia, in 1751. They (1982) concluded that "Clayton had named the new genus *Amsonia* in honor of his friend Dr. John Amson of Williamsburg." I have not found this information repeated by any more recent botanical authors.

The Berkeleys found one other published reference to this Dr. Amson, which noted only that he frequently used the expression "neither here nor there." Present-day search engines, although not providing all standard biographical data, do lead to further information about the Dr. Amson who was Clayton's contemporary in colonial Virginia.

Records in the Archives of Colonial Williamsburg, compiled and annotated by Mary A. Stephenson (1961), confirm the Berkeleys' finding that John Amson, a "Doctor of Physic," lived and practiced in Williamsburg in the mid-18th century. Clayton would have considered Williamsburg, ca. 22 km away across the York River in James City and York counties, near enough to Gloucester to justify the use of "here" in writing to Bartram in Philadelphia, especially since he had spent part of his youth in Williamsburg and members of his family lived there.

I have found no definite information on this Dr. Amson's genealogy or his life prior to his practicing medicine in Williamsburg. Records compiled by the Church of Jesus Christ of Latter-Day Saints provide limited data on a few individuals named John Amson who lived in England and Scotland during the first 40 years of the 18th century, but no data on anyone by that name in colonial Virginia. The record perhaps most likely to be relevant is that of John Amson, son of James and Margaret Amson, who was baptized 24 July 1699, at the age of one year, in St. Sepulchre Church, London (where Captain John Smith of early

Virginia history had been interred). The time and (in view of data presented below) the country fit, but nevertheless it is by no means certain that this was the same John Amson.

Although an English origin is not unlikely, the name Amson does not appear in Munk's Roll of the members of the Royal College of Physicians. However, since the surname is not common, it does seem probable that Dr. John Amson of colonial Virginia was the John Amson, M.D., who received that degree from the university at Rheims (now Reims), France, 2 September 1722. Such credentials would have been impressive in colonial America, consistent with the apparent reputation (below) of Dr. Amson of Williamsburg as one of the "best Physicians" in Virginia. This record is from a list of early students from the British Isles at medical schools in continental Europe, compiled by Dr. Harold T. Swan (1996). This compilation was based on manuscript notes that had been in the possession of the medical historian Dr. Robert W. Innes Smith at the time of his death in 1933 (originals at the University of Sheffield). Aside from the data noted above, it states only that this John Amson was English, as distinguished from Scottish or Irish. According to Dr. Swan (pers. comm. 11 April 2003), Innes Smith's notes contain nothing further on Amson. He considers it unlikely that Innes Smith found additional information at Reims, because many of the university's records from the relevant time had been destroyed, presumably during the French Revolution.

I have not found when Amson arrived in America, if in fact he was of English birth. The earliest record of his presence in Virginia that I have encountered is from 1738, when the estate of the late Dr. Charles Brown of Williamsburg retrieved a book that Amson had borrowed from Brown's library (James 1895).

A physician in Williamsburg in 1738 could hardly have avoided the controversy associated with John Tennent, a "practitioner of medicine" in that city (Blanton 1931; Jellison 1963). Tennent's domestic medical manual, *Every Man His Own Doctor*, was highly popular, but some physicians questioned his competence and objected to his pursuit of financial recognition from public funds. In particular, his advocacy of the use of *Polygala senega* L. became obsessive, and his reactions toward those who took issue with him became intemperate. He felt that physicians who held medical degrees from European universities were unjustifiably disdainful of those who had obtained their qualifications through apprenticeship and independent study. I have found no record of Amson's involvement in this controversy. In one of his statements in his own defense, however, Tennent (1738) implied that medical degrees were awarded too freely at Rheims, alleging that one had inadvertently been bestowed upon a horse. Rheims may by chance have provided an anecdote that Tennent considered suitable for his purposes, but one wonders if someone with a degree from Rheims was among those whom Tennent perceived as a hostile medical establishment.

In 1746, Amson bought the property identified as Lots 212–217, Block 36, City of Willamsburg, County of York, from Thomas Jones, nephew-in-law of the naturalist Mark Catesby. These lots at the intersection of Boundary and Scotland streets had been so numbered by the Trustees for the Land when the city was laid out. Much later they included the site of "Wheatlands," the home of the artist Georgia O'Keefe during her late teens. The property included at least one house plus outbuildings when it was acquired by Amson. He owned and resided on this property until his death. About 1751 he purchased from Henry Tyler 180 acres of land just outside the Williamsburg city limits (Stephenson 1961). As well as being a physician Amson appears to have been a planter, or gentleman farmer, as men primarily associated with other enterprises or professions often were in colonial times. At least as early as 1746 he was an alderman (Stephenson 1954), and in 1750–1751 he was mayor of Williamsburg (Bodie et al. ca. 1999).

In 1758 then-Colonel George Washington had been ill for some time, probably with dysentery, although he was concerned that he might have consumption. He traveled from Mount Vernon to Williamsburg "to receive the Advice of the best Physicians," and there consulted Dr. Amson on 15 March (Fitzpatrick 1931–1944, including a letter from Washington to Colonel John Stanwyx, 5 March 1758). Fitzpatrick, in editing Washington's papers, commented that Washington "seems to have received the proper treatment, for he was able to be back to his command at Fort Loudon April 5." Amson may also have treated Daniel Parke Custis, whose widow Washington subsequently married; he was listed among the creditors of Custis's estate, although Dr. James Carter was recorded as having been the attending physician during Custis's last illness (Stephenson 1959; Abbot 1988).

A few other references to Dr. John Amson of Williamsburg appear in historical sources. He was among the "officials of the government of Virginia" who signed an oath of allegiance to King George II (Virginia...1738–1752), probably having done so upon becoming alderman or mayor. York County records indicate that as of 21 September 1747 he was paying taxes on five "tithables," i.e., indentured slaves (Stephenson 1961). His name appears in the account book of the Yorktown merchant William Lightfoot (Lightfoot 1740–1764), and he was one of those who proved the will of Philip Lightfoot in 1748 (Tyler 1894). The jurist John Blair recorded having visited Amson's gardens 24 March 1751 (Tyler 1899), but wrote nothing about the gardens.

Neither Ms. Stephenson nor I have been able to determine the date of Amson's death, although the well-indexed *Virginia Gazette* usually published obituaries of prominent Williamsburg residents. His will was proved in the General Court of Virginia, of which the records from the relevant period are not extant (Stephenson 1961). His death evidently occurred after November 1761, when he was listed as a creditor of the estate of John Parke Custis, son of Daniel (Stephenson 1959; Abbot 1988), and before July 1765. Records of land ownership include that of a transaction in July 1765 in which Anne Anderson is said to have inherited the six lots and the buildings thereon in Williamsburg plus the 180 acres outside the city from "the late Dr. Amson." Mrs. Anderson, who was at that time the wife of Robert Anderson of Williamsburg, is thought likely to have been Amson's daughter, or possibly his widow if she had soon remarried, but the relationship has not been determined (Stephenson 1961). I have found no mention of any other individuals with the surname Amson in eighteenth-century Williamsburg and vicinity.

What may be Amson's only extant writing therefore appears to have been published posthumously, either from a handwritten heirloom or as a reprint from an earlier publication. This (Amson 1776) is a prescription for the treatment of whooping cough, which included several botanical ingredients, in quantities deemed appropriate for a boy of ten. The treatment began with an emetic containing ipecachuana and oxymel of squills (*Urginea maritima* (L.) Baker, a mild source of cardiac glycosides). This was followed first by chamomile tea, then by elixir paregoricum (an opiate) in pennyroyal tea and mint water. The next day the treatment called for gum ammoniac (resin from *Dorema ammoniacum* D. Don) in pennyroyal tea, mixed with the juice pressed from two hundred woodlice in white wine, with saffron and honey.

REFERENCES

Abbot, W.W. (ed.). 1988. The papers of George Washington: Colonial Series. Charlottesville: University Press of Virginia. (Amson mentioned passim in Vols. 5 and 6.)

Amson, J. 1776. Doctor Amson's prescription for the hooping-cough [sic]. The Virginia Gazette, September 27, 1776, p. 6. Facsimile on Internet: http://pastportal.org/browse/vg/.

Berkeley, E., and D.S. Berkeley. 1963. John Clayton: Pioneer of American botany. Chapel Hill: The University of North Carolina Press. (Material on Amson and *Amsonia* indexed as being on p. 224 is actually on p. 214.)

Berkeley, E., and D.S. Berkeley. 1982. The life and travels of John Bartram: From Lake Ontario to the River St. John. Tallahassee: University Presses of Florida.

Blanton, W.B. 1931. Medicine in Virginia in the Eighteenth Century. Richmond: Garrett & Massie.

Bodie, L.S., et al. (compilers). Ca. 1999. Mayors of Williamsburg. In City of Williamsburg web site: http://www.ci.williamsburg.va.us/history/govh7.htm

Britton, N.L., and A. Brown. 1896. An illustrated flora of the northern United States, Canada and the British Possessions … , ed. 1. New York: Charles Scribner's Sons.

Calmann, G. 1977. Ehret: flower painter extraordinary. Oxford: Phaidon Press.

Fernald, M.L. 1950. Gray's manual of botany, ed. 8. New York: American Book Company.

Fitzpatrick, J.C., ed. 1931–1944. The writings of George Washington 1745–1799 from the original manuscript sources. Washington: U.S. Government Printing Office. Adapted for Internet: Electronic Text Center, University of Virginia Library: http://etext.lib.virginia.edu/washingon/fitzpatrick/

Gray, A. 1856. Manual of the botany of the northern United States, ed. 2. New York: Ivison & Phinney.

Gronovius, J.F. 1739–1743. Flora Virginica exhibens plantas quas V.C. Johannes Clayton in Virginia Observavit atque Collegit. Leiden: Cornelius Haak. Reprinted 1946. Jamaica Plain: Arnold Arboretum. (*"Anonymus Suffrutex"* 1739.)

James, E.W. 1895. Libraries of Colonial Virginia (continued). William and Mary College Quart. Hist. Mag., ser. 1, 3: 246–253. Reprinted 1966. Same information, from York County Wills and Inventories 18, 1732–1740, pp. 476–477, on Internet: http://pastportal.org/cwdl_new/archive/probates/html/pi0315.htm

Jellison, R.M. 1963. Dr. John Tennent and the universal specific. Bull. Hist. Med. 37: 336–346.

Lightfoot, W. 1740–1764. Account book. In: William Lightfoot Papers, Manuscript MS 52.4, John D. Rockefeller, Jr., Library, Colonial Williamsburg Foundation, Williamsburg. (Index seen in the present study, at http://ead.lib.virginia.edu/vivaead/published/cw/vivadoc.pl?file=viwc00065.xml

Lindman, C.A.M. 1908, 1910. A Linnaean herbarium in the Natural History Museum in Stockholm. Ark. Bot. 7(3): 1–57; 9(6): 1–50.

Linnaeus, C. 1762–1763. Species plantarum … , ed. 2. Stockholm: Lars Salvius. (*Tabernaemontana Amsonia* 1762.)

Loudon, J.C. 1830. Loudon's hortus britannicus, ed. 1. London: Longman, Orme, Brown, Green, and Longman's.

Nicholson, G. 1884–1887. The illustrated dictionary of gardening … New York: J. Arnot Penman; London: L. Upcott Gill. (*Amsonia* 1884.)

Paxton, J. 1840. A pocket botanical dictionary, comprising the names, history, and culture of all plants known in Britain..., ed. 1. London: J. Andrews and W.S. Orr and Co.

Rafinesque, C.S. 1836–1838. New flora of North America. Philadelphia: Published by the author. Reprinted 1946. Jamaica Plain: Arnold Arboretum. (*Ansonia* [sic] 1838).

Rafinesque, C.S. 1840. Autikon botanikon. Philadelphia: The author. Reprinted 1942. Jamaica Plain: Arnold Arboretum.

Robinson, B.L., and M.L. Fernald. 1908. Gray's new manual of botany, ed. 7. New York: American Book Company.

Smith, J.E. 1819. *Tabernaemontana*. In: Rees, A., ed. The cyclopædia … 35(I). London: Longman, Hurst, Rees, Orme, & Brown.

Stephenson, M.A. 1954. (The) Red Lion historical report, Block 18-1, Building 23A Lot 44. Colonial Williamsburg Foundation Library Research Report Series 1423. Adapted for Internet: http://www.pastportal.com/Archive/research%20Reports/html/rr1423.htm

Stephenson, M.A. 1959. Custis Square historical report, Block 4, Lot 1–8. Colonial Williamsburg Foundation Library Research Report Series 1070. Adapted for Internet: http://www.pastportal.com/Archive/Research%20Reports/Html/RR1070.htm

Stephenson, M.A. 1961. Block 36, Lot 212 & 217 historical report. Colonial Williamsburg Foundation Library Research Report Series 1620. Adapted for Internet: http://www.pastportal.com/Archive/Research%20Reports/Html/RR1620.htm

Swan, H.T. (ed.). 1996. English-speaking medical students at continental universities [in the 18th century]: The work archive of R.W. Innes Smith. Typescript in the library of the Royal College of Physicians of Edinburgh. Adapted for Internet: http://www.rcpe.ac.uk/library/English_Students/Rheims/Rheims_A.html

Tennent, J. 1738. A memorial, humbly dedicated to the learned, impartial, and judicious world. The Virginia Gazette, Number 112, September 22, 1738, pp. 1–2, and Number 113, September 29, 1738, pp. 1–2. Facsimile on Internet: http://pastportal.org/browse/vg/

Tyler, L.G. (ed.). 1894. Lightfoot family (concluded). William and Mary College Quart. Hist. Mag., ser. 1, 3: 104–111. Reprinted 1966. Adapted for Internet: http://ftp.rootsweb.com/pub/usgenweb/va/schools/wmmary/quarterly/v03n2/pg104-111.txt.

Tyler, L.G. (ed.). 1899. Diary of John Blair [part 1]. William and Mary College Quart. Hist. Mag., ser. 1, 7: 133–153. Reprinted 1966. Adapted for Internet: http://ftp.rootsweb.com/pub/usgenweb/va/schools/wmmary/blair.txt

Virginia. Secretary of State. 1738–1752. Oath of allegiance to King George II of Great Britain, 1738–1752. Last page extant in Library of Congress; photocopy in Manuscripts Collections, Virginia Historical Society. Adapted for Internet: http://vhs3.vahistorical.org/cgi-bin/starfinder/16400/x.marc.txt

Walter, T. 1788. Flora Caroliniana … London: J. Fraser. Reprinted 1946. Jamaica Plain: Arnold Arboretum.

Website. Accessed 22 Oct 2003. http://www.familysearch.org/Eng/Search/frameset_search.asp (Latter-Day Saints genealogical records).

Website. Accessed 22 Oct 2003. http://linnaeus.nrm.se/botany/fbo/t/taber/tabeams.html.en (specimen of *Tabernaemontana amsonia* at S-LINN).

Website. Accessed 22 Oct 2003. http://linnaeus.nrm.se/botany/fbo/hand/welcome.html.en (examples of handwriting at S-LINN).

Wood, A. 1861. A class-book of botany … , ed. s.n. New York: A.S. Barnes & Co.

Woodson, R.E., Jr. 1928. Studies in the Apocynaceae. III. A monograph of the genus *Amsonia*. Annals Missouri Bot. Gard. 15: 379–434, plates 50–53.

BOOK NOTICES

Timber Press

GUY STERNBERG and JIM WILSON. 2004. **Native Trees for North American Landscapes**. (ISBN 0-88192-607-8, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $59.95, 552 pp., 513 color photos, 96 line drawings and 1 map, 8 1/2" × 11".

This is a book of detailed information on North American native trees for landscapes and gardens. The authors say they exclusively focus upon the cultivation and preservation of native trees. Most of the book is devoted to what the authors call the "Menu of Native Trees." Basically that is the ninety-six trees which are the feathered species. Each species begins with a silhouette of the tree and a leaf, description, leaves, flowers and fruit, best seasons, native and adaptive range, culture, problems, similar and related species, and comments. Oh, let's not forget the very nice color photographs that compliment each featured species.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 761202-4060, U.S.A.*

THOMAS HOBBS. 2004. **The Jewel Box Garden**. (ISBN 0-88192-66-9, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 176 pp., 160 color photos, 10" × 10".

The Jewel Box Garden is full of exciting plants, gardens, and garden designs in beautiful color. The photographs by David McDonald are a sight for sore eyes. What else can one say? This is one pretty book that any gardener would love to have. Just one look at this gem and you will be hard pressed not to want to use some of the ideas in the book —*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 761202-4060, U.S.A.*

WILLIAM T. STEARN. 2004. **Botanical Latin**. (ISBN 0-88192-627-2, pbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 560 pp., 42 line drawings, 6 3/4" × 9 3/4".

Botanical Latin was first published in 1966 and this is the first paperback edition.

JOSEF J. HALDA and JAMES W. WADDICK (Botanical Illustrations by Jarmila Haldová). 2004. **The Genus Paeonia**. (ISBN 0-88192-612-4, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 228 pp., 36 watercolors and 43 line drawings, 8 1/2" × 11".

Review forthcoming in volume 21, no. 2.

SIDA 21(1): 388. 2004

CARBON USE BY THE ENDANGERED TEXAS WILD RICE (*ZIZANIA TEXANA*, POACEAE)

Paula Power

U.S. Fish and Wildlife Service
National Fish Hatchery and Technology Center
500 E. McCarty Lane
San Marcos, Texas 78666, U.S.A.

Robert D. Doyle

Baylor University
Department of Biology
P.O. Box 97388
Waco, Texas 76798, U.S.A.

ABSTRACT

A pH drift experiment was conducted to determine the HCO_3^- uptake potential of Texas wild rice (*Zizania texana* Hitchc.). In 15 separate experimental runs, total inorganic carbon to alkalinity ratio varied between 0.93–0.99 and final pH varied between 8.54–9.21, strongly suggesting Texas wild rice is an obligate CO_2 plant unable to utilize HCO_3. The estimated CO_2 compensation point for Texas wild rice is 2 µmol l^{-1}.

Data from this study provide physiological evidence for the positive relationship between current velocity and biomass productivity observed in Texas wild rice (Power 1996a, 1996b, 2000; Poole & Bowles 1999; Saunders et al. 2001) and provides water resource managers with information they need to manage and protect the San Marcos River ecosystem.

RESUMEN

Un experimento de la variación del pH fue utilizado para determinar el potencial de absorción de HCO_3 del arroz salvaje de Tejas (*Zizania texana* Hitchc.). En 15 experimentos separados, la relación entre el carbono inorgánico y la alcalinidad varió entre 0,93–0,99 y el pH final varió entre 8,54–9,21, sugiriendo que el arroz salvaje de Tejas es una planta CO_2 obligatoria incapaz de utilizar el HCO_3. El punto estimado de compensación del CO_2 en el arroz salvaje de Tejas es 2 µmol l^{-1}.

Los datos de este estudio proporcionan la evidencia fisiológica para la relación positiva entre la velocidad actual y la producción de la biomasa observadas en el arroz salvaje de Tejas (Power 1996a, 1996b, 2002; Poole y Bowles 1999; Saunders et al. 2001) y ofrecen a los encargados de los recursos hídricos la información que necesitan manejar y proteger el ecosistema del río San Marcos.

INTRODUCTION

The San Marcos River arises from springs within the City of San Marcos, Hays County, Texas and flows 8.1 river km in a southeasterly direction before it joins the Blanco River. The source aquifer for the San Marcos River is the Edwards Aquifer, the sole source of municipal, agricultural, and industrial water for 1.5 million people in central Texas. Water is pumped continuously from the Edwards Aquifer for human use, but is recharged only during rain events. As water is pumped during drought periods when recharge is minimal, the level of the aquifer drops, threatening spring flow to the San Marcos River and other local spring systems. The spring-fed San Marcos River provides habitat for five federally listed species: fountain darter (*Etheostoma fonticola*), San Marcos gambusia (*Gambusia georgei*), San Marcos salamander (*Eurycea nana*), Texas

SIDA 21(1): 389 – 398. 2004

blind salamander (*Typhlomolge rathbuni*), and Texas wild rice (*Zizania texana*). The primary threat to each species is reduced spring flow from the source aquifer (U.S. Fish and Wildlife Service 1996). The threat became critical during a drought event in 1990 and all five species were the focus of an endangered species lawsuit initiated in 1991 (Sierra Club v Lujan, No. MO-91-CA-69). One outcome of the lawsuit was creation of a water authority to manage the aquifer for human use and to protect the San Marcos River ecosystem for endangered species by maintaining adequate spring flow. Defining "adequate" spring flow for a species is a monumental challenge met by research systematically addressing ecological and physiological aspects of the species.

The target species for this study was Texas wild rice. This species is endemic to the San Marcos River, TX and was listed as endangered in 1978 (U.S. Fish and Wildlife Service 1985). Texas wild rice is a perennial, submersed macrophyte now commonly found in swiftly flowing water. Under these conditions, it produces long, ribbon-like, submersed leaves and reproductive culms. Culms can become emergent and produce wind pollinated, terminal inflorescences. Nodes along each culm give rise to roots and asexual clones, called tillers. A thorough description of the species and its habitat is provided by Terrell et al. (1978), U.S. Fish and Wildlife Service (1995), Poole and Bowles (1999), and Saunders et al. (2001).

Texas wild rice has two distinct phenotypes under wild and cultured conditions. Wild plants found in flowing water (>0.46 m s^{-1}) in the San Marcos River are perennial and primarily submersed, although reproductive culms are present. Under cultivated conditions in slow moving water (<0.05 m s^{-1}), Texas wild rice has low vegetative productivity compared with study plants grown in faster flowing water ranging from 0.29–0.49 m s^{-1} (Power 1996a, 2002). Texas wild rice in slow moving water ranging from 0.001–0.12 m s^{-1} is primarily emergent, sexually reproductive, and annual to short-lived as is common for other North American *Zizania* species (Terrell et al. 1978; Power 1996a, 2002). Primarily emergent plants with low biomass productivity are especially vulnerable to herbivory because of the potential for loss of reproductive culms prior to seed set and the ultimate loss of the plant because of a shortened life span.

Carbon utilization by macrophytes has been shown to influence photosynthesis in experimental studies (Smith & Walker 1980) and may be an important factor influencing phenotypic variation in Texas wild rice. The relative concentrations of carbon species dissolved in water are influenced by pH. At lower pH proportionally more CO_2 is available; as pH rises, equilibrium shifts to HCO_3^-, then $CO_3^=$. Macrophytes utilize inorganic carbon in the form of CO_2 for photosynthesis and all submersed species are able to extract this form of dissolved inorganic carbon from the water when it is available. In addition, some submersed species show the ability to extract efficiently HCO_3^- from the water while others exhibit little or no ability to do so (Allen & Spence 1981; Maberly

& Spence 1983; Sand-Jensen 1983; Spence & Maberly 1985). In addition to the absolute concentration of dissolved inorganic carbon, the flow environment of the submersed leaves also influences their ability to extract carbon from the water. Flowing water reduces the thickness of the boundary layer surrounding leaves through which gases move predominantly by diffusion. Slower diffusion of CO_2 across the boundary layer can limit photosynthesis in still or very slow moving water (Smith & Walker 1980).

Differential carbon availability combined with carbon uptake potential may contribute to phenotypic variation in Texas wild rice and provide a physiological explanation for its preference for a flowing water habitat. The purpose of this study was to determine the bicarbonate uptake potential of Texas wild rice.

METHODS AND MATERIALS

Carbon use by Texas wild rice was examined using plants taken from culture after seedlings had been growing about three months in an outdoor cement raceway. The raceway was supplied with water pumped from the Edwards Aquifer and with chemistry similar to that of the San Marcos River. The plants had 4–6 leaves, each of which was 20–30 cm in length. The plants were maintained in aerated river water (4.5 meq l^{-1} alkalinity) under artificial illumination (250 μmol $m^{-2} s^{-1}$ PAR; 14:10 light/dark photoperiod) at laboratory temperature (22° C) until utilized. All experiments were conducted within four days of arrival of plant material at the lab.

For comparison data are also presented for *Hydrilla verticillata*, a submersed aquatic species known to be well adapted for extracting bicarbonate from water due to its unique, C-4 like photosynthetic pathway (Holaday & Bowes 1980). *Hydrilla verticillata* apical stem fragments were collected from culture ponds at the Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX.

The pH drift technique described by Allen and Spence (1981) was used to determine the HCO_3^- uptake potential of Texas wild rice. This method involves continuous measurement of pH in a solution bathing actively photosynthesizing plants in a closed system at constant alkalinity (ALK). The method relies on shifts in abundance of the three species of dissolved inorganic carbon (CO_2, HCO_3^-, $CO_3^=$) with pH. In a closed system, plants will continue to photosynthesize until inorganic carbon can no longer be extracted from the bathing solution. When photosynthesis ceases, the final pH of the solution is dependent on the concentration of total dissolved inorganic carbon (C_T) in solution which depends upon the carbon-extracting potential of the plant.

The pH endpoint of these experiments varies with a plant's ability to utilize HCO_3^- and on the alkalinity of the solution. Carbon dioxide obligate plants (those which cannot utilize HCO_3^-) cannot shift the pH of the bathing solution past the point where free CO_2 disappears from solution (pH ca. 9.2 depending on alkalinity). The CO_2 content of the solution at the pH where photosynthesis ceases is considered the CO_2 compensation point for that species. Removal of CO_2 from the water results in increased pH, but has little impact on C_T, and does not impact ALK.

Other aquatic plants are also able to utilize HCO_3^- as a source of inorganic carbon. In a closed system, these plants will shift the pH well above the threshold where CO_2 disappears. In this case, the final pH of the solution depends on the total C_T pool available as well as the affinity of the plant for HCO_3^-. The HCO_3^- content of the solution at the pH where photosynthesis ceases is considered the HCO_3^- compensation point for that species. The removal of HCO_3^- from solution has a stronger impact on C_T but still does not impact ALK, since the buffering capacity lost by the consumed HCO_3^- is balanced by the production of OH^-. The C_T:ALK ratio at the end of a pH drift experiment is considered a relative measure of a plant's ability to utilize HCO_3^- (Maberly and Spence 1983). The C_T:ALK ratio of CO_2-obligate plants is very close to 1.0, while the ratio of HCO_3^- users is well below 1.0.

Oxygen and pH were continuously measured in a re-circulating closed system. The experimental apparatus consisted of a glass incubation chamber, an acrylic probe block, and a submersible centrifugal pump, all connected by gas tight tubes of butyl rubber (total volume 400 ml) and submerged in a temperature-controlled water bath (20° C). The incubation chamber was a glass cylinder 5 cm in diameter × 30 cm long. A glass tube connector was fused to one end, while a ground-glass fitting with another glass tube connector was fused to the opposite end to allow access to the cylinder for plant tissue insertion and removal. Water was re-circulated at an approximate velocity of 2 cm s^{-1} through the incubation chamber and was sufficient to remove diffusive limitations of photosynthesis. The acrylic sensor mounting block allowed both pH and O_2 sensors to be screwed in so that the electrode tips were continually bathed by the re-circulating solution. The pH electrode (Ross combination electrode) had a sensitivity of 0.01 pH units and was connected to a pH transmitter (Jenco 629). The fast-response, low-consumption Clark-type polarographic oxygen sensor (YSI 5331) was connected to an oxygen meter (Cameron Instrument Corp). The oxygen electrodes were calibrated by submersing the probe in N_2-sparged water and fully aerated water at incubation temperature. pH sensors were calibrated prior to use utilizing pH 7.0 and 10.0 buffers. Outputs from the pH transmitter and the oxygen meter were continuously monitored by a computer equipped with data acquisition software (Strawberry Tree Workbench PC). The sensors were monitored continuously and data recorded every 3 minutes. Calibrations did not drift over the time-scale of the experiments. Alkalinity of the bathing solutions were determined by titration with dilute hydrochloric acid (APHA 1992).

Entire Texas wild rice rosettes consisting of 3–6 leaves (0.2–0.3 gdw) were used in the experiments. Light was provided by specialized fluorescent aquaria lights (6700 K) providing saturating light intensities (500 μmol m^{-2} s^{-1} PAR). The bathing solutions used for the experiments were either San Marcos River water (Alk = 4.5-5.0 meq l^{-1}), a general purpose culture solution (Alk = 0.82 meq l^{-1}; Smart and Barko 1985), or intermediate mixtures of the two. Prior to the start of the experiment, the incubation chambers were flushed with a bathing solution which had been bubbled with a gas mixture composed of 350 ppm CO_2 (atmospheric concentration) and 6% O_2 (approximately 30% atmospheric concentration) in nitrogen. This reduced the O_2 concentration to about 75 μmol l^{-1} while maintaining normal dissolved inorganic carbon and pH levels of the bathing solutions. Lowering the initial O_2 concentration allows photosynthesis to proceed for extended periods within the closed system without potential complications due to O_2 supersaturation which increases photorespiration.

Photosynthesis was measured as the rate of O_2 evolution in the closed system through time. Corrections were made for total volume of the incubation apparatus, and the results normalized to plant dry weight. Experiments were allowed to proceed until photosynthesis stopped and the pH stabilized. This usually consisted of 2 to 3 hour runs, although longer runs up to 12 hours were made to verify that steady state conditions were achieved in the shorter runs.

Concentrations of different carbon species as a function of pH and temperature were estimated from equilibrium constants and formulae in Stumm and Morgan (1981).

RESULTS

Table 1 shows the results of 15 independent pH drift experiments conducted on Texas wild rice and three experiments conducted on *H. verticellata*. Alkalinity was measured prior to the experiment for each bathing solution as was the final pH at the apparent photosynthetic compensation point. Total carbon and CO_2 were estimated based on these data. The C_T:ALK ratio for all experiments was very close to 1.0 and varied between 0.93–0.99, strongly suggesting that this species is a CO_2 obligate plant which is unable to utilize HCO_3^- at a rate sufficient to keep up with photosynthetic needs (see Maberly and Spence 1983). For CO_2-obligates, the CO_2 concentration at the end of the pH drift experiment represents a conservative estimate of the CO_2 compensation point for the species. In this series of experiments, the values varied from 1–13 μmol l^{-1}.

Rates of photosynthesis as a function of pH for two C_T concentrations are shown in Figure 1A. As expected, the rates of photosynthesis at a given pH are higher for the higher C_T solution. Since pH controls the proportion of C_T present as CO_2, the level of CO_2 present in the two solutions was actually very different. However, both data sets show a linear and strong reduction in photosynthesis as the pH of the solution approaches 9.0. In Fig. 1B these data are re-plotted to

TABLE 1. Summary of pH drift experiments for Texas wild rice and *Hydrilla verticillata* conducted in closed systems including alkalinity (Alk) of bathing solution, final pH, final concentration of total inorganic carbon (C_T), CO_2 remaining at the end of the experiment and the ratio of C_T/Alk.

Run ID	Alkalinity (meq l^{-1})	Final pH	C_T (mmol l^{-1})	CO_2 (µmol l^{-1})	C_T/Alk
Texas wild rice (San Marcos River)					
1	1.24	8.54	1.225	8	0.99
2	1.24	8.66	1.216	6	0.98
3	1.24	8.76	1.207	5	0.97
4	2.00	8.54	1.978	13	0.99
5	2.00	8.72	1.956	8	0.98
6	2.00	9.14	1.876	3	0.94
7	2.16	9.21	2.006	3	0.93
8	2.04	9.16	1.908	3	0.94
9	2.04	9.14	1.914	3	0.94
10	0.82	8.81	0.796	3	0.97
11	0.82	8.72	0.801	4	0.98
12	0.83	9.14	0.778	1	0.93
13	2.45	8.80	2.391	9	0.98
14	2.34	8.63	2.308	13	0.99
15	2.40	9.18	2.254	3	0.94
Hydrilla verticillata (pond culture)					
1	0.85	10.43	0.377	0.01	0.44
2	0.85	10.36	0.414	0.02	0.49
3	0.85	10.23	0.477	0.04	0.56

show the relationship of photosynthesis to actual CO_2 levels. The linear nature of this curve at low CO_2 is characteristic of CO_2-obligate plants and the extrapolated X-axis intercept of 2 µmol l^{-1} provides a reliable estimate of the CO_2-compensation point of photosynthesis for this species (Sand-Jensen 1983).

DISCUSSION

The experimental method used in this study identifies the upper pH limit for positive net photosynthesis. Net photosynthesis by Texas wild rice approached zero as pH approached 8.7 when CO_2 was 0.5% of total dissolved inorganic carbon. Bicarbonate in the bathing solution at pH 8.7 was 97.5% of total dissolved inorganic carbon. At this pH there was abundant HCO_3^- available for plant uptake. If Texas wild rice had the ability to remove HCO_3^- rapidly, positive net photosynthesis would continue after CO_2 was exhausted, driving pH above 9.2. During this study, no photosynthesis occurred above 8.7 suggesting submersed leaves of Texas wild rice are unable to take up HCO_3^-.

Carbon dioxide availability to submersed aquatic plants is a function of the interplay between water current velocity, leaf boundary layer thickness and

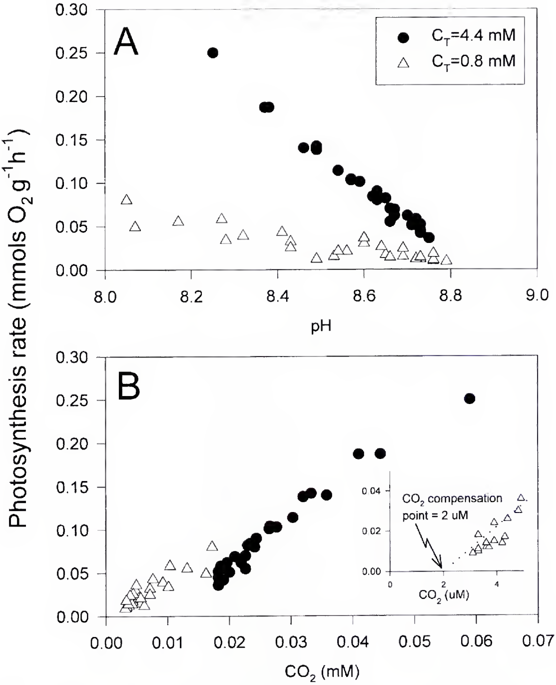


Fig. 1. Apparent net photosynthetic rate by Texas wild rice in a closed water-flow system. A) Plants take up CO_2 for photosynthesis, driving up pH. Photosynthesis ceases when pH reaches approximately 8.7. B) Estimated CO_2 compensation point for Texas wild rice is 2 μmol l^{-1}.

concentration gradient between surrounding water and leaf surface; as flow increases, boundary layer thickness decreases and CO_2 availability increases. Using a closed water-flow system Madsen and Søndergaard (1983) found apparent photosynthesis was stimulated by increasing velocities and a maximum rate was reached at 0.008–0.0012 m s^{-1}. In contrast, Madsen et al. (1993) found photosynthetic rates decreased with increasing current velocity and suggested that physical stress imposed on plants by agitation or stretching in flowing water was a key factor in the observed response. Ribbon-like submersed leaves of Texas wild rice are adapted for flowing water and can reduce carbon limitation by exploiting the flowing water habitat where boundary layer surrounding leaves and diffusion distances for CO_2 are reduced and leaves are continually bathed with carbon-rich water. In contrast, in slower moving water, photosynthesis by submersed leaves of Texas wild rice are probably carbon limited and few submersed leaves are produced, a greater proportion of biomass is allocated to reproductive parts, and plants are less productive overall (Power 2002). Emergent reproductive culms most likely are not carbon limited because culms obtain CO_2 from the atmosphere where CO_2 is more readily available owing to the higher diffusion rate and current velocity in air relative to water (Madsen & Sand-Jensen 1991; Denny 1993).

Texas wild rice is one of five endangered or threatened species which occur in the San Marcos River. As the result of a lawsuit involving the listed species, a water authority was created by the Texas Legislature to manage the source aquifer for the San Marcos River (Texas Legislature 1993). Flow requirements for Texas wild rice are important because of the legal requirement to manage the source aquifer for human needs while simultaneously protecting aquatic and wildlife habitat and protecting listed species. The potentially conflicting management goals of providing aquifer water for human use while maintaining adequate spring flow for endangered species cannot be attained without information concerning the habitat requirements for the listed species. Numerous surveys have identified flowing water habitat as a requirement for Texas wild rice and experimental studies have consistently shown a positive relationship between current velocity and productivity as well as biomass allocation to submersed plant parts (Power 1996a, 1996b, 2002; Poole & Bowles 1999; Saunders et al 2001). Data from this study provide a physiological explanation for these observations and furthers our understanding of habitat requirements for Texas wild rice.

ACKNOWLEDGMENTS

This research was supported by a Section 6 grant from U.S. Fish and Wildlife Service and Texas Parks and Wildlife. We would like to thank Kathryn Kennedy, Center for Plant Conservation; Dr. Michael Smart, Lewisville Aquatic Ecosystem Research Facility; and Stephen McClintik for technical support.

REFERENCES

Allen, E.D. and D.H.N. Spence. 1981. The differential ability of aquatic plants to utilize the inorganic carbon supply in fresh waters. New Phytol. 87:269–283.

APHA. 1992. Standard methods for examination of water and wastewater. 18th edition. A.E. Greensger, L.S. Clesceri and A.D. Eaton, eds. Amer. Water Works Assoc. and Wat. Pollution Control Federation, Washington, D.C.

Blanch S.J., G.G. Ganf, and K.F. Walker. 1999. Growth and resource allocation in response to flooding in the emergent sedge *Bolboschoenus medianus*. Aquatic Bot. 63:145–160.

Denny, M.W. 1993. Air and water: The biology and physics of life's media. Princeton University Press.

Idestam-Almquist, J. and L. Kautsky. 1995. Plastic responses in morphology of *Potamogeton pectinatus* L. to sediment and above-sediment conditions at two sites in the northern Baltic proper. Aquatic Bot. 52:205–216.

Holaday, A.S. and G. Bowes. 1980. C_4 acid metabolism and dark CO_2 fixation in a submersed aquatic macrophyte (*Hydrilla verticellata*). Plant Physiol. 65:331–335.

Maberly, S.C. and D.H.N. Spence. 1983. Photosynthetic inorganic carbon use by freshwater plants. J. Ecology 71:705–724.

Madsen, T.V., H.O. Enevoldsen, and T.B. Jørgensen. 1993. Effects of water velocity on photosynthesis and dark respiration in submerged stream macrophytes. Pl., Cell and Environm. 16:317–322.

Madsen, T.V. and K. Sand-Jensen. 1991. Photosynthetic carbon assimilation in aquatic macrophytes. Aquatic Bot. 41:5–40.

Madsen, T.V. and M. Sondergaard. 1983. The effects of current velocity on the photosynthesis of *Callitriche stagnalis* Scop. Aquatic Bot. 15:187–193.

Poole, J. and D.E. Bowles. 1999. Habitat characterization of Texas wild-rice (*Texas wild rice* Hitchcock), an endangered aquatic macrophyte from the San Marcos River, TX, USA. Aquatic Conservation: Mar. and Freshwater Ecosystems 9:291–302.

Power, P. 1996a. Effects of current velocity and substrate composition on growth of Texas wildrice (*Zizania texana*). Aquatic Bot. 55:199–204.

Power, P. 1996b. Reintroduction of Texas wildrice (*Zizania texana*) in Spring Lake: Some important environmental and biotic considerations. *In*: Proceedings from Second Southwestern Rare and Endangered Plant Conference: Rocky Mountain Forest & Range Experimental Station.

Power, P. 2002. Resource allocation patterns and phenotypic plasticity in relation to current velocity in the endangered Texas wildrice (*Zizania texana* Hitchc.). Sida. 20:571–582.

Rebsdorf, A. 1972. The carbon dioxide system of freshwater. A set of tables for easy computation of the carbon dioxide system. Printed booklet. Freshwater Biological Laboratory, Hillerod, Denmark.

Sand-Jensen, K. 1983. Photosynthetic carbon sources of stream macrophytes. J. Exp. Bot. 34:198–210.

Saunders, K.S., K.B. Mayes, T.A. Jurgensen, J.F. Trungale, L.J. Kleinsasser, K. Azziz, J.R. Fields, and R.E. Moss. 2001. An evaluation of spring flows to support the upper San Marcos River spring ecosystem, Hays County, Texas. River Studies Report No. 16.

SMART, R.M. and J.W. BARKO. 1985. Laboratory culture of submersed freshwater macrophytes on natural sediments. Aquatic Bot. 21:21–263.

SMITH, F.A and N.A. WALKER 1980. Photosynthesis by aquatic plants: effects of unstirred layers in relation to assimilation of CO_2 and HCO_3^- and to carbon isotopic discrimination. New Phytol. 86:245–259.

STUMM, W. and J.J. MORGAN. 1981. Aquatic chemistry: an introduction emphasizing chemical equilibia in natural waters. Wiley, New York.

TERRELL, E.E, W.P.H. EMERY, and H.E. BEATY. 1978. Observations on *Zizania texana* (Texas wildrice), an endangered species. Bull. Torrey Bot. Club 105:50–57.

TEXAS LEGISLATURE. 1993. Chapter 626, S.B. No. 1477. 73rd Legislature–Regular Session.

THOMAS, A.G. and J.M. STEWART. 1969. The effect of different water depths on the growth of wild rice. Canad. J. Bot. 47:1525–1531.

U.S. FISH AND WILDLIFE SERVICE. 1985. Endangered and threatened wildlife and plant taxa for listing as endangered or threatened species. Fed. Reg. 5C(188):39526–39584.

U.S. FISH AND WILDLIFE SERVICE. 1996. San Marcos/Comal (Revised) recovery plan. Albuquerque, New Mexico.

THE POST OAK SAVANNA ECOREGION: A FLORISTIC ASSESSMENT OF ITS UNIQUENESS

Michael H. MacRoberts and Barbara R. MacRoberts

Bog Research
740 Columbia
Shreveport, Louisiana 71104, U.S.A.
and
Herbarium
Museum of Life Sciences
Louisiana State University-Shreveport
Shreveport, Louisiana 71115, U.S.A.

ABSTRACT

Quantitative methods were used to compare the flora of the Post Oak Savanna and Oak-Pine-Hickory ecoregions of the West Gulf Coastal Plain. The analyses show that the two areas are nearly identical floristically.

Key Words: Post Oak Savanna ecoregion, Oak-Pine-Hickory ecoregion, biogeography. West Gulf Coastal Plain

RESUMEN

Se usaron métodos cuantitativos para comparar la flora de las ecoregiones Post Oak Savanna y Oak-Pine-Hickory de la llanura costera del West Gulf. Los análisis muestran que las dos áreas son casi idénticas florísticamente.

INTRODUCTION

A half century ago, Webb (1950) examined the methodology of biogeographers who worked in Oklahoma and Texas and found that not only they did not agree among themselves on the location and description of biogeographic regions, but that regional delineation was subjective. He suggested a remedy: "Quantitative methods must be developed before general agreement on the extent of the major [ecoregions] can be reached. As long as personal opinion and individual judgment are the only bases for judging the extent of the [ecoregions], fundamental and insoluble differences of opinion will continue" (Webb 1950:246). This situation remains essentially unchanged today (MacRoberts & MacRoberts 2003a). The purpose of this paper is to describe the botanical similarities and differences between the Post Oak Savanna (POS) region or ecoregion and the adjacent Oak-Pine-Hickory (OPH) region or ecoregion (herein region, ecoregion, and vegetation area are used interchangeably).

STUDY AREAS

The Post Oak Savanna region (POS) of Texas has been considered a distinct vegetation area (ecoregion) since Harshberger (1911) mapped it, but it was Shantz and Zon (1924) and later Gould (1962) who gave it its modern shape (MacRoberts & MacRoberts 2003a) (Fig. 1).

The POS region has been described repeatedly. It is a gently rolling or hilly region comprising 30,000 to 40,000 sq. km with elevations from 90 to 250 m above sea level. Annual rainfall is 75 to 115 cm with highest rainfall in May and June. The Carrizo Sands extend along the length of the region. Soils on the uplands are acid sandy loams or sands. Bottomland soils are generally acid sandy loams and clays. Prairies are scattered throughout, notably in the south. The area contains a diversity of plant communities, from hillside pitcher plant bogs, peat bogs, and upland marshes to open xeric sandylands, oak-hickory forests/woodlands, prairies, and bottomland floodplains. Overstory trees in the uplands are primarily *Quercus stellata* Wang., *Q. margaretta* (Ashe) Ashe ex Small, *Q. marilandica* Muenchh., and *Carya* spp. The virtual absence of pine is emphasized. Understory vegetation includes common grasses *Schizachyrium scoparium* (Michx.) Nash , *Sorgastrum nutans* (L.) Nash, *Panicum virgatum* L., *Tridens flavus* (L.) Hitchc., *Bothriochloa saccharoides* (Sw.) Rydb., *Nassella leucotricha* (Trin.& Rupr.) Pohl, *Chasmanthium sessilifolium* (Poir.) Yates. Further description of the POS region can be found in many sources (e.g., Correll & Johnston 1970; LBJ School of Public Affairs1978; Hatch et al. 1990; Telfair 1999).

McBryde (1933) conducted the first major floristic study of the POS region, emphasizing the Carrizo Sands. Recent studies have been on grasslands (Smeins & Diamond 1983), bogs and marshes (MacRoberts & MacRoberts 1998, 2001), creek systems (Telfair 1988), and xeric sandylands (MacRoberts et al. 2002a). What has not been studied is the floristic similarities and differences between the POS region and its adjacent "ecoregions" or "vegetation areas" (MacRoberts & MacRoberts 2003a).

The OPH region, to which we mainly compare the POS region, consists of about 175,000 sq. km in east Texas, west Louisiana, south Arkansas, and southeast Oklahoma. It is characterized by the presence of pine and by the frequent co-dominance of pine, oak, and hickory in the forest or woodland canopy. Precipitation is about 100 cm per year. The terrain varies from nearly level to gently undulating. Upland soils are generally acidic sandy loams and sands over sandy loam and clay. Bottomlands are acidic sands and clays and loams. The dominant vegetation is a mixed pine-hardwood forest on the uplands and a mixed hardwood forest on the bottomlands. *Pinus taeda* L. and *P. echinata* Mill. occur throughout. *Pinus palustris* Mill. is confined to the southern part of the OPH region. Principle hardwoods are those that occur over most of the southeast coastal plain: *Liquidambar styraciflua* L., *Quercus* spp., *Nyssa sylvatica* Marsh., *Magnolia* spp., *Ulmus* spp., *Populus deltoides* Bart. ex Marsh., *Carya* spp., *Acer* spp., *Fagus grandifolia* Ehrh., *Fraxinus* spp., *Taxodium distichum* (L.) L. Rich. Further description of the OPH region can be found in many sources (e.g.,

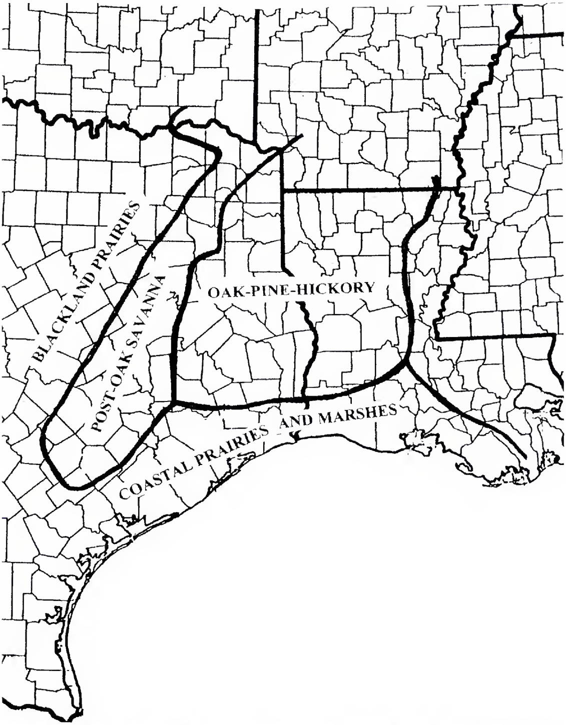


Fig. 1. Traditionally recognized ecoregions of the West Gulf Coastal Plain.

see Correll & Johnston 1970; Hatch et al. 1990; Telfair 1999 and references contained therein). The longleaf pine portion of the OPH region (often considered to be a separate ecoregion itself, is not so considered here) in southeast Texas and south-central Louisiana has been by far the best studied portion of the OPH region (see Harcombe et al. 1993; MacRoberts & MacRoberts 2003a for literature).

METHODS

1. In order to determine the uniqueness of the POS region, we examined the distribution of the taxa on the Singhurst et al. (2003) list of the flora of the 4,466 ha Gus Engeling Wildlife Management Area (GEWMA) in Anderson County, in the middle of the POS region. This sample contains 830 native taxa from a wide variety of communities and habitats including bogs, marshes, xeric sandylands, stream bottoms, and oak-hickory woodlands. Using all available sources (e.g., Hatch et al. 1990; Thomas & Allen 1993-1998; Turner et al. 2003; *Flora of North America*; Evans n.d.), we determined how many of the taxa on the Singhurst et al (2003) list occur in the OPH region and/or in the coastal region of southeast Texas and Louisiana and how many of them are either confined to the POS region or to that region and areas westward.

2. Since high endemism is often considered a key indicator of ecoregional uniqueness (Tahktajan 1986), we studied the distribution of endemic West Gulf Coastal Plain taxa to see how many are unique to the POS region (see MacRoberts et al. 2002b for West Gulf Coastal Plain endemics and their community affiliations).

3. In order to discover the North American affinities of the POS region, using Kartesz and Meacham (1999) we plotted the North American distribution by state or regional area of the 830 native taxa on the Singhurst et al. (2003) GEWMA list. We converted the results into percentage of taxa that occur in each state or regional area (see MacRoberts & MacRoberts 2003b for details of this method).

RESULTS

1. Ninety-eight percent of the native taxa found at GEWMA also occur in the OPH and/or coastal plain regions of Texas and Louisiana. Only two percent are either endemic to the POS region or reach their eastern limit in the POS region.

2. Of the approximately 100 endemic taxa of the West Gulf Coastal Plain, only nine are endemic or near endemic to the POS region. These are *Abronia macrocarpa* L. Galloway, *Brazoria truncata* (Benth.) Engelm. & Gray, *Hymenopappus carrizoanus* B.L. Turner, *Lactuca hirsuta* Muhl. ex Nutt. var. *albiflora* (Torr. & Gray) Shinners, *Monarda viridissima* Correll, *Paronychia setacea* Torr. & Gray, *Polygonella parksii* Cory, *Rhododon ciliatus* (Benth.) Eping, and *Valerianella florifera* Shinners. All of these taxa are associated with a single plant community: xeric sandylands (MacRoberts et al. 2002b). This community accounts for fifty percent of the endemics in the West Gulf Coastal Plain and is associated with the Carrizo Sands and other upland sandy areas and terraces that run the length of the POS region and spread out across the OPH region (McBryde 1933; MacRoberts & MacRoberts 1994, 1995, 1996; MacRoberts et al. 2002a). The remaining West Gulf Coastal Plain endemics occur in either both the POS region and the OPH region or in the OPH region alone.

3. The GEWMA flora is overwhelmingly eastern and notably southeastern (Fig. 2). Ninety-five percent of the taxa occurring at GEWMA occur in Louisiana, 92 percent in Arkansas, 89 percent in Oklahoma, 85 percent in Mississippi, 81 percent in the Carolinas, and 53 percent in New York and the New England states, but only 28 percent in New Mexico. This is consistent with our previous finding that eastern flora characterizes east Texas to about 95 degrees W. longitude, at which point east begins to give way to west over the next 300 km (MacRoberts & MacRoberts 2003b). GEWMA is located at about 96 degrees W. longitude on the eastern edge of this broad transition zone, and is thus essentially eastern, as the above figures indicate.

DISCUSSION

Unfortunately, for our floristic analysis there is no operational definition of ecoregion or any of the other "chorionomic" categories (e.g., region, province, district, subdistrict) that biogeographers use (Takhtajan 1986). The best definition we have found for ecoregion is that it is a distinct assemblage of natural communities and species involving a fairly large geographical region (Ricketts & Dinerstein 1999; The Nature Conservancy 2003). Takhtajan (1986) also states that endemism is fairly high, notably at the species and subspecies level. But these statements are of little help since they do not designate whether 25% or 50% difference in species composition constitutes a distinct assemblage or just what percent of the total should be endemic.

Nonetheless, our main finding is that the POS region differs only insignificantly from the OPH region. Far fewer than one percent of its taxa are endemic to it and only about two percent of its taxa do not also occur in the adjacent region to its east.

As part of our floristic study of the POS region, we examined and compared all community classifications for the POS and OPH region to see how many communities described for the POS region were unique to it (Marks & Harcombe 1981; Diamond et al. 1987; Harcombe et al. 1993; Texas Natural Heritage Program 1995; Nesom et al. 1997; Turner et al. 1999; Van Kley 1999a, 1999b; Bezanson 2000; Fleming et al. 2002; Louisiana Natural Heritage 2003; Singhurst et al. 2003). While this was not a quantitative analysis, we found the community structure of the POS region to be virtually identical with the OPH region. No community appeared to be unique to it. Those communities that typify it: upland post oak hickory forest/woodland, xeric sandylands, prairies, glades, baygalls, and so forth also occur in the OPH region (e.g., Marietta & Nixon 1983, 1984; Ward & Nixon 1993; Nesom et al. 1997; MacRoberts et al. 2002a). If there is anything distinctive about the POS region, it is that some of these communities (e.g., xeric sandylands, prairies) are more common in that region than they are farther east. Ironically, while the absence of pine is the feature most often noted for the POS region, pine does occur in the POS region, most dramatically

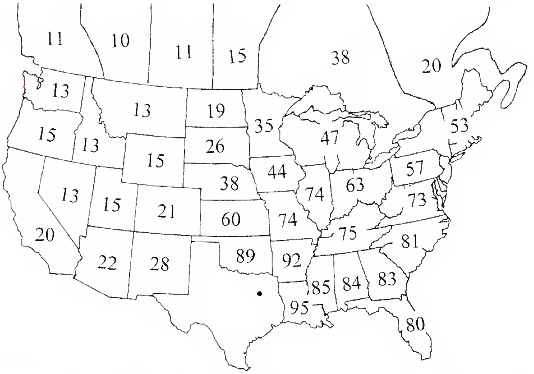


Fig. 2. Association of Post Oak Savanna flora expressed as percentages of flora at Gus Engeling Wildlife Management Area occurring in each state, province, or region. Dot in Texas is the location of Gus Engeling Wildlife Management Area (see text for further explanation).

at its western edge in Bastrop County, where *Pinus taeda* is often a dominant or co-dominant canopy species (Wilson 1990).

Neither a botanist nor a plant ecologist familiar with the southeastern flora would find much new in the POS. The main difference would be the absence of pines in some areas and the different frequency of communities and thus taxa in others. Even the few endemics to the region are tied to one community type—xeric sandylands—which occurs as far east as southwest Arkansas, central Louisiana, and southeast Texas (MacRoberts & MacRoberts 1994, 1995, 1996; MacRoberts et al. 2002a). The difference between the POS and the OPH regions is one of degree, not of kind. This finding agrees with a number of previous workers who have indicated the lack of a sharp boundary between the OPH and POS and who have questioned the floral uniqueness of the POS altogether (e.g., Tharp 1926; McCarley 1959; Diggs et al. 1999; MacRoberts & MacRoberts 2003a). Basically, the POS region is part of the 300 km ecotone between east and west, just as is the north central Texas prairie and cross timbers region (Diggs et al. 1999; MacRoberts & MacRoberts 2003b).

ACKNOWLEDGMENTS

Ray C. Telfair II and an anonymous reviewer made many useful comments on the paper.

REFERENCES

Bezanson, D. 2000. Natural vegetation types of Texas and representation in conservation areas. M.A. Thesis, University of Texas, Austin.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Diamond, D.D., D.H. Riskind, and S.L. Orzell. 1987. A framework for plant community classification and conservation in Texas. Texas J. Sci. 39:203–221.

Diggs, G.M., B.L. Lipscomb, and R.J. O'Kennon. 1999. Illustrated flora of North Central Texas. Sida Bot. Misc. 16:1–1626.

Evans, R.E. n.d. List of the taxa occurring in Region 1 of Texas. Unpublished manuscript.

Fleming, K.M., J.R. Singhurst, and W.C. Holmes. 2002. Vascular flora of Big Lake Bottom Wildlife Management Area, Anderson County, Texas. Sida 20:355–371.

Gould, F.W. 1962. Texas plants. A checklist and ecological summary. Tex. Agric. Exp. Sta. Misc. Publ. 585:1–112.

Harcombe, P.A., J.S. Glitzenstein, R.G. Knox, S.L. Orzell, and E.L. Bridges. 1993. Vegetation of the longleaf pine region of the West Gulf Coastal Plain. Proc. Tall Timbers Fire Ecology Conference 18:83–104.

Harshberger, J.W. 1911. Phytogeographic survey of North America. (2nd Ed.) Hafner, New York.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Misc. Publ. 1655:1–158.

Kartesz, J.T. and C.A. Meacham. 1999. Synthesis of North American flora. Version 1.0. North Carolina Botanical Garden. Chapel Hill.

LBJ School of Public Affairs. 1978. The natural regions of Texas. In: Preserving Texas's Natural Heritage. L.B.J. School of Public Affairs Policy Res. Proj. Rept. 31:17–24.

Louisiana Natural Heritage. 2003. Natural communities of Louisiana. Unpublished report, Louisiana Dept. Fish and Wildlife, Baton Rouge.

MacRoberts, M.H. and B.R. MacRoberts. 1994. Floristics of a xeric sandyland in western Louisiana. Phytologia 77:414–424.

MacRoberts, B.R. and M.H. MacRoberts. 1995. Floristics of xeric sandhills in northwestern Louisiana. Phytologia 79:123–131.

MacRoberts, B.R. and M.H. MacRoberts. 1996. Floristics of xeric sandhills in east Texas. Phytologia 80:1–7.

MacRoberts, B.R. and M.H. MacRoberts. 1998. Floristics of muck bogs in east central Texas. Phytologia 85:61–73.

MacRoberts, M.H. and B.R. MacRoberts. 2001. Bog communities of the West Gulf Coastal Plain: a profile. Bog Research Papers in Botany & Ecology 1:1–151.

MacRoberts, B.R., M.H. MacRoberts, and J.C. Cathey. 2002a. Floristics of xeric sandylands in the post oak savanna region of east Texas. Sida 20:373–386.

MacRoberts, M.H., B.R. MacRoberts, B.A. Sorrie, and R.E. Evans. 2002b. Endemism in the West Gulf Coastal Plain: importance of xeric habitats. Sida 20:767–780.

MacRoberts, M.H. and B.R. MacRoberts. 2003a. West Gulf Coastal Plain ecoregions. Sida 20:1247–1276.

MacRoberts, M.H. and B.R. MacRoberts. 2003b. The east-west transition of flora in Texas: a biogeographical analysis. Sida 20:1693–1700.

Marietta, K.L. and E.S. Nixon. 1983. Vegetational analysis of a post oak-black hickory community in eastern Texas. Texas J. Sci. 35:196–203.

Marietta, K.L. and E.S. Nixon. 1984. Vegetation of an open, prairie-like community in eastern Texas. Texas J. Sci. 36:25–32.

Marks, P.L. and P.A. Harcombe. 1981. Forest vegetation of the Big Thicket, southeast Texas. Ecol. Monogr. 51:287–305.

McBryde, J.B. 1933. The vegetation and habitat factors of the Carrizo Sands. Ecol. Monogr. 3:247–297.

McCarley, H. 1959. The mammals of eastern Texas. Texas J. Sci. 11:385–426.

Nesom, G.L., B.R. MacRoberts, and M.H. MacRoberts. 1997. A new plant community type in southeast Texas related to baygalls. Phytologia 83:371–383.

Ricketts, T.H. and E. Dinestein. 1999. Terrestrial ecoregions of North America. Island Press, Washington, D.C.

Shantz, H.L. and R. Zon. 1924. Natural vegetation. Atlas of American Agriculture. Pt. 1. U.S. Dept. Agriculture, Washington, D.C.

Singhurst, J.R., J. Cathey, D. Prochaska, H. Haucke, G.C. Kroh, and W.C. Holmes. 2003. Vascular flora of Gus Engeling Wildlife Management Area, Anderson County, Texas. Southeastern Naturalist 2:347–368.

Smeins, F.E. and D.D. Diamond. 1983. Remnant grasslands of the Fayette prairie, Texas. Amer. Midl. Naturalist 110:1–13.

Takhtajan, A. 1986. Floristic regions of the world. University of California Press, Berkeley.

Telfair, R.C. II. 1988. Conservation of the Catfish Creek ecosystem: a national natural landmark in eastern Texas. Texas J. Sci. 40:11–23.

Telfair, R.C. II. 1999. Introduction: ecological regions of Texas: description, land use, and wildlife. In: R.C. Telfair II. ed., Texas wildlife resources and land use. Univ. Texas Press, Austin. Pp. 1–39.

Texas Natural Heritage Program. 1995. Plant communities of Texas. Unpublished report. Texas Parks and Wildlife Department, Austin.

Tharp, B.C. 1926. Structure of Texas vegetation east of the 98th meridian. Univ. Texas Bull. 2606:1–99.

Thomas, R.D. and C.M. Allen. 1993–1998. Atlas of the vascular flora of Louisiana. The Nature Conservancy, Baton Rouge.

The Nature Conservancy. 2003. What is an ecoregion? www.tnc.org. (14. Jan. 2004).

Turner, B.L., H. Nicols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Sida, Bot. Misc. 24:1–888.

Turner, R.L., J.E. Van Kley, L.S. Smith, and R.E. Evans. 1999. Ecological classification system for the national forests and adjacent areas of the West Gulf Coastal Plain. The Nature Conservancy, Nacogdoches.

Van Kley, J.E. 1999a. The vegetation of the Kisatchie sandstone hills, Louisiana. Castanea 64:64–80.

Van Kley, J.E. 1999b. The vegetation of the high terrace rolling uplands, Louisiana. Castanea 64:318–336.

Ward, J.R. and E.S. Nixon. 1992. Woody vegetation of the dry, sandy uplands of east Texas. Texas J. Sci. 44:283–294.

Webb, W.L. 1950. Biogeographic regions of Texas and Oklahoma. Ecology 31:426–433.

Wilson, R.E. 1990. The eastward recession of the piney woods of northeastern Texas, 1815–1989. Texas J. Sci. 42:179–189.

BOOK NOTICE

Timber Press

Denise Wiles Adams. 2004. **Restoring American Gardens: An Encyclopedia of Heirloom Ornamental Plants, 1640-1940**. (ISBN 0-88192-619-1, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 420 pp., 155 color photos, 37 b/w photos, 154 line drawings, 1 table, 8 1/2" × 11".

The meat of this great book is the "Encyclopedia of Heirloom Ornamental Plants." The heirlooms are alphabetical under broad categories like Heirloom Trees, Heirloom Ornamental Shrubs, Heirloom Bulbs and Tuberous Plants, Heirloom Roses, etc. Each heirloom plant is listed with most of the following descriptive information: **1)** Scientific name, **2)** Common names, **3)** Synonym, **4)** Family, **5)** Nativity [native or exotic], **6)** Date of introduction into North America, **7)** Earliest American citation, **8)** Hardiness zone, **9)** Description, **10)** Design notes, **11)** Remarks, **12)** Heirloom varieties, **13)** Related species, and **14)** Historical commercial sources

I really like this book a lot! It is filled with hard to find information, great images of plants from old catalogs, as well as beautiful colored plates of the past three centuries, and modern color photographs.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 761202-4060, U.S.A.*

A QUANTITATIVE STUDY OF THE VEGETATION SURROUNDING YELLOW LADY-SLIPPER ORCHID (*CYPRIPEDIUM KENTUCKIENSE*, ORCHIDACEAE) POPULATIONS AT FORT POLK IN WEST CENTRAL LOUISIANA

Charles M. Allen
Colorado State Univ., Fort Polk
1645 23rd Street
Fort Polk, Louisiana 71459, U.S.A.

Sara Thames
Oak Ridge Institute for Science and Education
1645 23rd Street
Fort Polk, Louisiana 71459, U.S.A.

Spencer Trichell and Jeremy White
Dept. of Biology
University of Louisiana at Monroe
Monroe, Louisiana 71209, U.S.A.

ABSTRACT

The vegetation around five populations of yellow lady-slipper orchid (*Cypripedium kentuckiense* Reed) at Fort Polk, Louisiana were sampled using circular nested plots. Measurements included frequency, mean density, mean cover percent, mean dbh, importance value, and diversity (richness). The yellow lady-slippers at Fort Polk were associated with forests composed mainly of American beech (*Fagus grandifolia*), eastern hophornbeam (*Ostrya virginiana*), white oak (*Quercus alba*), horsesugar (*Symplocos tinctoria*), and witch hazel (*Hamamelis virginiana*) in the overstory and an abundance of poison ivy (*Rhus radicans*) and broad beechfern (*Thelypteris hexagonoptera*) in the understory.

RESUMEN

Se muestreó la vegetación alrededor de cinco poblaciones de *Cypripedium kentuckiense* Reed en Fort Polk, Louisiana mediante parcelas anidadas circulares. Las medidas incluyen frecuencia, densidad media, recubrimiento medio, diámetro medio a la altura del pecho, valor de importancia, y diversidad (riqueza). *Cypripedium kentuckiense* en Fort Polk está asociado a bosques compuestos principalmente por haya americana (*Fagus grandifolia*), *Ostrya virginiana*, roble blanco (*Quercus alba*), *Symplocos tinctoria*, y *Hamamelis virginiana* en el dosel arbóreo y abundante zumaque (*Rhus radicans*) y *Thelypteris hexagonoptera* en el sotobosque

INTRODUCTION

Yellow lady-slipper (*Cypripedium kentuckiense* Reed) is an herbaceous perennial in the Orchidaceae family. This species is reported from the southeastern U.S. in AL; AR; KY; LA; MS; OK; TN; TX; and VA (USDA, NRCS 2002). Globally this species is ranked G3 which is defined as either rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single physiographic region) or because of other factors making it vulnerable to extinction throughout its range, or with 21-100 known extant populations or 3,000 to 10,000 individuals (NatureServe 2003). It is ranked S1 in AL, GA, LA, OK, TX, and VA. An S1 species is defined as being critically imperiled in a state because of its extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extirpation. It is listed as S1/S2 in TN, S2/S3 in KY, S3 in AR, and SU in MS. The S2 ranking is defined as imperiled in the state because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extirpation while the S3 ranking is defined as rare and local throughout the state or found locally (even abundant at some of its locations) in a restricted region of the state, or because of other factors making it vulnerable to extirpation (21 to 100 known extant populations). The SU ranking is for those species that are possibly in peril in the state but with an uncertain status and more information is needed. Thirteen populations of this orchid are known from east Texas (Liggio & Liggio 1999). In Louisiana, it is reported from 11 parishes with four from unverified reports (Louisiana Department of Wildlife and Fisheries; Natural Heritage Program 2003).

The habitat for this species is described as mature floodplain forests and the slopes of mesic (relatively dry) ravines (Oklahoma Natural Heritage Inventory 2001) and rich, mesic to dry, deciduous forests on well-drained alluvium and bases of slopes, or mucky seeps; mostly 0–400m (Flora of North America Editorial Committee 2002). Orzell (1990) describes the habitat for this species as terraces and lower moist slopes in small stream valleys of pine-hardwood forests. This author lists the common trees of the canopy as American beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), black gum (*Nyssa sylvatica*), and southern magnolia (*Magnolia grandiflora*). The understory species reported by Orzell (1990) include flowering dogwood (*Cornus florida*), red maple (*Acer rubrum*), chalk maple (*Acer lecoderme*), bigleaf snowbell (*Styrax grandifolia*), and American hornbeam (*Carpinus caroliniana*). Orzell (1990) also reports that two shrubs species, maple-leaf viburnum (*Viburnum acerifolium*) and arrow wood (*Viburnum dentatum*) are frequently associated with this orchid. Herbaceous plants often found associated with yellow lady-slippers include cranefly orchid (*Tipularia discolor*), slender wood sedge (*Carex digitalis*), partridge berry (*Mitchella repens*), Christmas fern (*Polystichum acrostichoides*), Walter's violet (*Viola walteri*), eared goldenrod (*Solidago articulata*), broad beech fern (*Thelypteris hexagonoptera*), and slender wake robin (*Trillium gracile*) (Orzell 1990). The habitat in Louisiana is reported to be mesophytic woods, calcareous forests, and hardwood slope forests (Louisiana Department of Wildlife and Fisheries; Natural Heritage Program, 2003). A search of the literature yielded no quantitative data on the habitat for yellow lady-slipper throughout its range. The objective of this study was to quantitatively describe the habitat for yellow lady-slipper in west central Louisiana.

Five distinct groups of yellow lady-slipper are known from the Fort Polk Military Installation in Vernon Parish, Louisiana. Three of the five groups are located at one site while two are located at a different site. The two sites are located about six kilometers apart and each is a well drained ravine in a mesic hardwood forest. Each ravine has a small, intermittent stream at the bottom. The soils at both sites are Eastwood silt loam (Soil Survey Division, Natural Resources Conservation Service, United States Department of Agriculture 2003). These five groups have been observed for the past ten years with four clumps having flowered and one clump not flowering during this period.

METHODS

Three nested circular plots were sampled with the center of each of the five yellow lady- slipper groups serving as the center point of the plot. All trees and shrubs (woody non-vine species taller than 6 ft = 1.83m) were sampled within a 15m radius circle; shrubs and saplings (woody non-vine species shorter than 1.83m = 6 ft) and woody vines were sampled within a 5m radius circle; and all herbaceous species were sampled within a 1m radius circle. During the sampling period, the number of stems was counted and recorded for all species in the samples. For the trees and shrubs within the 15m radius samples, the dbh was measured at the standard 1.37m (4.5 ft) height using a diameter tape and recorded to the nearest 0.1 cm. For herbaceous plants, woody vines, and shrubs and saplings, cover was determined by measuring the area occupied by the individuals of the species in the sample. For the few species with only one or two individuals per sample, the actual area was used. For those species with more than two individuals per sample, the mean area was calculated by summing the area occupied by three or more randomly selected individuals of the species and dividing by the number of individuals selected. The cover was then calculated by multiplying the actual area or mean area times the number of individuals and then dividing by the area of the plot, 78.035m^2 for the 5m radius plots and 3.14m^2 for the 1m radius plots. The cover was converted to a percent by multiplying by 100.

All data were entered into a Microsoft Excel spread sheet for storage and calculation of variables. The mean diversity (richness) and mean density were calculated for each of the five plots for all plant groups while the mean dbh was calculated for trees and shrubs and mean cover percent was calculated for herbaceous plants, woody vines, and shrubs and saplings. The frequency and mean density were calculated for each species. The mean dbh was calculated for tree and shrub species and the mean cover percent for all other species. The relative values for each of these variables (frequency, mean density, mean dbh, and mean cover percent) were calculated by dividing the value for a species by the total for all species. Each value was converted to a percent by multiplying by 100 and the sum of these relative values was used to calculate the importance value.

RESULTS

The number of species totaled seventy-eight (78) with nine (9) woody vines, twenty-one (21) herbaceous plants, and forty-five (45) tree, shrub or saplings (Table 1). The mean number of species per sample ranged from 9.00 for woody vines to 23.80 for shrubs and saplings. The mean number of stems per sample (density) averaged 651.40 per sample for all plants and ranged from 77.00 for trees and shrubs to 216.80 for shrubs and saplings. The mean cover percent for all plants was 240.74 percent and ranged from 8.68 percent for woody vines to 159.86 percent for herbaceous plants. The mean dbh per sample was 877.98 cm.

The frequency, mean density, mean dbh, and importance value for the tree and shrub species are in Table 2, while the frequency, mean density, mean cover percent, and importance value for the appropriate plant group are in Tables 3, 4, or 5. The species are arranged in descending importance value in all four tables. The three most important tree and shrub species are American beech (28.12), white oak (*Quercus alba*) (27.73), and horsesugar (*Symplocos tinctoria*) (25.94) (Table 2). Eastern hophornbeam (*Ostrya virginiana*) was the dominant shrub and sapling species with an importance value of 55.01 followed by witch hazel (*Hamamelis virginiana*) (31.63) and horsesugar (23.64) (Table 3). The most important woody vine species was poison ivy (*Rhus radicans*) (128.28) and accounted for almost one-half of the total importance value of 300 while crossvine (*Bignonia capreolata*) (33.42) and common greenbrier (*Smilax rotundifolia*) (33.34) ranked second and third respectively (Table 4). The dominant herbaceous species was broad beechfern (*Thelypteris hexagonoptera*) with an importance value of 125.18 followed distantly by partridge berry (37.19) and longleaf woodoats (*Chasmanthium sessiliflorum* (20.51) (Table 5).

DISCUSSION

Allen et al (1994) reports physiognomy data for 4m radius samples in a beech forest area in the Louisiana Arboretum in Evangeline Parish near a yellow lady-slipper population. The diversity (richness) for this beech forest includes a mean of 8.20 species for the shrubs and saplings and 5.10 species of trees and shrubs compared to 23.80 species for shrubs and saplings and 19.00 for trees and shrubs in this study. The density and cover percent in the beech forest for the shrubs and saplings were 76.10 stems and 42.88 percent, respectively, which compared to 216.80 stems and 72.20 percent in this study. The mean trees and shrub density in this study was 77.00 compared to 10.30 in the Arboretum beech forest. The mean dbh in this study was 877.98 cm compared to 50.68 cm at the Arboretum. Newman (1995) reports physiognomy data from 4m radius samples in a hardwood slope forest in Caldwell Parish, Louisiana. This site is a short distance south of a yellow lady-slipper population in extreme southern Ouachita Parish. The shrub and sapling data from the Caldwell site included a mean diversity of 15.82 species compared to 23.80 species in this study; mean density of 67.65 stems compared to 216.80 stems; and mean cover percent of 39.56 percent compared to 72.20 percent. The trees and shrubs from the Caldwell Parish study

Table 1. Community physiognomy variables (diversity, density, cover percent, and dbh) in samples around yellow lady-slipper populations at Fort Polk, La.

	Diversity (Richness)				
	All Plants	**Trees & Shrubs**	**Shrubs & Saplings**	**Woody Vines**	**Herbaceous Plants**
Mean	48.00	19.00	23.80	9.00	10.20
Std Dev.	2.83	2.55	3.77	1.00	2.49
Range	45–51	16–22	18–27-	8–10	8–14
Total Number	78	33	41	12	21

	Density				
	All Plants	**Trees & Shrubs**	**Shrubs & Saplings**	**Woody Vines**	**Herbaceous Plants**
Mean	651.40	77.00	216.80	205.20	152.40
Std Dev.	83.46	20.41	55.95	77.86	88.49
Range	644–706	55–108	175–310	106–317	71–286

	Cover Percent				DBH (cm)
	All Plants	**Shrubs & Saplings**	**Woody Vines**	**Herbaceous Plants**	**Trees & Shrubs**
Mean	240.74	72.20	8.68	159.86	877.98
Std Dev.	141.53	25.44	2.81	136.79	124.00
Range	113.63-449.00	39.67-109.82	4.65-11.80	34.55-365.49	741.10-1011.20

had a mean diversity of 4.20 species compared to 19.00 in the present study; mean density of 8.28 stems compared to 77.00; and mean dbh of 68.03 cm compared to 877.98 cm. Some of the larger numbers in this study in comparison to both of these reports can be attributed to the difference in sample size, but the Fort Polk yellow lady-slipper area seems to be more diverse, with a higher vegetation density, and a higher basal area.

The five yellow lady-slipper populations at Fort Polk were associated with a forest composed of American beech, eastern hophornbeam, horsesugar, white oak, and witch hazel in the overstory and an abundance of poison ivy and broad beechfern in the understory. This description is very similar to the qualitative report of associated species by Orzell (1990) except that American hornbeam (*Carpinus caroliniana*) was not found in the sampled area at Fort Polk. The three most important shrubs and saplings reported from Caldwell Parish by Newman (1995) include American beech, red maple (*Acer rubrum*), and eastern hophornbeam and the top three reported from the Louisiana Arboretum by Allen et al (1994) include native bamboo (*Arundinaria gigantea*), pawpaw (*Asimina triloba*), and pignut hickory (*Carya glabra*). All of these species were found in the Fort Polk study except for pawpaw and pignut hickory. The three most important species of trees and shrubs in Caldwell Parish included flowering dogwood (*Cornus florida*), sweet gum (*Liquidambar styraciflua*), and east-

Table 2. Frequency, Mean Density, Mean dbh, and Importance Value for Trees and Shrubs in 15m radius samples around Yellow Lady-slipper Populations at Fort Polk, La.\<4>

Species	Frequency	Mean Density	Mean dbh	Importance Value
Fagus grandifolia	100.00	8.20	107.14	28.12
Quercus alba	100.00	4.80	142.56	27.73
Symplocos tinctoria	60.00	14.00	40.42	25.94
Nyssa sylvatica	100.00	3.60	92.90	20.52
Ostrya virginiana	100.00	6.20	46.96	18.66
Liquidambar styraciflua	100.00	3.40	69.76	17.62
Cornus florida	100.00	4.80	38.72	15.91
Ilex opaca	100.00	3.60	20.38	12.26
Pinus taeda	60.00	1.20	65.60	12.19
Hamamelis virginiana	100.00	3.80	9.80	11.31
Carya alba	60.00	1.80	51.04	11.31
Fraxinus americana	100.00	1.60	30.32	10.79
Acer rubrum	80.00	2.00	31.88	10.44
Acer leucoderme	60.00	2.80	21.48	9.24
Carya ovata	60.00	1.20	27.18	7.81
Quercus falcate	60.00	0.60	28.44	7.18
Styrax grandifolia	60.00	2.00	7.80	6.64
Arundinaria gigantea	40.00	2.60	1.92	5.70
Rhododendron canescens	60.00	1.20	1.62	4.90
Vaccinium elliottii	60.00	1.20	1.58	4.90
Vaccinium arboreum	40.00	1.60	6.10	4.88
Aralia spinosa	40.00	1.60	4.28	4.67
Chionanthus virginicus	60.00	0.60	1.84	4.15
Ulmus alata	20.00	0.60	10.04	2.98
Pinus echinata	20.00	0.40	10.24	2.74
Carya spp.	20.00	0.20	3.04	1.66
Crataegus spathulata	20.00	0.20	1.36	1.47
Crataegus marshallii	20.00	0.20	1.22	1.45
Viburnum rufidulum	20.00	0.20	0.76	1.40
Magnolia grandiflora	20.00	0.20	0.62	1.38
Ilex decidua	20.00	0.20	0.46	1.36
Morus rubra	20.00	0.20	0.30	1.35
Viburnum dentatum	20.00	0.20	0.22	1.34
Total	1900.00	77.00	877.98	300.00

ern hophornbeam, and in the Louisiana Arboretum the three most important species were American hornbeam, flowering dogwood, and American beech. All of these species were in the Fort Polk site except for the notable absence of American hornbeam. The absence of American hornbeam could be explained by the Fort Polk site being slightly drier than the other sites as American hornbeam's wetland ranking is FAC and eastern hophornbeam's ranking is FACU- (USDA-NRCS 2002).

TABLE 3. Frequency, Mean Density, Mean Cover Percent, and Importance Value for Shrubs and Saplings in 5m radius samples around yellow lady-slipper Populations at Fort Polk, La.

Species	**Frequency**	**Mean Density**	**Mean Cover**	**Importance Value**
Ostrya virginiana	80.00	39.00	24.30	55.01
Hamamelis virginiana	100.00	33.60	8.61	31.63
Symplocos tinctoria	80.00	10.20	11.24	23.64
Vaccinium elliottii	80.00	7.00	5.74	14.54
Styrax grandifolia	100.00	12.00	1.85	12.29
Ilex opaca	80.00	2.40	5.17	11.63
Arundinaria gigantea	20.00	12.20	3.22	10.93
Acer leudoderme	60.00	15.40	0.79	10.72
Callicarpa americana	60.00	3.60	3.29	8.74
Viburnum dentatum	100.00	7.00	0.54	8.18
Acer rubrum	100.00	7.00	0.31	7.87
Cornus florida	100.00	6.80	0.32	7.78
Pinus taeda	60.00	9.40	0.01	6.87
Chionanthus virginicus	100.00	3.40	0.65	6.68
Quercus alba	80.00	5.40	0.14	6.04
Vaccinium arboretum	60.00	2.20	1.49	5.60
Carya ovata	40.00	6.80	0.48	5.48
Prunus serotina	80.00	4.20	0.05	5.37
Fagus grandifolia	80.00	3.80	0.05	5.18
Carya spp.	60.00	4.40	0.31	4.98
Aralia spinosa	40.00	2.00	1.28	4.37
Rhododendron canescens	60.00	2.80	0.31	4.25
Fraxinus americana	80.00	1.00	0.25	4.17
Crataegus marshallii	40.00	3.40	0.51	3.96
Ilex decidua	60.00	1.80	0.37	3.87
Nyssa sylvatica	60.00	2.00	0.06	3.52
Viburnum rufidulum	60.00	1.60	0.05	3.32
Sassafras albidum	60.00	0.60	0.00	2.80
Vaccinium virgatum	40.00	0.80	0.18	2.30
Hypericum hypericoides	40.00	0.60	0.10	2.09
Crataegus spathulata	40.00	0.40	0.14	2.06
Hypericum frondosum	40.00	0.40	0.12	2.03
Cercis canadensis	40.00	0.40	0.05	1.94
Ulmus alata	40.00	0.40	0.01	1.88
Rubus argutus	40.00	0.40	0.01	1.88
Morus rubra	20.00	0.80	0.07	1.31
Liquidambar styraciflua	20.00	0.60	0.03	1.16
Quercus velutina	20.00	0.40	0.03	1.07
Ilex vomitoria	20.00	0.20	0.03	0.97
Persea palustrus	20.00	0.20	0.02	0.96
Quercus hemisphaerica	20.00	0.20	0.01	0.95
Total	2380.00	216.80	72.20	300.00

Table 4. Frequency, Mean Density, Mean Cover Percent, and Importance Value for Woody Vines in 5m radius samples around yellow lady-slipper Populations at Fort Polk, La.

Species	**Frequency**	**Mean Density**	**Mean Cover**	**Importance Value**
Rhus radicans	100.00	128.20	4.75	128.28
Bignonia capreolata	100.00	29.00	0.71	33.42
Smilax rotundifolia	100.00	8.40	1.57	33.34
Vitis rotundifolia	100.00	8.60	0.22	17.84
Smilax pumila	40.00	11.80	0.60	17.16
Parthenocissus quinquefolia	80.00	6.40	0.14	13.66
Smilax tamnoides	80.00	4.40	0.21	13.47
Smilax smallii	100.00	3.40	0.05	13.37
Vitis vulpina	60.00	1.60	0.29	10.75
Smilax glauca	80.00	1.40	0.02	9.78
Lonicera sempervirens	40.00	1.60	0.04	5.64
Berchemia scandens	20.00	0.40	0.07	3.28
Total	900.00	205.20	8.68	300.00

Table 5. Frequency, Mean Density, Mean Cover Percent, and Importance Value for Herbaceous Plants in 1m radius samples around yellow lady- slipper Populations at Fort Polk, La.

Species	**Frequency**	**Mean Density**	**Mean Cover**	**Importance Value**
Thelypteris hexagonoptera	40.00	82.00	107.82	125.18
Mitchella repens	100.00	37.60	4.34	37.19
Chasmanthium sessiliflorum	100.00	5.80	11.04	20.51
Dicanthelium boscii	100.00	6.20	4.29	16.56
Carex spp.	40.00	2.40	14.69	14.69
Cypripedium kentuckiense	100.00	2.40	4.42	14.14
Solidago caesia	60.00	3.00	1.43	8.74
Spigelia marilandica	60.00	2.60	1.51	8.53
Scleria oligantha	60.00	1.80	1.79	8.18
Aster lateriflorus	40.00	2.00	2.99	7.10
Sanicula canadensis	60.00	1.20	0.54	7.01
Salvia lyrata	40.00	1.20	1.69	5.76
Desmodium spp.	40.00	0.80	0.62	4.83
Elephantopus spp	40.00	0.40	0.14	4.27
Arisaema triphyllum	20.00	0.80	0.93	3.07
Polystichum acrostichoides	20.00	0.60	0.74	2.82
Aristolochia serpentaria	20.00	0.60	0.19	2.47
Dichanthelium commutatum	20.00	0.20	0.57	2.45
Ruellia carolinensis	20.00	0.40	0.10	2.28
Viola walteri	20.00	0.20	0.01	2.10
Viola spp.	20.00	0.20	0.01	2.10
Total	1020.00	152.40	159.86	300.00

This study is apparently the first report of quantitative data on the vegetation associated with yellow lady-slippers. The vegetation around other yellow lady-slipper populations throughout its range should be sampled and compared and contrasted to our results to provide data for ecologically sound management decisions to preserve and expand the populations of this threatened species.

ACKNOWLEDGMENTS

We are indebted to Fort Polk, the University of Louisiana at Monroe, and the two anonymous reviewers.

REFERENCES

Allen, C.M., M.F. Vidrine, and B. Borsari. 1994. Analysis of the woody vegetation of a beech forest area in the Louisiana Arboretum. Louisiana Environm.Professional 10–11(1): 17--26.

Flora of North America Editorial Committee. 2002. Flora of North America: Volume 26; Magnoliophyta: Liliidae: Liliales and Orchidales. Oxford Univ. Press, New York.

Liggio, J. and A.O. Liggio. 1999. Wild orchids of Texas. Univ. of Texas Press, Austin.

Louisiana Department of Wildlife and Fisheries; Natural Heritage Program. 2003. Rare Plant fact sheet for Cypripedium kentuckiense C.F. Reed. http://www.wlf.state.la.us/apps/netgear/clientFiles/lawlf/files/1049978676.pdf

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. 2002. Version 1.6 . Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: April 28, 2003).

Newman, S.D. A. 1995. Ecological analysis of the vegetation of a hardwood slope forest in northern Caldwell Parish, Louisiana. M.S. Thesis, Northeast Louisiana University, Monroe.

Oklahoma Natural Heritage. 2001. Cypripedium kentuckiense southern lady's slipper: status, description, life history, habitat, distribution, field characters, cause of decline, and recovery needs. http://www.biosurvey.ou.edu/

Orzell, S. L. 1990. Inventory of National Forests and National Grasslands in Texas. Texas Natural Heritage Program. Austin.

Soil Survey Division, Natural Resources Conservation Service, United States Department of Agriculture. 2003. Official soil series descriptions, Eastwood series. (http://ortho.ftw.nrcs.usda.gov/osd/)USDA, NRCS. 2002. The PLANTS database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

BOOK NOTICES

Sinauer Associates

Richard B. Primack. 2004. **A Primer of Conservation Biology. Third Edition.** (ISBN 0-87893-728-5, pbk.). Sinauer Associates, Inc. Publishers, 23 Plumtree Road, Sunderland, MA 01375, U.S.A. Orders: orders@sinauer.com, www.sinauer.com, $44.95, 320 pp., illustrated, 7" × 9".

Contents: **1)** Conservation and Biological Diversity. **2)** Threats of Biological Diversity. **3)** Conservation at the Population and Species Levels. **4)** Conserving Biological Communities, and **5)** Conservation and Sustainable Development. Appendix: Selected Environmental Organizations and Sources of Information, Glossary, Bibliography, and Index.

Barry G. Hall. 2004. **Phylogenetic Trees Made Easy: A How-to Manual. Second Edition.** (ISBN 0-87893-312-3, pbk.). Sinauer Associates, Inc. Publishers, 23 Plumtree Road, Sunderland, MA 01375, U.S.A. Orders: orders@sinauer.com, www.sinauer.com, $31.95, 221 pp., illustrated, 7" × 9 1/4".

According to the author, "This is a 'cookbook' intended as a tool to aid beginners in creating phylogenetic trees from protein or nucleic acid sequence data. There are four chapters that provide a step by step sequence for building phylogenetic trees. **1)** Tutorial: Create a Tree! **2)** Basic Elements in Creating and Presenting Trees. **3)** Advanced Elements in Constructing Trees. **4)** Using Alternative Software to Construct and Present Trees. Two appendices are included: **I:** File Formats and Their Interconversion. **II.** Printing Alignments.

CHANGES IN BAYGALL VEGETATION FROM 1986 TO 2001 AT FORT POLK IN WEST CENTRAL LOUISIANA

Charles M. Allen and John Pate

Colorado State Univ., Fort Polk
1645 23rd Street
Fort Polk, Louisiana 71459, U.S.A.

Sara Thames

Oak Ridge Institute for Science and Education
1645 23rd Street
Fort Polk, Louisiana 71459, U.S.A.

Spencer Trichell and Lacy Ezell

Department of Biology
University of Louisiana at Monroe
Monroe, Louisiana 71209, U.S.A.

ABSTRACT

Baygalls are a plant community associated with small streams in west central Louisiana. Plots from a 1986 study on the effects of sedimentation on baygall vegetation were resampled in 2001. Nested subsamples were used and the same areas were sampled during each time period. Importance values were calculated using frequency, individual density, stem density, and dbh. In 1986, the sedimented and control baygalls were significantly different in all variables except for woody individual density and woody stem density. In 2001, dbh was the only variable not significantly different between the control and sedimented baygalls. In the sedimented area between 1986 and 2001, the woody plant variables increased while herbaceous plant variables decreased. Woody species, *Liquidambar styraciflua* and *Alnus serrulata* showed a large decrease, however, *Toxicodendron radicans*, *Smilax rotundifolia*, and *Ligustrum sinense* increased. In the control baygalls, four fern species increased in importance value.

RESUMEN

Los "Baygalls" son una comunidad vegetal asociada a pequeños torrentes en el centro-oeste de Luisiana. Las parcelas de un estudio en 1986 sobre los efectos de la sedimentación en la vegetación baygall se volvieron a muestrear en 2001. Se usaron submuestras anidadas y se muestrearon en cada periodo las mismas áreas. Los valores de importancia se calcularon usando frecuencia, densidad individual, densidad de tallos, y diámetro a la altura del pecho. En 1986, los baygalls sedimentados y de control fueron significativamente diferentes en todas las variables excepto para la densidad individual de leñosas y densidad de tallos leñosos. En 2001, el diámetro a la altura del pecho fue la única variable no significativamente diferente entre el control y los baygalls sedimentados. En el área sedimentada entre 1986 y 2001, las variables de plantas leñosas aumentaron mientras que las variables de plantas herbáceas disminuyeron. Las especies leñosas *Liquidambar styraciflua* y *Alnus serrulata* mostraron una gran disminución, sin embargo, *Toxicodendron radicans*, *Smilax rotundifolia*, y *Ligustrum sinense* aumentaron. En los baygalls de control, cuatro especies de helechos incrementaron su valor de importancia.

INTRODUCTION

Baygall is a colloquial term that refers to the small drainage systems and to the vegetation developed along the streams (Allen et al. 1990). In the center of most baygalls is a small sandy or gravelly-bottomed stream that is intermittent in the upper drainage and usually continuous in the lower portions of the drainage. The smaller streams drain into slightly larger streams and ultimately into a larger watercourse. Baygalls are surrounded by pine forests and are narrow in the upper portion gradually widening downstream to a maximum width of 20–50 meters. Drainage from the surrounding upland pine forest percolates downward until it reaches an impervious layer of clay or rock typically forming seepage areas throughout the baygall. Pitcher plant bogs are found in open areas in and along the edge of many baygalls (Allen et al. 1987). The woody vegetation in the baygalls is predominately broad-leaved (dicotyledonous) deciduous or evergreen trees or shrubs contrasting with the very common evergreen (gymnospermous) needle-leaved trees of the upland pine forests. The vegetation developed along the floor of the baygall is sparse and contains a number of ferns, bryophytes, especially peat moss (*Sphagnum* spp.), and a few shade-tolerant flowering plants.

METHODS

In the summer of 2001, six baygalls used in a 1986 study (Allen et al. 1990) were examined for resampling. The study area in one of the sedimented baygalls was completely destroyed and thus was excluded from resampling. One of the two transects in two different control baygalls could not be relocated. Two transects were resampled in the one sedimented baygall with a total of 37 subsamples. Four transects in four different control baygalls were resampled with 94 subsamples. The 1986 data from these 37 and 94 relocated samples only were used for comparisons with the 2001 data.

In 1986, the starting point for each transect was randomly located in the center of a baygall using random numbers and pacing. The transect extended perpendicular from the baygall stream upslope to the end of the baygall vegetation or sedimented area. Subsamples were established using metal poles at one meter intervals along the transect. Most of the original metal poles were still in place along the transects. In both sampling periods, nested subsamples were taken along the transects at each of the one meter markers. A 0.09 meter (0.3 meter × 0.3 meter) quadrat was used to sample the herbaceous plants. The sample was taken on the upstream side of each point. The shrubs (woody plants with a dbh (diameter at breast high at approximately 4.5 feet) of less than 4 inches and/or shorter than 25 feet) were sampled using a 1 meter square quadrat with 1/2 meter on each side of the transect center line. The trees (woody plants 4 inches dbh or larger and/or 25 feet or taller) were sampled using 10 meter × 1 meter quadrat with 5 meters on each side of the transect center line. All species and total number of stems were recorded in each quadrat at each subsample. The dbh was recorded to the nearest 0.1 cm for woody taxa of sufficient height

Some of the herbaceous taxa could only be identified to genus, family

(Poaceae or Cyperaceae), or class. Data were entered and analyzed using Microsoft Excel software. The community physiognomy variables were calculated by summing the value for each subsample and dividing by the number of subsamples, 37 for sedimented baygalls and 94 for control baygalls. Species richness was calculated using all plant taxa. Individual density (number of individuals per subsample) and stem density (number of stems per subsample) were calculated for herbaceous taxa and also for woody taxa. The dbh was also calculated for woody taxa.

The population variables were calculated for all taxa by summing the value for each subsample and dividing by the number of subsamples, 37 for sedimented baygalls and 94 for control baygalls. The frequency (percentage of subsamples of occurrence) and mean value for individual density and stem density was calculated for all taxa. The mean value for dbh was calculated for the woody taxa of sufficient size. Relative frequency, relative individual density, and relative stem density were calculated for all herbaceous taxa from the sedimented baygalls by summing the values for all herbaceous taxa in the sedimented area and dividing the value for each taxon by the total. The relative values for frequency, individual density, and stem density were calculated identically for the herbaceous taxa from the control baygalls and for woody taxa from both control baygalls and sedimented baygalls. All relative values were then converted to a percentage. The importance value for each herbaceous taxon was calculated by summing the values for relative frequency, relative individual density, and relative stem density. The importance value for each woody taxon was calculated by summing the values for relative frequency, relative dbh, relative individual density, and relative stem density. The total importance value for all herbaceous taxa is 300 and for the woody taxa is 400.

Most plants were identified in the field by the senior author, and voucher herbarium specimens for most taxa were collected, mounted, and filed at Ft. Polk. Duplicates of many of the taxa were deposited in the Herbarium of the University of Louisiana at Monroe (NLU). Some taxa were identified in the laboratory using Allen, (1980 or 1992); Correll and Correll (1972); Correll and Johnston (1970); Diggs et al. (1999); Godfrey and Wooten (1979, 1981); or Radford et al. (1968). The scientific names are from USDA, NRCS (2002).

RESULTS

The mean physiognomy community variables (species richness, dbh, woody individuals, woody stems, herbaceous individuals, and herbaceous stems) per subsample for the sedimented and control baygalls for 1986 plus 2001 are presented in Table 1. The standard deviation is also given. The student's t-test was used to compare variables between control 1986 and control 2001, sedimented 1986 and sedimented 2001, control 1986 and sedimented 1986, and control 2001 and sedimented 2001. Allen et al. (1990) reported that t-test comparisons showed

TABLE 1. Community Physiognomy data (Species Richness, DBH, and Density) in control (94 subsamples) and sedimented baygalls (37 subsamples) for 1986 and 2001 at Fort Polk, La. All variables are significantly different at the 0.05 level between: control 1986 and control 2001; sedimented 1986 and sedimented 2001; control 1986 and sedimented 1986; and control 2001 and sedimented 2001, except where noted. Standard deviation is included in parentheses.

	Control Baygalls		**Sedimented Baygalls**	
	1986	**2001**	**1986**	**2001**
Species Richness	4.79 (2.36)	6.28(2.41)	7.32(2.67)	5.00(2.12)
No. Woody species	34	42	25	27
No. Herbaceous Species	24	23	34	3
DBH (cm)	17.16[a] (23.54)	17.71[a,b] (21.94)	6.19(21.64)	14.19[b] (15.30)
Woody Individual Density	7.13[c](4.40)	12.80(5.94)	6.73[c] (4.34)	10.41(5.59)
Woody Stem Density	8.10 (5.05)	15.87(7.42)	7.35[c](5.22)	11.32(6.14)
Herbaceous Individual Density	1.94[a](3.05)	1.38[a](1.64)	15.05(8.35)	0.16(0.55)
Herbaceous Stem Density	4.21[a] (7.82)	4.24[a] (6.10)	22.30(19.41)	0.19(0.62)

[a] Not significantly different between 1986 and 2001 control baygalls

[b] Not significantly different between 2001 control and 2001 sedimented baygalls

[c] Not significantly different between 1986 and 2001 sedimented baygalls

all variables between the control 1986 and sedimented 1986 data to be significantly different. However, when the data for the relocated samples only are used, the woody individual density and woody stem density were not significantly different between the control and sedimented baygalls in 1986. When the control 1986 data are compared to the control 2001 data, the species richness, woody individual density, and woody stem density were the variables that were significantly different. A comparison of the 1986 sedimented data to the 2001 sedimented data reveals that all six variables are significantly different. In the 2001 control and sedimented data, dbh was not significantly different while the other five variables were all significantly different. In Table 1, the variables that are not significantly different are indicated by: [a] if between 1986 and 2001 control baygalls; [b] if between 2001 control baygalls and 2001 sedimented baygalls; and [c] if between 1986 control baygalls and 1986 sedimented baygalls. The most dramatic changes from 1986 to 2001 occurred in the sedimented baygalls with great increases in dbh (6.19 cm to 14.19 cm), woody plant individuals (6.73 to 10.41), and woody plant stems (7.35 to 11.32). Large decreases occurred in herbaceous individuals (15.05 to 0.16) and herbaceous stems (22.30 to 0.19).

The importance values for each woody taxon in the control and sedimented baygalls for 1986 and 2001 are in Table 2. In 1986, the woody taxa with the highest

Table 2. List of woody taxa and importance value from control baygalls and sedimented baygalls for 1986 and 2001.

Taxon	1986 control	1986 sedimented	2001 control	2001 sedimented
Acer rubrum	17.87	22.27	17.06	7.54
Alnus serrulata	0.00	18.32	4.27	0.00
Aronia arbutifolia	5.59	1.74	8.52	0.00
Berchemia scandens	7.13	7.74	6.10	5.51
Bignonia capreolata	1.12	0.00	8.22	15.03
Callicarpa americana	2.50	1.74	4.83	2.11
Cephalanthus occidentalis	0.00	26.42	0.00	0.00
Chionanthus virginicus	0.56	0.00	1.19	0.00
Cornus florida	0.56	0.00	0.35	0.00
Cyrilla racemiflora	0.00	0.00	0.70	0.00
Gelsemium sempervirens	7.57	4.26	5.88	3.90
Hamamelis virginiana	0.00	0.00	0.70	0.00
Hypericum spp.	0.56	1.74	0.35	0.00
Ilex coriacea	22.45	0.00	35.00	3.08
Ilex opaca	7.91	1.74	5.62	0.00
Itea virginica	1.68	26.94	4.94	0.00
Ligustrum sinense	0.00	7.74	0.00	47.47
Liquidambar styraciflua	5.95	35.10	1.69	7.58
Lonicera japonica	0.00	0.00	0.00	6.51
Lyonia lucida	23.00	0.00	33.72	0.00
Magnolia virginiana	52.14	6.78	37.04	20.79
Morella caroliniensis	19.61	1.74	13.62	1.05
Morella cerifera	4.76	16.27	0.65	22.91
Nyssa sylvatica	78.30	148.97	51.69	69.28
Parthenocissus quinquefolia	0.00	0.00	0.35	0.00
Persea palustris	23.37	1.74	24.50	3.16
Pinus palustris	0.00	0.00	2.76	0.00
Pinus taeda	22.15	2.52	22.64	49.00
Quercus alba	0.00	0.00	1.34	0.00
Quercus falcata	0.56	0.00	0.00	0.00
Quercus nigra/laurifolia	4.73	22.51	6.95	9.32
Quercus seedling	0.00	0.00	0.35	0.00
Rhododendron spp.	7.12	0.00	4.85	0.00
Rhus copallina	0.00	1.74	0.35	0.00
Rubus spp.	8.13	6.96	18.60	2.11
Salix nigra	0.00	9.85	0.00	0.00
Sassafras albidum	1.12	0.00	0.00	0.00
Smilax glauca	5.88	0.00	8.92	1.05
Smilax laurifolia	9.46	0.00	8.32	6.27
Smilax rotundifolia	28.43	4.26	5.52	23.70
Smilax smallii	0.00	0.00	1.46	0.00
Smilax tamnoides	0.00	0.00	0.00	1.05
Toxicodendron radicans	9.24	16.64	21.31	60.40
Toxicodendron vernix	1.68	0.00	0.85	1.05

Table 2. continued

Taxon	1986 control	 sedimented	2001 control	 sedimented
Vaccinium arboreum	0.00	0.00	0.00	1.55
Vaccinium arkansanum	1.12	0.00	0.91	0.00
Vaccinium elliottii	1.96	0.00	2.30	2.11
Viburnum dentatum	4.33	4.26	4.23	18.32
Viburnum nudum	11.45	0.00	20.69	8.17
Vitis rotundifolia	0.00	0.00	0.70	0.00

importance value (>20.00%) in the control baygalls were *Nyssa sylvatica, Magnolia virginiana, Smilax rotundifolia, Persea palustris, Lyonia lucida, Ilex coriacea,* and *Pinus taeda* and in 2001, the top taxa were *Nyssa sylvatica, Magnolia virginiana, Ilex coriacea, Lyonia lucida, Persea palustris, Pinus taeda, Toxicodendron radicans,* and *Viburnum nudum.* In the sedimented baygalls in 1986, the most important taxon was *Nyssa sylvatica* with an importance value of 148.97%, which was almost five times as much as the second most important taxon. In 2001, *Nyssa sylvatica* was still the most important taxon, but its importance value was only 69.28%. In the sedimented baygalls in 1986, other taxa with importance value greater than 20.00% were *Liquidambar styraciflua, Itea virginica, Cephalanthus occidentalis, Quercus nigra/laurifolia,* and *Acer rubrum.* In the same sedimented baygalls in 2001, the taxa with more than 20.00% importance value were *Toxicodendron radicans, Pinus taeda, Ligustrum sinense, Smilax rotundifolia, Morella cerifera,* and *Magnolia virginiana.*

The importance value for each herbaceous taxon in the control baygalls for 1986 and 2001 are in Table 3. In 1986, the taxon with the highest importance value was Poaceae followed by *Rudbeckia scabrifolia, Dichanthelium tenue, Viola primulifolia,* and herbaceous dicotyledons. In 2001, the five taxa with the highest importance value (in decreasing order) were *Dichanthelium tenue, Woodwardia aerolata, Rudbeckia scabrifolia, Carex leptalea,* and *Chasmanthium laxum.* In 2001, there were only three herbaceous taxa observed in the sedimented baygalls (Poaceae 137.91%, *Chasmanthium laxum* 108.06%, and *Mitchella repens* 54.03%); this contrasted tremendously with the 43 taxa recorded in 1986 in all subsamples (Allen et al. 1990) and the 34 taxa in the relocated subsamples. The taxa with the highest importance value in 1986 were Poaceae, *Lycopus* spp., Herbaceous dicotyledons, *Juncus diffusissimus,* and *Juncus coriaceus.*

CONCLUSIONS

In 1986, the data indicated that sedimentation had a significant effect on the baygall vegetation community. The student's t test showed four variables to be

TABLE 3. List of herbaceous taxa and importance value from control baygalls for 1986 and 2001.

Taxon	1986	2001
Apteria aphylla	1.89	0.00
Arisaema triphyllum	3.78	8.46
Arnoglossum ovata	0.00	3.47
Athyrium felix-femina	4.01	9.62
Carex folliculata	0.00	15.72
Carex leptalea	0.00	24.50
Chasmanthium laxum	4.97	17.74
Coreopsis gladiata	10.19	0.00
Cyperaceae	2.70	6.42
Dichanthelium acuminatum	0.00	2.95
Dichanthelium commutatum	1.89	0.00
Dichanthelium dichotomum	0.00	4.22
Dichanthelium tenue	43.36	61.67
Erechtites hieracifolia	1.89	0.00
Eupatorium leucolepis	0.00	2.20
Eupatorium rotundifolium	1.89	0.00
Herbaceous dicot	27.29	0.00
Lachnocaulon anceps	3.50	0.00
Lobelia reverchonii	1.89	2.20
Lycopus spp.	0.00	2.20
Melanthium virginicum	2.65	0.00
Mitchella repens	14.29	16.32
Osmunda cinnamomea	5.80	10.32
Poaceae	47.72	2.20
Rhynchospora rariflora	4.72	0.00
Rudbeckia scabrifolia	43.98	29.89
Scleria oligantha	0.00	2.70
Solidago patula	1.89	9.39
Symphyotrichum spp.	0.00	4.23
Viola primulifolia	42.30	9.07
Woodwardia areolata	16.42	52.29
Woodwardia virginica	1.89	2.20
Xyris spp.	9.08	0.00

highly significantly different between the sedimented and control or non-sedimented baygalls. Species richness and herbaceous individuals and stems had increased in the sedimented baygalls while the dbh had decreased. Sedimentation had killed many of the larger woody plants which explained the decrease in the dbh. The increase in species richness and herbaceous individuals and stems probably occurred because the addition of sedimentation created a more mesic habitat.

When the two areas (control and sedimented) were compared again in 2001, the dbh had increased in the sedimented baygalls and was no longer different

(Table 1). A comparison of the sedimented area 1986 data to the 2001 data revealed that the species richness had decreased from 7.32 to 5.00 species per sample. The number of woody individuals and stems had almost doubled and the dbh had more than doubled in the sedimented baygalls. The biggest changes in the sedimented baygalls occurred with the herbaceous plants where the mean number of individuals decreased from 15.05 to 0.16 and the mean number of stems decreased from 22.30 to 0.19 stems. These changes in the sedimented baygall indicate that this area is changing from an open area to a forested area. The increase in trees and shrubs has created more shade and caused a large decrease in the number of herbaceous plants. The number of herbaceous species decreased from 34 to 3.

In the control baygalls between 1986 and 2001, species richness, woody individuals, and woody stems had all increased significantly and the dbh, herbaceous individuals, and herbaceous stems had remained fairly constant. These changes and lack of change could be attributed to normal succession in the baygalls.

Nyssa sylvatica is a tree that seems to be little affected by sedimentation, as its importance value is very high in the sedimented baygalls in 1986 (Table 2). The tree (*Liquidambar styraciflua*), shrubs (*Alnus serrulata* and *Cephalanthus occidentalis*), and vine (*Toxicodendron radicans*) seem to grow better in the sedimented areas as indicated by the increase in their values. Tree species (*Magnolia virginiana* and *Pinus taeda*), shrub species (*Persea palustris* and *Ilex coriacea*), and the vine (*Smilax rotundifolia*) seem to have been affected by sedimentation as their values decreased in the sedimented baygall. In 2001 in the control baygalls, the shrubs (*Ilex coriacea* and *Lyonia lucida*) had increased in importance value and is probably linked to natural succession in the baygalls. The sedimented baygalls had undergone more dramatic changes between 1986 and 2001 where early successional species (*Liquidambar styraciflua* and *Alnus serrulata*) showed a tremendous decrease in importance value; *Alnus serrulata* was completely absent in 2001 and *Liquidambar styraciflua* decreased from an importance value of 35.10% to 7.58%. The shade tolerant vines (*Toxicodendron radicans* and *Smilax rotundifolia*) increased greatly in importance values. The introduced species (*Ligustrum sinense*) had a large increase in importance value from 7.74% in 1986 to 47.47% in 2001. Most of these changes seemed to be linked to succession in a sedimented area except for the introduced species filling in the niches normally occupied by native shrubs.

The notable change in the herbaceous taxa in 1986 was the increase in the number of weedy taxa in the sedimented baygalls that were not present in the control areas or were present in small numbers (Allen et al. 1990). Some of the weedy taxa include several species of *Juncus* and *Solidago*, *Diodia teres*, *Ambrosia artemisiifolia*, and *Bidens aristosa*. The creation of a new habitat in the sedimented baygalls is the reason for the invasion by the weedy taxa. All of the ferns (*Athyrium felix-femina*, *Osmunda cinnamomea*, *Woodwardia aerolata*, and *Woodwardia virginica*) were not found in any of the sedimented samples but were present in the control samples. All four showed an increase in importance value between 1986 and 2001 in the control baygalls. The fern taxa in the sedimented baygalls in 1986 apparently decreased because of increased sun exposure caused by the death of trees in the baygall. These fern species probably increased in value in the control baygalls in between 1986 and 2001 as a result of increased shade. In 2001, the sedimented baygalls changed dramatically with virtually no herbaceous plants persisting. The dense shade produced by the trees and shrubs greatly decreased the number of herbaceous plants, especially weedy species.

ACKNOWLEDGMENTS

We are indebted to Fort Polk, the University of Louisiana at Monroe, and the anonymous reviewer.

REFERENCES

Allen, C.M. 1980. Grasses of Louisiana. Univ. Southwestern Louisiana Press, Lafayette.

Allen, C.M. 1992. Grasses of Louisiana 2nd ed. Cajun Prairie Habitat Preservation Society, Eunice, LA.

Allen, C.M., C.H. Stagg and S.D. Parris. 1987. Analysis of the vegetation in pitcher plant bogs in two baygalls at Ft. Polk in west central Louisiana. Proc. Louisiana Acad. Sci. 50:1–6.

Allen, C.M., H.D. Guillory, C.H. Stagg, and S.D. Paris. 1990. The effects of sedimentation on the vegetation and flora of baygalls in west central Louisiana. Proc. Louisiana Acad. Sci. 53:33–41.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Found., Renner.

Correll, D.S. and H.B. Correll. 1972. Aquatic and wetland plants of the southwestern United States. Environmental Protection Agency, Washington.

Diggs, G.M., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners and Mahler's illustrated flora of north central Texas. BRIT, Fort Worth.

Godfrey, R.K. and J.W. Wooten. 1979. Aquatic and wetland plants of Southeastern United States: Monocotyledons. Univ. Georgia Press, Athens, Georgia.

Godfrey, R.K. and J.W. Wooten. 1981. Aquatic and wetland plants of Southeastern United States: Dicotyledons. Univ. Georgia Press, Athens, Georgia.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolina. Univ. North Carolina Press, Chapel Hill.

USDA, NRCS. 2002. The PLANTS database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874–4490 USA.

BOOK NOTICES

Blackwell Publishing

ROBERT L. ZIMDAHL. 2004. **Weed-Crop Competition, A Review. Second Edition.** (ISBN 0-8138-0279-2, hbk.). Blackwell Publishing Professional, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax, www.blackwellprofessional.com). $54.99, 224 pp., graphs, 7" × 10".

Publisher Comments: "For the past 20 years, the first edition of this text has been widely cited as an authoritative academic reference. The latest edition continues the tradition set by the original book and covers weed science research that has been published since 1980. This book aims to reduce the instance of research duplication—saving scientists and supporting institutions time and money."

"Not only does the second edition of Weed-Crop Competition review, summarize, and combine current research, it critiques the research as well. This text has the potential to accelerate advancements in weed-crop competition, which remains an important factor affecting crop yields. Weed scientists, crop scientists, plant ecologists, sustainable agriculturists, and organic agriculturists will be well-pleased with this long overdue and much needed new edition."

Contents: **1)** Introduction: An historical Perspective. **2)** Definition of Plant Competition. **3)** Competition in the Community. **4)** Influence of Competition on the Plant. **5)** The Effect of Weed Density. **6)** The Effect of Competition Duration. **7)** The Elements of Competition. **8)** Weed Management Using the Principles of Competition. **9)** Methods Used to Study Weed-Crop Competition. **10)** Models and Modeling. **11)** Conclusion: The Complexity of Competition

NELS R. LERSTEN. 2004. **Flowering plant Embryology.** (ISBN 0-8138-2747-7, hbk.). Blackwell Publishing Professional, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax, www.blackwellprofessional.com). $79.99, 224 pp., b/w photos, line drawings, 7" × 10".

Publisher Comments: "This richly illustrated reference text, with more than 350 figures, presents general angiosperm embryology using examples from economically important plants. The unique focus of this book on economically significant plants makes *Flowering Plant Embryology* a "must-have" for all plant science researchers and students."

"Drawing from his career of teaching botany, and his original embryological research, Lersten emphasizes the plant species that affect human livelihood, including weeds, ornamentals, and other cultivated plants that are used for commercial products. Topics are treated with a uniformity of style that boosts comprehension, and technical terms are well-defined. The book presents research results, hypotheses, and speculations about why things are as they are, and also offers supporting facts and specific examples. This book provides a firm foundation for thorough understanding of embryological diversity among economic plants and belongs in the library of every plant scientist."

Contents: **1)** Introduction. **2)** Stamen and Androecium. **3)** Pollen Development: Theme and Variations. **4)** Pollen Development: Details of Stages. **5)** Carpel and Gynoecium. **6)** Ovule and Embryo Sac. **7)** Pollination and Pollen: Stigma Interaction. **8)** Pollen Germination, Pollen Tube Growth, and Double Fertilization. **9)** Endosperm. **10)** The Embryo.

VASCULAR FLORA OF HACKBERRY FLAT, FREDERICK LAKE, AND SUTTLE CREEK, TILLMAN COUNTY, OKLAHOMA

Bruce W. Hoagland[1] and
Priscilla H.C. Crawford

Oklahoma Biological Survey and
Department of Geography
University of Oklahoma
111 East Chesapeake St.
Norman, Oklahoma 73019, U.S.A.

Phillip T. Crawford

Oklahoma Biological Survey and
Department of Botany and Microbiology
University of Oklahoma
111 East Chesapeake St.
Norman, Oklahoma 73019, U.S.A.

Forrest Johnson (deceased)

Oklahoma Biological Survey
University of Oklahoma
111 East Chesapeake St.
Norman, Oklahoma 73019, U.S.A.

ABSTRACT

The objective of this study is to fill a floristic data gap for southwest Oklahoma. Based upon a review of the Atlas of the Flora of Oklahoma database, it was noted that Tillman County was floristically under-documented. This paper reports the results of an inventory of the vascular plants in Tillman County. A total of 371 taxa of vascular plants in 253 genera and 74 families were collected. The most species were collected from the families Asteraceae (65), Poaceae (67), and Fabaceae (25). There were 123 annual and 248 perennial species. Forty-one species of woody plants were present. Forty-two exotic species were collected representing 11% of the flora. A total of 266 previously unreported species were documented. Five species tracked by the Oklahoma Natural Heritage Inventory were located, none of which were Federally listed as threatened or endangered.

RESUMEN

El objetivo de este estudio es completar los datos floristicos del suroeste de Oklahoma. Basados en una revisión de la base de datos del Atlas of the Flora of Oklahoma, se percibió que el Tillman County estaba subdocumentado florísticamente. En este artículo se publican los resultados de un inventario de las plantas vasculares en Tillman County. Se colectaron un total 371 taxa de plantas vasculares de 253 géneros y 74 familias. La mayoría de las especies se colectaron de las familias Asteraceae (65), Poaceae (67), y Fabaceae (25). Había 123 especies anuales y 248 perennes. Estaban presentes cuarenta y una especies de plantas leñosas. Se colectaron cuarenta y dos especies exóticas que representan el 11% de la flora. Se documentan un total de 266 especies no citadas previamente. Se localizaron cinco especies con seguimiento por el Oklahoma Natural Heritage Inventory, ninguna de las cuales estaba listada federalmente como amenazada o en peligro.

INTRODUCTION

North American botany has had a long tradition of floristic exploration and inventory (Ertter 2000a). Nevertheless, floristic inventories are of continued

---

[1] corresponding author: (405)325-1985, e-mail: *bhoagland@ou.edu*

SIDA 21(1): 429 – 445. 2004

value for research, conservation, and management purposes (Palmer et al. 1995). For example, it has been recently documented that new taxa are discovered and described at a rate of 60 per year (Ertter 2000a). Inventories are also crucial to biogeographic research by filling gaps in the geographic distribution of taxa at all levels. Floristic inventories play a role in plant species conservation, both in locating populations of rare and/or undescribed species and bringing their presence to the attention of conservation organizations (Radford et al. 1980; Stuessy & Sohmer 1996). The lack of accurate florisitc data can jeopardize the long term persistence of sensitive species (Ertter 2000a). Finally, floristic inventories aid resource managers in locating populations of sensitive species and documenting the arrival of exotic and nuisance species (Barkley 2000). Ignorance of the presence of exotic species can be detrimental to sensitive species and/or exert adverse economic impacts (Ertter 2000b).

The objective of this study was to fill a gap in floristic data for southwest Oklahoma. Based on the Atlas of the Flora of Oklahoma database (AFO; Hoagland 2003), Tillman County is a floristically under-documented county. Prior to 1996, the year collecting began for this study, only 175 species were reported from Tillman County (Hoagland 2003). The first collection gathered in Tillman County was a specimen of *Eryngium diffusum* by G.W. Stevens on 17 October 1924. Peak years for plant collecting in Tillman County prior to this study were 1936 (30 specimens) and 1940 (45 specimens).

Study Area

Tillman County (Fig. 1) occupies 237,503 hectares and is located within the Subtropical Humid (Cf) climate zone (Trewartha 1968). Summers are warm (mean July temperature = 28.9° C) and humid, and winters are relatively short and mild (mean January temperature = 3.5° C). Mean annual precipitation is 78.7 cm., with periodic severe droughts (Oklahoma Climatological Survey 2003). Physiographically, the study area is located in the Osage Plains section of the Central Lowlands province (Hunt 1974) and within the Central Redbed Plains province of Oklahoma (Curtis & Ham 1979). The surface geology of Tillman County is predominately red sandstone and shale formed from shallow-marine and alluvial deposits of Permian age (Branson & Johnson 1979).

There are eight soil associations in Tillman County (Lamar & Rhodes 1974). The two predominant soil associations are the Tipton-Hardeman-Grandfield, which occurs on the floodplains of the Red and North Fork of the Red River and is nearly level, loamy, sandy soil with loamy subsoil, and the Ford-Tillman, which is a nearly level to gently sloping upland, loamy soil with loamy and clay subsoils. The Clairemont-Asa-Miller Association occupies bottomlands and is deep, nearly level soil which is loamy, clayey throughout (Lamar & Rhodes 1974).

The predominant potential natural vegetation in Tillman County (Duck & Fletcher 1943) includes the Mixedgrass Eroded Plains, which would occupy

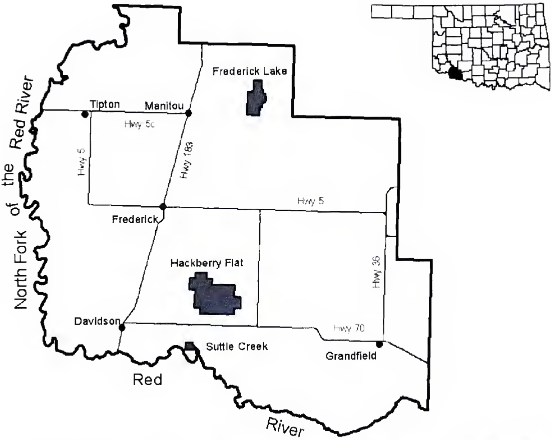


FIG. 1. Location of the three sites selected for florisitic sampling in Tillman County, Oklahoma.

138,565 hectares (58%) on loamy soil and shallow rocky soil, and 68,635 hectares (29%) of tallgrass prairie (Duck & Fletcher 1943). Sandsage grassland occupies 10,360 hectares (4%) and occurs on deep sand deposits along the North Fork of the Red River, Red River, and Otter Creek. Mesquite grassland occupies 4,403 hectares (2%). Bottomland forest occupies 15,540 hectares (6%).

METHODS

Collections were made at three locations: Hackberry Flat Wildlife Management Area (HF), and Lake Frederick (LF), a municipal reservoir, and Suttle Creek (SC) a Bureau of Land Management (BLM) holding along the Red River (Table 1). At each of these locations, collection sites were established for intensive floristic sampling. Sites were selected following a review of U.S. Geological Survey 1:24,000 topographic maps and field reconnaissance. The predominant vegetation association at these sites was classified according to Hoagland (2000). Collections were also made randomly throughout each location and the county. Collections at HF were made from April to October, 1996, and at LF and SC from April through October 2000, from March through October 2001. Vouchers for exotic species (defined as those species not native to North America) were made

TABLE 1: Location and elevation data for sample sites. Coordinates represent the north and southern most latitude and the east and west most longitude of each study site. Coordinates are presented in decimal degrees.

Site	North	South	East	West	Max. Elev.	Min. Elev.
Frederick Lake	34.54°N	34.51°N	98.87°W	98.90°W	381m	360m
Hackberry Flat	34.30°N	34.25°N	98.89°W	98.98°W	366m	349m
Suttle Creek	34.23°N	34.22°N	98.96°W	98.97°W	358m	332m

from naturalized populations only, thus excluding cultivated and ornamental plants. Specimens were processed at the Robert Bebb Herbarium of the University of Oklahoma (OKL) following standard procedures. Manuals used for specimen identification included Waterfall (1973), Great Plains Flora Association (1986), and Diggs et al (1999). Origin, either native or introduced, was determined using Taylor & Taylor (1991) and USDA-NRCS (2003). Nomenclature follows the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS 2003). A voucher set was deposited at OKL. Sorensens' Index of Similarity (Pielou 1984) was calculated for pairs of sites in order to determine similarity of floras.

RESULTS AND DISCUSSION

A total of 371 taxa of vascular plants in 74 families and 253 genera were collected in Tillman County. Among the angiosperms, 97 were monocots and 270 were dicots. In addition, one fern ally and one gymnosperm was recorded. The Asteraceae (65), Poaceae (67), and Fabaceae (25) had the greatest number of species. Genera with the greatest number of species were *Dalea* (6), *Cyperus* (5), *Panicum* (5) and *Bromus* (4). One hundred and twenty-three species were annuals and 248 were perennials. Forty-one species of woody plants were collected: 20 trees, 13 shrubs, and 8 woody vines.

Forty-two introduced species (11% of the flora) were collected in Tillman County. This is comparable to the number of exotics collected at the Chickasaw National Recreation, located in south-central Oklahoma, where 12% of the flora was composed of exotic species (Hoagland & Johnson 2001). The families with the greatest number of introduced species were Poaceae (17), Brassicaceae (5), and Asteraceae (4). Genera with the most exotic species were *Bromus* (4) and *Echinochloa* (3). Species tracked by the Oklahoma Natural Heritage Inventory (ONHI) were *Abronia fragrans* (G5, S2S3), *Argythamnia humilis* (G5,S2S3), *Cenchrus echinatus* (G5, S1), *Escobaria vivipara* (G5, S2S3), and *Malvella leprosa* (G5, S1S2). Species are ranked according to level of imperilment at the state (S) and global (G) levels on a scale of 1–5; 1 representing a species that is imperiled and 5 one that it is secure (Groves et al. 1995). No Federally listed threatened or endangered species were encountered.

Species richness was highest at LF (Table 2) and lowest at HF, which was by far the largest site (Table 3). The low species richness may be due to the fact that 97% of the land cover was classified as disturbed. Although LF was smaller in area than HF, which had the lowest species richness, there were more habitat types present. SC, which had the second lowest species richness, was 65% disturbed (Table 3). LF was only 10% disturbed. However, the number of annual species, which often indicates the degree of disturbance, was highest at LF, not HF.

Although all three sites were in close geographic proximity, Sorensen Indices were below 0.5 (Table 4). The highest similarity was scored for the comparison of HF and LF, which shared 53 species (Table 5). The high number of arenaceous species at SC may account for the low similarity index values between that site and the other two. Interestingly, the highest similarity was between the largest sites.

The AFO database (Hoagland 2003) lists 175 species for Tillman County that were collected prior to 1996. Seventy species in the Atlas database were not collected in this study. There were eight families in the AFO database that were not collected in this study; Acanthaceae (*Dyschoriste linearis* and *Justicia americana*), Apocynaceae (*Apocynum cannabinum*), Cuscutaceae (*Cuscuta cuspidata*), Dryopteridaceae (*Woodsia obtusa*), Fumariaceae (*Corydalis aurea*), Polemoniaceae (*Ipomopsis longiflora*), and Pteridaceae (*Pellaea atropurpurea*). Of the remaining species, 107 were reported both in AFO database and in this study. When that number is subtracted from the total of species in the checklist, this study contributed 266 species previously unreported from Tillman County. When the species unique to the AFO and this study are summed, along with the number of shared species, this gives a total of 441 species in Tillman County, a 40% increase in our previous knowledge.

Seven habitat types were found at the three primary collecting sites (Table 2). The actual number of habitat types at each site ranged from 3 to 6. A brief description of each habitat type follows.

Sandbars and dunes (SB)

Sandbars and dunes occurred only at the SC site. Vegetation on sandbars, which were in the Red River channel, was sparse, however *Cyperus esculentus*, *Heliotropium curassavicum*, and *Tamarix chinensis* were present. Sandunes, which occurred along the floodplain and terraces of the Red River, were vegetated by the *Artemisia filifolia/Sporobolus cryptandrus-Schizachyrium scoparium* shrubland association (Hoagland 2000). Associated species included *Dalea villosa*, *Prunus angustifolia*, *Calylophus serrulatus*, *Eriogonum anuum*, *Sideroxylon lanuginosa*, *Rhus aromatica*, *Vitis acerifolia*, and *Zanthoxylum hirsutum*. Tracked species found in this habitat type were *Abronia fragrans* and *Cenchrus echinatus*.

TABLE 2: Summary of floristic collections at three sites in Tillman County, Oklahoma. Format follows Palmer et al. (1995).

Taxonomic group	Species	Native spp.	Introduced spp.
Hackberry Flat			
Coniferophyta	0	0	0
Magnoliophya			
Magnoliopsida	86	75	11
Liliopsida	35	25	10
Total	121	100	21
Lake Frederick			
Coniferophyta	1	1	0
Magnoliophya			
Magnoliopsida	144	130	14
Liliopsida	41	35	5
Total	185	166	19
Suttle Creek			
Coniferophyta	1	1	0
Magnoliophya			
Magnoliopsida	127	119	8
Liliopsida	54	45	9
Total	182	165	17

TABLE 3: Habitat types mapped at the three primary collection sites in Tillman County, Oklahoma. Area = total area of the site, HT = number of habitat types at the site, SB = sandbars and dunes, AQ = aquatic, DA = Old fields and disturbed areas, PS = pasture, MG = mixedgrass prairie, MQ = mesquite shrubland, and BLF = bottomland forest. (HF = Hackberry Flat Wildlife Management Area, LF = Lake Frederick, SC = Suttle Creek). All values are reported in hectares.

Site	Area	HT	SB	AQ	DA	PS	MG	MO	BLF
HF	2,770	0	0	2,690	67	14	0	0	
LF	911	6	0	341	95	0	0	441	26
SC	161	5	17	9.6	105	0	0.1	0	28

TABLE 4: Sorensens' Index of Similarity values for three collection sites, Tillman County, Oklahoma (HF = Hackberry Flat Wildlife Management Area, LF = Lake Frederick, SC = Suttle Creek).

	Suttle Creek	Lake Frederick	Hackberry Flat
Suttle Creek	1	0.347	0.275
Hackberry Flat		0.352	1

TABLE 5: An inter-site comparison of shared species in Tillman County, Oklahoma. Unique refers to species found only at the site listed. W/ = species shared with two sites.

Site	Total	Unique	w/LF	w/HF
Hackberry Flat	121	45		
Lake Frederick	185	87		53
Suttle Creek	182	88	63	41

Aquatic and wetland habitats (AQ)

Aquatic habitats were found at LF and SC. Aquatic environments at LF were composed of the 341 hectare Lake Frederick and its shoreline. Vegetated areas were on the upper reaches of the lake, where the *Polygonum pensylvanicum–P. lapathifolium* herbaceous association (Hoagland 2000) was common. Associated species included *Eleocharis palustris, Juncus torreyi, Potamogeton pectinatus, Schoenoplectus pungens,* and *Xanthium strumarium.*

Wetlands at SC were formed by seeps and springs that emerged at the base of sand dunes and flowed into Suttle Creek. The vegetation in the seeps and springs was best characterized as the *Rorippa nasturtium-aquaticum* herbaceous association (Hoagland 2000). Associated species included *Eclipta prostrata, Hydrocotyle verticillata, Lobelia cardinalis, Ludwigia palustris, Myosurus minimus,* and *Ranunculus scleratus.*

Along broader stretches of Suttle Creek, the *Schoenoplectus americanus - Eleocharis* spp. herbaceous association (Hoagland 2000) was predominant. Associated species included *Amorpha fruticosa, Cephalanthus occidentalis, Distichlis spicata, E. palustris J. torreyi, Polypogon monspeliensis, Symphyotrichum subulatum* and *Typha domingensis.*

Disturbed areas and old fields (DA)

Disturbed areas occurred at all three sites and was the predominant cover type at HF and SC. Disturbed area designations included mowed lawns, roadsides, and other sites exhibiting signs of physical disruption. Common plants in disturbed areas included *Bothriochloa ischaemum, Cynodon dactylon, Daucus pusillus, Melilotus officinalis,* and *Mollugo verticillata.* Old-fields were characterized by *Ambrosia trifida, Amaranthus rudis, Cnidoscolus texanus, Conyza canadensis,* and *Sorghum halepense. Malvella leprosa* was the only species tracked by ONHI found in this habitat type.

Pasture (PS)

This habitat type occurred only at HF, where *B. ischaemum* had been planted on 67 ha in the northwest corner of the site. The pasture was essentially a monoculture of *B. ischaemum* with a few widely scattered individuals of *Prosopis glandulosa.*

Mixedgrass prairie (MG)

Mixedgrass prairie occurred at all three sample sites, but was most extensive at LF. *Bouteloua hirsuta - Bouteloua curtipendula* herbaceous association was common on coarse, shallow soils. Associated species included *Aristida purpurascens, Bouteloua rigidiseta, Crotonopsis elliptica, Leucelene asteroides, Lithospermum tenellum, Opuntia phaeacantha, Schizachyrium scoparium*, and *Thelesperma filifolia* (Hoagland 2000, Crawford 2002). On loamy soils, the *Schizachyrium scoparium - Sorghastrum nutans* herbaceous association predominates. Common associates include *Andropogon gerardii, A. purpurascens, Bouteloua curtipendula, Panicum virgatum, Sporobolus cryptandrus*, and *Symphyotrichum ericoides. Argythamnia humilis* and *Escobaria vivipara* were found in this habitat type and also in mesquite shrubland.

Mesquite shrubland (MQ)

This habitat type, representing the *Prosopis glandulosa/Bouteloua* sp. shrubland association (Hoagland 2000), was found only at LF. Unlike *P. glandulosa* shrublands throughout Tillman County, the herbaceous vegetation at LF was predominantly native species (Crawford 2002). Dominant grasses included *Bouteloua curtipendula* and *Schizachyrium scoparium*. Associated species included *Aristida purpurascens, Bouteloua rigidiseta, Echinacea angustifolia, Erioneuron pilosum, Eryngium leavenworthii, Opuntia phaeacantha, Sorghastrum nutans, Sporobolus cryptandrus, Symphyotrichum ericoides*, and *Thelesperma filifolia*.

Bottomland forest (BLF)

Bottomland forest occurred at LF and SC. Two vegetation types occurred in this category: *Fraxinus pennsylvanica - Ulmus americana* forest association and the *Populus deltoides/Salix (exigua, nigra)* forest association (Hoagland 2000). Associated species included *Ampelopsis cordata, Celtis laevigata, Teucrium canadense*, and *Toxicodendron radicans*.

ANNOTATED CHECKLIST

Annotated species list for Tillman County, Oklahoma. The first entry is the collection number (the prefix **BLM** = Suttle Creek, a Bureau of Land Management holding on the Red River, **HF** = Hackberry Flat Wildlife Management Area, and **PC** = Lake Frederick). Specimens with the prefix **M9** or the suffixes **BWH** or **98** represent specimens collected outside the three areas inventoried), followed by origin (**N** = native, **I** = introduced), life history (**A** = annual, **Bi** = biennial, **P** = perennial), and habitat (**SB** = sandbars and dunes, **AQ** = aquatic, **DA** = Old fields and disturbed areas, **PS** = pasture, **MG** = mixedgrass prairie, **MQ** = mesquite shrubland, and **BLF** = bottomland forest). Voucher specimens were deposited at the Robert Bebb Herbarium at the University of Oklahoma (OKL).

EQUISETOPHYTA

EQUISETACEAE

Equisetum laevigatum A. Braun; M9.134; N; P; AQ

CONIFEROPHYTA

CUPRESSACEAE

Juniperus virginiana L.; BLM0179, PC-138; N; P; DA, MG

MAGNOLIOPHYTA-LILIOPSIDA

AGAVACEAE

Yucca glauca Nutt.; BLM064; N; P; MG

ALISMATACEAE

Sagittaria brevirostra Mackenzie & Bush; BLM0348; N; P; AQ

CYPERACEAE

Carex tetrastachya Scheele; BLM033, HF032; N; P; AQ

Carex perdentata S.D. Jones; BLM045; N; P, AQ

Cyperus acuminatus Torr. & Hook. ex. Torr.; HF0158; N; P; DA

Cyperus squarrosus L.; 0119-90; N; A; AQ

Cyperus croceus Vahl; PC-168; N; A; DA

Cyperus esculentus L.; HF0151; I; P; DA

Cyperus odoratus L.; BLM0427; N; P; DA

Eleocharis montevidensis Kunth.; BLM031, N; P; AQ

Eleocharis palustris (L.) Roem. & Schult.; HF0019, PC-135; N; P; AQ

Fuirena simplex Vahl; BLM0357; N; P; AQ

Schoenoplectus americanus (Pers.) Volk ex Schinz & R. Keller; BLM067; N; P; AQ

Schoenoplectus pungens (Vahl) Palla. var. *longispicatus* (Britton) S.G. Sm.; PC-133; N; P; AQ

Schoenoplectus maritimus (L.) Lye; BLM0451; N; P; AQ

IRIDACEAE

Nemastylis geminiflora Nutt.; PC-2; N; P; DA, MG

Sisyrinchium angustifolium P. Mill.; HF065; N; P; DA, MG

Sisyrinchium chilense Hook.; PC-16; N; P; DA

JUNCACEAE

Juncus marginatus Rostk.; M9.132; N; P; AQ

Juncus torreyi Cov.; BLM0355, PC-132; N; P; AQ

LILIACEAE

Allium canadense L.; BLM0076; N; P; DA, MG

Cooperia drummondii Herbert; HF0141; N; P; MG

Erythronium albidum Nutt.; PC-232; N; P; BLF

Nothoscordum bivalve (L.) Britton; HF0166, PC-68; N; P; DA, MG, MQ

NAJADACEAE

Najas guadalupensis (Spreng.) Magnus; 2085-BWH; N; A; AQ

POACEAE

Aegilops cylindrica Host; HF051; I; A; AQ

Andropogon gerardii Vitman; BLM0435, PC-200; N; P; MG, MQ

Andropogon glomeratus (Walt.) B.S.P.; BLM0424; N; P; AQ, BLF

Aristida purpurascens Poir.; BLM0369; N; P; DA, MG

Aristida purpurea Nutt.; BLM0161, HF0104, PC-27; N; P; DA, MG

Bothriochloa ischaemum (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & Harlan; HF0139, PC-22; I; P; DA, PS

Bothriochloa saccharoides (Sw.) Rydb.; HF047, PC-60; N; P; DA, MG, MQ

Bouteloua curtipendula (Michx.) Torr., BLM0363, HF0105, PC-172; N; P; MG, MQ

Bouteloua hirsuta Lag.; PC-173; N; P; MG, MQ

Bouteloua rigidiseta (Steud.) A. S. Hitchc.; BLM0180, HF060, PC-21; N; P; MG, MQ

Bromus catharticus Vahl; BLM046, HF036, PC-63; I; P; BLF, DA, MQ

Bromus commutatus Schrad.; PC-46; I; A; DA

Bromus japonicus Thunb. Ex Murr.; BLM0509, HF01; I; A; DA, MQ

Bromus secalinus L.; HF09; I; A; DA

Buchloë dactyloides (Nutt.) Engelm.; BLM051, HF02, PC-61; N; P; DA. MG. MQ

Cenchrus echinatus L.; BLM0322; N; A; SB

Chloris cucullata Bisch.; BLM0183; N; P; SB

Chloris verticillata Nutt.; HF0103; N; P; DA, MG, MQ

Cynodon dactylon (L.) Pers.; BLM0432, HF0100, PC-128; I; P; DA, PS

Digitaria sanguinalis (L.) Scop.; BLM0450; N; A; DA

Distichlis spicata (L.) Greene; BLM0312; N; P; AQ, SB

Echinochloa colona (L.) Link; BLM0434; I; A; AQ

Echinochloa crus-galli (L.) Beauv.; BLM0431; I; A; AQ

Echinochloa crus-pavonis (H.B.K.) Schult. var. *macera* (Wieg.) Gould; PC-194; I; A; AQ

Echinochloa muricata (Beauv.) Fern.; HF0101; N; A; AQ

Elymus canadensis L.; PC-114; N; P; BLF, MG, MQ

Elymus virginicus L.; BLM0147, HF0110; N; P; MG, MQ

Eragrostis cilianensis (All.) Vign. ex Janchen; BLM0328, HF0168; I; A; DA

Eragrostis hirsuta (Michx.) Nees; BLM0449; N; P; DA, MG, SB

Eragrostis hypnoides (Lam.) B.S.P.; HF078; N; A; AQ

Eragrostis sessilispica Buckl.; PC-76; N; P; DA

Eriochloa contracta Hitchc.; HF0126; N; A; DA, MG

Eriochloa sericea (Scheele) Munro ex. Vasey; PC-71; N; P; DA, MG

Erioneuron pilosum (Buckley) Nash; BLM028, PC-59; N; P; MG

Hordeum pusillum Nutt.; BLM044, HF042, PC-29; N; A; DA

Leersia oryzoides (L.) Sw.; BLM0430; N; P; AQ

Leptochloa fusca (L.) Kunth.; BLM0511, HF0135; N; A; DA

Leptochloa panicea (Retz.) Ohwi ssp. *brachiata* (Steudl.) N. Snow; HF0152, PC-192; N; P; DA

Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi; BLM0437; N; P; AQ

Nassella leucotricha (Trin. & Rupr.) Pohl; BLM0195, PC-4; N; P; MG

Neeragrostis reptans (Michx.); PC-193; N; A; AQ

Panicum capillare L.; HF0124, PC-160; N; A; DA

Panicum halli Vasey var. *filipes* (Scribn.) F.R. Waller; PC-169; N; P; MG

Panicum obtusum H.B.K.; HF077, PC-156; N; P; BLF, DA, MG

Panicum rigidulum Bosc ex Nees; HF0122; N; P; MG

Panicum virgatum L.; BLM0488, PC-199; N; P; BLF, MG, MQ

Pascopyrum smithii (Rydb.) A. Löve; BLM0486, PC-62; N; P; AQ, BLF

Paspalum distichum L.; HF0150; N; P; DA

Paspalum setaceum Michx.; BLM0487; N; P; AQ

Pennisetum glaucum (L.) R. Br.; BLM0429, HF0130; I; A; DA, PS

Phalaris canariensis L.; BLM0161; I; A; AQ

Phalaris caroliniana Walt., HF033; N; A; AQ, MG

Poa annua L.; BLM047; I; A; DA

Poa arachnifera Torr.; BLM041; N; P; BLF

Polypogon monspeliensis (L.) Desf.; BLM0168; I; A; AQ, SB

Schedonnardus paniculatus (Nutt.) Trel.; HF050; N; P; DA, MG

Setaria parviflora (Poir.) Kerguelén; BLM0359; N; P; DA

Setaria viridis (L.) Beauv., BLM0500; I; A; DA

Sorghastrum nutans (L.) Nash; BLM0433; N; P; MG

Sorghum halepense (L.) Pers.; BLM0484, HF041, PC-124; I; P; DA

Sporobolus airoides (Torr.) Torr.; HF079, PC-182; N; P; DA, SB

Sporobolus cryptandrus (Torr.) A. Gray; BLM0326; N; P; MG, SB

Sporobolus coromandelianus (Retz.) Kunth; PC-183; N; P; DA

Tridens albescens (Vasey) Woot. & Standl.; BLM049, HF063, PC-3; N; P, MG

Triplasis purpurea (walt.) Chapman; BLM0436; N; A; SB

Vulpia octoflora (Walt.) Rydb.; BLM059; N; A; MG

POTAMOGETONACEAE

Potamogeton nodosus Poir.; 2084-BWH; N; P; AQ

SMILACACEAE

Smilax bona-nox L.; BLM0446, PC-203; N; P; BLF

Smilax rotundifolia L., 071-98; N; P; BLF

TYPHACEAE

Typha domingensis Pers.; BLM0375, PC-134; N; P; AQ

ZANNICHELLIACEAE

Zannichellia palustris L.; BLM030; N; P; AQ

MAGNOLIOPSIDA

AMARANTHACEAE

Amaranthus palmeri S. Wats.; HF091; N; A; DA

Amaranthus rudis Sauer; BLM0438, HF115; N; A; DA

ANACARDIACEAE

Rhus trilobata Nutt.; BLM0204; N; P; MG, MQ

APIACEAE

Ammoselinum popei Torr. & A. Gray; HF067; N; A; DA

Chaerophyllum tainturieri Hook.; BLM048; N; A; DA, MG

Cymopterus macrorhizus Buckl.; PC-221; N; P; MG

Daucus pusillus Michx.; BLM0154, HF053, PC-85; N; A; DA

Eryngium leavenworthii Torr. & A. Gray; PC-216; N; A; MG

Hydrocotyle verticillata Thunb.; BLM0502; N; P; AQ

Lomatium foeniculaceum (Nutt.) Coult. & Rose; PC-220; N; P; MG

Sanicula canadensis L.; BLM0499; N; Bi; BLF

ASCELPIADACEAE

Asclepias arenaria Torr.; BLM0492; N; P; MG

Asclepias asperula (Dcne.) Woods; HF054, PC-143; N; P; DA, MG

Asclepias viridiflora Raf.; PC-187; N; P; DA, MG, MQ

Asclepias viridis Walter; PC-53; N; P; MG

Funastrum cynanchoides (Decne.) Schltr.; BLM0345, PC-186; N; P; DA

Matelea biflora (Raf.) Woods; HF054; N; P; DA, MG

ASTERACEAE

Achillea millefolium L.; BLM042, HF022, PC-57; N; P; DA, MG, MQ

Ambrosia psilostachya DC; BLM0352, HF0155, PC-176; N; P; DA, MG, MQ, SB

Ambrosia trifida L.; HF0149; N; A; DA

Amphiachyris dracunculoides (DC.) Nutt.; BLM0439; N; A; DA

Aphanostephus ramosissimus DC.; BLM0201; N; A; SB

Artemisia filifolia Torr.; BLM0425; N; P; SB

Baccharis salicina Torr. & A.Gray; HF0107; N; P; BLF, DA, SB

Berlandiera texana DC.; M9.148; N; P; MG

Bidens frondosa L.; BLM0440; N; A; AQ

Centaurea americana Nutt.; 2126-BWH, PC-70; N; A; DA, MG

Chloracantha spinosa (Benth.) Nesom; BLM0370; N; P; BLF

Chaetopappa ericoides (Torr.) Nesom; BLM0157, PC-10; N; P; MG

Cirsium ochrocentrum A. Gray; HF0108; N; P; DA, MG

Cirsium texanum Buckley; HF094, PC-54; N; P; MG

Cirsium undulatum (Nutt.) Spreng.; BLM0177, HF030; N; P; DA, MG

Conyza canadensis (L.) Cronq.; HF014; N; A; DA

Coreopsis tinctoria Nutt.; HF040, PC-96; N; A; AQ, MG

Dracopis amplexicaulis (Vahl) Cass.; HF031, PC-84; N; A; AQ

Dysodiopsis tagetoides (Torr. & A.Gray) Rydb.; PC-80; N; P; DA, MG

Echinacea angustifolia DC.; PC-93; N; P; MG, MQ

Eclipta prostrata (L.) L.; HF164, BLM0453; N; A; AQ

Engelmannia peristenia (Raf.) Goodman & Lawson; BLM0152, HF059, PC-171; N; P; MG, MQ

Erigeron strigosus Muhl. ex Willd, HF018, PC-6; N, A; DA

Eupatorium serotinum Michx.; BLM0445; N; P; BLF, MG

Evax prolifera Nutt. ex DC; PC-37; N; A; DA

Gaillardia pulchella Foug.; BLM0186; N; A; DA, MG, MQ

Gaillardia sauvis (A. Gray & Engelm.) Britton & Rusby; BLM075, HF028, PC-17; N; P; DA, MG, MQ

Grindelia nuda A.W. Wood; PC-178; N; P; DA, MG, MQ

Grindelia papposa Neson & Suh; BLM00490; N; Bi; DA, MG, MQ

Grindelia squarrosa (Pursh) Dunal; HF0145; N; P; DA, MG, MQ

Grindelia lanceolata Nutt. var. *texana* (Scheele) Shinners; PC-215; N; P; DA, MG

Helenium microcephalum DC; HF081, PC-164; N; A; AQ, BLF

Helianthus annuus L.; HF087, PC-101; N; A; DA

Helianthus petiolaris Nutt.; BLM0329; N; A; DA, SB

Heterotheca subaxillaris (Lam.) Britton & Rusby; HF0109; N; A; DA, MG

Heterotheca villosa (Pursh) Shinners; PC-142; N; P; MG, SB

Hymenopappus flavescens Gray; BLM0188; N; Bi; MG

Hymenopappus scabieosus L'Hér.; M9.147; N; Bi; MG, MQ

Hymenopappus tenuifolius Pursh.; BLM0324, PC-14; N; Bi; MG

Hymenoxys odorata DC.; HF061; N; A; DA, MG

Iva annua L.; BLM0442, HF0146, PC-213; N; A; AQ

Lactuca ludoviciana (Nutt.) Riddell; HF095; N; Bi; DA

Liatris mucronata DC.; BLM0342; N; P; MG

Liatris punctata Hook.; HF0162, PC-212; N; P; MG

Lindheimera texana Gray & Engelm.; PC-15; N; A; MG, MQ

Machaeranthera pinnatifida (Hook.) Shinners; PC-179; N; P; MG

Machaeranthera pinnatifida (Hook.) Shinners ssp. *pinnatifida* var. *pinnatifida*; BLM0187, HF074; N; P; MG, MQ

Packera plattensis (Nutt.) W.A. Weber & A. Löve; PC-13; N; P; BLF

Pluchea odorata (L.) Cass.; BLM0495; N; A; AQ, BLF

Pyrrhopappus grandiflorus (Nutt.) Nutt.; BLM043; N; P; DA

Ratibida columnifera (Nutt.) Wooton & Standl.; HF056, PC-88; N; P; DA, MG, MQ

Senecio vulgaris L.; PC-243; I; Bi; BLF

Solidago missouriensis Nutt.; BLM0353, PC-185; N; P; DA, MG, MQ

Sonchus asper (L.) Hill; BLM036, HF07; I; A; DA
Sonchus oleracea L.; 2088-BWH; I; A; DA
Symphyotrichum ericoides (L.) Nesom; HF0156, PC-181; N; P; MG, MQ
Symphyotrichum subulatum (Michx.) Nesom; BLM0454, HF023; N; A; AQ
Taraxacum officinale G.H.Weber ex Wiggers; PC-244; I; P; DA
Tetraneuris linearifolia (Hook.) Greene; BLM058, PC-11; N; A; MG
Tetraneuris scaposa (DC.) Greene; BLM0174, PC-9; N; P; MG
Thelasperma filifolium (Hook.) A. Gray; BLM0483, PC-47; N; P; MG, MQ
Thelasperma megapotamcium (Spreng.) Kuntze; BLM0181; N; P; MG, MQ
Tragopogon dubius Scop.; BLM0498, HF043, I; A; DA
Vernonia marginata (Torr.) Raf.; PC-166; N; P; MG
Xanthisma texanum DC.; BLM9482; N; A; MG, SB
Xanthium strumarium L.; BLM0349, HF0163, PC 214; N; A; AQ

BORAGINACEAE

Buglossoides arvensis (L.) I.M. Johnston; BLM0156; I; A; DA
Heliotropium curassavicum L.; BLM0343, HF099, N; A; AQ, SB
Heliotropium tenellum (Nutt.) Torr.; PC-106; N; A; MG
Lithospermum incisum Lehm.; PC 236; N; P; MG

BRASSICACEAE

Capsella bursa-pastoris (L.) Medik; PC-249; I; A; DA
Descurainia pinnata (Walt.) Britton; BLM038; N; A; DA
Descurainia sophia (L.) Webb ex Prantl; PC-237; I; A; DA
Draba cuneifolia Nutt. ex Torr. & A. Gray; PC 223; N; A; DA, MG
Erysimum repandum L.; PC-230; I; A; DA
Lepidium austrinum Small; PC 24; N; A; DA
Lepidium densiflorum Schrad.; HF034; N; A; DA
Lesquerella gordonii (A. Gray) Wats.; BLM065; N; A; MG
Lesquerella gracilis (Hook.) S. Wats subsp. *Nuttallii* (T. & G.) Rollins & Shaw; PC-8; N; A, MG
Lesquerella gracilis (Hook.) S. Wats.; PC-223; N; A; MG
Lesquerella ovalifolia Rydb.; PC-44; N; P; MG
Rorippa nasturtium_aquaticum (L.) Hayek, BLM035; I; P; AQ
Sibara virginica (L.) Rollins; PC 229; N; A; DA, MG
Sinapis arvensis L.; HF016; I; A; DA

CACTACEAE

Escobaria vivipara (Nutt.) Buxbaum; 1542-BWH; N; P; MG
Opuntia leptocaulis DC.; BLM027; N; P; MG
Opuntia macrohiza Engelm.; BLM511, HF076; N; P; DA, MG, MQ
Opuntia phaeacantha Engelm. var. *major* Engelm.; PC-49; N; P; DA, MG, MQ

CAMPANULACEAE

Lobelia cardinalis L.; BLM0444; N; P; AQ
Triodanis perfoliata (L.) Nieuwl.; BLM0155; N; A; DA

CAPPARACEAE

Cleomella angustifolia Torr.; 040-98; N; A; DA

CARYOPHYLLACEAE

Arenaria serpyllifolia L.; PC-247; I; A; DA
Cerastium brachypodum (Engelm. ex Gray) B.L. Robins.; PC-224; N; P; DA
Paronychia jamesii Torr. & A. Gray; BLM0494, PC-205; N; P; MG
Stellaria media (L.) Vill.; BLM056; I; A; DA

CHENOPODIACEAE

Chenopodium album L.; HF090; I; A; DA
Chenopodium berlandieri Moq.; HF0157, PC 189; N; A; DA
Chenopodium pratericola Rydb.; HF012; N; A; DA
Cycloloma atriplicifolium (Spreng.) Coult.; BLM0489; N; A; DA
Monolepis nuttalliana (Schultes) Greene; HF017, PC-238; N; A; DA
Salsola tragus L.; PC-180; I; A; DA

CONVOLVULACEAE

Convolvulus arvensis L.; HF086, PC-18; I; P; DA

CORNACEAE

Cornus drummondii Mey.; 0132-98; N; P; DA, MG

CUCURBITACEAE

Cucurbita foetidissima Kunth.; HF070, PC-131; N; P; DA, MG, MQ

ELATINACEAE

Bergia texana (Hook.) Walp.; PC 137; N; P; MG

EUPHORBIACEAE

Acalypha ostryifolia Riddell; PC-188; N; A; DA
Argythamnia humilis (Engelm & A. Gray) Muell., Arg var. *leiosperma* Waterfall; PC-78; N; P; MG

Chamaesyce albomarginata (Torr. & A. Gray) Small; HF096; N; P; DA

Chamaesyce serpens (Kunth) Small; HF089; N; A; DA

Chamaesyce missurica (Raf.) Shinners; BLM0377, PC-125; N; A; DA

Chamaesyce nutans (Lag.) Small; PC-174; N; A; DA

Chamaesyce prostrata (Aiton) Small; PC-108; N; A; DA

Cnidoscolus texanus (Muell.-Arg.) Small; BLM0166; N; P; DA, SB

Croton capitatus Michx.; PC-152; N; A; DA, MG

Croton monanthogynus Michx.; PC-74, N; A; DA

Croton texensis (Klotzsch) Muell.-Arg.; BLM0428; N; A; DA, MG

Euphorbia dentata Michx.; PC-73; N; A; DA

Euphorbia marginata Pursh; BLM0347, HF0143, PC-35; N; A; DA, SB

Euphorbia spathulata Lam.; BLM050, PC-26; N; A; DA

Phyllanthus polygonoides Nutt. ex Spreng; PC-98; N; P; MG

Stillingia sylvatica Garden ex. L.; BLM0203; N; P; MG

FABACEAE

Acacia angustissima (Mill.) Kuntze. var. *hirta* (Nutt.) B.L. Rob.; HF093, PC-141; N; P; MG, MQ

Amorpha fruticosa L.; BLM0151; N; P; AQ

Astragalus lindheimeri Engel. ex A. Gray; PC-32; N; A; MG, MQ

Astragalus plattensis Nutt.; PC-28; N; P; MG, MQ

Chamaecrista fasciculata (Michx.) Greene; PC 204; N; A; MG, MQ

Dalea aurea Nutt. ex Pursh; PC-116; N; P; MG

Dalea candida Willd.; BLM0323, PC-122; N; P; MG, MQ

Dalea enneandra Nutt.; BLM0321, PC 115; N; P; MG

Dalea lanata Spreng.; BLM0306; N; P; SB

Dalea purpurea Vent.; PC-91; N; P; MG, MQ

Dalea villosa (Nutt.) Spreng.; BLM0305; N; P; SB

Desmanthus illinoensis (Michx.) MacM.; BLM0344, HF0111; N; P; DA

Gleditsia triacanthos L.; BLM073; N, P; BLF

Glycyrrhiza lepidota Pursh; BLM0310; N; P; SB

Hoffmannseggia glauca (Ort.) Eifert; HF039, PC-147; N; P; DA

Indigofera miniata Ort. var. *leptosepala;* BLM0159, PC-206; N; P; SB

Medicago minima (L.) L.; PC-31; I; A; DA

Medicago orbicularis (L.) Bartal.; HF045; I; A; DA

Melilotus officinalis (L.) Lam.; BLM0485, HF027, PC-195; I; A; DA

Mimosa nuttallii (DC.) B.L. Turner; BLM0189, HF066, PC-90; N; P; MG, MQ

Neptunia lutea Benth.; PC-100; N; P; MG, MQ

Pediomelum cuspidatum (Pursh) Rydb.; PC-83; N; P; MG, MQ

Pediomelum linearifolium (Torr. & A. Gray) J. Grimes ; PC-95; N; P; MG, MQ

Prosopis glandulosa Torr.; BLM0176, HF068, PC-64; N; P; DA, MG, MQ

Vicia sativa L.; BLM053; I; A; DA

GENTIANACEAE

Eustoma exaltatum (L.) Salisb. ex G. Don; BLM0341, PC-202; N; A; AQ

GERANIACEAE

Erodium cicutarium (L.) L'Hér. ex Aiton; BLM063, PC-240; I; A; DA

Geranium carolinianum L.; 2087-BWH, HF049; N; A; DA

HYDROPHYLLACEAE

Nama hispidum Gray; BLM0153; N; A; MG

KRAMERIACEAE

Krameria lanceolata Torr.; BLM0167, HF057, PC-81; N; P; MG, MQ

LAMIACEAE

Hedeoma reverchonii A. Gray; PC-126; N; P; MG, MQ

Lamium amplexicaule L.; BLM074, PC-239; I; A; BLF, DA

Monarda clinopodioides A. Gray; BLM0197, PC-69; N, A; DA, MG

Scutellaria drummondii Benth; PC-105; N; A; MG

Scutellaria resinosa Torr.; PC-5; N; P; MG

Teucrium canadense L.; BLM0331, PC-129; N; P; BLF

Teucrium laciniatum Torr.; BLM0149, HF055, PC-30; N, P; MG, MQ

LINACEAE

Linum perenne L.; BLM069; I; P; MG, MQ

Linum pratense (J.B.S Norton) Small; PC-103, N; A; MG, MQ

LOASACEAE

Mentzelia nuda (Pursh) Torr. & A. Gray var. *stricta* (Osterhout) Harrington ; BLM0325; N; P; SB

Mentzelia oligosperma Nutt. ex Sims.; PC-121; N; P; MG

LYTHRACEAE

Lythrum alatum Pursh; HF04; N; P; AQ

Lythrum californicum Torr. & A. Gray; PC-130; N; P; AQ

MALVACEAE

Malvella leprosa (Ortega) Krapov.- HF03; N; P; DA

Sphaeralcea coccinea (Nutt.) Rydb.; PC-7; N; P; MG, MQ

MENISPERMACEAE

Cocculus carolinus (L.) DC.; BLM0309; N; P; DA

MOLLUGINACEAE

Mollugo verticillata L.; HF075; N; A; DA

MORACEAE

Maclura pomifera (Raf.) Schneid.; BLM0318, HF069; N; P; BLF, DA

Morus alba L.; BLM0507, HF0117; I; P; DA

NYCTAGINACEAE

Abronia fragrans Nutt. ex Hook.; BLM057; N; P; SB

Mirabilis albida (Walt.) Heimerl; BLM0172, PC-162; N; P; SB

Mirabilis jalapa L.; HF0153; I; P; DA

Mirabilis linearis (Pursh) Heimerl; HF072; N; P; MG, MQ

OLEACEAE

Fraxinus pennsylvanica Marsh; PC-150; N; P; BLF

ONAGRACEAE

Calylophus hartwegii (Benth.) Raven subsp. *pubescens* (A. Gray) Towner & Raven; PC-33; N; P; MG

Calylophus serrulatus (Nutt.) Raven; BLM0202; N; P; MG, SB

Gaura coccinea Nutt. ex Pursh; BLM066, HF044; N; P; MG, SB

Gaura parviflora Dougl. ex Lehm.; PC-191, HF025; N; A; DA

Gaura sinuata Nutt. ex. Ser., PC-158; N; P; MG, MQ

Ludwigia peploides (Kunth) Raven; 2089-BWH; N; P; AQ

Ludwigia repens J.R. Forst.; BLM0198; N; P; AQ

Oenothera grandis Britton; BLM080, 062-97, PC-1; N; A; MG, SB

Oenothera rhombipetala Nutt. ex Torr. & A. Gray; BLM0378; N; Bi; DA, SB

Oenothera speciosa Nutt.; HF037, PC-34; N; P; DA, MG

Oenothera triloba Nutt.; M9.026; N; Bi; MG, MQ

Stenosiphon linifolius (Nutt. ex James) Heynh.; BLM0361, PC-89; N; P; DA, MG, MQ

OXALIDACEAE

Oxalis corniculata L.; PC-246; N; P; DA

PAPAVERACEAE

Argemone polyanthemos (Fedde) G.B. Ownbey; BLM0185; N; A; SB

PEDALIACEAE

Proboscidea louisianica (P. Mill) Thell.; HF088, PC-211; N; A; DA

PLANTAGINACEAE

Plantago rhodosperma Decne.; BLM079, PC-25; N; A; DA, MG

POLYGALACEAE

Polygala alba Nutt. BLM0148, PC-48; N; P; MG

POLYGONACEAE

Eriogonum annuum Nutt.; BLM0354; N; A; SB

Eriogonum longifolium Nutt.; PC-175; N; P; MG

Polygonum hydropiperoides Michx.; BLM0422; N; P; AQ

Polygonum lapathifolium L.; HF0148; N; A; AQ

Polygonum pensylvanicum L.; HF024; N; A; AQ

Polygonum ramosissimum Michx.; HF0160; N; A; DA

Rumex altissimus Wood; HF021; N; P; AQ, DA

Rumex crispus L.; HF05; I; P; AQ, DA, BLF

PORTULACACEAE

Portulaca oleracea L.; HF0137; N; A; DA

PRIMULACEAE

Androsace occidentalis Pursh; PC-248; N; A; DA

Samolus ebracteatus Kunth; BLM0184; N; P; AQ

Samolus valerandi L.; BLM0503; N; P; AQ

RANUNCULACEAE

Anemone berlandieri Pritz; PC-23; N; P; MG

Anemone caroliniana Walt.; PC-227; N; P; DA, MG

Delphinium carolinianum Walt. ssp. *virescens* (Nutt.) Brooks; PC-20; N; P; MG, MQ

Myosurus minumus L.; PC-234; N; A; AQ

Ranunculus sceleratus L.; BLM034; N; A; AQ

RHAMNACEAE

Ziziphus obtusifolia (Hook.) A. Gray; BLM0158; N; P; MG

ROSACEAE

Crataegus viridis L.; M9.129; N; P; BLF

Prunus angustifolia Marshall; HF052, PC-139; N; P; DA, MG
Rubus trivialis Michx.; BLM037; N; P; BLF

RUBIACEAE

Cephalanthus occidentalis L.; PC-119; N; P, AQ
Galium aparine L.; BLM039; N; A; BLF
Hedyotis nigricans (Lam.) Fosberg; BLM0191, PC-82; N; P; MG
Houstonia pusilla Schoepf; PC-226; N; A; DA

RUTACEAE

Zanthoxylum hirsutum Buckl.; BLM0160; N; P; SB

SALICACEAE

Populus deltoides Marsh. ssp. *monilifera* (Aiton) Eckenw.; PC-19; N; P; BLF
Populus deltoides Bartr. ex Marsh; HF0128, PC-251; N; P; BLF
Salix exigua Nutt.; BLM0308, N; P; SB
Salix nigra Marsh; BLM0314, HF029, PC-120; N; P, AQ, BLF, SB

SAPINDACEAE

Cardiospermum halicacabum L.; BLM0339; N; A; BLF, DA
Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson; HF026, PC-149; N; P; BLF, SB

SAPOTACEAE

Sideroxylon lanuginosum Michx.; BLM0173, PC-207; N; P; SB

SCROPHULARIACEAE

Lindernia dubia (L.) Pennell; M9.136; N; A; AQ
Penstemon cobea Nutt.; PC-51; N; P; MG
Veronica anagallis-aquatica L.; BLM052; N; P; AQ
Veronica peregrina L.; BLM081; N; A; DA

SIMAROUBACEAE

Ailanthus altissima (P. Mill.) Swingle; 0489-98; I; P; DA

SOLANACEAE

Chamaesaracha coniodes Moric. ex Dunal; PC-58; N; P; DA
Physalis angulata L.; HF0123; N; A; DA
Physalis longifolia Nutt.; BLM0351, PC-97; N; P; DA
Physalis mollis Nutt. var. *mollis*; HF0133, PC-167; N; P; DA
Quincula lobata (Torr.) Raf.; HF013, PC 52; N; P; DA; MQ
Solanum dimidiatum Raf.; BLM0153, PC-87; N; P; DA
Solanum elaeagnifolium Cav.; BLM0169, PC-50; N; P; DA, MG
Solanum rostratum Dunal; BLM0493, HF092; N; A; DA

TAMARICACEAE

Tamarix chinensis Lour.; HF020, PC-198; I; P; AQ, SB

ULMACEAE

Celtis laevigata Willd. var. *texana* (Scheele) Sang.; HF080, PC-110; N; P; BLF, SB
Ulmus americana L.; BLM0337, PC-253; N; P; BLF

URTICACEAE

Parietaria pensylvanica Muhl. ex Willd.; BLM0170; N; A; BLF

VALERIANACEAE

Valerianella radiata (L.) Dufr.; BLM083; N, A; DA

VERBENACEAE

Phyla lanceolata (Michx.) Greene; BLM0199; N; P; AQ
Phyla nodiflora (L.) Greene; BLM0330, PC-127; N; P; AQ
Glandularia bipinnatifida (Nutt.) Nutt.; PC-12; N; A; DA

Verbena plicata Greene; BLM060; N; P; MG
Verbena scabra Vahl; BLM0423; N; P; MG

VIOLACEAE

Viola bicolor Pursh; PC-225; N; A; DA

VISCACEAE

Phoradendron tomentosum (DC.) Engelm. ex A. Gray; BLM0164, PC-250; N; P; BLF

VITACEAE

Ampelopsis cordata Michx.; BLM0362; N; P; BLF
Cissus trifoliata (L.) L.; BLM072; N; P; MG
Parthenocissus quinquefolia (L.) Planch.; BLM0350; N; P; BLF
Vitis acerifolia Raf.; 0134-98; N; P; SB
Vitis riparia Michx.; 093-98; N; P; SB
Vitis vulpina L.; PC-208; N; P; MG, MQ

ACKNOWLEDGMENTS

This project was funded by a grants from the Oklahoma Department of Wildlife Conservation, and the Bureau of Land Management. We thank Debbie

Benesh, Amy Buthod, and Newell McCarty for assistance in the field. Todd Fagin produced the study area map.

REFERENCES

Barkley, T.M. 2000. Floristic studies in contemporary botany. Madrono 47:253–258.

Branson, C.C., and K.S. Johnson. 1979. Generalized geologic map of Oklahoma. In: K.S. et al., eds. Geology and earth resources of Oklahoma. Oklahoma Geological Survey, Norman.

Curtis, N.M. and W.E. Ham. 1979. Geomorphic provinces of Oklahoma. In: K.S. Johnson et al., eds. Geology and earth resources of Oklahoma. Oklahoma Geological Survey, Norman.

Diggs, G. M., B.L. Lipscomb, and R.J. O'Kennon. 1999. Illustrated flora of north central Texas. Sida, Bot. Misc. 16:1–1626.

Duck, L.G., and J.B. Fletcher. 1943. A game type map of Oklahoma. A Survey of the Game and Furbearing Animals of Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City.

Ertter, B. 2000a. Our undiscovered heritage: past and future prospects for species-level botanical inventory. Madrono 47:237–252.

Ertter, B. 2000b. Floristic surprises in North America north of Mexico. Ann. Missouri Bot. Gard. 87:81–109.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence.

Groves, C.R., M.L. Klein, and T.F. Breden. 1995. Natural heritage programs: public-private partnerships for biodiversity conservation. Wildl. Soc. Bull. 23:784–790.

Hoagland, B.W. 2000. The vegetation of Oklahoma: a classification of landscape mapping and conservation planning. Southw. Nat. 45:385-420.

Hoagland, B.W. 2003. Atlas of the flora of Oklahoma. (www.biosurvey.ou.edu) Oklahoma Biological Survey, University of Oklahoma, Norman.

Hoagland, B.W. and F.L. Johnson. 2001. Vascular flora of the Chickasaw National Recreation Area, Murray County, Oklahoma. Castanea 66:383-400.

Hunt, C.B. 1974. Natural regions of the United States and Canada. W.H. Freeman, San Francisco.

Lamar, O.W. and C.E. Rhodes. 1974. Soil survey of Tillman County, Oklahoma. United States Department of Agriculture.

Oklahoma Climatological Survey. 2003. Oklahoma Climatological Data. (http://www.ocs.ou.edu/). University of Oklahoma, Norman.

Pielou, E.C. 1984. Interpretation of ecological data. Wiley Interscience, New York.

Palmer, M.W., G.L. Wade, and P. Neal. 1995. Standards for the writing of floras. BioScience 45:339–345.

Radford, A.E., D.K. Otte, J.R. Massey, and P.D. Whitson. 1980. Natural heritage: classification, inventory, and information. University of North Carolina, Chapel Hill.

Stuessy, T.F. and S.H. Sohmer. 1996. Sampling the green world. Columbia University Press, New York.

Taylor, R.J. and C.S. Taylor. 1991. An annotated list of the ferns, fern allies, gymnosperms, and flowering plants of Oklahoma. Biology Dept. Herbarium, Southeastern Oklahoma State University, Durant.

Trewartha, G.T. 1968. An introduction to climate. McGraw-Hill, New York.

USDA-NRCS. 2003. The PLANTS database. (http://plants.usda.gov/plants). National Plant Data Center, Baton Rouge, LA.

Waterfall, U.T. 1973. Keys to the flora of Oklahoma. Published by the author, Stillwater, OK.

BOOK NOTICES

Blackwell Publishing

DON ETHRIDGE. 2004. **Research Methodology in Applied Economics. Second Edition.** (ISBN 0-8138-2994-1, hbk.). Blackwell Publishing Professional, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax, www.blackwellprofessional.com). $74.99, 224 pp., illustrated, 6" × 9".

Publisher Comments: "Emphasizing research methodology as it applies to economics, Ethridge provides an overview of the conceptual and philosophical basis of research methodology and procedural guidelines on designing, coordinating, and conducting research projects. This textbook integrates philosophies, concepts, and procedures in research methodology, adding practical tips such as how to write a research proposal, how to apply for funding, and how to write reports that effectively present research. This edition updates and increases the use of relevant examples for today's students, faculty, and researchers."

Contents: **Part I: 1)** Introduction. **2)** Research and Methodology. **3)** Methodological Concepts and Perspectives. **4)** Philosophical Foundations. **Part II: 5)** Planning the Research. **6)** The Research Problem and Objectives. **7)** The Literature Review. **8)** The Conceptual Framework. **9)** Methods and Procedures. **Part III: 10)** Reporting the Research. **Part IV:** Appendices. **A)** Example of a Research Proposal for a Government Agency; **B)** Example of a Master's Thesis Proposal; **C)** Example of a Ph.D. Dissertation Proposal. **D)** Guidelines for Critiquing Papers. **E)** Seeking Research Funding. References. Index.

BIRGITTA MALMFORS, PHIL GARNSWORTHY, and MICHAEL GROSSMAN. 2004. **Writing and Presenting Scientific Papers.** (ISBN 0-897676-12-3, pbk.). Nottingham University Press, Manor Farm, Main Street, Thrumpton Nottingham NG11 0AX, UK. (Orders: Blackwell Publishing Professional, 2121 State Avenue, Ames, IA 50014, U.S.A., 1-800-862-6657, 1-515-292-3348 fax, www.blackwellprofessional.com). $74.99, 224 pp., graphics, figures, tables, 6 3/4" × 9 1/2".

Contents: "Preface. **1)** Communicating Science. **2)** Sections of a Scientific Paper. **3)** Tables and Figures. **4)** Other Types of Scientific Writing. **5)** Getting Started in Writing. **6)** Improving your Writing. **7)** Writing Statistics. **8)** Literature Searching and Referencing. **9)** Getting a Paper into Print. **10)** Oral Presentation and Visual Displays. **11)** Poster Presentation. **12)** Training Students in Writing and Presentation. **13)** Reviewing Papers and Presentations.

SAWTOOTH OAK (*QUERCUS ACUTISSIMA*, FAGACEAE) IN NORTH AMERICA

Alan T. Whittemore

US National Arboretum
3501 New York Ave NE
Washington, DC (District of Columbia) 20002-1958, U.S.A.

ABSTRACT

Sawtooth oak (*Quercus acutissima* Carruth.), native to eastern Asia, is widely planted in the eastern United States as a source of food for wildlife (especially turkeys) and as a landscape tree in developed areas. Spontaneous reproduction of sawtooth oak outside of cultivation has now been confirmed for Alabama, Louisiana, Maryland, Missouri, Mississippi, North Carolina, Pennsylvania, and the District of Columbia A complete description and an illustration are provided. Feral populations of sawtooth oak are mostly confined to open, often disturbed areas, and it spreads very slowly, apparently due to limited dispersal of the acorns. Planting of large stands of *Quercus acutissima* in natural areas or revegetating areas for wildlife food is likely to result in the establishment of this exotic species and its spread into adjacent habitats, but the use of sawtooth oak as a landscape tree in developed areas usually poses much less danger of escape.

RESUMEN

Quercus acutissima Carruth., nativo del este de Asia, está ampliamente cultivado en el este de los Estados Unidos como fuente de alimento para la fauna salvaje (especialmente pavos) y como árbol de paisaje en áreas desarrolladas Su reproducción espontánea fuera de cultivo se ha confirmado ahora en Alabama, Louisiana, Maryland, Missouri, Mississippi, North Carolina, Pennsylvania, y el Distrito de Columbia. Se aporta una descripción completa y una ilustración. Las poblaciones silvestres de *Quercus acutissima* están mayormente confinadas a áreas abiertas alteradas, y se expande muy lentamente, debido aparentemente a la dispersión limitada de sus bellotas. El establecimiento de grandes plantaciones de *Quercus acutissima* en áreas naturales o áreas de revegetación para alimento de la fauna salvaje es probablemente la causa del establecimiento de esta especie exótica y su expansión en los hábitats adyacentes, pero el uso de *Quercus acutissima* como árbol de paisaje en áreas desarrolladas tiene mucho menos peligro de escape

Sawtooth oak, *Quercus acutissima* Carruth., is a deciduous tree, native to open woodlands in eastern Asia, from northeastern India east to northern Vietnam and north to Japan and Korea (Huang et al. 1999). It was first introduced to the United States in 1862 (Rehder 1940), but it has only become common in cultivation in the past 50 years. Sawtooth oak has been widely planted as a source of food for wildlife (especially turkeys), because of its fast growth and early, heavy fruiting (Sullivan & Young 1961; Mercer 1969; Hopkins & Huntley 1979; Goelz & Carlson 1997; Stribling 1994). It has also has gained favor in recent years as a landscape tree because of its attractive form, rapid growth, and tolerance of difficult conditions (Spicer 1971; Francis & Johnson 1985; Gilbert & Henry 1988; Hensley et al. 1991; Tuttle 1995; Dirr 1998).

Some concern has been expressed about the use of *Q. acutissima* as wildlife food in the United States. Mercer (1969) said, "The sawtooth oak has aroused some apprehension.... Foresters wonder if it might become a "weed" tree. So far none of the plantings studied has increased in number of trees." Coblentz (1981) suggested that its high germination rate and high resistance to insect damage might indicate that *Q. acutissima* has the potential to spread widely in the southern United States. He noted that the potential for hybridization between sawtooth oak and native North American oaks had not been investigated. He also cited papers indicating that the acorns of sawtooth oak are less nutritious than acorns of native species, and less utilized by North American wildlife, and concluded that long-term management goals will be best met by improved management of diverse native hardwood communities rather than by planting sawtooth oak. Perhaps because of these concerns, many wildlife programs have returned to planting native oaks.

In recent years, *Quercus acutissima* has been reported to reproduce outside of cultivation in six states: Alabama (Younghance and Freeman 1996), Louisiana (Thomas and Allen 1998), Maryland (Terrell et al. 2000), Missouri (Yatskievych and Summers 1993), Mississippi (Kartesz 1999), and Pennsylvania (Rhoads and Klein 1993). The species is not mentioned in the treatment of *Quercus* L. for Flora of North America (Nixon et al. 1997). There are almost no published data on the ecology of sawtooth oak in North America, and the very brief description in Rhoads and Klein (1993) is the only description of the species in a North American identification manual.

Field and herbarium work in the eastern United States, and inquiry among active fieldworkers in the area, indicates that *Quercus acutissima* is escaping at sites across the eastern United States. Spontaneous reproduction of sawtooth oak outside of cultivation has now been confirmed for seven states and the District of Columbia. Since the species is becoming widespread and is being collected more frequently, it seems desirable to supply a full description of *Q. acutissima*, and a summary of its current range and habitat preferences in North America.

KEY TO SEPARATE *QUERCUS ACUTISSIMA* FROM NATIVE OAK GROUPS OF THE EASTERN UNITED STATES

1. Acorns maturing in the first fall after flowering (so all acorns in summer are ± the same size, and immature acorns are not present on the tree in winter). Tips of veins at leaf margin never projecting as bristles. Axils of major veins on leaf underside without conspicuous tufts of hairs. Bark light to medium gray, splitting into loose or more or less persistent ridges, plates, blocks or strips ____________________ White oaks (**Quercus** section **Quercus**)

1. Acorns maturing in the second fall after flowering (thus with large and small acorns on single twigs in summer, and immature acorns present in winter). Tips of veins at leaf margin almost always projecting as bristles 0.5–7 mm long. Axils of major veins on leaf underside usually with tufts of stalked 4–15-rayed hairs 0.3–0.5 mm high. Bark medium to dark gray, splitting into persistent ridges or blocks.

2. Scales of acorn cup lanceolate or strap-shaped, strongly recurved, 8–10 mm long. Leaf unlobed, its margin with 10–23 bristles on each side __________ **Quercus acutissima** (**Quercus** section **Cerris** Loudon)
2. Scales of acorn cup triangular, appressed, 1.5–5 mm long. Leaf not as above: either deeply lobed or with 0–3 bristles on each side __________ Black oaks (**Quercus** sect. **Lobatae** Loudon, sometimes called **Quercus** subgenus **Erythrobalanus** (Spach) Oerst.)

Quercus acutissima Carruth., J. Linn. Soc., Bot. 6:33. 1862. (**Fig. 1**). SAWTOOTH OAK. Trees to 30 m tall. Bark medium to dark gray, divided into narrow persistent ridges. Twigs dark brown, puberulent with 1-5-rayed appressed (occasionally spreading) hairs, or glabrescent, 2–3 mm thick. Buds brown, 5–8 mm long, pubescent (at least the upper half), scales long-ciliate. Petioles 10–39 mm long. Leaf blade lance-oblong to lanceolate or oblanceolate, 11–21 cm long, 3–6 cm wide, base rounded or truncate; secondary veins each (except the basalmost) reaching the margin at the tip of a tooth and ending in a bristle, teeth 10–23 on each side of the blade, well-developed teeth obtuse to acuminate, each tooth ending in a single bristle 2–5 mm long. Upper surface of blade shiny, with scattered inconspicuous simple (rarely 2–4-rayed) hairs; lower surface green, the blade with inconspicuous unbranched appressed hairs, the veins with spreading simple hairs, vein axils with small tufts of ca 4-rayed stalked fasciculate hairs. Calyx of female flower fused to the ovary. Anthers retuse. Styles linear, their tips not broadened. Nuts ripe the second autumn after flowering. Peduncle 0–2 mm long. Acorn cup hemispherical, 14–15 mm long, 18–25 mm wide, covering 0.3–0.5 of the nut, its inner surface smooth, hairy. Cup scales narrowly lanceolate or strap-shaped from a short triangular base, 8–10 mm long, weakly costate, free from cup for their whole length and strongly recurved, the scales at the margin of the cup longer but otherwise not differentiated. Nut ovoid to ovoid-cylindrical, 15–20 mm long, 13–17 mm wide. Inner surface of the shell densely pubescent, abortive ovules near the base, seed coat adhering to the fruit wall.

Flowering in April. Native to Asia, from Korea and Japan south to Vietnam and west to northeastern India.

Representative specimens examined: **ALABAMA. Bibb Co.:** 8 mi S of Centerville along levee dirt road, off of county road 219, 32° 52' 30" N, 87° 00' 00" W, elev. 465 ft, *S.T. Smith s.n.*, 10 Jul 1999 (AUA). **DISTRICT OF COLUMBIA:** Spontaneous small tree 5 m tall, trunk 6.5 cm thick, open grassy (partly cleared) margin of *Quercus* spp. woodland, north side of Beechwood Road near its intersection with Ellipse Road, U.S. National Arboretum, *A.T. Whittemore 00-014*, 29 Aug 2000 (CAS, NA, MOR, MU, UNC, US). **LOUISIANA. Winn Parish:** along paved road leading to Blewer's Pond at Bienville Parish Line, north of LA 126 and NE of Roadheimer, sect. 6, T13N R5W, *K.H. Kessler 1864*, 20 Sep 1981 (AUA). **MARYLAND. Prince George's Co.:** scattered adult trees with frequent saplings, open second-growth *Quercus* woodland, edge of Beltsville Agricultural Research Center along I-495 near the Cherry Hill Rd. overpass, north side of College Park, *A.T. Whittemore 01-058*, 28 Nov 2001. (NA). **MISSISSIPPI. Lafayette Co.:** open area along Forest Service road, Tallahatchie Experimental Forest rd. T-3, N of County Road 244, Holly Springs National Forest, UTM: 2 76 238E, 38 21 127N (GPS); *L.M. McCook & M. Hodson 2180*, 26 Jun 2000 (MISS, NA). **MISSOURI. Franklin Co.:** *Quercus-Carya* woodland below

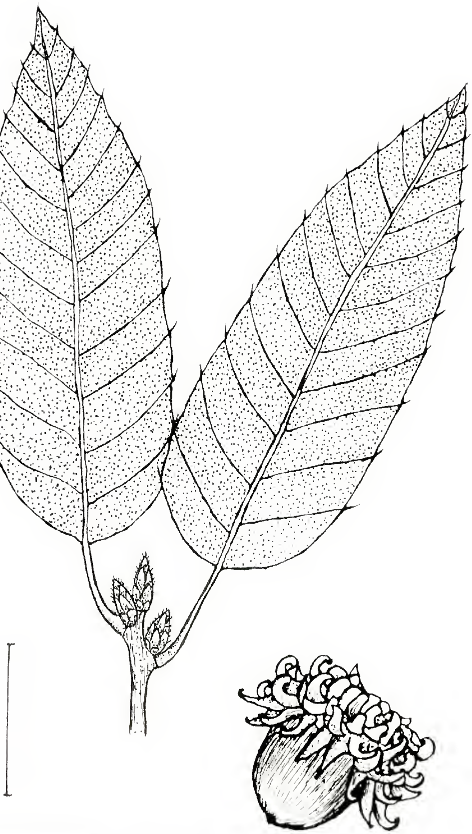


Fig. 1. *Quercus acutissima* foliage and acorn. Scale bar = 3 cm.

the nursery, next to Old Gray's Summit Road, Shaw Nature Reserve, S of Gray's Summit, *A.T. Whittemore 01-029* 15 Oct 2001 (NA). **NORTH CAROLINA. Orange Co.:** disturbed area: along drive to Craige Dormitory, UNC Campus, Chapel Hill, *Emily W. Wood 863*, 2 Apr 1974 (MO). **PENNSYLVANIA. Lehigh Co.:** escape in fallow field 2 mi NW of Newside, *R.L. Schaeffer, Jr. 49540*, 26 Jul 1955 (PH).

These specimens represent areas where the species is definitely reproducing outside of cultivation. Specimens of planted trees have been seen from most parts of the eastern United States.

Quercus acutissima is easily distinguished from all native North American oaks. No native North American oak has unlobed leaves with numerous marginal bristles, and no native North American oak has the scales of the acorn cup long and reflexed. Sterile specimens of *Castanea* spp. are sometimes confused with *Q. acutissima*. Species of *Castanea* almost always have the leaves and buds in two regular ranks and not crowded at the stem apex. The sole exception to this is *Castanea dentata* (Marshall) Borkhausen, in which the leaves and buds of lateral stems are two-ranked and not crowded apically, as in other *Castanea* spp., while those of the leading stems are arranged in several irregular ranks and ± crowded at the stem apex, similar to stems of *Quercus*. Fertile material of *Castanea* is easily distinguished by characters of the inflorescence (erect and rigid in *Castanea*, pendent and lax in *Quercus*) and fruit (the nut in *Castanea* is completely enclosed in a valvate husk that is covered with long spines, while in *Quercus* the nut is in an unlobed scaly cup). The only exotic oak that resembles *Q. acutissima* is *Q. variabilis* Blume, another Asian species that is rarely cultivated in North America. *Quercus variabilis* is very similar to *Q. acutissima*, differing only in having glabrous twigs, dense stellate pubescence on the underside of the leaf blade, and bark that is usually somewhat corky. A third species sometimes recognized from Asia, *Q. chenii* Nakai, is probably a synonym of *Q. acutissima*.

Quercus acutissima reproduces spontaneously in grassland, open margins of deciduous woodlands, and other open disturbed areas. Sawtooth oak is especially prolific in mowed meadows. Mowing keeps the seedlings small, but does not seem to harm them otherwise. Seedlings are found only in close proximity to adult trees. Careful searches at several sites in Missouri, Maryland and the District of Columbia showed that almost all seedlings and saplings grow within 20 m of an adult tree, and none was found more than 100 m from an adult, suggesting that spread of the tree is severely limited by short seed dispersal.

As with other introduced species (i.e. *Lonicera maackii* (Rupr.) Maxim., Luken & Thieret 1995), sawtooth oak was slow to appear in the North American floristic literature. The first literature report of sawtooth oak as an escape in North America (Rhoads & Klein 1993) came 38 years after the first herbarium collection documenting it (*Schaeffer 49540*, 26 Jul 1955; see specimens examined above), and it is still not treated in many recent floras. This may have delayed recognition of the plant in some areas, since collectors who encounter it may not be able to key it out or find descriptions of it.

Quercus acutissima is a member of *Quercus* sect. *Cerris* Loudon, a group of about forty species native to Eurasia and North Africa. In the past, this group has sometimes been included in sect. *Quercus* (the white oaks; Nixon 1993), but it is now clear that the white oaks and section *Cerris* are not closely related (Manos et al. 1999, 2001). Hybridization between *Q. acutissima* and native oaks, cited as a potential area of concern by Coblentz (1981), is not likely to be a problem. Cottam et al. (1982) attempted numerous crosses between species of sect. *Cerris* and various native North American oak species, with little success. They found that it is very difficult to obtain hybrids between species from different sections of the genus, even when all competing pollen is strictly excluded by bagging and emasculation of the bagged branches. *Quercus acutissima* was not one of the species they used, but they made extensive use of *Q. variabilis*, which is a very close relative based on numerous morphological (Huang et al. 1999) and molecular (Manos et al. 2001) characters. Cottam et al. (1982) attempted pollinations between *Q. variabilis* and sixteen species of white and black oaks, and they were unable to obtain a single hybrid from any of these pollinations.

It is difficult to predict the long-term performance of sawtooth oak in the vegetation of eastern North America, since the decades that have passed since large-scale planting of the species in North America began are less than a full generation for the species. Even so, because sawtooth oak seedlings are able to establish themselves, mature, and set seed in reasonably natural habitats, *Quercus acutissima* should be considered naturalized, in the sense of Nesom (2000). Concerns about planting large stands of *Quercus acutissima* in natural areas seem to be well founded. In such sites, sawtooth oak can be expected to reproduce and spread slowly into adjacent open fields and woodland margins. The use of sawtooth oak as a landscape tree in developed areas usually poses much less danger of escape, primarily because of the short seed dispersal distances of the species. However, trees planted close to disturbed grassland and open woodland may be expected to invade these sites. Furthermore, the heavy acorn drop in autumn and the frequent seedlings in garden beds are undesirable characteristics in a landscape tree and cultivars with lower seed set would certainly be desirable.

ACKNOWLEDGMENTS

I would like to thank David E. Boufford, Steve Clemants, Allison Cusick, Laurence Dorr, Craig C. Freeman, David Giannasi, Curtis J. Hansen, Robert R. Haynes, William Hess, Marion Lobstein, James Macklin, Bill McClain, Lucile McCook, Cynthia Morton, Guy Nesom, Ann F. Rhoads, John Schwegman, Ted Scott, Guy Sternberg, Jil Swearingen, John Thieret, John Townsend, James C.

Trager, Lowell E. Urbatsch, Michael A. Vincent, Alan Weakley, David Whetstone, Ronald Wieland, and George Yatskievych for providing information, herbarium citations, help in the field, and other kinds of assistance, Andrea Ottesen for drawing the figure, and the curators of the herbaria cited for providing loans or facilities for work at their institutions.

REFERENCES

COBLENTZ, B.E. 1981. Possible dangers of introducing sawtooth oak. Wildl. Soc. Bull. 9: 136–138.

COTTAM, W.P., J.M. TUCKER, and F.S. SANTAMOUR, Jr. 1982. Oak hybridization at the University of Utah. State Arboretum of Utah Publ. No. 1. pp. i–xiv, 1–82.

DIRR, M.A. 1998. Manual of woody landscape plants. ed. 5. Stipes Publishing, Champaign, IL.

FRANCIS, J.K. and R.L. JOHNSON. 1985. Direct-seeded sawtooth oaks (*Quercus acutissima* Carruth.) show rapid growth on diverse sites. Tree Pl. Notes–U. S. Forest Service 36:3–5.

GILBERT, C.F. and D.S. HENRY. 1988. *Quercus acutissima* 'Gobbler'. Amer. Nurseryman 168(3):122.

GOELZ, J.C.G. and D.W. CARLSON. 1997. Growth and seed production of sawtooth oak (*Quercus acutissima*) 22 years after direct seeding. Research note SO-386. USDA-Forest Service Southern Research Station, Stonesville MS. Pp. 1–7.

HENSLEY, D.L., S.C. WIEST, C.E. LONG, J.C. PAIR and F.D. GIBBONS. 1991. Evaluation of ten landscape trees for the midwest. J. Environ. Hort. 9:149–155.

HOPKINS, C.R. and J.C. HUNTLEY. 1979. Establishment of sawtooth oak as a mast source for wildlife. Wildl. Soc. Bull. 7:253–258.

HUANG, C., Y. ZHANG and B. BARTHOLOMEW. 1999. Fagaceae. In: Z.-Y. Wu and P.H. Raven, eds. Flora of China, vol. 4. Science Press, Beijing. Pp. 314–400.

KARTESZ, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American flora. CD-ROM, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

LUKEN, J.O. and J.W. THIERET. 1995. Amur honeysuckle (*Lonicera maackii*; Caprifoliaceae): its ascent, decline, and fall. Sida 16:479–503.

MANOS, P.S., J.J. DOYLE and K.C. NIXON. 1999. Phylogeny, biogeography, and processes of differentiation in *Quercus* subgenus *Quercus* (Fagaceae). Molec. Phylogenetics and Evol. 12:333–349.

MANOS, P.S., Z.-K. ZHOU and C.H. CANNON. 2001. Systematics of Fagaceae: phylogenetic tests of reproductive trait evolution. International journal of plant sciences. 162:1361–1379.

MERCER, J., Jr. 1969. Sawtooth oak holds promise as wildlife plant for Southeast. Soil Conservation 34:178.

NESOM, G.L. 2000. Which non-native plants are included in floristic accounts? Sida 19: 189–193.

NIXON, K. 1993. Infrageneric classification of *Quercus* (Fagaceae) and typification of sectional names. Ann. Sci. For. 50 (suppl. 1):25s–34s.

Nixon, K.C., R.J. Jensen, P.S. Manos and C.H. Muller. 1997. *Quercus*. In: Flora of North America Editorial Committee (eds.), Flora of North America Vol. 3. Oxford University Press, New York. Pp. 445–506.

Rehder, A. 1940. Manual of cultivated trees and shrubs hardy in North America, exclusive of the subtropical and warmer temperate regions. Ed. 2. New York.

Rhoads, A.F. and W.M. Klein Jr. 1993. The vascular flora of Pennsylvania: Annotated checklist and atlas. Amer. Philos. Soc., Philadelphia.

Spicer, G. 1971. Trees tough enough for the city. Amer. Nurseryman 133(10):7–8.

Stribling, H.L. 1994. Planting sawtooth oak for wildlife. Circular ANR-851. Alabama Cooperative Extension Service, Auburn. Pp. 1–2.

Sullivan, E.G. and W.C. Young. 1961. An exotic oak, *Quercus acutissima*, for wildlife food planting. In: E. Conner Jr., ed. Proceedings of the fifteenth annual conference of the Southeast Association of Game and Fish Commissions. Southeast Association of Game and Fish Commissions, Nashville, TN. Pp. 136-141.

Tuttle, G.A. 1995. Tree of the month: *Quercus acutissima*, sawtooth oak. Arbor Age 15(1):28.

Yatskievych, G. and B. Summers. 1993. Studies in the flora of Missouri, IV. Missouriensis 14: 27–42.

Younghance, S.L. and J.D. Freeman. 1996. Annotated checklist of trees and shrubs of Alabama. Sida 17:367-384.

SPOROBOLUS COAHUILENSIS (POACEAE): A NEW RECORD FOR THE U.S.A FROM TRANS-PECOS, TEXAS

B.L. Turner

Plant Resources Center
University of Texas
Austin, Texas 78713, U.S.A.

Recent collections by the present author in southern Brewster County has revealed the presence of at least two new, presumably natural, populations of the poorly known *S. coahuilensis* Valdes, heretofore known only by a few collections from gypseous soils of south-central Coahuila, Mexico (Fig. 1). Study of the grass collection at SRSC revealed three additional collections of the taxon from Brewster County made by yet others, these all identified as *S. pulvinatus* Swallen, and mapped as such by Turner et al. (2003). The Reeders of ARIZ suggested that an additional collection from along the Rio Grande in Hudspeth County might also belong to the taxon, which proved to be so. All of these collections follow:

TEXAS: Brewster Co.: West end of Maverick Mt., near Study Butte, 8 Nov 1991, *Powell 5805* (collected by Michael Clark); ca. 3 mi SW of Hen Egg Mt., 2.8 mi W of Hwy. 118 along unpaved South County Road, clayey soils immediately along roadside (ca 29° 27, 103° 33), 31 Oct 2003, *B.L. Turner 23-325* (SRSC, TEX) ; 3.4 mi W of Hwy 118 along South County Road, gypseous silty clays, 26 Dec 2003, *Turner 23-335* (SRSC, TEX); Study Butte, 30 Oct 1966, *Warnock 23434* (SRSC); N of Study Butte, 25 Oct 1968, *Warnock 23395* ? (SRSC). **Hudspeth Co.:** Quitman Mts., S tip of mountains at Indian Hot Springs Resort, "seep area along road at base of hill near Rio Grande," 3400 ft, 12 Oct 1980, *Worthington 6804* (UTEP).

In the treatment of the *Grasses of the Southwestern United States* by Gould (1988), the above collections will key to *Sporobolus patens* Swallen. Gould noted that the latter is "known only from the type collection made at Wilcox, Cochise County, Arizona (*Silveus 3504*, September 26, 1938)." He also noted that *S. patens* might prove to be but a variant of *S. pulvinatus*. *Sporobolus coahuilensis* differs from both in having more numerous smaller florets on longer, more divaricate, pedicels, as nicely illustrated by Valdes (1978) in his original description of the taxon.

In the treatment of the grasses of the Trans-Pecos and adjacent areas by Powell (1994), *S. coahuilensis* will key to *S. pulvinatus*, the only annual species said to occur in the area concerned. Indeed, as already noted, Powell referred several of the above cited specimens to *S. pulvinatus*, the latter readily distinguished from *S. coahuilensis* by its less open inflorescence and appressed florets on shorter pedicels. In the Trans-Pecos, typical elements of *S. pulvinatus*

SIDA 21(1): 455 – 457. 2004

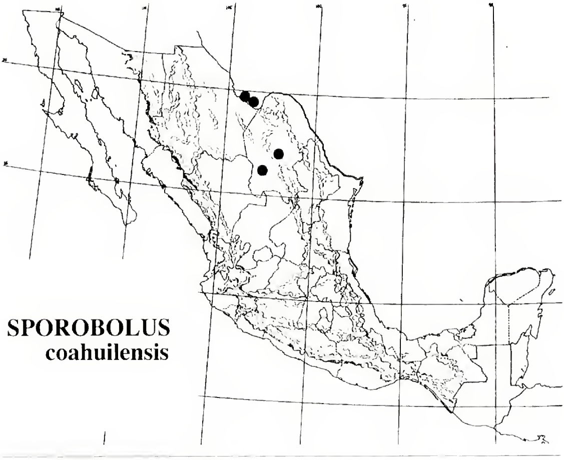


Fig. 1. Distribution of *Sporobolus coahuilensis*.

are known only from El Paso County, these having been reported by Correll and Johnston (1970) as *S. patens*, but subsequently referred to *S. pulvinatus* by Johnston (1990). Turner et al. (2003) mapped the latter as also occurring in southern Brewster County; such plants are accepted herein as *S. coahuilensis*.

In the account of *Sporobolus* for the *Flora of North America* (Peterson et al. 2003), *S. coahuilensis* will key to *S. pyramidatus* (Lam.) Hitchc. Unfortunately, the names *S. patens* and *S. pulvinatus* are not accounted for in their treatment; presumably, they regard the two names as synonymous with their concept of *S. pyramidatus*. Regardless, Peterson (pers. comm..) recognizes *S. coahuilensis* as distinct, as do most recent workers interested in Mexican grasses (e.g., Ortiz, by annotation, TEX).

In the area of Hen Egg Mt. where I first collected *S. coahuilensis* the population concerned was composed of 40 or more very uniform, late-flowering individuals growing with or near the much more abundant earlier flowering *S. pyramidatus*. By no stretch of my imagination might I have included these under the fabric of *S. pyramidatus*. Subsequent collections of *S. coahuilensis* from this same area (on 26 Dec 2003) showed that the latter occurred among or with numerous specimens of *S. pyramidatus*, there being no discernable intermediates between the taxa. During this second visit, approximately nine specimens of *S. coahuilensis* were detected growing with *S. pyramidatus* along a transect of some 40 yards along the edge of a recently plowed roadside.

ACKNOWLEDGMENTS

I am grateful to Charlotte Reeder for calling to my attention that the taxon concerned might be *S. coahuilensis*, and to her husband John, for yet other helpful comments. Thanks also to Richard Worthington at UTEP for the loan of *S. coahuilensis* from Hudspeth Co., the specimen itself composed of ca. five very uniform individuals mounted upon a single sheet.

REFERENCES

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, Texas.

Gould, F.W. 1988. Grasses of the southwestern United States (Fifth edition). Univ. of Arizona Press, Tucson

Johnston, M.C. 1990. A list up-dating the manual of vascular plants of Texas, Published by the author, Austin, Texas.

Peterson, P.M., S.L. Hatch, and A.S. Weakley. 2003. *Sporobolus*, in Fl. N. Amer. 25:115–139.

Powell, A.M. 1994. Grasses of the Trans-Pecos and adjacent areas. Univ. of Texas Press, Austin.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003 Atlas of the plants of Texas 2:859.

Valdes, J. 1978. *Sporobolus coahuilensis* (Gramineae), a new species from Coahuila, Mexico. Phytologia 41:81–84.

BOOK NOTICE

DALE LINDGREN and ELLEN WILDE. 2003. **Growing Penstemons: Species, Cultivars and Hybrids.** (ISBN 0-7414-1529-1, pbk.). Infinity Publishing.com, 519 West Lancaster Avenue, Haverford, PA 19041-1413, U.S.A. (Orders: 877-BUY-BOOK, 1-610-520-2500, 1-610-519-0261 fax, www.buybookssontheweb.com, Info@buybooksontheweb.com). $17.95, 149 pp., illustrated, 8 1/4" × 10 3/4".

Growing Penstemons begins with a history of Penstemons and the American Penstemon Society. The book is more than an alphabetical listing of species and cultivars with descriptions. Also included are chapters on *Penstemon* hybrids, selecting, growing and caring for Penstemons, methods of propagation, and creating your own hybrids. Eight appendices provide information from Penstemons for beginners to hunting for Penstemons in the wild.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 761202-4060, U.S.A.*

DOUGLAS CRASE. 2004. **Both: A Portrait in Two Parts.** (ISBN 0-375-42266-8, pbk.). Pantheon Books, 1745 Broadway, New York, NY 10019, U.S.A. (Orders: www.pantheonbooks.com, www.randomhouse.com). $24.00, 320 pp., illustrated, 5 3/4" × 7 1/2".

Publisher Comments: "*Both* is the enchanting account of a remarkable fifty-year relationship: Dwight Ripley, the child heir to an American railroad fortune, and Rupert Barneby, the product of a wealthy, baronial English upbringing, shared an obsession with botany from the moment they met at an exclusive boys' boarding school in England. Together they embarked on a lifelong pursuit of rare plants, first in Europe and then in the United States, where they migrated in the late 1930s. Every spring they explored the American Southwest in a sputtering Dodge, discovering new species and cultivating the spoils at their renowned home gardens. Barneby published so many taxonomic findings that he became a world authority on legumes. But the two men had other interests as well: they were intimates in the expatriate circles that included W. H. Auden and Peggy Guggenheim, and early collectors of painters such as Jackson Pollock and Joan Miró. Ripley, a prescient artist himself, whose startling work in colored pencil was lost in a trunk for several decades before being rediscovered, used his fortune to bankroll much of the avant-garde art scene of the early 1950s."

Sida Review coming in volume 21, no. 2.

NEW REPORTS OF *EURYBIA* AND *ASTER* S.STR. (ASTERACEAE: ASTEREAE) FROM CALIFORNIA, IDAHO, AND WYOMING

Luc Brouillet

Herbier Marie-Victorin
Institut de recherche en biologie végétale, Université de Montréal,
4101 Sherbrooke St. E, Montreal, Quebec, CANADA, H1X 2B2
luc.brouillet@umontreal.ca

ABSTRACT

I am reporting two new records of *Eurybia merita* (A. Nelson) G.L .Nesom for California (Siskyou County), and new records of *Aster alpinus* L. subsp. *vierhapperi* Onno for Idaho (Lost River Range) and Wyoming (Beartooth Pass).

RESUMEN

Se hacen dos nuevas citas de *Eurybia merita* (A. Nelson) G.L .Nesom de California (Siskyou County), y dos nuevas citas de *Aster alpinus* L. subsp. *vierhapperi* Onno de Idaho (Lost River Range) y Wyoming (Beartooth Pass).

INTRODUCTION

While reviewing herbarium material in preparation of the treatments of *Aster* L. s. str. and *Eurybia* (Cassini) S.F. Gray for the Flora of North America project, I came across specimens that represent new records for California, Idaho, and Wyoming.

Eurybia merita (A. Nelson) G.L. Nesom

CALIFORNIA. Siskyou Co.: Metcalf's ranch, northeast base of Mt. Eddy, in moist soil in the forest, 3900 ft, 30 Jul 1936, *Heller 12206* (MO); Mountains, 6000 ft, 5 Aug 5 1882, *Pringle 14590* (MO).

The two specimens I was able to examine are both typical *E. merita*, with purple-margined phyllaries and subserrate leaves, among other features. The Heller specimen was originally determined as *Aster* sp. and later annotated to *Aster radulinus* A. Gray by A.G. Jones. The Pringle specimen was identified as *Aster sibiricus* L. var. (=*A. montanus* Rich.; a form approaching *A. radulinus* A. Gray). Identification of both specimens as *E. radulina* (A. Gray) G.L. Nesom is not unexpected given that *E. merita* had not been reported for California (e.g., Allen 1993) and that taxonomic confusion exists between the two species. Yet, examination of a wide range of specimens in the course of preparation of the *Eurybia* treatment for FNA reveals that the two taxa are distinct (I have yet to find hybrid or intermediate material) and clearly identifiable using the following combination of features:

Stems ascending to erect, ± densely villous distally, leaf margins coarsely serrate (teeth mucronate), cauline often clasping; phyllaries without purple margins; rays white (sometimes purplish) __________ **Eurybia radulina**

Stems decumbent to ascending, villosulous distally; leaf margins entire to subserrate or ± serrate, cauline subauriculate or slightly clasping; phyllaries graduated, purple on margins; rays purple (sometimes pale) __________ **Eurybia merita**

In the flora of the Pacific Northwest, Cronquist (1955) stated that smaller forms of *E. radulina* (as *Aster*) with purple rays and anthocyanic involucres were difficult to distinguish from *E. merita* (as *A. sibiricus* var. *meritus*). He then mentioned ecological and geographical separation to advocate segregation of the two taxa and also observed that larger forms of the latter are very distinct from *E. radulina*. Part of the problem may lie (I have been unable to verify this) with the fact that some small individuals of *E. merita* may have been misidentified as *E. radulina*, causing confusion, and from the fact that the ranges of the two species (as exemplified by the records cited above) may not be as disjunct as initially envisioned by Cronquist and others. Though I did not find anthocyanic specimens of *E. radulina* during my study (admittedly a small sample of all material potentially available), the distribution of purplish coloration on the phyllaries of this species (if they ever are purplish) may differ from the typically purplish phyllary margins of *E. merita*. Cronquist (loc. cit.) did not address this issue. Further complicating the problem is the confusion between *E. merita* and *E. sibirica*, a species that barely reaches the conterminous United States. The definition of the range of characters of *E. merita* due to its inclusion within *E. sibirica* may have rendered its delimitation more difficult and thus less efficient. The recognition that *E. merita* is a species distinct from *E. sibirica* is crucial to our understanding of the former.

Given our current knowledge of the distribution of *Eurybia merita* in California, it appears to be of conservation concern in the state. Further study of *E. radulina* specimens in California herbaria may yield further localities for *E. merita* and provide more precise data as to its habitat and distribution there.

Aster alpinus L. subsp. **vierhapperi** Onno

IDAHO. Custer Co.: Lost River Range, Challis National Forest, ridge between two forks of upper Grouse Creek, ca. 1.5 mi W of Grouse Creek Mt., ca 19 mi N of Dickey; T12N R21E S23 NE1/4, 9900 ft, 14 Aug 1984, *Moseley 533* (RM). **WYOMING. Park Co.:** Beartooth Pass, US-212, 10940 ft, 5 Sep 1979, *Semple & Brouillet 4432* (MT, WAT).

Aster alpinus subsp. *vierhapperi* has not been reported from the floras of Idaho (Davis 1952) and Wyoming (Dorn 1977; Nelson & Hartman 1994; R.L. Hartman, pers. comm. 2003) (see also, e.g.,USDA-NRCS 2002, NatureServe 2003). The Moseley specimen was identified as *Aster sibiricus* var. *meritus*, while the Semple and Brouillet specimen was correctly identified but went unreported.

The species is easily recognized by its rosette leaves, single heads with subequal, foliaceous phyllaries, and obconic, flattened, 2-nerved, puberulent, apically glandular cypselae. Yet misidentifications abound with other species of asters, as well as, mostly, with species of *Erigeron*. The Idaho and Wyoming populations fill the gap between the southern Canadian populations of this species in Alberta and the Colorado locations (e.g., Hartman & Nelson 2001). All southern populations are at high elevations in the mountains, which may explain the rarity of records. Given that the Wyoming population is near the border with Montana and given the elevation of mountain ranges there, it is expected that collections of this taxon have been or will be made in this state; it should actively be sought there. Examination of *Erigeron* and other "aster" material from Idaho, Wyoming, Montana, and Colorado may yield further locations. Given the current state of our knowledge, *Aster alpinus* should be considered of conservation concern in Idaho and Wyoming.

CONCLUSION

The discovery of these new state records in well known states such as California, Idaho, and Wyoming from examination of herbarium specimens underscores the importance of herbaria and the value of revisionary and floristic work such as the Flora of North America project to our understanding of the continent's biodiversity.

REFERENCES

ALLEN, G.A. 1993. *Aster*. In: J.C. Hickman, ed. The Jepson manual: higher plants in California. University of California Press, Berkeley. Pp. 205–209.

CRONQUIST, A. 1955. Part 5: Compositae. In: C.L. Hitchcock, A. Cronquist, M. Ownbey & J.W. Thompson, Vascular plants of the Pacific Northwest. University of Washington Press, Seattle.

DAVIS, R.J. 1952. Flora of Idaho. Wm. C. Brown Co., Dubuque, Iowa.

DORN, R.D. 1977. Manual of the vascular plants of Wyoming. Garland Publ. Inc., New York. 2 vols.

HARTMAN, R.L., and B.E. NELSON, 2001. A checklist of the plants the vascular plants of Colorado. Rocky Mountain Herbarium, Laramie, Wyo. (obtained from http://www.rmh.uwyo.edu/colorado/index.html, September 2003).

NATURESERVE. 2003. NatureServe version 1.8 (1 July 2003) (http://www.natureserve.org/). Arlington, Va. (consulted September 2003).

NELSON, B.E. and R.L. HARTMAN. 1994. Checklist of the vascular plants of Wyoming. Rocky Mountain Herbarium, Laramie, Wyo. (obtained from http://www.rmh.uwyo.edu/species/index.htm, September 2003).

USDA-NRCS. 2002. The PLANTS database, Version 3.5 (http://plants.usda.gov) .National Plant Data Center, Baton Rouge, LA 70874-4490 USA (consulted September 2003).

THE NEW YORK BOTANICAL GARDEN
Institute of Systematic Botany
200th Street and Southern Blvd.
Bronx, New York 10458-5126

THE RUPERT BARNEBY AWARD

The New York Botanical Garden is pleased to announce that Karen Redden, currently a graduate student in the Department of Biological Sciences, George Washington University, Washington, D.C., is the recipients of the Rupert Barneby Award for the year 2004. Ms. Redden will be studying the systematics of a diverse group of legumes centered around *Dicymbe, paloue, paloveopsis, Heterostemon*, and *Elizabetha* that are concentrated in the Guiana Shield area.

The New York Botanical Garden now invites applications for the Rupert Barneby Award for the year 2005. The award of US $1,000 is to assist researchers to visit The New York Botanical Garden to study the rich collection of Leguminosae. Anyone interested in applying for the award should submit their curriculum vitae, a detailed letter describing the project for which the award is sought, and the names of 2–3 referees. Travel to the NYBG should be planned for sometime in the year 2005. The application should be addressed to Dr. James L. Luteyn, Institute of Systematic Botany, The New York Botanical Garden, 200th Street and Kazimiroff Blvd., Bronx, NY 10458-5126, U.S.A. and received no later than December 1, 2004. Announcement of the recipient will be made by December 15.

Anyone interested in making a contribution to THE RUPERT BARNEBY FUND IN LEGUME SYSTEMATICS, which supports this award, may send their check, payable to The New York Botanical Garden, to Dr. Luteyn.

NOTES ON THE DISTRIBUTION OF *PSEUDOGNAPHALIUM LUTEOALBUM* (ASTERACEAE: GNAPHALIEAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

The historical presence of *Pseudognaphalium luteoalbum* in Colorado and Pennsylvania is documented by collections from the 19th century, and it is first reported from Louisiana by a recent collection. The species is common in the southern half of California and locally common in southern Florida but uncommon or rare in other states. Historical collections from ballast also record its presence in New York, Oregon, and Washington, but it has not persisted in any of those states.

RESUMEN

La presencia histórica de *Pseudognaphalium luteoalbum* en Colorado y Pennsylvania está documentada mediante colecciones desde el siglo XIX, y esta es la primera cita de Luisiana mediante una colección reciente. La especie es frecuente en la mitad sur de California y localmente en el sur de Florida pero poco frecuente o rara en otros estados. Las colecciones históricas procedentes de lastre también señalan su presencia en New York, Oregón, y Washington, pero no ha persistido en ninguno de estos estados.

Pseudognaphalium luteoalbum (L.) Hilliard & Burtt has been known in the United States from California, Oregon, Washington, Nevada, Arizona, Utah, Florida, and New York (as summarized by Kartesz 1999), and recent reports have expanded the range to include New Mexico, Texas, and Arkansas (Nesom 2001, 2002). A recent collection from Louisiana, as well as historical collections from Colorado and Pennsylvania, are reported here.

LOUISIANA. Winn Parish: roadside along Hwy 84, 0.3 mi W of Cooley Methodist Church, ca. 13.5 mi WSW of Winnfield, area of Kisatchie National Forest, sandy soil in area of pine woods, ca. 100 plants scattered along 50 feet of roadside, 10 Apr 2004, *Nesom G2004-8* (BRIT, LSU, LSUS, MO, NY, NCU, UC, US). **COLORADO.** [Fremont Co.]: Cañon City, along ditches, 22 Jul 1872, *Redfield 188.5* (NY). **PENNSYLVANIA.** [Philadelphia Co.]: Philadelphia, Girard Point, in ballast, Aug 1877, *Parker s.n.* (NY). **NEW YORK.** N.Y., ballast filling, at northern terminus of 8th Ave., Jul 1879, *Brown s.n.* (NY).

Mitchell and Tucker (1997) listed *Pseudognaphalium luteoalbum* for New York as a non-native, non-persistent species; the 1879 collection from an early ballast site cited above perhaps is the basis for that citation. An early record of a ballast waif in Philadelphia, Pennsylvania, is added here. Historical collections from Oregon (Portland in 1902) and Washington (Bingen) also record introductions through ballast, and the species apparently has not persisted in those places (Cronquist 1955; Chambers & Sundberg 1998).

The cited collection from Colorado indicates that the species was present in that state more than a hundred years ago; it seems remarkable that it has not been documented there since then (e.g., Weber & Wittman 1994) but it perhaps is an indication, as probably true also for Oregon, Washington, New York, and Pennsylvania, that winter cold limits the distribution.

Pseudognaphalium luteoalbum is common in the southern half of California and locally common in southern Florida but uncommon or rare in other states. Relatively scattered and recent collections, however, indicate that it is naturalized and actively expanding its range into inland regions, and it probably should be expected to occur abundantly across the Gulf Coast region, once established. In the U.S.A., plants flower April through October and have been collected from roadsides, fields, gardens, ditches, riparian areas, and other disturbed sites. The species apparently is native to Eurasia and has been reported to occur in Africa, Australia, and New Zealand. It has been collected from scattered localities in Mexico.

ACKNOWLEDGMENTS

I am grateful to the staff at NY for their help during a recent visit, and I enjoyed the company of my mother on the April 10th afternoon of cudweed observations in Louisiana.

REFERENCES

Chambers, K.L. and S. Sundberg. 1998. Oregon vascular plant checklist: Asteraceae. Oregon Flora Project. Oregon State Univ., Corvallis.

Cronquist, A. 1955. Vascular plants of the Pacific Northwest. Part 5: Compositae. Univ. of Washington Press, Seattle.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. In: Kartesz, J.T., and C.A. Meacham. 1999. Synthesis of the North American flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, North Carolina.

Mitchell, R.S. and G.C. Tucker. 1997. Revised checklist of New York state plants. New York State Bull. 490. New York State Museum, Albany.

Nesom, G.L. 2001. New records in *Pseudognaphalium* (Gnaphalieae: Asteraceae) for the United States. Sida 19:1185–1190.

Nesom, G.L. 2002. New records in Asteraceae from Alabama and Arkansas. Sida 20: 403–404.

Weber, W.A. and R.C. Wittman. 1994. Catalog of the Colorado flora: A biodiversity baseline. Univ. Press of Colorado, Niwot, Colorado.

DICHANTHELIUM SCOPARIUM AND *MUHLENBERGIA GLABRIFLORIS*: NEW TO THE FLORA OF OHIO

Richard L. Gardner

The Nature Conservancy, Ohio Chapter
6375 Riverside Drive, Suite 50
Dublin, Ohio 43017, U.S.A.
Email:rgardner@tnc.org

James S. McCormac

Ohio Department of Natural Resources
Division of Natural Areas and Preserves
1889 Fountain Square, F-1
Columbus, Ohio 43224, U.S.A.

David Minney

The Nature Conservancy, Ohio Chapter
6375 Riverside Drive, Suite 50
Dublin, Ohio 43017, U.S.A.

ABSTRACT

Two native grasses are reported new to Ohio's flora, *Dichanthelium scoparium* (Lam.) Gould and *Muhlenbergia glabrifloris* Scribn. Both species share a similar coastal plain and Mississippi embayment distribution pattern. They were found at localities less than 4.5 km apart and in an area known for southern species reaching their northern limit

RESUMEN

Dos gramíneas nativas se citan como nuevas para la flora de Ohio. *Dichanthelium scoparium* (Lam.) Gould and *Muhlenbergia glabrifloris* Scribn. Ambas especies comparten un patrón de distribución en una llanura costera y desembocadura del Mississippi. Se encontraron en localidades a menos de 4.5 km y en un área conocida de especies meridionales que alcanzan allí su límite norte.

In 2001, Minney collected ***Dichanthelium scoparium***, velvet panic grass (Syn. *Panicum scoparium* Lam.) in Jackson County, Ohio, a species previously not reported for Ohio (Cooperrider et al. 2001; Flora of North America Committee (FNA) 1993). The authors revisited the site in 2002 to collect ecological data and additional voucher specimens. *Dichanthelium scoparium* is a distinctive, large, and easily identified species in a genus notorious for confounding botanists. Flowering culms can be up to 1.3 m in height (Fernald 1950), and are covered with soft, long-spreading hairs with the exception of a glabrous, viscid band below each node.

Distribution of this grass follows a coastal plain and Mississippi embayment pattern (Fig. 1). It ranges from Massachusetts south primarily along the coastal plain to Florida, west along the Gulf Coast to Texas, and north in the interior, primarily in the Mississippi River Valley and its tributaries to southeastern Kansas, southern Illinois, and Kentucky. Habitats for this species are variously reported as "wet soil" (Gleason & Cronquist 1991), "ditches and low woods" (Radford et. al 1968), "damp thickets, swales and shores" (Fernald 1950), "seepage bogs associated with the longleaf pine system" ([Alabama] Al Schotz, pers.

Fig. 1. Map showing the North American distribution of *Dichanthelium scoparium* adapted from Flora of North America Committee (1993).

comm. 2003), and "bottomland and upland prairies, sand prairies, ledges of bluffs, glades, margins of sinkhole ponds, fens, and openings of mesic upland forests, usually on acidic and especially sandy substrates; also roadsides, railroads, and fallow fields (Yatskievych 1999)." The wetland indicator status, as assigned by the U.S. Fish & Wildlife Service (Reed 1988) for the eastern U.S. is FACW (Facultative Wet), meaning that the plant usually occurs in wetlands (estimated probability 67%-99%), but is occasionally found in non-wetlands.

The Ohio population occurs on permanently saturated soil associated with a seepage outflow, and *Dichanthelium scoparium* largely defines the limits of the moist soils. It has formed a dense colony, nearly excluding other plants in some areas of the seepage meadow. While this site is in the right-of-way for a highway, we don't consider it introduced to this site, either intentionally as part of roadside plantings, or unintentionally by passing traffic or some other factor associated with the roadway. Of course, the spread of plants into new regions via roadways is a well-documented phenomenon (Reznicek & Catling 1987). The genera *Dichanthelium* and *Panicum* in Ohio are not known for non-natives, though. In the most recent listing of Ohio flora (Cooperrider et. al 2001), there are 36 species listed for these genera, and only one is not indigenous, *Panicum miliaceum* L. However, *P. miliaceum*, or millet, does not persist in the wild in Ohio, and is most often seen coming up around bird feeders where the seed has fallen to the ground. It should be noted that *Dichanthelium scoparium* is reported in Michigan by the USDA PLANTS Database, but there is no known specimen from Michigan and the report may be based on a synonymy error ([Michigan] Reznicek, pers. comm. 2003). And it was not discovered at another northernmost point in its range—southern Illinois—until 1967 (Mohlenbrock 1973), although it is considered native there. The species was discovered in southwestern Indiana in 1982 ([Indiana] Homoya, pers. comm. 2003) and again in 1998 in southeastern Indiana (Hedge et al. 1999). Another panic grass, *Panicum verrucosum* Muhl., which has a similar coastal plain distribution, is found in southern Ohio in Adams, Athens and Pike counties. It grows in adjacent Pike County on roadside banks along the Appalachian Highway. This species is currently listed as threatened in Ohio (Ohio Division of Natural Areas & Preserves 2002).

Although the *Dichanthelium scoparium* site is along a highway, the floristic composition is similar to parts of The Nature Conservancy's (TNC) Glade Wetland Preserve, which is a mosaic of low, poorly drained wetlands interspersed with higher knolls that support upland species. The preserve is about 4 km east of the *D. scoparium* site (Fig. 2). Plant taxa occurring at both sites include *Agalinis purpurea* (L.) Pennell, *Asclepias hirtella* (Pennell) Woodson, *Asclepias incarnata* L., *Carex annectens* Bickn. var. *xanthocarpa* (Bickn.) Wieg., *Carex complanata* Torr. & Hook., *Carex scoparia* Schk., *Eleocharis tenuis* (Willd.) Schultes var. *verrucosa* (Svenson) Svenson, *Juncus anthelatus* (Wiegand) R.E. Brooks, *Juncus biflorus* Elliott, *Juncus brachycarpus* Engelm., *Lysimachia quadriflora* Sims, *Panicum anceps* Michx., *Panicum microcarpon* Muhl., *Pycnanthemum tenuifolium* Schrader, *Rhynchospora capitellata* (Michx.) Vahl, *Sabatia angularis* (L.) Pursh, *Scutellaria integrifolia* L., and *Sorghastrum nutans* (L.) Nash. Another significant species at the *D. scoparium* site that is not at Glade Wetland Preserve is the state endangered *Scleria pauciflora* Muhl. ex Willd.

Voucher specimens: **OHIO. Jackson Co.:** dominant in 15 m × 10 m patch; scattered mostly in ditch for about 150 m along highway; seepage zone, open grassland, N and adjacent to Appalachian Highway (St. Rt. 32); 2.5 mi E of the Pike/Jackson County line, 5 Jul 2001, *Minney s.n.* (MICH); one large colony, covering several dozen square feet, in prairie-like opening on road bank, along seepage outflow, N side of OH Rt. 32, just E of jct. with C-23, sect. 8; Beaver Quad; Scioto Twp., 16 Jul 2002, *McCormac 7,296, Minney & Gardner* (CLM, KE, MICH, MU, OS).

In 2002, Minney collected ***Muhlenbergia glabrifloris*** Scribn. (clay-pan muhly), another species not reported for Ohio (Cooperrider et al. 2001; FNA 1993). In Gleason and Cronquist (1991) and Fernald (1950) the specific epithet is spelled *M. glabriflora* but we follow Scribner's original spelling, *M. glabrifloris* (FNA 2003). This species has a similar distribution as *D. scoparium*, however, it is un-

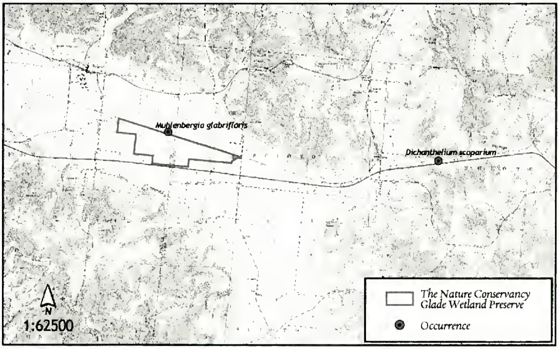


Fig. 2. Map showing the locations of *Dichanthelium scoparium* and *Muhlenbergia glabrifloris* in proximity to each other and The Nature Conservancy's Glade Wetland Preserve, Pike County, Ohio.

common throughout most of its range and is listed as rare in 7 states (NatureServe 2003). It ranges from the coastal plain of Virginia and North Carolina, and from Alabama to eastern Texas north to Missouri, southern Illinois, southwestern Indiana and western Kentucky (Fig. 3). The Ohio site is disjunct, as the closest locales are in Indiana and Kentucky, about 500 km away.

Muhlenbergia glabrifloris has well-developed rhizomes and flowering culms up to 1 m long with multiple lateral panicles. It strongly resembles a common muhly in Ohio's flora, *Muhlenbergia frondosa* (Poir.) Fern., however, the lemma is completely glabrous compared to the bearded lemma of *M. frondosa*. Habitats range from "bottomland forests, mesic upland forests, bottomland and upland prairies, and margins of glades; also railroads" in Missouri (Yatskievitch 1999) and "moist woodlands" in Illinois (Mohlenbrock 1973). Gleason and Cronquist (1991) list its habitat as "mostly in shade on low ground in heavy clay." The Ohio population is located just north of TNC's Glade Wetland Preserve (Fig. 2). The population is located on clay soils in a pin oak flatwoods (Fig. 4), a habitat similar to sites reported from other parts of its range.

Voucher specimen. **OHIO. Pike Co.:** pin oak–swamp white oak forest in clay soils of the pre-glacial Teays River Valley, woodlot about 5 acres in size; 0.5 mi N of the intersection of the Appalachian Highway (Rt. 32) and the Pike-Jackson County Line, 1 Oct 2002, *Minney s.n.* (OS).

The region where these two species were discovered is noted for unusual plant communities that support many rare species, including southern flora at the northern limits of their ranges (Beatley 1959; Spooner 1982). Some examples of

Fig. 3. Map showing the North American distribution of *Muhlenbergia glabrifloris* adapted from Flora of North America Committee (1993).

southern plants that are within 5 km of the Glade Wetland Preserve are *Gratiola viscidula* Pennell, *Magnolia macrophylla* Michx., *Panicum laxiflorum* Lam., *Polygala curtissii* A. Gray, and *Triadenum walteri* (S.G. Gmelin) Gleason. As the Ohio populations of *Dichanthelium scoparium* and *Muhlenbergia glabrifloris* occur in appropriate habitat in native plant communities, and their distribution mirrors that of other similarly distributed southern species, we consider both as native to Ohio. These species likely migrated into southern Ohio via the same route from the Mississippi River Valley into the Ohio River Valley. Similar habitats will be explored in the region for additional localities of these two species.

ACKNOWLEDGMENTS

We thank Al Schotz, Deborah White, Mike Homoya, John Pearson, Chris Frye, David Snyder and Bill Carr of Alabama, Kentucky, Indiana, Iowa, Maryland, New Jersey, and Texas Heritage Programs, respectively, for distribution and habitat information. We also thank Allison Cusick and Marleen Kromer for reviewing early drafts of this paper, and Daniel Boone for bringing to our attention the Indiana populations of *Dichanthelium scoparium*. We are grateful to Anton

Fig. 4. ***Muhlenbergia glabrifloris*** **was found in this pin oak flatwoods located adjacent to The Nature Conservancy's Glade Wetland Preserve, Pike County, Ohio (Photograph by Gary McFadden).**

Reznicek of the U. of Michigan for informing us on the status of *D. scoparium* in Michigan. Michael Lelong provided helpful information on *D. scoparium* nationwide distribution. Thanks to The Nature Conservancy and the Ohio Division of Natural Areas and Preserves for supporting our research.

REFERENCES

Beatley, J.C. 1959. The primeval forests of a preglacial area in the Allegheny Plateau (Vinton and Jackson Counties, Ohio) with a check list of vascular plants by Floyd Bartley. Ohio Biol. Surv. Bull. N.S. 1(1):1–181.

Cooperrider, T.S., A.W. Cusick and J.T. Kartesz (eds.). 2001. Seventh catalog of the vascular plants of Ohio. The Ohio State University Press, Columbus.

Fernald, M. L. 1950. Gray's manual of botany. 8th ed. American Book Co., New York, NY.

Flora of North America Editorial Committee (eds.). 1993+. Flora of North America north of Mexico. 7+ vols. New York and Oxford.

Gleason H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd ed. New York Botanical Garden, Bronx.

Hedge, C.L., M.A. Homoya, P. Scott, and C. Baker. 1999. An inventory of special plants within the U.S. Army Jefferson Proving Ground Phase II. Indiana Dept. of Natural Resources, Div. of Nature Preserves, Indianapolis.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett. 1990. Index herbarium. Part I, 8th ed. Regnum Veg. 120:1–693.

Mohlenbrock R.H. 1973. The illustrated flora of Illinois. Grasses: Panicum to Danthonia. Southern Illinois University Press, Carbondale and Edwardsville.

Ohio Division of Natural Areas & Preserves. 2002. Rare native Ohio plants 2002-03 status list. Columbus, Ohio.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The U. of North Carolina Press, Chapel Hill.

Reed, P.B., Jr. 1988. National list of plant species that occur in wetlands: north central (Region 3). United States Fish & Wildlife Service, St. Petersburg.

Reznicek, A.A. and P.M. Catling. 1987. *Carex praegracilis* in eastern North America: a remarkable case of rapid invasion. Rhodora 89:205–216.

Spooner, D. M. 1982. Wetlands in Teays-stage valleys in extreme southwestern Ohio: formation and flora. Symposium on Wetlands of the Unglaciated Appalachian Region. West Virginia U., Morgantown. Pp. 89–99.

Yatskievych, G. 1999. Steyermark's flora of Missouri. The Missouri Department of Conservation, Jefferson City. Vol. 1.

THE DELZIE DEMAREE TRAVEL AWARD

For assistance to attend the Missouri Botanical Garden
51st Annual Systematics Symposium (8–10 Oct 2004)

Graduate students in plant systematics are eligible to apply for the Delzie Demaree Travel Award, a $250 stipend to help defray expenses related to attendance at the Missouri Botanical Garden 51st Annual Systematics Symposium (8–10 Oct 2004). The 2004 symposium: *Latin American Biogeography—Causes and Effects.* http://www.mobot.org/MOBOT/research/symposium/welcome.shtml

The application should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

DELZIE DEMAREE ENDOWMENT FUND

NAME ______________________________

ADDRESS ______________________________

TELEPHONE ______________ EMAIL ______________

Please charge my ☐ Visa or ☐ Mastercard with US $______________

CREDIT CARD NUMBER ______________ EXPIRATION DATE ______________

SIGNATURE ______________________________

Mail your contribution by credit card or check to:
Delzie Demaree Travel Award
c/o Barney Lipscomb
Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060 USA

To make your contribution by phone, fax, or email, contact:
Yonie Hudson, Program Assistant
Voice: 817-332-4441 **FAX:** 817-332-4112
Email: yhudson@brit.org or barney@brit.org

NEW RECORDS OF *ERIGERON* (ASTERACEAE: ASTEREAE) FOR NEVADA

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

Study of specimens from NSMC reveals the presence in Nevada of *Erigeron nanus* Nutt., previously unknown in the state (Nesom 1992).

NEVADA. Elko Co.: Middle Stack Mountain, N end of the Granite Range, 6 airline mi NE of Contact, T45N, R65E, with *Artemisia* on steep gravel slopes of quartzite rock, 7900 ft, 10 Jun 1987, *Tiehm 11224* (NSMC). Originally identified as *Erigeron pumilus*

This is the westernmost locality for *E. nanus*, which previously has been known from the southwestern corner of Wyoming, northern Utah (Daggett and Box Elder cos.), and southeastern Idaho.

The typical variety of *Erigeron eatonii* A. Gray was previously recorded from Nevada by a single collection (**Clark Co.:** Virgin Mts., near the Utah border, *Tiehm 11256*, NSMC) (Nesom 1992). Additional collections verify its existence in the state and broaden the range.

NEVADA. Clark Co.: Virgin Mountains, VABM Virgin, Z11 E761100 N4056310, common throughout the peak area, with *Quercus gambelii*, *Cercocarpus ledifolius*, *Artemisia tridentata*, *Amelanchier utahensis*, *Arctostaphylos pungens*, 7380 ft, *Holland and Leary 4733* (NSMC). **Lincoln Co.:** Wilson Creek Range, Mount Wilson summit area, Douglas fir and aspen, 9250 ft, 17 Jul 1995, *Pinzl 11632* (BRIT, NSMC).

Nevada localities are at the southwestern extremity of the distribution of var. *eatonii* (see map, Fig. 2, Strother and Ferlatte 1988), which ranges to Colorado, Wyoming, southeastern Montana, and southeastern Idaho. *Erigeron eatonii* var. *sonnei* (Greene) Nesom occurs in the western part of Nevada and var. *nevadincola* (Blake) Nesom occurs in the northern half of the state.

ACKNOWLEDGMENTS

Thanks to Ann Pinzl at NSMC for arranging the loan of specimens.

REFERENCES

Nesom, G.L. 1992. *Erigeron* and *Trimorpha* (Asteraceae: Astereae) in Nevada. Phytologia 73:203–219.

Strother, J.L. and W.J. Ferlatte. 1988. Review of *Erigeron eatonii* and allied taxa (Compositae: Astereae). Madroño 35:77–91.

A PUTATIVE HYBRID OF *SCHOENOPLECTUS SAXIMONTANUS* AND *S. HALLII* (CYPERACEAE) FROM OKLAHOMA

Marian Smith

Department of Biology
Southern Illinois University
Edwardsville, Illinois 62026, U.S.A.

Paul McKenzie

U.S. Fish and Wildlife Service
Columbia, Missouri 65203, U.S.A.

Paige Mettler-Cherry

Underwood University
St. Charles, MO 63001, U.S.A.

Galen Smith

Department of Biology
University of Wisconsin-Whitewater
Whitewater, Wisconsin 53190, U.S.A.

ABSTRACT

Schoenoplectus saximontanus and *S. hallii* (Cyperaceae) are rare in North America and of conservation concern in every state in which they occur. Although the distribution of *S. saximontanus* extends farther west than that of *S. hallii* they are thought to be sympatric in five states in the central portion of their range in the U.S. The two species are indistinguishable vegetatively, but style morphology and achene characteristics are distinctive. In this paper, we report the collection of a putative hybrid from a mixed population of the two species in the Wichita Mountains Wildlife Refuge in OK, describe achenes of *S. saximontanus*, *S. hallii* and *Ss* × *Sh* that were collected from the site in 2002, and discuss the potential effects of hybridization on the two species.

RESUMEN

Schoenoplectus saximontanus y *S. hallii* (Cyperaceae) son raros en Norte América y con preocupaciones por su conservación en los estados en que aparecen of. Aunque la distribucion de *S. saximontanus* se extiende más al oeste que la de *S. hallii*, son simpátricos en cinco estados en la parte central de su rango en los Estados Unidos. Las dos especies son indiferenciables vegetativamente, pero la morfología del estilo y las características del aquenio son diferenciables. En este artículo, se cita la colección de un híbrido putativo en una población mixta de las dos especies en la Wichita Mountain Wildlife Refuge de Oklahoma, se describen los aquenios de *S. saximontanus*, *S. hallii* y *Ss* × *Sh* que fueron colectados en dicho lugar en 2002, y se discuten los efectos potenciales de la hibridación de las dos especies.

Schoenoplectus saximontanus (Fernald) J. Raynal and *S. hallii* (A. Gray) S.G. Smith, two small- to medium-sized members of *Schoenoplectus* section *Supini*, are vegetatively indistinguishable in the field, and are most often separated by achene cross-sectional shape and style morphology (Smith 2002). Both are found in damp sandy soil in ditches or depressions in cultivated fields or pastures and around the edges of temporary ponds. *Schoenoplectus saximontanus* and *S. hallii* are uncommon in North America (Schuyler 1969; Smith 2002) and are listed as species of conservation concern in every state in which they occur.

SIDA 21(1): 475 – 479. 2004

Although populations have been reported from 13 states for *S. saximontanus* and 13 states for *S. hallii* (Smith 2002; O'Kennon & McLemore 2004), populations of both species are transitory in nature and may disappear from an area for 20 or more years before re-emerging (McKenzie 1998), possibly from a long-lived soilbank. Although the distribution of *S. saximontanus* extends farther W than that of *S. hallii*, their ranges have been reported to overlap in six states (IL, KS, MO, NE, OK and TX) (Smith 2002; R. O'Kennon & C. McLemore 2004).

In 1999, *S. saximontanus* and *S. hallii* were found in close proximity at a single location in KS (H. Loring & C. Freeman, pers. comm.). In 2000, a survey of 134 potential population sites on the Wichita Mountain Wildlife Refuge, Indiahoma, OK revealed that individuals of the two species were located at 11 and 14 sites, respectively, with the species growing in mixed populations at five of the locations (Magrath 2002). No evidence of hybridization, however, was reported from either state.

PROCEDURES

In Aug 2001, the sites reported by Magrath (2002) were revisited by Marian Smith, Sam Waldstein (the Refuge Manager) and Paige Mettler, and the possibility of the presence of hybrids was noted. On 28 Jul 2002, Smith, Mettler, and Paul McKenzie collected specimens from several sites where both species were present. Voucher specimens were sent to Galen Smith and Alfred E. Schuyler who independently determined that P. McKenzie collection #2028 (specimens are deposited at PH, OKLA, WIS) appeared to be a hybrid. In the laboratory at Southern Illinois University, Edwardsville, two inflorescences each from individuals tentatively identified during collection of 8 August 2002 as being *S. hallii* or *S. saximontanus* and nine inflorescences from the putative *Ss* × *Sh* hybrid were examined under a dissecting microscope (Nikon Model SMZ800). Style morphology was noted, and achenes were counted and classified as either "normal" or "aborted."

RESULTS

All flowers in the two inflorescences collected from *S. saximontanus* and the nine inflorescences from the *Ss* × *Sh* hybrid had the 3-lobed styles and sharply trigonous achenes that are typical of *S. saximontanus*. All flowers and achenes of the *S. hallii* individuals were typical for that species (2-lobed styles and ovoid, plano-convex achenes). In *S. saximontanus*, *S. hallii* and the putative hybrid, 0%, 4% and 96%, respectively, of the achenes were aborted (Table 1). The five hybrid achenes that appeared to be normal (Table 1) were very similar in size, shape and surface contouring from those produced by *S. saximontanus*.

DISCUSSION

The only previously suspected case of interspecific hybridization of *S. hallii*

TABLE 1. Style morphology and number of normal and aborted achenes from individuals of *Schoenoplectus hallii*, *S. saximontanus* and *Ss* × *Sh* collected from Medicine Tank, Wichita Mountain Wildlife Refuge, Indiahoma, OK

				Achenes	
Species	**Collection No.**	**Infl. No.**	**Style (No. of styles)**	**Normal**	**Aborted**
S. hallii	2029	1	2-parted (5)	12	1
		2	2-parted (6)	11	0
S. saximontanus	2027	1	3-parted (9)	10	0
		2	3-parted (2)	3	0
Ss×*Sh*	2028	1	3-parted (3)	0	7
		2	3-parted (3)	2	14
		3	—	0	5
		4	3-parted (7)	0	16
		5	—	1	7
		6	3-parted (6)	1	19
		7	3-parted (3)	0	14
		8	3-parted (5)	1	21
		9	3-parted (7)	0	14

— indicates no intact styles present

occurred in GA where Smith (2002) reported a specimen that was intermediate between *S. hallii* and *S. erectus*, the third member of *Schoenoplectus* section *Supini* to occur in North America. Until the recent discoveries of mixed populations of *S. hallii* and *S. saximontanus*, there was little reason to expect the existence of hybridization between these two species. In addition to an assumed geographic isolation, the disparate diploid chromosome complements of the two species (*Sh*, 2n = 22; *Ss*, 2n = 50; Smith 2002) render hybridization an unlikely event. However, the collections recently taken in OK suggest that hybrids occur and produce achenes that have the appearance of normality.

Hybridization between *S. hallii* and *S. saximontanus* could be an important consideration in management and conservation concerns for both species. They are rare and occur in transient wetland habitats that may be declining in quality and availability. Because both often inhabit sandy soils along the margins of temporary ponds in agricultural areas, irrigation that lowers groundwater is potentially threatening, as is chemical runoff from fields. In KY (C. Baskin pers. comm.), the only known population of *S. hallii* is threatened by commercial development.

Hybridization may reduce a population by affecting its reproductive effectiveness (Fowler & Levin 1984), its competitive status (Norrington-Davies 1972) and by increasing potential interactions with herbivores (Fritz et al. 1994). The growth rate of a population may be retarded by the production of hybrid seed, which is produced in place of the rare species, i.e., resources are limited and an investment in hybrid seed reduces the amount of energy that can be allocated to conspecific seed. The outcome is the same whether the hybrid seeds abort or are viable. When species cross with equal facility in both directions, a numerically small population will produce a higher percentage of hybrid seed than a locally abundant species when the two are intermixed (Felber 1991; Levin et al. 1996). The numerical disadvantage of a rare species is compounded by the proliferation of fertile hybrids. The addition of these plants to a population containing two related species decreases the proportional representation of the rare species. In time, this backcrossing can result in the assimilation of the rare species, whose genetic identity will become extinct (Rhymer & Symberloff 1996). In the case of *S. saximontanus* and *S. hallii*, both species are rare, but the proportion varies among sites; therefore, it is impossible to predict which species will be most profoundly affected by hybridization. In collection #2028, the putative hybrids lacked any visible characteristics of *S. hallii*. Whether or not this varies, according to the identity of the maternal parent, is as yet unknown. In any case, site managers should be aware of the potential for hybridization, and any census of the species conducted to assess population number and risk of extinction should reflect the questionable status of the mixed populations.

Further work is needed to determine if achenes from the putative hybrid are viable, if they can produce plants, and whether or not these plants are fertile. We have initiated a mating study to answer some questions and plan to examine the achenes collected in the field for viability. Chromosomal studies on meiotic cells of field-collected and lab-grown individuals would be helpful in determining the mechanism of pairing during cell division, and sequencing work on parental and offspring arrays will be necessary to determine if alleles from the putative hybrid population are a combination of both parents. Chloroplast markers would allow one to infer which parent served as the maternal lineage. All of this depends upon further success in field collections and laboratory propagation.

ACKNOWLEDGMENTS

We thank Sam Waldstein and his Refuge staff for their hospitality and invaluable help in locating the study sites. We are grateful to Alfred E. Schuyler, Academy of Natural Sciences of Philadelphia, for his assistance with this project and we greatly appreciate his commitment and dedication in studying *Schoenoplectus* for many years. We thank Larry Magrath and an anonymous reviewer for their comments on the manuscript.

REFERENCES

Felber, F. 1991. Establishment of a tetraploid cytotype in a diploid population: effect of the relative fitness of the cytotypes. J. Evolutionary Biol. 4:195–204.

Fowler, N.L., and D.A. Levin. 1984. Ecological constraints on the establishment of a novel polyploidy in competition with its diploid progenitor. Amer. Naturalist 124:703–711.

Fritz, R.S., C.M. Nichols-Orians, and S.J. Brunsfeld. 1994. Interspecific hybridization of plants and resistance to herbivores: hypotheses, genetics and variable responses in a diverse herbivore community. Oecologia 97:106–117.

Levin, D.A., J. Francisco-Ortega, and R.K. Jansen. 1996. Hybridization and the extinction of rare plant species. Conservation Biol. 10:10–16.

Magrath, L.K. 2002. *Schoenoplectus hallii* and *S. saximontanus*: 2000 Wichita Mountains Wildlife Refuge Survey. Oklahoma Native Plant Record 2:54–64.

McKenzie, P.M. 1998. Hall's Bulrush (*Schoenoplectus hallii*) Status Assessment. U.S. Fish and Wildlife Service. Columbia, MO.

Norrington-Davies, J. 1972. Diallel analysis of competition between some barley species and their hybrids. Euphytica 21:292–308.

O'Kennon, R.J. and C. McLemore. 2004. *Schoenoplectus hallii* (Cyperaceae), a globally threatened species new for Texas. Sida 20:(in press).

Rhymer, J.M. and D. Symberloff. 1996. Extinction by hybridization and introgression. Ann. Rev. Ecological Syst. 27:83–109.

Schuyler, A.E. 1969. Three new species of *Scirpus* (Cyperaceae) in the southern U.S. Notul. Nat. Acad. Nat. Sci. Philadelphia 423:1–12.

Smith, S.G. 2002. *Schoenoplectus*. In: Flora of North America Editorial Committee, eds. Flora of North America, Vol. 23. Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York. Pp. 44–60.

ADDITIONS TO AND NOTEWORTHY RECORDS FOR THE VASCULAR FLORA OF WEST VIRGINIA

Cynthia M. Morton

Section of Botany
Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania 15213, U.S.A.

John Kartesz

Biota of North America Program
9319 Bracken Lane
Chapel Hill, North Carolina 27516, U.S.A.

Bonnie Isaac

Section of Botany
Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania15213, U.S.A.

Robert Coxe

Western Pennsylvania Conservancy/
Pennsylvania Natural Heritage Program
209 4th Avenue
Pittsburgh, Pennsylvania15223, U.S.A.

ABSTRACT

Sixteen vascular plant taxa not previously documented for West Virginia are reported with vouchers for each county of occurrence. These comprise of 2 lycophytes, 1 gymnosperm, 6 monocots and 7 dicots. Eleven species are native to the United States while 5 species have been introduced to the United States.

Key Words: vascular plants, West Virginia

RESUMEN

Dieciséis plantas vasculares que no habían sido previamente documentadas para West Virginia son reportadas con testigos para cada condado en donde están presentes. Estas incluyen 2 licopodios, una gimnosperma, 6 monocotiledóneas y 7 dicotiledóneas.

This study presents new information for the flora of West Virginia resulting from reexaminations of existing specimens and additional recent collections at Carnegie Museum of Natural History (CM). The following sixteen taxa are documented for their presence in West Virginia: *Brassica oleracea, Castanea mollissima, Chloris verticillata, Corallorhiza maculata* var. *occidentalis, Hordeum vulgare, Lycopodiella alopecuroides, Lycopodiella ×copelandii, Moehringia lateriflora, Pinus sylvestris, Platanthera ×andrewsii, Rubus elegantulus, Rubus immanis, Rubus meracus, Rubus porteri, Secale cereale,* and *Viola ×malteana.*

METHODS

Since the publications of the Flora of West Virginia (Strausbaugh and Core, 1970) additional plant collections from the state have been made along with reexaminations of existing specimens by specialists. Voucher specimens were prepared using the standard herbarium practices and are deposited at the Carnegie Museum of Natural History Herbarium (CM). Nomenclature follows

Kartesz (1999). Authorities are abbreviated according to Brummitt and Powell (1992). Every county for which there is a voucher specimen at CM is included.

RESULTS

The following entries are additions to the vascular flora of West Virginia. These taxa have not been reported previously as occurring in West Virginia. Taxa are listed alphabetically by family, genus and species with comments and citation of voucher specimens.

BRASSICACEAE

Brassica oleracea L.—Monongalia Co.: Morgantown, 20 May 1910, *K.S. Lashley s.n.*

Significance.—Determined by S.I. Warwick in 1995 for Flora of North America. First report for the state. This introduced species is also present in Pennsylvania, Maryland, Virginia, Ohio and Kentucky (USDA Plants Database).

CARYOPHYLLACEAE

Moehringia lateriflora (L.) Fenzl—Tucker Co.: Monongahela National Forest, ca. 4 mi SE of St. George on county 7 near junction of Horseshoe Run & Cheat River, sandy soil; dry slope along woodlot edge, 15 Jun 1984, *F.H. Utech 84-331.*

Significance.—This is the first report of this species from West Virginia. This native species occurs along the east coast from Maine to Pennsylvania and is rare in Maryland and Virginia.

FAGACEAE

Castanea mollissima Blume—Pendleton Co.: 4 km N of Franklin on US 220, roadside, 21 Aug 1994, *S.A. Thompson & J.E. Rawlins 11904.*

Significance.—This is the first report of this Asian species from West Virginia however it is present in Kentucky (USDA Plants Database).

LYCOPODIACEAE

Lycopodiella alopecuroides (L.) Cranfill—Tucker Co.: W of Thomas, bog, 12 Jul 1947, *H.A. Davis, T. Davis & H.P. Sturm 8310*; 1.5 mi E of junction with SR32 along SR93, turn onto dirt road on right, in old strip mine area 100 yards down dirt road, 30 Jul 1974, *J.G. Bruce, J. Reese & R. Fortney 74054.*

Significance.—Determined by R.E. Preston 2000. First report for the state. This native species also occurs in Pennsylvania, Maryland and Virginia (USDA Plants Database).

Lycopodiella ×copelandii (Eig.) Cranfill [*L. alopecuroides × appressa*]—Tucker Co.: 6 mi S of Thomas, bog, 5 Sep 1976, *D. Jolley s.n.*

Significance.—Determined by R.E. Preston 2000. First report of this hybrid for the state. This native hybrid also occurs in Pennsylvania, Maryland, Virginia and Kentucky (USDA Plants Database).

ORCHIDACEAE

Corallorhiza maculata (Raf.) Raf. var. **occidentalis** (Lindl.) Ames—Pocahontas Co.: Monongahela National Forest, Cranberry Glades Botanical Area at base of Kennison Mountain, bog forest, 17 Jul 1993, *J.S. Shriver, A. Shriver & C. Smith 94*; ca. 20 mi E of Richwood, Monongahela National Forest, bog forest, 11 Jun 1994, *J.S. Shriver, A. Shriver & C. Smith 213.*

Significance.—This species has been listed by the West Virginia Natural Heritage Program as critically imperiled. This native species also occurs in Pennsylvania and Virginia.

Platanthera ×andrewsii (M. White) Luer [P. *lacera ×psycodes*]—Pocahontas Co.: ca. 7 mi ENE of Marlinton, open exposure in marsh, 30 Jul 1994, *J.S. Shriver, A. Shriver & C. Smith 262.*

Significance.—Determined by J.S. Shriver in 1995. First report for the state. This native hybrid also occurs in Pennsylvania and Ohio (USDA Plants Database).

PINACEAE

Pinus sylvestris L.—Pendleton Co.: Mouth of Seneca, pasture border, 29 Sep 1973, *D.E. Boufford 12132.*

Significance.—This is the first report of this species from West Virginia. This European species has been reported to occur from Maine to Maryland along the east coast and from New Jersey through Illinois as far west as Minnesota. This introduced species occurs in the following surrounding states: Ohio, Pennsylvania and Maryland (USDA Plants Database).

POACEAE

Chloris verticillata Nutt.—Marshall Co.: 2.4 mi N along St. Rt. 2 from the Wetzel-Marshall Co. line, dry gravel soil in open riverbottom field, 18 Sep 1980, *E.E. Estep 1367.*

Significance.—"Report as new record for WV in 1981" on annotation, however apparently never published. This native species occurs in Pennsylvania, Ohio, Maryland, Kentucky and Virginia (USDA Plants Database).

Hordeum vulgare L.—Pendleton Co.: along North Fork River, field, 1 Jun 1940, *H.A. Davis & T. Davis 3633.* Randolph Co.: Huttonsville, along roadside, 6 Jun 1945, *H.A. Davis & T. Davis 6678.*

Significance.—West Virginia was one of only two states in the US not having reported this exotic species (the other state is Georgia) (USDA Plants Database).

Secale cereale L.—**Ohio Co.:** Wheeling, Thomson's Hill, 23 Jun 1877, *G. Guttenberg s.n.*

Significance.—West Virginia is one of only two states in the US not having reported this exotic species (other is Oklahoma) (USDA Plants Database).

ROSACEAE

Rubus elegantulus Blanch.—Randolph Co.: W side of river at Old Cheat Bridge, 9 Jul 1972, *E.E. Hutton D-16157.*

Significance.—This is the first report of this species from West Virginia. This record is the southern limit for this native species, which ranges from Maine to Pennsylvania and is disjunct in Wisconsin.

Rubus immanis Ashe—Hampshire Co.: in Gunbarrel Hollow near Capon Bridge, 1 Jul 1948, *H.A. Davis & T. Davis 8575.* Nicholas Co.: Mt. Nebo, on bank between road and run, 26 Aug 1947, *H.A. Davis & T. Davis 8279.*

Significance.—Sheets have *Rubus jugosus* written in H.A. Davis' handwriting. Davis (1990), synonymizes *R. jugosus* with *R. immanis.* This native species also occurs in Pennsylvania, Kentucky, and Virginia (USDA Plants Database).

Rubus meracus Bailey—Nicholas Co.: Strouds Creek, sandy ballast along railroad, 4 Jul 1946, *H.A. Davis & T. Davis 7409.* Webster Co.: near Nicholas Co. line, along road from Camden-on-Gauley, 1 Jun 1949, *H.A. Davis & T. Davis 8765*; Stroud's Creek, near Stemple's garden, across railroad, 2 Jun 1949, *H.A. Davis & T. Davis 8763*; Stroud's Creek at Grassy Run, 25 Jun 1953, *H.A. Davis & T. Davis 10376.*

Significance.—Determined by M.P. Widrlechner 2001. First report for the state. This native species also occurs in Pennsylvania and Kentucky (USDA Plants Database).

Rubus porteri Bailey—Tucker Co.: Roaring Plains, N of Dolly Sods, at picnic grounds, 3 Sep 1960, *W.H. Davis & Mrs. W.H. Davis 12985.*

Significance.—Sheets have written in H.A. Davis handwriting, *R. porteri.* A.M. Fuller in 1970 added "has all the earmarks for *R. porteri.*" Although considered as a synonym of *R. hispidus* by some, we are following the most current classification of Davis et al. (1967). Previously thought to be endemic to Pennsylvania.

VIOLACEAE

Viola _malteana House [V. *conspersa _rostrata*]—Monongalia Co.: White Day Creek, rocky woods, 26 Apr 1942, *H.A. Davis & T. Davis 5308.*

Significance.—Determined by H.A. Ballard, Jr. in 1991. First report for West Virginia. This native hybrid also occurs in Ohio and Pennsylvania (USDA Plants Database).

DISCUSSION

As a result of this study the number of species known from West Virginia has increased. The most notable discovery is a new population of *Corallorhiza maculata.* Specimens were collected by J.S. Shriver, A. Shriver and C. Smith in July 1993 and June 1994 in Pocahontas County. *Corallorhiza maculata* var.

occidentalis was recently rated by West Virginia Natural Heritage Program at a S1 ranking. The state ranking of S1 indicates that the taxon is considered critically imperiled.

ACKNOWLEDGMENTS

We thank the staff of the Western Pennsylvania Conservancy for their assistance. In addition, we would like to acknowledge the many private collectors that have contributed to the CM collections.

REFERENCES

Brummitt, R.K. and C.E. Powell. 1992. Authors of plant names. Royal Botanic Gardens, Kew.

Davis, H.A., A.M. Fuller, and T. Davis. 1967. Contributions toward the revision of the Eubati of Eastern North America. Castanes 32:20–37.

Davis, H.A. 1990. Studies in *Rubus*. Castanea 55:22–30.

Kartesz, J.T. 1999. A synonomized checklist of the vascular flora of the United States, Canada and Greenland. 1st ed. In: Kartesz, J.T. and C.A. Meacham, eds. Synthesis of North American flora, Version 1.0 North Carolina Botanical Garden, Chapel Hill.

Strausbaugh, P.D. and E.L. Core. 1970–1. Flora of West Virginia. Part 1 and 2. Ed. 2. West Virginia University, Morgantown.

USDA, NRCS. 2004. The PLANTS database, Version 3.5 (http://plants.usda.gov) <http://plants.usda.gov/>. National Plant Data Center; <http://npdc.usda.gov/npdc/index.html>,Baton Rouge, LA 70874-4490 USA.

PHALARIS ARUNDINACEA (POACEAE: AVENEAE) A SPECIES NEW TO TEXAS AND A KEY TO *PHALARIS* IN TEXAS

Stephan L. Hatch

S.M. Tracy Herbarium (TAES)
Department of Rangeland Ecology
and Management
Texas A & M University, 2126 TAMU
College Station, Texas 77843-2126, U.S.A.
s-hatch@tamu.edu

Dale A. Kruse

S.M. Tracy Herbarium (TAES)
Department of Rangeland Ecology
and Management
Texas A & M University, 2126 TAMU
College Station, Texas 77843-2126, U.S.A.
dakruse@taexgw.tamu.edu

Jennifer Pluhar

Box 931
Canyon, Texas 79015, U.S.A.
jjpluhar@arn.net

ABSTRACT

The occurrence of *Phalaris arundinacea* L., Reed canarygrass, in Texas is reported and a key to the genus *Phalaris* in Texas is provided.

RESUMEN

Se reporta la presencia de *Phalaris arundinacea* L., en Texas y se provee una clave para el genero *Phalaris* en Texas.

During the week of May 20–23, 2002, while compiling data from specimens at the herbarium of West Texas A & M University (WTS), a misidentified specimen of *Phalaris arundinacea* L. was found in the WTS collection. The sheet, originally identified as *Phalaris caroliniana* Walt., was collected by Larry C. Higgins in Hemphill County, Texas on June 29, 1978. Visits were made by the authors to the original collection site to determine whether the species still occurred in the state. In July 2002, the species could not be found, however on July 23, 2003, the species was located and persisting in the vicinity of Lake Kiowa on the Shannon Ranch in Hemphill County, Texas. At that time collections were made, and later accessioned at the S. M. Tracy Herbarium (TAES) of Texas A & M University in College Station, Texas. All specimens were identified using Chase (1951) and McGregor et al. (1986), and subsequently verified using TAES specimens.

The North American distribution of *P. arundinacea* is documented in numerous sources. Chase (1951) indicated a range from Canada extending south to New Mexico, Oklahoma, Missouri, Kentucky, and North Carolina. Allred (1993) cited occurrences in San Juan, Rio Arriba, Mora and Lincoln counties, New Mexico. McGregor et al. (1986), reported the species as common in the northern Great Plains but rare in Oklahoma. *Phalaris arundinacea, was not* listed in Louisiana by Allen (1992) nor in Texas by Correll and Johnston (1979), Gould (1975) and Hatch et al. (1990). Jones et al. (1997) listed *P. arundinacea* L. var. *picta* L. as being in the state, however this is a cultivated variety. No records for the species, in Texas, were found in collections at the University of Texas (TEX/LL) or at The Botanical Research Institute of Texas (BRIT). Inquiries were sent to curators of herbaria in Oklahoma (OKL, OKLA, WOH) and New Mexico (NMCR, SNM, UNM). None reported having collections of *P. arundinacea* from Texas.

Phalaris arundinacea was collected from the SE end of Lake Kiowa, NE of Lake Marvin in east-central Hemphill County, Texas. Lake Kiowa is a small to moderate size lake, ca. 7 hectares, which is fed by Boggy Creek and the Dry Fork of Boggy Creek, just N of the Canadian River. At the site, *P. arundinacea* is locally abundant as an understory species along the SE margin of the lake in association with *Spartina pectinata* Link, *Juncus*, *Carex*, *Salix*, *Baccharis*, *Cephalanthus occidentalis* L., *Scirpus pallida* (Britt.) Fern., *Typha*, and other vegetation associated with mesic to wetland habitats. Although the water level had dropped by the time of collection, there was evidence to indicate the site was inundated earlier in the season. The typical habitat for this species is meadows, stream banks, ditch banks, lake margins, or floating in water, Correll and Correll (1972), Arnow (1987) and Yatskievych (1999). The Hemphill County material appears to be at the southern limits of its distribution where it grows under the canopy of shrubs and trees. This makes finding the species more difficult compared to the populations in its northern distributions. This species may have been introduced to Hemphill County when the lakes, where it is found, were created. This species is distinguished from the other *Phalaris* species in Texas, by the presence of an obvious rhizome, being perennial, and having two reduced florets that are equal in length. *Phalaris* species in Texas are described in Gould (1975), with the exception of *P. arundinacea.*

Phalaris arundinacea L., Sp. Pl. 55. 1753. (**Fig. 1**).
Strongly rhizomatous perennials. ***Culms*** 50–160 cm tall, erect. ***Leaves*** basal and cauline. ***Sheath margins*** open. ***Ligules*** 5–9 mm long, membranous, obtuse (sometimes lacerate), decurrent. ***Blades*** to 35 cm long, to 16 mm wide, flat. ***Panicles*** 6–16 cm long, contracted, cylindrical (compact and sometimes lobed basally). ***Spikelets*** 4–6.5 mm long. ***Glumes*** 4–6.5 mm long, subequal, laterally compressed (keeled), mid-vein wingless, 3-veined, apiculate. ***Sterile floret lemmas*** 1–2.5 mm long, subulate, appressed pubescence, brownish. ***Fertile floret lemmas*** 3–4 mm long, ovate, glabrous to pubescent. ***Fertile floret paleas*** 2.7–3.6 mm long, appressed pubescence. ***Chromosome numbers*** $2n = 14, 28, 42, 56$, and aneuploid counts. ***Flowering period*** May–June.

Fig. 1. *Phalaris arundinacea*: *a*. floret, showing fertile and sterile lemmas; *b*, spikelet showing the strongly keeled glumes, fertile lemma, palea, and anthers; *c*, panicle, interrupted below; *d*, leaf sheath, ligule, blade, and node; *e*, habit, showing creeping rhizome; *f*, upper part of culm, showing panicle. (Used with permission: *A Flora of the Marshes of California*. Herbert L. Mason. University of California Press. 1957)

Specimens examined. **TEXAS**. Hemphill Co.: the old Boy Scout Camp 12 mi E of Canadian, 29 Jun 1978, *Higgins 12099* (WTU); Lake Kiowa, 12 mi E of Canadian, 23 Jul 2003, *Hatch* and *Hatch 8390* (TAES).

A KEY TO THE SPECIES OF *PHALARIS* IN TEXAS

1. Plants perennial; rhizomes present.
    2. Lower florets 2, about equal in length, 1–2.5 mm long ______ **P. arundinacea**
    2. Lower florets 1 or 2, unequal in length, one 0.5 mm long, longer one 1–2 mm long ______ **P. aquatica**
1. Plants annual; rhizomes absent.
    3. Reduced florets 1, scale-like ______ **P. minor**
    3. Reduced florets 2, scale-like.
        4. Reduced florets broad, more than one-half the length of the perfect floret ______ **P. canariensis**
        4. Reduced florets subulate, less than one-half the length of the perfect floret.
            5. Reduced florets 0.4–0.8 mm long ______ **P. brachystachya**
            5. Reduced florets 1–5 mm long.
                6. Panicles 2–7 cm long; culms to 70 cm tall ______ **P. caroliniana**
                6. Panicles 6–15 cm long; culms 60–150 cm tall ______ **P angusta**

ACKNOWLEDGMENTS

The authors thank the following: Angela Huff, Texas Agricultural Extension Service, Hemphill County, for establishing contact with the owner of the Shannon Ranch. Lonnie and Sue Cox, managers of the Shannon Ranch, for providing access to the property and transportation while on-site. David Sissom and Richard Kazmaier, the former and current curators of WTS for providing access to the collection, and the loan of specimens to TAES. The curators of BRIT and TEX/LL for access to their collections. Curators of the following herbaria for their assistance in searching their collections for species records in the region; NMCR, OKL, OKLA, SNM, UNM, and WOH.

REFERENCES

Allen, C.M. 1975. Grasses of Louisiana. University of Southwestern Louisiana. Lafayette.

Allred, K.W. 1993. A field guide to the grasses of New Mexico. Agric. Exp. Sta. Las Cruces.

Arnow, L.A. 1987. Gramineae. In: S.L. Welsh, N.D. Atwood, L.C. Higgins, and S. Goodrich. A Utah flora. Great Basin Naturalist Mem. Brigham Young University, Provo, UT. Pp. 684–788.

Chase, A. 1951. Hitchcock's manual of the grasses of the United States, 2nd ed. USDA. Misc. Publ. No. 200. U. S. Government Printing Office, Washington, D.C.

Correll, D.S. and H.B. Correll. 1975. Aquatic and wetland plants of southwestern United States. Environmental Protection Agency, U. S. Government Printing Office, Washington, D.C.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Gould, F.W. 1975. The grasses of Texas. Texas A & M University Press, College Station.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Bull. MP-1655, College Station.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas. University of Texas Press, Austin.

McGregor, R.L. and T.M. Barkley (eds.). 1986. Flora of the Great Plains. University of Kansas Press, Lawrence.

Yatskievych, G. 1999. Steyermark's flora of Missouri, Volume I. The Missouri Department of Conservation, Jefferson City.

SILENE CONOIDEA (CARYOPHYLLACEAE) NEW TO TEXAS

Monique Dubrule Reed

Biology Department Herbarium
TAMU 3258
Texas A&M University
College Station, Texas 77845-3258, U.S.A.

Silene conoidea L., Conoid Catchfly or Cone Catchfly, is an annual or biennial native to Europe. It can be weedy in temperate regions and has been recorded in the U.S. from California, Colorado, Delaware, Idaho, Maryland, Missouri, Montana, Nevada, Oregon, and Washington (USDA, NRCS 2004). The species was not listed for Texas by Correll and Johnston (1970) or by Jones et al. (1997).This is the first report of its occurrence in the state.

In March of 2003, two plants were found growing in a vegetable garden at Peaceable Kingdom Farm near Washington, in Washington County. *Vaccaria hispanica* (P. Mill.) Rauschert, uncommon in the area, was collected nearby. The garden owners suspect the seeds of both may have been introduced in a load of turkey manure.

Voucher specimen: U.S.A. **TEXAS. Washington Co.:** Peaceable Kingdom Farm, Washington, Mt. Falls School Road, vegetable garden, 27 Mar 2003, *Loring, Winston-Mize, and Mize 03-62* (TAMU). Images of the Washington County plants may be seen at http://www.csdl.tamu.edu/FLORA/cgi/gallery_query?q=silene+conoidea.

Silene conoidea somewhat resembles *S. antirrhina* L. (native to North America) and *S. gallica* L. (introduced), but it is larger in all respects. The leaves are lanceolate to oblanceolate, to 1 cm or more wide. The flowers are pink to purplish or white, with the petal blades 8–12 mm long and entire to toothed or notched. The most distinctive feature is the synsepalous calyx, which is 18–30 mm long and strongly inflated-conic at maturity, with about 20—30 strong ribs (Gleason & Cronquist 1991; Hickman 1993).

Silene conica L., another European species, is very similar but has petal blades only 3–6 mm long and a mature calyx only 12–17 mm long (Gleason & Cronquist 1991). It has been collected in the U.S. from Delaware, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Oregon, and Washington (USDA, NRCS 2004). It may eventually be found in Texas.

Though the owners of Peaceable Kingdom do not plan to let *S. conoidea* recur on their property, this is a species known to be weedy and it should be watched for.

SIDA 21(1): 493 – 494. 2004

ACKNOWLEDGMENTS

Thanks go to J.K. Morton (WAT) for his confirmation of the identification and to Amanda Neill (BRIT) for reviewing the text.

REFERENCES

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Gleason, H.A. and A. Cronquist. 1991. Manual of the vascular plants of northeastern United States and adjacent Canada, 2nd ed. New York Bot. Garden, Bronx.

Hickman, J.C. (ed.) 1993. The Jepson manual: higher plants of California. University of California Press, Berkeley.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas: a comprehensive checklist including synonymy, bibliography, and index. University of Texas Press, Austin.

USDA, NRCS. 2004. The PLANTS database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA.

NOTEWORTHY COLLECTIONS OF *CYPERUS DRUMMONDII* (CYPERACEAE) FROM TEXAS

David J. Rosen

S.M. Tracy Herbarium
Department of Rangeland Ecology and Management
Texas A&M University
College Station, Texas 77843-2126, U.S.A.

ABSTRACT

Recent collections of *Cyperus drummondii* Torr. & Hook. from Texas coastal prairies known as "Nash Prairie" and "Bailey's Prairie" are reported along with ecological notes and a synopsis of its Texas distribution.

RESUMEN

Se citan colectas recientes de *Cyperus drummondii* Torr. & Hook. de las praderas costeras de Texas conocidas como "Nash Prairie" y "Bailey's Prairie". Se añaden notas ecológicas notes y una sinopsis de su distribución en Texas.

Carter et al. (1999) recognized *Cyperus drummondii* Torr. & Hook. as distinct from *C. virens* Michx. and provided maps of the distribution of both taxa in the southeastern United States. *Cyperus drummondii* has been scarcely collected in Texas. Beside the type collection by Thomas Drummond, Denton (1978) reported only two other collections from Texas, *Cory 50890* (US) and *Hall s.n.* (F). In addition to these, Carter et al. (1999) reported *Jones 719* (US). In Texas, this taxon appears to be rare and restricted to the upper portion of the Gulf Prairies and Marshes as defined by Gould (1975). Recently, while conducting surveys of botanical resources on private property in Brazoria County, collections of *Cyperus drummondii* were made from populations encountered on large tracts of moderately disturbed to relatively undisturbed coastal prairie. These collections fill gaps in the distribution of this poorly understood taxon. Since pertinent works (Torrey 1836; Kükenthal 1935–1936; Denton 1978; Carter et al. 1999; Tucker et al. 2003) include scant information on the distribution and ecology of *C. drummondii* in Texas, the following notes and synopsis of its distribution are provided.

Distinguishing Characteristics

Specimens were easily distinguished from *C. virens* by key characters and diagrams provided by Carter et al. (1999). Upon critical examination, the ratio of achene length to scale length is sufficient to separate the taxa. *Cyperus drummondii* is also taller, has fewer and shorter primary inflorescence bracts, and

SIDA 21(1): 495 – 497. 2004

fewer sessile to sub-sessile primary peduncles. As Carter et al. (1999) suggested these characters are best observed in the field.

Habitat

Cyperus drummondii was rare to locally common in poorly drained, fine sandy loam and clayey soils of prairie depressions mapped as Edna fine sandy loam (Crenwelge et al. 1981). These large tracts were topographically intact as was evident by numerous pimple mounds. A composite list of closely associated species for all sites includes: *Axonopus fissifolius* (Raddi) Kuhlmann, *Boltonia diffusa* Ell., *Croton capitatus* Michx. var. *lindheimeri* (Engelm. & Gray) Müll., *Cyperus entrerianus* Boeck., *C. haspan* L., *Diodia virginiana* L., *Eryngium yuccifolium* Michx., *Helianthus angustifolius* L., *Hydrolea ovata* Nutt. ex Choisy, *Juncus brachycarpus* Engelm., *Leersia hexandra* Sw., *Ludwigia linearis* Walt., *Panicum hemitomon* Schult., *P. hians* Ell., *P. virgatum* L., *Paspalum floridanum* Michx. var. *floridanum*, *P. plicatulum* Michx., *Polygonum hydropiperoides* Michx., *Rhynchospora caduca* Ell., *R. corniculata* (Lam.) Gray, *R. indianolensis* Small, *Rudbeckia nitida* Nutt. var. *texana* Perdue, *Sesbania drummondii* (Rydb.) Cory, *Solidago tortifolia* Ell., *Tridens strictus* (Nutt.) Nash, *Tripsacum dactyloides* (L.) L., and *Vernonia missurica* Raf.

Specimens examined. **TEXAS. Brazoria Co.:** Nash Ranch; hay meadow W of CR 25, about 8.7 mi N of its intersection with Hwy. 35 in West Columbia, 25 Aug 2003, *Rosen & Carr 2590* (SBSC, TAES), and 19 Sep 2003, *Rosen 2631* (TEX, VSC); Nash Ranch, Head of the Creek Pasture W of Hwy. 35, about 2.7 mi S of its intersection with FM 1462 in Damon, 25 Aug 2003, *Rosen & Carr 2605*, (BRIT, VSC); Bailey's Prairie; W of FM 521, approximately .4 mi SW of its intersection with Hwy. 35, W of Angleton, 17 Dec 2003, *Rosen & Lange 2684* (MICH, VSC). **Goliad Co.:** 8 mi S of Coleto Creek, S of Victoria on Hwy. 77, hydric roadside ditch, frequent, 06 Jan 1988 *Jones 719* (TAES). **Harris Co.:** Houston, 1872, *Hall s.n.* (F, mixed with *Cyperus virens*). **Orange Co.:** Growing in shallow water, 6.5 mi W of Orange, 16 Nov 1945 *Cory 50890* (LL).

ACKNOWLEDGMENTS

Fieldwork was facilitated by the Nature Conservancy of Texas. Thanks to Diane Schenke and Bill Carr for offering the opportunity for access to the Nash Ranch, and to the curatorial staff at BRIT, F, TAES, and TEX/LL for their assistance. Thanks to Richard Carter, Steve Hatch and an anonymous reviewer for their helpful comments.

REFERENCES

Carter, R., D.K. Alexander, C.T. Bryson, and A. Lazari. 1999. The taxonomy of *Cyperus virens* and *Cyperus drummondii* in the Southeastern United States. Sida 18:1049–1063.

Crenwelge, G.W., J.D. Crout, E.L. Griffin, M.L. Golden, and J.K. Baker. 1981. Soil Survey of Brazoria County, Texas. United States Dept. of Agriculture, Soil Conservation Service.

Denton, M.F. 1978. A taxonomic treatment of the Luzulae group of *Cyperus* . Contr. Univ. Michigan Herb. 11:197–271.

GOULD, F.W. 1975. Texas plants–A checklist and ecological Summary. MP-585 Revised, Texas Agricultural Experiment Station, College Station.

KUKENTHAL, G. 1935–1936. *Cyperus*. In: A. Engler and L. Diels, eds. Das Pflanzenreich IV. 20 (Heft 101):1–671.

TORREY, G.C. 1836. Monograph of North American Cyperaceae. Ann. Lyceum Nat. Hist. New York 3:1–448.

TUCKER, G.C., B.G. MARCKS, and J.R. CARTER. 2003. *Cyperus*. In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico, Vol. 23. Oxford Univ. Press, New York. Pp. 141–191.

RUPPIA CIRRHOSA (RUPPIACEAE) IN NORTH CENTRAL TEXAS

Tiffany L. Morgan
Brazos River Authority
Waco, Texas 76714-7555, U.S.A
tiffanym@brazos.org

Walter C. Holmes
Baylor University
Waco, Texas 76798-7388, U.S.A.
walter_holmes@baylor.edu

Ruppia cirrhosa (Pentagna) Grande has been recently collected from Lake Granbury in Hood County and Possum Kingdom Lake in Palo Pinto County, both in North Central Texas. The species was found at multiple locations in Lake Granbury in association with *Stuckenia pectinata* (L.) Boerner. In Possum Kingdom Lake the plant was collected in only one location, a shallow area called the Peanut Patch. In both reservoirs, the species was submersed, had long stems rooted in the sediment in water less than two meters deep, and was abundant in the locations where it was found.

Voucher specimens: TEXAS. **Hood Co.:** Lake Granbury, approximately 0.3 mi ENE of Mallard Pointe, 6 Aug 2003, *Morgan 599* (BAYLU); Lake Granbury, approximately 0.05 mi SW of intersection of Port Ridglea Drive and East Port Ridglea Court, 6 Aug 2003, *Morgan 562* (BAYLU); Lake Granbury, approximately 0.09 mi SW of terminus of East Port Ridglea Court, *Morgan 564* (BAYLU); **Palo Pinto Co.:** Possum Kingdom Lake at the Peanut Patch S of Caudill Mountain, N 32.89253, W 98.50671, 27 Aug 2003, *Morgan 601* (BAYLU).

Lake Granbury has a normal water surface elevation of 693 feet above mean sea level. At normal water surface elevation, Possum Kingdom Lake is 1,000 feet above mean sea level. Lake Granbury lies on the dividing line of the Blackland Prairie Ecoregion and the Oak Woods and Prairie Ecoregion, while Possum Kingdom Lake lies in the Rolling Plains Ecoregion. The terrain around both reservoirs is varied, with rolling topography near the headwaters, and becomes increasingly rugged towards the dam. Lake Granbury is slightly saline with an annual average chloride concentration of 642 mg/L, an annual average sulfate concentration of 228 mg/L, and an annual average total dissolved solids concentration of 1269 mg/L. Possum Kingdom Lake is also saline with an annual average chloride concentration of 995 mg/L, an annual average sulfate concentration of 364 mg/L, and an annual average total dissolved solids concentration of 1,801 mg/L. *Ruppia* is known to frequent water with high calcium and sulfur concentrations (Haynes 2000).

In North America, *Ruppia* has been treated as part of the Najadaceae (Steyermark 1963), the Potamogetonaceae (Thorne 1992), the Ruppiaceae (Correll and Johnston 1970, Haynes 2000), the Zannichelliaceae (Small 1933), and the Zosteraceae (Fernald 1950). We are following Haynes (2000), the most recent account of the North American species available.

SIDA 21(1): 499 – 500. 2004

The genus consists of about ten species of nearly worldwide distribution, with two species, *Ruppia cirrhosa* and *R. maritima* L., recognized in North America (Haynes 2000). Both are known to occur in Texas (Turner et al. 2003). *Ruppia maritima* is limited to the Gulf Coast region of the state with almost all records being from coastal counties, while *R. cirrhosa* is known from nine counties that are widely scattered in the Panhandle, South Texas Plains, along the Pecos River, and the northeast (Van Zandt Co.). The two species may be distinguished by peduncle characteristics (Haynes 2000). The peduncle length in *R. cirrhosa* is greater than 30 mm and the peduncle has five or more coils, while in *R. maritima* the peduncle is 2–25 mm long and has less than five coils. Haynes (2000) also mentions that *R. maritima* is primarily of coastal occurrence and *R. cirrhosa* is mostly of inland occurrence. This is the first report of the genus and species for the area treated in Diggs et al. (1999).

ACKNOWLEDGMENTS

We thank Doug Amburn, Randy Johnston, Kyle Lewis, Craig Goen, and Mike Cox for their assistance in searching for the specimens on Lake Granbury and Kay Barnes for her helpful reviews.

REFERENCES

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Diggs, G.M., Jr., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners and Mahler's illustrated flora of north central Texas. Sida, Bot. Misc. 16. Botanical Research Institute of Texas, Fort Worth.

Fernald, M.L. 1950. Gray's manual of botany 8th ed. American Book Co., New York

Haynes, R.R. 2000. Ruppiaceae. In: Flora of North America editorial committee, Flora of North America. vol. 22. Oxford University Press, New York.

Small, J.K. 1933. Manual of the southeastern flora. University of North Carolina Press, Chapel Hill.

Steyermark, J.A. 1963. Flora of Missouri. Iowa State University Press, Ames.

Thorne, R.F. 1992. Classification and geography of the flowering plants. Bot. Rev. (Lancaster) 58:225–348.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. vol. 2. Sida, Bot. Misc. 24. Botanical Research Institute of Texas, Fort Worth.

OSMORHIZA BIPATRIATA (APIACEAE) IN TEXAS: TAXONOMIC STATUS AND CONSERVATION CONSIDERATIONS

Jun Wen

Department of Botany
The Field Museum of Natural History
1400 S. Lake Shore Dr.
Chicago, Illinois 60605-2496, U.S.A
and
Laboratory of Systematic & Evolutionary
Botany & Herbarium, Institute of Botany
Chinese Academy of Sciences
Beijing 100093, CHINA; wen@fieldmuseum.org

Porter P. Lowry II

Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166-0299, U.S.A.
and
Département de Systématique et Evolution
Muséum National d'Histoire Naturelle
Case Postale 39, 57 rue Cuvier
16 rue Buffon
75231 Paris, FRANCE; pete.lowry@mobot.org

James C. Zech

Department of Biology C-57
Sul Ross State University
Alpine, Texas 79832, U.S.A.; jzech@sulross.edu

ABSTRACT

The paper evaluates the taxonomic and conservation status of *Osmorhiza bipatriata* Constance & R.H. Shan. The available phylogenetic data support its recognition as a distinct species. It has a highly restricted distribution on Mt. Livermore of the Trans-Pecos region in Texas, as well as in Coahuila and Nuevo León, Mexico. Its habitat on Mt. Livermore is highly restricted within the mesic *Pinus strobiformis* community, where it is associated with several other taxa that are also rare in Texas, such as *Polemonium pauciflorum* S. Watson subsp. *hinckleyi* (Standl.) Wherry and *Aquilegia longissima* A. Gray. The population of *O. bipatriata* on Mt. Livermore is small (< 20 individuals), although apparently healthy, with a full range of age structure. Application of the IUCN Red List criteria shows that *O. bipatriata* is an endangered species [B2ab(iv)]. We recommend careful monitoring of *O. bipatriata* and its associated habitat, and restricted access to its only known locality within the United States.

RESUMEN

En este artículo se evalúa el estatus taxonómico y de conservación de *Osmorhiza bipatriata* Constance & R.H. Shan. Los datos filogenéticos disponibles apoyan su reconocimiento como una especie independiente. Tiene una distribución muy restringida en el Mt. Livermore de la región Trans-Pecos en Texas, así como en Coahuila y Nuevo León, México. Su hábitat en el Mt. Livermore está muy restringido dentro de la comunidad mésica de *Pinus strobiformis*, donde está asociado con otros varios taxa que también son raros en Texas, tales como *Polemonium pauciflorum* S. Watson subsp. *hinckleyi* (Standl.) Wherry y *Aquilegia longissima* A. Gray. La población de *O. bipatriata* en el Mt. Livermore es pequeña (< 20 individuos), aunque aparentemente saludable, con una estructura de edad con el rango completo. La aplicación de los criterios IUCN para la Lista Roja muestran que *O. bipatriata* es una especie amenazada [B2ab(iv)]. Recomendamos un control cuidadoso de *O. bipatriata* y su hábitat asociado, y acceso restringido a su única localidad conocida en los Estados Unidos.

SIDA 21(1): 501 – 506. 2004

INTRODUCTION

Osmorhiza Raf. (Apiaceae subfam. Apioideae) is a small genus of approximately 11 species, including nine that occur in North America (two of which are also disjunct in South America) and one each in Asia and the central Andes. Members of the genus are characterized by their deep brown to black, linear to oblong, fusiform to clavate fruits that are slightly compressed laterally and have a caudate basal appendage and filiform ribs, which in most species bear numerous retrorse bristles (Lowry & Jones 1984). Several recent molecular phylogenetic analyses have shown that *Osmorhiza* is monophyletic and that it is most closely related to the Old World genera *Myrrhis* Mill. and *Geocaryum* Coss. (Downie et al. 2000; Wen et al. 2002; Yoo et al. 2002). These studies have also indicated that all the New World members of *Osmorhiza* evolved from a common ancestor that arrived from Asia, where the genus appears to have originated (Wen et al. 2002). Within the New World clade, a group of largely western North American species forms a well supported subclade that probably diversified relatively rapidly. Two of these species, *O. berteroi* DC. and *O. depauperata* Phil., have subsequently dispersed into the Great Lakes area, eastern North America, and southern South America, and another, *O. mexicana* Griseb., has an interrupted range from northern Mexico to northern Argentina, while the remaining species occupy relatively narrow geographic ranges in the western United States (Lowry & Jones 1984; Wen et al. 2002).

Specimens attributed to one of these species, *Osmorhiza bipatriata* Constance & R.H. Shan, were first collected on September 28, 1935, by L.C. Hinckley on Mt. Livermore in the Davis Mountains of the Trans-Pecos region in Texas (*Hinckley 408*, SRSC). Constance & Shan (1948) described this sweet cicely (herein referred to as the bipatriate sweet cicely) from the Davis Mountains and northern Mexico as a species new to science based on a later collection by Hinckley (26 Jul 1937, *L.C. Hinckley s.n.*; holotype at NY and isotypes at ARIZ and GH). Constance & Shan chose the epithet to reflect the presence of *O. bipatriata* in two countries as well as the two nationalities of its authors. Lowry & Jones (1984) reported several morphological intermediates between *O. bipatriata* and *O. mexicana* collected from sites in northern Mexico, including on Cerro Potosí in Nuevo León, where the two taxa occur sympatrically. These intermediates prompted them to reduce *O. bipatriata* to a subspecies of *O. mexicana*. Recently, Turner et al. (2003) recognized the taxon as a variety of *O. mexicana* because he chose, somewhat arbitrarily, not to use the rank of subspecies in his work (B.L. Turner, pers. comm.).

TAXONOMIC STATUS

Phylogenetic analyses conducted in the last several years using sequence data from the nuclear ribosomal ITS regions and the chloroplast *ndh*F gene and *trn*L-

F regions (Downie et al. 2000; Wen et al. 2002; Yoo et al. 2002) suggest that *Osmorhiza mexicana* and *O. bipatriata* do not form a monophyletic group and indicate that they show considerable divergence in their sequence profiles of these markers (e.g., 1.415% divergence between the ITS sequences). In the ITS phylogeny, the positions of the two taxa are unresolved, although both are closely related to other western North American members of *Osmorhiza* (Downie et al. 2000; Wen et al. 2002). The chloroplast data set suggests that *O. bipatriata* is most closely allied to *O. depauperata* (Yoo et al. 2002). The available data thus do not support the inclusion of *O. bipatriata* within *O. mexicana* at an infraspecific level. The phylogenetic data suggest instead that it should be treated as a distinct species, as initially proposed by Constance & Shan (1948), using either the phylogenetic (Nixon & Wheeler 1990) or the lineage (de Queiroz 2000) species concept. While the presence of morphological intermediates in northern Mexico would appear to be incompatible with the recognition of *O. bipatriata* using the classical morphological species concept, as supported by Cronquist (1978), the phylogenetic data suggest that these intermediates may represent interspecific hybrids or perhaps may have resulted form introgression between *O. bipatriata* and *O. mexicana*. Detailed analyses, however, will be required to assess the origin of these intermediates.

Osmorhiza bipatriata differs from its congeners by its small (9–11 mm long) and glabrous fruits, which are linear-fusiform and taper into a short beak at the apex, and by its very short styles [0.5–0.75 mm long (Lowry & Jones 1984)]. Based primarily on fruit morphology, Constance & Shan (1948) placed *O. bipatriata* in subgen. *Glycosma*, but commented that it possessed characters intermediate with members of the typical subgenus, in particular with regard to its involucel, styles and stylopodium, which are similar to those of *O. mexicana*, which belongs to sect. *Mexicanae* of subgen. *Osmorhiza* (see Constance & Shan 1948; Lowry & Jones 1984). Our molecular phylogenetic studies (Wen et al. 2002; Yoo et al. 2002) show that *O. bipatriata* possesses a large number of unique molecular nucleotide substitutions, suggesting its antiquity. *Osmorhiza bipatriata* is thus perhaps best described as a relict species, which has survived in mesic habitats in the northeastern Chihuahuan Desert, which have undergone a gradual drying since the late Tertiary (Graham 1993).

An illustration of *Osmorhiza bipatriata* is found in Lundell & collaborators (1961: plate 42). Lowry & Jones (1984) provided comprehensive information on its morphology and distribution and cited specimens from both Texas and Mexico deposited in various herbaria. Below are some additional specimens from Texas that we have examined, but which were not seen by Lowry & Jones (1984).

U.S.A. Texas. Jeff Davis Co.: Madera Canyon, Mt. Livermore, 28 Sep 1935, in fr., *Hinckley 408* (SRSC); in wet soil of spring in Madera Canyon, Mt. Livermore, 23 Jul 1945, in young fr., *Hinckley 3489* (SRSC); at the upper spring of Madera Canyon, NW slope of Mt. Livermore, 7300 ft, 12 Sep 1947, in fr., *Warnock & Hinckley 4147* (SRSC); rare at upper spring in Madera Canyon on Mt. Livermore, Davis Mountains, igneous soil, 7500 ft, 11 Sep 1947, in fr., *Warnock & Hinckley 7479* (SRSC); infrequent in igneous soil on upper Madera Canyon of Mt. Livermore, 7500 ft, 23 Aug 1968, *Warnock 23015* (SRSC); upper Madera Canyon, Tobe Spring, NW of Mt. Livermore, just above a large horseshoe wall, in deep mesic canyon under *Pinus strobiformis – Quercus gambelii – Juniperus deppeana* forest, associated with *Rhamnus betulifolia, Symphoricarpos oreophilus, Aquilegia longissima, Polemonium pauciflorum* subsp. *hinckleyi, Salvia arizonica, Geranium caespitosa, Vitis arizonica, Ptelea trifoliata, Galium* sp., and *Thalictrum* sp., N30°38.364', W104°10.746', 7242 ft., 23 Aug 2003, in fl & fr, *Wen et al. 7265* (F).

CONSERVATION CONSIDERATIONS

Osmorhiza bipatriata has a highly restricted distribution, with only a few localities recorded on Mt. Livermore, Texas, and in Coahuila and Nuevo León, Mexico. Until recently, all of the collections from Texas were made by L.C. Hinckley and Barton Warnock (perhaps from the same locality), the most recent of which dates from 1968 (*Warnock 23015*, SRSC). During a recent study trip, we were able to relocate *O. bipatriata* on the northwestern slope of Mt. Livermore. A single, small population was found on 23 August 2003, comprising about 15 individuals, including 5–6 young seedlings. It occupied a small microhabitat with moist, rich soil in a deep mesic canyon under *Pinus strobiformis–Quercus gambelii–Juniperus deppeana* forest that differs considerably from most of the surrounding vegetation, which is primarily dominated by ponderosa pines and various oak species. The plants of *O. bipatriata* on Mt. Livermore were highly heterogeneous phenologically, with some individuals observed in flower, some in young fruit, and others in mature fruit, in addition to a few that were just emerging from the ground after a recent rain shower, which suggests that *O. bipatriata* is particularly sensitive to water availability.

Suitable habitat for *Osmorhiza bipatriata* is apparently rare in the Davis Mountains. Although the population we studied appears to be healthy, as indicated by the presence of a full age structure, from young seedlings to mature adult plants, it is small (less than 20 individuals) and only persists in a restricted microhabitat. Despite three days searching the mountain for comparable habitat, we were unable to locate any other populations. We thus recommend careful monitoring of the only known population in the United States, which may require controlled access to ensure its continued survival. *Osmorhiza bipatriata* also occurs sympatrically with two other rare taxa in the Davis Mountains: *Polemonium pauciflorum* S. Watson subsp. *hinckleyi* (Standl.) Wherry; and *Aquilegia longissima* A. Gray. We also observed two additional rare species (*Quercus depressipes* Trel. and *Aralia bicrenata* Wooton & Standl.) at a higher elevation on the same slope of Mt. Livermore, the summit of the Davis Mountains.

Osmorhiza bipatriata is not currently listed in the Texas Threatened and Endangered Species list (Texas Parks & Wildlife Department 2003) nor in the Threatened and Endangered Species System [TESS (U.S. Fish and Wildlife Service, 2003, *http://endangered.fws.gov*)]. Application of the IUCN Red List criteria (IUCN, 2001; see also *http://www.iucn.org/themes/ssc/redlists/*

RLcats 2001booklet.html) shows, however, that *O. bipatriata* is an endangered species [B2ab(iv)] because it has an area of occupancy estimated to be less than 500 km^2 and because it is both known from fewer than five localities (cf. Lowry & Jones 1984: fig. 17) and appears to have a declining number of subpopulations, as indicated by our observations on Mt. Livermore.

Most species of *Osmorhiza* have a relatively wide distribution (cf. Lowry & Jones 1984). Along with *O. glabrata* Phil., a central Andean endemic, and *O. brachypoda* Torr., found only in California and Arizona, *O. bipatriata* has one of the most restricted ranges in the genus. In the case of *O. bipatriata*, this may at least in part reflect the fact that its fruits lack the caudate appendages and retrorse bristles characteristic of most members of the genus, which are presumed to play a role in dispersal (Constance & Shan 1948; Lowry & Jones 1984), as suggested for the widespread *O. berteroi*, which Cruden (1966) concluded was bird dispersed.

In conclusion, *Osmorhiza bipatriata* is a distinct species with a long evolutionary history. It appears to be among the rarest plant species in the United States, with a single known population of less than 20 individuals occurring in a rare habitat in the Davis Mountains of west Texas. Careful studies need to be conducted to investigate its reproductive biology, seed germination and dispersal biology, ecological preferences, and conservation genetics to develop a suitable management plan for this relict species. Comparative analyses of its congeners with both widespread and restricted distributions should also provide insights into the biology of *O. bipatriata* that may be useful for its conservation. Furthermore, it is necessary to compare the Texas population with those in Coahuila and Nuevo León, Mexico in order to verify that they are indeed conspecific, as suggested by their morphology. The evolutionary consequence or impact of the possible hybridization and introgression between *Osmorhiza bipatriata* and *O. mexicana* also needs to be assessed.

ACKNOWLEDGMENTS

We thank the Nature Conservancy of West Texas for granting access to the Davis Mountains Preserve, authorizing our field study on Mt. Livermore in August, 2003, and providing lodging during the field work; we are grateful to John Karges for helpful advice, Patricia Manning for field assistance, Mike Powell for herbarium assistance, permission to examine the specimens at SRSC, and valuable comments on the manuscript, B.L. Turner for discussion and his open-mindedness of accepting the species status of *Osmorhiza bipatriata*, and George Schatz for assistance with the IUCN Red List analysis. Support for the study was provided by the Field Museum of Natural History, the Chinese Academy of Science (a grant of Excellent Overseas Chinese), and the National Science Foundation (DEB 0108536 to JW).

REFERENCES

Constance, L. and R.H. Shan. 1948. The genus *Osmorhiza* (Umbelliferae), a study in geographic affinities. Univ. Calif. Publ. Bot. 23:111–156.

Cronquist, A. 1978. Once again, what is a species? In: L.V.Knutson, ed. Biosystematics in agriculture. Allenheld Osmun, Montclair. Pp. 3–20.

Cruden, R.W. 1966. Birds as agents of long-distance dispersal for disjunct plant groups of the temperate western Hemisphere. Evolution 20:517–532.

De Queiroz, K. 2000. The general lineage concept of species and the defining properties of the species categories. In: R.A. Wilson, ed. Species: New interdisciplinary essays. MIT Press, Cambridge, Massachusetts. Pp. 49–89.

Downie, S.R., D.S. Katz-Downie, and K. Spalik. 2000. A phylogeny of Apiaceae tribe Scandiceae: evidence from nuclear ribosomal DNA internal transcribed spacer sequences. Amer. J. Bot. 87:76–95.

Graham, A. 1993. History of the vegetation: Cretaceous (Maastrichtian)-Tertiary. In: Flora of North America Editorial Committee, ed. Flora of North America north of Mexico. Oxford Univ. Press, New York. 1:57–70.

IUCN. 2001. IUCN Red list categories and criteria: Version 3.1. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.

Lowry II, P.P. and A.G. Jones. 1984. Systematics of *Osmorhiza* Raf. (Apiaceae: Apioideae). Ann. Missouri Bot. Gard. 71:1128–1171.

Lundell, C.L. and Collaborators. 1961. Flora of Texas, vol. 3. Texas Research Foundation, Renner.

Nixon, K. C. and Q. D. Wheeler. 1990. An amplification of the phylogenetic species concept. Cladistics 6:211–223.

Texas Parks and Wildlife Department. 2003. Texas threatened and endangered species. Distributed by Texas Parks and Wildlife Department, Austin.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Vol. 1. Sida, Bot. Misc. 24. Botanical Research Institute of Texas, Fort Worth.

U.S. Fish and Wildlife Service. 2003. Endangered and threatened plants. http://endangered.fws.gov.

Wen, J., P.P. Lowry II., J. Walck, and K.-O. Yoo. 2002. Phylogenetic and biogeographic diversifications of *Osmorhiza* (Apiaceae). Ann. Missouri Bot. Gard. 89:414–428.

Yoo, K.-O., P.P. Lowry II, and J. Wen. 2002. Discordance of chloroplast and nuclear ribosomal DNA data in *Osmorhiza* (Apiaceae). Amer. J. Bot. 89:966–971.

FIRST RECORD OF *CLITORIA MARIANA* (LEGUMINOSAE) IN WESTERN TEXAS

Brian P. Oswald[1]
Arthur Temple College of Forestry
Stephen F. Austin State University
Nacogdoches, TX 75965 U.S.A.
boswald@sfasu.edu

Mohammad Bataineh
Arthur Temple College of Forestry
Stephen F. Austin State University
Nacogdoches, TX 75965 U.S.A.
mb_96064001@yahoo.com

Amanda Rountree
Arthur Temple College of Forestry
Stephen F. Austin State University
Nacogdoches, TX 75965 U.S.A.
rountree_amanda@hotmail.com

The genus *Clitoria* includes 35 species that are mostly common in warmer parts of the world. Common names of pigeon-wings or butterfly pea are used for the entire genus (Correll & Johnston 1996). *Clitoria mariana* L. is a perennial herb found throughout the United States, including eastern Texas. This specific species is reported as frequent in eastern and central Texas and infrequent in southern Arizona from the Chiricahua to the Baboquivari Mountains, thus creating a wide gap in the distributional range of the species (Correll & Johnston 1996; Turner et al. 2003). In Arizona it is found under junipers and live-oaks in rich soils (Kearney & Peebles 1964). Confirmed identification of this species was made during a recent study of *Pinus ponderosa* L. and adjacent communities within the Davis Mountains of west Texas. The species was found at the bottom of a slope at approximately 1900 m elevation where the soils were the richest in the general area under ponderosa pine, with associated species including Mexican Pinyon (*P. cembroides* Zucc.), Alligator juniper (*Juniperus deppeana* Steud.), and Texas Madrone (*Arbutus xalapensis* Buckl.). This is the westernmost finding of *Clitoria mariana* in Texas. The isolated finding reported here supports similar conditions described for southern Arizona. *Clitoria mariana* may be found in other scattered locations across the Madrean Province.

Voucher Specimen: **U.S.A. TEXAS. Jeff Davis Co.:** TNC Davis Mountains Preserve, Madera Canyon, W 104° 7' 30" N 30° 39' 30", elevation 1900 m, ponderosa pine community, growing in sandy loam soil, 14 Aug 2003, *Mohammad Bataineh and Amanda Rountree 1* (SRSC).

ACKNOWLEDGMENTS

We gratefully thank Billie L. Turner and A. Michael Powell for their identification of the specimen and for their extensive assistance in plant identification in

---

[1] Corresponding Author

the field. Our special thanks are extended to the Sul Ross State University herbarium (SRSC) for specimen storage and we also thank Chris Davis and Allan Pringle for their fieldwork.

REFERENCES

Correll, D.S. and M.C. Johnston. 1996. Manual of the vascular plants of Texas. The University of Texas at Dallas.

Kearney, T.H. and R.H. Peebles. 1964. Arizona flora. University of California Press, Berkeley.

Turner, B.L., H. Nichols, G.C. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Volume 1, Dicots. Sida, Bot. Misc. 24. Botanical Research Institute of Texas, Fort Worth.

BOOK REVIEW

JOHN BOIK. 2001. **Natural compounds in cancer therapy: promising natural & antitumor agents from plants & other natural sources.** (0-9648280-1-4, pbk.) Oregon Medical Press, LLC. 325 10th Avenue North, Princeton, Minnesota 55371, U.S.A. (Orders: 800-610-0768; www.ompress.can). $32.00, 521 pp., b/w charts, figures, graphs, and tables, 13 appendices, 8 1/2" × 11".

Seldom does one encounter a seminal work wherein the author tackles the enormously complex immune system, the intricacies of the pathophysiological process involved in malignancies, combined with a most articulate description of botanical and other sources, the constituents of which possess potent anti-neoplastic properties.

The book is divided into three parts: *Part I: Cancer at the Cellular Level*, is comprised of Chapters 2 through 6, and is preceded in Chapter I which presents background information related to Parts I and II, notably, the seven strategies for cancer inhibition; *Part II: Cancer at the Level of the Organism*, and *Part III: Clinical Considerations*.

The topics included in Part I consist of the following: Mutations, Gene Expression, and Proliferation (Chp. 2); Results of Therapy at the Cellular Level (Chp. 3); Growth Factors and Signal Transduction (Chp. 4); Transcription Factors and Redox Signaling (Chp. 5); and Cell-to-Cell Communication (Chp. 6).

Several interesting and salient points are stressed. The central driving force behind the transformation of a normal cell into a cancer cell is mutation; especially through the expression of oncogenes and decreased expression of tumor suppressor genes. Both normal and cancer cells proliferate in response to the same signals, but in cancer the proliferative signals exceed apoptotic signals. At the cellular level, successful cancer therapies (1) can cause cancer cells to assume more normal morphology and function, (2) prevention of cancer cells to enter the cell cycle, (3) induction of cell death through apoptosis, and (4) induction of cell death through necrosis. The first three of these can be accomplished by a variety of natural compounds. To avoid apoptosis and promote proliferation, cancer cells override the control mechanisms that normally regulate these processes in healthy cells. Often cancer cells produce their own growth factors, signal transduction enzymes, and protein moieties. Of the three major transcription factors, cancer cells rely on abnormally low P53 protein activity and abnormally high NF-Kappa B and AP-1 activity. Intercellular communication and cell-matrix interaction are vital processes linking a cell to its environment. Cancer cells frequently exhibit aberrant forms of communication. Increasing E-cadherin expression and increasing gap junction communication can provide useful strategies in cancer treatment.

Part II consists of Chapters 7 through 12. Topics covered include: overview of Angiogenesis (Chp. 7), Natural Inhibitors of Angiogenesis (Chp. 8), Invasion (Chp. 9, Metastasis (Chp. 10), The Immune System (Chp. 11), and Natural Compounds that Affect the Immune System (Chp. 12). A number of valuable observations were noted. While angiogenesis is a normal part of wound healing, it is the major mainstay supporting tumor growth. The difference between wound healing and tumor growth is th4a fact that angiogenesis in wound healing is finite and self-limiting but completely unchecked in tumors. A large number of compounds are capable of inhibiting angiogenesis, especially antioxidants, anticopper complexes, and vitamins A and D_3. Combinations including genistein have shown real promise. Cancer cells produce three compounds that facilitate invasion: abnormal matrix components, enzymes (collagenase and hyaluronidase) that digest matrix Components, and variant CD44 surface proteins that aid cell migration. Metastasis is a five-step process, namely, (1) cell detachment and intravasation, (2) migration through circulatory channels, (3) arrest at a new location, (4) extravasation, and (5) cell proliferation and angiogenesis. it is highly likely that natural compounds could play a significant role in slowing down or abrogating metastasis. The response of the immune system to cancer involves two major processes: (1) innate immune response independent of the tumor antigens, and (2) adaptive immune responses. Ideal results have been achieved when an immunostimulant in combination with materials that prevent immune system evasion. Release of cytokines (IL-2 and the interferons) plus the addition of immune stimulants appear to have the greatest potential for therapy together with inhibitors of PGE 2 or other specific immunosuppressive compounds.

Part III consists of Chapters 13, through 23. Topics covered include. Back- ground for Part III (Chp. 13), Trace Metals (Chp. 14), Vitamin C and Antioxidants (Chp. 15), Polysaccharides (Chp. 16), Lipids (Chp. 17), Amino Acids and Related Compounds (Chp. 18), Flavonoids (Chp 19), Non-flavonoid Phenolic compounds (Chp. 20), Terpenes (Chp. 21), Lipid-soluble Vitamins (Chp. 22), Natural Compounds, Chemotherapy, and Radiotherapy (Chp. 23). Cogent observations include the following. An approach which uses several compounds in combination may be associated with fewer side-effects and possibly superior beneficial actions. Selenium compounds tend to decrease cancer risk while copper and iron appear to increase cancer risk. Depending upon the oxidative stress at the cancer site, antioxidants may either increase or decrease cancer cell proliferation. Polysaccharides have been shown to increase immunostimulation through release of cytokines and to decrease immunosuppressive moieties. They very possibly have other mechanisms which result in tumor inhibition, but many of these mechanisms remain to be calrified. N-6 lipids tend to promote tumor progression, an action probably shared with saturated fats in general. Fish oil, however, especially EPA, has been shown to inhibit cancer progression, decrease angiogenesis, lessen evasion, tendency to metastasize, and inhibit cachexia by reducing TNF-alpha levels. Both glutamine and bromelain appear to have immunostimulant properties. Phenolic compounds, although chemically diverse, seem to be able to inhibit cancer progression through cytotoxic mechanisms. Curcumin, lignans, and quinones may have possible roles in cancer therapy, but they require further study to ascertain their activities. Terpenes probably serve as anticancer agents through potent anti-inflammatory actions. Vitamins A and D., and their metabolites, have the ability to enter the nucleus and directly affect gene transcription. Vitamin E, located on cell membranes, may play a major role in regulating antigen presentation. Combining natural product administration along with either chemotherapy and/or radiotherapy may enhance the efficacy of both modalities of treatment.

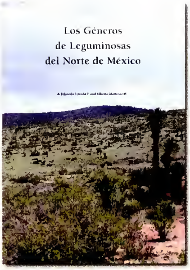
With such a wealth of information regarding the favorable effects of natural products in various processes cancer cells depict, it behooves all physicians, especially oncologists, other medical personnel, nutritionists and dietitians, and all persons who interact with cancer patients to peruse, assess, and incorporate those natural factors which they deem best aligned with their philosophical approaches to improve the statistics for cancer survival. But of even more import is for the information contained in this book to be available and utilized by cancer patients, themselves.

This book represents a truly remarkable compilation and assessment of natural products and their potential to significantly influence for good cancer therapies with increased survival of the disease's victims.—*Ivan E. Danhof, Ph.D., M.D., 222 S.W. 2nd Street, Suite 201, Grand Prairie, Texas 75051, U.S.A.*

This illustrated monograph is the most comprehensive generic treatment of legumes for any geographical area of Mexico. The book covers the genera of legumes known to be present in northern Mexico from Tamaulipas to Baja California Sur. The introductory material covers topography, climate, and vegetation types of northern Mexico. Included are 121 genera treated in three families: Fabaceae, Mimosaceae, and Caesalpiniaceae. The Fabaceae is the most abundant family with 87 genera followed by Mimosaceae (19) and Caesalpiniaceae (15). Keys to the families, tribes (only in Fabaceae), genera, and detailed line drawings of distinguishing characteristics are included for most of the genera to facilitate identification. Each genus is provided with a description, followed by distributional information, species number, chromosome number, and economic, ecological, and potential food importance.

Available from
Botanical Research Institute of Texas Press
509 Pecan Street
Fort Worth, TX 76102-4060, USA
E-mail: sida@brit.org ▪ Fax 1-817-332-4112
www.brit.org/Sida/Sida25 htm

Sida, Bot. Misc. No. 25, 2004
issn 0833-1475, isbn 1-889878-13-8 ▪ 7" × 10", x + 134 pp,
over 500 individual drawings.
$25 + p&h ▪ (USA $3; International $7)
Texas residents add $2.06 sales tax



**Los Géneros
de Leguminosas
del Norte de México
(The Genera of Legumes
of Northern Mexico)**

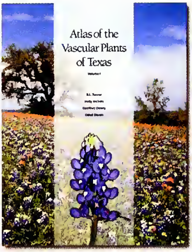
By
A. Eduardo Estrada C.
and
Alfonso Martínez M.

BRIT
PRESS

The Atlas of Texas covers about 6000 taxa. This is the result of 54 years of herbarium and fieldwork by B.L. Turner, beginning in 1948 at Sul Ross State University, Alpine, Texas. In short, the senior author has examined personally, touched, or "pored over" an estimated several hundred thousand sheets in the preparation of the forthcoming Atlas volumes. Contents include an introduction, atlas of Texas plants arranged alphabetically by family, by genus, by species, and an index.

Available from
Botanical Research Institute of Texas Press
509 Pecan Street
Fort Worth, TX 76102-4060, USA
E-mail: sida@brit.org ▪ Fax 1-817-332-4112
www.brit.org/Sida/Sida/24.htm

Sida, Bot. Misc. No. 24, 2003, issn 0833-1475,
isbn (vol. 1) 1-889878-08-1 ▪ isbn (vol. 2) 1-889878-09-X ▪ 7 1/2" × 10"
Vol. 1 approx. 630 pp. ▪ Vol. 2 approx. 275 pp.
Vol. 1 $50 + p&h* ▪ Vol. 2 $40 + p&h* ▪ Set $80 + p&h*
*USA: $10 (vol. 1); $9.50 (vol. 2); $12 (set)
*International: $12.50 (vol. 1) ▪ $11.50 (vol. 2); $25 (set)
Texas residents add sales tax: $4.13 (vol. 1) ▪ $3.30 (vol. 2) ▪ $7.43 (set)



**Atlas of the
Vascular Plants of Texas**

By
B.L. Turner,
Holly Nichols, Geoffrey Denny,
Oded Doron

BRIT
PRESS

GEORGIA NORTH AMERICA

KLAHOMA VIRGINIA OREGON NEBRASKA ALABAMA NEW MEXICO CALIF

Poaceae NORTH CAROLINA SOUTH CAROLINA MONTANA VERMONT IND

HIO MICHIGAN UNITED STATES ILLINOIS TENNESSEE ALASKA KENTUCKY NEW YORK

ENNSYLVANIA NEW JERSEY MASSACHUSETTS *Asteraceae*

WYOMING ARIZONA HAWAII NEVADA UTAH WASHINGTON SOUTH DAKOTA

DAKOTA *Cactaceae* RHODE ISLAND COLORADO DELAWARE MISSOURI

IRGINIA MINNESOTA CANADA ONTARIO ALBERTA BRITISH COLUMBIA SASKATCHEWAN

ERRITORY NORTHWEST TERRITORIES NOVA SCOTIA MANITOBA NEWFOUNDLAND MANITOBA

NEW BRUNSWICK PRINCE EDWARD ISLAND SOUTH AMERICA PERU CHILE

Myrsinaceae AMAZONIA ARGENTINA ECUADOR BELIZE COL

RENCH GUIANA URUGUAY SURINAME PARAGUAY VENEZUELA BOLIVIA GUATEMALA SAN SALV

ONDURAS GUYANA CENTRAL AMERICA NICARAGUA PANAMA COSTA

UBA PUERTO RICO DOMINICAN REPUBLIC HAITI BAHAMAS JAMAICA NORTH &

OREA ASIA TAIWAN JAPAN *Orchidaceae* VIETNAM CHINA

ODIA BURMA BANGLADESH MALAYSIA IRELAND FRANCE GERMANY ITALY NORWAY SW

EUROPE UNITED KINGDOM PHILIPPINES FINLAND AUSTRALIA HU

WITZERLAND CZECHOSLOVAKIA POLAND YUGOSLAVIA RUSSIA GREECE PAKISTAN SYRIA

MAN MADAGASCAR INDIA PAPUA NEW GUINEA NEPAL SYRIA SRI

NEW SOUTH WALES QUEENSLAND VICTORIA WESTERN AUSTRALIA NORTHERN TERRITORY

Fabaceae AUSTRALIA TASMANIA NEW ZEALAND MALAYSIA SUMATRA

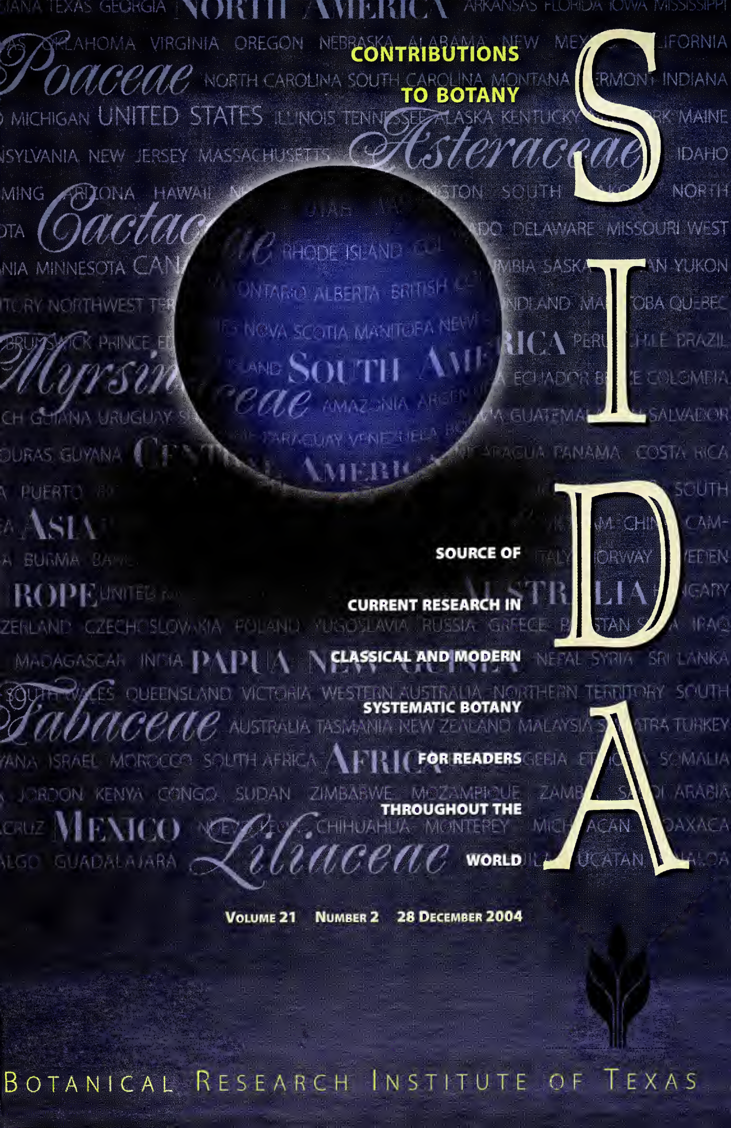
OTSWANA ISRAEL MOROCCO SOUTH AFRICA AFRICA EGYPT NIGERIA ETHIOPIA SO

JORDON KENYA CONGO SUDAN ZIMBABWE MOZAMBIQUE ZAMBIA SAUDI

MEXICO NUEVO LEON CHIHUAHUA MONTEREY MICHOACAN

IDALGO GUADALAJARA *Liliaceae* COAHUILA YUCATAN SI

ISSN 0036-1488



CONTRIBUTIONS TO BOTANY

SIDA

SOURCE OF CURRENT RESEARCH IN CLASSICAL AND MODERN SYSTEMATIC BOTANY FOR READERS THROUGHOUT THE WORLD

VOLUME 21 NUMBER 2 28 DECEMBER 2004

BOTANICAL RESEARCH INSTITUTE OF TEXAS

SIDA CONTRIBUTIONS TO BOTANY WAS FOUNDED BY LLOYD H. SHINNERS (LEFT) IN 1962. INHERITED BY WILLIAM F. MAHLER (RIGHT), DIRECTOR EMERITUS OF BRIT IN 1971, AND SINCE 1993, IT HAS BEEN PUBLISHED BY BRIT PRESS.

◆

BARNEY L. LIPSCOMB, EDITOR

Botanical Research Institute of Texas

509 Pecan Street

Fort Worth, Texas 76102 4060, USA

817 332-4441 / 817 332 4112 FAX

Electronic mail: sida@brit.org

Home page at the URL: http://www.brit.org/sida/

JOHN W. THIERET, ASSOCIATE EDITOR

Dept. of Biological Sciences

Northern Kentucky University

Highland Heights, KY 41099 USA

FÉLIX LLAMAS, CONTRIBUTING SPANISH EDITOR

Dpto. de Botánica, Facultad de Biologia

Universidad de León

E-2471 León, SPAIN

Guidelines for contributors are available upon request and on our SIDA home page as well as the last pages of each volume.

Subscriptions for year 2005:

$37 Individual

$65. USA Institutions

$75 Outside USA

numbers issued twice a year

BRIT
PRESS

©SIDA, CONTRIBUTIONS TO BOTANY

VOLUME 21, NUMBER 2, PAGES 511–1248.

28 DECEMBER 2004

PRINTED IN THE UNITED STATES OF AMERICA

ISSN 0036 1488

TABLE OF CONTENTS

SYSTEMATICS

DEVELOPMENT AND STRUCTURE

ETHNOBOTANY

BOTANICAL HISTORY

FLORISTICS, ECOLOGY, AND CONSERVATION

COMMEMORATIVE

Index to new names and new combinations in Sida 21(2), 2004

Herrickia kingii var. **barnebyana** (Welsh & Goodrich) Brouillet, Urbatsch & R.P. Roberts, comb. nov.—**898**

Herrickia wasatchensis (M.E. Jones) Brouillet, comb. nov.—**897**

Heterotheca subaxillaris subsp. **latifolia** (Buckley) Semple, comb. et stat. nov.—**759**

Lobelia decurrens subsp. **parviflora** Lammers, subsp. nov.—**616**

Minuartia nuttallii var. **fragilis** (Maguire & A.H. Holmgren) Rabeler & R.L. Hartman, comb. et stat. nov.—**753**

Minuartia nuttallii var. **gracilis** (B.L. Rob.) Rabeler & R.L. Hartman, comb. nov.—**753**

Minuartia nuttallii var. **gregaria** (A. Heller) Rabeler & R.L. Hartman, comb. et stat. nov.—**754**

Paronychia chartacea var. **minima** (L.C. Anderson) R.L. Hartman, comb. et stat. nov.—**754**

Phragmites australis subsp. **americanus** Saltonstall, P.M. Peterson & Soreng, subsp. nov.—**690**

Pseudognaphalium saxicola (Fassett) H.E.Ballard & Feller, comb. nov.—**777**

Pseudognaphalium thermale (E.E. Nelson) Nesom, comb. nov.—**781**

Ptilimnium ahlesii Weakley & Nesom, sp. nov.—**744**

Scutellaria petersoniae B.L. Turner & J.L. Reveal, sp. nov.—**679**

Silene drummondii subsp. **striata** Rydb. J.K. Morton, comb. et stat. nov.—**887**

Silene laciniata subsp. **californica** (Durand) J.K. Morton, comb. et stat. nov.—**888**

Silene ostenfeldii (A.E. Porsild) J.K. Morton, comb. nov.—**888**

Solidago subsect. **Multiradiatae** Semple, subsect. nov.—**760**

Solidago sect. **Ptarmicoidei** (House) Semple & Gandhi, comb. nov.—**756**

Stellaria cuspidata subsp. **prostrata** (Baldw. ex Ell.) J.K. Morton, comb. et stat. nov.—**888**

Symphyotrichum concolor var. **devestitum** (S.F. Blake) Semple, comb. nov.—**762**

Symphyotrichum rhiannon Weakley & Govus, sp. nov.—**828**

Symphyotrichum subulatum var. **elongatum** (Boss.) S.D. Sundb., comb. nov.—**907**

Symphyotrichum subulatum var. **ligulatum** (Shinners) S.D. Sundb., comb. nov.—**907**

Symphyotrichum subulatum var. **parviflorum** (Nees) S.D. Sundb., comb. nov.—**907**

Symphyotrichum subulatum var. **squamatum** (Spreng.) S.D. Sundb., comb. nov.—**908**

Symphyotrichum tenuifolium var. **aphyllum** (R.W. Long) S.D. Sundb., comb. nov.—**905**

Triniteurybia Brouillet, Urbatsch & R.P. Roberts, gen. nov.—**898**

Triniteurybia aberrans (A. Nelson) Brouillet, Urbatsch & R.P. Roberts, comb. nov.—**898**

SYSTEMATICS OF *DIRCA* (THYMELAEACEAE) BASED ON ITS SEQUENCES AND ISSR POLYMORPHISMS

James A. Schrader and William R. Graves

Department of Horticulture
Iowa State University
Ames, Iowa 50011-1100, U.S.A.
jschrade@iastate.edu

ABSTRACT

The genus *Dirca* consists of three disjunct species of shrubs. *Dirca palustris* is found in the eastern United States and adjacent Canada; *D. occidentalis* is limited to six counties near the San Francisco Bay in California; and the recently discovered *D. mexicana* is known from one isolated population in northeastern Mexico. The three species have been described and classified according to morphological characters, but the morphological evidence does not provide a clear assessment of the relationships among the species. Morphologically, *D. mexicana* most closely resembles *D. occidentalis*, but known biogeographical trends raise doubt regarding how the three species are interrelated. We used molecular techniques to examine and clarify phylogenetic relationships among the three species of *Dirca*. Evidence from Internal Transcribed Spacer (ITS) sequences and Inter-Simple Sequence Repeats (ISSR) polymorphisms confirms the species-level divergence of *Dirca mexicana* and reveals that, despite their morphological similarity, *D. mexicana* and *D. occidentalis* are the most divergent of the three species genetically, while *D. mexicana* and *D. palustris* are the most closely related. The molecular evidence also demonstrates that *Dirca occidentalis* was the first of the three species to diverge and has undergone the greatest degree of differentiation since divergence.

RESUMEN

El género *Dirca* consta de tres especies de arbustos separadas geográficamente. *Dirca palustris* se encuentra en la parte Este de los Estados Unidos y la parte contigua de Canadá; *D. occidentalis* se limita a seis condados alrededor de la bahía de San Francisco en California, EE.UU.; y la recién descubierta *D. mexicana* se conoce solamente de una población aislada en la parte noreste de México. Las tres especies han sido descritas y clasificadas según sus características morfológicas, pero las pruebas morfológicas han sido consideradas como no concluyentes para hacer una evaluación clara de las relaciones entre las especies. Morfológicamente, *D. mexicana* se parece más a *D. occidentalis*, pero las tendencias biogeográficas establecidas crean dudas sobre el grado de parentesco entre las dos especies. Hemos usado técnicas moleculares para examinar y clarificar las relaciones filogenéticas entre las tres especies de *Dirca*. Por las pruebas que encontramos en las secuencias del Espaciador Transcrito Interno (ETI) [Internal Transcribed Spacer (ITS)] y polimorfismos de Repeticiones de Secuencias Intra-Simple (RSIS) [Inter-Simple Sequence Repeats (ISSR)], llegamos a las siguientes conclusiones: 1. *Dirca mexicana* merece ser catalogada como especie; 2. *Dirca occidentalis* fue la primera de las especies en evolucionar, y ha experimentado el mayor grado de diferenciación desde su divergencia; y 3. Contrario a sus morfologías, *D. mexicana* tiene un grado de parentesco más alto, en términos genéticos, con *D. palustris* que con *D. occidentalis*.

INTRODUCTION

The genus *Dirca* L. is comprised of three species of slow-growing, understory shrubs found almost exclusively in nature on steep, west- or north-facing slopes

SIDA 21(2): 511–524. 2004

above a waterway (Johnson 1994; Nesom & Mayfield 1995; Graves 2004). While *D. palustris* L. is the most common of the species and is found in sparsely distributed colonies over most of eastern North America, the other two species, *D. occidentalis* Gray and *D. mexicana* Nesom & Mayfield, are rare and endemic. *Dirca occidentalis* is isolated to a six-county region surrounding the San Francisco Bay in California, and *D. mexicana* is endemic to only one valley in the Sierra Madre Oriental Mountains of Tamaulipas, Mexico (Nesom & Mayfield 1995; Graves 2004). Although there is interest in the genus due to the obscurity of plants in the wild, the vulnerability of plants in California (Johnson 1994), the discovery of the new species in Mexico (Nesom & Mayfield 1995), and the potential to utilize plants of this genus as shade-tolerant shrubs for managed landscapes (Dirr 1998), no research has been done to determine the phylogenetic relationships among the three species of *Dirca*.

In the most recent treatment of the genus *Dirca*, Nesom and Mayfield (1995) showed the three disjuncts to be morphologically distinct and found that *D. mexicana* more closely resembled *D. occidentalis* than it did *D. palustris*. But, they also questioned the relative similarity of *D. mexicana* and *D. occidentalis* "in view of the well-known pattern of close relationship and disjunction between species of the eastern and southeastern United States and the sierra of northeastern Mexico" (Nesom & Mayfield 1995). Considering biogeographical trends, Nesom and Mayfield (1995) believed the best explanation for the origin of three disjunct species was, first, the isolation of the ancestors of *D. occidentalis* from those of *D. palustris*, and, more recently, the isolation of the ancestors of *D. mexicana* from those of *D. palustris*. Our goals were to resolve the apparent inconsistency between morphological and biogeographical evidence by examining the genotypic relationships among the three species of *Dirca*, to reconstruct the phylogeny of *Dirca* spp. by utilizing methods of molecular systematics, and to determine if molecular evidence supports the classification of *D. mexicana* as a distinct species.

We used two classes of molecular markers, Internal Transcribed Spacer (ITS) sequences and Inter-Simple Sequence Repeats (ISSR), to quantify the genotypic variability of *Dirca*. ITS techniques compare the internal transcribed spacer sequences of the 18S-5.8S-26S nuclear ribosomal DNA. They hold many advantages over other methods, including biparental inheritance, intergenomic variability suitable for phylogenetic inference at the specific, generic, and family levels (Baldwin 1992; Baldwin et al. 1995), and easy amplification with universal primers (White et al. 1990). ITS sequence data are abundant and easily accessible in public databases, enabling direct comparisons among taxa and thus are used extensively for botanical phylogenetics at generic and infrageneric levels (Álvarez & Wendel 2003).

ISSR techniques (Zietkiewicz et al. 1994) are chosen most often for their capacity to resolve molecular differences below the specific level, but ISSRs are also valued because they sample a large portion of the genome and therefore avoid the bias accompanying phylogenies based on the sequence of only one or a few genes (Schrader & Graves 2004). Used together, these two methods can provide excellent resolution of genetic variability at and below the family level and proved effective for assessing infrageneric differences within the genus *Dirca*.

MATERIALS AND METHODS

Samples of genomic DNA were extracted from leaf tissue of 24 seedlings by utilizing the template preparation service of the DNA Sequencing and Synthesis Facility at Iowa State University. The seeds had been collected from plants of all *Dirca* spp. in their native habitats (Table 1). Eight samples of *D. palustris* and seven samples each of *D. mexicana* and *D. occidentalis* were used to compare genetic variation in *Dirca*. In addition, two samples of *Daphne mezereum* L. (Thymelaeaceae) and one sequence from *Hibiscus rosa-sinensis* L., also from within the Order Malvales, were used as outgroup representatives for phylogenetic analyses (Table 1). *Daphne mezereum* and *H. rosa-sinensis* (GenBank sample, Shi & Yuan 2001) were chosen to establish ancestral-character polarity at the generic and family levels, respectively.

ITS methods.—We amplified the entire ITS region (ITS 1 + 5.8S + ITS 2) of each sample by using the universal primers ITS4 and ITS5 (White et al. 1990), separated the ITS bands by use of agarose-gel electrophoresis, cut out bands, and eluted the purified samples from the agarose with the GenElute™ Gel Extraction Kit (SIGMA, St. Louis, Mo.). For ITS amplification, we used 25-µL reaction mixes that contained 50 ng of template DNA, 0.8 µM of each primer, 600 µM dNTP mix (SIGMA), 1× reaction buffer that contained $Mg(OAc)_2$, and 1.5 units of KlenTaq LA DNA polymerase (SIGMA). Thermocycler conditions were 94° C for 5 min (initial denaturing), 94° C for 1 min (denaturing), 45° C for 1 min (annealing), and 72° C for 2 min (extension), for 35 cycles with the final extension at 72° C for 5 min. The purified samples were sequenced on an Applied Biosystems (ABI) 3100 Genetic Analyzer by using the forward primer (ITS5) and the long-read service of the DNA Sequencing and Synthesis Facility at Iowa State University. We used CLUSTAL X Multiple Sequence Alignment Program (version 1.8) to align sequences for phylogenetic analyses and to confirm the presence of the plant-conserved, 5.8S rDNA motif (Jobes & Thien 1997) in all sample sequences.

ISSR methods.—ISSR fragments for each of the 24 DNA samples were amplified for three replications with each of eight fluorescent 3'-anchored ISSR primers [$(CA)_6RG$, $(AC)_8G$, $(AG)_8YT$, $(CT)_8TG$, $(GTG)_3GC$, $(CA)_6RT$, $(CAC)_3RC$, and $(CTC)_3SG$], which were synthesized at the DNA Sequencing and Synthesis

TABLE 1. Origins of the 25 individuals sampled for ITS and ISSR analysis. All plants sampled are from the Schrader and Graves *Dirca* collection at Iowa State University except *Hibiscus rosa-sinensis*, which was obtained through a BLAST search (Shi & Yuan 2001). Latitude and longitude are according to Global Positioning System (GPS) and are included when known.

Species	**Plant #**	**Accession**[z]	**Origin**	**Latitude**	**Longitude**	**Analysis**
Dirca mexicana	D.mex 1	DMTA02	Tamaulipas	23°59'161" N	99°28'635" W	ISSR
	D.mex 2	DMTA02	Tamaulipas	23°59'161" N	99°28'635" W	ITS/ISSR
	D.mex 3	DMTA02	Tamaulipas	23°59'161" N	99°28'635" W	ITS/ISSR
All in Mexico	D.mex 4	DMTA02	Tamaulipas	23°59'161" N	99°28'635" W	ITS/ISSR
	D.mex 5	DMTA02	Tamaulipas	23°59'161" N	99°28'635" W	ITS/ISSR
	D.mex 6	DMTA02	Tamaulipas	23°59'161" N	99°28'635" W	ITS/ISSR
	D.mex 7	DMTA02	Tamaulipas	23°59'161" N	99°28'635" W	ITS/ISSR
Dirca occidentalis	D.occ 9	DOFT02	Contra Costa Co.	37°49'555" N	122°10'775" W	ITS/ISSR
	D.occ 11	DOAV02	Contra Costa Co.	37°56'015" N	122°18'030" W	ITS/ISSR
	D.occ 12	DOAV02	Contra Costa Co.	37°56'015" N	122°18'030" W	ITS/ISSR
All in California	D.occ 13	DOAV02	Contra Costa Co.	37°56'015" N	122°18'030" W	ITS/ISSR
	D.occ 14	DOAV02	Contra Costa Co.	37°56'015" N	122°18'030" W	ITS/ISSR
	D.occ 15	DOAV02	Contra Costa Co.	37°56'015" N	122°18'030" W	ISSR
	D.occ 16	DOAV02	Contra Costa Co.	37°56'015" N	122°18'030" W	ITS/ISSR
Dirca palustris	D.pal 17	DPLSP01	Boone Co.	41°59'586" N	93°53'058" W	ISSR
	D.pal 18	DPLSP01	Boone Co.	41°59'586" N	93°53'058" W	ITS/ISSR
	D.pal 19	DPLSP01	Boone Co.	41°59'586" N	93°53'058" W	ITS/ISSR
All in Iowa	D.pal 20	DPLSP01	Boone Co.	41°59'586" N	93°53'058" W	ITS/ISSR
	D.pal 21	DPIA01	Boone Co.	41°56'316" N	93°51'595" W	ITS/ISSR
	D.pal 22	DPIA01	Boone Co.	41°56'316" N	93°51'595" W	ITS/ISSR
	D.pal 23	DPRMF01	Clayton Co.	42°48'838" N	91°20'437" W	ITS/ISSR
	D.pal 24	DPRMF01	Clayton Co.	42°48'838" N	91°20'437" W	ISSR
Daphne mezereum	DAPH 25	DMEZ03	Purchased	Forest Farm Nursery	Williams, Oregon	ITS/ISSR
	DAPH 27	DMEZ03	Purchased	Forest Farm Nursery	Williams, Oregon	ITS/ISSR
Hibiscus rosa-sinensis	Blast search	AF460187		NCBI website[y]		ITS

---

[z] Voucher specimens: *Dirca mexicana*, Accession DMTA02, Tamaulipas, Mexico, *Schrader 124* (ISC). *Dirca occidentalis*, Accession DOFT02, French Trail, Contra Costa Co., Calif., *Schrader 125* (ISC). *Dirca occidentalis*, Accession DOAV02, Aqua Vista, Contra Costa Co., Calif., *Schrader 126* (ISC). *Dirca palustris*, Accession DPLSP01, Ledges State Park, Boone Co., Iowa, *Schrader 127* (ISC). *Dirca palustris*, Accession DPIA01, Iowa Arboretum, Boone Co., Iowa, *Schrader 128* (ISC). *Dirca palustris*, Accession DPRMF01, Retz Memorial Forest, Clayton Co., Iowa, *Schrader 129* (ISC). *Daphne mezereum*, Accession DMEZ03, Purchased from Forest Farm Nursery, Williams, Oregon, *Schrader 130* (ISC).

[y] National Center for Biotechnology Information (NCBI). www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=Nucleotide&list_uids=32364883&dopt=GenBank

Facility at Iowa State University. Optimization reactions were run to determine proper reaction conditions and reagent concentrations for consistent PCR amplification. Thermocycler conditions for ISSR-PCR were 94° C for 5 min (initial denaturing), 94° C for 30 s (denaturing), primer-specific temperatures (see below) for 45 s (annealing), and 72° C for 2 min (extension), for 30–33 cycles with the final extension at 72° C for 5 min. Annealing temperatures for the eight primers were 47° C for $(CA)_6RG$, 52° C for $(AC)_8G$, 56° C for $(AG)_8YT$, 52° C for $(CT)_8TG$, 56° C for $(GTG)_3GC$, 48° C for $(CA)_6RT$, 52° C for $(CAC)_3RC$, and 52° C for $(CTC)_3SG$. In our 25-μL reaction mixes, we used 50 ng of template DNA, 1.2 μM of primer, 300 μM dNTP mix (SIGMA), 1× reaction buffer that contained $Mg(OAc)_2$, and 1 unit of KlenTaq LA DNA polymerase (SIGMA).

Amplification products were processed at the DNA Sequencing and Synthesis Facility at Iowa State University. Applied Biosystems (ABI) 377 automated DNA sequencing systems separated the DNA by electrophoresis and collected the gel image. Image data were analyzed by using ABI PRISM™ GeneScan® software that resolves DNA fragment length differences as small as one base pair. ISSR bands (loci) were scored as "1" for band presence and "0" for band absence. Only bands that appeared in at least two of the three replications were considered present. A locus was any fragment length that was present in at least one sample. The resulting two-state (1 · 0) data matrices for the eight primers were combined to form a cumulative data set for assessing molecular relationships among the three species of *Dirca*. Data from three of the primers, $(CA)_6RG$, $(AC)_8G$, and $(AG)_8YT$, were compared with the results of Schrader and Graves (2004) to help assess the relative taxonomic distances expected for specific and subspecific hierarchical levels according to ISSR methods (Tables 2 and 3).

Data analysis.—Cladistic analyses were performed by using PHYLIP (Phylogeny Inference Package; Felsenstein 1995). We used the Dnapars program for Wagner parsimony (Kluge & Farris 1969) analysis of ITS data and the Mix program for Wagner parsimony analysis of ISSR data. The Seqboot program was used for bootstrap (Felsenstein 1985) and jacknife (Farris et al. 1996) analyses (1000 resamplings each), and the Neighbor program for neighbor-joining analyses (Felsenstein 1995). Genetic distances for ITS analyses were generated under the Kimura 2-parameter model (Kimura 1980) by using the Dnadist program of PHYLIP, and genetic distances for ISSR analyses were Euclidean distances (Sneath & Sokal 1973). We compared and contrasted our ITS and ISSR phylogenies, a procedure termed "cross matrix disparity" by Bateman (1999), then merged the two data sets for a "simultaneous analysis" (Nixon & Carpenter 1996) using unweighted distances (Sneath & Sokal 1973) from the two data sets.

RESULTS

ITS.—Sequencing of the ITS region provided complete sequences for ITS 1, the 5.8S rRNA gene, and ITS 2 and provided partial sequences for the 18S (32 nucleotides) and 26S (22 nucleotides) rRNA genes. The ITS region varied in length among the four species we evaluated (630 bp for *D. mexicana*, 617 bp for *D. occidentalis*, 625 bp for *D. palustris*, and 596 bp for *D. mezereum*) and contained ample sequence variation for species-level phylogenetic analysis. The 5.8S rRNA gene was 165 base pairs long in all samples and the sequence was identical in *D. mexicana* and *D. palustris*, with only one site difference for *D. occidentalis* and four site differences for *D. mezereum*, one of which was common to *D. occidentalis*. There was no intraspecific sequence variation among ITS samples from *D. occidentalis*, *D. palustris*, nor *D. mezereum*. There was variation at six sites among the six ITS samples of *D. mexicana* (five insertion/deletions and one transversion, all in ITS 1), but the consensus sequence was identical to the sequence of one of those samples (D.mex 2).

In our phylogenetic analysis, exhaustive searches produced single most-parsimonious trees with each of the two chosen outgroups, *D. mezereum* and *H. rosa-sinensis*, showing 196 and 496 evolutionary steps, respectively. The trees agreed in topology and revealed that, within the genus *Dirca*, the ancestral line of *D. occidentalis* was the first to diverge (Fig. 1 and 2). Bootstrap and jacknife percentages (100% for all clades) showed very strong support for this topology, and our results using the family-level root (outgroup *H. rosa-sinensis*) support the choice of *D. mezereum* as a suitable outgroup for phylogenetic reconstruction of *Dirca*.

Sequence divergence (Kimura 2-parameter distance) between *D. occidentalis* and the other two *Dirca* species (*occidentalis* to *mexicana* = 0.0592, *occidentalis* to *palustris* = 0.0560) was much greater than the divergence between *D. mexicana* and *D. palustris* (0.0074). Results of the neighbor-joining analyses reveal both a much earlier divergence of *D. occidentalis* than the divergence of the other two species and greater differentiation than the other two species since their times of divergence (Figs. 1 and 2). This feature is particularly apparent when the phylogeny is constructed by using a generic-level root (Fig. 1), but is still evident when using a family-level outgroup (Fig. 2).

ISSR.—Amplification with the eight fluorescent 3'-anchored primers yielded 709 ISSR loci (fragment lengths) across the four species. The fine resolution of ISSR techniques is illustrated by the high degree of polymorphisms found among the three species of *Dirca* and the high number of species-specific loci (Table 2). Comparing these results with the results of an earlier, subspecific study that involved the same methods and three of the same ISSR primers (Schrader and Graves 2004), confirmed species-level divergence among the three taxa of *Dirca*. For the three primers used in both studies, the three species of *Dirca* had nearly double the percentage of polymorphic loci and taxon-specific loci of those seen among the three subspecies of *Alnus maritima* (Marsh.) Muhl. ex Nutt. (Table 2). The differentiation revealed in the number of taxon-specific loci found among the three species of *Dirca* was consistent with the

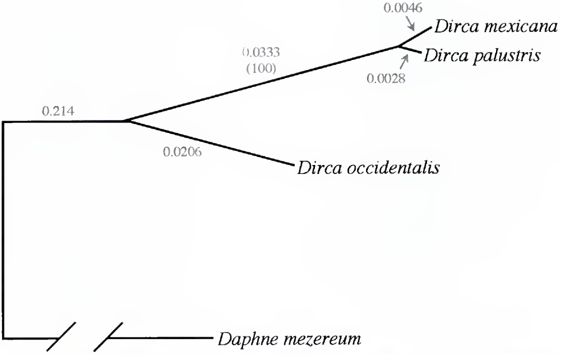


Fig. 1. ITS neighbor-joining dendrogram showing the inferred phylogenetic relationship among the three species of *Dirca*. Topology indicates that of the single most-parsimonious tree. Numbers indicate relative branch lengths; numbers in parentheses are both the bootstrap and jacknife percentages, which were identical. *Dahne mezereum*, another member of Thymelaeaceae, was used as the outgroup in order to establish ancestral-character polarity of the ITS sequence.

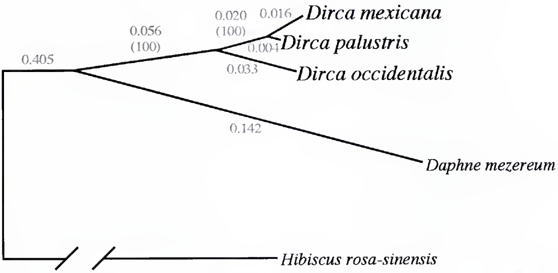


Fig. 2. ITS neighbor-joining dendrogram showing the inferred phylogenetic relationship among the three species of *Dirca* and another member of Thymelaeaceae, *Dahne mezereum*. Topology indicates that of the single most-parsimonious tree. Numbers indicate relative branch lengths; numbers in parentheses are both the bootstrap and jacknife percentages, which were identical. *Hibiscus rosa-sinensis*, another member of Order Malvales, was used as the outgroup to establish ancestral-character polarity of the ITS sequence.

Table 2. Percentage of polymorphic loci and percentage and number of taxon-specific bands resolved by using three (*Dirca* and *Alnus*) and eight (*Dirca*), 3'-anchored ISSR primers. Results for *Dirca* are from the present study; results for *Alnus* were obtained by Schrader and Graves (2004) by using the same methods and three of the same primers as the present study.

	Primers				
	$(CA)_6RG$	$(AG)_8YT$	$(AC)_8G$	Three primers	All eight primers
% of polymorphic loci					
Dirca species	87	95	88	90	83
Alnus maritima subspecies	41	55	46	48	
% Taxon-specific loci					
Dirca species	52	73	47	57	55
Alnus maritima subspecies	15	31	14	22	
# Taxon-specific loci					
Dirca mexicana	7	17	13	37	112
Dirca palustris	9	10	6	25	67
Dirca occidentalis	16	16	11	43	164
Alnus maritima					
subsp. *oklahomensis*	1	3	0	4	
subsp. *georgiensis*	0	1	2	3	
subsp. *maritima*	2	4	0	6	
Alnus japonica	9	16	12	37	

species-level differentiation in taxon-specific loci of the outgroup *Alnus japonica* (Thunb.) Steud. for each and all primers and was over four times that shown among the subspecies of *A. maritima*. Further evidence of species-level divergence was revealed by analysis of the genetic distances between the taxa (Table 3). The distance between the least divergent pair, *D. mexicana* and *D. palustris*, (103) is over five times greater than that of the most divergent subspecies of *A. maritima* (19).

After an exhaustive search, phylogenetic analysis of ISSR data produced a single most-parsimonious tree of 813 evolutionary steps (Fig. 3), and bootstrap and jacknife percentages (100% for both) showed very strong support for this topology. Consistent with the ITS results, ISSR data verified that *D. occidentalis* was the first of the three *Dirca* species to diverge (Fig. 3). Euclidean distances between species based on data from all eight primers were 410 for *D. occidentalis* and *D. palustris*, 392 for *D. occidentalis* and *D. mexicana*, and 302 for *D. palustris* and *D. mexicana*. These genetic distances and branch lengths derived from ISSR markers showed greater relative distance between *D. mexicana* and *D. palustris* than obtained from ITS, indicating a more uniform level of divergence among the three species (Fig. 3). Although divergence was shown to be more uniform,

Table 3. Comparative Euclidean distances for species (*Dirca*) and subspecies (*Alnus maritima*) obtained by the same methods and same three ISSR primers. Results for *Alnus maritima* were derived from Schrader and Graves (2004).

	Euclidean distances
Species level (*Dirca*)	
Dirca mexicana – Dirca occidentalis	110
Dirca mexicana – Dirca palustris	103
Dirca occidentalis – Dirca palustris	119
Subspecies level (*Alnus maritima*)	
oklahomensis – georgiensis	15
oklahomensis – maritima	19
georgiensis – maritima	12

ISSR results confirmed that *D. mexicana* and *D. palustris* are the most closely related of the three species. Our unweighted, simultaneous analysis of ITS and ISSR data (Fig. 4) shows the best synthesis for the phylogeny of *Dirca* based on all available molecular evidence.

DISCUSSION

Based on the results of ITS alone, we might conclude that *Dirca mexicana* and *D. palustris* could best be considered as the same species, a conclusion that would contradict the morphological evidence of Nesom and Mayfield (1995). With ITS, the mean genetic distance from *D. occidentalis* to these two species is nearly eight times greater than the distance between *D. mexicana* and *D. palustris*, and the neighbor-joining phylogeny, produced when using generic-level ancestral character as the root, illustrates how closely related the ITS regions of *D. mexicana* and *D. palustris* are to each other (Fig. 1). Results of ISSR analysis, however, provide conclusive evidence that *D. mexicana* and *D. palustris* have diverged sufficiently to be considered separate species, and they indicate that divergence of the three species is more uniform than indicated by ITS analysis (Table 2 and 3, Fig. 3). Although a suitable explanation for the seemingly contradictory levels of divergence indicated by ITS and ISSRs could be that different genetic markers may be differentially affected by occurrences such as interspecific gene flow or reticulate evolution (Comes & Abbott 1999), a more obvious explanation can be found in a closer examination of the two ITS phylogenies. Including family-level ancestral character (outgroup *H. rosa-sinensis*) in the analysis led to two important insights. First, there is a high degree of differentiation (long branch length) of *D. occidentalis* and *D. mezereum* that is evident after their divergence (Fig. 2), and this differentiation skews the tree produced by using *D. mezereum* as the outgroup (Fig. 1) causing *D. mexicana*

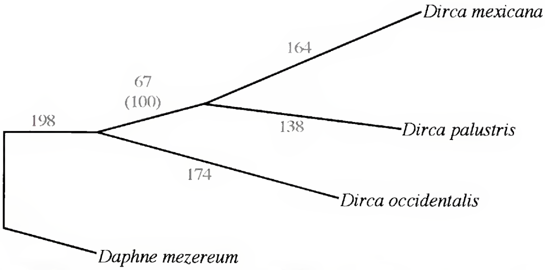


Fig 3. ISSR neighbor-joining dendrogram showing the inferred phylogenetic relationship among the three species of *Dirca*. Topology indicates that of the single most-parsimonious tree. Numbers indicate relative branch lengths; numbers in parentheses are both the bootstrap and jacknife percentages, which were identical. *Dahne mezereum*, another member of Thymelaeaceae, was used as the outgroup to establish ancestral-character polarity of ISSR banding patterns.

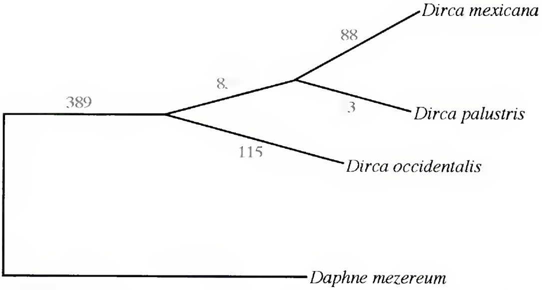


Fig. 4. Simultaneous ITS and ISSR neighbor-joining dendrogram using unweighted Kimura and Euclidean distances, respectively. *Dahne mezereum*, another member of Thymelaeaceae, was used as the outgroup to establish ancestral-character polarity.

and *D. palustris* to be placed further from *D. occidentalis* than they would be otherwise. Secondly, the phylogeny produced with family-level ancestral character in the root corrects for this disproportional differentiation and shows a more uniform species-level divergence between the three *Dirca* species, making the phylogeny more consistent with the results of the ISSRs. Together, the ISSR and ITS analyses support the species designation for *D. mexicana* established by Nesom and Mayfield (1995). These results also reinforce the principle that more than one genetic marker should be used in molecular systematics investigations (Hollingsworth et al. 1999) and that analysis of cross-matrix disparity can be a valuable method of clarifying phylogenetic features (Bateman 1999).

Contrary to the morphological evidence, both ITS and ISSR analyses indicate that *Dirca mexicana* is more closely related, genetically, to *D. palustris* than it is to *D. occidentalis*. This finding, and the findings that *D. occidentalis* was both the first of its genus to diverge and the most differentiated of the three species (Figs. 1–4), help to explain the apparent inconsistency between the morphological and biogeographical evidence noted by Nesom and Mayfield (1995). Although there is a greater morphological similarity between *D. mexicana* and *D. occidentalis*, they are the most divergent of the three species genetically (Figs. 1–4). These findings are consistent with the hypothesis of Nesom and Mayfield (1995) based on biogeography, that *Dirca* was probably continuous across North America as early as the Eocene, and disjunction between *D. occidentalis* and *D. palustris* may have taken place before or around the same time as the movement of *Dirca* into Mexico. This hypothesis seems especially well supported by our ITS and simultaneous phylogenies (Figs. 1, 2, and 4).

The typical ecological niche for the genus *Dirca* is considered to be the cool moist slopes of mature temperate deciduous forests. Both *D. palustris* and *D. mexicana* are found almost exclusively in such settings, and even though it has adapted to a different environment, *D. occidentalis* is struggling to survive amidst a drying climate, removal of overstory trees, and competition from evergreen trees and shrubs (Johnson 1994; Graves 2004). As mentioned by Nesom and Mayfield (1995), paleobotanical evidence suggests that *Dirca* was continuous across the midlatitudes of North America as part of the Eocene/Oligocene expansion of temperate deciduous vegetation that took place after the partial regression of the Cretaceous epeiric sea (Graham 1993). In fact, members of Thymelaeaceae are documented in the late Eocene flora of central Colorado (MacGinitie 1953; Graham 1993). In geologic time, this extensive range was probably short lived. Cooling during the middle Miocene brought the encroachment of coniferous forests from the north (Leopold & Denton 1987), and by the middle to late Miocene, colder winter temperatures and reduced summer rainfall in the area of the Great Plains had initiated the development of prairie grasslands (Graham 1993). While climatic cooling brought the isolation of eastern and western deciduous forests and, most likely, the eastern and western representatives of *Dirca*, it also enabled the movement of eastern deciduous forest element into eastern Mexico following rapid southward retreat of the lingering Mississippi Embayment by the middle to late Miocene (Graham 1973, 1993). Finally, the precursors to modern *D. palustris* and *D. mexicana* probably became disjunct as prairie and coniferous communities in western and southwestern North America spread during the Pliocene and elements of the broad-leaved deciduous forest that had extended into eastern Mexico became isolated (Graham 1973, 1993).

One phenotypic manifestation of the high level of differentiation seen in *D. occidentalis* is its obligate summer dormancy. Only *D. occidentalis* undergoes this drought-deciduous summer dormancy, which coincides with the dry season in the San Francisco Bay area. Trials we have conducted in a greenhouse indicate that this annual phenological event cannot be overcome by manipulation of the environment. The absence of this drought-deciduous trait in the other two species of *Dirca*, and, to the best of our knowledge, the rest of Thymelaeaceae, suggests that considerable change has taken place in *D. occidentalis* since its divergence to ensure survival in its Mediterranean climate (Freitas 1997). Such adaptation is the most plausible explanation for the continued existence of this disjunct species of *Dirca*. Without a means of drought avoidance, it is likely that the precursors of *D. occidentalis* would have expired along with the rest of the western *Dirca* element as western climates became increasingly dry. It is believed that during the Pliocene, the Cascade-Sierra Nevada and the Coast Ranges reached sufficient heights to create an effective rain shadow over the Basin and Range Province, resulting in a change from mesic and summer-wet to the xeric and summer-dry conditions that exist today (Axelrod 1986; Graham 1993). This trend most likely forced *D. occidentalis* into its meager coastal distribution, while promoting selection of the summer-deciduous habit.

The lower level of differentiation in *Dirca palustris* revealed by all four phylogenetic dendrograms should be considered consistent with its much larger potential gene pool and, until recently, its fairly uniform habitat. Because the fundamental niche of *D. palustris* is mature-forest understory, it is likely that, except for the temporary intrusion of glaciers and their adjacent boreal forest biome (Delcourt & Delcourt 1993), the genetic aggregate of *D. palustris* was continuous across eastern North America until the harvest of old-growth forests within the last 300 to 400 years. Future examination of the genetic variation within *D. palustris* should be performed to test this hypothesis and to provide an even clearer picture of the systematics of genus *Dirca*.

ACKNOWLEDGMENTS

We thank Gary Polking and the staff of the DNA Sequencing and Synthesis Facility at Iowa State University for their assistance with ITS and ISSR processing. We are grateful to Dr. Mark Widrlechner for his helpful critique of the manuscript and to Susan Benner and Fredy Romero for assistance with translation of the abstract to Spanish.

REFERENCES

Álvarez, I. and J.F. Wendel. 2003. Ribosomal ITS sequences and plant phylogenetic inference. Molec. Phylogenet. Evol. 29:417–434.

Axelrod, D.I. 1986. Analysis of some palaeogeographic and palaeoecologic problems of palaeobotany. Palaeobotanist 35:115–129.

Baldwin, B.G. 1992. Phylogenetic utility of the internal transcribed spacers of nuclear ribosomal DNA in plants: An example from the Compositae. Molec. Phylogenet. Evol. 1: 3–16.

Baldwin, B.G., M.J. Sanderson, J.M. Porter, M.F. Wojciechowski, C.S. Cambell, and M.J. Donoghue. 1995. The ITS region of nuclear ribosomal DNA: A valuable source of evidence on angiosperm phylogeny. Ann. Missouri Bot. Gard. 82:247–277.

Bateman, R.M. 1999. Integrating molecular and morphological evidence of evolutionary radiations. In: Molecular systematics and plant evolution. P.M. Hollingsworth, R.M. Bateman, and R.J. Gornall, eds. Taylor and Francis, London. Pp. 432–471.

Comes, H.P. and R.J. Abbott. 1999. Reticulate evolution in the Mediterranean species complex of *Senecio* sect. *Senecio*: Uniting phylogenetic and population-level approaches. In: Molecular systematics and plant evolution. P.M. Hollingsworth, R.M. Bateman, and R.J. Gornall, eds. Taylor and Francis, London. Pp. 171–198.

Delcourt, P.A. and H.R. Delcourt. 1993. Paleoclimates, paleovegetation, and paleofloras of North America north of Mexico during the late Quaternary. In: Flora of North America. Vol. 1. Oxford University Press, New York. Pp. 71–94.

Dirr, M.A. 1998. Manual of woody landscape plants: Their identification, ornamental characteristics, propagation and uses. 5th ed. Stipes Publishing Co., Champaign, Il.

Farris, J.S., V.A. Albert, M. Kallersjö, D. Lipscomb, and A.G. Kluge. 1996. Parsimony jacknifing outperforms neighbor-joining. Cladistics 12:99–124.

Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. Evolution 39:783–791.

Felsenstein, J. 1995. PHYLIP (Phylogeny Inference Package) Version 3.57c. Distributed by the author. Department of Genetics, University of Washington, Seattle.

Freitas, H.M.O. 1997. Drought. In: Plant ecophysiology. M.N.V. Prasad, ed. Wiley, New York. Pp. 129–149.

Graham, A. 1973. History of the arborescent temperate element in the northern Latin America biota. In: Vegetation and vegetation history of northern Latin America. A. Graham, ed. Elsevier Sci. Publ. Co., Amsterdam. Pp. 301–314.

Graham, A. 1993. History of the vegetation: Cretaceous (Maastrichtian)–Tertiary. In: Flora of North America. Vol. 1. Oxford University Press, New York. Pp. 57–70.

Graves, W.R. 2004. Confirmation that *Dirca* spp. (Thymelaeaceae) reproduce from rhizomes. Rhodora (In press).

Hollingsworth, P.M., R.M. Bateman, and R.J. Gornall. 1999. Preface. In: Molecular systematics and plant evolution. P.M. Hollingsworth, R.M. Bateman, and R.J. Gornall, eds. Taylor and Francis, London. Pp. xi–xvi.

Jobes, D.V. and L.B. Thien. 1997. A conserved motif in the 5.8S ribosomal RNA (rRNA) gene is a useful diagnostic marker for plant internal transcribed spacer (ITS) sequences. Plant Molec. Bio. Rep. 15:326–334.

Johnson, B.G. 1994. Plight of western leatherwood. Four Seasons, J. Regional Parks Bot. Gard. 9(4):38–41.

Kimura, M. 1980. A simple model for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. J. Molec. Evol. 16:111–120.

Kluge, A.G. and J.S. Farris. 1969. Quantitative phyletics and the evolution of anurans. Systematic Zoology 18:1–32.

Leopold, E.B. and M.F. Denton. 1987. Comparative age of grassland and steppe east and west of the northern Rocky Mountains. Ann. Missouri Bot. Gard. 74:841–867.

MacGinitie, H.D. 1953. Fossil plants of the Florissant Beds, Colorado. Contr. Paleontol. Carnegie Inst. Wash. 599.

Nesom, G.L. and M.H. Mayfield. 1995. A new species of *Dirca* (Thymelaeaceae) from the sierra of northeastern Mexico. Sida 16:459–467.

Nixon, K.C. and J.M. Carpenter. 1996. On simultaneous analysis. Cladistics 12:221–241.

Schrader, J.A. and W.R. Graves. 2004. Systematics of *Alnus maritima* (seaside alder) resolved by ISSR polymorphisms and morphological characters. J. Amer. Soc. Hort. Sci. 129: 231–236.

Shi, S. and C. Yuan. 2001. Direct submission. National Center for Biotechnology Information (NCBI). www.ncbi.nlm.nih.gov/BLAST/

Sneath, P.H. and R.R. Sokal. 1973. Numerical taxonomy. W.H. Freeman and Company, San Francisco.

White, T.J., T. Bruns, S. Lee, and J. Taylor. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: PCR protocols: A guide to methods and applications. M. Innis, D. Gelfand, J. Sninsky, and T. White, eds. Academic Press, San Diego. Pp. 315–322.

Zietkiewicz, E., A. Rafalski, and D. Labuda. 1994. Genome fingerprinting by simple sequence repeat (SSR)-anchored polymerase chain reaction amplification. Genomics 20: 176–183.

NOTES ON THE DISTRIBUTION AND NOMENCLATURE OF NORTH AMERICAN *GENTIANOPSIS* (GENTIANACEAE)[1]

James S. Pringle

Royal Botanical Gardens
P.O. Box 399, Hamilton
Ontario, CANADA L8N 3H8
jpringle@rbg.ca

ABSTRACT

The new combinations *Gentianopsis detonsa* subsp. *nesophila* and *G. virgata* subsp. *macounii* are published, bringing infraspecific classification into accord with the currently accepted names for the respective species.

RESUMEN

Las nuevas combinaciones *Gentianopsis detonsa* subsp. *nesophila* y *G. virgata subsp. macounii*, son publicadas trayendo la clasificación infraspecific de acuerdo con los nombres actualmente aceptados para las respectivas especies.

The fringed-gentian genus *Gentianopsis* Y.C. Ma is represented in North America north of Mexico by *G. barbellata* (Engelm.) H.H. Iltis and *G. simplex* (A. Gray) H.H. Iltis, which are believed to be relatively distantly related to the other North American species, and by two complexes (sensu Bouillé and Bousquet 1999) for which classifications have varied. These complexes correspond, respectively, to the taxa designated *Gentianella detonsa* (Rottb.) G. Don and *G. crinita* (Froel.) G. Don by Gillett (1957). Recent authors on *Gentianopsis* have generally adopted less inclusive species concepts.

In the *Gentianopsis detonsa* complex in North America the calyx keels are smooth and are suffused with purple. Branches often arise at or near the base of the main stem, except in *G. macrantha* (D. Don ex G. Don) H.H. Iltis. The basal rosettes of leaves are usually persistent at flowering time, and the cauline as well as the basal leaves are obtuse except in *G. detonsa* (Rottb.) Y.C. Ma subsp. *detonsa*. The peduncles are relatively long, those terminating the primary stems often being longer than the stems. Three western taxa in this complex are separated from each other geographically, viz. *G. macrantha*, *G. holopetala* (A. Gray) H.H. Iltis, and *G. thermalis* (Kuntze) H.H. Iltis. They have usually been treated as species in recent literature, although *G. thermalis* is sometimes included in *G. detonsa* as var. *elegans* (A. Nels.) N.H. Holmgren. Some recent as well as earlier authors have treated the remaining North American taxa in this complex as two or three species; others have included all of them in *G. detonsa*.

---

[1] Contribution No. 125 from the Royal Botanical Gardens, Hamilton, Ontario, Canada.

Within *G. detonsa*, three geographic races in North America north of Mexico have usually been accepted as subspecies since they were first so treated by Gillett (1957), viz. subsp. *detonsa*, subsp. *raupii* (A.E. Porsild) Á. Löve & D. Löve, and subsp. *yukonensis* (J.M. Gillett) J.M. Gillett. A fourth taxon, subsp. *nesophila*, is the only representative of this complex in eastern North America. It has more often been treated as a separate species, but neither in the transfer of the epithet to *Gentianopsis* (Iltis 1965) nor in any of the works in which the name *Gentianopsis nesophila* (Holm) H.H. Iltis has been employed has the rank appropriate for this taxon been discussed. Some recent authors, e.g. Blaney and Kotanen (2001), have simply included the taxon *nesophila* in *Gentianopsis detonsa* s. lat., there being no nomenclatural combination under *G. detonsa* by which it could be distinguished.

Subspecies *raupii* is notably variable in vegetative morphology. Plants in some populations approach subsp. *nesophila* in leaf shape and width, as noted by Gillett (1957) and in my studies, whereas other plants are more similar to subspp. *detonsa* and *yukonensis*. Conversely, plants of subsp. *nesophila* from the shores of James Bay sometimes approach subsp. *raupii*. Reports of subsp. *raupii* as a taxon rare in or perhaps extirpated from Ontario (Gillett & Keddy 1983) are based on three specimens from the shores of Hudson and James bays so identified by Gillett in 1957. All of these specimens have also, at times, been identified as *nesophila*. Boivin (1972) commented that they "have the shorter flowers and broader leaves" of *nesophila* and reidentified them accordingly. In my examination of these specimens I found that all three conform to the morphology of subsp. *nesophila*, and differ from that of subsp. *raupii*, in having corolla lobes distinctly less than half as long as the tube, with the margins subentire or merely toothed rather than fringed proximally. Two of these collections, *Dutilly & Lepage 16925* and *Lepage 31666* (both DAO), resemble subsp. *raupii* vegetatively in having fewer leaves than is usual in subsp. *nesophila*, but the third, *Spreadborough 9 Aug 1904* (CAN), fits well within the range of variation of subsp. *nesophila* in all respects. It was reidentified as *nesophila* by Gillett in 1979 (annotation). Cody (1971) and Porsild and Cody (1980) considered subsp. *raupii* to be endemic to the watershed of the Mackenzie and Slave rivers in the Northwest Territories and northern Alberta. In accord with their interpretation, I include all plants of *G. detonsa* s. lat. in the saline coastal meadows on the James and southern Hudson Bay shores in subsp. *nesophila*, rather than treating occasional plants as subsp. *raupii*, i.e., as geographically remote and ecologically anomalous occurrences of a different taxon, within the range and habitat of subsp. *nesophila*.

Subspecies *nesophila* is usually less similar in aspect to subspp. *detonsa* and *yukonensis* than to subsp. *raupii*. Among plants of comparable stature, those of subsp. *nesophila* are more often branched from the base, and the basal and proximal cauline leaves are generally wider, more numerous, and more closely spaced than those of subspp. *detonsa* and *yukonensis*. Also, as noted above, the corolla lobes of subsp. *nesophila* are less than half as long as the tube, whereas in the other subspecies they are more than half as long. Gillett (1957) observed, however, that occasional plants of subsp. *nesophila* from Newfoundland "resemble the typical subspecies [*detonsa*] rather closely." Conversely, some specimens of subsp. *detonsa*, e.g. *Ull 30 August 1987* (CAN) from the shore of Kotzebue Sound, Alaska, and some from Iceland (seen at GH), have a leafy aspect approaching that of subsp. *nesophila*.

Subspecies *nesophila* shares with subsp. *raupii* (while thus differing from subspp. *detonsa* and *yukonensis*) the combination of the calyx abruptly constricted at the base, all four calyx lobes nearly equal in length, a distinctly obconic rather than nearly cylindric corolla tube, proportionately wide corolla lobes with rounded rather than subacute apices, and seed coats with the papillae relatively large and distributed over the whole surface rather than being restricted to the ends (Gillett 1957, 1963). In these respects subsp. *raupii* is more similar to subsp. *nesophila*, from which it is relatively often separated at species rank, than to subsp. *detonsa* or subsp. *yukonensis*, with which it is usually treated as conspecific. The similarities between the taxa *nesophila* and *raupii* were recognized by Toyokuni (1967–1968), who treated them as one species, *G. nesophila*, comprising subsp. *nesophila* and subsp. *raupii* (A.E. Porsild) Toyok., and treated residual *G. detonsa* as another species. Nevertheless, despite the differences in morphology between most plants of *G. detonsa* subspp. *detonsa* and *yukonensis* and those of the *nesophila/raupii* group, the separation of the latter group at species rank does not seem appropriate when *G. detonsa* s. lat. is considered more thoroughly. As noted above, some plants of both subsp. *nesophila* and subsp. *raupii* approach subsp. *detonsa* in vegetative morphology. Subsp. *yukonensis* appears intermediate between subsp. *raupii* and subsp. *detonsa*, with some plants of subsp. *yukonensis* approaching each of those subspecies in morphology. I am, therefore, following Gillett (1957, 1963), Scoggan (1979), and Riley and McKay (1980) in including the taxon *nesophila* among the subspecies of *G. detonsa*, retaining the rank of subspecies that currently prevails in treatments of North American *Gentianopsis*. This requires the following transfer to *Gentianopsis*:

Gentianopsis detonsa subsp. **nesophila** (Holm) J.S. Pringle, comb. nov. BASIONYM: *Gentiana nesophila* Holm, Ottawa Nat. 15:111. 1901. *Gentianella detonsa* subsp. *nesophila* (Holm) J.M. Gillett, Ann. Missouri Bot. Gard. 44:216. 1957; *Gentianopsis nesophila* (Holm) H.H. Iltis, Sida 2:134. 1965; *Gentiana detonsa* var. *nesophila* (Holm) B.Boivin, Nat. Canad. 93:1060. 1966. TYPE: CANADA: QUÉBEC: Anticosti Island, near Salt Lake, *Macoun s.n.*, 9 Aug 1883 (HOLOTYPE: CAN!; photo DAO!).

In the *G. crinita* complex the calyx keels are generally minutely granular- or papillate-scabridulous proximally as seen at 50×, and may or may not be suffused with purple. Branching from the base of the main stem occurs occasionally in *G. virgata* subsp. *macounii* but is otherwise rare. The basal rosettes are often withered by flowering time, and the apices of the cauline leaves are acute to acuminate. Peduncle length varies, often being relatively long in *G. virgata* subsp. *macounii* but otherwise generally being proportionately shorter than in the *G. detonsa* complex. The *G. crinita* complex is predominantly eastern, although the range of *G. virgata* subsp. *macounii* extends west to the Northern Rocky Mountains. Chromosome counts for North American *Gentianopsis* remain few, but a difference in base number formerly thought to exist between the *G. crinita* and *G. detonsa* complexes now seems unlikely.

Gentianopsis crinita (Froel.) Y.C. Ma s. str. is distinguished by its combination of ovate to lanceolate leaves and corolla lobes that are fringed around the apex as well as laterally. In recent literature it has usually been treated as a species separate from the other components of the complex. The remaining taxa in this complex have narrowly lanceolate to linear leaves and corolla-lobe margins that are erose to dentate distally and fringed only laterally if at all. As with *G. detonsa* s. lat., some recent authors have recognized more than one species within this group, whereas others have treated these plants as a single species.

Bouillé and Bousquet (1999) found little divergence in nuclear ribosomal DNA internal transcribed spacers between *G. crinita* s. str. and the rest of this complex, in contrast to the greater divergence between taxa in the *G. crinita* complex and *G. detonsa* subsp. *nesophila*. They found no divergence at all among the other taxa in the *G. crinita* complex. They treated the *G. crinita* complex as a single species, *G. crinita*, consisting of subsp. *crinita* and subsp. *procera* (Holm) Á. Löve & D. Löve. Taxonomic recognition of the other entities was rejected. In more recent years, however, the appropriateness of nrDNA ITS as a genetic marker in the context of the circumscription of species and subspecies has increasingly been questioned. The taxa *virgata* s. str. (*procera* s. str.), *macounii*, and *victorinii* have diverged morphologically to the extent that they have consistently been recognized taxonomically for over 80 years, and they have become subjects of conservation concern. Presumably they have diverged in their DNA as well, even if not specifically in the nr ITS. I consider it appropriate, therefore, to maintain their taxonomic recognition.

Although *G. crinita* s. str. is less strongly divergent from the rest of the *G. crinita* complex than from the *G. detonsa* complex, I am treating *G. crinita* s. str. and *G. virgata* s. lat. as two species, in accord with most of the recent floras in which these species are included (e.g. Gleason & Cronquist 1991; Cooperrider 1995; Voss 1996; Wetter et al. 2001). This permits the continued recognition of the taxa *macounii* and *victorinii* as subordinate taxa within *G. virgata*, as was done by Iltis (in Mason & Iltis 1966) and Cronquist (in Gleason and Cronquist 1991, in both cases under *G. procera*), and by Lammers (2004) in the case of *G. virgata* subsp. *victorinii* (Fernald) Lammers. Morphological considerations do not support the recognition of *macounii* and *victorinii* as species. Both are similar to *G. virgata* subsp. *virgata* in morphology as well as in nrDNA ITS. Intergradation between the two wide-ranging subspecies, *virgata* (*procera*) and *macounii*, was noted by Gillett (1957) and Iltis (1965) and in my own studies.

Gentianopsis virgata has often been called *G. procera* (Holm) Y.C. Ma; on its nomenclature see Pringle (2003). When *G. virgata* is circumscribed as recommended above, one new combination under that specific epithet is required:

Gentianopsis virgata subsp. **macounii** (Holm) J.S. Pringle, comb. nov. BASIONYM: *Gentiana macounii* Holm, Ottawa Nat. 15:110. 1901. *Gentianella crinita* subsp. *macounii* (Holm) J.M. Gillett, Ann. Missouri Bot. Gard. 44:228. 1957; *Gentianopsis macounii* (Holm) H.H. Iltis, Sida 2:136. 1965; *Gentianopsis procera* subsp. *macounii* (Holm) H.H. Iltis, Trans. Wisconsin Acad. Sci. 54:315. 1966; *Gentianopsis crinita* subsp. *macounii* (Holm) Á. Löve & D. Löve, Taxon 31:352. 1982. LECTOTYPE (Gillett 1957): CANADA: ALBERTA: Lees Creek, Cardston, *Macoun s.n.*, 25 Jul 1895 (HOLOTYPE: CAN!; photo DAO!).

REFERENCES

BLANEY, C.S. and P.M. KOTANEN. 2001. The vascular flora of Akimiski Island, Nunavut Territory, Canada. Canad. Field-Nat. 115:88–98.

BOIVIN, B. 1972. Flora of the Prairie Provinces. Part III–Connatae. Phytologia 22:315–398. Also published as Provancheria 4:1–84.

BOUILLÉ, M. and J. BOUSQUET. 1999. Phylogenetic relationships and phylogeography of the *Gentianopsis crinita* complex (Gentianaceae) based on nrDNA ITS sequences. XVI International Botanical Congress Abstract Number 4070.

CODY, W.J. 1971. A phytogeographic study of the floras of the continental Northwest Territories and Yukon. Naturalist Canad. 98:145–158.

COOPERRIDER, T.S. 1995. The Dicotyledoneae of Ohio. Part 2. Linaceae through Campanulaceae. Ohio State University Press, Columbus.

GILLETT, J.M. 1957. A revision of the North American species of *Gentianella* Moench. Ann. Missouri Bot. Gard. 44:195–269.

GILLETT, J.M. 1963. The gentians of Canada, Alaska and Greenland. Res. Branch, Canada Dept. Agric., Publ. 1180.

GILLETT, J.M. and C.J. KEDDY. 1983. *Gentianopsis detonsa* (Rottb.) Ma ssp. *raupii* (Porsild) Löve & Löve. In: Argus, G.W., et al., eds. Atlas of the rare vascular plants of Ontario. Botany Division, National Museum of Natural Sciences, Ottawa. 1 unnumbered p.

GLEASON, H.A. and A. CRONQUIST. 1991. Manual of vascular plants of northeastern United States and adjacent Canada, ed. 2. The New York Botanical Garden, Bronx.

ILTIS, H.H. 1965. The genus *Gentianopsis* (Gentianaceae): Transfers and phytogeographic comments. Sida 2:129–154.

LAMMERS, T. 2003 [2004]. A new combination in *Gentianopsis virgata* (Rafinesque) Holub (Gentianaceae). Michigan Bot. 42:163.

MASON, C.T., JR. and H.H. ILTIS. 1966 [1965]. Preliminary reports on the flora of Wisconsin. No. 53. Gentianaceae and Menyanthaceae–gentian and buckbean families. Trans. Wisconsin Acad. Sci. 54:295–329.

Porsild, A.E. and W.J. Cody. 1980. Vascular plants of continental Northwest Territories, Canada. National Museums of Canada, Ottawa.

Pringle, J.S. 2002 [2003]. Nomenclature of the narrow-leaved fringed gentian of the Great Lakes region, *Gentianopsis virgata* (Raf.) Holub (Gentianaceae). Michigan Bot. 41: 137–140.

Riley, J.L. and S.M. McKay. 1980. The vegetation and phytogeography of coastal southwestern James Bay. Life Sci. Contrib. Roy. Ontario Mus. 124.

Scoggan, H.J. 1979. The flora of Canada. Part 4–Dicotyledoneae (Loasaceae to Compositae). Natl. Mus. Nat. Sci. Publ. Bot. 7:1117–1711.

Toyokuni, H. 1967–1968. Notes on *Gentianopsis* with special reference to Japanese species. Symb. Asahikawenses 2:57–72; 3:137–146.

Voss, E.G. 1996. Michigan flora: A guide to the identification and occurrence of the native and naturalized seed-plants of the state. Part III: Dicots (Pyrolaceae–Compositae). Cranbrook Inst. Sci. Bull. 61.

Wetter, M.A., T.S. Cochrane, M.R. Black, H.H. Iltis, and P.E. Berry. 2001. Checklist of the vascular plants of Wisconsin. Wisconsin Dept. Nat. Resources Techn. Bull. 192.

TAXONOMY OF THE POLEMONIACEAE: *GILIA* AND *LATHROCASIS*

Verne Grant

Section of Integrative Biology and Plant Resources Center
University of Texas at Austin
Austin, Texas 78712, U.S.A.

ABSTRACT

The infrageneric classification of *Gilia* is reviewed and revised on the basis of numerous phenetic and some molecular characters and by using a taxonomic approach. The result is a broadly defined multisection genus *Gilia* composed of two subgenera and seven sections (sects. *Gilia, Arachnion, Saltugilia, Giliastrum, Giliandra, Gilmania, Campanulastrum*), and a monotypic segregate genus (*Lathrocasis*). This system is compared with that of Porter and Johnson (2000) based primarily on molecular evidence and a cladistic approach. The two systems agree in some dispositions; in fact, the present system follows Porter and Johnson in recognizing *Lathrocasis*; but in other respects the two systems differ greatly. For example, the core genus *Gilia* is divided into six smaller genera in addition to *Lathrocasis* by Porter and Johnson. Basic differences between taxonomic and molecular cladistic approaches lead to the incongruences between alternative systems found here and elsewhere in the Polemoniaceae and in other plant families. These differences are discussed. A weakness of molecular cladistics is the attempt to classify groups by using DNA evidence primarily or exclusively. Better results can be obtained by combining the molecular characters with phenetic characters. There is a continuing need for new taxonomic revisions in the Polemoniaceae and other families that do this.

Key Words: Cladistics, *Gilia*, *Lathrocasis*, molecular systematics, Polemoniaceae, taxonomy

RESUMEN

Se revisa la clasificación infragenérica de *Gilia* en base a numerosos caracteres fenéticos y algunos moleculares, usando una aproximación taxonómica. El resultado es el género multisección ampliamente definido *Gilia* compuesto de dos subgéneros y siete secciones (sects. *Gilia, Arachnion, Saltugilia, Giliastrum, Giliandra, Gilmania, Campanulastrum*), y un género monotípico segregado (*Lathrocasis*). Este sistema se compara con el de Porter y Johnson (2000) basado primariamente en pruebas moleculares y una aproximación cladística. Los dos sistemas concuerdan en algunas disposiciones; de hecho, el presente sistema sigue a Porter y Johnson en el reconocimiento de *Lathrocasis*, pero en otros aspectos los dos sistemas difieren enormemente. Por ejemplo, el núcleo del género *Gilia* se divide en seis géneros más pequeños en adición a *Lathrocasis* según Porter y Johnson. Las diferencias básicas entre la aproximación taxonómica y la cladística molecular dan lugar a incongruencias entre sistemas alternativos como se encuentra aquí y en otros estudios sobre Polemoniaceae así como en otras familias. Se discuten estas diferencias. Un punto débil de la cladística molecular es el intento de clasificar grupos usando primaria o exclusivamente DNA. Se pueden obtener mejores resultados combinando caracteres moleculares con caracteres fenéticos. Hay una necesidad creciente de nuevas revisiones taxonómicas en las Polemoniaceae y otras familias de igual comportamiento.

INTRODUCTION

In the nineteenth century, *Gilia* was treated as a catchall genus for the temperate herbaceous Polemoniaceae that did not fit into the well-defined genera *Polem-*

SIDA 21(2): 531–546. 2004

onium, *Phlox*, and *Collomia*. *Gilia* in that era was consequently very heterogeneous and was subdivided into numerous sections (Bentham & Hooker 1873–1876; Gray 1886; Peter 1897).

In the early twentieth century as the plants became better known morphologically and in the field, it became apparent that many of these sections were only remotely related to one another. Milliken (1904) started the process of reclassification by segregating *Navarretia* and *Linanthus* from *Gilia*. Her *Gilia* remained heterogeneous with six subgenera. Subsequent authors continued the process of pruning by spinning off *Eriastrum*, *Leptodactylon*, *Allophyllum*, *Ipomopsis*, etc. as separate genera, while retaining a polymorphous core genus *Gilia*.

Grant's (1959) treatment recognized a core genus *Gilia* composed of five interrelated sections (sects. *Giliastrum*, *Giliandra*, *Gilia*, *Arachnion*, *Saltugilia*). Section *Giliastrum* has been subdivided subsequently into two or three smaller sections (Grant 1999) (Table 1).

In 1959 I thought that the disparate elements had all been removed from *Gilia*, and Alva Day thought so too, but this was not the case. In later studies using pollen-morphological characters, Day (1993a, b) found a small group of species in *Gilia* sect. *Saltugilia* (the *G. leptalea* group) that did not belong in *Gilia*. It was not clear in 1993 where these species did belong. Day placed them in a section *Kelloggia* of *Gilia* for holding purposes, and later she and I transferred them to *Allophyllum* (Grant & Day 1999).

All these groupings and regroupings were made by taxonomists working within the conceptual framework of traditional or evolutionary taxonomy, using numerous phenetic characters, and changing the system gradually and progressively. In the year 2000, Porter and Johnson published a radically different classification of the *Gilia* complex and of the family as a whole. Their system was arrived at by the approach of molecular cladistics; they used DNA sequence variation in selected organellar genes as evidence, and interpreted this evidence according to cladistic concepts.

In the Porter and Johnson (2000) system, the genus *Gilia* of Grant (1959, 1999) is broken up into seven genera, as shown in Table 1. With regard to one species group, the former *Gilia leptalea* group, both parties agree that it should come out of *Gilia*, but do not agree on where to put it (Table 1). The new monotypic genus *Lathrocasis* was set up for *Gilia tenerrima* (Porter & Johnson 2000); I did not at first accept *Lathrocasis* but do so now in this paper (Table 1). The genus *Gilia* of Porter and Johnson (2000) consists of *Gilia* sects. *Gilia* and *Arachnion* plus part of *Gilia* sect. *Saltugilia*. And their genus *Gilia* is separated at the tribal level from the other sections of *Gilia* (from *Gilia* subg. *Greeneophila*).

How do we explain the large differences between the two contemporaneous and up-to-date classifications of *Gilia* s. l.? Porter and Johnson (Johnson et al. 1996; Porter 1998; Porter & Johnson 2000) claim that *Gilia* s. l. is polyphyletic; their subdivided system is intended to correct the situation. I have argued

TABLE 1. Comparison of two current classifications of *Gilia* and certain gilioid taxa.

Grant system (1999, 2001, this paper)	Porter and Johnson system (2000)	Tribe in PJ system
Gilia* subgen. *Gilia		
Sect. *Gilia*	Genus *Gilia*	*Gilieae*
Sect. *Arachnion*	Genus *Gilia*	*Gilieae*
Sect. *Saltugilia*	Genus *Saltugilia*	*Gilieae*
Gilia* subgen. *Greeneophila		
Sect. *Giliastrum*	Genera *Giliastrum, Dayia, Bryantiella*	*Loeselieae*
Sect. *Giliandra*	*Aliciella*	*Loeselieae*
Sect. *Gilmania*	*Aliciella*	*Loeselieae*
Sect. *Campanulastrum*	*Linanthus campanulatus* group	*Phlocideae*
Lathrocasis (formerly in *Gilia*)	*Lathrocasis*	*Gilieae*
Allophyllum leptaleum group (formerly in *Gilia*)	*Navarretia leptalea* group (Formerly in *Gilia*)	*Gilieae*

elsewhere (Grant 2001, 2003a, b) that the claim of polyphyly is not supported by the evidence, except in the *Gilia leptalea* group. The polyphyly issue will be discussed again later in this paper.

The difference between the alternative treatments of the *Gilia* complex can be adequately explained as a result of using the very different approaches of taxonomy and cladistics. The differences in working concepts and methods can be summarized briefly here (see Grant 2003a for review). First, the systematic units of taxonomy are similarity groups or taxa, those of cladistics are inferred phyletic lineages or clades. Second, taxonomy uses a traditional definition of monophyly: any group descended from a close common ancestor; whereas cladistics defines monophyly as a group consisting of **all** the descendants of the common ancestor. A given group can be monophyletic by the taxonomic definition but non-monophyletic by the cladistic definition.

Third, taxonomy employs any and all characters that are useful in distinguishing taxa. Phenetic cladistics sets some restrictions on the characters used. Molecular cladistics uses one or a few preselected DNA segments; the data are valuable but the database is very narrow. Fourth, taxonomy and molecular cladistics sample different parts of the overall genomes. The phenetic characters used in taxonomy are expressions of the chromosomal genome. The organellar DNA used in molecular cladistics is cytoplasmic in origin in the case of chloroplast and mitochondrial genes and is encoded in a special kind of chromosome site in the case or ribosomes.

Finally, there is always a subjective element when a cladogram is transformed into a system of taxa. Is a given clade going to be treated as a genus or a section?

These factors inevitably bring about some differences between taxonomic and molecular cladistic systems of the same plant group. They account for the differences in the tribal classification of the Polemoniaceae of Porter and

Johnson (2000) and Grant (2003b). And they will explain most of the differences in the treatment of the *Gilia* complex.

This brings us to the next question. In cases of incongruence between taxonomic and molecular cladistic systems of classification, which system comes closest to the goal of expressing natural or phylogenetic relationships? The short answer is: sometimes one system or approach, sometimes the other.

I have found the following modes in comparisons of taxonomic with molecular cladistic systems in the Polemoniaceae and other plant groups. (1) Each system is acceptable by its own standards. (2) A cladistic author applies the cladistic definition of monophyly to a taxonomic system which is natural by the taxonomic definition of monophyly, and the cladistic author then falsely accuses the taxonomic treatment of being non-monophyletic. (3) The molecular cladograms reveal a relationship which taxonomists had not noticed and which leads to a desirable revision in the taxonomy. (4) The DNA evidence is in conflict with a pattern of variation in reliable phenetic characters. This is likely to occur when the DNA evidence is derived from cytoplasmic organelles, especially chloroplasts, which are semi-independent of the chromosomal genome which determines most taxonomic characters. A chloroplast DNA cladogram may give a very distorted picture of the organismic relationships in a plant group.

Many plant groups have been studied with respect to both DNA markers and morphological or other phenetic characters. Sometimes the two kinds of characters are in agreement, sometimes they are not, and the latter situation is common. Rieseberg et al. (1996) list 34 seed plant genera in which discordance is found between DNA markers and phenetic characters. The type of DNA that is most common in the list of unreliable markers is chloroplast DNA. Unreliable chloroplast markers are found for example in: *Helianthus* (Rieseberg 1991; Rieseberg et al. 1991), *Quercus* (Whittemore & Schaal 1991), *Eucalyptus* (McKinnon et al. 1999), and *Gossypium* (Cronn et al. 2002).

In *Helianthus* (Rieseberg 1991; Rieseberg et al. 1991), *Quercus* (Whittemore & Schaal 1991), *Gossypium* (Cronn et al. 2002), and *Phlox* (Ferguson & Jansen 2002) it is possible to compare the reliability of chloroplast DNA with that of ribosomal DNA. In each case ribosomal DNA is more concordant with phenetic character variation than chloroplast DNA is.

The various sources of incongruence between taxonomic and molecular cladistic systems, listed above, all occur in the *Gilia* complex and other Polemoniaceae. Examples will be given in this paper.

Old taxonomic treatments are currently being revised by cladistic, mainly molecular cladistic, methods, but cladistic systems are not always right. There is a continuing need for up-to-date taxonomic treatments. Such treatments provide a choice for those who use classifications. With this goal in mind, I have recently revised and updated the tribal classification of the Polemoniaceae (Grant 2003b), and am doing the same here for the genus *Gilia*.

MATERIALS AND METHODS

I assembled as many characters as I could that distinguish major subgroups in *Gilia* s. l. These are mostly gross morphological features but also micromorphological or biochemical.

Among the microscopic characters that are useful in *Gilia* is corolla venation. The lower part of the corolla in *Gilia* has five sets of veins, one set for each corolla lobe, and each set has three parallel veins. The veins of a set branch above or distally. In some sections of the genus, the veins remain separate distally, while in other sections they anastomose distally (Day & Moran 1986; Day, pers. comm.).

The flavonoids in the genus fall into three groups, designated as types A, B, and C, and these types vary among the sections (Smith et al. 1977). Type A flavonoids are kaempferal, quercitin, and myricetin; type B is 6-methoxyflavonal; and type C is C-glycosylflavone (Smith et al. 1977).

A number of studies of DNA sequence variation have been made in the Polemoniaceae (listed in Porter & Johnson 2000; and Grant 2003b. For the purpose of this study I used mainly the papers of Johnson et al. (1996), Porter (1997, 1998), and Johnson and Weese (2000) which have the best coverage of the *Gilia* complex. Johnson et al. present cladograms of cpDNA *matK*, Porter of rDNA ITS, and Johnson and Weese of rDNA ITS, *cpDNA trnL*, and *matK*.

Recently Johnson et al. (2004) have published a survey of the fine structure of the seed coat in *Gilia* and related genera (see their SEM photographs).

The descriptions in the formal classification consist mainly of diagnostic characters. These serve to show the evidence supporting the classification. Good complete descriptions are given by Porter and Johnson (2000).

ANALYTICAL KEY TO THE MAIN GROUPS OF *GILIA* AND *LATHROCASIS*

1. Glandular hairs with tiny black tips; pollen white; seeds one per locule in capsule ________ Genus **Lathrocasis**
1. Glandular hairs where present with amber or colorless terminal glands; pollen blue, yellow or cream; seeds generally several or many per locule in capsule ________ Genus **Gilia**
  2. Pollen blue; stamens inserted in sinuses of corolla lobes; annuals ________ **Gilia** subgen. **Gilia**
    3. Pubescence of long fine intertwined white cobwebby hairs; stipitate glandular hairs often present also ________ **Gilia** sect. **Arachnion**
    3. Cobwebby pubescence not present, pubescence consisting of multicellular trichomes and stipitate glandular hairs.
      4. Plants scapose ________ **Gilia** sect. **Saltugilia**
      4. Plants not scapose, cauline leaves ranging from large on lower stems to small on upper stems ________ **Gilia** sect. **Gilia**
  2. Pollen generally yellow or cream, but blue in one species; stamens inserted in corolla tube, throat, or sinuses; perennials and annuals ________ **Gilia** subgen. **Greeneophila**
    5. Plants usually branching from base with stems spreading, but sometimes single-stemmed; corolla generally campanulate or rotate; seeds mucilaginous when wet.
      6. Small annuals with wiry stems and small flowers ________ **Gilia** sect. **Campanulastrum**
      6. Perennials and some annuals; flowers showy or small ________ **Gilia** sect. **Giliastrum**

5. Plants scapose with a basal rosette and a central leader stem, corolla funnelform or sometimes trumpet-shaped; seeds not mucilaginous when wet or only slightly so.
    7. Lower leaves pinnate with a broad strap-shaped rachis and short lobes ____ **Gilia** sect. **Giliandra**
    7. Lower leaves with a broad blade and lobed margin, the lobes sharp-tipped ____ **Gilia** sect. **Gilmania**

CLASSIFICATION

Genus 1. Gilia Ruiz & Pavon, Prod. Fl. Peruv. 25, t. 4. 1794. Type: *Gilia laciniata* Ruiz & Pavon

Herbaceous perennials, biennials, or annuals, sometimes with a woody or soft woody base. Basal leaves well developed and upper cauline leaves much reduced in size, or moderately reduced in sect. *Gilia*. Generally spring blooming. Flowers usually in loose or glomerate cymes, or sometimes solitary or in capitate heads. Calyx lobes equal in length. Corolla frequently moderate-sized and showy, or small in many species. Pollen pores zonocolporate. Seeds small, angular, and sandy-colored, usually numerous in the capsule. Ancestral basic chromosome number $x = 9$ present in all sections; polyploidy common. Other characters vary between the subgenera and sections.

Distribution and taxa.—Widespread in western United States and Canada and northern Mexico; also in temperate South America. In arid or semiarid habitats, frequent in deserts. About 78 species.

Subgenus 1. Gilia

Leaves pinnately dissected, often bipinnate or tripinnate, but once pinnate or linear in reduced forms. Pubescence varies among the sections. Stipitate glandular hairs often present; they are medium-sized with a large terminal gland that is yellow or amber. Corolla usually funnelform, sometimes long-tubed and subsalverform. Corolla veins anastomosing in distal part of corolla (see Materials and Methods for explanation of this character.) Stamens inserted in corolla lobe sinuses. Pollen blue. Seeds generally numerous in capsules, mucilaginous when wet. Flavonoids of type A and/or C present, but not type B. (See Materials and Methods for explanation of these types.) Basic chromosome number $x = 9$ throughout.

Section 1. Gilia

Plants with leafy stems, the leaves being the largest on lower stems and smaller but well developed on upper stems. Pubescence of multicellular trichomes and medium-sized stipitate glandular hairs. Inflorescence an open cyme, or a capitate head in some species. Corolla concolored or bi- or tricolored with purple spots on the throat and yellow tube. Corolla veins anastomosing. Flavonoids of type A found (see Materials and Methods for explanation).

Distribution and taxa.—Cismontane California to British Columbia and Baja California, and in Peru and Chile. Ten species: *G. achilleaefolia*, *G. angelensis*, *G. capitata*, *G. clivorum*, *G. laciniata* (S. Amer.), *G. lomensis* (S. Amer.), *G. millefoliata*, *G. nevinii*, *G. tricolor*, *G. valdiviensis* (S. Amer.).

Section 2. Arachnion A.D. & V.E. Grant, Aliso 3:214, 1956. TYPE: *Gilia latiflora* A. Gray.

Plants scapose with a basal leaf rosette and central leader stem. Pubescence of long fine intertwined white cobwebby hairs; medium-sized stipitate glandular hairs often present also. Inflorescence an open cyme. Corolla often bi- or tricolored with contrastingly colored lobes, throat, and tube. Corolla veins anastomosing. Flavonoids of type C present.

Distribution and taxa.—Mountains and deserts of western North America, especially numerous in the Mojave desert; also in temperate South America. Twenty-five species: *G. aliquanta*, *G. austrooccidentalis*, *G. brecciarum*, *G. cana*, *G. clokeyi*, *G. crassifolia* (S. Amer.), *G. diegensis*, *G. flavocincta*, *G. inconspicua*, *G. interior*, *G. jacens*, *G. latiflora*, *G. leptantha*, *G. malior*, *G. mexicana*, *G. minor*, *G. modocensis*, *G. ochroleuca*, *G. ophthalmoides*, *G. salticola*, *G. sinuata*, *G. tenuiflora*, *G. tetrabreccia*, *G. transmontana*, *G. tweedyi*. The basic taxonomic treatment is that of Grant and Grant (1956).

Section 3. Saltugilia V.E. & A.D. Grant, Aliso 3:84, 1954. TYPE: *Gilia splendens* Douglas ex H.L. Mason & A.D. Grant, Madroño 9:212. 1948. Genus *Saltugilia* L.A. Johnson in Porter & Johnson, Aliso 19:69. 2000. Type designated by Johnson: *Saltugilia grinnellii* (Brand) L.A. Johnson. See Grant & Wendt (2003) for discussion of type.

Plants scapose with a basal leaf rosette and central leader stem. Pubescence of straight multicellular trichomes and stipitate glandular hairs, or with geniculate multicellular trichomes in *G. stellata*. Inflorescence an open cyme. Corolla usually concolored. Corolla veins anastomosing. Flavonoids of types A and C.

Distribution and taxa.—Central cismontane California to northern Baja California, and to western parts of desert. Woodland and desert habitats. Seven species: *G. australis*, *G. caruifolia*, *G. latimerii*, *G. scopulorum*, *G. splendens*, *G. stellata*, *G. yorkii*.

Gilia latimerii (T.L. Weese & L.A. Johnson) V.E. Grant, comb. nov. *Saltugilia latimeri* T.L. Weese & L.A. Johnson, Madroño 48:198. 2001. Related to *G. australis*.

Comment.—The species in sect. *Saltugilia* fall into two groups. The *G. splendens* group (*G.* splendens, *G. caruifolia*, *G. australis*, *G. latimerii*) is a natural interrelated group of woodland and desert species with mostly large flowers. The second group (*G. scopulorum*, *G. stellata*, *G. yorkii*) consists of small-flowered, mostly desert species which are similar to the G. splendens group in gross morphological characters. This was the basis for grouping them together in the same section in earlier studies (Grant & Grant 1954; Grant 1999).

However, the molecular evidence throws some doubt on this assumption. The *G. splendens* group and the second group form separate clades in the cladograms for chloroplast genes *matK* and *trnL* and ribosomal ITS (Johnson et al. 1996; Johnson & Weese 2000). A new character, sculpturing of the seed coat, also differs between the two groups (Johnson et al. 2004).

Porter and Johnson (2000) treat the *G. splendens* group as a segregate genus, *Saltugilia*, and leave the second group (*G. scopulorum* etc.) in their genus

Gilia. I of course believe that these groups should be treated at the rank of section rather than genus. Otherwise I agree that there is a problem concerning the closeness of the relationships between the two groups and within the second group itself. More morphological, breeding, and molecular studies are desirable to clarify the relationships. In the meantime we have the practical problem of making a place for the second group in the classification system. In the present system, the species of the second group are retained in the sect. *Saltugilia* until we know better what to do with them.

Subgenus 2. Greeneophila Brand, Pflanzenreich 4(250):144. 1907. TYPE: *Gilia rigidula* Benth.

Leaves with broad blades, or pinnately divided, or linear in reduced forms. Small or tiny glandular hairs, short-stalked, the glands translucent and colorless, or herbage sometimes glaucous in sect. *Campanulastrum*. Corolla varying in form: campanulate, rotate, funnelform, or trumpet-shaped. Corolla veins anastomosing or non-anastomosing (see section descriptions). Stamens often inserted in corolla tube or throat, but sometimes in sinuses (see section descriptions). Pollen yellow or cream, but blue in one species (in sect. *Giliastrum*). Seeds generally numerous in capsules; mucilaginous or non-mucilaginous (see section descriptions). Flavonoids of type B (6-methoxyflavonols) present in sects. *Giliastrum* and *Gilmania*; no data for the other sections. Basic number $x = 9$ present in all sections; $x = 9$ and 8 in sect. *Giliandra*.

Section 4. Giliastrum Brand, Pflanzenreich 4(250):147. 1907. TYPE: *Gilia rigidula* Benth. *Giliastrum* Rydb., Fl. Rocky Mts., ed. 2, 699, 1066. 1922. *Bryantiella* J.M. Porter, Aliso 19:70. 2000. TYPE: *Gilia palmeri* S. Wats., Proc. Amer. Acad. Arts 24:61. 1889. *Dayia* J.M. Porter, Aliso 19:71. 2000. TYPE: *Gilia scabra* T.S. Brandegee, Zoe 5:166, 1903.

Perennial herbs with a soft woody base and some annuals, stems branching from base. Leaf consisting of a broad blade with serrate margin, or blade cleft and with lobes, or reduced to a narrow linear rachis with narrow lobes. Corolla generally campanulate or rotate, rarely funnelform (in *G. scabra*); large or small. Corolla violet, blue, pink, or white, sometimes with a yellow tube. Corolla veins separate and non-anastomosing, except in *G. rigidula* where they do anastomose (see Materials and Methods). Stamens inserted in corolla base or throat. Pollen usually yellow, sometimes white, blue in one species (*G. scabra*). Seed coat mucilaginous when wet. Basic number $x = 9$; $n = 6$ and 12 occur in *G. insigne*.

Distribution and taxa.—Colorado and Kansas to Texas and northern Mexico and Baja California, also in temperate South America. Often in semiarid or arid plains and deserts. Twelve species: *G. castellanosii* (S. Amer.), *G. foetida* (S. Amer.), *G. glutinosa* (S. Amer.), *G. incisa*, *G. insigne*, *G. gypsophylla*, *G. ludens*, *G. palmeri*, *G. purpusii*, *G. rigidula*, *G. scabra* (includes *Dayia grantii* J.M. Porter pending further study), *G. stewartii*. See Turner (1994) for a treatment of the Texas and Mexican species. Porter and Johnson (2000) treat *Giliastrum* as a genus.

Gilia castellanosii (J.M. Porter) V.E. Grant, comb. nov. *Giliastrum castellanosii* J.M. Porter, Aliso 19:75. 2000.

Comment.—Gilia scabra of Baja California was poorly understood for many years. Brandegee (1903), who described it, stated that it was related to *Gilia floribunda* in section *Siphonella*. These are old names for *Linanthus nuttallii*. When compiling a list of species names in the 1950s, I followed Brandegee and listed *Gilia scabra* as a synonym of *Linanthus nuttallii* (Grant 1959, p. 140). I did not see herbarium material until much later. Recently Porter has studied this species in the field and laboratory, and gives a full description of its morphology (Porter and Johnson 2000). He also presents molecular evidence as noted below. Porter proposes a new genus, *Dayia*, for *D. scabra* and the closely related *D. grantii*. *G.* (or *D.*) *scabra* seems to fit into sect. *Giliastrum*, though it does differ from other species of *Giliastrum* in having funnelform corollas and blue pollen. Alva Day also views *G. scabra* as a member of sect. *Giliastrum* (pers. comm.).

The molecular evidence consists of sequence variation for the chloroplast gene *matK* and ribosomal ITS (Johnson et al. 1996; Porter 1997; Prather et al. 2000). Molecular evidence could help greatly to clarify the relationships of *Gilia scabra*, but in fact only raises more questions. In the DNA cladograms, *Gilia scabra* forms a clade consisting of itself and *Loeselia glandulosa*. This result is puzzling. *Gilia* sect. *Giliastrum* is only distantly related to *Loeselia* (Grant 2003b). *Gilia scabra* does not have the phenetic characters of *Loeselia*. In the cladograms *Gilia scabra* is adjacent to a *Giliastrum* clade, but *Loeselia glandulosa* seems very much out of place. The possibility of mislabelling plant material suggests itself. The assays of *Gilia scabra* and *Loeselia glandulosa* should be repeated. For the present it seems best to treat *G. scabra* as a member of sect. *Giliastrum*. In the future, with more study, it might be assigned to a new section, *Dayia*, related to sect. *Giliastrum*.

Gilia palmeri of Baja California and *G. glutinosa* of Peru and Chile have been treated as a related amphitropical species pair in sect. *Giliastrum* (Grant 1959). Porter proposes to treat them as a new bitypic genus, *Bryantiella* (Porter & Johnson (2000). The phenetic characters to support this change are not impressive. Porter has some molecular evidence from cpDNA and rDNA to support this proposal but this is unpublished (Porter & Johnson 2000, p. 71). I think these two species belong in sect. *Giliastrum*, and Alva Day (pers. comm.) is of the same opinion.

Section 5. Giliandra A. Gray, Proc. Amer. Acad. 8:276. 1870. Type: *Gilia stenothyrsa* A. Gray. *Aliciella* sect. *Giliandra* J.M. Porter, Aliso 17:27. 1998. *Aliciella* Brand, Pflanzenreich 4(250):150. 1907. Type: *Gilia triodon* A. Eastwood.

Woody-based perennials, short-lived perennials, biennials, and annuals. Plants scapose with a basal leaf rosette, central leader stem, and cymose inflorescence. Lower leaves leathery, pinnate, with a strap-shaped rachis and short lobes. Flowers showy in the perennial and biennial species, mostly small and inconspicuous in the annual species. Corolla in the large-flowered species funnelform or sometimes trumpet-shaped; blue, red, or pink. Corolla veins anastomosing (see Materials and Methods). Stamens inserted in corolla tube or sinuses. Pollen mostly yellow or cream-colored, rarely blue. Seeds not mucilaginous or only slightly so when wet. Two basic numbers, $x = 9$ and 8; $n = 8$ is common in the perennial and biennial species; polyploids are common in the annual species.

Distribution and taxa.—Colorado Plateau, Rocky Mountains, and adjacent plains for the perennial and biennial species; Mojave desert and neighboring deserts for the annual species. Nineteen species. *G. caespitosa, G. formosa, G. haydenii, G. heterostyla, G. humillima, G. hutchinsifolia, G. leptomeria, G. lottiae, G. mcvickerae, G. micromeria, G. nyensis, G. pentstemonoides, G. pinnatifida, G. sedifolia, G. stenothyrsa, G. subacaulis, G. subnuda, G. tenuis, G. triodon.*

Gilia humillima (Brand) A.G. Day ex V.E. Grant, comb. nov. Aliciella *triodon* var. *humillima* Brand, Pflanzenreich 4(250):150. 1907. *Aliciella humillima* J.M. Porter, Aliso 17:41.1998.

Comment.—Porter (1998) has recently revised sect. *Giliandra*, and treats it as a genus, *Aliciella*. He includes the *Gilia latifolia* group in *Aliciella*, whereas I assign it to a neighboring section, *Gilmania*. Porter's (1998) treatment contains much information about the geographical distribution, habitats, chromosome numbers, and other features of the species.

Section 6. Gilmania (H.L. Mason & A.D. Grant) V.E. Grant & A.D. Grant, Aliso 3:299. 1956. Type: *Gilia latifolia* S. Wats. *Gilia* subgen. *Gilmania* H.L. Mason & A.D. Grant, Madroño 9:205. 1948. *Aliciella* subgen. *Gilmania* J.M. Porter, Aliso 17:43. 1998.

Woody-based perennials and annual herbs. Plants scapose with a basal rosette, central leader, and cymose inflorescence. Lower leaves with a broad blade, lobed margin, and sharp-tipped lobes. Corolla funnelform, pink. Corolla venation not recorded. Stamens inserted in corolla tube. Pollen yellow. Seeds not mucilaginous or only slightly so when wet. Basic number $x = 9$.

Distribution and taxa.—Deserts from southeastern California to Utah. Two species: *G. latifolia* (annual) and *G. ripleyi* (perennial).

Section 7. Campanulastrum Brand, Pflanzenreich 4(250):144. 1907. Type: *Gilia campanulata* A. Gray. *Gilia* subgen. *Campanulastrum* H.L. Mason & A.D. Grant, Madroño 9:219. 1948. *Tintinabulum* Rydb., Fl. Rocky Mts., ed. 2, 698, 1065. 1922. Type: *Gilia filiformis* Parry ex A. Gray. *Gilia* subgen. *Tintinabulum* H.L. Mason & A.D. Grant, Madroño 9:220. 1948.

Small annuals. Stems very slender and wiry, branching from base and spreading. Pubescence glandular-puberulent, or commonly glabrous in *G. filiformis*. Leaves small and linear. Flowers solitary. Corolla campanulate, small, yellow or cream. Veins non-anastomosing (A. Day, pers. comm.). Stamens inserted in corolla throat or tube. Pollen yellow. Seeds mucilaginous when wet. Basic number $x = 9$, diploids.

Distribution and taxa.—Desert mountains, California to Utah and Arizona. Three species: *G. campanulata*, *G. filiformis*, *G. inyoensis*.

Comment.—Some phenetic characters of sect. *Campanulastrum* relate it to sect. *Giliastrum*, other characters relate it to sects. *Giliandra* or *Gilmania*. The molecular cladograms for ribosomal ITS and chloroplast genes *trnL* and *matK* show a *Campanulastrum* clade adjacent to a *Giliandra* clade (Johnson and Weese 2000). These authors list the species under generic names, *Linanthus* and *Aliciella*.

The question is how to express the relationships in the taxonomic system. Sect. *Campanulastrum* does not fit neatly into any one of the other sections in subgen. *Gilia*. Including the *Gilia campanulata* group in sect. *Giliastrum* as in Grant (1959) is not the answer. Segregating it as a genus *Tintinabulum* (Rydberg 1922; Grant 1999) obscures the relationship. Treating this group as a section in subgen. *Greeneophilia* seems to be the best solution.

Genus 2. Lathrocasis L.A. Johnson, Aliso 19:67. 2000. TYPE: *Gilia tenerrima* A. Gray.

Small annuals with small flowers. Stems branching from base and ascending. Leaves linear, with one or two lateral lobes, or simple. Pubescence of tiny stipitate glandular hairs with a black dot-like head. Corolla broad-throated funnelform, white or bluish with yellow spots in throat. Corolla veins branching but not anastomosing (Johnson & Weese 2000; Day, unpubl.). Stamens inserted in corolla throat. Pollen white. Pollen exhibiting an unusual zonocolporate condition with the pores in a broad equatorial band (Grant & Day 1999). Seeds rounded, 1 per locule, mucilaginous when wet. Flavonoids not reported. $2n = 36$, $x = 9$. See Johnson and Weese (2000) for a more detailed morphological description.

Distribution and taxa.—One species, *L. tenerrima*. Western mountains from Sierra Nevada, California, to Montana, Wyoming, and Utah.

Comment.—*Gilia tenerrima* possesses a unique combination of characters making it difficult to place in the system. On the basis of some characters, Day and I formerly placed this species in or near the *Gilia campanulata* group (Day 1993a; Grant & Day 1999). However, the more recent molecular evidence does not support this assignment (Johnson & Weese 2000).

A cladogram for rDNA ITS shows *G. tenerrima* as a clade adjacent to the sections *Saltugilia*, *Arachnion*, and *Gilia*. Cladograms for chloroplast genes *trnL* and *matK* agree with the ribosome cladogram (Johnson and Weese 2000). *Gilia tenerrima* is widely separated from *G. campanulata* in all three cladograms. It also differs from the *G. campanulata* group in seed coat sculpturing (Johnson et al. 2004).

In fact, *G. tenerrima* falls outside the range of variation of the genus *Gilia* as described in this paper. It differs from *Gilia* as described here in the type of glandular pubescence, seed shape and number, pollen color, and distribution of pores on the pollen grains.

Gilia tenerrima resembles *Allophyllum* in a number of phenetic characters (Grant 1999; Grant & Day 1999). However, this indication of relationships is not supported by the molecular evidence. *Gilia tenerrima* and *Allophyllum* fall in separate major clades in the molecular cladograms of Johnson and Weese (2000).

Johnson and coworkers set up a new monotypic genus, *Lathrocasis*, for *G. tenerrima* (Porter & Johnson 2000; Johnson & Weese 2000). This is a good solution for the taxonomic problem and is followed here.

Future study of *L. tenerrima* should include cytotaxonomic work. The few populations that have been chromosome-counted are tetraploid. Diploids could well turn up with further exploration and they might shed some light on the ancestry of the known tetraploid form.

DISCUSSION

Phylogenetic Relationships in the *Gilia* Tribe

The tribe Gilieae as defined by Grant (2001, 2003b, this paper) contains the temperate herbaceous members of the family with zonocolporate pollen, as contrasted with other temperate herbaceous groups which have pantoporate pollen. The tribe consisted of the genera *Gilia*, *Ipomopsis*, *Eriastrum*, *Langloisia*, and *Tintinabulum* in the recent treatments (Grant 2001, 2003b). In the present treatment, *Tintinabulum* is reduced to a section of *Gilia* (sect. *Campanulastrum*), and *Lathrocasis* is taken up, resulting in a tribe composed of *Gilia*, *Lathrocasis*, *Ipomopsis*, *Eriastrum*, and *Langloisia*.

The genera fall into two grades with respect to the basic chromosome number, which is $x = 9$ in *Gilia* and *Lathrocasis*, and $x = 7$ in *Ipomopsis*, *Eriastrum*, and *Langloisia*. $X = 9$ is the ancestral condition in the Polemoniaceae and $x = 7$ is derived (Grant 1959).

Gilia is regarded as basal in the tribe and the seven-paired genera as advanced. The latter do exhibit some advanced phenetic characters, such as bracteate flowering heads in *Eriastrum*, bilateral corollas in *Langloisia*, and hummingbird and hawkmoth flowers in *Ipomopsis*. The summer-blooming habit of *Eriastrum* and lowland species of *Ipomopsis* may be an advanced trait.

The woody-based perennials in *Gilia* sect. *Giliastrum* appear to be basal within *Gilia*. The other sections represent branches in a series of radiations. The California-centered annual gilias (sects. *Gilia*, *Arachnion*, *Saltugilia*) are one such major branch. Section *Giliandra* with $x = 9$ and also the reduced number $x = 8$ is another.

The seven-paired genera *Eriastrum* and *Ipomopsis* can be viewed as offshoots of one or two sections of perennial gilias in subgen. *Greeneophila*. The small desert genus *Langloisia* seems to be an offshoot of *Eriastrum*. *Lathrocasis* ($x = 9$) appears to be related to the California-centered annual gilias.

The molecular cladistic approach of Porter and Johnson (2000) and Johnson et al. (2004) leads to a very different classification, as mentioned in the introduction (see also Grant 2001). First, Gilia s. l. is broken up into numerous smaller genera (Table 1). Second, the segregate genera are assigned to three different tribes (Table 1).

Third, these tribes contain mixtures of genera with different ancestral roots as indicated by phenetic characters. For example, Porter and Johnson (2000) group the equivalent of Grant's *Gilia* subgen. *Gilia* together with *Allophyllum* and *Collomia* in their tribe *Gilieae* (Table 1). This is a non-monophyletic grouping according to strong phenetic evidence (Grant 1998, 2001, 2003b). The tribe *Loeselieae* of Porter and Johnson (2000) is also non-monophyletic, containing a mixture of *Loeselia* and most of *Gilia* subgen. *Greeneophila* (Table 1). *Loeselia* and *Gilia* have different roots and are assigned to different subfamilies in the taxonomic system (Grant 2003b).

Gilia Is Not Polyphyletic

Johnson et al (1996) state that *Gilia* s. l. is polyphyletic, repeating the statement several times for emphasis. The same conclusion is stated in other molecular systematic papers (Porter 1998; Porter & Johnson 2000; Weese & Johnson 2001). The authors do not present an explicit verbal justification for their claim. However, it is clear from the context that the basis for their conclusion is a broad incongruence between the existing taxonomic classification of *Gilia* s. l. and their molecular cladograms.

The comprehensive family-wide cladograms of Johnson et al. (1996) were the forerunner of a reclassification of the family as a whole including the *Gilia* complex. The molecular evidence consisted of the sequence variation in the chloroplast gene *matK*. Johnson et al. (1996) made the assumption that the cladograms for *matK* provide a reliable guide for the phylogeny of the species in the family. The clades were assigned informal taxonomic names.

Porter and Johnson (2000) set out to construct a phylogenetic classification system based on molecular evidence; and in practice they took up the cpDNA *matK* clades of Johnson et al. (1996) and transformed these into formal taxonomic groups with taxonomic names. The primary and secondary molecular clades became subfamilies and tribes respectively. Third-order clades became genera or small sets of genera. Evidence from studies of other DNA regions played a supporting role: rDNA ITS (Porter 1997, 1998) and rDNA ITS and cpDNA *trnL* (Johnson & Weese 2000).

Full descriptions of phenetic characters were attached to the taxonomic groups of Porter and Johnson (2000), but it is difficult to see what effect, if any, the phenetic characters had on the circumscription of the groups. In cases of conflict between molecular and phenetic evidence, the molecular evidence routinely prevails.

A comparison of the Porter and Johnson (2000) system with other systems before 2000 is thus a comparison of a cladistic system based primarily on DNA data with a taxonomic classification based primarily on phenetic characters.

In the molecular cladograms of Johnson et al. (1996), clades containing the subgroups of *Gilia* s. l. are scattered in different positions on the graph, and other genera such as *Eriastrum* and *Ipomopsis* lie between them. This topology indicates non-monophyly in cladistics, which uses the cladistic definition of monophyly; and it is probably the basis for Johnson et al.'s (1996) conclusion that *Gilia* is "extremely" polyphyletic. However, the topology is quite consistent with the concept of monophyly used by taxonomic students of *Gilia*. This is an example of a "false accusation" of polyphyly, as mentioned in the introduction.

The pattern of the molecular cladograms is consistent with the phylogenetic hypothesis that *Gilia* s. l. is a basal multisection genus in the tribe *Gilieae*. The sections differ in molecular as well as phenetic characters. Some sections of *Gilia* have given rise to derived genera such as *Eriastrum* and *Ipomopsis*, and these lie between sections of *Gilia* in the cladograms. The same pattern is seen in molecular cladograms of other plant groups and is often misinterpreted as evidence for polyphyly (see Grant 2003a).

Actually, the molecular evidence is in reasonably good agreement with the taxonomic classifications of *Gilia* s. l. The big incongruence is between the taxonomic classification and the molecular-based system. This suggests that the incongruence, or much of it, has developed in the process of converting molecular clades into taxa.

The Genus Concept in *Gilia*

The goal in both evolutionary taxonomy and molecular cladistics is to circumscribe genera so that they are natural or monophyletic. Beyond this basic goal, it is possible, in either school, to adjust the boundaries in various ways ranging from lumping to splitting. The two schools also apply different criteria for circumscription: significant phenetic differences between genera in evolutionary taxonomy, distinctive molecular clades in molecular cladistics. The results are seen in current treatments of *Gilia* where one school's sections are another school's genera.

Alva Day and I and other earlier evolutionary taxonomists such as Herbert Mason (Mason & Grant 1948) have favored a broad multisection genus *Gilia* because the broad circumscription expresses the interrelationships of the sub-branches. Splitting the sections off as a series of segregate genera (*Aliciella*, *Giliastrum*, etc.) obscures their interrelationships. Having one generic name (*Gilia*) for a related set of sections, rather than a different generic name for each subdivision, reinforces the sense of interrelationship, and in addition reduces the memory burden, and facilitates preliminary identification in the field or herbarium.

Gilia s. l. is more difficult to define diagnostically than its constituent sections, but it can be defined. Gilia as treated here is a genus of temperate herbaceous Polemoniaceae that has zonocolporate pollen, a basic chromosome number of $x = 9$, a spring-blooming habit, and generally angular seeds.

ACKNOWLEDGMENTS

Alva G. Day furnished valuable information and opinions. Tom Wendt was helpful in the U.T. Herbarium. Rancho Santa Ana Botanic Garden and Field Museum made loans of herbarium specimens and J.M. Porter donated some specimens. Karen A. Grant read the manuscript. Their help is gratefully acknowledged.

REFERENCES

Bentham, G. and J.D. Hooker. 1873–1876. Genera plantarum. Vol. 2. Reeve and Co., London.

Brandegee, T.W. 1903. Notes and new species of lower California plants. Zoe 5:155–174.

Cronn, R.C., R.L. Small, T. Haselcorn, and J.F. Wendel. 2002. Rapid diversification of the cotton genus (*Gossypium*, Malvaceae) revealed by analysis of sixteen nuclear and chloroplast genes. Amer. J. Bot. 89:707–725.

Day, A.G. 1993a. *Gilia*. In: J.C. Hickman, ed. The Jepson manual: higher plants of California, pp. 828–837. Univ. of California Press, Berkeley, California.

Day, A.G. 1993b. New taxa and nomenclatural changes in *Allophyllum*, *Gilia*, and *Navarretia* (*Polemoniaceae*). Novon 3:331–340.

Day, A.G. and R. Moran. 1986. *Acanthogilia*, a new genus of *Polemoniaceae* from Baja California, Mexico. Proc. Calif. Acad. Sci. 44:111–126.

Ferguson, C.J. and R.K. Jansen. 2002. A chloroplast DNA phylogeny of eastern *Phlox* (*Polemoniaceae*): implications of congruence and incongruence with the ITS phylogeny. Amer. J. Bot. 89:1324–1335.

Grant, A.D. and V. Grant. 1956. Genetic and taxonomic studies in *Gilia*. 8. The cobwebby gilias. Aliso 3:203–287.

Grant, V. 1959. Natural history of the phlox family. Martinus Nijhoff, The Hague.

Grant, V. 1998. Primary classification and phylogeny of the Polemoniaceae, with comments on molecular cladistics. Amer. J. Bot. 85:741–752.

Grant, V. 1999. Classification of the genus *Gilia* (*Polemoniaceae*). Phytologia 84:69–86.

Grant, V. 2001. A guide to understanding recent classifications of the family *Polemoniaceae*. Lundellia 4:12–24.

Grant, V. 2003a. Incongruence between cladistic and taxonomic systems. Amer. J. Bot. 90:1263–1270.

Grant, V. 2003b. Taxonomy of the *Polemoniaceae*: the subfamilies and tribes. Sida 20:1371–1386.

Grant, V. and A.G. Day. 1999. Transfer of some species from *Gilia* to *Allophyllum* and *Tintinabulum*, and the effects of the transfer on the generic definition of *Gilia* (*Polemoniaceae*). Phytologia 84:368–382.

Grant, V. and A.D. Grant. 1954. Genetic and taxonomic studies in *Gilia*. 7. The woodland gilias. Aliso 3:59–91.

Grant, V. and T. Wendt. 2003. Proposal to reject the name *Gilia grinnellii* (*Polemoniaceae*). Taxon 52:145–146.

Gray, A. 1886. Synoptical flora of North America. 2nd ed. Vol. 2. Ivison, Blakeman, and Taylor. New York.

Johnson, L. A., K.H. Huish, and J.M. Porter. 2004. Seed surface sculpturing and its systematic significance in *Gilia* (Polemoniaceae) and segregate genera. Internat. J. Plant Sci. 165:153–172.

Johnson, L.A., L. Schultz, D.E. Soltis, and P.S. Soltis. 1996. Monophyly and generic relationship of *Polemoniaceae* based on *matK* sequences. Amer. J. Bot. 83:1207–1224.

Johnson, L.A. and T.L. Weese. 2000. Geographic distribution, morphological and molecular characterization, and relationships of *Lathrocasis tenerrima* (*Polemoniaceae*). Western N. Amer. Naturalist 60:355–373.

Mason, H.L. and A.G. Grant. 1948. Some problems in the genus *Gilia*. Madroño 9:201–220.

McKinnon, G.E., D.A. Steane, B.M. Potts, and R.E. Vaillancourt. 1999. Incongruence between chloroplast and species phylogenies in *Eucalyptus* subgenus *Monocalyptus* (Myrtaceae). Amer. J. Bot. 86:1038–1046.

Milliken, J. 1904. A review of Californian *Polemoniaceae*. Univ. Calif. Publ. Bot. 2:1–71.

Peter, A. 1897. *Polemoniaceae*. Die natürlichen pflanzenfamilien 4(3):40–54.

Porter, J.M. 1997. Phylogeny of *Polemoniaceae* based on nuclear ribosomal internal transcribed spacer DNA sequences. Aliso 15:57–77.

Porter, J.M. 1998. *Aliciella*, a recircumscribed genus of *Polemoniaceae*. Aliso 17:23–46.

Porter, J.M. and L.A. Johnson. 2000. A phylogenetic classification of *Polemoniaceae*. Aliso 19:55–91.

Prather, L.A., C.J. Ferguson, and R.K. Jansen. 2000. *Polemoniaceae* phylogeny and classification; implications of sequence data from the chloroplast gene *ndhF*. Amer. J. Bot. 87:1300–1308.

Rieseberg, L.H. 1991. Homoploid reticulate evolution in *Helianthus*: evidence from ribosomal genes. Amer. J. Bot. 78:1218–1237.

Rieseberg, L.H., S.M. Beckstrom-Sternberg, A. Liston, and D.M. Arias. 1991. Phylogenetic and systematic inferences from chloroplast DNA and isozyme variation in *Helianthus* sect. *Helianthus* (Asteraceae). Syst. Bot. 16:50–76.

Rieseberg, L.H., J. Whitton, and C.R. Linder. 1996. Molecular marker incongruence in plant hybrid zones and phylogenetic trees. Acta Bot. Neer. 45:243–262.

Smith, D.M., C.W. Glennie, J.B. Harborne, and C.A. Williams. 1977. Flavonoid diversification in the *Polemoniaceae*. Biochem. Syst. Ecol. 5:107–115.

Turner, B.L. 1994. Taxonomic overview of *Gilia*, sect. *Giliastrum* (Polemoniaceae) in Texas and Mexico. Phytologia 76:52–68.

Weese, T.L. and L.A. Johnson. 2001. *Saltugilia latimeri*: a new species of Polemoniaceae. Madroño 48:198–204.

Whittemore, A.T. and B.A. Schaal. 1991. Interspecific gene flow in sympatric oaks. Proc. Natl. Acad. Sci. 88:2540–2544.

A NEW *CITHAREXYLUM* (VERBENACEAE) FROM ISLA SOCORRO, REVILLAGIGEDO ARCHIPELAGO, MEXICO

José Luis León de la Luz

Centro de Investigaciones Biológicas
del Noroeste (CIBNOR)
Apdo. Postal 128
La Paz, Baja California Sur, 23000, MÉXICO
jlleon04@cibnor.mx

Fernando Chiang

Departamento de Botánica
Instituto de Biología, UNAM
Apdo. Postal 70-233
México D.F. 04510, MÉXICO

ABSTRACT

A new species of Verbenaceae, *Citharexylum danirae* León de la Luz et Chiang, is described and illustrated. It is known only from the type collection at the north face of Evermann volcano in the remote Socorro Island, the largest of the Revillagigedo Archipelago, in the tropical Mexican Pacific Ocean. Its relationship to *C. caudatum* L. and *C. affine* D. Don is discussed.

RESUMEN

Se describe e ilustra una nueva especie de la familia de las Verbenáceas, *Citharexylum danirae* León de la Luz et Chiang. Hasta hoy es sólo conocida del ejemplar tipo, procedente de la vertiente norte del volcán Evermann, en la remota Isla Socorro, en el archipiélago de las Islas Revillagigedo, ubicada en el Pacífico tropical de México. Se discute su relación con *C. caudatum* L. y con *C. affine* D. Don.

Socorro Island is part of the Revillagigedo Archipelago, a group of three islands scattered off the tropical west coast of Mexico (18°45'N, 111°00'W). Socorro is located 400 km south of the southern tip of the Baja California peninsula, and about 580 km west-southwest of Cabo Corrientes, Jalisco, on the nearest west central Mexican mainland coast.

The floristic knowledge of the island and the archipelago has grown continuously since the late 19th century as result from sporadic botanical explorations, mainly describing new taxa and distributional records. Several floristic checklists also have been published (Johnston 1931; Miranda 1960; Levin & Moran 1989). The latter is the most complete, cataloguing the flora of the islands, particularly that of Socorro, which is the largest and more diverse in species (160 taxa of vascular plants), plant communities, and the richest in plant endemism (27 percent).

From three botanical explorations to Socorro Island by the first author (from 1988–1990), almost 180 duplicates were sent to Dr. Geoffrey Levin, then botanist at the San Diego Museum of Natural History (SD) and head of the Vascular Flora of Socorro Island Project, to contribute to the floristic compilation then in preparation. Of these collections, twelve taxa represent new distributional records (Levin & Moran 1989). The expeditions provided a total of 25

SIDA 21(2): 547–551. 2004

collecting days on Socorro Island that included the first-ever collections on the north side of Evermann Volcano (1150 m).

The collections made on February 25th 1990 on the north face of Evermann Volcano revealed several shrubby species, such as *Spermacoce nesiotica* (B.L. Rob.) G. A. Levin, *Chiococca alba* (L.) Hitchc., *Dodonaea viscosa* Jacq., *Zanthoxylum insulare* Rose, *Lepechinia hastata* (A. Gray) Epling subsp. *socorrensis* Moran, and *Rhamnus sharpii* M. & L.A. Johnston. These species occur in the scrubland that covers the middle elevations of the island. A terrestrial orchid (cf. *Habenaria*), collected in its vegetative stage, was never identified and represented the only member of this family with this habit on the island. Another collection (*León de la Luz 4518*) had remained undetermined in the HCIB herbarium until recently. As it is known only from one specimen it is presumed to be rare on the island. It was collected at 805 m, the highest part of the Mixed or Tropical Scrubland plant community, according to Miranda (1960) and León de la Luz et al. (1996).

The specimen was initially thought to have only inmature flowers, but a recent thorough examination revealed a couple of mature flowers, whose dissection enabled its placement as *Citharexylum*. This is only the third genus thus recorded for Verbenaceae on Socorro Island; the other being *Verbena* and *Lantana* (Levin & Moran 1989). The specimen was compared with descriptions of *Citharexylum* species in floras and monographs available for Mexico: Veracruz (Nash & Nee 1984), the west-central sector (Rzedowski & Rzedowski 2002), the Sonoran Desert (Shreve & Wiggins 1964) the Baja California Peninsula (Wiggins 1980), and the material examined by Moldenke (1958). Although seed and fruiting material was unavailable, it was determined that the specimen represent a new species differing from other taxa in both leaf and flower structure. The new species is herein described.

Citharexylum danirae León de la Luz & Chiang, sp. nov. (**Fig. 1**). TYPE: MEXICO. ISLA SOCORRO: Revillagigedo Archipelago: N side slopes of Evermann Volcano, mixed or tropical scrubland, 805 m elevation, 25 Feb 1990, *José Luis León de la Luz 4518* (HOLOTYPE: HCIB!).

Frutex ad 3 m altus; folia opposita 7–10 cm longa, 4–6 cm lata, ovata, apice acuta, glabrata; inflorescentiae racemosae 12–18 cm longae, pedicellis 1–2 mm longis, bracteatis, bracteis 2 mm longis, foliaceis, oblongo-lanceolatis; corolla albidi, 5 mm longa; calycis tubo ca. 4 mm sepalis parvis, petalis parvis; stamina robusta ca. 1.5 mm longa, filamenta parva, robusta; ovarium pyriforme, robustum, stylo parvo, ad apicem furcato, lobis 2, stigmatosis, parvis; fructus et semina ignota.

Shrub to 3 m high, stems tetragonal, nodes with prominent leaf and bundle scars; **leaves** opposite, ovate, 4–6 cm wide, acute acuminate at the apex, rounded at the base, the margins entire, the leaf blades subglabrous with sparse simple trichomes (less than 0.5 mm), the upper surface lustrous when young, less so with age, with 3-4(-5) parallel veins per side; petioles 15–25 mm long, canaliculate; **racemes terminal,** few branched, 12–18 cm in length, 20–35

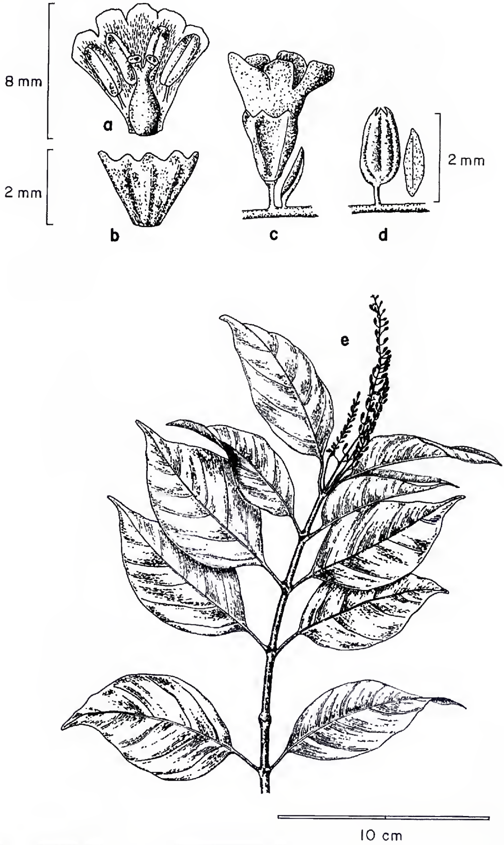


Fig. 1. *Citharexylum danirae* León de la Luz & Chiang. **a)** Dissection of calyx and corolla, note robust pistil and stamens. **b)** Flower. **c)** Flower bud and bract. **d)** Flowering branch.

TABLE 1. Morphological comparison between *Citharexylum danirae, C. caudatum,* and *C. affine.*

Characters	***Citharexylum caudatum***	***C. affine***	***C. danirae***
Habit	shrubby to arborescent	shrubby to arborescent	shrubby
Leaf size	8–17 cm × 2–6 cm	6–30 cm × 3–14 cm	7–10 cm × 4–6 cm
Leaf shape	oblong-elliptic	ovate, lanceolate-oblong	ovate
Leaf apex	short acuminate to acute	acuminate	abruptly acuminate
Leaf base	cuneate	rounded	rounded
Petioles length	0.5–2 cm	1–8 cm	1.5–2.5 cm
Inflorescences	racemes axillary and terminal	racemes terminal	racemes terminal
Pedicels	1–3 mm	1 mm	1–2 mm
Bracts length	up to 1 mm	up to 1 mm	2–2.5 mm
Corolla	white, 3–4 mm	pale blue, 4–6 mm	white-greenish, 5 mm
Corolla lobes	1–2 mm, glabrous	2–4 mm, glabrescent	1 mm, glabrous
Pistil	slender	slender	stout
Anthers	slender	slender	stout (± 1.5 mm)
Calyx at anthesis	tubular-campanulate, 2–3.5 mm	cyathiform, 3 mm	tubular, 4 mm

flowered; pedicels usually alternate along the axis, 1–2 mm; bracts oblong-lanceolate, up to 2 mm, longer than the pedicels; **calyces** to 4 mm in length at anthesis, shallowly 5 toothed, 5 nerved; **corollas** white greenish, twice as long as the calyx tubes, ± 5 mm in length, the short lobes 5, entire, not ciliate; stamens 4, anthers stout, 1.5 mm; staminode 1; ovary stout, ovoid, stout, styles 2, short; stigmas discoid-capitate; mature fruit and seeds unknown.

Etymology.—The new species is named in honor of Miss Danira León, the first author's much-loved daughter.

This new species is close to *C. caudatum* L., a widespread species in tropical Mesoamerica and northern South America, whose main resemblance is the shiny character of the upper leaf surface due to small shiny scales, although such scales seem to be only present in this new taxon at low density on young leaves. Superficially, the shape of the leaves resembles those of *C. affine* D. Don, but the flowers differ significantly. A comparison of the new species with the two species mentioned above is presented in Table 1.

The type locality has been explored botanically only once. This island sector probably harbors more interesting plants.

ACKNOWLEDGMENTS

We thank all the CIBNOR colleagues for those memorable expeditions to Socorro Island from 1988 to 1990. Thanks also to Ira Fogel for proofing the text and Oscar Armendáriz for the beautiful drawings. Critical revision by *Sida, Contributions to Botany* editorial staff, particularly Jim Henrickson, enhanced the quality of the manuscript.

REFERENCES

Johnston, I.M. 1931. The flora of the Revillagigedo Islands. Proc. California Acad. Sci. ser. 4, 20:9–104.

León de la Luz, J.L., A. Breceda, and R. Coria. 1996. Las comunidades vegetales en Isla Socorro, México. Sida 17:215–230.

Levin, G.A. and R.V. Moran. 1989. The vascular flora of Isla Socorro, Mexico. San Diego Soc. Nat. Hist. Mem. 16:1–71.

Miranda, F. 1960. La Isla Socorro: Vegetación. Monogr. Inst. Geofísica, Univer. Nac. Autón. México 2:129–152.

Moldenke, H.N. 1958. Materials toward a monograph of the genus *Citharexylum*. Phytologia 6:242–256(I); 262–320(II); 332–368(III); 383–432(IV); 448–505(V).

Nash, D.E. and M. Nee. 1984. Verbenaceae. Fascículo 41 de Flora de Veracruz. Instituto Nacional de Investigaciones sobre Recursos Bióticos. Xalapa, Veracruz. Pp. 1–154.

Shreve, F. and I.L. Wiggins. 1964. Vegetation and flora of the Sonoran Desert, 2 vols. Stanford University Press. Stanford, CA.

Rzedowski, J. and G.C. de Rzedowski. 2002. Familia Verbenaceae. Fascículo 100 de la Flora del Bajío y de regiones adyacentes. Instituto de Ecología, Centro Regional del Bajío. Pátzcuaro, Michoacán. Pp. 1–145.

Wiggins, I.L. 1980. Flora of Baja California. Stanford University Press, Stanford, CA.

BOOK REVIEW

DOUGLAS CRASE. 2004. **Both: A Portrait in Two Parts.** (ISBN 0-375-42266-8, hbk.) Pantheon Books, New York. (Orders: http://www.randomhouse.com/pantheon/catalog/). $25.00, 303 pp., 6 drawings, 34 photographs, 6" × 8".

Imagine two urbane, erudite, amusing (in several languages) characters. Make one an English aristocrat and the other heir to an American railroad fortune. Give them a group of friends who are the brightest members of the avant-garde on both side of the Atlantic Ocean. Add cameo parts for such luminaries as Juan Miro and Cary Grant. It sounds like the makings of a piece by Noel Coward or Evelyn Waugh.

What we have is a charming biography, *Both: A Portrait in Two Parts* by Douglas Crase. It is the story of the intertwined lives of the eminent botanist, Rupert Charles Barneby, and the horticulturalist-artist, Harry Dwight Dillon Ripley. They met as students at Harrow, drawn together by a mutual love of Latin and a mania for collecting plants. The relationship persisted through University and beyond, resulting in the disinheritance of Barneby by his father. Ripley was an orphan. The two men remained together for 48 years.

The author says that Ripley "was the enabling influence of Barneby's early direction as a botanist through his money, his affection, and the magnificent garden at his estate in Sussex." This place contained three greenhouses, every kind of special habitat, a herbaceous border, and a private herbarium. On the other side, Barneby with his inbred noblesse, was a buffer for the shy Ripley, who suffered from uncontrolled blushing, leading from embarrassment to panic.

After several visits to the United States, the couple moved to New York in 1939. Botany and horticulture continued to be at the center of their lives, but Ripley, the artist, also financed the Tibor de Nagy Gallery, a non-commercial enterprise, which became one of the most influential galleries in New York, when after the Second World War New York was the acknowledged leader in the arts. Ripley and Barneby were patrons and full participants in this exciting world of literature, music, and painting.

All of this is affectionately and gracefully recounted by Mr. Crase, a former MacArthur Fellow. He is not a botanist, but he was a friend of Barneby's and writes knowingly of his hard work and persistence. Although Ripley was regarded as something of a dilettante, he too left an impressive legacy. However, it is the relationship which is subject of this delightful book.—*Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

SPOROBOLUS (POACEAE: CHLORIDOIDEAE: CYNODONTEAE: ZOYSIEAE: SPOROBOLINAE) FROM NORTHEASTERN MÉXICO

Paul M. Peterson

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.
peterson.paul@nmnh.si.edu

Jesus Valdés-Reyna

Departamento de Botánica
Univerisidad Autonoma Agraria "Antonio Narro"
Buenavista, Saltillo
Coahuila 25315, MÉXICO
jvaldes@narro.uaaan.mx

Juan Javier Ortíz-Díaz

Departamento de Botánica
Univerisidad de Autónoma de Yucatán
Mérida, Yucatán 97000, MÉXICO
odiaz@tunku.uady.mx

ABSTRACT

A taxonomic treatment of *Sporobolus* R. Br. for northeastern México (Coahuila, Nuevo León, and Tamaulipas), is given. Seventeen species and one subspecies of *Sporobolus* are recognized in the study area. *Sporobolus airoides* subsp. *regis* is endemic to Coahuila, and *S. atrovirens* and *S. spiciformis* are endemic to México. Keys for determining the species, descriptions, distributions, specimens examined, illustrations, synonymies, and a brief discussion indicating relationships among all native and adventive species of *Sporobolus* in northeastern México are provided.

RESUMEN

Se presenta un estudio taxonómico de *Sporobolus* R. Br. para el noreste de México (Coahuila, Nuevo León y Tamaulipas). Se reconocen diecisiete especies y una subespecie de *Sporobolus* para el área de estudio. *Sporobolus airoides* subsp. *regis* es endémica para Coahuila, y *S. atrovirens* y *S. spiciformis* son endémicas para México. Se incluyen claves para determinar las especies, descripciones, distribuciones, especimenes examinados, ilustraciones, sinonimias, y una discusión breve indicando las relaciones entre todas las especies nativas y adventicias de *Sporobolus* para el noreste de México.

Northeastern México (Coahuila, Nuevo León, and Tamaulipas), covers an area of 291,955 km^2 or 15 % of the total land of the country. This area includes portions of two natural regions known as the Chihuahuan and Tamaulipan Deserts. These regions are considered a center of origin and diversification of arid and semi-arid plant species. As part of the current revision of the grass flora of northeastern México, an examination of the taxonomy and distribution of the species of *Sporobolus*, was begun to aid the agriculture and livestock industries. This study treats 17 species and one variety, for a total of 18 taxa.

Sporobolus R. Br. is a worldwide genus of more than 160 species occurring in the tropics, subtropics, and warm temperate regions (Clayton & Renvoize

SIDA 21(2): 553–589. 2004

1986; Peterson et al. 1997; Watson & Dallwitz 1992). There are 72 native species of *Sporobolus* in North, Central, and South America; 27 native in the United States and Canada; and 26 native in México (Espejo-Serna et al. 2000; Peterson et al. 2001, 2003, 2005). The genus is characterized by having single-flowered spikelets, 1-nerved lemmas, fruits with free pericarps or "modified caryopses" as proposed by Brandenburg (2003), and ligules with a line of hairs (Peterson et al. 1995, 1997). Species of *Sporobolus* generally inhabit dry, saline or alkaline sandy to clay loam soils in prairies, savannahs, and along disturbed roadsides (Peterson et al. 1997).

The subtribe Sporobolinae, as currently circumscribed, consists of three New World genera: *Calamovilfa* (A. Gray) Hack., *Spartina* Schreb., and *Sporobolus* (Peterson et al. 2005). In the New World the Sporobolinae share most of the same character trends as for the tribe Zoysieae, i.e., spikelets with a single floret, spiciform inflorescences of numerous deciduous racemelets disposed along a central axis, lemmas usually rounded and rarely with apical awns, and glumes often modified and oddly shaped, but differ by having modified caryposes (pericarps reluctantly free in *Spartina*), spikelets oriented abaxially along the aixis (lemma is facing the rachis), lemmas that are similar in texture to the glumes, and paleas that are relatively long and about the same length as the lemma (Peterson et al. 2005).

Within *Sporobolus*, Stapf (1898) first divided the genus into two sections: *Chaetorhacia* Stapf and *Eusporobolus* Stapf. Pilger (1956) then divided the latter section, which he elevated to *Sporobolus* subg. *Sporobolus* (Stapf) Pilg., into six groups based on life form and characteristics of the glumes and panicles. Based on caryopsis morphology, Bor (1960) divided *Sporobolus* into five rather unnatural groups (Baaijens & Veldkamp 1991). Working on the Malesian species, Baaijens & Veldkamp (1991) divided *Sporobolus* subg. *Sporobolus* into five sections based on overall morphology with special attention given to inflorescence branching. More recently, Weakley & Peterson (1998) recognized the *Sporobolus floridanus* complex to include five species in the southeastern United States and based on nuclear ribosomal DNA ITS sequences, Ortíz-Díaz & Culham (2000) presented evidence to support the recognition of at least 10 clades within *Sporobolus*. Recent major revisions of *Sporobolus* include Boechat & Wagner (1995) for Brazil, Simon & Jacobs (1999) for Australia, and Peterson et al. (2003) for the United States and Canada.

The following taxonomic treatment contains a key for determining the species, descriptions, distribution, specimens examined, illustrations, and synonymies for all native and adventive species of *Sporobolus* in northeastern México. This study is based on the examination of herbarium specimens from ANSM, COCA, MEXU, MO, NMSU, TEX, UAT, and US, including the type specimens of most of the species studied.

TAXONOMIC TREATMENT

Sporobolus R. Br., Prodr. 169. 1810. TYPE: *Sporobolus indicus* (L.) R. Br. [lectotype designated by L.K.G. Pfeiffer, Nom. Bot. 2:1274. 1874, also by Nash, Ill. Fl. N. US. (ed 2), 1:194. 1913].

Plants annual or perennial; sometimes rhizomatous, rarely stoloniferous. Flowering culms 10–250 cm tall, erect rarely mat-forming, caespitose (often forming large clumps), glabrous; leaf sheaths longer or shorter than the internodes usually with smooth margins, occasionally ciliate; ligule ciliate, a line of hairs; blades 3–70 cm long, 1–15 mm wide at base, filiform or linear, flat, involute, or terete, not pungent, cauline without auricles. Inflorescence a panicle 0.5–80 cm long, 0.3–30 cm wide, exserted or partially included in upper sheath; rachis smooth; primary branches appressed, spreading, divaricate, or reflexed from the main axis, solitary or loosely whorled, sometimes with capillary branches terminating in a spikelet; secondary branches appressed or spreading; pedicels erect, rarely secund, glabrous, scaberulous or scabrous; cleistogamous spikelets occassionally present, in axillary inflorescences. Spikelets 1–4(–7) mm long, solitary, laterally or dorsally compressed, sometimes terete; disarticulation usually above the glumes, commonly above the upper glume, occasionally below with the lemma and palea falling as a unit; glumes shorter or longer than the florets, very unequal, smooth, glabrous; lower glume without midvien or 1-veined; upper glume about the same length as the lemma, usually awnless, 1-veined; florets 1 per spikelet; lemma entire, awnless, glabrous or hairy, pubescent to pilose, 1-veined, rarely 3-veined, membranous with glabrous veins; palea glabrous, smooth, membranous, margins not enfolding the fruit, 2-veined, often splitting as grain matures; lodicules 2 or sometimes absent, truncate; stamens 2 or 3; anthers yellow, reddish-purple, or olivaceous-plumbeous; stigmas 2. Modified caryopsis a follicoid fruit with a free pericarp, commonly swelling and mucilaginous when wet; hilum punctiform; embryo with an epiblast, scutellar tail, and elongated mesocotyl internode (formula P+PF), endosperm hard. Base chromosome number, $x = 9$, and 10. Named from Greek *Sporo*, 'seed', and *bolos*, 'a throw', referring to the free seeds.

Comments.—The following five species included in this study have been placed in four different sections of *Sporobolus*: *S. atrovirens*, *S. indicus*, and *S. jacquemontii* (sect. *Sporobolus*), *S. virginicus* (sect. *Virginicae* Veldkamp), and *S. purpurascens* [sect. *Triachyrum* (Hochst. ex A. Braun) Veldkamp]. In addition to this, we recognize three prominent "groups" within the northeastern Mexican species of *Sporobolus*: 1) Airoidae – culms tall and densely caespitose; leaf blades as viewed in cross section (Annable et al. 1992) with bundle sheath extensions, first order vascular bundles with flattened adaxial ribs, second order vascular bundles with triangular ribs, and adaxial furrows above the third order vascular bundles; spiklelets dorsally compressed; modified caryopses plump; includes: *S. airoides*, *S. buckleyi*, and *S. wrightii*; 2) Cryptandrae—Leaf blades as viewed in cross section (Annable et al. 1992) with round adaxial ribs with furrows between each adjacent vascular bundle, distinctive fan-shaped bulliform cells, and lack bundle sheath extensions; spikelets laterally compressed; glumes with scabrous nerves; endosperm translucent yellow or orange; includes *S. contractus*, *S. cryptandrus*, *S. flexuosus*, *S. giganteus*, and *S. nealleyi*; 3) Pyramidatae – Panicle branches whorled or sub-whorled; embryo pandurate with a scutellum edge; includes *S. coahuilensis* and *S. pyramidatus*. These three groups parallel those presented by Ortíz-Díaz & Culham (2000) where their group E corresponds to our Cryptandrae and their group G, in part, corresponds to our Airoidae. Our Cryptandrae group is identical to the *Sporobolus cryptandrus* complex presented by Annable et al. (1992), and their *Sporobolus airoides* group includes *S. palmeri* Scribn. and *S. splendens* Swallen that do not occur in the study area.

Morphologically, *S. compositus* and *S. spiciformis* do not appear to be allied with other northeastern Mexican species of *Sporobolus*. *Sporobolus compositus* appears to be allied with *S. neglectus* Nash and *S. vaginiflorus* (Torr. ex A. Gray) Alph. Wood from the United States and Canada, whereas *S. spiciformis* is perhaps related to *S. phleoides* Hack. from Argentina. *Sporobolus compositus*, *S. neglectus*, and *S. vaginiflorus* all have contracted panicles that are included in the uppermost sheath and an embryo nearly as long as the modified caryopsis. *Sporoblous spiciformis* and *S. phleoides* also have contracted panicles with laterally compressed spikelets and upper glumes 1/4–1/2 as long as the floret.

KEY TO THE SPECIES OF *SPOROBOLUS* IN NORTHEASTERN MÉXICO

1. Plants with rhizomes.
  2. Panicles 3–10 cm long, 0.4–1.6 cm wide, contracted, spikelike, dense; culms 10–65 cm tall ____ **16. S. virginicus**
  2. Panicles 30–40 cm long, 10–15 cm wide, open, diffuse, subpyramidal; culms 80–130 cm tall ____ **1b. S. airoides** subsp. **regis**
1. Plants without rhizomes.
  3. Plants annual.
    4. Lower panicle nodes with 1–2 branches; spikelets 0.7–1.2 mm long; lemmas 0.7–1.2 mm long ____ **2. S. atrovirens**
    4. Lower panicle nodes with 7–20 branches (whorled); spikelets 1–1.8 mm long; lemmas 1.2–1.7 mm long.
      5. Pedicels 0.1–0.5(–1) mm long, appressed ____ **14. S. pyramidatus**
      5. Pedicels (2–)3–6(–8) mm long, widely spreading ____ **4. S. coahuilensis**
  3. Plants perennial.
    6. Spikelets usually more than 2.6 mm long.
      7. Lower panicle nodes with 3–5 branches ____ **13. S. purpurascens**
      7. Lower panicle nodes with 1 or 2 (–3) branches.
        8. Panicles terminal and axillary; sheaths without a conspicuous tuft of hairs at the summit ____ **5. S. compositus**
        8. Panicles all terminal, elongated; sheaths with a conspicuous tuft of hairs at the summit.

9. Culms 35–100(–120) cm tall, 2–4(–5) mm diameter near the base; mature panicles 0.2–0.8(–1) cm wide; anthers 0.3–0.5 mm long __________ **6. S. contractus**

9. Culms 100–200 cm tall, (3–)4–10 mm diameter near base; mature panicles 1–4 cm wide; anthers 0.6–1 mm long ______________ **9. S. giganteus**

6. Spikelets 1–2(–2.9) mm long.
   10. Lower sheaths strongly laterally compressed and keeled __________ **3. S. buckleyi**
   10. Lower sheaths rounded.
      11. Leaf sheaths and collar with a conspicuous tuft of white hairs.
         12. Panicles contracted, spike-like; branches appressed.
            13. Culms 35–100(–120) cm tall, 2–4(–5) mm diameter near the base ______________________________________ **6. S. contractus**
            13. Culms 100–200 cm tall, (3–)4–10 mm diameter near the base ______________________________________ **9. S. giganteus**
         12. Panicles open, branches spreading at least from the middle of the rachis to the apex, the base sometimes included.
            14. Culms 10–40 cm tall, 0.7–1.2 mm diameter near base, the base hard and knotty; blades stiff, spreading at right angles ____ **12. S. nealleyi**
            14. Culms 30–100(–120) cm tall, 1–3 mm diameter near base, the base not hard and knotty; blades erect or ascending, not stiff.
               15. Panicles usually exserted, branches divaricate and flexuous, usually tangled between branches or panicles; lower glumes 0.9–1.5 mm long ______________________ **8. S. flexuosus**
               15. Panicles usually included at the base, branches appressed or ascending, not markedly flexuous, not tangled; lower glumes 0.6–1.1 mm long ____________________ **7. S. cryptandrus**
      11. Leaf sheaths and collar glabrous (sparsely appressed pilose in *S. airoides* subsp. *regis*).
         16. Pancles 0.3–3 cm wide, spikelike, the branches appressed to main axis.
            17. Pancles 9–17 cm long, 3–5(–10) mm wide, whitish; glumes unequal, more than two thirds as long as the floret ___ **15. S. spiciformis**
            17. Panicles 7–60 cm long, 5–12 mm wide, not whitish; glumes about equal, less than two thirds as long as the floret.
               18. Spikelets 2–2.6(–2.7) mm long; upper glumes usually 1/2–2/3 as long as the florets, the apex acute to obtuse, entire ____ **10. S. indicus**
               18. Spikelets 1.4–1.8(–2) mm long; upper glumes usually less than 1/2 as long as the florets, rarely longer, the apex truncate, erose to denticulate _________________ **11. S. jacquemontii**
         16. Panicles 3–25 cm wide (somtimes only 0.3 cm wide in immature *S. pyramidatus*), open, the branches widely spreading at least from the middle of the rachis to the apex.
            19. Panicle branches widely divaricate and flexuous, usually tangled within branches or panicles ________________ **8. S. flexuosus**
            19. Panicle branches widely open or erect, not tangled.
               20. Culms 10–40 cm tall, delicate perennials, plants small; leaf blades borne near base; sheaths glabrous or with few ciliate hairs on the margins and summit.
                  21. Panicle branches arranged in whorls at lower nodes;

mature panicles pyramidal (immature and extreme forms spikelike); upper glumes 1.2–1.8 mm long ________ **14. S. pyramidatus**

21. Panicle branches solitary or paired but not in whorls at the lower nodes; mature panicles oblong to ovoid; upper glumes 0.4–0.7 mm long ____________ **2. S. atrovirens**

20. Culms 30–100(–120) cm tall, robust perennials, often forming large tough leafy tussocks; leaf blades cauline; sheaths usually bearded with long hairs on the margins and summit.

22. Panicles 10–45 cm long, the branches naked near the base; pedicels 0.5–2 mm long, usually erect, spreading ____________________________ **1. S. airoides**

22. Panicles 20–60 cm long, the branches densely flowered near the base; pedicels 0.2–0.5 mm long, appressed ______________________________ **17. S. wrightii**

1a. Sporobolus airoides (Torr.) Torr. subsp. **airoides**, Pacific Railr. Rep. Parke, Bot. 7:21 1856. (**Fig. 1, A & B**). *Agrostis airoides* Torr., Ann. Lyceum Nat. Hist. New York 1:151. 1824, non (Poir.) Raspail. *Vilfa airoides* (Torr.) Trin. ex Steud., Nomencl. Bot. (ed. 2) 2:766 1841. TYPE: U.S.A. COLORADO: on the branches of the Arkansas, near Rocky Mountains, *E James s.n.* (HOLOTYPE: NY-327612!; ISOTYPE: US-76255 fragm. & photostat ex herb. Torrey!).

Sporobolus diffusissimus Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:90. 1862. TYPE: U.S.A. TEXAS: Western Texas, 1849, *C. Wright 726* (ISOTYPE: US-3198038 fragm.!).

Sporobolus schaffneri Mez, Repert. Spec. Nov. Regni Veg. 17(19–30):295. 1921. TYPE: MÉXICO. SAN LUIS POTOSÍ: *W. Schaffner s.n.* (ISOTYPE: US-87214 fragm.!)

Sporobolus tharpii Hitchc., Proc. Biol. Soc. Wash. 41:161. 1928. TYPE: U.S.A. TEXAS: Padre Island, 4 Sep 1927, *B.C. Tharp 4772* (HOLOTYPE: US-1299827!).

Densely caespitose perennials. Culms 35–120(–150) cm tall, erect, stout, glabrous below the nodes; base diameter 1–2(–3.5)mm wide, rounded; internodes glabrous. Leaf sheaths 2/3 to about as long as the internodes above, glabrous, shinny, sometimes with a few long hairs near the summit, these hairs up to 6 mm long; ligules 0.1–0.3 mm long; blades (3–)10–45(–60) cm long, (1–)2–5(–6) mm wide, flat to involute, glabrous below and scaberulous to scabrous above; margins mostly smooth to scaberulous. Panicles (10–)15–45 cm long, 15–25 cm wide, open, diffuse, subpyramidal, often included in the uppermost sheath; branches 1.5–13 cm long, ascending to widely spreading 30–90° from culm axis; secondary branches mostly spreading and not floriferous on lower 1/4 to 1/3; pulvini in axils of primary branches glabrous; pedicels 0.5–2 mm long, spreading, glabrous to scabrous. Spikelets 1.3–2.8 mm long, spreading, purplish or greenish;.glumes 0.5–2.4(–2.8) mm long, lanceolate to ovate, membranous, unequal; lower glume 0.5–1.8 mm long, often appearing without a midvein, the apex acute; upper glume 1.1–2.4(–2.8) mm long, apex acute to obtuse; lemmas 1.2–2.5 mm long, ovate, membranous, glabrous, the apex acute; paleas 1.1–2.4 mm long, ovate, membranous, glabrous, the apex acute to obtuse; stamens 3; anthers 1.1–1.8 mm

Fig. 1. *Sporobolus airoides* ssp. *airoides*. **A.** Habit. **B.** Spikelet. *Sporobolus airoides* subsp. *regis*. **C.** Habit. **D.** Inflorescence, apical portion. **E.** Spikelet with stamens.

long, yellowish to purplish. Modified caryopses 1–1.4 mm long, ellipsoid, reddish-brown, striate. $2n = 80, 90, 108, 126$.

Distribution and habitat.—Sporobolus airoides occurs throughout the arid portions of northwestern North America and in México as far south as Puebla. It is common in dry to sandy gravely flats or slopes usually associated with alkaline soils, occurring with *Atriplex canescens* (Pursh) Nutt., *A. confertifolia* (Torr. & Frém.) S. Watson, *Larrea tridentata* (Sessé & Moc. ex DC.) Coville, *Sarcobatus vermiculatus* (Hook.) Torr., *Distichlis spicata* subsp. *stricta* (Torr.) Thorne, and *Ambrosia dumosa* (A. Gray) W.W. Payne; 50–2400 m. Flowering June through November. In northeastern México, *S. airoides* is a halophytic species forming the alkali zacaton grasslands where the edaphic effects of a diverse combination of chloride carbonates and sulfates accumulates to form very saline conditions.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Castaños, Paso de San Lázaro, Sierra de la Gavia, 37.6 mi S de Monclova, carretera 57, *Peterson et al. 9985* (ANSM, US); Municipio de Cuatrociénegas, Junto a Nuevo Atalaya, *Brigada III 4a* (COCA); Cuatrociénegas, *Brigada III 6* (COCA); 5 km N de la Poza de la Becerra, *J.A. Dávila s.n.* (ANSM); 11 km E de Cuatrociénegas, *X. Hernández 2036* (ANSM); Areas salinas S of Cuatrociénegas, *J.S. Marroquín 1351* (ANSM); Cerca de la Poza 'EL Bonito', *J.S. Marroquín s.n.* (MEXU); Dunas yesosas, cerca de la Poza El Bonito, *J.S. Marroquín s.n.* (ANSM); SE de Cuatrociénegas, *Sin collector 6* (COCA); 45 km S of Cuatrociénegas, *Peterson et al. 10002* (ANSM, US); Laderas de la Sierra de San Marcos 24 mi S Cuatrociénegas, *Peterson et al. 10008* (ANSM, US); Municipio de General Cepeda, Ejido La Rosa, carretera 40 Saltillo-Torreón, 20 km NE de General Cepeda, *S. Vásquez 82* (ANSM); Municipio de Juárez, Distrito de Riego 04, Don Martín, *P. De la Garza s.n.* (ANSM); Municipio de Ocampo, Laguna La Leche, aproximadamente 63 km de Ocampo rumbo a Sierra Mojada, *M.A. Carranza 630* (ANSM); Sierra La Encantada, rancho Puerto del Aire, *M.A. Carranza 780* (ANSM); Sierra del Pino, Ejido Acebuches, Cañón La Vaca, *M.A. Carranza 967* (ANSM); Rancho experimental La Rueda, 87 km NE de Ocampo, brecha Ocampo-Boquillas del Carmen, *D. Ibarra s.n.* (ANSM); Sierra El Pino, 9.2 km S of Rancho El Cimarrón along the eastern slope, *Peterson & Annable 10618* (ANSM, US); 35.5 km NW of Monclova and 11.3 km E of Sacramento on road to Cuatrociénegas, *Peterson et al. 8363* (ANSM, US); 4 km S de Laguna del Rey, de la Planta Quimica, *Peterson et al. 8371* (ANSM, US); 4 km S of Laguna El Rey Chemical Plant, *Peterson et al 8374* (ANSM, US); Laguna La Leche, *Valdés-Reyna 1330* (ANSM); Rancho experimental Santa Teresa de La Rueda, aproximadamente 87 km NE de Ocampo, brecha Ocampo-Boquillas del Carmen, *M. Vásquez s.n* (ANSM); Municipio de Parras, Rancho el Tunal, aproximadamente 25 km ESE de Parras de la Fuente, *A. Rodríguez 1171* (ANSM); Ejido 4 de Marzo, *F. Roing s.n.* (ANSM); 9 km S of Parras on Sierras Negras, *L. Stanford 189* (MEXU); Municipio de Ramos Arizpe, Cañada el Diente, Sierra de la Paila, altitud 1300 m., *J.A. Villarreal 5183* (ANSM); Municipio de Sacramento, 10 km de Sacramento rumbo a Cuatrociénegas, *A. Rodríguez 1229* (ANSM); Municipio de Saltillo, 53.2 km S of Saltillo on México hwy 54 and 9.6 km E on road to La Ventura, *Peterson et al 10038* (ANSM, US); 47 km S of Saltillo on México hwy 54 to Concepcion del Oro, *Peterson et al. 10034* (US); Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Sierra s.n.* (ANSM); 2 km N del ejido La Encantada, carretera Saltillo-Concepción del Oro, Zacatecas, *Valdés-Reyna 1511* (ANSM); 6 km W de General Cepeda. Carretera a Parras a orilla del camino, *Valdés-Reyna 1575* (ANSM); Buenavista, 6 km S de Saltillo por la carretera Saltillo-Zacatecas, *Valdés-Reyna 1890* (ANSM); 3 km S de la Ciudad de Saltillo, fraccionamiento Parque de la Cañada, *Valdés-Reyna 2282* (ANSM); Ejido La Colorada, aproximadamente 15 km S de Saltillo, carretera 54, Saltillo-Concepción del Oro, Zacatecas, *Valdés-Reyna s.n.* (ANSM); Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-

Concepción del Oro, Zacatecas, *J.A Villarreal 1769* (ANSM); km 34 carretera Saltillo-Concepción del Oro, Zacatecas, Entrada al rancho Los Angeles, *S. Villarruel s.n.* (ANSM); Municipio de Torreon, S of Torreon between Jimulco and Juan Eugenio, *Peterson & Valdés-Reyna 8478* (US). **Nuevo León:** Municipio de Doctor Arroyo, Ejido Lagunita y Ranchos Nuevos, *M.E. Pérez 107* (ANSM); Ejido La Escondida, 5 km N carretera 102 Doctor Arroyo-Galeana, *J.A. Villarreal 6518* (ANSM); Municipio de Galeana, along highway 57, about 12 mi N of San Roberto, *K. Allred 5515.5* (ANSM, NMCR); 5.6 mi E of jtn of hwy 57 on hwy 58 towards Linares, *Peterson & Knowles 13296* (US); 13.4 mi E of hwy 57 on hwy 58 at crossing of Rio Potosí, *Peterson & Knowles 13312* (US); Near La Trinidad, (Highway 57), 71 mi S of Saltillo, *T. Soderstrom 373* (MEXU, US). **Tamaulipas:** Municipio de Bustamante, Poblado Bustamante, *J.G. Galván 30* (COCA); Municipio de Llera, Ejido Portes Gil *J. Barrientos 97* (COCA); Municipio de Tula, Ejido Francisco Medrano, *J. Iribe 126* (COCA); Ejido 5 de Mayo, *P. Moya 64* (COCA).

KEY TO THE SUBSPECIES OF *SPOROBOLUS AIROIDES*

1. Sheaths generally glabrous or minutely scabrous on abaxial surface; primary branches of the panicle glabrous, without tufts of hairs in the axils below ____ **1a. S. airoides** subsp. **airoides**

1. Sheaths pilose on abaxial surface; primary branches of the panicle with a tuft of hairs in the axils below ____ **1b. S. airoides** subsp. **regis**

1b. Sporobolus airoides subsp. **regis** (I.M. Johnst.) Wipff & S.D. Jones, Sida 16:164. 1994. (**Fig. 1, C & D**). *Sporobolus regis* I.M. Johnst., J. Arnold Arbor. 24:393. 1943. TYPE: MÉXICO. COAHUILA: Municipio de Ocampo, salt flat 4 km SE of Laguna del Rey, abundant, 1040 m, 18 Sep 1942, *R. Stewart 2653* (HOLOTYPE: GH; ISOTYPE: US-90729 fragm.!).

Rhizomes elongate, knotty with internodes 10–12 mm long, 3–4 mm in diameter. Culms 80–130 cm tall, erect, densely leafy. Leaf sheaths and collars pilose on abaxial surface with hairs 2–4 mm long, glabrous with age; ligules 0.1–0.3 mm long, fimbriate or densely ciliolate; blades 10–30 cm long, 3–4 mm wide, usually loosely involute. Panicles 30–40 cm long, 10–15 cm wide, open, diffuse, subpyramidal, exserted or partly included below, the branches with a tuft of trichomes in the axils; glumes 1–1.8 mm long; lemmas 1.9–2.5 mm long; paleas as long as the lemma.

Distribution and habitat.—Sporoboluls airoides subsp. *regis* is an endemic species known only from Coahuila, México on saline flats of Laguna del Rey, the type locality, and Salinas del Rey. *Sporobolus airoides* subsp. *regis* is distinguished from *S. airoides* subsp. airoides by its pubescent sheaths and tuft of trichomes in the axils of the panicle branches. Wipff and Jones (1994) considered these characters not significant to warrant specific rank, however, they felt that they are significant to warrant infraspecific recognition.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Ocampo, 12 km S of Salinas del Rey, *Henrickson 14152* (TEX).

2. Sporobolus atrovirens (Kunth) Kunth, Revis. Gramin. 1:68. 1829. (**Fig. 2, A–C**). *Vilfa atrovirens* Kunth, Nov. Gen. Sp. 1:138. 1816. *Agrostis atrovirens* (Kunth) Roem. & Schult., Syst. Veg. 2:361. 1817. TYPE: MÉXICO. DISTRITO FEDERAL: in valle Mexicana prope El Penon del Marques, *Humboldt and Bonpland s.n.* (HOLOTYPE: P-Bonpl!; ISOTYPE: BM!)

Small caespitose perennials, sometimes appearing annual. Culms 7–30 cm tall,

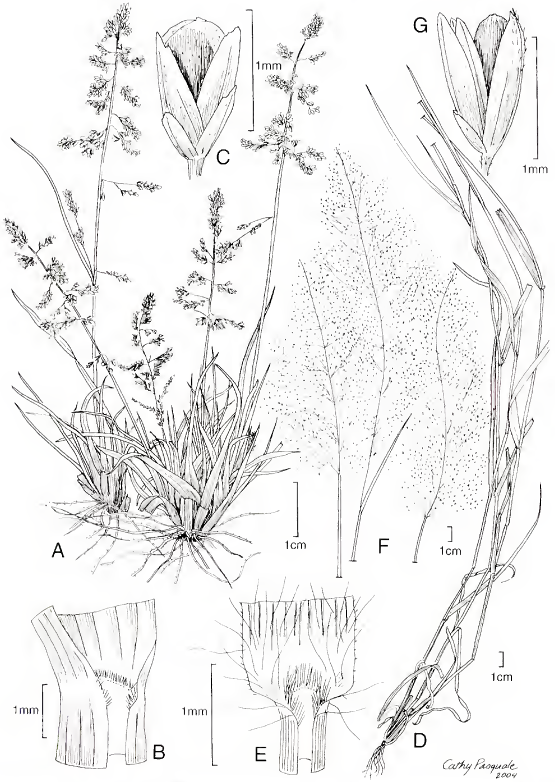


FIG. 2. *Sporobolus atrovirens*. **A.** Habit. **B.** Ligule. **C.** Spikelet with modified caryopsis. *Sporobolus coahuilensis*. **D.** Habit. **E.** Ligule. **F.** Inflorescences. **G.** Spikelet with modified caryopsis.

erect, with 1–2 nodes above the base; base diameter 0.5–0.8 mm. Leaf sheaths short, ciliolate; collar glabrous or with few hairs; ligules 0.1–0.2 mm long; blades 3–15 cm long, 2–4 mm wide, lanceolate, flat, glabrous, borne near base. Panicles 5–20 cm long, 3–10 cm wide, oblong to ovoid, completely exserted; primary branches spreading 70–120° from culm axis, naked below on lower 1/4–1/3, the lowermost solitary or paired at the nodes; pulvini in the axils of the primary branches glabrous, yellowish; pedicels 0.5–1.6 mm long. Spikelets 0.7–1.2 mm long, greenish or purplish to plumbeous; glumes without nerves, apex obtuse; lower glumes 0.3–0.5 mm long, the apex obtuse or erose; upper glumes 0.4–0.7 mm long, the apex obtuse to acute; lemmas 0.7–1.2 mm long, the apex acute to obtuse; paleas 0.9–1.2 mm long, the apex obtuse; stamens 1 or 2; anthers 0.4–0.8 mm long, purplish. Modified caryopses 0.5–0.8 mm long, pyriform or quadroid, somewhat laterally flattened, light brownish.

Distribution and habitat.—*Sporobolus atrovirens* is a rare species for northeastern México usually found occupying xeric habitats in gypsum soils at 10–1500 m. It has been reported in México in Aguascalientes, Baja California, Coahuila, Durango, Hidalgo, Guanajuato, Jalisco, México, Oaxaca, Puebla, San Luis Potosí, Tamaulipas, Tlaxcala, Veracruz, Yucatán, and Zacatecas. In the Sierra La Lagunita at 1450 m, *S. atrovirens* (*Peterson et al. 16690*) was found growing on slopes with a dominant vegetation of *Pinus pseudostrobus* Lindl., *Juniperus flaccida* Schltdl., *Juglans*, *Agave*, and *Muhlenbergia dubia* E. Fourn. Other associated native and adventive species from this site include: *Chloris*, *Tragus berteronianus* Schult., *Urochloa meziana* (Hitchc.) Morrone & Zuloaga, *Paspalum dilatatum* Poir., *Erioneuron avenaceum* (Kunth) Tateoka, *Eragrostis intermedia* Hitchc., *Oplismenus hirtellus* (L.) P. Beauv., *Bromus anomalus* Rupr. ex E. Fourn., *Schizachyrium*, and *Panicum bulbosum* Kunth. This latter site was perhaps unusual for this species since it was in a heavily wooded and shaded environment.

Specimens examined. **MÉXICO. Coahuila:** Municipio Saltillo, Los Cerritos, near Saltillo, Oct 1912, *Lyonnet sn.* (TEX). **Nuevo León:** Municipio de Monterrey, 5 mi SW of Hidalgo at Parque de Potrero (ca 15 airline mi NW of Monterrey), *B.L. Turner & J. Crutchfield 6285* (TEX). Sierra La Lagunita, 9.5 mi SE of Aramberri on road towards Agua Fria, 24° 03' 37.9" N, 99° 45' 35.8" W, 19 Sep 2002, *Peterson et al. 16690* (ANSM, US). **Tamaulipas:** Municipio de Jaumave, Altas Cumbres km 160 carretera Victoria-Jaumave, 950 m, *M. Martínez 727* (ANSM, TEX, UAT); Río Guayalejo, 2 km E del ejido San Vicente rumbo a Jaumave, 10 m, *A. Mora 5358* (UAT); Municipio de Tula, 30 km al SW de Tula, cerca del limite de San Luis Potosí and Tamaulipas, *Gonzalez Medrano F. 4422* (TEX).

3. Sporobolus buckleyi Vasey, Bull. Torrey Bot. Club 10:128. 1883. (**Fig. 3. A & B**).
TYPE: U.S.A. TEXAS: 1883, *S.B. Buckley s.n.* (ISOTYPE: US-556873!).

Caespitose perennials. Culms 40–100 cm tall, erect, glabrous, base flattened, internodes glabrous; base diameter 0.7–3 mm wide. Leaf sheaths 4/5 as long as the internodes to longer than the internodes above, glabrous, margins occasionally hairy near summit, sometimes with a line of hairs from one margin to the next, the hairs up to 1.2 mm long, lower sheaths strongly laterally compressed

Fig. 3. *Sporobolus buckleyi*. **A.** Habit. **B.** Spikelet with modified caryopsis. *Sporobolus spiciformis*. **C.** Habit. **D.** Ligule. **E.** Spikelet with stamens.

and keeled; ligules 0.2–0.4 mm long; blades 12–35 cm long, 4–12 mm wide, flat, glabrous below and scaberulous above; margins smooth to scaberulous. Panicles 15–50 cm long, 7–22(–30) cm wide, open, diffuse, ovate; primary branches ascending to widely spreading mostly 2–17 cm long, not floriferous on lower 1/4 –1/2; secondary branches appressed to loosely spreading; pulvini in axils of primary branches glabrous; pedicels 0.2–1.2 mm long, mostly apressed, scaberulous. Spikelets 1–2 mm long, purplish or brownish; glumes 0.5–1.8 mm long, narrow lanceolate to lanceolate, membranous, unequal, prominently keeled, scaberulous along the distal portion of the keel; lower glumes 0.6–1mm long, the apex acuminate to acute; upper glumes 1.1–1.8 mm long, the apex acute; lemmas 1.2–2 mm long, lanceolate, membranous, glabrous, the apex acute; paleas 1.2–2 mm long, ovate, membranous, often splitting in two between the veins at maturity, glabrous, the apex acute; stamens 3; anthers 0.2–0.4 mm long, purplish. Modified caryopses 0.6–1 mm long, ovoid, slightly flattened, reddish brown. $2n = 40$.

Distribution and habitat.—In northeastern México, *S. buckleyi* is a common species of the Tamaulipan desert scrub on loamy soils near margins of woods sometimes in partial sunlight associated with *Acacia, Quercus*, and *Prosopis* thickets and thorn scrub; 40–700 m. Flowering April to November.

Specimens examined. **MÉXICO. Nuevo León:** Montemorelos, Ojo de Agua. Matorral xerófito. *M. A. Pantí 823* (MEXU), Monterrey. *C. G. Pringle 2520* (MEXU); Municipio de Allende, 6.1 km S de Allende on México 85 towards Montemorelos, off highway on dirt road near asociation de Avicultures (grain storage), just N of Canoas, *Peterson & King 8336* (ANSM, US); Municipio de Cerralvo, Sierra de Picachos, rancho El Gallo, *S. Rodríguez 94,102* (ANSM); Sierra de Picachos, Rancho El Gallo, *J.A. Villarreal 8014* (ANSM); Municipio de Guadalupe, Guadalupe, *E. Cantú s.n.* (ANSM); Municipio de Linares, Rancho El Nogalar, ubicado en la carretera Linares-San Roberto, km 12, *M. Castillo 92* (COCA); Los Fresnos, *J. Ortíz s.n.* (ANSM); Municipio de Marín, Facultad de Agronomía, Universidad Autónoma de Nuevo León, km 17, *M. Castillo 26* (COCA); Municipio de Pesquería, A la salida del pueblo de Zacatecas rumbo a Agua Fría en las orillas del río Pesquería, *P. Jauregu 80* (COCA); Municipio de Santa Catarina, Cañón El Diente, Sierra Madre Oriental, aproximadamente 20 km S de Monterrey, *J. Valdés-Reyna 1969* (ANSM, UAT); Municipio de Santiago, 4 km N de Los Cavazos, *I. Cabral 128* (ANSM); Río San Juan, *I. Cabral 383* (ANSM); Carretera Monterrey-Marín entronque con la carretera a Zuazua, *P.A. García 1864* (COCA). **Tamaulipas:** Municipio de Abasolo, Ejido La Esperanza, *J. Iribe 149* (COCA); Municipio de Aldama, La Muralla, *R. Carranco 127* (COCA); Rancho El Rosario, *M. Cervera 211* (COCA); Ejido El Nacimiento, propieda privada, *R. Díaz 319* (UAT); Piedras Negras, *J. Galván 235* (COCA); Municipio de Antiguo Morelos, Ejido Las Flores, *J. Ramos 12* (COCA); Ejido El Refugio *J. Ramos 122* (COCA); Municipio de Casas, Rancho José Roberto, *R. Carranco 278* (COCA); Ejido Lázaro Cárdenas. A orilla de la vía de F.F.C.C., *J. Ramos 207* (COCA); Municipio de Gomez Farías, Ejido El Nacimiento, *M. Crespo 310* (ANSM); Ejido Sabinas, *M. Crespo 422* (ANSM); Municipio de González, Ejido Guadalupe Victoria, *J. Iribe 136* (COCA); 15 mi W of Gonzalez toward Mante, *M.C. Johnston 4929* (MEXU); Ejido Josefa Ortíz de Domínguez, *P. Moya 36* (COCA); Municipio de Güémez, Río Corona, *J. Iribe 298* (COCA); Municipio de Hidalgo, Ejido Nicolás Bravo, *J. Barrientos 100* (COCA); Ejido El Progreso, *J. Iribe 248* (COCA); Ejido La Colombina, *J. Iribe 262* (COCA); Rancho La Purisima, *J. Iribe 303* (COCA); Municipio de Hidalgo, Rio Los Mimbres, 20 mi W if Rio Purificación, *Peterson & Valdés-Reyna 15939* (US); Municipio de Jiménez, Ejido Sor Juana Inés de la Cruz, *R. Carranco 410* (COCA); Ejido Sor Juana Inés de la Cruz, *R. Carranco 411* (COCA); 7 mi S of Santander Jiménez, *M.C. Johnston 4393-A, 4393-B* (TEX-

LL, MEXU); Municipio de Llera, Rancho el Lloradero, *A. Brito, s.n.* (UAT); km 152 carretera Llera-Mante, *R. Carranco 272* (COCA); km 157 carretera Llera-Mante, La Mina, *R. Carranco 272a* (COCA); Camino al Ejido Lucio Blanco, *J.F. Iribe 285* (COCA), Municipio de Mainero, Ejido Boreal Real, *M. Cervera 343* (COCA); Municipio de Padilla, km 65 carretera Victoria-Matamoros, *A. Brito 63* (COCA); Municipio de San Carlos, Ejido Puerto Rico, *R. Carranco. 295* (COCA); Cerro del Diente, *R. Carranco 47* (COCA); Cerro del Diente, *J. A. Franco 92* (COCA); Cerro del Diente, *J. Iribe 94* (COCA); Municipio de San Fernando, La Joya, *R. Carranco 101* (COCA); Municipio de Soto la Marina, Rancho San Alfonso, *J. Barrientos 6* (COCA); San José de las Rusias, *M. Cervera 84* (COCA); Tramo San José de las Rusias-5 de Mayo, *J.G. Galván 161* (COCA); Ejido Verde Chico, *J.F. Iribe 337* (COCA); Los Eslabones, *J.E. López 44* (COCA); Municipio de Tampico, Laguna del Chairel, *M.G. Torres s.n.* (COCA); Municipio de Tula, Puerto de La Virgen, *A. Brito, 50* (COCA); Municipio de Victoria, Libramiento Portes Gil, *M. Cervera 305* (COCA); Ejido Santa Ana, *M. Cisneros 31, 32* (COCA); Municipio de Villagrán, La Palma, *M. Cervera 160* (COCA).

4. Sporobolus coahuilensis Valdés-Reyna, Phytologia 41:81. 1978. (**Fig. 2, D–G**). TYPE: MÉXICO. COAHUILA: 58 air mi SW of Cuatrocienegas, near 26° 17' N, 102° 40' W, 815 m, 15 Aug 1976, *J. Henrickson & B. Prigge 15363* (HOLOTYPE: LL!; ISOTYPES: CSLA, MEXU!).

Annuals. Culms 15–60 cm tall, ascending, glabrous. Leaf sheaths shorter than the internodes, glabrous; ligules 0.5–1 mm long, ciliate, the hairs 0.5–1 mm long; blades 4–12 cm long, 1.5–6 mm wide, flat, spreading, evenly distributed, sparsely ciliate-pustulate above. Panicles 6–22 cm long, (-1)5–13 cm wide, open, sometimes contracted; branches ending in a spikelet, lowest branches whorled, in verticels of 7–20; pedicels (2)3–6(-8) mm long, widely spreading, capillary. Spikelets 1.1–1.5 mm long; glumes thin, the apex acute; lower glumes ca. 0.5 mm long; upper glumes 1.4–1.5 mm long; lemmas 1.3–1.4 mm long, the apex acute; paleas 1–1.3 mm long, hyaline. Modified caryopses 0.6–0.9 mm long, oblong, light brown; embryo 0.2–0.4 mm long.

Distribution and habitat.—In México, *S. coahuilensis* is known only from Central Coahuila, near Las Delicias and Cuatrocienegas. This species has recently been found in Texas (per. comm. B.L. Turner).

Comments.—*Sporobolus coahuilensis* appears closely related to *S. pyramidatus*, a widespread species, and can be separated from the latter species by having long capillary pedicels and wider panicles.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Cuatrociénegas, SE de Cuatrociénegas, *Brigada III 1* (COCA); cerca 45 km SW of Cuatrociénegas, 760 m., *Peterson et al. 10000* (ANSM, US).

5. Sporobolus compositus (Poir.) Merr. var. **compositus**, Circ. Div. Agrostol. U.S.D.A. 35:6. 1901. (**Fig. 4, A–C**). *Agrostis composita* Poir., Encycl. 1:254. 1810. *Vilfa composita* (Poir.) P. Beauv., Ess. Agrostogr. 16, 147, 181. 1812. *Muhlenbergia composita* Trin. ex Kunth, Enum. Pl. 1:229. 1833, *nom. inval.* TYPE: U.S.A. "CAROLINA": *L.A.G. Bosc s.n.* (HOLOTYPE: not known).

Agrostis aspera Michx., Fl. Bor.-Amer. 1:52. 1803, nom. illeg. non Weber. *Vilfa aspera* P. Beauv., Ess. Agrostogr. 16, 147, 181. 1812. *Muhlenbergia aspera* (P. Beauv.) Trin., Gram. unifl. sesquifl. 193. 1824. *Sporobolus asper* (P. Beauv.) Kunth, Révis. Gram. 1:68. 1829. TYPE: U.S.A. ILLINOIS: *A. Michaux s.n.* (HOLOTYPE: P-MICH; ISOTYPE: US-76431 fragm. & photo ex P!).

Agrostis longifolia Torr., Fl. N. Middle United States 1: 90. 1823. *Vilfa longifolia* (Torr.) Torr., N. Amer.

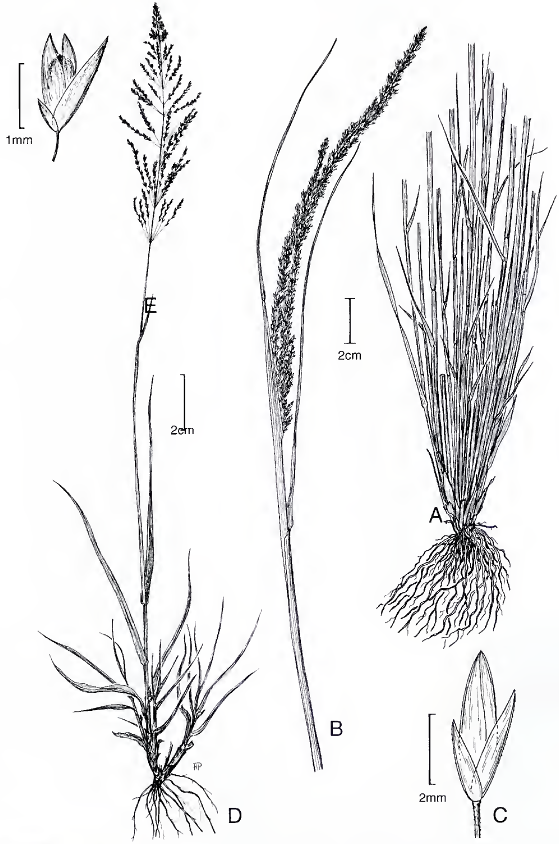


Fig. 4. *Sporobolus compositus*. **A.** Habit. **B.** Inflorescence. **C.** Spikelet. *Sporobolus pyramidatus*. **D.** Habit. **F.** Spikelet with modified caryopsis.

Gram. 1:4. 1834. *Sporobolus longifolius* (Torr.) Alph. Wood, Class-book Bot. (ed. 1861) 1861:775. 1861. Type: U.S.A. Pennsylvania: (holotype: not known).

Vilfa hookeri Trin., Mêm. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(1–2):106. 1840. *Sporobolus asper* var. *hookeri* (Trin.) Vasey, Descr. Cat. Grass. U.S. 43. 1885. Type: U.S.A. Texas: *T. Drummond 306* (isotypes: US-997649 fragm.!, US-997663 fragm.!)

Glyceria stricta Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:95. 1862, nom. illeg. hom., non Hooker f. Type: U.S.A. Texas: middle Texas, *S.B. Buckley s.n.* (lectotype: PH, designated by Hitchcock, Man. Grass. U.S. 958. 1935, but without citing a specific sheet in a specific herbarium; isolectotype: US fragm. & photo ex PH!).

Sporobolus pilosus Vasey, Bot. Gaz. 16(1):26. 1891. *Sporobolus asper* unranked *pilosus* (Vasey) Hitchc., Proc. Biol. Soc. Wash. 41:161. 1928. *Sporobolus asper* var. *pilosus* (Vasey) Hitchc., N. Amer. Fl. 17(7):488. 1928. Type: U.S.A. Kansas: Coolidge, 1890, *B.B. Smyth 217* (holotype: US-556890!; isotypes: US-746585!, US-75038!).

Caespitose to solitary-stemmed perennials. Culms (20–)30–130(–150) cm tall, glabrous below the nodes, internodes glabrous; base diameter 0.7–5 mm wide. Leaf sheaths 3/4 to 1 1/2 as long as the internodes above; upper (terminal) sheaths 1–6 mm wide, mostly glabrous, summit with a few hairs up to 3 mm long; ligules 0.1–0.5 mm long; blades 5–70 cm long, 1.5–10 mm wide, flat to folded or involute, glabrous below and glabrous to scaberulous above, sometimes pilose just above the ligule, rarely pilose throughout; margins mostly glabrous. Panicles 5–30 cm long, 0.4–1.6(–3) mm wide, terminal and axillary, narrow, sometimes densely spike-like, the base usually included in the uppermost sheath; primary branches 0.4–6 cm long, appressed, usually floriferous to base; secondary branches appressed; pedicels 0.3–3.5 mm long, appressed, glabrous to scaberulous. Spikelets 4–6 (–10) mm long, stramenious to purplish-tinged; glumes (1.2–)2–5(–6) mm long, lanceolate, membranous to chartaceous, usually with a greenish midvein that is scrabous towards the apex, subequal; lower glumes (1.2–)2–4 mm long, the apex acute; upper glumes (2–)2.5–5(–6) mm long, the apex acute; lemmas (2.2–)3–6(–10) mm long, lanceolate, membranous to chartaceous, rarely 2- or 3-veined, glabrous to minutely pubescent or long, ovate to lanceolate, membranous to chartaceous, the apex acute to obtuse; stamens 3; anthers 0.2–3.2 mm long, yellow to orangish. Modified caryopses 1–3 mm long, ellipsoid and laterally flattened, often striate, reddish brown. 2*n* = 54, 88, 108.

Distribution and habitat.—A rare species in northeastern México, only known from a single collection initially determined by F.W. Gould. Roadsides, railroad right of ways, beaches, cedar glades, pine woods, live oak-pine forests, prairies and many other partially disturbed, semi-open sites; 0–1600 m. Flowering August to November.

Specimen examined. **MÉXICO. COAHUILA.** Municipio de Muzquiz, La Boquilla, Rancho La Encantada, *J. A. Santos s.n.* (ANSM).

6. Sporobolus contractus Hitchc., Amer. J. Bot. 2:303. 1915. (**Fig. 5, A–D**). *Sporobolus cryptandrus* var. *strictus* Scribn., Bull. Torrey Bot. Club 9:103. 1882. *Sporobolus strictus* (Scribn.) Merr., Circ. Div. Agrostol. U.S.D.A. 32:6. 1901, *non* Franchet. Type: U.S.A. Arizona: Banks of Rillita [Rillito] Brook, near Camp Lowell, 15 Jun 1881, *C.G. Pringle s.n.* (isotype: US-825284!).

Fig. 5. *Sporobolus contractus*. **A.** Inflorescence. **B.** Sheath, blade, and portion of culm. **C.** Lower glume. **D.** Spikelet with modified caryopsis. *Sporobolus cryptandrus*. **E.** Habit. **F.** Glumes. **G.** Floret with modified caryopsis.

Caespitose perennials. Culms 35–100(–120) cm tall, erect, glabrous below the nodes, rrounded near base, internodes glabrous; base diameter 2–4(–5) mm long. Leaf sheaths 3/4 to longer than the internodes above, glabrous; margins with ciliate hairs especially on the upper portions, these hairs up to 3 mm long forming a conspiuous tuft near the summit; ligules 0.4–1 mm long; blades (2–)4–35 cm long, 3–8 mm wide, flat to involute, glabrous below and above; margins whitish, somewhat scaberulous. Panicles (10–)15–45(–50) cm long, 0.2–0.8(–1) cm wide, narrow, tightly contracted, dense and spike-like, usually included in the uppermost sheath; primary branches 0.3–1.5 cm long, appressed; secondary branches appressed and floriferous to base; pulvini in axils of primary branches glabrous; pedicels 0.2–2 mm long, appressed, scaberulous. Spikelets 1.7–3.2 mm long, whitish to plumbeous; glumes 0.7–3.2 mm long, narrow lanceolate, membranous, unequal, prominently keeled, scaberulous along the keel; lower glumes 0.7–1.7 mm long, rarely without a midvein, the apex acute to acuminate; upper glumes 2–3.2 mm long, the apex acute; lemmas 2–3.2 mm long, linear membranous, glabrous, the apex acute; paleas 1.8–3 mm long, linear lanceolate, membranous, glabrous, the apex acute; stamens 3; anthers 0.3–0.5 mm long, light yellowish. Modified caryopses 0.8–1.2 mm long, ellipsoid, laterally flattened, light brownish or translucent. $2n = 36$.

Distribution and habitat.—In México, *S. contractus* ranges from Baja California, Chihuahua, and Sonoroa to Coahuila and Nuevo León on dry to moist sandy soils, occasionally in salt-desert scrub associated with *Atriplex confertifolia*, *A. canescens*, *Artemisia tridentata* Nutt., desert grasslands with *Bouteloua* and *Muhlenbergia*, and pinyon-juniper woodlands; 300–2300 m. Flowering July through November.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Ocampo, Sierra La Encantada, rancho Puerto del Aire, *M.A. Carranza 726,767* (ANSM); Municipio de Progreso, 34 mi N of Monclova on Mex hwy 57 at junction of road to Progreso, *Peterson & Valdes-Reyna 8376* (ANSM, US); 6 mi W of Saltillo along highway 40 toward Torreón, *S. Hatch 5046* (ANSM, TAES); 26 km W de Saltillo, por camino Saltillo-General Cepeda. La Noria, *Valdés-Reyna 1566* (ANSM); Municipio Ramos Arizpe, 6 km E of Ramos at Rancho Las Sabanier, *Peterson et al. 8440* (US); N of Cañada Oscura, *I. M. Johnston 8460* (MEXU). **Nuevo León:** Municipio de Doctor Arroyo, Ejido Lagunita y Ranchos Nuevos, *Pérez, M.E. 126* (ANSM).

7. Sporobolus cryptandrus (Torr.) A. Gray, Manual 576. 1848. (**Fig. 5, E–G**). *Agrostis cryptandra* Torr., Ann. Lyceum Nat. Hist. New York 1:151. 1824. *Vilfa cryptandra* (Torr.) Trin., Mem. Acad. Imp. Sci. Saint-Petersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6:69. 1840. *Sporobolus cryptandrus* var. *typicus* E.K. Jones & Fassett, nom. inval., Rhodora 52:125. 1950. TYPE: U.S.A. TEXAS or OKLAHOMA : Canadian River, E. James s.n (HOLOTYPE: NY-128298!, ISOTYPE: US-76269 fragm. & photo ex NY!).

Vilfa tenacissima var. *fuscicolor* Hook., Fl. Bor.-Amer. 2:239. 1839. *Sporobolus cryptandrus* subsp. *facicola* (Hook.) E.K. Jones & Fassett, Rhodora 52:126. 1950. *Sporobolus cryptandrus* var. *fuscicolor* (Hook.) R.W. Pohl, Iowa State Coll. J. Sci. 40:500. 1966. TYPE: U.S.A. WASHINGTON: Columbia River, Menzies [Hayden's] Island, *D. Douglas s.n.* (HOLOTYPE: not found).

Vilfa triniana Steud., Syn. Pl. Glumac. 1:156. 1854. TYPE: CANADA. BRITISH COLUMBIA: (HOLOTYPE: not found).

Sporobolus cryptandrus var. *vaginatus* Lunell, Amer. Midl. Naturalist 2:123. 1911. TYPE: U.S.A. NORTH DAKOTA: Benson County: bare, gravelly hillsides at Pleasant Lake, 28 Jul 1911, *J. Lunell 93* (HOLOTYPE: not found).

Sporobolus cryptandrus var. *involutus* Farw., Michigan Acad. Sci. Rep. 22: 179. 1921. TYPE: U.S.A. MICHIGAN: Rochester, 4 Sep 1919, *O.A. Farwell 5393* (HOLOTYPE: not found).

Sporobolus cryptandrus var. *occidentalis* E.K. Jones & Fassett, Rhodora 52:125. 1950. TYPE: U.S.A. OREGON: Baker County: bars of Snake River, Ballard's Landing, ca. 3 mi NE of Homestead, 8 Jul 1899, *W.C. Cusick 2222* (HOLOTYPE: US-362493!).

Caespitose perennials. Culms 30–100(–120) cm tall, erect to decumbent, base flattened to rounded, glabrous below the nodes, internodes glabrous; base diameter 1–3.5 mm wide. Leaf sheaths 2/3–3/4 as long as the internodes above, glabrous to scaberulous, sometimes ciliate along the upper margins, summit with a conspicuous tuft of white hairs up to 4 mm long; ligules 0.5–1 mm long; blades (2–)5–26 cm long, 2–6 mm wide, flat to involute, erect or ascending, mostly glabrous below and scaberulous above; margins scaberulous. Panicles 15–40 cm long, 2–12(–14) cm wide, narrowly pyramidal, ultimately open, main axis ascending and straight, lower branches longest, usually included in the uppermost sheath; primary branches 0.6–6 cm long, appressed or ascending, spreading 0–130° from the culm axis; secondary branches mostly appressed not floriferous on lower 1/8–1/4; pulvini in axils of primary branches ascending, glabrous; pedicels 0.1–1.3 mm long, appressed, glabrous to scaberulous. Spikelets 1.5–2.5(–2.7) mm long, brownish, plumbeous or purplish-tinged; glumes 0.6–2.5(–2.7) mm long, linear-lanceolate to ovate, membranous, unequal; lower glumes 0.6–1.1 mm long, rarely without a midvein, the apex acute to acuminate; upper glumes 1.5–2.7 mm long, the apex acute; lemmas 1.4–2.5(–2.7) mm long, ovate to lanceolate, membranous, glabrous, the apex acute; paleas 1.2–2.4 mm long, lanceolate, membranous, glabrous, the apex acute; stamens 3; anthers 0.5–1 mm long, yellowish to purplish. Modified caryopses 0.7–1.1 mm long, ellipsoid, light brownish to reddish-orange. $2n = 36, 38, 72$.

Distribution and habitat.—In México, *S. cryptandrus* ranges from Baja California, Chihuahua, and Sonora to Coahuila, Nuevo León and Tamaulipas. This species is found on sandy soils, rocky slopes, washes, calcareous ridges, and roadsides in salt-desert scrub with *Atriplex confertifolia*, *A. canescens*, *Grayia spinosa* (Hook.) Moq., *Ceratoides lanata* (Pursh) J.T. Howell, and *Lycium*; pinyon-juniper woodlands; yellow pine forests; and southwest plains grasslands with *Aristida*, *Bouteloua*, and *Hilaria*; 60–2900 m. Flowering May through November.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, Nueva Autopista Carbonera-Ojo Caliente, *J.A. García 31* (COCA); Jamé, aproximadamente 20 km NE de la carretera nacional 57, *IX Semestre de Biología, UANE s.n.* (ANSM); Municipio de Castaños, Sierra de la Gavia, rancho la Gavia, aprox. 3 km S de la casa por el cañón, *M.A. Carranza 2304* (ANSM); Camino al Ejido San Francisco, *E. Pérez 19* (COCA); Cuesta de La Muralla, carretera 57, Saltillo-Monclova, aproximadamente 1 km N de la Cuesta de La Muralla, *Valdés-Reyna 1309* (ANSM); Municipio de Cuatrociénegas, Sierra de la Madera, cañada Los Posos (E-draining) in N foothill area of range: along main arroyo 1.3 mi up (W) from Tanque La Boquilla; 4.5 mi W from Rancho Cerro de la Madera by road, *Valdés-Reyna 1088* (ANSM); Entrada al Casco del Rancho Potrero de Menchaca, *R. Vásquez 60* (ANSM); Municipio de Múzquiz, Arroyo el Encinal, Hacienda La Rosita, aproximadamente 66 km N de Múzquiz, carretera Múzquiz-Boquillas del Carmen, *Valdés-Reyna 1285* (ANSM); Municipio de Ramos Arizpe, San Juan de las Bonitas, *F. Alcalá 16* (COCA); San Juan de las Bonitas, *E. Pérez 26* (COCA); Arroyo El Jaral, E de Ramos Arizpe, *A. Rodríguez 122a* (ANSM), Cañada el Diente, Sierra de la Paila, *J.A. Villarreal 5246* (ANSM); Municipio de Saltillo, Area de reforestación en Buenavista, *I. Cabral 850* (ANSM); 5 km SW de la Universidad Autónoma Agraria Antonio Narro, orillas de la carretera Saltillo-Zacatecas, *P.E. García 25* (ANSM); 3.2 mi E of Saltillo on México hwy 57 to Matehuala, *Peterson et al. 10081* (US); 5 km SW de Buenavista, a orillas de la carretera Saltillo-Concepción del Oro, Zacatecas, *P.E. García s.n.* (ANSM); Los Cerritos NE de Saltillo, *Peterson et al. 10084* (ANSM, US); Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J.S. Sierra s.n.* (ANSM); 47 km S of Saltillo on hwy 54 to Concepcion del Oro, *Peterson et al. 10035* (US);16 km W de Saltillo por camino Saltillo-General Cepeda, 3 km W de Palma Gorda, a la orilla del camino, *Valdés-Reyna 1564* (ANSM); 26 km W de Saltillo por camino Saltillo-General Cepeda, La Noria, *Valdés-Reyna 1565* (ANSM); Cerro del Pueblo, O de la Ciudad de Saltillo, *Valdés-Reyna 2044* (ANSM); Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J.A. Villarreal 1770* (ANSM); Municipio de San Buenaventura, Sierra de Obayos, rancho Valle de Colombia, *R. Vásquez 246* (ANSM). **Nuevo León:** Municipio de Galeana, En los alrededores del poblado Santa Clara de González, *B. Bazaldua 104* (COCA); Alrededor de Galeana, *J.A. Ochoa 1260* (COCA), Municipio de Linares, Río Pablillo, *J.J. Ortíz 1* (ANSM); near San Rafael, *Peterson & Valdés-Reyna 15812* (US), 16 km NE of Sandia on road to La Ascensión, *Peterson & Valés-Reyna 15825* (US).. **Tamaulipas:** Municipio de Güémez, Carretera Güémez-Padilla, *R.A. Carranco 113* (COCA); km 30 Tramo Güémez-Padilla, *R.A. Carranco 118* (COCA); Municipio de Nuevo Laredo, 20 km al W de Cd. Guerrero, Matorral mediano espinoso, *F. González Medrano et. al. 6329* (MEXU); Municipio de San Fernando, La Joya, *A. Brito 53* (COCA); At San Fernando in thorn scrub, *F. Martínez 2437* (MEXU); Municipio de Soto la Marina, Ejido Verde Chico, *J.F. Iribe 339* (COCA).

8. Sporobolus flexuosus (Thurb. ex Vasey) Rydb., Bull. Torrey Bot. Club 32:601. 1905. **(Fig. 6, A–C)**. *Vilfa cryptandra* var. *flexuosa* Thurb. ex Vasey, Rep. U.S. Geogr. Surv., Wheeler 6:282. 1879 [title page 1878]. *Sporobolus cryptandrus* var. *flexuosus* (Thurb. ex Vasey) Thurb., Bot. California 2:269. 1880. TYPE: U.S.A. NEVADA and ARIZONA: 1871 and 1872, *G.M. Wheeler s.n.* (ISOTYPE: US-556875!).

Caespitose perennials, rarely appearing annual. Culms 30–100(–120) cm tall, erect to decumbent, base flattened to rounded, glabrous below the nodes, and on internodes; base diameter 1–3 mm wide. Leaf sheaths 2/3–3/4 as long as the internodes above, glabrous to scaberulous, sometimes ciliate along the upper margins, summit with a tuft of hairs up to 4 mm long; ligule 0.5–1 mm long; blades (2–)5–24 cm long, 2–4(–6) mm wide, flat to involute, erect or ascending, mostly glabrous below and scaberulous to scabrous above; margins scaberulous. Panicles 10–30 cm long, 4–12 cm wide, open, subovate to oblong, the main axis flexuous and drooping, lower branches no longer than those in the middle, usually with the base included in the uppermost sheath; primary branches 1–8 (–12) cm long, widely spreading to reflexed, flexuous and tangled, mostly spreading 70–130° from the culm axis; secondary branches widely spreading not floriferous on lower 1/8–1/2; pulvini in the axils of primary branches re-

Fig. 6. *Sporobolus flexuosus*. **A.** Inflorescence. **B.** Pulvinus. **C.** Spikelet with caryopsis. *Sporobolus nealleyi*. **D.** Habit. **E.** Spikelet.

curved, pubescent; pedicels 0.3–3 mm long, mostly spreading, scaberulous. Spikelets 1.8–2.5 mm long, plumbeous; glumes 0.9–2.5 mm long, ovate, membranous, unequal; lower glumes 0.9–1.5 mm long, the apex acute; upper glumes 1.4–2.5 mm long, the apex acute; lemmas 1.4–2.5 mm long, lanceolate to ovate, membranous, glabrous, the apex acute; paleas 1.4–2.4 mm long, ovate, membranous, the apex acute; stamens 3; anthers 0.4–0.7 mm long, yellow. Modified caryopses 0.6–1 mm long, ellipsoid, light brownish to reddish-orange. 2*n* = 36, 38.

Distribution and habitat.—In México, *S. flexuosus* occurs in Chihuahua, Sonora, and Coahuila on sandy to gravely slopes, flats, and roadsides in desert scrub with *Atriplex* spp., *Coleogyne*, *Larrea tridentata*, *Grayia spinosa*, *Chrysthamnus*, and *Lycium*; plains grasslands with *Hilaria*, *Buchloe*, *Aristida*, and *Bouteloua*; pinyon-juniper woodlands with *Artemisia tridentata*; and yellow pine forests; 760–2100 m. Flowering May through November.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Cuatrociénegas, Cuatrociénegas, *Brigada III 14* (COCA); Dunas yesosas, cerca de la Poza El Bonito, *J.S. Marroquín s.n.* (ANSM); 45 km SW of Cuatrociénegas, *Peterson et al. 9999* (ANSM, US); Municipio de Ocampo, 4 km S of Laguna El Rey Chemical Plant, *Peterson & Valdés-Reyna 8372* (ANSM, US); 4 km S de Laguna del Rey, de la Planta Quimica, *Valdés-Reyna 2014* (ANSM).

9. Sporobolus giganteus Nash, Bull. Torrey Bot. Club 25:88. 1898. (**Fig. 7, A & B**). *Sporobolus cryptandrus* var. *giganteus* (Nash) E.K. Jones, Contr. W. Bot. 14:11. 1912. TYPE: U.S.A. NEW MEXICO. Doña Ana Co.: White Sands, 4000 ft, 26 Aug 1897, *E.O. Wooton 394* (HOLOTYPE: NY-128297!; ISOTYPE: US-330618!).

Sporobolus cryptandrus var. *robustus* Vasey, Contr. U.S. Natl. Herb. 1(2):56. 1890. TYPE: U.S.A. TEXAS. Presidio Co.: 1887, *G.C. Nealley 746* (ISOTYPE: US-556883!).

Robust perennials. Culms 100–200 cm tall, erect, stout, glabrous below the nodes, base rounded, internodes glabrous; base diameter (3–)4–10 mm wide. Leaf sheaths longer than the internodes above, glabrous, striate, margins with ciliate hairs especially on upper portions, these hairs up to 2 mm long forming a conspicuous tuft near the summit; ligules 0.5–1.5 mm long; blades 10–50 cm long, (3–)4–10(–13) mm wide, flat, glabrous below and above; margins whitish, scaberulous. Panicles 25–75 cm long, 1–4 cm wide, narrow, contracted, dense and spike-like, usually included in the uppermost sheath; primary branches mostly 0.5–6 cm long, appressed to spreading 0–30° from the culm axis; secondary branches appressed and floriferous to base; pulvini in axils of primary branches glabrous; pedicels 0.5–2 mm long, appressed. Spikelets 2.6–3.5(–4) mm long, whitish to plumbeous; glumes 0.6–3.5 mm long, narrow lanceolate, membranous, unequal, prominently keeled, somewhat scaberulous along the keel; lower glumes 0.6–2 mm long, the apex acute to acuminate; upper glumes 2–3.5(–4) mm long, the apex acute; lemmas 2.5–3.5(–4) mm long, linear lanceolate, membranous, glabrous, the apex acute; paleas 2.4–3.4(–3.8) mm long, linear lanceolate, membranous, glabrous, the apex acute; stamens 3; anthers 0.6–1 mm

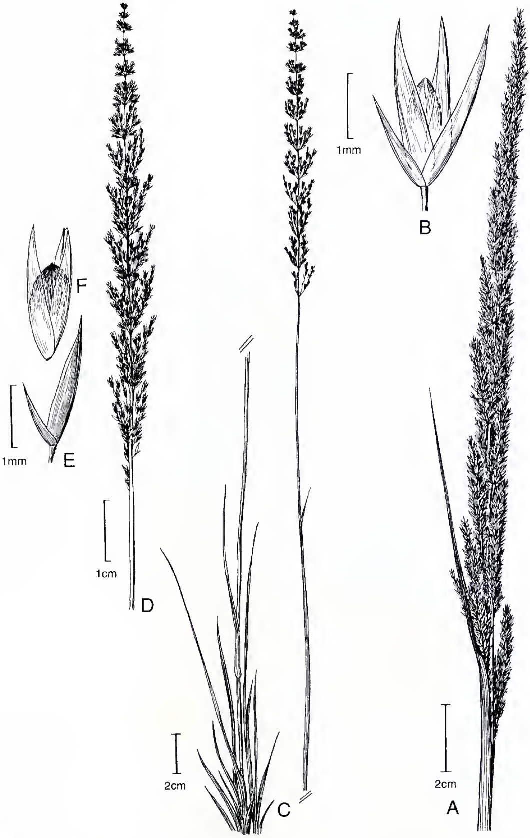


Fig. 7. *Sporobolus giganteus*. **A.** Inflorescence. **B.** Spikelet with modified caryopsis. *Sporobolus purpurascens*. **C.** Habit. **D.** Inflorescence. **E.** Glumes. **F.** Floret with modified caryopsis.

long, yellowish. Modified caryopses 0.8–1.7 mm long, ellipsoid, light yellowish-brown sometimes translucent. $2n = 36$.

Distribution and habitat.—Sand dunes, sandy areas along rivers, calcareous slopes, roadsides, associated *with Acacia constricta* Benth. ex A. Gray, *Larrea tridentata*, *Jatropa dioica* Cerv., *Viguiera stenoloba* Blake, *Juniperus osteosperma* (Torr.) Little, *and Atriplex canescens*; 760–1220 m. Flowering July through October.

Specimens examined. **MEXICO. Coahuila:** Cuatrocienegas, ca 33 (air) mi SSW of Cuatrocienegas, on N slopes of Sierra de Los Alamitos along trail, 6.4 mi S of El Hundido, 28 Sep 1973, near 26°30' N, 102°16' W, *J. Henrickson 13659* (TEX); 24 mi SW of Cuatrocienegas & 2.6 mi S of Poza La Becerra on slopes of Sierra San Marcos, 23 Sep 1990, *Peterson et al 10008* (US).

10. Sporobolus indicus (L.) R. Br., Prodr. 170. 1810. (**Fig. 8, A & B**). *Agrostis indica* L., Sp. Pl. 1:63. 1753. *Agrostis elongata* Lam., Tabl. Encycl. 1:162. 1791, nom. illeg. superfl. *Vilfa elongata* (Lam.) P. Beauv., Ess. Agrostogr. 16, 147, 181. 1812, nom. illeg. superfl. *Sporobolus lamarckii* Desv. ex Ham., Prodr. Pl. Ind. Occid. 4-5. 1825., nom. nov. *Vilfa indica* Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6,4(1-2):96. 1840. *Vilfa indica* (L.) Trin. ex Steud., Nomencl. Bot. (ed. 2) 2:767. 1841. *Vilfa tenacissima* var. *intermedia* E. Fourn., Mexic. Pl. 2: 99. 1886, *nom, illeg.* TYPE: U.S.A. VIRGINIA : *J. Clayton 460B* (LECTOTYPE, LINN-84.36!, designated by Hubbard, Agron. Lusit. 28:67.1966; ISOLECTOTYPE: SI fragm!

Agrostis compressa Poir., Encycl., Suppl. 1:258. 1810. nom. illeg. hom., not Willd. 1790. *Milium compressum* Poir., Encycl., Suppl. 1:258. 1810, nom. inval. *Axonopus poiretii* Roem. & Schult., Syst. Veg. 2:318. 1817. *Sporobolus poiretii* (Roem. & Schult.) Hitchc., Bartonia 14:32. 1932. TYPE: U.S.A. "CAROLINA": *L.A.G. Bosc s.n.* (ISOTYPE: P not seen)

Agrostis tenuissima Spreng., Syst. Veg. 1:258. 1824. TYPE: WEST INDIES and SOUTH AMERICA: (HOLOTYPE: not found).

Vilfa berteroana Trin., Mem. Acad. Imp. Sci. Saint-Petersbourg, Ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 6:100. 1840. *Sporobolus berteroanus* (Trin.) Hitchc. & Chase, Contr. U.S. Natl. Herb. 18.370. 1917. TYPE: DOMINICAN REPUBLIC. SANTO DOMINGO: *C.G.L. Bertero s.n.* (HOLOTYPE: LE-TRIN-1682.01!; ISOTYPES: B, MO-2095245).

Vilfa exilis Trin., Mem. Acad. Imp. Sci. Saint-Petersbourg, Ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 6, 4:89. 1840. *Vilfa tenacissima* var. *exilis* (Trin.) E. Fourn., Mexic. Pl. 2:99. 1886. *Sporobolus exilis* (Trin.) Balansa, J. Bot. (Morot) 4:164. 1890. *Sporobolus indicus* var. *exilis* (Trin.) T. Koyama, J. Jap. Bot. 37:235. 1962. TYPE: MÉXICO. JALAPA: 28 Aug, *C.J.W. Schiede s.n.* (HOLOTYPE: LE-TRIN-1699.03 & fig!).

Sporobolus angustus Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:88. 1862. *Vilfa angustata* Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:88. 1862, nom. illeg. TYPE: U.S.A. TEXAS: Buchanan, Jun, *S.B. Buckley* (HOLOTYPE: PH, ISOTYPE: US-611005 fragm ex PH!).

Caespitose perennials or at least long-living annuals with tough fibrous roots. Culms 30–100(–120) cm tall, erect, base mostly flattened, glabrous below the nodes, internodes glabrous; base diameter 1–3.5(–5) mm wide. Leaf sheaths 1/2 to about as long as the internodes, glabrous; ligules 0.2–0.5 mm long; blades (6–)10–30(–50) cm long, 1–5 mm wide, flat, glabrous below and above. Panicles 20–35(–50) cm long, 0.3–2.2(–3) cm wide, narrow, contracted, sometimes included in the uppermost sheath; primary branches mostly 0.4–2.5(–5) cm long, appressed sometimes ascending spreading 0–40° from the culm axis; secondary

Fig. 8. *Sporobolus indicus*. **A.** Habit. **B.** Spikelet with modified caryopsis. *Sporobolus jacquemontii*. **C.** Habit. **D.** Primary branch with spikelets. **E.** Spikelet.

branches appressed and floriferous to base; pulvini in axils of primary branches glabrous; pedicels 0.1–1.8 mm long, appressed. Spikelets 2.0–2.6(–2.7) mm long, plumbeous to light brownish; glumes 0.4–1.6 mm long, ovate or obovate, membranous, subequal; lower glumes 0.3–1 mm long, often without a midvein, the apex acute, obtuse to truncate, often erose; upper glumes 0.6–1.6 mm long, the apex acute obtuse to truncate, often erose; lemmas 1.4–2.6(–2.7) mm long, ovate, membranous, glabrous, the apex acute or obtuse; paleas 1.3–2.4 mm long, ovate, membranous, glabrous, the apex acute; stamens 3; anthers 0.5–1.1 mm long, white, sometimes purple-tinged. Modified caryoposes 0.6–1.2 mm long, ellipsoid-quadrate, truncate towards apex, flattened laterally, reddish brown. $2n$ = 18, 24, 36.

Distribtion and habitat.–*Sporobolus indicus* is found throughout the western hemishphere and is common in disturbed places, open areas, roadsides, pastures, along lake shores and beaches in sandy or clay soils associated with many plant communities; 3–2460 m. Flowering throughout the year, more commonly March to December.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, Zona Urbana, altitud 1660 m., *P. Moya 430* (COCA). **Nuevo León:** Municipio de Garza García, Vereda a la meseta de Chipinque en San Pedro Garza García, *M.M. Castillo 60* (COCA); Municipio de General Zaragoza, Camino a Tinajas, *G. Bores 61* (COCA); Municipio de Marín, orillas del canal Marín, carretera Marín-Higueras a 3 km de la cabecera municipal de Marín, *P. Jauregui 101* (COCA); Municipio de Monterrey, Sierra Madre mountains *C.H. Mueller 381* (MEXU); Municipio de Santiago, Camino a la Cola de Caballo, localizada en Santiago, *P. Jauregui 49* (COCA). **Tamaulipas:** Municipio de Aldama, Barra del Tordo, *M.H. Cervera 96* (COCA); Entrada al Ejido Lauro Aguirre, *J.G. Galván 302* (COCA); Rancho Nuevo, *J.G. Galván 44* (COCA); Municipio de Casas, 5 de Febrero, *J.F. Iribe 427* (COCA); Municipio de Gomez Farías, Rancho El Cielo, *M.H. Cervera 247*, 513 (COCA); El Julilo, *J.F. Iribe 433* (COCA); El Julilo, *C.R. López 214* (COCA); Ejido San José, *J.L. Ramos 26* (COCA); Ejido Manantiales, *J.L. Ramos 28* (COCA); Municipio de Güémez, Rancho Nuevo, *G. Bores 24* (COCA); El Chihue, *J.G. Galván 107* (COCA); Municipio de Hidalgo, Colonia Veteranos de la Revolución, *J.L. Ramos 46* (COCA); Municipio de Jaumave, Ejido Joya de Salas, *J.A. Franco 11* (COCA); Ejido Avila y Urbina, *J.F. Iribe 244* (COCA); Ejido 20 de Abril, *J.F. Iribe 423* (COCA); Ejido 20 de Abril, *C.R. López 218* (COCA); Municipio de Tula, Ejido El Guajolote, *J.F. Iribe 223* (COCA); Municipio de Victoria, Altas Cumbres, *G. Bores 86* (COCA); Puerto de Arrazola, altitud 1730 m., *R.A. Carranco. 140* (COCA); Los San Pedros, *R.A. Carranco 15* (COCA); Carretera Federal 101, km 130, *R.A. Carranco 96* (COCA); Los San Pedros, *J.G. Galván 23* (COCA); Camino a Altas Cumbres, Ejido El Huizachal, *J.G. Galván 340* (COCA); Sierra de San Carlos, Cerro de la Bufa, El Diente, *O. L. Briones, 1961* (MEXU)

11. Sporobolus jacquemontii Kunth, Revis. Gramin. 2:427, t. 127. 1831. (**Fig. 8, C–E**). *Vilfa jacquemontii* (Kunth) Trin., Mem. Acad. Imp. Sci. Saint-Petersbourg, Ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 6, 4:92. 1840. *Sporobolus pyramidalis* var. *jacquemontii* (Kunth) Jovet & Guédès, Taxon 22:163. 1973. TYPE: DOMINICAN REPUBLIC. SANTO DOMINGO: 1827, *V. Jacquemont s.n.* (HOLOTYPE: P; ISOTYPES: L, LE-TRIN-1712.01!).

Plants perennial, densely cespitose, without rhizomes. Culms 40–100 cm tall. Leaf sheaths keeled or rounded, glabrous, ciliate at apex; ligules 0.2–0.4 mm long; blades 10–40 cm long, 2–4 mm wide, flat but soon becoming involute, tapering to a fine point. Panicles 14–35 cm long, 0.4–3 cm wide, contracted, interrupted, and rather lax; primary branches appressed to strongly ascending, spikelet-bearing to the base, the lower branches 1.5–5 cm long, much longer than the adjacent internodes; pedicels 0.1–1.2 (–1.8) mm long. Spikelets 1.4–1.8(–2) mm long, plumbeous to greenish; glumes 0.3–0.7 mm long; lower glumes 0.3–0.5 mm long, obtuse; upper glumes 0.4–0.7 mm long, usually less than 1/2 as long as the florets, faintly 1-veined, truncate, erose to denticulate; lemmas 1.4–2 mm long, elliptic, glabrous, 1-veined, acute; paleas 1.4–2 mm, elliptic; stamens 3(2); anthers 0.9–1.1 mm long. Modified caryopses 0.7–1 mm long, quadrangular, laterally compressed, truncate, reddish brown. $2n = 24$.

Distribution and habitat.—This species is widely distributed and is found in Australia, Africa, and is apparently native to North America, South America, Central America, and the West Indies. In the study area, *S. jacquemontii* is more abundant in the Tamaulipan scrub vegetation at 10–1900 m.

Comments.—Simon and Jacobs (1999) noted that the spikelet morphology is essentially the same as *S. pyramidalis* P. Beavu. However, Simon and Jacobs (1999) observed *S. pyramidalis* and *S. jacquemontii* growing adjacent to each other and noted that individuals thought to be *S. jacquemotii* had shorter culms and lacked pyrimidal shaped panicles. *Sporobolus jacquemontii* has been placed as a synonym of *S. pyramidalis* by Baaijens and Veldkamp (1991) and Laegaard and Peterson (2001). We choose to take the conservative route and retain *S. jacquemontii* at the rank of species until there is more evidence (Peterson et al. 2003).

Specimen examined. **MEXICO. Coahuila:** Municipio de Arteaga, 12 km de Saltillo, hacia Matehuala, *M.A. Madrigal s.n.* (ANSM). **Nuevo León:** Municipio de Allende, Río Ramos, 1 km S de Allende, carretera 85, *J.A. Villarreal 6777* (ANSM); Municipio de Linares, Las Palmas, *I. Cabral s.n.* (ANSM); Municipio de Santiago, 4 km N de Los Cavazos, *I. Cabral 217* (ANSM); San José de Las Boquillas, *I. Cabral 565* (ANSM); Municipio de General Zaragoza, 13.5 mi SE of Aramberri on road towards Agua Fria, *Peterson et al. 16708* (US). **Tamaulipas:** Municipio de Aldama, 20 km de Aldama a Barra del Tordo, *R.A. Carranco 437* (ANSM, COCA); Rancho 'Don Enrique', *M.H. Cervera 6* (COCA); Las Alazanas, *C.R. López 293* (ANSM, COCA); Ejido Lauro Aguirre, *C.R. López 309* (ANSM, COCA); Municipio de Altamira, 8 mi from of Tampico on the Mante highway, *M.C. Johnston 4063A* (MEXU); Municipio de Gomez Farías, Ejido Alta Cima, *Cisneros, M. 160* (COCA); Gómez Farías, *M.E. Crespo 103* (ANSM); Ejido Alta Cima, *M.E. Crespo 197* (ANSM); Cabecera Municipal de Gomez Farías, *M.E. Crespo 26* (ANSM); Paraje casa de piedra, ejido Alta Cima, *M.E. Crespo 322* (ANSM); Camino al rancho El Cielo, *M.E. Crespo 374* (ANSM); Camino de Gómez Farías, Ejido El Azteca, *M.E. Crespo 63* (ANSM); Las Huertas. Reserva de la Biósfera El Cielo, *A. Mora 604* (ANSM); Municipio de Hidalgo, 440 km SW of hwy 85 towards Dulce Nombres, *Peterson & Valdés-Reyna 15902* (US); Municipio de Jaumave, Montecristo, *J.L. Ramos 198* (COCA); Municipio de San Carlos, San José, Sierra San Carlos, *O.L. Briones 1625* (ANSM); Cerro de la San José, Sierra San Carlos, *O.L. Briones 1961* (ANSM); Municipio de Tampico, Laguna El Chairel, *M.G. Torres s.n.* (ANSM); Municipio de Victoria, Ejido Vicente Guerrero, *M. Cisneros 21* (COCA); Camino al Molino, *P. Moya 140* (COCA); Camino a Santa Clara, *P. Moya 143* (COCA).

12. Sporobolus nealleyi Vasey, Contr. U.S. Natl. Herb. 1(2):57. 1890. (**Fig. 6, D & E**). TYPE: U.S.A. TEXAS. Brazos Co.: Brazos Santiago, 1887, *G.C. Neally 752* (HOLOTYPE: US-556888!).

Caespitose perennials from a hard knotty base. Culms 10–40 cm tall, erect, base rounded, glabrous below the nodes and grooved on one side, internodes mostly glabrous; base diameter 0.7–1.2 mm wide. Leaf sheaths 1/2–4/5 as long as the internodes above, villous to tomentose with soft kinky hairs along the margins and back occasionally almost glabrous, the hairs up to 4 mm long; ligules 0.2–0.4 mm long; blades (0.6–)1.5–6(–7) cm long, 1–1.5 mm wide, involute, stiffly divergent from the culms at right angles, glabrous below and scaberulous above; margins smooth. Panicles 3–10 cm long, (0.3)1–5(–6) cm wide, ultimately open, subovate, the lower portion sometimes included in the uppermost sheath; primary branches 0.5–5 cm long, appressed or ascending spreading 0–90° from the culm axis, secondary branches appressed or spreading not floriferous on lower 1/8–1/4; pedicels 0.2–2 mm long. Spikelets 1.4–2.1 mm long, purplish; glumes 0.5–2 mm long, linear-lanceolate to ovate, membranous, unequal; lower glumes 0.5–1.1 mm long, the apex acuminate; upper glumes 1.3–2 mm long, the apex acuminate to acute; lemmas 1.4–2.1 mm long, ovate, membranous, glabrous, the apex acute; paleas 1.4–2.1 mm long, ovate, membranous, the apex acute; stamens 3; anthers 0.7–1 mm long, purplish. Modified caryopses 0.7–1 mm long, orangish to whitish. $2n = 40$.

Distribtion and habitat.—In México, *S. nealeyi* is known only from Coahuila, Nuevo León, and San Luis Potosí on sandy and gravely soils usually derived from gypsum or near alkaline habitats associated with desert grasslands with *Pleuraphis jamesii* Torr., *Muhlenbergia villiflora* Hitchc., *Bouteloua chasei* Swallen, *Dasyochloa pulchella* (Kunth) Willd. ex Rydb., *Ephedra torreyana* S. Watson, *Chrysothamnus nauseousus* (Pall.) Britton, *Atriplex confertifolia*, and *Gutierrezia microcephala* (DC.) A. Gray; 750–2100 m. Flowering June to November.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Saltillo, 53.2 km S of Saltillo on México highway 54 and 28.5 km E on road to La Ventura, *Peterson et al. 10039* (ANSM, US); La Ventura, aproximadamente 80 km S de Saltillo, *Valdés-Reyna 1991, 3503* (ANSM). **Nuevo León:** Municipio de Galeana, Galeana, *J A. Ochoa 1009* (COCA); 2 km S del Salero, 1 km E de carretera 57 Matehuala-Saltillo, *Valdés-Reyna 1617* (ANSM), Near San Rafael, *Peterson & Valdés-Reyna 15810* (US); Carretera a Trinidad China, *Ochoa-Guillemar, José Amando 1230* (COCA); 4 mi SE of Galeana, on fine gypsiferous soil, *Reeder & Reeder 3655* (MEXU).

13. Sporobolus purpurascens (Sw.) Ham., Prodr. Pl. Ind. Occid. 5. 1825. (**Fig. 7, C–F**). *Agrostis purpurascens* Sw., Prodr. 25. 1788. *Vilfa purpurascens* (Sw.) P. Beauv., Ess. Agrostogr. 16, 182. 1812. *Sporobolus purpurascens* (Sw.) Kuhlm., Comm. Lin. Telegr., Bot.67:92. 1922. TYPE. JAMAICA: *O.P. Swartz s.n* (HOLOTYPE: S not seen; ISOTYPE: BM not seen).

Vilfa densiflora E. Fourn., Mexic. Pl. 2:98. 1886. TYPE: MÉXICO: Orizaba, *Botteri 139* (HOLOTYPE: P not seen; ISOTYPES: US fragm. ex B!, US ex CGE!, US ex P!).

Vilfa grisebachiana E. Fourn., Mexic. Pl. 2:98. 1886. TYPE: CUBA. *C. Wright 3427a* (SYNTYPE: P? not seen); MÉXICO. VERACRUZ: Orizaba, *E. Bourgeau s.n.* (SYNTYPE: P not seen); *M. Botteri 32* (SYNTYPE: P not seen).

Vilfa liebmanni E. Fourn., Mexic. Pl. 2.100. 1886. TYPE: MÉXICO. "Absque loco," *F.M. Liebmann 693* (SYNTYPE: P?).

Vilfa muelleri E. Fourn., Mexic. Pl. 2:98. 1886. *Sporobolus muelleri* (E. Fourn.) Hitchc., N. Amer. Fl. 17(7):490. 1937. TYPE: MÉXICO. VERACRUZ: Orizaba. 1835, *Müller 2117* (LECTOTYPE: US-998486 ex W!, designated by Hitchcock, N. Amer. Fl. 17:490. 1937).

Caespitose perennials, not rhizomatous. Culms 25–95 cm tall. Leaf sheaths rounded below, sometimes sparsely hispid-ciliate on the upper margins, the summit hairy, the hairs to 5 mm long; ligules 0.2–0.3 mm long; blades 8–22 cm long, 2–5 mm wide, flat or involute, glabrous abaxially, scaberolous adaxially; margins scabrous, sometimes sparsely hispid. Panicles 5–30 cm long, 0.4–1.6 cm wide, contracted, lower nodes with 3–5 primary branches; primary branches 0.3–2 cm long, appressed or spreading up to 20° from the rachis, spikelet-bearing to near the base; secondary branches appressed; pedicels 0.2–2.5 mm long, appressed, scaberolous. Spikelets 2.8–3.8 mm long, purplish-red; glumes unequal, linear-lanceolate to lanceolate or ovate, hyaline to membranous; lower glumes 0.9–3 mm long; upper glumes 2.9–3.8 mm long, subequal to the florets; lemmas 2.9–3.8 mm long, ovate, membranous, glabrous, the apex acute; paleas 2.9–3.8 mm, ovate, membranous; anthers 1.5–2 mm, yellowish to purplish. Modified caryopses 1.8–2.3 mm, ellipsoid, somewhat laterally flattened, rugulose, reddish-brown. $2n = 60$.

Distribution and habitat.—In México, *S. purpuascens* is known to occur in Chiapas, Pueblo, Tamaulipas, and Veracruz; primarily in oak forests; 900–1500 m.

Specimens examined. **MÉXICO. Tamaulipas:** Highest part of the Sierra de Tamaulipas, road from Rancho Las Yucas to Santa Maria de los Nogales trough El Columpio from Los Cerritos to the Cerro de San Juan, 22 Sep 1956 *F. Martinez & G. Borja F-1936* (TEX).

14. Sporobolus pyramidatus (Lam.) Hitchc., Man. Grasses W. Ind. 84. 1936. (**Fig. 4, D & F**). *Agrostis pyramidata* Lam., Tabl. Encycl. 1:161. 1791. *Sporobolus affinis* Kunth, Revis. Gramin. 1:68. 1829, nom. illeg. superfl. TYPE: WEST INDIES. MARTINIQUE: *J. Richard s.n.* (HOLOTYPE: P not seen; ISOTYPE: LE-TRIN-1645.01 fragm. & illustr!).

Vilfa arguta Nees, Fl. Bras. Enum. Pl. 2:395. 1829. *Sporobolus argutus* (Nees) Kunth, Enum. Pl. 1:215. 1833. *Vilfa humifusa* var. *major* E. Fourn., Mexic. Pl. 2:97. 1886, non Kunth 1816. *Sporobolus arkansanus* Nutt. ex Vasey, Contr. U.S. Natl. Herb. 3:61. 1892, *nom. inval.* TYPE: BRAZIL: Brasilia, *F. Sellow s.n.* (SYNTYPE: LE-TRIN-1676.01!).

Vilfa arkansana Trin., Mem. Acad. Imp. Sci., Saint-Petersbourg, Ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 6, 4:64. 1840. TYPE: U.S.A. ARKANSAS: *H.K. Beyrich s.n.* (HOLOTYPE: LE-TRIN-1677.01!; ISOTYPE: US fragm. ex LE-TRIN!).

Vilfa subpyramidata Trin., Mem. Acad. Imp. Sci., Saint-Petersbourg, Ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 6, 4:61. 1840. TYPE: U.S.A. TEXAS: *T. Drummond 377* (HOLOTYPE: LE-TRIN-1744.01!; ISOTYPE: US-557438!).

Vilfa richardi Steud., Syn. Pl. Glumac. 1:153. 1854. *Agrostis pyramidalis* Rich. *ex* Steud., Syn. Pl. Glumac. 1:153. 1854, *pro syn.* TYPE: WEST INDIES. Antilles. (HOLOTYPE: MPU not seen).

Vilfa agrostoidea Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:88. 1862. TYPE: U.S.A. TEXAS: Llano Co.. (HOLOTYPE: not found).

Vilfa sabeana Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:90. 1862. *Sporobolus sabeana* Buckley *ex* Vasey, Contr. U.S. Natl. Herb. 3^1:61 (1892). TYPE: U.S.A. TEXAS. San Saba Co.: *S.B. Buckley s.n.* (LECTOTYPE: PH, designated by Hitchcock Man. Grass. U.S. 957. 1935, not seen).

Sporobolus tuberculatus Hack., Anales Mus. Nac. Buenos Aires 13:470, t.13. 1906. Sporobolus argustus var. tuberculatus (Hack.) Hack., Anales Mus. Nac. Buenos Aires 21:90. 1911. TYPE: ARGENTINA. SALTA: Rosario de la Frontera, 1905, *M. Lillo 3908* (HOLOTYPE: CORD-Stuckert Herb. no. 15397 not seen; ISOTYPE: US-87217 fragm!).

Sporobolus patens Swallen, J. Wash. Acad. Sci. 31:352, f. 5. 1941. TYPE: U.S.A. ARIZONA: Wilcox, 26 Sep 1938, *W.A. Silveus 3504* (HOLOTYPE: US-1723881!; ISOTYPES: US-3278441!, US-F3215630!).

Sporobolus pulvinatus Swallen, J. Wash. Acad. Sci. 31:351, f. 4. 1941. TYPE: U.S.A., ARIZONA. Apache Co.: Adamana, 6–15 Aug 1903, *D. Griffiths 5107* (HOLOTYPE: US-997877!).

Caespitose annuals, larger plants sometimes appearing perennial, with intravaginal branching at base. Culms 7–35(–60) cm tall, erect or decumbent, base rounded, glabrous below the nodes, internodes glabrous; base diameter 1–1.6 mm wide. Leaf sheaths 1/2 to almost as long as the internodes above, glabrous or with ciliate hairs on the margins and summit, the hairs up to 3 mm long; ligules 0.3–1 mm long; blades 2–12(–20) cm long, 2–6 mm wide, flat, glabrous below and scaberulous above, sometimes with a few hispid hairs, mostly borne near base; margins ciliate-pectinate. Panicles 4–15(–18) cm long, 0.3–6 cm wide, open and pyramidal with verticillate branches spreading 30–90°, contracted and narrow when immature; primary branches 0.5–4.5 cm long, not floriferous on the lower 1/3–1/2, lowest branches whorled in verticels of 7–12(–15), lower portions of each branch with elongated glands; secondary branches appressed; pedicels 0.1–0.5 (–1) mm long, appressed. Spikelets 1.2–1.8 mm long, plumbeous or brownish, often secund along the branch; glumes 0.3–1.8 mm long, ovate to obovate, membranous, unequal; lower glumes 0.3–0.7 mm long, without a midvein, the apex acuminate, obtuse or irregularly truncate; upper glumes 1.2–1.8 mm long, the apex acute or acuminate and sometimes scaberulous; paleas 1.1–1.6 mm long, ovate to elliptic, membranous, the apex acute to obtuse; stamens 3; anthers 0.2–0.4 mm long, yellow or purplish. Modified caryopses 0.6–1 mm long, obovoid, faintly striate, light brownish. $2n = 24, 36, 54$.

Distribution and habitat.—*Sporobolus pyramidatus* is common throughout México occurring on disturbed soils, roadsides and railways, coastal sands, and alluvial slopes in many plant communities; 5–1750 m. Flowering March to November.

Comments.—Morphologically, *S. pyramidatus* is very similar to the Eastern Hemisphere *S. coromandelianus* (Retz.) Kunth, suggesting that they are closely related or perhaps represent the same taxon. Further systematic study is necessary to address this question.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Acuña, Rancho Las Norias, *J.A. Villarreal 6920* (ANSM); Municipio de Cuatrociénegas, 3.2 km NW of Cuatrociénegas on road to Ocampo, *Peterson et al. 9993* (ANSM, US); Ladera baja de la Sierra de San Marcos, frente a las dunas de Cuatrociénegas, *A. Rodríguez 1145* (ANSM, MEXU); Sierra de la Madera, Rancho Laguna de la Leche, aproximadamente 62 km de Ocampo rumbo a Sierra Mojada, *M.A. Carranza 616* (ANSM); S of Laguna de La Leche, *M.C. Johnston 8626* (MEXU); Municipio de Parras, Ejido 4 de Marzo, *A. Roing 156* (ANSM); Municipio de Ramos Arizpe, Cañón de Loma Prieta, rumbo al valle de los Angeles, *J.A. Marroquín 2312* (ANSM); Predio La Esmeralda, *E. Pérez 50* (COCA); 11 km E de Cuatrociónegas, en carretera 30 a Monclova, bajío al S de la carretera, *Valdés-Reyna 985* (ANSM); Municipio de Saltillo, 2 mi E de Saltillo, carretera 57 Matehuala. San Luis Potosí, *Peterson et al. 10080* (ANSM, US); Los Cerritos NE de Saltillo, *Peterson et al. 10083, 10085* (ANSM, US). **Nuevo León:** Municipio de China, Rancho El Chaparral, km 56 carretera China-Méndez, camino a Pobladores, *M. Castillo 54* (COCA); 2 km N del Chilán, *Valdés-Reyna 45* (ANSM); Presa La Ceja, carretera 40, *J.A. Villarreal 6844* (ANSM); Municipio de Doctor González, 1 km al SE del poblado de Doctor González, rumbo a los fresnos a la orilla del río Doctor González, *B. Bazaldua 69* (COCA); Municipio de General Bravo, 34.8 km W of China on highway 40 to Monterrey, altitud 270 m., *Peterson et al. 11146* (ANSM); 3 km N del rancho 'El Brasil', *Valdés-Reyna s.n.* (ANSM); Municipio de Linares, Baño de San Ignacio, 22 km NE de Linares, M.. *Cotera s.n.* (ANSM); Ejido Cerro Prieto, *J. Ortíz s.n.* (ANSM); Ejido el Porvenir, *J. Ortíz s.n.* (ANSM); Municipio de Los Ramones, Entronque Centro Camionero carretera 40, *J.A. Villarreal 6825* (ANSM); Municipio de Salinas Victoria, La Soledad Salinas Victoria, *J.A. Ochoa 1118* (COCA); Municipio de San Nicolás de los Garza, Maleza de la Ciudad Universitaria, *R. Uresti s.n.* (ANSM). **Tamaulipas:** Municipio de Abasolo, Rancho de Mauro Garza 5 km NE de Abasolo, *D. Baro 576* (UAT); 5–6 km NW del ejido Abasolo, *R. Díaz 140* (UAT); Canales del Distrito de riego 086 Soto la Marina, *A. Mora 5341* (UAT); Municipio de Aldama, Santa Rosa, *G. Bores 7* (COCA); Rancho Nuevo, *M. Cervera 91* (COCA); Playa Rancho Nuevo, *R. Díaz 30* (UAT); Municipio de Altamira, Al E de la Cabecera Municipal de Altamira, *J.G. Galván 144* (COCA); Municipio de Casas, rumbo a Lavín, *G. Bores 96* (COCA); Casas, *J.L. Ramos 149* (COCA); Ejido Las Tortugas, *J.L. Ramos 179* (COCA); Municipio de González, Ejido Gustavo A. Madero, *J.A. Barrientos 21* (COCA); 5 km antes del poblado por la carretera vía corta a Tampico, *M Cisneros 8* (COCA); 7 km al NW de González, *P. Larraga 40* (ANSM, COCA); Ejido Josefa Ortíz de Domínguez, *J.L. Ramos 155* (COCA); Municipio de Güémez, Rancho El Melón, *G. Bores 137* (COCA); Municipio de Guerrero, Ejido San Ignacio 41 km SE de Nuevo Laredo, carretera Dorado-Ciudad Mier, *R. Díaz 107* (UAT); Municipio de Jaumave, Ejido San Francisco del Cañón, *M. Cisneros 145* (COCA); Ejido San Antonio km 132 carretera Victoria-Jaumave, *M. Martínez 287* (UAT); Municipio de Jiménez, Camino al Barranco *G. Bores 26* (COCA); Adelante de la Parida, *G. Villegas 470* (COCA); Municipio de Llera, 2 km W de Estación Forlón, *D. Baro 10* (ANSM, UAT); Ejido Portes Gil, *J.A. Barrientos 96* (COCA); Ejido 1° de Abril, *M. Cervera 79* (COCA); La Gloria II, *J.E. López 146* (COCA); Municipio de Matamoros, km 26 al E de la carretera a playa Lauro Villar, *D. Baro 252* (UAT); Playa Lauro Villar, *A. Brito 1232* (UAT); km 18 carretera Matamoros-Valle Hermoso, *A. Brito 54* (COCA); Playa Lauro Villar, *A. Brito 61* (COCA); Los Saucitos, *J. Cantú 1* (COCA); km 18 carretera Matamoros-Valle Hermoso, *R.A. Carranco 103* (COCA); Antes de llegar a los Sauces, *R.A. Carranco 110* (COCA); Playa Lauro Villar, *R.A. Carranco 111* (COCA); Municipio de Méndez, San Tomás, *B.E. Castillo 1* (COCA); Municipio de Ocampo, Sierra de las Cucharas, *R.A. Carranco 371* (COCA); Municipio de Padilla, Campo Turístico El Sargento *M. Cervera 321* (COCA); Municipio de San Fernando, Laguna Madre, *A. Brito 62, 64* (COCA); km 120 carretera Jiménez-San Fernando, *R.A. Carranco 346* (COCA); Municipio de Soto la Marina, Barra de Soto la Marina E del Carrizo, *D. Baro 335* (UAT); Carretera del Poblado La Pesca-La Playa, *A. Brito 169* (COCA); Al N del Laboratorio de cultivo de Camarón, *A. Brito s.n.* (UAT); La Pesca, *J.G. Galván 29,256* (COCA); La Pesca, *J.F. Iribe 318* (COCA); Canales de riego. Distrito de riego, bajo Río Bravo, *A. Mora 5202* (UAT); Municipio de Tampico, Puente Chairel río Morillo, *D. Baro 18 b* (UAT); Municipio de Tula, Ejido La Laguna, *M, Cervera 386* (COCA); Municipio de Victoria, Carretera Victoria-Jaumave, *M. Cisneros 87* (COCA); Municipio de Villagrán, Rancho Vista Hermosa, *A. Rodríguez 246 a* (ANSM).

15. Sporobolus spiciformis Swallen, Proc. Biol. Soc. Wash. 56:78. 1943. (**Fig. 3, D & F**). TYPE: MÉXICO. COAHUILA: Puerto del norte, Cuatrocienegas, 1460 m, 18 Jul 1939, *L.H. Harvey 1225* (HOLOTYPE: US-176006!).

Caespitose perennials. Culms 30–70 cm tall, erect, mostly glabrous; base diameter 1–1.8 mm wide. Leaf sheaths shorter than the internodes, rounded, striate, scaberulous, glabrous and hairy only at the corners; ligules 0.8–1 mm long, densely ciliate; blades 7–20 cm long, 1.5–2 mm wide at the base, flat or becoming involute or at least boat shaped in section, firm, flexuous, adaxial surface with white ridges. Panicles 9–17 cm long, 3–5(–10) mm wide, spiciform and spikelike, white, often the lower portion included in the sheath; Spikelets 1.6–2.3 mm long; glumes 0.8–1.8 mm long, unequal, hyaline, the apex obtuse to acute, minutely erose; lower glumes 0.8–1.2 mm long; upper glumes 1–1.8 mm long, 1-nerved; lemmas 1.6–2.3 mm long, the apex obtuse to acute, minutely erose; paleas 1.6–2.3 mm long, the apex minutely two-toothed; anthers 1–1.3 mm long, yellow. Modified caryopses 0.8–1 mm long, ellipsoid. $2n = 40$.

Distribution and habitat.—*Sporobolus spiciformis* is endemic to the Chihuahuan Desert Region, reported from Chihuahua, Coahuila, and Nuevo León where it is restricted to saline or gypsum-derived soils associated with *Yucca, Ephedra, Nama, Suaeda, Chilopsis linearis* (Cav.) Sweet, *Prosopis*, and *Petalonyx*; 410–1750 m.

Comments.—*Sporobolus spiciformis* is morphologically similar to *S. phleoides*, an Argentinian desert endemic also commonly found growing on saline soils. *Sporobolus phleoides* can be separted from *S. spiciformis* by having broader leaf blades up to 6.6 mm wide, acuminate lemmas, and shorter anthers only 0.4–0.6 mm long.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Cuatrociénegas, Balneario Los Mezquites, *Brigada III 15* (COCA); Dunas yesosas, cerca de la Poza El Bonito, *J.S. Marroquín s.n.* (ANSM); 45 km SW of Cuatrociénegas, *Peterson et al. 10001* (ANSM, US); 3.2 km NW of Cuatrociénegas on road to Ocampo, *Peterson et al. 9991* (ANSM, US); 33 mi SSW of Cuatrocienagas on road to San Pedro, *Reeder & Reeder 4579* (ARIZ), 11 km E de Cuatrociénegas, en carretera 30 a Monclova, bajío al S de la carretera, *Valdés-Reyna 986* (ANSM); 6 mi NW of Las Delicias along hwy 30 & 44 mi NE of San Pedro, *J. Henrickson 6021* (CSLA, US); Municipio de Monclova, Arroyo Río Salado, 9 km N de Rancho Las Adjuntas, *Valdés-Reyna 1300, 1303a* (ANSM); Municipio de Parras, Ejido Cuatro de Marzo, *A. Roing s.n.* (ANSM); Municipio de Ramos Arizpe, Estación Paredón, *A. Rodríguez 902* (UAT); Municipio de Viesca, Camino al Bajío de Ahuichila 16 km S de Viesca, *J.A. Villarreal 7729* (ANSM); 17 km SE de Viesca, camino a Ahuichila, *J.A. Villarreal 8226* (ANSM). **Nuevo León:** 33 mi SE of jct Monterrey-Monclova. *Reeder & Reeder 5190* (ARIZ). **Tamaulipas:** Municipio de San Fernando, Near Santa Teresa, 50 mi S of Matamoros and 40 mi N of San Fernando, *M.C. Johnston 5495* (MEXU).

16. Sporobolus virginicus (L.) Kunth, Révis. Gramin. 1:67. 1829. (**Fig. 9, A–C**). *Agrostis virginica* L., Sp. Pl. 1:63. 1753. *Vilfa virginica* (L.) P. Beauv., Ess. Agrostogr. 16, 149, 182. 1812. *Crypsis virginica* (L.) Nutt., Gen N. Amer. Pl. 1:49. 1818. *Podosaemum virginicum* (L.) Link, Hort. Berol. 1:85. 1827. *Sporobolus virginicus* (L.) Brongn., Voy. Monde 2.17. 1829. TYPE: U.S.A. VIRGINIA: *J. Clayton 507* (LECTOTYPE: LINN-84.30 designated by Hitchcock, Contr. U.S. Natl. Herb. 12:119. 1908; ISOLECTOTYPES: BM, US-76294 ex BM!)

Agrostis littoralis Lam., Tabl. Encycl. 1:161. 1791. *Agrostis barbata* Pers., Syn. Pl. 1:75. 1805, nom. illeg. superfl. *Vilfa barbata* (Pers.) P. Beauv., Ess. Agrostogr. 16, 147, 181, *nom. illeg. superfl.* 1812. *Vilfa littoralis* (Lam.) P Beauv., Ess. Agrostogr. 16, 147, 181. 1812. *Sporobolus littoralis* (Lam.) Kunth, Revis. Gramin. 1:68. 1829. *Sporobolus virginicus* var. *littoralis* (Lam.) Hitchc. N. Amer. Fl. 17(7):486. 1937. *Sporobolus virginicus* subsp. *littoralis* (Lam.) Borhidi & O. Muñiz, Bot. Közelem. 58(3):175. 1971. TYPE. ANTILLES. VIRGIN ISLANDS: May 1787, *L.C.M. Richard s.n.* (LECTOTYPE: P designated by Baaijens & Veldkamp, Blumea 35:446. 1991; ISOLECTOTYPE: P-LAM).

FIG. 9. *Sporobolus virginicus*. **A.** Habit. **B.** Rhizome. **C.** Spikelet with stamen. *Sporobolus wrightii*. **D.** Habit. **E.** Spikelet.

Vilfa intermedia Trin., Gram. Unifl. Sesquifl. 156. 1824. *Vilfa matrella* Nees, Fl. Bras. Enum. Pl. 2:400, 401. 1829, nom. illeg. superfl. *Sporobolus matrella* Nees, Fl. Afr. Austral. Ill. 152. 1841, nom. illeg. superfl. TYPE: WEST INDIES. MAURITIUS: *Sieber II-38* (HOLOTYPE: LE-TRIN-1710.01!; ISOTYPES: K, L).

Strongly rhizomatous and stoloniferous perennials. Culms 10–65 cm tall, base flattened or rounded, widely creeping in rows and branching virgately, erect to decumbent, mostly glabrous and smooth and shinny below the nodes, internodes glabrous; base diameter 1–2.2 mm wide. Leaf sheaths 1/2 to almost as long as the internodes above, overlapping, glabrous, ciliate along the margins, summit with a tuft of hairs, the hairs up to 2 mm long; ligules 0.1–0.4 mm long; blades 4–16 cm long, 2–5 mm wide, flat to loosely involute, conspicuously distichous, glabrous below and scaberulous above; margins scaberulous. Panicles 3–10 cm long, 0.4–1.6 cm wide, narrow, contracted, densely flowered and spikelike; primary branches 0.5–2 cm long, ascending and appressed, floriferous to base; pedicels 0.2–1.4 mm long, apressed. Spikelets (1.8–)2–3.2 mm long, ochroleucus to purplish-tinged, sometimes grayish; glumes 1.5–3(–3.2) mm long, ovate-oblong, membranous, subequal, scaberulous along the keel; lower glumes 1.5–2.4 mm long, the apex acute; upper glumes 1.8–3(–3.2) mm long, the apex acute; lemmas 2.1–3 mm long, ovate to lanceolate, membranous, glabrous, the apex acute; paleas 2.1–3 mm long, ovate, membranous, the apex acute to obtuse; stamens 3; anthers 1–1.7 mm long, yellowish. Modified caryopses usually absent. $2n = 20, 30$.

Distribution and habitat.—*Sporobolus virginicus* occurs along sandy beaches, sand dunes, and saline habitats and is particularly common along the immediate coast throughout México associated with *Avicennia*, *Batis*, *Borrichia*, *Distichlis*, *Panicum amarulum* Hitchc. & Chase, *Salicornia*, and *Spartina*; 0–270 m. Flowering May to October.

Specimens examined: **MÉXICO. Nuevo León:** Municipio de Linares, Baño de San Ignacio, 22 km NE de Linares, *I. Cabral 658* (ANSM); Baño de San Ignacio, 22 km NE de Linares, *I. Cabral 759* (ANSM, MEXU). **Tamaulipas:** Municipio de Aldama, Rancho Nuevo, 23 km E del ejido San Rafael, *D. Baro 32* (ANSM); Rancho Nuevo, 23 km E del ejido San Rafael, *D. Baro 398, 420* (UAT); Barra del Tordo, Laguna, *A. Mora 5474* (UAT); Municipio de Ciudad Madero, Playa Miramar, *D. Baro 362* (ANSM); Municipio de Matamoros, 35 km S de la playa Lauro Villar, *D. Baro 263* (ANSM); Playa Bagdad, 16 km al N de Playa Lauro Villar, *D. Baro 284,466* (ANSM); Dunas Playa Lauro Villar, *A. Brito 15* (COCA, UAT); Camino a la Playa Lauro Villar, *M.H. Cervera 108* (COCA); Playa Bagdad, *J.A. Villarreal 6849* (ANSM); Municipio de San Fernando, Laguna La Carbonera, *R.A. Carranco 112* (COCA); Municipio de San Fernando, Laguna de San Andrés, Isla de las Garzas, *A. Mora 5539* (UAT); Municipio de Soto la Marina, Playa La Pesca, *A. Brito 171* (COCA, UAT); La Pesca, *R.A. Carranco 239* (COCA); Zona inundable cercana a la desembocadura del Río Soto la Marina, *A. Mora 5432* (UAT), Municipio de Tampico, 1 km adelante del puente Moralillo, límite de estados Tamaulipas-Veracruz, *R. Díaz 20* (UAT).

17. Sporobolus wrightii Munro ex Scribn., Bull. Torrey Bot. Club 9:103.1882. (**Fig. 9, D & E**). *Sporobolus airoides* var. *wrightii* (Munro ex Scribn.) Gould, Madroño 10:94. 1949. TYPE: U.S.A. ARIZONA: near Pantano, 28 Jun 1881, *C.G. Pringle 190* (ISOTYPE: US-825415!).

Bauchea karwinskyi E. Fourn., Mexic. Pl. 2:87. 1886. TYPE: MÉXICO: Cañon de las Minas and Victoria [Ciudad Victoria], *W.F. Karwinsky 1015* (SYNTYPE: P not seen; ISOSYNTYPE: US-998324-fragm!); Tanquecillas, *W.F. Karwinsky 1015b* (SYNTYPE: P not seen).

Sporobolus altissimus Vasey, Proc. Calif. Acad. Sci., Ser. 2, 2:212. 1889. TYPE: U.S.A. CALIFORNIA. San Diego Co: 1888, *E. Palmer s.n.* (HOLOTYPE: US-82015!).

Sporobolus altissimus var. *minor* Vasey, Proc. Calif. Acad Sci., Ser. 2, 2:213. 1889. *Sporobolus airoides* var. *minor* (Vasey) Beetle, Phytologia 54:5. 1983. TYPE: MÉXICO. BAJA CALIFORNIA: San Enrique, 4 May 1889, *T.S. Brandegee s.n.* (HOLOTYPE: US-998328!).

Densely caespitose perennials. Culms 90–250 cm tall, erect, stout, glabrous below the nodes, base rounded, internodes glabrous; base diameter 2—9 mm wide. Leaf sheaths 2/3 to a little longer than the internodes above, glabrous, shinny, rarely with a few long hairs near the summit, these hairs up to 6 mm long; ligules 1-2 mm long; blades 20–70 cm long, 3–10 mm wide, flat rarely involute, glabrous below and scabrous above; margins scabrous roughened. Panicles 20–60 cm long, 12–26 cm wide, open, broadly lanceolate, exserted; primary branches 1.5–10 cm long, ascending to widely spreading 20–70° from the culm axis; secondary branches appressed and floriferous to base; pulvini in axils of primary branches glabrous; pedicels mostly 0.2–0.5 mm long, appressed. Spikelets 1.5-2.5 mm long, crowded and appressed, purplish or greenish; glumes 0.5–2 mm long, lanceolate to ovate, membranous, unequal; lower glumes 0.5–1 mm long, often appearing without a midvein, the apex acute; upper glumes 0.8–2 mm long, the apex acute to obtuse; lemmas 1.2–2.5 mm long, ovate, membranous, glabrous, the apex acute to obtuse; paleas 1.1–2.5 mm long, ovate, membranous, glabrous, the apex acute to obtuse; stamens 3; anthers 1.1–1.3 mm long, yellowish to purplish. Modified caryopses 1–1.4 mm long, ellipsoid, reddish-brown or blackish, striate. $2n = 36$.

Distribution and habitat.—Moist clay flats and rocky slopes near saline habitats associated with *Atriplex, Acacia, Suaeda, Prosopis,* and *Opuntia*; 5–1800 m. Flowering May to December.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Acuña, 19 km by winding road N of El Jardín, 3 km S of Mina El Popo; E slope of Sierra del Carmen S of Cañón del Diablo, *M.C. Johnston 11931* (ANSM); Open country between Rancho Santo Domingo and Hacienda Piedra Blanca, *F. Wynd 497* (ANSM); Municipio de Cuatrociénegas, Junto a Nuevo Atalaya, *Brigada III 4* (COCA); About 2 mi W of Cuatrociénegas, *J.F. Cano 47* (TAES); About 2 mi W of Cuatrociénegas, *F.W. Gould 11175* (TAES); Dunas yesosas, cerca de la Poza El Bonito, *J.S. Marroquin s.n.* (ANSM); 3.2 km NW of Cuatrociénegas on road to Ocampo, *Peterson et al. 9992* (ANSM, US); Municipio de Múzquiz, Hacienda La Babia, without collector (MEXU); Municipio de Nadadores, 22 mi NW de Monclova y 7 mi E de Sacramento por la carretera a Cuatrociénegas, *Peterson & Valdés-Reyna 8362* (ANSM, US); Municipio de Ocampo, Sierra La Encantada, rancho Puerto del Aire, *M.A. Carranza 790* (ANSM); S of Laguna de La Leche, *I.M. Johnston 8624* (MEXU); Sierra El Pino, 18.8 km SW of Rancho El Cimarrón, *Peterson & Annable 10638* (ANSM, US); Sierra La Encantada, rancho Puerto del Aire, *R. Vásquez 239* (ANSM); Municipio de Saltillo, Saltillo, *E. Palmer 1* (MEXU); Small suburb of Cerritos, NE of Saltillo, *Peterson et al. 10082* (ANSM, US). **Nuevo León:** Municipio de Doctor Arroyo, Doctor Arroyo, *J.A. Ochoa 1278* (COCA); Municipio de Galeana, Arroyo Hondo, Hacienda San José de Raices, *C.H. Mueller 2292* (MEXU);

Saltillo-Monterrey, *J.A. Ochoa 1209* (COCA). **Tamaulipas:** Municipio de Jaumave, Jaumave, *G. Villegas 232* (COCA); Municipio de Matamoros, Rancho La Aurora, *J. Cantú 35* (COCA); Rancho La Aurora, *J. Cantú 36* (COCA); Municipio de San Fernando, La Carbonera, *A. Mora 5408* (UAT).

ACKNOWLEDGMENTS

We wish to thank the curators at the following herbaria for help locating specimens: COCA, MEXU, MO, NMCR, TEX, UAT; the Smithsonian Institutions, Fellowships and Grants for supporting research visits by JVR and JJOD to the United States National Herbarium; the Scholarly Studies Program, Research Opportunities, Atherton Seidell Foundation, and Biodiveristy Surveys and Inventories Program all at the Smithsonian Institution for financial support; Utah State University for permission to use illustrations that appeared in Flora of North America, Volume 25, prepared by Linda A. Vorobik and Hana Pazdirkova; Cathy Johnson for preparing illustrations; Alice R. Tangerini for preparing the plates; and Kelly W. Allred, Yolanda Herrera Arrieta, and Barney Lipscomb for reviewing the manuscript.

REFERENCES

Annable, C.R., P.M. Peterson and J. Valdés-Reyna. 1992. Anatomical studies in the *Sporobolus airoides* and *S. cryptandrus* complexes. Amer. J. Bot.79 (abstracts):134.

Baaijens, G.J. and J.F. Veldkamp. 1991. *Sporobolus* (Gramineae) in Malesia. Blumea 35: 393–458.

Boechat, S.C. and H.M. Longhi-Wagner. 1995. O gênero *Sporobolus* (Poaceae: Chloridoideae) no Brasil. Acta Bot. Bras. 9:21–86.

Bor, N.L. 1960. Poideae-Sporoboleae. In: The grasses of Burma. Ceylon, India and Pakistan. Pergamon Press, London. Pp. 622–636.

Brandenburg, D.M. 2003. Notes on free pericarps in grasses (Poaceae). J. Ky. Acad. Sci. 64: 114–120.

Clayton, W.D. and S.A. Renvoize. 1986. Genera graminum: grasses of the world. Her Majesty's Stationary Office, London.

Espejo-Serna, A., A.R. López-Ferrari, and J. Valdés-Reyna. 2000. Poaceae In: A. Espejo Serna & A.R. López-Ferrari, eds. Las Monocotyledóneas Mexicanus: una Synopsis Florística, Partes IX–XI. Consejo Nacional de la Flora de México, A.C., Univerisidad Autónoma Metropolitana-Izapalapa, and Comisión Nacional para el conocimiento y uso de la Biodiversidad, México, D.F. Pp. 10:8–236.

Laegaard, S. and P.M. Peterson. 2001. 214(2). Gramineae (part 2) subfam. Chloridoideae. In. G. Harling & L. Andersson (eds.), Flora of Ecuador no. 68. Botanical Institute, University of Göteborg & Section for Botany, Riksmuseum, Stockholm. Pp. 1–131.

Ortíz-Díaz, J.J. and A., Culham. 2000. Phylogenetic relationships of the genus *Sporobolus* (Poaceae: Eragrostideae) based on nuclear ribosomal DNA ITS sequences. In: S.W.L. Jacobs and J. Everett, eds. Grasses: Systematics and Evolution. CSIRO Publishing, Collingwood, Australia. Pp. 184–188.

Peterson, P.M., J.T. Columbus, and S.J. Pennington. 2005. Classification and biogeography of New World grasses: Chloridoideae. In: J.T. Columbus, ed. Grass Systematics and Evolution (Grasses IV). Rancho Santa Ana Botanic Garden, Claremont, In press.

Peterson, P.M., S.L. Hatch, and A.S. Weakley. 2003. *Sporobolus*. In: Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Flora of North America North of Mexico, volume 25. Oxford University Press, New York. Pp. 115–139.

Peterson, P.M., R.J. Soreng, G. Davidse, T.S. Filguerias, F.O. Zuloaga and E.J. Judziewicz. 2001. Catalogue of New World grasses (Poaceae): II. subfamily Chloridoideae. Contr. U.S. Natl. Herb. 41:1–255.

Peterson, P.M., R.D. Webster, and J. Valdés-Reyna. 1995. Subtribal classification of the New World Eragrostideae (Poaceae: Chloridoideae). Sida 16:529–544.

Peterson, P.M., R.D. Webster, and J. Valdés-Reyna. 1997. Genera of the New World Eragrostideae (Poaceae: Chloridoideae). Smithsonian Contr. Bot. 87:1–50.

Pilger, R. 1956. Sporobolinae. In: H. Melchior and E. Werdermann, eds. Gramineae II, Unterfamilien: Micraiodeae, Eragrostideae, Oryzoideae, Olyroideae. Die Naturlichen Pflanzenfamilien, second ed. 14:53–67.

Simon, B.K. and S.W.L. Jacobs. 1999. Revision of the genus *Sporobolus* (Poaceae: Chloridoideae) in Australia. Austral. Syst. Bot. 12:375–448.

Stapf, O. 1898. Gramineae. In: W.T. Thiselton-Dyer. Flora Capensis 7:315, 578–589. London.

Valdés-Reyna, J. 1978. *Sporobolus coahuilensis* (Gramineae) a new species from Coahuila, Mexico. Phytologia 41:81–84.

Watson, L. and M.J. Dallwitz. 1992. The grass genera of the World. C.A.B. International, Wallingford, U.K.

Weakley, A.S. and P.M. Peterson. 1998. Taxonomy of the *Sporobolus floridanus* complex (Poaceae: Sporobolinae). Sida 18:247–270.

Wipff, J.K. and S.D. Jones. 1994. *Sporobolus potosiensis* (Poaceae: Eragrosteae): a new rhizomatous species from San Luis Potosi, México, and a new combination in *S. airoides*. Sida 16:163–169.

BOOK NOTICES/BOOKS RECEIVED

WILLIAM W. DUNMIRE. 2004. **Gardens of New Spain How Mediterranean Plants and Foods Changed America.** (ISBN 0-292-70564-6, pbk.). The University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: 800-252-3206, fax 800-687-6046, www.utexas.edu/utpress). $24.95, 392 pp., 6" × 9".

Publisher Comments: "*Gardens of New Spain* tells the fascinating story of the diffusion of plants, gardens, agriculture, and cuisine from late medieval Spain to the colonial frontier of Hispanic America. Beginning in the Old World, William Dunmire describes how Spain came to adopt plants and their foods from the Fertile Crescent, Asia, and Africa. Crossing the Atlantic, he first examines the agricultural scene of Pre-Columbian Mexico and the Southwest. Then he traces the spread of plants and foods introduced from the Mediterranean to Spain's settlements in Mexico, New Mexico, Arizona, Texas, and California. In lively prose, Dunmire tells stories of the settlers, missionaries, and natives who blended their growing and eating practices into regional plantways and cuisines that live on today in every corner of America."

Table of Contents: **1)** Pre-Columbian Spain—the Full Hourglass; **2)** Mexico Before Columbus; **3)** Pre-Columbian Agriculture in the American Southwest; **4)** European Plantways to the New World: 1492-1521; **5)** Old World Agriculture Comes to the Mexican Mainland; **6)** Spanish Trade, Technology, and Livestock; **7)** New Mexico's First Mediterranean Gardens; **8)** Into Sonora and Arizona; **9)** The Corridor into Texas; **10)** Hispanic Farmers Return to New Mexico; **11)** Mediterranean Connections to Florida and California; Epilogue; Appendix: Master Plant List; Glossary; Sources; Selected Bibliography; and Index.

BETTY FUSSELL. 1992. **The Story of Corn.** (ISBN 0-8263-3592-6, pbk.)
University of New Mexico Press, MSC01 1200, University of New Mexico, Albuquerque, NM 87131-0001, U.S.A. (Orders: 1-800-249-7737, Fax: 505-277-9270, www.anmpress.com) $24.95, 356 pp., b/w photos, 8" × 9 1/4".

Publisher Comments: "Now in paperback for the first time, *The Story of Corn* is Betty Fussell's mesmerizing account of the extraordinary grain that built the New World. In a form as uniquely hybrid as its subject, it blends history and myth, science and art, anecdote and image, personal narrative and epic to tell the story of this amazing crop and the people who for centuries have planted, eaten, worshipped, processed, and profited from it."

REVISION OF *LOBELIA* SECT. *HOMOCHILUS* (CAMPANULACEAE: LOBELIOIDEAE)

Thomas G. Lammers

Department of Biology and Microbiology
University of Wisconsin Oshkosh
Oshkosh, Wisconsin 54901, U.S.A.

ABSTRACT

Lobelia L. sect. *Homochilus* A. DC. comprises six species, two of which are divided into pairs of geographic subspecies. All are robust polycarpic (iteroparous) perennial herbs or shrubs with relatively large more-or-less racemose flowers on ebracteolate or minutely bibracteolate pedicels; hemispheric or depressed hemispheric hypanthia; bilabiate or subbilabiate (unilabiate in one species) red, orange, yellow, pink, or purple-hued corollas with a straight cylindrical or apically tapering tube equaling or longer than the monomorphic lobes; ventral anthers with tufts of white or yellow trichomes at apex; and oblong or ellipsoid seeds with a faintly striate or minutely reticulate testa (Murata Type D); the three taxa that have been studied cytologically are diploid with $n = 7$. *Lobelia aguana*, *L. ghiesbreghtii*, *L. guererrensis*, and *L. laxiflora* have pedicels longer than the red, orange, or yellow typically bicolored flowers, and are distributed primarily in Mexico and/or Central America; *L. decurrens* and *L. heteroclita*, in contrast, have pedicels shorter than the monochromatic pink or purple-hued flowers, and are confined to the Andes of South America.

RESUMEN

Lobelia L. sect. *Homochilus* A. DC. comprende seis especies, dos de las cuales están divididas en pares de subespecies geográficas. Todas son hierbas perennes robustas policárpicas o arbustos con flores relativamente grandes más o menos racemosas sobre pedicelos ebracteolados o diminutamente bibracteolados; hipantos hemisféricos o hemisférico deprimidos; bilabiados o subbilabiados (unilabiados en una especie) corolas rojas, anaranjadas, amarillas, rosas, o tonos púrpura con un tubo cilíndrico o estrechado apicalmente tan largo o más que los lóbulos monomórficos; anteras ventrales con mechones apicales de tricomas blancos o amarillos; y semillas oblongas o elipsoides con una testa débilmente estriada o diminutamente reticulada (Murata Tipo D); los tres taxa que han sido estudiados citológicamente son diploides con $n = 7$. *Lobelia aguana*, *L. ghiesbreghtii*, *L. guererrensis*, y *L. laxiflora* tienen pedicelos más largos que las flores típicamente bicólores rojas, anaranjadas, o amarillas, y están distribuidas primariamente en México y/o América Central; *L. decurrens* y *L. heteroclita*, por contra, tiene pedicelos más cortos que las flores monocromáticas rosa o tonos púrpura, y están confinadas a los Andes de Sur América.

Lobelia L. is the largest of the 30 genera of Lobelioideae (Campanulaceae), comprising over 400 species of annual and perennial herbs, shrubs, trees, and giant rosette plants, with solitary or racemose (rarely paniculate or corymbose) flowers on bibracteolate pedicels; blue, purple-hued, or white (rarely red, pink, green, or yellow) corollas with the tube dorsally cleft to the base and the lobes monomorphic or dimorphic and the ventral larger; and apically bivalvate capsules or rarely berries (Lammers 1993, 2004; Murata 1995). The genus is virtually cosmopolitan in distribution, with representatives native to the floras of six conti-

SIDA 21(2): 591–623. 2004

nents and several major oceanic archipelagoes. Nearly 38% of the species are indigenous to Africa and another 29% to North America; Asia and Australasia each have about 10% of the species, South America 8%, and Polynesia 3%, while just two species occur in Europe (Lammers, unpublished data).

The last comprehensive monograph of *Lobelia* was that of Wimmer (1953, 1968), who divided its species among three subgenera: subg. *Lobelia* with two sections; subg. *Mezleria* (C. Presl) E. Wimm. (a name unfortunately referable to the genus *Monopsis* Salisb.; cf. Lammers 1999), with two sections; and subg. *Tupa* (G. Don) E. Wimm. with six sections. Further taxonomic structure was indicated by dividing many of the 10 sections into subsections and other subordinate taxa (cf. Lammers 1993). This classification was revised by Murata (1995), who maintained the three subgenera but altered their division into sections, recognizing a total of 14 and abandoning all subordinate taxa.

Among the six sections of subg. *Tupa* recognized by Murata (1995) was sect. *Homochilus* A. DC. Wimmer (1953, 1968) had circumscribed this section to include six species of perennial herbs and shrubs distributed from the southwestern United States to Peru. These species were characterized by their large racemose flowers with a hemispheric hypanthium, bilabiate or subbilabiate red, orange, yellow, or purple corolla with a straight cylindrical tube equaling or longer than the monomorphic lobes; ventral anthers bearded apically with tufts of white trichomes; and faintly striate oblong or ellipsoid seeds (Type D of Murata 1992, 1995).

Although Murata (1995) accepted Wimmer's (1953, 1968) treatment of sect. *Homochilus*, a preliminary study of some of its members (Eakes & Lammers 1996; cf. Hamlin 1995; Lammers 1999) suggested that neither this classification nor that of McVaugh (1943) was optimal, especially at the infraspecific level. Furthermore, since these treatments were published, two additional species thought referable to the section have been described (McVaugh 1965; Lammers 1999). The purpose of the present study, then, was to re-evaluate taxonomic relationships in the section, particularly at the infraspecific level, and to promulgate a formal classification that would satisfactorily reflect these relationships.

TAXONOMIC HISTORY

The genus *Lobelia* was first divided into named subordinate taxa by Candolle (1839), who recognized three sections: unispecific sect. *Trimeris* (C. Presl) A. DC., sect. *Lobelia* [as "sect. Rapuntium," nom. invalid.] with the bulk of the species, and sect. *Homochilus* with six species. This last was characterized by flowers with a hemispheric hypanthium and a red, yellow, or purple bilabiate corolla with an elongate cylindrical tube almost equaling the lobes in length. As originally circumscribed, it was geographically heterogeneous. Its members were *L. decurrens* Cav. of "Chile" (actually Peru; see below), *L. laxiflora* Kunth and *L. rigidula* Kunth of Mexico, *L. kraussii* Graham of Dominica and Martinique in the Lesser Antilles, *L. rotundifolia* Juss. ex A. DC. of Hispaniola and Puerto Rico in the Greater Antilles, and *L. gaudichaudii* A. DC. of O'ahu in the Hawaiian Islands.

Bentham (1876) expanded the circumscription of *Lobelia* by incorporating several genera that Candolle (1839) and others had recognized as distinct. In doing so, he retained Candolle's three sections and added five more: sect. *Tupa* (G. Don) Benth., sect. *Tylomium* (C. Presl) Benth., sect. *Rhynchopetalum* (Fresen.) Benth., sect. *Hemipogon* Benth., and sect. *Holopogon* Benth. As regards sect. *Homochilus*, Hawaiian *L. gaudichaudii* was explicitly removed to sect. *Rhynchopetalum*. Of the two West Indian species in the section, *L. rotundifolia* was removed, presumably to sect. *Tylomium*, but *L. kraussii* was implicitly left in sect. *Homochilus*. Schönland's (1889) classification of the genus was similar and his treatment of sect. *Homochilus* identical. The section was likewise recognized by Uphof (1910) and (under the generic name *Rapuntium* Mill.) by Post and Kuntze (1903).

In treating the North American representatives of sect. *Homochilus*, McVaugh (1943) recognized two additional species as members: *L. aguana* E. Wimm. and *L. ghiesbreghtii* Decne. West Indian *L. kraussii* was removed to sect. *Tylomium*, leaving only plants of the American mainland in sect. *Homochilus*. From his earlier comments (McVaugh 1940), it would appear that *L. decurrens* was also excluded from sect. *Homochilus* (and perhaps even from all of subg. *Tupa*; cf. McVaugh 1965). McVaugh divided *L. laxiflora* into four more-or-less geographic varieties, one of which encompassed *L. rigidula*.

Wimmer's (1953, 1968) treatment of these species was identical, with the following exceptions. *Lobelia decurrens* was definitely included within the section, and divided into two varieties. *Lobelia delessertiana* was segregated from *L. laxiflora* var. *laxiflora*, while *L. laxiflora* var. *nelsonii* was elevated to specific rank as *L. haenkeana* (C. Presl) A. DC. and divided into two varieties. What remained of *L. laxiflora* was then divided into six varieties plus 12 *formae*. This circumscription and classification of sect. *Homochilus* was accepted by Murata (1995).

MATERIALS AND METHODS

Revision of the classification of sect. *Homochilus* was based upon morphological data analyzed via traditional taxonomic methodology (Leenhouts 1968; Qualls 1986; Vogel 1987; Maxted 1992; Watson 1997; Winston 1999). These data were gathered from over 3400 specimens deposited in 38 herbaria (see Acknowledgments for a complete list of institutions); all extant types were seen, either as the original specimen or as a high-resolution image. Definitions of qualitative character states follow Harris and Harris (1994), supplemented by Radford (1986).

The classification promulgated here embodies a morphological species concept (Michener 1970; Cronquist 1978; Stuessy 1990), though it is assumed that the species recognized are more or less equivalent to the biological species (Grant 1981) that would be recognized were data on reproductive behavior available. When it is possible on the basis of morphology to discern clusters of conspecific populations that are geographically coherent, such clusters are recognized as subspecies (cf. Raven et al. 1974; Thorne 1978; Lammers 1988, 1991, 1995, 1999; Thompson & Lammers 1997). It is understood that conspecific subspecies will not be as clearly demarcated as congeneric species, and may show some intergradation in their zone of contact.

Altogether, over the past two centuries, a total of 48 heterotypic names referable to sect. *Homochilus* have been published, together with an additional 45 homotypic synonyms. The protologues for all 93 names were examined. All nomenclature was brought into compliance with current provisions of the *International Code of Botanical Nomenclature* (ICBN; Greuter et al. 2000) and typification was clarified as necessary.

RESULTS AND DISCUSSION

Revising the classification of a genus or infrageneric taxon is essentially a two-stage process (Qualls 1986; Maxted 1992; Watson 1997). First, one must determine the appropriate circumscription of the taxon as a whole, i.e., what individuals and populations to include within it. Second, these constituent units must be divided into a number of subordinate taxa: species and perhaps subspecies.

Circumscription of the section.—A detailed evaluation of the circumscription of sect. *Homochilus* can only be performed in the context of a thorough re-examination of the classification of all 400+ species of *Lobelia*. Murata's (1995) attempts in that direction are probably the best that can be accomplished at the present time without molecular data or phylogenetic analysis. His classification of *Lobelia* is certainly more natural than that of Wimmer (1953, 1968), as it takes into account a larger assemblage of characters. For this reason, Murata's (1995) treatment is accepted here as an overall framework within which to work.

Murata's (1995) studies supported Wimmer's (1953, 1968) circumscription of sect. *Homochilus* and he explicitly accepted it in his revision. However, he did note that additional species might be assigned there. Murata did not study in any detail the Central American and West Indian species treated by Wimmer (1953, 1968) as "species antillanae" within sect. *Tupa* (as sect. *Eutupa* E. Wimm., nom. illeg. sub Art. 52.1) but did comment that they "may be attributable" to sect. *Homochilus* rather than sect. *Tupa*. These species (e.g., *L. assurgens* L., *L. cirsiifolia* Lam., *L. nubicola* McVaugh) do indeed differ from members of sect. *Tupa* as circumscribed by Murata (1995) and Lammers (2000) in their conspicuously bibracteolate (vs. ebracteolate or minutely bibracteolate) pedicels; globose or ovoid seeds with a reticulate testa (Murata Type E) (vs. oblong or ellipsoid with a faintly striate or minutely reticulate testa [Murata Type D]), and diploid (vs. hexaploid) chromosome number. Furthermore, Wimmer's "species antillanae" do indeed resemble sect. *Homochilus* in certain features, including their robust habit; relatively large flowers with red, orange, yellow, pink, or purple-hued corolla; and diploid chromosome number (so far as known; Lammers 1993).

However, these "species antillanae" also differ from sect. *Homochilus* in several important characters. First, their bracteoles are conspicuous and foliaceous (vs. absent or minute in sect. *Homochilus*). Second, the corolla tube is curved or arcuate (vs. straight) with the lobes often unilabiate and deflexed (vs. usually bilabiate or subbilabiate and recurved or straight). Finally and perhaps most significantly, the seeds are ovoid or globose, with a reticulate testa of Murata Type E (vs. oblong or ellipsoid with a faintly striate or minutely reticulate testa of Murata Type D). After weighing all the data, it seems best to exclude Wimmer's "species antillanae" from both sect. *Tupa* and sect. *Homochilus*; they are here recognized as sect. *Tylomium*, following McVaugh (1940, 1943) and other recent authors (e.g., Wilbur 1991; Lammers & Proctor 1994; Buss et al. 2001).

In her detailed account of *Heterotoma* Zucc., Ayers (1986, 1990) mentioned that, on the basis of her very preliminary cladistic analyses, the type of that genus, *H. lobelioides* Zucc., might logically be included within *Lobelia* sect. *Homochilus*. This species does resemble members of sect. *Homochilus* in a number of features, including its robust polycarpic habit; suffruticose stems; racemose inflorescence; ebracteolate pedicels; relatively large flowers with red or orange and yellow bicolored corolla; ventral anthers bearded apically with tufts of white trichomes; faintly striate (Murata Type D) seeds; and diploid chromosome number (Lammers 1993). However, *H. lobelioides* differs conspicuously from any species of *Lobelia* (and is unique among Campanulaceae) in its large arcuate basally inflated nectar spur and in the nearly perpendicular exsertion of the staminal column from the corolla tube during the carpellate phase of the flower (Ayers 1986, 1990). In light of this and the preliminary nature of her cladograms, it is best to follow Ayers' (1986, 1990) recommendation and recognize *H. lobelioides* as the sole species of a distinct genus.

Although *L. decurrens* was included in sect. *Homochilus* from the very beginning, McVaugh (1940) implied that it should be excluded from that section (and perhaps even from the entire subgenus; cf. McVaugh 1965). It does indeed differ from the species included there by McVaugh (1940, 1943) in a number of features, including its rank odor; decurrent leaves; pedicels shorter than (vs. equaling or longer than) the flowers, making the inflorescence appear spikelike (vs. clearly racemose); fimbriate (vs. entire or minutely toothed) calyx lobes; and monochromatic purple-hued (vs. red, orange, or yellow and usually bicolored) corollas. However, *L. decurrens* does resemble the other species of sect. *Homochilus* in its robust polycarpic habit, ebracteolate pedicels, depressed hemispheric hypanthium, straight cylindrical or slightly tapering corolla tube, monomorphic corolla lobes, faintly striate (Murata Type D) seeds, and diploid chromosome number (Lammers 1993). Though it is somewhat discordant in sect. *Homochilus*, it would be even more so in the other sections of subg. *Tupa*, e.g., sect. *Colensoa* (Hook. f.) J. Murata, sect. *Tupa*, or sect. *Tylomium*. For these reasons, *L. decurrens* is assigned to sect. *Homochilus*.

In naming and describing *L. heteroclita*, McVaugh (1965) did not assign his new species to a specific section, merely commenting that it was "apparently referable to the subgenus *Tupa* as delimited by Wimmer." It differs from all other species assigned here to sect. *Homochilus* in its ventrally oblique hypanthium (cf. Ayers 1990) and deep pink unilabiate corolla with a tube that tapers conspicuously towards the mouth. However, it resembles the rest of the section in its robust habit, reduced or absent bracteoles, depressed hemispheric hypanthium, straight corolla tube, and monomorphic corolla lobes. It particularly resembles *L. decurrens*, the only other exclusively South American member of the section, in having pedicels shorter than the flowers, making the inflorescence appear spike-like, and in its monochromatic corollas. As with *L. decurrens*, it is even more discordant in any other section of subg. *Tupa*. It seems best assigned here, and regarded as related most closely to *L. decurrens*.

The newest member of the section, *L. guerrerensis*, was explicitly assigned to sect. *Homochilus* by its authors (Lammers 1999). The degree to which it conforms to that section's characterization is indicated by the fact that all the specimens upon which it was based had previously been identified as *L. laxiflora*, the type of the section.

Species and subspecies.—After a thorough comparative study of all material, it was concluded that just six species could be recognized in sect. *Homochilus*. These are essentially the species assigned to the section by Wimmer (1953, 1968), except that *L. delessertiana* and *L. haenkeana* are subsumed into *L. laxiflora*, and two species described after Wimmer's death are added.

Two of these species exhibit relatively minor variation in morphology that is correlated with geography, making possible the recognition of subspecies. In *L. laxiflora*, the morphometric analysis of Eakes and Lammers (1996) supported the recognition of two subspecies based on leaf dimensions rather than the complex infraspecific classifications of McVaugh (1943) or Wimmer (1953, 1968). Plants of northeastern Mexico and Arizona have very narrow leaves, while those in the rest of the range are wider. This treatment, which is essentially identical to that of Candolle (1839), was implemented by Lammers (1999) and is maintained here. In *L. decurrens*, variation in flower size supports recognition of two subspecies, which differ from the two varieties recognized on the basis of pubescence by Wimmer (1937, 1953). Plants in the northern portion of the range have markedly smaller flowers than those in the south.

Summary.—The circumscription of sect. *Homochilus* adopted here encompasses six species, which fall into two subordinate groups, based on morphology and geography; because of the few species involved, these subgroups are not named formally. The first group (*L. aguana*, *L. ghiesbreghtii*, *L. guerrerensis*, and *L. laxiflora*) comprises species distributed primarily in Mexico and Central America (*L. laxiflora* extends into southern Arizona and southwestern Colombia), with pedicels longer than the typically bicolored red, orange, or yellow flowers. The second group (*L. decurrens* and *L. heteroclita*) encompasses species of the Andes of northern South America with pedicels shorter than the monochromatic pink or purple-hued flowers. One species in each group (*L. decurrens* and *L. laxiflora*) shows geographically correlated variation in morphology and is divided into a pair of subspecies.

TAXONOMIC TREATMENT

Lobelia sect. **Homochilus** A. DC. in DC., Prodr. 7:383. 1839. *Rapuntium* sect. *Homochilus* (A. DC.) Kuntze in T. Post & Kuntze, Lex. Gen. Phan. 479. 1903. TYPE (designated by Murata 1995): *L. laxiflora* Kunth.

Robust polycarpic (iteroparous) perennial herbs and shrubs. Stems 0.2-3 m tall, herbaceous, suffruticose, or woody, single or several from the base, branched or unbranched, erect or ascending, moderately to densely leafy, glabrous or pubescent; latex white or cream-colored, viscous. Leaves alternate, simple, exstipulate, sessile or petiolate, glabrous or pubescent, the lower ones often deciduous; lamina ovate, oblong, narrowly oblong, elliptic, narrowly elliptic, lanceolate, oblanceolate, or linear, chartaceous, flat (cernuous in *L. guerrerensis*); margin entire, denticulate, serrulate, serrate, biserrate, or crenate, plane (minutely revolute in *L. guerrerensis*); apex obtuse, acute, acuminate, or narrowly acuminate; base attenuate, cuneate, obtuse, rounded, or decurrent. Flowers tetracyclic, perfect and proterandrous, zygomorphic, epigynous, pedicellate and resupinate, relatively large and numerous, solitary in the axils of the upper leaves or these reduced gradually to bracts towards the apex and so forming a terminal raceme (the distinction not always clear); pedicels erect, ascending, spreading, or incurved, stiff or flexuous, glabrous or pubescent, ebracteolate or minutely bibracteolate; bracteoles (when present) subulate or linear. Calyx synsepalous; tube adnate to the ovary, forming a hemispheric or depressed hemispheric hypanthium, the base rounded or truncate (ventrally oblique in *L. heteroclita*), glabrous or pubescent; lobes 5, valvate, persistent, subulate, linear triangular, narrowly triangular, or triangular, shorter than the corolla tube, glabrous or pubescent, the margin entire, toothed, or fimbriate, the apex acuminate. Corolla sympetalous, zygomorphic, bilabiate or subbilabiate (unilabiate in *L. heteroclita*), red, orange, or yellow and the lobes often a different color than the tube, or pink or various shades of purple throughout, glabrous or pubescent; tube straight, cylindric or tapering towards the mouth, laterally fenestrate towards base, dorsally cleft nearly to base; lobes 5, valvate, monomorphic; the two dorsal lobes linear or narrowly triangular, recurved or straight (all deflexed in *L. heteroclita*), one-fourth as long to about as long as the tube, acuminate or acute at apex; the three ventral lobes forming a trifid lip, the segments narrowly triangular, slightly shorter than the dorsal, straight or slightly deflexed. Stamens 5, antisepalous, connate for most of their length, exserted, emerging from the corolla above the dorsal lobes, glabrous or pubescent; dorsal anthers longer than the ventral, overhanging the orifice of the tube and partly occluding it; ventral anthers with tufts of white or yellow trichomes at apex; pollen tricolporate, prolate, ellipsoid. Ovary 2-loculed, inferior, adnate to the hypanthium for 1/3-2/3 its length; placentae large, axile; ovules numerous; style 1, slender, terete, with a ring of stiff white hairs near the apex; stigma 2-lobed, the lobes appressed and non-receptive as the style grows through the anther tube, pushing out pollen, after which the stigmas spread and become receptive. Fruit an ovoid or broadly ovoid capsule, 1/3-3/4-inferior, the conical apex dehiscing as two triangular valves; seeds honey-colored, oblong or ellipsoid, compressed, relatively small, the testa faintly striate or minutely reticulate (Type D of Murata 1992). Chromosome number (three taxa known) $n = 7$ (Lammers 1993).

Pollination biology.—Based on floral morphology, it is assumed that the species of sect. *Homochilus* are pollinated by hummingbirds. This assumption of ornithophily is supported for *L. laxiflora* by notes on herbarium labels (e.g., *Bye et al. 9192*, ASU, TEX; *Hurd 6*, MICH; *Marshall 133*, ARIZ, RSA) and by a published photograph (Anonymous 2003). In the bicolorous species, the corolla may change color to varying degrees through the course of anthesis. Typically, the corolla is more uniformly yellowish or orangish in bud or in staminate phase; the red pigments become best developed (and thus contrast reaches its peak) during carpellate phase. This phenomenon has also been observed in *L. excelsa* Bonpl. of sect. *Tupa* (Lammers 2000). The biological significance of such changes has been described by Weiss (1995).

KEY TO THE SPECIES AND SUBSPECIES

1. Pedicels shorter than the flowers, the inflorescence appearing spike-like; corolla monochromatic, various shades of purple (violet, red-purple, magenta, mauve, lavender) or deep pink (South America).
    2. Leaves rounded or cuneate at base; pedicels 15–23 mm long; hypanthium oblique ventrally; calyx lobes entire or with 1–2 minute denticulations per side; corolla tube 29–38 mm long, tapering conspicuously to mouth, corolla lobes 1/4–1/3 as long as tube, all five forming a single ventral lip; filament tube 32–38 mm long; dorsal anthers 4–5 mm long, 1/8–1/7 as long as filament tube (Colombia) ____ **6. L. heteroclita**
    2. Leaves long decurrent at base; pedicels 5–14 mm long; hypanthium symmetrical; calyx lobes fimbriate with 3–9 teeth per side; corolla tube 14–30 mm long, cylindric or tapering slightly towards mouth; corolla lobes 1/3–9/10 as long as tube, two dorsal and three ventral; filament tube 20–33 mm long; dorsal anthers 6–8.5 mm long, 1/4–1/3 as long as filament tube.
        3. Corolla 31–42 mm long, the tube 20–30 mm long, 2.5–3 times longer than the dorsal lobes; filament tube 24–33 mm long, 3.4–4.2 times longer than the dorsal anthers (S Peru) ____ **5a. L. decurrens** subsp. **decurrens**

3. Corolla 22–33 mm long, the tube 14–19 mm long, a little longer than the lobes to 1.8 times longer; filament tube 20–26 mm long, 2.5–3.6 times longer than the dorsal anthers (N Peru) ______ **5b. L. decurrens** subsp. **parviflora**

1. Pedicels equaling or longer than the flowers, the inflorescence clearly racemose; corolla usually bicolored, red, orange, and/or yellow (Mexico and Central America primarily).
   3. Stems, flowers, and ventral surface of lamina white-tomentose; lamina broadest at or near middle, 3.5–8 cm wide, on a petiole 10–30 mm long (Oaxaca) ______ **4. L. ghiesbreghtii**
   3. Stems, flowers, and ventral surface of lamina glabrous or pubescent, but never white-tomentose; lamina usually broadest below middle, 0.2–5 cm wide, sessile or on a petiole up to 7 mm long.
      4. Pedicels 85–210 mm long; calyx lobes 6–18 mm long; dorsal corolla lobes 20–33 mm long, the ventral 18–26 mm long; dorsal anthers 9–12 mm long, the ventral 7.5–9.5 mm long; capsules 10–15 mm long; seeds minutely reticulate (Guerrero to Guatemala) ______ **3. L. aguana**
      4. Pedicels 20–130 mm long; calyx lobes 1–6 mm long; dorsal corolla lobes 10–22 mm long, the ventral 10–21 mm long; dorsal anthers 6–9 mm long, the ventral 4.5–7.6 mm long; capsules 6–12 mm long; seeds faintly striate.
         5. Lamina cernuous, the margin entire or nearly so and minutely revolute; corolla yellow or yellowish orange on tube, red or orange on lobes; anther tube with dense dirty yellow trichomes 2–4 mm long from apex to base; ventral anthers with a tuft of dirty yellow trichomes 1.5–2 mm long at apex; capsules 9–11 mm in diameter; seeds 0.7–0.8 mm long, 0.3–0.4 mm wide (Guerrero) ______ **2. L. guerrerensis**
         5. Lamina flat, the margin denticulate, serrulate, serrate, or doubly serrate and plane; corolla red or orange on tube, orange or yellow on lobes; anther tube with sparse to moderately dense white trichomes 0.5–1 mm long on dorsal surface towards apex; ventral anthers with a tuft of white trichomes 0.7–1.3 mm long at apex; capsules 7–9 mm in diameter; seeds 0.5–0.6 mm long, 0.2–0.3 mm wide.
            6. Lamina 1–5 cm wide, 2–8 times longer than wide, the base rounded, obtuse, or cuneate (Mexico to Colombia) ______ **1a. L. laxiflora** subsp. **laxiflora**
            6. Lamina 0.2–1.4 cm wide, 12–18 times longer than wide, the base attenuate (Arizona & NE Mexico) ______ **1b. L. laxiflora** subsp. **angustifolia**

1. Lobelia laxiflora Kunth in Humb., Bonpl. & Kunth, Nov. Gen. Sp. 3:311 (quarto), 242 (folio). 1819 (Nov). *Rapuntium laxiflorum* (Kunth) C. Presl, Prodr. Monogr. Lobel. 26. 1836. *Tupa laxiflora* (Kunth) Planch. & Oerst., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1857:154. 1857. *Lobelia persicifolia* var. *laxiflora* (Kunth) Vatke, Linnaea 38:723. 1874. *Dortmanna laxiflora* (Kunth) Kuntze, Revis. Gen. Pl. 972. 1891. TYPE: MEXICO. [GUERRERO:] Acaguisotla, *Humboldt 3918* (HOLOTYPE: P-Bonpl. [IDC-microfiche!; photographs: F! MICH!]; ISOTYPES: B! [photographs: F! MICH!] B-W [IDC-microfiche!]). The isotype at B-W is the holotype of *L. fissa*. Though it seems that the name *L. persicifolia* var. *laxiflora* was used for the nomenclaturally typical "α" variety, neither the type of *L. persicifolia* (see below) nor the name itself was cited; the name thus is validly published under Art. 26.2.

Stems 0.2–3 m tall, herbaceous, suffruticose, or woody, unbranched or sparingly branched, erect or ascending, glabrous or pubescent. Leaves sessile or petiolate; lamina ovate, lanceolate, oblong, elliptic, narrowly elliptic, lanceolate, or linear, 2.5–19 cm long, 0.2–5 cm wide; adaxial surface glabrous or sparsely pubescent; abaxial surface glabrous or pubescent; margin denticulate, serrulate, serrate, or doubly serrate; apex acuminate or acute; base attenuate, cuneate, obtuse, or rounded; petiole (when present) 1–7 mm long, glabrous or pubescent. Flowers solitary in the axils of the upper leaves or forming a terminal raceme; pedicels 20–100 mm long, erect, ascending, spreading, or incurved, stiff or flexuous, glabrous or pubescent, ebracteolate or bibracteolate at or below the middle; bracteoles (when present) linear, 0.5–1.1 mm long. Hypanthium depressed hemispheric, 2–5 mm long, 4–11 mm in diameter, glabrous or pubescent; base rounded or truncate. Calyx lobes subulate, linear triangular, narrowly triangular, or triangular, 1–6 mm long, 0.8–3 mm wide, glabrous or pubescent; margin entire. Corolla bilabiate or subbilabiate, red or orange on tube, grading to orange or yellow on the lobes (rarely all yellow), 24–40 mm long, glabrous or pubescent; tube 14–25 mm long, 4–9.5 mm in diameter at base, 3.5–7 mm in diameter at mouth, cylindric or tapering slightly towards mouth; dorsal lobes linear, 10–22 mm long, 1–2 mm wide, recurved or straight, half as long to about as long as the tube, acuminate or acute at apex; ventral lip 10–20 mm long, the segments triangular or narrowly triangular, 1–10 mm long, 0.5–2 mm wide, acute or acuminate at apex. Filament tube 18–34 mm long, 0.7–2 mm in diameter, reddish or yellowish, glabrous or pubescent; anther tube 1.5–3.9 mm in diameter, the dorsal surface towards the apex moderately to densely pubescent with white trichomes 0.5–1 mm long; dorsal anthers 6–9 mm long; ventral anthers 4.5–7.5 mm long, with tufts of white trichomes 0.7–1.3 mm long at apex. Capsules broadly ovate, 6–12 mm long, 7–9 mm in diameter; seeds oblong or ellipsoid, 0.5–0.6 mm long, 0.2–0.3 mm wide, ca. 0.1 mm thick, the testa faintly striate. Chromosome number $n = 7$ (Ayers 1986).

Distribution.—Found throughout much of Mexico, south through Central America to Panama, and in the Cordillera Occidental of southwestern Colombia, with one population in the southwestern United States, in southern Arizona. The inclusion of the West Indies and Peru within the species' range (Nash 1976; Ayers 2000) was erroneous, as was its attribution to Georgia in the southeastern United States (Don 1838; Knowles & Westcott 1838). Its presence in northern Ecuador, while expected (Jeppesen 1981; Jørgensen 1999), is as yet unsubstantiated.

Cultivation.—The species was introduced to horticulture in 1825 as a half-hardy perennial and is still cultivated today, though not commonly (Hooker 1837; Don 1838; Vatke 1874; Siebert & Voss 1894; Anonymous 1915; Thomas 1990; Lancaster 1991; Huxley 1992; Ayers 2000); it appears that most plants cultivated today represent subsp. *angustifolia* (A. DC.) Eakes & Lammers (see below).

Discussion.—This widespread species shows considerable variation throughout its geographic range in leaf dimensions, pubescence, pedicel posture, and other features. Candolle (1839) was the first to use this variation to divide *L. laxiflora* into infraspecific taxa, recognizing narrow-leaved plants as var. *angustifolia* A. DC. Vatke (1874) expanded on this, dividing the species (under the illegitimate name *L. persicifolia*; see below) into five varieties: var. *laxiflora* (Kunth) Vatke, var. *mollis* Vatke, var. *warscewiczii* (Regel) Vatke, var. *amygdalina* Vatke, and var. *angustifolia* (A. DC.) Vatke. Little or no information on geographic distribution was provided. In support of his classification, Vatke commented that "omnes cultura sibi constant."

McVaugh (1943) divided *L. laxiflora* into four varieties, each of which had a reasonably coherent if overlapping geographic range: var. *angustifolia* (Arizona and Baja California to San Luis Potosi and Oaxaca), var. *laxiflora* (Puebla and Vera Cruz to Guatemala and Honduras), var. *nelsonii* (Fern.) McVaugh (Sonora to Chiapas), and var. *stricta* (Planch. & Oerst.) McVaugh (Michoacan, Jalisco and Nayarit south to Colombia). Wimmer (1953) segregated *L. laxiflora* var. *nelsonii* as a distinct species, *L. haenkeana* (C. Presl) A. DC., and carved three additional varieties out of the remaining three: var. *brevipes* E. Wimm., var. *patula* (Planch. & Oerst.) E. Wimm., and var. *petiolata* E. Wimm. With this classification, the degree of geographic overlap among varieties increased markedly. For example, three of the varieties were ascribed to Colombia, vs. one in McVaugh's scheme, and three to Guatemala, vs. two.

Eakes and Lammers (1996) undertook a detailed multivariate study of morphological variation in *L. laxiflora* and its allies *L. aguana* and *L. ghiesbreghtii*. States of 100 characters in 71 specimens were scored and these data subjected to cluster and principal components analyses. The results of their study failed to support either McVaugh's (1943) or Wimmer's (1953) classification; instead, they supported the original classification of Candolle (1839). Populations of *L. laxiflora* fell into two weakly discriminated clusters: narrow-leaved plants of northeastern Mexico and Arizona, and broad-leaved plants of the rest of the range. For the sake of consistency (cf. Lammers 1988, 1991, 1995), these two taxa were accorded the rank of subspecies by Lammers (1999); that treatment is followed here.

1a. **Lobelia laxiflora** subsp. **laxiflora**

Lobelia persicifolia Cav., Icon. 6:12. 1800, nom. illeg.; non Lam., Encycl. 3:584. 1792. *Lobelia cavanillesiana* Schult. in Roem. & Schult., Syst. Veg. 5:43. 1819 (Dec). *Lobelia cavanillesii* Mart., Ausw. Merkw. Pfl. 12. 1830, nom. superfl. *Rapuntium cavanillesianum* (Schult.) C. Presl, Prodr. Monogr. Lobel. 27. 1836; non *Rapuntium persicifolium* (Lam.) C. Presl, Prodr. Monogr. Lobel. 27. 1836. *Tupa persicifolia* G. Don in Sweet, Hort. Brit. ed. 3:424. 1839 (sero); non (Lam.) A. DC. in DC., Prodr. 7:395. 1839 (Dec). *Siphocampylus cavanillesii* J. W. Loud., Ladies' Fl. Gard. Ornam. Greenh. Pl. 184. 1848; non *Siphocampylus cavanillesianus* G. Don, Gen. Hist. 3:702. 1834, nom. illeg. sub Art. 52.1; nec *Siphocampylus persicifolius* (Lam.) G. Don in Sweet, Hort. Brit. ed. 3:424. 1839. TYPE: MEXICO. Acambaro, *Née s.n.* (HOLOTYPE: MA [photographs: MA! W!]; ISOTYPE: MA!).

Lobelia rigidula Kunth in Humb., Bonpl. & Kunth, Nov. Gen. Sp. 3:311 (quarto), 243 (folio). 1819 (Nov). *Rapuntium rigidulum* (Kunth) C. Presl, Prodr. Monogr. Lobel. 26. 1836. TYPE: "Amérique Équatoriale," *Humboldt s.n.* (HOLOTYPE: P-Bonpl. [IDC-microfiche!; photographs: F! MICH!]).

Lobelia fissa Willd. ex Schult. in Roem. & Schult., Syst. Veg. 5:57. 1819 (Dec). TYPE: "America meridionalis," *Humboldt 3918/Willdenow 3993* (HOLOTYPE: B-W [IDC-microfiche!]; ISOTYPES: B! [photographs: F! MICH!] P-Bonpl. [IDC-microfiche!; photographs: F! MICH!]). The isotype at P-Bonpl. is the holotype of *L. laxiflora*.

Lobelia amygdalina Willd. ex Schult. in Roem. & Schult., Syst. Veg. 5:57. 1819 (Dec). *Rapuntium amygdalinum* (Willd. ex Schult.) C. Presl, Prodr. Monogr. Lobel. 27. 1836. *Dortmanna amygdalina* (Willd. ex Schult.) Kuntze, Revis. Gen. Pl. 972. 1891. TYPE: "America meridionalis," *Humboldt 4425/Willdenow 3992* (HOLOTYPE: B-W [IDC-microfiche!]).

Rapuntium haenkeanum C. Presl, Prodr. Monogr. Lobel. 26. 1836. *Lobelia haenkeana* (C. Presl) A. DC. in DC., Prodr. 7:382. 1839. *Dortmanna haenkeana* (C. Presl) Kuntze, Revis. Gen. Pl. 972. 1891. TYPE: PHILIPPINES. LUZON: *Haenke s.n.* (HOLOTYPE: PR! [photograph: F!]). As with *Rapuntium longifolium* (Thompson and Lammers 1997), the locality was an error and the specimen was actually collected in the New World (Merrill 1923).

Lobelia prunifolia Humb. ex C. Presl, Prodr. Monogr. Lobel. 37. 1836. *Siphocampylus prunifolius* (Humb. ex C. Presl) A. DC. in DC., Prodr. 7:401. 1839. TYPE: Sine loc., *Humboldt 2167* (LECTOTYPE [designated by Wimmer 1953]: B! [photograph: F!]).

Lobelia canescens C. Presl, Prodr. Monogr. Lobel. 38. 1836. *Siphocampylus canescens* (C. Presl) A. DC. in DC., Prodr. 7:402. 1839. TYPE: MEXICO. Pasquaro, *Humboldt s.n.* (HOLOTYPE: PR! [photograph: F!]; ISOTYPES: B! B-W [IDC-microfiche!]).

Siphocampylus bicolor D. Don in Sweet, Brit. Fl. Gard. (ser. 2) 4:pl. 389. 1838. *Lobelia laxiflora* var. *bicolor* (D. Don) Endl., Cat. Hort. Acad. Vindobon. 1:436. 1842. *Tupa bicolor* (D. Don) Planch., Hort. Donat. 78. 1858. TYPE: GREAT BRITAIN. Messrs. Low & Co., raised from seeds collected in Georgia USA by Alexander Gordon (LECTOTYPE, here designated: Don 1838, pl. 389!). Because no specimen that might be considered original material has been found, the plate that accompanied the original description is designated here as the lectotype. The geographic source of the seed is almost certainly an error, unless the plants were cultivated there.

Lobelia ovalifolia Hook. & Arn., Bot. Beechey Voy. 300. 1838. TYPE: MEXICO. [Nayarit: Tepic, 8 Dec 1827 - Feb 1828, *leg.* Lay,] *Beechey s.n.* (HOLOTYPE: K! [photograph: F!]; ISOTYPE: E!). Information in brackets for this and the two following names is taken from the official itinerary (Hooker & Arnott 1830).

Lobelia angulatodentata Hook. & Arn., Bot. Beechey Voy. 301. 1838 (as 'angulato-dentata'). TYPE: MEXICO. [NAYARIT: Tepic, 8 Dec 1827 -Feb 1828, *leg.* Lay,] *Beechey s.n.* (HOLOTYPE: K! [photographs: F! MICH!]; ISOTYPE: E!). The hyphen is deleted from the epithet in accordance with Art. 60.9.

Lobelia lanceolata Hook. & Arn., Bot. Beechey Voy. 301. 1838, nom. illeg.; non (Gaudich.) Hook. & Arn., Bot. Beechey Voy. 88. 1832. *Lobelia laxiflora* f. *lanceolata* E. Wimm., Pflanzenr. IV.276b:683. 1953. TYPE: MEXICO. [NAYARIT: Tepic, 8 Dec 1827 - Feb 1828, *leg.* Lay,] *Beechey s.n.* (HOLOTYPE: K! [photographs: F! MICH!]).

Lobelia concolor M. Martens & Galeotti, Bull. Acad. Roy. Sci. Bruxelles 9(2):46. 1842, nom. illeg.; non R. Br., Prodr. 563. 1810. *Dortmanna concolor* Kuntze, Revis. Gen. Pl. 972. 1891. *Lobelia laxiflora* f. *concolor* (Kuntze) E. Wimm., Pflanzenr. IV.276b:684. 1953. TYPE: MEXICO. VERACRUZ: Xalapa, 4000 ft, Jun-Oct [Nov–Apr on K isotype] 1840, *Galeotti 1972* (HOLOTYPE: BR! [photograph: F!]; ISOTYPES: BR! G! K!).

Lobelia andina Benth., Pl. Hartweg. 213. 1845. TYPE: COLOMBIA. Andes of Popayan, 8000 ft, *Hartweg 1183* (HOLOTYPE: K! [photographs: F! MICH!]; ISOTYPE: K! [photograph: F!]).

Siphocampylus mollis Regel, Flora 33:353. 1850 (21 Jun); non Planch., Fl. Serres Jard. Eur. 6:36. 1850 (incerta). *Siphocampylus warscewiczii* Regel, Schweiz. Z. Gartenbau 1850:131. 1851. *Lobelia persicifolia* var. *warscewiczii* (Regel) Vatke, Linnaea 38:723. 1874. TYPE: GERMANY. Berlin Botanic Garden, grown from seed sent by Warscewicz from Guatemala (neotype here designated: Regel 1851, unnumbered plate!). Because no specimen that might be considered original material has been found, and as no illustration accompanied the original description, a plate published soon after by its author is designated as the neotype.

Tupa costaricana Planch. & Oerst., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1857:154. 1857. *Tupa costaricana* var. *stricta* Planch. & Oerst., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1857:155. 1857. *Lobelia costaricana* (Planch. & Oerst.) E. Wimm., Ann. Naturhist. Mus. Wien 46:239. 1933. *Lobelia laxiflora* var. *stricta* (Planch. & Oerst.) McVaugh, N. Amer. Fl. 32A:96. 1943. TYPE: COSTA RICA. Prope Cartago, *Oersted 9245* (LECTOTYPE [designated by McVaugh 1943]: C! [photographs: F! GH! MICH!]; ISOLECTOTYPES: C[4!] [photographs: F!]). Though it seems that the name *T. costaricana* var. *stricta* was used for the nomenclaturally typical ("α") variety, no types were cited and the name thus is validly published under Art. 26.2.

Tupa costaricana var. *patula* Planch. & Oerst., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1857:155. 1857. *Lobelia laxiflora* var. *patula* (Planch. & Oerst.) E. Wimm., Pflanzenr. IV.276b:683. 1953. TYPE: COSTA RICA. CARTAGO: southern slopes of Volcán Irazú in small patches of woods left in cleared meadows, 2500 m, 27 Mar 1967, *Wilbur & Stone 8747* (neotype here designated: MICH! [photograph: F!]). Because no original material could be located, a specimen from the same general area which conforms to the protologue is here chosen as the neotype.

Lobelia persicifolia var. *mollis* Vatke, Linnaea 38:722. 1874. *Lobelia laxiflora* var. *mollis* (Vatke) Zahlbr., Repert. Spec. Nov. Regni Veg. 14:185. 1916. TYPE: not located. Name based on plants grown in the botanic garden at Berlin in 1854, their origin unknown. McVaugh (1943) reported seeing what he considered the type specimen at B, but did not cite details. It is no longer extant (cf. Lammers 1994), nor does the Field Museum's Type Photograph Collection (cf. Nitecki 1980, Grimé and Plowman 1986) contain a photo of it (C. Niezgoda, pers. comm.).

Lobelia patzquarensis Sessé & Moç., Pl. Nov. Hisp. 152. 1890. TYPE: MEXICO. [MICHOACÁN: Pátzcuaro, in frigidis et saxosis montibus, Sep 1790,] *Sessé and Moçiño Icones Florae Mexicanae 398* (HOLOTYPE: Hunt Institute-6331.119 [color transparency!; photograph: F!]; ISOTYPE: MA [photograph: F!]). The information in brackets is taken from the protologue and McVaugh (1977).

Lobelia nelsonii Fern., Proc. Amer. Acad. Arts 36:503. 1901. *Lobelia laxiflora* var. *nelsonii* (Fern.) McVaugh, Ann. Missouri Bot. Gard. 27:349. 1940. TYPE: MEXICO. JALISCO: along road near Huachinango, oak woods on hills, 4500–5500 ft, 4 Mar 1897, *Nelson 4009* (HOLOTYPE: GH! [photograph: F!]; ISOTYPES: GH! US! [photographs: F! W!]).

Lobelia laxiflora var. *brevifolia* Zahlbr., Repert. Spec. Nov. Regni Veg. 14:185. 1916. *Lobelia laxiflora* f. *brevifolia* (Zahlbr.) E. Wimm., Pflanzenr. IV.276b:684. 1953. TYPE: COLOMBIA. NARIÑO: Pasto, Río Guaitara, 1600–2000 m, *Lehmann 4674* (HOLOTYPE: K! [photograph: F!]).

Lobelia laxiflora var. *foliosa* Zahlbr., Repert. Spec. Nov. Regni Nov. 14:185. 1916. TYPE: COLOMBIA. CAUCA: bei Chapa, 1850 m, über Popayan, 2200m, Mar 1884, *Lehman 3656* (HOLOTYPE: G! [photograph: F!]; ISOTYPES: BM! K! US!).

Lobelia delessertiana E. Wimm., Repert. Spec. Nov. Regni Veg. 19:386. 1924. TYPE: MEXICO. OAXACA: Oct 1842, *Ghiesbreght s.n.* (HOLOTYPE: G! [photograph: F!; fragment: W!]).

Lobelia loretensis M. E. Jones, Contr. W. Bot. 18:68. 1933. TYPE: MEXICO. BAJA CALIFORNIA: Primiera Agua, near Loreto, 19 Oct 1930, *Jones 27279* (HOLOTYPE: POM! [photograph: F!]; ISOTYPE: POM!).

Lobelia costaricana var. *magna* E. Wimm., Repert. Spec. Nov. Regni Veg. 38:85. 1935. *Lobelia laxiflora* f. *magna* (E. Wimm.) E. Wimm., Pflanzenr. IV.276b:684. 1953. TYPE: MEXICO. Sine loc., 1835, *Hegewisch s.n.* (HOLOTYPE: GOET! [photograph: F!]).

Lobelia rensonii E. Wimm., Repert. Spec. Nov. Regni Veg. 38:85. 1935. TYPE: EL SALVADOR. Vicinity of San Salvador, *Renson 54* (HOLOTYPE: NY! [photograph: F!]).

Lobelia haenkeana var. *panamensis* E. Wimm., Ann. Naturhist. Mus. Wien 56:368. 1948. TYPE: PANAMA. CHIRIQUI: forests around El Boquete, banks of rivers, 1000–1300 m, 2 Mar 1911, *Pittier 2869* (HOLOTYPE: US! [photograph: F!]).

Lobelia laxiflora var. *petiolata* E. Wimm., Ann. Naturhist. Mus. Wien 56:369. 1948. TYPE: MEXICO.

OAXACA: Jotao, 4000 ft, *Galeotti 1989B* (LECTOTYPE, here designated: B! [photograph: F!]). Wimmer cited this plus Liebmann material from Chinantla in unspecified herbaria. While I have seen sheets of the latter at BM, MO, and NY, none was annotated by Wimmer, while in 1942 he annotated the Galeotti specimen as "orig!"

Lobelia laxiflora f. *lutea* Standl. & Steyerm., Publ. Field Mus. Nat. Hist., Bot. Ser. 23:98. 1944. TYPE: GUATEMALA. QUETZALTENANGO: above Santa Maria de Jesús, moist thicket, 1650 m, 1 Mar 1939, *Standley 67195* (HOLOTYPE: F!; ISOTYPE: NY!).

Lobelia laxiflora f. *flava* E. Wimm., Pflanzenr. IV.276b:685. 1953. TYPE: EL SALVADOR. Vulcán de San Salvador, brushy slope, 1000–1800 m, 7 Apr 1922, *Standley 22973* (HOLOTYPE: US; ISOTYPE: NY!).

Stems glabrous or pubescent. Lamina ovate, lanceolate, elliptic, narrowly elliptic, or oblong, 2.5–19 cm long, 1–5 cm wide; adaxial surface glabrous or sparsely pubescent; abaxial surface glabrous or pubescent; margin denticulate, serrulate, serrate, or doubly serrate; apex acuminate or acute; base cuneate, obtuse, or rounded; petiole (when present) 1–7 mm long. Pedicels 20–100 mm long, erect, ascending, spreading, or incurved, stiff or flexuous. Hypanthium 2–5 mm long, 4–11 mm in diameter, glabrous or pubescent. Calyx lobes subulate, linear triangular, narrowly triangular, or triangular, 1.5–6 mm long, 0.8–2 mm wide, glabrous or pubescent. Corolla 24–40 mm long; tube 14–25 mm long, 4–9.5 mm in diameter at base, 3.5–7 mm in diameter at mouth; dorsal lobes 10–22 mm long; ventral lip 10–20 mm long, the segments 1–10 mm long, 0.5–2 mm wide. Filament tube 18–34 mm long; anther tube 1.5–3.9 mm in diameter; dorsal anthers 6–8.5 mm long; ventral anthers 4.5–7.5 mm long. Capsules 8–12 mm long, 7–9 mm in diameter. Chromosome number $n = 7$ (Ayers 1986).

Icones.—Cavanilles (1801), pl. 518 [as *L. persicifolia*]; Don (1838), pl. 389 [as *S. bicolor*]; Knowles and Westcott (1838), pl. 69 [as *S. bicolor*]; Loudon (1848), pl. 37 fig. 1 [as *S. cavanillesii*]; Wittmack and Graebener (1889), pl. 1301 and Abbildung 54; Wimmer (1953), figs. 103a1, 103a3 [as *L. laxiflora* var. *petiolata*], 103a4 and 103a5 [as *L. laxiflora* var. *stricta*], 103b [as *L. haenkeana*], 103c [as *L. delessertiana*]; Nash (1976), fig. 54D–I; Wilbur (1977), fig. 6 [as *L. laxiflora* var. *stricta*]; Mason and Mason (1987), p. 228.

Distribution, habitat, and phenology.—Throughout much of Mexico, from Baja California del Sur, southern Sonora, and southern Chihuahua, south throughout Central America to Panama, and in the Cordillera Occidental of southwestern Colombia. Populations occur at elevations of 250–3450 m, in a wide variety of dry to mesic open to shaded habitats, often on slopes, and most commonly associated with various types of coniferous, deciduous, and mixed forests. In the northern portion of its range (Sonora, Chihuahua, Durango), flowering begins in February and continues through June. The flowering season becomes progressively longer to the south: starting in December in Sinaloa and Nayarit, in October from Jalisco and Queretaro south to Oaxaca, and essentially year-round from Veracruz and Chiapas south to Colombia.

Vernacular Names.—Numerous local names have been recorded on herbarium labels and in the literature. In Mexico, these include the Nahuatl names *chipalxochil* and *oxpatzihuatl*; the Tzeltal names *ch'aal wamal*, *pameyat*, *pameyat te'*, *pirima najk*, *tak'inal chikin*, *tujtin pamayat*, *turisna wamal*, and *tzajal nich*; the Tzotzil names *bik'tal ba ikatzil*, *pimil jomol*, *piri nich jomol*, *pojovil jomol*, *poxil yaijel*, *putzil nichim*, *rimon*, *rion vomol*, *sera nich jomol*, and *turisno vet*; and the Spanish names *aretillo* (Vera Cruz), *campanilla* (Puebla), *campanita* (Puebla), *campanole* (Puebla), *chilitos* (Michoacan), *chilillo* (Puebla), *clarincillo* (Jalisco), *cordoncillo* (Puebla), *hierba de burro* (Guerrero), *hierba del manzo* (Nayarit), *huajillo* (Jalisco), *primón* (Chiapas), *yerba del aigre* (Baja California), and *zarcillillo* (Jalisco). In Central America, the plant is known as *caballito* (Honduras), *chilillo* (Guatemala; Nash 1976), *cohetillo* (Guatemala; Nash 1976), *diente de chucho* (El Salvador, Honduras), *diente de perro* (Honduras, Nicaragua), *lengua de chuco* (El Salvador), *pastorcito* (El Salvador), *quiebramachete* (Guatemala; Nash 1976), *srukatzunúm* (Guatemala; Nash 1976), and *yuquilla* (Costa Rica).

Ethnobotany.—Herbarium labels also provide much information on local use of the plant. The Tzeltal use the roots to promote conception, aid menstruation, and relieve flatulence; the leaves and roots to treat stomach pains; the leaves to treat coughs and tuberculosis; and the entire plant to treat heart pains. The Tzotzil use the latex to treat wounds and relieve itching; the roots to relieve colic; and the leaves to relieve diarrhea, fever, and headache. In Puebla, the plant is used in baths to relieve rheumatism; in Veracruz, to treat pimples; in El Salvador, to induce vomiting and treat internal inflammation. According to Weimann and Heinrich (1997), the Nahuatl bathe in an infusion of the aerial parts to treat skin inflammations, local infections, and wounds. Nash (1976) stated that it was sometimes used in Guatemala as a remedy for mange in horses and dogs. Recently, bulk material was collected for pharmacological screening.

Discussion.—As one might suspect from the lengthy synonymy, this subspecies shows considerable morphological variation. Pubescence is especially variable, with plants spanning a continuum from perfectly glabrous to densely canescent. Pedicels vary conspicuously, from stiff erect stalks holding the flowers close to the rachis of the raceme, to lax flexuous stalks that create a very open diffuse inflorescence. However, morphometric analyses by Eakes and Lammers (1996; cf. Hamlin 1995; Lammers 1999) did not reveal any geographically correlated gaps in the pattern of variation, by which additional taxa might be distinguished. The variation is real, but it does not sort itself into a meaningful pattern.

Plants with all-yellow flowers lacking any red or orange pigment have been collected in Jalisco (*Cuevas & Nieves 2210*, WIS; *Iltis et al. 29556*, WIS; *McVaugh 10037*, MICH), Guatemala (*Standley 65175*, F; *Standley 67195*, F, NY), and El Salvador (*Standley 22973*, NY). For those interested in such things, the correct name in this subspecies for plants of this sort is f. *lutea* Standl. & Steyerm.

Representative specimens: **MEXICO. Chiapas:** Pueblo Nuevo Solistahuacán, *Raven & Breedlove 19823* (ARIZ, BM, MICH, TEX). **Chihuahua:** Sierra Charuco, *Gentry 8091* (ARIZ, RSA, US). **Colima:** Colima, *Kerber 117* (B). **Distrito Federal:** Desviación a El Conejo, *Ventura 1234* (CAS). **Durango:** San Ramón, *Palmer 88* (F, GH, MO, NY, US). **Guanajuato:** 7–8 mi above Xichú, *McVaugh 14837* (MICH). **Guerrero:** Petlacala, *Mexia 9034* (ARIZ, F, G, K, MO, NY, W). **Hidalgo:** Hwy 85, *Parfitt & Kaspar 824* (OSH). **Jalisco:** near Guadalajara, *Pringle 3112* (B, BM, BR, E, F, G, GH, GOET, K, MO, MU, NY, PH, RSA, US, W, WIS, WU). **Mexico:** 1 km W of Nanachititla, *Rzedowski 22101* (DS, ENCB, MICH, WIS). **Michoacan:** San Miguel de las Cuevas, *Rzedowski 50603* (F, MA). **Morelos:** 12 mi NE of Cuernavaca, *Ayers & Scott 118* (TEX). **Nayarit:** Tepic, *Lamb 603* (B, DS, E, F, G, GH, MO, NY, US). **Oaxaca:** 5 mi N of Ixtlan de Juarez, *Harriman 14362* (OSH). **Puebla:** 5 km E of Huauchinango, *Fosberg 29389* (MU, OSH). **Queretaro:** 2 km W of Santa Agueda, *Zamudio 6109* (MEXU). **San Luis Potosi:** 10 mi S of Xilitla, *Harriman et al. 10869* (OSH). **Sinaloa:** Canyon de Tarahumare, *Gentry 7168* (ARIZ, GH, MICH, RSA). **Sonora:** Tepopa, *Gentry 1431* (A, ARIZ, F, MO, WIS). **Vera Cruz:** La Monera, *Ventura 317* (ARIZ, DS, ENCB, LL, RSA, WIS).

GUATEMALA. Alta Verapaz: Coban, *Tuerckheim 73* (B, BR, G, GOET, K, NY, PH, WU). **Baja Verapaz:** Union Barrios, *Contreras 11027* (LL). **Chemaltenango:** Tecpán, *Molina et al. 16096* (NY, W). **Chiquimula:** La Cumbre, *Molina & Molina 26813* (ENCB, MICH). **Escuintla:** Finca El Rosario de La Vista Hermosa, *Wilbur 14732* (GH, MICH, MO). **Guatemala:** 21 km NW of Guatemala City, *Molina et al. 15991* (NY). **Huehuetenango:** Todos Santos, *Melhus & Goodman 3609* (ISC). **Quezaltenango:** 2 km W of Zunil, *Williams et al. 23016* (NY). **Quiché:** Utatlán Ruins, *Molina & Molina 25082* (MO). **Sacatepequez:** Cuesta Las Canas, *Castillo & Luarca 1649* (F). **San Marcos:** 6 km N of San Marcos, *Williams et al. 25899* (NY). **Santa Rosa:** Aguacoliente, *Kellerman 7714* (NY). **Solola:** 1 km W of Mirador Mario Mendez Montenegro, *Boeke & Utzschneider 2861* (F). **Suchitepequez:** Finca Moca, *Skutch 2119* (NY).

HONDURAS. Atlantida: road from Olanchito to La Ceiba, *Blackmore & Chorley 4102* (BM, TEFH). **Choluteca:** road between Sabana Grande and Pespire, *Pilz & Pilz 1538* (MO). **Comayagua:** 2 1/2 km E of Terreritos, *Lentz 319* (TEFH). **Copán:** near El Mirador, *Blackmore & Chorley 3792* (BM, F, TEFH). **Cortes:** Montaña San Idalfonso, *Molina 11567* (NY). **El Paraiso:** Cerro Montserrat, *Nelson & Vargas 2410* (TEFH). **Francisco Morazán:** Cerro Triquilapa, *Nelson 3931* (TEFH). **Intibucá:** 9 km S of La Esperanza, *Barkley & Hernández 40102* (GH, TEFH). **La Paz:** 7 km S of Marcala, *Keyser 1152* (TEFH). **Lempira:** 2 km from Erandique, *Molina 24038* (NY). **Ocotepeque:** Alrededoros de Belén Gualcho, *Rubio 52* (MO). **Olancho:** 20 km W of Campamento, *Izaguirre 166* (TEFH). **Santa Bárbara:** San Pedro Sula, *Thieme 5335* (B, G, K, MICH, MO, NY).

EL SALVADOR. Ahuachapán: 2–3 mi NE of Puente Impossible, *Croat 42156* (MO). **Libertad:** El Boqueron crater, *Davidse & Pohl 2032* (MO). **Morazán:** Montes de Cacaguatique, *Tucker 614* (G, K, MICH, NY, PH). **Sonsonate:** Cerro Verde, *Molina & Montalvo 21727* (NY). **San Salvador:** San Marcos, *Carlson 9* (CAS, MO). **San Vivente:** San Vicente, *Standley 21202* (MO, NY).

NICARAGUA. Chinandega: Volcán San Cristóbal, *Moreno 24998* (NY). **Esteli:** Fila La Estrechura, *Stevens 22794* (MO). **Granada:** Plan de Las Flores, *Moreno 91* (MO). **Jinotega:** 2 mi S of Jinotega, *Wilbur & Almeda 16509* (LL, MICH). **Leon:** San Nicholas, *Moreno 22723* (MO). **Madriz:** Cerro Volcán de Somoto, *Araquistain & Moreno 2116* (ENCB, MO). **Managua:** Sierra de Managua, *Stevens 4749* (ENCB, MO). Matagalpa: Finca Santa Maria de Pstuma, *Williams & Molina 42590* (MICH). **Nueva Segovia:** N of Ocotal, *Atwood & Seymour 5005* (B, BM, MICH, NY, TEX).

COSTA RICA. Alajuela: 6 mi SW of San Ramón, *Wilbur & Stone 9918* (DS, GH, MICH, NY, TEX, US). **Cartago:** Volcán Irazú, *Hill et al. 17809* (F, GH, NY). **Heredia:** Volcán Barba, *Hatheway 1317* (F, GH, US). **Puntarenas:** 10 km W of Monteverde, *Wilbur 14230* (F, MO). **San Jose:** San Ignacio, *Khan et al. 213* (BM, MO).

PANAMA. Chiriquí: Volcán Baru, *Stein 1264* (MO). **Coclé:** 7 km from El Valle de Antón, *Wilbur & Luteyn 11703* (DS, F, GH, LL, MICH, MO, NY, RSA). **Darien:** Cerro Pirre, *Duke & Elias E13716a* (MO). **Panama:** 6 km S of El Valle, *Sytsma & D'Arcy 3562* (CAS).

COLOMBIA. Cauca: Coconuco, *Yepes 337* (COL, F, US). **Nariño:** Yacuanquer, *Uribe 5289* (COL).

CULTIVATION: U.S.A.: Washington, 12 Mar 1870, *Schott s.n.* (F). **Great Britain:** Begonia House, Jan 1892, *anonymous s.n.* (K). **Germany:** Dahlem, 12 Mar 1922, *Schlechter s.n.* (B). **Egypt:** Cairo, 1885, *Schweinfurth s.n.* (B). **Kenya:** Kaporetwa near Kitale, *Verdcourt 2451* (K).

1b. Lobelia laxiflora subsp. **angustifolia** (A. DC) Eakes & Lammers, Novon 9:384. 1999. *Lobelia laxiflora* var. *angustifolia* A. DC. in DC., Prodr. 7:383. 1839. *Lobelia persicifolia* var. *angustifolia* (A. DC.) Vatke, Linnaea 38:723. 1874. *Lobelia laxiflora* f. *angustifolia* (A. DC.) Voss in Siebert & Voss, Vilm. Blumengärtn. ed. 3 1:576. 1894. *Lobelia angustifolia* (A. DC.) Urbina, Cat. Pl. Mexican. 201. 1897, nom. illeg.; non Cham., Linnaea 8:219. 1833; nec Benth. in Endl., Enum. Pl. 74. 1837. TYPE: MEXICO. MEXICO: Toluca, Apr 1834, *Andrieux 267* (LECTOTYPE [designated by Eakes and Lammers in Lammers 1999]: K! [photograph: F!]; ISOLECTOTYPES: K! W!).

Lobelia dracunculoides Willd. ex Schult. in Roem. & Schult., Syst. Veg. 5:56. 1819 (Dec). TYPE: "America meridionalis," *leg.* Humboldt and Bonpland, *Herb. Willdenow* 3989 (HOLOTYPE: B-W [IDC-microfiche!]).

Rapuntium kunthianum C. Presl, Prodr. Monogr. Lobel. 27. 1836. *Lobelia persicifolia* var. *amygdalina* Vatke, Linnaea 38:723. 1874. Both validated by reference to: *Lobelia persicifolia* Cav. sensu Kunth in Humb., Bonpl. & Kunth, Nov. Gen. Sp. 3:310 (quarto), 242 (folio). 1819 (Nov). TYPE: MEXICO. MEXICO: prope Zumpango, *Humboldt & Bonpland s.n.* (LECTOTYPE [designated by Eakes and Lammers in Lammers 1999]: P-Bonpl. [microfiche!]; ISOLECTOTYPES: B, B-W [microfiche!]). Presl's binomial was not an avowed substitute name for *L. persicifolia* Cav., nom. illeg. (see above), as on the same page, he recognized that species under the replacement name *R. cavanillesianum* (Schult.) C. Presl. Similarly, Vatke's trinomial was not a new combination based on *L. amygdalina* Willd. ex Schult., as Vatke explicitly stated that the type specimen of that name pertained to *L. persicifolia* Cav., sens. str.

Lobelia cavanillesii var. *lutea* F. Haage & K. Schmidt, Gartenflora 52:577. 1903. *Lobelia laxiflora* f. *lutea* (F. Haage & K. Schmidt) E. Wimm., Pflanzenr. IV.276b:682. 1953, nom. illeg.; non Standl. & Steyerm., Publ. Field Mus. Nat. Hist., Bot. Ser. 23:98. 1944. TYPE: not located. Name based on yellow-flowered plants raised from seed of normally pigmented progenitors at a commercial nursery in Erfurt, Germany. This spontaneous appearance of yellow-flowered variants from seed has also been observed in *L. excelsa* of sect. *Tupa* (Lammers 2000).

Lobelia nelsonii var. *fragilis* B. L. Rob. & Fern., Proc. Amer. Acad. Arts 43:27. 1907. *Lobelia laxiflora* f. *fragilis* (B. L. Rob. & Fern.) E. Wimm., Pflanzenr. IV.276b:682. 1953. TYPE: MEXICO. MORELOS: Parque Station, rocky hills, 7500 ft, 13 Feb 1907, *Pringle 10360* (HOLOTYPE: GH! [photograph: F!]; ISOTYPES: B! BM! E! F! G[3]! GOET! K! MEXU! MIN! MO! NY! PH! US! W!).

Lobelia laxiflora var. *brevipes* E. Wimm., Pflanzenr. IV.276b:683. 1953. TYPE: MEXICO. BAJA CALIFORNIA: Cape region, Jan–Mar 1901, *Purpus 234* (HOLOTYPE: WU!; ISOTYPES: E! K! MO! US!).

Stems glabrous. Lamina linear, lanceolate, or narrowly elliptic, 5–15 cm long, 0.2–1.4 cm wide, glabrous; margin serrulate or serrate; apex acuminate; base attenuate; petiole (when present) 1–5 mm long. Pedicels 25–85 mm long, erect or ascending, stiff. Hypanthium 3–5 mm long, 6–9 mm in diameter, glabrous. Calyx lobes linear triangular, narrowly triangular, or triangular, 1–6 mm long, 1–3 mm wide, glabrous or pubescent. Corolla 28–38 mm long; tube 14–20 mm long, 5–8 mm in diameter at base, 4.5–6 mm in diameter at mouth; dorsal lobes 11–17 mm long; ventral lip 12–17 mm long, the segments 1–5 mm long, 0.5–1.2 mm wide. Filament tube 21–31 mm long; anther tube 1.7–2.4 mm in diameter; dorsal anthers 7–9 mm long; ventral anthers 5.5–7.5 mm long. Capsules 6–10 mm long, 7–8 mm in diameter. Chromosome number $n = 7$ (Ayers 1986).

Icones.—Martius (1830), pl. 9 [as *L. cavanillesii*]; Hooker (1837), pl. 3600 [as

L. cavanillesii]; Anonymous (1915), fig. 82; McVaugh (1940), figs. 4, 9; Wimmer (1953), fig. 103a2 [as *L. laxiflora* var. *brevipes*]; Thomas (1990), pl. II no. 6; Lancaster (1991), pp. 474–475; Anonymous (2003), pp. 40–41 (unidentified).

Distribution, habitat, and phenology.—Throughout northeastern Mexico, from Sonora and Chihuahua to Puebla, with one population in the United States, in southern Arizona. Populations occur at elevations of 1300–3400 m, in a wide variety of mesic to relatively wet open to shaded habitats, often on stream bottoms and gravel bars, and most commonly associated with various types of coniferous, deciduous, and mixed forests. In the northern part of the range, flowering begins in March, while in the south, it begins as early as October; flowering typically is finished by June or July.

Vernacular Names.—Names recorded on herbarium labels include *aretillo*, *contrahiedra*, and *pericos*.

Ethnobotany.—Labels of several specimens from Puebla mention unspecified medicinal usage of the plant.

Discussion.—Plants from Guerrero, formerly identified as this taxon, differ in a number of morphological traits and have been segregated as *L. guerrerensis* (see below).

Plants with all-yellow flowers totally lacking any red or orange pigment have been collected in Durango (*Breedlove 14314*, CAS, MICH) and Zacatecas (*Jones 397*, POM, US), and have apparently appeared spontaneously in cultivation (Anonymous 1903). There is no legitimate name at the rank of *forma* for plants of this sort in this subspecies.

Representative specimens: **U.S.A. ARIZONA: Santa Cruz Co.:** Sycamore Canyon, *McManus et al. 326* (ARIZ), 1 Jun 1992, *Scott s.n.* (ASU).

MEXICO. Aguascalientes: Sandovales, *Figueroa 24* (RSA). **Baja California:** Arroyo de San Francisquito, *Carter & Ferris 3335* (DS, TEX, US); Sierra Laguna, *Gentry 4431* (ARIZ, DS, GH, K, MO). **Chihuahua:** 1 mi N of Maguarachi, *Ayers & Scott 394* (TEX); Cascada de Basaseachic, *Yen & Estrada 4125* (MU, OSH). **Distrito Federal:** 4 km SW of Santa Lucía, *Rzedowski 27248* (DS, ENCB, MICH); Rancho El Conejo, *Ventura 2610* (ASU, ENCB, MICH). **Durango:** Tobar, *Palmer 255* (C, F, GH, MO, NY, US); 19 mi. SW of Durango, *Ripley & Barneby 13496* (CAS, NY). **Guanajuato:** Guanajuato, *Duges 24* (GH). **Hidalgo:** Tecozautla, *Argüelles 2014* (OSH); Dublan, *Pringle 13095* (B, C, CAS, F, GH, MICH, MO, US). **Jalisco:** 4 km SW of Villa Guerrero, *Flores 2332* (TEX, WIS); 7 mi. SW of Teocaltiche, *McVaugh 11977* (MICH). **Mexico:** Valley of Mexico. *Pringle 1457* (F, G, GH, K, NY, RSA, US, WIS, WU); San Bernardino, *Ventura 365* (ENCB, F). **Michoacan:** Morelia, *Arsène 5417* (BM, GH, MO, NY, US); Zamora, *Nelson 6535* (GH, NY, US). **Morelos:** 7.5 mi W of Tres Cumbres, *McPherson 959* (CAS, ENCB, MICH); Tepetixtla, *Sánchez 2133* (ARIZ). **Oaxaca:** 5 km N of Tamazulapán, *Lorence & García 3456* (CAS, ENCB); Teposcolula, *Mendoza 154* (ENCB, NY). **Puebla:** Tlamililolpa, *Tlapa & Ubierna 634* (MEXU); Acatzingo a Tepeaca, *Vibrans 3032* (MEXU); San Francisco Tepeyecac, *Whitmore 12* (ENCB, MICH, WIS). **Queretaro:** Hda. Rivera, *Arsène 20600* (MO). **San Luis Potosí:** San Luis Potosí, *Parry & Palmer 560* (B, BM, E, F, G, ISC, K, MO, NY, PH, US); Río Ahogado, *Rzedowski 5459* (ENCB, MICH). **Sonora:** 32 mi. E of Yecora, *McLaughlin 547* (ARIZ); 10 mi. E of Imuris, *Wiggins 11653* (MICH, TEX, US). **Tlaxcala:** Tlaxcala, *Balls & Gourlay B.4831* (B, BM, K, NY, US); Ciénega de San Juan Zacualpan, *Weber 181* (ENCB). **Zacatecas:** 24 mi SW of Jalpa, *Mahler & Thieret 5818* (OSH); San Antonio, *McVaugh 12032* (MICH).

CULTIVATION. U.S.A. Arizona: Tempe, *Keil & Lehto 6197* (ASU). **California:** Berkeley, *Bracelin*

1262 (BR, RSA); San Francisco, *Norris 4343* (OSH). **GERMANY:** Berlin, 1 May 1924, *Schlechter s.n.* (B). **ZIMBABWE:** Salisbury, *Biegel 3977* (K).

2. Lobelia guerrerensis Eakes & Lammers, Novon 9:381. 1999. TYPE: MEXICO. GUERRERO: municipio de Atoyac de Alvarez, a 6 km al SO de Puerto del Gallo, bosque mesófilo de montaña, 2320 m, 29 Mar 1983, *Soto & Martínez 5136* (HOLOTYPE: MEXU!).

Stems 1–2 m tall, woody or suffruticose, branched or unbranched, erect or ascending, glabrous. Leaves sessile; lamina linear or lanceolate, 7–18 cm long, 0.3–1.1 cm wide, cernuous; adaxial surface glabrous; abaxial surface glabrous; margin entire or sometimes with a few distant minute callose teeth, minutely revolute; apex narrowly acuminate; base cuneate or attenuate. Flowers solitary in the axils of the upper leaves; pedicels 60–130 mm long, ascending, spreading, or slightly incurved, stiff, glabrous, bibracteolate below the middle; bracteoles linear, 0.5–3 mm long. Hypanthium depressed hemispheric, 4–5 mm long, 9–11 mm in diameter, glabrous; base rounded or truncate. Calyx lobes narrowly triangular or triangular, 2.5–5 mm long, 1–2 mm wide, glabrous; margin entire. Corolla bilabiate, yellow or yellowish orange on tube, grading to orange or red on the lobes, 35–44 mm long, glabrous; tube 19–25 mm long, 7–10 mm in diameter at base, 6–8 mm at mouth, tapering slightly towards mouth; dorsal lobes linear, 14–22 mm long, 1.5–3 mm wide, recurved, half as long as the tube, acute at apex; ventral lip 12–21 mm long, the segments triangular, 4–8 mm long, 1.5–2.5 mm wide, acute at apex. Filament tube 29–33 mm long, 1.3–1.7 mm in diameter, pale yellow, glabrous; anther tube 2.5–4 mm in diameter, the surface densly covered with dirty yellow trichomes 2–4 mm long; dorsal anthers 8.5–9 mm long; ventral anthers 7–7.6 mm long, with tufts of yellow trichomes 1.5–2 mm long at apex. Capsules broadly ovoid, 8–10 mm long, 9–11 mm in diameter; seeds oblong or ellipsoid, 0.7–0.8 mm long, 0.3–0.4 mm wide, 0.1–0.2 mm thick, the testa faintly striate.

Icon.—Lammers (1999), Fig. 1.

Distribution, habitat, and phenology.—Endemic to Guerrero, Mexico, where it grows on steep wooded slopes and moist banks in pine, pine-oak, and mixed deciduous forests, at elevations of 1890–2750 m in the Sierra Madre del Sur. Flowering begins in early October and continues through February.

Discussion.—This species was first collected by Ynes Mexia in 1937. That initial gathering was identified as *L. laxiflora* var. *angustifolia* by Rogers McVaugh, as were most subsequent collections by their collectors or by specialists. However, multivariate analyses by Eakes and Lammers (1996; cf. Hamlin 1995; Lammers 1999) revealed that these Guerrero plants differed consistently from *L. laxiflora* subsp. *angustifolia* in a number of features, specifically their glabrous herbage, cernuous leaves with minutely revolute and usually entire margin, the reverse pigmenation of the flowers (i.e., tube yellow and lobes red), the longer apical teeth of the ventral corolla lip, the long dense pubescence of the anther tube, and the slightly larger seeds.

Representative specimens. **MEXICO. Guerrero:** Mazatlán, *Berlín 53* (ENCB); 1–3 km NW of Puerto El Gallo, *Breedlove 36058* (CAS, MICH), 37.9 km NE de El Paraíso, *Cowan 4961* (TEX); 6.5 km W de Puerto del Gallo por camino a Paraíso, *Hernández & Tenorio 858* (MICH); second ridge west of Petlacala, *Mexia 9049* (ARIZ, B, CAS, G, K, MO, NY, W); 3 mi SW of Puerto del Gallo, *Reveal et al. 4337* (CAS, GH, K, MICH, MO, NY, TEX); Cerro Alquitrán cerca Tuxpan, 9 Jan 1977, *Schwabe s.n.* (B).

3. Lobelia aguana E. Wimm., Repert. Spec. Nov. Regni Veg. 38:86. 1935. TYPE: GUATEMALA. DEPT. SACATEPÉQUEZ: Volcano Agua, 10500 ft, 4 Feb 1908, *Kellerman 7502* (HOLOTYPE: F!; ISOTYPES: MEXU! NY! US!).

Lobelia laxiflora var. *insignis* Donn. Sm., Bot. Gaz. (Crawfordsville) 16:12. 1891. TYPE: GUATEMALA. DEPT. SACATEPÉQUEZ: Volcan de Agua, 10000 ft, Apr 1890, *Donnell Smith 2173* (HOLOTYPE: US! [photograph: F!]; ISOTYPES: B! K! [photograph: F!]).

Stems 0.5–3 m tall, woody or suffruticose, branched or unbranched, erect or ascending, glabrous or pubescent. Leaves sessile or petiolate; lamina lanceolate or narrowly elliptic, 9–22 cm long, 1.3–4.5 cm wide; adaxial surface glabrous or rarely pubescent; abaxial surface pubescent or rarely glabrous; margin serrulate or serrate; apex narrowly attenuate; base attenuate, cuneate, or rarely rounded; petiole (when present) 1–7 mm long, glabrous or pubescent. Flowers solitary in the axils of the upper leaves; pedicels 85–210 mm long, erect or incurved, flexuous, glabrous or pubescent, ebracteolate or bibracteolate in the lower two-thirds; bracteoles (when present) linear, 1–9 mm long. Hypanthium hemispheric, 4–9 mm long, 8.5–13 mm in diameter, glabrous or pubescent; base rounded or truncate. Calyx lobes subulate, linear triangular, or narrowly triangular, 6–18 mm long, 1.5–3 mm wide, glabrous or pubescent; margin entire. Corolla bilabiate, orange or red on tube, grading to yellow or orange on the lobes, 35–56 mm long, glabrous or sparsely pubescent; tube 18–26 mm long, 8–12 mm in diameter at base, 6–10 mm in diameter at mouth, cylindric or tapering slightly towards mouth; dorsal lobes linear, 20–33 mm long, 2–3 mm wide, recurved, 1/2–3/4 as long as the tube, acute at apex; ventral lip 18–26 mm long, the segments triangular, 1–6 mm long, 0.5–2.5 mm wide, acute at apex. Filament tube 28–40 mm long, 1.2–1.6 mm in diameter, pale yellow or reddish, glabrous; anther tube 3–3.6 mm in diameter, the dorsal surface towards the apex pubescent with white trichomes 0.5–1.5 mm long; dorsal anthers 9–12 mm long; ventral anthers 7.5–9.5 mm long, with tufts of yellowish white trichomes 1.3–2 mm long at apex. Capsules ovoid, 10–15 mm long, 10–12 mm in diameter; seeds oblong or ellipsoid, 0.8–0.9 mm long, 0.3–0.4 mm wide, ca. 0.1 mm thick, the testa minutely reticulate.

Icones.—Wimmer (1953), fig. 103d.

Distribution, habitat, and phenology.—Southwestern Mexico (Guerrero, Oaxaca, and Chiapas) and western Guatemala, on moist slopes and grassy banks in conifer or mixed conifer-deciduous forests at elevations of 1850–3350 m. Flowering from mid-July to late April.

Vernacular Names.—Known as *pitijo* and *coral* in Guatemala (Nash 1976).

Discussion.—This species is very similar to *L. laxiflora* subsp. *laxiflora* but differs in its markedly larger flowers. In Oaxaca, it hybrizes occasionally with *L. ghiesbreghtii* (see below).

Representative specimens. **MEXICO. Guerrero:** 8.5 km NE of Puerto del Gallo, *Barrie & Martínez 696* (NY, TEX); Cerro Teotepec, *Breedlove 36079* (MICH); 7 mi al E del entronque Filo de Caballo/Cerro Toro Muerto, *Cowan 4981* (TEX); 1–2 km E of Cerro Teotepec, *Cruden 1636* (MICH); Asoleadero, *Feddema 2852* (MICH, MO, PH); Pie de la Cuesta Toro Muerto, *Hinton et al. 11081* (K, RSA); Teotepec, *Hinton et al. 11127* (K, NY, RSA, WTU); 22 km al SO de Higueros, *Koch & Fryxell 82120* (MEXU, MICH, NY, OSH, TEX, US); 15 km al NE de Puerto del Gallo, *Martínez & Barrie 5640* (MEXU); 10.8 mi NE of Puerto del Gallo, *Reveal et al. 4316* (MICH, NY, TEX); 9.4 mi NE of Puerto del Gallo, *Reveal et al. 4318* (K, MICH, NY, TEX); Cerro Teotepec, *Rzedowski & McVaugh 227* (ENCB, ISC, MICH), *Rzedowski 16513* (MICH, NY). **Oaxaca:** N of San Jose el Pacifico, *Alexander 700* (MICH). **Chiapas:** Volcan Tacana west, *Matuda 2893* (F, GH, MEXU, MICH, NY, US).

GUATEMALA. San Marcos: Volcan Tajumulco, *Sharp 46120* (MICH); entre Serchil y San Marcos, *Smith 584* (ISC); 6 km N of San Marcos, *Williams et al. 25890* (NY); near San Andrés, *Williams et al. 27000* (NY). **Huehuetenango:** 7 mi S of San Juan Ixcoy, *Breedlove 8484* (MICH); between Paquix and San Juan Ixcoy, *Molina et al. 30073* (MO). **Sacatepéquez:** Volcán de Acatenango, *Castillo 1379* (F); above Santa Maria de Jesús, *Spooner et al. 7001* (F). **Solola:** between Huehuetenango and Chimaltenango, *Croat & Hannon 63506* (NY). **Totonicapán:** Momostenango, *Molina 21419* (F, NY); La Cumbre de Totonicapán, *Molina & Molina 25053* (MO); Concordia, *Molina et al. 31340* (MO); 10–15 km S of Totonicapán, *Williams et al. 41487* (NY).

4. Lobelia ghiesbreghtii Decne., Rev. Hort. (sér. 3) 2:341. 1848; non Lem., Ill. Hort. 1:pl. 34. 1854. TYPE: MEXICO. OAXACA: Oct 1842, *Ghiesbreght s.n.* (HOLOTYPE: P [photographs: MICH! WIS!]; ISOTYPES: G[3]! [photographs: F!]).

Tupa crassicaulis Hook., Bot. Mag. 76:pl 4505. 1850. TYPE: GREAT BRITAIN: "Hort. Kew" [received from Mr. Makoy of Liége], *Herb. Hook. s.n.* (HOLOTYPE: K! [photograph: F!]).

Lobelia regalis Fern., Proc. Amer. Acad. Arts. 36:503. 1901. TYPE: MEXICO. OAXACA: Cuicatlán, alt. 550 m, 2 Dec 1895, *leg.* L. C. Smith, *Conzatti 105* (LECTOTYPE [designated by McVaugh 1943]: GH! [photograph: F!]).

Stems 2–3 m tall, woody, commonly branched above, erect or ascending, white-tomentose. Leaves petiolate; lamina elliptic, narrowly elliptic, oblong, or narrowly oblong, 9–20 cm long, 3.5–8 cm wide; adaxial surface glabrous or sparsely pubescent; abaxial surface white-tomentose; margin entire or denticulate; apex acuminate; base cuneate; petiole 10–30 mm long, tomentose. Flowers solitary in the axils of the upper leaves or forming a terminal raceme; pedicels 35–64 mm long, ascending, stiff, ebracteolate or bibracteolate at or above the middle; bracteoles (when present) subulate, 0.5–3 mm long. Hypanthium depressed hemispheric, 4–6.5 mm long, 8.5–10 mm in diameter, tomentose; base rounded or truncate. Calyx lobes triangular or deltate, 3.5–6 mm long, 1–3 mm wide, tomentose; margin entire. Corolla bilabiate, yellow suffused with red or all red, 30–40 mm long, tomentose; tube 17–22 mm long, 7.5–8.5 mm in diameter at base, 6–7.5 mm in diameter at mouth, tapering slightly towards mouth; dorsal lobes linear, 12–20 mm long, 1–2 mm wide, about as long as the tube, acute at apex; ventral lip 10–18 mm long, the segments 1.5–6 mm long, 1–2 mm wide, acute at apex. Filament tube 24–36 mm long, 1.3–1.5 mm in diameter, pale yellow, pubescent; anther tube 2.5–3 mm in diameter, the dorsal surface towards the apex sparsely to moderately pubescent with trichomes ca. 1 mm long; dorsal anthers 7.5–8.5 mm long; ventral anthers 6.5–7 mm long, with tufts of yellow trichomes 1–2 mm long at apex. Capsules broadly ovate, 10–12 mm long, 10–12 mm in diameter; seeds oblong or ellipsoid, 0.5–0.6 mm long, 0.3–0.4 mm wide, ca. 0.1 mm thick, the testa minutely reticulate.

Icones.—Decaisne (1848), fig. 18; Hooker (1850), pl. 4505 [as *Tupa crassicaulis*].

Distribution, habitat, and phenology.—Endemic to Oaxaca, Mexico. Growing on streambanks, in partially shaded loam soil, at 550–2135 m above sea level. Flowering from October to April. Apparently rare, collected but thrice since 1937, in 1960 (*King 2482*), 1966 (*Ernst 2473*), and 1974 (*Walker 72016*).

Cultivation.—This species was introduced to horticulture in the late 1840s (Decaisne 1848, Hooker 1850) but is no longer available.

Discussion.—This species resembles *L. laxiflora* subsp. *laxiflora*, but differs in its dense white tomentum and distinctly petiolate leaves broadest at middle. I have examined a few specimens from Oaxaca that are intermediate in morphology (pubescence, leaf shape and width, petiole length, pedicel length, and flower size) between this species and *L. aguana*, which also occurs in Oaxaca; they are assumed to represent F_1 hybrids. Such specimens have been collected in Juquila (*MacDougall 559.S*, ENCB, NY; *Rzedowski 19533*, MEXU, TEX), Miahuatlán (*Campos & Peterson 3396*, MEXU), and northeast of Sola de Vega (*Villaseñor et al. 1157*, TEX).

Representative specimens. **MEXICO. Oaxaca:** 15 km S of Oaxaca, *Camp & Conzatti 2768* (MICH, NY); Cerro del Tule, *Conzatti 1777* (BM); Montañas de Mitla, *Conzatti & Ostlund 5184* (K); Valle de Tlacolula, *Conzatti & Camp 5236 1/2* (MICH, NY); toward Oaxaca from Mitla, *Ernst 2473* (MEXU); Javejia, *Galeotti 1989* (BR); Oaxaca, *Jurgensen 494* (G); 8–10 miles from Oaxaca, *King 2482* (MICH, TEX); Oaxaca, *Liebmann 7769* (C, W); Río Tehuantepec below Totolapam, *Seler & Seler 1669* (B); between Tlacolula and San Dionisio Chichicapa, *Seler & Seler 1673* (B); Tlalixtac Canyon, *Walker 72016* (NY).

CULTIVATION. Switzerland: Jardin Bot. de Paternie, 14 Mar 1860, *Candolle s.n.* (G).

5. Lobelia decurrens Cav., Icon. 6:13. 1800; non Roth, Nov. Pl. Sp. 145. 1821. *Rapuntium decurrens* (Cav.) C. Presl, Prodr. Monogr. Lobel. 24. 1836. *Tupa decurrens* (Cav.) G. Don in Sweet, Hort. Brit. ed. 3:424. 1839. *Dortmanna decurrens* (Cav.) Kuntze, Rev. Gen. Pl. 2:972. 1891. TYPE: CHILE: In ripis fluminis Claro, *Née s.n.* (LECTOTYPE, here designated: MA!; ISOLECTOTYPES: CONC! F! MA!).

Plants malodorous. Stems 0.8–2 m tall, numerous from the root crown, herbaceous or suffruticose, unbranched, erect or ascending, sparsely pubescent. Leaves sessile; lamina elliptic, narrowly elliptic, narrowly oblong, or oblanceolate, 4–15 cm long, 1.5–2.6 cm wide; adaxial surface glabrous or sparsely pubescent; abaxial surface glabrous or sparsely pubescent; margin biserrate (rarely merely denticulate) with 5–10 falcately triangular acuminate teeth up to 8 mm long per cm; apex acuminate or acute; base long decurrent on stem. Flowers in a terminal raceme; pedicels 7–14 mm long, erect or ascending, stiff, densely pubescent, ebracteolate (but cf. Sweet 1831). Hypanthium depressed hemispheric, 2.5–5 mm long, 5–7 mm in diameter, pubescent; base rounded or truncate. Calyx lobes linear triangular or narrowly triangular, 7–16 mm long, 1.2–4 mm wide, sparsely to moderately pubescent; margin fimbriate with 3–9 thread-like segments up to 4 mm long per side. Corolla bilabiate or subbilabiate, violet, red-purple, magenta, mauve, or lavender, 22–42 mm long, pubescent at least on the lobes; tube 14–30 mm long, 3–6.5 mm in diameter at base, 2.5–5 mm in diameter at mouth, cylindric or tapering slightly towards mouth; dorsal lobes narrowly triangular, 8–16 mm long, 2–4 mm wide, straight or somewhat recurved, 1/4–1/2 as long as the tube, acuminate at apex; ventral lip 8–17 mm long, the segments narrowly triangular, 4–14 mm long, 1.5–3 mm wide, acuminate at apex. Filament tube 20–33 mm long, 0.8–1.4 mm in diameter, reddish or purplish, glabrous; anther tube 1.7–2.8 mm in diameter, the surface glabrous (rarely sparsely pubescent toward apex); dorsal anthers 6–8 mm long; ventral anthers 4.8–6 mm long, with tufts of white trichomes 1–1.5 mm long at apex. Capsules ovoid, 10–15 mm long, 7–9 mm in diameter; seeds ellipsoid, 0.5–0.6 mm long, 0.2–0.3 mm in diameter, ca. 0.1 mm thick, the testa faintly striate. Chromosome number $n = 7$ (Diers 1961).

Distribution.—Endemic to Peru. As with *L. cordigera* Cav. (cf. Thompson and Lammers 1997), the supposedly Chilean type locality of *L. decurrens* appears to be an error (Reiche 1905); this is supported by the labels of some of the syntypes (see below). Reports of the species from Ecuador (Wimmer 1937, 1953) are likewise unsubstantiated (Candolle 1839; Jeppesen 1981; Jørgenson 1999).

Vernacular Names.—According to Wimmer (1929), this species is known in various parts of Peru as *contonya*, *contoya*, *contonsa*, and *contunya*. An isotype of var. *jaensis* E. Wimm. (see below) states "peruvianis vulgo *Concho*."

Ethnobotany.—In Apurimac, this plant is "feared" as a cause of warts (*Stork et al. 10633*). The plant allegedly "exudes a nauseous odor which impedes breathing" (*Eyerdam 10755*), and is regarded as "venenatissi[ma]" and "drastica" (*Pavon s.n.*).

Cultivation.—This species was introduced to horticulture in the 1824 but is no longer available (Sweet 1831; Lindley 1836).

Typification.—In the protologue, *L. decurrens* was said to have been based on plants collected "in regno Chilensi ad ripas fluminis vulgo *Claro* ... Vidi sic. in memorato herbario" [i.e., "*Née herbar.*"]. At MA are four specimens of this species collected by Née. All match the original description, but only two (MA-475909 and MA-475910) bear locality data matching that cited. However, the former is annotated "Nee dedit anno 1804," making it unlikely that Cavanilles saw it prior to publication. For this reason, the latter sheet is here designated as the lectotype, and the former treated as a duplicate. The other two specimens are of interest in regard to the presumably erroneous locality data of the protologue and lectotype. On MA-475908, the locality is given as "Peru Panama y Chile" while on MA-475911, it is "nov. Hispania et Peruvia," suggesting early confusion over the provenance of the specimens. These may well be duplicates of the lectotype with variant label data, but it seems best to treat them as separate gatherings.

Discussion.—Candolle (1839) described an unnamed variety of *L. decurrens*, which he denoted as "β" and equated with *L. foliosa* and with Sweet's (1831) and Lindley's (1836) illustrations of *L. decurrens*; Heynhold (1840) provided the name *L. decurrens* var. *foliosa* for it. Candolle characterized this taxon as having "calyce et corollâ ubiquè hirsutis," but Wimmer (1929) argued that this differed in no way from typical *L. decurrens*.

Subsequently, Wimmer (1937) described var. *jaensis*, distinguishing it from typical *L. decurrens* (including var. *foliosa*) by its long pubescent (vs. glabrous) stem and leaves and corolla 45 mm (vs. 30 mm) long. He equivocated regarding the latter character, however, noting that "longitudo corollae variat inter 26–45 mm."

My own analysis of morphological variation in *L. decurrens* showed that Wimmer (1937, 1953) was on the right track, but erred in emphasizing pubescence over corolla length. In this study, I detected a pronounced north-south increase in flower size in this species. In the northern part of the range, the corolla is as little as 22 mm long, vs. up to 42 mm long in the south. Most of this increase occurs in the tube, which varies from 14 mm long in the north to 30 mm long in the south. This increase in tube length while lobe length stays relatively constant means that the proportionality of the corolla varies. In the north, the tube is often not much longer than the dorsal lobes; in the south, it can be as much as three times as long. Concomitantly, length of the filament tube varies from 20 mm in the north to 33 mm in the south, though the length of the anthers remains relatively constant. As a result, the filament tube is as little as 2.5 times as long as the dorsal anthers in the north, but up to 4.2 times as long in the south.

As noted above, Wimmer utilized variation in vegetative pubescence to distinguish infraspecific taxa in this species. However, my analysis showed that this variation was not as clear cut geographically as flower size variation. Plants in the north tend to be more densely pubescent than those in the south, but there are many exceptions. This explains Wimmer's statement regarding the extreme variation in corolla length within var. *jaensis*. By emphasizing pubescence, his circumscription encompassed both northern and southern plants; pubescent plants occur in both regions. In a similar vein, the leaves of plants in the north generally are less pronouncedly serrate than those in the south, but again with numerous exceptions.

A morphological continuum such as that seen here in flower size can be difficult to divide meaningfully (Stuessy 1990; Winston 1999). However, there seems to be something of a gap in the variation pattern north of Lima; this is best seen in the corolla tube and its proportionality to the lobes. North of that *departamento*, corolla tubes are 20–30 mm long and 2.5–3 times longer than the dorsal lobes; from Lima south, they are 14–19 mm long and only 1–1.8 times longer than the dorsal lobes. This gap makes it possible to recognize two subspecies within *L. decurrens*. Other floral characters (see above) show minor overlap in their ranges, but this is to be expected in a case of parapatric geographic subspecies (Raven et al. 1974; Grant 1981; Stuessy 1990).

As noted above, vegetative pubescence and leaf serration are weakly correlated with geography: the northern subspecies tends to be more densely pubescent and less pronouncedly serrate. Additionally, the northern subspecies tends to occur at lower elevations than the southern: 750–2540 m (with one coastal population at 10 m) vs. 2280–3355 m. The phenology of the northern subspecies lags behind the southern by about a month. The single chromosome count for this species (Diers 1961) was made from plants at Matucana in Dpto. Lima and thus pertains to the southern subspecies. The plants introduced to horticulture in 1824 (Sweet 1831; Lindley 1836) appear to have likewise represented the southern subspecies.

The types of *L. decurrens* and of its var. *foliosa* are referable to the southern subspecies, which thus takes the autonym. I originally assumed that the epithet *jaensis* would be available for the northern subspecies, based on the fact that some of the specimens cited by Wimmer in the protologue (i.e., paratypes) were collected in the north and represented that subspecies. However, careful examination of the holotype showed that it represented the southern race. As a result, the northern race is here described as new and christened with an appropriate if unimaginative epithet.

5a. Lobelia decurrens subsp. decurrens

Lobelia foliosa Kunth in Humb., Bonpl. & Kunth, Nov. Gen. Sp. 3:310 (quarto), 242 (folio). 1819 (Nov). *Rapuntium foliosum* (Kunth) C. Presl, Prodr. Monogr. Lobel. 24. 1836. *Lobelia decurrens* var. *foliosa* (Kunth) Heynh., Nom. Bot. Hort. 1:471. 1840. TYPE: "Amerique Equitoriale," *Humboldt & Bonpland s.n.* (HOLOTYPE: P-Bonpl. [IDC-microfiche!]). The protologue states "Regni Quitensis [i.e., Ecuador], juxta pagum Guancabamba;" this seems erroneous in light of subsequent collections.

Lobelia decurrens var. *jaensis* E. Wimm. in J.F. Macbr., Fl. Peru 6:478. 1937. TYPE: "Perou ou Chile," *Pavón s.n.* (HOLOTYPE: G!; ISOTYPES: CONC! G-BOIS!). The G-BOIS isotype, which was not annotated by Wimmer, carries more specific locality data: Peru, Lurini collibus et Chouchin, Ciuchin in siciis callidis, Apr 1829.

Lamina elliptic, narrowly elliptic, or oblanceolate, 4–10 cm long, 1.6–2.6 cm wide; margin teeth up to 8 mm long. Pedicels 8–14 mm long. Hypanthium 2.5–5 mm long, 5–7 mm in diameter. Calyx lobes linear triangular or narrowly triangular, 9–13 mm long, 1.8–4 mm wide; margin fimbriate with 3–6 segments up to 4 mm long per side. Corolla red-purple, violet, or mauve, 31–42 mm long; tube 20–30 mm long, 4–6.5 mm in diameter; dorsal lobes 9–12 mm long, 2.5–4 mm wide; ventral lip 9–15 mm long, 3–4.5 mm wide, the lobes connate for 1/3–1/2 their length. Filament tube 24–33 mm long, 0.8–1.2 mm in diameter; anther tube 2–2.8 mm in diameter; dorsal anthers 6–8 mm long; ventral anthers 4.8–5.5 mm long, with tufts of white trichomes 1–1.4 mm long at apex. Capsules 2/5–2/3-inferior, 11–15 mm long, 7–8 mm in diameter. Chromosome number $n = 7$ (Diers 1961).

Icones.—Fig. 1A; Cavanilles (1801), pl. 521; Sweet (1831); Lindley (1836).

Distribution, habitat, and phenology.—Endemic to the Andes of southern Peru, from Lima to Arequipa, at elevations of 2280–3355 m, in a wide variety of open to shaded usually mesic environments, including roadsides, fencerows, streamsides, and abandoned fields. Flowering occurs from January to August, and fruiting through October.

Representative specimens. **PERU. Apurimac:** N de Abancay, *Núñez & Vargas 7232* (MO); Abancay, *Soukup 707* (F); Abancay (Río Marino), *Stork, Horton & Vargas 10633* (F, MO); alrededores de Abancay, *Vargas 477* (F). **Arequipa:** 22 km S of Arequipa, *Eyerdam & Beetle 22166* (K, MO); Yura, hills to the east, *Solomon 2817* (F, MO); Yura, *Stafford D.46* (K); Yura, *Williams 2536* (BM, K, NY). **Ayacucho:** Ayacucho to Huancayo, *Balls 6963* (F, K, US); Ayacucho, May 1867, *Pearce s.n.* (BM, K); Ayacucho, *Soukup 4012* (US). **Huancavelica:** just below Huaytará on road Pisco – Ayacucho, *Weigend & Förther 97/625* (F). **Lima:** above Paya, *Asplund 10802* (US); Tambo Viso, Río Rimac, *Eyerdam 10755* (F, NY, US); los baños de Churín, *Ferreyra 3524* (US); entre Chosica y Matucana, *Ferreyra 5325* (US); Ayarpongo, cerca de Churín, *Ferreyra 5358* (US); arriba de Surco, *Ferreyra 6059* (US); Churín, *Ferreyra 6174* (US); Surco, *Ferreyra 7596* (MO, US); Sta. Eulalia, *Goodspeed 33146* (MO); 2 km W of Matucana, *Hutchinson 1043* (K, MO, NY, US); Matucana, *Macbride & Featherstone 99* (F, NY); Obrajillo, *U.S. Exploring Expedition s.n.* (US); Río Chillón near Viscas, *Pennell 14317* (F, GH, NY); San Bartolomé, *Rose & Rose 18678* (NY, US); km 75 Central Highway, *Saunders 370* (BM); Matucana, 22 Apr 1877, *Savatier s.n.* (K); Surco, *Soukup 3727* (MO, US); Chosica, *Stafford D.43* (K); just above Matucana, km 80 on the Carretera Central, *Ugent & Ugent 5299* (US).

CULTIVATION. Great Britain: "... gathered in Chili or Peru by Mr. Miller and raised in 1824," *anonymous s.n.* (K).

5b. **Lobelia decurrens** subsp. **parviflora** Lammers, subsp. nov. TYPE: PERU. PIURA: Prov. Ayabaca, dry open hillsides, scattered brush, on road to Ayabaca, 18 km above Puente Tandopa (Río Quiroz), 1700m, 24 Sep 1964, *Hutchinson & Wright 6687* (HOLOTYPE: NY!; ISOTYPES: K! MO!).

Plantae ex Peruvia septentrionali, a reliquo speciei floribus parvioribus cum corolla 22–33 mm long (tubo 14–19 mm longo et lobis 1.1–1.8plo longiori) et filamentorum tubo 20–26 mm longo antheris dorsalibus 2.5–3.6plo longiori distinguenda; plantae plerumque plus pubescentes cum foliis minus serratis.

Lamina narrowly oblong or oblanceolate, 6–15 cm long, 1.5–2.4 cm wide; margin teeth up to 5 mm long. Pedicels 7–12 mm long. Hypanthium 3–5 mm long, 6–7 mm in diameter. Calyx lobes linear triangular, 7–16 mm long, 1.3–2.8 mm wide; margin fimbriate with 3–9 segments up to 3 mm long per side. Corolla red-purple, magenta, or lavender, 22–33 mm long; tube 14–19 mm long, 3–6 mm in diameter; dorsal lobes 8–16 mm long, 2–3 mm wide; ventral lip 8–17 mm long, 4–4.5 mm wide, the lobes connate for 1/2–2/3 their length. Filament tube 20–

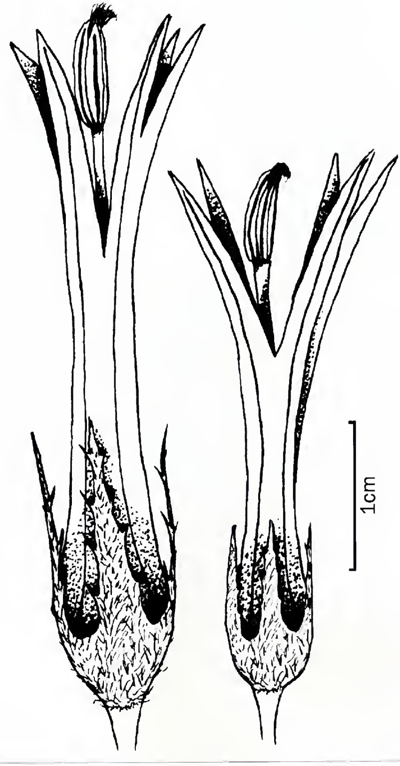


Fig. 1. Flowers of *Lobelia decurrens*. **A.** *L. decurrens* subsp. *decurrens* (based on *Ferreyra 7596*, US). **B.** *L. decurrens* subsp. *parviflora* (based on *Mostacero et al. 1725*, MO).

26 mm long, 0.9–1.4 mm in diameter; anther tube 1.7–2.5 mm in diameter; dorsal anthers 6.5–8 mm long; ventral anthers 5–6 mm long, with tufts of white trichomes 1.2–1.5 mm long at apex. Capsules 1/3–1/2-inferior, 10–14 mm long, 7–9 mm in diameter.

Icon.—Fig. 1B.

Distribution, habitat, and phenology.—Endemic to the Andes of northern Peru, from Piura to Ancash and Huánuco, typically at elevations of 750–2540 m, in a wide variety of open to shaded usually mesic environments, including roadsides, fencerows, streamsides, and abandoned fields; of note is a specimen collected from dunes in coastal desert at an elevation of just 10 m (*Dillon & Whalen 4009*). Flowering occurs from February to October, and fruiting through November.

Representative specimens. **PERU. Ancash:** ca. 48 km N of Pativilca on PanAmerican Hwy., *Dillon & Whalen 4009* (NY). **Cajamarca:** km 156 E of Olmos, *Hutchinson 1417* (MO, NY), *Hutchinson 1418* (F); Llama, *Laudeman 4159* (K); alrededores de Sócota, *Mostacero et al. 1725* (MO, NY); Casa Blanca (Platanar-Lives), *Sagástegui et al. 8774* (NY); E of Quinden, *Sánchez 3407* (F, MO); Balsas-Celendin road, 16–23 km from Balsas, *Smith 6191* (MO, NY). **Huánuco:** Maria del Valle, *Macbride 3567* (F, NY); Huánuco, *Sawada P.58* (F). **La Libertad:** arriba de Plazapampa (Ruta Salpo-Samne), *Leiva & Leiva 552* (F); abajo de Piedra Gorda (Ruta Salpo-Samne), *Leiva, Paredes & Rodríguez 1202* (F, MO). **Piura:** Abra de Porculla, *Sagástegui, Leiva & Lezama 15067* (F, MO).

6. Lobelia heteroclita McVaugh, Ann. Missouri Bot. Gard. 52:404. 1965. TYPE: COLOMBIA. BOYACA: Sierra Nevada de Cocuy, Laguna Seca, in more or less cleared area of cloud forest, ca. 2750 m, 18 Aug 1957, *Grubb, Curry & Fernandez-Perez 599* (HOLOTYPE: US!; ISOTYPE: K!).

Stems 1.5 m tall, herbaceous, apparently unbranched, erect or ascending, pubescent with a mix of short stiff and long lax hairs. Leaves sessile or short-petiolate; lamina broadly elliptic or oblanceolate, 7–10.7 cm long, 2.6–4.5 cm wide; adaxial surface glabrous; abaxial surface with scattered lax hairs 1–1.5 mm long on veins; margin crenate toward apex; apex obtuse or acute; base rounded or cuneate; petiole (when present) up to 0.7 mm long, pubescent. Flowers in a terminal raceme; pedicels 15–23 mm long, ascending, spreading, or slightly incurved, stiff, pubescent with long spreading hairs, ebracteolate or bibracteolate toward base; bracteoles (when present) linear, 1–7 mm long. Hypanthium asymmetrically depressed hemispheric, 2–4 mm long, 6–7 mm in diameter, pubescent; base rounded or truncate, ventrally oblique. Calyx lobes linear triangular, 5–9 mm long, 1.5–2.2 mm wide, sparsely pubescent; margin entire or with 1–2 pairs of minute teeth. Corolla unilabiate, deep pink, 36–47 mm long, glabrous; tube 29–38 mm long, 5–7 mm in diameter at base, 1.5–3 mm at mouth, tapering conspicuously towards mouth, ventrally somewhat gibbous at base; lobes linear, 5–12 mm long, 1.2–1.5 mm wide, deflexed, 1/4–1/3 as long as the tube, acuminate at apex. Filament tube 32–38 mm long, 1–1.4 mm in diameter, pinkish, glabrous; anther tube 2–2.6 mm in diameter, the surface glabrous; dorsal anthers 4–5 mm long; ventral anthers 2.8–3.6 mm long, with tufts of white trichomes 0.7–0.9 mm long at apex. Mature capsules and seeds not seen.

Icon.—McVaugh (1965), Fig. 2A.

Distribution, habitat, and phenology.—Endemic to the Cordillera Oriental of north-central Colombia and known only from the type.

Discussion.—McVaugh (1965) did not specify the affinities of his new species, stating only that it seemed referable to subg. *Tupa*. It is unique within the subgenus by virtue of its ventrally oblique hypanthium (Ayers 1986, 1990). However, on the basis of its habit, pedicels shorter than the flowers (making the inflorescence appear spike-like), reduced or absent bracteoles, depressed hemispheric hypanthium, monochromatic corolla, straight corolla tube, and monomorphic corolla lobes, it is best referred to sect. *Homochilus* and seems most closely related to the other exclusively South American member of the section, *L. decurrens*.

ACKNOWLEDGMENTS

In the preliminary stages of this work, I enjoyed the enthusiastic assistance of Michael James Eakes, an undergraduate intern from the University of Illinois, who was supported by the Office of Academic Affairs of the Field Museum of Natural History. Completion of the research was made possible by Grant #FDR001 from the University of Wisconsin Oshkosh (UWO) Faculty Development Board. Figure 1 was skillfully delineated by UWO graduate student Yvette Evrard, to whom I extend my sincerest appreciation. The curators and staffs of the following institutions are gratefully acknowledged for lending specimens in their care: ARIZ, ASU, B, BM, BR, C, CAS, CONC, DS, E, F, ENCB, G, GH, GOET, ISC, K, LL, MA, MEXU, MICH, MIN, MO, MU, NY, OSH, PH, POM, PR, RSA, TEFH, TEX, UNM, US, W, WIS, WTU, and WU. Special thanks to reviewers Tina Ayers and Tatyana Shulkina for their helpful comments.

REFERENCES

Anonymous. 1903. Neue und empfehlenswerte Pflanzen. Neuheiten von Samen einiger Züchtung oder Einführung für 1904 von Haage & Schmidt in Erfurt (nach den Beschreibungen der Züchter. Gartenflora 52:577.

Anonymous. 1915. *Lobelia laxiflora* var. *angustifolia*. Gard. Chron. (ser. 3)57:262–263.

Anonymous. 2003. Humdingers. Birds & Blooms Collector's Ed. Pp. 41–42.

Ayers, T.J. 1986. Systematics of *Heterotoma* Zucc. (Campanulaceae–Lobelioideae). Ph.D. dissertation, University of Texas at Austin.

Ayers, T.J. 1990. Systematics of *Heterotoma* (Campanulaceae) and the evolution of nectar spurs in the New World Lobelioideae. Syst. Bot. 15:296–327.

Ayers, T.J. 2000. *Lobelia*. In: J. Cullen, J.C.M. Alexander, C.D. Brickell, J.R. Edmondson, P.S. Green, V.H. Heywood, P.M. Jørgensen, S.L. Jury, S.G. Knees, H.S. Maxwell, D.M. Miller, N.K.B. Robson, S.M. Walters, and P.F. Yeo. The European garden flora, vol. 6. Cambridge University Press, Cambridge. Pp. 499–501.

Bentham, G. 1876. Campanulaceae. In: G. Bentham and J.D. Hooker, Genera plantarum, vol. 2. Reeve and Co., London. Pp. 541–564.

Buss, C.C., T.G. Lammers, and R.R. Wise. 2001. Seed coat morphology and its systematic implications in *Cyanea* and other genera of Lobelioideae (Campanulaceae). Amer. J. Bot. 88:1301–1308.

Candolle, A. de 1839. Lobeliaceae. In: A.P. de Candolle, Prodromus systematis naturalis regni vegetabilis, vol. 7. Treuttel and Würtz, Paris. Pp. 339–413, 784–786.

Cavanilles, A.J. 1801. Icones et descriptiones plantarum, vol. 6. Regia Typographia, Madrid.

Cronquist, A. 1978. Once again, what is a species? In: L.V. Knutson, ed. Biosystematics in agriculture. Allenheld Osmun, Montclair. Pp. 3–20.

Decaisne, J. 1848. *Lobelia ghiesbreghtii*, Dne. Rev. Hort. (sér. 3) 2:341 + fig. 18.

Diers, L. 1961. Der Anteil an Polyploiden in den Vegetationsgürtelm der Westkordillere Peru. Z. Bot. 49:437–488.

Don, D. 1838. *Siphocampylus bicolor*. Two-coloured Siphocampylus. In: R. Sweet, ed. The British flower garden (ser. 2) vol. 4. James Ridgway and Sons, London. Pl. 389 + 2 unnumbered pp. of text.

Eakes, M.J. and T.G. Lammers. 1996. Phenetic analysis of the *Lobelia laxiflora* complex (Campanulaceae: Lobelioideae) reveals a previously undescribed species in Mexico [abstract]. Amer. J. Bot. 83 (6, Suppl.):154.

Grant, V. 1981. Plant speciation, ed. 2. Columbia University Press, New York.

Greuter, W., J. McNeill, F.R. Barrie, H.M. Burdet, V. Demoulin, T.D. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth (eds.). 2000. International code of botanical nomenclature (St. Louis Code) Adopted by the Sixteenth International Botanical Congress St. Louis, July–August 1999. Koeltz, Königstein.

Grimé, W.E. and T. Plowman. 1986. Type photographs at Field Museum of Natural History. Taxon 35:932–934.

Hamlin, J. 1995. Sophomore's discovery. In the Field 66(5):3.

Harris, J.G. and M.W. Harris. 1994. Plant identification terminology: an illustrated glossary. Spring Lake Publ., Spring Lake.

Heynhold, G. 1840. *Lobelia*. In: Nomenclator botanicus hortensis, vol. 1. Arnoldischen, Dresden. Pp. 470–474.

Hooker, W.J. 1837. *Lobelia cavanillesiana*. Cavanilles' Lobelia. Bot. Mag. 64:pl. 3600 + 2 unnumbered pages.

Hooker, W.J. 1850. *Tupa crassicaulis*. Thick–stemmed Tupa. Bot. Mag. 76:pl. 4505 + 2 unnumbered pages.

Hooker, W.J. and G.A.W. Arnott. 1830. List of the places visited by the expedition under the command of Captain Beechey, R.N. Pp. 1–2. In: W.J. Hooker and G.A.W. Arnott, The botany of Captain Beechey's voyage. Henry G. Bohn, London.

Huxley, A. J. (ed.) 1992. *Lobelia*. In: The new Royal Horticultural Society dictionary of gardening, vol. 3. MacMillan Press, London. Pp. 104–106.

Jeppesen, S. 1981. Lobeliaceae. In: G. Harling and B. Sparre (eds.), Flora of Ecuador, no. 14. Riksmuseum, Stockholm. Pp. 9–170.

Jørgensen, P.M. 1999. Campanulaceae. In: P.M. Jørgensen and S. Léon-Yánez, eds. Catalogue of the vascular plants of Ecuador. Missouri Botanical Garden Press, St. Louis. Pp. 3 74–382.

Knowles, G.B. and F. Westcott. 1838. *Siphocampylus bicolor.* (Two-coloured Siphocampylus.) Fl. Cab. 2:97–98 + pl. 69.

Lammers, T.G. 1988. New taxa, new names, and new combinations in the Hawaiian Lobelioideae (Campanulaceae). Syst. Bot. 13:496–508.

Lammers, T.G. 1991. Systematics of *Clermontia*. Syst. Bot. Monogr. 32:1–97.

Lammers, T.G. 1993. Chromosome numbers of Campanulaceae. III. Review and integration of data for subfamily Lobelioideae. Amer. J. Bot. 80:660–675.

Lammers, T.G. 1994. Typification of the names of Hawaiian Lobelioideae (Campanulaceae) published by Wilhelm Hillebrand or based upon his specimens. Taxon 43:545–572.

Lammers, T.G. 1995. Transfer of the southern African species of *Lightfootia*, nom. illeg., to *Wahlenbergia* (Campanulaceae, Campanuloideae). Taxon 44:333–339.

Lammers, T.G. 1999. A new *Lobelia* from Mexico, with additional new combinations in world Campanulaceae. Novon 9:381–389.

Lammers, T.G. 2000. Revision of *Lobelia* sect. *Tupa* (Campanulaceae: Lobelioideae). Sida 19: 87–110.

Lammers, T.G. 2004. Campanulaceae. In: N. Smith, S.A. Mori, A. Henderson, D.W. Stevenson, and S.V. Heald, eds. Flowering plants of the Neotropics. Princeton University Press, Princeton. Pp. 78–80.

Lammers, T.G. and G.R. Proctor. 1994. *Lobelia vivaldii* (Campanulaceae: Lobelioideae), a remarkable new species of sect. *Tylomium* from Isla de Mona, Puerto Rico. Brittonia 46:273–278.

Lancaster, R. 1991. Plant profile: *Lobelia laxiflora* var. *angustifolia*. Garden (London 1975+) 116:474–475.

Leenhouts, P.W. 1968. A guide to the practice of herbarium taxonomy. Regnum Veg. 58: 1–60.

Lindley, J. 1836. *Lobelia decurrens*. Bot. Reg. 22:pl. 1842 + 1 unnumbered pg. of text.

Loudon, J.W. 1848. The ladies' flower garden of ornamental and greenhouse plants. William Smith, London.

Martius, K.F.P. von. 1830. Auswahl merkwürdiger Pflanzen des k. botanischen Gartens zu München, part 2. Brönne'schen, Frankfurt.

Mason, C.T., Jr., and P.B. Mason. 1987. A handbook of Mexican roadside flora. University of Arizona Press, Tucson.

Maxted, N. 1992. Towards defining a taxonomic revision methodology. Taxon 41:653–660.

McVaugh, R. 1940. A key to the North American species of *Lobelia* (sect. *Hemipogon*). Amer. Midl. Naturalist 24:681–702.

McVaugh, R. 1943. Campanulales, Campanulaceae, Lobelioideae. N. Amer. Fl. 32:1–134.

McVaugh, R. 1965. South American Lobelioideae new to science. Ann. Missouri Bot. Gard. 52:399–409.

McVaugh, R. 1977. Botanical results of the Sessé & Mociño expedition (1787–1803) I. Summary of excursions and travels. Contr. Univ. Michigan Herb. 11:97–195.

Merrill, E.D. 1923. An enumeration of Philippine flowering plants, vol. 3. Bureau of Science, Manila.

Michener, C.D. 1970. Diverse approaches to systematics. Evol. Biol. 4:1–38.

Murata, J. 1992. Systematic implications of seed coat morphology in *Lobelia* (Campanulaceae–Lobelioideae). J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 15:155–172.

Murata, J. 1995. A revision of infrageneric classification of *Lobelia* (Campanulaceae-Lobelioideae) with special reference to seed coat morphology. J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 15:349–371.

Nash, D.L. 1976. Flora of Guatemala, Campanulaceae. Fieldiana, Bot. 24:396–431.

Nitecki, M.H. 1980. Featured institution–Field Museum of Natural History. A.S.C. Newslett. 8:61–70.

Post, T.E. von and O. Kuntze. 1903. Lexikon generum phanerogamarum. Deutsche Verlags-Anstalt, Stuttgart.

Qualls, D. 1986. Summary for revisionary studies of plant taxa. In: A.E. Radford, Fundamentals of plant systematics. Harper & Row, New York. Pp. 467–468.

Radford, A.E. 1986. Fundamentals of plant systematics. Harper & Row, New York.

Raven, P.H., S.G. Shetler, and R.L. Taylor. 1974. Proposals for the simplification of infraspecific terminology. Taxon 23:828–831.

Regel, E. 1851. *Siphocampylus warscewisczii.* Schweiz. Z. Gartenbau 1850:131 + unnumbered plate.

Reiche, K. 1905. Estudios criticos sobre la flora de Chile, especies problemáticas. Anales Univ. Chile 117:461–462.

Schönland, S. 1889. Campanulaceae. In: A. Engler and K. Prantl, Die natürlichen Pflanzenfamilien, IV. Teil, 5. Abteilung. Wilhelm Engelmann, Leipzig. Pp. 40–70.

Siebert, A. and A. Voss. 1894. Campanulaceae. In: Vilmorin's Blumengärtnerei Beschreibung Kultur und Verwendung, ed. 3, vol. 1. Paul Parey, Berlin. Pp. 560–578.

Stuessy, T.F. 1990. Plant taxonomy: the systematic evaluation of comparative data. Columbia University Press, New York.

Sweet, R. 1831. *Lobelia decurrens*. Brit. Fl. Gard. (ser. 2) 1:pl. 86 + 2 unnumbered pp. of text.

Thomas, G.S. 1990. Perennial garden plants or the modern florilegium, ed. 3. Sagapress, Portland.

Thompson, S.W. and T.G. Lammers. 1997. Phenetic analysis of morphological variation in the *Lobelia cardinalis* complex (Campanulaceae: Lobelioideae). Syst. Bot. 22:315–331.

Thorne, R.F. 1978. New subspecific combinations for southern Californian plants. Aliso 9:189–196.

Uphof, J.C.T. 1910. Die Pflanzengattungen. Theodor Oswald Weigel, Leipzig.

Vatke, W. 1874. Notulae in Campanulaceas herbarii regii berolinensis. Linnaea 38:699–735.

Vogel, E.F. de (ed.) 1987. Manual of herbarium taxonomy: theory and practice. UNESCO, Jakarta.

Watson, M. 1997. On revising a genus. Plant Talk 10:31–34.

Weimann, C. and M. Heinrich. 1997. Indigenous medicinal plants in Mexico: the example of the Nahua (Sierra de Zongolica). Bot. Acta 110:62–72.

Weiss, M.R. 1995. Floral color change: a widespread functional convergence. Amer. J. Bot. 82:167–185.

Wilbur, R.L. 1977. Flora of Panama. Campanulaceae. Ann. Missouri Bot. Gard. 63:593–655.

Wilbur, R.L. 1991. Synopsis of the Mexican and Central American representatives of *Lobelia* sect. *Tylomium* (Campanulaceae: Lobelioideae). Sida 14:555–567.

Wimmer, F.E. 1929. Plantae Raimondianae, Campanulaceae-Lobelioideae. Notizbl. Bot. Gard. Berlin-Dahlem 10:724–746.

Wimmer, F.E. 1937. Campanulaceae. In: J.F. Macbride, Flora of Peru, part VI, no. 2. Field Museum of Natural History, Chicago. Pp. 383–489.

Wimmer, F.E. 1953. Campanulaceae-Lobelioideae, II. Teil. In: R. Mansfeld, ed. Das Pflanzenreich IV.276b. Akademie–Verlag, Berlin. Pp. i–viii, 261–814.

Wimmer, F.E. 1968. Campanulaceae–Lobelioideae supplementum et Campanulaceae-Cyphioideae. In: S. Danert, ed. Das Pflanzenreich IV.276c. Akademie-Verlag, Berlin. Pp. i–x, 815–1024.

Winston, J.E. 1999. Describing species: practical taxonomic procedure for biologists. Columbia University Press, New York.

Wittmack, L. and C. Graebener. 1889. *Lobelia laxiflora* H.B.K. (*Siphocampylus bicolor* D. Don als Winterblüher.). Gartenflora 38:337–339 + pl. 1301.

BOOK NOTICES/BOOKS RECEIVED

TEXAS GARDENING THE NATURAL WAY

HOWARD GARRETT. 2004. **Texas Gardening the Natural Way: The Complete Handbook.** (ISBN 0-292-70542-5, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A., (Orders: 800-252-3206, 800-687-6046 fax). $34.95, 396 pp., 833 color photos, 13 color illus., 6 maps, 3 line drawings, 8 1/2" × 11".

Howard Garrett's newest book is a masterpiece. He has pulled together all the information contained in his earlier works and has compiled it into one comprehensive and integrated volume. *Texas Gardening the Natural Way* is indeed the complete handbook for Texas organic gardeners.

He has drawn on his previous works for completeness. They include: *Garrett's Plants for Texas* (1996), *Texas Organic Vegetable Gardening* (1999), *Texas Bug Book* (1999), *Herbs for Texas* (2001), *The Organic Manual* (2002), and *Howard Garrett's Texas Trees* (2002).

Consulting the table of contents reveals that there is no topic he has not included in his *Handbook*. He begins with landscape and gardening design, continues with plant selection, maintenance, and nurturing, and concludes with pest control and poisonous plants. Also included are weather data and instructions for building garden structures, including bat houses.

Is your *Plants for Texas* or your *Texas Organic Vegetable Gardening* so thumbed through and so worn that it is in danger of falling apart in your hands? Look no further for a replacement. Every organic gardener, beginning and veteran, should obtain this book. Non-organic gardeners would benefit also from his recommended listings of plants, trees, and herbs, as well as the landscape and garden design instructions. It is recommended for general collections in public libraries, and in arboretum and horticultural libraries.

Howard Garrett is a landscape architect, certified arborist, horticulturist, and organic practitioner in Dallas, Texas.—*Gary L. Jennings, Librarian, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

THREE NEW SPECIES OF *ERIOCAULON* (ERIOCAULACEAE) FROM PENINSULAR INDIA

Sachin Anil Punekar

Botanical Survey of India
Western Circle, 7-Koregaon Road
Pune- 411 001, Maharashtra, INDIA

Nilesh Vijay Malpure

Adosa Society, Sasane Nagar
Hadapsar, Pune-411 028
Maharashtra, INDIA

P. Lakshminarasimhan

Indian Liaison Officer
Royal Botanic Gardens
Kew, Richmond, Surrey, TW9 3AE, U.K.

ABSTRACT

Three new species of the genus *Eriocaulon* L., two species viz., *E. anshiense* & *E. kanarense* from Karnataka and one species *E. konkanense* from Maharashtra are described and illustrated. A distribution map has been provided. A key to distinguish these three species from their allied species is also given.

RESUMEN

Tres especies nuevas del género *Eriocaulon* L. son aquí descritas e ilustradas, dos de ellas., *E. anshiense* y *E. kanarense* encontradas en Karnataka y la tercera *E. kankanense* en Maharashtra. Se proporciona un mapa de distribución de las mismas. Así mismo, se ofrece una clave de identificación para distinguirlas, en la que se incluyen también especies próximas.

INTRODUCTION

The genus *Eriocaulon* L. is distributed throughout the tropical and sub-tropical regions of both hemispheres and is estimated to consist of ca. 400 species (Mabberley 1997). Karthikeyan et al. (1989) enumerated 72 species, 14 varieties and 1 forma from India. Ansari and Balakrishnan (1994) rendered a systematic account of the genus in India, wherein 65 species were treated. Subsequently, various workers (Myrthong et al. 1984; Bole & Almeida 1987; Koshi & Pushpangadan 1993; Yadav et al. 1998; Sreedevi & Binoj Kumar 1999; Khanna et al. 2000; Gaikwad et al. 2002; Gaikwad et al. 2003 (pers. comm.); Punekar et al. 2003; Punekar & Lakshminarasimhan 2002; Punekar et al. 2003; Pradeep & Sunil 2003) have added 16 more species to this genus. Gaikwad and Yadav (2002) reported 40 species from Maharashtra and Das and Singh (2001) reported 35 species from Karnataka. Presently, the genus *Eriocaulon* L. is represented by 84 species in India including the three new species described here.

During the course of botanical exploration in the West Coast and Western Ghats of Indian Peninsula, three interesting specimens of *Eriocaulon* were collected. After a perusal of the literature, comparison with herbarium collections at BSI & K and our own field observations, the specimens were found to be very distinct from other species of *Eriocaulon* and hence have been considered as new species and are described and illustrated here.

1. Eriocaulon anshiense Punekar, Malpure & Lakshmin., sp. nov. **(Fig. 1, 2A).** TYPE: INDIA. KARNATAKA STATE: North Kanara (Uttara Kannada) District, Anshi National Park, waterfall near Mopai Ghat 600 m, 22 Sep 2003, *Punekar 187761* (HOLOTYPE: CAL; ISOTYPES: BSI, MH).

Eriocaulon anshiense E. eurypeplo Körn. similis sed capitulis spinulosis griseis, bracteis involucralibus plerumque acuminatis, bracteis floralibus ad apicem caudatis, sepalis femineis longe acuminatis atque bracteas florales excedentibus, et seminibus plerumque rostratis differt.

Acaulescent rosulate herbs, to 21.5 cm high. Roots fibrous. Leaves linear, oblong or lanceolate, broad at base, apex acute or acuminate, glabrous, almost equal to the sheaths, membranous, 9.5 × 0.7 cm. Peduncles solitary or many, up to 21.5 cm long, 4–5 ribbed, broad at apex, twisted, glabrous. Sheaths up to 11 cm long, glabrous; limb lanceolate, acuminate, entire. Heads hemispherical or depressed globose, sometimes with central depression, 7 × 5 mm, grey, spinulate. Receptacles ovoid, with central depression, pilose. Involucral bracts spreading, hidden inside the head, ovate or obovate, usually acuminate, rarely acute, sparsely hoary dorsally, glabrous inside, straw colored, 1.2–1.6 × 0.8 mm. Floral bracts closely imbricated, broadly cuneate, caudate and dorsally hoary towards apex, ventrally glabrous, black-straw colored, hyaline along margin, 2 × 1.2 mm. **Male flowers:** pedicels minute; sepals 2, free, conduplicate, keeled, obtuse or truncate and hoary at apex, straw colored, chartaceous at margin, 0.9 × 1.1 mm; petals 3, equal, ovate to linear, minute, hairy at apex, gland dotted; stamens 6, anther lobes black. **Female flowers:** pedicels short; sepals 2, free, exceeding the floral bracts, obovate to elliptic, conduplicate, deeply keeled, long acuminate, straw colored with black tinge, dorsally hoary towards apex or in upper half, chartaceous along margins, 2.2 × 0.3 mm; petals 3, free, linear, acute, barbate towards apex, gland dotted, glands elongated, hyaline, 1.2 × 0.2 mm; ovary sessile, ovoid, 0.6 × 0.5 mm; style trifid. Seeds ovoid to ellipsoid, brownish, apiculate or obtuse, 0.8 × 0.5 mm, cells of seed coat transversely elongated, aligned in vertical rows, appendages are of different types in the seeds of same plant, 1 from the middle of the transverse radial wall, so that they appear to be in vertical lines on the surface of seeds, setiform, dilated or hooked at apex.

Eriocaulon anshiense is similar to *Eriocaulon eurypeplon* Körn. (Fig. 2B) but differs from the latter in having spinulate and grey heads, involucral bracts usually acuminate, floral bracts caudate at apex, female sepals long acuminate, exceeding the floral bracts and usually beaked seeds.

Distribution.—The species is so far restricted to few localities of two states viz., water fall near Mopai ghat, Anshi National Park, North Kanara (Uttara Kannada) District, Karnataka State and Usgao, Verlem, Waghai and on the way to Ondoford-Butpal of Goa State (Fig 5).

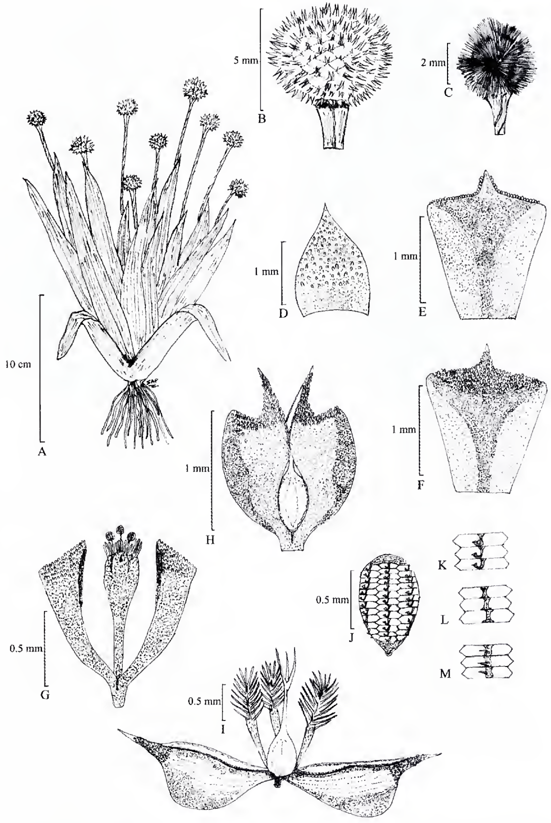


Fig. 1. *Eriocaulon anshiense* Punekar, Malpure & Lakshmin. **A.** Habit; **B.** Head; **C.** Receptacle; **D.** Involucral bract; **E.** Floral bract- ventral view; **F.** Floral bract- dorsal view; **G.** Male flower; **H.** Female flower; **I.** Female flower- sepals spread out to show details; **J.** Seed; **K–M.** Portion of seed showing different types of appendages enlarged.

Fig. 2. A. *Eriocaulon anshiense* Punekar, Malpure & Lakshmin.; **B.** *Eriocaulon eurypeplon* Körn.

Habitat and Ecology.—Grows in dense colonies in the shallow depressions on rocky slopes along the streams surrounded by moist deciduous forests. This species is often found associated with *Coelachne perpusilla, Drosera burmanni, Eriocaulon achiton, E. lanceolatum, Fimbristylis aestivalis, F. dichotoma, Indopoa paupercula, Rotala malampuzhensis, Utricularia reticulata, Xyris indica,* etc.

Flowering and Fruiting.—August–December.

Etymology.—The specific epithet of the new species is based on the type locality viz., Anshi National Park of Karnataka State.

PARATYPES: **INDIA. GOA:** on the way to Ondoford-Burpal, 24 Aug 1963, *Kanodia 89525* (BSI); Usgao, 8 Oct 1964, *Raghavan 103414* (BSI); Verlem, Bhuta Baicha Dongar, 12 Oct 1970, *Singh 125358* (BSI); Waghai, without date, *Singh 124812* (BSI). **KARNATAKA: North Kanara District:** Anshi National Park, Mopai Ghat waterfall 600 m, 7 June 2003, *Punekar & Malpure 187746* (BSI); same locality, 11 Dec 2003, *Punekar 187822* (BSI).

2. Eriocaulon kanarense Punekar, Watve & Lakshmin., sp. nov. **(Fig. 3).** TYPE: INDIA. KARNATAKA: North Kanara District, 15 km S of Ankola on Karwar-Mangalore national highway, 2 Sep 2003, *Watve 187781* (HOLOTYPE: CAL; ISOTYPES: BSI, MH).

Eriocaulon kanarense E. talbotii Ansari & N.P. Balakr. similis sed foliis pedunculisque minoribus, vaginis quam foliis longioribus, capitulis albis, lobis sepalorum masculorum truncatis, antheris nigris, petalis femineis ad apicem eglandulosis et seminibus ellipsoideis rostratis differt.

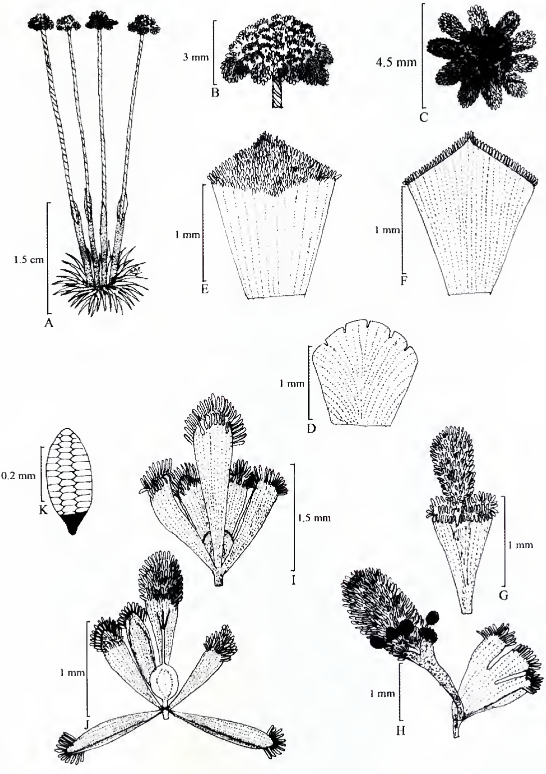


FIG. 3. *Eriocaulon kanarense* Punekar, Watve & Lakshmin. **A.** Habit; **B.** Head- lateral view; **C.** Head- top view; **D.** Involucral bract; **E.** Floral bract- dorsal view; **F.** Floral bract- ventral view; **G.** Male flower; **H.** Male flower- sepal spread out to show details; **I.** Female flower; **J.** Female flower- sepals spread out to show details; **K.** Seed.

Acaulescent rosulate herbs, to 3–5 cm high. Roots fibrous. Leaves linear, broad at base, gradually narrowing towards apex, acuminate, pale green, glabrous, shorter than sheaths, 4 nerved, 8 × 0.6 mm. Peduncles usually 3–4, rarely solitary, up to 4.2 cm long, 5-ribbed, twisted, glabrous. Sheaths up to 1.4 cm long, glabrous; limb lanceolate, acute, entire. Heads hemispherical, 4.5 mm across, white. Receptacles ovoid, glabrous. Involucral bracts spreading, obovate, obtuse and notched at apex, up to 1.5 × 1 mm, straw colored, glabrous. Floral bracts cuneate, usually acute or rarely cuspidate and densely hoary dorsally at apex, blackish, 1.6 × 1 mm. **Male flowers:** pedicels minute; sepals obovate, connate into a spathe of 1 × 0.8 mm, 3- lobed, lobes truncate and densely hairy dorsally at apex, lobes are almost half the length of sepals, black, stipe of corolla 1 mm long; petals 3, unequal, lateral petals minute, hairy at apex, 0.2 mm long, middle odd petal elliptic to oblong, ventrally densely hairy throughout, dorsally glabrous, 1.2 × 0.8 mm, obtuse at apex; anthers 6, black. **Female flowers:** pedicels short; sepals 3, free, subequal, all densely hoary at apex, oblanceolate to oblong, canaliculate, not keeled, obtuse at apex, black, 1 × 0.2–0.3 mm; petals 3, unequal, all obtuse at apex, ventrally densely hairy at apex, dorsally glabrous, eglandular, spathulate, larger petal 1.8 × 0.45 mm, laterals 1 × 0.3 mm; ovary stipitate, globose; style trifid. Seeds ellipsoid, beaked, yellow, dark at one end, 0.4 × 0.2 mm, cells of seed coat transversely elongated, aligned in vertical rows, appendages absent.

Eriocaulon kanarense is similar to *E. talbotii* Ansari & N.P. Balakr., but differs from the latter in having smaller leaves and peduncles, sheaths longer than leaves, heads white, male sepal lobes truncate, anthers black, female petals eglandular at apex and seeds ellipsoid, beaked.

Distribution.—15 km south of Ankola on Karvar-Mangalore national highway, North Kanara (Uttara Kannada) District, Karnataka State (Fig. 5).

Habitat and Ecology.—Common, forming dense cover on lateritic plateau along coast in moist soil in association with *Ammannia* sp., *Drosera indica*, *Fimbristylis* sp., *Trithuria konkanensis*, *Utricularia reticulata*, etc.

Flowering and Fruiting.—August–November.

Etymology.—The specific epithet of the new species is based on the type locality viz., North Kanara District of Karnataka State.

3. Eriocaulon konkanense Punekar, Malpure & Lakshmin., sp. nov. **(Fig. 4).** TYPE: INDIA. MAHARASHTRA: Ratnagiri District, Plateau near MIDC area, Airport road, 7 Sep 2003, *Malpure 187784* (HOLOTYPE: CAL; ISOTYPES: BSI, MH).

Eriocaulon konkanense E. odorato Dalzell similis sed capitulis albis, bracteis involucralibus ad apicem incisis, incisuris 2 vel 3 mumero, sepalis femineis 2 ad apicem obtusis vel rotundatis, seminibus flavis, muris transversalibus seminorum appendiculas 2–4 ferentibus et mures verticalibus seminorum non appendiculatis differt.

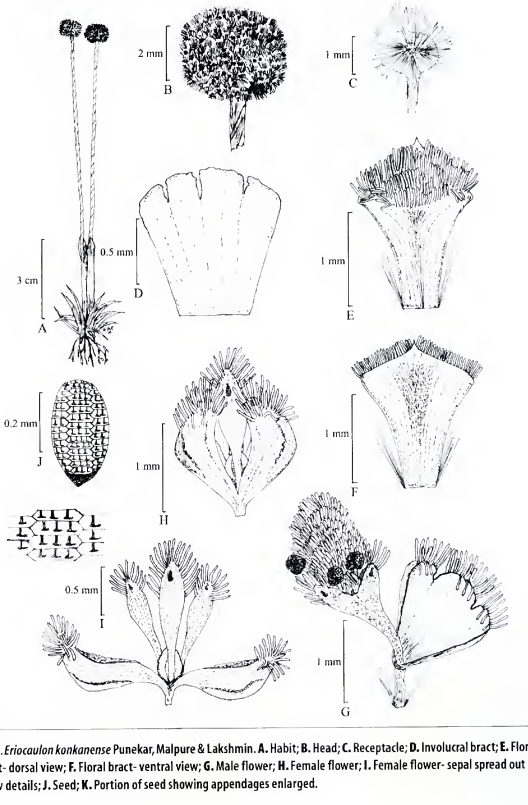


Fig. 4. *Eriocaulon konkanense* Punekar, Malpure & Lakshmin. **A.** Habit; **B.** Head; **C.** Receptacle; **D.** Involucral bract; **E.** Floral bract- dorsal view; **F.** Floral bract- ventral view; **G.** Male flower; **H.** Female flower; **I.** Female flower- sepal spread out to show details; **J.** Seed; **K.** Portion of seed showing appendages enlarged.

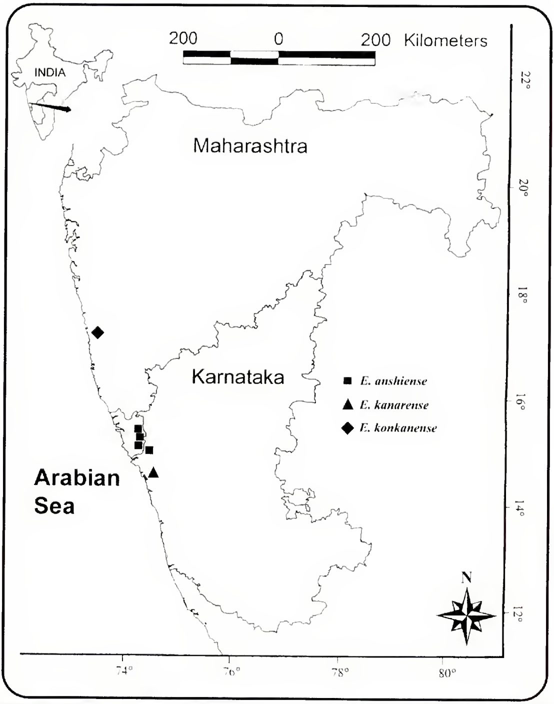


Fig. 5. Distribution map of *Eriocaulon* species.

Acaulescent rosulate herbs, to 16.5 cm high. Roots fibrous. Leaves rosulate, 7–11, linear, broad at the base, tapering towards apex, acuminate, shorter than sheaths, up to 1.7 cm long and 0.25 cm broad, glabrous. Peduncles 1–5, twisted, glabrous, up to 16.5 cm long, 6-ribbed. Sheaths up to 2.7 cm long, glabrous; limb lanceolate, entire, acute. Heads ovoid to quadrangular, 5 mm across, white. Receptacles depressed globose, pilose. Involucral bracts spreading, obovate, rounded and notched at apex, straw colored with blackish tinge, papery, glabrous, 1.2 × 1 mm. Floral bracts oblanceolate, cuneate, acute to acuminate, dorsally hoary and blackish towards apex, hyaline towards base, 1.8 × 1 mm. **Male flowers:** pedicels 0.4 mm long; sepals obovate, connate into a spathe of 1.2 mm long and 0.8 mm across, 3-lobed, lobes truncate to obtuse and dorsally hoary at apex, hyaline with slight blackish tinge; stipe of corolla 0.5–0.7 mm long; petals 3, unequal, laterals linear, minute, middle oblong to narrowly elliptic, obtuse at apex, 1 × 0.3 mm, all densely hoary inside, glabrous outside, gland dotted; stamens 6; anther lobes black. **Female flowers:** pedicels 2–3 mm long; sepals 2, free, oblanceolate, conduplicate, keeled, straw colored with blackish tinge, dorsally hoary and obtuse-rounded at apex, 1.5 mm long; petals 3, free, hyaline, unequal, laterals smaller, 1 × 0.5 mm, hairy at apex, middle larger, 1.5 × 0.2 mm, ventrally hoary in upper half, dorsally sparsely hairy at apex, all oblanceolate, obtuse at apex, gland dotted, stipitate between sepals and petals; ovary stipitate, ovoid, 0.2 × 0.3 mm; style trifid. Seeds ellipsoid, acute, 0.4 × 0.25 mm, yellow; cells of seed coat transversely elongated, aligned in vertical rows, appendages 2–4 from transverse radial walls, setiform, dilated at apex.

Eriocaulon konkanense is similar to *E. odoratum* Dalzell but differs from the latter in having white heads, involucral bracts notched at 2 or 3 places at apex, female sepals 2, obtuse to rounded at apex, seeds yellow, with 2–4 appendages from transverse walls and none from vertical walls.

Distribution.—This species is so far restricted to the coastal lateritic plateau near MIDC area, Airport road, Ratnagiri district, Maharashtra (Fig. 5).

Habitat and Ecology.—Common on coastal lateritic plateau in association with *Eriocaulon parviflorum*, *Eriocaulon richardianum*, *Exacum pumilum*, *Fimbristylis* sp., *Pentanema indicum*, *Rhamphicarpa longiflora*, *Utricularia reticulata*, etc.

Flowering & Fruiting.—August–November.

Etymology.—The specific epithet of the new species is based on the type locality viz., Konkan Coast of Maharashtra State.

KEY TO NEW SPECIES AND ALLIED SPECIES

1. Sepals of male flowers free.
   2. Heads spinulate; involucral bracts usually acuminate; sepals of female flowers longer than floral bracts ______ **E. anshiense**
   2. Heads not spinulate; involucral bracts usually obtuse or subacute; sepals of female flowers as long as floral bracts ______ **E. eurypeplon**

1. Sepals of male flowers connate into a spathe.
   3. Petals of male flowers subequal; anther lobes white ______ **E. talbotii**
   3. Petals of male flowers unequal; anther lobes black.
      4. Sepals of female flowers 2 ______ **E. konkanense**
      4. Sepals of female flowers 3.
         5. Petals of female flowers subequal, glandular; seeds with appendages ____ **E. odoratum**
         5. Petals of female flowers unequal, eglandular; seeds without any appendages ______ **E. kanarense**

ACKNOWLEDGMENTS

The authors are grateful to the Director, Botanical Survey of India, Kolkata for providing facilities and to P.S.N. Rao, Joint Director, Botanical Survey of India, Western Circle, Pune for constant encouragement. One of us (PL) is also thankful to the Keeper, Royal Botanic Gardens, Kew for facilities. Our thanks are also due to N.P. Balakrishnan, Ex-Joint Director, Botanical Survey of India, Coimbatore for his valuable suggestions regarding the species. Help rendered by Melanie Thomas (Wilmot-Dear), Royal Botanic Gardens, Kew for Latin diagnosis and to Lourdes Rico, Royal Botanic Gardens, Kew for the Spanish abstract is gratefully acknowledged. We also wish to thank the Karnataka Forest Department for various help rendered by them and also to Mahesh Shindikar, Ecology Laboratory, Dept. of Botany, University of Pune, who prepared the distribution map.

REFERENCES

Ansari, R. and N.P. Balakrishnan. 1994. The family Eriocaulaceae in India. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Bole, P.V. and M.R. Almeida. 1986 [1987]. Material for the flora of Mahabaleshwar-7. J. Bombay Nat. Hist. Soc. 83:570–602.

Das Das, S. and N.P. Singh. 2001. Taxonomic studies on Eriocaulaceae in Karnataka State. J. Econ. Taxon. Bot. 25:449–484.

Gaikwad, S.P. and S.R. Yadav. 2001. Eriocaulaceae in Maharashtra In: T. Pullaiah, ed. Biodiversity of India 1:256–341.

Gaikwad, S.P., M.M. Sardesai, and S.R. Yadav. 2002. A new species of *Eriocaulon* L. (Eriocaulaceae) from Maharashtra, India. Rheedea 12:133–136.

Gaikwad, S.P., M.M. Sardesai, U.S. Yadav, and S.R. Yadav. 2003. A new species of *Eriocaulon* L. (Eriocaulaceae) from Karnataka, India. Rheedea (under publication).

Karthikeyan, S., S.K. Jain, M.P. Nayar, and M. Sanjappa. 1989. Florae Indicae Enumeratio: Monocotyledonae. Flora of India Series 4. Botanical Survey of India.

Khanna, K.K., V. Mudgal, and A. Kumar. 2000. A new species of *Eriocaulon* (Eriocaulaceae) from Madhya Pradesh, India. Nord. J. Bot. 20:413–414.

Koshy, K.C. and P. Pushpangadan. 1993. On the occurrence of *Eriocaulon minimum* Lam. in India. Rheedea 3:117–119.

MABBERLEY, D.J. 1997. The plant book. ed.2. (Reprinted, 2000). Cambridge University Press.

MYRTHONG, S., Y. KUMAR, and R.R. RAO. 1983 [1984]. *Eriocaulon echinulatum* Mart. (Eriocaulaceae)–a new record for India. J. Bombay Nat. Hist. Soc. 80:667–668.

PRADEEP, A.K. and C.N. SUNIL. 2003. *Eriocaulon ansarii* Pradeep & Sunil (Eriocaulaceae), a new species from India. Candollea 58:321–323.

PUNEKAR, S.A., P. LAKSHMINARASIMHAN, and M.K.V. RAO. 2002 [2003]. *Eriocaulon balakrishnanii* (Eriocaulaceae), a new species from Western Ghats of India. Nord. J. Bot. 22:609–611.

PUNEKAR, S.A. and P. LAKSHMINARASIMHAN. 2002. *Eriocaulon peninsulare* (Eriocaulaceae), a new species from India. Nord. J. Bot. (under publication).

PUNEKAR, S.A., N.V. MALPURE, and P. LAKSHMINARASIMHAN. 2003. Five new species of *Eriocaulon* L. (Eriocaulaceae) from Western Ghats of India. Rheedea (In press).

SREEDEVI, B. and M.S. BINOJ KUMAR. 1999. *Eriocaulon melanocephalum* Kunth (Eriocaulaceae)–a new record for India. J. Econ. Taxon. Bot. 23:742–743.

YADAV, S.R., S.P. GAIKWAD, and M.M. SARDESAI. 1998. A new species of *Eriocaulon* L. (Eriocaulaceae) from India. Rheedea 8:145–147.

BOOK NOTICES

ROBERT J. BLACK and EDWARD F. GILMAN. 2004. **Landscape Plants for the Gulf and South Atlantic Coasts.** (ISBN 0-8130-2722-5, pbk.). The University Press of Florida, 15 NW 15th Street, Gainesville, FL 32611-2079, U.S.A. (Orders: 1-800-226-3822, fax: 352-392-7302, www.upf.com). $24.95, 240 pp., 21 b/w drawings, 513 color photos, 11 tables, hardiness zone map, 7" × 10".

Publisher Comments: "Robert J. Black and Edward F. Gilman tell gardeners how to conquer these hurdles and establish aesthetic and functional plants that can adapt to a coastal site. Beginning with basic gardening precepts, they present step-by-step information on specific plants, planting, best landscape uses, cultural needs, and plant maintenance. They address watering, fertilization, pruning, and other care concerns of salt tolerable plants."

"Combined with colorful photographs of more than 400 plants, Black and Gilman's expert advice will be indispensable for all southern coastal homeowners, landscape architects, landscape designers and installers, landscape maintenance personnel, retail nursery personnel, extension agents, and for inland gardeners who face problems that result from salt water intrusion."

Chapter 6 is the Plant Selection Guide listing the plants alphabetical by genus. Plants are listed in four categories: **1)** Salt-tolerant trees, **2)** Salt-tolerant shrubs, **3)** Salt-tolerant vines and ground covers, and **4)** Salt-tolerant palms. Each entry includes a color photograph of the plant.

CHET VAN DUZER. 2004. **Floating Islands A Global Bibliography.** (ISBN 0-9755424-0-0, hbk.) Cantor Press, 12117 Winton Way, Los Altos Hills, CA 94024-6431, U.S.A. (Orders: 1-800-247-6553, www.cantorpress.com). $44.95, 428 pp., 6" × 9".

Publisher Comments: "This book is a unique treasury of information about one of nature's marvels: floating islands. The bibliography contains more than 1800 citations of books and articles in twenty languages on the subject; the entries are annotated and cross-referenced, and there are both thematic and geographic indices. All aspects of floating islands are addressed, including the formation of floating islands, the causes of their buoyancy, their role in the ecology of lakes and wetlands, their flora and fauna, their role in the dispersal of plants and animals, and methods for controlling and managing them. Works are also cited on artificial floating islands used for agriculture, human habitation, wildlife habitat, and improvement of water quality; and floating islands in literature, myth, and legend. The book includes the text and an English translation, with detailed notes, of G.C. Munz's rare 1711 thesis on floating islands, Exercitatio academica de insulis natantibus, as well as photographs of several floating islands."

NOMENCLATURE AND TYPIFICATION IN THE GENUS *USNEA* (LICHENIZED ASCOMYCETES)— IV. *USNEA STUPPEA* & *USNEA SUBSTERILIS*

James C. Lendemer

Botany Department
The Academy of Natural Sciences of Philadelphia
1900 Benjamin Franklin Pky.
Philadelphia, Pennsylvania 19103, U.S.A.
lendemer@acnatsci.org

Isabelle I. Tavares

University Herbarium
University of California
1001 VLSB #2465
Berkeley, California 94720-2465, U.S.A.

ABSTRACT

This, the fourth part of our series discussing typification and nomenclature in the lichenized ascomycete genus *Usnea* attempts to clarify the application of the names *Usnea stuppea* (Räsänen) Motyka and *U. substerilis* Motyka. Both names are lectotypified and the differences between the two taxa are discussed.

RESUMEN

Esta, que es la cuarta parte de nuestra serie que discute la tipificación y nomenclatura en el género de ascomycete liquenizado *Usnea* intenta clarificar la aplicación de los nombre *Usnea stuppea* (Räsänen) Motyka y *U. substerilis* Motyka. Ambos nombres son lectotipificados y se discuten las diferencias entre los dos taxa.

INTRODUCTION

Some researchers may consider our approach to the typification of *Usnea* species overly cautious and technical; however, we would like to stress that the taxonomic study of *Usnea* has been (and still is) considered extremely difficult and complicated. Thus it would seem logical that the first step towards a clear and thorough revision of the genus would be a careful, precise review of the application of the published names with regard to their types. Unfortunately, many species of *Usnea* have not been properly typified, and often recent lectotypifications have not taken into account the fact that Motyka's monograph includes the lectotypifications of numerous taxa. It should also be remembered that Motyka's treatment remains the only complete revision of the genus to date.

The two species treated here belong to a series of closely related taxa that remains much confused and poorly understood. The first species, *U. stuppea* (Räsänen) Motyka, has been placed in synonymy with *U. substerilis* Motyka by Halonen et al. (1998). Here, we reject the recent lectotypification of *U. stuppea* by Halonen et al. (1998) because of an earlier typification by Motyka (1936). In order to clarify the typification (and taxonomy) of *U. stuppea* we also examined the type material of *U. substerilis*. As a result we have concluded that the synonymy of *U. stuppea* with *U. substerilis* should be reconsidered. To clarify the application of the name *U. substerilis* we have also chosen a single thallus as the lectotype from among those lectotypified by Clerc (1987).

I. **Usnea stuppea** (Räsänen) Motyka

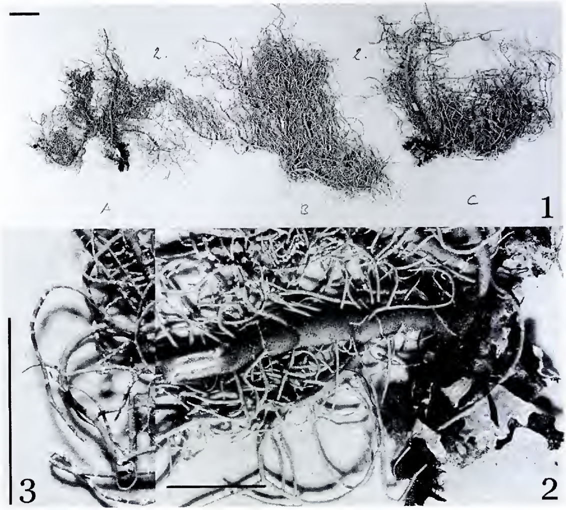
When Räsänen (1933) described *U. comosa* var. *stuppea* he cited only a single locality with a short diagnosis[1]. Later, when Motyka (1936) treated the taxon in his monograph he elevated Räsänen's epithet to the specific rank and lectotypified the name on a specimen in the Räsänen herbarium. Unfortunately, there are three packets in the Räsänen herbarium with the same label data. Two of these were labeled by Räsänen himself (the packet numbered "1" was selected by Halonen et al. (1998) as the lectotype) and one is a specimen of Gyelnik's *Lichenotheca Exsiccati* 17. Only one of these packets retains an annotation by Motyka and thus this is the only packet we can conclusively state was reviewed by him. Because we consider Motyka's (1936) use of the term "type" to be effective lectotypification we consider the packet annotated by Motyka to be the lectotype. Halonen et al. (1998) selected as the lectotype the packet labeled by Räsänen and not annotated by Motyka, apparently because they were not aware of Motyka's previous lectotypification. The lectotypification of Halonen et al. (1998) thus had no standing since it was predated by Motyka's lectotypification. The lectotype selected by Motyka consists of two thalli (marked "A" and "C") mounted on a card with one thallus (marked "B") annotated by Motyka as a different taxon. The thalli marked "A" and "C" agree both with Räsänen's scant original description and Motyka's (1936) later description. The thallus marked "B" contains usnic and norstictic acids (I.M. Brodo, annotation) and was given the manuscript name *Usnea lapponica* var. *americana* by Motyka. Thus, in order to clarify Motyka's lectotypification and the application of this name we select the thallus marked "C" as the "second-step" lectotype (Greuter et al. 2000, Art. 9.14, Ex. 6):

Usnea stuppea (Räsänen) Motyka, Lich. gen. Usnea 1:262. 1936. (**Figs. 1–3**). *Usnea comosa* var. *stuppea* Räsänen, Ann. Missouri Bot. Gard. 20:9. 1933. TYPE: CANADA BRITISH COLUMBIA: Hazelton, on *Picea murrayana*, Sep 1931, *Kujala s.n.* (LECTOTYPE, here designated: H (Räsänen Herbarium; packet marked "2," thallus on right marked "C").

The type collection of *U. stuppea* is a mixture of more than one taxon; we have made an effort to examine some of the duplicates distributed in Gyelnik's *Lichenotheca Exsiccati*. This examination revealed that some duplicates are a mixture of *U. lapponica* and *U. stuppea* while others include other taxa. Likewise the duplicate card in the Räsänen herbarium (packet marked "1") that was cited by Halonen et al. (1998) is also a mixture of *U. lapponica* and *U. stuppea*.

---

[1] Rasanen (1933: 9). "Thallus erectus aut suberectus, brevior fruticulosus, 5–7 cm. longus, laevigatus vel leviter verrucosus, sorediosus, pallido-stramineus, soredia maculiformia, demum parce isidiosa. Medulla laxa, stuppea, K-."



Figs. 1–3. *Usnea stuppea*. **Fig. 1.** Lectotype card, thalli marked A and C = *U. stuppea*, thallus marked B = *U. lapponica*. **Fig. 2.** Detail of lectotype thallus: internal anatomy and basal point of attachment to the substrate. (Note sunken area of cortex on main branch below cut.) **Fig. 3.** Detail of lectotype thallus: small fibrils and secondary branches with soralia lacking isidiomorphs. Scale bar = 1 cm.

The duplicate of *Lichenotheca Exsiccati 17* in Räsänen's herbarium consists of one large thallus of *U. stuppea*.

II. **Usnea substerilis** Motyka

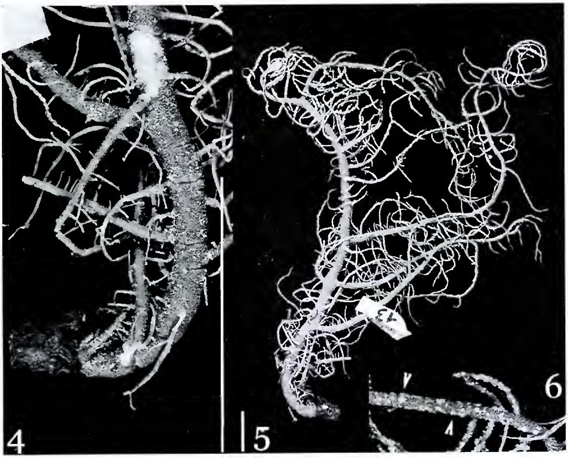
When Motyka (1930) first described *U. substerilis* he did not designate a type specimen. Later, however, he selected an exsiccatum of *Arnold Lichenes Exsiccati 1538b* in W as the lectotype (Motyka, 1936). While treating some of the species of the *U. fragilescens*-group, Clerc (1987) also selected part of an exsiccatum of *Arnold Lichenes Exsiccati 1538b* in W as the lectotype noting that it was a mixture of several taxa. While reviewing the status of *U. stuppea* we also attempted to confirm the typification (and taxonomy) of *U. substerilis*. A loan of the type material from W revealed that the packet selected by Clerc bore no annotation by Motyka, a situation similar to that of *U. stuppea*. This case differs from *U. stuppea*, however, because no specimen matching the data given for the lectotype by Motyka (1936) with Motyka's annotation was located in W. Thus, because no specimen annotated by Motyka could be found his lectotypification must be superseded by that of Clerc (1987). In order to avoid any doubt as to the application of the name *U. substerilis* we have thus chosen to further clarify the lectotypification of Clerc (1987) and select a single thallus from among the thalli selected as the lectotype by Clerc.

Usnea substerilis Motyka, Wyd. Muz. Söask. w Katow. 24. 1930. (**Figs. 4–6**). Type: ITALY. Groeden, ad ramulos emortuos *Laricis* in silva supra Unterkoffel prope St. Ulrich, 1889, *Arnold s.n. – Lichenes Exsiccati 1538b* (Lectotype, here designated: W!(thallus figured herein).

Halonen et al. (1998) placed *U. stuppea* in synonymy with *U. substerilis* Motyka without discussion; however, we prefer to maintain *U. stuppea* as a distinct taxon based on a number of differences in internal and external anatomy. First, in the type of *U. substerilis* the papillae on the primary branches are raised (tall), rounded at the top, and worn off to some degree closer to the base of the thallus. They are also better defined in shape, and gradually sparser, closer to the tips of the main branches. On the secondary branches the papillae also gradually become sparser, larger, and more infrequent towards the tips of the branches. The type of *U. stuppea* however, possesses papillae that are evenly distributed from the base to the tips of the main branches. The papillae themselves are less raised (shorter), and more blunt. On the secondary branches the papillae are nearly absent except close to the point of attachment to the main branch.

The size, shape, and ontogeny of soralia have also been considered valuable characters in distinguishing species (Herrera-Campos et al. 1998; Halonen et al. 1998; Ohmura 2001) and the soralia of *U. stuppea* and *U. substerilis* differ in a number of characters. Those of *U. substerilis* are raised above the cortex (not excavate) and produce few to many small isidiomorphs. As the isidiomorphs are abraded away with age the soralium becomes excavate and larger in size. This is contrasted with the soralia of *U. stuppea* which are not distinctly raised above the cortex and do not produce isidiomorphs. Instead, the soralia produce large coarse soredia, and, with age the soralia become larger in size and considerably deeper (more excavate).

As discussed by Tavares (1987) and Ohmura (2001) cortical anatomy is also a valuable character for distinguishing *Usnea* taxa. The cortex of *U. substerilis* is harder, more rigid, and considerably thicker than that of *U. stuppea* and has a dusty gray-brown (subpruinose) appearance in the herbarium. Likewise, the cortex of *U. stuppea* tends to be softer (occasionally sinking into slight foveae or depressions on the main branches) and lacks the granular appearance of *U. substerilis*. The branches of *U. substerilis* are also distinctly shorter than those of *U. stuppea*. It is important to note that both *U. stuppea* and *U. substerilis* differ from material currently referred to *U. lapponica* Vainio (i.e. thallus "B" on



Figs. 4–6. *Usnea substerilis*. **Fig. 4.** Detail of lectotype thallus: internal anatomy and basal point of attachment to the substrate. (Note rough appearance of cortex and tall raised papillae.) **Fig. 5.** Lectotype thallus, marked No. 13 in packet by P. Clerc. **Fig. 6.** Detail of lectotype thallus: secondary branch and fibrils showing raised soralia with isidiomorphs (indicated by arrows). Scale bar = 1 cm (fig. 4, scale identical for fig. 6), .5 cm (fig. 5).

the lectotype card of *U. stuppea*) by the presence of a subpruinose (*U. substerilis*) or subglabrous (*U. stuppea*) cortex. The cortex of the material here referred to *U. lapponica* is lighter in color (yellower in the herbarium) than those of the other two taxa and glabrous instead of subpruinose or subglabrous.

ACKNOWLEDGMENTS

We wish to thank the curators of the following herbaria for loaning material for this study: BP, FH, H, NY, LBL, S, W. We are grateful for the comments of Gerry Moore and an anonymous reviewer.

REFERENCES

Clerc, P. 1987. Systematics of the *Usnea fragilescens* aggregate and its distribution in Scandinavia. Nordic J. Bot. 7:479–495.

Clerc, P. 1997. Notes on the genus *Usnea* Dill. ex Adanson. Lichenologist 29:209–215.

Greuter, W., J. McNeill, F.R. Barrie, H.M. Burdet, V. Demoulin, T.D. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth (eds.). 2000. International code of botanical nomenclature (St. Louis Code) Adopted by the Sixteenth International Botanical Congress St. Louis, July–August 1999. Koeltz, Königstein.

Halonen, P., P. Clerc, T. Goward, I.M. Brodo, and K. Wulff. 1998. Synopsis of the genus *Usnea* (lichenized Ascomycetes) in British Columbia, Canada. Bryologist 101:36–60.

Herrera-Campos, M.A., P. Clerc, and T.H. Nash III. 1998. Pendulous species of *Usnea* from the temperate forests of Mexico. Bryologist 101:303–329.

Motyka, J. 1930. Materialy do flory porostów Slaska (matériaux pour la connaissance des lichens de Silésie). Wydawncitwa Muzeum Söaskiego w Katowicach 3:1–28.

Motyka, J. 1936. Lichenum generis *Usnea* studium monographicum, pars systematica. 1: 1–304.

Ohmura, Y. 2001. Taxonomic study of the genus *Usnea* (lichenized Ascomycetes) in Japan and Taiwan. J. Hattori Bot. Lab. 90:1–96.

Rasanen, V.J.P.B. 1933. Contributions to the lichen flora of North America. Ann. Missouri Bot. Gard. 20:7–21.

Tavares, I.I. 1987. The taxa of *Usnea* (Lichenes) described by Michaux from eastern North America. Mycotaxon 30:39–68.

NOMENCLATURE AND TYPIFICATION IN THE GENUS *USNEA* (LICHENIZED ASCOMYCETES)— III. *USNEA ALATA* & *USNEA SULCATA*

James C. Lendemer

Botany Department
The Academy of Natural Sciences of Philadelphia
1900 Benjamin Franklin Pky.
Philadelphia, Pennsylvania 19103, U.S.A.
lendemer@acnatsci.org

Isabelle I. Tavares

University Herbarium
University of California
1001 VLSB #2465
Berkeley, California 94720-2465, U.S.A.

ABSTRACT

This paper, the third in a series presenting cases of confusion of nomenclature and typification in the genus *Usnea*, discusses two names of pendent, apotheciate, angulose *Usnea* species from South America. The first, *Usnea alata* Motyka, was not correctly typified by Motyka (1937) at the time of description and is lectotypified here. The second, *Usnea sulcata* Motyka, has been misapplied due to a lectotypification that is in conflict with the protologue; the species is thus re-lectotypified here. A lectotype is also selected for the name *U. angulata* f. *ferruginea* Krempelhuber, which is considered a synonym of *U. sulcata* var. *sulcata*.

RESUMEN

Este artículo, el tercero de una serie que presenta casos de confusión en la nomenclatura y tipificación en el género *Usnea*, discute dos nombres de especies de *Usnea* colgantes, con apotecios, angulosas de Sur América. El primero, *Usnea alata* Motyka, no fue tipificado correctamente por Motyka (1937) en el momento de su descripción y se lectotipifica aquí. El segundo, *Usnea sulcata* Motyka, ha sido mal aplicado debido a una lectotipificación que está en conflicto con el protólogo; La especie es pues re-lectotipificada aquí. También se selecciona un lectotipo para el nombre *U. angulata* f. *ferruginea* Krempelhuber, que es considerado un sinónimo de *U. sulcata* var. *sulcata*.

I. **Usnea alata** Motyka

Usnea alata Motyka is one of the pendent, angulose, apotheciate species of *Usnea* known to occur in South America. Though Motyka (1937) clearly intended a specimen in the Vainio herbarium (TUR) to serve as the type, no specimen annotated as the type by him has been located there. As noted by Alava (1986) there are in fact two specimens matching the collection data given in the protologue. One of these specimens (TUR-VAINIO #000492) represents a collection not distributed in Vainio's *Lichenes Brasiliensis Exsiccati* and the other (TUR-VAINIO #00493) is a duplicate of *Lichenes Brasiliensis Exsiccati* #395. Since Motyka did not indicate if he intended the exsiccati collection to serve as the type there is no way to conclude with certainty which of these two specimens Motyka might have regarded as the type. Thus, we have chosen to lectotypify the species using the specimen distributed in Vainio's exsiccati instead of simply assuming its status as the holotype. It should be noted that Her-

SIDA 21(2): 643–650. 2004

rera-Campos et al. (1998) did not effectively lectotypify *U. alata* when they stated "TYPE: BRAZIL, Minas Geraës, *Chequeira, 1885* (TUR holotype)..." because a single specimen was not cited and two specimens are present in Vainio's herbarium.

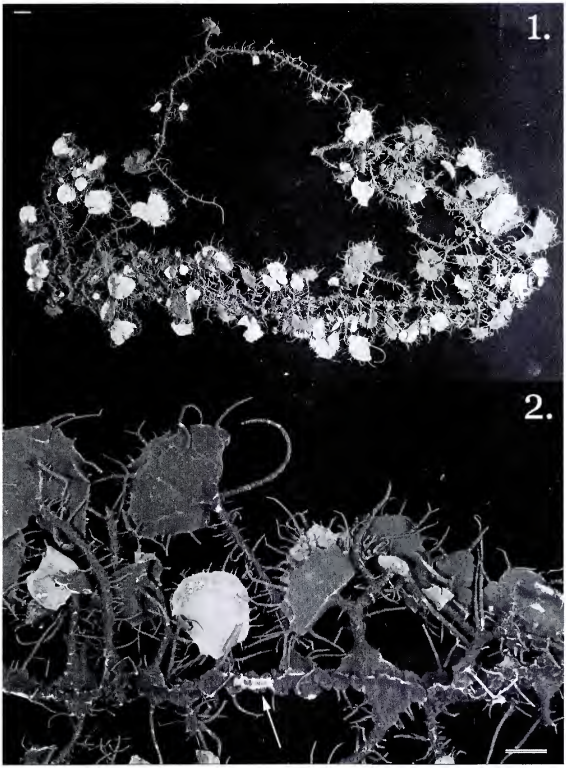
The specimen here selected as the lectotype agrees well with Motyka's protologue and all duplicates of this collection reviewed by the first author are conspecific with the specimen selected as the lectotype.

Usnea alata Motyka, Lich. gen. Usnea 2(1):395–396. 1937. (**Figs. 1–2**). TYPE: BRAZIL. MINAS GERAES: Chequeira, in arbore, 1885, *Vainio s.n. = Lichenes Brasiliensis Exsiccati #395* (LECTOTYPE, here designated: TUR! (Vainio Herbarium #00493); ISOLECTOTYPE: S!

Though *U. alata* was considered a distinct taxon by Herrera-Campos et al. (1998) it seems likely that some authors would consider it conspecific with *U. sulcata* Motyka (as redefined here). These two taxa differ in a number of respects, however, including the type of angulation of the branches, structure and shape of the fibrils, size of the apothecia, and overall appearance. Furthermore, much confusion has apparently resulted from the fact that Motyka changed his interpretation of *U. alata* prior to the publication of the monograph and after he annotated most of the specimens cited therein. That Motyka re-interpreted *U. alata* shortly before its publication is evidenced by the fact that many specimens in S that were annotated by Motyka as *U. alata* or "*U. angulata* var. *alata*" were cited by him as paratypes of *U. sulcata* var. *neutra* Motyka. Indeed, these specimens are not referable to *U. alata* in the sense of the type because they possess apothecia that are generally smaller than those of the type, the branches are angulose (having parallel ridges or sharp foveae) instead of alate, the fibrils are long, slender, regular, and abundant, and the chemistry of the type of *U. alata* apparently differs from that of *U. sulcata* var. *neutra*. (Incidentally, Motyka (1937) reported the type of *U. alata* to have a KOH- medulla; however as reported by Herrera-Campos et al. (1998) the type actually contains norstictic and connorstictic acids.) It is tempting to consider the possibility that *U. alata* represents the non-sorediate, fertile counterpart to *U. paradoxa* Motyka (as defined by Lendemer & Tavares 2003).

II. **Usnea sulcata** Motyka

While the first author was working with *U. angulata* Acharius, a number of problems in typification and taxonomy were encountered involving taxa recently placed in synonymy with *U. angulata* by other authors (Awasthi 1986; Herrera-Campos et al. 1998; Ohmura 2001). One such synonym is *U. sulcata* Motyka. Motyka (1937) described *U. sulcata* without the mention of soralia and with the description of small pruinose apothecia. As Tavares (2002) has noted, this taxon (originally described as apotheciate) was lectotypified with a soraliate specimen that lacked apothecia and the species was then placed in synonymy with *U. angulata* (Awasthi 1986). *Usnea angulata* in our opinion is a



Figs. 1–2. *Usnea alata*. **Fig. 1.** Lectotype thallus. **Fig. 2.** Detail of lectotype: strongly alate branch with "winged" secondary branch attachments; arrow indicates cut through branch showing internal anatomy. Scale bar = 0.5 cm.

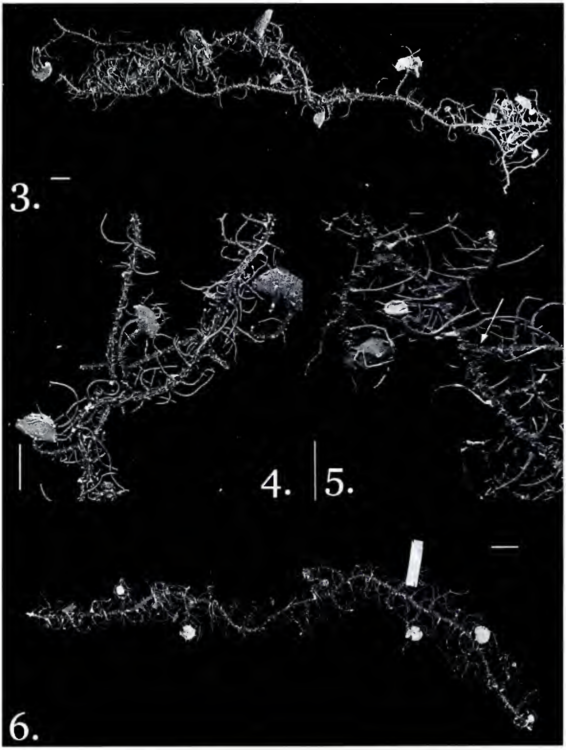
soraliate species from eastern North America and northern Mexico. Apparently these names were placed into synonymy because the lectotype selected by Awasthi (1986) is densely soraliate (not apotheciate) and thus superficially similar to *U. angulata*. All later workers with the exception of Tavares (2002) have continued to include *U. sulcata* as a synonym of *U. angulata*.

Motyka's designation of the type specimen of *U. sulcata* was simply "Typus in Museo Botan. Univ. Fennicae in Turku.—Locus classicus: Brasilia, Minas Geraës, Sitio, 1885 Vainio." As noted by Tavares (2002) there are four specimens in TUR-VAIN matching this description, one of which (TUR-VAIN 00450) was selected by Awasthi as the lectotype. One of us (JCL) has examined all four of these specimens; three of the four thalli are soraliate and thus not suitable candidates for lectotypification. A fourth thallus, though not soraliate, is small, poorly developed, and lacking apothecia. This fourth specimen is a possible candidate for lectotypification (since it does not possess soralia); however, it is too poorly developed to allow positive identification as *U. sulcata* and does not possess apothecia, a feature Motyka described in the protologue. It would seem, therefore, that none of the specimens in TUR-VAIN matching Motyka's published data are ideal for lectotypification. It should be noted that Vainio (1890) stated that all of the specimens of "*U. angulata*" from Sitio were sterile. Interestingly, though the specimens at Turku that were collected at Sitio are not apotheciate, all of the other specimens we have examined that Motyka cited in the protologue are either apotheciate, pycnidial, or lack both apothecia and pycnidia but are not soraliate. Likewise, with the exception of the specimens distributed by Vainio in his *Lichenes Brasilienses Exsiccati*, all of the exsiccati specimens (that we have examined) cited by Motyka in the protologue also are either apotheciate or pycnidial. There is, however, a specimen in Motyka's herbarium (now at LBL) labeled as having come from Sitio that is apotheciate and it is this specimen that we select as the lectotype.

The comparisons Motyka (1937) made between *U. sulcata* and other taxa also serve to confirm that the lectotype selected by Awasthi conflicts with the published diagnosis. Motyka contrasted *U. sulcata* with *U. paradoxa* Motyka, a soraliate taxon (see Lendemer & Tavares 2003) and placed in synonymy with *U. sulcata* a previously described form and a variety of *U. angulata* (*U. angulata* forma *ferruginea* Krphb. and *U. angulata* var. *rubiginosa* Hillmann), both of which are based on apotheciate specimens. Unfortunately, the type material of *U. angulata* var. *rubiginosa* Hillmann was destroyed during World War II and thus is not available for study. It is retained here as a questionable synonym.

Usnea sulcata Motyka var. **sulcata**, Lich. gen. Usnea 2(1):478–480. 1937. (**Figs. 5–6**). TYPE: BRAZIL: MINAS GERAES: Sitio, 1885, *Vainio s.n.* (LECTOTYPE, here designated: LBL! #300.7 (fragment figured here).

= *Usnea angulata* Acharius forma *ferruginea* Krempelhuber, Flora 61(28):437. 1878. TYPE: *Lorentz & Hieronymus s.n.* (LECTOTYPE, here designated: M!; ISOLECTOTYPE: UC!).



Figs. 3–6. *Usnea sulcata* var. *neutra*. **Fig. 3.** Lectotype thallus. **Fig. 4.** Detail of lectotype: angulose branch. *Usnea sulcata* var. *sulcata*. **Fig. 5.** Detail of lectotype: arrow indicates papillate "winged" secondary branch attachment. **Fig. 6.** Lectotype thallus. Scale bar = 0.5 cm.

(?) = *Usnea angulata* Acharius var. *rubiginosa* Hillmann, Repert. Spec. Nov. Regni Veg. 27(16–25):291. 1930. TYPE: BRAZIL. *Sellow* s.n. (HOLOTYPE: B, destroyed).

The lectotype packet (LBL 300.7.) of *U. sulcata* contains fragments of several thalli, four of which possess apothecia. The fragment selected here as the lectotype contains norstictic, caperatic, and connorstictic acids by TLC (R.C. Harris, pers. comm.) and thus is chemically similar to the type of *U. alata* Motyka. It is important to note that the lectotype selected here differs in appearance from the soraliate specimen previously selected as the lectotype (by Awasthi 1986) and possibly does not represent part of the same gathering.

Since we have shown here that *U. sulcata* Motyka is in fact an apotheciate species from South America the previously accepted synonymy with *U. angulata* Acharius should be rejected. *Usnea angulata* f. *ferruginea* Krempelhuber was described without the designation of a type; thus here we have chosen to select the specimen in Krempelhuber's herbarium (M) as the lectotype. It should be noted that the red coloration which Krempelhuber's epithet suggests is not actually a pigmentation of the cortex such as that seen in *U. michauxii* I.I. Tavares or *U. pensylvanica* Motyka but instead is simply a discoloration of the entire collection. No other collection with similar discoloration has been seen by us.

Motyka (1937) also described *U. sulcata* var. *neutra* Motyka on the basis of its medulla having a negative KOH reaction. Later, Rizzini (1952) elevated this taxon to specific rank. Subsequent authors have not discussed this taxon; when re-evaluating the status of the other apotheciate angulose taxa in South America it became clear that *U. sulcata* var. *neutra* was also in need of revision. The type specimen was indicated by Motyka (1937) to be in his personal herbarium (now at LBL); however no such specimen was located in a loan of specimens from LBL of the apotheciate angulose taxa discussed here. Furthermore, it was also clear that there exists much confusion in the use of this name because prior to publishing the name *U. sulcata* var. *neutra* Motyka included specimens later cited as paratypes of *U. sulcata* var. *neutra* in his concept of *U. alata* Motyka. In order to affix the usage of the name *U. sulcata* var. *neutra* to a specimen, we have chosen to lectotypify the name with one of three specimens from S matching the data given in Motyka's protologue. All of these specimens differ chemically from the type *U. sulcata* var. *sulcata* (see below).

Usnea sulcata Motyka var. **neutra** Motyka, Lich. gen. Usnea 2(1):480–481. 1937. (**Figs. 3–4**). *Usnea neutra* (Motyka) Rizzini, Revista Brasil Biol., 12(4):page #. 1952. TYPE: BRAZIL. MINAS GERAES: Ciade de Caldas, 1879. *Regnell s.n.* (LECTOTYPE, designated here: S! #L160 (apotheciate fragment figured here).

Of the specimens lent to the first author from S, three specimens matched the data given in Motyka's protologue for the type of *U. sulcata* var. *neutra* Motyka. Only the specimen selected here as the lectotype was actually identified as *U.*

sulcata var. *neutra* (R. Santesson, undated annotation) and marked "TYPUS" (not in Motyka's hand). It is important to note, however, that at present we do not consider *U. alata* and *U. sulcata* var. *neutra* to be synonyms because they differ both chemically and morphologically. We also prefer to retain *U. sulcata* var. *neutra* as distinct from *U. sulcata* var. *sulcata* because the type specimens of the two taxa also differ on chemical and morphological grounds. (The lectotype of *U. sulcata* var. *neutra* contains the stictic acid complex in addition to usnic and norstictic acids whereas the lectotypes (selected here) of *U. alata* and *U. sulcata* var. *sulcata* lack the stictic acid complex.) As noted above, Rizzini (1952) elevated Motyka's epithet to specific rank; we however choose to follow Motyka's original placement pending further study. It should be noted that *U. sulcata* var. *neutra* Motyka is not synonymous with *U. angulata* var. *neutra* Motyka ex Räsänen, a soraliate taxon. The latter name will be treated in a future publication (Lendemer in prep.).

ACKNOWLEDGMENTS

We wish to thank Orvo Vitikainen (H) for providing data associated with the lectotype of *U. angulata* as well as Paul Silva (UC) for providing nomenclatural advice; also, we thank Soili Stenroos (TUR) for providing access to the Vainio specimens from Sitio, and Jan Bystrek (LBL) for locating the material from Motyka's herbarium. Also, we wish to thank James Macklin (PH) and Richard Moe (UC) for reviewing drafts of the manuscript, the curators of B, LBL, M, and TUR, for loaning material to the first author, and R.C. Harris for performing TLC on several of the specimens cited here.

REFERENCES

Alava, R. 1986. Edvard August Vainio's journey to Brazil in 1885 and his Lichenes Brasilienses exsiccati. Publ. Herbarium, Univ. Turku 1:1–174.

Awasthi, G. 1986. Lichen genus *Usnea* in India. J. Hattori Bot. Lab. 61:333–421.

Greuter, W., J. McNeill, F.R. Barrie, H.M. Burdet, V. Demoulin, T.D. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth (eds.). 2000. International code of botanical nomenclature (St. Louis Code) Adopted by the Sixteenth International Botanical Congress St. Louis, July–August 1999. Koeltz, Königstein.

Herrera-Campos, M.A., P. Clerc, and T.H. Nash III. 1998. Pendulous species of *Usnea* from the temperate forests of Mexico. Bryologist 101:303–329.

Hillmann, J. 1930. Einige bemerkungen über die roten Usneen. Repert. Spec. Nov. Regni Veg. 27(16–25):287–291.

Krempelhuber, A. 1878. Lichenes, collecti in republica Argentina a Doctoribus Lorentz et Hieronymus, determinati et descripti a Doct. A. de Krempelhuber, Monacoensi. Flora 61(28):432–439.

Lendemer, J.C. in. prep. A revision of the pendent angulose species of the genus *Usnea* in the Americas.

Lendemer, J.C. and I.I. Tavares. 2003. Nomenclature and typification in the genus *Usnea* (Lichenized Ascomycetes) II.: *Usnea paradoxa* and *Usnea fallax*. Proc. Acad. Nat. Sci. Philadelphia 153:181–185.

Motyka, J. 1937. Lichenum generis *Usnea* studium monographicum. Pars Systematica 2(1):305–560.

Ohmura, Y. 2001. Taxonomic study of the genus *Usnea* (lichenized Ascomycetes) in Japan and Taiwan. J. Hattori Bot. Lab. 90:1–96.

Rizzini, C.T. 1952. Species Organenses generis lichenum Usneae. (Omnes acidum usnicum praebentes). Revista Brasil. Biol. 12:337–348.

Tavares, I.I. 2002. Notes on lectotypification of *Usnea fulvoreagens*, *U. gigantea*, *U. sulcata*, and *U. cavernosa*. Constancea 83: (http://ucjeps.berkeley.edu/constancea/83/tavares/usnea.html)

Vainio, E.A. 1890. Étude sur la classification naturelle et la morphologie des lichens du Bresil. Acta Soc. Fauna Fl. Fenn. 7:1–247.

RESURRECTION OF A LITTLE-KNOWN SPECIES OF *OENOTHERA* SECT. *OENOTHERA* IN NORTHEASTERN MEXICO (TRIBE ONAGREAE: ONAGRACEAE)

Warren L. Wagner

Department of Botany, MRC-166
P.O. Box 37012
Smithsonian Institution
Washington, DC (District of Columbia) 20013-7012, U.S.A.
wagnerw@si.edu

ABSTRACT

Oenothera pennellii Munz (*Oenothera* sect. *Oenothera* subsect. *Nutantigemma*) was recently placed in synonymy with the widespread and variable *O. pubescens* Willd. ex Spreng. A series of recent collections from Coahuila, Nuevo León, Tamaulipas, and Zacatecas, México, show that *O. pennellii* is a distinctive, subacaulescent, apparently perennial species restricted to northeastern Mexico at relatively high elevations. It is largely allopatric from the widespread, caulescent, annual or biennial *O. pubescens*. Like *O. pubescens*, *O. pennellii* is a permanent translocation heterozygote species

Key Words: *Oenothera* sect. *Oenothera* subsect. *Nutantigemma*, evening-primrose, Mexico, Onagraceae

RESUMEN

Oenothera pennellii Munz (perteneciente a *Oenothera* subsect. *Nutantigemma*) fue colocada recientemente en la sinonimia de *O. pubescens* Willd. ex Spreng., una especie muy variable y de amplia distribución. Las colecciones procedentes de Coahuila, Nuevo León, Tamaulipas, y Zacatecas en México, muestran que *O. pennellii* es una especie distinguible por su hábito sub-acaulescente y que aparentemente está restringida al noreste de México en elevaciones relativamente altas, donde es ampliamente alopátrica con *O. pubescens*, especie caulescente, anual y de amplia distribución.

Oenothera pennellii Munz was described in 1939 and was maintained in Munz's treatment of all North American Onagraceae (1965). Following detailed studies of subsect. *Raimannia*, Dietrich and Wagner (1988) placed *O. pennellii* in synonymy with the widespread and variable *O. pubescens* Willd. ex Spreng. They considered it a rare (five known collections) but noteworthy variant among several in *O. pubescens* (Dietrich & Wagner 1988: 77). Subsequent to that study, many new specimens have been collected in high-elevation areas (2,000–3,600 m) in the northeastern Mexican states of Coahuila, Nuevo León, Tamaulipas, and Zacatecas; most of these collections are deposited at TEX/LL. What previously seemed a sporadic variant now appears to represent a distinguishable species restricted to northeastern Mexico at relatively high elevations, and largely allopatric from *O. pubescens*, which ranges from Arizona and New Mexico to Guatemala, and in South America in the Andes of Colombia, Ecuador, and Peru. The geographical ranges of the two species overlap only in Sierra del Carmen in Coahuila, but the single collection of *O. pubescens* from there was made several hundred meters lower than the lowest known populations of *O. pennellii*.

Oenothera pennellii characteristically has small flowers (petals 6–8 mm long) and is subacaulescent, with stems 0–2(–4) cm long. In contrast, *O. pubescens* usually has petals (6–)15–25(–35) mm long and is always caulescent with conspicuous stems up to 100 cm long, even in adverse moisture regimes. *Oenothera pubescens* never flowers from the basal rosette but has flowers formed in the leaf axils near the tips of the stems, as is typical in the genus. It is also annual or biennial, whereas *O. pennellii* appears to be a short-lived perennial from an enlarged taproot. On this basis I am here resurrecting this regional endemic to species status. Like *O. pubescens*, *O. pennellii* is a permanent translocation heterozygote (PTH) species. Pollen fertility is about 50% judging from several collections (*McDonald 2064*, *Hinton 18858*, *20452*) examined. Permanent translocation heterozygosity has been very important in the evolution of the genus *Oenothera* and several other genera of the Onagraceae. The metacentric chromosomes with pycnotic, condensed proximal regions (Kurabayashi et al. 1962; Cleland 1972; Raven 1979) have been associated with the regular occurrence of rings of chromosomes, resulting from reciprocal translocations. The phenomenon of reciprocal translocations reaches an endpoint of development in the specialized system known as PTH. The best known species possessing this system are the members of *Oenothera* subsect. *Oenothera*, in which the structure and mechanisms were worked out (Cleland 1972; Harte 1994; Deitrich et al. 1997). In addition to the translocations, the system requires balanced lethals, which prevent the formation of the homozygous combinations (most easily observed as ca. 50% infertile pollen), self-pollination, and alternate disjunction of the chromosomes during meiosis.

Oenothera pennellii Munz, Leafl. W. Bot. 2:156, 157. 1939. (**Fig. 1**). TYPE: MEXICO. NUEVO LEON: Sierra Madre Oriental, Mt. "El Infiernillo," Pablillo, SE of Galeana, 2,750–2,900 m, 29 Jun 1934, *F.W. Pennell 17139* (HOLOTYPE: US-01640419, ISOTYPE: PH not seen, POM).

Acaulescent or subacaulescent, short-lived perennial herb from fairly stout taproot; stems occasionally present, 1–4 cm long. Rosette and cauline leaves 2–6(–10) × 0.2–1.5 cm long, oblong-lanceolate, sinuate-pinnatifid to occasionally remotely serrate on smaller leaves, strigillose and hirtellous, especially on the veins. Flowers axillary, arising among the basal leaves or on the short stems. Floral tube 17–30 mm long, nodding prior to anthesis, reddish purple, sparsely hirtellous, the hairs appressed or spreading, and occasionally also strigillose. Sepals reflexed in pairs at anthesis, 5–6 mm long, oblong-lanceolate, pubescent, free tips ca. 0.2 mm long. Petals 6–8 mm long, about as broad, yellow, changing to reddish orange when wilted, slightly notched apically with short tooth in

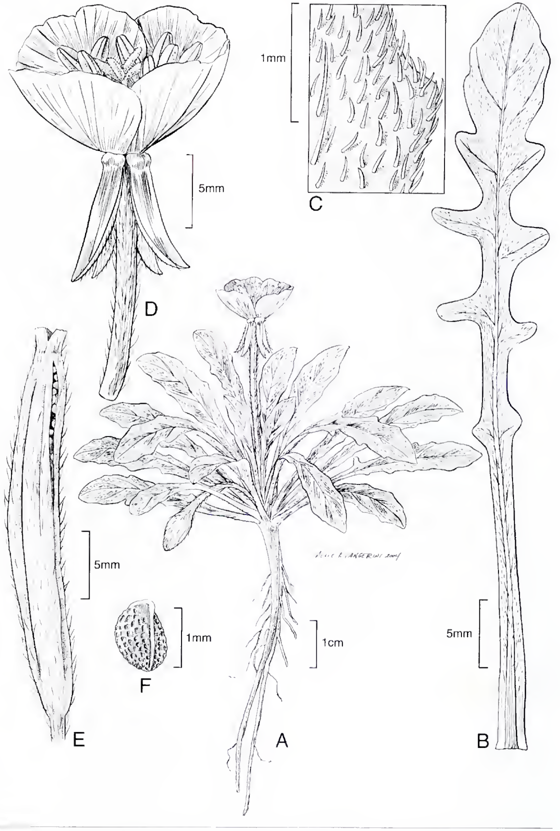


Fig. 1. *Oenothera pennellii.* **A.** Habit (*Hinton et al. 20452* & *Wendt & Adamcewicz 523C*), unopened bud (*Pennell 17139*, holotype). **B.** Leaf (*Pennell 17139*, holotype). **C.** Inset showing pubescence (*Hinton et al. 20452*). **D.** Flower with part of floral tube, but not ovary (*Hinton et al. 18858*). **E.** Capsule (*Pennell 17139*, holotype). **F.** Seed (*Pennell 17139*, holotype).

notch. Staminal filaments 6–7 mm long, subequal; anthers 2–3.2 mm long; pollen ca. 50% fertile. Style 20–35 mm long; stigma surrounded by the shedding anthers at anthesis, the lobes ca. 1.5 mm long. Capsules 16–28 mm long, cylindrical, thin-walled, sessile, hirtellous and strigillose, ca. 3 mm in diameter. Seeds 1–1.2 mm long, light brown, globose-obovoid, with median ridge and shallowly regularly pitted surface.

Distribution.—*Oenothera pennellii* occurs in open areas in mixed conifer (*Pinus, Pseudotsuga, Abies*) and *Quercus* forests and in subalpine *Pinus* forest, Coahuila, Nuevo León, Tamaulipas, and Zacatecas, Mexico, from 2,000 to 3,600 m. Flowering from May through September.

Specimens Examined: **MEXICO. Coahuila:** Madera del Carmen, upper end of Dos Canyon, at road fork to Campo Uno, 23 Jun 1976, *Fryxell 2715* (LL, NY); Sierra Madera del Carmen, at Campo El Tres, an abandoned logging camp in the high country, [29°00' N, 102°36' W], 7 Aug 1974, *Wendt & Adamcewicz 523C* (TEX); Ocampo, along old logging road, of mill at Campo 4 adjacent to sawdust pile, [28°59' N, 102°33' W], 28 May 1975, *Riskind & Patterson 1826* (LL); Sierra de Parras, *Purpus 4624* (UC); Arteaga, Sierra Zapaliname, 27 Jun 1990, *Hinton et al. 20452* (TEX); Sierra del Coahuila, 2 Jun 1985 *Hinton et al. 18858* (TEX); Sierra del Arteaga, Canon de la Carbonera, Las Vigas, [25°20' N, 100°39' W], s.d., *Villarreal & Carranza 3776* (TEX). **Nuevo León:** Picacho de San Onofre, ladera este, 5 Jul 1985, *McDonald 1662* (TEX). **Tamaulipas:** filo y lado este de Peña Nevada, 5 Jul 1985, *McDonald 1630* (TEX); Miquihuana, Sierra de Peña Nevada, ceja y ladera S y SO [23° 35' N, 99° 46' W], 3600 m, 22 Aug 1986, *McDonald 2064* (MO, TEX [2]). **Zacatecas:** Sierra Madre Oriental, Mt. "El Temoroso," N of Aranzazu, 17 Jul 1934, *Pennell 17466* (US).

The five collections cited by Dietrich and Wagner (1988) as the low-growing phenotype are a mix of short-stemmed *Oenothera pubescens* and *O. pennellii*. Three of the collections represent *O. pennellii* and are cited above. The collection from Sierra del Carmen, Coahuila (*Henrickson 11643* [MO]), is *O. pubescens* but was collected in a heavily grazed area and thus had very short stems. Cultivated material of this collection at MO has stems up to 30 cm long and is atypical of *O. pubescens* only in having flowers much smaller than usual (petals ca. 6 mm). Another collection (*Moore 3157* from Hidalgo, MO) also is *O. pubescens* and occurs well outside the range of *O. pennellii*.

The substrate for *Oenothera pennellii* is largely unknown. *Wendt & Adamcewicz 523C* give the substrate as rhyolite, and *Pennell 17466* gives it as gravelly andesite, both volcanics. With the information available it is not possible to ascertain if *O. pennellii* is restricted to volcanic substrates; however, Guy Nesom (pers. comm.) indicates that the type locality is gypseous. Since limestone is very common throughout this region it should be looked for on this substrate as well.

ACKNOWLEDGMENTS

I thank Tom Wendt for calling my attention to the large number of recent collections in TEX of Onagraceae, particularly *Oenothera*, which allowed me to appreciate the distinctions between *O. pubescens* and *O. pennellii*. I thank Alice

Tangerini for her excellent illustration and Denise Mix for assistance with the collections and comments on the draft manuscript. I also appreciate the reviews by Peter Hoch and Guy Nesom, which improved the clarity and information content of the paper.

REFERENCES

Cleland, R.E. 1972. *Oenothera* cytogenetics and evolution. London: Academic Press.

Dietrich, W. and W.L. Wagner. 1988. Systematics of *Oenothera* section *Oenothera* subsection *Raimannia* and subsection *Nutantigemma* (Onagraceae). Syst. Bot. Monogr. 24:1–91.

Dietrich, W., W.L. Wagner, and P.H. Raven. 1997. Systematics of *Oenothera* sect. *Oenothera* subsect. *Oenothera* (Onagraceae). Syst. Bot. Monogr. 50:1–234.

Harte, C. 1994. *Oenothera*: Contributions of a plant to biology. Monographs on Theortical and Applied Genetics vol. 20. Berlin: Springer-Verlag.

Kurabayashi, M., H. Lewis, and P.H. Raven. 1962. A comparative study of mitosis in the Onagraceae. Amer. J. Bot. 49:1003–1026.

Munz, P.A. 1939. Interesting western plants IV. Leafl. W. Bot. 2:156–158.

Munz, P.A. 1965. Onagraceae. N. Amer. Fl. II. 5:1–278.

Raven, P.H. 1979. A survey of reproductive biology in Onagraceae. New Zealand J. Bot. 17:575–593.

BOOK NOTICES

Books from the Hunt Institute for Botanical Documentation

Gavin D.R. Bridson, James J. White, and Lugene B. Bruno. 2003. **American Botanical Prints of Two Centuries.** (ISBN 0-913196-75-4, pbk.) Hunt Institute of Botanical Documentation, 5th Floor, Hunt Library, Carnegie Mellon University, Pittsburgh, PA 15213, U.S.A. (Orders: 412-268-2434; 412-268-5677 fax; email: huntinst@andrew.cmu.edu; huntbot.andrew.cmu.edu). $25.00, 239 pp., 114 figs (106 color). Pictorial stiff paper cover, 8" × 10 1/2".

Two centuries of botanical prints is a wide range to cover in so short a book, but this task is managed quite well in *American Botanical Prints of Two Centuries.* Starting with the 19th century, the authors take us through a period of utilitarian prints designed for the sole purpose of botanical research. We see the evolution of the botanical print as one of necessity to one of art.

As technology improved, artists were free to elaborate and put their own personal touch on a piece. Starting with the 20th century, we begin to see the effects of light and color. We see more stylized works, things we would want to hang on the wall.

American Botanical Prints of Two Centuries is laid out very well. There is no table of contents, but there is a very well-organized catalogue of prints including biographical information on the artists on pages 150–195.

It is impossible to merely glance at the prints displayed in this book. Every picture is a work of art, even the utilitarian prints. Who knew a cluster of walnuts could be so enjoyable and beautiful to look at!—*Abra Alexander, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Gavin D.R. Bridson (Compiler), Scarlett T. Townsend, Elizabeth A. Polen, and Elizabeth R. Smith (eds.). 2004. **BPH-2. Periodicals with Botanical Content: Constituting a Second Edition of Botanico-Periodicum Huntianum (Volume 1 A–M, Volume 2 N–Z).** (ISBN 0-913196-78-9, pbk.) Hunt Institute of Botanical Documentation, 5th Floor, Hunt Library, Carnegie Mellon University, Pittsburgh, PA 15213, U.S.A. (Orders: 412-268-2434; 412-268-5677 fax; email: huntinst@andrew.cmu.edu; huntbot.andrew.cmu.edu). $130.00 (2 vol. set), 1470 pp., 8 1/2" × 11".

Congratulations to the team at the Hunt Institute of Botanical Documentation for a second edition of *Botanico-Periodicum-Huntianum* or *BPH-2*. From an editor who has already used the second edition, here is a big thank you for an incredible job. The first edition of BPH was published in 1968 and recorded periodicals published down to the end of 1967. In 1991, *B-P-H/S* (*Botanico-Periodicum-Huntianum/Supplementum*) was published. With *B-P-H/S*, the number of titles jumped to over 25,000 from the 12,000 recorded in the first edition. Now the new edition adds even more titles bringing the total to over 33,000, about 21,000 additional titles since 1967. "*BPH-2* is a fairly, but not wholly, comprehensive listing by title of periodicals from 1665 to 2000 that regularly contain (or, in some period of their history, included) articles dealing with the plant sciences, their history and bibliography." Good job thou good and faithful servants!—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

TAXONOMY OF *HYMENOXYS* SUBGENUS *MACDOUGALIA* (ASTERACEAE: HELENIEAE: TETRANEURINAE)

Mark W. Bierner

School of Biological Sciences and Plant Resources Center
The University of Texas
1 University Station, C0930
Austin, Texas 78712, U.S.A.
Bierner@mail.utexas.edu

ABSTRACT

A taxonomic treatment is presented for *Hymenoxys* subg. *Macdougalia*, which includes a single species, *Hymenoxys bigelovii*. The treatment includes a discussion of the original circumscription of *Hymenoxys bigelovii* (as *Actinella bigelovii*), the later description of the genus *Macdougalia* to accommodate this taxon, and the eventual placement, based on chemical, cytological, and morphological evidence, of *Macdougalia* within *Hymenoxys* as a monotypic subgenus. The treatment also includes synonymies of *Hymenoxys* subg. *Macdougalia* and *Hymenoxys bigelovii*, lectotypification of *Actinella bigelovii*, and a description and range map for *Hymenoxys bigelovii*.

RESUMEN

Se presenta un tratamiento taxonómico de *Hymenoxys* subg. *Macdougalia*, que incluye una sola especie, *Hymenoxys bigelovii*. El tratamiento incluye una discusión de la circunscripción original de *H. bigelovii* (como *Actinella bigelovii*), la descripción del género *Macdougalia* para acomodar este taxon, y la colocación eventual, basada en pruebas químicas, citológicas, y morfológicas, de *Macdougalia* en *Hymenoxys* como un subgénero monotípico. El tratamiento incluye también sinonimias de *Hymenoxys* subg. *Macdougalia* y *Hymenoxys bigelovii*, lectotipificación de *Actinella bigelovii*, y una descripción y mapa de distribución de *Hymenoxys bigelovii*.

Hymenoxys Cass. subg. *Macdougalia* (A. Heller) Bierner comprises only one species, *Hymenoxys bigelovii* (A. Gray) K.L. Parker. This taxon was originally described as *Actinella bigelovii* A. Gray, *Actinella* Pers. being the generic name commonly used at that time (e.g., Torrey & Gray 1842) for taxa now placed in *Tetraneuris* Greene and *Hymenoxys*. When describing *Actinella bigelovii*, Gray (1853) made no comments that would indicate any hesitation on his part as to its placement in *Actinella*.

Later (1883), when Gray positioned *Actinella bigelovii* in *Actinella* section *Hymenoxys*, he commented, "Connects [section] *Hymenoxys* with [section] *Euactinella*, and with section *Dugaldea* [sic] of *Helenium*." This statement indicates to me that Gray may not have been completely comfortable with his placement of this taxon. His section *Hymenoxys* equates today with *Hymenoxys* subg. *Hymenoxys*, *Hymenoxys* subg. *Phileozera* (Buckley) Cockerell (in part), and *Hymenoxys* subg. *Picradenia* (Hook.) Cockerell (Bierner 2001), his section *Euactinella* equates today with *Tetraneuris*, *Hymenoxys* subg. *Phileozera* (in part), and *Hymenoxys* subg. *Rydbergia* (Greene) Bierner (Bierner 2001; Bierner & Turner 2003), and his section *Dugaldea* [sic] of *Helenium* equates today with *Hymenoxys* subg. *Dugaldia* (Cass.) Bierner (Bierner 2001).

Heller (1898) seems to have been even less sure about its placement, as indicated by his comment, "In habit it is more like the genus *Tetraneuris*, but has a different involucre, and while its involucre is somewhat similar to that of the genus *Picradenia* [= *Hymenoxys* subg. *Picradenia*], there is a wide difference in habit." His solution was to describe the genus *Macdougalia* to accommodate this one taxon, a circumscription followed by Cockerell (1904), Rydberg (1915), and Robinson (1981). Other workers, such as Turner and Powell (1977) and Karis and Ryding (1994), felt there was no clear basis for maintaining *Macdougalia* as a separate genus and submerged it in *Hymenoxys*.

Spring et al. (1994) began their study of chemical components of glandular trichomes in *Hymenoxys* and related genera by recognizing *Macdougalia* as a genus separate from *Hymenoxys*. By the end of the study they were of the opinion, based on sesquiterpene lactone and monoterpene glycoside chemistry, that *Macdougalia* should be incorporated into a broader concept of *Hymenoxys*. Likewise, Bierner and Jansen (1998), who began their study of DNA restriction site variation in *Hymenoxys* and related genera recognizing *Macdougalia* as a distinct genus, concluded that it is in fact congeneric with *Hymenoxys*. The relationship of *Macdougalia* to *Hymenoxys* is further supported by similarities of flavonoid chemistry (e.g., Wagner et al. 1972) and chromosome number, $2n = 30$ being the chromosome number of *H. bigelovii* (Speese & Baldwin 1952; Strother 1966; Bierner unpublished and Parker & McClintock unpublished—see representative specimens) and the predominant number among the diverse taxa of *Hymenoxys* (e.g., Speese & Baldwin 1952; Beaman & Turner 1962; Strother 1966; Sanderson 1973; Turner et al. 1973). In 2001, Bierner formally recognized *Macdougalia* as a subgenus of *Hymenoxys*.

While Spring et al. (1994) were confident about the association of *Macdougalia* with *Hymenoxys*, they were less sure about its relationship to other taxa within *Hymenoxys*. The phenogram prepared from sesquiterpene lactone data placed *H. bigelovii* (as *Macdougalia bigelovii*) closest to *H. hoopesii* of subg. *Dugaldia* and *H. rusbyi* of subg. *Picradenia*. The strict consensus tree prepared by Bierner and Jansen (1998) placed *H. bigelovii* (as *Macdougalia bigelovii*) in the clade containing taxa of *Hymenoxys* subg. *Dugaldia*, *Hymenoxys* subg. *Picradenia*, and *Hymenoxys* subg. *Plummera*, but no clear association with any species in particular was apparent.

Morphology also supports the placement of *Macdougalia* in *Hymenoxys*. The stems, peduncles, receptacles, ray florets, and disc florets of *Hymenoxys bigelovii* are very similar to those of the *Hymenoxys* species in general. Conversely, a substantial number of morphological differences support the recognition of *Macdougalia* as a subgenus.

Hymenoxys bigelovii usually has all simple leaves that are eglandular or sparsely glandular. Among the other taxa of *Hymenoxys*, only *H. hoopesii* has all simple leaves, and only *H. texana* has leaves that are weakly to moderately glandular (all of the other taxa have distinctly glandular leaves).

As in essentially all of the perennial taxa of *Hymenoxys* (and *Tetraneuris* as well), the basal leaf bases of *H. bigelovii* are persistent and tend to thicken the caudices distally as the plants age. The basal leaves of *H. bigelovii*, however, decay down to the veins so that the tops of the caudices usually appear to be encased in a stringy cocoon. I have observed this decay to the veins occasionally in other taxa of *Hymenoxys*, but it is unusual and never creates the appearance of a stringy cocoon.

The phyllaries of *Hymenoxys bigelovii* are in two unequal series, as they are in most of the taxa of *Hymenoxys* (those of subg. *Dugaldia* and subg. *Rydbergia* are in two or three subequal series). The outer phyllaries of *H. bigelovii* are basally connate only slightly to 1/5 their lengths; the outer phyllaries of the other *Hymenoxys* taxa with two unequal series (except for *H. texana*) are basally connate 1/4 to 2/3 their lengths. The inner phyllaries of *H. bigelovii* are narrowly lanceolate to narrowly obovate, have aristate apices, and very distinctly exceed the outer in length; inner phyllaries of the other *Hymenoxys* taxa with two unequal series are usually obovate, have acuminate to usually mucronate apices, and surpass the outer in length only slightly or not at all.

The relationship of *Hymenoxys bigelovii* to other taxa of *Hymenoxys* remains unclear. Its relatively large involucres (13–20 mm high by 23–32 mm wide) might suggest a connection to *H. hoopesii*, *H. brandegeei*, or *H. grandiflora*, but the phyllaries are very different. Perhaps a clue rests with some unusual populations of *H. richardsonii* var. *richardsonii* from Fremont County, Wyoming (e.g., *Fisser 661* and *699* [RM], and *Dorn 3516* [NY, RM]). The phyllaries look so much like those of *H. bigelovii* that I was convinced when I first saw the specimens that these plants represented an undescribed species belonging to subgenus *Macdougalia*, even though the plants had divided leaves (blades are only rarely divided into three segments in *H. bigelovii*) and were well separated geographically from *H. bigelovii*. When I was able to see them in the field, however, it was obvious that they are indeed plants of *H. richardsonii* var. *richardsonii*, but with narrower, longer, aristate inner phyllaries. Yet, this illustrated to me that it is not a long morphologic leap from the involucres of *H. bigelovii* to those of some other *Hymenoxys* species.

TAXONOMY

Hymenoxys subg. **Macdougalia** (A. Heller) Bierner, Lundellia 4:39. 2001. *Macdougalia* A. Heller, Bull. Torrey Bot. Club 25:629. 1898. Type Species: *Actinella bigelovii* A. Gray, Pl. Wright. 2:96. 1853. (= *Hymenoxys bigelovii*)

Hymenoxys bigelovii (A. Gray) K.L. Parker, Madroño 10:159. 1950. Basionym: *Actinella* *bigelovii* A. Gray, Pl. Wright. 2:96. 1853. TYPE: U.S.A. NEW MEXICO. Grant or Sierra Co.: "Copper Mines - on the mountains" (lectotype label), 17 Apr 1852, *Bigelow s.n.* (LECTOTYPE [per previous annotations] here designated: GH!; PROBABLE ISOLECTOTYPES: NY!, US-27506!, US-27507!, US-27508!). The following notation in the protologue, "On mountains near the copper mines, and near the Mimbres, New Mexico; April, June," indicates that Gray was looking at more than one Bigelow collection when he wrote the description. Furthermore, the type sheet at GH contains three Bigelow specimens, one with the notation "Copper Mines" (far right), another with the notation "Near the Mimbres June 1852" (center), and another with the notation "Copper Mines - on the mountains, April 17. 1852." (far left). The specimen to the far left was already annotated as the lectotype when I borrowed it (no name or date on the label), and I likewise annotated it as the lectotype. I did so because there is no doubt at all that Gray was using this specimen; it is the only plant on the sheet that has cauline leaves that are divided into three segments, and the original description includes, "...foliis angustissime linearibus rigidis integerrimis paucisve caulinis trilobis..." In addition, collection information beneath the specimen includes, "*Actinella Bigelovii*, n. sp. (Pl. Wr.)." The lectotype bears no collection number; specimens at NY and US that appear to be part of the type collection bear the number 637. = *Actinea bigelovii* [as *Bigelowii*] (A. Gray) Kuntze, Rev. Gen. Pl. 1:303. 1891. = *Macdougalia bigelovii* (A. Gray) A. Heller, Bull. Torrey Bot. Club 25:629. 1898. = *Actinea bigelovii* (A. Gray) A. Nelson, Univ. Wyoming Publ. Sci., Bot. 1:139. 1926, nom. superflu.

Actinea gaillardia A. Nelson, Univ. Wyoming Publ. Sci., Bot. 1:140. 1926. TYPE: U.S.A. ARIZONA. Coconino Co.: "Rocky hillsides, among Yellow Pine Flagstaff Ariz." (holotype label), 2 Jun 1922, *Hanson 32* (HOLOTYPE: RM-100733!; PROBABLE ISOTYPE: MO-895987!).

Polycarpic perennials. Caudices sparingly branched, thickened distally, usually encased in a stringy cocoon-like covering formed by the veins of the decaying leaf bases. Aerial stems 1–5, erect, usually unbranched distally, green throughout to purple-red-tinted distally to purple-red-tinted throughout, 20–70 cm, sparsely to densely pubescent, often tomentose proximally, eglandular or sparsely dotted with sessile glands. Leaves basal and cauline, alternate, linear to linear-lanceolate to linear-oblanceolate, simple and entire or blades rarely divided into three segments, glabrous or sparsely to densely pubescent, eglandular or sparsely dotted with impressed glands; basal leaf bases expanded, clasping, persistent, sparsely to densely long-villous-woolly. Heads 1–5 per plant, usually borne singly but sometimes in paniculiform arrays. Peduncles (1.5–)6–20(–29) cm, expanded apically, moderately to densely pubescent, densely tomentose distally beneath the involucres, sparsely to moderately dotted with sessile glands. Involucres hemispheric to broadly campanulate, 13–20 × 23–32 mm. Phyllaries in 2 series; outer phyllaries 13–19, basally connate only slightly to 1/5 their lengths, green throughout or yellow to yellow-green proximally and green distally, often purple-red tinted on the margins, lanceolate to narrowly lanceolate or obovate to narrowly obovate, 7–11 × 1.3–2.8 mm, weakly to moderately keeled, apices acute to acuminate, abaxial faces sparsely to densely pubescent, sparsely to moderately dotted with sessile and impressed glands, adaxial faces glabrous or sparsely pubescent, eglandular or sparsely dotted with sessile glands; inner phyllaries 13–18, free, bodies yellow to yellow-green and scale-like, usually green distally, often purple-red tinted at the apices, narrowly

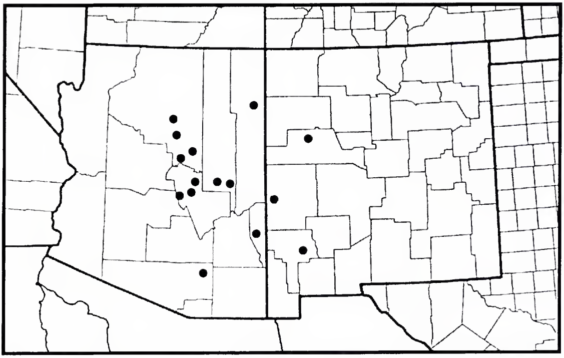


Fig. 1. Known distribution of *Hymenoxys bigelovii*.

lanceolate to narrowly obovate, 8.5–12.6 × (1.1–)1.5–2.2 mm, distinctly surpassing the outer, not keeled or weakly to moderately keeled, apices aristate, abaxial faces glabrous or sparsely pubescent, eglandular, adaxial faces glabrous, eglandular. Ray florets 13–15, pistillate, fertile; corollas yellow, extending well beyond the phyllaries, 13–26 × 5.4–9.5 mm, lobes 3, abaxial faces glabrous or sparsely pubescent, eglandular, adaxial faces glabrous, eglandular. Disc florets 100–250+, bisexual, fertile; corollas yellow, cylindric to cylindric campanulate, 5.7–7.4 × 0.7–0.9 mm, lobes 5, glabrous or sparsely pubescent, eglandular. Receptacles hemispheric to globoid to ovoid, paleae none. Cypselae narrowly obpyramidal, 4.2–4.7 × 0.9–1.2 mm, densely pubescent with straight, forked, antrorse hairs, eglandular; pappi 9–11(–15), obovate- to oblanceolate-aristate, 4.7–7.3 × 0.7–1.3 mm. Chromosome number, $2n = 30$.

Flowering and Distribution.—Flowering May to June. Roadsides, edges of juniper-pine and pine forests, 1375–2470 m. Central to eastern Arizona and western New Mexico (Fig. 1).

Representative specimens examined. **UNITED STATES. ARIZONA. Apache Co.:** 7 mi N of hwy 264 on rd to Sawmill, 24 Jun 1965, *Strother 402* (TEX). **Coconino Co.:** Hwy 89, ca 13 mi N of IH 40 (jct in Flagstaff) at turnoff to Sunset Crater National Monument, 20 May 1989, *Bierner 89-25* (ARIZ, TEX); 7 mi NE of Strawberry, 29 May 1966, *Lehto 6311* (ASU); 26 mi E of Strawberry, $2n = 30$, 16 Jun 1947, *Parker & McClintock 6851* (ARIZ); ca 10 mi S of Flagstaff on hwy 79, 14 Jun 1965, *Strother 339* (TEX). **Gila Co.:** Barnhart Pass, Mazatzal Mts, 15 May 1935, *Collom 299* (ARIZ); 20 mi SW of Young, Sierra Ancha Mts, 1 May 1947, *Parker 531* (ARIZ); 5 mi N of Young, Pleasant Valley, 14 Jun 1947, *Parker & McClintock 6692* (ARIZ, TEX). **Greenlee Co.:** 20 mi N of Clifton, 7 Jun 1935, *Maguire* et al. *11865* (ARIZ).

Navajo Co.: Hwy 60, 12.8 mi SW of hwy 260 (jct in Show Low), $2n = 15\text{II}$, 19 May 1988, *Bierner 88-54* (ARIZ, TEX); Lakeside, White Mts, 9 Jun 1928, *Harrison 5467* (ARIZ, LL). **Pima Co.:** 3 mi up Mt. Lemmon Rd past entrance sign to Coronado Forest, 31 May 1967, *Mears 1663b* (TEX). **NEW MEXICO. Catron Co.:** just W of Luna, 23 Jun 1965, *Strother 394* (TEX). **Cibola Co.:** Near Bluewater Canyon Dam, 12 mi S of Bluewater, 20 May 1936, *Parker & Parker 3481* (ARIZ); **Grant Co.:** near Santa Rita Copper Mines (Santa Rita del Cobre), 22 mi E of Silver City, 18 May 1936, *Parker & Parker 3452* (ARIZ).

Note.—More than 70 specimens were examined for this treatment. Those listed above were chosen as representative of the geographic distribution and morphologic variation of *Hymenoxys bigelovii*.

ACKNOWLEDGMENTS

I am grateful to the following institutions for loans of specimens: ARIZ, ASU, LL, NY, RM, TEX. I also thank John Strother for his help with the description of *Hymenoxys bigelovii* and José Panero for his help with preparation of the Spanish abstract. Guy L. Nesom and A. Michael Powell provided helpful review comments.

REFERENCES

Beaman, J.H. and B.L. Turner. 1962. Chromosome numbers in Mexican and Guatemalan Compositae. Rhodora 64:271–276.

Bierner, M.W. 2001. Taxonomy of *Hymenoxys* subgenus *Picradenia* and a conspectus of the subgenera of *Hymenoxys* (Asteraceae: Helenieae: Tetraneurinae). Lundellia 4:37–63.

Bierner, M.W. and R.K. Jansen. 1998. Systematic implications of DNA restriction site variation in *Hymenoxys* and *Tetraneuris* (Asteraceae, Helenieae, Gaillardiinae). Lundellia 1:17–26.

Bierner, M.W. and B.L. Turner. 2003. Taxonomy of *Tetraneuris* (Asteraceae: Helenieae: Tetraneurinae). Lundellia 6:44–96.

Cockerell, T.D.A. 1904. The North American species of *Hymenoxys*. Bull. Torrey Bot. Club 31:461–509.

Gray, A. 1853. Plantae Wrightianae Texano-Neo-Mexicanae: an account of a collection of plants made by Charles Wright, A.M., in an expedition from Texas to New Mexico, in the summer and autumn of 1849, with critical notices and characters of other new and interesting plants from adjacent regions, &c. 2:96. Smithsonian Institution, Washington.

Gray, A. 1883. I. Contributions to North American botany. I. Characters of new Compositae, with revisions of certain genera, and critical notes. Proc. Amer. Acad. Arts 18:1–73.

Heller, A.A. 1898. New and interesting plants from western North America.–IV. Bull. Torrey Bot. Club 25:626–629.

Karis, P.O. and O. Ryding. 1994. Tribe Helenieae. In: K. Bremer, ed. Asteraceae: cladistics & classification. Timber Press, Portland, Oregon. Pp. 521–558.

Robinson, H. 1981. A revision of the tribal and subtribal limits of the Heliantheae (Asteraceae). Smithsonian Contr. Bot. 51:1–102.

Rydberg, P.A. 1915. *Macdougalia*. North American Flora 34:109–110. The New York Botanical Garden, New York.

Sanderson, S.C. 1973. In: IOPB chromosome number reports XL. Taxon 22:285–291.

Speese, B.M. and J.T. Baldwin. 1952. Chromosomes of *Hymenoxys*. Amer. J. Bot. 39:685–688.

Spring, O., B. Zitterell-Haid, M.W. Bierner, and T.J. Mabry. 1994. Chemistry of glandular trichomes in *Hymenoxys* and related genera. Biochem. Syst. Ecol. 22:171–195.

Strother, J.L. 1966. Chromosome numbers in *Hymenoxys* (Compositae). Southw. Naturalist 11:223–227.

Torrey, J. and A. Gray. 1842. A flora of North America: containing abridged descriptions of all the known indigenous and naturalized plants growing north of Mexico; arranged according to the natural system. 2(2):381–383. Wiley & Putnam, New York.

Turner, B.L. and A.M. Powell. 1977. Helenieae–systematic review. In: V.H. Heywood, J.B. Harborne, and B.L. Turner, eds. The biology and chemistry of the Compositae. Academic Press, London. Pp. 699–737.

Turner, B.L., A.M. Powell, and T.J. Watson. 1973. Chromosome numbers in Mexican Asteraceae. Amer. J. Bot. 60:592–596.

Wagner, H., M.A. Iyengar, L. Horhammer, and W. Herz. 1972. Flavonol-3-glycosides in eight *Hymenoxys* species. Phytochemistry 11:3087–3088.

BOOK NOTICE

David J. Wishart. 2004. **Encyclopedia of the Great Plains.** (ISBN 0-8032-4787-7, hbk.). The University of Nebraska Press, P.O. Box 84555, Lincoln, NE 68501-4555, U.S.A. (Orders: 402-472-3584, Fax: 402-472-6214, www.unp.unl.edu) $75.00, 919 pp., b/w photos, 8 1/2" × 11".

Publisher Comments: "The Great Plains is a vast expanse of grasslands stretching from the Rocky Mountains to the Missouri River and from the Rio Grande to the coniferous forests of Canada—an area more than eighteen hundred miles from north to south and more than five hundred miles from east to west. The Great Plains region includes all or parts of Texas, New Mexico, Oklahoma, Kansas, Colorado, Nebraska, Wyoming, South Dakota, North Dakota, Montana, Alberta, Saskatchewan, and Manitoba. The region, once labeled "the Great American Desert," is now more often called the "heartland," or, sometimes, "the breadbasket of the world." Its immense distances, flowing grasslands, sparse population, enveloping horizons, and dominating sky convey a sense of expansiveness, even emptiness or loneliness, a reaction to too much space and one's own meager presence in it."

"With 1,316 entries contributed by more than one thousand scholars, this groundbreaking reference work captures what is vital and interesting about the Great Plains-from its temperamental climate to its images and icons, its historical character, its folklore, and its politics. Thoroughly illustrated, annotated, indexed, this remarkable compendium of information and analysis will prove the definitive and indispensable resource on the Great Plains for many years to come."

What an impressive book this is. The 27 chapters range from African Americans to Water with each chapter being introduced with a major essay or synthesis of the topic. I explored the index to see what was listed under "Cotton." There is a nice summary of Cotton (*Gossypium hirsutum*) and an impressive b/w photo of a Cotton field in West Texas. I looked up to see what information was available on the flora and there is a relatively short entry, yet a nice summary, provided under the Chapter, *Physical Environment*. "More than 2,900 species of vascular plants from some 730 genera in 159 families grow in the Great Plains." The author of this entry cites none other than the *Flora of the Great Plains* (1986).—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

ERIGERON PEREGRINUS AND *ERIGERON GLACIALIS* (ASTERACEAE: ASTEREAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.
gnesom@brit.org

ABSTRACT

Erigeron glacialis (Nutt.) A. Nels. (= *E. callianthemus* Greene) is recognized as a species separate from *E. peregrinus* (Banks ex Pursh) Greene. It has most recently been treated as *E. peregrinus* subsp. *callianthemus*. Intermediates between *E. glacialis* and *E. peregrinus* do occur but the two species are mostly distinct even where in close contact in Washington and British Columbia; intermediates are uncommon or absent as *E. glacialis* at the western edge of its range is contiguous or perhaps intermittently sympatric with *E. peregrinus* northward into Alaska. **Erigeron glacialis** var. **hirsutus** (Cronq.) Nesom, comb. nov., is proposed in order to complete the alternate taxonomy. If Cronquist's recognition of two subspecies within *E. peregrinus* is to be followed, the name *E. peregrinus* subsp. *callianthemus* (1943) is incorrect, the precedent for a name at that rank set by *E. salsuginosus* subsp. *angustifolius* (1906).

RESUMEN

Erigeron glacialis (Nutt.) A. Nels. (= *E. callianthemus* Greene) se reconoce como una especie diferente de *E. peregrinus* (Banks ex Pursh) Greene. Ha sido tratada recientemente como *E. peregrinus* subsp *callianthemus*. Se encuentran intermedios entre *E. glacialis* y *E. peregrinus* pero las dos especies son muy distintas incluso cuando están en contacto en Washington y en Columbia Británica; los intermedios son raros o ausentes ya que *E. glacialis* en el límite Oeste de su área vive contiguo o quizás intermitentemente simpátrico con *E. peregrinus* hacia el Norte hasta Alaska. Se propone **Erigeron glacialis** var. **hirsutus** (Cronq.) Nesom, comb. nov., para completar la taxonomía alternativa. Si se sigue el reconocimiento de Cronquist de dos subespecies en *E. peregrinus*, el nombre *E. peregrinus* subsp. *callianthemus* (1943) es incorrecto, el precedente de un nombre en ese rango está establecido por *E. salsuginosus* subsp. *angustifolius* (1906).

A taxon previously known as *Erigeron salsuginosus* (Richards. ex R. Br.) A. Gray was united by Cronquist (1943) at subspecific rank with *E. peregrinus* (Banks ex Pursh) Greene. Cronquist observed that *Erigeron* (*Aster*) *glacialis* (Nutt.) A. Nels. is the oldest name at specific rank to replace the misapplied *E. salsuginosus* but that the type of *E. callianthemus* Greene is more representative of the taxon, thus he used the latter for the name at subspecific rank (see nomenclatural summary below). He later (1947) recognized several varieties within each subspecies.

Erigeron peregrinus subsp. *callianthemus* is widely distributed in the mountains of the western U.S.A. and southwestern Canada, while *E. peregrinus* subsp. *peregrinus* occurs in coastal and near coastal habitats from southern Alaska to the northwestern conterminous U.S.A. Their ranges are largely dis-

SIDA 21(2): 665–672. 2004

tinct (Fig. 1) but the occurrence of intermediates in Washington and British Columbia suggested to Cronquist (1947) that the two taxa were best treated within a single species, a taxonomic arrangement that has since been followed in accounts of North American *Erigeron*. Douglas et al. (1998, p. 252) also noted that the subspecies "intergrade" where ranges overlap. My observation, in contrast, is that intermediates do occur but that even where they overlap or are in close contact in Washington and British Columbia, populations of 'good' subsp. *peregrinus* (without signs of intermediacy) and 'good' subsp. *callianthemus* are more common.

The distribution of subsp. *peregrinus* runs from the Kamchatka area of the Russian Far East (Commander Islands: Botschantzev 1959; Czerepanov 1995) across the Aleutian Islands, southern-central Alaska, southwestern Yukon, and southward along the Alaskan-British Columbian archipelago into western Washington and northwest Oregon (Fig. 1; more detailed maps in Hultén 1950, 1968; Cody 2000). From the Yukon region, it trails southward in a relatively thin line along the Pacific; as noted by Douglas et al. (1998), it is "common in and west of the Coast-Cascade Mountains, rare east of the Coast-Cascade Mountains." Calder and Taylor (1968, p. 533) observed that in the Queen Charlotte Islands "a few collections [of subsp. *peregrinus* sensu stricto] show a tendency towards ssp. *callianthemus* as the involucral bracts are not conspicuously villous and tend to be slightly glandular."

Subspecies *callianthemus* is widely distributed and relatively abundant in montane regions throughout the western U.S.A. as well as in southwestern Alberta and British Columbia. At the western edge of its range from British Columbia northward into Alaska, it is contiguous and perhaps intermittently sympatric with subsp. *peregrinus*. Subsp. *callianthemus* is absent from the Queen Charlotte Islands (Calder & Taylor 1968) and absent or rare in other insular portions of the Alaskan-British Columbian archipelago. It is rare in southwestern Yukon and southeastern Alaska, apparently growing within the range of subsp. *peregrinus*. Scoggan (1979) recorded subsp. *peregrinus* for Alberta, but this probably is based on plants such as *Breitung 16978* (BRIT) from Waterton Lakes National Park, which have phyllaries stipitate-glandular and also sparsely villosulous on the proximal half, "determined by A. Cronquist" as *E. peregrinus* subsp. *callianthemus* var. *scaposus*. Typical subsp. *callianthemus* is the common form in the same region.

In the U.S.A., subsp. *peregrinus* occurs in Whatcom, Skagit, Snohomish, King, and Pacific counties, Washington, and Clatsop Co., Oregon. *Erigeron peregrinus* var. *thompsonii* occurs in Grays Harbor Co., Washington. Typical subsp. *callianthemus* is known from Whatcom, Snohomish, and King counties, and it also occurs in Clallam and Jefferson counties of the Olympic peninsula, Washington, immediately north of Grays Harbor Co. In Oregon, it occurs in Tillamook Co., immediately south of Clatsop Co.

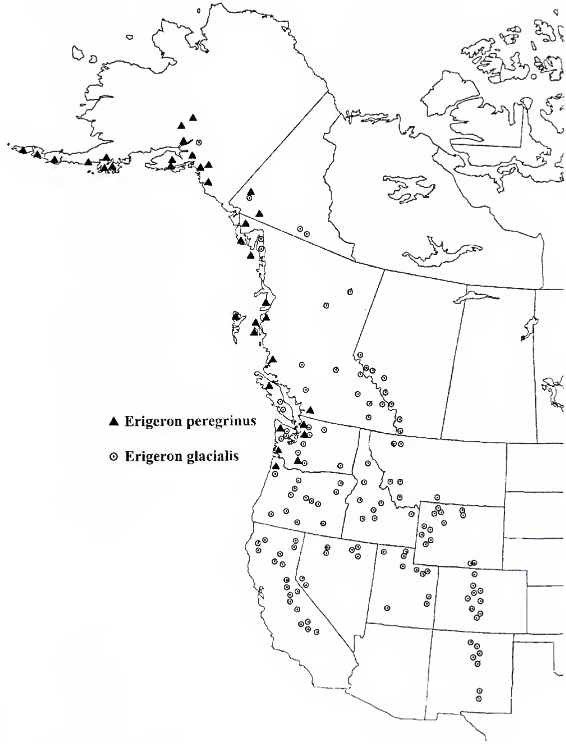


Fig. 1. Summary distribution of *Erigeron peregrinus* and *E. glacialis*. The distribution of *E. peregrinus* continues westward along the Aleutian Islands and into the Kamchatka region.

In the view here, subsp. *peregrinus* and subsp. *callianthemus* are reasonably treated as separate species, *E. peregrinus* and *E. glacialis*, apparently occasionally hybridizing but not intergrading in a sense that would imply the existence of a zone of intermediacy reflecting continuous gene exchange. The two species can be identified by the following morphological contrasts.

Phyllaries eglandular or sparsely sessile-glandular at the apices, rarely sparsely glandular over the surface, sparsely to moderately villous-hirsute on surfaces, margins usually ciliate ______ **Erigeron peregrinus**

Phyllaries densely and evenly stipitate-glandular, without other hairs or rarely sparsely villous on surfaces and margins of outer phyllaries ______ **Erigeron glacialis**

Cronquist (1955) noted other distinctions of *E. peregrinus* (vs. *E. glacialis*): leaves often toothed (vs. usually entire), often soft-pubescent (vs. usually glabrous), peduncular hairs rather loose (vs. close), but these are less diagnostic.

Choice of specific over infraspecific rank in this case emphasizes three factors:

(1) Reproductive isolation, although incomplete, apparently exists between *E. glacialis* and *E. peregrinus*, as noted above.

(2) The distinction between *E. glacialis* and *E. peregrinus* is analogous to that between other closely related species of *Erigeron*, where relatively small but consistent and conspicuous differences in vestiture are significant (e.g., *E. compactus-E. consimilis*; *E. ursinus-E. gracilis*; *E. caespitosus-E. abajoensis*; *E. tracyi* (*E. colomexicanus*)-*E. flagellaris*; *E. engelmannii-E. pumilus*; and *E. flettii-E. algidus-E. simplex/grandiflorus*).

(3) *Erigeron glacialis* may be as closely related to *E. howellii* (A. Gray) A. Gray as to *E. peregrinus*. These three species form a morphological unit and apparently are more closely related among themselves than to any other species. *Erigeron howellii*, which is essentially endemic to an area along the Columbia River in Oregon and Washington, differs from *E. glacialis* in its distally strigillose but otherwise glabrous stems (vs. stems strigillose, more densely so distally), more consistently spatulate basal and lower cauline leaves (vs. leaves linear-oblanceolate to broadly lanceolate or spatulate), consistently white rays (vs. rays blue to rose-purple or pink, less commonly white to pale blue), and habitats mostly at lower elevation. *Erigeron howellii* and *E. glacialis* are nearly identical in involucral vestiture, and a reasonable hypothesis is that the narrow endemic and *E. glacialis* are sister species. This is not intended as a "cladistic argument" for recognition of *E. glacialis* at specific rank, and it is clear that *E. glacialis* is more strongly differerentiated from *E. howellii* than from *E. peregrinus*, but it adds a line of evidence for consideration in this admittedly subjective decision concerning choice of rank.

Erigeron peregrinus (Banks ex Pursh) Greene, Pittonia 3:166. 1897. *Aster peregrinus* Banks ex Pursh, Fl. Amer. Septent. 2:556. 1814. TYPE: U.S.A. ALASKA. Unalaschka, *D. Nelson* s.*n*. (HOLOTYPE: BM).

Phyllaries moderately to densely hirsute to villous-hirsute on the surfaces, margins ciliate; ray corollas purplish to pink or white; upland habitats_________ **Erigeron peregrinus** var. **peregrinus**

Phyllaries very sparsely villous-hirsute to glabrous on the surfaces, margins ciliate; ray corollas white; sphagnum bogs _________________ **Erigeron peregrinus** var. **thompsonii**

Erigeron peregrinus (Banks ex Pursh) Greene var. **peregrinus**

Erigeron unalaschkensis Less., Linnaea 6:122. 1831.
Erigeron peregrinus (Banks ex Pursh) Greene var. *dawsonii* Greene, Pittonia 3:166. 1897.

Erigeron peregrinus var. *dawsonii* was described from the Queen Charlotte Islands, where var. *peregrinus* is abundant. Calder and Taylor (1968) did not recognize var. *dawsonii*, noting that populational variants include plants of both varieties and numerous intermediates.

Cronquist (1955, p. 188) noted that "A phase of ssp. *peregrinus*, resembling var. *peregrinus* but perhaps properly to be segregated, occurs on Saddle Mt. in Clatsop Co., Oreg." Chambers (pers. comm.) observes that these plants "combine the genetic traits of *glacialis* and *peregrinus*," with villous hairs most abundant on the outer phyllaries, dense glandular indument on the inner phyllaries. They are perhaps "best interpreted as derived from a history of gene exchange between *E. peregrinus* and *E. glacialis*, along with segregation and recombination of the genes affecting the principal morphological differences in pubescence. 'Good' *peregrinus* has not yet been found in this part of the state, but 'good' *glacialis* is present nearby."

Erigeron peregrinus (Banks ex Pursh) Greene var. **thompsonii** (Blake ex J.W. Thompson) Cronquist, Brittonia 6:144. 1947. *Erigeron thompsonii* Blake ex J.W. Thompson, Rhodora 34:238. 1932. TYPE: U.S.A. WASHINGTON. GRAYS HARBOR CO.: open bog near Lake Quinault, 10 Jul 1931, *J.W. Thompson 7336* (HOLOTYPE: US!; ISOTYPES: GH!, K, MO!, UC). From details and wording of the protologue and description, it seems clear that Blake wrote both; he was not credited by Thompson, however, other than being cited as sole author of the name and the authorhip must be attributed to Thompson as "ex" rather than "in."

Cronquist (1947, p. 148) observed that var. *thompsonii* "is in a sense intermediate between [*E. glacialis* and *E. peregrinus*] and intergrades both ways." The taxonomic status and evolutionary relationships of this taxon, which is endemic to a small area of the Olympic peninsula in western Washington, need to be investigated in more detail.

Erigeron glacialis (Nutt.) A. Nels., Bot. Gaz. 37:270. 1904. *Aster glacialis* Nutt., Trans. Amer. Philos. Soc. n. ser. 7:291. 1840. *Erigeron salsuginosus* (Richards. ex R. Br.) A. Gray var. *glacialis* (Nutt.) A. Gray, Synopt. Fl. N. Amer. 1, pt. 2:209. 1884. TYPE: U.S.A. Nuttall's protologue observed that the habitat of *A. glacialis* was "with the preceding" species, *Aster andinus* Nutt. [=*Symphyotrichum spathulatum* (Lindl.) Nesom], which was noted to have been collected "on the highest summits of the Rocky Mountains, near the line of perpetual snow, in 42°. About ten thousand feet above the level of the sea. Near summit of Thornberg's Ridge, where we made an ineffectual attempt to cross the Northern Andes, in August, still deeply buried in snow." Gray saw the specimen—"Nutt.!" as indicated in Torrey and Gray (1841, p. 155) and later noted (1884, p. 209) "first coll. by Nuttall in Wyoming." According to Graustein (1967), it is likely that Nuttall's group was on or near Hyndman Peak (Blaine Co., Idaho), at the place they called Thornberg's Ridge or Thornberg's Pass on 12–13 Aug 1834, this confirmed by the expedition narrative reproduced in McKelvey (1955). (HOLOTYPE: PH; HOLOTYPE fragment: CAS).

Stems densely strigillose with loosely appressed, slightly crinkled hairs, most densely strigillose close beneath the heads; leaves glabrous to short-villous on both surfaces ____ **Erigeron glacialis** var. **glacialis**

Stems hirsute to hirsute-villous; leaves hirsute to hirsute-villous on both surfaces ____ **Erigeron glacialis** var. **hirsutus**

Erigeron glacialis (Nutt.) A. Nels. var. **glacialis**

Erigeron callianthemus Greene, Leafl. Bot. Observ. Crit. 2:197. 1912. *Erigeron peregrinus* (Banks ex Pursh) Greene subsp. *callianthemus* (Greene) Cronq., Rhodora 45:264. 1943. *Erigeron peregrinus* (Banks ex Pursh) Greene var. *eucallianthemus* Cronq., Brittonia 6:145. 1947. *Erigeron peregrinus* (Banks ex Pursh) Greene var. *callianthemus* (Greene) Cronq., Univ. Wash. Publ. Biol. 17(5):188. 1955 (in clave).

Aster salsuginosus Richards. ex R. Br. var. *angustifolius* A. Gray, Bot. Calif. 1:325. 1876. *Erigeron salsuginosus* (Richards. ex R. Br.) A. Gray var. *angustifolius* (A. Gray) A. Gray, Proc. Amer. Acad. Arts 16:93. 1880. *Erigeron angustifolius* (A. Gray) Rydb., Bull. Torrey Bot. Club 24:295. 1897. *Erigeron salsuginosus* (Richards. ex R. Br.) A. Gray subsp. *angustifolius* (A. Gray) Piper, Contr. U.S. Natl. Herb. 11:565. 1906. *Erigeron peregrinus* (Banks ex Pursh) Greene var. *angustifolius* (A. Gray) Cronq., Brittonia 6:147. 1947.

Aster salsuginosus Richards. ex R. Br. var. *scaposus* Torr. & A. Gray, Fl. N. Amer. 2:503. 1841. *Erigeron peregrinus* (Banks ex Pursh) Greene var. *scaposus* (Torr. & A. Gray) Cronq., Brittonia 6:146. 1947. *Erigeron callianthemus* Greene var. *scaposus* (Torr. & A. Gray) Breitung, Canad. Field-Naturalist 71:69. 1957.

As earlier observed (Nesom 1992, p. 190), within *Erigeron peregrinus* subsp. *callianthemus*, var. *scaposus* and var. *angustifolius* can be recognized apart from var. *callianthemus* "only as arbitrarily distinguished and intergrading populations." Douglas et al. (1998) also noted that the varieties "often grow together and show a continuous variation." Cronquist (1947, p. 148) regarded var. *scaposus* as a "reduced alpine phase" with the dwarfing "probably genetically controlled," but he observed that it "intergrades profusely with var. *eucallianthemus* ... and both are often present in the same collection." Var. *angustifolius*, also, was seen by Cronquist to be strongly intergrading with other expressions of the species.

If *Erigeron glacialis* is maintained at infraspecific rank within *E. peregrinus*, the taxon *E. peregrinus* subsp. *callianthemus* (sensu Cronquist) includes all varietal taxa, but if the widespread entity identified by Cronquist as *E. peregrinus* var. *callianthemus* is interpreted to include either var. *scaposus* or var. *angustifolius* or both, it should be recognized that both latter names at varietal rank have precedence over var. *callianthemus* (var. *scaposus* the oldest). If any of these varieties are to be recognized within *E. glacialis*, the type of *E. glacialis* represents the alpine form treated as var. *scaposus*. In the taxonomic alternative proposed here, all three of these taxa are included within *Erigeron glacialis* var. *glacialis*.

Further complicating the nomenclature is the observation that the earliest name at subspecific rank in this whole complex is *Erigeron salsuginosus* subsp. *angustifolius* (A. Gray) Piper, from 1915, rendering Cronquist's combination in 1943 based on *E. callianthemus* incorrect (superfluous, because it included the type of "subsp. *angustifolius*"). Thus, if one desires to follow Cronquist's concept of recognizing two subspecies within *E. peregrinus*, the one he treated as "subsp. *callianthemus*" requires a new combination, based on Gray's original *Aster salsuginosus* var. *angustifolius*.

Erigeron glacialis (Nutt.) A. Nels. var. **hirsutus** (Cronq.) Nesom, comb. nov. *Erigeron peregrinus* (Banks ex Pursh) Greene var. *hirsutus* Cronq., Brittonia 6:147. 1947. TYPE: U.S.A. CALIFORNIA. [TUOLUMNE CO.]: Yosemite National Park, vicinity of Lake Tenaya, 8300 ft, Jun 1902, *H.M. Hall and E.C. Babcock 3506B* (HOLOTYPE: UC).

Variety *hirsutus* is restricted to the seven southernmost counties in the range of the species in California (Fresno, Inyo, Madera, Mariposa, Mono, Tulare, and Tuolumne cos.) and in Mineral Co., Nevada. I also have seen plants of typical *E. glacialis* and intergrades toward var. *hirsutus* from Mono, Tulare, Fresno, and Inyo cos., but they apparently are less common than those identified as typical var. *hirsutus*.

ACKNOWLEDGMENTS

I thank Bob Kiger for pointing out that *Erigeron peregrinus* var. *callianthus* is not the correct name when it includes var. *scaposus* and var. *angustifolius* (as I have used it in the past). His comments precipitated the presentation of this taxonomic alternative, which I have anticipated for more than a decade. Ken Chambers further pointed out that the name *E. peregrinus* subsp. *callianthemus* is incorrect, as it was preceded at that rank by "subsp. *angustifolius*." Ron Hartman gave advice on geography of the *E. glacialis* type collection, Kanchi Gandhi reviewed aspects of the nomenclature, James Macklin provided information on the type collection at PH, and Ken Chambers reviewed the whole manuscript and arranged a loan of pertinent specimens from OSU. Review comments by David Murray also were very helpful.

REFERENCES

BOTSCHANTZEV, V.P. 1959. *Erigeron*. Flora U.R.S.S. 25:191–288. Translated from Russian, 1999, Smithsonian Institution Libraries, Washington, D.C.

CALDER, J.A. and R.L. TAYLOR. 1968. Flora of the Queen Charlotte Islands. Part 1: Systematics of the vascular plants. Canada Dept. of Agriculture, Monograph No. 4, Part 1. Ottawa, Canada.

CODY, W.J. 2000. Flora of the Yukon Territory (ed. 2). NRC.CNRC, NRC Research Press, Ottawa.

CRONQUIST, A. 1943. The identity of *Aster salsuginosus*. Rhodora 45:262–264.

CRONQUIST, A. 1947. A revision of the North American species of *Erigeron*, north of Mexico. Brittonia 6: 121–302.

CRONQUIST, A. 1955. Vascular plants of the Pacific Northwest, Part 5: Compositae. Univ. of Washington Press, Seattle.

CZEREPANOV, S.K. 1995. Vascular plants of Russia and adjacent states (the former USSR). Cambridge Univ. Press, Cambridge, England.

DOUGLAS, G.W., G.B. STRALEY, D. MEIDINGER, and J. POJAR. 1998. Illustrated flora of British Columbia. Vol. 1, Gymnosperms and Dicotyledons (Aceraceae through Asteraceae). British Columbia Ministry of Environment, Lands and Parks, Ministry of Forests. Victoria, British Columbia.

GRAUSTEIN, J.E. 1967. Thomas Nuttall, naturalist: Explorations in America 1808–1841. Harvard Univ. Press, Cambridge, Mass.

HULTÉN, E. 1950. Flora of Alaska and Yukon. Vol. X. C.W.K. Gleerup, Lund.

HULTÉN, E. 1968. Flora of Alaska and neighboring territories. Stanford Univ. Press, Stanford, California.

MCKELVEY, S.D. 1955. Botanical exploration of the trans-Mississippi West, 1790–1850. Arnold Arboretum of Harvard University, Jamaica Plain, Mass.

NESOM, G.L. 1992. Taxonomic notes on *Erigeron* (Asteraceae: Astereae) of California, Nevada, and Arizona. Phytologia 73:186–202.

SCOGGAN, H.J. 1979. The flora of Canada. Part 4–Dicotyledoneae (Loasaceae to Compositae). Natl. Mus. Nat. Sci. Publ. Bot. No. 7(4).

A NEW SPECIES OF *ERIGERON* (ASTERACEAE: ASTEREAE) FROM NORTHWESTERN CALIFORNIA

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.
gnesom@brit.org

Thomas W. Nelson

4244 Fairway Drive
Eureka, California 95503–6413, U.S.A.

ABSTRACT

Erigeron maniopotamicus G.L. Nesom & T.W. Nelson, sp. nov., a member of the *E. eatonii* alliance, apparently is endemic to east-central Humboldt County and immediately adjacent Trinity County, California. It is sympatric with *E. robustior* but it perhaps is more closely related to *E. eatonii* or *E. lassenianus*.

RESUMEN

Erigeron maniopotamicus G.L. Nesom & T.W. Nelson, sp. nov., un miembro del grupo *E. eatonii*, aparentemente es endémico del Este-centro del condado de Humboldt y el inmediatamente adyacente condado de Trinity, California. Es simpátrico con *E. robustior* pero quizás está más cercanamente relacionado con *E. eatonii* o *E. lassenianus*.

In preparation of a taxonomic treatment of *Erigeron* by Nesom for Flora of North America, three collections (HSC) from Humboldt Co., California, appeared divergent from known taxa of the genus. During a study of the *Erigeron eatonii* A. Gray alliance, Strother (1987, by annotation) identified these collections as "*E. decumbens* var. *robustior* vel aff.," but he did not comment on them in a related publication (Strother & Ferlatte 1988). Nesom (2004) noted that they might represent an undescribed entity. One of the three original HSC collections was made by a coauthor of the current report (Nelson), and in order to investigate their identity, he subsequently made two additional collections of the same entity from the same area. These plants occur within the geographic range of *E. robustior* (Cronq.) Nesom but are morphologically distinct. They are out of the known range of any other species of the *E. eatonii* alliance and are here formally described as a distinct species.

Erigeron maniopotamicus G.L. Nesom & T.W. Nelson, sp. nov. (**Fig. 1**). TYPE: U.S.A. CALIFORNIA. Humboldt Co.: Board Camp Mt., off Forest Service Road 49N38, 1 mi from jct with FS Road 1, T4N, R4E, Sec. 28, UTM 450779 E 438981, small, dry, rocky, open meadow, 4860 ft, 18 Jun 2004, *T.W. Nelson* 9253 and S. Carothers (HOLOTYPE: HSC; ISOTYPES: BRIT, NY, OSC, UC, US).

Differt a *E. robustiore* radicibus palaribus crassioribus, caulibus brevioribus, foliis latioribus, involucris minoribus, et phyllariis elliptici-oblanceolatis vel oblongi-oblanceolatis abrupte acuminatis; differt a *E. eatonii* var. *plantagineo* caudicibus plerumque non ramosis, foliis caulinis non redactis, et

PLANTS OF THE NORTH COAST
RANGES OF CALIFORNIA

Erigeron manipotamicus Nesom & Nelson

Humboldt County. T4N,R4E,Sec. 28.
UTM N 4505779 E 438981. Elev. 4860'.
Board Camp Mountain Road off Forest
Service Road 49N38 1 mile from
junction with Forest Service Road 1.
Dry, rocky, bare beadow.

18 June 2004 9253

Thomas W. Nelson & Sydney Carothers

ISOTYPE OF:
Erigeron manipotamicus Nesom & Nelson

Fig. 1. Habit of *Erigeron maniopotamicus* (isotype, BRIT).

phyllariis elliptici-oblanceolatis vel oblongi-oblanceolatis abrupte acuminatis.

Plants perennial, taprooted (roots [3–]5–8 mm thick); caudex usually simple, rarely with branches to 20 cm long. **Stems** (including peduncles) 2–6(–8), 10–22(–27) cm long, basally ascending to decumbent-ascending, sparsely to densely strigose, eglandular, stems and leaves usually basally purplish. **Leaves** basal and cauline, basal persistent into anthesis, oblanceolate to spatulate-oblanceolate, 3–10 cm long, (3–)5–12(–14) mm wide, strongly to weakly 3-nerved, margins entire, cauline gradually reduced distally or not, usually continuing relatively unreduced to near heads, elliptic-oblanceolate to elliptic-lanceolate, sometimes narrowly lanceolate or oblanceolate, hirsute-pilose to weakly pilose on both surfaces, eglandular. **Heads** 1(–4) on peduncles 0.5–1(–5) cm long, held well beyond leaves at peak anthesis, from branches near midstem or slightly more distal; involucres (5–)6–7 mm high, 9–12(–14) mm wide (pressed), phyllaries in 2–3(–4) equal to subequal series, elliptic-oblanceolate to oblong-oblanceolate, abruptly acuminate, usually each with an orange midnerve, with narrow scarious margins, hirsute-strigose to hirsute-pilose, densely villous at base, eglandular to sparsely glandular. **Ray florets** (16–)21–33, corollas 10–12 mm long, 1.5–2.5 mm wide, laminae white to pinkish or purplish, not coiling (or weakly so) or reflexing. **Disc florets**: corollas 3.2–3.8 mm long, throat not indurate or inflated. **Cypselae** 2–2.5 mm long, 2-nerved, sparsely strigose; pappus of 16–20 bristles 2.5–3 mm long, with a few outer setae ca. 0.1 mm long.

Etymology, habitat, and phenology.—Known only from east-central Humboldt Co. and adjacent Trinity Co., California. The Mad River (whence the epithet) more or less dissects the geographic range of the species. Though the river's name may have been meant to convey the madness (as "angriness") of the torrents and rapids, the epithet here implies that the river is deranged (mad as "crazy"). There apparently is no psychological assessment of the subject, but we like the audile flow of the syllables. Populations of *Erigeron maniopotamicus* occur at elevations of 1350–1500 meters on a tan-colored, rocky, non-serpentine soil sharply distinct from typical regional soils surrounding the sites. The sites are relatively dry and might be described as "barrens" because few other plant species occur there, and they often are bordered by somewhat stunted woods of mixed conifer, mostly Douglas fir. Serpentine outcrops are scattered in the area, especially on ridges, but apparently do not influence the 'erigeron barrens.' Flowering June through August.

Conservation significance.—Because of the limited distribution and few known collections of this species, a more detailed assessment of its distribution and biology would be valuable.

Additional collections examined: **CALIFORNIA. Humboldt Co.:** near Mad River Buttes, Pilot Creek Quad, 40° 42' 15", 123° 44' 41", meadow, 4739 ft, 28 Jun 1980, *Baker 2479* (HSC), *Baker 2499* (HSC); Jack Rabbit Valley, along Swayback Ridge 4-wheel drive road 1 mi S of jct with Forest Service road, Blocksburg Quad, T1N, R5E, NE 1/4 of NW 1/4, Sec. 26, meadow on metasediments, 4900 ft, 10 Jun 1980, *Nelson and Nelson 5395* (HSC); along Swayback Ridge Road, which branches off Forest Service Road 1N08 ca. 1/4 mi past gate, T1N, R5E, Sec. 23, dry open hillside, 4450 ft, 18 Jun 2004, *Nelson 9249* and Carothers (BRIT, HSC, NY, OSC, RM, UC, US); Twin Lakes vicinity, Snow Camp and Twin Lakes trip, with Mr. Murphy, frequent locally in gravelly open places, 26 Jun 1951, *Tracy 19581* (UC 223009, photocopy). **Trinity Co.:** Kitten-Pum [Kettenpom] Valley, 26 Jun 1893, *Blankinship s.n.* (UC 87679, photocopy). [Trinity Co. or Humboldt Co.]: Mad River, 1 Jul 1893, *Blankinship s.n.* (UC 87680, photocopy).

Erigeron maniopotamicus occurs within the range of *E. robustior*, which is known from Humboldt, Trinity, and Mendocino cos. and is recorded as growing in sagebrush-scrub, glades and meadows, and lower montane coniferous forest, sometimes in seeps and sometimes over serpentine, at elevations of (200-)700–1500 meters. In the range of *E. maniopotamicus, E. robustior* is not common—it grows in loamy soil in openings and along edges of moist fir-oak woods and has not been observed in close proximity to *E. maniopotamicus*. No intermediates between *E. maniopotamicus* and *E. robustior* or any other species have been encountered in the present study. Populations of the new species are relatively large (over 200 plants) and are relatively uniform in morphology.

The description of *Erigeron decumbens* subsp. *robustior* Cronq. by Cronquist (1947) (see Nesom 2004 for its treatment at specific rank) probably included measurements of *E. maniopotamicus*, judging from the low ranges of involucral size; one of the specimens that he cited as subsp. *robustior*, *Blankinship s.n.*-UC 87679, is identified here as *E. maniopotamicus*. Our comparisons are primarily drawn from study of collections at NY and HSC. In his review of the present manuscript, John Strother also reviewed collections at UC and sent photocopies of two that are referable to the new species. *Erigeron maniopotamicus* and *E. robustior* are contrasted morphologically in the following couplet.

a. Taproots relatively thick, (3–)5–8 mm wide; stems 10–22(–27) cm long; basal leaves oblanceolate to spatulate-oblanceolate; cauline leaves relatively unreduced to near heads; involucres (5–)6–7 mm high, 9–12 mm wide; phyllaries elliptic-oblanceolate to oblong-oblanceolate, abruptly acuminate ____________ **Erigeron maniopotamicus**

a. Taproots relatively thin, 2–3 mm wide; stems (15–)25–55 cm long; basal leaves linear to very narrowly oblanceolate; cauline leaves usually reduced or none near heads; involucres 6–8.5 mm high, (12–)14–20 mm wide; phyllaries narrowly oblanceolate to lanceolate, acute-acuminate ____________________ **Erigeron robustior**

The *Erigeron eatonii* alliance (sensu Strother & Ferlatte 1988) is recognized by the following set of features: taprooted; caudex branches generally slender, plants not caespitose; stems erect or basally ascending to decumbent, sometimes purplish at the base, proximal internodes not elongate; leaves basal and cauline, linear to oblanceolate, (1–)3-nerved; heads commonly more than one. Distinctions among the taxa often are subtle but discretely defined geographic ranges give confidence that the morphological differences reflect evolutionary differentiation.

Erigeron eatonii comprises a group of contiguous varieties sometimes intergrading at points of contact (see Strother and Ferlatte 1988 for maps). *Erigeron eatonii* var. *villosus* (Cronq.) Cronq. and *E. eatonii* var. *lavandulus* Strother & Ferlatte are exceptions: var. *villosus* occurs north of all other varieties except var. *lavandulus*, which is sympatric with var. *villosus*, and one or both of these probably is justifiably treated at specific rank. *Erigeron canaani* Welsh occurs at the southwestern extreme of the range of *E. eatonii* var. *eatonii* and may be better treated at varietal rank within *E. eatonii*. Among other species of the alliance, *E. jonesii* Cronq. and *E. lassenianus* Greene also occupy essentially allopatric ranges; they are discontinous in morphology from contiguous taxa. The ranges of *E. robustior* and *E. decumbens* are relatively isolated on the western margin the alliance.

There are no sympatric taxa of the *Erigeron eatonii* alliance that appear to have a sister relationship, and the sympatry of *E. maniopotamicus* and *E. robustior* suggests that their relationship also is more distant than "sister." The closest relationship of the new species may be closer to *E. eatonii* itself, perhaps with *E. eatonii* var. *plantagineus* (Greene) Cronq., which is the segment of the species geographically closest to *E. maniopotamicus*. The closest approach of var. *plantagineus* to *E. maniopotamicus* is in the northeast corner of Siskyou Co. and Shasta Co. (Strother & Ferlatte 1988). The two taxa are similar in sizes of involucres, florets, and cypselae but differ conspicuously in habit, particularly in features of caudex and size and distribution of cauline leaves. *Erigeron maniopotamicus* might be treated at varietal rank within *E. eatonii*, but the nature of its relationship there would be ambiguous, and it is morphologically and geographically disjunct from var. *plantagineus*. The leafy stems of *E. maniopotamicus* are more like those of *E. lassenianus* (which approaches the range of *E. maniopotamicus* in northeastern Trinity Co. and Tehama Co.), and it is possible that *E. maniopotamicus* has genetic elements from that species and from *E. eatonii*. In any case, the choice here of taxonomic rank for *E. maniopotamicus* is admittedly somewhat arbitrary. Morphological contrasts between *E. maniopotamicus* and *E. eatonii* var. *plantagineus* are provided in the following couplet.

a. Caudex branches commonly present, usually slender; cauline leaves usually strongly reduced in size from the basal, absent or reduced near heads; phyllaries narrowly lanceolate to narrowly oblanceolate, apically acute; pappus bristles 6–12 ____ **Erigeron eatonii** var. **plantagineus**

a. Caudex usually unbranched; cauline leaves usually continuing relatively unreduced to near heads; phyllaries elliptic-oblanceolate to oblong-oblanceolate, apically abruptly acuminate; pappus bristles 16–20 ____ **Erigeron maniopotamicus**

To place *Erigeron maniopotamicus* in a broader perspective, the following key distinguishes all of the California taxa of the *E. eatonii* alliance.

1. Involucres 6–10.5 mm high, (12–)14–23 mm wide; phyllaries eglandular.
    2. Involucres 6–8.5 mm high, (12–)14–20 mm wide; disc corollas 3.5–4.5 mm long; cypselae (1.8–)2–3.2 mm long ____ **Erigeron robustior**
    2. Involucres 7–10.5 mm high, (14–)17–23 mm wide; disc corollas 4.4–6.8 mm long; cypselae 4–4.5 mm long ____ **Erigeron eatonii** var. **nevadincola**
1. Involucres 4.2–5.6(–7) mm high, 6–12(–14) mm wide; phyllaries glandular or eglandular.
    3. Phyllaries densely minutely glandular ____ **Erigeron lassenianus**

3. Phyllaries essentially eglandular.
  4. Cauline leaves continuing relatively unreduced to near heads; phyllaries elliptic-oblanceolate to oblong-oblanceolate, apically abruptly acuminate _______ **Erigeron maniopotamicus**
  4. Cauline leaves absent or bracteate near heads; phyllaries narrowly lanceolate to narrowly oblanceolate, apically acute.
    5. Caudex branches usually absent or relatively short and thickened; involucres 8–12(–16) mm wide; disc corollas 3.5–5 mm; cypselae 2.8–3.5 mm long _______ **Erigeron eatonii** var. **sonnei**
    5. Caudex branches commonly present, usually slender; involucres (9–)11–12(–14) mm wide; disc corollas 3–4 mm long; cypselae 1.8–2.3 mm long _______ **Erigeron eatonii** var. **plantagineus**

ACKNOWLEDGMENTS

This study originated from observations made possible by a loan to Nesom of the *Erigeron* collection at HSC. John Strother and Ken Chambers made constructive comments that much improved the manuscript. Strother also searched UC-JEPS collections for possible additional material of *E. maniopotamicus* and sent photocopies of the Blankinship and Tracy collections cited here. Tiana Franklin and Amanda Neill (BRIT) provided the digital image.

REFERENCES

NESOM, G.L. 1992. *Erigeron* and *Trimorpha* (Asteraceae: Astereae) in Nevada. Phytologia 73:203–219.

NESOM, G.L. 2004. Taxonomic reevaluations in North American *Erigeron* (Asteraceae: Astereae). Sida 21:19–40.

STROTHER, J.L. and W.J. FERLATTE. 1988. Review of *Erigeron eatonii* and allied taxa (Compositae: Astereae). Madroño 35:77–91.

A NEW SPECIES OF *SCUTELLARIA* (LAMIACEAE) FROM GUERRERO, MEXICO

Billie L. Turner

Plant Resources Center
The University of Texas
Austin, Texas, 78712, U.S.A.

James L. Reveal

University of Maryland
College Park, Maryland, 20742, U.S.A.
The New York Botanical Garden
Bronx, New York 10458-5126, U.S.A.

ABSTRACT

A new species, *Scutellaria petersonaie* B.L. Turner & J.L. Reveal is described from the state of Guerrero, Mexico. It is closely related to *S. hintoniana* of the section Crassipedes, but amply distinct.

RESUMEN

Se describe una nueva especie, *Scutellaria petersonaie* B.L. Turner & J.L. Reveal del estado de Guerrero, México. Está muy relacionada con *S. hintoniana* de la sección Crassipedes, pero es muy diferente.

Scutellaria petersoniae B.L. Turner & J.L. Reveal, sp. nov. (**Fig. 1**). TYPE: MEXICO. GUERRERO: Sierra Madre del Sur, along the Milpillas-Atoyac road via Puerto del Gallo, ca. 58 mi SW of Mexico Hwy 95, ca. 20.5 mi SW of Carrazal del Bravo and 1.8 mi NE of Yerba Santa in a mixed deciduous forest, 17 Oct 1975, *J.L. Reveal, K.M. Peterson, R.M. Harley, & C.R. Broome* 4282 (HOLOTYPE: TEX; ISOTYPES: to be distributed).

Similis *Scutellariae hintonianae* Epling sed caulibus pubescentibus habentibus pilos breves et acclives et laminis in petiolum gradatim decrescentibus (vice laminarum abrupte petiolatum).

Perennial herbs to 50 cm high, arising from fusiform tuberous roots. Primary stems much-branched from the base, moderately appressed-pubescent with upswept small hairs. Leaves opposite throughout, gradually reduced upwards, those at mid-stem mostly 3.0–4.5 mm long; petioles 0.5–1.2 cm long; blades ovate, undulate, somewhat dentate to nearly entire, gradually tapering upon the petioles, the upper surfaces moderately short-pubescent to glabrate, the lower surfaces, venose, glandular-punctate, pubescent along the major veins. Flowers 2 at each of the uppermost several nodes. Pedicels 4–5 mm long. Calyx 5–6 mm long, 3–5 mm wide, pubescent like the stems. Corollas red, 3.0–3.5 cm long, glabrous within at the very base for ca. 3 mm, pubescent thereafter with downswept hairs for ca. 6 mm; upper lip 0.8–1.0 cm long; lower lip 0.4–0.8 cm long. Upper stamens exserted from the tube for 8–10 mm; filaments attached ca. 4 mm below the corolla's orifice; anthers pale lavender, ca. 0.8 mm long. Mature nutlets not examined.

Scutellaria petersoniae is obviously very closely related to *S. hintoniana* Epling (not to be confused with *S. hintonianum* Henrickson), differing mainly in vestiture and leaf shape. *Scutellaria hintoniana* is known only from the state

---

GUERRERO: Sierra Madre del Sur, along the Milpillas-Atoyac road via Puerto del Gallo, about 58 miles southwest of Mexico Highway 95, about 20.5 miles southwest of Carrizal del Bravo and 1.8 miles north-east of Yerba Santa, in a mixed deciduous forest.

Tubers fusiform.

Fig. 1. *Scutellaria petersoniae*, holotype.

of Mexico in oak woodlands, while *S. petersoniae* is seemingly confined to eastern Guerrero, an area well known for its amalgamation of unusual species.

Etymology.—Scutellaria petersoniae commemorates Kathleen M. Peterson, gifted teacher and skilled botanist (p. 1239 of the current issue, Reveal 2004).

With the present description, Epling's previously monotypic section Crassipedes now contains two taxa, both confined to the Pacific slopes of western Mexico. These two species are distinguished within the genus by their habits (rhizomatous herbs) and elongate, pubescent, red corollas. The following couplet should help distinguish the two taxa:

Stems moderately to densely pilose with spreading hairs; blades abruptly petiolate ____ **S. hintoniana**

Stems moderately pubescent with short upswept appressed hairs; blades tapering upon the petioles ____ **S. petersoniae**

ACKNOWLEDGMENTS

Thanks to Tom Wendt for scanning the holotype, and to Gayle Turner for the Latin diagnosis. Guy Nesom and Richard Olmstead are thanked for their helpful reviews.

REFERENCE

Epling, C. 1942. The American species of *Scutellaria*. Univ. Calif. Publ. Bot. 20:1–141.

Reveal, J.L. 2004. Kathleen M. Peterson, 1948–2003. Sida 21:1239–1243.

BOOK NOTICE

Lavishly Illustrated Book on Tropical & Subtropical Trees

MARGARET BARWICK. 2004. **Tropical & Subtropical Trees an Encyclopedia.** (0-88192-661-2, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $69.95, 484 pp., 2,305 illustrations, 1,981 in color, hardiness zone map, 8 1/4" × 11 5/8".

Publisher Comments: "Margaret Barwick's lovingly researched book represents the first comprehensive compendium of botanical and practical information on this previously undervalued topic. The culmination of more than forty-five years as a hands on gardener and landscape designer, the work reflects her passion for the subject and her appreciation of what fellow gardeners, both lay and professional, need to know about trees selection for tropical and subtropical climates."

"Listed alphabetically, more than 650 species are covered in detail with information on the size, shape of the tree, its cultivation requirements, ornamental value, and rate of growth. The book is supplemented with the finer detail of flower, fruit, foliage, bark, texture, and fragrance."

"With text that is both scientifically accurate and easy-to-read, the book is lavishly illustrated with more than 2500 photographs, many taken in the wild."

Each genus is represented by a type species, usually chosen as the most typical and well known of the genus. The type species is illustrated by photographs of the overall form, the flowers, fruit, bark and, if possible, the natural habitat. An incredible amount of concise information is summarized in sidebars for each type species. Throughout the book one will find fascinating facts about the plants (from trees that can kill to love, sex, and beauty).—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

RECOGNITION OF *PHRAGMITES AUSTRALIS* SUBSP. *AMERICANUS* (POACEAE: ARUNDINOIDEAE) IN NORTH AMERICA: EVIDENCE FROM MORPHOLOGICAL AND GENETIC ANALYSES

Kristin Saltonstall

Horn Point Laboratory
University of Maryland Center
for Environmental Science
PO Box 775
Cambridge, Maryland 21613, U.S.A.
kristin.saltonstall@aya.yale.edu

Paul M. Peterson and Robert J. Soreng

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, District of Columbia (DC) 20013-7012, U.S.A.
peterson.paul@nmnh.si.edu
soreng.rob@nmnh.si.edu

ABSTRACT

A new native subspecies of ***Phragmites australis*** subsp. ***americanus*** Saltonstall, P.M. Peterson & Soreng is described. The new subspecies can be separated from the introduced and Gulf Coast North American lineages of *P. australis* by having caducous leaf sheaths, ligules 1.0–1.7 mm long, lower glumes 3.0–6.5 mm long, upper glumes 5.5–11.0 mm long, lemmas 8.0–13.5 mm long, and by possessing chloroplast DNA haplotypes of A-H, S, Z, AA. The new subspecies is clearly distinguished in a PCA analysis and when bivariate plots of the morphological features are compared. Additional work is needed to morphologically distinguish the introduced from Gulf Coast lineages. *Phragmites berlandieri* is lectotypified. A key and distribution maps to the three lineages are included.

RESUMEN

Se describe una nueva subespecie nativa **Phragmites australis** subsp. **americanus** Saltonstall, P.M. Peterson & Soreng. La nueva subespecie puede separarse de los linajes introducidos en la Gulf Coast de Norte América de *P. australis* por tener vainas caducas, lígulas de 1.0–1.7 mm, glumas inferiores de 3.0–6.5 mm, glumas superiores de 5.5–11.0 mm long, lemas de 8.0–13.5 mm, y por tener haplotipos del DNA plastidial A-H, S, Z, AA. La nueva subespecie queda claramente diferenciada en un análisis de PCA y cuando se comparan gráficos bivariantes de las características morfológicas. Se necesita trabajo adicional para diferenciar morfológicamente los linajes introducidos de la Gulf Coast. Se lectotipifica *Phragmites berlandieri*. Se incluyen una clave y mapas de distribución de los tres linajes.

Phragmites Adans. is a cosmopolitan genus found throughout the world and is currently placed in the tribe Arundineae with *Arundo* L., *Hakonechloa* Makino ex Honda, and *Molinia* Schrank, the latter three genera all introduced in North America (Soreng et al. 2004; Zuloaga et al. 2003). *Phragmites* is an erect perennial grass, 2–5 m tall, that can form dense stands. A number of species, subspecies, and varieties have historically been described in the genus *Phragmites* and today four species are recognized: *P. australis* (Cav.) Trin. ex Steud., *P. karka* (Retz.) Trin. ex Steud., *P. mauritianus* Kunth, and *P. japonicus* Steud. All temperate subspecies and varieties are now included under the designation *P. australis* (Clayton 1968). Using five specimens collected in Texas and Mexico, Fournier (1877)

SIDA 21(2): 683–692. 2004

distinguished a North American *Phragmites* (*P. berlandieri* E. Fourn.) from that found elsewhere in the world. Based on measurements of glumes from 28 European specimens and many North American specimens, Fernald (1932) supported this distinction of a North American variety, *P. communis var. berlandieri* (E. Fourn.) Fernald.

Recent genetic studies indicate that three genetic lineages of *Phragmites* are found in North America (Saltonstall 2002, 2003a,b). A lineage endemic to North America is found across much of Canada and in the United States, from New England and the Mid-Atlantic states across to the Pacific coast and into the southwest (Fig. 1a). Regional structuring can be found within this native lineage, with east coast, midwestern, and western populations showing different chloroplast DNA haplotypes (A-H, S, Z, AA, Saltonstall 2003a). Another lineage is found in the southern United States from Florida across to the Gulf of California, and this lineage is also found in Central America and in Asia (Fig. 1b). It is characterized by chloroplast haplotype I (hereafter referred to as the Gulf Coast lineage). A third lineage, chloroplast haplotype M, is EurAsian in origin and was likely introduced to North America since European colonization. It is found across the continent, both in areas where *Phragmites* was historically present and also in places (such as the southeastern US) where *Phragmites* is not native to the flora (Fig. 1c; Saltonstall 2002). Today, this introduced lineage is the most common type of *Phragmites* in North America and can be found in a variety of habitats including both brackish and freshwater marshes, inland fens, along the banks of rivers and lakes, and along roadsides.

With the recognition that both native and introduced populations of *Phragmites* may be present, many state and regional management authorities are now revising their *Phragmites* management strategies with a goal of preserving native populations while controlling introduced ones. This has also encouraged Natural Heritage programs to consider listing native *Phragmites* as a rare or threatened plant in a number of states. However, the appropriate level of taxonomic classification of the different lineages has not yet been clarified.

A number of qualitative characters have been suggested for distinguishing the native and introduced lineages including culm color, culm texture, and adherence of leaf sheaths to culms (Blossey 2002). While these characters appear to be correlated with ecological characteristics, they are problematic in that they are subject to observer judgment and may require observation at different times of the year. Although genetic testing can provide definitive information as to the lineage of a population, quantitative measurements of morphological features may provide a means of confirming origin in conjunction with qualitative characteristics. Robichaud and Catling (2003) performed such an analysis using *Phragmites* specimens collected in southern Ontario and found significant differences in the length of the lower glume between the native and

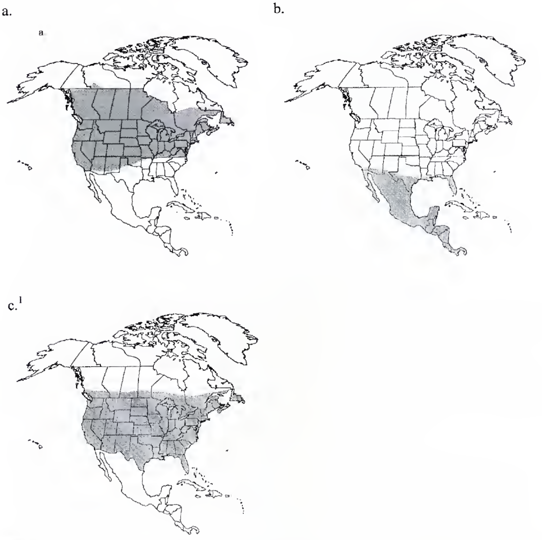


Fig. 1. Distribution of a) Native, b) Gulf Coast, and c) Introduced lineages of *Phragmites australis* in North America. Sources of distribution information include Catling et al. 2004, COMREED 1999, Saltonstall 2002.

introduced population lineages. However, that study was limited by its geographic scope. This study quantifies differences in size seen in the ligules, lower and upper glumes, and lemmas of native, introduced, and Gulf Coast populations of *Phragmites* from North America. We formally recognize the native lineage that occurs in the USA and Canada as *P. australis* subsp. *americanus* Saltonstall, P.M. Peterson & Soreng.

---

[1] Although not documented across the Gulf Coast except for in the Mississippi river delta (Saltonstall 2002), introduced *Phragmites* may already have invaded these regions and certainly has the potential to spread into them. The distribution of introduced *Phragmites* is not known south of the U.S. border and thus is not included in this figure.

METHODS

The genetic lineage of specimens was determined prior to taking morphological measurements. DNA extractions were done using a CTAB extraction protocol (Doyle & Dickson 1987). Lineages were identified either by sequencing two noncoding chloroplast gene regions, *trnT*(UGU)-*trnL*(UAA)5' and *rbcL-psaI*, to determine the chloroplast DNA haplotype (Saltonstall 2002) or using an RFLP diagnostic assay on the abovementioned chloroplast regions that distinguishes the three North American *Phragmites* lineages (Saltonstall 2003c).

Ligules were measured using a Nikon PZ500 dissecting microscope fitted with a 0.1–10 mm micrometer. All samples were obtained from live populations in 1999–2003 throughout the range of *Phragmites* in North America. Several leaf blades per sample were initially observed to see if there was variation in the ligule lengths. Since no within-plant or within-population variation was detected only one leaf blade was examined for the majority of specimens. Ligule length was calculated by measuring the ligule (both the membrane and its hairy margin) at the center of the leaf blade to the nearest 0.05 mm.

Measurements of lower and upper glumes and lemmas were taken from a single inflorescence per clone. Ten glumes and ten lemmas were measured from each specimen. Samples were obtained from live populations during 1999–2003 or from herbarium specimens and cover the geographic range of all *Phragmites* lineages in North America. Measurements were made to the nearest 0.5 mm using a ruler. From each specimen, ten spikelets showing visible rachilla hairs were selected from the middle part of the inflorescence. Upper and lower glume and lemma lengths were measured from the articulated base to the tip. A complete data set of the morphological characters used in this study is available from KS upon request.

Data were analyzed using the PROC MIXED procedure in SAS 8.2. Tukey's comparisons were used to distinguish significant differences between population types. Since the majority of samples measured for ligule length were different from those measured for glume and lemma lengths, the data were randomized and treated as groups representing variation within each of the three genetic lineages. Bivariate comparisons were plotted to illustrate these differences between lineages. A Principal Components Analysis (PCA) was performed using PC-ORD (Version 4, McCune & Mefford 1999) using a correlation matrix of standardized data for the variables.

RESULTS AND DISCUSSION

The morphological characters measured in this study clearly distinguish native from introduced and Gulf Coast *Phragmites* lineages. This mirrors the distinctiveness seen at the genetic level between the lineages, where all native North American haplotypes shared five unique mutations not seen in any other haplotypes (Saltonstall 2002). Native specimens have longer ligules, glumes, and lem-

TABLE 1. Mean values and their significance level for ligule, glume and lemma lengths by *Phragmites* lineages: Native (N), Introduced (I), and Gulf Coast (GC).

Structure	Population Type	Sample size	Mean ± SE (mm)	Significant Difference ($p<0.01$)
Ligule	Native	28	1.26 ± 0.04	I, GC
	Introduced	20	0.69 ± 0.03	N
	Gulf Coast	14	0.57 ± 0.04	N
Lower glume	Native	28	4.6 ± 0.1	I, GC
	Introduced	17	3.4 ± 0.1	N, GC
	Gulf Coast	15	3.9 ± 0.1	N, I
Upper glume	Native	28	7.3 ± 0.2	I, GC
	Introduced	17	5.8 ± 0.2	N
	Gulf Coast	15	6.3 ± 0.1	N
Lemma	Native	28	11.1 ± 0.2	I, GC
	Non-Native	17	9.2 ± 0.2	N
	Gulf Coast	15	10.1 ± 0.2	N

mas than both introduced and Gulf Coast specimens (Table 1; Ligule—$F_{2,59}=120.21$; Lower glume—$F_{2,57}=37.59$; Upper glume—$F_{2,57}=21.01$; Lemma—$F_{2,58}=17.07$; $p<0.0001$ for all comparisons). Of the four characters measured, the ligule is the most definitive in separating the native from the other two lineages (Fig. 2a–c). The length of the lower glume is also a good way of distinguishing native from introduced specimens, although some overlap is seen (Fig. 2d).

The Gulf Coast lineage, although significantly different from others at several measurements, is intermediate between the other two types when comparing these four characters (Table 1, Fig. 2a–d). Thus at this time, it remains difficult to distinguish morphologically and it appears premature to conclude that this lineage is a different species (Jones et al. 1997). It appears more similar to introduced than native *Phragmites* for all morphological measurements, in addition to being genetically more closely related to the introduced haplotype M than the native haplotypes (Saltonstall 2002, 2003a). Additional characters that distinguish this lineage morphologically have yet to be identified. Although not verified quantitatively, the leaf internode distance of the Gulf Coast plants appears to be shorter than both the introduced and native lineages (Saltonstall pers. obs.). The syntype of *P. berlandieri* (*J.L. Berlandier 1446*, US-82049 ex P) was included in our morphological survey and falls within the Gulf Coast lineage. Fernald (1932) did not indicate if he used one of the syntypes designated by Fournier (1877) in his study. Clearly Fernald was referring to the native lineage in his study since the lower glumes range from 4–6 mm long and the upper glumes range from 6–8.5 mm long. To avoid confusion in the future, particularly if one chooses to use the name *P. berlandieri* to include the Gulf Coast lineage, we formally lectotypify *P. berlandieri* E. Fourn., Bull. Soc. Bot. France

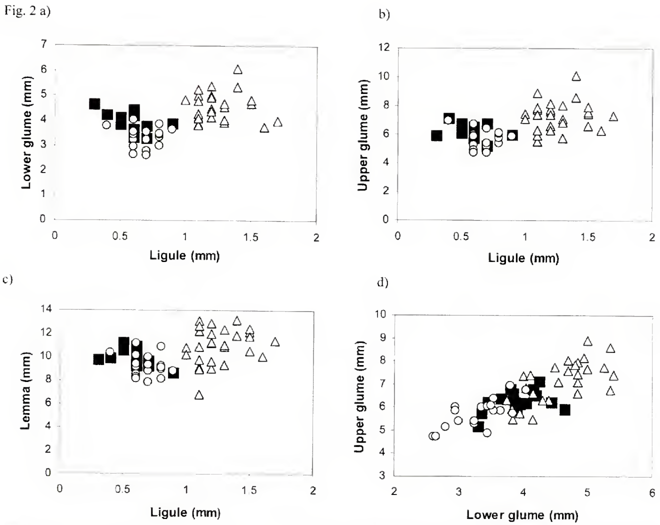


Fig. 2. Bivariate comparisons of morphological data for Native (   ), Introduced (■) and Gulf Coast (○) *Phragmites* individuals.

Table 2. Eigenvector loadings for the principal components (PC). Relative eigenvalues, percent of variance, and cumulative percent of variance are also listed.

	PC 1	PC 2	PC 3	PC4
Ligule	-0.4030	-0.8859	0.2293	-0.0143
Lower glume	-0.5285	0.0584	-0.7301	-0.4292
Upper glume	-0.5489	0.2219	-0.0574	0.8038
Lemma	-0.5069	0.4032	0.6411	-0.4116
Eigenvalue	2.996	0.636	0.267	0.101
% of variance	74.904	15.905	6.676	2.515
Cumulative % of variance	74.904	90.809	97.485	100.000

24:178. 1877. Type: U.S.A. Texas: Laredo, 1828, *J.L. Berlandier 1446* (lectotype: P; isolectotype, the large specimen on the sheet that includes a culm with a complete inflorescence: US-82049 ex W!).

The PCA confirmed and enhanced the above mentioned results further. The first two PC's accounted for 90.8% of the total variation in the data (Table 2, Fig. 3). The first axis alone accounts for 74.9% of the total variance and has negative loadings for the majority of Native specimens and positive ones for introduced and Gulf Coast specimens. Thus more negative values along PCI indicate larger morphological structures (Fig. 2), as seen in the native specimens.

Analysis of nuclear microsatellite DNA indicates that there is little evidence for hybridization between the native and introduced lineages since alleles considered diagnostic for each of the two lineage types were rarely found in the alternative lineage. Further, this nuclear DNA dataset strongly supports the genetic differentiation seen in the chloroplast DNA between the native and introduced lineages (Saltonstall 2003b). Although *Phragmites* has been said to be self-incompatible (Gustaffson & Simak 1963), little is known about the mating system of this genus and it is not known if hybrids between population types can occur. The morphological data clearly support separation of the native lineage from the introduced/Gulf Coast lineages. We have demonstrated that the native lineage has morphological features (longer ligules, glumes, and lemmas) and unique genetic mutations that differentiate it from the introduced/ Gulf Coast lineages. We chose to recognize the native lineage formally as *Pharagmites australis* subsp. *americanus*. The following key using morphological and genotype features is given to separate these three lineages.

KEY TO THE LINEAGES OF *PHRAGMITES AUSTRALIS* IN NORTH AMERICA

1. Ligules 1.0–1.7 mm long; lower glumes 3.0–6.5 mm long; upper glumes 5.5–11.0 mm long; lemmas 8.0–13.5 mm long; leaf sheaths caducous with age; culms exposed in the winter, smooth and shiny; rarely occurs in a monoculture; chloroplast DNA haplotypes A-H, S, Z, AA (see Saltonstall 2002, 2003a) ____ **P. australis** subsp. **americanus** (Native lineage)

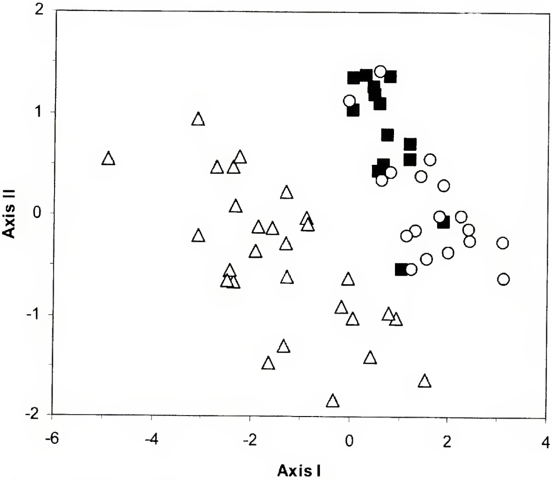


Fig. 3. Principal components analysis of morphological data for *Phragmites australis*: Native ( ), Introduced (■) and Gulf Coast (○) individuals.

1. Ligules 0.4–0.9 mm long; lower glumes 2.5–5.0 mm long; upper glumes 4.5–7.5 mm long; lemmas 7.5–12.0 mm long; leaf sheaths not caducous with age; culms not exposed in the winter, smooth and shiny or ridged and not shiny; often occurs as a monoculture; chloroplast DNA haplotypes I or M.
    2. Culms smooth and shiny; southern California, Arizona, New Mexico, Texas to Florida, throughout Mexico and Central America; chloroplast DNA haplotype I ________ *P. australis* var. berlandieri (E. Fourn.) C.F. Reed (Gulf Coast lineage)
    2. Culms ridged and not shiny; southern Canada from British Columbia to Quebec south throughout the Continental United States; chloroplast DNA haplotype M ________ *P. australis* (Introduced lineage)

Phragmites australis subsp. **americanus** Saltonstall, P.M. Peterson & Soreng, subsp. nov. Type: U.S.A. Montana. Fergus Co.: near the mouth of Dog Creek, 12 Sep 1883, *Frank Lamson Scribner 378* (holotype: US-824621!).

A *Phragmite australi* (Cav.) Trin. ex Steud. vagina caduca cum aetate, ligulis 1.0–1.7 mm longis, glumis inferioribus 3.0–6.5 mm longis, glumis superioribus 5.5–11.0 mm longis, lemmatibus 8.0–13.5 mm longis, recedit.

Plants usually do not occur as a monoculture. Culms exposed in the winter, smooth and shiny, sometimes purplish at the nodes and internodes. Leaf sheaths caducous with age; ligules 1.0–1.7 mm mm long. Spikelet lower glumes 3.0–6.5 mm long, upper glumes 5.5–11.0 mm long; lemmas 8.0–13.5 mm long.

Distribution.—(Fig. 1a). This subspecies is known to occur in southwestern Northwest Territories east and south to California, Arizona, New Mexico, and east to northern Texas, Oklahoma, northern Arkansas, West Virginia and North Carolina, and north to Newfoundland and Quebec.

Specimens examined (included in the genetic and morphological data sets): **CANADA. BRITISH COLUMBIA:** Osoyors Lake, *J. Grant s.n.* (US-2432752). **UNITED STATES. COLORADO:** La Salle, *P.A. Rydberg 2511* (US-908102). **IOWA. Fayette Co.:** *B. Fink 592* (US-230468). **IDAHO:** St. Anthony, *E.D. Merrill & E.N. Wilcox 429* (US-908094). **INDIANA. Fulton Co.:** W of Rochester, *C.C. Deam 30010* (US-1062053). **KANSAS. Pottawatomie Co.:** *J.B.S. Norton 922* (US-353717). **MAINE:** Lake Anagunticook, Harford, *J.C. Parlin 2022* (US-908068). **MICHIGAN. Allegan Co.:** Kalamazoo River near Douglas, *W.F. Wright 125* (US-430189). **MINNESOTA:** Lake Mellissa, *H.L. Bolley 879* (US-908078). **MONTANA:** banks of the Missouri River, *F.L. Scribner 378* (US-153245). **NORTH DAKOTA. Banson Co.:** Leeds, *J. Lunell s.n.* (US-898853); **NEBRASKA. Thomas Co.:** Sand Hills near Plummer Ford, *P.A. Rydberg 1631* (US-207984). **NEW JERSEY:** New Durham, *W.M. Van Sickle s.n.* (US-244226). **NEW MEXICO:** Bremonds Ranch near Roswell, *J.D. Tinsley 12* (US-739106). **NEVADA. Nye Co.:** Amargosa Drainage Basin, *J.C. Beatley 9723* (US-2876499). **OKLAHOMA:** E of Woodward, H.E. Runyan 1030 (1722877). **OREGON:** Klammoth Co., Klammoth Lake, *E.I. Applegate 813* (US-273602). **SOUTH DAKOTA:** Canning, *D. Griffiths 105* (US-908084). **UTAH:** Rabbit Valley, *L.F. Ward 534* (US-153247). **WASHINGTON. Okanogan Co.:** Banks of the Okanogan River, *A.D.E. Elmer 519* (US-352294). **WYOMING. Fremont Co.:** Musk-Rat Creek, *L.O. Gooding 519* (US-899997).

ACKNOWLEDGMENTS

We thank Susan Pennington for help with the literature cited and specimen citations, Dan Nicolson and Alain Touwaide for correcting the Latin diagnosis; and Bernd Blossey, J.K. Wipff and an anonymous reviewer for their comments on the manuscript. This is Contribution 3787 from the University of Maryland Center for Environmental Sciences.

REFERENCES

Blossey, B. 2002. *Phragmites*: common reed. Morphological differences between native and introduced genotypes. Accessed June 20, 2004. http://www.invasiveplants.net/invasiveplants/phragmites/morphology.asp.

Catling, P.M., G. Mitrow, L. Black, and S. Carbyn. 2004. Status of the alien race of common reed (*Phragmites australis*) in the Canadian maritime provinces. Bot. Electronic News 324.

Clayton, W.D. 1968. The correct name of the common reed. Taxon 17:168–169.

Comreed. 1999. COMREED Database. E. Haber [ed.]. National Botanical Services, Ottawa, ON, Canada. Accessed June 20, 2004. 24.43.80.21/nbs/IPCAN/reedmap.html

Doyle, J.J. and E.E. Dickson. 1987. Preservation of plant samples for DNA restriction endonuclease analysis. Taxon 36:715–722.

Fernald, M.L. 1932. *Phragmites communis* Trin. var. *Berlandieri* (Fournier), comb. nov. Rhodora 34:211–212.

Fournier, M.E. 1877. Sur les Arundinacées du Mexique. Bull. Soc. Bot. France 24:177–182.

Gustafsson, A. and M. Simak. 1963. X-ray photography and seed sterility in *Phragmites communis* Trin. Hereditas 49:442–450.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas. University of Texas Press, Austin.

McCune, B. and M.J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data. Version 4. MJM Software Design, Gleneden Beach, OR.

Robichaud, L. and P.M. Catling. 2003. Potential value of the first glume length in differentiating native and alien races of common reed, *Phragmites australis*. Bot. Electronic News 310.

Saltonstall, K. 2002. Cryptic invasion by a non-native genotype of the common reed, *Phragmites australis*, into North America. Proc. Natl. Acad. U.S.A. 99:2445–2449.

Saltonstall, K. 2003a. Genetic variation among North American Populations of *Phragmites australis*: implications for management. Estuaries 26:444–451.

Saltonstall, K. 2003b. Microsatellite variation within and among North American lineages of *Phragmites australis*. Mol. Ecol. 12:1689–1702.

Saltonstall, K. 2003c. A rapid method for identifying the origin of North American *Phragmites* populations using RFLP analysis. Wetlands 23:1043–1047.

Soreng, R.J., G. Davidse, P.M. Peterson, F.O. Zuloaga, E.J. Judziewicz, T.S. Filgueiras, and O. Morrone. 2004 (23 March). Suprageneric classification in catalogue of New World grasses (Poaceae). http://mobot.mobot.org/W3T/Search/nwgc.html (originally published in 2000).

Zuloaga, F.O., O. Morrone, G. Davidse, T.S. Filgueiras, P.M. Peterson, R.J. Soreng, and E.J. Judziewicz. 2003. Catalogue of New World grasses (Poaceae): III. subfamilies Panicoideae, Aristidoideae, Arundinoideae, and Danthonioideae. Contr. U.S. Natl. Herb. 46:1–662.

LAS ESPECIES DE *NOTOTRICHE* (MALVACEAE) DE ECUADOR

Magda Chanco

Herbario San Marcos, Museo de Historia Natural
Universidad Nacional Mayor de San Marcos
Apartado 14-0434 Lima, PERÚ
mchancoe@unmsm.edu.pe

Carmen Ulloa Ulloa

Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166-0299, U.S.A.
carmen.ulloa@mobot.org

ABSTRACT

Four species of *Nototriche* are recognized for Ecuador, all are endemic. *N. hartwegii* is re-established. A key, descriptions, and illustrations of the species are provided.

RESUMEN

Se reconocen cuatro especies de *Nototriche* para el Ecuador, todas endémicas. Se restablece *N. hartwegii*. Se presentan clave, descripciones e ilustraciones de las especies.

Nototriche Turcz., es un género netamente andino sudamericano que se distribuye en el páramo de Ecuador y punas de Perú, Chile, Bolivia y norte de Argentina. Comprende alrededor de 130 especies distribuidas entre los 3500 y 5000 metros de elevación. La mayor concentración de especies se encuentra en Perú con aproximadamente 65 especies.

La monografía del género de hace más de un siglo (Hill, 1909) presentó 62 especies. Varios trabajos posteriores de Krapovickas (1950, 1951, 1953, 1957a, 1957b, 1973), Fryxell (1990) y Chanco (1992) han aumentando el número de especies conocidas para el género y una nueva monografía actualizada para la serie *Flora Neotropica* está en camino (Krapovickas y Chanco, en prep.).

En la monografía de la familia para el Ecuador, Fryxell (1992) presentó tres especies: *N. ecuadoriensis* Fryxell, *N. jamesonii* A.W. Hill y *N. phyllanthos* (Cav.) A.W. Hill, las mismas que fueron registradas por Jørgensen y León-Yánez (1999). Recientes colecciones realizadas en el sur del Ecuador indican la presencia de una cuarta especie, *N. hartwegii* A.W. Hill. Ésta fue considerada por Fryxell (1992) como un sinónimo de *N. jamesonii*, pero nuestros estudios del material tipo indican que se trata de una entidad distinta, muy diferente del resto de colecciones de *N. jamesonii*. En este trabajo se restablece la especie *N. hartwegii* A.W. Hill para la flora de Ecuador, que actualmente cuenta con cuatro especies endémicas, duplicando el número de endémicas registrado por Valencia et al. (2000). Además se proporciona su estado de conservación según las categorías de la UICN (2001).

Las especies de *Nototriche* son hierbas de apariencia acaulescente, que forman cojines compactos de hojas densamente arrosetadas en las ramificaciones apicales de los tallos. Los tallos son por lo general subterráneos, profundos, robustos, leñosos y están recubiertos por los restos de las hojas. Las hojas son

SIDA 21(2): 693–703. 2004

flabeladas a ovadas, palmati o pinnatipartidas, glabras a densamente recubiertas de tricomas estrellados; parte de las estípulas y el pecíolo están adheridos y forman una vaina o vagina laminar, membranosa. La porción libre del pecíolo y de las estípulas varía según las especies. Las flores solitarias con pedicelo muy corto se insertan en el punto o debajo donde se separan los ápices libres de las estípulas, carecen de involucelo; el cáliz es gamosépalo, partido en 5 dientes; la corola es vistosa, consiste de 5 pétalos obovados; el androceo es monadelfo con una columna estaminal estrecha, con las numerosas anteras que forman una cabezuela en su ápice; los estilos son hasta 14, más largos que la columna estaminal, los estigmas son clavados. Los frutos son esquizocarpos, variadamente hirsutos, dehiscentes, compuestos de hasta 14 mericarpos, cada uno con arista apical larga o corta.

Todas las especies crecen en las partes más altas de los Andes en hábitats rocosos y arenosos sobre los 3500 m, hasta más de 5000 m de elevación.

Dos especies, *N. pinnata* (Cav.) A.W. Hill y *N. acaulis* (Cav.) Krapov., tipificadas por colecciones realizadas, según las descripciones, por Née en el volcán Chimborazo, provienen probablemente de Perú, ya que de otra manera no se conocen en Ecuador.

CLAVE PARA DETERMINAR LAS ESPECIES

1. Hojas glabras excepto los ápices de los lóbulos con uno o más cilios largos, lámina pinnatipartida con 20 o más lóbulos ligulados; cáliz glabro por fuera, menos los bordes y el nervio medio de los dientes con algunos cilios, viloso en los dientes por dentro ____ **Nototriche ecuadoriensis** Fryxell

1. Hojas pubescentes al menos en la superficie superior, la lámina flabeliforme, lobulada con menos de 20 lóbulos obtusos; cáliz densamente estrellado-tomentoso en ambas superficies.

    2. Superficie inferior de la lámina, estípulas y pecíolo glabra o esparcidamente pubescente, vernicosa; superficie superior densamente tomentosa ____ **Nototriche phyllanthos** (Cav.) A.W. Hill

    2. Superficie superior e inferior de la lámina, estípulas y pecíolo densamente pubescentes.

        3. Lámina estrellado-vilosa con pelos largos y sedosos; parte libre del pecíolo de 2–3 mm de largo; ramas aéreas hojosas formando cilindros de hasta 15 cm de largo × 4–5 cm de diámetro ____ **Nototriche hartwegii** A.W. Hill

        3. Lámina estrellado-velutina con pelos cortos; parte libre del pecíolo de 6–19 mm de largo; ramas aéreas hojosas formando rosetas laxas de hasta 5 cm de largo × 5 cm de ancho ____ **Nototriche jamesonii** A.W. Hill

Nototriche ecuadoriensis Fryxell, Contr. Univ. Michigan Herb. 17:164. 1990. (**Figs. 1A, E**). TIPO: ECUADOR: Cotopaxi/Napo, road San Miguel (Salcedo), Puerto Nuevo (Napo) under construction, 29 km from San Miguel (Cerro Verde Filo), bunch grass páramo and rocky escarpment (78°25'W,0°59'S), 3950–4050 m, 1 Oct 1976, *Øllgaard & Balslev 9929* (HOLOTIPO: AAU!; ISOTIPOS: F!, MO!, NY!).

Hierba perenne, acaulescente, arrosetada o formando cojines compactos; eje subterráneo leñoso, ramificado, en cuyos ápices de las ramas se agrupan las hojas

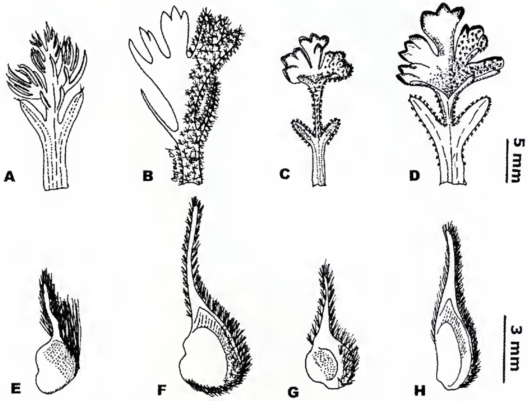


Fig. 1. **Arriba: Hoja con la lámina, la porción libre del pecíolo, la porción libre de las estípulas y la vagina. Abajo: Mericarpos. A y E,** ***N. ecuadoriensis*****. B y F,** ***N. hartwegii*****. C y G,** ***N. jamesonii*****. D y H,** ***N. phyllanthos*****.**

formando rosetas de hasta 4,5 cm de diámetro. Pecíolo y estípulas forman una vagina de 8–11 mm de largo × 3–4 mm de ancho, glabra. Parte libre de las estípulas, ancha, obtusa, de 5 mm de largo × 3 mm de ancho, las superficies glabras, los ápices con algunos cilios. Parte libre del pecíolo glabro, de 1–2 mm de largo. Lámina pinnatipartida, de 8–12 mm de largo × 7–10 mm de ancho, los lóbulos de la lámina con divisiones de segundo orden forman lóbulos ligulados de ápice subagudo, ambas superficies totalmente glabras excepto los ápices de los lóbulos con 1 ó más cilios. Cáliz de 9–12 mm de largo, los dientes triangulares, de 4,5 mm de largo × 3 mm de ancho en la base, el exterior glabro o cercano a ello con algunos pelos largos y suaves en el nervio medio y en los bordes de los dientes, el interior glabro menos los dientes con pelos largos dirigidos hacia el ápice. Nectarios internos basales 5, aislados, más anchos que altos, ca. 1 mm de ancho. Corola glabra, de un violeta pálido (purpúreo en seco); tubo de la corola de 4 mm de largo × 2 mm de ancho. Pétalos de 10–12 mm de largo × 5,5–6 mm de ancho, con una pequeña escotadura apical; cada pétalo se continúa sobre el tubo de la corola formando dos pequeñas "alas" ca. 2,5 mm de largo. Tubo estaminal glabro, más corto que los pétalos, de 4–6 mm de largo, las anteras dispuestas en una cabezuela globosa, subsésiles de color violáceo. Estilos 7 apenas sobresalen de las anteras, los estigmas capitados. Mericarpos de 6 mm de largo (incluidas las aristas de 3 mm) × 3 mm de ancho, con el dorso y el ápice largamente hirsutos.

Material adicional estudiado: **ECUADOR. Pichincha:** Slopes north-west of north peak of Antisana, 4400 m, 00.30S 078.00W, *P.J. Grubb et al. 578* (K, NY). **Napo:** Paramo de Papallacta, sector El Paso, 4060 m, 28 Oct 1984, *Freire 33* (QCA).

Distribución y conservación.—Especie endémica de la Cordillera Oriental, en los páramos del volcán Antisana, Papallacta y Cerro Verde, entre 3950 y 4400 m. Esta especie es conocida sólo de cuatro poblaciones y se la considera como Vulnerable (VU).

Notrotriche ecuadoriensis se distingue del resto de especies ecuatorianas por tener las hojas totalmente glabras excepto algunos cilios en el ápice de los lóbulos y por la lámina pinnatipartida con lóbulos ligulados. Por la presencia de un tubo de la corola es afín a *N. jamesonii*, se diferencia porque esta última tiene la lámina flabeliforme con lóbulos obtusos y por otros caracteres indicados en la clave.

Nototriche hartwegii A.W. Hill, Trans. Linn. Soc. London 7:221–222, pl. 29, fig. 14, 1909. (**Figs. 1B, F y 2**). Tipo: ECUADOR: Cañar: "Monte Assuay ad Las Cruces," 4550 m, *Hartweg 918* (holotipo K!, isotipos: BM (como foto digital), CGE n.v., G como foto digital, NY!, P!).

Hierba perenne, acaulescente, pulviniforme, lanosa; eje subterráneo leñoso, ramificado, en cuyos ápices de las ramas se agrupan numerosas hojas formando masas compactas cilíndricas. Estípulas y pecíolo forman una vagina de 6–7 mm de largo × 3–4 mm de ancho. Parte libre de las estípulas linear, de ápice subagudo, de 5–9 mm de largo × 0,7–1 mm de ancho. Parte libre del pecíolo de 2–3 mm de largo. Pecíolo, estípulas y vagina densamente cubiertos por pelos estrellados largos y suaves en ambas superficies, en los márgenes con pelos estrellados pedicelados más grandes. Lámina flabelada de base cuneiforme, de 10–15 mm de largo × 9–18 mm de ancho en la parte superior, 3-partida, cada segmento se divide en 3 o más lóbulos, el segmento medio entero o poco dividido, los lóbulos oblongos de ápice obtuso, la superficie superior densamente pilosa con pelos estrellados largos y suaves (lanosa), la inferior igualmente pilosa pero en menor proporción. Cáliz de 15–20 mm de largo, los dientes de 11–15 mm de largo × 2,5–5 mm de ancho en la base, el exterior todo piloso con pelos similares a la hoja, el interior glabro menos los ápices de los dientes. Nectarios internos basales 5, aislados, triangulares, de 1,5 mm de alto × 2 mm de ancho. Corola violácea con base blanquecina; tubo de la corola ausente. Pétalos de 20–25 mm de largo × 10–13 mm de ancho, la base con pelos estrellados largos. Tubo estaminal de 12–15 mm de largo, las anteras sésiles reunidas en cabezuela alargada, 2/3 del tubo estaminal, con pelos estrellados largos y caedizos. Estilos y estigmas en número de 12. Mericarpos 12, uniovulados, de 9 mm de largo (incluidas las aristas de 5 mm) × 3 mm de ancho, con pelos estrellados cortos en el dorso y ápices con cilios largos.

Fig. 2. *Nototriche hartwegii* en el Páramo del Cajas, Azuay, Ecuador. Arriba: detalle de las flores. Abajo: hábito mostrando la planta en cojín. Fotografías ©Carmen Ulloa Ulloa.

Material adicional estudiado: **ECUADOR:** "Quito," *Jameson s.n.* (K). Azuay: Parque Nacional Cajas. Road Cuenca-Sayausi-Molleturo, 4110-4350 m, 4 Ene 2000, *Jørgensen et al. 2114* (MO); Parque Nacional Cajas, sendero paragüillas, 21 Nov 2000, 4100-4400 m, *Jørgensen et al. 2422* (MO), 13 Ene 2003, 4100-4180 m, *Ulloa et al. 1184* (MO, USM).

Distribución y conservación.—Endémica de los páramos del sur del país entre 4100 y 4400 m en Cañar y Azuay (la colección de Jameson tiene una localidad como "Quito" que no necesariamente corresponde a la provincia de Pichincha). Esta especie fue recientemente recolectada luego de 150 años. Si bien hoy en día la especie se encuentra protegida dentro del Parque Nacional Cajas, se conoce sólo una población y su área de distribución es muy pequeña por lo que se le considera como En Peligro (EN).

Nototriche hartwegii se distingue por la lámina flabelada con base cuneiforme y poco lobulada; por las numerosas hojas agrupadas en los ápices de las ramas formando cilindros compactos; y por la densidad de pelos largos estrellados (lanosos) que dan a toda la planta una apariencia verde-gris.

Nototriche jamesonii A.W. Hill, Trans. Linn. Soc. London 7:228. 1909. (**Figs. 1C, G**). Tipo: ECUADOR: "Quito," *Jameson 154* (lectotipo: K!; isolectotipos: G n.v. (foto F-neg 23747 en F, MO, NY), GH n.v.).

Nototriche chimborazoensis Hochr., Candollea 16:82. 1957. Tipo: ECUADOR: Chimborazo, 4700-5100 m. *Rauh & Hirsch E-328* (holotipo: G!).

Hierba perenne, acaulescente, eje subterráneo leñoso, ramificado con los extremos apicales cubiertos de hojas dispuestas en rosetas. Pecíolo y estípulas forman una vagina herbácea de 6-7 mm de largo × 2,5 mm de ancho. Parte libre de las estípulas linear-oblonga, de 3-5 mm de largo × 0,8-1,2 mm de ancho. Parte libre del pecíolo de 6-19 mm de largo × 1,2-1,5 mm de ancho. Pecíolo, estípulas y vagina con superficies pilosas (la vagina con la superficie inferior glabra), con pelos estrellados cortos, los márgenes con pelos largos ciliados. Lámina flabeliforme, de 7-9 mm de largo × 9-11 mm de ancho, 3-fida, segmento medio más desarrollado que los laterales, los segmentos divididos en 3 ó más lóbulos oblongo-obtusos; superficie superior de la lámina pilosa velutina, con pelos estrellados cortos, la superficie inferior igualmente pilosa pero menos densa que la superior. Cáliz campanulado, de 8-11 mm de largo, dividido hasta cerca de la mitad en 5 dientes de ápice obtuso, exteriormente todo piloso con pelos estrellados similares a los de la lámina, el interior glabro menos los ápices de los dientes con pelos estrellados más grandes. Nectarios internos basales 5, más anchos que altos, cerca de 1 mm de ancho × 0,8 mm de alto. Corola violácea; tubo de la corola de 2,5-4 mm de largo, piloso. Pétalos de 15-18 mm de largo × 7-9 mm de ancho, la base con pelos estrellados. Tubo estaminal de 8-10 mm de largo, piloso con pelos algo rígidos y esparcidos, las anteras subsésiles dispuestas en una cabezuela oblonga. Estilos y estigmas cerca de 10. Mericarpos 10, de 6 mm de largo (incluidas las aristas de 2 mm de largo) × 2,5 mm de ancho, el dorso con pelos estrellados pequeños, parte superior y aristas con pelos estrellados largos y ciliados.

Material adicional estudiado: **ECUADOR:** Sin localidad, "14.000 ft," *Pearce s.n.* (K). **Bolívar:** Volcán Chimborazo, wind-swept gravel paramo, with open cushion plant association, 4200 m, 01.28S 078.55W, 04 Ago 1979, *Holm-Nielsen 18745* (AAU, F, MO, NY); Superpáramo area W of volcán Chimborazo, ca. 33 km N of Guaranda, 4120 m, 01.30S 078.56W, 29 Nov 1989, *Luteyn 13397* (NY, QCA), 16 Ene 1985, *Luteyn & Cotton 11080* (NY, QCA); Chimborazo, sin col. 4200 m (LIL). **Chimborazo:** "Diversa Chimborazo prope Totorillas ad nives perpect," 4600 m, 7 Jul 1876, *André 3948* (K, NY(2)), 4200 m, *André 3953* (K); Southern slope of Mount Chimborazo, sandy ground, 4600 m, 18 Jul 1939, *Asplund 8379* (F, LIL, NY, P), 4260 m, 23 Jun 1989, *Dorr & Valdespino 6437* (NY, QCA); Arenales del Chimborazo, superpáramo, 4300 m, 19 Oct 2001, *Endara et al. 361* (QCA), 25 Oct 1987, *Ramsay & Merrow-Smith 997* (K, QCA), 10 May 1939, *Penland & Summers 698* (F), 6 May 1927, *Rorud s.n.* (F). **Pichincha:** Cayambe mountain, N side, 4000 m, 24 Oct 1960, *Pennington 22C* (K, NY). **Tungurahua:** El Arenal, On the Via Whymper about 2 km from Cruce Arenal, 4150 m, 17 Abr 1983, *Brandbyge 42143* (AAU), 03 Sep 1983, *Brandbyge 42236* (AAU).

Distribución y conservación.—Especie endémica en los páramos del norte y centro del país entre 4000 y 5100 m. La especie está bien representada en varios páramos por lo que se la considera de Preocupación Menor (LC).

Nototriche jamesonii se distingue por la disposición de las hojas en los extremos de las ramas formando rosetas laxas. La porción libre del pecíolo es bastante larga en relación con las otras especies. La presencia del tubo de la corola es un carácter que comparte con *N. ecuadoriensis* (ver observaciones de dicha especie).

Nototriche phyllanthos (Cav.) A.W. Hill, Bot. Jahrb. Syst. 37:579. 1906. (**Figs. 1 D, H y 3**). *Sida phyllanthos* Cav., Diss. 5:276–277, tab. 127 fig. 4. 1788. *Malvastrum phyllanthos* (Cav.) A. Gray, U.S. Expl. Exped. Phan. 152. 1854. TIPO: "Pérou," *J. de Jussieu s.n.* (HOLOTIPO: P-JU No. 12282 como microficha; ISOTIPOS: MA n.v., P!).

Sida saxifraga Bonpl., Pl. Aequinoct. 2:116. 1813. TIPO: ECUADOR: Cerro Antisana, *Bonpland 2257* (HOLOTIPO: P como microficha, foto F-neg 35507; ISOTIPOS: B-W No. 12730 como microfich, P!).
Sida pichinchensis Bonpl., Pl. Aequinoct. 2:115–117, tab. 116. 1813. *Malvastrum pichinchense* (Bonpl.) A. Gray. U.S. Expl. Exped. Phan.1:152. 1854. *Nototriche pichinchensis* (Bonpl.) A.W. Hill, Bot. Jahrb. Syst. 37:579. 1906; A.W.Hill, Trans. Linn. Soc. London, Bot. 7:231, pl. 29 fig. 12, pl. 30 fig. 9. 1909. TIPO: ECUADOR: Pichincha, in monte Ruccu Pichincha, *Bonpland 3032* (HOLOTIPO: P; ISOTIPO: B-W No. 12731 como microficha).

Hierba perenne, acaulescente, arrosetada o formando densos cojines; eje subterráneo leñoso, ramificado, los ápices cubiertos de numerosas hojas verde-incano. Estípulas y pecíolo forman una vagina membranosa, de 12–15 mm de largo × 3–4 mm de ancho. Parte libre de las estípulas triangular o lineal-subulada de ápice agudo, de 8–10 mm de largo × 2–3 mm de ancho. Parte libre del pecíolo de 4–6 mm de largo × 1,5–2 mm de ancho. Pecíolo, estípulas y vagina con pelos estrellados pequeños en la superficie superior, glabrescente en la inferior, en los márgenes con pelos estrellados más grandes. Lámina flabeliforme, profundamente 3-partida, de 6–12 mm de largo × 10–18 mm de ancho, segmentos

FIG. 3. *Nototriche phyllanthos*, original publicado como *Sida pichinchensis* en Plantas aequinoctiales v. 2 (Humboldt y Bonpland, 1813, pl. 116). Reproducido con permiso de la biblioteca del Missouri Botanical Garden.

3–5-lobulados, los lóbulos ovado-oblongos de ápice obtuso con márgenes frecuentemente enrollados, la superficie superior de la lámina incano-tomentosa, la inferior glabra o subglabra y vernicosa. Cáliz campanulado, de 9–10 mm de largo, los dientes de 5 mm de largo × 3 mm de ancho en la base, el ápice subagudo, el exterior todo piloso con pelos similares a los de la lámina excepto los márgenes con pelos estrellados más grandes, el interior glabro excepto los dientes con pelos estrellados similares a los márgenes. Nectarios internos basales 5, de 1,2 mm de alto × 1,5 mm de ancho. Corola violácea; tubo de la corola ausente. Pétalos de 16–25 mm de largo × 8–10 mm de ancho, la base con abundantes pelos estrellados largos. Tubo estaminal de 9–10 mm de largo, glabro, las anteras dispuestas en una cabezuela oblonga, 4 mm de largo. Estilos y estigmas 7. Mericarpos 7, de 7 mm de largo (incluidas las aristas de 1,5 mm) × 2 mm de ancho, dorso estrellado-ciliado.

Material adicional estudiado: **ECUADOR:** Localidad desconocida, 1943, *Paredes s.n.* (F). **Bolivar:** 28–29 km NE Guaranda, Guaranda-Ambato hwy. Superpáramo, 4185 m, 01.36S 079.00W, 25 Jun 1989, *Dorr & Valdespino 6482* (AAU, CTES, F, K, MO, NY, QCA, QCNE). **Chimborazo:** Volcán Chimborazo, 4750 m, 07 Feb 1988, *Molau & Eriksen 2986* (AAU, QCA); 4400 m, 01.30S 078.52W, 12 Jul 1997, *Neill & et al. 10788* (MO, QCNE). **Cotopaxi:** Paramo Ilinizas, 4 mi W Magdalena, 4600 m, 00.39S 078.40W, 2 Abr 1991, *Bensman* 362 (MO); **Imbabura:** Páramo de Zumbagua, 4000 m, 21 Jun 1986, *Urgilés 19* (QCA); **Napo:** Quito–Baeza (Páramo de Guamaní). 4150–4250 m, 10 Oct 1976, *Øllgaard & Balslev 10084* (AAU, F, MO, NY); Volcán Antisana, 60 km SE Quito, páramo, 4200 m, 00.28S 78.05W, 14 Jun 1991, *Gentry & Ortiz 74363* (MO), 11 Ene 1979, *Holm-Nielsen 20651* (AAU, MO), Lago Mauca-Machay, 4350 m, 02 Nov 1979, *Holm-Nielsen 20721* (AAU), 28 Noviembre 1998, *Vargas & Narváez 3114* (MO, QCNE), 28 November 1998, *Neill et al. 11494* (MO, QCNE), 16 Jul 1960, *Grubb et al. 510* (NY), 19 Jul 1960, *Grubb et al. 571* (NY), 23 Jun 1979, *Black 68* (AAU), Santapamba, 4200 m, 17 Sep 1979, *Black 174* (AAU), Pamba Chuzalongo Chico, 4400 m, 14 May 1979, *Black 5* (AAU), Laguna Micacocha, 01 Jul 1979, *Løjtnant & Molau* 15388 (AAU). **Pichincha:** "In montibus Antisana et Pichincha," *Hartweg 917* (NY); "Sive Andium Quitensium," May 1859, *Jameson s.n.* (K); "Andes Quitenses," *Couthouy s.n.* (NY(2)), *Jameson s.n.* (NY), *Spruce 6542* (K); Rucu Pichincha, 4400 m, 00.10S 078.34W, 13 May 1995, *Sklenar & Kosteckova* 264 (AAU), 31 Ago 1939, *Asplund 8601* (NY, P), Loma de las Antenas, 2800 m[?], 00.07S 78.30W, 10 Sep 1995, *Clark & Fishman 1456* (QCNE, MO), 25 Jun 1934, *Heinrichs 705* (NY), 27 Abr 1920, *Holmgren 550* (F); Volcán Guagua Pichincha, 4450–4650 m, 09 Ene 1988, *Molau et al. 2387* (AAU, MO, QCA), 21 Abr 1996, *Clark 2522* (MO,QCNE), 25 May 1985, *Nowak & Marcillo 47* (QCA); Volcán Pichincha, 4100–4500 m, 17 Ago 1923, *Hitchcock 21051* (NY, US), 3 Jul 1876, *André 3878* (K, NY), 15 Abr 1930, *Benoist 2396* (LIL, P), *Mexia 7653* (MO, NY, UC), 15500 ft, *Jameson 97* (NY), *Jameson s.n.* (NY), *Jameson s.n.* (K), *Desconocido 105* (NY), *Desconocido 8* (K); Antisana, páramo 4350 m, 11 Sep 1986, *Ehrenburg 102* (QCA), 16000 ft, 16 Jul 1939, *Balls B7287* (F, K); Volcán Cayambe, 4550–4660 m, 01 Mar 1988, *Molau & Eriksen 3227* (AAU, QCA), 3 Dic 1993, *Freire-Fierro et al. 2587* (AAU, NY, QCA), 18 Jun 1980, *Holm-Nielsen 24251* (AAU, MO); Cerro Puntas, 4450 m, 09 Jun 1985, *Nowak & Marcillo 214* (QCA); Volcán Iliniza, NE slope below the refugio, 4430 m, 00.39S 78.42W, 13 Ago 1980, *Holm-Nielsen et al. 24902* (AAU, MO), 19 Mar 1995, *Clark 470* (QCNE, MO); near border with Cotopaxi, 4200–4400 m, 7 Mar 1972, *Harling 11170* (NY); **Tungurahua:** Páramo, ca. 2 km NW of the mountain Carihuairazo, 3500–4500 m, 01.24S 78.47W, 23 Abr 1995, *Clark 716* (QCNE, MO).

Distribución y conservación.—Especie endémica de los páramos del norte y centro del país entre 3500 y 4650 m. Está ampliamente distribuida y por lo tanto se la considera de Preocupación Menor (LC).

Brako y Zarucchi (1993) registraron esta especie para Perú sobre la base del ejemplar tipo y de colecciones del departamento de Huancavelica. Los ejemplares de Rauh P-374(a) y P-450 corresponden a *N. ulophylla* (A. Gray) A.W.Hill, una especie muy distinta de *N. phyllantos*. En cuanto a la colección tipo, apenas tiene la inscripción que dice "Perou," pero bien podría corresponder a alguna localidad ecuatoriana ya que en tiempos de la colonia parte de Ecuador estaba bajo la jurisdicción del Virreinato de Perú. De otra manera no habiendo registros para Perú, pensamos que la especie está restringida a Ecuador.

Fryxell (1992) cita como holotipo de *Sida pichinchensis* una muestra de Humboldt y Bonpland s.n. sobre la base de una microficha del herbario de Willdenow en Berlín. Sin embargo, el Ing. Antonio Krapovikas (com. pers.) nos indica que él considera el holotipo a la colección, por él estudiada, de Bonpland 3032 incorporada en el herbario general de París ya que ese material es el que el autor debe haber usado para describir la planta más no aquel de Berlín.

Nototriche phyllanthos es una especie bastante común, fácil de distinguir por el envés de las hojas glabro y con un brillo singular.

AGRADECIMIENTOS

Agradecemos a los curadores de los herbarios por habernos permitido estudiar o haber enviado en préstamo ejemplares de sus instituciones. C. Aedo (MA), B.Klitgaard (BM), G. Lewis (K), V. Noble (BM), P. Barriga y C. Quintana (QCA), L. Ramella (G), nos ayudaron a obtener fotografías de material depositado en esos herbarios y F. Keusenkothen escaneó la figura 3. A Paul Fryxell y Antonio Krapovickas por la minuciosa revisión del manuscrito. M. Chanco agradece al Ing. Antonio Krapovickas del Instituto de Botánica del Nordeste, Corrientes, Argentina, por las facilidades y el material botánico de estudio brindados durante la estadía en su Institución. El trabajo de campo de C. Ulloa en el sur del Ecuador se llevó a cabo con subsidios de la Nacional Geographic Society (Jørgensen 6327-98 y Ulloa 7744-02).

REFERENCIAS

Brako, L. y J.L. Zarucchi. 1993. Catalogue of the flowering plants and gymnosperms of Peru. Monogr. Syst. Bot., Missouri Bot. Gard. 45:1–1286.

Chanco, M. 1992. Dos nuevas especies de *Nototriche* (Malvaceae) del Perú. Novon 2: 12–15.

Hill, A.W. 1909. A revision of the genus *Nototriche* Turcz. Trans. Linn. Soc. London, Bot. 7:201–266, pl. 27–30.

Fryxell, P.A. 1990. New species of Malvaceae from South America. Contr. Univ. Michigan Herb. 17:163–171.

Fryxell, P.A. 1992. 118. Malvaceae, In: G. Harling & L. Andersson, eds. Fl. Ecuador 44:1–141.

Jørgensen, P.M. y S. León-Yánez (eds.). 1999. Catalogue of the vascular plants of Ecuador. Monogr. Syst. Bot., Missouri Bot. Gard. 75:1–1181.

Krapovickas, A. 1950. Una nueva especie del género *Nototriche* (Malvaceae). Bol. Soc. Argent. Bot. 3:170–173.

Krapovickas, A. 1951. Notas citotaxonómicas en *Nototriche* (Malvaceae). I. Bol. Soc. Argent. Bot. 4:107–116.

Krapovickas, A. 1953. Notas citotaxonómicas sobre *Nototriche* (Malvaceae). II. (1). Bol. Soc. Argent. Bot. 5:51–74.

Krapovickas, A. 1957a. Tres especies nuevas de *Nototriche* (Malvaceae) de Perú. Bol. Soc. Argent. Bot. 6:233–238.

Krapovickas, A. 1957b. Sobre las especies polígamas de *Nototriche* (Malvaceae). Lilloa 28: 269–277.

Krapovickas, A. 1973. Las especies de *Nototriche* publicadas por Cavanilles en "Icones et descriptiones plantarum." Bol. Soc. Argent. Bot. 15:285–286.

UICN. 2001. Categorías y criterios de la lista roja de la UICN: Versión 3.1. Comisión de Supervivencia de Especies de la UICN. UICN, Gland, Suiza y Cambridge, Reino Unido.

Valencia, R., N. Pitman, S. León-Yánez, y P.M. Jørgensen (eds.). 2000. Libro rojo de las plantas endémicas del Ecuador 2000. Herbario QCA, Pontificia Universidad Católica del Ecuador, Quito.

BOOK NOTICES

Two Books on *Agapanthus* from Timber Press

WIM SNOEIJER. 2004. **Agapanthus: A Revision of the Genus.** (0-88192-631-0, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 372 pp., 101 color photos, 9 color illus., 7 tables, 6 drawings, 6" 9".

Agapanthus is a genus from southern Africa with about 10 species, but there are hundreds of cultivars. The author has invested eight years of research and scholarship in preparing the "definitive" work on *Agapanthus* in cultivation. The author breaks down his research into six chapters: **1)** Introduction, **2)** Genome Size; **3)** Taxonomy and Nomenclature; **4)** Classification of the Cultivars; **5)** Descriptions of the Genus, Species, and Cultivars; and **6)** Cultivation. An appendix on Breeders/Introducers and Their Cultivars is followed by References and an Index.

HANNEKE VAN DIJK. 2004 **Agapanthus for Gardeners.** (0-88192-656-6, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 96 pp., 147 color photos, 1 color map, 2 line drawings, 4 color illus., 8 1/2" × 8 1/2".

Publisher Comments: "*Agapanthus for Gardeners* is an informative and practical guide to growing this popular perennial. It includes descriptions of all species and subspecies, along with a selection of 80 cultivars that have proven themselves in the garden and in containers; information on choosing and buying plants, cultivation requirements, propagation, and pests and diseases; and a discussion of *Agapanthus* as a cut flower."

"Illustrated with over 75 photographs, this is a useful companion to Wim Snoeijer's more scholarly and exhaustive *Agapanthus: A Revision of the Genus,* also published by Timber Press."

This small colorful book is truly a little jewel on "The Flower of Love." It covers everything from history to propagating to all the cultivars from A to Z.

ACERCA DE LA IDENTIDAD DE *BACCHARIS SUBSCULPTA* (ASTERACEAE: ASTEREAE)

Arturo Granda Paucar

Dpto. de Biología-Herbario
Universidad Nacional Agraria La Molina
Apdo. 456, Lima, PERÚ
a.granda@lycos.com

Daniel A. Giuliano

Dpto. Científico de Plantas Vasculares
Museo de La Plata
Paseo del Bosque s/n
B1900FWA La Plata, ARGENTINA
giuliano@museo.fcnym.unlp.edu.ar

ABSTRACT

After analyzing protologues and types, *Baccharis subsculpta* Hochr., a supposedly Peruvian endemic, is considered a synonym of the more widespread *B. pulchella* Sch. Bip. ex Griseb. A lectotype is selected for the name of the new synonym.

KEY WORDS: *Baccharis subsculpta*, *B. pulchella*, Asteraceae, Peru

RESUMEN

Después del análisis de los tipos y protólogos, *Baccharis subsculpta* Hochr., una especie peruana supuestamente endémica, es considerada un sinónimo de *B. pulchella* Sch. Bip. ex Griseb. de más amplia distribución. Se selecciona un lectotipo para el nombre del nuevo sinónimo.

PALABRAS CLAVE: *Baccharis subsculpta*, *B. pulchella*, Asteraceae, Perú

El género *Baccharis* L. (Asteraceae) es reconocido, entre las Astereae, por su primacía en cuanto al número de especies que lo integran, todas exclusivamente americanas, como por su complicada taxonomía. Sus aproximadamente 360 especies ocupan un área bastante extensa que abarca toda Sudamérica hasta alcanzar la zona sur de Estados Unidos de América, pero se extiende además por ambas costas norteamericanas más allá del paralelo 40 N. Se desarrollan en condiciones ecológicas muy dispares, habitando desde lugares húmedos hasta sitios muy secos y desde el nivel del mar hasta las mayores alturas andinas (Cuatrecasas 1969); empero, su mayor diversidad se encuentra focalizada básicamente en la región neotropical.

La delimitación de sus especies generalmente se muestra confusa y la interpretación cabal de las mismas ofrece serias dificultades, que radican en el extremo polimorfismo de muchas de ellas (o en una cierta continuidad morfológica en otras que forman complejos o alianzas de especies), así como en la gran cantidad de entidades fundadas, que las más de las veces corre pareja con la superficialidad de las diagnosis e ilustraciones que se han publicado a su respecto. A todo ello se suma su peculiar diecia, que supone una cierta diferencia en la facies de los individuos pistilados y estaminados de una misma especie—que puede inducir a confusión en el observador poco agudo—, y la distribución geográfica, que en algunas de sus especies es muy vasta, poniendo de relieve una gran capacidad adaptativa, mientras que en otras es de extensión muy limitada señalando su condición de endémicas. Por otro lado, sucede también que varias especies son halladas en el campo en poblaciones relativamente grandes, otras en cambio, se manifiestan como individuos escasos; como consecuencia, existen entidades que están bastante bien colectadas y algunas, por contraste, resultan poco representadas en herbario.

Estos factores apenas aludidos han contribuido a que la trayectoria taxonómica experimentada por algunas de las especies de *Baccharis* resultara errática pues, a menudo, una entidad tempranamente descripta, con el transcurso del tiempo, sufrió diversas interpretaciones y determinaciones erróneas; esta situación motivó que los autores posteriores que se ocuparon de alguna manera del género, utilizaran y difundieran otros epítetos para designarla. Lo dicho queda en evidencia al apreciarse la abultada sinonimia que reúnen ciertas especies, v. gr. *Baccharis salicifolia* (Ruiz & Pav.) Pers., *B. rhexioides* Kunth, *B. linearis* (Ruiz & Pav.) Pers., etc.

Baccharis pulchella Sch. Bip. ex Griseb. es un taxón distribuido desde Perú central y meridional hasta el centro de la Argentina. Desde que fuera originalmente descripta por A. Grisebach en 1879—sobre la base de una colección del viajero francés Gilbert Mandon proveniente de Sorata, Bolivia (Fig. 1)—, esta especie ha recibido la atención de otros botánicos en distintas ocasiones, quienes le aplicaron cada cual denominaciones diferentes, no teniendo en cuenta la plasticidad morfológica de la especie; ésta presenta marcado polimorfismo en varios caracteres, a saber: pubescencia (existen desde plantas densamente tomentosas hasta casi glabras), ancho de la hoja (varía desde 0,5 cm hasta 3 cm), disposición de los capítulos (reunidos en cimas corimbiformes difusas—o aun capítulos solitarios—o bien, agrupadas en racimos foliosos bien definidos). En efecto, el estudio de los tipos respectivos no ha dejado duda alguna sobre la identidad de las mismas y, en consecuencia, que se trata de nombres que han originado un listado de sinónimos en décadas recientes (Ariza Espinar 1971, 1973).

Precisamente, el asunto que nos ocupa, y que estimamos conveniente dar a conocer a continuación, ilustra un caso adicional de sinonimia en *Baccharis pulchella* que recientemente hemos advertido. En el intento de determinar ciertos ejemplares peruanos colectados poco tiempo atrás por uno de nosotros (A. G.) en el departamento de Lima, nos encontramos frente a la duda de asignarles este nombre—al que parecían ajustarse bien de acuerdo a literatura moderna (Cabrera 1978; Giuliano 2000) y al estudio de ejemplares de herbario—o, por otro lado, aplicarles el binomio *Baccharis subsculpta* Hochr., correspondiente a una rara planta peruana supuestamente endémica de territorio limeño con la que guardaban indiscutibles semejanzas morfológicas según comprobamos al observar un fototipo de la misma (Fig. 2), y a más del detalle muy sugerente de provenir del *locus typicus* de la especie antedicha, la

Fig. 1. Isotipo de *Baccharis pulchella* Sch. Bip. ex Griseb. (*Mandon 185*, NY [foto LP]).

"cuesta de Puruchuco". Estos antecedentes nos llevaron de inmediato a sospechar de la verdadera identidad de *B. subsculpta*, de modo que intentamos reunir todos los elementos de juicio a nuestro alcance para aclarar nuestra presunción de un posible caso de sinonimia; dispusimos de los protólogos y fototipos de ambas entidades con el fin de estudiarlos y realizar un análisis comparativo. A juzgar

Fig. 2. Lectotipo de *Baccharis subsculpta* Hochr. (*Matthews 758*, K [foto LP]).

por las coincidencias entre ambas diagnosis, como así por la innegable similitud entre los respectivos ejemplares originales—para *B. pulchella* especialmente en el caso del isotipo en NY, ya que los isotipos de K y LP presentan hojas más breves y angostas, demostrando su variabilidad intraespecífica—, resulta indudable que *B. pulchella* es la misma entidad que ulteriormente Hochreutiner volvió a denominar *B. subsculpta*.

Conviene hacer notar que como expresáramos anteriormente, la existencia de la diecia ha motivado, dentro de *Baccharis*, la proposición de nuevas especies basadas justamente en ejemplares funcionalmente estaminados o pistilados. Tal es el caso de *B. subsculpta*, descripta en base a especímenes correspondientes al pie estaminado exclusivamente, mientras que *B. pulchella* lo fuera a partir de ambos tipos de individuos. Sin embargo, como parte de nuestro análisis, examinamos ejemplares de diferentes poblaciones de la especie *B. pulchella*, los cotejamos con el protólogo y con fotos e imágenes del material original peruano de *B. subsculpta* (su presunto sinónimo) y, a nuestro juicio, es imposible hallar la más mínima diferencia de ningún tipo que permita fundamentar separación alguna.

Debe mencionarse que, si bien Hochreutiner incluyó a su *Baccharis subsculpta* en la sección Oblongifoliae DC., este taxón infragenérico era altamente heterogéneo y artificial según su concepción original (cfr. Candolle 1836); luego de la redelimitación que de la misma realizara Cuatrecasas (1967), queda claro que la especie no corresponde en absoluto a dicha sección. Asimismo, en el protólogo de *B. subsculpta* se menciona que la especie es muy cercana a *B. sculpta* Griseb., y que también guarda semejanzas con *B. sphaerocephala* Hook. & Arn. y con *B. grandicapitulata* Hieron.; no obstante, esta aparente similitud es sólo superficial, ya que *B. subsculpta* no presenta afinidades con ninguna de esas especies, pertenecientes a distintas secciones del género.

Por todo lo expuesto, proponemos a *Baccharis subsculpta* Hochr. como un nuevo sinónimo de la muy extendida *B. pulchella* Griseb., lo cual documentamos a continuación:

Baccharis pulchella Sch. Bip. ex Griseb., Symb. Fl. Argent. 181. 1879. TIPO: BOLIVIA. DPTO. LARECAJA: viciniis Sorata, Nov 1858–Mar 1859, *Mandon 185* (HOLOTIPO: GOET; ISOTIPOS: K [foto LP!], LP!, NY [foto LP!]).

= *Baccharis subsculpta* Hochr., Bull. New York Bot. Gard. 6(21):292. 1910. Syn. nov. TIPO: PERÚ. "Cuesta of Perruchuca [Puruchuco]," *Matthews 758* (LECTOTIPO, aquí designado, K, foto LP!); "In Peruvia interiore," *Matthews 564* (sintipo NY, foto LP!). Obs.: La selección del ejemplar *Matthews 758* como lectotipo de la especie se fundamenta principalmente en que dicho espécimen proviene de una localidad explícitamente citada, además del hecho de considerar a éste como mejor representativo de la misma.

Ejemplares examinados: **ARGENTINA. Prov. Catamarca:** Dpto. Belén, *Falcone & Castellanos 3528* (LP). Dpto. Tinogasta, *Cabrera et al. 24649* (LP). **Prov. Córdoba:** Dpto. Calamuchita, *Hunziker 7217* (CORD, LP); idem, *Roig 1111* (LP). **Prov. Jujuy:** Dpto. Santa Bárbara, *Cabrera et al. 24075, 25503* (LP). **Prov. La Rioja:** Dpto. Vinchina, *Biurrun et al. 5123* (IZAC, LP). Dpto. no identificado, *Morello 5162*

(LP). **Prov. Mendoza:** Dpto. Las Heras, *Sleumer 516* (LIL, LP). Dpto. Tunuyán, *Ruiz Leal 23050* (LP). **Prov. Salta:** Dpto. Santa Victoria, *Adler 6* (LP). Dpto. La Viña, *Burkart 13285* (LP, SI). **Prov. San Juan:** Dpto. Angaco, *Kiesling & Sáenz 4127* (LP, SI). Dpto. Sarmiento, *Kiesling & Sáenz 4177* (LP, SI). **Prov. Tucumán:** Dpto. Capital, *Venturi 913* (SI). Dpto. Chicligasta, *Venturi 4614* (LP).

BOLIVIA. Dpto. Cochabamba: Prov. Quillacollo, *Hensen 402* (SI). **Dpto. La Paz:** Prov. B. Saavedra, *Beck 11360* (SI); s/loc., *Buchtien s.n.* (LP 69942).

PERÚ. Dpto. Apurímac: Prov. Abancay, *Ferreyra 9800* (US, USM). **Dpto. Cusco:** Prov. Cusco, *Solomon 2968* (MO, USM); *Ferreyra 20841* (USM). Prov. Urubamba, *Zamalloa 61* (LP). **Dpto. Lima:** Prov. Chancay, *Cerrate 6339* (MO, USM,). Prov. Canta, *Granda 1238* (MOL); ídem, *Granda & Alegría 1293, 1318, 1319, 1984, 2232* (MOL). Prov. Huarochirí, *Cerrate & Tovar 1901* (USM).

AGRADECIMIENTOS

Agradecemos a Charlotte Taylor y a Guy Nesom por las valiosas sugerencias y aportes que condujeron a la versión definitiva del texto. El primer autor desea expresar su reconocimiento a las autoridades y al personal del Herbario del Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos (USM) por las facilidades prestadas; no olvida, por supuesto, al Bach. José Alegría por la lectura diligente del manuscrito.

REFERENCIAS

Ariza Espinar, L. 1971. Novedades sobre *Baccharis* (Compositae) de Argentina. Kurtziana 6:69–75.

Ariza Espinar, L. 1973. Las especies de *Baccharis* (Compositae) de Argentina Central. Bol. Acad. Nac. Ci. 50:175–305.

Cabrera, A. 1978. *Baccharis*. En: A.L. Cabrera, dir. Fl. prov. Jujuy 13(10):207–247. Colección Científica del Instituto Nacional de Tecnología Agropecuaria, República Argentina.

Candolle, A.P. de. 1836. *Baccharis*. Prodr. 5:398–429. París (Treuttel & Würtz).

Cuatrecasas, J. 1967. Revisión de las especies colombianas del género *Baccharis*. Revista Acad. Colomb. Ci. Exact. 13(49):5–102.

Cuatrecasas, J. 1969. *Baccharis*. En: Prima flora Colombiana 3. Compositae-Astereae. Webbia 24:233–299.

Giuliano, D.A. 2000. Subtribu Baccharidinae: *Baccharis*. En: A.T. Hunziker, ed. Fl. Fanerog. Argent. 66:6–67.

GAMOCHAETA COARCTATA, THE CORRECT NAME FOR *GAMOCHAETA SPICATA* (ASTERACEAE: GNAPHALIEAE)

John F. Pruski
Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166-0299, U.S.A.

Guy L. Nesom
Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Gamochaeta spicata "(Lam.) Cabr." is based on an illegitimate later homonym (*Gnaphalium spicatum* Lam. 1788, non P. Miller 1768) and is to be attributed as *Gamochaeta spicata* Cabr., nom. nov. Cabrera's "nomen novum," however, also is illegitimate because *Gnaphalium coarctatum* Willd., a replacement name for *Gnaphalium spicatum* Lam., is the first legitimate name for Lamarck's plant. Details in the publication and specimen citations are clarified for the typification of **Gamochaeta coarctata** (Willd.) Kerg., the correct name in *Gamochaeta* for this species. *Gnaphalium spicatum* P. Miller is a synonym of *Pterocaulon virgatum* (L.) DC. *Gnaphalium spicatum* (Forssk.) Vahl is a synonym of *Ifloga spicata* (Forssk.) Sch. Bip.

RESUMEN

Gamochaeta spicata "(Lam.) Cabr." está basado en un homónimo posterior ilegítimo (*Gnaphalium spicatum* Lam. 1788, non P. Miller 1768) y debe consignarse como *Gamochaeta spicata* Cabr., nom. nov. El "nomen novum" de Cabrera, sin embargo, es también ilegítimo ya que *Gnaphalium coarctatum* Willd., un nombre reemplazo de *Gnaphalium spicatum* Lam., es el primer nombre legítimo para la planta de Lamarck. Para la clarificación de la tipificación de **Gamochaeta coarctata** (Willd.) Kerg., el nombre correcto en *Gamochaeta* de esta especie, se brindan detalles acerca de la publicación y citación de los especímenes. *Gnaphalium spicatum* P. Miller es un sinónimo de *Pterocaulon virgatum* (L.) DC. *Gnaphalium spicatum* (Forssk.) Vahl es sinónimo de *Ifloga spicata* (Forssk.) Sch. Bip.

During work preliminary to treatments for *Flora Mesoamericana* and *Flora of North America*, we noted that the species previously identified as *Gamochaeta* (*Gnaphalium*) *spicata* (Lam.) Cabr. (Compositae: Gnaphalieae) should be called *Gamochaeta coarctata* (Willd.) Kerg. Kerguélen's combination (1987) was made preliminary to the Flora of France, after *Flora Europaea* (Holub in Tutin et al. 1976), and it has not been widely used. For example, *Gamochaeta spicata* was used in Freire (1995), but *Gamochaeta coarctata* was correctly used subsequently by Freire & Iharlegui (1997) and Cabrera et al. (2000). Typification of *Gamochaeta coarctata*, however, has been confused, and because the species is a worldwide weed (e.g., Cabrera 1961; Drury 1971; Kerguélen 1987; Nesom 2004a, 2004b), we provide details of typification necessary for convincing use of the name.

In essence, the name *Gnaphalium spicatum* was validly published by three different authors for three different species from three different continents; these species are now referred to three different genera. *Gnaphalium spicatum* Lam. (1788) is the only one of the three that refers to a *Gamochaeta* species. It was used as a legitimate name by Cabrera (1961), but it is an illegitimate later homonym of *Gnaphalium spicatum* P. Mill. (1768). Vahl's combination (1790), based on *Chrysocoma spicata* Forssk., added the third *Gnaphalium spicatum*. Willdenow (1803) provided a replacement name (*Gnaphalium coarctatum*) for Lamarck's (1788) illegitimate *Gnaphalium spicatum*. Cabrera (1961) resurrected *Gamochaeta* from synonymy within *Gnaphalium*, but Kerguélen (1987) was the first to correctly use the first legitimate name for Lamarck's type in *Gamochaeta*.

The nomenclature and taxonomy of the three different names *Gnaphalium spicatum* are as follows:

1. Gnaphalium spicatum P. Miller, Gard. Dict., ed. 8, *Gnaphalium* no. 24. 1768. SYNTYPE: JAMAICA: *Sloane 38 Volume 5:26* (BM, digital image!). It is possible that a Miller collection from the Chelsea Botanic Garden, England is preserved in the Banks herbarium (BM).

Current name.—*Pterocaulon virgatum* (L.) DC.

Distribution.—southern United States to South America (Cabrera & Ragonese 1978).

Miller's protologue reads "24 *Gnaphalium* (*spicatum*) foliis lanceolatis decurrentibus tomentosis, floribus spicatis terminalibus lateralibusque." Additionally, Miller (1768) cited "Elichrysum caule alato, floribus apicatis. Sloan. Cat. Jam. 125," in direct reference to Sloane's polynomial "Helichrysum caule alato, floribus spicatis" (Sloane, 1696:125) as illustrated in Sloane (1707:tab. 152, fig. 5!). Miller stated that the plant "grows naturally in Jamaica, and in other of the hot parts of America" and that it "flowers in July and August, but never perfectly sets seed in England."

Gnaphalium spicatum P. Miller, was not cited in the monograph of *Pterocaulon* (Cabrera & Ragonese 1978) but was listed by Jackson (1893) as a synonym of *Pterocaulon virgatum* (L.) DC. Based on our observation of the Sloane syntype (BM) of *Gnaphalium spicatum* P. Miller, of the cited original illustration (Sloane 1707) of *Gnaphalium spicatum* P. Miller, and of the lectotype of *Gnaphalium virgatum* L. (LINN 993.29, IDC microfiche 177. 578.II.5!), we treat *Gnaphalium spicatum* P. Miller as a synonym of *Pterocaulon virgatum* (L.) DC.

2. Gnaphalium spicatum (Forssk.) Vahl, Symb. Bot. 1:70. 1790, hom. illegit., non P. Miller 1768. *Chrysocoma spicata* Forssk., Fl. Aegypt. 73. 1775. *Ifloga spicata* (Forssk.) Schultz-Bip. in Webb & Berthelot, Hist. Nat. Iles Canaries, vol. 3 (2, sect. 2):310. 1836–1850 [1845]. TYPE: EGYPT: 1761–1763, *Forsskal s.n.* (HOLOTYPE: C, IDC 2200 27.I.1!).

Current name.—*Ifloga spicata* (Forssk.) Schultz-Bip.

Distribution.—Canary Islands, northern Africa east to Pakistan (Davis 1975:100–101).

This widespread herb less than 15 centimeters tall with densely crowded and spiralling filiform leaves and axillary capitula was described from Egyptian material. This species was referred to *Gnaphalium* (Vahl 1790) and in turn to *Ifloga* (Schultz-Bipontinus 1844–1850). Davis (1975) and Anderberg (1991) treated this species as *Ifloga spicata* (Forssk.) Schultz-Bip.

3. Gnaphalium spicatum Lam., Encycl. Méth. Bot. 2:757. 1788, hom. illegit., non P. Miller 1768. *Gnaphalium coarctatum* Willd., Sp. Pl. 3(3):1886. 1803, nom. nov. *Gnaphalium purpureum* L. var. *spicatum* Klatt, Linnaea 42:140. 1878, nom. et stat. nov. *Gamochaeta spicata* Cabr., Bol. Soc. Argent. 9:380. 1961, nom. illegit. *Gamochaeta coarctata* (Willd.) Kerg., Lejeunia 120:104. 1987. TYPE: URUGUAY. Montevideo, *Commerson s.n.* [HOLOTYPE: P-LAM, IDC microfiche 6207.325.I.1!; possible ISOTYPE: P (photographs F!, GH!, TEX!, all photographs from C.B.G.N. negative 37573)].

Cabrera (1961:380–381) cited a sheet ("Des environs de Buenos Ayres... *Commerson*") seen in P as "type" of *Gnaphalium spicatum* Lam. Drury (1971) cited the same sheet as lectotype. The locality on the label of this sheet (Buenos Aires, Argentina) conflicts with that of Lamarck's protologue ("Monte-video"), and the lectotype selection by Drury is rejected here. Although Montevideo, Uruguay, and Buenos Aires, Argentina, are 200 km apart and on different banks of the Río La Plata, these two sheets are, nevertheless, conceivably of the same gathering. The sheet labeled "Buenos Ayres" is listed here as a possible "isotype" not lectotype.

Current name.—*Gamochaeta coarctata* (Willd.) Kerg.

Distribution.—cosmopolitan weed.

The names listed in the above citation of *Gnaphalium spicatum* Lam. are homotypic. *Gnaphalium coarctatum* Willd. (1803) is treated as having been originally a nomem novum for Lamarck's plant, and it dates from 1803. In providing a replacement name for Lamarck's *Gnaphalium spicatum*, Willdenow (1803:1886) cited the locality as "Monte Video" (echoing Lamarck's citation) for the species. On the same page, Willdenow treated the name *Gnaphalium spicatum* (Forssk.) Vahl as referring to an Egyptian species, citing *Chrysocoma spicata* Forssk. as a synonym (see #2, above). In the *Gnaphalium* treatment, Lamarck (1788) did not specifically refer to the earlier *Gnaphalium spicatum* P. Miller.

Cabrera's (1961:380) intended transfer of Lamarck's illegitimate name to *Gamochaeta* (as "*Gamochaeta spicata* (Lam.) comb. nov.") is to be treated as having been originally a nomem novum. *Gamochaeta spicata* Cabr., however, is illegitimate (vidi ICBN Art. 52.1) because the "available" and legitimate *Gnaphalium coarctatum* should have been adopted. Kerguélen (1987) treated *Gnaphalium coarctatum* and *Gnaphalium spicatum* Lam. as homotypic and supplied the correct (in *Gamochaeta*) combination for this plant.

Gamochaeta spicata was treated as a synonym of *Gamochaeta americana* (P. Miller) Wedd. by Nesom (1990), but *G. coarctata* commonly differs from *G. americana* by stems being up to 60 (vs. to 25) cm tall, basal leaves wider (vs. narrower) than 8 mm, involucres 3–4 (vs. 4.5) mm high, and phyllaries blunt and straight (vs. acute, cuspidate, and reflexed), as noted by Drury (1971).

ACKNOWLEDGMENTS

We appreciate the reviews and comments by John Strother and Kanchi Gandhi.

REFERENCES

Anderberg, A.A. 1991. Taxonomy and phylogeny of the tribe Gnaphalieae (Asteraceae). Opera Bot. 104:1–195.

Cabrera, A.L. 1961. Observaciones sobre las Inuleae-Gnaphalineae (Compositae) de América del Sur. Bol. Soc. Argent. Bot. 9:359–386.

Cabrera, A. L. and A.M. Ragonese. 1978. Revision des género *Pterocaulon* (Compositae). Darwiniana 21:185–257.

Cabrera, A.L., J.V. Crisci, G. Delucchi, S.E. Freire, D.A. Guiliano, L. Iharlegui, L. Katinas, A.A. Saenz, G. Sancho, and E. Urtubey. 2000. Catálogo ilustrado de las Compuestas (= Asteraceae) de la Provincia de Buenos Aires, Argentina: Sistemática, Ecología y Usos. Secretaria de Política Ambiental, Buenos Aires.

Davis, P.H. (ed.). 1975. Compositae. Flora of Turkey and the East Aegean Islands, vol. 5. University Press, Edinburgh.

Drury, D.G. 1971. The American spicate cudweeds adventive to New Zealand (*Gnaphalium* section *Gamochaeta* - Compositae). New Zealand J. Bot. 9:157–185.

Freire, S.E. 1995. 280. Asteraceae, parte 2. Tribu IV. Inuleae. Flora Fanerogámica Argentina. Fascículo 14:1–60. PROFLORA, CONICET, Córdoba.

Freire, S.E. and L. Iharlegui. 1997. Sinopsis preliminar del género *Gamochaeta* (Asteraceae, Gnaphalieae). Bol. Soc. Argent. Bot. 33:23–35.

Holub, J. 1976. *Gamochaeta*. In: Tutin, T.G., V.H. Heywood, N.A. Burges, D.H. Valentine, S.M. Walters & D.A. Webb, eds. Flora Europaea, vol. 4. Cambridge Univ. Press, Cambridge. P. 127.

Jackson, B.D. 1893. Index kewensis, vol. 1: A–J. Clarendon Press, London.

Kerguélen, M. 1987. Données taxonomiques, nomenclaturales et chorologiques pour une révision de la flore de France. Lejeunia 120:1–264.

Lamarck, J.B. 1788. Encyclopédie méthodique: botanique, vol. 2. Panckoucke, Paris.

Miller, P. 1768. The gardeners dictionary, ed. 8. Rivington Printers, London.

Nesom, G.L. 1990. The taxonomic status of *Gamochaeta* (Asteraceae: Inuleae) and the species of the United States. Phytologia 68:186–198.

Nesom, G.L. 2004a. New species of *Gamochaeta* (Asteraceae: Gnaphalieae) from the eastern United States with comments on similar species. Sida 21:717–741.

Nesom, G.L. 2004b. New distribution records for *Gamochaeta* (Asteraceae: Gnaphalieae) in the United States. Sida 21:1175–1185.

Schultz-Bipontinus, C.H. 1844–1850. Compositae. In: P.B. Webb & S. Berthelot. 1836–1850. Histoire naturelle des Iles Canaries, vol. 3 [Botanique], part 2, sect. 3. Bureaux, Paris. Pp. 203–473 + figs. 82–136B.

Sloane, H. 1696. Catalogus plantarum quae in insula Jamaica. D. Brown Printers, London.

Sloane, H. 1707. A voyage to the islands Madera, Barbados, Nieves, S. Christophers and Jamaica, with the natural history of the herbs and trees. 2 vols. B.M. Printers, London.

Steudel, E.T. 1840. Nomenclator botanicus, ed. 2, vol. I: A–K. Tubingae, Stuttgart.

Vahl, M. 1790. Symbolae botanicae, vol. 1. Printed privately, Copenhagen.

Willdenow, C.L. 1803. [Syngenesia, vol. 3, part 3, pages 1477–2409]. Caroli a Linné species plantarum. Nauk, Berlin.

A REVISION OF *AGOSERIS APARGIOIDES* (ASTERACEAE: LACTUCEAE)

Gary I. Baird

Department of Biology, Brigham Young University–Idaho, 525 S. Center St.
Rexburg, Idaho, 83460-1100, U.S.A., bairdg@byui.edu

ABSTRACT

A brief review of *Agoseris apargioides* is presented. The species is redefined to exclude *A. hirsuta*, a grassland species found along the Coast Ranges of California. *Agoseris apargioides* occurs on coastal dunes along the Pacific coast from central California to Washington. Three varieties are recognized: var. *apargioides*, var. *eastwoodiae*, and var. *maritima* (E. Sheld.) G.I. Baird, comb. et stat. nov.

RESUMEN

Se presenta una breve revisión de *Agoseris apargioides*. La especie se redefine para excluir *A. hirsuta*, una especie que se encentra en los pastos a lo largo de las cordilleras costeras de California. *Agoseris apargioides* aparece en las dunas costeras a lo largo de la costa del Pacífico desde el centro de California hasta Washington. Se reconocen tres variedades: var. *apargioides*, var. *eastwoodiae*, y var. *maritima* (E. Sheld.) G.I. Baird, comb. et stat. nov.

In 1816, the Romanzov Expedition (1815–1818) spent the month of October at the Spanish presidio on the north side of what is now San Francisco, California (Chamisso 1836). At this time, L. A. von Chamisso, a member of the expedition, collected the type of *Agoseris apargioides* (Less.) Greene. This species occurs on coastal dunes along the Pacific coast from central California to Washington. In the protologue, Lessing (1831) noted a peculiar feature of this plant: due to its preference for dune habitats, the stems often are buried by drifting sands, leaving a terminal rosette of leaves exposed. These buried stems become pseudorhizomatous, a feature unique within the genus.

In his monograph of *Agoseris*, Jones (1954) mistakenly interpreted the type description of *A. apargioides* as belonging to an allied but separate species, *A. hirsuta* (Hook.) Greene. *Agoseris hirsuta* is a grassland species found along the Coast Ranges of California. It is strictly acaulescent and only rarely occurs adjacent to the Pacific shore (and then not on dunes). Jones (1954) incorrectly treated *A. hirsuta* as "*A. apargioides* ssp. *apargioides*" and *A. apargioides* as "*A. apargioides* ssp. *maritima*." This last subspecies was based on *A. maritima* E. Sheld., the type collected at Coos Bay, Oregon. Within ssp. *maritima*, Jones (1954) recognized two varieties: "var. *maritima*" and "var. *eastwoodiae*," this last variety based on *A. eastwoodiae* Fedde, the type collected at Bodega Bay, California. Jones' (1954) view of *A. apargioides* has been the basis for all recent treatments of this species (e.g., Jones 1960; Chambers 1993).

In my recent monograph of *Agoseris* (Baird 1996), it became apparent that Jones (1954) had misinterpreted *A. apargioides*. The name *A. hirsuta* is here reestablished as the correct name for the inland species. *Agoseris apargioides* is redefined to include just those plants that occur along the Pacific coastal strand. Three variants within *A. apargioides* are morphologically and geographically distinct.

SIDA 21(2): 715–716. 2004

Agoseris apargioides (Less.) Greene, Pittonia 2:177. 1891. *Troximon apargioides* Less., Linnaea 6:501. 1831. TYPE: U.S.A. CALIFORNIA. San Francisco, Oct 1816, *Chamisso s.n.*

Perennials, ± caulescent, buried stems pseudo-rhizomatous. Leaves linear to spathulate, entire to lobate, or filiformly pinnatifid, 3–15 cm × 1–30 mm, glabrous to villous, mostly prostrate to reclining; lobes 3–5(–7) pairs, filiform to spathulate. Scapes 7–45 cm, villous to tomentose, glandular or not. Involucres obconic to hemispheric, 1.5–2.5 cm tall; phyllaries in 2–4 series, glabrous to tomentose and ± glandular; receptacle naked. Florets 25–200; corollas yellow; tubes 2–5.5 mm; ligules 3–16 × 1–3 mm; anthers 1.5–4.5 mm. Achenes 5–12 mm, beaked; body fusiform to obconic, 3–5 mm; beak 3–8 mm. Pappi of bristles, 4–9 mm. $x = 18$.

KEY TO VARIETIES

1. Corolla ligules 3–6 mm long, involucres non-glandular ____ var. **maritima**
1. Corolla ligules 8–16 mm long, involucres ± glandular.
    2. Leaves oblanceolate to spathulate, dentate to lobate; involucres densely villous to tomentose ____ var. **eastwoodiae**
    2. Leaves linear to oblanceolate, entire to dentate or filiformly pinnatifid, involucres glabrous to villous ____ var. **apargioides**

Agoseris apargioides var. **apargioides**. Occurs from San Francisco south to Pt. Sur.

Agoseris apargioides var. **eastwoodiae** (Fedde) Munz, Aliso 4:100. 1958. = *Agoseris eastwoodiae* Fedde, Bot. Jahresb. 31:808. 1904. TYPE: U.S.A. CALIFORNIA. Sonoma Co.: Bodega Point, 4 Jul 1900, *Eastwood s.n.*

Occurs from Pt. Reyes north to about Pt. Arena.

Agoseris apargioides var. **maritima** (E. Sheld.) G.I. Baird, comb. et stat. nov. = *Agoseris maritima* E. Sheld., Bull. Torrey Bot. Club 30:310. 1903. = *Agoseris apargioides* subsp. *maritima* (E. Sheld.) Q. Jones ex Cronq., Vasc. Pls. Pacif. Northw. 5:24. 1955. TYPE: U.S.A. OREGON. Clatsop Co.: Clatsop Beach, 21 Aug 1902, *Sheldon 11250.*

Occurs from Humboldt Bay, California, to Neah Bay, Washington.

ACKNOWLEDGMENTS

I thank the curators and staff at BM, CAS, DS, GH, JEPS, K, NY, ORE, OSC, POM, UC, US, WILLU, and WTU for their assistance with loan materials. I appreciate the prompt and excellent comments of Guy Nesom (BRIT).

REFERENCES

BAIRD, G.I. 1996. The systematics of *Agoseris* (Asteraceae: Lactuceae). Ph. D. diss., Univ. of Texas, Austin.

CHAMBERS, K.L. 1993. *Agoseris*. In: Hickman, J.C. ed. The Jepson manual: higher plants of California. Berkeley, Los Angeles & London. Pp. 190–193.

CHAMISSO, L.A. VON. 1836. A voyage around the world with the Romanzov exploring expedition in the years 1815–1818 in the brig Rurik, Captain Otto von Kotzebue. Translated and edited by H. Krantz. 1986. Honolulu.

JONES, Q. 1954. Monograph of *Agoseris*, tribe Cichorieae. Ph. D. diss., Harvard Univ., Cambridge.

JONES, Q. 1960. 153. *Agoseris* Raf. In: Abrams, L. and R.S. Ferris, eds. Illustrated flora of the Pacific States, vol. 4: Compositae. Stanford. Pp. 562–567.

LESSING, C.F. 1831. De plantis in expeditione Romanzoffiana: observatis disserere pergitur. Synathereae Addendae. Linnaea 6:501.

NEW SPECIES OF *GAMOCHAETA* (ASTERACEAE: GNAPHALIEAE) FROM THE EASTERN UNITED STATES AND COMMENTS ON SIMILAR SPECIES

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Gamochaeta argyrinea Nesom, sp. nov., is documented from 19 states, primarily in the southeastern U.S.A., and from Puerto Rico. It is a common and abundant species of ruderal habitats and has usually been identified within a broad concept of *Gamochaeta purpurea*, which has a similar but broader geographic range. *Gamochaeta argyrinea* apparently is most closely similar to *G. ustulata*, another species commonly identified as *G. purpurea* but native to the Pacific coast region of the U.S.A. and adjacent Canada. **Gamochaeta chionesthes** Nesom, sp. nov., is described from localities in Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, South Carolina, and North Carolina—these plants also have been identified previously primarily as *G. purpurea*. A key and distribution maps are provided for the six species of *Gamochaeta* in the U.S.A. with strongly bicolored leaves: *G. argyrinea*, *G. ustulata*, *G. chionesthes*, *G. purpurea*, *G. simplicicaulis*, and *G. coarctata*. The name *Gamochaeta americana* has been misapplied to *G. coarctata*, but *G. americana* sensu stricto has not been documented for the U.S.A.; it occurs in the Antilles, Central America, Mexico, and South America and is reported to occur elsewhere as an adventive. In order to further clarify its identity, a technical description and commentary are provided for *G. americana*.

RESUMEN

Se documenta **Gamochaeta argyrinea** Nesom, sp. nov., de 19 estados, principalmente del Sureste de U.S.A., y de Puerto Rico. Es una especie común y abundante en hábitats ruderales y ha sido identificada usualmente dentreo del concepto amplio de *Gamochaeta purpurea*, que tiene un rango geográfico similar pero más amplio. *Gamochaeta argyrinea* es aparentemente más parecida a *G. ustulata*, otra especie identificada comúnmente como *G. purpurea* pero nativa de la región costera del Pacifico de U.S.A. y Canadá adyacente. **Gamochaeta chionesthes** Nesom, sp. nov., se describe de localidades de Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, Carolina del Sur, y Carolina del Norte—estas plantas también han sido identificadas previamente como *G. purpurea*. Se ofrece una clave y mapas de distribución de las seis especies de *Gamochaeta* de U.S.A. con hojas bicolores: *G. argyrinea*, *G. ustulata*, *G. chionesthes*, *G. purpurea*, *G. simplicicaulis*, y *G. coarctata*. El nombre *Gamochaeta americana* ha sido mal aplicado a *G. coarctata*, pero *G. americana* sensu stricto no se ha documentado para U.S.A.; está en las Antillas, América Central, México, y América del Sur y se cita de otros lugares como adventicia. Se ofrece una descripción técnica y comentarios sobre *G. americana* para clarificar su identidad.

Studies of North American *Gamochaeta* Wedd. (Godfrey 1958; Nesom 1990) have identified plants with leaves strongly bicolored (persistently white-pannose abaxially with a closely matted vestiture completely obscuring the epidermis, evidently green to grayish green adaxially) mostly as *Gamochaeta purpurea*

SIDA 21(2): 717–741. 2004

(L.) Cabr. Review of North American plants shows that more species are present than recognized in these earlier studies and also that some names have been misapplied. Taxonomic studies of *Gamochaeta* in New Zealand (Drury 1971; Webb 1988), where all the species are non-native and include a number of those found in the U.S.A., have been more discerning, at least in some respects, than previous studies of North American species.

In the present study, two species that have been identified mostly as *Gamochaeta purpurea* are described as new to science. One is distributed over a large part of the eastern U.S.A. and also is known from Puerto Rico; the other is known from Gulf Coast states of the U.S.A. Neither of new species keys unambiguously in a recent overview of *Gamochaeta* (Freire & Iharlegui 1997), and a survey of the genus in South America and Central America indicates that neither of these species now recognized in North America has received a name, although it is possible that one or both is native to South America. It also is possible that both are weeds widely distributed on several continents. Hypotheses regarding the nativity of all species of *Gamochaeta* occurring in the U.S.A. are provided in an accompanying discussion (Nesom 2004). All of the species in North America with strongly bicolored leaves are reviewed here.

The distinctiveness of *Gamochaeta* as a genus was emphasized by Cabrera (1961 and later floristic treatments of South American species, e.g., 1963, 1971, 1974, 1978), Dillon and Sagástegui (1991a, 1991b), Cabrera and Freire (1998), and by other botanists who have treated it (e.g., Nesom 1990; Anderberg 1994; Freire & Iharlegui 1997). *Gamochaeta* is distinguished by its combination of small heads in a spiciform capitulescence, concave post-fruiting receptacles, truncate collecting appendages of the disc floret style branches, small achenes with minute, mucilage-producing papilliform trichomes on the surfaces, and pappus bristles basally connate in a smooth ring and released as a single unit.

A widespread new species from eastern U.S.A. related to *Gamochaeta ustulata*

Godfrey (1958) noted variation within what he identified as *Gnaphalium purpureum* and I have observed *Gamochaeta (Gnaphalium) purpurea* sensu stricto growing in close proximity to a "variant" or intermixed with it in many localities in eastern North America. Intergradation apparently occurs rarely if at all and the two entities can be consistently and accurately distinguished, both in the field and herbarium. In fact, the variant is more similar and probably more closely related to *Gamochaeta ustulata* (Nutt.) Holub, a species apparently native to western North America (see comments and description below) than to *G. purpurea*. The plants of eastern North America are recognized here as a previously undescribed species and documented to occur in 19 states.

Gamochaeta argyrinea Nesom, sp. nov. (**Figs. 1, 2, 3, 4, 6**). TYPE: U.S.A. NORTH CAROLINA. Pender Co.: Hwy 421 at junction with Hwy 210, between towns of Currie and Rocky Point, roadsides and grassy median strip, in sandy soil; in close association with *Gamochaeta purpurea* sensu stricto, *Gamochaeta pensylvanica*, *Gamochaeta antillana*, and *Gamochaeta*

PLANTS OF NORTH CAROLINA

Gamochaeta argyrinea Nesom

Pender County. Hwy 421 at junction with Hwy 210, between Currie and Rocky Point. Roadsides and grassy median strip. Sandy soil. Five species of *Gamochaeta*, commonly intermixed along roadside: *G. pensylvanica*, *G. purpurea*, *G. coarctata*, *G. antillana*, and *G. argyrinea*. *Gamochaeta coarctata* and *G. argyrinea* in median strip. Common. **HOLOTYPE.**

28 April 2001
Guy Nesom WMGT 16

Fig. 1. Habit of *Gamachaeta argyrinea*.

PLANTS OF GEORGIA
ASTERACEAE

Gamochaeta chionesthes Nesom, ined.

Meriwether County. Town of Gay, mowed lawn of U.S. Post Office on Hwy 74/85, near jct with Hwy 109. Loamy soil. *Gamochaeta coarctata* and *G. chionesthes* present and abundant at this site; *G. argyrinea* uncommon
Common and abundant. Few plants with involucres lighter colored than normal.
TYPE COLLECTION: HOLOTYPE

14 April 2004
G.L. Nesom GASC04–14

Fig. 2. Habit of *Gamochaeta chionesthes*.

coarctata, all growing along the roadside, 28 Apr 2001, *G. Nesom WMGT-14* (HOLOTYPE: BRIT; ISOTYPES: AKU, BM, BRIT, CANB, CANU, F, GA, GH, K, LP, MEXU, MO, NCU, NSW, NY, P, RB, S, TEX, UC, US, USF).

Differt a *Gamochaeta purpurea* radicibus plerumque fibrosis, foliis caulinis oblanceolatis vel oblanceolati-spathulatis, trichomatis paginarum foliarium adaxialium filiformibus ad basi a apici, capitulis 3–3.5 mm altis, phyllariis intimis laminis oblongis truncato-rotundatis apiculatis ad apices, et flosculis bisexualibus (3–)4–6.

Plants annual to winter annual, densely fibrous-rooted, rarely slender-taprooted. **Stems** decumbent-ascending from the base, 12–40 cm tall, simple or few-branched, closely white-pannose, the vestiture usually of individually evident trichomes, less commonly nearly cloth-like. **Leaves** basal and cauline, basal persisting and green through flowering, basal and lower cauline oblanceolate to oblanceolate-oblong or oblanceolate-obovate, 1.5–5(–8) cm long, 5–12(–18) mm wide, gradually reduced in size upward, not clasping or decurrent, bicolored, closely white-pannose abaxially, persistently very sparsely arachnoid adaxially (sometimes necessary to examine at 10x). **Capitulescence** cylindric in early season, 1.5–5 cm long, 10–12 mm wide (pressed), later producing axillary glomerules from lower nodes and elongating, becoming strongly interrupted and up to 18 cm long (but still narrowly cylindric). **Involucres** campanulate, 3–3.5 mm, imbedded at base in cottony tomentum; phyllaries in 4–6 series, outermost ovate-acute to ovate-lanceolate, tawny-transparent, 1/3–4/5 as long as the inner, inner elliptic-oblong to oblong, stereome ca. 2/3 the length, lamina apically truncate-rounded and apiculate, flexing slightly outward at maturity, hyaline-translucent and slightly brownish-tinged, often purplish tinged around the stereome/lamina junction; receptacles shallowly concave. **Florets**: bisexual 4–5(–6), all corollas purple- to yellow-brown-tipped; pistillate numerous in a broad zone. **Cypselae** oblong, 0.5–0.6 mm long, tan, papillate.

Flowering Mar–Jun(–Jul, –Oct). Roadsides, fields, lawns, open woods, sand to sandy clay, almost always in open, disturbed areas; ca. 0–250 m. USA: Alabama, Arkansas, Delaware, Florida, Georgia, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia; Puerto Rico; Argentina?, New Zealand?, Australia?, Portugal? In the southeastern U.S.A., *Gamochaeta argyrinea* commonly grows with *G. coarctata* and *G. chionesthes*. The epithet (from Gr. *argyreos*, silvery) alludes to the silvery appearance of the plants, especially when growing in colonies.

Representative specimens examined. **U.S.A. ALABAMA. Marion Co.:** Hamilton, vacant lot, sandy loam, 22 Apr 1966, *Shinners 31207* (SMU). **ARKANSAS. Cleburne Co.:** Tumbling Shoals, rocky bluffs, 500 ft, 19 May 1951, *Demaree 39517* (SMU). **DELAWARE. Sussex Co.:** 4 mi SE of Laurel, open ground at Moore's (Trussum) Pond, 19 May 1939, *Tatnall 4163* (DOV). **FLORIDA. Leon Co.:** near Tallahassee, fallow field, 31 Mar 1955, *Godfrey 53123* (SMU). **GEORGIA. Clarke Co.:** Athens, along River Road, moist roadside, 700 ft, 2 May 1947, *Cronquist 4369* (SMU). **KANSAS. Cherokee Co.:** tallgrass prairie hay meadow, openings, T34S, R24E, Sec 24, 5 May 1988, *McGregor 38825* (VDB). **KENTUCKY. Whitley Co.:** N of Jellico, meadow, 11 Jul 1937, *Smith and Hodgdon 3808* (GH). **LOUISIANA. Lincoln Parish:** Dubach, low ground by hwy, sandy clay, 1 May 1955, *Shinners 19976* (SMU). **MARYLAND. Calvert Co.:** St. Leonard, District No. 1, 3 Aug 1956, *Seymour 16837* (MO). **MISSISSIPPI. Rankin Co.:** 1 mi E of Rankin-Madison County line, Hwy 43, sandy weedy field, 2 May 1970, *Jones 18632* (SMU). **MISSOURI. Howell Co.:** 3.5 mi N of Brandsville, rocky, brushy pastureland, 25 Apr 1992, *Summers 4827* (MO). **NORTH CAROLINA. Davidson Co.:** ca. 12 mi ESE of Lexington on Hwy 64, 0.7 mi E of jct. Hwy 109, loamy soil of roadbank below steep road cut, area of white oak-hickory woods, 30 May 2001, *Nesom GX1* (BRIT, NCU, MO, US). **Wake Co.:** E. Raleigh, Longview Gardens, fallow field, 20 Apr 1948, *Godfrey 48072* (SMU). **OKLAHOMA. Delaware Co.:** 8.5 mi SE of Jay, open woods hillside, chert rock soil, 22 Apr 1967, *Stephens 10543* (SMU). **PENNSYLVANIA. Northumberland Co.:** Herndon, in dry soil along roadside, 30 Sep 1930, *Moldenke 4186* (NY). **SOUTH CAROLINA. Berkeley Co.:** 0.5 mi N of Honey Hill, sandy soil along route 45, 16 Apr 1971, *Churchill s.n.* (SMU). **TENNESSEE. Knox Co.:** Knoxville, U.T. campus, lawn, 19 Apr 1968, *Morton 2861* (SMU). **TEXAS. Brazos Co.:** near Peach Creek, open areas in woods, 7 Apr 1974, *Fryxell 2367* (SMU). **VIRGINIA. Charles City Co.:** 7.5 mi W of Rustic, 30 Apr 1970, *Ware 2870* (VDB). **WEST VIRGINIA. Cabell Co.:** base of Robert's Hill, Milton, 1 May 1938, *Williams 699* (MO).

PUERTO RICO. Barranquitas region, wet place, 700 m, 14 Nov 1979, *Liogier 30027* (NY, UPR); Cuilarte Forest, on slope, 900 m, 16 Jan 1980, *Liogier 30271* (NY, UPR). **Ciales:** Los Tres Picachos, Rt 149, km 35.5, dirt road through old coffee plantation, disturbed wet mountain forest, ca. 600–750 m, 14 Mar 1992, *Axelrod 4213* (NY, UPRRP). **Ponce:** Bo. Anón, Toro Negro Forest Reserve, trail along SE side of Monte Jayuya, wet mountain forest, ca. 1200 m, 24 Apr 2003, *Axelrod 12545* (BRIT); near Cerro de Punta, Jayuya, in thickets, 1200 m, 10 Apr 1982, *Liogier 33089* (NY, UPR); rte 143 at Cerro de la Punta, roadsides and thickets, 1000 m, 29 May 1988, *Taylor 8116* (UPRRP). **Salinas:** Barrio Lapa, Las Tetas de Cayey, summit area of E. peak, 820–830 m, low exposed thicket near brink of cliff, 31 Mar 1988, *Proctor 44634* (SJ).

A population in Davidson Co., N.C. (*Nesom GX1*, as cited above) is a variant—the plants tend to produce small tubers or cormlike swellings. Plants of other populations in the same area often produce offsets that are nearly rhizome-like (e.g., Davie Co., N.C., *Nesom GX2*, BRIT).

Essential differences that distinguish *Gamochaeta argyrinea* from *G. purpurea* are given in the following couplet.

a. Basal leaves persistent and green at flowering; cauline leaves oblanceolate to oblanceolate-oblong or oblanceolate-obovate, trichomes of adaxial leaf surfaces filiform from base to tip; involucres 3–3.5 mm high; inner phyllaries with lamina oblong, apically truncate-rounded and apiculate; bisexual florets 4–5(–6) per head ____ **Gamochaeta argyrinea**

a. Basal leaves usually withered and becoming deciduous at flowering; cauline leaves spatulate, trichomes of adaxial leaf surfaces with basal cells expanded and vitreous; involucres 4–4.5 mm high; inner phyllaries with lamina triangular, apically acute but not apiculate; bisexual florets 3–4 per head ____ **Gamochaeta purpurea**

Plants common in the Pacific coast region have usually been identified as *Gamochaeta purpurea*, but they are more similar to *G. argyrinea* and are identified here as *G. ustulata*. New Zealand plants identified by Drury (1971) and Webb (1988) as *G. purpurea* var. *ustulata* have measurements characteristic of *G. ustulata*, but plants in Portugal identified as *G. ustulata* by Afonso (1984) are more likely *G. argyrinea*. *Gamochaeta ustulata* (Figs. 3, 4, 7) is recognized by its fibrous rooted habit, large, weakly bicolored leaves persistently arachnoid on

Fig. 3. Involucres of *Gamochaeta* species (left to right). (Top) *G. argyrinea*, *G. ustulata*, *G. coarctata*, *G. americana*, (bottom) *G. purpurea*, *G. chionesthes*, and *G. simplicicaulis*.

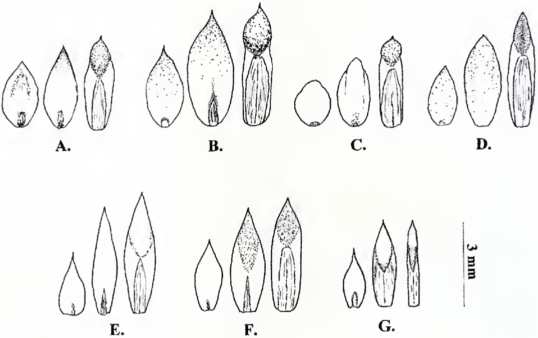


Fig. 4. Phyllary morphology of *Gamochaeta* species: outer, middle, and inner phyllary for each species. **(A)** *G. argyrinea*, **(B)** *G. ustulata*, **(C)** *G. coarctata*, **(D)** *G. americana*, **(E)** *G. purpurea*, **(F)** *G. chionesthes*, and **(G)** *G. simplicicaulis*.

the adaxial surfaces, and large brownish capitula in a thick, usually continuous capitulescence. It differs from *G. purpurea* in its longer duration, thicker and shorter stems, wider and more compact capitulescence, larger capitula, and prominently brown, blunt-apiculate inner phyllaries with a subterminal keel. *Gamochaeta ustulata* and *G. argyrinea* differ primarily by features in the following couplet.

a. Capitulescence 12–18 mm wide (pressed), uninterrrupted or rarely so and only at the base, mostly 1–6(–8) cm long; involucres 4.5–5 mm high; outer phyllaries and often lamina of inner phyllaries dark brown, commonly the whole involucre with a dark brown cast; mid phyllaries with a low, subterminal keel; cypselae 0.7–0.8 mm long ____ **Gamochaeta ustulata**

a. Capitulescence 10–12 mm wide (pressed), early uninterrupted and 1.5–5 cm long, later producing axillary glomerules from lower nodes and elongating, becoming strongly interrupted and up to 18 cm long; involucres 3–3.5 mm high; phyllaries greenish-silvery to stramineous or golden, sometimes light brown but the whole involucre not with a dark brown cast; phyllaries not keeled; cypselae 0.5–0.6 mm long ____ **Gamochaeta argyrinea**

Gamochaeta ustulata (Nutt.) Holub, Folia Geobot. Phytotax. 11:83. 1976 (non Nesom, Phytologia 68:196. 1990). *Gnaphalium purpureum* var. *ustulatum* (Nutt.) Boivin, Naturaliste Canad. 87:34. 1960. *Gnaphalium ustulatum* Nutt., Trans. Amer. Philos. Soc. ser. 2, 7:404. 1841. LECTOTYPE (Nesom 1990): USA. CALIFORNIA: Near St. Barbara in Upper California, [March or April 1836], *T. Nuttall s.n.* (BM, GH-photo!, TEX-photo!).

Gnaphalium pannosum Gandoger, Bull. Soc. Bot. France 65:42. 1918 (non A. Gray 1883; non Schultz-Bip. 1845). SYNTYPES: USA. WASHINGTON. Klickitat Co.: on damp ground, Columbia River, 10 May 1893, *W.N. Suksdorf 1580* (NY-2 sheets, US!); WASHINGTON. Chehalis Co.: near Montesano, 200ft, 8 Jun 1898, *A.A. Heller 3919* (NY-2 sheets!). Images of both the Suksdorf and Heller collections can be seen on NY and US internet sites.

Plants annual to biennial or short-lived perennial, fibrous-rooted. **Stems** erect to ascending, commonly decumbent-ascending and rhizome-like, 10–40 cm tall, densely white-pannose. **Leaves** basal and cauline, basal persistent but often withering by flowering, spatulate to oblanceolate, 2–5 cm long, 6–12(–35) mm wide, apiculate, not clasping or decurrent, continuing upwards little reduced until into the capitulescence, weakly bicolored, adaxial surfaces sparsely to densely arachnoid with persistent trichomes, closely white-pannose abaxially. **Capitulescence** 1–6(–8 or more) cm long, 12–18 mm wide (pressed), uninterrrupted or rarely so and only at the base. **Involucres** campanulate-urceolate, 4.5–5 mm high, base imbedded in cottony tomentum; outer phyllaries broadly triangular-ovate, half as long as the inner, all with a brown or greenish-brown cast, inner with lamina dark brown, apically abruptly obtuse and (on the middle phyllaries) with a low, subterminal keel and apiculum, sometimes purplish at the stereome-lamina junction; receptacles shallowly concave. **Florets:** bisexual (3–)4–6, all corollas yellowish- or sometimes purplish-tipped; pistillate numerous in a broad zone. **Cypselae** oblong, 0.7–0.8 mm long, tan to brownish, papillate.

Flowering Apr–Jul(–Oct). Mostly in coastal and near-coastal localities: dunes and other sandy sites, ocean bluffs, less commonly in clay-loam, fields, roadsides and roadcuts, ditches, cliffs, pine woods, chaparral slopes, tidal marsh edges; 0–650(–1050) m. California, Oregon, and Washington; southwestern British Columbia.

A new species from the Gulf coastal plain

Another species with strongly bicolored leaves, known to me from eight states of the U.S.A. Gulf coastal plain, appears to be undescribed. Among species occurring in North America (including Mexico), it is similar in general aspect to *Gamochaeta argyrinea* because of the basally decumbent-ascending stems, white-pannose vestiture, bicolored leaves (gray-green abaxially), the basal in a persistent rosette, and mostly oblanceolate cauline leaves, but conspicuous details of the vestiture, phyllary morphology, and cypselae are different. It keys to the area of *G. purpurea* and *G. americana* (P. Miller) Wedd. in Freire y Iharlegui (1997), emphazing the bicolored leaves and acute to acuminate inner phyllaries. Concepts of *G. americana* by Cabrera (1963, 1971, 1974), Cabrera and Freire (1998), and others may represent or include this North American species, judging from illustrations of involucral and phyllary morphology, but *G. americana* sensu stricto, as interpreted here (see below), does not occur in the U.S.A. It is possible or even likely that the new species is native to South America, as it is known by relatively few and recent collections in the U.S.A.

Gamochaeta chionesthes Nesom, sp. nov. (**Figs. 2, 3, 4, 8**). TYPE: U.S.A. GEORGIA. Meriwether Co.: town of Gay, mowed lawn of U.S. Post Office on Hwy 74/85, near jct with Hwy 109, loamy soil, *Gamochaeta coarctata* , *G. argyrinea*, and *G. chionesthes* present and abundant at this site, 14 Apr 2004, *G. Nesom GASC04-14* (HOLOTYPE: BRIT; ISOTYPES: CANB, GA, GH, K, LP, LSU, MO, NCU, NY, P, TEX, UNA, US, USF).

Differt a *Gamochaeta purpurea* caulibus ac paginis adaxialibus foliorum with vestimento tenui albido textiloideo, foliis basalibus numerosis persistentibus, foliis caulinis oblanceolatis vel oblanceolati-spathulatis, involucris 3–3.5 mm altis, flosculis plerumque luteis (vs. purpureis) ad apices, phyllariis omnibus apicibus aut laminis brunneis, et cypselis pupureis.

Plants annuals to winter annuals, fibrous-rooted. **Stems** erect to decumbent-ascending from the base, 10–45 cm tall, simple or rarely few-branched, closely white-pannose, the vestiture sheath-like, like a continuous covering by a thin, closely appressed, polished cloth formed of filiform trichomes usually not individually evident. **Leaves** basal and cauline, basal persisting and green through flowering, basal and lower cauline oblanceolate to oblanceolate-spatulate, 2–6(–7) cm long, 5–13 mm wide, gradually reduced upward in size to linear bracts into the lower part of the capitulescence, not clasping, strongly bicolored, light green above but persistently lightly arachnoid with extremely closely appressed, nearly microscopic trichomes, closely white-pannose abaxially. **Capitulescence** cylindric in early season, mostly 3–5(–7) cm long, 10–12 mm wide (pressed), later producing axillary glomerules from lower nodes and elongating, sometimes strongly interrupted and up to 20 cm long. **Involucres** campanulate-cylindric, 3.5–4 mm long, base imbedded in cottony tomentum and lightly arachnoid on the lower 1/4–1/2; phyllaries in 4–5 series, all apically acute to acute-acuminate, outermost ovate, 1/3 as long as the inner, inner oblong-lanceolate, with green stereome ca. 3/5 the length of the phyllary, lamina apically acute, not apiculate, lightly striate, slightly flaring outward at maturity, purplish coloration absent or faint and present only at stereome apex and distal margins; receptacles shallowly concave. **Florets:** bisexual 2–4, all corollas brownish-yellow to purple distally, sometimes purple only on adaxial surface of bisexual corolla lobes; pistillate numerous in a broad zone. **Cypselae** oblong, 0.5–0.6 mm long, purple, papillate.

Flowering (Mar–)Apr–May(–Jun). Disturbed, open sites, especially roadsides, clearings, fields, flood plains, low pastures, lawns and almost any other place that has been mowed, sandy, loamy, and clay soil; 0–200 m; Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina. *Gamochaeta chionesthes* is abundant and common at least in Georgia and Alabama, where it often grows with *G. coarctata* and *G. argyrinea*. The epithet (Gr. *chioneos*, snowwhite, and *esthes*, clothing) alludes to the bright white, cloth-like covering of the stems and abaxial leaf surfaces.

Collections examined. **U.S.A. ALABAMA. Baldwin Co.:** Gulf Shores State Park, arid inland sand hills with *Quercus* spp., *Pinus glauca*, and shrubs, 11 Apr 1966, *Iltis 25208b* (WIS); Spanish Fort, sandy field by Ala. 225, 0.5 mi N of jct US 31, 27 Mar 1971, *Kral 41865* (MO). **Bibb Co.:** Cahaba River at Hwy 24, 2.8 mi SE of Blocton, rocky woods and low, sandy soil of floodplain, 12 May 1977, *Sessler 1329* (VDB). **Chilton Co.:** S of Clanton on Interstate Hwy 65, 4.4 mi S of jct with Hwy 31/22, grassy roadsides, 17 May 2001, *Nesom AL2K1-10* (BRIT). **Choctaw Co.:** low pasture beside Tombigbee River bridge of Ala Hwy 10, 22 Jun 1966 [past mature fruit], *Clark 3084* (NCU); 8.8 mi N of Toxey, longleaf pine hills, 15 Apr 1967, *Kral 28371* (VDB). **Conecuh Co.:** Repton, sandy loam of clearing in pine flatwoods by US 84, 5 May 1988, *Kral 74710* (VDB). **Coosa Co.:** roadside on dirt road N of Peckerwood Creek, ca. 1 mi S of Talladega Springs, 29 Apr 1967, *Clark 11391* (NCU); site of Sears Chapel Methodist Church on Hwy 231, 2.3 mi N of jct Hwy 22 in Rockford, open field, cemetery, and roadside, rocky soil, 17 May 2001, *Nesom AL2K1-7* (BRIT, CANB, LSU, MISS, UARK, UNA). **Greene Co.:** by small ditch in Forkland, 6 May 1967, *Naugle G264* (LSUS). **Lee Co.:** 2–3 mi W of junction Ala Hwys 22 and 280, N of Phoenix City, shortleaf pine-oak, sandy soil, 10 May 1969, *Lazor 3161* (NCU). **Pike Co.:** roadside of Banks Hwy, 5 mi N of Troy, 24 Apr 1967, *Shirah 39* (NCU). **Talladega Co.:** ca. 3 mi S of Childersburg (at jct of Hwys 280 and 8) on Ala. Hwy 8, area of cutover woods, pine-mixed hardwood, gravelly clay soil, very common along roadside, 17 May 2001, *Nesom AL2K1-3* (BRIT, MISS, UARK, UNA, US, USF). **Winston Co.:** downtown Haleyville, abandoned homesite near Central Bank, 7 Jun 1975, *Whetstone 4507* (NCU). **ARKANSAS. Hot Springs Co.:** Malvern P.O., Magnet Cove, rocky ridges, 600 ft, 24 Apr 1973, *Demaree 66292* (MO). **FLORIDA. Baker Co.:** 5 mi W of Glen St. Mary, grassy roadside shoulders, 1 May 1959, *Godfrey 58540* (VDB). **Escambia Co.:** N edge of Pensacola, open grassy bank of field, 1 May 1982, *Correll 53821* (NY, USF); just N of Pensacola, E side of US 29 just S of its jct with Burgess Road, 20 May 1981, *Wilhelm and Ladd 8859* (USF). **Leon Co.:** Tallahassee, common in vacant lots, 6 Apr 1958, *Godfrey 56420* (NY-3 sheets). **Washington Co.:** dry roadside, US Hwy 90, 3.2 mi W of Chipley, 12 May 1967, *Ward 6486* (NCU). **GEORGIA. Appling Co.:** along Hwy 121 in town of Surrency, 0.2 mi S of jct Hwy 341/27, front lawn and road border of deserted house, 15 Apr 2004, *Nesom GASC04–38* (BRIT). **Ba-**

con Co.: along Hwy 32, 4 mi W of jct Hwy 23/4-1 in Alma, mowed roadside and lawn-like area between truck stop store and highway, sandy soil, 15 Apr 2004, *Nesom GASC04—34* (BRIT). **Bulloch Co.:** ca. 15 mi SW of Statesboro along Hwy 321, at jct with Hwy I-16, mowed roadside area, gravelly soil, 15 Apr 2004, *Nesom GASC04—45* (BRIT). **Coffee Co.:** E side of city of Douglas on Hwy 32, near jct Hwy 221/135, lawn area of business, 15 Apr 2004, *Nesom GASC04—32* (BRIT). **Cook Co.:** weedy area between highway and a railroad at Cecil, 30 Apr 1970, *Faircloth 6624* (NCU). **Fayette Co.:** N side of Fayetteville, along Hwy 314, ca. 2 mi N of jct with Hwy 85, roadside, mowed, beside strip of pine woods, 14 Apr 2004, *Nesom GASC04—4* (BRIT, GA). **Fulton Co.:** S side of Atlanta area on Hwy 279 (Old National Highway) 2.5 mi S of I-85/285, at jct with Flat Shoals Road, closely mowed lawn area of quick-stop food store, 14 Apr 2004, *Nesom GASC04—2* (BRIT). **Grady Co.:** upland pine woods alongside a logging trail on Balfour's Nickelville forest, 6.3 mi S of Whigham, 11 Apr 1970, *Faircloth 6541* (MO, NCU). **Greene Co.:** 3 mi SW of Greenboro on Hwy 44, at jct with I-20, lawn area of commercial strip bordering highway, 16 Apr 2004, *Nesom GASC04—57* (BRIT, GA). **Lee Co.:** 7 mi E of Leesburg on Hwy 32 at jct with Hwy 91 to Albany, W side of junction, large mowed field on N side of road, drier than roadsides, compacted sand, 15 Apr 2004, *Nesom GASC04—26* (BRIT, GA, LP, MO). **Montgomery Co.:** 2.4 mi E of Ailey on US 80, 18 May 1976, *Solomon 5562* (MO). **Morgan Co.:** S side of Madison, just off Hwy 129/24 at jct with I-20, lawn area of motel, sloping toward southeast, 16 Apr 2004, *Nesom GASC04—58* (BRIT). **Newton Co.:** S side of Covington, at jct of I-20 and Hwy 142, grassy area beside access road from I-20 to Hwy 142, 16 Apr 2004, *Nesom GASC04—59* (BRIT). **Screven Co.:** Georgia welcome station, N side of Hwy 301 ca. 0.2 mi W of South Carolina state line, mowed lawn area, 16 Apr 2004, *Nesom GASC04—48a* (BRIT). **Sumter Co.:** S side of Americus, at jct Hwy 280/49 and Hwy 19, mowed lot beside pecan orchard, sandy loam, 15 Apr 2004, *Nesom GASC04—22* (BRIT, GA). **Tatnall Co.:** ca. 7 mi SW of Mendes on Hwy 169, at jct Hwy 121, mowed area with lawn grass, beside store, 15 Apr 2004, *Nesom GASC04—41* (BRIT). **Turner Co.:** E side of Ashburn on Hwy 107, mowed, lawn-like area between car wash and store, 15 Apr 2004, *Nesom GASC04—29* (BRIT, NCU). **Warren Co.:** ca. 6 mi NW of Norwood on Hwy 278, at jct of I-20, grassy roadside, 16 Apr 2004, *Nesom GASC04—56* (BRIT). **LOUISIANA. Lincoln Par.:** [Ruston], Illinois Central Railway right of way, clay soil, 3 May 1984, *Wise 39* (DOV). **Natchitoches Par.:** W of Natchitoches near jct of Interstate Hwy 49 and La Hwy 6, hard-packed sandy soil in front of gas station complex, past flower and fruit, 5 Jul 2004, *Nesom GA04—63* (BRIT). **MISSISSIPPI. Covington Co.:** right-of-way, US Hwy 49, 11.8 mi N of Hattiesburg, 8 May 1966, *Temple 2746* (NCU). **Scott Co.:** Raworth Recreation Area, between Forest and Morton, sticky dark clay soil, open areas in loblolly pine forest, 1 May 1970, *Jones 18493* (VDB). **NORTH CAROLINA. Bladen Co.:** 0.2 mi E of Cape Fear River on NC 41, dry roadside [alongside] flood plain forest, 16 May 1976, *Solomon 1895* (MO). **Duplin Co.:** jct of Hwy 40 and Hwy 117, just N of Magnolia, grassy roadsides, edge of ditch, edge of woods, sandy soil, intermixed with *G. purpurea*, *G. coarctata*, and *G. argyrinea*, 28 Apr 2001, *Nesom WMGT 6* (BRIT, MO, NCU, US). **SOUTH CAROLINA. Aiken Co.:** S side of New Ellenton, at jct of Hwy 278 and Hwy 19, roadside area, sandy soil, 16 Apr 2004, *Nesom GASC04—53* (BRIT, LSU, NCU, USCH). **Aiken Co.:** area of Beech Island (SE of Augusta) near jct of Hwy 278 and Hwy 125, at Beech Island Avenue, ca. 7 mi SE of N. Augusta, roadside and ditch edges, sandy soil, 16 Apr 2004, *Nesom GASC04—54* (BRIT, F, MISS, US, USCH). **Allendale Co.:** along Hwy 301, 5.2 mi WSW of jct Hwy 125/278 in Allendale, 8 mi ENE of Savannah River and state line, grassy roadside median of 4-lane highway, sandy soil, 16 Apr 2004, *Nesom GASC04—50* (BRIT, LP, USCH). **Bamberg Co.:** ca. 2 mi NE of Ulmer, at jct of Hwy 301 and Hwy 321, broad lawn area of Connelly Motel, 16 Apr 2004, *Nesom GASC04—51* (BRIT, K, USCH). **Barnwell Co.:** SE side of Barnwell on Hwy 64, 1.8 mi ESE of jct Hwy 3 in Barnwell, mowed, sandy field beside lookout tower, 16 Apr 2004, *Nesom GASC04—52* (BRIT, USCH).

As noted above, *Gamochaeta chionesthes* is similar to *G. argyrinea*, but the former is distinct in significant features, including habit and phenology, vestiture, capitulescence and involucral morphology, and cypselar color. The early-season branches of *G. chionesthes* lie nearly flat, with capitulescences on ascending branch tips. The early branches of *G. argyrinea* are basally decumbent-ascending to ascending, but the capitulescences are more quickly borne on stems completely erect or with erect distal portions. The difference in habit is particularly evident in mid-April, because *G. chionesthes* is several weeks later in phenological development and usually lies nearly flat at the same time that *G. argyrinea* is producing abundant, erect flowering branches. Because of this, it is easy to distinguish the two species when they grow intermixed or in close proximity, as is often the case. Additionally, the stems and leaves of *G. chionesthes* are stiff, almost brittle-feeling, compared to the softer ones of *G. argyrinea*.

The cauline vestiture *Gamochaeta chionesthes* is cloth-like, formed of filiform trichomes usually not individually evident but united in a continuous covering like a thin, closely appressed, polished cloth; the abaxial leaf vestiture sometimes is similar. In the closely pannose cauline vestiture of *G. argyrinea* and *G. purpurea*, the trichomes usually are individually evident in their longitudinal orientation; the cauline vestiture of *G. coarctata* also usually is cloth-like, similar to that of *G. chionesthes*. The "tightening" of the individual trichomes apparently is accentuated during drying, because this feature is more easily observed on herbarium specimens.

The phyllaries of *Gamochaeta chionesthes* are evenly graduate in length, all apically acute and usually the whole lamina or at least the apex of each is brown, usually giving the whole involucre a distinctly brown hue; purplish coloration is absent or faint and present only at stereome apex and distal margins. The brown hue of the involucres is a good "field" character even without a lens; with a field lens, the difference in phyllary shape between *G. chionesthes* and *G. argyrinea* is easily evident. And finally, if mature cypselae are present, the purple ones of *G. chionesthes* are distinct from those of similar U.S.A. species, which are tan.

Gamochaeta chionesthes is contrasted individually with both *G. purpurea* and *G. argyrinea* in the following pair of couplets. In the context of all U.S.A. species with strongly bicolored leaves, *G. chionesthes* also is identified in a key further below.

Gamochaeta chionesthes contrasted with *G. purpurea*:

a. Cauline vestiture a white, closely appressed, cloth-like covering, trichomes usually not individually evident; basal leaves abundant and persistent; cauline leaves oblanceolate to oblanceolate-spatulate; adaxial leaf surfaces appearing not hairy but with a whitish, minutely thin, closely appressed, sheath-like or cloth-like covering (sometimes incomplete) without individually evident trichomes; involucres 3–3.5 mm high; florets mostly yellowish at the apices; inner phyllaries with brown-tinted lamina—purplish coloration, when present on phyllaries, faint and only at the apex and distal margins of the stereome; cypselae purple __________ **Gamochaeta chionesthes**

a. Cauline vestiture densely but loosely pannose or pannose-tomentose; basal leaves often few or not persistent; cauline leaves distinctly spatulate; adaxial leaf surfaces loosely arachnoid, trichomes with basal cells expanded and vitreous; involucres 4–4.5 mm high; florets strongly purplish-tipped; inner phyllaries with whitish or slightly silvery lamina at maturity, often purplish when young; cypselae tan __________ **Gamochaeta purpurea**

Gamochaeta chionesthes contrasted with *G. argyrinea*:

a. Cauline vestiture a white, closely appressed, cloth-like covering, trichomes usually not individually evident; phyllaries evenly graduate in length, all phyllaries apically erect, acute to acute-acuminate, and with brown apex or lamina; bisexual florets 2–4; cypselae purple __________ **Gamochaeta chionesthes**

a. Cauline vestiture closely pannose with trichomes individually evident, minutely filiform and longitudinally oriented, the vestiture uncommonly cloth-like; phyllaries unevenly graduate in length, outer and middle phyllaries ovate to ovate-lanceolate, apically obtuse to broadly acute, inner phyllaries with lamina oblong with apex slightly spreading, truncate-rounded and apiculate, hyaline-translucent and slightly brown; bisexual florets 4–5(–6); cypselae tan __________ **Gamochaeta argyrinea**

Identity of *Gamochaeta purpurea* sensu stricto

Gamochaeta purpurea (Figs. 3, 4, 5) is distributed widely through the world, but the name has been used in various contexts in the U.S.A, often to identify any plant of *Gamochaeta* with bicolored leaves. A narrower, more accurate concept is documented here.

Gamochaeta purpurea (L.) Cabr., Bol. Soc. Argentina Bot. 9:377. 1961. *Gnaphalium purpureum* L., Sp. Pl. 854. 1753. Type: Linnaeus noted "Habitat in Carolina, Virginia, Pensylvania." A Kalm collection (LINN fiche!) may be part of the type material. Two specimens in the Clayton Herbarium (BM) were annotated by James Reveal in 1990 as syntypes: U.S.A. In Virginia, *J. Clayton 385* (GH-photo!, internet images! at <http://internt.nhm.ac.uk/cgi-bin/botany/clayton>). Accessed March 2004.

Gnaphalium rosaceum I.M. Johnston, Contr. Gray Herb. ser. 2, 68:99. 1923. *Gamochaeta rosacea* (I.M. Johnst.) Anderb., Opera Bot. 104:157. 1991. Type: MÉXICO. San Luis Potosí: region of San Luis Potosí, 1878, *C.C. Parry and E. Palmer 426* (holotype: GH!).

Gnaphalium heteroides Klatt, Linnaea 42:137. 1878. Type: MEXICO: locality unspecified, *Ehrenberg 972* (GH fragment and drawings!).

Plants winter annual or annual, fibrous-rooted or slender-taprooted. **Stems** erect to basally ascending-decumbent, 10–40(–50) cm, densely but loosely pannose or pannose-tomentose. **Leaves** basal and cauline, oblanceolate-spatulate to spatulate, basal and lower cauline 1–6 cm long, 5–14 mm wide, persisting or withering at flowering, similarly shaped leaves continuing into at least the lower part of the capitulescence, sometimes closely sinuate on the margins, usually strongly bicolored, closely white-pannose abaxially, adaxial surfaces loosely and sparsely arachnoid, the trichomes with basal cells expanded and vitreous, often glabrescent but at least the basal cells of each trichome persisting. **Capitulescence** initially a continuous cylinder 1–4(–5) cm long, (5–)10–15 mm

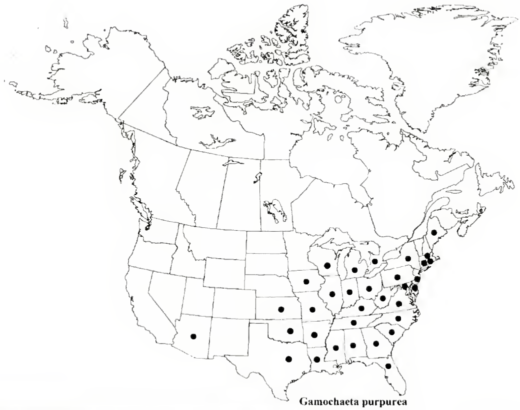


Fig. 5. State-level distribution of *Gamochaeta purpurea*.

wide, the arrangement becoming interrupted and elongate, of widely separated, bracteate glomerules, with lower axillary glomerules often on long peduncles. **Involucres** turbinate-cylindric, 4–4.5 mm long, base imbedded in cottony tomentum and lightly arachnoid on the lower 1/3–1/2; outer phyllaries ovate-triangular, inner triangular-lanceolate, apically acute, usually with a prominently striate texture, lamina purplish when young, becoming whitish or slightly silvery at maturity; receptacles shallowly concave. **Florets:** bisexual florets 3–4, all corollas usually purplish-tipped; pistillate numerous in a broad zone. **Cypselae** oblong, 0.6–0.7 mm long, tan, papillate. $2n = 14, 28$, but identities of vouchers for these chromosome reports need to verified.

Flowering Apr–May(–Jun). Open, usually disturbed habitats, roadsides, fields, woodland clearings and edges, almost always in sand; Canada (Ontario); USA (Arkansas, Arizona, Alabama, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachussetts, Michigan, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia); Hawaii; Mexico (Nuevo León, San Luis Potosí, Veracruz, Puebla, Michoacan, Chihuahua, Sonora), Central America (Nicaragua), Antilles (Hispaniola); also reported in South America and as adventive in other parts of the world. In the western U.S.A., *G. purpurea* has

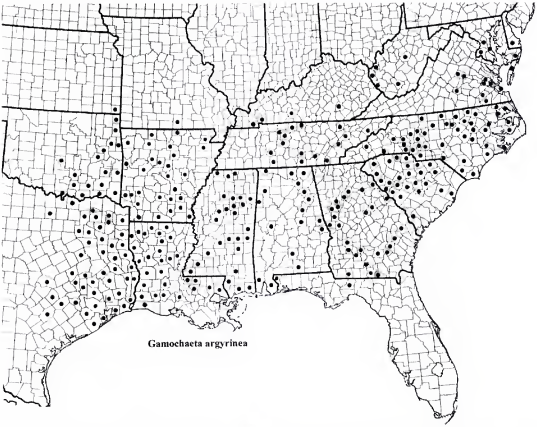


Fig. 6. County-level distribution of *Gamochaeta argyrinea*. With more intensive herbarium surveys and collecting, the distribution probably would be shown as nearly continuous (all counties; personal observation) at least in North Carolina (except perhaps high montane), South Carolina, Georgia, Alabama, Mississippi, and Arkansas. The implied loop in Georgia reflects the route of a collecting trip made in April 2004. The only known record for Pennsylvania (Northumberland Co., as cited in the text) is not shown on the map.

been recorded only from Arizona (see comments and documentation in Nesom 2004). *Gamochaeta purpurea* commonly occurs in disturbed sites, but at least in the eastern and southeastern USA, it seems more often to occur in more nearly natural sites, such as woodland edges and clearings, it is true to sandy soil, and it is my impression that in the last 50 years, *G. purpurea* probably has become much less common. *Gamochaeta purpurea* is uncommon compared to *G. argyrinea*, *G. chionesthes*, and *G. coarctata* (personal observation), in the range of the latter three. The species is rare or extirpated in the northeastern U.S.A. (summary in Kartesz 1999), where the latter three do not occur. *Gamochaeta purpurea* was excluded from Wisconsin's flora by Wetter et al. (2001), but Cochrane (pers. comm. 2004) notes that an undated collection from Sheboygan by Charles Goessl (WIS, photocopy-BRIT!) probably should be accepted as a valid record, although it probably was a garden weed or waif; it remains the only collection for the state. The species is described by Voss (1996) as "doubtless adventive" in the few southern counties of Michigan from which it is known.

Gamochaeta purpurea is recognized by its mostly spatulate cauline leaves,

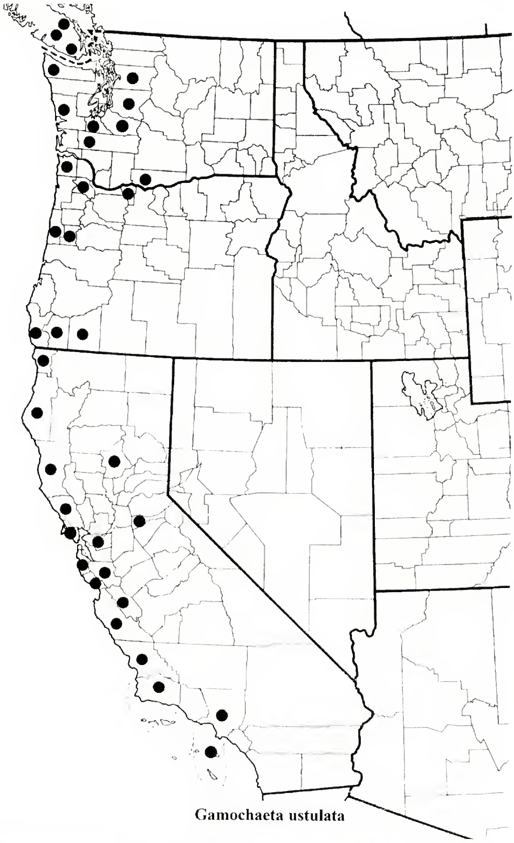


Fig. 7. County-level distribution of *Gamachaeta ustulata*.

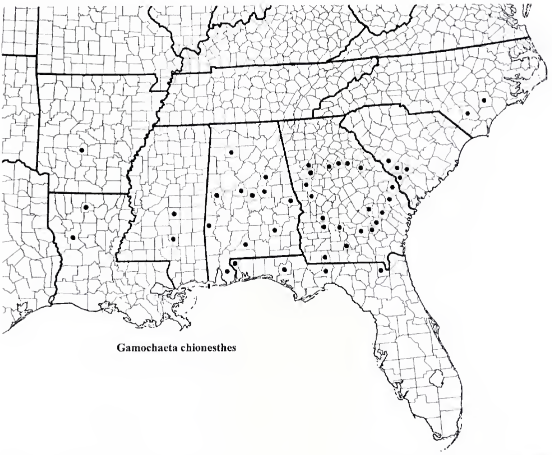


Fig. 8. County-level distribution of *Gamochaeta chionesthes*. At least in Georgia and Alabama, this species is much more common than indicated by the map, and it probably extends across South Carolina. The loop shown in Georgia and South Carolina reflects an April 2004 collecting trip, where the author found it remarkably simple to collect the species in every county sampled.

involucres 4–4.5 mm high, and inner phyllaries with whitish-hyaline, erect, apically acute lamina. The purple-tipped corollas are visible through the translucent lamina. The base of the trichomes on the adaxial leaf surfaces also is a diagnostic character—the basal cells of each trichome are expanded and glassy (use a lens), compared to comparable trichomes of most other species, which are evenly filiform to the very base. The pronouncedly spatulate leaves are distinctive and with experience, one can usually distinguish this species from others by leaf shape, but it is admittedly a subtle difference and the leaf dimensions of *G. purpurea* are similar to those in other species. In localities from Maryland northward, plants of *G. purpurea* are clearly annual, usually producing a small basal rosette and very shallow fibrous roots or a filiform taproot; southward and southwestward from Maryland, the basal rosette tends to be larger and the fibrous roots denser, and plants may be winter annual in this region, or at least the longer growing season is reflected in the plant habit.

I have identified *Gamochaeta purpurea* in various localities in Mexico (state

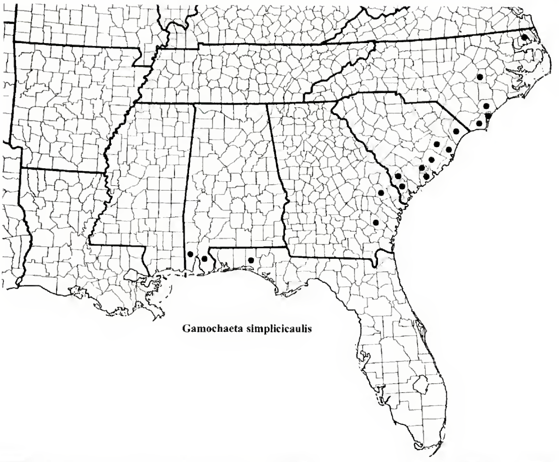


Fig. 9. County-level distribution of *Gamochaeta simplicicaulis*.

citations above) at elevations of 1300–2800 meters. Phyllaries of these plants characteristically are distinctly brownish on the lamina and apices, but the plants otherwise are similar to those of the U.S.A.

Gamochaeta coarctata vs. *Gamochaeta americana* in the USA.

Plants of the U.S.A. previously identified as *Gamochaeta americana* (e.g., Nesom 1990, 1999) are here identified as *Gamochaeta coarctata* (Willd.) Kerg. (Figs. 3, 4, 10). Godfrey (1958) correctly identified these plants as *Gnaphalium spicatum*, although the latter name is now treated as a synonym. *Gamochaeta coarctata* occurs mostly in the southeastern states and also apparently is naturalized in California (see Nesom 2004).

Gamochaeta coarctata (Willd.) Kerg., Lejeunia 120:104. 1987. *Gnaphalium spicatum* Lam., Encycl. Méth. Bot. 2:757. 1788, hom. illegit. (non P. Miller 1768). *Gnaphalium coarctatum* Willd., nom nov., Sp Pl. 3(3):1886. 1803. *Gnaphalium radians* Benth. var. *spicatum* (Lam.) Klatt, nom. illeg., Linnaea 42:140. 1878. *Gnaphalium purpureum* L. var. *spicatum* (Lam.) Baker in Mart., nom. illeg., Fl. Bras. 6(3):125. 1882. *Gamochaeta spicata* Cabr., nom. nov. illeg., Bol. Soc Argent. 9:380. 1961. HOLOTYPE: [URUGUAY]. "In Monte-video," *Commerson s.n.* (P-LAM, IDC microfiche 6207.325.I.1!). Cabrera (1961, p. 380–381) cited as "lectotype" of *Gnaphalium spicatum* Lam. "Des environs de Buenos Ayres," without date, *Commerson s.n.* Lamarck's protologue,

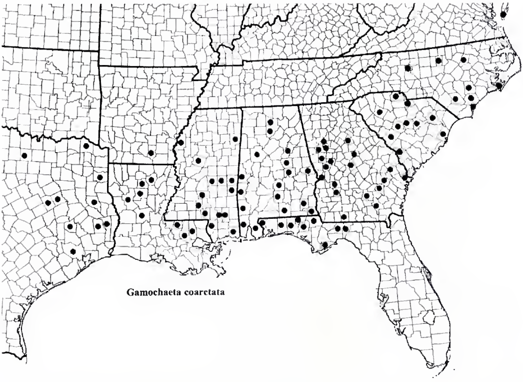


Fig. 10. County-level distribution of *Gamochaeta coarctata*. At least within the outline implied by the records mapped here, the distribution is essentially continuous (all counties; personal observation), probably reflecting a rapid, recent spread. Counties of occurrence in California are cited in Nesom (2004).

however, specified the locality as "Monte-video," as does the P-LAM sheet cited above as holotype. See Pruski and Nesom (2004) for discussion of the typification of this species.

Plants winter annual or biennial(?) herbs, fibrous-rooted. **Stems** basally decumbent-ascending, 15–35(–50) cm tall, usually several from the base, white-pannose, the tomentum usually sheath-like. **Leaves** basal and cauline, basal in a persistent rosette, spatulate to oblanceolate-obovate, (1.5–)3–8(–12) cm long, 6–15(–22) mm wide, cauline gradually or little reduced in size above the basal, not clasping or decurrent, slightly succulent and often becoming crenulate-margined upon drying, strongly bicolored, the adaxial surfaces green and glabrate to completely glabrous, closely white-pannose abaxially. **Capitulescence** usually a dense and continuous cylinder 2–20 cm, becoming branched and highly interrupted in older plants with elongation of branches at lower nodes. **Involucres** cylindric-campanulate, 2.5–3 mm high, shiny and completely glabrous from base to apex; phyllaries: outermost elliptic-obovate to broadly elliptic ovate with rounded to obtuse apices, often slightly but distinctly purplish or rosy, 1/3–1/4 as long as the inner, inner with a distinctly brown-hyaline, apically rounded to blunt, apiculate lamina; receptacles shallowly concave. **Florets:** bisexual 2–3, all corollas usually purplish-tipped; pistillate numerous in a broad zone. **Cypselae** oblong, 0.5–0.6 mm long, tan, papillate. $2n = 28$.

Flowering Apr–Jun. Ditch banks, roadsides, lawns, fields, gardens, sidewalk cracks, shaded spots around buildings; 0–150 m; U.S.A. (Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, Virginia); Mexico, Antilles (Jamaica, Puerto Rico), South America, Europe, Japan, Taiwan, Australia, New Zealand. In the southeastern USA, *Gamochaeta coarctata* commonly grows with *G. argyrinea* and *G. chionesthes*. Collections documenting the occurrence of this species in Arkansas, California, and Virginia are cited in Nesom (2004).

Plants of *Gamochaeta coarctata* are recognized by their persistent, slightly succulent, strongly bicolored leaves (green and glabrate or usually completely glabrous on the adaxial surfaces), involucres 2.5–3 mm high, completely glabrous and evidently purplish-tinted, outer phyllaries elliptic-obovate to broadly elliptic ovate with rounded to obtuse apices, and 2–3 bisexual florets per head. It usually can be distinguished at a glance from *G. argyrinea* and *G. chionesthes* because of the distinctive vestiture and involucres.

The status of *Gamochaeta americana*

Gamochaeta americana (Figs. 3, 4) is another species with strongly bicolored leaves. Its occurrence in the U.S.A. has not been documented, which is remarkable in view of its widespread distribution in the Antilles and Mexico. The name has been incorrectly used to identify species of the U.S.A. (Nesom 1990).

The type collection of *Gamochaeta americana* was made from Jamaica (below), and I have studied collections from Jamaica, Puerto Rico, Hispaniola, and Cuba (all at NY) and from South America, Central America, and Mexico (various herbaria). It is reported from New Zealand (Drury 1971; Webb 1988) and Australia (Everett 1990). *Gamochaeta americana* was designated lectotype of the genus by Cabrera (1961, p. 362).

Gamochaeta americana (P. Mill.) Wedd., Chlor. Andina 1:151. 1856. *Gnaphalium americanum* P. Mill., Gard. Dict. ed. 8, no. 17. 1768. *Gnaphalium purpureum* L. var. *americanum* (P. Mill.) Klatt, Linnaea 42:140. 1878. LECTOTYPE (Fawcett & Rendle 1936, p. 206): JAMAICA. 1731, *Houstoun s.n.* (BM, NY-photo!)

Gnaphalium guatemalense Gandoger, Bull. Soc. Bot. France 65:42. 1918. *Gamochaeta guatemalensis* (Gandoger) Cabr., Bol. Soc. Argent. Bot. 9:371. 1961. TYPE: GUATEMALA. Alta Verapaz, *Tuerckheim* (not seen).

Gamochaeta irazuensis Nesom, Phytologia 68:199. 1990. TYPE: COSTA RICA. Volcan Irazú, 10,000–11,330 ft, 1 Dec 1937–1 Jan 1938, *P.H. Allen 702* (HOLOTYPE: F!).

Plants annual to short-lived perennial herbs from a slender, short but lignescent taproot, shallow fibrous roots, or a short, fibrous-rooted rhizome or caudex region. **Stems** usually erect from the base, less commonly decumbent-ascending, 10–40(–65) cm tall, arising singly or less commonly with 2–3 shoots, decumbent stems often developing adventitious roots, loosely lanate-tomentose (not sheath-like). **Leaves** basal and cauline, basal obovate-oblanceolate, 3–7(–10) cm long, 4–12(–16) mm wide, usually withering or withered by flowering and not persisting in a rosette, lower and midcauline often distinctly subclasping (but not auriculate), often slightly decurrent, cauline oblong to oblong-oblanceolate, sometimes narrowly revolute, adaxial surfaces glabrous to glabrate, sometimes more densely and persistently hairy, abaxial surfaces densely white to gray-white pannose. **Capitulescence** a continuous spiciform cluster 1–6 cm long, 8–12(–15) mm wide (pressed), usually becoming much longer and strongly interrupted by development of axillary clusters from lower nodes. **Involucres** campanulate-cylindric, 4–4.5 mm high, shiny and completely glabrous from base to apex; phyllaries in 4–5 series, outermost ovate to lanceolate-ovate with broadly acute to nearly obtuse apices, 1/4–1/2 as long as the inner, inner oblong-lanceolate, with light green stereome 2/3 the length of the phyllary, lamina dark brown-hyaline, apically broadly acute, sometimes nearly rounded, to (less commonly) obtuse apiculate, erect, without purplish coloration or slightly purplish only around the stereome-lamina junction; receptacles shallowly concave. **Florets:** bisexual ca. 3–6, all corollas yellowish distally; pistillate numerous in a broad zone. **Cypselae** oblong, 0.5–0.6(–0.7) mm long, tan, papillate.

Flowering all year, perhaps most abundantly Jun–Sep. Llanos, openings in pine, pine-oak, and deciduous woods, fallow fields, pastures, roadsides and other disturbed sites, commonly in wet or moist soil; 1250–3200 m. Mexico (Chiapas, Chihuahua, Colima, Dist. Federal, Durango, Guerrero, Hidaldo, Jalisco, México (Edo.), Michoacan, Morelos, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Sinaloa, Sonora, Veracruz); Central America (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama); Antilles (Cuba, Hispaniola, Jamaica, Puerto Rico); South America; Galapagos Islands.

Gamochaeta americana is generally recognized by erect stems, strongly bicolored leaves with glabrate to glabrous adaxial surfaces, the cauline oblong to oblong-oblanceolate and relatively narrow, commonly subclasping and slightly decurrent, heads clustered in an interrupted spike, involucres shiny and completely glabrous, usually with a distinctly brownish cast. The lamina of the inner phyllaries characteristically are dark brown and sharply delimited in color from the proximal portion of the phyllaries; often the whole involucre is infused with brown color.

Considerably more variation is expressed within *Gamochaeta americana*, at least as it is understood here, than in similar species in the U.S.A. In Central America and Mexico, plants of *G. americana* commonly appear to be short-lived perennial, or at least biennial, because of the development of fibrous roots from a short caudex or rhizome or adventitious roots from the lower portion of decumbent stems. In the Antilles (including the type locality, Jamaica), South America, and scattered through the Mexican and Central American range are plants with shallow fibrous roots or a thin taproot—these plants apparently distinctly annual.

Leaves of *Gamochaeta americana* are characteristically strongly bicolored, with adaxial surfaces glabrous to glabrate, but in western Mexico (mostly Durango, Chihuahua, and Sonora), there is a tendency for the adaxial surfaces to be persistently hairy, sometimes resulting in a weakly bicolored appearance. Similar plants also appear sporadically in other parts of Mexico, and Dillon and Sagástegui (1991) noted that similar variation also occurs in South America. In Cordillera de Talamanca region of Costa Rica, a distinctive race with dense, silvery-white vestiture on abaxial leaf surfaces and with sheath-like cauline vestiture is being described as a new species (Nesom & Pruski in prep.).

Identification of *Gamochaeta* species in the U.S.A. with strongly bicolored leaves

The following key distinguishes the six species of *Gamochaeta* with strongly bicolored leaves currently known to occur in the U.S.A. *Gamochaeta americana* is included so that the key might be used in regions outside of the U.S.A., but its position in the first couplet directs the key toward contrasts of species known within the U.S.A. The abaxial leaf surfaces of all of these are white-pannose with a closely matted vestiture completely obscuring the epidermis, while the adaxial surfaces are evidently green to grayish green, glabrous to sparsely arachnoid. Five of these species occur primarily in the eastern and southeastern U.S.A. *Gamochaeta ustulata* occurs mostly in coastal and near-coastal Pacific localities in the western U.S.A. and British Columbia.

From observations in herbarium and field, *Gamochaeta* species in the U.S.A. appear to be remarkably constant in diagnostic morphological features, particularly in the vestiture of stems, leaves, and phyllaries and in the shape, size, and coloration of the phyllaries. The species common grow closely intermixed, but intermediates that might indicate hybridity are not common, or at least they are not often observed. In contrast, the capitulescence may vary in degree of compactness or openness to a greater degree than has been generally recognized. In *G. purpurea*, *G. argyrinea*, and *G. coarctata*, for example, the capitulescence begins as an essentially uninterrupted cylinder but may elongate greatly and become highly interrupted and branched. Keys that utilize a difference of this sort in capitulescence morphology (e.g., Freire & Iharlegui 1997) probably are recognizing artificially separated taxa.

1. Basal leaves usually withering or withered by flowering and not persisting in a rosette, cauline oblong to oblong-oblanceolate, lower and midcauline often distinctly subclasping (but not auriculate), often slightly decurrent ________ **Gamochaeta americana**
1. Basal leaves usually persisting in a rosette at flowering (except in *G. simplicicaulis*), cauline spatulate to oblanceolate, oblanceolate-oblong, or oblanceolate-obovate, none clasping or decurrent.
   2. Basal and lower cauline leaves on elongate internodes, usually withered or absent at flowering, clusters of small leaves usually produced in cauline axils; stems strictly erect, (30–)50–85 cm tall; inner phyllaries apically acute; flowering mostly July–August ________ **Gamochaeta simplicicaulis**
   2. Basal and lower cauline leaves on relatively congested nodes, usually green and persistent at flowering, clusters of small leaves absent in cauline axils; stems erect

to decumbent-ascending, mostly less than 50 cm tall; inner phyllaries apically acute to obtuse or rounded; flowering mostly April–June.

3. Adaxial leaf surfaces usually completely glabrous; involucres 2.5–3 mm high, completely glabrous, with evident purplish coloration; outer phyllaries elliptic-obovate to broadly elliptic-ovate, apically rounded to obtuse; bisexual florets 2–3 per head ____ **Gamochaeta coarctata**
3. Adaxial leaf surfaces with persistent vestiture (sometimes necessary to view at 10x); involucres 3–4.5 mm high, base imbedded in cottony tomentum and often lightly arachnoid on the lower 1/5–1/2, with or without purplish coloration; outer phyllaries ovate, apically acute to acute-acuminate; bisexual florets 2–6 per head.
    4. Stems usually appearing not hairy but with a white, closely appressed, cloth-like covering, trichomes usually not individually evident; involucres 3–3.5 mm high; all phyllaries apically acute to acute-acuminate and brownish; bisexual florets 2–4 per head; cypselae purple ____ **Gamochaeta chionesthes**
    4. Stems usually closely white-pannose with trichomes individually evident, minutely filiform and longitudinally oriented; involucres 3–4.5 mm high; inner phyllaries apically acute or oblong and blunt-apiculate, at least outer and mid phyllaries not apically brownish; bisexual florets 3–6 per head; cypselae tan.
        5. Cauline leaves mostly spatulate, trichomes of adaxial surfaces with basal cells expanded and vitreous; involucres 4–4.5 mm high; inner phyllaries with lamina triangular, apically acute but not apiculate; bisexual florets 3–4 per head; fibrous-rooted or slender-taprooted ____ **Gamochaeta purpurea**
        5. Cauline leaves oblanceolate to oblanceolate-oblong or oblanceolate-obovate, trichomes of adaxial surfaces filiform from base to tip; involucres 4.5–5 or 3–3.5 mm high; inner phyllaries with lamina oblong, apically truncate-rounded and apiculate; bisexual florets (3–)4–6 per head; fibrous-rooted, rarely slender-taprooted.
            6. Capitulescence 12–18 mm wide (pressed), uninterrrupted or rarely so and only at the base, mostly 1–6(–8) cm long; involucres 4.5–5 mm high; outer phyllaries and often lamina of inner phyllaries dark brown, the whole head commonly with a dark brown or greenish brown cast; mid phyllaries with a low subterminal keel; cypselae 0.7–0.8 mm long ____ **Gamochaeta ustulata**
            6. Capitulescence 10–12 mm wide (pressed), early uninterrupted and 1.5–5 cm long, later producing axillary glomerules from lower nodes and elongating, becoming strongly interrupted and up to 18 cm long; involucres 3–3.5 mm high; phyllaries greenish-silvery to stramineous or golden, sometimes light brown but never dark brown, the whole head not with a dark brown cast; phyllaries not keeled; cypselae 0.5–0.6 mm long ____ **Gamochaeta argyrinea**

ACKNOWLEDGMENTS

Staffs of GH, MO, NCU, NY, and US were helpful during recent study at their institutions, ARIZ, ASU, DOV, HSC, LSUS, MO, TEX, UPRRP, USCH, and USF sent loans of specimens, Nancy Elder (University of Texas Life Science Library) helped with literature, and Tom Zanoni (NY), Emily Wood (GH), and Ted Cochrane (WIS) provided specimen data. Review comments by John Pruski and

Susana Freire are appreciated. It also seems appropriate to acknowledge the obsessive compulsion of people and agencies in the southeastern U.S.A. to mow, mow, mow to nearly dirt level, creating a continuous and expansive habitat of fields, lots, lawns, and roadsides that *Gamochaeta coarctata*, *G. argyrinea*, and *G. chionesthes* spread across. These species and other colonizers can only be expected to become more abundant.

REFERENCES

Afonso, R.M.L. 1984. Contribuição para o conhecimento do género *Gamochaeta* Weddell em Portugal continental e insular. Bol. Soc. Brot., Sér. 2, 57:113–127.

Anderberg, A.A. 1991. Taxonomy and phylogeny of the tribe Gnaphalieae (Asteraceae). Opera Bot. 104:5–195.

Cabrera, A.L. 1961. Observaciones sobre las Inuleae-Gnaphalinae (Compositae) de América del Sur. Bol. Soc. Argent. Bot. 9:359–386.

Cabrera, A.L. 1963. Flora de la Provincia de Buenos Aires. Parte VI. Compuestas. Colección Científica del I.N.T.A. Buenos Aires, Argentina.

Cabrera, A.L. 1971. Flora Patagonica. Parte VII. Compositae. Colleción Científica del I.N.T.A., Buenos Aires, Argentina.

Cabrera, A.L. 1974. Flora Ilustrada de Entre Rios (Argentina). Parte VI: Dicotiledoneas Metaclamideas (Gamopétalas) B: Rubiales, Cucurbitales, Campanulales (Incluso Compuestas). Colleción Científica del I.N.T.A., Buenos Aires, Argentina.

Cabrera, A.L. 1978. Flora de la Provincia de Jujuy. Parte X. Compositae. Colección Científica del I.N.T.A., Tomo XIII, Buenos Aires, Argentina.

Cabrera, A.L. and S.E. Freire. 1998. Flora del Paraguay—27. Compositae V. Conservatoire et Jardin botaniques, Ville de Genève. Missouri Botanical Garden.

Dillon, M.O. and A. Sagastegui A. 1991a. Flora of Peru. Family Asteraceae: Part V. Fieldiana, Bot. (n. ser.) 26:1–70.

Dillon, M.O. and A. Sagástegui A. 1991b. Sinopsis de los generos de Gnaphaiinae (Asteraceae-Inuleae) de Sudamerica. Arnaldoa 1:5–91.

Drury, D.G. 1971. The American spicate cudweeds adventive to New Zealand (*Gnaphalium* sect. *Gamochaeta*–Compositae). New Zeal. J. Bot. 9:157–185.

Everett, J. 1990. *Gnaphalium*. Harden, G.J., ed. Flora of New South Wales, Volume 3. Royal Botanic Garden, Sydney, Australia. Pp. 206–210.

Fawcett, W. and A.B. Rendle. 1936. Flora of Jamaica. Vol. VII. Dicotyledons: Families Rubiaceae to Compositae. British Museum (Natural History), London.

Freire, S.E. and L. Iharlegui. 1997. Sinopsis preliminar del género *Gamochaeta* (Asteraceae, Gnaphalieae). Bol. Soc. Argent. Bot. 33:23–35.

Godfrey, R.K. 1958. A synopsis of *Gnaphalium* (Compositae) in the southeastern United States. Quart. J. Florida Acad. Sci. 21:177–184.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. In: Kartesz, J.T. and C.A.

Meacham. 1999. Synthesis of the North American flora. North Carolina Botanical Garden, Chapel Hill, NC.

Kerguélen, M. 1987. Données taxonomiques, nomenclaturales et chorologiques pour une révision de la flore de France. Lejeunia 120:1–264.

Nesom, G.L. 1990. The taxonomic status of *Gamochaeta* (Asteraceae: Inuleae) and the species of the United States. Phytologia 68:186–198.

Nesom, G.L. 1999. *Gamochaeta simplicicaulis* (Asteraceae: Gnaphalieae) in four southeastern states and new for North America. Sida 18:1259–1264.

Nesom, G.L. 2004. New distribution records for *Gamochaeta* (Asteraceae: Gnaphalieae) in the United States. Sida 21: 1175–1185.

Pruski, J. and G.L. Nesom. 2004. *Gamochaeta coarctata*, the correct name for *Gamochaeta spicata* (Compositae: Gnaphalieae). Sida 21:711–715.

Voss, E.G. 1996. Michigan flora. Part III: Dicots (Pyrolaceae–Compositae). Cranbrook Inst. Science Bull. 161 and Univ. of Michigan Herb., Ann Arbor.

Webb, C.J. 1988. *Gnaphalium*. In: Webb, C.J., W.R. Stokes, and P.J. Garnock-Jones. Flora of New Zealand, Volume IV. Naturalized Pteridophytes, Gymnosperms, Dicotyledons. Botany Division, D.S.I.R., Christchurch, New Zealand. Pp. 234–249.

Wetter, M.A., T.S. Cochrane, M.R. Black, H.H. Iltis, and P.E. Berry. 2001. Checklist of the vascular plants of Wisconsin. Dept. of Natural Resources, Tech. Bull. 192. Madison, Wisconsin.

BOOK REVIEW

Gardener's Guide for *Hemerocallis*

JOHN P. PEAT and TED L. PETIT. 2004. **The Daylily: A Guide for Gardeners.** (0-88192-666-3, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 200 pp., 200+ color photographs and illustrations, 7 3/4" × 9 1/4".

Publisher Comments: "Few perennials are as tough and versatile as daylilies (genus *Hemerocallis*), and even fewer offer daylilies' enormous range of color, shape, and growing characteristics. The ease of hybridizing daylilies is a major attraction for the enthusiast. Any backyard gardener can hybridize daylilies, but this blessing of easy breeding can also be something of a curse to the newcomer. Tens of thousands of new daylilies are bred each year. How to choose and grow daylilies amidst this profusion? John Peat and Ted Petit have come to the rescue in this authoritative overview of all aspects of daylily history, cultivation, and breeding. Inspired by R.W. Munson Jr.'s classic treatment, *Hemerocallis*, they fully describe the history of the modern daylily. In the heart of the book, they detail the various types of hybrids and provide indispensable advice for growing all of them well. More than 200 beautiful color photographs and illustrations round out the work."

Hemerocallis is an ornamentally and economically important genus of ca. 15–30 species native to eastern Asia. Growers and hybridizers have developed an amazing number of cultivars over the years. According to the authors there are more than 50,000 registered daylilies and choosing the ones to include in the book was a difficult task. Actually the authors limited their selections to those that were introduced since 1992. So if you're looking for a cultivar older than 1992 you are out of luck. Besides the many colorful pics of the new cultivars, there is practical information on landscaping with daylilies, horticultural requirements, and daylily pests and diseases. IF you love daylilies you will enjoy this book.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

A NEW SPECIES OF *PTILIMNIUM* (APIACEAE) FROM THE ATLANTIC COAST

Alan S. Weakley

University of North Carolina Herbarium (NCU)
North Carolina Botanical Garden
Coker Hall, CB 3280
University of North Carolina
Chapel Hill, North Carolina 27599-3280, U.S.A.

Guy L. Nesom

Botanical Research Institute of Texas (BRIT)
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Ptilimnium ahlesii Weakley & Nesom, sp. nov., is described from localities in eight counties of North Carolina, South Carolina, and Georgia in tidal freshwater marshes within 20 miles of the Atlantic coast. The species has been previously identified as *P. capillaceum* but differs from the latter in its conspicuously large ovaries and fruits, which at maturity are 2.7–4.2 mm long and 1.8–2.2 mm wide (vs 1.4–2.5 mm long and 0.8–1.2 mm wide in *P. capillaceum*), in its less-divided leaves, and in its inflorescences with fewer umbellets per umbel and fewer flowers per umbellet. The new species also flowers and fruits earlier than *P. capillaceum* (May–early June, late May–July, vs. mid June–early August, July–September, respectively). *Ptilimnium ahlesii* is rare and restricted to freshwater or slightly brackish marshes, while *P. capillaceum* has a wider geographic range and ecological tolerance, but the two species grow in close proximity in their area of sympatry.

RESUMEN

Se describe **Ptilimnium ahlesii** Weakley & Nesom, sp. nov., de varias localidades en ocho condados de Carolina del norte, Carolina del Sur y Georgia en bordes de charcas de agua dulce en una banda de 20 millas en la costa atlántica. La especie ha sido previamente identificada como *P. capillaceum* pero difiere de ésta por los ovarios y frutos claramente más grandes, que en la madurez tienen 2.7–4.2 mm de longitud y 1.8–2.2 mm de anchura (contra 1.4–2.5 mm de longitud y 0.8–1.2 mm de anchura en *P. capillaceum*), por sus hojas menos divididas, y por sus inflorescencias con menos umbélulas por umbela y menos flores por umbélula. La nueva especie también florece antes que *P. capillaceum* (principios de mayo–junio, finales de mayo–julio, vs. mediados de junio–principios de agosto, julio–septiembre, respectivamente). *Ptilimnium ahlesii* es rara y restringida a charcas de agua dulce o ligeramente salobres, mientras que *P. capillaceum* tiene un rango geográfico y tolerancia ecológica más amplia, pero las dos especies crecen muy próximas en su área de simpatría.

An exceptionally large-fruited form of *Ptilimnium* has been observed and collected in coastal counties of North Carolina, South Carolina, and Georgia (Figs. 1, 2, and 3). This plant apparently drew the attention of the late Harry E. Ahles, then working at the University of North Carolina Herbarium (NCU), and specimens at NCU include annotations in his hand indicating his opinion that they represented an undescribed species to be named "*P. macrospermum*." In the Carolinas "Guide" (Radford et al. 1964), these plants were included in the key and species summaries as "*Ptilimnium macrospermum* Ahles." The following year, it was mapped in the Carolinas "Atlas" in Brunswick, New Hanover, and Pender

SIDA 21(2): 743–752. 2004

counties, North Carolina, and Georgetown and Jasper counties, South Carolina (Radford et al. 1965). Three years later, in the first printing of the Carolinas "Manual," this entity was placed as a synonym of *P. capillaceum* (Michx.) Raf. with the notation that the name was "a nomen nudum" attributed to Ahles, but was confusingly included in the key as "*P. macrospermum*" (Bell 1968, in Radford et al.); in later printings it was also removed from the key, presumably confirming the intent of Bell not to include the taxon. Bell (pers. comm., June 2004) states that he was uncertain of the taxonomic distinctiveness of the taxon, because of the paucity of herbarium material available, and as it had not been validly published he decided not to include it in the "Manual" (see Sorrie 1997 for examples of other unpublished names by Ahles).

The name in similar form has resurfaced in a widely used database (Kartesz 1999), as "*Ptilimnium macrospermum* Kartesz, sp. nov. ined." Additionally, the taxon has been considered to be of conservation concern by the network of Natural Heritage Programs and has been tracked as a rare species under the unofficial name "*Ptilimnium sp. 1*" in North Carolina and Georgia (Franklin 2004, Georgia Natural Heritage Program 2004). The potential conservation importance of the putative taxon demands that this taxonomic and nomenclatural confusion be resolved, and the species has been the subject of field and herbarium study by the authors since 1990. With these additional observations, we conclude that this plant is a distinctive and undescribed species. We are pleased to provide it with a valid name, allowing it to proceed in polite company, rather than under a twice-naked name ("*Ptilimnium macrospermum*"), a non-name ("*Ptilimnium sp. 1*"), or inappropriately ignored under *Ptilimnium capillaceum* (Michx.) Raf. The new epithet validated here honors the original insight of Harry E. Ahles regarding this, as well as his general contributions to the understanding of the flora of the Carolinas through his voracious collecting.

Ptilimnium ahlesii Weakley & Nesom, sp. nov. (**Figs. 1–3**). TYPE: NORTH CAROLINA. Brunswick Co.: tidal freshwater marsh of the Brunswick River, just E of the Brunswick River and just N of the US 74-76 causeway, ca. 2 mi W of Wilmington, growing with *Typha angustifolia*, *Carex hyalinolepis*, *Pontederia cordata*, *Pentandra virginica*, *Sagittaria lancifolia*, *Rumex verticillatus*, and *Taxodium distichum*, 34° 14' 04.7"N, 77° 59'05.7" (NAD 83), *Alan S. Weakley 7317 and Richard J. LeBlond*, 10 Jun 2004 (HOLOTYPE: NCU; ISOTYPES: BRIT, CLEMS, GH, MO, NY, TEX, UGA, US, USCH.

Ptilimnio capillaceo (Michx.) Raf. similis bracteis involucralibus divisis, ramis brevibus styli, et costis lateralibus fructus valde evolutis, sed differt foliis divisionibus 2–3 (versus 3) per nodum, umbellulis 5–8(–13) per umbellam, floribus 5–8 per umbellulam, fructibus majoribus (2.7–4.2 mm longis versus 1.4–2.5 mm), geographica ac habitatione multo magis restrictis, et tempore praecoci florendi ac fructificandi.

Annual, glabrous, caulescent herbs from a short system of fibrous roots, the stems erect, 4–13 dm tall, unbranched or in vigorous individuals branching above mid-stem. Lower stem leaves (often withered by anthesis) phyllodial (re-

Fig. 1. Holotype of *Ptilimnium ahlesii*. Note the nearly phyllodial lower stem leaves, the broadened segments of the mid-cauline leaves, and the large fruits (not fully mature).

Fig. 2. Inflorescence of *Ptilmnium ahlesii* (from an isotype). Note the large fruits, the divided involucral bracts, and the few umbellets/umbel and few flowers/umbellet (as compared to *P. capillaceum*)

duced to the hollow rachis and lacking lateral segments, thus closely resembling the quill-leaves of *P. fluviatile*, *P. nodosum*, and *P. viviparum*) to simply pinnate, the segments (when present) flattened, to 2 mm wide; mid- and upper-stem leaves pinnately decompound, 3–21 cm long, the segments filiform to distinctly flattened, with 2–3 divisions at primary nodes on the rachis; petioles 3–25 mm long, broadly winged, ca 5-ribbed. Inflorescence umbellate, distinctly and irregularly flat-topped (the rays variable in length), once-compound, the umbels terminal and axillary on the upper half of the stem, peduncles 5–14 cm

Fig. 3. Fruits (nearly but not fully mature) of *Ptilimnium ahlesii*, from an isotype.

long; primary rays 5–13, 5–35 mm long, pedicels (2–)4–10, (3–)5–10 mm long; involucre of linear bracts, entire or 3-parted; involucel of linear bracts. Calyx teeth deltoid, acute to subacuminate, persistent; petals white, obovate, 0.6–0.8 mm long; stylopodium conic, the styles mostly slightly shorter than the stylopodium, ascending to erect-ascending or widely spreading; anthers light purplish. Carpophore bifid at the apex. Fruit elliptic-ovoid, slightly compressed laterally, 2.7–3.5 mm long, 1.8–2.2 mm wide, the mericarps loosely connate and usually separated at maturity; dorsal ribs 3, narrow and sharp-edged, the lateral ribs similar but with a broad, rounded, corky-thickened extension, the extensions of the adjacent mericarps connate and forming a broad, conspicuous band around the fruit; oil tubes dark rusty-brown. In tidal freshwater marshes; flowering May to early June, fruiting late May to July.

Collections examined. **UNITED STATES. GEORGIA. Chatham Co.:** Savannah National Wildlife Refuge, along Hwy 17, fresh-water marsh, 14 Jul 1966, *Bozeman 6100* (NCU, distributed as "*Ptilimnium macrospermum* Ahles"). **NORTH CAROLINA. Brunswick Co.:** Wilmington, Jun 1898, *Ashe s.n.* (NCU). **New Hanover Co.:** 1 mi N of US 17 on Wrightsboro Road, marsh, 2 Jun 1949, *Radford 4353* (NCU); brackish marsh on the Cape Fear River on US 17, 29 Jun 1963, *Ahles 58397* (NCU) **Pender Co.:** swamp on Northeast Cape Fear River near Rocky Point—Hampstead Road, 1 Jun 1950, *Radford 5142* (NCU). **SOUTH CAROLINA. Beaufort Co.:** 0.5 mi W of Co. Road 111 on Co. Road 33, cat-tail swamp near Trichinham Plantation, 27 Jun 1956, *Bell 3767* (NCU). **Berkeley Co.:** Cooper River at the mouth of Durham Creek, low salinity, 7 Jun 1990, *McAninch 23* (NCU). **Colleton Co.:** 1.4 mi NE of Ashepoo on US Hwy 17, swamp, 26 Jun 1956, *Bell 3703* (NCU). **Georgetown Co.:** tidal marsh of Baruch Plantation, 20 Jun 1967, *Barry 103* (USCH); Baruch Plantation, fresh-water marsh affected by tidal action, 17 Jun 1969, *Batson s.n.* (USCH); Baruch Plantation, slough in freshwater marsh, 27 Jun 1969, *Batson s.n.* (USCH); occasional in sunny spots in wet swampy woods, W side of South Island Road (S-18) about 4 mi W of Intracoastal Waterway, 16 May 1990, *Nelson 9024* (USCH); Sampit River near US 17A, 9.5 mi W of Georgetown, fresh-water marsh, 13 Jun 1957, *Radford 25139* (NCU).

Relationships within the genus

Ptilimnium is a relatively small genus centered in the southeastern and south-central United States. The five to seven species are separable into subgroups on the basis of differences in morphology and chromosome number, although apparent dysploid differences in chromosome number suggest that the situation may be more complex than the current assessment allows. Plants with leaves reduced to a winged petiole and extended rachis (with lateral segments suppressed, the structures sometimes referred to as "phyllodia") are diploids based on $x = 6$ ($2n = 12$; Easterly 1957; Bell & Constance 1960). These plants have been regarded as comprising from one to three species, *P. nodosum* (Rose) Mathias, *P. viviparum* (Rose) Mathias, and *P. fluviatile* (Rose) Mathias) (Kral 1981; Kress et al. 1994; Bartgis 1997); the appropriate taxonomic disposition remains unclear and is under additional study. *Ptilimnium costatum* (Ell.) Raf. has distinctly petiolate leaves with short, crowded, verticillate segments, long styles, and a tetraploid chromosome complement based on $x = 8$ ($2n = 32$; Easterly 1957). One population of *P. costatum* from Illinois has been counted as $2n = 22$ (Bell & Constance 1960), this perhaps a tetraploid ($x = 6$, $2n = 24$) having lost one pair of chromosomes.

Ptilimnium ahlesii, *P. capillaceum*, and *P. nuttallii* are similar in their relatively short styles (shorter than or equalling the stylopodia) and primarily diploid chromosome number based on $x = 7$ ($2n = 14$; Easterly 1957, Bell and Constance 1960). Tetraploid plants ($2n = 28$) of *P. capillaceum* were reported by Easterly (1957) from central Georgia (Unadilla County). These were found apparently intermixed with diploid plants of the same species and with plants of *P. nodosum* "nearby in the same ditch." Easterly did not comment on any morphological difference between the conspecific diploids and tetraploids. One population of *P. capillaceum* from Florida has been counted as $2n = 16$ (Constance et al. 1976). It is notable that the basal and lower stem leaves of *P. ahlesii*, produced in the spring and typically withering prior to flowering and fruiting, have few to no leaflets, and therefore closely resemble the reduced "quill leaves" of the "Harperella" group of *Ptilimnium* (*P. fluviatile*, *P. nodosum*, and *P. viviparum*). This supports the broader circumscription of *Ptilimnium* as including *Harperella* Rose that has been generally followed in recent decades.

Ptilimnium texense Coulter & Rose was originally described as a species (Coulter & Rose 1909) but later (Mathias & Constance 1944–45; Easterly 1957) interpreted to be of hybrid origin and of intermediate morphology between *P. capillaceum* and *P. nuttallii*. This interpretation has been accepted and repeated by subsequent workers (e.g., Correll & Johnston 1970; Correll & Correll 1972), although Mathias & Constance (1961) placed it in synonymy, without comment, under *P. costatum*. Study of *Ptilimnium* collections at LL,TEX shows only a single entity in Texas (interpreted here as *P. costatum*) other than *P. capillaceum* and *P. nuttallii*.

In the freshwater tidal marshes west of Wilmington, North Carolina, three species of *Ptilimnium* grow in close proximity to one another: *Ptilimnium ahlesii*, *P. capillaceum*, and *P. costatum*. They are morphologically distinctive; no intermediates have been seen. Observations over the past decade further suggest that the flowering times of the three species are largely or completely non-overlapping, with *P. ahlesii* flowering first (May to early June), followed by *P. capillaceum* (mid-June to early August), and then *P. costatum* (late July to August). The phenologic separation provides additional evidence corroborating the status of *P. ahlesii* as a distinct taxon and not merely a large-fruited form of *P. capillaceum*.

Of its closest relatives, *Ptilimnium ahlesii* is most similar to *P. capillaceum*, particularly in its divided involucral bracts, minute calyx teeth, dorsal fruit ribs narrower than the intervals, and lateral ribs with expanded, corky margins encircling the fruit like a band (*P. costatum* also shares the distinctive fruit morphology). The two species are separated by the following contrasts (and see Figs. 1 and 2).

1. Mature fruit elliptic-ovate, 2.7–4.2 mm long, 1.8–2.2 mm wide; umbels flat-topped, irregular, the rays variable in length; umbellets 5–8(–13) per umbel, the rays 5–35

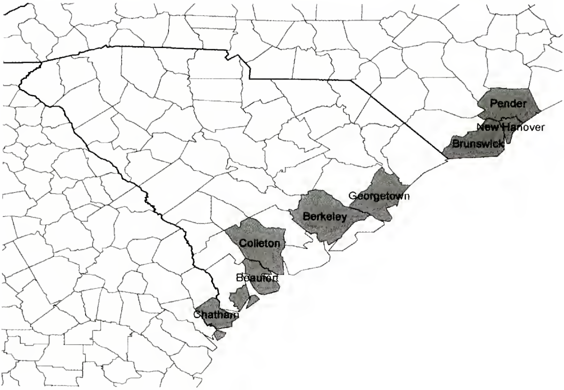


Fig. 4. Map of documented county distribution (in, from north to south, North Carolina, South Carolina, and Georgia) of *Ptilimnium ahlesii*.

mm long; flowers 5–8 per umbellet; petals 0.6–0.8 mm long; leaf segments of mid-stem leaves 15–30(–40), capillary to linear, 0.5–2.0 mm wide; flowering May-early June, fruiting late May-July; tidal freshwater marshes, rare in North Carolina, South Carolina, and Georgia __________ **Ptilimnium ahlesii**

1. Mature fruit ovate to orbicular, 1.4–2.5 mm long, 0.8–1.2 mm wide; umbels generally rounded to hemispheric, the rays generally nearly equal in length; umbellets (5–)9–21 per umbel, the rays 5–21 mm long; flowers usually 10 or more per umbellet; petals 0.3–0.6 mm long; leaf segments of mid-stem leaves 50 or more, capillary, usually less than 0.5 mm wide (except in submersed leaves); flowering June-August, fruiting July-September; ditches, marshes, other wet places; common and widespread in eastern North America, ranging from Massachussetts and New York to Missouri and Kansas, south to Florida and Texas __________ **Ptilimnium capillaceum**

Descriptions by various authors (e.g., Fernald 1950; Mathias and Constance 1944–45; Easterly 1957) of *P. capillaceum* with fruit longer than 3 mm almost certainly included observations of *P. ahlesii*. Annotations by both Constance and Easterly of NCU collections of *P. ahlesii* as *P. capillaceum* appear to confirm this. Associated with the smaller number of umbellets and flowers borne by *P. ahlesii*, as noted in the key, plants produce about 45–70 flowers/fruits per inflorescence, compared to those of *P. capillaceum*, which usually produce over 100. Depauperate plants of *P. capillaceum*, however, can have reduced inflorescences.

It appears that this species is narrowly distributed ecologically and geographically, to tidal marshes associated with the tidal reaches of rivers in southeastern North Carolina, South Carolina, and eastern Georgia (Fig. 4).

ACKNOWLEDGMENTS

We thank the staffs of LL-TEX, NCU, and US for help with herbarium studies at their institutions and staff of USCH for a loan of specimens. Richard LeBlond (North Carolina Natural Heritage Program) assisted with field studies. Ronald L. Hartman and an anonymous reviewer provided helpful suggestions.

REFERENCES

Bartgis, R.L. 1997. The distribution of the endangered plant *Ptilimnium nodosum* (Rose) Mathias (Apiaceae) in the Potomac River drainage. Castanea 62:55–59.

Bell, C.R. 1968. Apiaceae. In: A.E. Radford, H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. North Carolina Press, Chapel Hill. Pp. 761–789.

Bell, C.R. and L. Constance. 1960. Chromosome numbers in Umbelliferae. II. Amer. J. Bot. 47:24–32.

Constance, L., T.-I. Chuang, and C.R. Bell. 1976 Chromosome numbers in Umbelliferae. V. Amer. J. Bot. 63:608–625.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, Texas.

Correll, D.S. and H.B. Correll. 1972. Aquatic and wetland plants of the southwestern United States. Environmental Protection Agency, Washington, DC.

Coulter, J.M. and J.N. Rose. 1909. Supplement to the monograph of the North American Umbelliferae. Contr. U.S. Natl. Herb. 12:441–451.

Easterly, N.W. 1957. A morphological study of *Ptilimnium*. Brittonia 9:136–145.

Fernald, M.L. 1950. Gray's manual of botany (ed. 8). American Book Co., New York.

Franklin, M.A. (ed.). 2004. Natural Heritage Program list of rare plant species of North Carolina: 2004. N.C. Natural Heritage Program.

Georgia Natural Heritage Program. 2004. Special concern plant species in Georgia. [http://georgiawildlife.dnr.state.ga.us/content/specialconcernplants.asp]

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: Kartesz, J.T., and C.A. Meacham. 1999. Synthesis of the North American flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, North Carolina.

Kral, R. 1981. Notes on some quill-leaved umbellifers. Sida 9:124–134.

Kress, W.J., G.D. Maddox, and C.S. Roesel. 1994. Genetic variation and protection priorities in *Ptilimnium nodosum* (Apiaceae), an endangered plant of the eastern United States. Conserv. Biol. 8:271–276.

Mathias, M.E. and L. Constance. 1944–45. Umbelliferae. N. Amer. Fl. 28B:43–295.

Mathias, M.E. and L. Constance. 1961. Umbelliferae. In: C.L. Lundell, ed. Flora of Texas, Vol. 3. Texas Research Foundation, Renner, Texas. Pp. 263–329.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1964. Guide to the vascular flora of the Carolinas. The Book Exchange, Univ. of North Carolina, Chapel Hill.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1965. Atlas of the vascular flora of the Carolinas. North Carolina Agric. Exp. Stat. Tech. Bull. No. 165.

Sorrie, B.A. 1997. Notes on *Lycopus cokeri* (Lamiaceae). Castanea 62:119–126.

NEW COMBINATIONS IN NORTH AMERICAN CARYOPHYLLACEAE

Ronald L. Hartman

Rocky Mountain Herbarium
Department of Botany
University of Wyoming
Laramie, Wyoming 82071-3165, U.S.A.
rhartman@uwyo.edu

Richard K. Rabeler

University of Michigan Herbarium
3600 Varsity Drive
Ann Arbor, Michigan 48108-2287, U.S.A.
rabeler@umich.edu

ABSTRACT

The following new combinations in the Caryophyllaceae are proposed: *Arenaria lanuginosa* var. *saxosa*, *Eremogone ferrisiae*, *Minuartia nuttallii* vars. *fragilis*, *gracilis*, and *gregaria*, and *Paronychia chartacea* var. *minima*.

Key words: Caryophyllaceae, *Arenaria*, *Minuartia*, *Eremogone*, *Paronychia*.

RESUMEN

Se proponen las siguientes combinaciones nuevas en Caryophyllaceae: *Arenaria lanuginosa* var. *saxosa*, *Eremogone ferrisiae*, *Minuartia nuttallii* vars. *fragilis*, *gracilis*, y *gregaria*, y *Paronychia chartacea* var. *minima*.

During the course of our work on the treatments of *Arenaria*, *Minuartia*, and *Paronychia* for Flora of North America (Hartman, Rabeler, and Utech, in prep.; Rabeler, Hartman, and Utech, in prep.; and Hartman, Thieret, and Rabeler, in prep., respectively), we found the following combinations necessary to consistently treat infraspecific variation.

Arenaria lanuginosa (Michx.) Rohrb. var. **saxosa** (A. Gray) Zarucchi, R.L. Hartman & Rabeler, comb. et stat. nov. Basionym: *Arenaria saxosa* A. Gray, Smithsonian Contr. Knowl. 5 (Art. 6):280 [Plantae Wrightianae, pt. 2:18]. 1853, priority of the autonym established by *A. saxosa* var. *cinerascens* B.L. Rob., Proc. Amer. Acad. Arts 29:293. 1894.

The varietal combination often used for this plant, *Arenaria lanuginosa* var. *cinerascens* (B.L. Rob.) Shinners, is not correct because of Art. 11.6 of the International Code (Greuter et al. 2000) which states that "an autonym is treated as having priority over the name or names of the same date and rank that established it."

Minuartia nuttallii (Pax) Briq. var. **fragilis** (Maguire & A.H. Holmgren) Rabeler & R.L. Hartman, comb. nov. Basionym: *Arenaria nuttallii* Pax subsp. *fragilis* Maguire & A.H. Holmgren, Madroño 8:260. 1946. *Arenara nuttallii* var. *fragilis* (Maguire & A.H. Holmgren) C.L. Hitchc., Vasc. Pl. Pacific North W. 2:258. 1964. *Minuartia nuttallii* subsp. *fragilis* (Maguire & A.H. Holmgren) McNeill, Rhodora 82:499. 1980.

Minuartia nuttallii (Pax) Briquet var. **gracilis** (B.L. Rob.) Rabeler & R.L. Hartman, comb. nov. Basionym: *Arenaria nuttallii* Pax var. *gracilis* B.L. Rob., Proc. Amer. Acad.

Arts 29:304. 1894. *Arenaria nuttallii* subsp. *gracilis* (B.L. Rob.) Maguire, Madrono 8:261. 1946. *Minuartia nuttallii* subsp. *gracilis* (B.L. Rob.) McNeill, Rhodora 82:499. 1980.

Minuartia nuttallii (Pax) Briquet var. **gregaria** (A. Heller) Rabeler & R.L. Hartman, comb. et stat. nov. BASIONYM: *Arenaria gregaria* A. Heller, Bull. S Calif. Acad. Sci. 2:67. 1903. *Alsinopsis gregaria* (A. Heller) A. Heller, Muhlenbergia 8:96. 1912. *Arenaria nuttallii* Pax subsp. *gregaria* (A. Heller) Maguire, Fl. Calif. 1:492. 1914. *Arenaria nuttallii* var. *gregaria* (A. Heller) Jepson, Madrono 8:261. 1946. *Minuartia nuttallii* subsp. *gregaria* (A. Heller) McNeill, Rhodora 82:499. 1980.

While the four infraspecific entities traditionally recognized within *Arenaria* (*Minuartia*) *nuttallii* Pax are often distinct, occasional specimens, especially of varieties *fragilis* and *gracilis*, do intergrade where their ranges overlap, especially in Oregon and Nevada. All have been treated as varieties in at least one earlier treatment of this group and we feel that this is the appropriate rank.

Paronychia chartacea Fernald var. **minima** (L.C. Anderson) R.L. Hartman, comb. et stat. nov. BASIONYM: *Paronychia chartacea* Fernald subsp. *minima* L.C. Anderson, Sida 14:436. 1991.

Postscript.—After additional study of *Eremogone macradenia* (S. Watson) Ikonn., we now believe that *E. macradenia* should be split into two taxa with *E. macradenia* var. *ferrisiae* (Abrams) R.L. Hartman & Rabeler being elevated to species rank (Hartman & Rabeler 2004).

Eremogone ferrisiae (Abrams) R.L. Hartman & Rabeler, comb. nov. BASIONYM: *Arenaria macradenia* S. Watson subsp. *ferrisiae* Abrams, Ill. Fl. Pacif. States 2:151. 1944. *Eremogone macradenia* (S. Watson) Ikonn. var. *ferrisiae* (Abrams) R.L. Hartman & Rabeler, Sida 21:240. 2004.

ACKNOWLEDGMENTS

We wish to acknowledge James Zarucchi (MO) for discovering that the *Arenaria* combination was required and to Kanchi Gandhi (GH) for confirming this fact. Curators of F, MICH, and RM are thanked for providing specimens of the *Minuartia nuttallii* complex.

REFERENCES

GREUTER, W., J. MCNEILL, R. BARRIE, H.-M. BURDET, V. DEMOULIN, T.S. FILGUERIAS, D.H. NICOLSON, P.C. SILVA, J.E. SKOG, P. TREHANE, N.J. TURLAND, and D.L. HAWKSWORTH (eds.). 2000. International code of botanical nomenclature (Saint Louis Code) adopted by the Sixteenth International Botanical Congress, St. Louis, Missouri, July–August 1999. Regnum Veg. 138: xviii + 1–474.

HARTMAN, R.L. and R.K. RABELER. 2004. New combinations in North America *Eremogone* (Caryophyllaceae). Sida 21:237–241.

SOLIDAGO SECT. *PTARMICOIDEI*, A NEW COMBINATION TO REPLACE A "RANKLESS" NAME USED BY TORREY AND A. GRAY (ASTERACEAE: ASTEREAE)

John C. Semple

Department of Biology
University of Waterloo
Waterloo, Ontario, CANADA N2L 3G1
jcsemple@sciborg.uwaterloo.ca

Kanchi N. Gandhi

Gray Herbarium
Harvard University
Cambridge, Massachusetts 02138-2020, U.S.A.
gandhi@oeb.harvard.edu

ABSTRACT

Within the treatment of *Solidago*, Torrey and Gray (1842), there are no textual indicators of the ranks intended for subdivision of the genus, and all of the Torrey and Gray names for subdivisions of *Solidago* are rankless. The new combination **Solidago** sect. **Ptarmicoidei** is made.

RESUMEN

En el tratamiento de *Solidago*, Torrey y Gray (1842), no hay indicadores textuales de los rangos que se hacen para la subdivisión del género, y todos los nombres de Torrey y Gray para las subdivisiones de *Solidago* no tienen rango. Se hace la nueva combinación **Solidago** sect. **Ptarmicoidei**.

Discussions concerned with the ranks of names of subdivisions of genera published by Torrey and Gray (1842) led to the conclusion that by and large such names are rankless unless a rank was explicitly indicated within the text (John Strother, John Pruski, John McNeill, pers. comm. with K.N. Gandhi). Torrey and Gray used the symbol § to represent either a subgenus or section. Unless a rank is explicitly indicated, names marked by the symbol § are rankless as are lower level names marked by indicators such as *, **, *** etc. Within the treatment of *Solidago* (Torrey and Gray 1842, pp. 195-231), there are no textual indicators of the ranks intended, and thus all of the Torrey and Gray infrageneric names in *Solidago* are rankless.

In Gray (1884), sectional and subgeneric ranks are clear. In his preface (vol. 2(1). 1878), Gray used the symbol § and large-type capital letters for names of sections and subgenera. He used nouns for names of subgenera and adjectives for names of sections. Additionally, Gray did mention subsection and further lower divisions (he did not mention series or subseries); he used the symbols *, **, etc. and small-type capital letters for names of subsections. By implication, a *, **, etc. denoted the rank of subsection because those symbols are placed at the beginning of the diagnostic statement and sectional name immediately follows the statement. One may dispute this; we go by implication. For example, *Solidago* [rankless] *Corymbosae* Torr. & A. Gray (in 1842) can be taken as *Sol-*

idago subsect. *Corymbosae* (Torr. & A. Gray) A. Gray (in 1884) because Gray (1884) listed it as "***** ... CORYMBOSAE" [small capitals].

Nesom (1993) summarized the infrageneric taxonomy of *Solidago* and lectotypified some names. He treated the corymbiform, oligoneurate species in a separate genus *Oligoneuron* Small. He accepted Torrey and Gray names with ranks generally accepted at that time by other authors following the rationale for doing so presented by Holmgren (1979) and Jones (1980). Nesom did not validate *Solidago* sect. *Corymbosae* Torr. & A. Gray. One of the criteria for valid publication of a name is that the author (in this case Nesom) must accept and use the name. Nesom cited "Solidago sect. Corymbosae T. & G." as a synonym of *Oligoneuron* sect. *Ptarmicoidei* (House) Nesom; therefore, he did not validate the former name. Semple, Ringius and Zhang (1999) followed Nesom's infrageneric nomenclature, except that they treated *Oligoneuron* as *Solidago* sect. *Corymbosae* Torr. & A. Gray with synonyms but did not list full bibliographic data for each name. Had they done so, they might have inadvertently validated the name at sectional rank.

Solidago L. sect. **Ptarmicoidei** (House) Semple & Gandhi, comb. nov. Based on *Aster* sect. *Ptarmicoidei* House, N.Y. State Mus. Bull. 254. 710. 1924, nom. et stat. nov. based on *Unamia* Greene (1903). *Oligoneuron* sect. *Ptarmicoidei* (House) G.L. Nesom, Phytologia 75:27. 1993. TYPE: *Inula alba* Nutt. = *Aster ptarmicoides* Torr. & A. Gray = *Solidago ptarmicoides* (Torr. & A. Gray) Boivin. [*Solidago asteroides* Semple (in Semple, Ringius and Zhang, U. Waterloo Biol. Ser. 39:72. 1999.) is a superfluous later name for the nomenclatural type because the much older *Aster ptarmicoides* Torr. & A. Gray is accepted as legitimate (see Voss 1996).]

Solidago [rankless] *Corymbosae* Torr. & A. Gray, Fl. N. Amer. 2(2):208. 1842. *Solidago* subsect. *Corymbosae* (Torr. & A. Gray) A. Gray in A. Gray et al., Syn. Fl. N. Amer. 1(2):159. 1884. TYPE: *S. corymbosa* Elliott.

Names of subdivisions of genera are automatically typified by the species name from which the name of the subdivision is derived. For group *Corymbosae*, Torrey and A. Gray included *S. corymbosa*. Nesom (1993:26) erred in designating *Solidago rigida* L. as the lectotype.

Oligoneuron Small, Fl. SE. U.S. 1188. 1903. *Solidago* subg. *Oligoneuron* (Small) House, N.Y. State Mus. Bull. No. 254. 693. 1925. LECTOTYPE [Nesom 1993:26]: *Oligoneuron rigidum* (L.) Small = *Solidago rigida* L.

Unamia Greene, Leafl. Bot. Observ. 1:6. 1903. TYPE: *Inula alba* Nutt. = *Unamia ptarmicoides* (Torr. et A. Gray) Greene, nom. superfl. for *Unamia. alba* (Nutt.) Rydb.

Oligoneuron ser. *Ptarmicoidei* (House) G.L. Nesom, Phytologia 75:28. 1993. *Aster* sect. *Ptarmicoidei* House, N.Y. State Mus. Bull. 254. 710. 1924. TYPE: *Inula alba* Nutt. = *Aster ptarmicoides* Torr. & A. Gray = *Solidago ptarmicoides* (Torr. & A. Gray) Boivin = *Oligoneuron album* (Nutt.) G.L. Nesom.

Oligoneuron ser. *Xanthactis* G.L. Nesom, Phytologia 75:28. 1993. TYPE: *Oligoneuron riddellii* (Frank) Rydb. = *Solidago riddellii* Frank.

Other nomenclatural decisions made by Nesom (1993) related to the rankless Torrey and Gray names include:

Solidago sect. *Solidago*

Solidago subsect. **Maritimae** (Torr. & A. Gray) G.L. Nesom, Phytologia 75:12. 1993.

Based on *Solidago* [rankless] *Maritimae* Torr. & A. Gray, Fl. N. Amer. 2(2):211. 1842. LECTOTYPE [Nesom 1993:12]: *Solidago sempervirens* L. [Nesom made this subsectional name inadvertently.]

Solidago subg. *Stenactila* Raf., Fl. Tellur. 2:42. 1836 [1837]. LECTOTYPE [Nesom 1993:12]: *Solidago sempervirens* L.

Solidago [rankless]] *Uliginosae* Mackenzie in Small, Man. SE. Fl. 1345, 1347. 1933. TYPE: *Solidago uliginosa* Nutt. cited under *Solidago uniligulata* (DC.) Porter.

Solidago subsect. **Triplinerviae** (Torr. & A. Gray) G.L. Nesom, Phytologia 75:8. 1993. *Solidago* [rankless] *Triplinerviae* Torr. & A. Gray, Fl. N. Amer. 2(2):222. 1842; A. Gray, Syn. Fl. N. Amer. 1(2):155. 1884. LECTOTYPE [Nesom 1993:8]: *Solidago canadensis* L. [Nesom made this subsectional name inadvertently.]

Solidago subg. *Brachyactis* Raf., Fl. Tellur. 2:42. 1836. TYPE: *Solidago juncea* Aiton. Nesom (1993:8) erred in designating a LT.; Raf. designated *S. juncea* as the type.

Solidago subg. *Triactis* Raf., Fl. Tellur. 2:42. 1836 [1837]. TYPE: *Solidago retrorsa* Michx. Nesom (1993:11) erred in designating a LT.; Raf. designated *S. retrorsa* as the type.

Solidago [rankless] *Serotinae* Rydb., Fl. Rocky Mts. 868. 1917. TYPE: *Solidago serotina* Aiton (1789), non Retz. (1781) = *Solidago gigantea* Ait.

Solidago [rankless] *Serotinae* Mackenzie in J. K. Small, Man. SE. Fl. 1345, 1350. 1933, non Rydb. (1917). TYPE: *Solidago serotina* Retz. (1781), non Ait. (1789) = ? *S. tortifolia* Ell. (1824).

ACKNOWLEDGMENTS

This research was supported by a Natural Sciences and Engineering Council of Canada Discovery Grant to JCS. Guy Nesom and John Strother are thanked for their useful review comments.

REFERENCES

GRAY, A. 1878. Synoptical flora of North America. vol. 2, part. 1. Ivison, Blakeman, Taylor & Co., New York.

GRAY, A. 1884. Synoptical flora of North America. vol. 1, part. 2. Ivison, Blakeman, Taylor & Co., New York.

HOLMGREN, N.H. 1979. Subgeneric and sectional names for Intermountain *Penstemon* (Scrophulariaceae). Brittonia 31:358–364.

JONES, A.G. 1980. A classification of the New World species of *Aster* (Asteraceae). Brittonia 32:230–239.

NESOM, G.L. 1993. Taxonomic infrastructure of *Solidago* and *Oligoneuron* (Asteraceae: Astereae) and observations on the phylogenetic position. Phytologia 75:1–44.

SEMPLE, J.C., G.S. RINGIUS, and J.J. ZHANG. 1999 (October). The goldenrods of Ontario: *Solidago* L. and *Euthamia* Nutt. 3rd Ed. Univ. Waterloo Biol. Ser. 36:1–90.

TORREY, J. and A. GRAY. 1842. *Solidago* L. Flora of North America. 2(2):195–231. Wiley & Putnam, New York.

VOSS, E.G. 1996. Michigan flora. Part III. Dicots (Pyrolaceae-Compositae). Cranbrook Inst. Sci. Bull. 61.

TWO BEAUTIFUL BOOKS FROM THE ANTIQUE COLLECTOR'S CLUB

Margaret Mee's Passion and Painting

MARGARET MEE. 2004. **Margaret Mee's Amazon: Diaries of an Artist Explorer.** (ISBN 1-85149-454-5, hbk.) Antique Collectors' Club Ltd., Eastworks, 116 Pleasant Street, Suite 60B, Easthamton, MA 01027, U.S.A. (Orders: 413-529-0861, Fax: 413-529-0862, www.antiquecc.com) $59.50, 319 pp., color figures & plates, 9 1/2" × 11 1/8".

Review forthcoming in volume 21, no. 3.

Legendary Plant Hunter George Forrest

BRENDA MCLEAN. 2004. **George Forrest: Plant Hunter.** (1-85149-461-8, hbk) Antique Collectors' Club Ltd., Eastworks, 116 Pleasant Sreet, Suite 60B, Easthamton, MA 01027, U.S.A. (Orders: 413-529-0861, Fax: 413-529-0862, www.antiquecc.com). $59.50, 250 pp., 80 color and 80 b/w illustrations, 8 1/4" × 11".

Publisher Comments: "George Forrest was a legendary plant collector in the heyday of the British Empire. His career spanned the decades before and after the First World War. Risking his safety and health, he discovered hundreds of new species, introduced many plants to our gardens, and became one of the most outstanding plant collectors in the Sino-Himalaya. As many plants were named after him, he is well known in gardening circles yet this is the first biography of Forrest, and the first book on him for fifty years."

"This book, published to celebrate the centenary of Forrest's first setting out for the mountains of Yunnan, south-west China, brings Forrest to life, drawing on his own letters and those of his contemporaries. It tells of Forrest's adventures and his escape from death at the hands of warring Lamas. It shows the influence of his patrons, describes the excitement of his plant and animal discoveries, and reveals his rivalry with other plant hunters, Reginald Farrer and Frank Kingdon Ward."

I like to read about explorers, adventurers, and discoverers and George Forrest was such a person. He was a naturalist. Appendix 9 in the book lists some 175 genera of plants with a *forrestii* species named after George Forrest. There is a dragonfly (*Temnogomphus forrestii*) named after George Forrest. Then there are birds named after George Forrest. Not just one but six different genera with species named *forresti*. Oh wait, there are some mammals that bear the species name *forresti*, not to mention the 20 or so taxa described as new from Forrest's mammal collection at the Natural History Museum, London (Appendix 10). George Forrest realized he had the support of many people and I'm sure he thanked them in many different ways, but Forrest did the botanist/collector thank you by naming many of his newly discovered plants after them.

If you enjoy the history of exploration then the book—*George Forrest: Plant Hunter*—is for you.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

MISCELLANEOUS NOMENCLATURAL CHANGES IN ASTEREAE (ASTERACEAE)

John C. Semple

Department of Biology
University of Waterloo
Waterloo, Ontario, CANADA N2L 3G1
jcsemple@sciborg.uwaterloo.ca

ABSTRACT

The following new name and combinations are proposed: ***Heterotheca subaxillaris*** subsp. ***latifolia***, ***Solidago*** subsect. ***Multiradiatae***, and ***Symphyotrichum concolor*** var. ***devestitum***.

RESUMEN

Se proponen un nombre nuevo y varias combinaciones: **Heterotheca subaxillaris** subsp. **latifolia**, **Solidago** subsect. **Multiradiatae**, y **Symphyotrichum concolor** var. **devestitum**.

The proposed new name and combinations were determined to be needed during work to prepare the treatments of *Heterotheca* (Semple 2005), *Solidago* (Semple & Cook 2005) and *Symphyotrichum* (Brouillet et al. 2005) for the Flora North America project.

Heterotheca subaxillaris (Lam.) Britt. & Rusby subsp. **latifolia** (Buckley) Semple, comb. et stat. nov. BASIONYM: *Heterotheca latifolia* Buckley, Proc. Acad. Sci. Phila. 13:459. 1862. *Heterotheca subaxillaris* (Lam.) Britt. & Rusby var. *latifolia* (Buckley) Gandhi & Thomas, Sida Bot. Misc. 4:110. 1989. TYPE: TEXAS. Llano Co.: *Buckley s.n.* (HOLOTYPE: PH, not seen).

The weedy *Heterotheca subaxillaris* complex has been treated as a single species without varieties (Nesom 1990) and as four separate species: *H. chrysopsides* DC., *H. latifolia*, *H. psammophila* Wagenknecht, and *H. subaxillaris* (Semple 1996 and earlier authors). Harms (1964) presented data supporting Wagenknecht's (1960) division of the complex into four species and provided a general range map of the four taxa. Nesom (1990) opted to merge all four species into a single undivided species because he did not find taxonomically significant differences between the four putative species. Semple (1996) continued to followed Wagenknecht and Harms. However, after considerable study of members of the complex, I have adopted Nesom's position that only one species should be recognized (Semple 2005). Nonetheless, while much of the supposed differences between regional taxon do not appear to be supported, some phytogeographic patterns in variation occur within the complex and two infraspecific taxa can be recognized based on differences in phyllary traits. Typical *Heterotheca subaxillaris* is for the most part confined to the outer coastal plain from New York to northern Mexico, where they can occur further inland. These plants have a well developed tuft of larger hairs near the phyllary tips (Figs. 1A–H) and are treated here as subsp. *subaxillaris*. This combination of distinctive morphology plus the geographic isolation of much of the range of the morphotype warrant subspecies level recognition following Semple (1974). In contrast, plants of subsp. *latifolia* have phyllaries without such large hairs concentrated near the tip (Figs. 1I–L). Mid series phyllaries of subsp. *subaxillaris* on average are slightly wider (0.62 mm wide) compared to the average width of those of subsp. *latifolia* (0.57 mm wide) with the narrowest occurring in Arizona and New Mexico plants ("psammophila'). However, the ranges in widths overlap so much that the trait cannot be used as a diagnostic difference.

Within each subspecies there appear to be patterns to the phyllary variation but these are not sufficiently strong that additional infraspecific taxa can be justifiably recognized at this time. There is a general geographic trend to the variation in tufted hairs in subsp. *subaxillaris*. Plants with the most hairs in the apical tuft occur from Mexico to Florida (Figs. 1A–D), while the number of hairs generally decreases from Florida to New Jersey and New York (Figs. E–H). Plants with a few hairs near the apex occur scattered across the range of the species and may represent introductions of subsp. *subaxillaris* or the occasional more hairy than normal individual of subsp. *latifolia*. Plants occurring in an arch from Arizona and adjacent New Mexico through Mexico into trans-Pecos Texas tend to be more densely glandular than plants from elsewhere in the range (Fig. 1L) in the United States; these have been treated as *H. psammophila* Wagnknecht. Plants from northeastern Mexico tend to have more glands and more hairs on the mid series phyllaries and are more likely to be weakly perennial; these have been treated as *H. chrysopidis*. Plants treated previously as *H. latifolia* tend to have fewer hairs and fewer glands on the phyllaries than other members of subspecies *latifolia*. These occur across the southern prairies and through the south eastern U.S. on the Piedmont as shown in Harms (1965), although the weedy nature of the species appears to be facilitating dispersal into the range of subsp. *subaxillaris* on occasion. Additional study may find new evidence supporting recognition at varietal or subspecies level for the *psammophila* and *chrysopsides* morphs, but my recent efforts have not discovered such evidence.

Solidago subsect. **Multiradiatae** Semple, subsect. nov. Type: *Solidago multiradiata* L. *Solidago* ser. *Multiradiatae* Juz., Fl. URSS 25:47. 1959. nom. invalid, no Latin diagnosis. *Solidago* subsect. *Multiradiatae* (Juz.) Semple, Sida 20:1605. 2003. non valid name. Type: *Solidago multiradiata* Aiton (**Fig. 2A**).

Solidagini sect. *Solidago* accedens sed capitulescentiis corymbiformis rotundatis differt.

Members of subsect. *Multiradiatae* are distinguished from other species in sect. *Solidago* by having a somewhat rounded-corymbiform capitulescence. Other North America members of the section have variously paniculiform

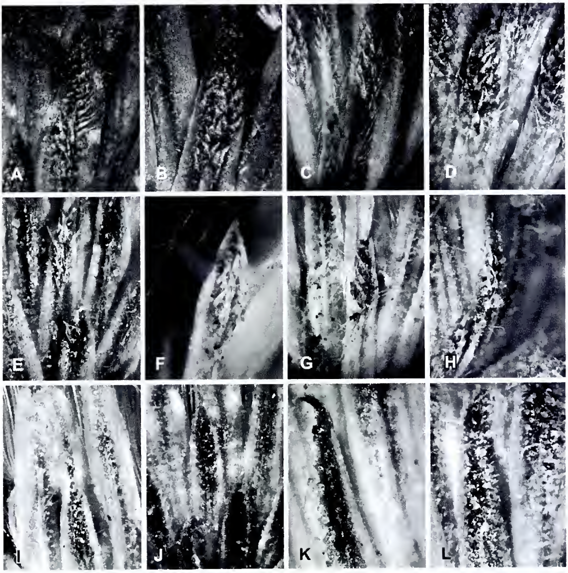


Fig. 1. Phyllary tip variation in *Heterotheca subaxillaris*. **A–H.** Subsp. *subaxillaris*. **A–B.** Mexico. **A.** Veracruz, *Turner 15372* (TEX). **B.** Tamaulipas, *LaSueur 496* (TEX). **C–H.** United States. **C.** Texas, Cameron Co., *King 2* (MINN). **D.** Louisiana, Cameron Par., *Dutton & Pritchett 2549* (WAT). **E.** Florida, Orange Co., *Semple et al. 2557* (WAT). **F.** North Carolina, Brunswick Co., *Bright 6236* (MINN). **G.** New Jersey, Gloucester Co., *Long 60507* (MINN). **H.** New York, Queens Co., *Semple 2031* (WAT). **I–L.** Subsp. *latifolia*. **I.** Mexico, Chihuahua, *Sundberg & Lavin 2811* (TEX; "chrysopsides"). **J–L.** United States. **J.** Georgia, Elbert Co., *Coile 1626* (WAT). **K.** Oklahoma, Caddo Co., *Semple 2735* (WAT). **L.** Arizona, Maricopa Co., *Lehto L19116* (WAT; "psammophila").

capitulescences [*S.* subsect. *Humiles* (Rydberg) Semple]. Like most other taxa in the genus, the phyllaries have a single vein. In robust plants the capitulescence becomes more paniculiform as branches develop from upper stem leaves. Two other species besides the nomenclatural type are included in the subsection: *S. leiocarpa* DC. (Fig. 2B) and *S. spithamaea* M.A. Curtis ex A. Gray (Fig. 2C). These are both narrowly distributed endemics in eastern North America (Semple & Cook 2005). *Solidago leiocarpa* (synonym: *S. cutleri* Fern.) includes tetraploids

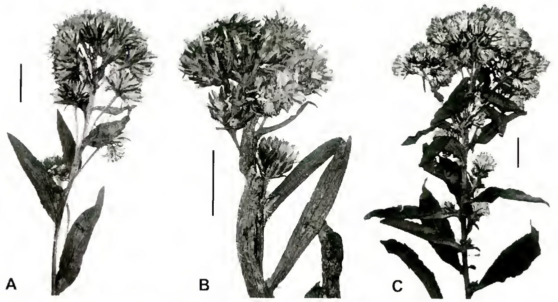


Fig. 2. *Solidago* subsect. *Multiradiatae*, capitulescences. **A.** *Solidago multiradiata*, Yukon, *Chmielewski et al. CC3824* (WAT). **B.** *Solidago leiocarpa*, New Hampshire, *Ringius 1584* (WAT). **C.** *Solidago spithamaea*, North Carolina, *Semple & Suripto 9669* (WAT). Scale bars = 1 cm.

found at disjunct high elevations in eastern New York, the Green Moutains in Vermont, the White Mountains in New Hampshire, and on Mt. Katadhin and a few higher peaks in Maine (Beaudry 1963; Morton 1981; Magee & Ahles 1999). *Solidago spithamaea* includes hexaploids restricted to the highest granitic outcrops in the mountains of western North Carolina (Cronquist 1980; Semple et al. 1984; Semple & Cook 2004). *Solidago multiradiata* includes diploids and tetraploids and is widely distributed across northern North America from the Maritimes to Alaska across Canada and down the cordillera at higher elevations in the western United States to California, Arizona, Nevada, and New Mexico (Semple et al. 1999). Other goldenrods that can have a rounded-corymbiform capitulescence occur in *Solidago* sect. *Ptarmicoidei* Semple & Gandhi, but these have striate phyllaries ((Semple & Gandhi 2004). *Solidago wrightii* A. Gray sometime can also have a rounded somewhat corymbiform capitulesence, but the species has short-petiolate mid stem leaves and often glandular phyllaries (Semple & Cook 2005).

Kanchi H. Gandhi (pers. comm.) noted that my combination proposed last year (Semple 2003) was based on an invalid basionym because the protologue lacked a Latin diagnosis.

Symphyotrichum concolor (L.) Nesom var. **devestitum** (S.F. Blake) Semple, comb. nov. Basionym: *Aster concolor* L. var *devestitus* S.F. Blake, Rhodora 32:145. 1930. Type: U.S.A. Florida. Bay Co.: Lynn Haven, in dry sandy open soil, 13 Oct 1921, *Billington 80* (holotype: US-1116195!).

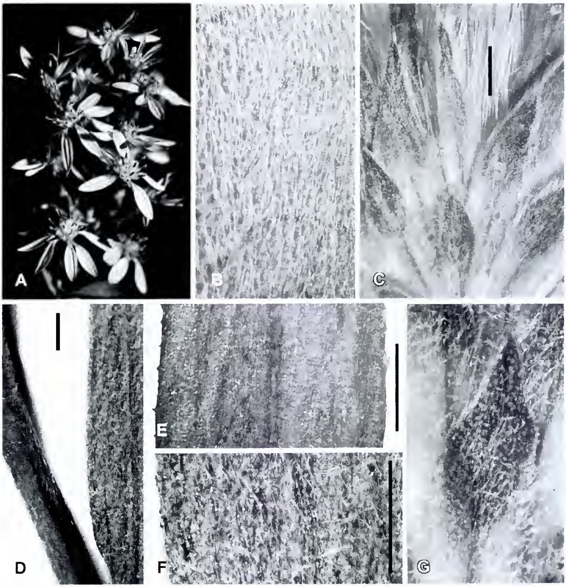


Fig. 3. Morphology of *Symphyotrichum concolor*. **A.** Flowering heads, Florida. **B–C.** Variety *concolor*. **B.** Mid stem leaf surface; Georgia, *Semple & Chmielewski 6213* (WAT). **C.** Phyllaries; Florida, Suwanee Co., *Semple, Brouillet & Canne 3930* (WAT). **D–G.** Variety *divestitum*, Florida; **E,** Bay Co., *Semple & Godfrey 3118*; **D, F–G,** Santa Rosa Co., *Semple, Brouillet & Canne 3880* (WAT). **D.** Mid stem and leaf. **E–F.** Mid stem leaf surfaces. **G.** Phyllary. Scale bar = 1 mm in C, E–F and 1 cm in D.

Symphyotrichum concolor is characterized by its narrow, elongate capitulescence of usually many, violet-rayed heads (Fig. 3A). The var. *concolor* has more moderately to densely silky pubescent leaves and phyllaries (Figs. 3B–C), while var. *devestitum* has glabrous to very sparsely pubescent stems and glabrate to sparsely pubescent leaves and phyllaries (Figs. 3D–G). Plants similar to the type of var. *devestitum* occur in the western Florida Panhandle. The involucres of such Florida plants tend to be larger than those of diploid var. *concolor* (Blake 1930). Very sparsely pubescent-leaved individuals also occur in southern Miss., Ala., Ga., and S.C. These may prove to belong in var. *devestitum* pending more detailed study. Semple (1984) described and illustrated the distribution of diploids (2n = 8) and tetraploids ($2n = 16$) in *S. concolor* under the name *Virgulus concolor*, but did not discuss varieties and noted incorrectly that no obvious differences occurred between diploids and tetraploids. In Florida, the range of tetraploids is contained within the range of var. *devestitum*; tetraploids are currently unknown outside Florida. Cytovouchers of tetraploids in WAT have glabrous to sparsely pubescent leaves and belong in var. *devestitum*. The tetraploid condition may account for the larger involucres.

ACKNOWLEDGMENTS

This research was supported by a Natural Sciences and Engineering Council of Canada Discovery Grant to the author. Joanna Stinson assisted in collecting data on phyllary variation in the *Heterotheca subaxillaris* complex. Guy Nesom is thanked for his helpful review of the manuscript.

REFERENCES

Beaudry, J.R. 1963. Studies on *Solidago* L. VI. Additional chromosome numbers of taxa of the genus Canad. J. Genet. Cytol. 5:150–174.

Blake, S.F. 1930. A glabrous variety of *Aster concolor*. Rhodora 32:144–145. 1930.

Cronquist, A. 1980. Vascular flora of the southeastern United States. I. Asteraceae. University of North Carolina Press. Chapel Hill.

Harms, V.L. 1965. Biosystematic studies in the *Heterotheca subaxillaris* complex (Compositae-Astereae). Trans. Kansas Acad. Sci. 68:122–124.

Morton, J.K. 1981. Chromosome numbers in Compositae from Canada and the U.S.A. Bot. J. Linn. Soc. 82:357–368.

Nesom, G.L. 1990. Taxonomy of *Heterotheca* section *Heterotheca* (Asteraceae: Astereae) in Mexico, with comments on the taxa in the United States. Phytologia 69:282–294.

Magee, D.W. and H.E. Ahles. 1999. Flora of the northeast: a manual of the vascular flora of New England and adjacent New York. University of Massachusetts Press. Amherst.

Semple, J.C. 1974. The phytogeography and systematics of *Xanthisma texanum* DC. (Asteraceae): proper usage of infraspecific categories. Rhodora 76:1–19.

Semple, J.C. 1984. Cytogeographic studies on North American asters. I. range surveys of *Virgulus adnatus, V. concolor, V. georgianus, V. grandiflorus, V. novae-angliae, V. oblongifolius, V. patens*, and *V. walteri*. Amer. J. Bot. 71:522–531.

Semple, J.C. 1996. A revision of *Heterotheca* sect. *Phyllotheca* (Nutt.) Harms (Compositae: Astereae): the prairie and montane goldenasters of North America. Univ. Waterloo Biol. Ser. No. 37:1–164.

Semple, J.C. 2003. New names and combinations in *Solidago* (Asteraceae: Astereae). Sida 20:1605–1616.

Semple, J.C. 2005. *Heterotheca* Cass. In Flora North America Editorial Committee, eds. Flora of North America. Vol. 20. Asteraceae. Oxford University Press.

SEMPLE, J.C. and R.E. COOK. 2004. Chromosome number determinations in fam. Compositae, Tribe Astereae. VII. Some eastern North American and Eurasian taxa. Rhodora 106:xxx–xxx. In press.

SEMPLE, J.C. and R.E. COOK. 2005. *Solidago*. pp. xxx-xxx. In Flora North America Editorial Committee, eds. Flora of North America. Vol. 20. Asteraceae. Oxford University Press.

SEMPLE, J.C., G.S. RINGIUS. and J.J. ZHANG. 1999. The goldenrods of Ontario: *Solidago* L. and *Euthamia* Nutt. 3rd Ed. Univ. Waterloo Biol. Ser. 36:1–90.

SEMPLE, J.C., G.S. RINGIUS, C. LEEDER, and G. MORTON. 1984. Chromosome numbers of goldenrods, *Euthamia* and *Solidago* (Compositae: Astereae). II. Additional counts with comments on cytogeography. Brittonia 36:280–292. Addendum Brittonia 37:121–121. 1985.

WAGENKNECHT, B.L. 1960. Revision of *Heterotheca* sect. *Heterotheca* (Compositae). Rhodora 62:61–76, 97–107.

BOOK NOTICES/BOOKS RECEIVED

RICARD SOLE and BRIAN GOODWIN. 2000. **Signs of Life: How Complexity Pervades Biology.** (0-465-01928-5, pbk.). Basic Books, 387 Park Avenue South, New York, NY 10016, U.S.A. (Orders: 212-340-8100, Fax: 212-340-8115, www.basicbooks.com) $17.50, 322 pp., b/w photos, drawings, and diagrams, 6" × 9 1/4".

Publisher Comments. "In every major field of biology, from molecular genetics and neurobiology, through animal behavior and ecology, to evolution, extinction, and economics, there are well-known phenomena that today's standard theories are powerless to explain: Why don't cells in identical environments with identical genomes live identical lives? How do such simple creatures as ants and termites manage such complex behavior as building nests? Why did all the animal kingdom's basic body plans appear in a single geological era, and no new ones since? Yet, as Ricard Sole and Brian Goodwin show, various tools of complexity theory can offer us new ways to understand these phenomena. A tour of biology such as you've never seen before, *Signs of Life* is about explaining the unexplainable-by using new ideas to answer questions yesterday's ideas can't help us with."

The authors point out that the real aim of this book is to show how the new ideas are exerting their influence in a variety of biological areas. Signs of Life is divided up into 10 chapters: **1)** nonlinearity, Chaos, and Emergence; **2)** Order, Complexity, Disorder; **3)** Genetic Networks, Cell Differentiation, and Development; **4)** Physiology on the Edge of Chaos; **5)** Brain Dynamics; **6)** Ants, Brains, and Chaos; **7)** The Baroque of Nature; **8)** Life on the Edge of Catastrophe; **9)** Evolution and Extinction; and **10)** Fractal Cities and Market Crashes.

Biodiversity of Deserts

SARA OLDFIELD (Photography by Bruce Coleman Collection). 2005. **Deserts: The Living Drylands.** (ISBN 0-262-15112-X, hbk.). The MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493, U.S.A. (Orders: 800-405-1619, mitpress-orders@mit.edu, http://mitpress.mit.edu). $29.95, 160 pp., 180 illustrations, color throughout, 12 1/2" × 9 1/2".

Publisher Comments. "Deserts represent the ultimate challenge to life on Earth. Their lack of water and extreme temperatures make survival difficult for both wildlife and people, yet deserts are rich in animal and plant life and culture. Their unique species and ancient civilizations include fragile treasures needing protection in a rapidly changing world. Deserts are among our planet's last great wilderness regions, and they continue to offer scientific puzzles and new discoveries. *Deserts: The Living Drylands* is a celebration of the world's least understood ecosystems. In this richly illustrated book—featuring 180 color photographs—wildlife expert Sara Oldfield leads readers on a journey to some of the most remote places on earth, from the rolling sand dunes of the Arabian Peninsula's Empty Quarter to the ancient rock formations of central Australia. *Deserts* is both a vivid inventory of spectacular images, facts, and stories and an invaluable source of reference. It brings to life our planet's unique arid habitats at a time when they are more in need of protection than ever.

This is a book with incredibly beautiful and often unbelievable photographs. Once you open the book you will not want to close it. If you think you've seen the desert, think again. The seven chapters take you through a survey of deserts of the world: Africa, The Middle East, Asia, Australia, The Americas, and ends with the future of drylands.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

A NEW COMBINATION IN *ANTENNARIA* (ASTERACEAE: GNAPHALIEAE) FROM NORTH AMERICA

Randall James Bayer

CSIRO, Plant Industry
Centre for Plant Biodiversity Research
Australian National Herbarium
GPO Box 1600
Canberra, 2601, AUSTRALIA
randy.bayer@csiro.au

ABSTRACT

Antennaria pulcherrima subsp. ***eucosma*** (Fernald & Wiegand) R.J. Bayer, comb. nov., is based on *Antennaria eucosma* (Fernald & Wiegand) from North America. The new combination is essential as a result of the expansion of the circumscription of *A. pulcherrima* to include *A. eucosma.*

RESUMEN

Antennaria pulcherrima subsp. **eucosma** (Fernald & Wiegand) R.J. Bayer, comb. nov., se basa en *Antennaria eucosma* (Fernald & Wiegand) de Norteamérica. La nueva combinación es esencial como resultado de la extensión de la circunscripción de *A. pulcherrima* para incluir *A. eucosma.*

INTRODUCTION

In preparation for publication of my treatment of *Antennaria* Gaertn. for the *Flora of North America North of Mexico*, I came to re-evaluate *Antennaria pulcherrima* (Hook.) Greene, an amphimictic species, occurring as diploid ($2n = 28$) and tetraploid ($2n = 56$) cytotypes from Colorado to Alaska, east to Ontario, and parts of western Quebec. It appears to be uniformly tetraploid throughout its range in Canada and Alaska (Urbanska 1983), but four diploid populations are known from Montana (one population), Wyoming (one population), and Colorado (two populations) (Bayer & Stebbins 1987). Apparently, *A. pulcherrima* arose in the U.S. Rockies as a diploid and presumed derived autotetraploid cytotypes spread north into Canada and Alaska post glaciation. It is generally found in moist willow thickets throughout its range (Urbanska 1983; Bayer & Stebbins 1987). Porsild (1943) suggested that *A. pulcherrima* is restricted to calcareous soils; this has never been empirically demonstrated (Urbanska 1983). *Antennaria eucosma* Fernald & Wiegand is a narrow endemic restricted to limestone and serpentine barrens on the island of Newfoundland and Anticosti Island, Quebec. Like the Canadian populations of *Antennaria pulcherrima, A. eucosma* is amphimictic and tetraploid (Urbanska 1983; Bayer & Stebbins 1987). Its morphological similarity to *A. pulcherrima* is obvious and the two are separated primarily by the presence of prominent flags[1] in *A. pulcherrima* and their usual absence in *A. eucosma*.

Porsild (1943, 1965), who had quite a narrow species concept in *Antennaria*, treated *A. eucosma* as a synonym of *A. pulcherrima*. Urbanska (1983), who studied the ecology, cytology, and distribution of the Pulcherrimae group, while recognizing it as a distinct species, stated that, *A. eucosma* may represent nothing more than a specialized group of populations of *A. pulcherrima* with a distinct ecology. It has the same chromosome number as boreal populations of *A. pulcherrima* and its range is parapatric with that of *A. pulcherrima*. Furthermore, she suggested that *Antennaria eucosma* may have arisen via quantum speciation and genetic drift in geographically marginal populations of *A. pulcherrima* (Urbanska 1983). Ledyard Stebbins and I recognized *A. eucosma* as a distinct species (Bayer & Stebbins 1987, 1993), and we remarked on the problem of its circumscription as a distinct species (Bayer & Stebbins 1993).

Because *Antennaria eucosma* is also morphologically very similar to, and not always consistently distinct from, *A. pulcherrima*, it is best to recognize *A. eucosma* as an infraspecific taxon under *A. pulcherrima*. Stebbins and I applied the same set of taxonomic criteria when evaluating *A. luzuloides* Torr. & A. Gray subsp. *luzuloides* and *A. luzuloides* Torr. & A. Gray subsp. *aberrans* (E.E. Nelson) R.J.Bayer & Stebbins (= *A. microcephala* A. Gray); the two subspecies differ in their ecology, but are not adequately morphologically differentiated to warrant recognizing them as distinct at species rank (Bayer & Stebbins 1993). A scenario whereby marginal populations of tetraploid *A. pulcherrima* in Atlantic Canada, which may already have been adapted to calcareous soils, became genetically isolated and subsequently morphologically and ecologically differentiated from the central populations of *A. pulcherrima*, seems apparent.

TAXONOMY

Antennaria pulcherrima (Hook.) Greene subsp. **eucosma** (Fernald & Wiegand) R.J. Bayer, comb. nov. *Antennaria eucosma* Fernald & Wiegand, Rhodora 13 23. 1911. TYPE: CANADA. NEWFOUNDLAND: Flora of Western Newfoundland, Region of Port au Port Bay, dry limestone barrens, upper slopes and tablelands, altitude 200–300 m, Table Mountain, 16 Aug 1910, *M.L. Fernald & K.M. Wiegand 4144* (HOLOTYPE: GH!; ISOTYPES: CAN!, NY!).

Antennaria carpatica (Wahlenb.) R.Br. var. *humilis* Hook., Fl. Bor. Amer. 1:329. 1834.

KEY TO THE SUBSPECIES OF *ANTENNARIA PULCHERRIMA*

Distal cauline leaves usually flagged; pistillate corollas 4.5–6.5 mm; staminate corollas 4–5 mm; wet habitats in willow thickets at subalpine elevations or subarctic in western North America from Colorado to Alaska, east to Ontario, parts of western Quebec ____________________ subsp. **pulcherrima**

---

[1] Flags are flat, linear, scarious appendages of the leaf tips that are similar to the tips of the phyllaries, not to be confused with ordinary subulate or blunt leaf tips that are essentially green and herbaceous.

Distal cauline leaves mostly not flagged (sometimes flagged just proximal to heads); pistillate corollas 3–4.4 mm; staminate corollas 3–4 mm; limestone substrates in willow thickets of western Newfoundland and Anticosti Island, Quebec _____ subsp. **eucosma**

ACKNOWLEDGMENTS

I thank curators at CAN, GH, and NY for making specimens available for study. Appreciation is extended to Kirsten Cowley, Edward Cross, Guy Nesom, John Strother, and Matthew Unwin for their critique and helpful suggestions concerning the draft manuscript and to J. Tupac Otero for editing the Spanish summary.

REFERENCES

Bayer, R.J. and G.L. Stebbins. 1987. Chromosome numbers, patterns of distribution, and apomixis in *Antennaria* (Asteraceae: Inuleae). Syst. Bot. 12:305–319.

Bayer, R.J. and G.L. Stebbins. 1993. A synopsis with keys for the genus *Antennaria* (Asteraceae: Inuleae: Gnaphaliinae) for North America. Canad. J. Bot. 71:1589–1604.

Porsild, A.E. 1943. Materials for a flora of the continental Northwest Territories of Canada. Sargentia 4:1–79.

Porsild, A. E. 1965. The genus *Antennaria* in eastern arctic and subarctic America. Saetryk af Bot. Tidssk. 61:22–55.

Urbanska, K.M. 1983. *Antennaria carpatica* (Wahlb.) Bl. et Fing. s.l. in North America. I. Chromosome numbers, geographical distribution and ecology. Ber. Geobot. Inst. E.T.H., Stiftung Rübel 50:33–66.

BOOK NOTICES/BOOKS RECEIVED

Annual Review of Phytopathology

Deborah P. Delmer, Hans J. Bohnert, and Sabeeha Merchang (editors). 2003. **Annual Review of Phytopathology: Volume 42, 2004**. (ISBN 0-8243-1342-9, hbk; ISSN 0066-4286). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $173.00 (USA), $178.00 (Int'l.), 498 pp., 6" × 9".

Contents of Volume 54 of *Annual Review of Phytopathology*:

- The Accidental Plant Pathologist
- Tobacco Mosaic Virus: A Model System for Plant Biology
- Assessment and Management of Soil Microbial Community Structure for Disease Suppression
- Analysis of Disease Progress as a Basis for Evaluating Disease Management Practices
- Evolution of Plant Parasitism Among Nematodes
- Lessons Learned from the Genome Analysis of *Ralstonia solanacearum*
- Management and Resistance in Wheat and Barley to Fusarium Head Blight
- Comparative Genomics Analyses of Citrus-Associated Bacteria
- Systemic Acquired Resistance
- Molecular Aspects of Plant Virus Transmission by Olpidium and Plasmodiophorid Vectors
- Microbial Diversity in Soil: Selection Microbial Populations by Plant and Soil Type and Implications for Disease Suppressiveness
- Microbial Dynamics and Interactions in the Spermosphere
- Biological Control of Chestnut Blight with Hypovirulence: A Critical Analysis
- Integrated Approaches for Detection of Plant Pathogenic Bacteria and Diagnosis of Bacterial Diseases
- Nematode Molecular Diagnostics: From Bands to Barcodes
- Type III Secretion System Effector Proteins: Double Agents in Bacterial Disease and Plant Defense
- Plant Virus Satellite and Defective Interfering RNAS: New Paradigms for a New Century
- Chemical Biology of Multi-Host/Pathogen Interactions: Chemical Perception and Metabolic Complementation
- Index and Errata

NOMENCLATURE OF THE VIRGINIA-BLUEBELL, *MERTENSIA VIRGINICA* (BORAGINACEAE)[1]

James S. Pringle

Royal Botanical Gardens
P.O. Box 399
Hamilton, Ontario, CANADA L8N 3H8
jpringle@rbg.ca

ABSTRACT

Mertensia virginica (L.) Pers. ex Link is the correct name for the Virginia-bluebell. It should not be replaced by *M. pulmonarioides* Roth.

RESUMEN

Mertensia virginica (L.) Pers. ex Link es el nombre correcto para la especie usualmente así conocida. No debe reemplazarse por *M. pulmonarioides* Roth.

Virginia-bluebell or Virginia-cowslip, *Mertensia virginica* (L.) Pers. ex Link, is native to eastern North America and widely cultivated as an ornamental perennial. It has consistently been called *M. virginica* in floras covering its natural range, including all editions of *Gray's Manual of Botany* (Gray 1848, 1856, 1862, 1863, 1867; Gray et al. 1890; Robinson & Fernald 1908; Fernald 1950) and continuing to the most recent state and provincial floras and checklists. That name was accepted in Williams's (1937) monograph on *Mertensia* in North America and in Al-Shehbaz's (1991) monograph on the Boraginaceae of the southeastern United States. It is also the accepted name in horticultural references including *Hortus III* (Staff...1976), the most recent edition of *The Royal Horticultural Society Dictionary of Gardening* (Huxley et al. 1992), *The Plant-Book* (Mabberly 1997), and *The European Garden Flora* (Richardson 2000).

In recent years, nevertheless, this species has with increasing frequency been called *M. pulmonarioides* Roth in horticultural literature and in seed and nursery catalogues. All or most post-1990 use of the name *M. pulmonarioides* is probably derived directly or indirectly from *Index Hortensis* (Trehane 1989), which is an exception among standard references in that the name *M. pulmonarioides* is accepted and *M. virginica* is listed as a synonym. Following the publication of *Index Hortensis*, the name *M. pulmonarioides* was accepted in the 1997 edition of *The American Horticultural Society A-Z Encyclopedia of Garden Plants* (Brickell & Zuk 1997) with *M. virginica* as a synonym. The name *M. pulmonarioides* was also accepted in the 1998/99 edition of the *RHS Plant Finder* (Lord et al. 1998), although in the 2003/04 edition (Lord et al. 2003) *M.*

---

[1] Contribution No. 118 from the Royal Botanical Gardens, Hamilton, Ontario, Canada.

SIDA 21(2): 771–775. 2004

virginica is the accepted name and *M. pulmonarioides* is cross-indexed as a synonym. Schmid (2002), in *An Encyclopedia of Shade Perennials*, commented that with taxonomists having "switched" the long-established name *M. virginica* to *M. pulmonarioides*, the latter name would "show up more and more often."

Nomenclatural matters are not discussed in *Index Hortensis*, and the name *M. virginica* was used in the literature cited for the species. The name *M. pulmonarioides* may have been taken from the original component of *Index Kewensis* (Jackson 1894), in which *M. pulmonarioides* was listed as an accepted name and *M. virginica* as a synonym. No taxonomic publication that specifically discusses the nomenclature of Virginia-bluebell was cited in the extensive bibliography compiled by Al-Shehbaz (1991) or in *The Kew Record of Taxonomic Literature Relating to Vascular Plants* or any of the other bibliographies I consulted. In view of the confusion now associated with the nomenclature of this species, it seems appropriate to present such a study here.

Virginia-bluebell was named and described at the rank of species by Linnaeus (1753) in the first edition of *Species Plantarum*, as *Pulmonaria virginica*. Two specimens are relevant to the typification of this name. One, designated the type by Williams (1937) and accepted as such by Charles E. Jarvis in the Linnaean Plant Names Typification Project (M. Grant, pers. comm.), is from Linnaeus's own herbarium (LINN) and was collected in North America by Pehr Kalm. It bears the Sprague Catalogue number 184.5. From a photograph in the library of the Arnold Arboretum, this specimen is unequivocally identifiable as Virginia-bluebell.

Linnaeus cited an earlier description from Gronovius's (1739) *Flora Virginica*, which had been based on a manuscript by John Clayton. The specimen *Clayton 339*, now in the herbarium of the Natural History Museum (London) (BM), is from Gronovius's herbarium. According to data on the herbarium sheet, it was taken from a plant sent from Virginia to England by Mark Catesby and subsequently cultivated in the garden of Peter Collinson. An image can be seen on the museum's web site, with the designation "Linnaean type status: original element." Its identity as Virginia-bluebell is likewise unmistakable.

The genus *Mertensia* was segregated from *Pulmonaria* in 1797 by A.W. Roth, who gave Virginia-bluebell the new name *M. pulmonarioides*. Roth did not mention the name *P. virginica* L. and may not have been aware that he had described the same species. The name *M. pulmonarioides* should therefore be considered a heterotypic synonym. *Pulmonaria virginica* L., with the species epithet *virginica* retained, was transferred to *Mertensia* in 1829 by J.H.F. Link, who cited *M. pulmonarioides* Roth as a synonym. Link attributed the combination *M. virginica* to Persoon, probably on the basis of herbarium annotations or correspondence, as there is no record of Persoon's actually having published the binomial. The authorship of the binomial may therefore be cited as "(L.) Pers. ex Link" or simply as "(L.) Link." The combination is occasionally attributed to Persoon, following Fernald (1950) or Gleason and Cronquist (1991), who routinely omitted the name of the publishing author in such contexts, but under current rules of nomenclature that is incorrect.

The binomial *M. pulmonarioides* Roth was published before *M. virginica* (L.) Pers. ex Link, but as long as the taxonomic rank is not changed, priority is based on the date of publication of the species epithet rather than on that of the binomial. Adoption of the earliest available species epithet is retroactively required under Articles 11.4 and 52 of the *International Code of Botanical Nomenclature*, 2000 ed. (Greuter et al. 2000). In this case, the earliest available epithet for the species described by Linnaeus is *virginica*, the priority of which dates from 1753, the starting point of botanical nomenclature.

During the interval 1797-1829 three homonyms of the genus name *Mertensia* were published: *Mertensia* Willd. for a genus of ferns; *Mertensia* Thunb. ex Roth for a genus of red algae; and *Mertensia* Kunth for a genus of Ulmaceae. These illegitimate homonyms were used only briefly and by few authors. A search of Broun's (1938) *Index to North American Ferns* and the Internet resources AlgaeBase and The International Plant Names Index (websites) indicated that the species epithet *virginica* was not used under any of those homonymic genus names. Nor did the IPNI or any other index disclose any pre-1829 use of the combination *M. virginica* for any other species in the boraginaceous genus.

In summary.—The traditional use of the name *M. virginica* is compatible with its typification. The epithet *virginica* in this context has priority from the starting point of botanical nomenclature, 1753, whereas that of *pulmonarioides* is from 1797. The binomial *M. virginica* (L.) Pers. ex Link is not a homonym of a name previously used for any other species. The familiar name *Mertensia virginica* (L.) Pers. ex Link is the correct name for the Virginia-bluebell; it should not be replaced by *M. pulmonarioides* Roth.

ACKNOWLEDGMENTS

I am grateful to Mike Grant and W. George Schmid for very helpful correspondence, and to my colleague Dennis Eveleigh for useful information and valued suggestions. I am also grateful to the staff of the Gray Herbarium/Arnold Arboretum Library for access to historic literature and a photograph of the Linnaean herbarium specimen. Crinan Alexander and Guy Nesom are thanked for reviewing the manuscript.

REFERENCES

Al-Shehbaz, I.A. 1991. The genera of Boraginaceae in the southeastern United States. J. Arnold Arbor. Suppl. Ser. 1:1–169.

Brickell, C. and J.D. Zuk (eds.-in-chief). 1997. The American Horticultural Society A–Z encyclopedia of garden plants. Macmillan Publishing Company, New York.

Broun, M. 1938. Index to North American ferns. Published by the compiler, Orleans, MA.

Fernald, M.L. 1950. Gray's manual of botany, ed. 8. American Book Company, New York. Republished 1970. D. Van Nostrand Company, New York. Republished 1987. Dioscorides Press, Portland, OR.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada, ed. 2. The New York Botanical Garden, Bronx.

Gray, A. 1848. A manual of the botany of the northern United States, ed. 1. James Munroe & Co., Boston and Cambridge.

Gray, A. 1856. Manual of the botany of the northern United States, ed. 2. Ivison & Phinney, New York.

Gray, A. 1862. Manual of the botany of the northern United States, ed. 3. Ivison, Phinney & Co., New York.

Gray, A. 1863. Manual of the botany of the northern United States, ed. 4. Ivison, Phinney, Blakeman & Co., New York.

Gray, A. 1867. Manual of the botany of the northern United States, ed. 5. Ivison, Blakeman, Taylor & Co., New York.

Gray, A., S. Watson and J.M. Coulter (revisers). 1890 ["1889"]. Manual of the botany of the northern United States, ed. 6. American Book Company, New York

Greuter, W., J. McNeill, F.R. Barrie, H.M. Burdet, V. Demoulin, T.D. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth (eds.). 2000. International code of botanical nomenclature (St. Louis Code) Adopted by the Sixteenth International Botanical Congress St. Louis, July–August 1999. Regnum Veg. 138. Koeltz, Königstein.

Gronovius, J.F. 1739. Flora Virginica exhibens plantas quas V.C. Johannes Clayton in Virginia observavit atque collegit, pars prima. Cornelius Haak, Leiden. Republished 1946. Arnold Arboretum, Jamaica Plain, MA.

Huxley, A., M. Griffiths, and M. Levy (eds.). 1992. The new Royal Horticultural Society dictionary of gardening. The Stockton Press, New York; The Macmillan Press, London.

Jackson, B.D. 1893–1895. *Mertensia*. In: Index Kewensis [original 2 vols.]. Clarendon Press, Oxford. 2(3):213. 1894.

Link, J.H.F. 1829. Handbuch der Erkennung der nutzbarsten und am häufigsten vorkommenden Gewächse. Erster Theil. Haude und Spenerschen Buchhandlung (S.J. Josephy), Berlin.

Linnaeus, C. 1753. Species plantarum, ed. 1. Lars Salvius, Stockholm. Republished 1957–1959. The Ray Society, London.

Lord, T., et al. (eds.). 1998. The RHS plant finder 1998-99. Dorling Kindersley, London.

Lord, T., et al. (eds.). 2003. Royal Horticultural Society plant finder 2003-2004. Dorling Kindersley, London.

Mabberley, D.J. 1997. The plant-book, ed. 2. Cambridge University Press, Cambridge.

Richardson, J.E. 2000. *Mertensia* Roth. In: The European garden flora. Cambridge University Press, Cambridge. 6:134–135.

Robinson, B.L. and M.L. Fernald. 1908. Gray's new manual of botany, ed. 7. American Book Company, New York.

Roth, A.W. 1797. Catalecta botanica. Fasc. 1. J.G. Müller, Leipzig.

Schmid, W.G. 2002. An encyclopedia of shade perennials. Timber Press, Portland, OR.

Staff of the Liberty Hyde Bailey Hortorium. 1976. Hortus third. Macmillan Publishing Company, New York.

Trehane, [R.]P. 1989. Index hortensis. Volume 1: Perennials. Quarterjack Publishing, Wimborne, Dorset, U.K.

Website. Accessed 19 July 2004. www.algaebase.org/

Website. Accessed 19 July 2004. www.ipni.org/index.html

Williams, L.O. 1937. A monograph of the genus *Mertensia* in North America. Ann. Missouri Bot. Gard. 24:17–159.

BOOK NOTICES/BOOKS RECEIVED

Wild Orchids of the Southeastern United States

Paul Martin Brown with drawings by Stan Folsm. 2004. **Wild Orchids of the Southeastern United States, North of Peninsular Florida.** (ISBN 0-8130-2749-7, pbk.) University Press of Florida, 15 Northwest 15th St, Gainesville, FL 32611-2079, U.S.A. (Orders: www.upf.com, 800-226-3822). $27.95, 394 pp., color photos, b/w illus., 6" × 9".

Publisher Comments: "In more than 100 years of orchid research in Florida, *Wild Orchids of Florida* is the first field guide to be published for this orchid-rich state. Providing more than 400 color photos as well as line drawings by Stan Folsom, distribution maps, and detailed descriptions of each species, this guide should enable even the novice to easily identify any of the orchids found growing in the wild.

"Illustrated keys are provided to aid in identification. Each of the 117 species and varieties has a full page of text, a line drawing, and distribution map with a facing page of full-color photographs. Species deemed as naturalized, escaped, or waifs are also treated. A final chapter enabling the reader to use this book in the nearby southeastern Coastal Plain states makes it an even more valuable resource."

From the color photos and line drawings to the simple but general range maps, Paul Martin Brown has given us another good Wild Orchids book of the USA, this time from the southeastern United States.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

CLIFF CUDWEED AT SPECIFIC RANK IN *PSEUDOGNAPHALIUM* (ASTERACEAE: GNAPHALIEAE)

Harvey E. Ballard, Jr.

Department of Environmental & Plant Biology
Ohio University
Athens, Ohio 45701-2979 U.S.A

Danielle Sky Feller

Robert K. Godfrey Herbarium
Biology Unit 1, Room 100
Florida State University
Tallahassee, Florida 32306-4370, U.S.A.

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Gnaphalium saxicola is treated at specific rank as **Pseudognaphalium saxicola** (Fassett) H.E.Ballard & Feller, comb. nov. It is likely an evolutionary derivative of *Pseudognaphalium obtusifolium* but is consistently different in a number of mophological characters. No intermediates between *P. saxicola* and any other taxon have been observed.

RESUMEN

Gnaphalium saxicola se trata a nivel específico como **Pseudognaphalium saxicola** (Fassett) H.E.Ballard & Feller, comb. nov. Es aparentemente un derivado evolutivo de *Pseudognaphalium obtusifolium* pero es bastante diferente en un número de caracteres morfológicos. No se han observado intermedios entre *P. saxicola* y cualquier otro taxon.

The "Cliff Cudweed," *Gnaphalium saxicola* Fassett, is endemic to a relatively small area of Wisconsin. It was initially described as a distinct species but subsequently reduced in rank to a variety of *Pseudognaphalium* (*Gnaphalium*) *obtusifolium* (L.) Hilliard & Burtt. Cronquist (1946, p. 121) noted that "At least until a larger series of specimens demonstrates its morphological and genetic discontinuity, it seems better treated as a variety of *G. obtusifolium*." We find that treatment at specific rank most accurately reflects the biological and evolutionary situation and transfer of *G. saxicola* to the genus *Pseudognaphalium* is necessary to reflect newly emerging understanding of natural evolutionary groups in the Gnaphalieae. The new combination will be available for use in the forthcoming "Flora of North America" treatments of Asteraceae.

Pseudognaphalium saxicola (Fassett) H.E.Ballard & Feller, comb. nov. *Gnaphalium saxicola* Fassett, Rhodora 33:75. 1931. *Gnaphalium obtusifolium* var. *saxicola* (Fassett) Cronq., Rhodora 48:121. 1946. *Pseudognaphalium obtusifolium* var. *saxicola* (Fassett) Kartesz, Synthesis N. Amer. Fl., Nomencl. Innov.: no. 32. 1999. TYPE: U.S.A. WISCONSIN. ADAMS CO.: Coldwater

Canyon, Dells of the Wisconsin River, sandstone ledges, 22 Sep 1929, *N.C. Fassett, F.M. Uhler, and W.T. McLaughlin 9590* (HOLOTYPE: WIS!; ISOTYPE: GH!).

Plants annual, filiform-taprooted. Stems erect, 4–15(–30) cm tall, filiform, persistently tomentose with a loose, envelope-like, transparent haze of extremely thin hairs, doubling the stem width, eglandular. Leaves cauline, 4–6, elliptic-oblanceolate to oblanceolate, gradually narrowed to the base, not clasping or decurrent, 5–30 mm, largest at midstem, sessile, green on both surfaces, within veiny reticulum evident, thinly arachnoid-tomentose to glabrate, eglandular. Heads 2–4 in a terminal, capitate cluster, commonly immediately subtended by uppermost cauline leaf, sometimes several clusters in a corymbiform array. Involucres turbinate, 4–5 mm; phyllaries narrowly triangular to narrowly oblong-triangular, acute, in 3(–4) gradate series, whitish to slightly tawny. Pistillate florets 25–28. Bisexual florets 6–7. Cypselae smooth, without raised ridges or papillae.

Flowering (Jul–)Aug–Sep. Mostly bare sandstone cliff faces, ledges, and cracks, S- to E-facing but commonly shaded; 200–300 m; Wisc. (Adams, Columbia, Richland, Sauk, and Vernon cos.).

It seems likely that *Pseudognaphalium saxicola* is an evolutionary derivative of *P. obtusifolium* but it consistently diverges from the latter in many respects. Full details of complementary studies conducted by Ballard and Kowal (1992) and Feller (2000) will be submitted as a combined manuscript for publication but are summarized here in support of the nomenclatural transfer. Phenetic and preliminary greenhouse comparisons of *P. saxicola* with *P. obtusifolium*, *P. helleri* (Britt.) Anderb., and *P. micradenium* (Weatherby) Nesom have distinguished *P. saxicola* by the following: annual duration and absence of a basal rosette; shorter stature (commonly only a few centimeters tall in fruit); loose, partially detaching cobwebby-tomentose pubescence on stems, and complete absence of glands or glandular hairs on stems and leaves; fewer leaf nodes with shorter and broader, thinner and more membranous, essentially glabrous leaves; larger and more open inflorescence; few, small heads with relatively few florets; and more slender, uniformly narrowly acute-tapering, semi-translucent phyllaries. Depauperate individuals of *P. obtusifolium* over its whole geographic range may sometimes be as short as 5–10 cm, approaching the habit of *P. saxicola*; such plants differ from *P. saxicola*, however, in their close and more dense stem vestiture, bicolored and relatively narrow leaves, larger heads with greater number of pistillate florets, and broader phyllaries with rounded apices. No intermediate specimens between *P. saxicola* and any other taxon have been confirmed in hundreds of collections.

Genetic studies of *Pseudognaphalium saxicola* populations using Inter-Simple Sequence Repeats indicate that the taxon is strongly and perhaps obligately apomictic; isolated greenhouse flats set abundant seeds, supporting this hypothesis.

ACKNOWLEDGMENTS

The authors gratefully appreciate the assistance of curators of herbaria at Harvard University (GH), Philadelphia Academy of Sciences (PH), Smithsonian Institution (US), University of Michigan (MICH), University of Wisconsin-Milwaukee (MIL) and University of Wisconsin-Madison (WIS) for facilitating studies of herbarium collections of *Pseudognaphalium*. June Dobberpuhl provided help with development of the project and secured funding from the Wisconsin Bureau of Endangered Resources and the U.S. Fish & Wildlife Service for it. Staff of Wisconsin State Parks were helpful in gaining access to sandstone outcrops for searches.

REFERENCES

Ballard, H.E., Jr. and R.R. Kowal. 1992. Status survey and taxonomic study of *Gnaphalium saxicola* Fassett. Report, Bureau of Endangered Species, Department of Natural Resources, Madison, Wisconsin.

Cronquist, A. 1946. Notes on the Compositae of the northeastern United States. III. Inuleae and Senecioneae. Rhodora 48:116–125.

Feller, D.M.S. 2000. A study of the distribution, ecology, and genetic diversity of *Pseudognaphalium saxicola* (Fassett) comb. nov. (Asteraceae), a rare annual plant endemic to Wisconsin. Masters Thesis, University of Wisconsin.

BOOK NOTICES/BOOKS RECEIVED

Natural Resources Management

P.F. Ffolliott, L.A Bojorquez, and M. Hernandez-Narvaez. 2001. **Natural Resources Management Practices: A. Primer.** (ISBN 0-8138-0913-4, pbk.) Iowa State Press, A Blackwell Publishing Company, PO Box 570, Ames, IA, 50010-0570, U.S.A. (Orders: 800-862-6657; www.iowastatepress.com). $34.99, 256 pp., b/w figures, tables, 5 appendices, 6" × 9".

The topic of natural resources practices are of ever-increasing interest to many. Authors, Ffolliot, Bojorquez and Hernandez-Narvaez, provide a wonderful introduction to the management approaches of many natural resource arenas in their book entitled Natural Resources Management Practices: A Primer. The easy-to-understand text would be appropriate for undergraduate introduction to the topic of natural resources management. In addition, it is well suited for anyone with an interest in the practices that help preserve wildlife, outdoor recreation areas and that help protect soil, water, forests and other natural products and resources.

The text presents management and conservation practices for water, watersheds, rangeland, timber, agroforestry, wildlife, fisheries, outdoor recreation areas, wilderness, fire and pest control, soil conservation, and rehabilitation of disturbed lands. There is also an excellent discussion of the decision-making process when considering various management options in the integrated natural resources management chapter. Each chapter ends with a review of the main features of each management topic.

Throughout the text the reader is encouraged to think of management in a broad ecosystem-based approach and to consider potential impacts from changes in practices regarding one use on other uses or activities in an area. Basic backgrounds for each management topic areas are introduced prior to discussion of management techniques and greatly enhance understanding of the management methodology discussed. The "real world" examples of selected management techniques are incredibly helpful and interesting. Many such real world applications are referenced to journal articles, which allow individual exploration on a technique or topic of interest.

The appendices include various approaches for analyzing and evaluation of management methods. There is a brief introduction to experimental design and statistical analysis of plot studies performed to measure potential impacts of management practices. These plot studies allow researchers to better predict the effectiveness of a management method by testing that method on small-scale areas. Computer simulation modeling, allows researchers or managers to examine impacts and changes that may arise from application of a management technique in a virtual way. Geographic Information Systems (GIS) are discussed as a possible tool in evaluating and guiding management methods.

The authors used English units in a number of examples. English units may increase the understanding of examples for many readers, as they are familiar with feet and inches, but metric units (Systeme Internationale) are considered more appropriate in academia. The authors have provided values in an appendix to allow conversion to metric values if desired.

Natural Resources Management Practices: A. Primer provides a very informative introduction to many facets of natural resources management. The text also provides a well-rounded overview to related topics of data analysis, computer simulation and GIS to evaluate or compare management techniques. The book is recommended not only for science or engineering students, but also for any reader who wishes to gain a better understanding of natural resources management techniques and rationale.—*Lee Luckeydoo, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

PSEUDOGNAPHALIUM CANESCENS (ASTERACEAE: GNAPHALIEAE) AND PUTATIVE RELATIVES IN WESTERN NORTH AMERICA

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Pseudognaphalium canescens, *Pseudognaphalium microcephalum*, *Pseudognaphalium beneolens*, and **Pseudognaphalium thermale** (E.E. Nelson) Nesom, comb. nov., are treated as separate species. A recent treatment of the California flora combined these taxa as subspecies within a single species (*P. canescens*) but earlier floristicians have viewed them as distinct species. The current study also concludes that they are distinct and appropriately treated at specific rank. A nomenclatural and ecological summary and a distribution map are provided for each species and the four are morphologically distinguished in a key. A lectotype is designated for *Gnaphalium wrightii*.

RESUMEN

Pseudognaphalium canescens, *Pseudognaphalium microcephalum*, *Pseudognaphalium beneolens*, y **Pseudognaphalium thermale** (E.E. Nelson) Nesom, comb. nov., se tratan como especies independientes. Un reciente tratamiento de la flora de California combinaba estos taxa como subespecies dentro de una única especie (*P. canescens*) pero los floristas previos las han visto como especies distintas. El presente estudio también concluye que son distintas y que lo apropiado es tratarlas a nivel específico. Se ofrece un resumen nomenclatural y ecológico, así como un mapa de distribución de cada especie, y se distinguen morfológicamente las cuatro en una clave. Se designa un lectotipo para *Gnaphalium wrightii*.

For the forthcoming treatment of *Pseudognaphalium* in the Flora of North America, I will recognize as species four taxa that were recently treated (Stebbins & Keil 1992; Stebbins 1993) as subspecies of a single species: *P. canescens* (DC.) A. Anderb., *P. microcephalum* (Nutt.) A. Anderb., *P. beneolens* (Davidson) A. Anderb., and (as validated below) *P. thermale* (E.E. Nelson) Nesom.

Pseudognaphalium thermale (E.E. Nelson) Nesom, comb. nov. *Gnaphalium thermale* E.E. Nelson, Bot. Gaz. 30:121. 1900. *Gnaphalium microcephalum* var. *thermale* (E.E. Nelson) Cronq., Leafl. West. Bot. 6:47. 1950. *Gnaphalium microcephalum* subsp. *thermale* (E.E. Nelson) G.W. Douglas, Canad. J. Bot. 64:2726. 1986. *Gnaphalium canescens* subsp. *thermale* (E.E. Nelson) Stebbins & Keil, Novon 2:437. 1992. *Pseudognaphalium canescens* subsp. *thermale* (E.E. Nelson) Kartesz, Syn. Checklist & Atlas, Nom. Innov. 1999. *Pseudognaphalium microcephalum* (Nutt.) Anderb. var. *thermale* (E. Nelson) Dorn. Vasc. Pl. Wyoming, ed. 3. 375. 2001. TYPE: U.S.A. WYOMING. [Park Co.]: Yellowstone Park, geyser formations of Norris geyser basin, 25 Jul 1899, *A. Nelson and E. Nelson 6139* (HOLOTYPE: RM; ISOTYPES: GH!, US!).

Gnaphalium williamsii Rydb., Bull. Torrey Bot. Club 37:324. 1910. TYPE: U.S.A. MONTANA. [Flathead Co.]: Columbia Falls, 11 Aug 1894, *R.S. Williams s.n.* (HOLOTYPE: NY!).

Gnaphalium johnstonii G.N. Jones, Univ. Wash. Publ. Bot. 7:159, 176. 1938. Type: U.S.A. Washington. [Thurston Co.]: upper valley of the Nesqually, open, barren ground, 15 Sep 1896, *O.D. Allen 223* (isotype [as so annotated]?: WTU, digital image!).

Flowering Jun–Sep(–Oct). Dry, sandy roadbanks, roadside ditches, river beds and banks, lakeshores, granitic sand, open woods of yellow pine, Jeffrey pine, red fir, Douglas fir, mixed conifer, and mixed evergreen; (50–)300–2300(–2500) m. British Columbia; California, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming.

Pseudognaphalium beneolens (Davidson) A. Anderb., Opera Bot. 104:147. 1991. *Gnaphalium canescens* subsp. *beneolens* (Davidson) Stebbins & Keil, Novon 2:437. 1992. *Pseudognaphalium canescens* subsp. *beneolens* (Davidson) Kartesz, Syn. Checklist & Atlas, Nom. Innov. 1999. *Gnaphalium beneolens* Davidson, Bull. S. Calif. Acad. Sci. 17:17. 1918. Type: U.S.A. California. [Los Angeles Co.]: Crescenta, 1 Sep 1917, *F.E. Burlew 3275* (isotype: GH!).

Flowering (Apr–)Jun–Oct. Dry, open slopes and ridges, river beds, roadbanks and other disturbed sites, sandy flats, dunes, coastal sage scrub, chaparral, yellow pine, foothill pine, blue oak woodland; (1–)50–850(–1950) m. California; Mexico (Baja California).

Pseudognaphalium microcephalum (Nutt.) A. Anderb., Opera Bot. 104:147. 1991. *Gnaphalium microcephalum* Nutt., Trans. Amer. Philos. Soc. ser. 2, 7:404. 1841. *Gnaphalium canescens* subsp. *microcephalum* (Nutt.) Stebbins & Keil, Novon 2:437. 1992. *Pseudognaphalium canescens* subsp. *microcephalum* (Nutt.) Kartesz, Syn. Checklist & Atlas, Nom. Innov. 1999. Type: U.S.A. California. [San Diego Co.]: San Diego, [April or early May], 1836, *T. Nuttall s.n.* (BM, photo-GH!). After examining a photo of the type of *Gnaphalium microcephalum*, Johnston (1924) noted that *G. microcephalum* was correctly applied to the species usually called *Gnaphalium bicolor* Bioletti (= *Pseudognaphalium biolettii* A. Anderb.); he then proposed *Gnaphalium albidum* to account for the species left without a name. The present interpretation, however, of the type and of Nuttall's description is that they refer to *P. microcephalum* in the concept here (see key below). Ferris (1960 , p. 469) examined the photograph of the type and her interpretation of its identity was similar to that here. She commented that "The specimen probably was collected in the spring (see Madrono 2:146–47. 1934) [Jepson 1934]. This would account for the weather-beaten appearance (darkened foliage and rubbed tomentum) of this plant which normally flowers in summer and early fall."

Gnaphalium albidum I.M. Johnston, Contr. Gray Herb. 70:84. 1924. Type: U.S.A. California. San Diego Co.: Granite, in chaparral, 1850 ft, 11 Jul 1916, *M.F. Spencer 69* (holotype: GH!; isotype: US!).

Flowering (Apr–)Jun–Aug(–Nov). Grassy hillsides, gravelly canyon bottoms, coastal sage scrub, chaparral; 50–900(–1800) m. California; Mexico (Baja California).

Pseudognaphalium canescens (DC.) A. Anderb., Opera Bot. 104:147. 1991 (non W.A. Weber 1991). *Gnaphalium canescens* DC., Prodr. 6:228. 1838. Type: MEXICO. Guanajuato: León, *Méndez s.n.* (holotype: G-DC, fiche!, photos F! and TEX!).

Gnaphalium wrightii A. Gray, Proc. Amer. Acad. Arts 17:214. 1882. <b7,10>Type: U.S.A. Texas. [El Paso or Hudspeth Co.]: valley between El Paso and the Guadalupe Mts., Oct [1849], *C. Wright*

394 (LECTOTYPE, designated here: GH!; ISOLECTOTYPES: GH, US!). Gray's protologue referred to three collections: he directly cited (1) *Parry & Palmer 419* (GH) from San Luis Potosi, Mexico, collected in 1878; he cited "*G. microcephalum*, Gray, Pl. Wright, i. & ii., non Nutt." in reference to his earlier identification as *Gnaphalium microcephalum* of (2) a collection by Wright in Texas from the "Valley between El Paso and the Guadalupe Mts.; Oct." (Pl. Wright. [Smithsonian Contr. Knowl. 3(5) 1852] 1:124. 1852) and (3) another collection by Wright in 1851 from New Mexico, "from mountains near the copper mines" (Pl. Wright. [Smithsonian Contr. Knowl. 5(6) 1853] 2:99. 1853).

Gnaphalium albatum Osterh., Muhlenbergia 1:141. 1906. TYPE: U.S.A. COLORADO. Larimer Co.: Canyon of Thompson River, 16 Aug 1905, *G.E. Osterhout 3158* (ISOTYPE [as annotated by C. Anderson, 1972]: NY!).

Gnaphalium sonorae I.M. Johnston, Contr. Gray Herb. 68:99. 1923. TYPE: MEXICO. SONORA: Hermosillo, 1888, *M.A. Crawford s.n.* (HOLOTYPE: GH!; ISOTYPE: US!).

Gnaphalium viridulum I.M. Johnston, Contr. Gray Herb. 70:86. 1924. TYPE: U.S.A. NEW MEXICO. [Grant Co.]: Bear Mts. near Silver City, 2400 m, 19 Sep 1903, *O.B. Metcalfe 742* (HOLOTYPE: GH!; ISOTYPE: US!).

Gnaphalium texanum I.M. Johnston, Contr. Gray Herb. 70:86. 1924. TYPE: U.S.A. TEXAS. [Brewster Co.]: mouth of "Tarlingua" [Terlingua Creek], Sep 1883, *V. Havard 26* (HOLOTYPE: GH!; ISOTYPE: US!).

Flowering Aug–Nov(–Jan). Lava beds, grasslands, oak, pine-oak, and pine woodlands, 1150–2450(–2700) m; Arizona, California, Colorado, New Mexico, Oklahoma, Texas, Utah; Mexico (Baja California, Chihuahua, Coahuila, Durango, Nuevo León, San Luis Potosí, Sinaloa, Sonora, and other states to the south).

KEY TO *PSEUDOGNAPHALIUM CANESCENS* AND PUTATIVE RELATIVES IN CALIFORNIA

1. Basal and lower cauline 1.5–6 mm wide, similarly colored on abaxial and adaxial surfaces, cauline decurrent 5–14 mm, the decurrent portion appearing as a thin line, densely and prominently sessile-glandular beneath the tomentum; plants aromatic.
   2. Stems 20–40 cm tall; basal and lower cauline leaves narrowly oblanceolate, gradually or abruptly reduced in size and becoming linear upwards, not coiling upon wilting; capitulescence corymbiform; involucres 4–5 mm long; phyllaries in 3–4(–5) series, usually slightly hyaline and shiny; bisexual florets (2–)4–7; habitats at (600–)900–2500 m ____ **Pseudognaphalium thermale**
   2. Stems 35–100 cm tall; basal and lower cauline leaves linear to linear-oblanceolate, relatively even in size and shape upwards, usually twisting or broadly coiling upon wilting; capitulescence usually elongate-paniculiform; involucres 5–6 mm long; phyllaries in (4–)5–6(–7) series, usually opaque and dull; bisexual florets (3–)5–10(–13); habitats at 5–800(–1550) m ____ **Pseudognaphalium beneolens**
1. Basal and lower cauline leaves (2–)5–10(–15) mm wide, often weakly bicolored, cauline not decurrent, eglandular (*P. microcephalum*) or eglandular to minutely and inconspicuously sessile-glandular (*P. canescens*); plants not aromatic.
   3. Stems 50–100 cm tall, usually 3–5 mm diameter near the base; leaves eglandular; phyllaries in 4–5 series, outer ovate; bisexual florets 4–9 ____ **Pseudognaphalium microcephalum**
   3. Stems 20–70 cm tall, usually 2–3 mm diameter near the base; leaves eglandular to minutely and inconspicuously sessile-glandular beneath the adaxial tomentum; phyllaries in 3–4 series, outer ovate-lanceolate; bisexual florets (1–)2–5(–6), 4–6 more common in the USA ____ **Pseudognaphalium canescens**

DISCUSSION

All four of the taxa considered here occur in California (Figs. 1–4). *Pseudognaphalium microcephalum* and *P. beneolens* are primarily Californian. *Pseudognaphalium canescens* ranges eastward to Colorado, Oklahoma, and Texas and southward in Mexico as far as Chiapas, although it appears to be rare south of the state of Mexico. *Pseudognaphalium thermale* occurs northward into southern British Columbia, Idaho, and Montana and barely reaches Utah and Wyoming. Stebbins and Keil (1992) observed that in southern California, where all four occur, they "intergrade to such a degree with respect to characters used in current keys (Ferris 1960; Munz 1959, 1968, 1974) to differentiate them — decurrent versus nondecurrent leaf bases, nature of tomentum, character of capitulescence, size and shape of heads, and acute versus obtuse phyllary tips — that they cannot be consistently be separated from each other." Cronquist (1955) earlier treated *Gnaphalium thermale* and *G. microcephalum* at varietal rank within a single species, but his concept of the latter apparently included at least *G. beneolens*. In contrast, other botanists have regarded each of the four as a separate species (i.e., Ferris 1960; Munz 1959, 1968), and I also find that consistent separation is possible.

Local and regional floras in California have treated *Pseudognaphalium microcephalum* and *P. beneolens* as separate species where they occur together: San Luis Obispo Co. (Hoover 1970), "southern California" (Munz 1974), the Santa Monica Mountains of Los Angeles Co. (Raven et al. 1986), and Santa Cruz Island of Santa Barbara Co. (Junak et al. 1995). These two species are sympatric in the southern coastal counties (Figs. 2 and 3) and I have not seen collections that might be indicative of hybridization.

Pseudognaphalium beneolens and *P. thermale* are similar in their aromatic character and their relatively narrow, decurrent, concolored leaves prominently sessile-glandular beneath the other indument. The two are largely allopatric in geographic range (Figs. 3 and 4) and *P. beneolens* generally occurs at lower elevations. Ferris (1960, p. 470) noted that "some plants of the lower western slopes of the Sierra Nevada are intermediate between [*Gnaphalium beneolens*] and *G. thermale*, having the opaque phyllary-tips and larger heads of the former and the growth habit and shorter inflorescence of the latter." My observation is that these plants (e.g., Tuolumne, Mariposa, and Fresno cos.), which I identify as *P. beneolens*, occur at higher elevations than coastal populations and they tend to have slightly wider basal leaves, but otherwise they fit within the species. In any case, even if they are somewhat differentiated from coastal populations, it is not clear that genes from *P. thermale* are the influencing factor. Further, there does not appear to be evidence of intergradation even in Mariposa and Fresno counties, where the two species apparently occur in relatively close proximity.

Pseudognaphalium beneolens was reported for Oregon by Ferris (1960) and

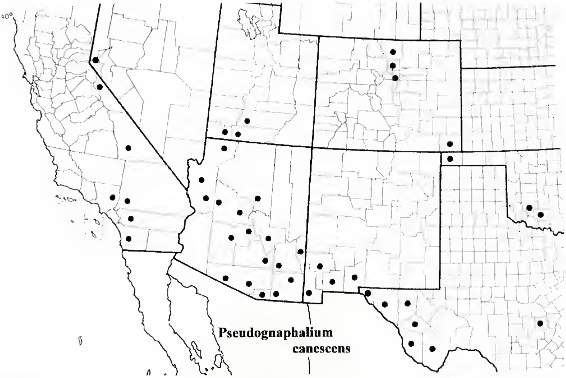


FIG. 1. Distribution of *Pseudognaphalium canescens* in the United States. The distribution continues into south-central Mexico (see text).

Munz (1974) and the current study records its occurrence in immediately adjacent California (Fig. 3), considerably north of the main range of the species. Both records are documented here: CALIFORNIA. Del Norte Co.: Hazelview Summit on Crescent City-Grant's Pass road, 2800 ft, 24 Jul 1928, *Kildale 5813* (LL); OREGON. Josephine Co.: Illinois River between McGuire Gulch and Oak Flat, 1300 ft, 8 Aug 1929, *Kildale 8881* (LL).

Pseudognaphalium canescens and *P. microcephalum* are mostly odorless and have relatively broader, non-decurrent, and weakly bicolored leaves without glands or with minute and weakly developed glands. These two species differ in geography and ecology and it is unlikely that they hybridize.

Variation in *Pseudognaphalium canescens*

Variability in phyllary morphology apparently was the primary basis for I.M. Johnston's descriptions of the several different taxa now treated within *Pseudognaphalium canescens*. Plants of *P. canescens* characteristically produce strongly white-opaque phyllaries with a filiform keel and apiculum, but in the southern portion of its range (Jalisco southeastward) and scattered localities elsewhere, the phyllaries may be more hyaline and lack a pronounced keel and apiculum. Similar plants from New Mexico were the basis for Johnston's recognition of *Gnaphalium viridulum*, but these are not distinct on the basis of other

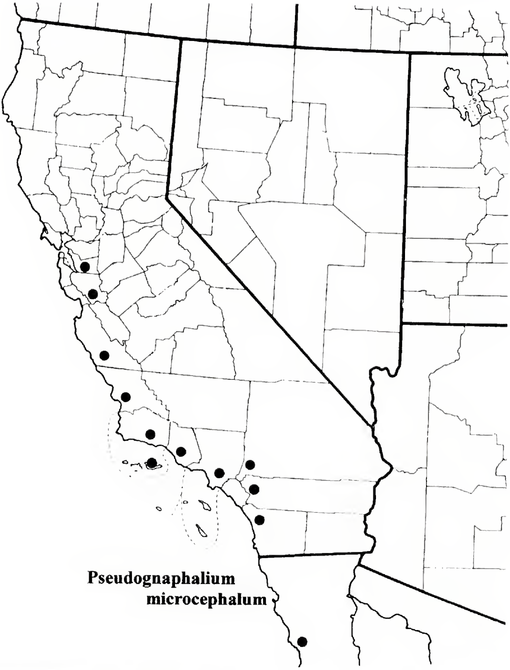


Fig. 2. Distribution of *Pseudognaphalium microcephalum*.

characters. The widely disjunct populations of *P. canescens* in Texas, Oklahoma, and Colorado (Fig. 1) do not appear to be significantly differentiated from those in areas where the species is more continuously distributed.

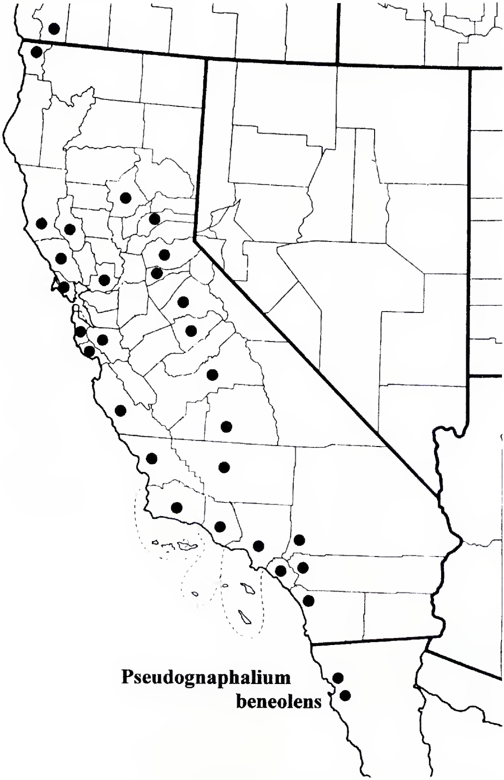


FIG. 3. Distribution of *Pseudognaphalium beneolens*.

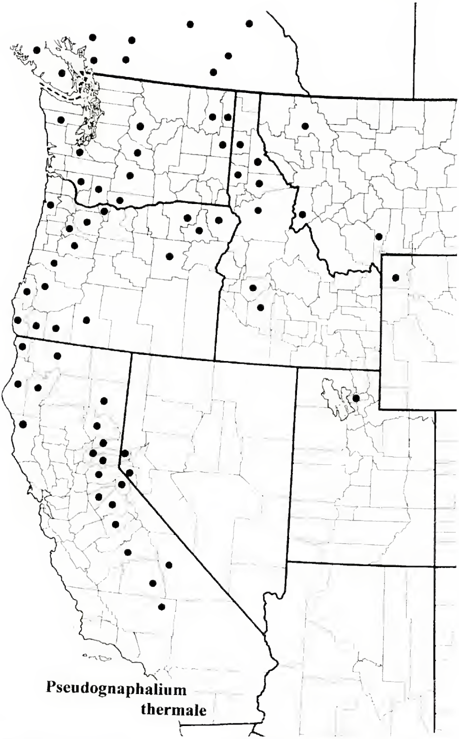


Fig. 4. Distribution of *Pseudognaphalium thermale*. Some records were taken from databases available through herbaria of the University of British Columbia (UBC), Washingon State University (WTU), and Oregon State University (OSU).

ACKNOWLEDGMENTS

David Giblin (WTU) provided data and a digital image of the type of *Gnaphalium johnstonii*, Scott Sundberg (OSU) helped in accessing the Oregon State University database of vascular plants, and Walter Kittredge (GH) provided information on the syntypes and typification of *Gnaphalium wrightii*. Observations and distribution maps are based on specimens from ARIZ, GH, HSC, MO, TEX/LL, and SMU/BRIT, except where noted for Fig. 4. Review comments from David Keil are much appreciated.

REFERENCES

Cronquist, A. 1955. Vascular plants of the Pacific Northwest, Part 5: Compositae. Univ. of Washington Press, Seattle.

Ferris, R.M. 1960. Compositae. In: L. Abrams and R.S. Ferris. Illustated flora of the Pacific states, Vol. 4. Stanford Univ. Presss, Stanford, California. Pp. 98–613.

Hoover, R.F. 1970. The vascular plants of San Luis Obispo County, California. Univ. of California Press, Berkeley.

Jepson, W.L. 1934. The overland journey of Thomas Nuttall. Madrono 2:143–147.

Johnston, I.M. 1924. Taxonomic records concerning American spermatophytes. Contr. Gray Herb. 70:61–92.

Junak, S., T. Ayers, R. Scott, D. Wilken, and D. Young. 1995. A flora of Santa Cruz Island. Santa Barbara Botanic Garden in collaboration with the Calif. Native Plant Society.

Munz, P.A. 1959. A California flora. Univ. California Press, Berkeley.

Munz, P.A. 1968. Supplement to a California flora. Univ. California Press, Berkeley.

Munz, P.A. 1974. A flora of southern California. Univ. California Press, Berkeley.

Raven, P.H., H.J. Thompson, and B.A. Prigge. 1986. Flora of the Santa Monica Mountains, California (ed. 2). Southern California Botanists Special Publ. No. 2.

Stebbins, G.L. and D.J. Keil. 1992. New combinations in *Gnaphalium* (Asteraceae: Inuleae). Novon 2:437.

Stebbins, G.L. 1993. *Pseudognaphalium*. In: J.C. Hickman, ed. The Jepson manual: higher plants of California. Univ. California Press, Berkeley. Pp. 270–271.

BOOK NOTICES/BOOKS RECEIVED

Timber Press book on Lavender

Tim Upson and Susyn Andrews. 2004. **The Genus Lavandula.** (ISBN 0-88192-642-6, hbk.) Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $49.95, 442 pp., 30 color plates by Georita Harriott, Christabel King, and Joanna Langhorne), 4 b/w photos, 126 color photos, 28 maps, 41 line drawings, 12 tables, 7 3/8" × 9 5/8".

According to the authors, "***The Genus Lavandula*** is the most comprehensive and authoritative account of lavenders to be published to date." After spending some time thumbing through it, I am inclined to agree. Besides describing some 39 species and their hybrids, it encompasses the taxonomy, distribution, history and cultivation, with additional chapters on propagation, products, chemistry, essential oils, and pests and diseases, in a relatively small book. Besides making a lovely coffee table book, it is incredibly useful when identifying species, with the 31 full page color paintings, 45 line drawings and numerous maps. A part of the book that I found unique was the 50 page chapter on the History of Lavender Cultivation; an A–Z listing of all the people, places and companies involved in the world of Lavender. Among the nine appendices, some that I found to be useful were a highly detailed one on how to photograph lavender, giving advice on lighting, camera, film and backgrounds; Plant Breeders' Rights and Plant Patents; and National Collections and Nurseries, which lists up-to-date information including, telephone and email addresses. With all that's included in this book, I think it is well worth the $49.95 (U.S) it costs.—*Asha McElfish, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Editor's note.—Appendix 1 list new taxa and combinations of which there are 18 including two new species (*Lavandula samhanensis* and *Lavandula qishnensis*).

A TAXONOMIC REVIEW OF THE *ERIOPHORUM RUSSEOLUM—E. SCHEUCHZERI* COMPLEX (CYPERACEAE) IN NORTH AMERICA

Jacques Cayouette

National Program on Environmental Health–Biodiversity
Agriculture and Agri-Food Canada
Wm. Saunders Building (#49)
Central Experimental Farm
Ottawa, Ontario, CANADA, K1A 0C6
email: cayouettej@agr.gc.ca

ABSTRACT

The taxonomy of *Eriophorum russeolum—E. scheuchzeri* complex in North America is reviewed, including the northwestern North American related species *E. chamissonis*. A key to the taxa including new characters of the medial fertile scales and achenes is presented. The new nothosubspecies ***Eriophorum* ×*medium*** subsp. ***album*** J. Cayouette is described; it represents the hybrid between *E. russeolum* subsp. *leiocarpum* and *E. scheuchzeri* subsp. *scheuchzeri* from northeastern Canada (northern Quebec and Nunavut), based on intermediate characters observed in herbarium specimens. The typical hybrid subspecies, *E.* ×*medium* subsp. *medium* (*E. russeolum* subsp. *russeolum* × *E. scheuchzeri* subsp. *scheuchzeri*) is also characterized and added to the flora of North America (Quebec and Labrador). The two hybrid subspecies are compared to their parental subspecies. Another related taxon, *E. scheuchzeri* subsp. *arcticum*, poorly known in North America, is compared to the typical subspecies and its range is established in northeastern North America. Lectotypes of *E. russeolum* Fries and *E. russeolum* var. *majus* Sommier are here designated.

RÉSUMÉ

Une révision taxonomique du groupe des *Eriophorum russeolum—E. scheuchzeri* en Amérique du Nord est proposée, incluant l'espèce voisine *E. chamissonis* du nord-ouest de l'Amérique. Une clef des taxons basée sur des caractères inédits des écailles fertiles médianes et des akènes est présentée. Une nouvelle notho-sous-espèce, l'***Eriophorum* ×*medium*** subsp. ***album*** J. Cayouette, est décrite, représentant l'hybride entre l'*Eriophorum russeolum* subsp. *leiocarpum* et l'*E. scheuchzeri* subsp. *scheuchzeri*, et localisée dans le nord-est du Canada (nord du Québec et Nunavut), à partir d'observations de caractères intermédiaires sur des spécimens d'herbier. La sous-espèce typique de l'hybride, l'*E.* ×*medium* subsp. *medium* (*E. russeolum* subsp. *russeolum* × *E. scheuchzeri* subsp. *scheuchzeri*), est également caractérisée et rapportée comme nouvelle pour l'Amérique du Nord (Québec et Labrador). Les deux sous-espèces de l'hybride sont comparées à leurs sous-espèces parentales respectives. Un autre taxon voisin, l'*E. scheuchzeri* subsp. *arcticum*, peu connu en Amérique du Nord, est comparé à la sous-espèce typique, et son aire de répartition est précisée dans le nord-est de l'Amérique. Les lectotypes de l'*E. russeolum* Fries et de l'*E. russeolum* var. *majus* Sommier sont désignés.

Key Words: *Eriophorum*, Cyperaceae, hybrid, Canada, Quebec, Labrador, Nunavut, arctic

In the course of the preparation of the collaborative project "la Flore du Québec-Labrador nordique," spearheaded by "le Centre d'Études nordiques" and "l'Herbier Louis-Marie" (QFA), both of Laval University, Quebec City, Canada, the genus *Eriophorum* (Cyperaceae) was found to be very difficult taxonomically, especially within the *E. russeolum* Fries in Hartman and *E. scheuchzeri* Hoppe groups of rhizomatous species with solitary spikelets, in subgenus *Eriophorum*. Approximately 700 specimens from the region of the projected flora were examined, covering the Quebec-Labrador peninsula north of 54° N, including adjacent islands in Hudson Bay and Ungava Bay that belong administratively to Canada's Nunavut Territory. Specimens from outside the region were also studied. Material was examined from the following herbaria: CAN, DAO, FI, GH, MICH, MINN, MT, MTMG, QFA, QFBE, QUE, SFS, TRTE, UPS, and WIS (abbreviations according to Holmgren et al. 1990).

Marcel Raymond (1954) was one of the first to circumscribe the taxa related to *Eriophorum chamissonis* C.A. Meyer and *E. russeolum*. He recognized five different species complexes worldwide based on the color and the shape of the spikelets, the pubescence of the achenes, the color pattern of the medial fertile scales, and in using some distributional characteristics. He also proposed three varieties of *E. russeolum* based on the color of the bristles and the pubescence of the achenes, two colored-bristle forms for *E. chamissonis*, and three colored-bristle forms for *E. ×medium* Andersson which he presumed to represent the hybrid between *E. russeolum* and *E. scheuchzeri*. His key to these taxa was very brief and does not work well. He believed that both *E. chamissonis* and *E. russeolum* occurred in eastern and western North America. In northeastern North America, he separated *E. russeolum* into two varieties based on achene pubescence. Specimens determined by Raymond as *E. chamissonis* in northeastern North America did not match the characters he gave in his publication for that species (first proximal scale length, stem width). It is almost impossible to clearly separate *E. chamissonis* from *E. russeolum* in northeastern North America based on his work.

Later, Novoselova (1993) proposed an alternative circumscription of these taxa, and made other changes in the *E. scheuchzeri* group (Novoselova 1994a, 1994b). She believed that in subgenus *Eriophorum* two rhizomatous species with orange-brown spikelets occur in North America, *E. chamissonis* and *E. russeolum* subsp. *russeolum*. She restricted the range of *E. chamissonis* to North America (both western and eastern North America), considering the Russian material to be referable to other species of the group. She also considered *E. russeolum* subsp. *russeolum* to be an amphi-Atlantic taxon. Ball and Wujek (2002) included *E. russeolum* within *E. chamissonis*, and considered *E. scheuchzeri* to be monotypic.

This investigation supports the circumscriptional concepts of Novoselova (1993, 1994a, 1994b), with the addition of a new taxon to the *E. russeolum*—*E. scheuchzeri* group. Moreover, based on examination of North American rhizomatous taxa of subgenus *Eriophorum* with orange-brown spikelets, it appears that *E. chamissonis* is present only in Alaska and British Columbia, while

Eriophorum russeolum subsp. *russeolum* occurs only in the northeastern North America.

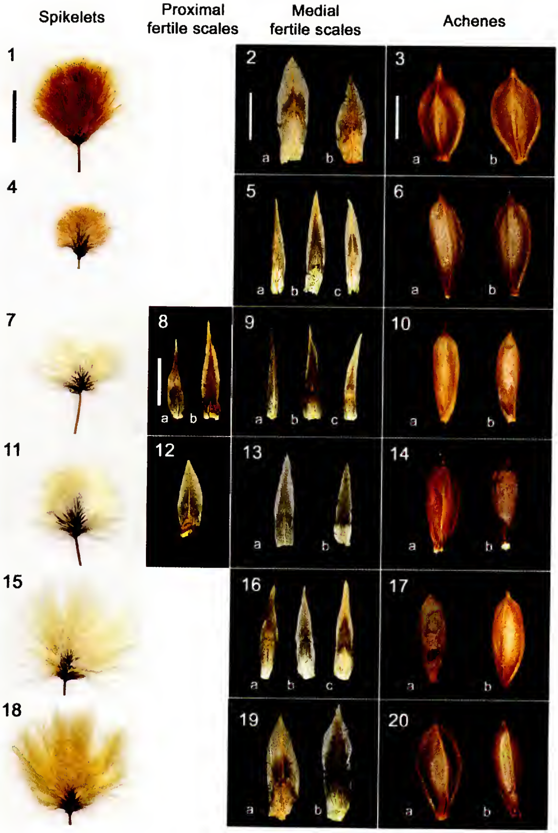
Examination of material from northeastern North America, revealed that rhizomatous specimens with orange-brown spikelets are highly variable. The variation includes typical and atypical *E. russeolum* subsp. *russeolum*, and what is known in western Russia and northwestern Europe as *E.* ×*medium*, the hybrid between *E. russeolum* subsp. *russeolum* and *E. scheuchzeri* subsp. *scheuchzeri* (Novoselova 1993, 1994a), a taxon not previously reported in North America. A few specimens seem to be atypical *E. russeolum* subsp. *russeolum*, or perhaps backcrosses of *E.* ×*medium* with *E. russeolum* subsp. *russeolum*.

Variation is even greater among rhizomatous taxa with white spikelets in the *Eriophorum russeolum* and *E. scheuchzeri* groups. *Eriophorum russeolum* subsp. *leiocarpum* Novoselova can be considered the white phase of *E. russeolum*. Two subspecies can be discerned in the *E. scheuchzeri* group, the common boreal and arctic-alpine subsp. *scheuchzeri*, and the recently recognized high-Arctic subsp. *arcticum* Novoselova. Novoselova (1994b) reported the latter subspecies for Arctic North America, without adequately establishing its distribution in northeastern North America. It should be noted that despite the high variability of *E. russeolum* subsp. *leiocarpum* (Novoselova 1993), some specimens with white spikelets match neither the description of that subspecies nor that of any subspecies in the *E. scheuchzeri* group. Since these specimens have many intermediate characters between *E. russeolum* subsp. *leiocarpum* and *E. scheuchzeri* subsp. *scheuchzeri*, I conclude that they represent a hybrid of these two subspecies. To account for this hybrid, I propose and describe below a new nothosubspecies of *E.* ×*medium*.

With the naming and description of a new taxon, the discovery of a second as new to North America (*E.* ×*medium* subsp. *medium*), and the realization that a third (*E. scheuchzeri* subsp. *arcticum*), while recognized as present, is poorly known on the continent, it has been necessary to identify new characters that help to distinguish these taxa from the commoner *E. russeolum* subsp. *russeolum*, subsp. *leiocarpum* and *E. scheuchzeri* subsp. *scheuchzeri*. The characters are based on various features of the medial fertile scales (size, shape, apex, color pattern), on features of the achenes (size, shape, surface, beak shape and size), and on the lengths of hypogynous perianth bristles and stigmatic branches. Complete descriptions of all six taxa are provided below. The main differences among these taxa are illustrated in Figs. 1–20, summarized in Tables 1 and 2, and employed in the key to the taxa.

As the northwestern North American *E. chamissonis* has been previously reported in northeastern North America, and confused with *E. russeolum*, a complete description is also provided and some of its main differences are included in Table 1 and employed in the key.

General ranges are given for the widespread *E. russeolum* subsp. *russeolum*


Spikelets
Proximal fertile scales
Medial fertile scales
Achenes
1
2
a
b
3
a
b
4
5
a
b
c
6
a
b
7
8
a
b
9
a
b
c
10
a
b
11
12
13
a
b
14
a
b
15
16
a
b
c
17
a
b
18
19
a
b
20
a
b

and *E. scheuchzeri* subsp. *scheuchzeri*, while selected specimens or paratypes are cited for the other five taxa.

Eriophorum chamissonis

Eriophorum chamissonis C.A. Meyer in Ledeb. Fl. Alt. 1:70. 1829. TYPE: U.S.A. ALASKA: (LECTOTYPE: "Legit Eschsch. in Unalaska," by Novoselova (1993), p. 88).

Herbs perennial with short to elongate rhizomes. Vegetative shoots 1–3, 21–61 cm high, leaf margins glabrous. Stems erect, glabrous, terete in cross section, 27–95 cm high, 1.0–2.2(–2.5) mm in diameter below the inflorescence. Leaves basal and cauline 2–5. Proximal sheaths pale brown, pale reddish-brown to reddish-brown, with orange-brown spots on distal membranous parts, ligules obtuse or truncate. Highest distal sheath situated above or below the medial part of the stem, 2.3–4.2 mm wide, without blades or with reduced blades. Blades of proximal sheaths flat to slightly cymbiform, 25–430 × 1.4–1.5 mm, glabrous in distal parts, the apex rounded. Blades of distal sheaths 0 or 0.9–3.5 × 0.4–1.0 mm. Spikelets solitary, typically spherical at maturity, sometimes widely obovoid, 2–6 × 2–7 cm, with 100–200 florets. Proximal scales 3–7, without florets. First proximal scale olive to pale gray-olive, becoming pale beige with reddish-brown dots in marginal and distal parts, triangular-lanceolate to elliptic, 12–23(–30) × 2.6–6.5 mm, with 4–10 pale orange, pale brown to blackish nerves converging below the apex, acute, acuminate or rarely short-awned. Medial fertile scales with a non demarcated, or demarcated short to slightly extended proximal part, 1.0–2.5 mm long, averaging 19–42% of total scale length, whitish, greenish, pale beige-brown to pale orange-brown, with small reddish-brown longitudinal spots, with medial part frequently grayish or forming a ± extended blackish triangle, with narrow-hyaline or whitish marginal and distal parts, very often covered with small dark reddish longitudinal spots, mostly lanceolate, sometimes elliptic, 4.2–6.3 × 1.2–1.5(–1.8) mm, the widest part near the middle

---

FIGS. 1–20. Spikelets, proximal (pfs) and medial fertile scales (mfs), and achenes of six *Eriophorum* taxa. **1–3.** *Eriophorum russeolum* subsp. *russeolum*. **1.** Spikelet (*Gauthier & Roy 83-45* QFA). **2a.** Mfs. (*Payette & Légère LM-148* QFA). **2b.** Mfs. (*Deshaye 90-3090* QUE). **3a.** Achene (*Gauthier & Roy 83-41* QFA). **3b.** Achene (*Lemieux 21731* QFA). **4–6.** *Eriophorum ×medium* subsp. *medium*. **4.** Spikelet (*Blondeau 501* QFA). **5a.** Mfs. (*Robinson 74b* GH). **5b.** Mfs. (*Blondeau 501* QFA). **5c.** Mfs. (*Duellet s.n. 1974* CAN). **6a–b.** Achenes (*Robinson 74b* GH). **7–10.** *Eriophorum scheuchzeri* subsp. *scheuchzeri*. **7.** Spikelet (*Blondeau PDLB-88339* QFA). **8a.** Pfs. (*Dutilly et al 7991* DAO). **8b.** Pfs. (*Blondeau 85036* QFA). **9a.** Mfs. (*Calder 2308* DAO). **9b.** Mfs. (*Blondeau 85036* QFA). **9c.** Mfs. (*Deshaye 80* QFA). **10a.** Achene (*Calder 2308* DAO). **10b.** Achene (*Dutilly et al 87313* QFA). **11–14.** *Eriophorum scheuchzeri* subsp. *arcticum*. **11.** Spikelet (*Blondeau 85060* QFA). **12.** Pfs. (*Dutilly et al 87516* SFS). **13a.** Mfs. (*Forbes 70* DAO). **13b.** Mfs. (*Dutilly et al 87562* QFA). **14a–b.** Achenes (*Dutilly et al 87516* SFS). **15–17.** *Eriophorum ×medium* subsp. *album*. **15.** Spikelet (*Blondeau 84435* QFA). **16a.** Mfs. (*Polunin 2599* CAN). **16b.** Mfs. (*Garneau 91-405M* QFA). **16c.** Mfs. (*Cayouette J82-212* DAO). **17a.** Achene (*Soper s.n. 1925* CAN–Holotype). **17b.** Achene (*Cayouette J82-212* DAO). **18–20.** *Eriophorum russeolum* subsp. *leiocarpum*. **18.** Spikelet (*Dutilly et al 20806* QFA). **19a.** Mfs. (*Brisson & Forest 20502* QUE). **19b.** Mfs. (*Dignard 98-159* QUE). **20a.** Achene (*Deshaye 90-1593* QUE). **20b.** Achene (*Dignard 98-159* QUE). Scale bar for Fig. 1 and all the spikelets equals 2 cm; for Fig. 2 and all fertile scales equals 3 mm; for Fig. 3 and all achenes equals 1 mm.

Table 1. Selected morphological differences of *Eriophorum* ×*medium* hybrids and their respective parents, also including *E. chamissonis*.

Characters (1)	Characters (2)	*E. chamissonis*	*E. russeolum* subsp. *russeolum*	*E.* ×*medium* subsp. *medium*	*E. scheuchzeri* subsp. *scheuchzeri*	*E.* ×*medium* subsp. *album*	*E. russeolum* subsp. *leiocarpum*
Spikelet	shape (mature)	spherical or widely obovoid	obovoid to ellipsoid	hemispherical, ovoid or ellipsoid	hemispherical	hemispherical, ovoid or obovoid	ellipsoid or obovoid
"	color of bristles	pale beige-brown	orange-brown to dark orange-brown	pale orange-brown to orange-brown	white or cream white	white or dull white	white or dull white
"	length (cm)	2.0–6.0	1.5–4.0	1.4–4.0	1.0–3.0	1.6–4.0	2.0–4.0
First proximal scale	length (mm)	12–23(–30)	7–14(–18)	7–11(–17)	5–12	7.1–11.5	(5.7–)7–16.5
Medial fertile scales	proximal part length (mm)	1.0–2.5	1.5–3.5	0.9–1.5	0.1–0.9	0.5–1.7	0.8–3.2
	% of proximal part to maximum length	19–42	30–49	17–27(–37)	2–25	9–34	(11–)18–57
"	proximal part color pattern	whitish, greenish, pale beige-brown	orange-brown to beige-brown	whitish, pale green or pale beige	whitish or pale green	whitish, pale green or pale beige	orange-brown, pale brown, pale green or whitish
"	color pattern of other parts	grayish, or blackish medial triangle with narrow-hyaline margins, with small dark longitudinal spots	dark wide medial triangle with wide-hyaline margins	blackish with usually narrow-hyaline margins	dark grey or blackish with dark or narrow hyaline margins	dark medial triangle with reduced hyaline margins	usually dark wide medial triangle with wide or reduced hyaline margins
"	greatest width (mm)	1.2–1.5(–1.8)	1.3–2.2	0.7–1.3	0.4–1.0	0.6–1.1	(0.8–)1.0–2.4

Table 1. continued

Characters (1)	Characters (2)	*E. chamissonis*	*E. russeolum* subsp. *russeolum*	*E.* × *medium* subsp. *medium*	*E. scheuchzeri* subsp. *scheuchzeri*	*E.* × *medium* subsp. *album*	*E. russeolum* subsp. *leiocarpum*
"	position of the greatest width	below or near middle	above or near middle	below middle	below middle or near base	below middle	above, below or near middle
"	apex	acute	acute, rarely obtuse or acuminate	acuminate	narrowly acuminate	acuminate	acute
"	width (mm) at 0.2 mm below the apex	0.3–0.5	0.2–0.5(–0.9)	0.1–0.3	0.05–0.1(–0.2)	0.15–0.3(–0.4)	0.25–0.6
Hypogynous bristles	length (mm)	25–40	25–32	15–20	10–25	(10–)22–32	12–30
Anther	length (mm)	0.7–1.6	1.5–3.1	0.8–1.5(–1.8)	0.35–0.8	0.9–1.6	(1.3–)1.5-3.1
Stigmatic branches	length (mm)	1.5–2.6	1.2–1.8	0.7–2.0	0.5–1.3	1.0–2.2	1.3–3.2
Achene	shape	ellipsoid or slightly obovoid	obovoid or ellipsoid	frequently narrowly obovoid	narrowly obovoid	narrowly obovoid or narrowly ellipsoid	obovoid or ellipsoid
"	width (mm)	0.8–1.1	0.75–1.3	0.6–0.9(–1.1)	0.5–0.85	0.6–0.9	0.6–1.2
"	surface (pubescence)	glabrous or scabrous	glabrous or scabrous	glabrous	glabrous	glabrous	glabrous or scabrous
"	beak width at base (mm)	0.1–0.2	0.1–0.25	0.1–0.15	0.05–0.1	0.1	0.1–0.2
"	beak shape	straight, rarely oblique	straight, rarely oblique	straight or oblique	more often oblique than straight	straight or oblique	more often straight than oblique

TABLE 2. Selected morphological differences between the two subspecies of *Eriophorum scheuchzeri*.

Characters	*E. scheuchzeri* subsp. *scheuchzeri*	*E. scheuchzeri* subsp. *arcticum*
Spikelet shape	hemispherical	spherical
Proximal fertile scale pattern	missing hyaline margins or reduced margins well-separated from darker body	conspicuous hyaline margins passing to inner various tones of gray, to darker medial and basal parts
Medial fertile scale shape	narrowly lanceolate	lanceolate
Medial fertile scale width at the middle (mm)	0.3–0.7(–0.9)	(0.5–)0.7–1.4(–1.6)
Medial fertile scale apex	narrowly acuminate	acuminate
Medial fertile scale width (mm) at ca. 0.2 mm below the apex	mostly 0.1	mostly 0.2
Anther length (mm)	0.35–0.8	0.6–1.0
Achene color	brown to olive-brown	orange-brown to dark reddish-brown
Achene surface	glossy	dull

or below, with 1–3 incomplete nerves, acute, 0.3–0.5 mm wide at 0.2 mm below the apex. Perianth of 50–80 hypogynous bristles, pale beige-brown (or whitish in f. *turneri* Raymond), 25–40 mm long. Stamens with filaments about as wide as perianth bristles, anthers pale yellow, 0.7–1.6 mm long. Styles with 3(–4) stigmatic branches closed or sometimes spreading at maturity, branches 1.5–2.6 mm long. Achenes orange-brown, ellipsoid or slightly obovoid, trigonous to compressed-trigonous, glabrous or scabrous in the distal part, mostly dull, 1.9–2.6 × 0.8–1.1 mm, base cuneate, apex obtuse, with a straight beak, rarely oblique, slightly conical, 0.2–0.5 mm long, 0.1–0.2 mm wide at base.

Distribution and habitat.—*Eriophorum chamissonis* is restricted to northwestern North America, in Alaska and British Columbia. It is found in various kinds of sphagnum and minerotrophic bogs, marshy and beaver meadows, shallow ponds, muskeg, and heat tundra.

Discussion.—This taxon has a long history of various interpretations, of which the most important are those of Raymond (1954) and Novoselova (1993). As many morphological features of *E. chamissonis* overlap with those of *E. russeolum*, *E. chamissonis* has been frequently mistakenly reported in eastern North America (Raymond 1954; Novoselova 1993) and in eastern Russia. Material from Russia has been reassigned by Novoselova to other taxa such as *E. mandshuricum* Meinsch. subsp. *mandshuricum* or subsp. *sibiricum* Novoselova.

Eriophorum chamissonis is best differentiated from *E. russeolum* subsp. *russeolum* by the following characters (see also Table 1): mostly spherical spikelets with pale beige-brown bristles (typically obovoid spikelets with red-brown to dark orange-brown bristles in *E. russeolum*), anthers 0.7–1.6 mm (1.5–3.1 mm in *E. russeolum*), and various color pattern and shape of medial fertile scales: grayish to blackish middle and distal parts, sometimes with a more defined blackish triangle, with usually narrow-hyaline or whitish marginal and distal parts, very often covered with small dark reddish longitudinal spots (see Novoselova 1993, Fig. 1a), mostly lanceolate, the largest width below or near the middle (usually dark wide medial triangle with wide-hyaline margins, mostly without dark longitudinal spots, typically obovate, sometimes lanceolate or elliptic, the largest width above or near the middle in *E. russeolum*).

There are some individuals in northeastern North America with occasional pale orange-brown spikelets, shorter anthers (0.9–1.9 mm), darker, elliptic or lanceolate medial fertile scales with the largest width sometimes below the middle. At first glance, they could be considered within the variation of *E. chamissonis*, but they differ by two main characters. In *E. chamissonis* the first proximal sterile scale is 12–23(–30) mm long and the stem diameter below the inflorescence is 1.0–2.2 mm, whereas the odd northeastern material has the corresponding measurements of 8–11 mm long and 0.6–1.2 mm in diameter respectively. Those specimens are considered in this paper to be atypical *E. russeolum* subsp. *russeolum* or backcrosses of *E.* ×*medium* subsp. *medium* with *E. russeolum* subsp. *russeolum*. See the discussion below under *E. russeolum* subsp. *russeolum*.

In addition, micromorphological differences in the achene surface of *E. chamissonis* and *E. russeolum* have been pointed out by Tucker and Miller (1990). They also consider *E. chamissonis* to be a western North American species.

Selected specimens: **CANADA. British Columbia:** Hart Highway N of Prince George, 8 mi N of Ft. McLeod, 3 Aug 1954, *J.A. Calder et al. 13949* (DAO); near Hilliers between Parksville and Alberni, 49°16'N–124°46'W, 13 Jun 1961, *J.A. Calder & K.T. MacKay 30390* (DAO); near Kispiox River, about 12 mi NNW of Kispiox, N of Hazelton, 19 Aug 1954, *J.A. Calder et al. 14728* (DAO); along Kitsumkalum Lake road, about 8 mi N of Terrace, 22 Aug 1954, *J.A. Calder et al. 14907* (DAO); Hope Island, off N end of Vancouver Island, between Roller Bay and Mexicana Point, 5 Jul 1961, *J.A. Calder & K. T. MacKay 31290* (DAO); Lake Beautiful, 30 Jul 1935, *P.P. Henson s.n.* (DAO); between Prince Rupert and Galloway rapids, 18 Jul 1954, *J.A. Calder et al. 13216* (DAO); Queen Charlotte Islands (QCI), Graham Island, about 3/4 mi SW of Jalun Lake and 9 mi W of head of Naden Harbour, 1 Jul 1964, *J.A. Calder & R.L. Taylor 35663* (DAO); QCI, Graham Island, Masset Inlet, Mamin River delta at Juskatla, 15 Jun 1957, *R.L. Taylor 124* (DAO); QCI, Graham Island, about 8 mi on road from Port Clements to Tlell, 9 Jun 1957, *J.A. Calder et al. 21358* (DAO); QCI, Graham Island, 4 mi W of Tlell on road to Port Clements, 26 Jun 1964, *J.A. Calder & R.L. Taylor 35457* (DAO); QCI, Graham Island, 2–3 mi E of Tow Hill, 20 Jul 1957, *J.A. Calder et al. 22756* (DAO); QCI, Graham Island, about 1 1/2–2 mi W of Tow Hill and E of Masset, 19 Jul 1957, *J.A. Calder et al. 22726* (DAO); QCI, Moresby Island, Cumshewa Inlet, a few mi N of Moresby Logging Camp, 29 Jun 1957, *J.A. Calder et al. 21938* (DAO); Seeley Lake, S of Hazelton, 24 Jun 1949, *R. Pillsbury 191* (DAO); Sicamous-Revelstoke Highway, E end of Victor Lake, 7 Jun 1953, *J.A. Calder & D.B.O. Savile 8796* (DAO); Southern Cariboo Mountains, Wells Gray Provincial Park, E side of Battle Mt., 1.5 mi NE of Stevens Lake, 25 Jul 1961, *L. & T. Ahti 7092* (DAO); 1 mi NW of Trout Lake on road from Beaton to Kaslo, 10 Jun 1954, *J.A. Calder & D. B. O. Savile 8964* (DAO); about 1 mi N of Trout Lake, 50°39'N–117°34'W, 25 Jun 1962, *J.A. Calder & K.W. Spicer 33647* (DAO). **UNITED STATES. Alaska:** Attu

Island, Peaceful Valley, near Navy Town, 52°50'N-173°11'W, 18 Aug 1983, *B.F. Friedman (83-59) & J.A. Michaelson* (DAO, 2 collections); Eagle River, near Juneau, 28 Jun 1940, *J.P. Anderson 6201* (DAO, 2 collections).

Eriophorum russeolum—Eriophorum scheuchzeri complex

A) Taxa with orange-brown spikelets (**Figs. 1–6**)

1. Eriophorum russeolum Fries in Hartman subsp. **russeolum**, Handb. Scand. Fl. ed. 3:13. 1838. TYPE: SWEDEN. TORNE LAPPMARK, Karesuando, *L.L. Laestadius s.n.* (LECTOTYPE, designated here: "Lappon. Tornens. Karesuando, *L.L. Laestadius s.n.* Herbarium normale Fasc. 3, no 67" UPS V-108936!, DAO (photograph)! The sheet selected bears three specimens, the middle one clearly rhizomatous.

Eriophorum russeolum var. *majus* Sommier, Fl. Ob Infer. 103. 1896. TYPE: RUSSIA. WESTERN SIBERIA: Ob River, *E. Sommier s.n.* (LECTOTYPE, designated here: "Siberia, ad flumen Ob, ripae laevae terra firma Muzhi, solo subpaludoso, sphagnoso, 4-VIII-1880, *E. Sommier s.n.*" FI!, DAO (photograph)! The four specimens on the sheet have scabrous achenes and medial fertile scales with wide-hyaline margins.

Herbs perennial with short to elongate rhizomes. Vegetative shoots 1–3, 19–32 cm high, leaf margins mostly glabrous. Stems erect, glabrous, mostly terete in cross section, 15–55 cm high, 0.7–1.6 mm in diameter below the inflorescence. Leaves basal and cauline 2–6. Proximal sheaths brown, pale brown to gray-brown, with orange-brown spots on distal membranous parts, ligules obtuse. Highest distal sheath situated above, below or near the medial part of the stem, 1.6–3.5 mm wide, with reduced blades. Blades of proximal sheaths flat to slightly cymbiform, 30–240 × 0.9–1.6 mm, glabrous or rarely scabrous in distal parts, the apex obtuse to rounded. Blades of distal sheaths 2–18 × 0.9–1.2 mm. Spikelets solitary, typically obovoid at maturity (Fig. 1), but often ellipsoid, 1.5–4.0 × 1.5–5.0 cm, with 100–150 florets. Proximal scales 3–7, without florets. First proximal scale olive-brown to dark olive-green, becoming pale beige to hyaline in distal parts, triangular-lanceolate, elliptic to ovate, 7–14(–18) × 3.4–4.4 mm, with 3–8 orange-brown nerves converging below the apex, acute, acuminate or rarely short-awned. Medial fertile scales with well demarcated and extended proximal part (Fig. 2), 1.5–3.5 mm long, averaging 30–49% of total scale length, orange-brown to beige-brown, with medial part forming a ± extended dark triangle, with wide-hyaline or whitish marginal and distal parts, typically obovate (Fig. 2a), sometimes lanceolate or elliptic, 4.0–7.5 × 1.3–2.2 mm, the widest part near the middle or above, rarely below, with 1 incomplete nerve, obtuse, acute or acuminate, 0.2–0.5(–0.9) mm wide at 0.2 mm below the apex. Perianth of 50–70 hypogynous bristles, pale to dark orange-brown or red-brown (Fig. 1), 25–32 mm long. Stamens with filaments about as wide as perianth bristles, anthers yellow, 1.5–3.1 mm long. Styles with 3 stigmatic branches open to spreading at maturity, branches 1.2–1.8 mm long. Achenes pale olive-green, gray-olive, dark olive-green or brownish (Fig. 3), obovoid or ellipsoid, trigonous to compressed-trigonous, glabrous (Fig. 3b) or scabrous (Fig. 3a) in the distal part, lustrous or slightly lustrous, 2.05–2.70 × 0.75–1.30 mm, base cuneate, apex obtuse to slightly rounded, with a straight beak (Fig. 3a), rarely oblique (Fig. 3b), conical, 0.2–0.6 mm long, 0.1–0.25 mm wide at base. Figs. 1–3.

Distribution and habitat.—This typical subspecies is amphi-Atlantic, ranging from central Russia westward to Northern Europe and eastern North America, from Newfoundland, Labrador, the Maritime provinces, Quebec, the islands of Nunavut in James Bay to Ontario. Its ecological affinities in North America are boreal and its range does not extend far beyond the treeline. It is found mostly in fens or minerotrophic bogs of various kinds, at the edge of pools, ponds or on lakeshores, the typical habitats for all six taxa in the *E. russeolum* and *E. scheuchzeri* groups.

Discussion.—This is the most common taxon with orange-brown spikelets in northeastern North America. Its distinguishing features are the typically obovoid spikelets and their orange-brown to dark orange-brown color (Fig. 1). The characters of the medial fertile scales are important (Table 1, Fig. 2): a unique color pattern consisting of a long demarcated proximal part, usually orange-brown, that covers up to half the length of the scale (Fig. 2a), a central zone represented by a wide black triangle, and wide marginal and distal whitish or hyaline parts; a wide lanceolate, elliptical or obovate shape, the widest of all the taxa considered here (1.3–2.2 mm), the widest area situated above (Fig. 2a) or near the middle (Fig. 2b) of the scale, with a mostly acute apex (better indicated by measurements taken at 0.2 mm below the apex: 0.2–0.5(–0.9) mm) (Table 1). Anthers and achenes are the longest and largest of all orange-brown taxa. Achenes (Fig. 3) are about equally glabrous or scabrous (Table 1, Fig. 3), which is a bit different from data reported for material from Russia and northwestern Europe (Berggren 1969; Novoselova 1993). Achene beaks are the longest of all the taxa (0.2–0.6 mm) and the widest at the base (0.1–0.25 mm); they are more often straight than oblique. The achene beaks of *E.* ×*medium* subsp. *medium* differ in that they are shorter, narrower and more frequently oblique (Table 1, Fig. 6).

Variation is also encountered in a group of specimens considered atypical because of darker and narrower medial scales, shorter anthers (mostly 1.3–1.9 mm), more frequently glabrous achenes, and achenes with narrower beaks. When these atypical specimens are found outside the range of the hybrid *E.* ×*medium* subsp. *medium*, they could be interpreted as expressions of the variation of *E. russeolum* subsp. *russeolum*. When they occur within the range of that hybrid they could also represent backcrosses of *E.* ×*medium* subsp. *medium* with *E. russeolum* subsp. *russeolum*. Experimental and field studies will be needed to help solve the problem represented by these atypical specimens.

2. Eriophorum ×**medium** Andersson subsp. **medium**, Bot. Not. 1857:62. 1857. (*Eriophorum russeolum* subsp. *russeolum* × *E. scheuchzeri* subsp. *scheuchzeri*) TYPE: SWEDEN. LULE LAPPMARK: prope Quickjock, *N.J. Andersson s.n.* (HOLOTYPE: S, not seen).

Eriophorum ×*gauthieri* Boivin, Provancheria 25:43. 1992. TYPE: CANADA: LABRADOR, Grady and Cross Islands, 26 Jul 1933, *G. Gardner 18* (HOLOTYPE: QFA!; ISOTYPE: QFA!).

Herbs perennial with short to elongate rhizomes. Vegetative shoots 1–3, 8–24 cm high, leaf margins mostly glabrous. Stems erect, glabrous, mostly terete in cross section, 16–42 cm high, 0.7–1.5(–1.7) mm in diameter below the inflorescence. Leaves basal and cauline 3–7. Proximal sheaths green, olive-green, beige-brown, reddish brown to dark brown, with orange-brown spots on distal membranous parts, ligules obtuse. Highest distal sheath situated below the medial part of the stem, 1.8–3.4 mm wide, with reduced blades. Blades of proximal sheaths flat to slightly cymbiform, 50–190 × 0.7–1.6 mm, glabrous or rarely scabrous in distal parts, the apex obtuse to rounded. Blades of distal sheaths 1–13 × 0.4–0.9 mm. Spikelets solitary, hemispherical (Fig. 4), sometimes ovoid or ellipsoid at maturity, 1.4–4.0 × 0.9–6.0 cm, with 100–150 florets. Proximal scales 3–5, without florets. First proximal scale dark olive-brown to blackish, becoming hyaline brown in marginal and distal parts, ovate, 7–11(–17) × 2.2–4.7 mm, with 5–10 orange-brown or pale brown nerves converging below the apex, acuminate. Medial fertile scales with reduced proximal part (Fig. 5), 0.9–1.5 mm long, averaging 17–27(–37) % of total scale length, whitish, pale green or pale beige, with medial and distal parts blackish (Fig. 5a), with marginal and distal parts reduced-hyaline (Figs. 5b–c), lanceolate, 3.6-7.3(–8.0) × 0.7–1.3 mm, the widest part mostly below the middle, with 1 incomplete nerve, acuminate, mostly 0.1–0.3 mm wide at 0.2 mm below the apex. Perianth of 30–50 hypogynous bristles, orange-brown to pale orange-brown (Fig. 4) or red-brown, 15–20 mm long. Stamens with filaments about as wide as perianth bristles, anthers yellow, 0.8–1.5(–1.8) mm long. Styles with 3 stigmatic branches mostly closed at maturity, branches 0.7–2.0 mm long. Achenes chestnut brown (Fig. 6), obovoid, mostly narrowly obovoid, rarely ellipsoid, compressed-trigonous, glabrous, slightly lustrous, 1.6–2.5 × 0.6–0.9(–1.1) mm, base cuneate, apex acute or obtuse, with a straight (Fig. 6b) or oblique beak (Fig. 6a), mostly cylindrical, 0.2–0.3 mm long, 0.1–0.15 mm wide at base. Figs. 4–6.

Distribution.—Described from Scandinavian material, up until now this hybrid had been found only in north central Russia, westward to northern Scandinavia (Novoselova 1993, 1994a). Reports of *E. medium* from an almost continuous range in the Russian Arctic (Tolmachev 1996) do not in every case represent hybrids between *E. russeolum* subsp. *russeolum* and *E. scheuchzeri*, because they refer to a taxon bearing white or orange-brown spikelets. *Eriophorum* ×*medium* subsp. *medium* can now be added to the flora of North America based on collections in Labrador and northern Quebec (Nunavik), ranging from ca 51°N to 59°N. Previous reports of *E.* ×*medium* in North America, mostly from the Northwest, did not represent hybrids between *E. russeolum* subsp. *russeolum* and *E. scheuchzeri* subsp. *scheuchzeri*. *E.* ×*medium* is a boreal amphi-Atlantic taxon like one of its parents, *E. russeolum* subsp. *russeolum*.

Discussion.—This hybrid is occasional in the sympatric range of its two parental species in eastern North America. It had not been previously detected despite the fact that many morphological characters are intermediate between those of the two parents (Table 1). The orange-brown spikelets are more often than not paler and smaller (Fig. 4) than those of *E. russeolum* subsp. *russeolum*, and their shape is highly variable, more often than not hemispherical, like those of *E. scheuchzeri* subsp. *scheuchzeri* (Fig. 7). Anther lengths are intermediate (0.8–1.5 mm) as are the majority of achene characters. The main differences are illustrated by the medial fertile scales which are closer to those of *E. scheuchzeri* subsp. *scheuchzeri* in the preponderance of blackish color, in the frequent reduction of marginal and distal hyaline parts, in the color variation and shortness of proximal parts, in the narrow width (0.7–1.3 mm) and acuminate apex, and in the maximum width mostly being located below the middle (Table 1, Figs. 5, 9). This is in accordance with Novoselova's observations (1993) of *E.* ×*medium* in Russia and northwestern Europe. Some individuals from North America have medial scales with more developed hyaline margins and a narrow central blackish triangle (Fig. 5c), corresponding to material from northern Europe studied by Faegri (1958: Fig. 1D–E) and reported to belong in part to *E.* ×*medium*. I observed the same pattern in some individuals of the hybrid between *E. russeolum* subsp. *leiocarpum* and *E. scheuchzeri* subsp. *scheuchzeri* (Fig. 16c).

The examination of type material of *E.* ×*gauthieri* Boivin (1992), described from Labrador as the hybrid between *E. chamissonis* and *E. scheuchzeri*, shows that it is identical to *E.* ×*medium* subsp. *medium*. Boivin (1992) included both whitish and orange-brown taxa of *E. russeolum* within *E. chamissonis*.

The presence of well-formed achenes in many individuals seems to indicate that some specimens may have become stabilized enough to be considered orthospecies of hybrid origin, as has been hypothesized for plants in northern Europe (R. Elven, pers. comm.). Further studies are needed to confirm this hypothesis.

Specimens examined. **CANADA. Labrador:** Belle Isle, South Point, 51°53'N–55°24'W, 25 Jul 1986, *T.A. Hedderson 4061* (CAN); Black Island, 17–19 Jul 1938, *G. Gardner 38113* (QFA, 2 collections); Grady and Cross Islands, 26 Jul 1933, *G. Gardner 18 [B]* (QFA, 2 collections, holotype & isotype of *Eriophorum* ×*gauthieri* Boivin, mixed with *E. scheuchzeri* subsp. *scheuchzeri*); Indian Harbour & Fox Cove, 16 Jul 1892, *C. Waghorne 32288-B* (CAN); Knob Lake area, valley on Geren Hill, 23 Jul 1961, *J. Sangster s.n.* (MTMG); Lake Attikamagen, Northwest Bay, 54°59'N–66°41'W, 19 Jul 1953, *F. Harper 3630* (CAN); Port Manvers, 10 Aug 1922, *R. Robinson 74* (GH); Red Bay, on Strait of Belle Isle, 23 Jul 1996, *M.J. Oldham 19156* (MICH). **Québec: Nunavik:** Abloviak Fjord, [59°27'N–65°10'W], 2 mi from head, 1 mi from shore, 20 Jul 1978, *H. Ouellet 82* (CAN, MT, SFS); environs de Kuujjuaq, ouest de la riv. Koksoak, env. 30 km au nord de Fort-Chimo, 58°22'N–68°14'W, 17 Jul 1982, *M. Blondeau 501* (Hb. Blondeau, QFA); Fort Chimo area, 58°07'N–68°23'W, 4 Aug 1948, *J.A. Calder 2338* (MT); Kangiqsualujjuaq, estuaire de la rivière George, 1 km au NNO du village, 58°41'40"N–65°58'05"W, 26 Jul 1984, *R. Gauthier 84-161* (MICH, QFA), *84-162* (QFA); idem, embouchure de la rivière George, 58°42'N–65°54'W, 20 Jul 1988, *M. Blondeau GR-88079* (QFA); Lac Ford, 59°13'N–70°08'W, 10 Jul 1975, *H. Ouellet s.n.* (CAN); Rivière Boniface, 57°45'N–76°09'W, 9 Aug 1987, *A. St-Louis 104* (QFA); idem, à l'est de la Passe au Renard, 57°43'50"N–76°07'20"W, 26 Jul 1991, *M. Garneau 91-553-M* (QFA); idem, à l'est du camp, 17 Jul 1994, *P. Levasseur 76*

(QFA); Rivière aux Feuilles, 18 km en amont du le rapide, ca 58°30'N–70°30'W, 18 Jul 1974, *H. Ouellet s.n.* (CAN). Rivière George, environ 3 milles à l'ouest du lac Indian House, ca 56°20'N–64°47'W, 29 Jul 1947, *J. Rousseau 564* (DAO, MT); idem, Lac Indian House, ca 56°25'N, 30 Jul 1947, *J. Rousseau 580* (DAO, MT); idem, près de Hades Hills, ca 56°58'N, 5 Aug 1947, *J. Rousseau 734* (MT).

B) Taxa with white spikelets (**Figs. 7–20**)

3. Eriophorum russeolum Fries in Hartman subsp. **leiocarpum** Novoselova, Bot. Žurn. (St. Petersburg) 78(8):86. 1993. TYPE: RUSSIA. FAR EAST: E Chukotka, in vicinus pagi Nutepelmen, vallis rivi in sinum Pyngo-pilchin influentes, 16 Aug 1969, *A.A. Neczaeva & T.V. Plieva s.n.* (HOLOTYPE: LE, not seen).

Herbs perennial with short to elongate rhizomes. Vegetative shoots 1–3, 15–21 cm high, leaf margins mostly glabrous. Stems erect, glabrous, mostly terete in cross section, 14–51 cm high, 0.7–1.5 mm in diameter below the inflorescence. Leaves basal and cauline 1–7. Proximal sheaths brown, pale brown, chestnut brown to dark brown, with orange-brown spots on distal membranous parts, ligules acute to obtuse. Highest distal sheath mostly situated below the medial part of the stem, 2.1–3.5 mm wide, with blades reduced or lacking. Blades of proximal sheaths flat to slightly cymbiform, 40–230 × 0.7–2.3 mm, mostly glabrous, the apex obtuse. Blades of distal sheaths 0.2–21 × 0.2–1.1 mm, or lacking. Spikelets solitary, ellipsoid or obovoid at maturity (Fig. 18), 2.0–4.0 × 1.5–3.5 cm, with 150 or more florets. Proximal scales 4–6, without florets. First proximal scale olive-brown, olive-green, dark gray to blackish, becoming pale beige to whitish hyaline in distal parts, lanceolate to ovate-lanceolate, (5.7–)7–16 × 3.0–5.3 mm, with 1–5 orange-brown or blackish nerves converging below the apex, acute or acuminate. Medial fertile scales with moderate to extended proximal part (Fig. 19), 0.8–3.2 mm long, averaging (11–)18–57% of total scale length, orange-brown, pale brown, pale green or whitish, with the medial part forming a ± extended dark triangle, with marginal and distal parts mostly wide-hyaline (Fig. 19a), obovate, lanceolate or elliptic, 3.7–8.4 × (0.8–)1.0–2.4 mm, the widest part near the middle or above, rarely below, with 1 incomplete nerve, acute, 0.25–0.6 mm wide at 0.2 mm below the apex. Perianth of 15–50 hypogynous bristles, white to dull white (Fig. 18), 12–30 mm long. Stamens with filaments about as wide as perianth bristles, anthers yellow or dark yellow, (1.3–)1.5–3.1 mm long. Styles with 3(–4) stigmatic branches barely open at maturity, branches 1.3–3.2 mm long. Achenes pale or dark olive-green, brownish or black-brownish (Fig. 20), obovoid (Fig. 20b) or ellipsoid (Fig. 20a), trigonous to compressed-trigonous, glabrous (Fig. 20b) or scabrous (Fig. 20a) in the distal part, slightly lustrous, 2.0–2.7 × 0.6–1.2 mm, base cuneate, apex obtuse, with a beak more straight than oblique, conical, 0.2–0.5 mm long, 0.1–0.2 mm wide at base. Figs. 18–20.

Distribution.—The group of *E. russeolum* with white spikelets has a very different range from the group with orange-brown spikelets and was found to be distinct enough to be considered a subspecies by Novoselova (1993). Its range is amphi-Beringian, discontinuous in northwestern Russia, continuous from north central Russia eastward to Alaska, the Canadian Yukon and Northwest Territories, the islands and continental portion of Nunavut, the Prairie provinces as far east as Manitoba, with scattered sites in eastern North America: Ontario, Quebec, Labrador, New Brunswick and Nova Scotia, with an extension in Minnesota and Wisconsin. Reports of *E. chamissonis* s.l. from the Rocky Mountains (Ball & Wujek 2002) have not been searched for this study and I dont know if they could refer to *E. russeolum* subsp. *leiocarpum* or not. The present study brought collections from the northern part of Nunavik in Quebec (ca 60°–61°N) to light for the first time.

Discussion.—For a long period in the North American literature, the group of *E. russeolum* with white spikelets was called *E. russeolum* var. *albidum* F. Nylander, and even *E. chamissonis* var. *albidum* (F. Nylander) Fernald or f. *albidum* (F. Nylander) Fernald. In his protologue, Nylander (1846: 10) designated a specimen from Alaska (Kodiak Island) that has not yet been found at LE as the type of his variety. This is not in accordance with Novoselova (1993) who states that Nylander's variety, a taxon she considers a synonym for *E.* ×*medium* [subsp. *medium*], was described from Scandinavian material. Even if one accepts that *E. russeolum* var. *albidum* was described from within the actual range of *E. russeolum* subsp. *leiocarpum*, it is difficult to consider var. *albidum* a synonym for subsp. *leiocarpum* because of a major divergent character of the medial fertile scales in Nylander's protologue. Nylander described var. *albidum*'s fertile scales as being "narrowly-lanceolate" (squamis lineari-lanceolatis), whereas subsp. *leiocarpum*'s are typically obovate, elliptic or lanceolate (Fig. 19). Novoselova's name (subsp. *leiocarpum*) is retained here because the subspecific level is more appropriate for separating the almost non-sympatric *E. russeolum* taxa, and because *leiocarpum* was the first name to be attributed at the subspecific level.

Eriophorum russeolum subsp. *leiocarpum* is quite variable and some specimens can be considered merely as white-colored counterparts to orange-brown *E. russeolum*. Nevertheless, the spikelets of this subspecies tend to be more often ellipsoid than obovoid, the achenes more often obovoid than ellipsoid, and the achene beaks narrower on average than in subsp. *russeolum* (Table 1). This variation is encountered in all parts of subsp. *leiocarpum*'s North American range. Specimens from higher latitudes (e.g. Nunavut) tend to have more blackish medial scales (Fig. 19b), but all other characters are within the variation of the subspecies.

Specimens examined. **CANADA. Yukon:** Kluane National Park, Alder Creek, 60°18'15"N–137°21'45"W, 7 Aug 1974, *R.D. Wickstrom 318.11 K-AC* (DAO); Northern Richardson Mountains, 68°22'53"N–137°07'31"W, 7 Jul 1993, *V. Loewen & J. Staniforth 93-154* (DAO); Idem, 68°11'42"N–137°25'27"W, 17 Jul 1993, *V. Loewen & J. Staniforth 93-252* (DAO); North Yukon National Park, British Mountains, Firth River delta, 69°30'N–139°30'W, 26 Jul 1988, *C. Kennedy 174* (DAO). **Northwest Territories:** The Enterprise-Mackenzie River Highway, mile 50, 16 Jul 1959, *J.W. Thieret & R.J. Reich 5392* (DAO); Porter Lake, 61°44'N, 26 Jul 1970, *W.J. Cody 19107* (DAO), Small Tree Lake, 61°N–105°W, 20 Jul 1961, *J.S. Maini*

478 & J. M. A. Swan (DAO); Tuktoyaktuk Peninsula, Hutchison Bay, 69°42'N–132°18'W, 29–30 Jul 1981, *D.L. Allen & V. Stringer 7766* (DAO); Yellowknife, by lake in front of hospital, 62°27'N–114°22'W, 8 Aug 1949, *W.J. Cody & B. McCanse 3324* (DAO). **Nunavut:** Bylot Island, A. R. Camp, Site B-3, 73°24'N–80°43'W, 30 Jul 1983, *G. Scotter s.n.* (DAO); Chesterfield Inlet, 1/4 mi W of settlement, 63°21'N–90°42'W, 4 Aug 1950, *D.B.O. Savile & C.T. Watts 1277* (DAO); Rasmussen Lowlands, S of Murchison Lake, 68°05'43.8"N–92°39'22.8"W, 12 Jul 1994, *V. Johnston 1* (DAO). **Manitoba:** Vicinity of Churchill, 58°46'N–94°10'W, 14 Jul 1956, *W.B. Schofield & H.A. Crum 6664* (CAN); idem, 18 Jul 1956, *W.B. Schofield & H.A. Crum 6825* (CAN); Reindeer Lake, Sawbill, 57°37'N–101°44'W, 4 Aug 1951, *W.K.W. Baldwin 2327* (MICH); Wasagaming, South Onanole, 50°37'N–99°58'W, 8 Jun 1967, *W.K.W. Baldwin 10900* (MICH); York Factory, 22–26 Jul 1949, *H.J. Scoggan 5993* (CAN); idem, 20 Jul 1949, *H.J. Scoggan 5929* (CAN). **Ontario:** Cape Henrietta-Maria, Hudson Bay, 55°10'N–82°20'W, 12–18 Jul 1979, *R. A. Sims 2699B* (MICH); Cochrane district, 50°00'N–83°42'W, 10 Jul 1979, *J.L. Riley 10576* (CAN); 5 km N of Kesagami River, 50°14'N–80°12'W, 22 Aug 1983, *D.F. Brunton 4595* (CAN); Hudson Bay lowlands, Attawapiskat River, 53°08'N–83°18'W, 12 Jun 1957, *A.E. Porsild, W.K.W. Baldwin, H. & G. Sjörs 200060* (CAN); Thunder Bay District, Fort William, 48°24'N–89°16'W, 4 Jun 1972, *W. Hartley 1509* (CAN); City of Thunder Bay, NW side of Expressway in Northwood area of Intercity fen, 5 Jul 1978, *C.E. Garton 18297* (DAO); Thunber Bay Districy, Little Postagoni Lake, 2 Aug 1960, *C. E. Garton 7938* (DAO); S of Wabusk Island, about 25 km W of Cape Henrietta-Maria, 55°10'N–82°50'W, 19–20 Jul 1979, *R.A. Sims 2736A* (MICH). **Québec:** Nunavik, Nouveau-Québec, Lac Élizabeth, 55°40'N–75°34'W, 14 Aug 1977, *G. Lemieux 21031* (QFA (2 collections), CAN); Poste-de-la-Baleine, 55°17'N–77°46'W, 22 Jul 1969, *S. Brisson & P. Forest 20502* (QUE, QFA); idem, rive N, 3 1/2 mi à l'E du poste, 11 Aug 1970, *S. Brisson & P. Forest 22380* (SFS); Territoire du Nouveau-Québec, 55°46'N–76°13'W, 26 Aug 1990, *J. Deshaye 90-1593* (QUE); Rivière Chukotat, ca 2 km au N, 14 km au SSO du lac Hubert, 61°19'38"N–76°21'49"W, 8–9 Jul 2003, *J.F. Duchesne s.n.* (QUE); Rivière Korak, 60°58'N–76°58'W, 29 Jul 1987, *L. Dion K9-4* (QFBE); Rivière Povungnituk, 61°26'04"N–73°56'06"W, 7 Aug 1998, *N. Dignard 98-159* (QUE); Rivière Puvirnituq, environ 4 km au SO du lac Vaillant, 61°25'30"N–73°51'35"W, 7 Aug 1998, *R. Gauthier 98-148* (QFA); Baie James, Fort George, 5 Aug 1950, *E. Lepage 12572* (QFA, 2 collections); idem, 9 Aug 1950, *E. Lepage 12638* (QFA, 2 collections); Baie James, pointe Mesakonan, baie Hannah, 51°33'N–79°32'W, 16 Aug 1958, *A. Dutilly & E. Lepage 36739* (QFA); **Gaspé Co.:** Tabletop Mts., headwaters of the Magdalen River, 1000–1050 m. alt., 9 Aug 1906, *M.L. Fernald & J.F. Collins 73180* (CAN, MT); Tabletop Mts., Mt. Auclair, ca.1200 m. alt., 10 Aug 1923, *M.L. Fernald & L.B. Smith 25603* (CAN, MT). **Labrador:** Battle Harbour, [52°16'N], 24 Aug 1871, *C. Waghorne 16366-2* (CAN). **New Brunswick: Kent Co.:** near Rexton, 13 Jul 1957, *E.C. Smith et al. 16418* (CAN, DAO). **Nova Scotia: Cumberland Co.:** West Advocate, 12 Jun 1950, *E.C. Smith et al. 3109* (CAN). **UNITED STATES. ALASKA:** Nome River, 1 mi from the sea, 5 Jul 1947, *A. Dutilly, E. Lepage & H. O'Neill 20806* (QFA). **MINNESOTA. Becker Co.:** Itasca Park, E side of road to Morison Lake, 4 Jul 1933, *J.B. Moyle 727* (MINN). **Beltrami Co.:** 10.8 mi N of Waskish P.O., 13 Jul 1975, *G.B. Ownbey 4979* (MINN). **Blue Earth Co.:** bogs, [1883], *J. R. Sanberg s.n.* (MINN). **Cass Co.:** near Swamp Lake, 10 Jul 1995, *J. Boe 95071001* (MINN). **Clearwater Co.:** along Co. Rt. 39, about 1 mi N of Rt. 113, 11 Jun 1991, *V. E. McNeilus 91-406* (WIS). **Hennepin Co.:** about 1.5 mi SE of Chanhassen, 4 Aug 1992, *W.R. Smith 21238* (MINN). **Hubbard Co.:** Itasca Park, 10 Jul 1929, *C. O. Rosendahl 5908* (MINN). **Lake of the Woods Co.:** Brown's Lake area, Brown's Creek Trail, 21 Jun 1979, *J.S. Boe 328* (MINN); idem, SE of Mud Lake, 21 Jul 1980, *P.H. Glaser 1300* (MINN). **Morrison Co.:** Camp Ripley Military Reservation, 4 Jun 1991, *B. Delaney 91082* (MINN). **Roseau Co.:** Roseau River Peatland, about 18 mi NW of Roseau, 14 Jun 1984, *W.R. Smith 9181* (MINN). **Stearns Co.:** 6 mi S of St. Augusta, 21 May 1998, *M.D. Lee MDL2056* (MINN). **St. Louis Co.:** Cruiser Lake Trail, 48°28'22"N–92°48'49"W, 4 Aug 1977, *M.R. Smith 466* (MINN); idem, Highway 53, S of Kabetogama, 12 Jun 1950, *O. Lakela 10363* (MINN). **Wright Co.:** by Hwy 55 on the SE side of Maple Lake, 16 Jun 1998, *M.D. Lee & D. Wovcha MDL2140* (MINN). **WISCONSIN. Ashland Co.:** Long Island, lake Superior, S of Madeline Island, 10 Jun 1972, *R.G. Koch 7378* (WIS). **Bayfield Co.:** NW of Eagle Lake, 10 Jul 1996, *E.J. Judziewicz 11958* (WIS). **Douglas Co.:** SW side of junction of Co. A and

Empire Wilderness Road, 24 Jul 1996, *E.J. Judziewicz 11979* (WIS). **Iron Co.:** W side of old rail road grade at Sandrock, 17 Jul 1996, *E.J. Judziewicz 11938* (WIS).

4. Eriophorum ×medium Andersson subsp. **album** J. Cayouette, subsp. nov. (*E. russeolum* subsp. *leiocarpum* × *E. scheuchzeri* subsp. *scheuchzeri*) TYPE: CANADA. NUNAVUT: Baffin Island, Nettiling Lake, 66°40'N–70°W, 28 Jul 1925, *J. Dewey Soper s.n.* (HOLOTYPE: CAN 25686).

A subspeciei typica setis albis vel subcremeis, (10–)22–32 mm longis differt. Verosimiliter hybrida inter *Eriophorum russeolum* subsp. *leiocarpum* et *Eriophorum scheuchzeri* subsp. *scheuchzeri*. Plantae perennes rhizomatibus abbreviatis vel elongatis. Culmi erecti, laeves, teretes, 22–40 cm alti, 0.8–1.1 mm diametro sub spiculis. Vagina superior culmi media parte inferiore inserta, raro ad medium, foliis 0.3–17 mm longis, 0.3–0.8 mm latis, vel nullis. Spiculae unicae, fructificatione hemisphaericae, ovoideae vel obovoideae, 1.6–4 cm altae, setis albis vel subcremeis. Squama sterilis infima 7.1–11.5 mm longa. Squamae fertiles medianae cum proximale parte breviore, 0.5–1.7 mm longa, 9–34% squamae totae longitudinis delemitante, albida, pallide viride vel pallide ferruginea, cum media parte anguste triangulariter atrata, cum marginibus et apice anguste hyalinis, 0.6–1.1 mm latae, squamae media parte inferiore maxima latitudine, apice acuminato, 0.15–0.3(–0.4) mm lato ad 0.2 mm infra apicem. Setae hypogyneae (10–)22–32 mm longae. Antherae 0.9–1.6 mm longae. Stigmatum rami tres vel quatuor, 1.0–2.2 mm longi. Achenia glabra, anguste obovoidea vel ellipsoidea, 0.6–0.9 mm lata, rostro recto vel curvato, praecipue cylindrico, basi 0.1 mm lato. Figs. 15–17.

Herbs perennial with short to elongate rhizomes. Vegetative shoots 1–2, 6–24 cm high, leaf margins mostly glabrous. Stems erect, glabrous, terete in cross section, 22–40 cm high, 0.8–1.1 mm in diameter below the inflorescence. Leaves basal and cauline 2–6. Proximal sheaths beige-brown to reddish brown, with orange-brown spots on distal membranous parts, ligules acute. Highest distal sheath situated below the medial part of the stem, rarely near the middle, 2.2–2.9 mm wide, with blades reduced or lacking. Blades of proximal sheaths flat to slightly cymbiform, 120–150 × 0.8–0.9 mm, glabrous, the apex obtuse. Blades of distal sheaths 0.3–17 × 0.3–0.8 mm, or lacking. Spikelets solitary, hemispherical, ovoid or obovoid at maturity (Fig. 15), 1.6–4.0 × 2.0–4.5 cm, with about 150 florets. Proximal scales 3–5, without florets. First proximal scale dark olive-green or blackish, becoming brown-hyaline or brown-beige in distal and marginal parts, ovate to ovate-lanceolate, 7.1–11.5 × 2.6–3.7 mm, with 3–5 brown to orange-brown nerves converging below the apex, acuminate. Medial fertile scales with a reduced proximal part (Fig. 16), 0.5–1.7 mm long, averaging 9–34% of total scale length, whitish, pale green or pale beige, with the medial part blackish forming a narrow triangle (Fig. 16b), with marginal and distal parts reduced-hyaline (Figs. 16a–b), lanceolate, 3.8–6.7 × 0.6–1.1 mm, the widest part mostly below the middle, with 1 incomplete nerve, acuminate, 0.15–0.3(–0.4) mm wide at 0.2 mm below the apex. Perianth of about 50 hypogynous bristles, white to dull white (Fig. 15), (10–)22–32 mm long. Stamens with filaments about as wide as perianth bristles, anthers yellow-green, 0.9–1.6 mm long. Styles with 3(–4) stigmatic branches mostly closed at maturity, branches 1.0–2.2 mm long. Achenes beige-brown to orange-brown (Fig. 17), narrowly obovoid or narrowly ellipsoid, compressed-trigonous or slightly biconvex, glabrous, slightly lustrous, 1.9–2.5 × 0.6–0.9 mm, base cuneate, apex obtuse, with a straight (Fig. 17b) or oblique (Fig. 17a) beak, mostly cylindrical, 0.2–0.3 mm long, 0.1 mm wide at base. Figs. 15–17.

Distribution.—This nothosubspecies is currently known only in northeastern Canada, from continental Nunavut (Chesterfield Inlet), the Nunavut part of the Arctic Archipelago (Baffin and Southampton Islands, from 63°N to 66°N), south to northern Quebec (Nunavik), in the northernmost part of the peninsula (61°N–62°N) and at treeline near Hudson Bay (57°N–58°N). Since the sympatric range of the two parental taxa covers large parts of the Nunavut and Northwest Territories, the western Canadian provinces, Alaska, and eastern to western parts of Russia, *E.* ×*medium* subsp. *album* is likely to be discovered in some of these major areas. Nevertheless, no specimen from outside of northeastern Canada has yet been identified as this hybrid subspecies (Novoselova pers. comm.). There is a slight possibility that the taxon described from Alaska as *E. russeolum* var. *albidum* by Nylander (1846: 10) and bearing "narrowly lanceolate scales" could refer to that new nothosubspecies, but the type should be searched and examined.

Discussion.—A grouping among specimens that did not fit the normal variation of either *E. russeolum* subsp. *leiocarpum* or *E. scheuchzeri* subsp. *scheuchzeri* was perceived and formally given the taxonomic status of a new nothosubspecies. Although different from these taxa, the specimens shared most of the characteristics of *E.* × *medium* subsp. *medium* except for the color of the spikelets and the length of the stigmatic branches (Table 1). The two subspecies of *E.* ×*medium* share size, shape, apex, color pattern, and maximum width below the middle of the medial fertile scales (Figs. 5, 16); medium-sized anthers (0.9–1.6 mm); and important achene characters (shape, width, beak width and shape) (Table 1, Figs. 6, 17). The shared characters are intermediate between those of *E. russeolum* subsp. *leiocarpum* and *E. scheuchzeri* subsp. *scheuchzeri*. Even if some characters of the hybrid subspecies overlap with extremes of variation of *E. russeolum* subsp. *leiocarpum*, I prefer to consider this taxon as a hybrid because many characters are intermediate between those of the two parental taxa (Table 1). A similar situation has been encountered and studied in a few Arctic *Ranunculus* hybrids (Cayouette et al. 1997).

Some specimens cited as paratypes have been previously considered by other authors as hybrids or potential hybrids involving the whitish *E. russeolum* and *E. scheuchzeri*. Polunin so annotated several specimens from Nunavut (CAN) and later discussed the possibility of *E. russeolum*–*E. scheuchzeri* hybridization (Polunin 1940: 100). Boivin (1992) cited one Polunin collection of the then undescribed *E.* ×*medium* subsp. *album* from Nunavut as a paratype of *E.* ×*gauthieri*, a taxon that Boivin believed to be an *E. chamissonis* × *E. scheuchzeri* combination. All these published remarks match the description of *E.* ×*medium* subsp. *album*.

A form of *E.* ×*medium* subsp. *medium* with white spikelets known as f.

candidum (Norman) Blomgren, has been described from Scandinavia (Hylander 1982). Although not yet known in North America, this form may be expected in the vicinity of the treeline in northern Quebec, where the two subspecies of *E. russeolum* coexist with *E. scheuchzeri*. In the event of its discovery there, *E.* ×*medium* subsp. *medium* f. *candidum* might be mistaken for *E.* ×*medium* subsp. *album*. To avoid any possible confusion, I have selected a type specimen for *E.* ×*medium* subsp. *album* from Nunavut (Baffin Island), where only *E. russeolum* subsp. *leiocarpum* is sympatric with *E. scheuchzeri* subsp. *scheuchzeri*. To date, all specimens of subsp. *album* collected at the treeline in northern Quebec have turned out to be similar to the type specimen selected from Baffin Island (66°N).

As for the typical hybrid subspecies, some paratypes of *E.* ×*medium* subsp. *album* have been seen with good mature achenes, indicating that subsp. *album* has perhaps become a stabilized orthospecies of hybrid origin in some areas. Further investigations are needed to clarify this interpretation.

PARATYPES. **CANADA. Nunavut:** Baffin Island, Clyde, 15 Sep 1936, *N. Polunin 2599* (CAN); idem, Frobisher Bay, head of Tarr Inlet, 24 Jul 1965, *I.A. McLaren 34* (CAN); idem, Frobisher Bay, vicinity of Air Base, 18 Jul 1953, *V.C. Wynne-Edwards 9324* (CAN); idem, Lake Harbour, 26–28 Jul 1936, *N. Polunin 1172* (GH); Chesterfield Inlet, 1/2 mi NW of settlement, 63°21'N–90°21'W, 15 Aug 1950, *D.B.O. Savile & C.T. Watts 1437* (DAO); Southampton Island, Coral Harbour, 64°10'N–83°15'W, 1 Jul 1976, *S. White 761093* (TRTE). **Québec:** Nunavik, Cratère du Nouveau-Québec, 61°22'18"N–74°10'30"W, 28 Jul 2000, *N. Dignard & J. Gagnon 00-174* (QUE); Golfe de Richmond, 1971–1973, *S. Payette et al. GR-121 A* (QFA, mixed with *E. scheuchzeri*); environs d'Ivujivik, 62°24'N–77°55'W, 28 Jul 1984, *M. Blondeau 84435* (Hb. Blondeau, QFA); lac Chavigny, entre le lac Chavigny et le lac au sud, 58°03'N–75°05'W, 29 Jul 1982, *J. Cayouette J82-212* (DAO, QFA); rivière Boniface, 9.5 km à l'ouest de la Passe du Loup, 57°45'10"N–76°20'25"W, 21 Jul 1991, *M. Garneau 91-405-M* (QFA); idem, rivière Boniface, tronçon de la rivière à l'ouest de la Passe du Loup, 57°45'10"N–76°20'25"W, 25 Jul 1991, *M. Garneau 91-496-M* (QFA); au nord de la petite rivière Puvirnituq, 61°26'N–75°15'W, 16 Jul 1985, *L. Dion 1.1-4* (QFBE); territoire du Nouveau-Québec, 56E39'N–74E51W', 5 Sep 1989, *J. Deshaye FOR89-85* (QUE).

5. Eriophorum scheuchzeri Hoppe subsp. **scheuchzeri**, Bot. Taschenb. 104, plate 7. 1800. TYPE: AUSTRIA ("... am Tuscher Tauern") (HOLOTYPE: W, monocots destroyed, see Holmgren et al. 1990).

Herbs perennial with short to elongate rhizomes. Vegetative shoots 1–3, 5–30 cm high, leaf margins glabrous. Stems erect, glabrous, terete in cross section, 9–42 cm high, 0.6–1.5(–1.8) mm in diameter below the inflorescence. Leaves basal and cauline 3–5. Proximal sheaths pale green at first, becoming pale or dark orange-brown, with orange-brown spots on distal membranous parts, ligules acute or obtuse. Highest distal sheath very often situated below the medial part of the stem, 2.1–3.6 mm wide, with blades reduced or lacking. Blades of proximal sheaths flat to slightly cymbiform, 25–130 × 0.5–1.4 mm, glabrous or rarely scabrous in distal parts, the apex mostly acute. Blades of distal sheaths shorter, 0.2–55 × 0.2–1.0 mm, or lacking. Spikelets solitary, typically hemispherical at maturity (Fig. 7), 1.0–3.0 × 1.4–4.5 cm, with 150 or more florets. Proximal scales 5–6, without florets. First proximal scale olive-brown or blackish, becoming pale brown, yellowish brown or pale beige in distal parts, and pale beige or hyaline on the margins, widely lanceolate or ovate, 5–12 × 1.6–4.3 mm, with 4–9 beige or olive nerves converging below the apex, acuminate. Medial fertile scales with a short proximal part (Fig. 9), 0.1–0.9 mm long, averaging 2–25% of total scale length, pale green or whitish, with the medial part blackish or dark gray, with marginal parts blackish (Fig. 9a) or narrowly hyaline (Figs. 9b–c), and the distal part dark or hyaline, narrowly lanceolate, 3.2–5.3 × 0.4–1.0 mm, the widest part below the middle or close to the base, with width at the middle 0.3–0.7(–0.9) mm, with 1 incomplete nerve, narrowly acuminate, 0.05–0.1(–0.2) mm wide at 0.2 mm below the apex. Proximal fertile scales very similar (Fig. 8), blackish, with well-delimited narrow hyaline margins (Fig. 8b) or with hyaline margins lacking (Fig. 8a). Perianth of about 30 hypogynous bristles, white or cream white (Fig. 7), 15–25 mm long. Stamens with filaments about as wide as perianth bristles, anthers yellow or pale yellow, 0.35–0.8 mm long. Styles with 3(–4) stigmatic branches barely open at maturity, branches 0.5–1.3 mm long. Achenes beige-brown to olive-brown (Fig. 10), narrowly obovoid, obscurely trigonous, slightly biconvex or plano-convex, glabrous, slightly lustrous, 1.7–2.4 × 0.5–0.85 mm, base cuneate, apex acute, with a beak more often oblique or curved (Fig. 10b) than straight (Fig. 10a), mostly cylindrical, 0.15–0.4 mm long, 0.05–0.1 mm wide at base. Figs. 7–10.

Distribution.—*Eriophorum scheuchzeri* was recently subdivided into two subspecies by Novoselova (1994b), and the typical subspecies is very common and widespread in the southern parts of the Arctic zones. *Eriophorum scheuchzeri* subsp. *scheuchzeri* is an arctic-alpine circumpolar taxon (Novoselova 1994a, 1994b). In North America, it covers both Arctic and Boreal zones (Hultén and Fries 1986). In northeastern North America, it is sympatric with both subspecies of *E. russeolum*, ranging southward to Labrador, Newfoundland, and the southern reaches of James Bay at about 51°N (Scoggan 1978).

Discussion.—The typical subspecies of *E. scheuchzeri* differs from other rhizomatous taxa with solitary whitish spikelets, including their hybrids with the two subspecies of *E. russeolum*, by having the shortest anthers (0.35–0.8 mm) and the narrowest (0.4–1.0 mm) and the most narrowly acuminate medial fertile scales (Table 1, Fig. 9). These scales are dark gray or blackish with narrow hyaline margins or with hyaline margins absent. Achenes are narrowly obovoid, obscurely trigonous, their beaks narrowly cylindrical, and more often oblique than straight (Table 1, Fig. 10). The main differences between subsp. *scheuchzeri* and subsp. *arcticum* are given in Table 2.

6. Eriophorum scheuchzeri Hoppe subsp. **arcticum** Novoselova, Bot. Žurn. (St. Petersburg) 79(4):112. 1994. TYPE: RUSSIA. JENISSEJSK, hibernaculum inter sinus Wildii et Stellingii, 23 Jul 1915, *I. Trzhemesky 35* (HOLOTYPE: LE, not seen).

Herbs perennial with short to elongate rhizomes. Vegetative shoots 1–3, 4–7 cm high, leaf margins glabrous. Stems erect, glabrous, terete in cross section, 11–28 cm high, 0.7–1.6(–1.8) mm in diameter below the inflorescence. Leaves basal and cauline 1–4. Proximal sheaths apple green first, becoming pale orange-brown, with or without orange-brown spots on distal membranous parts, ligules acute or obtuse. Highest distal sheath most often situated below the medial part of the stem or near the base, 2.2–3.4 mm wide, with blades reduced or mostly lacking. Blades of proximal sheaths flat to slightly cymbiform, 15–80 × 0.5–1.1 mm, glabrous, the apex mostly obtuse. Blades of distal sheaths shorter, 2–20 × 0.4–0.8 mm, or mostly lacking. Spikelets solitary, typically spherical (Fig. 11) or slightly flattened at maturity, 1.5–2.5 × 1.5–4.0 cm, with 100 or more florets. Proximal scales 1–4, without florets. First proximal scale blackish, becoming pale brown or pale beige in distal parts, with well developed hyaline margins, ovate-lanceolate, 6–9 × 2.9–4.2 mm, with 3–7 brown or gray nerves converging below the apex, acute. Medial fertile scales with a short proximal part (Fig. 13), 0.5–1.0 mm long, averaging 8–21% of total scale length, pale green, pale brown or blackish, with the medial part grayish or dark gray-brown, with marginal parts dark (Fig. 13b) or narrowly hyaline (Fig. 13a), and the distal part dark or hyaline, lanceolate, 4.0–6.0 × 0.7–1.5(–1.7) mm, the widest part below the middle, with width at the middle (0.5–) 0.7–1.4(–1.6) mm, with 1 incomplete nerve, acuminate, 0.1–0.25(–0.3) mm wide at 0.2 mm below the apex. Proximal fertile scales different (Fig. 12), bicolor, with lower and medial parts dark but gradually passing into various tones of gray and conspicuous marginal and distal hyaline areas. Perianth of 25–40 hypogynous bristles, white (Fig. 11), 16–25 mm long. Stamens with filaments about as wide as perianth bristles, anthers yellow or pale yellow, 0.6–1.0 mm long. Styles with 3 stigmatic branches barely open at maturity, branches 0.7–1.5 mm long. Achenes orange-brown to dark reddish-brown (Fig. 14), narrowly obovoid, mostly biconvex or slightly plano-convex, glabrous, mostly dull, 1.5–2.2 × 0.5–0.7(–0.9) mm, base cuneate, apex acute, with a beak more often oblique or curved (Fig. 14a) than straight (Fig. 14b), mostly cylindrical, 0.15–0.3 mm long, 0.05–0.1 wide at base. Figs. 11–14.

Distribution.—Like *Eriophorum scheuchzeri* subsp. *scheuchzeri*, subsp. *arcticum* is at least partially circumpolar, according to Novoselova (1994a, 1994b), but its range is more High Arctic than the typical subspecies, as is illustrated by its distribution in northern Russia. Novoselova claims that subsp. *arcticum* ranges across Alaska, Arctic North America and Greenland. My results confirm its presence in the Canadian High Arctic Nunavut (from at least 67°N to 81°N) and establish its southern limits on islands in Hudson Bay and in Arctic Quebec at latitude 59°N or 60°N (see specimens examined). Since one cited collection is from Port Burwell, Quebec, its presence in adjacent northern Labrador is expected, but no specimen has yet been positively identified.

Discussion.—Differences between the two subspecies were pointed out by Novoselova (1994b). Since no North American specimens of subsp. *arcticum* were cited in her work, the attempt was made to uncover voucher collections of the subspecies in order to discover the most useful characters to differentiate between the two *E. scheuchzeri* taxa. The results are highlighted in Table 2 and have been confirmed by Novoselova (pers. comm.). The best characteristics were noticed in the color pattern of the proximal fertile scales (Figs. 8, 12), and in the widths of the medial fertile scales if measured near the middle of the scales and at 0.2 mm below the apex (Figs. 9, 13). Scales were wider in subsp. *arcticum* and acuminate (Fig. 13), instead of being narrowly acuminate (Fig. 9) as in the typical subspecies. Mature spikelets tended to be spherical (Fig. 11) in subsp. *arcticum*, rather than hemispherical (Fig. 7) as in subsp. *scheuchzeri*. A color difference was observed in mature achenes (Table 2, Figs. 10, 14). At the southernmost limit of *E. scheuchzeri* subsp. *arcticum* and elsewhere in the sympatric range of the two subspecies, a few specimens tend to be of intermediate nature.

Since only a few voucher specimens of subsp. *arcticum* were collected within the borders of Quebec, I have proposed that it be added to the provincial list of threatened and endangered vascular plant species.

Specimens examined. **CANADA. Nunavut:** Axel Heiberg Island, 79°54' N–87°43' W, 19 Jul 1980, *G.W. Scotter & S. C. Zoltai 45048* (DAO); Baffin Island, head of Clyde Fjord, Jul 1950, *M.E. Hale Jr. 40* (WIS); Devon Island, Truelove Lowland, 75°38' N–84°30' W, 24 Jul 1989, *B.C. Forbes 70* (DAO); Cambridge Bay, 69°03' N–104°50' W, 7 Aug 1950, *E.H.N. Smith & G.K. Sweatman 42* (DAO); Ellesmere Island, east coast, between Baird Inlet and Tanquary Glacier, 78°29' N–76°31' W, 20 Jul 1979, *J. Bridgland 694* (DAO); idem, Eureka, 80°01' N–86°00' W, 19 Aug 1953, *P.F. Bruggeman 697* (DAO); idem, Eureka, 79°59' N–85°50' W, 16–18 Jul 1980, *G.W. Scotter & S.C. Zoltai 45292* (DAO); idem, Hazen Camp, 81°49' N–71°21' W, 9 Jul 1962, *D.B.O. Savile 4583* (DAO); idem, Skraeling Island, 78°36.5' N–75°38.5' W, 20 Jul 1981, *W. Blake Jr. 24-1* (DAO); Ottawa Islands [wrongly considered as North Sleeper Islands, see Morisset and Payette (1980)], 2 Aug 1939, *G. Gardner 39891 [a]* (MT, QFA); idem [not N. Sleeper Islands], 59°17' N–80°40' W, 2 Sep 1939, *A. Dutilly, H. O'Neill, & M. Duman 87562* (QFA); Ottawa Island Archipelago, Pattee Island, 59°42' N–80°09' W, 27 Aug 1939, *A. Dutilly, H. O'Neill, & M. Duman 87516* (CAN, DAO, QFA, SFS); Prince Charles Island, 67°51'27" N–75°06'07.2" W, 7 Jul 1997, *V. Johnston 97-161* (DAO); Somerset Island, 72°49' N–92°56' W, 19 Jul 1975, *S.C. Zoltai 751135* (DAO); Southhampton Island, Coral Harbor, 64°09' N–83°18' W, 16 Jul 1948, *W.J. Cody 1348* (DAO, WIS). **Québec:** environs d'Akulivik, 60°48' N–78°12' W, 8 Jul 1985, *M. Blondeau 85060* (QFA); environs d'Ivujivik, 62°24' N–77°55' W, 17 Jul 1984, *M. Blondeau 84235B* (QFA); Ivujivik, 62°25' N–78°05' W, 23 Jul 1938, *M. Duman 1874* (QFA); Port Burwell, 60°22' N–64°50' W, 30–31 Aug 1927, *M. O. Malte 118677* (CAN).

KEY TO TAXA (INCLUDING *ERIOPHORUM CHAMISSONIS* AND ATYPICAL *E. RUSSEOLUM* SUBSP. *RUSSEOLUM*)

1. Spikelets with dark to pale orange-brown bristles.
    2. Medial fertile scales 0.7–1.3 mm wide, acuminate, 0.1–0.3 mm wide at 0.2 mm below the apex; achenes narrowly obovoid, glabrous; hypogynous bristles 30–50, 15–20 mm long ____________ **Eriophorum ×medium** subsp. **medium**
    2. Medial fertile scales 1.2–2.2 mm wide, acute, rarely obtuse or acuminate, 0.2–0.5(–0.9) mm wide at 0.2 mm below the apex, achenes obovoid or ellipsoid, glabrous or scabrous; hypogynous bristles 50–80, 25–40 mm long.
        3. Anthers 1.5–3.1 mm long; medial scales with conspicuous hyaline margins and apex, the widest area near the middle or above; spikelets typically obovoid, with dark to pale orange-brown bristles ____________ **Eriophorum russeolum** subsp. **russeolum**

3. Anthers 0.7–1.6(–1.9) mm long, medial scales often with reduced hyaline margins and apex, the widest area not above the middle; spikelets various, spherical, obovoid, or hemispherical, with pale beige-brown to darker bristles.

4. Spikelets spherical, with pale beige-brown bristles; first proximal scale 12–23(–30) mm long; stem below the inflorescence 1.0–2.2 mm wide; medial scales covered with small reddish-brown longitudinal spots in hyaline areas; achene beak rarely curved; western North America _____ **Eriophorum chamissonis**

4. Spikelets obovoid or hemispherical, with pale to dark orange-brown bristles; first proximal scale 8–11 mm long; stem below the inflorescence 0.6–1.2 mm wide; medial scales usually without reddish-brown longitudinal spots; achene beak frequently curved; amphi-Atlantic ____________ atypical **Eriophorum russeolum** and/or intermediates between **E. ×medium** and **E. russeolum**

1. Spikelets with white to whitish bristles.

5. Medial scales (0.8–)1.0–2.4 mm wide, acute, 0.25–0.6 mm wide at 0.2 mm below the apex, widest mostly at the middle or above, with well developed hyaline margins; anthers (1.3–)1.5–3.1 mm long; achenes ellipsoid or obovoid, scabrous or glabrous, beak base 0.1–0.2 mm wide ____ **Eriophorum russeolum** subsp. **leiocarpum**

5. Medial scales 0.3–1.5(–1.7) mm wide, acuminate to narrowly acuminate, 0.05–0.3(–0.4) mm wide at 0.2 mm below the apex, widest below the middle or close to the base, with frequently reduced hyaline margins; anthers 0.35–1.6 mm long; achenes narrowly obovoid, always glabrous, beak base 0.05–0.1 mm wide.

6. Anthers 0.9–1.6 mm long; hypogynous bristles (10–)22–32 mm long; stigmatic branches 1.0–2.2 mm long _________________ **Eriophorum ×medium** subsp. **album**

6. Anthers 0.35–1.0 mm long; hypogynous bristles 10–25 mm long; stigmatic branches 0.5–1.3(–1.5) mm long _________________ **Eriophorum scheuchzeri** s.l.

7. Spikelets hemispherical; proximal fertile scales dark, with dark margins or reduced hyaline margins sharply differentiated from the darker parts; medial scales narrowly acuminate (usually 0.1 mm wide at 0.2 mm below the apex), 0.3–0.7(–0.9) mm wide near the middle; mature achenes beige brown to olive-brown, slightly lustrous _______________ **Eriophorum scheuchzeri** subsp. **scheuchzeri**

7. Spikelets spherical; proximal fertile scales bicolored, with lower and medial parts dark but gradually passing to various tones of gray and conspicuous marginal and apical hyaline areas; medial scales acuminate (usually 0.2 mm wide at 0.2 mm below the apex), (0.5–)0.7–1.4(–1.6) mm wide near the middle; mature achenes orange-brown to dark reddish-brown, mostly dull _______________________ **Eriophorum scheuchzeri** subsp. **arcticum**

ACKNOWLEDGMENTS

The author thanks the curators of the cited herbaria for access to their collections, as well as the following individuals for their help: M. Garneau, R. Néron, and K. Damboise of the Northern Québec-Labrador flora project for the illustrations; my colleagues Y. Dalpé and J. McCarthy for the production of the color plate; M.S. Novoselova for her comments on an earlier version of this paper, her translations from the Russian and for various other bibliographic information; R. Moberg (UPS) for his help in selecting a lectotype of *E. russeolum*; R. Elven, P. Morisset, and M. Dubé for information; P.W. Ball, E. Small, P.M. Catling, and G. Hall for criticism of the manuscript.

REFRENCES

Ball, P.W. and D.E. Wujek. 2002. *Eriophorum* Linnaeus. In: Flora of North America Editorial Committee (editors). Flora of North America North of Mexico, Volume 23: Magnoliophyta:Commelinidae (in part):Cyperaceae. Oxford University Press, New York and Oxford. Pp. 21–27.

Berggren, G. 1969. Atlas of seeds and small fruits of Northwest-European plant species with morphological descriptions. Part 2. Cyperaceae. The Swedish Natural Science Research Council, Stockholm.

Boivin, B. 1992. Les Cypéracées de l'est du Canada. Provancheria 25:1–230.

Cayouette, J., M. Blondeau, and P.M. Catling. 1997. Pollen abortion in the *Ranunculus gmelinii-hyperboreus* group (Ranunculaceae, Section *Hecatonia*) and its taxonomic implications. Rhodora 99:263–274.

Faegri, K. 1958. Zur Hybridbildung in der Gattung *Eriophorum*. Veröff. Geobot. Inst. Rübel Zürich 33:50–58.

Holmgren, P.K., N.H. Holmgren, and L.C. Burnett. 1990. Index Herbariorum, Part I: The Herbaria of the World, 8th edition. New York Botanical Garden.

Hultén, E. and M. Fries. 1986. Atlas of North European vascular plants north of the Tropic of Cancer. Vols. I and III. Koeltz Scientific Books, Königstein.

Hylander, N. 1982. Nordisk Kärlväxtflora. Volume 2, ed. 2. Almqvist & Wiksell, Stockholm.

Morisset, P. and S. Payette. 1980. La flore et la végétation des Îles Dormeuses (Baie d'Hudson, Territoires du Nord-Ouest). Naturaliste Canad. 107:63–86.

Novoselova, M.S. 1993. The taxonomy of the *Eriophorum* (Cyperaceae) species allied to *Eriophorum russeolum*. Bot. Žurn. (St. Petersburg) 78(8):80–89. [In Russian].

Novoselova, M.S. 1994a. The system of the genus *Eriophorum* (Cyperaceae). II. Subgenus *Eriophorum*. Bot. Žurn. (St. Petersburg) 79(12):66–75. [In Russian].

Novoselova, M.S. 1994b. Critical notes on the species of the genus *Eriophorum* (Cyperaceae) allied to *Eriophorum scheuchzeri*. Bot. Žurn. (St. Petersburg) 79(4):111–119. [In Russian].

Nylander, F. 1846. Eriophori monographia. Acta Soc. Sci. Fenn. 3:1–23.

Polunin, N. 1940. Botany of the Canadian eastern Arctic. Part I: Pteridophyta and Spermatophyta. Natl. Mus. Canada, Bull. 92:1–408.

Raymond, M. 1954. What is *Eriophorum chamissonis* C.A. Meyer? Svensk Bot. Tidskr. 48:65–82.

Scoggan, H.J. 1978. The flora of Canada. Part 2. Pteridophyta, Gymnospermae, Monocotyledonae. National Museums of Canada, Ottawa. Pp. 93–545.

Tolmachev, A.I. 1996. *Eriophorum* L. Cotton grass. In: A.I. Tolmachev and J.G. Packer, eds; translator G.C.D. Griffiths. Flora of the Russian Arctic. Volume 2: Cyperaceae–Orchidaceae. The University of Alberta Press, Edmonton, Canada. Pp. 3–18.

Tucker, G.C. and N.G. Miller. 1990. Achene microstructure in *Eriophorum* (Cyperaceae): Taxonomic implications and paleobotanical applications. Bull. Torrey Bot. Club 117: 266–283.

TAXONOMY OF THE *LIATRIS PILOSA* (*GRAMINIFOLIA*) COMPLEX (ASTERACEAE: EUPATORIEAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.
gnesom@brit.org

Jon M. Stucky

Department of Botany
North Carolina State University
Raleigh, North Carolina 27695

ABSTRACT

Liatris graminifolia Willd. is the name generally used for the grass-leaved gayfeather of the southeastern United States. Gray (1884), Gaiser (1946), and Wilbur (1962) observed that the name *Liatris pilosa* (Aiton) Willd. apparently applies to this species and has priority; Fernald and Griscom (1938) dissented, but the present study concurs that *L. pilosa* should replace *L. graminifolia* as the correct name. A lectotype from BM is designated for *Liatris* (*Serratula*) *pilosa*. This specimen probably was collected in New Jersey or Delaware and apparently represents a particularly hairy populational variant of the species that occurs in the area but that intergrades there with plants more characteristic of the species in the broader Atlantic coast region. Two taxa that have been identified as varieties of *L. graminifolia* are here treated at specific rank: *Liatris elegantula* (Greene) K. Schum. occurs on the Gulf coastal plain in Mississippi (rare), Alabama, Florida, and Georgia; *Liatris virgata* Nutt. (= *Liatris regimontis*, *Lacinaria smallii*) occupies an intermediate geographic position, ranging in South Carolina and Georgia northward through western North Carolina into Virginia. These three taxa differ consistently in involucral morphology and the range of *L. virgata* is geographically juxtaposed between *L. pilosa* and *L. elegantula*. Intermediates have not been observed in areas of sympatry at the range margins. *Liatris cokeri* Pyne & Stucky is a fourth member of this group, possibly most closely related to *L. virgata*. A taxonomic summary is provided, including nomenclature, distribution maps, ecological summaries, and a key.

RESUMEN

Liatris graminifolia Willd. es el nombre que se usa generalmente para la planta del Sureste de los Estados Unidos. Gray (1884), Gaiser (1946), y Wilbur (1962) observaron que el nombre *Liatris pilosa* (Aiton) Willd. aparentemente se aplica a esta especie y tiene prioridad; Fernald and Griscom (1938) disintieron, pero en el presente estudio se concluye que *L. pilosa* debe remplazar a *L. graminifolia* como nombre correcto. Se designa un lectotipo de BM para *Liatris* (*Serratula*) *pilosa*. Este espécimen probablemente fue colectado en Nueva Jersey o Delaware y aparentemente representa una variante poblacional particularmente pelosa de la especie que se encuentra en el área pero que se intergrada con plantas más características de la especie en la región Atlántica costera más amplia. Dos taxa que han sido identificados como variedades de *L. graminifolia* se tratan aquí con rango específico: *Liatris elegantula* (Greene) K. Schum. vive en la llanura costera del Golfo en Mississippi (rara), Alabama, Florida, y Georgia; *Liatris virgata* Nutt. (= *Liatris regimontis*, *Lacinaria smallii*) ocupa una posición geográfica intermedia, yendo desde Carolina del Sur y Georgia por el Oeste de Carolina del Norte hasta Virginia. Estos tres taxa difieren consistentemente en la morfología involucral y el rango de *L. virgata* está yuxtapuesto geográficamente entre *L. pilosa* y *L. elegantula*. No se han observado intermedios en áreas de simpatría en los extremos de área. *Liatris cokeri* Pyne & Stucky es un cuarto miembro de este grupo, posiblemente más relacionado con *L. virgata*. Se ofrece un resumen taxonómico que incluye nomenclatura, mapas de distribución, resúmenes ecológicos, y una clave.

SIDA 21(2): 815–826. 2004

Liatris graminifolia Willd. is the name generally applied to the grass-leaved gayfeather, a taxon of the southeastern U.S.A. (e.g., Radford et al. 1968; Cronquist 1980; Figs. 1 and 2). Gaiser (1946) recognized five infraspecific taxa: var. *graminifolia*, var. *elegantula* (Greene) K. Schum., var. *lasia* Fernald & Griscom, var. *dubia* (W.P.C. Barton) A. Gray, and var. *smallii* (Britton) Fernald & Griscom Of these five, var. *dubia* and var. *lasia* both are representative of the Atlantic coast species, as is var. *graminifolia*; var. *elegantula* is treated here at specific rank; and var. *smallii* is treated here as a synonym of another formally recognized species. Fernald (1950) recognized *L. graminifolia* var. *graminifolia*, var. *racemosa* (DC.) Venard (as a replacement name for var. *dubia*), var. *lasia*, var. *smallii*, and var. *virgata* (Nutt.) Fernald. We observe that Fernald's concept of var. *virgata* (1949, 1950) was artificial and that var. *racemosa* represents the same taxon as the type of var. *virgata*. The only recent treatment of the genus in the area that includes all of these variants is Cronquist (1980), who reduced the formally recognized taxa to *L. graminifolia* vars. *graminifolia* and *elegantula*. In our assessment, these two and two more, *L. graminifolia* var. *virgata* sensu stricto and *L. cokeri* Pyne & Stucky, constitute the evolutionary entities of this complex. *Liatris cokeri* is a species of the fall-line sandhills of southern North Carolina and adjacent South Carolina (Stucky & Pyne 1990). Our treatment recognizes four taxa, each at specific rank: **L. pilosa** (Aiton) Willd., **L. elegantula** (Greene) K. Schum., **L. virgata** Nutt., and **L. cokeri**.

Taxonomic rank

It is clear that *Liatris pilosa*, *L. elegantula*, *L. virgata*, and *L. cokeri* are closely related among themselves. Morphological differences among them, mostly in involucral features, are relatively small but they are consistent and a series of principal components analyses (Stucky 1990, 1992) indicates that *L. cokeri*, *L. pilosa*, and *L. virgata* are distinct. *Liatris elegantula* was not included in the analyses by Stucky, and it has consistently been treated as a variety of *L. graminifolia* since Gaiser reduced it in rank. In addition to morphology, the decision regarding the rank of these taxa rests on biology. *Liatris cokeri* is completely sympatric with *L. pilosa* but contiguous or nearly so with *L. virgata* (Figs. 1 and 2). *Liatris virgata* is geographically juxtaposed between *L. pilosa* and *L. elegantula* and probably forms a reproductive barrier between them. From the sample of specimens studied and mapped here, it appears that the degree of sympatry between *L. virgata* and *L. elegantula* may be greater than between *L. virgata* and *L. pilosa*; in neither instance, however, have we seen collections that would clearly indicate that hybridization, intermediacy, or introgression occurs in the areas of sympatry (see comments below). Each of these taxa has been treated at varietal rank, but the nomenclature for treating them as species is already established.

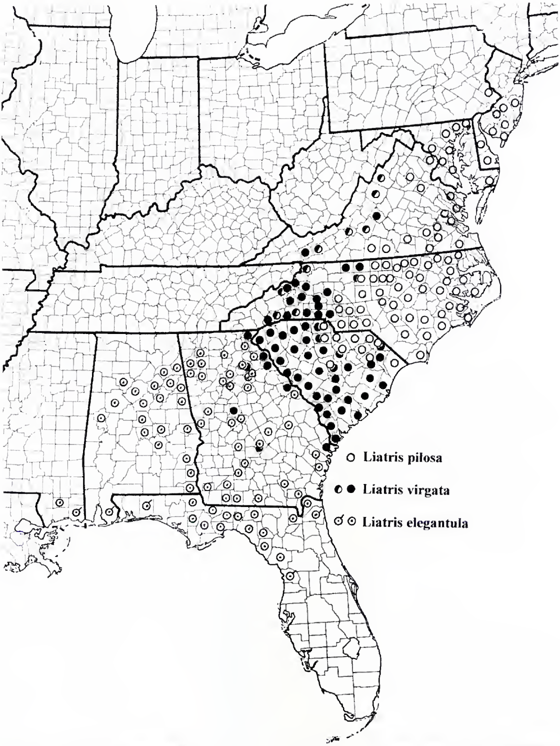


Fig. 1. Geographic distribution of *Liatris pilosa*, *Liatris virgata*, and *Liatris elegantula*. Records are from specimens studied from DOV, NCU, SMU/BRIT, TEX/LL, USCH, and VDB. Tagged symbols for *L. elegantula* in Florida are from Wunderlin and Hansen (2004), in Alabama and Mississippi from Gaiser (1946). Some records for *L. virgata* (half-filled circles) are added from Stucky & Pyne (1990).

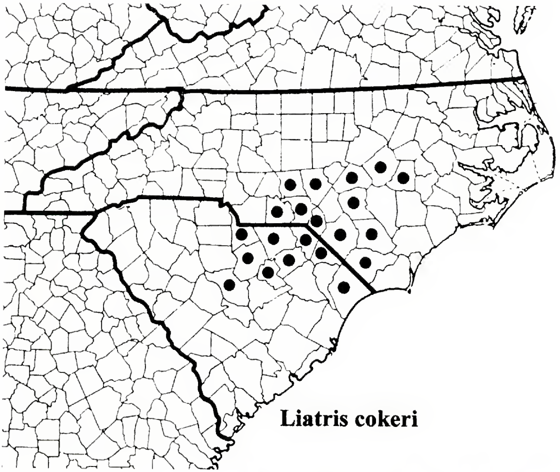


Fig. 2. Geographic distribution of *Liatris cokeri*. Records are from specimens studied from NCU, SMU/BRIT, USCH, and VDB.

Identification of the species

With the maps and following key, we believe that identifications can be made with accuracy and consistency. All key contrasts are not mutually exclusive, but they contribute toward an understanding of distinctions among the taxa. Species descriptions are provided in a treatment of the genus for the forthcoming Flora of North America volumes of Asteraceae (Nesom in prep.).

KEY TO THE SPECIES OF THE *LIATRIS PILOSA* COMPLEX

1. Phyllaries apically rounded, lamina relatively thin, eglandular or with superficial to shallowly inset punctate glands, completely bordered by a narrow, hyaline rim; involucres turbinate (obconic) to turbinate-campanulate.
   2. Stems glabrous to sparsely or moderately pilose distally or over whole stem; leaf laminae glabrous to sparsely pilose on abaxial surface; heads relatively densely arranged, on internodes (1–)2–5(–7) mm long; peduncles 0–10(–17, –80 in proximal region of capitulescence) mm long; involucres (7–)8–10 mm long, phyllaries in (3–)4–5(–6) series; florets (6–)7–12(–13), mostly 9–13 in N.J. and Del. _____ **Liatris pilosa**
   2. Stems glabrous; leaf laminae glabrous; heads relatively loosely arranged, on internodes (2–)5–10(–14) mm long, peduncles 0–2(–7) mm long; involucres 6–8 mm long; phyllaries in 3–4(–5) series; florets (7–)8–11(–13) __________ **Liatris elegantula**

1. Phyllaries apically angular, lamina relative thin or thick, with inset or superficial glands, bordered on the lateral margins but not at the apex by a narrow, hyaline rim; involucres cylindric-campanulate.
   3. Heads densely arranged, on internodes 1–2(–5) mm long, often secund; phyllary apex sharply acuminate-acute, distinctly involute, lamina relatively thin, glands consistently present and superficial at least on proximal portion; florets 4–7(–9) per head; basal and lower cauline leaves 2–5 mm wide, gradually reduced in length distally ____ **Liatris cokeri**
   3. Heads loosely arranged, on internodes 6–15(–20) mm long, not secund; phyllary apex sharply acute to obtuse-angled with a thickened apiculum, not markedly involute, lamina relatively thick, usually with evidently sunken punctate glands, without superficial glands; florets 7–10(–12) per head; basal and lower cauline leaves 4–9(–12) mm wide, quickly reduced in width and length distally ____ **Liatris virgata**

Liatris pilosa: the oldest correct name for *L. graminifolia*

Liatris pilosa (Aiton) Willd. 1803 (based on *Serratula pilosa* Aiton 1789) is the oldest name in the *L. graminifolia* complex but was treated by Gaiser as a synonym of *L. graminifolia* var. *dubia*. Fernald (1950) did not include the name *L. pilosa* in his account of the genus. Gray (1856) had treated *L. pilosa* as a distinct, montane species ("Mountains of Virginia and southward"), but he later (1884) regarded *L. pilosa* as a questionable synonym of *L. graminifolia* var. *dubia*. Fernald and Griscom (1935) examined the "fragments of a head from Aiton's type" of *Serratula pilosa* (from GH, perhaps obtained by Gray from type material at BM), but they concluded that "*Serratula pilosa* has nothing to do with *Liatris graminifolia*" – emphasizing the "long pedunculate" heads (from the type description) and the "linear and acute ... involucral bracts" (from the GH fragments). Gray (1884) had observed these same features and noted that *L. pilosa* represents a 'state' of *L. graminifolia* with "unusually narrow involucral scales." Gaiser's lengthy discussion of the typification of *L. pilosa* (1946, pp. 257–258) indicated that she regarded it as conspecific with *L. graminifolia*, and her placement of it in the synonymy of var. *dubia* seems to have been more of a nomenclatural error than reluctance to use the name because of uncertainty about its identity. Wilbur (1962) accepted *L. pilosa* as the correct name for the species, perhaps based on Gaiser's comments, while acknowledging the different interpretation by Fernald and Griscom; he noted that it seemed undesirable to provide new combinations for infraspecific taxa prior to critical study of infraspecific variation.

After a detailed survey of variation within *Liatris graminifolia* in the context of a study of the whole genus, and with the opportunity to study type material of *Liatris pilosa* from BM, we also conclude that the name *L. pilosa* does indeed apply to the species and must replace *L. graminifolia* as the correct name. Gaiser (1946, pp. 257–258) quoted notes from E.G. Baker of the National Herbarium, who apparently also examined type material of *Serratula pilosa* and whose observations regarding its morphology agree with ours. Some plants from New Jersey and Delaware, at the northern extremity of the range of the species, which have prominently pilose stems and leaf lamina and a tendency to produce long peduncles, are similar to the BM type. We have seen collections of this "morphotype" from Atlantic, Camden, and Cumberland cos., New Jersey, and Sussex and Kent cos., Delaware. The lanceolate, apically acute phyllaries of the *Serratula pilosa* type are unusual for the species over most of its range but this feature appears sporadically in plants of the New Jersey-Delaware region.

Some plants in New Jersey corresponding to *Liatris pilosa* sensu stricto occur in populations of relatively uniform morphology (David Snyder, pers. comm.): these plants have "lower branches up to 11 cm long with up to 5 heads. The branching is most pronounced on the lower half of the stem but the heads of the upper are long peduncled (up to 4 cm long). The branches are strictly ascending. Stems, peduncles, and leaf bases are densely hirsute." On the other hand, plants more similar to those in eastern Virginia and North Carolina apparently are at least as common or more so in New Jersey (Atlantic, Burlington, Cape May, Ocean cos.!) and Delaware (Sussex and Kent cos.!) as the prominently hairy ones. Plants from this region with stems and leaf lamina glabrous or sparsely hairy but with slightly larger heads were identified as *L. graminifolia* var. *dubia* by Gaiser (1946), who cited collections from New Jersey, Delaware, Maryland, District of Columbia, Virginia, and Pennsylvania (Bucks Co.). Our study substantiates the observation that some populations of this region are distinct in their combination of characters, but the tendencies for relatively densely pilose stems and leaves, long-pedunculate heads, more florets per head, and inner phyllaries with subacute apices apparently are only loosely correlated among themselves. We have not been able to meaningfully sort the variation, but this is an area that needs to be investigated more closely.

Liatris elegantula

Plants of *Liatris elegantula* have consistently glabrous stems and leaves, relatively short and distinctly turbinate (obtriangular) involucres with a reduced number of phyllaries (evidenced by fewer series), and the heads tend to be more widely spaced than in *L. pilosa*. Records for this taxon cited by Gaiser (1946) from southwestern Alabama (Baldwin Co.) and adjacent Mississippi (Jackson Co.) have not been examined in this study.

Treatment of *Liatris elegantula* at specific rank is perhaps the most divergent proposal of the current overview. It is most similar to *L. pilosa* in involucral morphology, but small differences between the two are consistent and the geographic hiatus is real. *Liatris elegantula* and *L. pilosa* might be treated as conspecific, as has been generally done, or *L. elegantula*, *L. pilosa* and *L. virgata* might all be considered as a single species, but this would not account for apparent reproductive isolation in areas of sympatry (comments above) or a possible close relationship between *L. virgata* and *L. cokeri*.

Liatris virgata and *L. cokeri*

Liatris virgata has mostly been identified within *Liatris graminifolia* sensu lato, and as observed by Stucky (1992), this name has not been included in most of the pertinent taxonomic literature for the genus, even as a synonym, although one of its synonyms (*L. graminifolia* var. *smallii*) has sometimes been correctly applied. A principal components analysis (Stucky 1992) indicates that *L. virgata* and *L. graminifolia* (*L. pilosa*) are morphologically distinct. The name *L. regimontis* (Small) K. Schum., now understood to be a synonym of *L. virgata*, mostly had been applied to the species segregated by Stucky and Pyne (1990) as *L. cokeri*.

The range of *Liatris virgata* is essentially contiguous with *L. elegantula* on the southwestern margin and with *L. pilosa* on the northeastern margin, but some overlap occurs in both areas (Fig. 1). Although *L. virgata* has been collected in close proximity to both of its closest relatives and all three species flower in generally the same period of time, our observations indicate that the taxa are discrete even in areas of sympatry. For example, from York Co., S.C., we have studied five collections of *L. virgata* (*Nelson 4994*, *Kennemore 917*, *997*, *1046*, *1486*, all USCH) and three of *L. pilosa* (*Nelson 4989*, *4998*, *5024*, all USCH)—all eight of these were collected within Kings Mountain National Military Park. From Richland Co., S.C., we have studied 20 collections of *L. virgata* (USCH, NCU, BRIT) and a single one of *L. pilosa* (*Nelson 11244*, USCH), south of its primary range. Field and herbarium studies are needed to further the understanding of the geographic and evolutionary relationship between *L. virgata* and its close relatives. If hybridization and intergradation prove to be more significant than observed in the current study, treatment of these three taxa as conspecific might be more appropriate.

Spacing of the heads and phyllary morphology are features that provide the most immediate recognition of *Liatris virgata*. Contrasted with *L. pilosa* and *L. elegantula*, the phyllary lamina is thicker and the glands are distinctly sunken into the tissue, and the apex is generally angular (vs. rounded) and lacks the narrow hyaline rim that borders the lateral margins. In Richland Co., S.C., from which numerous collections are available, the apex shape varies from sharply acute to obtuse, but even the obtuse angle is distinct, as the tip characteristically ends in a thickened and slightly raised (keel-like) apiculum or mucro. Similar variation occurs over the range of the species, although a tendency for obtuse apices apparently is more common on the coastal plain.

Variation in *Liatris virgata* also occurs in involucral size and configuration. Larger-headed plants (including the types of *Lacinaria smallii* and *Lacinaria regimontis*) are mostly montane and piedmont. Larger heads are more elongate-cylindric and have phyllaries in 5–6(–7) series with more consistently sharply acute apices, while smaller heads have 3–5(–6) series. Number of florets tends to be slightly higher in larger heads.

Finally, we note that the distribution of *Liatris virgata* from outer coastal plain into montane habitats is unusual, but *L. pilosa* and *L. elegantula* both occur on the piedmont as well as their primary coastal plain range, and other species of *Liatris* range widely across habitats and ecological zones (e.g., *L. squarrulosa* Michx. and *L. aspera* Michx.). Further study of *L. virgata* may demonstrate geographic patterns of differentiation that we have not been able to delimit.

Stucky and Pyne (1990) observed that apparent intermediates between *Liatris virgata* and *L. cokeri* occur on the coastal plain of North Carolina and South Carolina. In the present study, however, we have identified some of those putative intermediates as *L. cokeri*, and we have not confirmed the occurrence of *L. virgata* where the putative intermediates occur in North Carolina (Stucky & Pyne 1990, Fig. 10). *Liatris cokeri* is characterized by phyllaries with acute-angled apices, and this is likely an indication of close relationship to *L. virgata*. Indeed, evolutionary relationships within the *L. pilosa* complex, as outlined here, may be that of two sister pairs—*L. pilosa-elegantula* and *L. virgata-cokeri*.

NOMENCLATURE AND TYPOLOGY

Liatris pilosa (Aiton) Willd., Sp. Pl. 3:1636. 1803. *Serratula pilosa* Aiton, Hort. Kew. 3:138. 1789. *Lacinaria graminifolia* (Willd.) Kuntze var. *pilosa* (Aiton) Britton, Mem. Torrey Bot. Club 5:314. 1894. *Lacinaria pilosa* (Aiton) A. Heller, Muhlenbergia 1:6. 1900. LECTOTYPE, here designated: U.S.A. Cultivated plant, without collection data but the original stock probably from New Jersey or Delaware, probably collected by William Young, Jr. prior to 1783 (BM-Banks Herbarium, photo!, fragment of lectotype GH). A handwritten inscription on the back of the lectotype sheet reads "Hort Kew. 1785" and matches the handwriting of Jonas Dryander (Marshall 1978), who assumed the primary responsibilities of describing and naming plants for the Hortus Kewensis after the death of Daniel Solander in 1782. The publication itself, however, credited authorship solely to William Aiton (see Britten 1912). Photos of the lectotype have been deposited at BRIT, GH, NCSC, NCU, and US.

The protologue of *Serratula pilosa* described the plants as "foliis linearibus pilosis, floribus axillaribus longe pedunculatis" and noted "Nat. of North America. Introd. 1783, by Mr. William Young." William Young, Jr. lived in Philadelphia and made forays into "the Carolinas" as he collected horticultural stock for English gardeners (Harshberger 1917). It seems a reasonable surmise that the material of *L. pilosa* was collected by Young in the region of his home, probably close by in New Jersey or Delaware, where plants of this morphology are known to occur (as also true for the type of *L. dubia*, see below; Keller and Brown [1905] noted records in New Jersey and Delaware for "*Liatris graminifolia pilosa*"). The type specimen presumably was grown in cultivation at Kew Gardens, as Young was supported as "Botanist to their Majestys" in collecting horticultural possibilities. Young informally used the name *Serratula pilosa* for gayfeather material in his plant collection (Young 1985).

Liatris graminifolia Willd., Sp. Pl. 3:1636. 1803. *Lacinaria graminifolia* (Willd.) Kuntze, Revis. Gen. Pl. 1:349. 1891. TYPE: Original not located. U.S.A. NORTH CAROLINA. New Hanover Co. edge of Wilmington, common in the open pine woods skirting the Cypress Tree Park, 24 Oct 1948, *E.O. White s.n.* (NEOTYPE (Gaiser 1950, p. 414): GH, internet image!; ISONEOTYPES: [MO!] noted by Gaiser to have been deposited at NY and US). The collection date apparently was miscited by Gaiser as "25 Oct," because the GH specimen reads "24 Oct" and corresponds in all other details with the citation. Many authors, including Gaiser (1946), have interpreted Willdenow's name as a new combination based on a name of Thomas Walter (*Anonymos graminifolius* Walter, Fl. Carol. 197. 1788), but as noted by Wilbur (1962) and others, Walter's names using "Anonymos" as the genus are interpreted as invalid (ICBN 2000: Arts. 20.4, 43.1). Willdenow's protologue cited "Anonymos (*graminifolius*) ... Walt. carol. 197." and "Habitat in Carolina. 4 (v.s.)" and it fully quoted Walter's description. Despite Willdenow's apparent suggestion that he saw material corresponding to Walter's type, such a specimen apparently has not been relocated. Gaiser (1946, p. 255) noted that observations had been made on a BM specimen labeled "*Chrysosoma affinis* F. 309 (supposedly referring to Fraser) and with Nuttall's annotation *Liatris* in pencil," which she interpreted as authentic type material, but she later rejected this interpretation in favor of a neotype. The only specimen in the Willdenow herbarium identified as *Liatris graminifolia* (B-Willdenow fiche 14838!) is a plant of *Liatris spicata* (L.) Willd. var. *spicata* with a label that notes "Habitat in Pensylvania;" the label also cites "*Anonymos graminifolia* W. carol. 197," but it seems unlikely that Willdenow would have intended this collection as the type for *L. graminifolia*, which he explicitly understood was from "Carolina."

Liatris dubia W.P.C. Barton, Veg. Mater. Med. U.S. 2:223, t. 49. 1819. *Liatris graminifolia* Willd. var. *dubia* (W.P.C. Barton) A. Gray, Manual, ed. 2, 185. 1856. TYPE: U.S.A. [perhaps NEW JERSEY or DELAWARE, in the region where plants of this morphology occur]. This is the only element of potential type material used by the author and presumably stands as the HOLOTYPE (ICBN 2000, Art. 9.1). No collection data were cited, but Barton, a Philadelphia resident, apparently drew the illustration from a live plant, judging from the realistic dimensionality of the drawing, even though the broad leaves and elongate involucres suggest that considerable artistic license was in play. The description and illustration portray a plant with hairy stems and peduncles, linear-lanceolate lower leaves, and loosely arranged, long-pedunculate heads with elongate, "subacute" phyllaries. Gray (1848) mentioned "var. *dubia*" under *L. graminifolia*, but he did not provide a basis of reference to the basionym until the second edition in 1856. Fernald and Griscom (1935) noted that *L. dubia* was "suggestive of Aiton's plant" (i.e., *L. pilosa* s. str.).

Liatris pilosa (Aiton) Willd. var. *laevicaulis* DC., Prodr. 5:131. 1836. TYPE: U.S.A. Nov. Caesar. [Nova Caesarea = NEW JERSEY]. 1835, [no other data,] *Mr. Torrey* (HOLOTYPE: G-DC, fiche!). This plant has long peduncles, apparently glabrous stems, long, narrow phyllaries apparently with subacute apices, and (fide de Candolle) 7–8 florets per head.

Liatris propinqua Hook., Bot. Mag. 67 (n. ser. 14): t. 3829. 1840. TYPE: [U.S.A., cultivated in England]. With regard to its origin, Hooker noted only "Sent from the Horticultural Society's garden of Edinburgh in the autumn of 1839, under the name of *L. paniculata*." The illustration shows a plant with relatively large, turbinate-cylindric, sessile to subsessile heads in a loosely spiciform array, acute phyllaries, and narrowly oblanceolate, punctate leaves prominently ciliate on the proximal margins. The stems and leaf lamina are not described or depicted as being hairy. The common name given by Hooker to this plant, "Sharp-scale spiked *Liatris*," referred to the acute phyllaries. The identification seems reasonable as *L. pilosa*, especially in view of the prominently cilate leaves, but the sparsely pubescent (or glabrous?) stems, acute phyllaries, and relatively few florets ("subdecemfloro," from the description) leave open the possibility that it might be *L. virgata*. The name (*L. propinqua*) is ambiguous in reference until a type specimen is located or designated.

Liatris graminifolia Willd. var. *lasia* Fernald & Griscom, Rhodora 37:183. 1935. TYPE: U.S.A. NEW JERSEY. Camden Co.: Lindenwold, dry sandy soil, 29 Sep 1923, *J.M. Fogg, Jr. 622* (HOLOTYPE: GH).

Flowering (Aug–)Sep–Oct(–Nov). Old fields, pine barrens, scrub oak-pine sandhills, openings in pine, oak, and oak-hickory woods, tidal marsh edges, sandy fields, dune hollows, wet sand near beach, edge of tidal marsh sand to sandy clay-loam; ca. (0–)10–500 m. Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, South Carolina, Virginia.

Liatris elegantula (Greene) K. Schum., Bot. Jahresber. (Just) 29:569. 1903. *Lacinaria elegantula* Greene, Pittonia 4:316. 1901. *Liatris graminifolia* Willd. var. *elegantula* (Greene) Gaiser, Rhodora 48:254. 1946. Type: U.S.A. Alabama. Lee Co.: Auburn, 18 Oct 1896, *F.S. Earle* (Holotype: ND-G).

Flowering Aug–Oct(–Nov). Longleaf pine-scrub oak, pine, live oak-pine, deciduous oak-pine, deciduous flatwoods, sandhills, savanna edges, edge of cypress depressions, depression meadows, live oak-pine-palmetto hammocks, sandy clay or loam, rarely clay; 5–300(–450) m. Alabama, Florida, Georgia, Mississippi.

Liatris virgata Nutt., J. Acad. Nat. Sci. Philadelphia 7:72. 1834. *Liatris graminifolia* Willd. var. *virgata* (Nutt.) Fernald, Rhodora 51:104. 1949. Type: U.S.A. Georgia. [probably Nov 1815], *T. Nuttall s.n.* (Lectotype (Stucky 1992, p. 179): PH!; probable type material, "Hb. Nuttall" s.n., NY! ex BM). Nuttall noted "*Hab.* In Georgia and North Carolina" in the protologue; the PH specimen shows "Geo." as the only collection data. Nuttall later (1841) described the habitat as "In the pine forests of Georgia, and near Newbern, N. Carolina"—the plants from near Newbern are almost certainly *Liatris cokeri* Stucky & Pyne (see Stucky & Pyne 1990). Graustein (1967, pp. 100–101) noted that in mid October, 1815, Nuttall traveled by boat to Savannah, Georgia, and then northward along the Savannah River to Augusta and vicinity, through longleaf pine sandhill vegetation and north at least to "where hills of deciduous trees (oaks, hickories, &) and primitive soil commence." Nuttall's protologue noted that the capitulescence was a subpaniculate and branched raceme and referred to the "long leafy pedicels of the flowers." Gaiser (1946) apparently saw the PH specimen (she referred to it as "isotype") and placed *L. virgata* in synonymy of *L. graminifolia* var. *dubia*, but the latter is here interpreted as a synonym of *Liatris pilosa* sensu stricto. Fernald's concept of *L. graminifolia* var. *virgata* (1949, 1950) was artificial (including many citations from the Atlantic coast region, based on plants with strongly branched capitulescence), though he surely was aware that the type was from Georgia, having indicated that he saw the Nuttall collection or at least a photo of it. Details on morphology of the PH specimen are provided in Stucky (1992).

Liatris spicata L. var. *racemosa* DC., Prodr. 5:130. 1836. *Liatris graminifolia* Willd. var. *racemosa* (DC.) Venard, Rhodora 51:35. 1949. Type: U.S.A. Georgia. Savannah, 1832, no collector indicated (Holotype: G-DC, fiche!). The description by de Candolle noted "capitulis distincte pedicellatis ... caule glabro ... foliis ciliatis ... floribus in invol. 8." The G-DC sheet has 2 branches with heads of nearly identical morphology: one was broken off and the heads are borne on peduncles up to 5 cm long; the other is intact and the distal heads are sessile while the proximal ones are on peduncles ca. 1 cm long. The involucres are campanulate-cylindric, and the phyllaries are apically thickened and subacute, the outer slightly spreading.

Liatris regimontis (Small) K. Schum., Bot. Jahresber. (Just) 26:378. 1900. *Lacinaria regimontis* Small, Bull. Torrey Bot. Club 25:473. 1898. Type: U.S.A. North Carolina. Cleveland Co.: King's Mt., wooded slopes, 27–30 Aug 1894, *J.K. Small s.n.* (Holotype: NY!; isotype: NY!).

Lacinaria smallii Britton, Man. Fl. N. States 927. 1901. *Liatris graminifolia* Willd. var. *smallii* (Britton) Fernald & Griscom, Rhodora 37:182. 1935. Type: U.S.A. Virginia. Smyth Co.: along Dickey Creek on Iron Mtn., 2900 ft, 8 Aug 1892, *J.K. Small s.n.* (Holotype: NY!; isotype: MO!).

Flowering (Jul–)Aug–Oct(–Nov). Edge of swampy woods, creek margins, slopes, clearings, and edges of upland woods, rocky woods, pine-oak woods, mixed deciduous woods, roadsides, Iredell soil, clay; ca. 50–1000 m. Georgia, North Carolina, South Carolina, Virginia.

Liatris cokeri Pyne & Stucky, Sida 14:205. 1990. TYPE: U.S.A. NORTH CAROLINA. Harnett Co.: 0.2 mi E jct NC Rte 27 and Co. Rd. 1243 along NC 27 on S side of road, sandy roadside and margin of longleaf pine/turkey oak/wiregrass association, 23 Sep 1989, *J.M. Stucky 511* (HOLOTYPE: NCU; ISOTYPES: GH, NCSC, NCU, NY, US, USCH).

Flowering (Aug–)Sep–Oct. Sand ridges, sandy fields and roadsides, turkey-oak, longleaf pine-oak; 50–150 m. North Carolina, South Carolina.

ACKNOWLEDGMENTS

The analysis and map for this study were based on specimens were studied from BRIT, NCU, TEX,LL, and VDB (personal visits) and DOV, PH, USCH, and BM (loans). We are grateful to staff at the University of Texas Life Sciences Library for help with access to literature and microfiche, David Snyder, Botanist for the New Jersey Natural Heritage Program, for his insights regarding variation in *Liatris pilosa*, Walter Kittredge and other GH staff for help with data and type images, Milo Pyne for his perspectives on the identity of *Liatris pilosa*, and to Alan Weakley and Bruce Hansen for their review comments.

REFERENCES

BRITTEN, J. 1912. The history of Aiton's 'Hortus Kewensis.' J. Bot. 50, No. 599 (suppl.):1–16.

CRONQUIST, A. 1980. Vascular flora of the southeastern United States, Vol. I. Asteraceae. Univ. of North Carolina Press, Chapel Hill.

FERNALD, M.L. 1949. Studies of eastern American plants. Rhodora 51:43–57; 61–85; 93–104.

FERNALD, M.L. 1950. Gray's manual of botany (ed. 8). American Book Co., New York.

FERNALD, M.L. and L. GRISCOM. 1935. Three days of botanizing in southeastern Virginia. Rhodora 37:181–183.

GAISER, L.O. 1946. The genus *Liatris*. Rhodora 48:165–183, 216–263, 273–326, 331–382, 393–412.

GAISER, L.O. 1950. Chromosome studies in *Liatris*. II. *Graminifoliae* and *Pauciflorae*. Amer. J. Bot. 37:414–423.

GRAUSTEIN, J.E. 1967. Thomas Nuttall, Naturalist: Explorations in America 1808–1841. Harvard Univ. Press, Cambridge, Mass.

GRAY, A. 1848. A manual of the botany of the northern United States (ed. 1). James Munroe and Co., Boston & Cambridge.

GRAY, A. 1856. Manual of the botany of the northern United States (ed. 2). Ivison & Phinney, New York.

GRAY, A. 1884. Synoptical flora of North America. Vol. I. – Part II. Ivison, Blakeman, Taylor, and Co., New York.

HARSHBERGER, J.W. 1917. William Young, Jr., of Philadelphia, Queen's botanist. Torreya 17: 91–99.

Keller, I.A. and S. Brown. 1905. Handbook of the flora of Philadelphia and vicinity. Philadelphia Botanical Club, Philadelphia, Pa.

Marshall, J.B. 1978. The handwriting of Joseph Banks, his scientific staff and amanuenses. Bull. Brit. Mus. (Nat. Hist.), Bot. 6:1–85.

Nuttall, T. 1841. Descriptions of new species and genera of plants in the natural order of the Compositae. Trans. Amer. Philos. Soc., ser. 2, 7:284.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill.

Stucky, J.M. 1991. Affinity of *Liatris cokeri* Pyne & Stucky (Asteraceae), a sandhills endemic of the Carolinas, and its widely distributed relative, *L. graminifolia* Willd. Amer. Midl. Naturalist 125:323–330.

Stucky, J.M. 1992. *Liatris virgata* (Asteraceae) in the southeastern United States. Sida 15: 177–183

Stucky, J.M. and M. Pyne. 1990 A new species of *Liatris* (Asteraceae) from the Carolina sandhills. Sida 14: 189–208

Wilbur, R.L. 1962. The identity of Walter's species of *Anonymos*. J. Elisha Mitchell Sci. Soc. 78:125–131.

Wunderlin, R.P. and B.F. Hansen. 2004. Atlas of Florida Vascular Plants [S.M. Landry and K.N. Campbell (application development), Florida Center for Community Design and Research.]. Institute for Systematic Botany, Univ. of South Florida, Tampa. <http://www.plantatlas.usf.edu/>

Young, W. 1985. Herbarium specimens (microfiche). Early American herbaria and related drawings from the British Museum (Nat. Hist.). Meckler Publ., Westport, Conn.

A NEW SPECIES OF *SYMPHYOTRICHUM* (ASTERACEAE: ASTEREAE) FROM A SERPENTINE BARREN IN WESTERN NORTH CAROLINA

Gary L. Kauffman

U.S.D.A. Forest Service
P.O. Box 2750
Asheville, North Carolina 28802, U.S.A.

Guy L. Nesom

Botanical Research Institute of Texas (BRIT)
509 Pecan Street
Fort Worth, Texas 76102, U.S.A.

Alan S. Weakley

University of North Carolina Herbarium (NCU)
North Carolina Botanical Garden
Campus Box #3280
Chapel Hill, North Carolina 27599, U.S.A.

Thomas E. Govus

3711 Big Creek Road
Ellijay, Georgia 30540, U.S.A.

Laura M. Cotterman

North Carolina Botanical Garden
Campus Box #3375
Chapel Hill, North Carolina 27599, U.S.A.

ABSTRACT

Symphyotrichum rhiannon Weakley & Govus, sp. nov., is described from the Buck Creek ultramafic barren (over serpentinized dunite and olivine) in the Blue Ridge province of southwestern North Carolina. It is similar to *Symphyotrichum puniceum* but different in its smaller stature, thinner rhizomes, subspatulate cauline leaves, narrower and fewer-headed capitulescence, phyllaries with shorter, rhombic-lanceolate apical green zones, and shorter ray corollas. Its geographic range is imbedded within that of typical *S. puniceum* but morphological intergrades have not been observed, despite the co-occurrence of the two taxa within several meters of one another at the type locality. The Buck Creek site is within the Nantahala National Forest; 42 hectares of the site are managed by the United States Forest Service as a Special Interest Area and registered as a heritage area with the North Carolina Natural Heritage Program.

RESUMEN

Symphyotrichum rhiannon Weakley & Govus, sp. nov., se describe del Buck Creek ultrabásico (sobre dunita y olivino serpentinizados) en la provincia Blue Ridge del Suroeste de Carolina del Norte. Es similar a *Symphyotrichum puniceum* pero diferente por su talla más baja, rizomas más finos, hojas caulinares subespatuladas, capitulescencia más estrecha y con menos capítulos, filarias con zonas verdes apicales rómbico-lanceoladas más cortas, y radios de las corolas más cortos. Su rango geográfico está incluido en el de *S. puniceum* típico pero no se ha observado intergradación morfológica, a pesar de la co-ocurrencia de los dos taxa a unos pocos metros en la localidad tipo. El Buck Creek está en el Nantahala National Forest; 42 hectáreas están gestionadas por el Servicio Forestal de los Estados Unidos como un Área de Especial Interés y registrado como un área del Natural Heritage Program de Carolina del Norte.

SIDA 21(2): 827–839. 2004

INTRODUCTION

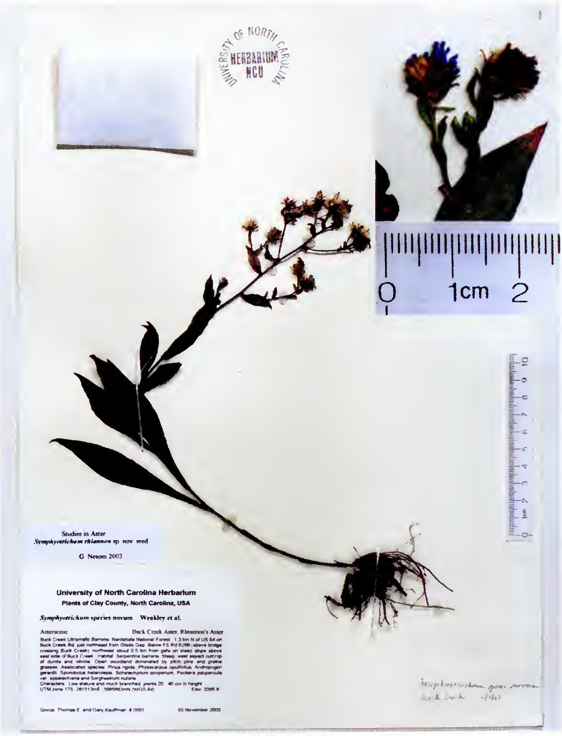
A new species of *Symphyotrichum* is described from the Buck Creek ultramafic barren in the Blue Ridge province of southwestern North Carolina (Clay County). The naming of this species ends more than twenty years of bewilderment regarding its identity, which has troubled researchers at the site since the late 1970's. Mansberg (1981) was apparently the first botanist to encounter this entity and collect it, a significant component of the ultramafic barren and adjoining woodlands. Despite consulting with experts at the time, she labeled this entity as "unidentifiable aster" and suggested that it might be a hybrid. Collections made during later studies of the vegetation at Buck Creek barren by the North Carolina Vegetation Survey in the 1990s yielded similar confusion, with specimens being identified as "*Aster laevis* var. *concinnus*?," "*Aster surculosus*?," or "*Aster # 1*." Even more recently, U.S. Forest Service botanists involved in the management of Buck Creek barren have been troubled by the identity of this aster and have made additional guesses as to its affinity. Serendipitous circumstances have led to a revisiting of this persistent problem, and following additional study we now decisively describe this species as new.

A comparison of the putative new taxon to all other species of *Symphyotrichum* in eastern and central North America reveals that it has a unique set of characteristics. Furthermore, it does not appear to be a recent or stabilized F1 hybrid, intermediate between any other two species of *Symphyotrichum*, although it is possible (as noted below) that gene flow has been involved in its origin. In our assessment, it is a distinct taxon worthy of specific rank, possibly most closely related to *Symphyotrichum puniceum* (L.) A. & D. Löve.

Symphyotrichum rhiannon Weakley & Govus, sp. nov. (**Fig. 1**). TYPE: U.S.A. NORTH CAROLINA. Clay Co.: Buck Creek Ultramafic Barrens, Nantahala National Forest, 1.3 km N of US 64 on Buck Creek Rd, just NE from Glade Gap, below FS Rd 6269 (above bridge crossing Buck Creek), NW ca. 0.5 km from gate on steep slope above E side of Buck Creek; serpentine barrens, steep W aspect outcrop of dunite and olivine, open woodland dominated by pitch pine and prairie grasses, 3385 ft elev., UTM zone 17S, 261513mE, 3885663mN (WGS-84), 3 Nov 2003, *T.E. Govus and G. Kauffman 1* (HOLOTYPE: NCU; ISOTYPES: BRIT, US, WAT).

Symphyotricho puniceo similis sed differt statura minore, rhizomatibus tenuioribus, foliis caulinis subspatulatis, capitulescentiis angustioribus paucicapitatis, phyllariis zonis apicalibus viridibus rhombi-lanceolatis brevioribus, et corollis radii brevioribus.

Plants perennial herbs, apparently without a distinct caudex, arising from a system of slender, scale-leaved rhizomes 0.5–1 mm wide and up to 10 cm long, older rhizomes woody or lignescent, thickened to 2–4 mm wide. **Stems** 15–40 cm tall, erect from the base, hirsute to hispid-hirsute with spreading to spreading-ascending, uniseriate trichomes 0.2–0.6 mm long (Type A, sensu Nesom 1976), evenly distributed or concentrated in vertical lines, lines especially evident immediately below nodes, hirsutulous below heads, also with closely ap-



Studies in Aster
Symphyotrichum rhiannon sp. nov. med.

G. Nesom 2003

University of North Carolina Herbarium
Plants of Clay County, North Carolina, USA

***Symphyotrichum* species novum** **Weakley et al.**

Asteraceae Buck Creek Aster, Rhiannon's Aster

Buck Creek Ultramafic Barrens. Nantahala National Forest. 1.3 km N of US 64 on Buck Creek Rd. just northeast from Glade Gap. Below F.S. Rd 6269 (above bridge crossing Buck Creek) northwest about 0.5 km from gate on steep slope above east side of Buck Creek. Habitat: Serpentine barrens. Steep, west aspect outcrop of dunite and olivine. Open woodland dominated by pitch pine and prairie grasses. Associated species: Pinus rigida, Physocarpus opulifolius, Andropogon gerardii, Sporobolus heterolepis, Schizachyrium scoparium, Packera paupercula var. appalachiana and Sorghastrum nutans.
Characters: Low stature and much branched, plants 20 - 40 cm in height.
UTM zone 17S 281513mE 3885883mN (WGS-84) Elev. 3385 ft

Govus, Thomas E. and Gary Kauffman # 0001 03 November 2003

Fig. 1. *Symphyotrichum rhiannon*: **A.** Holotype; **B.** Closeup of capitulum (isotype).

pressed, uniseriate trichomes 0.1–0.2 mm long [Type B, sensu Nesom 1976), eglandular. **Leaves**: basal and lower cauline usually not persistent at flowering, subspatulate when present, 3–7 cm long, blades oblanceolate-elliptic, 10–15 mm wide, shallowly crenate to serrate-crenate, prominent midvein and reticulate secondary venation, gradually narrowed to a petiolar region 4–6 mm wide, clasping to subclasping and shallowly auriculate, midcauline usually longer than lower, 5–11 cm long, 8–22 mm wide, with petiolar region remaining evident but becoming shorter and relatively broader or the upper leaves oblong-lanceolate, upper cauline (of capitulescence) 1–3 cm long, 4–6(–8) mm wide, all adaxially scabrous with stiff, thick-based, ascending hairs 0.1–0.2 mm long (foreshortened Type A), abaxially inconspicuously strigose (use lens) with thin, closely appressed trichomes 0.05–0.2 mm long (Type B). **Heads** in a sparsely leafy-bracteate, broadly cylindric-paniculate to subcorymboid arrangement, clustered near branch tips on ultimate peduncles 5–15(–30) mm long; involucres turbinate-campanulate, 6–11 mm wide (pressed); phyllaries in 3–4 weakly graduate series, mostly narrowly oblong-lanceolate, inner 6–7 mm long, outer 1/2–3/4 the length of the inner, outer white-indurate on the basal 1/2–2/3, upper 1/2–1/3 with a rhombic-lanceolate green zone 1.8–2.5(–3.0) mm long from widest point to tip, glabrous or the upper part of the green zone minutely strigose-puberulent, margins usually irregularly ciliolate, eglandular. **Ray florets** 18–32, corollas 6–9 mm long, laminae 0.8–1.4 mm wide, blue to lavender, tightly coiling with wilting or maturity, tube and lower lamina sparsely appressed-puberulent with minute biseriate trichomes (Type C, sensu Nesom 1976). **Disc florets**: corollas (4.0–)4.5–5.5 mm long, yellow but at least the lobes usually turning purple, sparsely appressed-puberulent with biseriate trichomes (Type C), tube 1.5–2.1 mm long, throat and limb cylindric, lobes 0.8–1.0 mm long, erect; style branches with narrowly triangular collecting appendages 0.3–0.5 mm long. **Achenes** oblong to narrowly obovate in outline, slightly compressed, 2.6–3.0 mm long, 0.7–0.9 mm wide, 4–6-nerved (with 1 nerve on each edge and 1–2 on each face), sparsely short-strigose, tan or often purplish at maturity; pappus 1-seriate, of 36–46 barbellate bristles.

Etymology.—*Symphyotrichum rhiannon* is named in honor of Rhiannon Weakley, whose desire to rest during a field excursion led the authors to further investigate and finally resolve this decades-old taxonomic conundrum, and also in honor of the original Rhiannon, a Welsh goddess figure associated with the underworld, and therefore particularly appropriate for a plant endemic to a serpentine substrate.

Additional collections examined. **NORTH CAROLINA. Clay Co.**: Buck Creek Ultramafic Barrens, Nantahala National Forest, 1.6 km N of US 64 on Buck Creek Rd, NE from Glade Gap, 0.5 km below bridge over Buck Creekand W upslope along old road to powerline ROW, E aspect slope of dunite and olivine, pitch pine woodland with abundant prairie grasses, 3280 ft elev., UTM zone 17S, 261347mE, 3885588mN (WGS-84), 3 Nov 2003, *Govus* and *Kauffman* 2 (NCU); Buck Creek Serpentine Pine Barrens; in grassy understory; west-facing slope, midslope; pH 6.5, 20 Sep 1981, *Mansberg* 421 (NCU 575098); Buck Creek Serpentine Pine Barrens; in grassy understory; west-facing slope, lower slope; pH 6.0, 20 Sep 1981, *Mansberg* 422 (NCU 575100); Buck Creek Serpentine Pine Barrens; in grassy understory; west-facing slope, midslope; pH 7.0, 20 Sep 1981, *Mansberg* 423 (NCU 575099).

DISCUSSION

Symphyotrichum rhiannon is closest in morphology to *S. puniceum* and *S. prenanthoides*. These three taxa share a set of features: plants eglandular, stoloniferous; leaves with serrate margins, scabrous upper surfaces, the basal petioled but not cordate, cauline clasping, those of capitulescence reduced in size and relatively few; phyllaries long-acuminate to attenuate, subequal to weakly graduate in length. The leaves of *S. prenanthoides* are distinctly spatulate with dilate-auriculate bases, which contrast with both of the other species, and the new species keys to *S. puniceum* (Radford et al. 1968; Gleason & Cronquist 1991; Cronquist 1980) because of the leaf shape. Of features noted here as characteristic of *S. rhiannon*, only its subspatulate leaf shape apparently is not found in at least a few populations of *S. puniceum*. Thus, *S. rhiannon* might be considered intermediate between *S. puniceum* and *S. prenanthoides*, either from common ancestry or perhaps a result of hybridization. Contrasts between these three taxa are summarized in the following couplet.

1. Basal and cauline leaves distinctly spatulate, abruptly constricted to a petiolar region, auriculate-clasping, the auricles dilated from the petiole base and completely enveloping stem; lower 1/2–1/3 of stem generally glabrous ____________ **Symphyotrichum prenanthoides**
1. Cauline leaves subspatulate or oblong to oblong-oblanceolate or lanceolate, gradually narrowed or not toward the base, base clasping to subclasping but not dilated-auriculate and not completely enveloping the stem; lower 1/2–1/3 of stem generally hairy.
    2. Plants 1.5–4 dm tall; young rhizomes thin, 0.5–1.0 mm wide; midcauline leaves subspatulate, slightly narrowed toward the base to a petiolar region; green area of phyllary apices rhombic-lanceolate, 1.8–2.5(–3.0) mm long from widest point to apex; ray corollas 6–9 mm long ____________ **Symphyotrichum rhiannon**
    2. Plants mostly 4–20 dm tall; young rhizomes thickened, 2–4 mm wide; midcauline leaves mostly oblong to oblong-oblanceolate, not narrowed to a petiolar region; green area of phyllary apices narrowly lanceolate, 2.5–4.0 mm long from widest point to apex; ray corollas 10–15(–20) mm long _____ **Symphyotrichum puniceum**

Apart from the distinction in leaf shape, differences between *Symphyotrichum rhiannon* and *S. puniceum* are largely quantitative and are primarily reductions in size. Stems of the new species are relatively short and the capitulescence tends to be narrower with fewer heads. Phyllaries with short green regions are not generally characteristic of *S. puniceum* but do occasionally occur in the species, but the rhombic-lanceolate green zones and more graduate phyllaries of *S. rhiannon* give the heads a distinctive appearance. The cumulative effect of these and the more quantitative differences, however, coupled with the unique habitat and restricted distribution of *S. rhiannon*, is that the latter can be recognized as sharply distinct. Typical *S. puniceum* occurs in most if not all of the counties in the mountains and piedmont of North Carolina (Radford et al. 1968), where it characteristically grows in wet habitats, especially fens, seepages, swamp forests, wet meadows, and in altered wetlands such as ditches and other drainages.

Fernald (1950) treated *Symphyotrichum puniceum* (as *Aster puniceus* L.) with a number of varietal taxa, but all of these are now recognized as populational variants or intergrading populations except one — Warners and Laughlin (1999) have provided a convincing case for treatment of *S. firmum* (Nees) Nesom as a distinct species, in contrast to many earlier treatments of it as *Aster puniceus* var. *firmus* (Nees) Torr. & Gray or *A. puniceus* var. *lucidulus* Gray. Evidence has been presented for recognition of *S. puniceum* var. *scabricaule* (Shinners) Nesom (Nesom 1997), the only infraspecific taxon currently recognized within the species. It might be argued that *S. rhiannon* would be more appropriately treated at varietal rank, especially in view of its largely quantitative difference, but we infer that the new species is reproductively isolated because its geographic range is imbedded within that of typical *S. puniceum* and morphological intergrades have not been observed, despite the co-occurrence of the two taxa within several meters of one another at the type locality.

It is possible and likely that adaptation to the relatively drier habitat of the serpentine barren play a significant part in the observed size reductions of *Symphyotrichum rhiannon*. Common garden experiments would be of interest to determine what component, if any, of the differences are phenotypic. The differences in leaf shape, however, suggest that other genomes might have been involved in the evolution of *S. rhiannon*. *Symphyotrichum prenanthoides*, which apparently is closely related and which is sympatric with *S. puniceum* over much of its range, has cauline leaf blades distinctly narrowed to a petiolar region and Semple (pers. comm.) hypothesizes that *S. rhiannon* is most closely related to *S. prenanthoides*, apparently weighting the tendency in *S. rhiannon* to produce subspatulate leaves. *Symphyotrichum rhiannon*, *S. prenanthoides*, *S. puniceum*, and *S. firmum* have been treated as members of *Symphyotrichum* sect. *Symphyotrichum* (sensu Nesom 1994), but because hybrids in many parental combinations have been observed in *Symphyotrichum*, hypotheses regarding evolutionary ancestry could justifiably include species of putatively more distant relationship. It is perhaps notable that the stem leaves of *S. rhiannon* are less strongly clasping than those of either *S. puniceum* or *S. prenanthoides*.

Symphyotrichum rhiannon has only been documented within a serpentine plant community endemic to a 120 ha area surrounding Buck Creek in the southern Nantahala Mountains of Clay County, North Carolina (Fig. 2). Serpentine soils in the Southern Appalachian Mountains are very rare, and only a

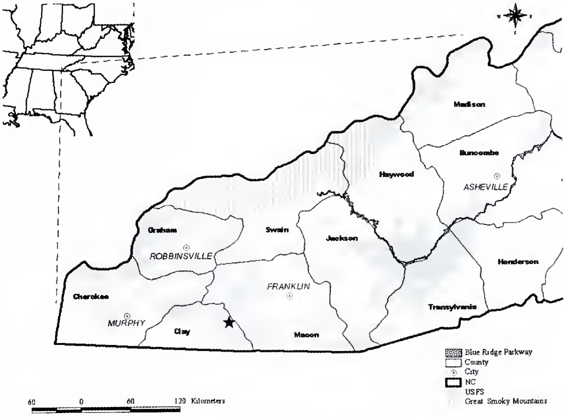


Fig. 2. Location of Buck Creek serpentine site (denoted by star) in Clay County, western North Carolina.

few serpentine barrens have been located and studied, beginning with a pioneering study by Albert E. Radford (1948). The Buck Creek Serpentine Barren was discovered in 1951, following Radford's dissertation, by the late Robert K. Godfrey, then at N.C. State University, and has been periodically studied by botanists and ecologists ever since, as it is the largest and floristically and vegetationally most distinctive of the Southern Appalachian serpentine barrens. In the late 1970s and early 1980s, Laura Mansberg (now Cotterman) conducted the most detailed study of this unique plant community, describing it as a Pine-Savanna (Mansberg 1981; Mansberg & Wentworth 1984). The unusual aster here described as *Symphyotrichum rhiannon* was initially noted during this study by Mansberg, and was referred to in her thesis and subsequent paper as "an undescribed *Aster*." Schafale and Weakley (1990) classified the Buck Creek site as an Ultramafic Outcrop Barren, and considered it to be the best-developed and largest example of this critically imperiled natural community type. The hierarchical United States National Vegetation Classification classifies the community association type as a *Quercus alba–Pinus rigida / Sporobolus heterolepis–Andropogon gerardii* Woodland and assigns it a conservation rank of G1 (Critically Imperiled) (NatureServe 2004).

A physiognomic patchwork of forest, dense grass patches and partially open woodland occurs across the Buck Creek site (Fig. 3). The dominant rock types, serpentinized dunite and olivine, influence the striking vegetation present on this site (Hadley 1949; Pratt & Lewis 1905). Soil depth is variable, ranging from 0 to 60 cm, although rock outcrops represent between 5 and 10% of the local landscape. Soil characteristics reveal higher base saturation, cation exchange capacity, pH, and magnesium relative to surrounding sites in the Nantahala Mountains (Mansberg & Wentworth 1984). The serpentine plant communities occupy both east and west-facing slopes extending from 975 meters elevation along Buck Creek to over 1220 meters elevation atop Corundum Knob. *Symphyotrichum rhiannon* occurs within the woodland and grass-dominated areas.

Within the woodland the forest canopy varies from 20-60% cover depending on the intensity and frequency of recent prescribed burns. The woodland is dominated in the tree canopy by older stunted *Quercus alba* and smaller denser *Pinus rigida* stems. *Tsuga canadensis, Sassafras albidum, Acer rubrum, Oxydendrum arboreum*, and *Amelanchier laevis* also occur within the canopy and subcanopy. Shrub cover is meager, typically occurring in clumps and providing no more than 10% cover. Diagnostic shrub species include *Rhododendron viscosum, Physocarpus opulifolius, Viburnum cassinoides, Kalmia latifolia, Lyonia ligustrina* var. *ligustrina, Vaccinium stamineum*, and *V. corymbosum*.

The grass dominance within the herb stratum is reminiscent of prairie vegetation and presents a striking contrast to the regionally typical herbaceous layer consisting of mesophytic, broad-leaved forbs. *Andropogon gerardii, Schizachyrium scoparium* var. *scoparium*, and *Sporobolus heterolepis* are the most important grasses. Characteristic forb species include *Hexastylis arifolia* var. *ruthii, Thalictrum macrostylum, Packera plattensis, Castilleja coccinea, Phlox ovata, Oxypolis rigidior, Sanguisorba canadensis, Polygala pauciflolia, Asplenium platyneuron, Solidago nemoralis, Symphyotrichum undulatum* and *S. phlogifolium*. A striking contrast within the herb layer is the juxtaposition of both mesophytic and xerophytic species. It is not unusual to observe *Sanguisorba canadensis* and *Oxypolis rigidior* emerging from a grassy thicket of *Sporobolus heterolepis* and *Schizachyrium scoparium*. Mansberg noted a perched water table while surveying the site and suggested that there is a complex soil moisture gradient within the serpentine site (Mansberg & Wentworth 1984). Many of the minerals predominant in mafic and ultramafic rocks chemically weather to clays, and the soils at Buck Creek have a substantial clay component, providing a perched water table and abundant seepage after rains, but drying to highly xeric conditions during droughts.

In response to periodic mining threats, 42 hectares of the serpentine site at Buck Creek are now managed by the USFS as a Special Interest Area and registered as a Natural Heritage Area with the North Carolina Natural Heritage Program. In 1995, the U.S. Forest Service initiated active conservation management

Fig. 3. Buck Creek serpentine woodland in mid August. The dominant grass is *Andropogon gerardii*.

Fig. 4. Emerging grasses at Buck Creek serpentine woodland 3 weeks following a prescribed burn designed to reduce the canopy layer. Prescribed fire was conducted in April of 1995.

Table 1. Status of North Carolina rare plant species documented at Buck Creek serpentine site.

Species	**G-rank**[a]	**S-rank**[b]	**Relative Rarity within North Carolina**
Sporobolus heterolepis	G5	S1	1 of 2 occurrences documented in NC; disjunct eastwards from a primary distribution in the Great Plains
Deschampsia cespitosa ssp. *glauca*	G5	S1	Only known occurrence in NC; disjunct from further west
Elymus trachycaulus ssp. *trachycaulus*	G5T5	S1	Only known occurrence in NC; disjunct from further west
Calamagrostis porteri ssp. *porteri*	G4T4	S1	1 of 8 extant occurrences within NC
Poa saltuensis	G5	S1	1 of 2 occurrences documented in NC; disjunct from further west
Muhlenbergia glomerata	G5	S1	1 of 2 occurrences documented in NC; disjunct from further west
Carex woodii	G4	S2	Dense in forested area within and surrounding serpentine site; northern species near its southern range extent
Calystegia catesbiana var. *sericata*	G3T3	S3	Locally common in Southwestern NC Mts; broad Southern Appalachian endemic
Liparis loeselii	G5	S1	Locally restricted to only a few individuals; circumpolar, near its southern range extent
Gentianopsis crinita	G5	S1	1 of 2 high quality occurrences in NC
Oenothera perennis	G5	S2	1 of 3 high quality occurrences in NC
Ranunculus fascicularis	G5	S1	1 of 2 occurrences documented in NC
Pedicularis lanceolata	G5	S1	1 of 2 drainages with extant populations in NC
Parnassia grandifolia	G3	S2	1 of 3 high quality occurrences in NC
Viola appalachiensis	G3	S2	Largest population documented in NC; Central and Southern Appalachian endemic
Brachyelytrum aristosum (= *B. septentrionale*)	G4G5	S3?	Locally common in higher elevations in the southwestern Mountains of NC; northern species near its southern range extent
Drepanolejuenea appalachiensis	G2?	S2	Remarkable occurrence for tiny liverwort that more typically occurs in mesic hardwood forest; Southern Applachian endemic; with one disjunct occurrence in West Indies

Table 1. continued

Species	G-rank[a]	S-rank[b]	Relative Rarity within North Carolina
Celastrina nigra	G4	S2?	1 or 6 occurrences documented in NC, near eastern range limit
Speyeria aphrodite cullasaja	G5T1	S1?	Only known occurrence in NC; southern Appalachian endemic
Chlosyne gorgone	G5	S1?	Only known occurrence in NC; primarily Midwestern and western species near eastern range limit
Phyciodes batesii maconensis	G5	S2	Largest population documented in NC; southern Appalachian endemic

[a] G-rank indicates global rarity and threat status. See NatureServe (2004) for definitions.
[b] S-rank indicates state rarity and threat status. See NatureServe (2004) for definitions.

of the site, using prescribed fire as the primary tool, resulting in reduction of woody growth encroaching on the site and an increase in herbaceous cover, particularly the grasses once dominant at the site (Fig. 4). Within the last 10 years monitoring plots were established both by both the North Carolina Vegetation Survey and the U.S. Forest Service to document current vegetation and provide a baseline for detecting change. A review of this plot data shows that *S. rhiannon* prefers more open conditions, occurring exclusively within plots (n = 27) with less than 50% tree cover and primarily in plots with less than 33% canopy cover. *S. rhiannon* grows sparsely; cover estimates in plots have not exceeded 2% cover. *S. rhiannon* has either maintained its coverage or slightly increased its density within fire-maintained areas at the Buck Creek Serpentine Barren.

In addition to the presence of the unusual plant community, the presence of rare species adds to the conservation importance of the Buck Creek Serpentine Barren. Seventeen state-listed rare plant species and four state-listed butterfly species occur within the site (Franklin & Finnegan 2004; LeGrand et al. 2004; Gatrelle 1998; Table 1). Most of these species are primarily wide-ranging and globally secure (G4 or G5 rank), yet rare in NC; a few are restricted to only this site within the state. Although serpentine is well known for its tendency to generate locally endemic species (Brooks 1987), relatively few endemics have been described from the serpentine areas in eastern North America. A number of endemics have been described from the well known serpentine barrens of Maryland and Pennsylvania, including *Symphyotrichum depauperatum* (Fernald) Nesom, though the taxonomic distinctiveness of many remains controversial. The less well known serpentine areas in Virginia, North Carolina, and Georgia have not heretofore yielded endemic taxa described. However, a number of odd putative taxa (*Carex, Hexastylis, Rhododendron, Symphyotrichum,* *Thalictrum*) from serpentines in Virginia and North Carolina are currently the subject of taxonomic investigation and may add to a growing list of eastern North American serpentine endemics.

Current information suggests that *S. rhiannon* is a serpentine endemic restricted to the G1-ranked woodland community at the Buck Creek Serpentine Barren. We hope that publication of this species will result in the discovery of other populations, at the few other Southern Appalachian serpentine barrens, though the potential for locating other undocumented occurrences within ultramafic rock influenced woodlands or barrens within the region is probably limited given the overall scarcity of this habitat.

ACKNOWLEDGMENTS

We thank Luc Brouillet (Université de Montréal, MT), co-author of the taxonomic treatment of *Symphyotrichum* for the forthcoming FNA volumes (Flora of North America), for his comments on the distinctiveness of the new species. We thank John Semple (University of Waterloo, WAT) for helpful discussions about the taxon and comments improving the manuscript. We thank the curators of GMU and VPI for the loan of specimens of other *Symphyotrichum* entities found in ultramafic and mafic sites in Virginia.

REFERENCES

Ballard, T.J. 1947. Report of investigations on Buck Creek Corundum, Clay County, North Carolina. U.S. Department of Interior, Bureau of Mines, R.I. 4052.

Brooks, R.R. 1987. Serpentine and its vegetation: A multidisciplinary approach. Dioscorides Press, Portland, Oregon. 454 pp.

Cronquist, A. 1980. Vascular flora of the southeastern United States. Vol. 1. Asteraceae. Univ. North Carolina Press, Chapel Hill.

Fernald, M.L. 1950. Gray's manual of botany (ed. 8). American Book Co., New York, NY.

Franklin, M.A. and J.T. Finnegan. 2004. Natural Heritage Program list of the rare plant species of North Carolina. North Carolina Natural Heritage Program, Raleigh, North Carolina. 112 pp.

Gatrelle, R.R. 1998. Two new Nymphalidae from western North Carolina: new subspecies of *Speyeria aphrodite* and *Phyciodes batesii*. The Taxonomic Report of the International Lepidoptera Survey volume 1, number 3, 7pp.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada (ed. 2). The New York Botanical Garden, Bronx, NY.

Hadley, J.B. 1949. Preliminary report on corundum deposits in the Buck Creek peridotite, Clay County, North Carolina. Washington, D.C. U.S. Department of Interior, Strategic Minerals Investigations 1945, Bulletin 948-E.

LeGrand, H.E., S.E. McRae, S.P. Hall and J.T. Finnegan. 2004. Natural Heritage Program List of the rare animal species of North Carolina. North Carolina Natural Heritage Program, Raleigh, North Carolina. 99 pp.

Mansberg, L. 1981. Vegetation, soils, and canopy age-structure of the Buck Creek Serpentine Pine Barren, Clay Co., North Carolina. M.S. thesis, Curriculum in Ecology, North Carolina State University.

Mansberg, L., and T.R. Wentworth. 1984. Vegetation and soils of a serpentine barren in western North Carolina. Bull. Torrey Bot. Club 111:273-286.

NatureServe. 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Virginia. Available www.natureserve.org/explorer.

Nesom, G.L. 1976. A new species of *Erigeron* (Asteraceae) and its relatives in southwestern Utah. Brittonia 28:263–272.

Nesom, G.L. 1994. Taxonomic overview of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. Phytologia 77:141–297.

Nesom, G.L. 1997. The status of *Aster scabricaulis* (Asteraceae: Astereae), an endemic of the Gulf coastal plain. Phytologia 82:300–315.

Radford, A.E. 1948. The vascular flora of the olivine deposits of North Carolina and Georgia. Ph.D. dissertation, Department of Botany, University of North Caroina at Chapel Hill.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill.

Schafale, M.P., and A.S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. N.C. Natural Heritage Program, Raleigh, N.C.

Warners, D.P. and D.C. Laughlin. 1999. Evidence for a species-level distinction of two co-occurring asters: *Aster puniceus* L. and *Aster firmus* Nees. Michigan Bot. 38:19–31.

BOOK REVIEW

Blueberries and Cranberries

Jennifer Trehane. 2004. **Blueberries, Cranberries and Other Vacciniums.** (ISBN 0-88192-615-9, hbk.) Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). U.S. $29.95, CAN $39.95, 272 pp., 66 color photos, 7" × 9".

In the new book by Jennifer Trehane, *Blueberries, Cranberries and Other Vacciniums*, she begins by tracing the story of the most widely grown species of *Vacciniums*, blueberries and cranberries. The book deals with their propagation, cultivation, harvest, and uses, including their health benefits; varieties are also fully described. Other relatively unfamiliar, fruiting vacciniums are dealt with in the section on garden cultivation, as are some cold-hardy and neo- or subtopical species and "forms."

The reader should note, the book contains sufficient information on growing blueberries, cranberries, and even lingonberries on a small scale commercial basis, but is not intended as a complete manual for large scale commercial growing.

In part one the author gives a semi-brief overview of the genus, including the history, archaeology, cultivation, pests, diseases, and botany. I found it to be useful in that the information was divided up by the species, common name, and inside that chapter, she covered all the aforementioned topics, specific to that plant.—*Asha McElfish, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

BOOK NOTICE

Ma de la Luz Arreguín-Sánchez, Rafael Fernández Nava, and Vavid Leonor Quiroz García. 2004. **Pteridoflora del Valle de México.** (ISBN not given) Instituto Politécnico Nacional, Escuela Nacional de Ciencias Biológicas, Prolongación de Carpio y Plan de Ayala, Santo Tomás, CP 11340, México DF. (Orders: same). Price not given, approx. 400 pp., color photos.

Table of contents: Introducción; Material y métodos; Morfología de pteridofitas; referencias bibliográficas citadas en los antecedents e introducción; Clave para separar las familias de pteriodofitas del Valle de México; Descripción de las familias, geéneros y especies; Ilustraciones de las diferentes espeices descritas; Glosario de términus utilizado; y Índice de nombres científicos del material del Valle de México.

A SYNOPSIS OF THE GENUS *OTOSTYLIS* (ORCHIDACEAE: MAXILLARIEAE SUBTRIBE ZYGOPETALINAE) WITH A NEW RECORD FROM SOUTHERN PERU

Miguel Chocce

San Marcos Herbarium (USM)
Museo de Historia Natural
Avenida Arenales 1256, Jesús Maria
Apdo. 14-0434, Lima 14, PERÚ
miguel176@yahoo.com

John P. Janovec

Botanical Research Institute of Texas (BRIT)
Fort Worth, Texas 76102-4060, U.S.A.
jjanovec@brit.org
(Corresponding author)

Eric A. Christenson

1646 Oak Street
Sarasota, Florida, 34236, U.S.A.
orchideric@juno.com

ABSTRACT

The genus *Otostylis* (Orchidaceae) is one of the lesser known genera in the *Zygopetalum* alliance, which has had a problematic taxonomic history. *Otostylis* consists of four species distributed in South America and Trinidad. The purpose of this paper is to provide a synopsis of the genus, with descriptions of the four species and keys for their identification. *Otostylis paludosa* is resurrected from previous synonomy under *O. lepida* and reported as a new record for the genus in Peru, occurring as a dominant herb in bog wetlands of the Department of Madre de Dios.

RESUMEN

El género *Otostylis* (Orchidaceae) es uno de los géneros poco conocidos en la alianza de *Zygopetalum*, que ha tenido una historia taxonómica problemática. *Otostylis* consiste en cuatro especies distribuidas en América del sur y Trinidad. El objetivo este articulo es proveer de una sinopsis del género, con descripciones de las cuatro especies y claves para su identificación. *Otostylis paludosa* dejo de ser sinonimo de *O. lepida* y esta reportado como un record nuevo para el Perú, siendo una hierba dominante en los pantanos del Departamento de Madre de Dios.

INTRODUCTION

The circumscription of orchid genera related to *Zygopetalum* W.J. Hook. has been problematic throughout the history of botany, and periodically all taxa have been united within an impossibly broadly defined *Zygopetalum*. Our modern understanding of generic limits in the group begins with a generally accepted review by Garay (1973). Subsequent authors have dealt with nomenclatural problems (Christenson 1988), generic reviews (Christenson 2002), and the confounding generic issues of taxa lacking pseudobulbs (Dressler 2000).

One of the lesser-known genera in the *Zygopetalum* alliance is *Otostylis*

SIDA 21(2): 841–852. 2004

Schltr. It was described by the German orchidologist Rudolf Schlechter in 1918 in a review of genera previously combined with *Aganisia* Lindl. The name is derived from the Greek *otos*, meaning ear, and *stylis*, meaning column, referring to the conspicuous subapical wings on the column. This character separates it from related genera including *Aganisia*, *Warreella* Schltr., and *Warreopsis* Garay. *Otostylis* has been generally accepted in floristic accounts since its original publication. Rather astonishingly, despite their showy flowers, plants of *Otostylis* have been rarely cultivated in modern times and are only now being reintroduced to horticulture.

The purpose of this note is to provide a synopsis of *Otostylis* and report the discovery of the genus for the first time in southern Peru. Recent collecting of vouchers for botanical and ecological studies in Madre de Dios, Peru, under the auspices of the Botanical Research Institute of Texas (BRIT) and the San Marcos Herbarium (USM) has revealed a substantial population of *O. paludosa* (Cogn.) Schltr., a previously endemic Brazilian taxon incorrectly reduced to synonymy in recent times.

TAXONOMY

Otostylis Schltr., Orchis 12:38. 1918. Type: *Otostylis lepida* (Linden & Rchb.f.) Schltr.

Caespitose terrestrials. Pseudobulbs ovoid, small, typically concealed by bracts and leaf bases. Leaves several, plicate, lanceolate, petiolate, acuminate, sometimes with subsimilar foliaceous bracts subtending the pseudobulbs. Inflorescences axillary erect long-pedunculate racemes, the floral bracts inconspicuous. Flowers numerous, several open at once, showy, long-lasting, predominately white, crystalline in texture. Sepals and petals subsimilar, subequal, free, spreading. Lip unlobed or obscurely three-lobed, subauriculate, with a basal transverse crested callus, sometimes biseriate. Column straight, conspicuously winged, with a short foot; pollinia 4, on a common linear viscidium.

Otostylis comprises four superficially similar species native to South America and Trinidad.

KEY TO THE SPECIES

1. Callus minutely warty, W-shaped with two short continuous arms extending onto the blade of the lip ____ **O. lepida**
1. Callus not warty, entire or biseriate without continuous extensions.
  2. Callus biseriate comprising a transverse ridge with three low parallel keels in front ____ **O. brachystalix**
  2. Callus entire, a high crest.
    3. Callus toothed, inflorescences less than 50 cm tall (northern South America) ____ **O. alba**
    3. Callus ridged but not forming distinct teeth, inflorescences commonly 1 m tall (southern Brazil and Peru) ____ **O. paludosa**

1. Otostylis alba (Ridl.) Summerhayes, Kew Bull. 6:293. 1951. *Aganisia alba* Ridl., Timehri 5:204. 1886; *Zygopetalum venustum* Ridl., Trans. Linn. Soc. Bot., ser. 2, 2:283, t. 47. 1887; *Aganisia venusta* (Ridl.) Rolfe ex J.D. Hooker, Bot. Mag. 118: sub t. 7270. 1892; *Warreella venusta* (Ridl.) Schltr., Die Orchideen, ed. 1:425. 1914; *Koellensteinia alba* (Ridl.) Schltr., Orchis 9:32. 1915; *Otostylis venusta* (Ridl.) Schltr., Orchis 12:41. 1918. TYPE: VENEZUELA: Bolivar, Mt. Roraima district, along the Kookenam River, 1000 m, *E.F. Im Thurn 360* (HOLOTYPE: BM!; ISOTYPE: K!).

Pseudobulbs ovoid, to 1.5 cm long, ca. 1 cm wide and 0.5 cm thick, completely concealed by the leaf bases, apically unifoliate. Leaves 3–4, arching, linear-lanceolate, petiolate, acuminate, to 25 × 2 cm. Inflorescences erect long-pedunculate racemes to 40 cm long, longer than the arching leaves, the floral bracts triangular-ovate, acute, to 0.6 cm long. Flowers 10–12, to 2.5 cm across, white, the callus and surrounding field yellow. Sepals and petals subsimilar, subequal, elliptic, obtuse, the dorsal sepal to 1.3 × 0.8 cm, the lateral sepals to 1.5 × 1 cm, the petals to 1.2 × 0.7 cm. Lip unlobed, elliptic, obtuse, minutely emarginate, to 1.3 × 1.3 cm, the callus a high transverse semicircular crest divided into blunt teeth, ca. 7 mm wide. Column winged, to 1 cm long, width at wings 7 mm wide, width at base 2.5 mm wide, the wings obliquely ovate. Fruits not seen.

Distribution.—Venezuela, the Guianas, and Brazil at elevations around 1000 m (Foldats 1970).

Some authors reduce this species to the synonymy of *O. lepida* (e.g., Dunsterville & Garay 1965; Pabst & Dungs 1977; Senghas & Gerlach 1996; Romero-González 2003) but we are following Foldats (1970) in keeping it separate. *Otostylis lepida* has been recorded from the Brazilian states of Amazonas, Matto Grosso and Para (Pabst & Dungs 1977). The records for Amazonas are likely correct; the records for Matto Grosso are based on the previous inclusion of *O. paludosa* in synonymy; and the records for Para require reexamination of those vouchers, outside the scope of this paper.

2. Otostylis brachystalix (Rchb.f.) Schltr., Orchis 12:39. 1918. (**Figs. 1, 2**). *Zygopetalum brachystalix* Rchb.f., Ann. Bot. Syst. 6:660. 1863; *Aganisia brachystalix* (Rchb.f.) Rolfe, Orchid Rev. 22:200. 1914; *Koellensteinia brachystalix* (Rchb.f.) Schltr., Orchis 9:31. 1915. TYPE: TRINIDAD: *leg. ignot. s.n.* (HOLOTYPE: W, drawing seen).

Pseudobulbs short, ovoid, to 2 cm long, completely concealed by the leaf bases. Leaves 3–4, erect, grass-like, acuminate, to 70 × 2 cm, often half that size. Inflorescences erect long-pedunculate racemes to 70 cm long, longer than the leaves, the floral bracts inconspicuous, ovate, acute, 6 mm long. Flowers 5–30, to 2.5 cm across, sepals and petals white, the lip white with a yellow center. Sepals elliptic, obtuse, to 1.8 × 1.2 cm. Petals obovate, obtuse, to 1.7 × 1 cm. Lip obscurely three-lobed, to 1.2 × 1.2 cm, the lateral lobes small, subauriculate, flanking the callus, the midlobe transversely kidney-shaped, obtuse, the callus a low transverse ridge across the lateral lip lobes in a raised crescent that diminishes to the sides of the lobes. Column stout with conspicuous rhombic subapical wings, to 0.8 cm long, 6 mm wide across the wings, 2.5 mm wide at the base. Fruits capsules, ellipsoid, smooth.

Fig. 1. Habit of *Otostylis brachystalix* from the Aripo Savannah wetland of Trinidad-Tobago. (Photograph by Julian Kenny, Trinidad-Tobago, 2003)

Fig. 2. Inflorescence and flowers of *Otostylis brachystalix* from Trinidad-Tobago. (Photograph by Julian Kenny, Trinidad-Tobago, 2003)

Distribution.—Trinidad, Colombia (Ortiz 1995), Venezuela, the Guianas, Brazil, and Peru (Loreto) at elevations of 150–1675 m.

Much early confusion surrounding this species was resolved by Ames (1922) who provided the first illustration of *O. brachystalix* based on a plant from Trinidad, where it was collected for the first time in the Aripo Savannah. Described by Reichenbach in 1861 as *Zygopetalum brachystalix*, this species is characterized by having a weakly three-lobed lip and a biseriate callus consisting of a low transverse ridge between the auriculate lip lobules supplemented by three small longitudinal keels in front. Figures 1 and 2 provide images of the habit, inflorescence, and flowers of *O. brachystalix*, courtesty of Dr. Julian Kenny. Pabst and Dungs (1977: 285) provided an illustration of a flower dissection of *O. brachystalix*.

According to Julian Kenny (2004, pers. comm.), *O. brachystalix* is known in eastern Trinidad from the Aripo Savannah, which is a 360-hectare bog-like grassland lying on a bed of quartz sand over a clay pan. The savannah is boggy during the rainy season and arid during the dry season. The dominant vegetation consists of grasses and sedges, as well as bog indicators, *Drosera* and *Sphagnum* species.

In the Aripo Savannah, *O. brachystalix* is more often seen on well-drained, slightly elevated patches. It flowers typically in the dry season from January to April (Kenny 1988). A mature plant grows to about 70 cm tall. Populations have declined significantly in the last 20 years (Kenny 2004, pers. comm.), presumably due to overcollecting, as it is the easiest to grow of the savannah orchids. A pot of sand and exposure to sun and proper watering is all that is necessary to cultivate this species (Kenny 2004, pers. comm.). Several other orchids exist in this habitat, such as *Cleistes tenuis* (Rchb.f.) Schltr., *Epistephium parviflorum* Lindl., *Habenaria leprieurii* Rchb.f., *H. mesodactyla* Griseb., and *Sarcoglottis simplex* (Griseb.) Schltr. *Cyrtopodium parviflorum* Lindl. also exists in the same habitat but according to Kenny (2004, pers. comm.) it is now rare due to overcollecting.

3. Otostylis lepida (Linden and Rchb.f.) Schltr., Orchis 12:40. 1918. *Aganisia lepida* Linden and Rchb.f., Beitr. Orchideenkunde 15, t. 5. 1869. TYPE: BRAZIL. AMAZONAS: Rio Negro, *G. Wallis s.n.* (HOLOTYPE: W!).

Pseudobulbs slender, fusiform, to 6 cm long, to 1 cm in diameter, subtended by nonfoliaceous bracts. Leaves 1–3, arching-erect, linear-lanceolate, petiolate, acuminate, to 65 × 6 cm, often half that size. Inflorescences erect long-pedunculate racemes, shorter than the leaves, to 25 cm long, the floral bracts inconspicuous, ovate, acute, to 0.4 cm long. Flowers 4–10, 2 mm across, white, the sepals and petals often suffused with pink toward the apices, the callus and surrounding field yellow. Sepals and petals subsimilar, elliptic, acute, the sepals to 2 × 1 cm, the petals to 1.8 × 0.8 cm. Lip unlobed, elliptic-suborbicular, slightly constricted above the base (= obscurely pandurate), obtuse-truncate with a minutely apiculate apex formed by conduplicate folding, to 1.8 × 1.8 cm,

Fig. 3. Habit of *Otostylis paludosa* in a palm swamp of Madre de Dios, Peru, showing the erect leaves and elongated inflorescence of this species. (Photograph by John Janovec, 2002)

FIG. 4. Inflorescence and flowers of *Otostylis paludosa* from Madre de Dios, Peru. (Photograph by Mathias Tobler, 2002)

Fig. 5. Palm swamp habitat of *Otostylis paludosa* in Madre de Dios, Peru. (Photograph by Mathias Tobler, 2002)

the callus loosely W-shaped, a transverse minutely warty ridge extending as two short arms. Column winged, to 1.2 cm long, 7 mm wide across the wings, 3 mm wide at the base, the wings quadrate, truncate. Fruits not seen.

Distribution.—Venezuela, Guiana, and Brazil at elevations of 750–1615 m.

This species is easily recognized by its minutely warty callus with arms that extend onto the blade of the lip.

4. Otostylis paludosa (Cogn.) Schltr., Repert. Spec. Nov. Regni Veg. 15:214. 1918. (**Figs. 3–5**). *Zygopetalum paludosum* Cogniaux, Comm. Linh. Tel. Est. Matto Grosso, Annex. 5, pt. 3:12, t. 64. 1912. TYPE: BRAZIL. MATTO GROSSO: Rio Juruena, May, *F.C. Hoehne (Comm. Rondon) 2000 & 2013* (SYNTYPE: BR!).

Pseudobulbs ovoid, to 2 cm long, completely concealed by leaf bases. Leaves 1–2, erect, linear-lanceolate, petiolate, acuminate, to 60.7 cm long, 2.3 cm wide. Inflorescences erect long-pedunculate racemes, longer than the leaves, the peduncle to 62.4 cm long, the rachis 10–15 cm long, the floral bracts lanceolate, acute, to 0.5 cm long. Flowers 10–20, to 3 cm across, white, the center of the lip yellow, the inner face of the column purple. Sepals and petals subsimilar, subequal, spreading, oblong-elliptic, obtuse, the dorsal sepal to 17 × 7 mm, the lateral sepals to 15 × 8 mm, the petals to 15 × 6 mm. Lip unlobed auriculate, the midlobe suborbicular to transversely kidney-shaped, broadly rounded, to 12 × 11 mm, the callus a transverse, lunate crest, incised forming ridges but not distinct teeth, to 2.5 mm long and 5 mm wide. Column stout, to 8 mm long, with obtuse, quadrangular wings, to 4 × 1.9 mm, the width at wings to 7 mm and at base to 3.5 mm. Fruits ellipsoid, smooth capsules.

Distribution.—Brazil (Matto Grosso) and Madre de Dios, Peru, in the hot, humid lowlands at ca. 230–250 m.

This somewhat obscure species, generally maintained in the synonymy of *O. lepida* (e.g., Pabst & Dungs 1977), has rather ironically been well illustrated in the literature. In particular, the drawing from *Flora Brasílica* (Hoehne 1948, 1953) was reproduced in the very widely available horticultural manual *Encyclopaedia of Cultivated Orchids* (Hawkes 1965: 348). In addition, a watercolor drawing of a flower, clearly showing the high callus without ancillary structures in front, was reproduced in Pabst and Dungs (1977: 229, as *O. lepida*).

A swamp dweller as the name implies, plants of *O. paludosa* are remarkable for their stature when in flower, being about twice as tall as the other species in the genus (Fig. 3). The flowers, however, are similar in size to other species of *Otostylis*. A photograph of a flowering plant *in situ* on the Parecis plateau and its habitat was given by Miranda (1996) as *O. lepida* but is probably *O. paludosa*. See Figure 4 for images of the inflorescence and flowers of *O. paludosa* from Madre de Dios, Peru.

We record this species as new to the flora of Peru based on a collection by Janovec et al. from the Department of Madre de Dios. It has only been found in bog-like savannah habitat associated with large swamps dominated by the palm

Mauritia flexuosa L. (Arecaceae), known commonly as the Aguaje palm. Figure 5 shows the habitat of *O. paludosa* from a study site in Madre de Dios, Peru.

Otostylis paludosa is the largest, most abundant, and conspicuous orchid growing in the open boggy savannahs of the Aguaje palm swamp habitat in the region. This species grows with ferns, grasses, rushes, sedges, and other plants on small moist raised areas of *Sphagnum* emerging like small islands from the bog water. Botanical and ecological studies in progress have documented hundreds of individuals of this species per hectare (Janovec et al., in prep.). Despite its abundance, this species has never been recorded in Peru, most likely due to a major lack of exploration of vast wetland habitats, especially of Madre de Dios, Peru.

The peak flowering season in Peru is July–September, when the white flowering inflorescences of this species can be observed in abundance, but flowers have also been observed in January–March. The plants can be seen holding fruits during March–July and September–February.

Collections examined: **PERU. Madre de Dios:** Manu Province, *Mauritia flexuosa* (Arecaceae) palm swamp 7 km up the Madre de Dios River from the Los Amigos River, 230 m, 19 Aug 2002, *J.P. Janovec et al. 2662* (USM, BRIT); same locality, *M.A. Chocce 277, 279, & 295* (USM).

EXCLUDED SPECIES

Otostylis hirtzii Dodson, Icon. Pl. Trop., ser. 1, t. 976. 1984. TYPE: ECUADOR: Pichincha, between San Juan and Chiriboga on old road from Quito to Santo Domingo, 1800–2200 m, 7 Mar 1982, *A. Hirtz & J. Leon 201* (HOLOTYPE: SEL) = *Warreopsis pardina* (Rchb.f.) Garay (see Senghas & Gerlach 1993).

Stems short, completely concealed by leaf bases. Leaves 3–5, lanceolate, long-petiolate, acuminate, to 75 × 8 cm. Inflorescences erect long-pedunculate racemes to 75 cm long, the floral bracts lanceolate, acute, to 0.5 cm long. Flowers 12–15, to 1.7 cm across, the sepals and petals yellow with purple spots, the lip pinkish-white. Sepals and petals subsimilar, subequal, oblong-elliptic, obtuse, to 1 × 0.5 cm, the dorsal sepal concave. Lip unlobed, auriculate, fan-shaped, notched at the apex, to 0.8 × 0.9 cm, the callus an inverted U-shaped crest. Column straight, without wings, to 0.6 cm long, the foot to 0.2 cm long. Fruits not seen.

Distribution.—Known from Colombia and Ecuador at elevations of 1800–2200 m.

This species has always been out of place in *Otostylis* by virtue of its column which is devoid of any wings and its boldly spotted yellow sepals and petals. With the removal of this species to *Warreopsis*, all species of *Otostylis* have the generic character of prominent column wings as well as unmarked white sepals and petals.

ACKNOWLEDGMENTS

We would like to thank the Gordon and Betty Moore Foundation, Beneficia Foundation, Upton Foundation, World Wildlife Fund, Winrock International, Amazon Conservation Association, and the Asociación para la Conservación de la Cuenca Amazónica, for supporting the studies that led to the discovery of *Otostylis paludosa* in Madre de Dios, Peru. Piher Maceda, Fernando Cornejo, Jorge Herrera, Juan Carlos Flores, and Fausto Espinosa deserve special thanks for supporting logistics and fieldwork. We thank Asunción Cano, Director of the San Marcos Herbarium, and Carlos Reynel, Professor and Director of the La Molina Forestry Herbarium, for their support of the project, and the Peruvian Ministry of Natural Resources (INRENA) for providing research and collection permits for studies of this and other plant species in Madre de Dios, Peru. Amanda Neill and Ted Barkley provided important comments on earlier versions of the manuscript. We thank Mathias Tobler for allowing us to use his photographs and for contributing as a major collaborator in studies of wetlands in Madre de Dios, Peru. We are grateful to Julian Kenny who kindly provided photographs and essential information from his studies of *Otostylis brachystalix* in in the Aripo Savannah of Trinidad-Tobago. Finally, we thank Leslie Garay for freely sharing critical information from his private research files.

REFERENCES

Ames, O. 1922. Studies of *Otostylis brachystalix* and the species with which it has been confused. Orchidaceae 7:49–62.

Christenson, E.A. 1988. Nomenclatural changes in neotropical Orchidaceae. Lindleyana 3:221–223.

Christenson, E.A. 2002. The genus *Kefersteinia*. Orchid Digest 66(3):110–114.

Dodson, C.H. and P.M. Dodson 1984. *Otostylis hirtzii* Dodson. Icon. Pl. Trop., ser. 1, t. 976. 1984.

Dressler, R.L. 2000. Precursor to a revision of the *Chondrorhyncha* complex. Orquideología 21:233–247.

Foldats, E. 1970. *Otostylis*. Fl. Venez. 15(4):284–291.

Garay, L.A. 1973. El Complejo *Zygopetalum*. Orquideología 8:15–34, 51.

Hawkes, A.D. 1965. Encyclopaedia of Cultivated Orchids. Faber & Faber, Ltd., London.

Hoehne, F.C. 1949. Iconografía das Orchidaceas do Brasil. Plate 209.

Hoehne, F.C. 1953. *Otostylis*. Fl. Brasil. fasc. 10 (vol. 12, no. 7):143–147.

Kenny, J. 1988. Native Orchids of the Eastern Caribbean. Macmillan Caribbean, London.

Miranda, F. 1996. Orchids from the Brazilian Amazon. Editora Expressão e Cultura, Rio de Janeiro.

Ortiz V.P. 1995. Orquídeas de Colombia. Indo-American Press Service, Bogotá.

Pabst, G.F.J. and F. Dungs 1977. Orchidaceae Brasilienses. Band II. Brücke-Verlag Kurt Schmersow, Hildesheim.

Schlechter, R. 1918. Die Gattung *Aganisia* Lindley und ihre Verwandten. Orchis 12:38–42.

Senghas, K. and G. Gerlach. 1993. Subtribus: Zygopetalinae. In Brieger et al., R. Schlechter, Die Orchideen, Band I/B 60:1674–1703.

UNDERSTANDING *PLATANTHERA CHAPMANII* (ORCHIDACEAE), ITS ORIGINS AND HYBRIDS

Paul Martin Brown

10896 SW 90th Terrace
Ocala, Florida 34481, U.S.A.

ABSTRACT

Platanthera chapmanii (Small) Luer emend. Folsom is a rare orchid endemic to the southern coastal plain of the southeastern United States. Since its original description by Small in 1902 as *Blephariglottis chapmanii*, *Platanthera chapmanii* has been recognized at various taxonomic levels. Folsom (1984) clarified this problem by once again recognizing it at the species level and also provided evidence for the hybrid origin of the species and a new contemporary hybrid, *P.* ×*channellii*. Because Folsom's work was not widely available, much misunderstanding still persists as to the correct identity and rank of *Platanthera chapmanii*. Several species and hybrids are involved in this complex and all have contributed to the confusion. Those misunderstandings and relationships are clarified here.

RESUMEN

Platanthera chapmanii (Small) Luer emend. Folsom es una orquídea rara endémica de la llanura costera del Sur de los Estados Unidos. Desde su descripción original por Small en 1902 como *Blephariglottis chapmanii*, *Platanthera chapmanii* ha sido reconocida en varios niveles taxonómicos. Folsom (1984) clarificó este problema reconociéndola una vez más a nivel específico y también aportó pruebas del origen híbrido de la especie y un nuevo híbrido contemporáneo, *P. _channellii*. Debido a que el trabajo de Folsom no estuvo ampliamente disponible, todavía persiste mucho malentendido para la correcta identidad y rango de *Platanthera chapmanii*. Varias especies e híbridos están implicados en este complejo y todos han contribuido a la confusión. Se clarifican estos errores y relaciones.

Although geographically restricted to the southern portion of the southeastern United States, Chapman's fringed orchis, *Platanthera chapmanii* (Small) Luer emend. Folsom, is an important component of the summer-flowering orchid flora of this area. No other complex within the Orchidaceae in the southeastern United States has the unique position of having a species with an ancestral hybrid origin: *P. chapmanii*, and also having a current, or contemporary, occurring hybrid: *P.* ×*channellii*, with the same parentage. Historically known from East Texas, much of northern Florida, and southern Georgia, today it can be best found in the Apalachicola and Osceola National Forests of Florida. A few other small sites in northern Florida persist. The species is absent from the eastern half of the Panhandle. The Marion and Polk County, Florida records appear to be Channell's hybrid fringed orchis, *P.* ×*channellii* Folsom. Few sites remain in East Texas (Liggio & Liggio 1999) and the Georgia locales are based upon historic collections. No collections have ever been made from the area between the Apalachicola National Forest and East Texas.

Although Correll cites the range for *Platanthera chapmanii* (as *Habenaria* ×*chapmanii*) from New Jersey to Georgia and Florida and west to Texas, he was basing his knowledge on plants of both *P. chapmanii* and *P.* ×*channellii*. True *Platanthera chapmanii* has always been, and continues to be, one of the rarest orchids found in North America and is endemic to this lower portion of the southeastern Coastal Plain (Fig. 1) (Brown & Folsom 2002).

Chapman's fringed orchis originally was described by Small (1903) as *Blephariglottis chapmanii*. Ames (1910), noting its intermediacy between *Habenaria ciliaris* and *H. cristata*, made a new combination as *Habenaria* × *chapmanii*. This hybrid status remained for many years, including the new combination of *Platanthera* ×*chapmanii* (Small) Luer made by Luer (1972). It was not until Jim Folsom's work in 1984 that the taxon was restored to its rightful status of full species and a new, contemporary, hybrid, *P.* ×*channellii*, was described (Folsom 1984).

Understanding *Platanthera chapmanii* and its relationships to the closely related orange fringed orchis, *P. ciliaris*, and orange crested orchis, *P. cristata*, is greatly simplified if the observer can see all three taxa in one field session. This can only be accomplished in the Osceola National Forest, because *P. ciliaris* is historically and apparently currently absent from any of the other known localities. Liggio and Liggio (1999) clearly state that *P. ciliaris* has never been found within any of the Texas locales for *P. chapmanii*. Although vouchered from the panhandle counties encompassing the Apalachicola National Forest, no records exist for *P. ciliaris* within the Apalachicola National Forest (Anglin, pers. comm.; Brown & Folsom 2002; Folsom 1984, 1985). Conversely, *P. cristata* is often found growing within or nearby many of the *P. chapmanii* sites, especially in eastern Florida.

Folsom (1984) clearly demonstrated that the origins of *Platanthera chapmanii* were most likely an ancient hybridization of *P. ciliaris* and *P. cristata*. Therefore *P. chapmanii* is intermediate in size and characters between the two ancestors. Over the years it has evolved into a stable, reproducing species with a very distinctive bent column. This evolution of the column shape is critical in the pollination of the species. At the same time the contemporary hybrid of *P. ciliaris* and *P. cristata*, Channell's hybrid fringed orchis, *P.* ×*channellii*, occurs in rare situations when both parents are present. It, too, is intermediate between the parents, but the column is unlike that of *P. chapmanii*. Folsom (1984) illustrates all of these characters in great detail. Because Folsom's original publication in *Orquidea* (Mex.) was not readily available to many interested orchidists, the article, with minor revisions, was reprinted in the *North American Native Orchid Journal* in 1995, and included all of Folsom's graphics (Folsom 1995).

One of the best aids in the initial determination of plants in the field is observing what predominates in the area. If both *Platanthera ciliaris* and *P. cristata* are present and only a few intermediates are to be found, then they in

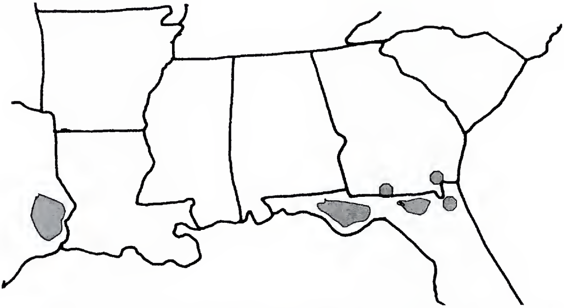


FIG. 1. Distribution of Chapman's fringed orchid (*Platanthera chapmanii*) in the southeastern United States.

all probability would be the hybrid *P.* ×*channellii*. If the majority of plants appear intermediate between *P. ciliaris* and *P. cristata* and only a few of either of the latter species are present then the observer needs to look carefully at the shape of the column, and most likely the majority of plants will be *P. chapmanii*. The rostellum lobes of the column in *P. chapmanii* have a prominent, distinctive, and characteristic hook that is clearly visible while the rostellum lobes of the columns of *P. ciliaris* are triangular and the tips pointing straight forward and those of *P. cristata*, are much shorter, nearly truncated, and with a very slight hook.

In addition, characters that help in determining which species are present may also include geographic location, diameter of raceme, size of flower, length and position of spur, and shape of orifice (Folsom 1984, 1995). To simply state that *Platanthera ciliaris* is larger, *P. chapmanii* intermediate in size, and *P. cristata* smaller has led to much confusion. For many orchid enthusiasts this, although not explicitly stated, implied overall size, especially height. That is not accurate and height should never be taken into account. All three species can grow from 10 or 15 cm to, in the case of *P. chapmanii* and *P. ciliaris*, over a meter in height! When size comparisons are made they refer to the diameter of the raceme and the measurements of the individual flowers. Even the overall height of the flowering raceme is not a good criterion for identification. Because of the ancestral parentage of *P. chapmanii* plants can easily favor the overall raceme shape of either parent, but the raceme diameter appears to remain constant. Spur length in the three species is helpful as well. Typically, in *P. ciliaris* the spur is 20–25 mm long, in *P. chapmanii* 10–14 mm long, and in *P. cristata* 5–

8 mm long. Figures 2 and 3 show the relationships of *P. cristata*, *P. chapmanii*, and *P. ciliaris* and will assist in understanding this comparison.

In addition to understanding the species orchid observers need to be aware of the hybrids that are involved in this complex include:

Platanthera ×*apalachicola* P.M. Brown & S. Stewart—(*P. chapmanii* × *P. cristata*)
Platanthera ×*channellii* Folsom—(*P. ciliaris* × *P. cristata*)
Platanthera ×*osceola* P.M. Brown & S. Stewart—(*P. chapmanii* × *P. ciliaris*)

Relationships among this group are best summed up in Figure 4. *Platanthera blephariglottis*, *P. conspicua*, and *P. integrilabia* are included in this diagram for completeness in the group (Brown 2003; Brown & Folsom 2004). These relationships and putative parentages are based upon morphological criteria. Artificially created hybrids, cytological, and molecular work has yet to be done on this entire complex.

Because hybrid swarms of some or all three species occur it may be difficult to determine individual plants. *Platanthera* ×*apalachicola* is locally common in northern Florida where both parents frequently grow together. They usually occur as individuals and may appear within stands of *P. chapmanii* as smaller flowered, more slender plants or within stands of *P. cristata* as larger flowered more robust individuals. The hooked column of *P. chapmanii* is usually dominant, but the spur length and position is intermediate (Brown & Stewart 2003).

Platanthera ×*channellii* and *P. chapmanii* can be difficult to tell apart. In the field one of the best ways is to look about and see which other species are growing nearby. If all the plants observed are the same, and within the range of *P. chapmanii*, it is most likely *P. chapmanii*, whereas if it is a colony of mixed species and only a few intermediate plants are present it is more likely to be *P.* ×*channellii*.

Platanthera ×*osceola* is known only from Osceola National Forest where it is the only place documented that both parents are found growing together. Plants of the hybrid usually occur as individuals and may appear within stands of *P. chapmanii* as larger flowered, more robust plants with decidedly longer spurs or within stands of *P. ciliaris* as smaller more compactly flowered individuals. The hooked column of *P. chapmanii* is not as dominant as in *P.* ×*apalachicola* (Brown & Stewart 2003).

Understanding both the history of *Platanthera chapmanii* and the hybrid swarms that may accompany plants in the wild hopefully will help in clarifying some of the mystery around this rare and spectacular orchid. Photographs and details of all of the taxa mentioned above are found in Brown and Folsom (2002, 2003, and/or 2004). All orange-flowered plants throughout the over-

Fig. 2. Ancestral parentage of *Platanthera chapmanii*. From left to right in all photos: *Platanthera cristata*, *chapmanii*, and *ciliaris*.

FIG. 3. *Platanthera* cristata (left), *Platanthera chapmanii* (center), *Platanthera ciliaris* (right).

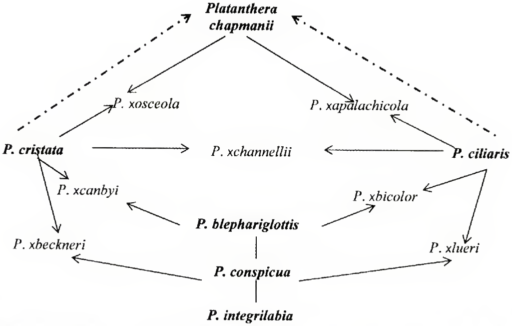


FIG. 4. Relationships among related species in the orange and white fringed orchid complex. *Platanthera blephariglottis*, *P. conspicua*, and *P. integrilabia* are included for completeness in the group.

lapping ranges of *P. ciliaris*, *P. cristata*, and *P. chapmanii* should be carefully examined for the possibility of additional sites for Chapman's fringed orchis.

ACKNOWLEDGMENTS

The author thanks Scott Stewart, Bill and Pamela Anderson, Gustavo Romero (AMES), and Guy Anglin for assistance in locating populations in the field. Scott Stewart, Joe Liggio, and Larry Magrath made several helpful suggestions. Jim Folsom provided initial information some years ago and Stan Folsom executed the line art.

REFERENCES

AMES, O. 1910. Orchidaceae: illustrations and studies of the family Orchidaceae issued from the Ames Botanical Laboratory, North Easton, Massachusetts. The genus *Habenaria* in North America. The Merrymount Press, Boston, MA. 4:155.

BROWN, P.M. 2002. Revalidation of *Platanthera conspicua*, the southern white fringed orchis. North Amer. Native Orchid J. 8:3–9.

BROWN, P.M. and S.N. FOLSOM. 2002. Wild orchids of Florida. University Press of Florida, Gainesville.

BROWN, P.M. and S.N. FOLSOM. 2003. The wild orchids of North America, North of Mexico. University Press of Florida, Gainesville.

BROWN, P.M. and S.N. FOLSOM. 2004. Wild orchids of the southeastern United States, north of peninsular Florida. University Press of Florida, Gainesville.

BROWN, P.M. and S. STEWART. 2003. Two new hybrids in the genus *Platanthera*. North Amer. Native Orchid J. 9:35.

FOLSOM, J.P. 1984. Relationships in the yellow fringed orchid complex. Orquidea (Mex.) 9:321–45.

FOLSOM, J.P. 1995. The real identity of *Platanthera chapmanii*. North Amer. Native Orchid J. 1(3):211–238. (reprinted with minor changes from Folsom, 1984)

LIGGIO, J. and A.O. LIGGIO. 1999. Wild orchids of Texas. University of Texas Press, Austin.

LUER, C.A. 1972. The native orchids of Florida. New York Botanical Garden, Bronx.

SMALL, J.K. 1903. Flora of the southeastern United States. Published by the author, New York. P. 314.

BOOK NOTICE

Beautiful Peonies

Josef J. Halda and James W. Waddick (Botanical Illustrations by Jarmila Haldová). 2004. **The Genus Paeonia**. (ISBN 0-88192-612-4, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 228 pp., 36 watercolors and 43 line drawings, 8 ×" × 11".

The Genus *Paeonia* by Josef J. Halda with James W Waddick, botanical illustrations by Jarmila Haldová, presents 36 watercolor paintings depicting the peony. Simply put, botanical art is a mixture of science and art. The more balanced the mix, the higher the chance of success The 22 color portraits here by book illustrator Jarmila, succeed more as art than science.

Grand flowers, dramatically lit, are posed against sophisticated taupe backgrounds. As art, the works are beautiful and haunting. The papery quality of the petals is convincing. The dark colored peonies so saturated in color as to appear satin-like. Veining on leaves is captured in rich detail. Delicate hairs on stems a virtuoso handling of the brush. But an inconsistent light source that cast bright to almost white coloring on flowers yet placed no shadow at all on some stems and leaves, disappointed. Given the rigid standards of botanical drawing, better to abandon dramatic lighting altogether and spend all available time on the accuracy of the live plant specimen placed in front of you. An uncomfortable shortening of leaves and twisting of some flower heads to fit the formatting of the paper resulted in perspective issues. Ideal positioning of flower placement on paper should be studied before the start of the drawing. While not strict botanical renderings of peonies, these are stunning portraits of peonies lovely enough to frame

In addition to the color paintings in The Genus *Paeonia*, are 43 stunning black and white line and stipple drawings. These are sure and confident Cooly devoid of illustrative styling. The perfect mix of art and science.—*Cynthia Padilla, Botanical Arts Instructor,* 9760 Mixon Dr., Dallas, Texas 75220, U.S.A. (214) 351-3447 ph/fx, Email padillacasa@juno.com. ***Cynthia Padilla** popular instructor for universities, arboretums, garden and plant societies, travels extensively researching art and nature. Available for research projects, commissioned plant portraits, workshops and a travel leader on sketching tours. Her art is available for exhibit.*

A PRELIMINARY ANALYSIS OF *CLEMATIS* (RANUNCULACEAE) IN SUB-SAHARAN AFRICA

Frederick B. Essig

Institute for Systematic Botany
Department of Biology SCA 110
University of South Florida
Tampa, Florida 33620 U.S.A.

ABSTRACT

Based on a survey of the literature and a representative sampling of herbarium material, it appears that the approximately 70 published binomials for *Clematis* in sub-Saharan Africa can be reduced to 10–13 distinct species or species complexes. A key to these species, along with a commentary on each, is provided as a preliminary guide for further floristic and taxonomic studies.

RESUMEN

Basado en una revisión de la literatura y una prueba representativa del material herbario, parece que los aproximadamente 70 binómenes publicados para las clemátides del África sub-Sahariana pueden ser reducidos a 10–13 complejos de especies, o especies distintas. Se proporciona una clave para estas especies, junto con un comentario para cada una, como una guía preliminar para estudios adicionales florísticos y taxonómicos.

INTRODUCTION

This report originated as part of an effort to develop tentative hypotheses about the number and distribution of the species of *Clematis* in various parts of the world. It was found, however, that the literature referencing *Clematis* in sub-Saharan Africa, in which approximately 70 species have been named, was confusing, patchy, inconsistent and often contradictory. The goal of this exercise was therefore to make the first continent-wide survey of sub-Saharan *Clematis* in Africa, combining study and synthesis of the diverse literature on the subject with a limited but representative herbarium study, in order to provide a preliminary overview of the number, correct names, and distribution of the species. North African species were excluded because they are more naturally a part of the Mediterranean flora. It is hoped that this preliminary report will provide a framework, some meaningful hypotheses, and a stimulus for regional African botanists to take up the detailed work that needs to be done. A comprehensive treatment of African *Clematis* will require extensive study in the herbaria of Europe and Africa, as well as a great deal of fieldwork in all parts of this large continent.

Since the study was initiated, global surveys of *Clematis*, including the African species, have been completed by Johnson (1997) and Grey-Wilson

SIDA 21(2): 861–877. 2004

(2000). Both authors have great familiarity with *Clematis* and each brings some interesting perspectives to the study of this genus, but neither addressed the many taxonomic and nomenclatural problems of the African *Clematis* in any depth. The relationship of the African species with those of other parts of the world is of great interest, but no definitive phylogenetic studies have been completed. Grey-Wilson considers the African species, with the exception of *C. grandiflora* and the species of section *Pseudanemone*, to constitute a subsection of the section *Meclatis*. This is an interesting and feasible hypothesis, but needs to be born out by formal phylogenetic studies. Other authors, such as Tamura (1967) and Johnson (1997) have considered the African species to be part of the subgenus or section *Clematis*, which includes similar white-flowered species in Eurasia and the Americas.

Even under the best of circumstances *Clematis* is a taxonomically difficult genus, due to great variability within species and minimal diagnostic differences in floral morphology between species, at least as can be seen in herbarium material. Previous work with North American *Clematis* (Essig 1990) had suggested that taxonomic problems in this genus might be largely resolved through careful analysis of existing herbarium material. In that study, the two widespread and frequently confused white-flowered species in eastern North America were found to be distinguishable by subtle morphological features plus differences in blooming season and substrate preferences. Such studies are feasible for taxa that are readily collected by generalists, and hence abundantly represented in herbaria. This study was initiated with the anticipation that this would be true of African *Clematis* as well.

MATERIALS AND METHODS

The survey of herbarium material was based on the collection of African *Clematis* at the Missouri Botanical Garden (MO), consisting of some 550 specimens. The Missouri Botanical Garden has a strong history and a sizeable ongoing program of fieldwork in Africa, and probably the best herbarium collection of African plants in North America. The collection includes sets of duplicates from important collectors in all parts of Africa, including Exell & Mendonca in Angola, deWilde, Ash, Westphal and Pichi-Sermolli in Ethiopia, Pawek, Phillips and Brass in Malawi, Reekmans in Burundi, Richards in Zambia and Tanzania, and countless other collectors who have collectively made a huge contribution. Table 1 shows the origin, by country, of the collections at Missouri. The best represented areas in the Missouri collections are the African upland areas stretching from South Africa to Ethiopia. Weakly represented areas include tropical west Africa from Senegal to Angola, the northern tier of the savanna belt running from Senegal to the Sudan, and the east coastal regions from Mozambique through Tanzania. These results probably reflect both the abun

TABLE 1. Collections in the Missouri Botanical Garden Hebarium (MO) by country of origin.

Ethiopia 45	Uganda 20	Kenya 20	Burundi /Rwanda 33
Tanzania 46	Malawi 77	Zambia /Zimbabwe 67	Zaire 31
Angola 30	Namibia/Botswana 12	South Africa 101	Mozambique 13
Tropical West Africa 36			

dance of *Clematis* and the intensity of botanical activity in these areas, but suggest a reasonably balanced coverage of the continent, sufficient for at least the preliminary survey undertaken here.

RESULTS

The collections of the Missouri Botanical Garden were readily sorted into 10 broadly distributed groups that can be interpreted as species or potentially as species complexes. These were identified using the earliest validly published name applicable to each group, as determined through examination of type materials, and/or original descriptions/diagnoses of the many species described in the literature. These widespread and variable taxa include *C. villosa*, *C. uhenensis*, *C. chrysocarpa*, *C. grandiflora*, *C. longicauda*, *C. dolichopoda*, *C. hirsuta*, *C. simensis*, *C. brachiata*, and *C. welwitschii*. This is a conservative interpretation, a hypothesis of what appears to be the minimum number of distinct species in Africa. Support for an additional three narrowly distributed species recognized by some authorities (*C. burgensis*, *C. sigensis*, and *C. viridiflora*), was weak or lacking in the Missouri collections, but are worth considering further and included in this treatment. In addition, the subspecies of *Clematis villosa* and *C. chrysocarpa* recognized by Brummitt (2000) are well-supported by this study, and may be nearly as distinct as the other species recognized. The preliminary nature of this study is stressed. Additional species may very well emerge after more exhaustive study.

The species have distinctive but overlapping geographic and altitudinal ranges. A number of intermediate specimens suggest hybridization or incomplete separation of the taxa, but most specimens fall clearly into one taxon or another. The taxa are defined primarily on the number, size, and shape of the leaflets, and in some cases by significant differences in flower size. Otherwise, flowers in African *Clematis* are relatively uniform with respect to morphology. All are bisexual and of a nodding habit (different from white-flowered species elsewhere, in which flowers are erect). Sepals vary only in size and slightly in texture, vestiture or color. Stamens are numerous, and all have hairy filaments. Carpels are numerous, all developing into achenes with long, plumose tails. Floral characters referred to by earlier authors (e.g. anther shape) have been found to vary as much within taxa as between taxa. Finally, ecological separation is suggested by some differences in blooming season and altitudinal range, but data on habitat and soil type were meager and inconsistent. Other subtle biological differences, such as differences in floral fragrance and flower color, are hinted at sporadically on labels, and need to be investigated in the field.

A key to these species, and discussion of each, follow.

KEY TO THE SPECIES OF *CLEMATIS* IN SUB-SAHARAN AFRICA

1. Plants erect, stiff-stemmed, perennial herbs; flowers with sepals imbricate in bud (species formerly segregated as the genus *Clematopsis*, key based on Brummitt, 2000).
  2. Achenes with golden-brown hairs; flowers solitary; leaves with 1–2 (very rarely 3) pairs of pinnae ____ **(C. chrysocarpa)**
    3. Leaves mostly trifoliolate; sepals 32–55 mm long; achenes (including plumose style) 55–70 mm long. Angola, Zaire ____ **C. chrysocarpa** subsp. **chrysocarpa**
    3. Leaves mostly 5–7-foliolate; sepals 20–32 mm long; achenes 35–50 mm long. Malawi, Tanzania and Mozambique ____ **C. chrysocarpa** subsp. **bijuga**
  2. Achenes with gray hairs; flowers 1-many per stem; leaves simple to tripinnate.
    4. Leaves simple; flowers solitary; sepals 32–60 mm long. Angola and Zaire to Tanzania ____ **C. uhehensis**
    4. Leaves trifoliate to tripinnate; flowers 1-many per stem; sepals 17–33 mm long ____ **(C. villosa)**
      5. Leaves trifoliolate or occasionally 5-foliolate, flowers 1–5 per stem. Cameroun and Nigeria to Tanzania ____ **C. villosa** subsp. **oliveri**
      5. Leaves pinnate to tripinnate, rarely trifoliolate; flowers 1–many per stem.
        6. Leaves tripinnae with segments 1–5(–8) mm broad; flowers 1–5 per stem; Zambia to Namibia and S. Africa ____ **C. villosa** subsp. **stanleyi**
        6. Leaves pinnate to bipinnate, with segments 5–40 mm broad; flowers 1-many per stem.
          7. Leaves densely sericeous beneath, pinnae lobes up to 15 mm broad and usually rounded at the apex; flowers 1–7(–13) per stem; W. Zaire, Angola, S. Uganda, W Tanzania ____ **C. villosa** subsp. **villosa**
          7. Leaves sparsely to densely appressed-pubescent beneath, pinnae lobes up to 40 mm broad and acute at apex; flowers 5–many per stem; S. Zaire, Tanzania, Mozambique, Malawi, Zambia ____ **C. villosa** subsp. **kirkii**
1. Plants vining or trailing; flowers with sepals valvate in bud.
  8. Flowers large, solitary or in clusters of 3, with sepals 15–45 mm long; carpels 50–200 per flower.
    9. Flowers campanulate, sepals strongly ribbed, greenish to yellowish or cream-colored, mostly more than 2.5 cm long (but with some specimens as short as 1.8 cm); leaves mostly 3–5-foliolate, with leaflets mostly more than 50 mm long.
      10. Leaves mostly 5-foliolate, leaflets lanceolate-ovate, rarely lobed, finely and regularly toothed; west equatorial Africa, from Guinea to Angola, 300–1600 m ____ **C. grandiflora**
      10. Leaves mostly 3-foliolate, leaflets broadly 3-lobed, irregularly toothed, foliage conspicuously reddish-golden pubescent; Ethiopia, 1350–2100 m ____ **C. longicauda**
    9. Flowers with spreading to reflexed sepals, sepals mostly 15–25 mm long; leaflets mostly less than 5 cm long.

11. Leaves 3–5-foliolate, leaflets broadly to narrowly ovate, abaxially reddish-golden pubescent; flowers white, reddish-golden pubescent externally, the sepals somewhat ridged; occurring in evergreen montane forest, Tanzania, Burundi, 1000–2500 m ______ **C. dolichopoda**
11. Leaves mostly twice pinnate, leaflets ovate-apiculate to linear-elliptic, subglabrous to moderately white-hirsute; flowers white to cream-colored or rarely tinged with pink, sepals not conspicuously ribbed; occurring in open woodland, Angola to Zaire, Tanzania, Malawi, & Zimbabwe, 400–1600 m ______ **C. welwitschii**

8. Flowers small, numerous, with sepals mostly less than 15 mm long (to 20 mm long in some populations of *C. hirsuta*), white, cream, greenish or yellowish; leaves mostly 5- or more foliolate, of various shapes; carpels fewer than 50 per flower.
    12. Leaves 3–5-foliolate with leaflets ovate-lanceolate, rarely lobed.
        13. Leaflets regularly and finely toothed. Ethiopia to Zaire and Nigeria ______ **C. simensis**
        13. Leaflets with margins essentially entire.
            14. Achenes with style 50–70 mm long; sepals 12–15 mm long. Kenya, Tanzania ______ **C. sigensis**
            14. Achenes with style to 33 mm long; sepals 10 mm long. Ethiopia ______ **C. burgensis**
    12. Leaves 5- or more foliolate with leaflets broadly ovate and frequently deeply lobed, irregularly or infrequently toothed.
        15. Flowers yellowish-green, coastal Mozambique and Tanzania ______ **C. viridiflora**
        15. Flowers white to cream or greenish.
            16. Leaves mostly once-pinnate, 5–9-foliolate, leaflets broadly ovate, irregularly lobed and toothed; tropical woodland and savanna, Angola to n.e. South Africa and Zimbabwe, northward to Ethiopia, and from there westward to Senegal, 220–2340 m ______ **C. hirsuta**
            16. Leaves mostly twice-pinnate, leaflets narrow, deeply lobed and infrequently toothed; temperate to subtropical grassland, South Africa to Zimbabwe, Botswana & Namibia; 400–2200 m ______ **C. brachiata**

TAXONOMIC SYNOPSIS AND COMMENTARY

Note: Three species of African *Clematis*, *C. chrysocarpa*, *C. uhehensis* and *C. villosa*, were formerly segregated in the genus *Clematopsis*, and not originally included in this survey. The recent paper by Brummitt (2000) provides a thorough treatment of those species, while providing the rationale for including them in *Clematis*. I am in full agreement with that decision, and include the species in this synopsis, but refer the reader to Brummitt's paper for more detail and discussion.

1. Clematis brachiata Thunb., Prod. pl. cap. 94. 1800. TYPE: not cited, but photos of authentic material from Uppsala have been seen.

Clematis oweniae Harv. in Harv. & Sond., Fl. cap. 1:2. 1860.
Clematis stewartiae Burtt Davy, Man. Flowering Pl. Ferns Transvaal. 1:37, 111. 1926.
Clematis thunbergii Steud., Nom., ed 2, 1:380. 1841, Harv. in Harv. & Sond., Fl. Cap 1:2. 1860.
Clematis triloba Thunb., Prod. pl. cap. 94. 1800 (non B. Heyne ex Roth, Nov. pl. sp. 251. 1851). TYPE: not cited.

The first species of *Clematis* described from sub-Saharan Africa, *C. brachiata* is similar to *C. hirsuta*, as both are widespread, variable species of open, disturbed habitats, and both produce numerous small white flowers. Exell and Milne-Redhead (1960), along with Thulin (1993), considered that *C. brachiata* and *C. hirsuta* would probably have to be combined, although earlier, Exell (1937) recognized *C. hirsuta* in Angola and *C. brachiata* in South Africa. White (1962) considered *C. hirsuta* and *C. inciso-dentata* as synonyms of *C. brachiata*. The two species can, however, be generally separated by the simply pinnate leaves of *C. hirsuta* compared with the doubly- (or more) compound leaves of *C. brachiata*. The geographic separation, with *C. brachiata* confined primarily to the subtropical grasslands of eastern South Africa and *C. hirsuta* occurring primarily in tropical savannas and woodlands, also suggests ecological differences.

Confusion between *C. hirsuta* and *C. brachiata* may have arisen in part because of a discrepancy between Thunberg's diagnosis of the latter species and his own specimens at the Uppsala Herbarium. Thunberg actually described two species from South Africa. One (*C. brachiata*) supposedly had simply pinnate leaves, and the other (*C. triloba*) had doubly compound leaves. Thunberg did not designate types, but authentic specimens have been found at Uppsala, one for each species, and apparently annotated by Thunberg. In contradiction to his diagnoses, both specimens have doubly compound leaves, as do the great majority of South African specimens. The specimen annotated as *C. triloba* has larger flowers (sepals 10 mm long vs 5 mm long) than the specimen annotated as *C. brachiata*. Both flower size and the dissection of the leaf are quite variable, and the differences between these two specimens of Thunberg become insignificant when a large number of specimens are examined. Because of its simply pinnate leaves, *C. hirsuta* may have been equated with Thunberg's diagnosis of *C. brachiata* by some authors. For them the species with doubly-compound leaves was *C. triloba* or one of the later names discussed below.

There was some additional confusion concerning the name *C. triloba* Thunb.. It was apparently assumed by some later authors that this name was anteceded by *C. triloba* Roth ex B. Heyne, which however was not published until 1821. The name *C. thunbergii* was published by Steudel in 1841, apparently as a new name for *C. triloba*, so the latter name has been little used. In 1860, Harvey published *C. oweniae* for some South African specimens with doubly-compound leaves, apparently unaware of *C. triloba*. Some authors have attempted to distinguish *C. oweniae* from *C. brachiata* on the basis of anther shape, with the former species possessing short ovoid anthers and the latter elongate anthers. These differences do not hold up when a broad range of specimens is examined. The same applies to the species *C. stewartiae*.

Johnson (1997) and Grey-Wilson (2000) recognized three South African species, *C. brachiata*, *C. triloba*, and *C. oweniae*. Grey-Wilson distinguished *C. oweniae* from *C. triloba* by its smaller flowers (sepals 10–12 mm long vs. 12–18 mm long). He also says that the latter has "deliciously scented" flowers, but does not mention scent for *C. oweniae*. Flowers of *C. brachiata* are simply described as "fragrant," and he appears to have misinterpreted *C. brachiata* as similar in foliage to *C. simensis*. Once again, variation in leaf form and flower size in South African *Clematis* are such that these kinds of lines are hard to draw without extensive field studies. Particular morphological combinations may indeed prove to be consistent within populations occupying specialized habitats or geographical areas. The issue of fragrance also needs to be examined more rigorously and consistently.

Hybridization between *Clematis brachiata* and *Clematis villosa* subsp. *stanleyi*, both of which are common in the Johannesburg area, has been noted in the literature (Letty 1962) and on some herbarium specimens. One specimen that is clearly intermediate in character between these two species is *Mogg 36528*. This underscores the close relationship between the species formerly segregated into *Clematopsis* and other African species, as well as the possibility that many unusual specimens in Africa could be the result of hybridization.

2. Clematis burgensis Engl., Bot. Jahrb. Syst. 45:272. 1910.

A distinct species according to Demel (1987), native to Ethiopia. Three of the specimens cited under *C. simensis* (*Ash 1294*, *J. deWilde 6224*, *Westphal & Westphal-Stevels 3062*) have smooth leaflet margins as indicated for this species, but lack flowers so the other traits could not be verified. I was unable to draw any conclusions about this species from the MO material.

3. Clematis chrysocarpa Welw. ex Oliv., Fl. trop. Afr. 1:5. 1865. *Clematis villosa* subsp. *chrysocarpa* (Welw. ex Oliv.) Kuntze, *Clematopsis chrysocarpa* (Welw. ex Oliv) Hutch. (see Brummitt, 2000).

a. Clematis chrysocarpa subsp. **chrysocarpa**
Brummitt (2000) places the following species in synonymy here: *Clematis chrysocarpoides* DeWilde., *Clematopsis speciosa* Hutch. (*Clematis angolana* M. Johnson, 1997, Släktet Klematis: 145, *nom. nov.*: replaced synonym: *Clematopsis speciosa* Hutch.)

b. Clematis chrysocarpa subsp. **bijuga** Brummitt, Kew Bull. 55:97–108. 2000.
Brummitt (2000) placed the following species in synonymy here: *Clematopsisineariloba* Hutch. & Summerh., *Clematopsis oliveri* forma *lineariloba* (Hutch. & Summerh.) Staner & Leonard. (*Clematis africolineariloba* W.T.Wang, Acta Phytotax. Sin. 39:336. 2001, replaced synonym: *Clematopsis lineariloba* Hutchinson & Summerhayes).

4. Clematis grandiflora DC, Syst. nat. 1:151. 1818. TYPE: not indicated.

Clematis pseudograndiflora Kuntze, Verh. Bot. Vereins Prov. Brandenburg 26:128. 1885. TYPE: ANGOLA: *Welwitsch 1218, 1219*.

Clematis kakoulimensis Schnell, Bull. Soc. Bot. France 96:223. 1949. TYPE: GUINEA: Mt. Kakoulima, 2000 ft, *Schnell 2461* (HOLOTYPE: n.v.)

Clematis chlorantha Lindl., Edward's Bot. Reg. 16, t. 1234. 1829. Belongs here according to Oliver (1868) and Johnson (1997).

A very distinctive species with very large, campanulate flowers. Leaves are 5-pinnate, with leaflets ovate, rarely lobed, and finely toothed, much like those of *C. simensis*. Material referred to as *C. kakoulimensis* and *C. pseudograndiflora* have somewhat smaller flowers, with sepals 18–20 mm long, and about 50 carpels per flower, but otherwise similar to the large-flowered specimens. They appear to represent extremes in the range of variation. A remarkable photograph of this species appears in Johnson (1997), showing large, pendant, yellowish flowers, reminiscent of Asian species in the section *Connatae*.

5. Clematis dolichopoda Brenan, Kew Bull. 1949:71. 1949. *Clematis hirsuta* var. *dolichopoda* (Brenan) Staner & J. Leonard, Bull. Soc. Roy. Bot. Belgique 82:36, 1950 and Flore du Congo Belge 2:187. 1951.

Clematis longipes Engl., Bot. Jahrb. Syst. 45:273. 1910. Illegitimate name, cf. *Clematis longipes* Freyn, 1890, from Madagascar.

Poorly represented in the MO collections, this species appears to be similar to *C. longicauda*, but with smaller flowers. the foliage has the same distinctive indumentum of golden hairs ("rusty ferrugineous"). Sepals are 13–20 mm long, variously described as white, golden-white, or yellowish, the latter perhaps due to the heavy external covering of golden hairs. Leaflets are essentially heart-shaped, with irregular teeth, or in some material from Burundi, the leaflets are narrow-elongate. It is possible that the latter material represents hybrids with *C. welwitschii*. The species occurs mostly in high mountains, up to 3500 m, but as low as 1000 m in some Burundi material. One specimen, *Williams 35*, is placed here questionably. It is a fruiting specimen, but the large number of fruiting heads in the inflorescence suggests that the flowers are much smaller than in the other specimens. The hairs are much sparser on the leaves, though still golden in color.

6. Clematis hirsuta Guill. & Perr. in Guill., A. Rich. & Perr., Fl. Seneg. tent. 1:1. 1831. TYPE: not cited, collected by Perrottet in 1829 at Cape Verde, Senegal near Kounoun and Rufisk.

Clematis inciso-dentata A. Rich., Tent. fl. abyss. 1:2, fig 1. 1847. TYPE: not specified, but collected by A. Petit in Shoa Province, Ethiopia, between 1838 and 1843; = *C. hirsute* fide Demel (1987) and Johnson (1997).

Clematis wightiana auct non Wall.

Clematis grata (non Wall.) sensu Oliv., Fl. trop. Afr. 1:7. 1868.

Clematis glaucescens Fresen., Beitr. Fl. Abyssin., in Mus. Senckenb. 2: 268. 1837. TYPE: Not cited; = *C. hirsuta* fide Demel (1987) and Johnson (1997).

Clematis djalonensis A. Cheval., Bull. Mus. Hist. Nat. (Paris), ser. 2. 4:1010. 1932. TYPE: FRENCH GUINEA: Fouta-Djalon, 1300 m, *Chevalier 34545* (n.v.) (= *C. hirsuta* fide Hutch. & Dalziel).

Clematis chariensis A. Cheval., Bull. Mus. Hist. Nat. (Paris), ser. 2. 4:1012. 1932. TYPE: CENTRAL AFRICAN REPUBLIC: Haut-Chari, between Dekoua and Nana, *Chevalier 6192;* said to be a cousin of *C. hirsuta* by Chevalier, described as a low-growing scrambler adapted to frequent bush fires, sprouting annually from the rootstock.

Clematis petersiana Klotsch in Peters, Naturw. Reise Mossambique 6(1):170. 1861. From the ambiguous description, this species appears to be indistinguishable from ordinary *C. hirsuta*. It is from the upland, interior province of Tete, and so not likely to be equated with *C. viridiflora*.

In the conservative treatment presented here, this is a widespread, variable species found throughout the tropical savannas and open woodlands of central Africa. It's distribution correlates roughly with that of *Acacia sieberana* in mid-elevation plains and plateaus in what is called the Sudano-Zambezian region (Brenan 1978). The correlated distribution of the two species includes disjunct populations of each in central Angola. The two other widespread species with numerous white flowers appear to be geographically and/or altitudinally separated: *C. simensis* at generally higher elevations, and *C. brachiata* further south in the warm-temperate to subtropical grasslands of South Africa. A fourth species that appears to be in this complex, *C. viridiflora* is a lowland species found along the coast of Mozambique and possibly Tanzania. There are morphological differences as well, but definitely gray areas between these species, both geographically and morphologically. *Clematis hirsuta* is distinguished from *C. simensis* by its lobed, irregularly toothed leaflets, as opposed to the unlobed, finely dentate leaflets of the latter, and from *C. brachiata* by its simply pinnate leaves, as opposed to the doubly compound leaves of *C. brachiata. C. viridiflora* is hard to distinguish from herbarium material, but its flowers are somewhat larger, with the sepals said to be thinner and more yellowish.

Clematis species with numerous, small, white flowers are found throughout the world, including the *C. virginiana/catesbyana/ ligustifolia* group in North America, *C. dioica* and its relatives in tropical America, *C. grata/ wightiana* and similar species in Asia, *C. vitalba* in Europe, and other species in New Guinea, Australia and New Zealand. All of these species are abundant, variable and widespread, occupying open, disturbed habitats, and can generally be described as "weedy." Species with larger, fewer, and often more colorful and/or fragrant flowers, on the other hand, tend to be less common and more restricted in both their distribution and habitat preferences. This pattern holds for Africa as well.

The species placed in synonymy here were based on one or a few variant specimens and appear to fall within the range of variation in the widespread species, although they do warrant further study. The vestiture of the leaves in *C. hirsuta* is variable. Some, as the name implies, are rather densely hirsute, while others are nearly glabrous. The greatest concentration of heavily hirsute specimens is in the Ethiopia/Uganda region. Some populations in Ethiopia have significantly larger flowers with rather attenuate sepals, as opposed to the more obtuse sepals in other specimens, suggesting some degree of subspecific differentiation. This appears to have been the basis for recognizing both *C. glaucescens* and *C. inciso-dentata*, neither of which were recognized by Demel Tekatay (1987) in his thorough study of *Clematis* in Ethiopia. The present study also suggests that there are numerous intermediate specimens, making such a distinction difficult. Grey-Wilson (2000) recognized *C. djalonensis* from southwest Mali and northern Guinea, on the basis of its smaller flowers that are more rounded in bud and said to be more fragrant, and with shorter pedicels. This again appears to fall within the range of variation for *C. hirsuta*, but needs to be investigated further. The photograph of *C. hirsuta* in Grey-Wilson appears to be misidentified. The flowers appear to be much larger than those of the many specimens examined in this study, and the leaves appear to be more deeply divided. The plant looks more like *C. welwitschii*.

One difficulty in verifying the proper application of the name *C. hirsuta* is the lack of authentic type material. The type should be at Paris, but it cannot be found, and the Missouri collection contains no specimens from Senegal at all. The protologue for that species indicates that the foliage is ternate to biternate, and densely villous. No dimensions were given for the flowers, which were said only to be in clusters of 1–3. Biternate leaves are rare in the species as currently understood, suggesting the possibility that the population at Cape Verde (near sea-level) is distinct at some level from the more widespread form. In his flora of Senegal, Berhaut (1967) describes the leaves as having two pairs of leaflets, and the white flowers produced in large panicles, which is consistent with *C. hirsuta* elsewhere in its range. It is not known whether Berhaut had material from the Cape Verde area, however. If the species still exists there, it needs to be studied in order to resolve any further doubts.

7. Clematis longicauda Steud. ex A. Rich., Tent. fl. abyss. 1:2. 1847. TYPE: ETHIOPIA: *Schimper 1284* (n.v.).

This taxon has large flowers similar to those of *C. grandiflora*. The 3-foliolate leaves differ conspicuously in the broader, lobed leaflets and the fine reddish-gold pubescence. It is found at higher elevations (1350–2100 m), and only in Ethiopia. Johnson (1997) and Grey-Wilson (2000) both misinterpret this very distinctive species as a synonym of *C. hirsuta*.

8. Clematis simensis Fresen., Beitr. Fl. Abyssin., in Mus. Senckenb. 2:267. 1837. TYPE: *Ruppell* (n.v.).

Clematis altissima Hutch. belongs here according to Hutchinson and Dalziel (1954) and Johnson (1997).

This is a distinctive species occurring throughout central and eastern Africa, generally at higher elevations than *C. hirsuta*, with which it overlaps geographically. Leaves are typically 5-foliolate, with the leaflets finely toothed and unlobed. Flowers tend to be numerous in elongate inflorescences, well exserted above the foliage. One specimen from Kenya, *Taylor 1455*, has unusually large flowers, representing perhaps a taxonomic variant or hybrid with a large-flowered species.

9. Clematis sigensis Engl., Bot. Jahrb. Syst. 45:271. 1910.

A distinct species according to Beentje (1989), found in Kenya and Tanzania; no matching specimens at MO.

10. Clematis uhehensis Engl., Bot. Jahrb. Syst. 28:387. 1900. *Clematopsis scabiosifolia* subps. *uhenensis* (Engl.) Brummitt, *Clematopsis villosa* subsp. *uhehensis* (Engl.) J. Raynal & Brummitt (see Brummitt, 2000).

Brummitt (2000) includes the following names in synonymy here: *?Clematis villosa* var. *teuszii* Kuntze, *Clematopsis teuszii* (Kuntze) Hutch.; *Clematis homblei* De Wild., *Clematopsis homblei* (DeWild) Staner & J. Leonard, *Clematopsis katangensis* Hutch., *Clematis katangensis* (Hutch.) M. Johnson, *Clematopsis simplicifolia* Hutch & Summerh., *Clematopsis grandifolia* Staner & J. Leonard, *Clematis grandifolia* (Staner & J. Leonard) M. Johnson.

11. Clematis villosa DC., Syst. nat. 1:154. 1818.

a. Clematis villosa subsp. **villosa**
Brummitt (2000) placed the following species in synonymy here: *Clematis scabiosifolia* DC., *Clematis villosa* var. *scabiosifolia* (DC.) Hiern., *Clematopsis scabiosifolia* (DC.) Hutch., *Clematis villosa* subsp. *argentea* Kuntze, *Clematis argentea* (Kuntze) Prantl, *Clematopsis argentea* (Kuntze) Hutch., *?Clematis mechowiana* Kuntze, *? Clematis villosa* var. *angolensis*, *Clematis stuhlmannii* Hieron. ex Engl., *Clematopsis stuhlmannii* (Hieron. ex Engl.) Hutch., *Clematis villosa* forma *obtusiloba* Hiern, *Clematis villosa* forma *stenophylla* Hiern, *Clematis sapinii* De Wild, *Clematopsis sapinii* (De Wild.) Staner & J. Leonard.

b. Clematis villosa subsp. **stanleyi** (Hook.) Kuntze, Verh. Bot. Vereins Prov. Brandenburg 26:172. 1885. *Clematis stanleyi* Hook., *Clematopsis scabiosifolia* subsp. *stanleyi* (Hook.) Brummitt, *Clematopsis stanleyi* (Hook.) Hutch. (see Brummitt, 2000).

Brummitt (2000) places the following species in synonymy here: *Clematis villosa* var. *tomentosa* (Kuntze) T. Durand & Schinz.

This is a very distinctive subspecies, with finely dissected leaves.

c. Clematis villosa subsp. **kirkii** (Oliv.) Brummitt, Kew Bull. 55:97–108. 2000. *Clematis kirkii* Oliv., *Clematis villosa* var. *kirkii* (Oliv.) Kuntze, *Clematopsis kirkii* (Oliv.) Hutch., *Clematopsis scabiosifolia* subsp. *kirkii* (Oliv.) Brummitt (see Brummitt 2000).

Brummitt (2000) places the following species in synonymy here: *Clematis villosa* var. *pubescens* Kuntze; *Clematis stanleyi* var. *pubescens* (Kuntze) T. Durand & Schinz; *Clematis goetzei* Engl.; *Clematis busseana* Engl.; *Clematis lugnignu* De Wild.

d. Clematis villosa subsp. **oliveri** (Hutch.) Brummitt, Kew Bull. 55:97–108. 2000.

Clematopsis scabiosifolia subsp. *oliveri* (Hutch.) Brummitt

Brummitt (2000) included the following species in synonymy here: *Clematopsis nigerica* Hutch.

12. Clematis viridiflora Bertol., Misc. bot. 19:7, pl. 3. 1830.

The number of specimens available for this species at MO are few, but it appears to be a distinct species ecologically as well as morphologically. The name suggests that the flowers are greenish. This is confirmed on one specimen (*Lemos & Balsinhas 37*) who describe the flower color as "amarelo-esverdeades." Exell and Milne-Redhead (1960), describe the sepals as "thin and membranous" as opposed to the thicker sepals of *C. brachiata*, which they equate with *C. hirsuta*. Ecologically, it appears to be a coastal species, apparently growing on dunes—a most unusual habitat for African *Clematis*, although in North America there are populations of *C. catesbyana* in a similar habitat (Essig 1990). A photograph of a cultivated plant attributed to this species in Grey-Wilson (2000) shows a plant with yellowish flowers. If accurately identified, it confirms a distinctly different species, and also strengthens the argument of a relationship with section *Meclatis*. One specimen from Zanzibar Island is tentatively placed here, though it has smaller flowers, reported to be white, and leaflets less lobed than the material from Mozambique. It may be represent *C. zanzibarensis* Bojer ex Loud., who found it similar to *C. vitalba* and *C. grata*, the latter a name widely misapplied to *C. hirsuta*. It has to be remembered also that Zanzibar has been a center of trade for centuries and that exotic species may have been brought in.

13. Clematis welwitschii Hiern ex Kuntze, Verh. Bot. Vereins Prov. Brandenburg 26:171. 1885. TYPE: *Welwitsch 1217* (photo seen, MO- Angola); see also Exell & Mendonca (1937).

Clematis antunesii Engl., Bot. Jahrb. Syst. 45:274. 1910. TYPE: ANGOLA. *Antunes A56* (BD, n.v.), belongs here according to Exell and Mendonca (1937).

Clematis commutata Kuntze, Verh. Bot. Vereins Prov. Brandenburg 26:128. 1885. TYPE: ANGOLA: *Welwitsch 1215a* (MO-photo seen).

Clematis prostrata Hutch., Botanist southern Africa. 484. 1946. TYPE: *Hutchinson 3504* (n.v.); appears to belong here from the description, placed here by Exell &Milne-Redhead, 1960.

Clematis thalictrifolia Engl., Bot. Jahrb. Syst. 45:270. 1910. Zaire, Zambia. Tanzania; close to *C. welwitschii* fide Exell & Milne-Redhead (1960), distinguished by larger, solitary flowers.

This taxon includes specimens with medium-large flowers (sepals 1.5–2 cm long) with spreading sepals. Flowers are reported to be white to cream-colored, but sometimes with a pink tinge on the outside. Foliage is extremely variable in this species. Leaves are pinnately to doubly pinnately compound, with leaflets coarsely toothed, deeply lobed, elongate, and sometimes very finely dissected. The types of both *C. welwitschii* and *C. commutata* were collected in Angola, and both names have been applied to specimens with moderately large flowers in a broad area from Angola, Zaire and Cameroon to Tanzania. Differences between them, primarily leaf shape and number of flowers, blur considerably when a large number of specimens are examined, and they appear at this point to be just forms of one variable species. Johnson (1997) and Grey-Wilson (2000) both recognize *C. commutata* and *C. thalictrifolia* as separate species, but the distinctions are not clear or convincing, and the ranges overlap. The Missouri collections did not contain any specimens with flowers as large as those reported for *C. thalictrifolia.* They are said to be up to 50 mm across, which put them in the range of *C. grandiflora* or one of the species of section *Pseudanemone*, such as *C. villosa.* This potential species is certainly worth investigating. A number of the specimens cited below have broad, cordate leaves and/or somewhat smaller flowers, strongly suggesting hybridization with a species such as *C. hirsuta.* These include *Exell & Mendonca 1076* from Angola, *Lacroix 3020*, *Tawakali & Kaunda 190*, and *Pawek's 6255, 12644*, and *13658* from Malawi.

ERRONEOUS AND UNRESOLVED NAMES IN AFRICAN *CLEMATIS*

The following names are either erroneous, invalid or require further research to determine their status. (note: IPNI = International Plant Name Index at www.ipni.org)

Clematis capensis Poir. Encyc. Suppl. 2, 298. (= *Anemone capensis* according to IPNI).

Clematopsis costata Weim., Bot. Not. 1936:28. Zimbabwe/Zambia.

Clematis friesiorum Ulbr., Notizbl. Bot. Gart. Berlin-Dahlem, 10:914. 1930. Kenya. (= *C. hirsuta* fide Johnson 1997)

Clematis intermedia Chiov., Ann. Bot. (Roma) 9:51. 1911. hybr, Ethiopia; said to be a natural hybrid between *C. simensis* and "*C. thunbergii*" (*C. hirsuta*?).

Clematis iringaensis Engl., Bot. Jahrb. Syst. 28:388. 1900. Zambia and Tanzania; resembles *C. welwitschi*, but flower buds covered with "yellow" indumentum, possibly as in *C. dolichopoda.*

Clematis kassneri Engl., Bot. Jahrb. Syst. 45:274. 1910; Zaire. (= *C. welwitschii* fide Grey-Wilson (2000).

Clematis keilii Engl., Bot. Jahrb. Syst. 45:273. 1910; Burundi. (= *C. welwitschii* fide Grey-Wilson (2000; but said by Engler to be "ferrugineo-pilosus" and similar to *C. longipes*, i.e. *C. dolichopoda*).

Clematis kerrii Steud., Nom. ed. 2. 1:379. 1840. South Africa.

Clematis kissenyensis Engl. in Wiss. Ergebn. Deutsch. Zentr. Afr.-Exped. 1907–8, 2:207. 1911. Tropical East Africa. (=*C. simensis* fide Johnson 1997)

Clematis massoniana DC., Syst. nat. 1:135. 1818. (= *C. brachiata* fide IPNI). Ethiopia? South Africa.

Clematopsis pulchra Weim., Bot. Not. 1936:27.

Clematis schinziana Engl. & Gilg ex Engl., Pflanzenw. Ost.-Afrikas 3:1. 1895. (Engl. & Drude, Veg. Erde 9:172. 1915, in obs.). Namibia.

Clematis spathulifolia (Kuntze) Prantl, Bot. Jahrb. Syst. 9:258. 1888, in obs. Zaire (cannot be determined fide Brummitt 2000).

Clematis stolzii Engl., Bot. Jahrb. Sys. 45:272 (1910), Malawi. (= *C. simensis* fide Johnson 1997, but has few, rather large flowers; could be a form of *C. welwitschii* or a hybrid).

Clematis tenuifolia Poir., Encyc. Suppl. 2, p. 298. 1786. (=*Anemone tenuifolia* fide IPNI).

Clematis teusczii (Kuntze) Engl., Pflanzenw. Ost.-Afrikas 3:1. 1895. (Engl. & Drude, Veg. Erde 9:170. 1915, in obs. (= *C. villosa* var. *teuszii* fide IPNI). Angola.

Clematis tibestica Quezel, Bull Soc. Hist. Nat. Afrique N. 48:86. 1957. Tibesti Mountains of Sudan (treated as a separate species by Johnson (1997) and Grey-Wilson (2000), who also indicated its close affinity with *C. simensis*).

Clematis zanzebarica Sweet, Hort. brit. ed. 2, 1. 1832. = C. *zanzibarensis* Loudon, fide IPNI (=*C. viridiflora?*).

Clematis zanzibarensis Bojer ex Loudon, Hort. brit.. ed 2, 228. 1832. (=*C. viridiflora?, similar to C. vitalba* or *C. grata* fide Exell & Mendonca 1937).

APPENDIX

Abbreviated listing of specimens examined (all from MO)

Clematis brachiata Thunb.—**Botswana:** *Skarpe 284.* **Namibia:** *Leistner et al. 194; Muller & Tilson 917; Seydal 2150, 4123, 4291.* **South Africa:** *Allardice 1572; Arnold 205; Balsinhas 2857, 3416; Bayliss 1188, 1331, 4674; Booi 32; Borle 508, 1110; Brink 596, 628; Buitendag 812; Burtt-Davy 15148; Codd 9648, Dahlstrand 2387, 2542, 3515, 3588; Davidse 6776; Drege s.n.* (6 specimens with meager label data); *Ecklon s.n.* (3 specimens with meager label data); *Edwards 175; Edwards & Vahrmeyer 4281, Germishuizen 225, 3168, 3924; Gibbs et al 234; Goldblatt 1688; Halliwell 5126; Hilliard & Burt 9836; Joffe 232; Kemp 864; Krause 1234; Leendertz 50; Liebenberg 7564, 8820; Madley-Wood 4733, s.n. (1900); McLean 331, 534, 829; Mogg 19347, 21053, 25264, 25832; Morley 377. Pillans 10910; Phillipson 551; Raymond s.n. (1972); Reardon 17; Retief & Germishuizen 286, Rodin 3685, 3874, Scheepers 1398, 1485, Sidey 683, 2432, Stinton 83; Strey 2542, 9745, 86411181, 11263; Vahrmeyer 2425; van Hoepen 1648; Welman 729, 801; Wild 5781; Zambatis 1182.* **Swaziland:** *Kemp.* **Zimbabwe:** *Davies 388, Ngoni 372; Norrgrann 103a.*

Clematis chrysocarpa subsp. **chrysocarpa** Welw. ex Oliv—**Angola:** *Exell & Mendonca 794, 1360, 2547; Homble 828bis* (photo, BR); *Welwitsch 1222* (photo, BM). **Zaire:** *Symoens 6060*

Clematis chrysocarpa subsp. **bijuga** Brummitt—**Malawi:** *Brummitt et al. 15601; Chapman & Chapman 7510; Lacroix 4257; Pawek 6256, 8044, 8415, 8894, 10797; Phillips 799, 1310; Reekmans 5527.* **Mozambique:** *Jansen & Boane 7882; Pereira et al. 1827.* **Tanzania:** *Bidgood & Congdon 147; Kayombo & Kayombo 166, Gereau & Kayombo 4363, Richards 15564. Stolz 2385* (type of *C. lineariloba* Hutch. & Summerhayes)

Clematis dolichopoda Brenan—**Tanzania:** *Williams 35, Verdcourt 275; Schlieben 3991.* **Burundi:** *Reekmans 2298, 2365, 8476.*

Clematis grandiflora DC—**Angola:** *Gossweiler 10311, Welwitsch 1218* (photo, BM, type of *C. pseudograndiflora*), *1219.* **Cameroon:** *Bates 1257, Guile 10, Latilo & Daramola FHI 28900, de Wilde & de Wilde-Duyfjes 1157.* **Côte d'Ivoire:** *Hepper & Maley s.n.* (1984). **Ghana:** *Vigne 2681.* **Guinea:** *Adam 3857, 7562.* **Liberia:** *Konnel 621.* **Nigeria:** *Dalziel s.n.* (1912). **Sierra Leone:** *Adam 22116, 22315, 22409, 22974.* **Zaire:** *Liben 3192.*

Clematis hirsuta Guill. & Perr—**Angola:** *Giess et al. 6612; Gossweiler 10285, 11379.* **Botswana:** *Smith 616, 3520.* **Burundi:** *Lewalle 4674; Reekmans 595, 3444, 5132, 5133, 5138, 6271, 8029, 8983, 9145, 10258, 10420.* **Cameroon:** *Thomas 3105; Baldwin 13852; de Wilde & de Wilde-Duyfjes 4332, 4117; Latilo & Dasabika 28773; Leeuwenberg 7561, 10497.* **Central African Republic:** *Fay 5562, 6084.* **Côte d'Ivoire:** *Gautier-Beguin 460.* **Ethiopia:** *Ash 652, 1279, 1343; de Wilde & de Wilde-Duyfjes 8693, 9277; J. de Wilde 5773, 5866, 6225, 7350, Mengeshu s.n.* (1958); *Nievergelt & Nievergelt 1227;* Pappi 4642, 507; *Pichi-Sermolli 2372; Schimper 212, 1481; Westphal & Westphal-Stevels 2476, 2876, 2951.* **Fernando Po:** Guinea 1876. **Guinea:** *Adam 2630, 7174, 7190.* **Kenya:** *Agnew et al. 10283; Mwangangi 77; Faden et al. 74/655, Harmsen & Agnew 6540; Paolo 541. Perdue & Kibuwa 8155; Williams 315.* **Malawi:** *Banda & Thera 2612; Brass 17112, 17119; Chapman & Chapman 7496, Kwatha & Balaka 139; LaCroix 4562; Pawek 5547, 5548, 7162, 11354; Phillips 1438, 2678, 2823; Salubeni 1536, 2799, 3156; Salubeni & Tawakali 4960, 5000;*

Stolz 206; LaCroix 4562; Willan 65. **Mozambique:** *de Konig 7436; Jansen et al. 301.* **Nigeria:** *Olorunfemi et al. OBB94, OBB501; Guile 13.* **Rwanda:** *Bouxin & Radoux 2216.* **Sierra Leone:** *Adam 22214, 22768, 22223, 23259, 22944; Morton SL2804.* **Somalia:** *Pichi-Sermolli 138.* **South Africa:** *Cooper 191; Galpin 14413, 14418; Hemm 596; Stalmans 441.* **Swaziland:** *Kemp 734, 847.* **Tanzania:** *Flock 423; Frame 149; Gereau & Mziray 1678; Gereau et al. 4600; Grant s.n.* (1928); *Greenway & Kanuri 15164; Jefford et al. 243; Kayombo 555; Lovett 2182; Lovett & Congdon 1852; Lovett & Kayambo 3458; Mathias et al. A86; Newbould & Harley 4220; Paget-Wilkes 4, Richards 27090, Sanane220; Schlieben 4393; Tanner 627, 4922; Williams 690.* **Togo:** *Breteler 7229; Ern et al. 776; Robertson 72; Schafer 7628.* **Uganda:** *Brown 63; Dummer 177; Elliot 6567, 7818; Katende 2601, 2219; Loveridge 190, 421; Ross 889; Rwaburindore 326, 998, 1474, 2035, 2676; Taylor 2214, 2275, 2550, 3283.* **Zaire:** *Bamps 3003; Callens s.n.* (July 1958), *s.n.* (Aug 1958); *de Craene 231; Evrard 6350; Jean Lebrun 5352, 8241, 9132; Jean Louis 20, 709, 4509; Michel 2922; Michel & Reed 92; Robyns 2296; Toussaint 2417.* **Zambia:** *Angus 208, 1279, 1610; Bainbridge 782, 786; Best 328, 327; Chase 8605; Davies 1166, Kabisa 22, Mshasha 66; Richards 9421, 9553,15136, 15148, 15195, 22233; White 3222.* **Zimbabwe:** *Bayliss 10087, 10488; Biegel 3126; Chase 4887; Davies 388, 1166; Kabisa 22; Mshasha 66; Muller 2475, 3403, 3087; Noel 2436; Nyarini 168; Plowes 1622; Rushworth 689; Siniou 2194, West 2161, Wild 5781.*

Clematis longicauda Steud. ex A. Rich.—**Ethiopia:** *Ash 2767, de Wilde & de Wilde-Duyfjes 9384, 10133, 10434; J. De Wilde 6118, 6720, Meyer 7718, Pichi-Sermolli 2352, Schimper 1284.*

Clematis simensis Fresen.—**Burundi:** *Reekmans 7905, 10671.* **Cameroon:** *Thomas 2637.* **Ethiopia:** *Ash 35, 679, 1294; J. de Wilde 3062, 4077, 6224; de Wilde & de Wilde-Duyfjes 8238, 8374, 8966, 8984, 10145; Pichi-Sermolli 135, 138; Schimper 1512; Westphal & Westphal-Stevels 1019, 2350, 3062* **Kenya:** *Agnew 7707, 9438; D'Arcy 7364; Greenway & Kanuri 13838, 14895; Maas Geesteranus 6049; Mabberley & McCall 12; Robertson 1567; Taylor 125361455.* **Malawi:** *Brass 16106, 16860, 16836, Chapman & Chapman 7807; LaCroix 3103; Pawek 7014, 9711, 10000; Phillips 1704, 2825.* **Nigeria:** *Sanford 5494.* **Rwanda:** *Fossey B/7* **Tanzania:** *Gereau & Abdallah 1745, Iwarsson et al. 1065; Jefford et al. 1745; Mathias & Taylor A86; Mwasumbi 16316; Richards 16802.* **Uganda:** *Katende 3305; Robertson 1567.* **Zaire:** *Louis 4817.*

Clematis uhehensis Engl.—**Malawi:** *Pawek 7910; Phillips 136, 337, 452, 1360.* **Mozambique:** *Sousa 1641.* **Tanzania:** *Brummitt et al. 18141; Gereau et al. 2833; Goetze 579* (photo, B); *Magogo 255; Stolz 2514; Suleman & Fundi 16.* **Zaire:** *Bambs & Malaisse 8407; Kassner 3347* (photo, BM); *Shantz 554* (photo, K).

Clematis villosa subsp. **stanleyi** (Hook.) Kuntze—**Angola:** *Exell & Mendonca s.n.* (1961); *Rodin 9349; Young 1385.* **Namibia:** *Seydel 2067.* **South Africa:** *Bayliss 3145, 4664; Bourell et al. 2571; Burke 1853; Joffe 192; Liebenberg 8815; Mogg 18811, 21054; Rand 1282; Scheepers 1486; Sidey 1456; J. Thode 1348; Welman 592.* **Zimbabwe:** *Chubb 108; Cross 353; Plowes 1647; Gonde 386; Leach 8200, Miller 2087, 2189; G. West 2538.* **Zimbabwe or Zambia:** *Monro s.n.; Mshasha 162; Opperman s.n.* (1969). **Zambia:** *Grant 4518; Harder et al. 4018; Nawa et al. 123; F. White 1918.*

Clematis villosa subsp. **kirkii** (Oliv.) Brummitt—**Angola:** *Exell & Mendonca 120, 1702, 1741, 160.* **Malawi:** *Banda 1509; Brass 17453; Chapman & Chapman 7326; Grosvenor & Renz 933; Patel et al. 1484; Pawek 5463, 6634, 8253; Phillips 768A, 1181, 1449, 3671; Salubeni et al. 2518.* **Mozambique:** *Correia 215; Gomes & Sousa 1662; Torre & Paiva 379.* **Tanzania:** *Bally & Carter 16461; Gribb et al. 11247; Kayombo & Kayombo 212; Lovett 1482; Lovett et al. 1899; Muumba DSM 3029; Paget-Wilkes 785; Prins-Lambert 392; Stolz 146; Thulin & Mhoro 3125.* **Zaire:** *Brookes et al. 191; Robyns 1587.* **Zambia:** *Lusaka Natural History Club 228; Richards 22153.* **Zimbabwe:** *Bayliss 10659; Chase 7926; Davies 47; Gote 198; Rhodin 4368; Rutherford-Smith 482; West 2541.*

Clematis villosa subsp. **oliveri** (Hutch.) Brummitt—**Burundi:** *Reekmans 2756, 3824, 5337, 5527, 6754.* **Cameroon:** *De Wilde & de Wilde-Duyfjes 2344; Leeuwenberg 7619, 7668; Thomas 6072.* **Nigeria:** *Ekwuno et al. 291, Sanford 5162, 6176; Wit et al. 1998.* **Ruanda:** *Michel 3250.* **Tanzania:** *Gereau & Kayombo 4773; Haarer 2251; Lovett & Congdon 2912; Mwanoka & Kayombo 662; Ndama & Mabira 2251; Shabani 973.* **Zaire:** *Grant 4501a; Lebrun 9519a; Malaisse 11214; Michel & Reed 2, 232.* **Zambia:** *Harder et al. 2610.*

Clematis villosa DC subsp. **villosa—Angola:** *Exell & Mendonca 1924, 2503, 2967.* **Burundi:** *Reekmans 1756.* **Tanzania:** *Gobbo et al. 723; Haarer 2252; Paget-Wilkes 383.*

Clematis viridiflora Bertol.—**Mozambique:** *Correia & Marques 2189; Edwards & Vahrmeyer 4281; Lemos & Balsinhas 37; deKoning & Hiemstra 9022.* **Tanzania (Zanzibar):** *Haji DSM 4026.*

Clematis welwitschii Hiern ex Kuntze—**Angola:** *Carisso & Mendonca, 575; Exell & Mendonca 358, 382, 396, 1076; Welwitsch 1215a* (photo of type of *C. commutata* at BM); *Welwitsch 1217* (photo of type of *C. welwitschii* at BM). **Cameroon:** *Breteler et al. 2448.* **Malawi:** *Chapman & Chapman 9008; LeCroix 3020, Tawakali & Kaunda 190; Lovett & Congdon 2885; Pawek 6255, 7151, 8405, 12644, 12686, 13658, 14352.* **Mozambique:** *Edwards & Vahrmeyer 4281.* **Tanzania:** *Bidgood & Congdon 150; Gereau & Kayombo 4228; Mwangoka & Kayombo 872; Mwasumbi 16172; Richards 20438.* **Zaire:** *Quarre 5383.* **Zambia:** *Lumba Natural History Club 38; Schmidt et al. 1333; Vesey-Fitzgerald 1172; White 2643.* **Zimbabwe:** *Bayliss 10086; Leech & Brunton 9841; Rodin 4369.*

Clematis welwitschii Hiern ex Kuntze—**Angola:** *Carisso & Mendonca, 575; Exell & Mendonca 358, 382, 396, 1076; Welwitsch 1215a* (photo of type of *C. commutata* at BM); *Welwitsch 1217* (photo of type of *C. welwitschii* at BM). **Cameroon:** *Breteler et al. 2448.* **Malawi:** *Chapman & Chapman 9008; LeCroix 3020, Tawakali & Kaunda 190; Lovett & Congdon 2885; Pawek 6255, 7151, 8405, 12644, 12686, 13658, 14352.* **Mozambique:** *Edwards & Vahrmeyer 4281.* **Tanzania:** *Bidgood & Congdon 150; Gereau & Kayombo 4228; Mwangoka & Kayombo 872; Mwasumbi 16172; Richards 20438.* **Zaire:** *Quarre 5383.* **Zambia:** *Lumba Natural History Club 38; Schmidt et al. 1333; Vesey-Fitzgerald 1172; White 2643.* **Zimbabwe:** *Bayliss 10086; Leech & Brunton 9841; Rodin 4369.*

ACKNOWLEDGMENTS

I am grateful to the staff of the Missouri Botanical Garden for making their collection of African *Clematis* available to me for this study, and to Richard Brummitt of the Royal Botanic Gardens, Kew, and Gretchen Walters of the Missouri Botanical Garden, for comments on earlier versions of the manuscript.

REFERENCES

Beentje, H.J. 1989. The reinstatement of Clematis sigensis Engl. (Ranunculaceae). Utafiti 2(1):16.

Berhaut, J. 1967. Flore du Senegal. 2nd. Ed. Clairafrique. Dakar.

Brenan, J.P.M. 1978. Some aspects of the phytogeography of Tropical Africa. Ann. Missouri Bot. Gard. 65:437–478.

Brummitt, R.K. 2000. Inclusion of *Clematopsis* Hutch. in *Clematis* L. *(Ranunculaceae)*. Kew Bull. 55:97–108.

Crosby, M.R. 1978. Systematic studies in Africa: the twenty-fourth Systematics Symposium. Ann. Missouri Bot. Gard. 65:367–368.

Durand, T. 1895. Conspectus florae Africae. Jardin botanique de l'état, Bruxelles. Pp. 1–8.

Essig, F.B. 1990. The *Clematis virginiana* (Ranunculaceae) complex in the southeastern United States. Sida 14:49–68.

Exell, A.W. and Mendonca 1937. Conspectus florae Angolensis. Lisboa, Portugal. 1:1–4.

Exell, A.W. and E. Milne-Redhead. 1960. *Clematis*. In: A.W. Exell and H. Wild, eds. Flora Zambesiaca. Pp. 89–93.

Grey-Wilson, C. 2000. *Clematis*, the genus. Timber Press. Portland, OR.

JOHNSON, M. 1997. Slaektet Klematis. Magnus Johnsons Plantskola AB. Soedertaelje. Sweden.

HUTCHINSON, J. and J.M. DALZIEL. 1954. Flora of West Tropical Africa. London, Crown Agents for Oversea Governments and Administrations. Pp. 64–65.

LETTY, C. 1962. Wild flowers of the Transvaal. Trustees of the Wild Flowers of the Transvaal Book Fund. P. 140.

OLIVER, D. 1868. Flora of Tropical Africa. London, L. Reeve and Co. 1:7.

TAMURA, M. 1967. Morphology, ecology and phylogeny of the Ranunculaceae VII. Sci. Rep. Osaka Univ. 16:21–43.

TEKATAY, D. 1987. Revision of the genus *Clematis* L. in Ethiopia. Belmontia 19(108):1–42.

THULIN, M. 1993. Flora of Somalia. Royal Botanic Gardens, Kew. 1:22.

WHITE, F. 1962. The forest flora of northern Rhodesia. Oxford University Press. Pp. 46–47.

BOOK NOTICES

Southeastern Botany

RONALD W. GILMOUR. 2002. **Foundations of Southeastern Botany: An Annotated Bibliography of Southeastern American Botanical Explorers Prior to 1824.** (ISSN 0008-7475, pbk.). The Southern Appalachian Botanical Society, Dr. Patricia Cox, TVA Heritage Program, PO Box 1589, Norris, TN 37828, U.S.A. (Orders: same). Price not given, 142 pp., 6 3/4" × 10".

Abstract: "This paper lists published sources pertaining to the lives and work of seventy individuals who contributed to early botanical knowledge of the Southeastern United States. General sources, primarily biographical compilations and scientific bibliographies, are listed at the beginning of the paper, followed by entries for individual botanists. For each botanist, the listed information includes name (with any variants), place and year of birth and death, location of manuscripts and plant specimens, citations for published portraits and handwriting samples, lists of any plant or fungal genera named for the botanist, a brief summary statement about the person's significance to Southeastern botany, and entries for published sources pertaining to the botanist. Works both by and about each botanist are listed with annotations. All entries are cross-referenced parenthetically throughout the text."

DAVID E. ALLEN and GABRIELLE HATFIELD. **2004. Medicinal Plants in Folk Tradition: An Ethnobotany of Britain & Ireland.** (ISBN 0-88192-638-8, hbk.) Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 432 pp., 31 color plates, 57 b/w illus., 1 map, 6" × 9".

Review forthcoming in Sida 21(3).

THE ACTIN I INTRON—A PHYLOGENETICALLY INFORMATIVE DNA REGION IN *CLEMATIS* (RANUNCULACEAE)

Jonathan M. Slomba, James R. Garey, and Frederick B. Essig

Department of Biology
University of South Florida
Tampa, Florida 33620, U.S.A.
essig@chuma1.cas.usf.edu

ABSTRACT

As part of a search for DNA regions suitable for phylogenetic analysis in the genus *Clematis* (Ranunculaceae), the nuclear-encoded Actin I intron was employed in a preliminary sampling of a small number of species selected to represent the major subdivisions of the genus. This DNA region was found to be more informative and to provide a more robust phylogenetic tree than chloroplast DNA regions. Trees generated were consistent with phylogenetic hypotheses based on morphology and with published molecular analyses. Moreover, three species of the section Crispae (subgenus Viorna) native to Florida, considered closely related on morphological grounds, formed a well-supported clade, and were distinguishable from one another. This suggests that this DNA region might be a useful tool for distinguishing groups of closely-related species, individual species, and possibly hybrids.

RESUMEN

Como parte de una búsqueda de regiones de DNA apropiadas para análisis filogenéticos en el género *Clematis* (Ranunculaceae), se empleó el intrón Actin I nuclear en un muestreo preliminar de un pequeño número de especies seleccionadas para representar las grandes subdivisiones del género. Esta región de DNA se encontró que era más informativa y daba un árbol filogenético más consistente que las regiones de DNA plastidial. Los árboles generados eran consistentes con la hipótesis filogenética basada en la morfología y con los análisis moleculares publicados. Además, tres especies de la sección Crispae (subgénero Viorna) nativas de Florida, consideradas fuertemente emparentadas en aspectos morfológicos, formaron un clado muy coherente, y eran distinguibles una de otra. Esto sugiere que esta región del DNA puede ser un instrumento útil para diferenciar grupos de especies muy emparentadas, especies individuales, y posiblemente híbridos.

INTRODUCTION

The infrageneric classification of *Clematis* (Ranunculaceae), a genus of more than 300 species distributed worldwide, has been uncertain pending definitive phylogenetic studies. Traditional classifications have relied primarily on floral characters for the major divisions of the genus (as in Tamura 1967). However, characters of seedling and juvenile morphology have been cited in recent decades as supporting a fundamental division in the infrageneric classification of the genus (Tamura 1987; Essig 1991; Miikeda et al. 1999). A specialized syndrome of seedling and vegetative characters, featuring a suppressed hypocotyl

SIDA 21(2): 879–886. 2004

and opposite seedling leaves ("Type II," Essig 1991, "opposite" in Miikeda et al. 1999; see also Appendix 1) appears to have arisen from the more general Ranunculaceous type featuring an elongate hypocotyl and alternate seedling leaves ("Type I," or "alternate"), but it has been uncertain whether this morphological complex has arisen just once or more than once, as it is found in species formerly placed in different subgenera.

We have been seeking appropriate molecular tools with which to resolve these and other phylogenetic questions within *Clematis*. The use of DNA sequencing techniques has thus far been of limited success. Miikeda et al. (1999) utilized several chloroplast genes, including matK (maturase-encoding gene), trnK (UUU) intron, trnL (UAA) intron, the intergenic spacer between trnL and trnF (GAA), and the intergenic spacer between rbcL and atpB. Employing approximately 4,400 bp. of sequence for the eight taxa included in the study, the team produced a tree that was consistent with Essig's proposal, but was weakly resolved. Our own efforts with chloroplast DNA also produced weak results.

A search for alternative tools led us to consider some nuclear DNA regions, which are expected to be more informative than chloroplast non-coding regions in determining species level phylogenies because the nuclear genome has a substitution rate 5 to 10 times faster than the chloroplast genome (Li 1997). In particular, we have focused on a non-coding intron of the Actin I gene. Actin is one of the components of the cellular cytoskeleton, and is produced through the activity of a large multigene family (Moniz de Sa & Drouin 1996). The location of the Actin I intron is highly conserved across all angiosperm families, making the development of primers suitable for the PCR amplification of the intron possible. A preliminary test of this DNA region as a phylogenetic tool in *Clematis* was conducted using a small sampling of species representing the major subdivisions of the genus.

MATERIALS AND METHODS

Materials were obtained from the Chicago Botanical Garden and the University of South Florida Botanical Garden (Table 1). Samples were selected to represent the major subdivisions of the genus *Clematis*. They include several species with Type I vegetative morphology, and several with Type II vegetative morphology, while also representing the traditional sections *Clematis* and *Viorna* (as in Tamura 1967), and the rearranged sections (elevated to subgenera) of Tamura (1987) (Table1). The traditional sections each contained subsections with Type I and Type II morphologies, and in his revision, Tamura (1987) reorganized his classification to reflect those different morphologies. Note that two of the species included in this study were realigned in that taxonomic shift. *Clematis terniflora* in subsection *Rectae* was formerly included in section Clematis, while *C. stans*, in subsection *Tubiflorae* was formerly included in section *Viorna*. This analysis is thus a preliminary test of that taxonomic revision.

Table 1. Taxa included in the analysis (with seedling morphology type indicated as I or II).

Species	**Classification (Tamura 1987)**	**Voucher**
Clematis reticulata Walt.	(Viorna: Crispae II)	*Arias 71* (USF)
Clematis crispa L.	(Viorna: Crispae II)	*Essig 011001-6* (USF)
Clematis baldwinii Torr. & A. Gray	(Viorna: Crispae II)	*Essig 011001-7* (USF)
Clematis terniflora DC	(Flammula: Rectae II)	*Essig 860904-1* (USF)
Clematis virginiana L.	(Clematis: Dioicae I)	Chicago B. G. acc. # 356-81
Clematis stans Sieb. & Zucc.	(Campanella: Tubulosae I)	*Essig 011001-3* (USF)
Anemone pulsatilla var. vulgaris L.	(outgroup I)	*Essig 020305-2* (USF)

The samples for this study also includes three species native to Florida that on morphological grounds appear to be closely related. Their inclusion provides a test of the resolving power of the Actin I DNA sequence.

A species of *Anemone* (*A. pulsatilla* var. *vulgaris* L) was chosen as the outgroup. *Anemone* has traditionally been identified as closely related to *Clematis*, and *A. pulsatilla* shares with *Clematis* the very distinctive elongate styles of the mature achenes. A number of recent phylogenetic studies (Johansson & Jensen 1993; Hoot 1995, and Kosuge et al. 1995) have identified a clade that includes *Clematis* along with *Anemone, Pulsatilla* (sometimes treated as a segregate of *Anemone*), *Knowltonia, Hepatica*, and sometimes *Ranunculus* and/or *Trautvettaria*. A more comprehensive study will include more of these genera as outgroups. An unnamed species of *Anemone* was also used as the outgroup in the study by Miikeda et al. (1999).

Angiosperm Actin (ac1) gene sequences from a broad range of taxa were obtained from Genbank (*Arabidopsis, Zea, Oryza*, and *Glycine* (accession #'s M20016, J01238, X15865, and J01298, respectively). These sequences were aligned using Clustal X (Thompson et al. 1994; Higgins et al. 1996). The primer sequences were selected from the alignment by anchoring the forward primer in a highly conserved (relatively guanine and cytosine rich [48%]) coding region just downstream of the intron. The reverse primer was anchored in a highly conserved coding region just upstream of the intron (Table 2). This primer set corresponds to a region of approximately 300 nucleotides in the taxa listed above.

Some specimens were deep frozen at -80° C before use, others were prepared immediately for extraction. Total genomic DNA was extracted from leaf samples following the modified CTAB protocol developed by Doyle & Doyle (1987).

Polymerase chain reaction (PCR) was carried out on all extracted DNA samples using primers for the gene regions shown in Table 2. PCR reactions (amplification) were carried out in 100 μL volumes, using a taq polymerase kit from Enzypol (Boulder CO), following their instructions. Thermal cycling parameters were the same for all species: 1 min. initial denature at 95°C, followed by 35

Table 2. PCR primers for Actin genes.

Actin I forward:	CCC	GAA	TTC	CTT	GTT	TGC	GAC	AAT	GGA	AC
Actin I reverse:	CCC	GAA	TTC	ACA	ATT	CCA	TGC	TCA	AT	

cycles of 15 sec. at 95°C, annealing at 48 °C for 30 sec., a 90 sec. extension at 72°C, followed by a 10 min. hold at 72°C, and then a final hold at 4°C.

The ˜300 bp PCR product of the Actin I intron was gel purified and cloned into a pBluescript vector and transformed into DH5μ *Escherichia coli* cells (Gibco, Carlsbad CA). White colonies were picked from bacterial plates, grown in small cultures with ampicillin and sequencing template prepared using the alkaline lysis method (Ausubel 2000). After purification, cycle sequencing reactions were carried out in 200μL thin-walled capped tubes using a Perkin-Elmer (Foster City, CA) DYEnamic ET terminator cycle sequencing kit with an ABI Model 310 genetic analyzer.

Phylogenetic trees were constructed from DNA sequence alignments generated by Clustal X (Thompson et al. 1994; Higgins et al. 1996) and modified by hand using Genedoc (Nicholas et al. 1997). Neighbor-joining trees from molecular data were made using MEGA 2.1 software (Kumar et al. date) using Kimura 2-parameter distances with 1000 bootstrap replicates. For comparison, a brief morphological analysis incorporating vegetative and floral characters used in recent classifications was carried out (Fig. 1B, and Appendices 1 & 2). The morphological tree was recovered using PAUP 4.0b10 (Swofford 2001) using an heuristic search with default parameters and 200 bootstrap replicates.

RESULTS AND DISCUSSION

The Actin intron sequences yielded an alignment of 316 bp with 27 variable sites, 17 parsimony informative sites and 28 sites with gaps. The alignment was relatively unambiguous and resulted in a neighbor-joining tree (Fig. 1A) with two well-supported clades that coincide with Type I and Type II seedling morphology as described by Essig (1991). A maximum parsimony tree based on morphology (Fig. 1B) recovered the type II clade, and illustrates the plesiomorphic distribution of the Type I character syndrome. The molecular analysis produced a strongly supported (bootstrap value 100%) derived clade containing *Clematis crispa*, *C. reticulata* and *C. baldwinii*. These are morphologically similar species native to the southeastern U.S. belonging to the traditional group *Crispae* (variously designated as a section or subsection) in subgenus *Viorna*, and exhibiting type II morphology. There is a strong sister group relationship (97%) between this group and *C. terniflora*, a Eurasian species also with Type II morphology, but with panicles of small whitish flowers—a reproductive morphology syndrome it shares with Type I members of the traditional subgenus *Clematis*. *Clematis virginiana* and *C. stans* form a separate well-sup-

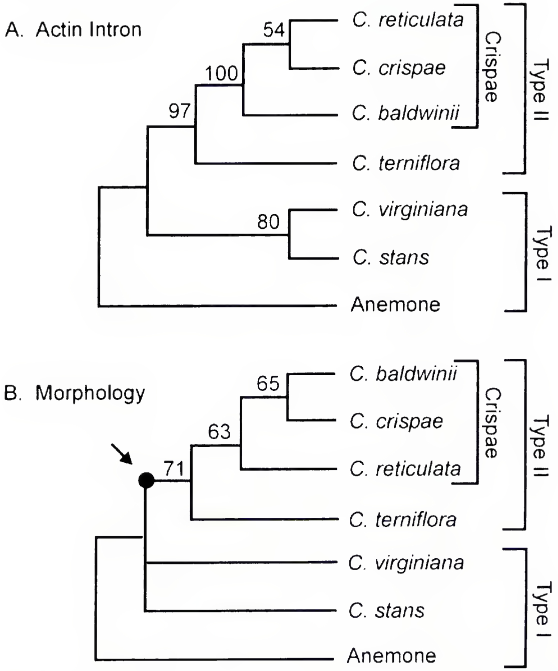


Fig. 1. **A.** Neighbor Joining tree from the Actin intron alignment. A maximum parsimony analysis (not shown) also found the Type II and *Crispae* nodes but with 90 and 99 percent bootstrap values respectively. **B.** Maximum parsimony tree from morphological data (see Appendices 1 and 2). Type I and Type II are syndromes of morphological characters, primarily of seedlings, as described in Essig (1991). The arrow on B indicates the origin of the Type II syndrome. *Crispae* is the sectional name for North American species of subgenus *Viorna* (Tamura 1987).

ported clade (80%) and both have Type I seedling morphology, despite having different floral morphologies.

The results of this preliminary analysis are consistent with those obtained by Miikeda et al. (1999). The species used in the two studies were different, but representative of the same infrageneric taxa. The results are also supportive of Tamura's (1987) revised classification, and Essig's (1991) proposal that taxa with type II seedling morphology represent a monophyletic clade and might be placed together in a major infrageneric division of the genus.

The results also confirm the close relationship of the 3 species of the subsection *Crispae* occurring in the southeastern U.S.A., and appear to resolve those species from one another. The relationship of the three species was slightly different in the DNA analysis from that in the morphological analysis, or from what one would expect through conventional taxonomic analysis. More extensive sampling within species is needed, along with analysis of additional DNA regions, to fully evaluate the resolving power of the Actin I intron region at this level.

Another discrepancy between the two analyses is the sister group relationship between *C. virginiana* and *C. stans* found in the molecular tree but not in the morphological tree. Too few taxa were included in this study to draw any conclusions about the deeper branches in the genus, however. A great many more taxa with both Type 1 and Type 2 morphologies exist. A more complete analysis will include a great many more of the species of this large genus, and in particular, as many of the recognized infrageneric taxa (sections, subsections) as possible, along with a comprehensive morphological analysis, in order to fully understand the phylogeny of this genus and develop a definitive infrageneric classification.

In conclusion, the results of this preliminary analysis are consistent with taxonomic concepts based on morphology and with other DNA-based analyses, and also appear to discriminate among fairly closely related species. Therefore, it appears that the Actin I gene region will be a very useful tool for the analysis of infrageneric relationships in *Clematis*, and likely in other angiosperm genera.

APPENDIX 1

Characters used in morphological analysis. Note: characters 1–4 are the primary features distinguishing the Type I (0) from the Type II (1) syndrome; characters 6–8 are the floral characters traditionally cited in distinguishing subgenus *Clematis* from subgenus *Viorna*.

1. Seedlings with hypocotyl elongate (0) vs hypocotyl suppressed (1)
2. Seedling leaves alternate (0) vs leaves opposite (1)
3. Eophylls 3-lobed (0) vs eophylls elliptic (1)
4. Leaves dentate (0) vs leaves entire (1)
5. Stems erect (0) vs stems vining (1)

6. Flowers with sepals spreading to reflexed from the base(0) vs flowers tubular, urceolate or campanulate with sepals spreading at the tips(1) vs flowers campanulate with strongly reflexed limbs (2)
7. Flowers colored (0) vs flowers white to cream (1)
8. Stamens with filaments glabrous (0) vs filaments hirsute (1)
9. Achenes narrow, turgid (0) vs achenes broad, flattened (1)

APPENDIX 2. SPECIES/MORPHOLOGICAL CHARACTER MATRIX

	1	2	3	4	5	6	7	8	9
Anemone pulsatilla	0	0	0	0	0	0	0	0	0
Clematis stans	0	0	0	0	1	1	0	1	0
Clematis virginiana	0	0	0	0	0	0	1	0	0
Clematis terniflora	1	1	1	1	0	0	1	0	1
Clematis reticulata	1	1	1	1	0	1	0	1	1
Clematis crispa	1	1	1	1	0	2	0	1	1
Clematis baldwinii	1	1	1	1	1	2	0	1	1

ACKNOWLEDGMENTS

This publication was derived from the Master's thesis of the first author. We acknowledge the support of NSF grants CHE-0221834 and DEB-0344372. We thank the Chicago Botanic Garden for providing materials. We thank Nancy Moreno and John Syring for providing valuable review comments.

REFERENCES

AUSUBEL, F.M., R. BRENT, R.E. KINGSTON, D.D. MOORE, J.G. SEIDMANN, J.A. SMITH, and K. STRUHL. 2000. Current protocols in molecular biology. Greene Publishing Associates, NY.

DOYLE, J.J. AND J.E. DOYLE. 1987. A rapid DNA isolation procedure for small quantities of fresh leaf material. Phytochemistry J. 19:11–15.

ESSIG, F.B. 1991. Seedling morphology in *Clematis* (Ranunculaceae) and its taxonomic implications. Sida 14:377–390.

HIGGINS, D.G., J.D. THOMPSON, and T.J. GIBSON. 1996. Using CLUSTAL for multiple sequence alignments. Meth. Enzymol. 266:383–402.

HOOT, S.B. 1991. Phylogeny of the Ranunculaceae based on epidermal microcharacters and macromorphology. Systematic Bot. 16:741–755.

HOOT, S.B. 1995. Phylgenetic relationships in *Anemone* (Ranunculaceae) based on DNA restriction site variation and morphology. Pl. Syst. Evol., suppl. 9:195–200.

JOHANSSON, J.T. and R.K. JENSEN. Chloroplast DNA variation and phylogeny inof the Ranunculaceae. Pl. Syst. Evol. 187:29–49.

KOSUGE, K., K. SAWADA, T. DENDA, and K. WATANABE. 1995. Phylogenetic relationships of some genera in the Ranunculaceae based on alcohol dehydrogenase genes. Pl. Syst. Evol., Suppl. 9:263–271.

KUMAR, S., K. TAMURA, I.B. JAKOBSEN, and M. NEI. 2001. MEGA2: Molecular evolutionary genetics analysis software, Arizona State University, Tempe.

Li, W.H. 1997. Molecular evolution. Sinauer Assoc. Inc., Sunderland, MA.

Miikeda, O.S. Koga, T. Handa, and T. Yukawa. 1999. Subgeneric relationships in *Clematis* (Ranunculaceae) by DNA sequences. In: S. Andrews, A.C. Leslie, and C. Alexander, eds. Taxonomy of cultivated plants. Third International Symposium. Royal Botanic Gardens. Kew. Pp. 355–358.

Moniz de Sa, M. and G. Drouin. 1996 . Phylogeny and substitution rates of angiosperm actin genes. Molec. Bio. Evol. 13:1198–1212.

Nicholas, K.B., H.B. Nicholas, and D.W. Deerfield II. 1997. GeneDoc: analysis and visualization of genetic variation, Embnew. News 4:14.

Tamura, M. 1967. Morphology, ecology and phylogeny of the Ranunculaceae VII. Sci. Rep. Osaka Unv. 16–2:21–43.

Tamura, M. 1987. A classification of the genus *Clematis*. Acta Phytotax. Geobot. 38:33–44.

Thompson, J.D., D.G. Higgins, and T.J. Gibson. 1994. CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. Nucleic Acids Res. 22:4673–4680.

NEW COMBINATIONS IN NORTH AMERICAN CARYOPHYLLACEAE

J.K. Morton

Department of Biology
University of Waterloo
Waterloo, Ontario, CANADA N2L 3G1
jkmorton@sciborg.uwaterloo.ca

ABSTRACT

The following new combinations are proposed. *Cerastium velutinum* Raf. var. *villosissimum* (Pennell) J.K. Morton, *Silene drummondii* Hook. subsp. *striata* (Rydb.) J.K. Morton, *Silene laciniata* Cav. subsp. *californica* (Durand) J.K. Morton, *Silene ostenfeldii* (A.E. Porsild) J.K. Morton and *Stellaria cuspidata* Willd. ex Schlecht. subsp. *prostrata* (Baldw. ex Ell.) J.K. Morton.

RESUMEN

Se proponen las siguientes nuevas combinaciones. *Cerastium velutinum* Raf. var. *villosissimum* (Pennell) J.K. Morton, *Silene drummondii* Hook. subsp. *striata* (Rydb.) J.K. Morton, *Silene laciniata* Cav. subsp. *californica* (Durand) J.K. Morton, *Silene ostenfeldii* (A.E. Porsild) J.K. Morton y *Stellaria cuspidata* Willd. ex Schlecht. subsp. *prostrata* (Baldw. ex Ell.) J.K. Morton.

During the preparation of treatments of *Cerastium*, *Silene* and *Stellaria* for the Flora of North America, the need for the following new combinations became apparent.

NEW COMBINATIONS

Cerastium velutinum Raf. var. **villosissimum** (Pennell) J.K. Morton, comb. nov.
BASIONYM: *Cerastium arvense* L. var. *villosissimum* Pennell, Bartonia 12:11. 1931. TYPE: U.S.A: PENNSYLVANIA. Chester Co.: rocky cliff, serpentine below Lees Mills by Octoraro Creek, 21 Sep 1920, *Pennell 10767* (HOLOTYPE: PH; ISOTYPE: NY).

Cerastium arvense L. in North America consists of at least three species. One of these, *Cerastium velutinum* Raf., includes the plant that Pennell (1931) described as *Cerastium arvense* L. var. *villosissimum*. The new combination is required to accommodate this change.

Silene drummondii Hook. subsp. **striata** (Rydb.) J.K. Morton, comb. et stat. nov.
BASIONYM: *Lychnis striata* Rydb., Bull. Torrey Bot. Club 31:408. 1904. TYPE: COLORADO: Cameron Pass, 1000 ft, 30 Jul 1896, *Baker s.n.* (HOLOTYPE: NY; ISOTYPE: MO).

Silene drummondii contains two taxa, subsp. *drummondii* which is characteristically a prairie taxon, and subsp. *striata* which is associated with the Rocky Mountains from near the Canada border southwards. Though the two subspecies are clearly distinct in their extreme forms they intergrade where they come into contact.

SIDA 21(2): 887–888. 2004

Silene laciniata Cav. subsp. **californica** (Durand) J.K. Morton, comb. et stat. nov. BASIONYM: *Silene californica* Durand, J. Acad. Nat. Sci. Philadelphia, n.s. 3:83. 1855. TYPE: CALIFORNIA: *Pratten s.n.* (HOLOTYPE: P, n.v.).

The Mexican Pinks (*S. laciniata, S. californica and S. greggii* A. Gray) have frequently been regarded as distinct species. In the context of North America this is probably appropriate, for all three have clearly recognizable morphological characters. However, in Mexico, where their distribution is centred, many collections show intergrading characters and are not readily identifiable. For this reason, subspecific status is more appropriate.

Silene ostenfeldii (A.E. Porsild) J.K. Morton, comb. nov. BASIONYM: *Melandrium ostenfeldii* A.E. Porsild, Sargentia 4:37. 1943. TYPE: CANADA: Narakay Island, Dease Arm, Great Bear Lake, Northwest Territories, 1 Aug 1928, *A.E. & R.T. Porsild 4839* (HOLOTYPE: CAN).

Silene taimyrensis (Tolm.) Bocquet is the name that has been used for this species since Bocquet created the combination in 1967. Unfortunately, Bocquet did not have access to the type specimen on which the name is based (*Tolmatchew 762*; holotype, L). Recently Petrovsky & Elven (in the on-line Pan Arctic Flora- www.mun.ca/biology/delta/arcticf) reported that they had examined Tolmatchew's specimen and consider it to be a form of *Silene involucrate* (Cham. & Schlecht.) Bocquet. The combination *Silene ostenfeldii* has apparently not been validly published. Electronic publication is not acceptable under Article 29.1 of the International Code of Botanical Nomenclature (Greuter et al. 2000). Accordingly the combination is validated here.

Stellaria cuspidata Willd. ex Schlecht. subsp. **prostrata** (Baldw. ex Ell.) J.K. Morton, comb. et stat. nov. BASIONYM: *Stellaria prostrata* Baldw. ex Ell., Sketch Bot. S. Carolina 1:518. 1821. TYPE: FLORIDA: on the island of Fort George, East-Florida (Apalachicola), without date, *Baldwin s.n.* (HOLOTYPE: NY).

Stellaria cuspidata and *S. prostrata* frequently intergrade and hence are better treated as subspecies. The former tends to be montane and the latter to be a lowland weed.

REFERENCES

BOCQUET, G. 1967. Physolychnidum olim Gastrolychnidum nomenclaturae fundamentum includens combinationes taxaque nonnuila Silenes generis. Candollea 22:1–38.

GREUTER, W., J. MCNEILL, F.R. BARRIE, H.M. BURDET, V. DEMOULIN, T.D. FILGUEIRAS, D.H. NICOLSON, P.C. SILVA, J.E. SKOG, P. TREHANE, N.J. TURLAND, and D.L. HAWKSWORTH (eds.). 2000. International code of botanical nomenclature (St. Louis Code) Adopted by the Sixteenth International Botanical Congress St. Louis, July–August 1999. Koeltz, Königstein.

PENNELL, F.W. 1931. On some critical species of the serpentine barrens. Bartonia 12:1–23.

TONESTUS KINGII AND *T. ABERRANS* ARE RELATED TO *EURYBIA* AND THE MACHAERANTHERINAE (ASTERACEAE: ASTEREAE) BASED ON NRDNA (ITS AND ETS) DATA: REINSTATEMENT OF *HERRICKIA* AND A NEW GENUS, *TRINITEURYBIA*

Luc Brouillet

Herbier Marie-Victorin
Institut de recherche en biologie végétale
Université de Montréal
4101 Sherbrooke St. E
Montreal, Québec, CANADA, H1X 2B2
luc.brouillet@umontreal.ca
(author for correspondence)

L. Urbatsch

LSU Herbarium and Biological Sci. Dept.
202 Life Sciences Bldg.
Louisiana State University
Baton Rouge, Louisiana 70803, U.S.A.
leu@lsu.edu

R.P. Roberts

LSU Herbarium and Biological Sci. Department
202 Life Sciences Bldg.
Louisiana State University
Baton Rouge, Louisiana 70803, U.S.A.
and
Department of Biological Sciences
Towson University, Towson, Maryland 21252-0001, U.S.A.

ABSTRACT

Phylogenetic analysis of nrDNA (ETS and ITS) sequence data for 50 species of Astereae (Asteraceae) belonging to the *Eurybia-Machaerantherinae* clade show that *Tonestus kingii* and *T. aberrans* belong to this group. The genus *Herrickia* is reinstated and expanded to include *H. kingii* as well as members of *Eurybia* section *Herrickia* sensu Nesom (1994). A new genus, *Triniteurybia*, is established for *T. aberrans*, which is sister to the *Machaerantherinae*.

RESUMEN

El análisis filogenético de secuencia de bases de nrDNA (ETS y ITS) de 50 especies de Astereae (Asteraceae) pertenecientes al clado *Eurybia-Machaerantherinae* muestra que *Tonestus kingii* y *T. aberrans* pertenecen a este grupo. El género *Herrickia* se reinstaura y expande para incluir a *H. kingii* así como a miembros de *Eurybia* sección *Herrickia* sensu Nesom (1994). Se establece un nuevo género, *Triniteurybia*, para *T. aberrans*, que es "sister group" de *Machaerantherinae*..

INTRODUCTION

Several species of tribe Astereae in North America have proven difficult to assign taxonomically to genera or groups. Molecular phylogenetic studies, notably following the seminal paper of Noyes and Rieseberg (1999), have helped to solve the relationships of many of these taxa. Nevertheless, the disposition of some species still remain controversial, notably species recently included in *Tonestus* by Nesom and Morgan (1990), *T. aberrans* (A. Nelson) G.L. Nesom & Morgan (basionym *Macronema aberrans* A. Nelson), and by Nesom (1991), *T. kingii* (D.C. Eaton) G.L. Nesom (basionym *Aster kingii* D.C. Eaton). The basis for inclusion of these species in *Tonestus* were the woody caudices, leaf shape and anatomy, eglandular (or sparsely short-stipitate-glandular) herbage, mostly single-headed capitulescences and foliaceous outer phyllaries (not in *T. aberrans* however). Nesom and Morgan (1990) did not discuss the specific reasons for the inclusion of *Macronema aberrans* in *Tonestus*, but pointed out its similarities to *T. graniticus*. Nesom (1991) reviewed the detailed taxonomic history of *Aster kingii*, which has also been named *Machaeranthera kingii* (D.C. Eaton) Cronquist & Keck, and he pointed out that various authors had seen relationships of this species with genus *Aster* s.l., notably western members of *Eurybia* and *Oreostemma*. The similarities invoked to link this species to *Tonestus* are those cited above. The only discordant feature in the group would be its white rays in a yellow-rayed group. All species placed in *Tonestus* are n= 9, a primitive and frequent number in the tribe.

A recent molecular phylogeny of *Chrysothamnus* and related *Solidagininae* (Roberts & Urbatsch 2004) suggests, however, that *Tonestus* sensu Nesom is polyphyletic. Further investigations by Urbatsch and colleagues (unpublished) suggested that *T. aberrans* and *T. kingii* might better be placed near *Eurybia*. Likewise, a study of the position of the North American asters within tribe Astereae had suggested that *T. kingii* was better placed with *Eurybia* and *Oreostemma*, two North American segregates of *Aster* s.l. (see summarized phylogeny in Semple et al. 2002) that will be called henceforth the eurybioid lineage. Therefore, in preparation for the treatment of *Eurybia* and relatives (Asteraceae, Astereae) for the Flora of North America, we are using ITS and 3'ETS molecular phylogenetic data to investigate the taxonomic position of *T. aberrans* and *T. kingii* within the Astereae. These molecular markers have proved useful in determining the position of taxa in tribe Astereae (e.g., Noyes & Rieseberg 1999; Roberts & Urbatsch 2004). We show that these species belong to the eurybioid grade within the North American clade and are presenting the necessary combinations to reflect this phylogenetic position. Genus *Herrickia* is reinstated and *T. kingii* transferred to it as *H. kingii* (along with congeners *H. glauca* and *H. wasatchensis*), and a new monotypic genus is described to accommodate *T. aberrans*, *Triniteurybia*. These names are subsequently used in the paper.

MATERIAL AND METHODS

Samples were preserved either as frozen leaf material, in silica gel, or taken from herbarium specimens. Data for the Machaerantherinae were taken from Markos and Baldwin (2001). Extraction and molecular methods used here are as described in Roberts and Urbatsch (2004) (Urbatsch laboratory) and in Fougère-Danezan et al. (2003) (ITS, Brouillet laboratory). For ETS (Brouillet laboratory), the primers Ast-8 (Markos & Baldwin 2001) and 18S-2L (Linder et al. 2000) were used, with PCR conditions similar to ITS (above); this resulted in longer ETS sequences than those produced in the Urbatsch laboratory (*T. kingii* and *T. aberrans*).

Sequences were input into already aligned matrices of ITS and ETS for the Astereae and manually adjusted. All new sequences used in this study are deposited in GenBank under the accession numbers provided in Table 1. Sources for already published sequences are provided also.

Preliminary parsimony analyses were done on the full ITS (more than 500 taxa in Astereae) and ETS (106 taxa) matrices, using PAUP* 4.0b10 (Swofford 2002). Resulting trees (not shown) clearly indicate that *T. kingii* and *T. aberrans* are members of the *Eurybia* complex (eurybioids) at the base of the *Machaerantherinae* (see Semple et al. 2002), but the trees were unresolved (polytomy) in the current region of interest. Given that the trees were not in conflict, data were combined for 50 taxa for which both sets were available, in an attempt to better define the position of these species within the *Eurybia* complex. The total number of characters in the combined ETS + ITS matrix is 1149, of which 195 are parsimony informative; few phylogenetically informative indels are found in the reduced taxon matrix (mostly in the ITS portion) and they were not coded as distinct characters. The matrix was subjected to parsimony analysis using PAUP* 4.0b10 (TBR, characters unordered, unweighted, gaps as missing, random addition, Multrees in effect), and to Bayesian analysis using MrBayes3 (Ronquist and Huelsenbeck, 2003). For the latter, the following parameters were applied: 4 chains, 1,000,000 generations, burn in 100,000, every 10,000th tree saved, model GTR+ gamma+gamma inv, nst=6. Analyses were run to completion. Bootstrap and jacknife supports were calculated for the parsimony analysis (5000 replicates, TBR, random addition); for the jacknife, 50% of characters were deleted in each run. Strict and 50% majority rule consensus trees were drawn for the parsimony analysis, and posterior probabilities were input onto the 50% majority rule tree for the Bayesian analysis. Trees were rooted using *Chloracantha spinosa* and *Canadanthus modestus*.

RESULTS

Parsimony analysis of the ETS + ITS matrix yielded 6910 trees of length 687, CI 0.662, RI 0.812 and RC 0.538. In the strict consensus tree (not shown) the eurybioids + *Machaerantherinae* form a clade, within which *Oreostemma*, *Eurybia* and *Eurybia* sect. *Herrickia* form a polytomy sister to a *T. aberrans*-*Machaerantherinae* clade. The parsimony 50% majority rule tree is similar to that shown for the Bayesian analysis (Fig. 1), which resulted in 9002

TABLE 1. List of voucher specimens for the sequences generated for the current study, and sources of previously published data. Current species names (e.g., Morgan & Hartman 2003){ Sida 20:1403} are used and original published names are provided in parentheses when differing (as deposited in GenBank; Markos & Baldwin 2001). For eurybioids, names proposed here are used and formerly used ones are in parentheses.

Species	**Source (collectors, number, Herbarium or citation)**	**GenBank accession number**	
		ITS	**ETS**
Canadanthus modestus (Lindl.) G.L. Nesom	*Semple 10639* (WAT)	AY772432	AY772446
Chloracantha spinosa (Bentham) G.L.Nesom	*Spellenberg 13101* (MT)	AY772431	AY772445
Oreostemma alpigenum (Torr. & A.Gray) Greene var. *haydenii* (T.C.Porter) G.L.Nesom	*Semple 10419* (WAT)	AY772430	AY772444
Triniteurybia aberrans (A. Nelson) Brouillet, Urbatsch & R.P.Roberts clone 1 (*Tonestus aberrans* (A. Nelson) G.L.Nesom & D.R. Morgan)	*Urbatsch 7812* (LSU)	AY772426	AY772440
Triniteurybia aberrans (A. Nelson) Brouillet, G.L.Nesom & D.R.Morgan) clone 2 (*Tonestus aberrans* (A. Nelson)	*Urbatsch 7812* (LSU)	AY772427	AY772441
Herrickia kingii (D.C Eaton) Brouillet, Urbatsch & R.P.Roberts clone 1 (*Tonestus kingii* (D.C.Eaton) G.L.Nesom)	*Garrett 1576* (US)	AY772428	AY772442
Herrickia kingii (D.C.Eaton) Brouillet, Urbatsch & R.P.Roberts clone 2 (*Tonestus kingii* (D.C.Eaton) G.L.Nesom)	*GS. Goodrich* 16357 (*UT*)	AY77242	AY772443
Herrickia horrida Wooten & Standl.	*Spellenberg & Fletcher 6027* (NMC)	AY772425	AY772439
Herrickia glauca (Nutt.) Brouillet (*Eurybia glauca* (Nutt.) G.L.Nesom)	*Semple 5758* (WAT)	AY772424	AY772438
Eurybia divaricata (L.) G.L.Nesom	*Semple 10710* (WAT)	AY772423	AY772437
Eurybia surculosa (Michx.) G.L.Nesom	*Semple 10527* (WAT)	AY772422	AY772436
Eurybia sibirica (L.) G.L.Nesom	*Semple 10627* (WAT)	AY772421	AY772435
Eurybia eryngiifolia (Torr. & A.Gray) G.L.Nesom	*Semple 10557* (WAT)	AY772420	AY772434
Dieteria bigelovii (A. Gray) D.R.Morgan & R.L. Hartman (*Machaeranthera bigelovii* (A.Gray) Greene)	*Semple 10468* (WAT)	AY772419	AY772433

Table 1. continued

Species	**Source (collectors, number, Herbarium or citation)**	**GenBank accession number** **ITS**	 **ETS**
Benitoa occidentalis (H.M.Hall) D.D.Keck (*Lessingia occidentalis* (H.M.Hall) M.Lane)	Markos & Baldwin (2001)	AF251585	AF251643
Haplopappus foliosus DC.	Markos & Baldwin (2001)	AF251577	AF251635
Haplopappus glutinosus Cass.	Markos & Baldwin (2001)	AF251578	AF251636
Haplopappus macrocephalus (Less.) DC.	Markos & Baldwin (2001)	AF251579	AF251637
Haplopappus marginalis Phil.	Markos & Baldwin (2001)	AF251580	AF251638
Haplopappus paucidentatus Phil.	Markos & Baldwin (2001)	AF251581	AF251639
Hazardia detonsa (Greene) Greene	Markos & Baldwin (2001)	AF251582	AF251640
Hazardia squarrosa (Hook. & Arn.) Greene var. *grindelioides* (DC.) W.D.Clark	Markos & Baldwin (2001)	AF251583	AF251641
Hazardia whytnei (A.Gray) Greene	Markos & Baldwin (2001)	AF251584	AF251642
Isocoma acradenia (Greene) Greene subsp. *eremophila* (Greene) G.L.Nesom	Markos & Baldwin (2001)	AF251572	AF251630
Isocoma menziesii (Hook. & Arn.) G.L.Nesom var. *vernonioides* (Nutt.) G.L.Nesom	Markos & Baldwin (2001)	AF251571	AF251629
Lessingia arachnoidea Greene	Markos & Baldwin (2001)	AF251587	AF251645
Lessingia filaginifolia (Hook. & Arn.) M.A.Lane var. *californica* (DC.) M.A.Lane	Markos & Baldwin (2001)	AF251593	AF251651
Lessingia filaginifolia (Hook. & Arn.) M.A.Lane var. *filaginifolia*	Markos & Baldwin (2001)	AF251589	AF251647
Lessingia germanorum Cham.	Markos & Baldwin (2001)	AF251596	AF251654
Lessingia glandulifera A.Gray var. *glandulifera*	Markos & Baldwin (2001)	AF251599	AF251657
Lessingia glandulifera A.Gray var. *pectinata* (Greene) Jepson	Markos & Baldwin (2001)	AF251597	AF251655
Lessingia glandulifera A.Gray var. *tomentosa* (Greene) Ferris	Markos & Baldwin (2001)	AF251603	AF251661
Lessingia hololeuca Greene	Markos & Baldwin (2001)	AF251604	AF251663
Lessingia lemmonii A.Gray var. *lemmonii*	Markos & Baldwin (2001)	AF251606	AF251664

Table 1. continued

Species	Source (collectors, number, Herbarium or citation)	GenBank accession number	
		ITS	ETS
Lessingia lemmonii A.Gray var. *peirsonii* (J.T.Howell) Ferris	Markos & Baldwin (2001)	AF251608	AF251666
Lessingia lemmonii A.Gray var. *ramulosissima* (Nelson) Ferris	Markos & Baldwin (2001)	AF251610	AF251668
Lessingia leptoclada A.Gray	Markos & Baldwin (2001)	AF251612	AF251670
Lessingia micradenia Greene var. *glabrata* (D.D.Keck) Ferris	Markos & Baldwin (2001)	AF251614	AF251672
Lessingia micradenia Greene var. *micradenia*	Markos & Baldwin (2001)	AF251615	AF251673
Lessingia nana A.Gray	Markos & Baldwin (2001)	AF251616	AF251674
Lessingia nemaclada Greene	Markos & Baldwin (2001)	AF251618	AF251676
Lessingia ramulosa A.Gray	Markos & Baldwin (2001)	AF251620	AF251678
Lessingia tenuis (A.Gray) Coville	Markos & Baldwin (2001)	AF251622	AF251680
Lessingia virgata A.Gray	Markos & Baldwin (2001)	AF251624	AF251682
Arida parviflora (A. Gray) D.R.Morgan & R.L.Hartman (*Machaeranthera parviflora* A.Gray)	Markos & Baldwin (2001)	AF251568	AF251626
Machaeranthera tanacetifolia (Kunth) Nees	Markos & Baldwin (2001)	AF251567	AF251625
Pyrrocoma lanceolata Greene	Markos & Baldwin (2001)	AF251574	AF251632
Xanthisma spinulosum (Pursh) D.R.Morgan & R.L.Hartman (*Machaeranthera pinnatifida* (Hook.) Shinners)	Markos & Baldwin (2001)	AF251569	AF251627
Xanthisma texanum DC. subsp. *drummondii* (Torr. & A.Gray) Semple	Markos & Baldwin (2001)	AF251575	AF251633
Xylorhiza tortifolia (Torr. & A.Gray) Greene	Markos & Baldwin (2001)	AF251570	AF251628

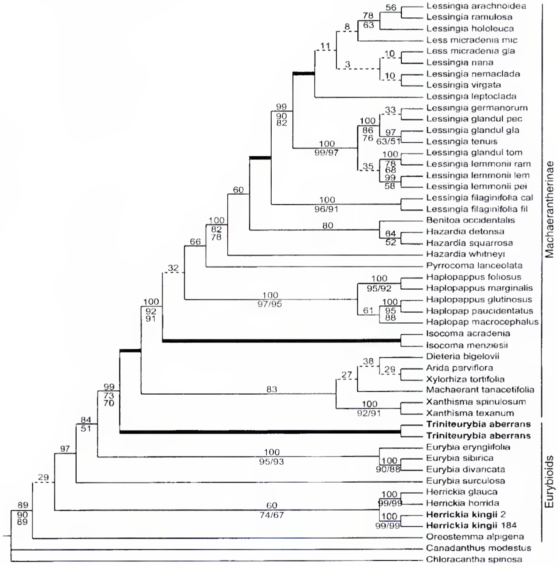


Fig. 1. 50% majority rule consensus tree of the Byaseian analysis of the eurybioids-*Machaerantherinae* (Asteraceae: Astereae); *T. aberrans* and *H. kingii* are in bold; dash lines indicate branches with less than 50% posterior probabilities, thick ones those that have 100% posterior probability, 100% parsimony bootstrap and 100% jacknife support. Posterior probabilities are indicated above the lines, bootstrap and jacknife (second figure) below.

trees. Posterior probabilities are shown on Figure 1, as well as the bootstrap and jacknife support values from the parsimony analysis.

DISCUSSION

Both the preliminary separate ITS and ETS parsimony analyses and the reduced combined analyses (Fig. 1) show that *Herrickia kingii* and *Triniteurybia aberrans* belong to the eurybioid-*Machaerantherinae* lineage of the Astereae. The basal branch of the eurybioid-*Machaerantherinae* receives strong support (posterior probabilities 89%, bootstrap 90%, jacknife 89%), a fact further reinforced by the possession of a non-homoplasic, synapomorphic 1-bp deletion at position 124 (ITS1). Such a relationship had been foreseen for *H. kingii* when described as a species of *Aster* s. l. (e.g., Welsh 1983) or when transferred to *Machaeranthera* section *Xylorhiza* (Cronquist and Keck 1957). Watson (1977), however, later excluded it from *Xylorhiza* when he segregated the section from *Machaeranthera*, pointing out instead similarities to *Aster* s.l. species (*Oreostemma alpigena*, *Eurybia conspicua* and *E. integrifolia*). Hartman (1990) likewise excluded *H. kingii* from *Machaeranthera*. Nesom (1991) mentioned that A. G. Jones (in pers. comm.) thought the species was associated with *Aster* sect. *Oreostemma* (*Oreostemma*), a basal group in the eurybioids. Nesom (1994), however, did not consider this possibility in his review of North American asters, though he did discuss *Tonestus* and the species studied here, noting that this (possibly polyphyletic) genus stood clearly outside *Machaerantherinae*. In transferring *H. kingii* to *Tonestus*, Nesom (1991) stressed its similarities to *T. aberrans*. A relationship to *Aster* s.l. was never envisioned for *T. aberrans*. However, the species was treated in *Macronema*, *Sideranthus* and *Haplopappus*, before its transfer to *Tonestus*, a yellow-rayed member of the *Solidagininae*, by Nesom and Morgan (1990). In all these genera, *T. aberrans* appeared unusual and aptly named.

The combined ETS + ITS analyses (Fig. 1) allow us to determine the position of *T. aberrans* and *H. kingii* within the eurybioid grade. In the parsimony strict consensus tree (not shown), the eurybioids are mostly polytomous, but *T. aberrans* emerges as sister taxon to the *Machaerantherinae*. This relationship is seen clearly in Figure 1 and receives high posterior probabilities (99%), as well as good bootstrap (73%) and jacknife (70%) support in the parsimony analysis (Fig. 1). In no analysis (Brouillet, unpublished data) is *T. aberrans* associated with *Eurybia* species. It occupies an isolated position between *Eurybia* and the *Machaerantherinae* and deserves recognition as a new monotypic genus, described below. Identification of this taxon as sister to the *Machaerantherinae* does not affect relationships previously determined within the subtribe (e.g., Morgan 2003; Markos & Baldwin 2001), and may shed light on the early evolution of this complex of mostly xeric, western species that have undergone a rapid diversification in ecology, morphology and karyology.

The position of *T. kingii* also appears resolved, but in a less striking manner. In all analyses (including a larger ITS study using different sequences for the species than those used here; Brouillet et al., in preparation), the species is sister to *Herrickia* (*Eurybia* sect. *Herrickia* of Nesom 1994; see below) (Fig. 1); it groups here with *H. glauca* and *H. horrida*, two of the three members of the genus. Support for this relationship, however, is not strong (posterior probabilities, 60%; bootstrap 74%, jacknife 67%), and is based on a single synapomorphy (in ETS) that is homoplasic due to parallel changes in the *Machaeranthera* complex. In all analyses done so far (including the large ITS parsimony study), *Herrickia* appears either in a polytomy or basal within *Eurybia* sensu Nesom

(1994). Its distinction from *Eurybia* receives 97% posterior probability, but this branch receives no support in parsimony analyses. Yet, it is defined by two synapomorphies (both from ITS1) without reversal or homoplasy. Another observation reinforces the conclusion that *Herrickia* may be best segregated from *Eurybia*, coming from cpDNA trnL-F sequence data (Brouillet, unpublished): while species of *Eurybia* s. str. have a 4-bp synapomorphic deletion, *Oreostemma*, *Herrickia*, *T. aberrans* and the *Machaerantherinae* all have the standard sequence, which suggests that *Eurybia* s. str. is a distinct clade. Despite this observation, one could advocate separating *E. surculosa* from other *Eurybia* on the basis of its position in Figure 1. The branch leading to this species is long, however. Furthermore, in analyses of ITS data using a larger set of eurybioids, *E. surculosa* groups with other *Euribia* species, though *Eurybia* and other eurybioidds globally are polytomous. The position of *E. surculosa* in the current tree appears the result of low taxon sampling and a long branch in the combined data. At the present time, relationships within and monophyly of *Eurybia* s. str. (including subgenera *Eurybia* and *Heleastrum* of Nesom 1994) cannot be tested appropriately. This is not the case for *Herrickia*, which forms a group in these analyses. Nevertheless, *Herrickia* as a genus appears monophyletic and worthy of reinstatement, with a new circumscription that includes the taxa grouped within section *Herrickia* by Nesom (1994) (i. e., *H. horrida*, *H. glauca* and *H. wasatchensis*), as well as *H. kingii*, as sister to the clade *Eurybia* s. str.-*Triniteurybia*-*Machaerantherinae*.

Herrickia Wooton & Standley, Contr. U.S. Natl. Herb. 16:186. 1913. *Eurybia* section *Herrickia* (Wooton & Standley) G.L. Nesom, Phytologia 77:258. 1994. TYPE: *Herrickia horrida* Wooton & Standley.

Herrickia horrida Wooton & Standley, Contr. U.S. Natl. Herb. 16:186. 1913. *Aster horridus* (Wooton & Standley) S.F. Blake, J. Washington Acad. Sci. 27:379. 1937. *Eurybia horrida* (Wooton & Standley) G.L. Nesom, Phytologia 77:260. 1994.

Herrickia glauca (Nutt.) Brouillet, comb. nov. BASIONYM: *Eucephalus glaucus* Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:299. 1841. *Aster glaucus* (Nutt.) Torr. & A. Gray [*nom. illeg.*], Fl. N. Amer. 2:159. 1841 (non Nees 1818). *Eurybia glauca* (Nutt.) G.L. Nesom, Phytologia 77:260. 1994.

Herrickia glauca (Nutt.) Brouillet var. **glauca**. *Aster glaucodes* S.F. Blake, Proc. Biol. Soc. Washington 35:174. 1922. *Eucephalus formosus* Greene, Pittonia 4:156. 1900. *Aster glaucodes* var. *formosus* (Greene) Kittell in Tidestrom & Kittell, Fl. Ariz. & New Mexico 404. 1941.

Herrickia glauca (Nutt.) Brouillet var. **pulchra** (S.F. Blake) Brouillet, comb. nov. BASIONYM: *Aster glaucodes* S.F. Blake subsp. *pulcher* S.F. Blake, Proc. Biol. Soc. Washington 35:174. 1922. *Eurybia pulchra* (S.F. Blake) G.L. Nesom, Phytologia 77:261. 1994. *Eurybia glauca* (Nutt.) G.L. Nesom var. *pulchra* (S.F. Blake) Brouillet, Sida 20:1562. 2003.

Herrickia wasatchensis (M.E. Jones) Brouillet, comb. nov. BASIONYM: *Aster glaucus* (Nutt.) Torr. & A.Gray var. *wasatchensis* M.E. Jones, Proc. Calif. Acad. Sci., ser. 2, 5:694. 1895. *Eucephalus* Rydb., Fl. Rocky Mts. 1067. 1917. *Aster wasatchensis* (M.E. Jones) S.F. Blake, Contr. U.S. Natl. Herb. 25:557. 1925. *Eurybia wasatchensis* (M.E. Jones) G.L. Nesom, Phytologia 77:262. 1994.

Herrickia kingii (D.C. Eaton) Brouillet, Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Aster kingii* D.C. Eaton, Botany Fortieth Parallel 5:141. 1871. *Machaeranthera kingii* (D.C. Eaton) Cronquist & Keck, Brittonia 9:239. 1957. *Tonestus kingii* (D.C. Eaton) G.L. Nesom, Phytologia 71:125. 1991.

Herrickia kingii (D.C. Eaton) Brouillet, Urbatsch & R.P. Roberts var. **kingii**.

Herrickia kingii (D.C. Eaton) Brouillet, Urbatsch & R.P. Roberts var. **barnebyana** (Welsh & Goodrich) Brouillet, Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Machaeranthera kingii* (D.C. Eaton) Cronquist & Keck var. *barnebyana* Welsh & Goodrich, Brittonia 33:299. 1981. *Aster kingii* D.C. Eaton var. *barnebyana* (Welsh & Goodrich) Welsh, Great Basin Naturalist 43:221. 1983. *Tonestus kingii* (D.C. Eaton) G.L. Nesom var. *barnebyana* (Welsh & Goodrich) G.L. Nesom, Phytologia 71:125. 1991.

Triniteurybia Brouillet, Urbatsch & R.P. Roberts, gen. nov. TYPE: *Macronema aberrans* (A. Nelson) Brouillet, Urbatsch & R.P. Roberts

Ab *Eurybia* differt capitulae eradiatae et foliae stipitato-glandulosae. Differs from *Eurybia* by its eradiate capitula and stipitate-glandular leaves.

Herbs perennial, cespitose; caudices woody, ramified, from slender, creeping taproots. Stems erect, simple, slender, 0.5–2.5(–3) dm, stipitate-glandular. Leaves basal and cauline, alternate; basal mostly persistent, petiolate to subpetiolate, bases tapering, distal sessile; blades ascending, simple, obovate or oblong to broadly oblanceolate, distal usually gradually reduced, 1-nerved, margins sparsely serrate, apices obtuse to subacute, faces stipitate-glandular. Capitulescences of solitary heads or 2–4 in dense, ± corymbiform arrays, sessile or subsessile in axils of distalmost leaves. Heads discoid. Involucres cylindro-campanulate, 9–14 mm. Phyllaries in 3–4 series, imbricate, graduated, bases indurate, 1-nerved, green zones +/- basally truncate, occupying distal 1/2–1/3, apices acute, faces glandular-viscid (exposed parts). Receptacles slightly convex, alveolate, margins toothed, chartaceous, epaleate. Disc florets 25–60, bisexual, fertile; corollas yellow and often reddish (particularly in lobes), slenderly cylindric, barely ampliate, tubes shorter than throats, lobes 5, erect, lanceolate, ca. 0.8 mm, minutely and sparsely puberulent; style-branch 2–3 mm, moderately exserted, appendages linear-triangular, very acute, +/- equaling stigmatic portion, short-hairy. Cypselae fusiform, ca. 10-nerved, ca. 3 mm, faces sparsely strigillose, eglandular; pappi of few bristles in 1 series, unequal, soft, barbellate, barely exceeding disc corollas.

Etymology.—*Triniteurybia* is named for Trinity Lake, Idaho, the type locality, and the closely related genus *Eurybia*, to indicate its relationships.

The genus is known only from the Sawtooth Mountains of Idaho and the Bitterroot Mountains of Montana, where it is considered of conservation concern. It inhabits the crevices of cliffs and outcrops of the dry coniferous montane forest zone, sometimes at or above timberline. The chromosome number is yet unknown.

Triniteurybia aberrans (A. Nelson) Brouillet, Urbatsch & R.P. Roberts, comb. nov. BASIONYM: *Macronema aberrans* A. Nelson, Bot. Gaz. (Crawfordsville) 53:226. 1912. *Sideranthus* *aberrans* (A. Nelson) Rydb., Fl. Rocky Mts. 1067. 1917. *Haplopappus aberrans* (A. Nelson) H.M. Hall, Carnegie Inst. Washington Publ. 389:185. 1928. *Tonestus aberrans* (A. Nelson) G.L. Nesom & Morgan, Phytologia 68:174–180.

ACKNOWLEDGMENTS

The authors wish to thank John C. Semple (University of Waterloo) and Rich Spellenberg (New Mexico State University) for providing leaf material for this study and Guy L. Nesom for useful comments. The research was made possible through grant 11-01 from NSERC (Canada) to L. Brouillet and support from the Biological Sciences Department, Louisiana State University, to L.E. Urbatsch. We thank Guy Nesom for reviewing an earlier draft of this manuscript

REFERENCES

Cronquist, A. and D.D. Keck. 1957. A reconstitution of the genus *Machaeranthera*. Brittonia 9:231–239.

Fougère-Danezan, M., S. Maumont, and A. Bruneau. 2003. Phylogenetic relationships in resin-producing Detarieae inferred form molecular data and preliminary results for a biogeographic hypothesis. In: B.B. Klitgaard and A. Bruneau, eds. Advances in legume systematics, part 10, higher level systematics. Royal botanic Gardens, Kew. Pp. 161–180.

Hartman, R.L. 1990. A conspectus of *Machaerantehra* (Asteraceae: Astereae). Phytologia 68:439–465.

Linder, C.R., L.R. Goertzen, B. Vanden Heuvel, J. Francisco-Ortega, and R.K. Jansen. 2000. The complete External Transcribed Spacer of 18S-26S rDNA: Amplification and phylogenetic utility at low taxonomic levels in Asteraceae and closely allied families. Molec. Phylog. Evol. 14:285–303.

Markos, S. and B.G. Baldwin. 2001. Higher-level relationships and major lineages of *Lessingia* (Compositae, Astereae) based on nuclear rDNA internal and external transcribed spacer (ITS and ETS) sequences. Syst. Bot. 26:168–183.

Morgan, D.R. 2003. nrDNA external transcribed spacer (ETS) sequence data, reticulate evolution, and the systematics of *Machaeranthera* (Asteraceae). Syst. Bot. 28:179–190.

Morgan, D.R. and R.L. Hartman. 2003. A synopsis of *Machaeranthera* (Asteraceae; AStereae), with recognition of segregate genera. Sida 20:1387–1416.

Nesom, G.L. 1991. Transfer of *Aster kingii* to *Tonestus* (Asteraceae: Astereae). Phytologia 71:122–127.

Nesom, G.L. 1994. Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae) emphasizing the New World species. Phytologia 77:141–297.

Nesom, G.L. and D.R. Morgan. 1990. Reinstatement of *Tonestus* (Asteraceae: Astereae). Phytologia 68:174–180.

Noyes, R.D. and L.H. Rieseberg. 1999. ITS sequence data support a single origin for North American Astereae (Asteraceae) and reflect deep geographic divisions in *Aster s.l.* Amer. J. Bot. 68:398–412.

Roberts, R.P. and L.E. Urbatsch. 2004. Molecular phylogeny of *Chrysothamnus* and related genera (Asteraceae, Astereae) based on nuclear ribosomal 3'ETS and ITS sequence data. Syst. Bot. 29:199–215.

Ronquist, F. and J.P. Huelsenbeck. 2003. Mr. Bayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19:1572–1574.

Semple, J.C., S.B. Heard, and L. Brouillet. 2002. Cultivated and native Asters of Ontario (Compositae: Astereae): *Aster* L. (including *Asteromoea* blume, *Diplactis* Raf. and *Kalimeris* (Cass.) Cass.), *Callistephus* Cass., *Galatella* Cass., *Doellingeria* Nees, Oclemena E.L. Greene, Eurybia (Cass.) S.F. Gray, Canadanthus Nesom, and *Symphyotrichum* Nees (including *Virgulus* Raf.). Univ. Waterloo Publ. Biol. Series 41.

Swofford, D.L. 2002. PAUP*. Phylogenetic Analysis using Parsimony (*and Other Methods). Version 4. Sunderland: Sinauer Associates.

Watson, T.J., Jr. 1977. The taxonomy of *Xylorhiza* (Asteraceae-Astereae). Britonnia 29:199–216.

Welsh, S.L. 1983. Utah flora: Compositae (Asteraceae). Great Basin Naturalist 43:179–357.

NEW COMBINATIONS IN *EUTROCHIUM* (ASTERACEAE: EUPATORIEAE), AN EARLIER NAME THAN *EUPATORIADELPHUS*

Eric E. Lamont

Honorary Research Associate
Institute of Systematic Botany
The New York Botanical Garden
Bronx, New York 10458, U.S.A.

ABSTRACT

The following new combinations are proposed: *Eutrochium dubium, Eutrochium fistulosum, Eutrochium maculatum, Eutrochium maculatum* var. *bruneri, Eutrochium maculatum* var. *foliosum, Eutrochium purpureum, Eutrochium purpureum* var. *holzingeri*, and *Eutrochium steelei*.

RESUMEN

Se proponen las siguientes combinaciones nuevas: *Eutrochium dubium, Eutrochium fistulosum, Eutrochium maculatum, Eutrochium maculatum* var. *bruneri, Eutrochium maculatum* var. *foliosum, Eutrochium purpureum, Eutrochium purpureum* var. *holzingeri*, y *Eutrochium steelei*.

Plants known as Joe-Pye weeds have been long treated in *Eupatorium* L. (Lamont 1995). Sometimes, they have been treated as generically distinct, as members of *Eupatoriadelphus* R.M. King & H. Robinson (1970). Recent studies based on chloroplast DNA (cpDNA) restriction site analysis (Schilling et al. 1999) and nuclear internal transcribed spacer (ITS) sequence data (Schmidt & Schilling 2000) have been interpreted as providing support for recognizing *Eupatoriadelphus* as distinct. If treated as distinct at generic rank, an earlier name should be used for the group, *Eutrochium* Raf.

Eutrochium Raf., New Fl. 4:78. 1836 [1838]. TYPE: *Eutrochium purpureum* (L.) E.E. Lamont (LECTOTYPE, here designated).

The following new combinations are needed for treatment of Joe-Pye weeds as members of *Eutrochium* in a forthcoming volume of Flora of North America North of Mexico.

Eutrochium dubium (Willd. ex Poiret) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium dubium* Willd. ex Poiret in J. Lamarck et al., Encycl. Suppl. 2:606. 1811. *Eupatoriadelphus dubius* (Willd. ex Poiret) R.M. King & H. Robinson, Phytologia 19:432. 1970.

Eutrochium fistulosum (Barratt) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium fistulosum* Barratt, Eupatoria Verticillata no. 1. 1841; in A. Wood, Class-book Bot., ed. 10, 314. 1849. *Eupatoriadelphus fistulosus* (Barratt) R.M. King & H. Robinson, Phytologia 19:432. 1970.

Eutrochium maculatum (L.) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium maculatum* L., Cent. Pl. I, 27. 1755. *Eupatoriadelphus maculatus* (L.) R.M. King & H. Robinson, Phytologia 19:432. 1970.

Eutrochium maculatum (L.) E.E. Lamont var. **bruneri** (A. Gray) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium bruneri* A. Gray in A. Gray et al., Syn. Fl. N. Amer. 1(2):96. 1884. *Eupatoriadelphus maculatus* (L.) R.M. King & H. Robinson var. *bruneri* (A. Gray) R.M. King & H. Robinson, Phytologia 45:465. 1980.

Eutrochium maculatum (L.) E.E. Lamont var. **foliosum** (Fernald) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium purpureum* L. var. *foliosum* Fernald, Rhodora 10:86. 1908. *Eupatorium maculatum* L. var. *foliosum* (Fernald) Wiegand, Rhodora 22:66. 1920.

Eutrochium purpureum (L.) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium purpureum* L., Sp. Pl. 838. 1753. *Cunigunda purpurea* (L.) Lunell, Amer. Midl. Naturalist 5:35. 1917. *Eupatoriadelphus purpureus* (L.) R.M. King & H. Robinson, Phytologia 19:432. 1970.

Eutrochium purpureum (L.) E.E. Lamont var. **holzingeri** (Rydberg) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium holzingeri* Rydberg, Brittonia 1:97. 1931. *Eupatorium purpureum* L. var. *holzingeri* (Rydberg) E.E. Lamont, Phytologia 69:468. 1990 [1991].

Eutrochium steelei (E.E. Lamont) E.E. Lamont, comb. nov. BASIONYM: *Eupatorium steelei* E.E. Lamont, Brittonia 42:279. 1990. *Eupatoriadelphus steelei* (E.E. Lamont) G.J. Schmidt & E.E. Schilling, Amer. J. Bot. 87:726. 2000.

ACKNOWLEDGMENTS

Appreciation is expressed to George Yatskievych for calling attention to *Eutrochium* Raf. being the oldest validly published generic name for the Joe-Pye weeds; Harold Robinson for sharing his insight into the taxonomy of *Eupatorium*, *Eupatoriadelphus*, and *Eutrochium*; John Strother and Guy Nesom for reviewing an earlier draft of this manuscript; and Barney Lipscomb for expediting publication of these new nomenclatural combinations.

REFERENCES

KING, R.M. and H. ROBINSON. 1970. Studies in Eupatorieae (Compositae). XXV. A new genus, *Eupatoriadelphus*. Phytologia 19:431–432.

LAMONT, E.E. 1995. Taxonomy of *Eupatorium* section *Verticillata* (Asteraceae). Mem. New York Bot. Gard. 72:1–68.

SCHILLING, E.E., J.L. PANERO, and P.B. COX. 1999. Chloroplast DNA restriction site data support a narrowed interpretation of *Eupatorium* (Asteraceae). Pl. Syst. Evol. 219:209–223.

SCHMIDT, G.J. and E.E. SCHILLING. 2000. Phylogeny and biogeography of *Eupatorium* (Asteraceae: Eupatorieae) based on nuclear ITS sequence data. Amer. J. Bot. 87:716–726.

NEW COMBINATIONS IN NORTH AMERICAN *SYMPHYOTRICHUM* SUBGENUS *ASTROPOLIUM* (ASTERACEAE: ASTEREAE)

Scott D. Sundberg

Department of Botany & Plant Pathology
Oregon State University
2082 Cordley Hall
Corvallis, Oregon 97331-2902, U.S.A.
sundbers@science.oregonstate.edu

ABSTRACT

Five new combinations in *Symphyotrichum tenuifolium* and *S. subulatum*, of subgenus *Astropolium* (Nutt.) Semple are presented. A selection of synonyms are listed for each taxon. Geographical ranges of each variety is presented and the characteristics and distributions of intermediate populations are discussed.

RESUMEN

Symphyotrichum subgenus *Astropolium* (Nutt.) Semple ha sido típicamente circunscrita usando los nombres de *Aster* subg. *Oxytripolium* (DC.) Torr. & A. Gray o *S.* sect. *Oxytripolium* (DC.) G.L. Nesom (Jones 1980; Semple & Brouillet 1980; Sundberg 1986; Nesom 1994). Todas las interpretaciones recientes han incluido un grupo central de taxa norteamericanos y se han incluido otros taxa principalmente en base a una morfología compartida o número cromosomático base.

INTRODUCTION

North American species of *Symphyotrichum* subgenus *Astropolium* (Nutt.) Semple have typically been treated as *Aster* subg. *Oxytripolium* (DC.) Torr. & A. Gray (Jones 1980; Semple & Brouillet 1980; Sundberg 1986). These references have included a core group of taxa with shared morphological characteristics and base chromosome number. Several additional taxa were included in the subgenus, but were excluded by Sundberg (1986). Nesom (1994) placed the core group of taxa in *Symphyotrichum* sect. *Oxytripolium* (DC.) G.L. Nesom and added seven South American species. Sundberg's (1986) treatment of the subgenus included eight taxa in three species, all of which were recognized at the species rank by Nesom (1994).

This paper presents five new combinations in *Symphyotrichum tenuifolium* and *S. subulatum*, making them available for use in an upcoming volume of the Flora of North America. No new combinations are proposed in the third North American species of subgenus *Astropolium*, *S. potosinum* (A. Gray) G.L. Nesom. A selection of synonyms are listed for each taxon. Data presented here are summarized from Sundberg (1986).

SIDA 21(2): 903–910. 2004

Symphyotrichum tenuifolium

Symphyotrichum tenuifolium consists of the two parapatric varieties, *tenuifolium* and *aphyllum*. Both varieties are diploids with $n = 5$ chromosomes (var. *tenuifolium*: Louisiana, St. Mary Parish, *Sundberg 2195*; var. *aphyllum*: Florida, Monroe Co., *Sundberg 2325*). The varieties can be distinguished using the following key:

1. Plants colonial, rhizomes long, not profusely branched; stems solitary, not wiry; midstem leaves (1.5–)3–6 mm wide; involucres 6–9.5(–11) mm; disc florets 25–45(–54), (4–)4.7–6(–6.5) mm; ray florets (12–)17–25; cypselae 2.8–4(–4.5) mm; pappus 5–6.1 mm _____ var. **tenuifolium**
1. Plants not colonial, rhizomes short, compact, profusely branched; stems clustered, slender, wiry, narrow; midstem leaves nearly filiform, (1–)1.5–2.7 mm wide; involucres 4.1–5.3 mm; disc florets (10–)13–23, 3.4–4.6 mm; ray florets 10–16 mm; cypselae 1.5–2(–2.5) mm; pappus 3–4.4 mm _____ var. **aphyllum**

Symphyotrichum tenuifolium var. *tenuifolium* is distributed along the Atlantic coast of the United States from Massachusetts to northern Florida, and along the Gulf of Mexico coast from northern Florida to Texas. It is not uncommon on dark-colored mud in coastal salt marshes.

Variety *aphyllum* has a more southern distribution and is known from dark mud or marl in coastal salt marshes of southern and central Florida, the Bahamas, and Cuba.

Intermediates between the two varieties are frequent along the Gulf of Mexico Coast, from Taylor to Pinellas counties, in northern and central peninsular Florida. In these populations varieties *tenuifolium* and *aphyllum* intergrade in nearly all distinguishing characters (Table 1, Table 2), especially in stem diameter, leaf width, and head size. The rhizome system of intermediates is generally more like that of var. *tenuifolium*. Individuals in the northern part of this zone of intergradation closely approach the morphology of var. *tenuifolium*, southern populations are more similar to var. *aphyllum*, but most populations combine features of both varieties. Observations of populations in the field suggest that the extreme forms are clonally-derived, peripherally divergent populations between the varieties.

Sundberg (1986) conducted hybridization experiments between two individuals of var. *tenuifolium* with var. *aphyllum*. Following sixteen attempts to cross the varieties, he reported a 31% hybridization success rate (based on recovery of mature cypselae). Hybrid plants exhibited a mixture of vegetative traits of the two varieties. When compared to the parent taxa, the hybrids were intermediate in leaf and stem widths and rhizome morphology. Only vegetative characters were assessed, as experiments were terminated before the hybrids flowered.

Symphyotrichum tenuifolium (L.) G.L. Nesom, Phytologia 77:293. 1994 (1995). BASIONYM: *Aster tenuifolius* L., Sp. Pl. 2:873–874. 1753. TYPE?: "in America septentrionale," without collector or date, specimen number 997.26 (LINN; photographs GH!, NY!, UC!). This specimen is annotated *A. tenuifolius* in Linnaeus' handwriting.

TABLE 1. Character states used to distinguish *Symphyotrichum tenuifolium* var. *tenuifolium*, var. *aphyllum*, and intermediates in Table 2.

Character	var. *tenuifolium*	var. *aphyllum*	intermediates
Habit	rhizomes creeping	stems clustered	na
Midstem leaf width	> 3mm	< 2 mm	2–3 mm
Involucre height	> 6 mm	< 5 mm	5–6 mm
Number of disk florets	> 25	< 22	22–25
Disk floret length	> 4.6 mm	< 4.3 mm	4.3–4.6 mm
Number of rays	> 17	< 14	14–17
Cypsela length	> 2.8 mm	< 2.4 mm	2.4–2.8 mm
Pappus length	> 4.5 mm	< 4.0 mm	4.0–4.5 mm

TABLE 2. Representative specimens of *Symphyotrichum subulatum* vars. *tenuifolium* and *aphyllum*, arranged from north to south along the Gulf coast of peninsular Florida. *Morphological characteristics of var. *tenuifolius* (T), var. *aphyllus* (A), or intermediate (-); characters are listed in the order used in Table 1.

Florida County	Voucher	Character states*	Identification
Gulf	*Sundberg 2241* (TEX)	T-TTTT-T	var. *tenuifolius*
Franklin	*Sundberg 2253* (TEX)	T-TTTTTT	var. *tenuifolius*
Taylor	*Godfrey 61659* (FSU)	TAAAAAAA	intermediate
Taylor	*Sundberg 2271* (TEX)	TATT-T—	intermediate
Levy	*Sundberg 2291* (TEX)	TAT-T—T	intermediate
Levy	*Sundberg 2293* (TEX)	TATTTT-T	intermediate
Levy	*Cooley & Eaton 6417* (FSU)	ATA——	intermediate
Citrus	*Godfrey 65111* (FSU)	AATT—AA	intermediate
Citrus	*Barilotti s.n.* (NLU)	TATAT-AA	intermediate
Hernando	*Sundberg 2302* (TEX)	TA-AA-AA	intermediate
Hernando	*Sundberg 2302* (TEX)	TAT—TA	intermediate
Hernando	*Cooley 5460* (NY)	AA-A—A-	intermediate
Hernando	*Cooley 5460* (GH)	TAT-TTA-	intermediate
Pinellas	*Thorne 9401* (GH)	TA-AT—	intermediate
Hillsborough	*Sundberg 2308* (TEX)	AAAAAAAA	var. *aphyllus*
Charlotte	*Sundberg 2315* (TEX)	AAAAAAAA	var. *aphyllus*
Lee	*Brumbach 8726* (NY)	AAAAAAAA	var. *aphyllus*

Symphyotrichum tenuifolium (L.) G.L. Nesom var. **aphyllum** (R.W. Long) S.D. Sundb., comb. nov. BASIONYM: *Aster tenuifolius* L. var. *aphyllus* R.W. Long, Rhodora 72:40. 1970. TYPE: U.S.A. FLORIDA. Hillsborough Co.: NW of Tampa, S of State Route 580 and W of Rocky Creek, 24 Dec 1962, *Lakela 25610* (HOLOTYPE: GH!; ISOTYPES: GA!, RSA!, USF!).

Aster bracei Britton ex Small, Fl. Miami 190, 200. 1913. *Symphyotrichum bracei* (Britton ex Small) G.L. Nesom, Phytologia 77:276. 1994 (1995). TYPE: BAHAMAS. NEW PROVIDENCE: 31 Aug 1904, *Britton & Brace 394* (HOLOTYPE: NY!).

Symphyotrichum subulatum

Symphyotrichum subulatum is widely distributed in moist habitats in the Americas, from southern and eastern states of the United States, through the Caribbean islands and Central America, to South America. Variety *ligulatum* is a widespread weedy annual on disturbed soils from Nebraska south to Tamaulipas, Mexico, and from Alabama to New Mexico. Variety *parviflorum* occurs in North America, West Indies, Mexico, and northern South America and has been introduced in other parts of the world. Variety *elongatum* grows in Florida, coastal Georgia, and the Bahamas. Variety *subulatum* is common in salt marshes and brackish areas along the Atlantic coast from New Brunswick to northern Florida. Variety *squamatum* is an introduced taxon in the United States and elsewhere, with a native habitat of saline and freshwater regions, especially in the southern half of South America.

The five varieties recognized here differ in chromosome number, ligule size, capitulescence morphology, number of disk and ray florets, head size, and presence of basal rosettes. Within a single population plants may be tall and with numerous capitula, or short and monocephalous. Within a variety it is typical for individual diagnostic characters to vary.

Symphyotrichum subulatum has a base chromosome number of $x = 5$. Varieties *ligulatum* (Texas, Travis Co., *Sundberg 1375*), *parviflorum*, (California, Kern Co., *Sundberg 2094*) and *subulatum* (Georgia, Glynn Co., *Sundberg 2342*) are diploids with $n = 5$, and varieties *elongatum* (Florida, Dade Co., *Sundberg 2324*) and *squamatum* (Argentina, Prov. Salta, *Lavin & Lavin 5809*) are tetraploids with $n = 10$ (for 79 more chromosome count citations, see Sundberg 1986). Greenhouse studies of the species (Sundberg 1986) showed that varieties *elongatum*, *parviflorum*, *squamatum*, and *subulatum* are self-compatible. This may facilitate the fixation of variant forms and result in greater infraspecific variability in these varieties. Variety *ligulatum* is not self compatible and is the least variable taxon.

The varieties intergrade morphologically where their distributions approach one another. This may be the result of past hybridization events and limited gene flow across reproductive barriers. Artificial hybrids produced in the greenhouse among the varieties are highly sterile, yet, for example, 2% of the pollen of the triploid hybrid, var. *parviflorum* × var. *elongatum* stains darkly with cytoplasmic stain, suggesting that a small fraction of the pollen may be viable (Sundberg 1986).

Varieties *ligulatum* and *parviflorum*: Populations intermediate in ligule length and width occur in trans-Pecos Texas, parts of New Mexico (including the type of *A. neomexicanus* Wooton & Standl., collected in Chaves Co.), Arizona, and Chihuahua, Mexico. These are fertile plants in stable populations and produce plump, apparently viable cypselae.

Varieties *elongatum* and *subulatum*: Intermediates between these varieties occur sporadically in northeastern Florida (Duval County) and along the coast of the Florida panhandle. Intergradation is demonstrated in the compactness of the capitulescence and the number of disk and ray florets.

Varieties *elongatum* and *parviflorum*: Although readily distinguishable over much of their ranges, similar forms of the two varieties are found in southern Florida, where their distributions approach. In this area individuals of var. *parviflorum* are more robust (to 1.5 m tall) than elsewhere and the ligules are often pink, instead of white. Variety *parviflorum* is usually more diffusely and more equally branched in the capitulescence than var. *elongatum*. The latter variety often has long branches in the capitulescence, with shorter peduncles that are often disposed toward the upper side of the branch. In addition, variety *parviflorum* has shorter heads, narrower phyllaries, fewer and shorter ray florets, and fewer disk florets than var. *elongatum*.

Symphyotrichum subulatum (Michx.) G.L. Nesom, Phytologia 77:293. 1994 (1995). *Aster subulatus* Michx.. Fl. Bor.-Amer. 2:111. 1803. TYPE: U.S.A. "Pensylvania:" *Michaux s.n.* (LECTOTYPE [Bosserdet 1970]: P, photograph TEX!).

Symphyotrichum subulatum (Michx.) G.L. Nesom var. **elongatum** (Boss.) S.D. Sundb., comb. nov. BASIONYM: *Aster subulatus* var. *elongatus* Boss., Taxon 19:250. 1970. TYPE: U.S.A. FLORIDA. Hillsborough Co.: Tampa, 20 Aug 1895, *Nash 2416* (LECTOTYPE [Jones & Lowry 1986]: P; photograph: TEX!).

Aster bahamensis Britton, Bull. Torrey Bot Club 41:14. 1914. *Aster subulatus* Michx. var. *bahamensis* (Britton) Boss., Taxon 19:249. 1970. *Symphyotrichum bahamense* (Britton) G.L. Nesom, Phytologia 77:276. 1994 (1995). TYPE: BAHAMAS. Great Bahama: Barnett's Point, 5–13 Feb 1905, *Britton & Millspaugh 2621* (HOLOTYPE: NY!, photograph TEX!; ISOTYPE: F!).

Symphyotrichum subulatum (Michx.) G.L. Nesom var. **ligulatum** (Shinners) S.D. Sundb., comb. nov. BASIONYM: *Aster subulatus* Michx. var. *ligulatus* Shinners, Field & Lab. 21:159. 1953. TYPE: U.S.A. TEXAS. Hill Co.: 6.9 mi SW of Hillsboro, bottom of dried-up pond, sandy clay, rays light lavender, 23 Oct 1949, *Shinners 12057* (HOLOTYPE: SMU; ISOTYPE: GH!).

Tripolium divaricatum Nutt., Trans. Amer. Philos. Soc. n.s. 7:296. 1841. *Aster divaricatus* (Nutt.) Torr. & A. Gray, Fl. N. Amer. 2:163. 1841. non L., Sp. Pl.: 873. 1753, *Symphyotrichum divaricatum* (Nutt.) G.L. Nesom, Phytologia 77:279. 1994 (1995). Type: Innundated [sic] banks of the Mississippi, *Nuttall s.n.* (HOLOTYPE: PH!, photograph TEX!).

Distinctive, localized forms of variety *ligulatum* occur in some areas. Collections from the Dallas-Fort Worth area of Texas have particularly small heads and florets. Along the coast of Texas and Tamaulipas, near the mouth of the Rio Grande and southward, plants are especially large, sometimes over two meters tall, and exhibit the largest capitula, with the most phyllaries, ray florets, and disk florets found in the variety. These forms intergrade gradually into more typical forms and are not deemed to be worthy of nomenclatural recognition.

Symphyotrichum subulatum (Michx.) G.L. Nesom var. **parviflorum** (Nees) S.D. Sundb., comb. nov. BASIONYM: *Tripolium subulatum* (Michx.) DC. var. β *parviflorum* Nees, Gen. sp. Aster.: 157, 286. 1833. TYPE: U.S.A. HAWAII: Oahu, 1816 or 1817, *Chamisso s.n.* (LECTOTYPE, here designated: G-DC; microfiche!, photograph!).

Erigeron expansus Poepp. ex Spreng., Syst. Veg. 3:518. 1826. *Symphyotrichum expansum* (Poepp. ex Spreng.) G.L. Nesom, Phytologia 77:281. 1994 (1995). TYPE: "En. pl. Cub. MSS. In siccis calidis Cubae. Octbr." (HOLOTYPE: W?; ISOTYPES: HAL!, MO!, NY, F!).

Aster divaricatus (Nutt.) Torr. & A. Gray var. *sandwicensis* A. Gray in H. Mann, Proc. Amer. Acad. Arts 7:173. 1867. *Aster sandwicensis* (A. Gray in H. Mann) Hieron., Bot. Jahrb. Syst. 29:20. 1901. *Aster subulatus* Michx. var. *sandwicensis* (A. Gray ex H. Mann) A.G. Jones, Brittonia 36:465. 1984. TYPE: U.S.A. HAWAII: Oahu, 1816 or 1817, *Chamisso s.n.* (LECTOTYPE: [Jones 1984]: G-DC; microfiche!, photograph!).

Jones (1984) designated a specimen in G-DC as the lectotype of *Aster divaricatus* var. *sandwicensis* and listed homotypic and heterotypic synonyms of the variety. She listed *Tripolium subulatum* (Michx.) DC. var. β Nees as "unnamed" in the list of homotypic taxa, but did not recognize, or explicitly lectotypify, the variety. Sundberg later examined high resolution photographs of the lectotype and identified the specimen as var. *parviflorum*, and not var. *squamatum*, as the name has been applied in earlier publications.

Nees (1833) cited *Tripolium subulatum* (Michx.) DC. var. β as "β. Parviflorus, caule supradecomposito, calathiis dimidio minoribus," which could be interpreted as a polynomial, or an informal description of a form. However, on page 286, in "synonyma addenda vel corrigenda" Nees writes, "Ad *Tripolium subulatum* var. β *parviflorum* p. 157, *Aster inconspicuus* Less. in Schlechtend. Lin. V. p. 143," which changed the "*parviflorus*" to "*parviflorum*" to agree in gender with *Tripolium*. He indicated that "β *parviflorum*" was based on *A. inconspicuus* Less., and associated "Var." with the varietal epithet. Thus, Nees' correction was to list *A. inconspicuus* Less as a synonym of his new variety. The lectotype of var. *parviflorum* is further selected on the basis of Nees' (1833) statements on p. 143 that "Var. β in O Wahu insula (Cham.)." and "Vidi exempla Americae borealis et O Wahu insulae," indicating that he had seen a specimen of the variety collected in Oahu by Chamisso.

Variety *parviflorum* varies in ligule length, ligule pigmentation (white or pink), head size, and vegetative characters. Populations with abnormally large heads and pigmented ligules occur sporadically in the states of Mexico and Veracruz, of central Mexico.

Symphyotrichum subulatum (Michx.) G.L. Nesom var. **squamatum** (Spreng.) S.D. Sundb., comb. nov. BASIONYM: *Conyza squamata* Spreng., Syst. Veg. 3:515. 1826; *Aster squamatus* (Spreng.) Hieron., Bot. Jahrb. Syst. 29:19. 1901. *Conyzanthus squamatus* (Spreng.) Tamamschjan, FL., U.R.S.S. 25:186. 1959. *Symphyotrichum squamatum* (Sprengel) G.L. Nesom, Phytologia 77:292. 1994 (1995). TYPE: URUGUAY: Montevideo, *Sello[w] s.n.* (HOLOTYPE: P).

Sprengel's Asteraceae specimens were sold to Schultz-Bipontinus, whose herbarium is now part of the Cosson herbarium at P (Stafleu & Cowan 1985). Because this is the only known collection by Friedrich Sellow from Montevideo in the Sprengel Herbarium, the P specimen (Sprengel Herb #1064) may be regarded as a holotype. Stafleu and Cowan note that Sello crossed out the letter "w" on many labels to reflect the original family name. Sprengel used the spelling, "Sello" in the original description.

The branching of the capitulescence, head size, and cypsela pubescence vary greatly in var. *squamatum*. Populations with glabrous cypselae, and narrow phyllaries and heads occur in the vicinity of Tucuman Province in Argentina, as well as around Buenos Aires. In other respects these plants are typical of the variety. In Chile a form with large involucres (8.5 mm high), ligules that extend 1.5 mm beyond the pappus, and cypselae ca. 3.2 mm long exist. These occur in proximity to populations of typical var. *squamatum*, which has shorter involucres, cypselae, and ligules. Similar large-headed forms, but with short ligules are found in Peru. Collections of these variants of var. *squamatum* are few and additional study may reveal that some of the populations represent distinct varieties.

Symphyotrichum subulatum (Michx.) G.L. Nesom var. **subulatum**

Aster subulatus Michx. var. *obtusifolius* Fernald, Rhodora 16:61. 1914. TYPE: CANADA. NEW BRUNSWICK. Gloucester Co.: Bathurst, brackish marsh along Middle River, 13 Aug 1913, *Blake* 5372 (HOLOTYPE: GH!; ISOTYPES: CAS!, LL!, NY!, US!).

Aster subulatus Michx. var. *euroauster* Fernald & Griscom, Rhodora 37:183. 1935. TYPE: U.S.A. VIRGINIA. Norfolk Co.: border of gum swamp near North Landing, 22 Sep 1933, *Fernald & Griscom 2919* (HOLOTYPE: GH!).

Aster ensifer Boss., Taxon 19:250. 1970. TYPE: U.S.A. MASSACHUSETTS: Cambridge, margin of salt marsh, 2 Oct 1901, *Robinson & Fernald 65* (HOLOTYPE: P, photograph TEX!; ISOTYPES: CAS!, DS!, GA!, GH!, ILL, LL!, MICH!, MO!, NY!, POM!, UC!, US!).

Plants of variety *subulatum* from the northern Atlantic coast are shorter, with fewer capitula, larger leaves in the capitulescence, and longer ligules than plants from the southern Atlantic coast of the United States. The form that occurs in New Brunswick has been treated as *Aster subulatus* Michx. var. *obtusifolius* Fernald. However, this represents an extreme form in a gradual cline, and one variable variety is recognized here.

ACKNOWLEDGMENTS

I thank Linda Hardison for assisting with the production of the manuscript, Laurent Gautier and Muriel Hecquet for sending high-resolution photographs of a type specimen at G-DC, Almut Jones for providing photographs of type specimens, Guy Nesom for his comments on the manuscript, and the curators of CAS, DS, F, FSU, GA, GH, HAL, K, LL, MICH, MO, NLU, NY, POM, RSA, TEX, and USF for specimen loans used for this study.

REFERENCES

BOSSERDET, P. 1970. Deux acceptions d'*Aster subulatus*. Taxon 19:244–250.

JONES, A.G. 1980. A classification of the new world species of *Aster* (Asteraceae). Brittonia 32:230–239.

Jones, A.G. 1984. Nomenclatural notes on *Aster* (Asteraceae)—III. The status of *A. sandwicensis*. Brittonia 36:463–466.

Jones, A.G. and P.P. Lowry. 1986. Types and selected historic specimens of *Aster* s.l. (Asteraceae) in the Herbarium, Laboratoire de Phanérogamie, Muséum national d'Histoire naturelle, Paris (P). Adansonia 4:393–412.

Nees, C.G. 1833. Genera et species Asterearum, 2nd printing.

Nesom, G.L. 1994 (1995). Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. Phytologia 77:141–297.

Semple, J.C. and L. Brouillet. 1980. A synopsis of North American asters: the subgenera, sections, and subsections of *Aster* and *Lasallea*. Amer. J. Bot. 67:1010–1026.

Stafleu, F.A. and R.S. Cowan. 1985. Taxonomic literature: vol. v: Sal–Ste. Boston: W. Junk Publishers, The Hague.

Sundberg, S.D. 1986. The systematics of *Aster* subgenus *Oxytripolium* (Compositae) and historically allied species. Ph.D. dissertation, University of Texas at Austin, Austin.

SEED AND CAPSULE CHARACTERS IN *ARCYTOPHYLLUM*, *BOUVARDIA*, AND *MANETTIA* (RUBIACEAE), WITH NOTES ON *A. SERPYLLACEUM*

Edward E. Terrell[1]

Research Collaborator
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.

Harold Robinson

Curator
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.

ABSTRACT

Seed and capsule characters of several species of *Arcytophyllum*, *Bouvardia*, and *Manettia* (Hedyotideae: Rubiaceae) are described and compared. Seed characters are illustrated by scanning electron microscopy. Morphological similarities and differences are emphasized and outlined by a descriptive key. All characters of *Arcytophyllum serpyllaceum* and *A. muticum* were compared in tabular format, and a strong similarity was noted. These results support previous work that considered A. *serpyllaceum* a member of the genus *Arcytophyllum*.

RESUMEN

Las semillas y frutos de algunas especies de *Arcytophyllum*, *Bouvardia* y *Manettia* (Hedyotideae; Rubiaceae) son descritas y comparadas. Los caracteres de las semillas son representados mediante imágenes producidas por un microscopio electrónico de barrido. Las semejanzas y diferencias morfológicas de estos géneros son enfatizadas y esquematizadas por medio de una clave descriptiva. Todos los caracteres de *Arcytophyllum serpyllaceum* y *A. muticum* fueron comparados en una tabla, mostrando éstos un alto grado de similitud. Los resultados obtenidos, apoyan la noción sugerida por estudios previos, de que *Arcytophyllum serpyllaceum* es en realidad un miembro del genero *Arcytophyllum*.

INTRODUCTION

This study of seeds and capsules of three genera belonging to the tribe Hedyotideae (Rubiaceae), follows the pattern of recent work on this tribe (e.g., Terrell 1996; Terrell & Robinson 2003). These studies involved examination of surface features of seeds by dissecting microscope and scanning electron microscopy (SEM). Revision of *Houstonia* (Terrell 1996) showed seed characters and chromosome numbers to be especially important in revealing relationships.

The three genera in the present study, *Arcytophyllum*, *Bouvardia*, and *Manettia*, are from Mexico, and Central and South America. These genera have largely escaped the past tendency to include many members of the tribe in a broad concept of the genus *Hedyotis*, and *Bouvardia* and *Manettia* have sometimes been placed in the tribe Cinchoneae because of the conspicuous papery winged seeds.

---

[1] Address for correspondence: 14001 Wildwood Drive, Silver Spring, Maryland 20905, U.S.A

Bremer and Manen (2000) in a molecular study placed *Manettia* and *Bouvardia* in the combined Hedyotideae/Spermacoceae where the older name Spermacoceae was adopted. Terrell and Wunderlin (2003) questioned this action on the basis of fundamental morphological differences between the two tribes. Here and elsewhere (e.g., Terrell & Robinson 2003) we continue to place the present genera in the tribe Hedyotideae sens. str.

All three of our studied genera have recorded chromosome numbers of $x = 9$ (Lewis 1965: 199), a number that is frequent in the Hedyotideae, but unusual in the family Rubiaceae that has mostly $x = 11$.

The purpose of this study is to present for comparison illustrations and/or data on the seeds and capsules of the three genera and to re-examine seed data published by Terrell (1999) and Andersson et al. (2002) for *Bouvardia* and *Arcytophyllum serpyllaceum*.

MATERIALS AND METHODS

Seeds were obtained from the U.S. National Herbarium (US), Smithsonian Institution, and from other herbaria including CHAPA, GH, NY, TENN. Seeds were examined by dissecting microscope and mature, well-formed seeds were viewed by scanning electron microscopy (SEM) at the Smithsonian Institution, and prior to 1985 at the Electronics Lab, U.S. Department of Agriculture, Beltsville, Maryland.

Seed descriptions for each species and inclusive descriptions for each species-group provide basic data.The nomenclatural authors and collection data are added to the seed descriptions for each species. Seed collections viewed by SEM are indicated by a designation such as B35, as e.g. for *Arcytophyllum lavarum*.

Light microscopy was used to observe pollen and some additional structures such as corollas, calyx lobes, and stipules in type species and other selected species of all three genera. Material was mounted on slides in Hoyer's solution (Anderson 1954).

RESULTS

The light microscope study included material of *Arcytophyllum nitidum*, *A. serpyllaceum*, *Bouvardia ternifolia*, and *Manettia alba* and *M. reclinata*. The first, third, and fifth of these species are the types of their respective genera. Pollen in *Arcytophyllum* and *Bouvardia* show essentially identical spherical, tricolporate pollen with minor variation in the granulation of the exine. Only *Manettia* differs by a sometimes more oblate shape with projecting pores. The grains of *M. reclinata* are commonly lying on their more flattened poles and seem almost triangular. The light microscope also showed prominent raphide bundles in stipules, calyx and sometimes the corolla of *Manettia* that were not seen in *Arcytophyllum* or *Bouvardia* slides.

A review of the genera and species for seed and capsule data is as follows:

Arcytophyllum Willd. ex Schult. in Roem.& Schult., Syst. Veg. Mant. 3:5. 1827. This Andean and Central American genus of 16 species of shrubs, subshrubs, and suffruticose herbs grows at higher elevations from Costa Rica to Bolivia (Mena 1990). Most species have rather restricted ranges. Mena found the most useful characters to be the shape of the stipules and the leaf and corolla shapes.

We examined seeds of nine of the sixteen species of *Arcytophyllum*, of which six species were treated by SEM. The seeds of the studied species fell into three groups, as outlined below.

Group A

This group includes the type of the genus. The species are *A. filiforme, A. lavarum, A. macbridei, A. muticum, A. nitidum*, and *A. serpyllaceum*. *Arcytophyllum lavarum, A. muticum*, and *A. serpyllaceum* have lenticular seeds, polygonal or suborbicular in outline, with centric punctiform or slightly raised hila (Fig. 1). *Arcytophyllum lavarum* may or may not be winged, but is shown in this figure as being winged. The remaining three species, *A. filiforme, A. macbridei*, and *A. nitidum* were not done by SEM, but their descriptions are included below. Descriptions of the seeds of the six species follow:

Arcytophyllum filiforme (Ruiz & Pav.) Standl.—Seeds 0.7–1.0 mm diam., black, moderately to strongly compressed, suborbicular in outline, lenticular, thickly to thinly concavo-convex, hilar area rounded or slightly raised, areoles not seen in detail. *Harling & Andersson 12638* (US), Ecuador (det. Boom); *Fosberg & Giles 23135* (US), Ecuador (det. L.B.Smith).

Arcytophyllum lavarum K. Schum.—Seeds 0.7–1.0 mm diam., black, strongly compressed, suborbicular or polygonal in outline, lenticular, biconvex, wing absent or partial, very narrow, fragile, hilum punctiform, areoles isodiametric or polygonal, their walls thick, testa smooth. *Cuatrecasas & Leon 26524* (US), Costa Rica, R8a; *Herrera & Robles 791* (US), Costa Rica, B35 (Fig. 2).

Arcytophyllum macbridei Standl.—Seeds 1.4–1.6 mm diam., black, strongly compressed, suborbicular in outline, lenticular, concavo-convex, wing partial, very narrow, fragile, hilum punctiform or slightly raised, areoles not seen in detail. *Wurdack 1273* (US), Peru (dupl.det. Steyermark).

Arcytophyllum muticum (Wedd.) Standl.—Seeds 1.0–1.4 mm diam., black, moderately to strongly compressed, suborbicular or polygonal in outline, lenticular, rather thickly biconvex or only convex dorsally, hilum punctiform, slightly raised, or a short ridge, areoles isodiametric or polygonal, small, their walls thick, testa smooth. *Fosberg 19196* (US), Colombia, (det. Mena), B36; *Haught 5803* (US), Colombia, R7; *Martin & Plowman 93* (US), Colombia (det. Mena) (Fig. 1).

Arcytophyllum nitidum (Kunth) Schltdl.—Seeds 0.7–1.0 mm diam., black, strongly compressed, polygonal to suborbicular in outline, lenticular, convex dorsally, flat or bent ventrally, hilum punctiform, areoles not seen in detail. *Fosberg & St. John 21880* (US), Colombia.

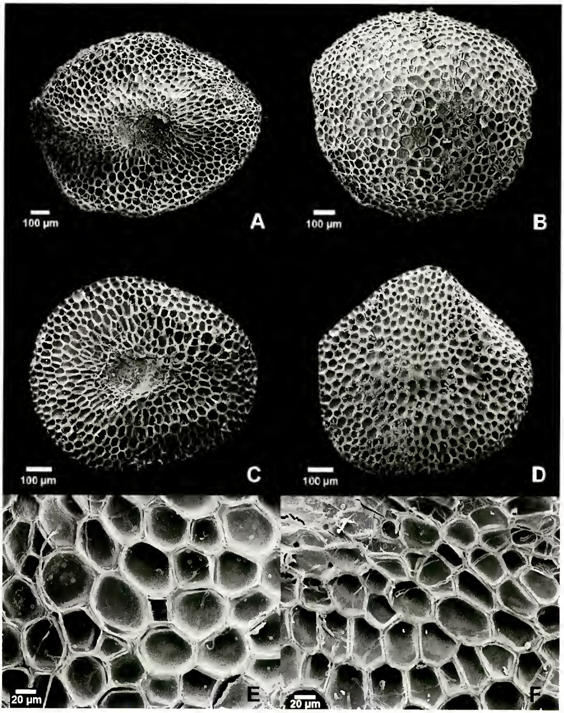


Fig. 1. Seeds of *Arcytophyllum* species examined by SEM. A, B, E, *Arcytophyllum muticum, Fosberg 19196* (US), Colombia. C, D, F, *Arcytophyllum serpyllaceum, Williams et al. 22771* (US), Guatemala. A, C, ventral views; B, D, dorsal views; E, F, areoles.

Arcytophyllum serpyllaceum (Schltdl.) Terrell—Seeds 0.6–1.2 mm diam., black, moderately to strongly compressed, suborbicular or polygonal in outline, lenticular, rather thickly biconvex or flat on one face, hilum punctiform, areoles isodiametric or polygonal, small, their walls thick, testa smooth. *Sharp*

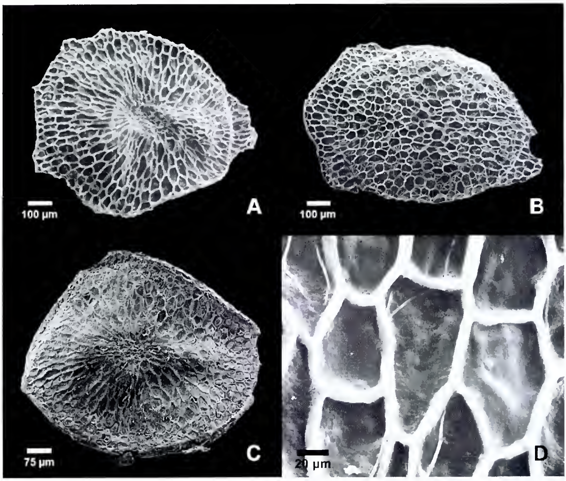


Fig. 2. Seeds of *Arcytophyllum lavarum* examined by SEM. **A, B, D,** *Cuatrecasas & Leon 26524* (US), Costa Rica; **C,** *Herrera & Robles 791* (US), Costa Rica. **A, C,** ventral views; **B,** dorsal view; **D,** areoles.

45143 (TENN), Guatemala, R12; *Williams et al. 22771* (US), Guatemala, B38; *Alexander 1063* (NY), Chiapas, Mexico (Fig. 1).

An inclusive description follows: Seeds 0.6–1.6 mm diameter, black, moderately to strongly compressed, suborbicular or polygonal in outline, thickly to thinly lenticular, faces (sides) flat, concave, convex, or biconvex, wings absent or present, partial, very narrow, fragile, hilum punctiform, rounded, or slightly raised, areoles isodiametric or polygonal, small, walls thick, testa smooth.

Group B

This group includes only *A. aristatum*. Seeds are polygonal in outline, lumpy, not lenticular, and have a strongly raised or ridged ventral face.

Arcytophyllum aristatum Standl.—Seeds 0.7–1.0 mm diam., black, moderately to slightly compressed, lumpy, polygonal in outline, dorsal face convex, ventral face with a strongly raised hilar area or a short to long hilar ridge, areoles small, isodiametric or polygonal, walls thick, testa smooth. *Cuatrecasas*

18976 (US), Colombia, B34; *Luteyn & Luteyn 6758* (US), Ecuador; *Steere 8034* (US), Ecuador (Fig. 3).

Group C

This group includes *Arcytophyllum rivetii* and *A. thymifolium* and has elliptical or oblong seeds with a low hilar ridge.

Arcytophyllum rivetii Danguy & Cherm.—Seeds 1.0–1.3 × 0.6–0.7 mm, black, strongly compressed, broadly elliptic or oblong in outline, biconvex, concavo-convex, or flat, wing none or very narrow at one end of seed, hilum a low linear ridge, areoles isodiametric or polygonal, their walls thick, testa smooth. *Wurdack 1288* (US), Peru, B37 (Fig. 3).

Arcytophyllum thymifolium (Ruiz & Pav.) Standl.—Seeds 0.8–1.2 × 0.5–0.7 mm, black or dark brown, strongly compressed, broadly elliptic or oblong in outline, rather thin, concavo-convex or flat, hilum a low linear or oblong ridge, areoles isodiametric or polygonal, their walls thick, testa smooth. *Firmin s.n., 5/12/27* (US), Ecuador, B39; *Fosberg 21196* (US), Colombia; *Schultes & Villarreal 7880* (US), Colombia (Fig. 3).

An inclusive description is as follows: Seeds 0.8–1.3 × 0.5–0.7 mm, black or dark brown, strongly compressed, broadly elliptic or oblong in outline, biconvex, concavo-convex, or flat, wing none or very narrow at one end of seed, hilum a low, linear or oblong ridge, areoles isodiametric or polygonal, their walls thick, testa smooth.

Summary of Arcytophyllum.—A general survey of *Arcytophyllum* seeds shows that they are strongly or moderately dorsiventrally compressed, with a ventral punctiform centric hilum or a hilar ridge. A few species may have very narrow, fragile, partial wings, but the more common state is wingless. The areoles (cells) are usually isodiametric or polygonal and rather thick-walled with smooth testa. There are three distinct kinds of seeds.

Group A seeds are polygonal or suborbicular in outline. The seeds are lenticular, varying thicker or thinner and biconvex or concavo-convex or flat on a face. The hilum is centric, i.e., on or near the center of the ventral face of the seed, and is often punctiform, appearing as a dot or a small round or raised area. (Figs. 1, 2). Group B has thicker, lumpy seeds with ventral face raised or a short to long hilar ridge. (Fig. 3). Group C has oblongoid or ellipsoid seeds which are slightly to strongly concave ventrally. A low narrow hilar ridge extends along part or most of the seed (Fig. 3).

Mena's (1990) description of *Arcytophyllum* seeds as irregularly patelliform (dish- or saucer-shaped) or cymbiform (boat-shaped) and coarsely alveolated (honeycombed) is somewhat misleading because it suggests that they have shallow or deep ventral cavities or concavities such as are typical of *Houstonia* (Terrell 1996). In *Arcytophyllum*, however, the seeds are in Group A lenticular, in Group B lumpy, and in Group C are ellipsoidal or oblongoid and longitudi-

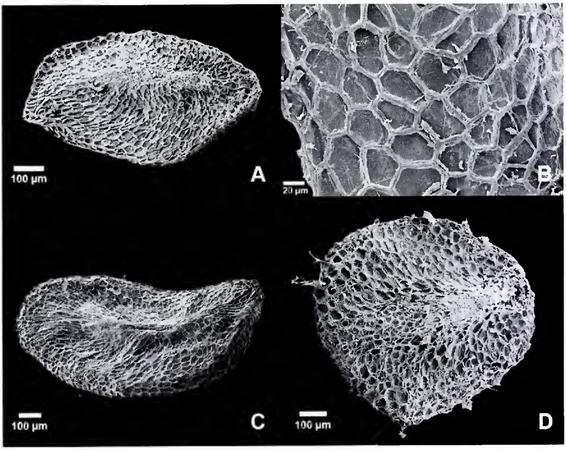


Fig. 3. Seeds of *Arcytophyllum* species examined by SEM. **A–B,** *Arcytophyllum rivetii, Wurdack 1288* (US), Peru. **C,** *Arcytophyllum thymifolium, Firmin s.n.*, 5/12/27, (US), Ecuador. **D,** *Arcytophyllum aristatum, Cuatrecasas 18976* (US), Colombia. **A, C, D,** ventral views; **B,** areoles.

nally concave or bent. The seed surfaces are never honey-combed, but are reticulate and like most seeds of Hedyotideae are made up of walled areoles or cells.

Capsules of *Arcytophyllum* were described by Standley (1921) as biloculate, turbinate to globose, and usually septicidally dehiscent to the base. Mena's description was "septicidal, sometimes only the beginning of the dehiscence loculicidal", crowned by the persistent calyx lobes and intercalycine teeth. For eight of our studied species Mena said that the capsules varied 1–3 mm in diameter, and were mostly subglobose. He found 2–15 seeds per locule (4–30 per capsule). For *A. thymifolium* Mena found 1.7–2 × 2–2.5 mm, which suggests a dimension wider than long. Terrell for *A. thymifolium* recorded 2 × 1 (ellipsoid or oblongoid) in one collection; in a second collection 1.5–2 × 1.0–1.7 (subglobose to oblongoid). Terrell found 5–12 seeds per capsule in *A. lavarum* and *A. thymifolium*. The capsules of *A. serpyllaceum* are 1.5–4 × 2–3.5 mm, turbinate, loculicidal, nerved, and have 8–29 seeds per capsule. This species is further discussed below and compared with *A. muticum*.

Bouvardia Salisbury, Parad. Lond. Pl. 88. 1805.
Blackwell (1968) recognized 31 species in three subgenera in *Bouvardia*. The species are primarily Mexican, with extensions into Central America and southwestern United States, and are shrubs except for four species in the third subgenus. The first subgenus recognized by Blackwell was *Bouvardiastrum* Schltdl. with 15 species, of which we examined *B. capitata*, *B. cordifolia*, *B. laevis*, and *B. multiflora*. The second subgenus, *Bouvardioides* Schltdl. has 8 species, none of which are represented in our study. The third subgenus, *Bouvardia* Schltdl., has 8 species of which we examined *B. ternifolia* and two recently described or transferred perennial herbs, *B. rzedowskii* and *B. xestosperm* (Terrell and Koch 1994), which are similar to and apparently related to the perennial herbs, *B. rosea* Schltdl. and *B. tenuifolia* Standl. Several additional *Bouvardia* species have been described in recent years, but our study utilizes mainly the species studied by Blackwell (1968).

Previous field work in Mexico provided a foundation for the present study. *Bouvardia rzedowskii* was collected and described and *B. xestosperma* was recollected in Oaxaca (Terrell and Koch 1994). Other species of *Bouvardia* were seen in Mexico during this work.

Individual descriptions of seeds are given as follows, with capsule data added from Blackwell (1968). Two groups of species are recognized for this genus.

Group A
The first group includes four shrubby species in subgenus *Bouvardiastrum* (*B. capitata*, *B. cordifolia*, *B. laevis*, *B. multiflora*) and one shrubby species in subg. *Bouvardia* (*B. ternifolia*). These species seem to be generally similar in seed morphology.

Bouvardia capitata Bull.—Seeds 2.5–3.5 mm diam., brown with tan wing, papery thin, orbicular in outline, ventral face concave, seed body 1.0–1.5 mm wide, wing 0.3–1.0 mm wide, its margin entire, undulate, hilum punctiform, often a raised point, areoles radially elongated, their walls thin, testa smooth. *Hinton 8600* (US), Tejupilco, Tepascaltepec (?), Mex. (det. Blackwell), B41 (Fig. 4).

Bouvardia multiflora (Cav.) Schult. & Schult.f.—Seeds 2–3 mm diam., dark brown or black with brown wing, papery thin, orbicular in outline, ventral face concave or almost flat, seed body 0.8–1.4 mm wide, wing 0.2–1.0 mm wide, its margin entire, undulate, hilum punctiform, sometimes a raised point, areoles radially elongated, their walls thin, testa smooth. *H.S. Gentry 8388* (US), Durango, Mexico, (det. Blackwell), B42; *E. Palmer 708* (US), Mexico (Fig. 4).

Bouvardia ternifolia (Cav.) Schltdl.—Seeds 2–3 mm diam., black with brown wing, papery thin, orbicular in outline, ventral face concave, seed body 1.0–2.2 mm wide, wing 0.2–0.6 mm wide, its margin entire, undulate, hilum punctiform, a slightly raised point or rounded area, areoles radially elongated, their walls thin, testa smooth. *Dziekanowski et al. 1860* (US), Hidalgo, Mexico, H52 (Fig. 4).

An inclusive description is as follows: Seeds 2–3.5 mm diam., brown, black,

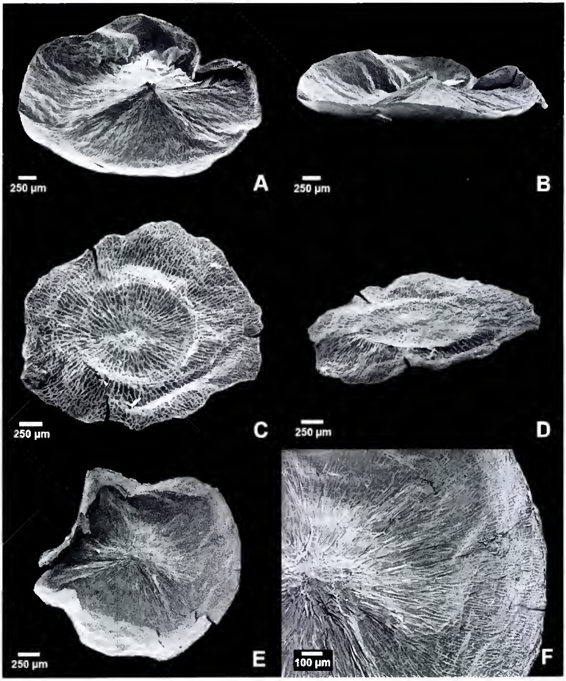


Fig. 4. Seeds of *Bouvardia* species examined by SEM. **A–B,** *Bouvardia capitata, Hinton 8600* (US), Mexico. **C, D,** *Bouvardia ternifolia, Dziekanavski et al. 1860* (US), Mexico. **E, F,** *Bouvardia multiflora, H.S. Gentry 8388* (US), Mexico. **A–F,** ventral views; **F,** enlarged section showing areoles.

or tan, papery thin, orbicular in outline, ventral face concave, seed body 0.8–2.2 mm wide, wing 0.2–1.0 mm wide, its margin entire, undulate, hilum punctiform, a raised point or rounded area, areoles radially elongated, their walls thin, testa smooth.

Capsules in group A have the following inclusive description: 3–9 × 3.5–11 mm., subglobose or slightly oblate, dehiscing loculicidally then septicidally (Blackwell). Standley (1921) recorded capsules as globose and loculicidally dehiscent.

Group B.

The second group includes two recently described or transferred perennial herbs in subg. *Bouvardia* (*B. rzedowskii* and *B. xestosperma*).

Bouvardia rzedowskii Terrell & S.D. Koch—Seeds 1–2 mm diam., dark brown with brown wing, papery thin, orbicular in outline, ventral face concave or flat, seed body 0.5–1.0 mm wide, wing 0.1–0.4 mm wide, its margin entire, undulate, hilum punctiform, sometimes a raised point, areoles radially elongated, their walls thin, testa smooth. *Koch & Koch 8935* (CHAPA), Oaxaca, Mexico, H51 (Fig. 5).

Bouvardia xestosperma (Rob. & Greenm.) Terrell & S.D. Koch—Seeds 1–2 mm diam., dark brown or black, thin, orbicular or oval in outline, ventral face flat or slightly concave, seed body 0.3–1.0 mm wide, wing partial or complete, 0.1–0.5 mm wide, entire, sometimes undulate, hilum punctiform, a slightly raised point, areoles radially elongated, their walls thin, testa smooth. *Koch & Koch 8934* (CHAPA), Oaxaca, Mexico, B45; *Conzatti & Gonzalez 248* (GH), Oaxaca, Mexico, H4 (Fig. 5).

Inclusive description: Seeds 1–2 mm diam., dark brown or black, papery thin, orbicular or oval in outline, ventral face concave or flat, seed body 0.3–1.0 mm wide, wing partial or complete, 0.1–0.5 mm wide, entire, undulate, hilum punctiform, sometimes a raised point, areoles radially elongated, their walls thin, testa smooth.

Capsules 3–5 × 3.5–4.5 mm in *B. rzedowskii*, and 2.5–4 mm long in *B. xestosperma*, with loculicidal dehiscence.(Terrell & Koch 1994).

Due to limited sampling summaries are not given for *Bouvardia* and *Manettia*; however, a comparison of *Bouvardia* groups A and B shows that group B of perennial herbs has smaller seeds and partial instead of complete wings. *Bouvardia ternifolia*, a shrubby species, seems more allied to *Bouvardiastrum* or *Bouvardioides* which have shrubby species.

Manettia Mutis ex L., Mant. Pl. 553, 558.1771, nom. cons.

The genus includes vines or herbs distributed in tropical America, principally in South America. Standley (1921) treated 10 species from West Indies, Mexico, and Central America. Chung (1967, 1968) studied five species in the section *Heterochlora* K. Schum. and six species in section *Pyrrhanthos* K. Schum. Steyermark (1974) estimated 140 species of *Manettia* altogether, and treated 19 species from Venezuela. *Manettia* has broadly winged seeds similar to those of *Bouvardia*. Our data on *Manettia* are limited, and our main purpose here is to present seed descriptions of five species and SEM illustrations of three species of *Manettia* for comparison with similarly-seeded *Bouvardia*. We do not reach any conclusions regarding possible relationships to *Bouvardia*.

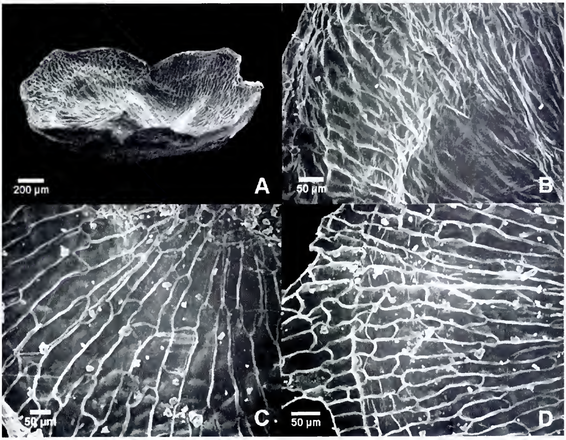


Fig. 5. Seeds of *Bouvardia* species examined by SEM. A–B, *Bouvardia rzedowskii, Koch & Koch 8935* (CHAPA), Mexico. C, D, *Bouvardia xestosperma, Conzatti & Gonzalez 248* (GH), Mexico. A, ventral view; B, C, D, areoles.

We examined the seeds of the following five species of *Manettia*: *M. calycosa* var. *karsteniana*; *M. divaricata*; *M. flexilis*; *M. meridensis*, and *M. reclinata*. Three of these were examined by SEM: *M. calycosa* var. *karsteniana*, *M. flexilis*, and *M. reclinata*.

Manettia calycosa Griseb.var. *karsteniana* K. Schum.—Seeds 0.8–1.1 mm diam., black with brown wing, thin, orbicular in outline, flat or slightly concave ventrally, seed body ca. 0.7 mm wide, wing 0.1–0.3 mm wide, its margin erose, hilum punctiform, areoles radially elongated, walls thin, testa smooth. *Steyermark & Wiehler 106576* (US), Venezuela, B47 (Fig. 6).

Manettia divaricata Wernham—Seeds 2–3 mm diam., black with brown wing, thin, orbicular in outline, flat or slightly concave ventrally, seed body 1.0–1.5 mm wide, wing 0.4–1.0 mm wide, its margin ornately erose or toothed, hilum depressed to slightly raised, areoles not seen in detail. *Schunke V. 838* (US), Peru, (det. D.R. Simpson).

Manettia flexilis Brand.—Seeds 2.0–3.5 mm diam., dark brown with light brown wing, thin, orbicular in outline, flat, seed body 0.6–1.5 mm wide, wing 0.4–1.2 mm wide, its margin erose, hilum punctiform or flat, areoles radially

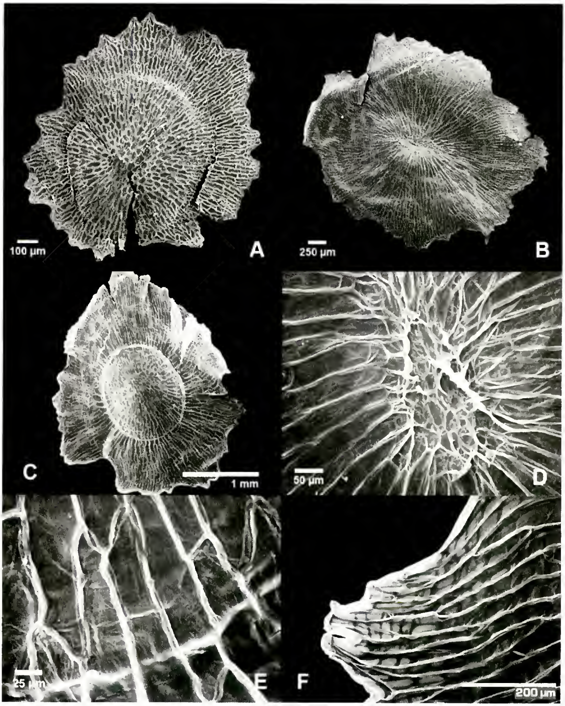


Fig. 6. Seeds of *Manettia* species examined by SEM. A, *Manettia calycosa* var. *karsteniana, Steyermark & Wichler 106576* (US), Venezuela. B, *Manettia reclinata, Hoover 161* (US), Mexico. C–F, *Manettia flexilis, Smith P2360* (US), Costa Rica. A–B, ventral views; C, dorsal view; D, hilar area; E, F, areoles and wing areoles.

elongated, walls thin, testa smooth. *A. Smith P2360* (US), Costa Rica, H32, (det. S. F. Blake) (Fig. 6).

Manettia meridensis K. Schum.—Seeds 2–3 mm diam., black with dark brown wing, thin, orbicular in outline, flat or slightly concave ventrally, seed body 0.5–1.5 mm wide, wing 0.4–0.8 mm wide, its margin entire or minutely erose, hilum punctiform, flat or a slightly raised point, areoles not seen in detail. *Bro. Daniel 1707* (US), Colombia.

Manettia reclinata Mutis ex L.—Seeds 2.5–3.0 mm diam., black with brown wing, thin, orbicular in outline, flat or slightly concave ventrally, seed body 0.7–1.2 mm wide, wing 0.5–1.2 mm, its margin erose, hilum area flat or slightly depressed, areoles radially elongated, walls thin, testa smooth. *Hoover 161* (US), Chiapas, Mexico, B46 (Fig. 6).

Inclusive description of the five species is as follows: Seeds 0.8–3.5 mm diam., black or brown, thin, orbicular in outline, flat or slightly concave ventrally, seed body 0.5–1.5 mm wide, wing 0.1–1.2 mm wide, its margin erose, coarsely toothed, or entire, hilum punctiform, flat or depressed, or slightly raised, areoles radially elongated, walls thin, testa smooth.

Seeds of *Manettia* have wings with margins erose or coarsely and irregularly toothed, much more ornate than *Bouvardia* wings.

Manettia capsules were described by Standley (1921) as septicidally dehiscent, obovoid or turbinate, and coriaceus or chartaceous. Steyermark (1974) also considered the capsules as septicidally dehiscent and described *M. calycosa* as subglobose to ellipsoid or turbinate and 4–7 mm long; for *M. reclinata* obconic and 10–12 × 7–9 mm.

In this study we found *M. divaricata* with capsules 10 × 5.5 and obovoid; *M. meridensis* 5 × 5 and obovoid; and *M. reclinata* 8 × 6.5–8 mm wide and subglobose or broadly ellipsoid. All capsules seen had septicidal dehiscence. Capsules often had two separated halves with each half having a slit or longitudinal opening into the locule reminescent of the diplophragmous capsules of *Hedyotis* subgenus *Hedyotis* (Terrell & Robinson 2003).

DISCUSSION

Capsule characters Capsules in *Arcytophyllum* and *Manettia* have septicidal dehiscence, whereas *Bouvardia* primarily has loculicidal dehiscence followed by septicidal dehiscence. Capsule thicknesses and sizes are much greater in *Bouvardia* and *Manettia* and more varied in shape, although a predominant shape in *Arcytophyllum* and *Bouvardia* is subglobose.

Seed characters The following descriptive key is based on the the present sample of species. *Bouvardia* and *Manettia* seeds are so similar that they are here treated as one unit.

1. Seeds 0.6–1.6 mm long or diam, orbicular or elliptical in outline, moderately or strongly compressed, lenticular, faces biconvex, concavo-convex, or flat or else somewhat concavo-convex, wings none or very narrow and partial, hila centric, flat or slightly depressed or slightly raised, or else a low ridge, areoles isodiametric or somewhat polygonal, their walls thick ______ **Arcytophyllum**
1. Seeds 0.8–3.5 mm diam, orbicular in outline, strongly compressed, flat, thin, most

species broadly winged, wing papery, fragile, seed body and wing often incurved or concave, wing margin entire and undulate (*Bouvardia*) or erose or toothed (*Manettia*), or else wing narrow, hila centric, flat or sometimes raised slightly to form a point, areoles radially elongated, their walls thin ________________ **Bouvardia, Manettia**

Relationships of Arcytophyllum serpyllaceum

The species long known as *Hedyotis serpyllacea* Schltdl. (Linnaea 9:599. 1834) occurs at higher elevations (usually 1500-3500 m) in southern Mexico (Veracruz, Chiapas, Oaxaca) and Guatemala. It is a prostrate, creeping, mat-forming, suffruticose herb that is often abundant in open, grassy places or fields. It produces small white flowers that tend to be purplish or greenish on their abaxial faces. During field work in Mexico (Terrell & Koch 1994) the species was observed and collected in Veracruz.

This species was long retained in *Hedyotis* but differed from other Mexican species that had been placed in that genus. Terrell (1999) described and discussed it in detail, transferred the name *Hedyotis serpyllacea* to *Arcytophyllum* (1827) and noted that there is a precedent for its placement in *Arcytophyllum*. John Donnell Smith (1893) described the species from Guatemala, placing it in *Mallostoma* (Karst. 1862), a synonym of *Arcytophyllum*, as *M. shannoni*. Smith provided a rather complete description of the entire plants, including the following: "capsule obovate ... 8-costate, loculicidal at apex, septicidal at base; seeds 8–20, compressed, roundish, ... finely punctate, black and shining." The "punctate" seed description apparently refers to the polygonal areoles, visible at lower power magnification as reticulations, a common feature of hedyotoid seeds. Standley (1916) transferred *M. shannoni* (without comment) to *Arcytophyllum* as *A. shannoni*, but included only *A. lavarum* in his treatment of Rubiaceae for the North American Flora (Standley 1921). (Apparently, *A. muticum* was not known from Panama and Costa Rica in 1921; see other comments below about *A. muticum*)

Although Mena (1990) in his revision of *Arcytophyllum* had merely listed *Hedyotis serpyllacea* in his category of Excluded and Dubious Names, nonetheless there are similarities to the prostrate, suffruticose species of *Arcytophyllum*, suggesting that *A. serpyllaceum* could be an extension of *Arcytophyllum* northward from Costa Rica into Guatemala and southern Mexico.

The transfer of this species to *Arcytophyllum* was questioned by Andersson et al. (2002) based on their Analysis 1, data from the *rps*16 intron. A phylogenetic tree indicated a close relationship to *Bouvardia* rather than *Arcytophyllum*. Their study of *A. serpyllaceum* was based on a Mexican collection from the MO herbarium, *Stafford et al. 203*. Hoping to examine this collection we corresponded with Charlotte Taylor, curator of Rubiaceae at MO. She has been unable to find this herbarium sheet either under *Hedyotis* or related genera, although Andersson has written to Terrell stating that the loan of MO specimens to GB was returned to MO. Presently, the location of this specimen remains unknown.

Table 1. Comparison of characters of *Arcytophyllum muticum* and *A. serpyllaceum*.

Characters	**muticum**	**serpyllaceum**
Roots and stems	"Subshrubs", prostrate, stoloniferous, mat-forming	Suffruticose herbs, prostrate, woody rhizomes, creeping, mat-forming
Stipules	Genus: interpetiolar, entire or with toothed projections, glabrous or with pustuliform papillae Species: Decurrent, deltate, with acuminate projections 0.4–0.7 mm long, scattered short hairs	Interpetiolar, to 2 mm long, ovate, with short to long narrow caudae, marginal teeth with apical glands, glabrous to ciliolate
Leaves	Sessile or subsessile, 2.5–4.5 × 0.8–1.8 mm, ovate, transversely falcate, coriaceous, glabrous	Sessile, 2–9 × 1–5 mm, ovate or elliptic, thickened, coriaceous, glabrous
Flowers	Solitary, sessile, apparently isostylous	Solitary, pedicels to 7 mm long, heterostylous
Calyces	1–2.5 mm long, trullate or triangular, glabrous, with intercalycine teeth	Lobes (1–)3–8 × 0.5–1.5 mm, lanceolate to ovate or obovate, glabrous, with intercalycine teeth
Corollas	6–9 mm long, salverform–funnelform, purple or bluish abaxially, white adaxially	(4–)6–10 mm long, funnelform, greenish or purple abaxially, white adaxially, thickish
Corolla lobes	2–4.5 × 2–3.5 mm, deltate, papillose, scattered hairs in margin and abaxially, scattered shiny scales adaxially	2.5–4.8 × 1.2–1.7 mm, ovate or elliptic, densely white pubescent adaxially
Corolla tubes	3–4.5 × 1–2 mm, glabrous	3–5 × 2–3 (at throat), glabrous abaxially, pubescent distally adaxially
Stamens	Anthers 1 × 0.3 mm, slightly exserted	Anthers ca. 1–2 mm long, oblong, slightly exserted (thrum flowers), included (pin flowers)
Stigmas	1 mm long, papillose adaxially	1–2.3 mm long (pin), 1–1.4 mm long (thrum)
Capsules	1–3 mm diam., globose, septicidal, 4–24 seeds/capsule	1.5–4 × 2–3.5 mm, broadly oblong or obovate, loculicidal, 8–29 seeds/capsule
Seeds	1.0–1.4 mm diam., often strongly compressed, often polygonal in outline, lenticular, often biconvex, hilum sl. raised, areoles often isodiametric, small.	0.6–1.2 mm diam., other characters very similar to those of *A. muticum*

In the absence of confirmation of the voucher for the study by Andersson et al. (2002), the present study follows the species placement based on structural features of the plants. Two species of *Arcytophyllum* occur in Central America and are of particular interest here. These are *A. lavarum*, endemic to Costa Rica and Panama, and *A. muticum*, native to Costa Rica and Panama and extending south to Ecuador. (Mena 1990 does not list *A. muticum* from Costa Rica except as the type for a synonym, but there are nine collections from Costa Rica in herbarium US). The two similar species, *A. muticum* and *A. serpyllaceum*, are compared in Table 1, listing all of the main characters. The flowers of the two species differ in styly, but this is not considered a generic difference (e.g., Terrell 1996 found both stylies in *Houstonia*).

The data on capsules suggest that *A. muticum* differs somewhat in size, shape, and number of seeds per locule (Table 1) from *A. serpyllaceum*. The two species differ also in *A. muticum* having septicidal dehiscence versus loculicidal dehiscence in *A. serpyllaceum*. Comparison of dehiscence in other genera of Hedyotideae shows considerable variation and the presence of septicidal (e.g., *Hedyotis* subg. *Hedyotis*) and loculicidal dehiscence (e.g., *Houstonia* and *Oldenlandia*).

Contrary to statements by Andersson et al. (2002) that *A. serpyllaceum* seeds resemble those of *Bouvardia*, we find that their seeds are distinctly different, not only in the presence or absence of conspicuous or inconspicuous wings, but also in the appearance of the often raised pointed hila and in the presence of thick-walled isodiametric areoles versus thin-walled radially elongate areoles.

Comparison of seeds of *A. muticum* and *A. serpyllaceum* show them to be so similar that we did not detect any differences in shape, position of hilum, or sizes and shapes of the areoles, and without identity data it would be impossible to distinguish them (Fig. 1). *Arcytophyllum lavarum* was also similar to the other two species (Fig. 2).

A more detailed study of additional species of Hedyotideae is needed in order to provide both molecular and morphological evidence concerning relationships. It is hoped that time will permit such a survey to be carried out with assistance from a person knowledgeable in molecular studies.

ACKNOWLEDGMENTS

We thank the herbarium curators for loans of specimens, Susann Braden for the SEM work, and Marjorie Knowles for formatting the illustrations. We also thank Charlotte Taylor, Curator of the Rubiaceae at MO, for her assistance in searching for a missing specimen needed to confirm an identity (see text), and Pedro Acevedo for providing the Spanish Resumen. Piero Delprete and an anonymous reviewer provided helpful comments on an earlier draft.

REFERENCES

Anderson, L.E. 1954. Hoyer's solution as a rapid permanent mounting medium for Bryophytes. The Bryologist 57:242–244.

Andersson, L., J.H.E. Rova, and F. Alazata Guarin. 2002. Relationships, circumscription, and biogeography of *Arcytophyllum* (Rubiaceae) based on evidence from cpDNA. Brittonia 54:40–49.

Blackwell, W.H., Jr. 1968. Revision of *Bouvardia* (Rubiaceae). Ann. Missouri Bot. Gard. 55:1–30.

Bremer, B. and J.-F. Manen. 2000. Phylogeny and classification of the subfamily Rubioideae (Rubiaceae). Pl. Syst. Evol. 225:43–72.

Chung, I.-C. 1967. Studies in *Manettia* (Rubiaceae) section *Heterochlora* Schum. Phytologia 15:272–288.

Chung, I.-C.. 1968. Studies in *Manettia* (Rubiaceae) section *Pyrrhanthos* Schum. Phytologia 17:353–366.

Lewis, W.H. 1965. Cytopalynological studies of African Hedyotideae (Rubiaceae). Ann. Missouri Bot. Gard. 52:182–211.

Mena V., P. 1990. A revision of the genus *Arcytophyllum* (Rubiaceae: Hedyotideae). Mem. New York Bot. Gard. 60:1–26.

Smith, J.D. 1893. Undescribed plants from Guatemala, XI. Bot. Gaz. 18:203–204.

Standley, P.C. 1916. Studies of tropical American phanerogams. 2. Contrib. U. S. Natl. Herb. 18:128.

Standley, P.C. 1921. Rubiaceae. N. Amer. Flora 32: 38--39, 96–111.

Steyermark, J.A. 1974. *Manettia*. In: T. Lasser and J. Steyermark. Flora de Venezuela. Vol. 9. Edicion Especial del Instituto Botanico, Ministerio de Agricultura y Cría, Caracas. Pp. 121–158.

Terrell, E.E. 1996. Revision of *Houstonia* (Rubiaceae-Hedyotideae). Syst. Bot. Monogr. 48:1–118.

Terrell, E.E. 1999. Morphology and taxonomy of *Arcytophyllum serpyllaceum* (Rubiaceae), a transfer from *Hedyotis*. Novon 9:263–264.

Terrell, E.E. and S.D. Koch. 1994. A new species of *Bouvardia* (Rubiaceae) from Mexico, and transfer of *Hedyotis xestosperma* to *Bouvardia*. Novon 4:179–182.

Terrell, E.E. and H. Robinson 2003. Survey of Asian and Pacific species of *Hedyotis* and *Exallage* (Rubiaceae) with nomenclatural notes on *Hedyotis* types. Taxon 52:775–782.

Terrell, E.E. and R.P. Wunderlin. 2002. Seed and fruit characters in selected Spermacoceae and comparison with Hedyotideae (Rubiaceae). Sida 20:549–547.

THE 2004 DELZIE DEMAREE TRAVEL AWARD RECIPIENT

Mr. Orlando Alvarez-Fuentes

Michigan State University

Mr. Orlando Alvarez-Fuentes was awarded the 16th Annual Delzie Demaree Travel Award at the 51st Annual Systematics Symposium (8–10 Oct 2004) at the Missouri Botanical Garden.

Applications for the 2005 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. Applications need to be received 4 weeks ahead of the Symposium date. The Systematics Symposium dates for 2005 are 7–8 October.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

SIDA 21(2): 928. 2004

GENERIC PLACEMENT OF *CHAPTALIA HINTONII* (ASTERACEAE: MUTISIEAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Chaptalia hintonii, of south-central Mexico, was recently transferred to the otherwise essentially Old World genus *Gerbera* on the basis of the occurrence of staminodes in the pistillate flowers. No clear position within *Gerbera* was determined for the species. In contrast, *C. hintonii* also has been placed among the eight species of sect. *Chaptalia*, based on its similarity in a set of features including scape morphology, head behavior, ray corolla morphology, cypselar vestiture, flower biology, and geography. Other species of South American and Mexican *Chaptalia*, including one other from sect. *Chaptalia*, also are known to produce staminodes, a feature interpreted here as plesiomorphic, either as vestigial occurrence or as the result of developmental intermediacy between bisexual disc florets and outer, pistillate ray florets. The hypothesis that *C. hintonii* belongs with *Chaptalia* is stronger than that for positioning *C. hintonii* in *Gerbera*.

RESUMEN

Chaptalia hintonii, del centro-sur de México, fue transferida recientemente al género esencialmente del Viejo Mundo *Gerbera* en base a la presencia de estaminodios en las flores pistiladas. No se determinó una posición clara en *Gerbera* para la especie. Por contra, *C. hintonii* ha sido colocada entre las ocho especies de la sect. *Chaptalia*, en base a su similitud en un conjunto de características que incluyen la morfología del escapo, comportamiento del capítulo, morfología de los radios de la corola, indumento de las cipselas, biología floral, y geografía. Otras especies de *Chaptalia* de Sur América y México, incluida otra de la sect. *Chaptalia*, también se sabe que producen estaminodios, una característica interpretada aquí como plesiomórfica, tanto como ocurrencia vestigial o como resultado de desarrollo intermedio entre flósculos bisexuales del disco y flores radiadas pistiladas. La hipótesis que *C. hintonii* pertenece a *Chaptalia* es más fuerte que la que posiciona a *C. hintonii* en *Gerbera*.

In a recent discussion of the Mexican species *Chaptalia hintonii* Bullock and its relationship to other species groups of Mutisieae-Mutisiinae, Katinas (1998) concluded that *C. hintonii* should be placed in *Gerbera* rather than *Chaptalia*. In contrast, in a revision of the 12 North American and continental Central American species most recently considered to be *Chaptalia*, Nesom (1995) treated *C. hintonii* among the six species of sect. *Chaptalia*. Two additional species from Mexico were added to sect. *Chaptalia* by Cabrera and Nesom (2003). Indeed, the distinction between the New World *Chaptalia* Vent., 1802, and the Old World genus *Gerbera* L., 1758, is not sharply defined, as observed by Jeffrey (1967). Hansen (1990) provided additional perspective on taxonomic problems in the larger generic group of monocephalous, essentially scapose species of

SIDA 21(2): 929–933. 2004

Mutisiinae (the "*Gerbera*-complex") that includes these two genera and informally suggested a return to earlier positions of Schultz-Bipontinus (1856) and Baillon (1882), who believed that the limits of *Gerbera* should include New World species now treated in *Chaptalia*. Nesom (1995) also noted that recognition of the taxonomic boundary between *Chaptalia* and *Gerbera* is problematic but maintained *Chaptalia* as distinct.

In the observations by Katinas (1998), she did not deal directly with significant considerations pertinent to a judgement of generic placement of *Chaptalia hintonii*—it is among the species that constitute sect. *Chaptalia* (Nesom 1995), and cypselar vestiture suggests that *Chaptalia* has evolved apart from *Gerbera* (Hansen 1990).

Species of sect. *Chaptalia* are characterized by monocephalous, ebracteate or few-bracted scapes, heads nodding in bud, broad, cream-colored rays with a purple midstripe on the abaxial surface, and functionally staminate disc flowers. This set of features apparently does not consistently occur in any other group of Mutisiinae. *Chaptalia tomentosa* Vent., the type of the genus, is native to the Atlantic and Gulf coastal plains of the southeastern United States; the other seven species occur in montane habits in eastern and south-central Mexico. Within the section, three species groups can be recognized: (a) *C. tomentosa* and *C. madrensis* Nesom produce narrowly beaked cypselas and pistillate ray corollas without an inner lip; (b) *C. pringlei* Greene is alone in its heads without a zone of rayless pistillate flowers (all pistillate flowers produce conspicuous rays), and cypselas with a short neck; (c) *C. lyratifolia* Burkart, *C. hidalgoensis* Cabr. & Nesom, *C. mexicana* Burkart, *C. hintonii*, and *C. estribensis* Nesom are similar in their colonial habit from rhizomes, leaves with cordate blades and mucronulate margins, pistillate flowers with relatively short style branches, and unbeaked cypselas. *Chaptalia hintonii* differs from *C. lyratifolia C. hidalgoensis*, *C. mexicana*, and *C. estribensis* primarily in its thicker, more easily disconnected rhizomes, and thinner leaves, but the geographic and morphological coherence of these five species within sect. *Chaptalia* seems apparent. The transfer of *Chaptalia hintonii* to *Gerbera* implies that the species belongs to neither the *C. lyratifolia* group ("group c" above) nor sect. *Chaptalia*, but Katinas's observation on the implied non-cohesiveness of sect. *Chaptalia* is indirect—only through her removal of *C. hintonii*.

"The characteristic lack of staminodes in *Chaptalia* and their presence in *Gerbera*" led [Katinas] to place [*Chaptalia*] *hintonii* in the genus *Gerbera*" (Katinas 1998, p. 380). Also, "*Chaptalia hintonii* is much closer to *Gerbera* in its floral characteristics" (p. 382). She noted that for *C. hintonii*, "all florets bilabiate," "outer ray florets conspicuously surpass the involucre," and "ray florets possess staminodes" were features supporting its removal from *Chaptalia*. Numerous other species of *Chaptalia*, however, have all florets bilabiate, all species of sect. *Chaptalia* have large outer rays (e.g., see numerous published photographs of *C. tomentosa*), and staminodes also occur in the inner pistillate flowers of at least three other Mexican species: *C. estribensis* (sect. *Chaptalia*) from the locality in Oaxaca, but not from the localities in Hidalgo; *C. texana* Greene (sect. *Leria* (DC.) Burkart) in plants of Baja California Sur but apparently not from mainland localities; and *C. hololeuca* Greene (sect. *Leria*) from one locality in Coahuila but not from others. Similar staminodes also occur sporadically in both the outer and inner pistillate flowers of the South American species *C. incana* Cuatr., a species suggested by Cuatrecasas (1961) to belong in sect. *Leria* (DC.) Burkart. Finally, Burkart (1944) viewed a group of cordate-leaved South American *Chaptalia* species as better placed in *Trichocline* Cass. than *Chaptalia*, particularly in view of their production of staminodes in the outer pistillate florets. Jeffrey (1967) and Hansen (1990) found that pappus texture and cypselar vestiture refer these species to *Chaptalia* rather than to *Trichocline* or any group of the *Gerbera*-complex.

Parallel variation in the production of staminodes is found in Old World *Gerbera*. Katinas, following Hansen (1990), noted that a reduction to vestigial staminodes has occurred in several groups of *Gerbera* and that they are completely absent in *Gerbera* sect. *Parva* H.V. Hansen.

Hansen (1990) and Nesom (1995) have observed that the inner pistillate florets in *Chaptalia* are intermediate between the disc florets and the outer ray florets. "The inner pistillate flowers of *Chaptalia* appear to be transitional between the ligulate, outer, pistillate ones and the tubular, inner, bisexual flowers in two ways: 1) they usually are bilabiate, even if the outermost are not, and 2) in some species they sporadically produce small, abortive stamens [staminodes]" (Nesom 1995, p. 155). The occurrence of staminodes in *Chaptalia* and other entities of the *Gerbera*-complex is a plesiomorphic feature (Hansen 1990)—they may be interpreted as vestigial organs or as developmentally intermediate in origin (as above). A plesiomorphic similarity between Mexican *C. hintonii* and certain groups of Old World *Gerbera* does not imply closeness of relationship.

What genus?

Evidence at hand indicates that *Chaptalia hintonii* belongs in the same genus as *C. tomentosa*, the type species of *Chaptalia*. If *C. hintonii* is to become a species of *Gerbera*, then so also must the type and at least the other species of sect. *Chaptalia*. Most of *Chaptalia* as a genus holds together well. Species of sects. *Leria* (DC.) Burkart (*C. nutans* Polak., the type), *Archichaptalia* Burkart (*C. rotundifolia* D. Don, the type), and *Pseudotrichocline* Burkart (*C. isernina* Cuatr., the type) are similar to those of sect. *Chaptalia* in their nodding buds and cypselar vestiture, which provides evidence for the phylogenetic coherence of *Chaptalia* apart from Old World members of the *Gerbera*-group.

"Almost all taxonomic main groups [of the *Gerbera*-complex] can be circumscribed by having a special type of achene (cypsela) hair" (Hansen 1990, p.

471). *Chaptalia* has "achene hairs as in *Gerbera* sect. *Piloselloides* Less. but more narrow and either much smaller or much longer and then less inflated" (p. 476, Table 4). Katinas (p. 382) noted that "the species of section *Piloselloides* seem to be the most closely related [to *Chaptalia*] by virtue of the length of the outer ray florets and the type of pubescence on the cypselas ..." but her Table 1 and related comments do not indicate that the cypselar pubescence in these two groups is identical. There is slight variation among cypselar hairs within sect. *Chaptalia*, but I find the vestiture of *C. hintonii* indistinguishable from that of other species of the *C. lyratifolia* group.

Chaptalia sects. *Chaptalia*, *Leria*, and *Archichaptalia* are overlapping in morphological features—leaf shape, degree of elaboration of bracts on the scape, presence/absence of inner pistillate florets, style morphology, elaboration of the inner lip of pistillate florets, ray size, and degree of elaboration of cypselar beak. Especially in their long-petiolate, cordate leaves and broad rays, species of sect. *Archichaptalia* are similar to those of the *Chaptalia lyratifolia* group of sect. *Chaptalia*. Even the distinctive ovarian sterility of the central florets of sect. *Chaptalia* is not a totally exclusive feature. A Brazilian species (Dias de Moraes 1998) is said to be most closely similar to species of sect. *Archichaptalia*, but it apparently is anomalous there in its functionally staminate disc florets (as well as lack of inner pistillate florets, ebracteate scapes, all characters found in some species of sect. *Chaptalia*, where the Brazilian species might technically be placed). Cuatrecasas (1965) described variation in fertility between heads of different plants of the Peruvian *C. malcabalensis* Cuatr.: one head with outer radiate pistillate florets and bisexual fertile central florets, lacking inner rayless pistillate florets; another head with outer radiate pistillate florets, inner rayless pistillate florets, and central florets with sterile ovaries, except for two florets with fertile ovaries and sterile anthers.

Chaptalia sect. *Lieberkuhna* (Cass.) Burkart (*C. piloselloides* (Vahl) Baker, the type) and sect. *Loxodon* (Cass.) Burkart (*C. exscapa* (Pers.) Baker, the type), as a combined group, stand apart from all the rest of *Chaptalia* in production of erect buds, potential for cleistogamous heads, and distinctive cypselar vestiture, and it is possible that this small group of species will be separated at generic rank. This group apparently is the one underlying Hansen's notice (1990) that *Chaptalia* is separable into two groups, based on morphology of cypselar hairs. The Antillean group sect. *Microchaptalia* Burkart appears to be heterogeneous, but I agree with Burkart (1969) that all of it belongs with true *Chaptalia*, rather than being divided between *Chaptalia* and *Lieberkuhna*, as suggested by Jeffrey (1967).

Katinas found similarities between *Chaptalia hintonii* and *Gerbera* sects. *Lasiopus* (DC.) Schultz-Bip., *Pseudoseris* (Baillon) C. Jeffrey, and *Piloselloides* Less. (= *Piloselloides* (Less.) C. Jeffrey), although the species did not fit within any of them. In Hansen's strict consensus tree for the *Gerbera*-complex (1990), these three groups are most closely related to *Chaptalia* and phyletically separate from *Gerbera* sensu stricto, which is the basal OTU in the whole *Gerbera*-complex and separated from *Chaptalia* by *Leibnitzia* Cass., *Perdicium* L., and others. Thus the transfer of *C. hintonii* to *Gerbera* appears equivalent to a step toward recognizing the whole *Gerbera*-complex as a single genus rather than a precise hypothesis of relationship.

The ultimate fate of all of *Chaptalia* may be to join a much broadened *Gerbera*, as suggested by Hansen and earlier botanists, or it may be maintained (perhaps disjoined from *Lieberkuhna*) among a group of smaller genera, as suggested by Jeffrey, but the taxonomic decision in either case should be made in a broad perspective. The taxonomic segregation of *C. hintonii* has little support compared to the geographic and morphological coherence of this species with *Chaptalia* sect. *Chaptalia* and the apparent phylogenetic unity of most of the whole genus *Chaptalia*.

ACKNOWLEDGMENTS

I am particularly grateful to John Strother for various helpful comments on the manuscript.

REFERENCES

Baillon, M.H. 1882. Histoire des plantes 8. Compositae. Paris.

Burkart, A. 1944. Estudio del género de Compuestas *Chaptalia* con especial referencia a las especies argentinas. Darwiniana 6:505–594.

Burkart, A. 1969. Commentario acerca de *Chaptalia* Vent. (Compositae) a raiz de las publicaciones de Baldwin and Speese (1947), Jeffrey (1967) y otras autores. Darwiniana 15:554–555.

Cabrera, L. and G.L. Nesom. 2003. A new species of *Chaptalia* (Asteraceae: Mutisieae) from Mexico and rediscovery of *C. mexicana*. Sida 20:1363–1370.

Cuatrecasas, J. 1961. Studies on Andean Compositae V. Proc. Biol. Soc. Washington 74: 17–28.

Cuatrecasas, J. 1965. Miscelanea sobre flora Neotropica, II. Ciencia (México) 23:121–124.

Hansen, H.V. 1990. Phylogenetic studies in the *Gerbera*-complex (Compositae, tribe Mutisieae, subtribe Mutisiinae). Nordic J. Bot. 9:469–485.

Jeffrey, C. 1967. Notes on Compositae: II. The Mutisieae in east Tropical Africa. Kew Bull. 21:177–223.

Katinas, L. 1998. The Mexican *Chaptalia hintonii* is a *Gerbera* (Asteraceae, Mutisieae). Novon 8:380–385.

Moraes, M.D. 1998. *Chaptalia hermogenis* (Asteraceae: Mutisieae), a new species from the Brazilian Atlantic rain forest. Novon 8:173–175.

Nesom, G.L. 1995. Revision of *Chaptalia* (Asteraceae: Mutisieae) from North America and continental Central America. Phytologia 78:153–188.

Schultz-Bipontinus, C.H. 1856. Flora of the north-western Mexico. Compositae. In: B.C. Seemann. The botany of the voyage of H.M.S. Herald. London. Pp. 297–315.

COMMEMORATIVE

Raymond John Taylor Jr.

20 January 1930–9 November 2004

As this issue of *Sida* was going to press, I received the news that my good friend and colleague had just passed away. Dr. John Taylor retired from Southeastern Oklahoma State University, Durant in 1990 after a long and productive career in botany. I remember John as an excellent teacher and an accomplished botanist who enjoyed field work and collecting plant specimens.

A full memorial is forthcoming in *Sida.—Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

THE *GERBERA* COMPLEX (ASTERACEAE: MUTISIEAE): TO SPLIT OR NOT TO SPLIT

Liliana Katinas

Departamento Científico de Plantas Vasculares
Museo de La Plata
Paseo del Bosque
1900 La Plata, ARGENTINA

ABSTRACT

The transfer of *Chaptalia hintonii* to the genus *Gerbera* was rejected by Nesom (this issue), who retains the species in *Chaptalia* sect. *Chaptalia*. *Chaptalia* and *Gerbera* belong to the *Gerbera*-complex, a group of scapose genera whose circumscriptions are still in flux and whose largest genera still lack complete revisions. Important morphological characters of the corollas, staminodes, and cypsela hairs are discussed, and a key to genera of the *Gerbera*-complex is provided. The short, filiform corollas of the inner ray florets and the lack of staminodes are characters that allow the circumscription of *Chaptalia*. Certain species must be excluded from this genus and the sections within it must be redefined. Staminodes and inner ray florets with bilabiate corollas that are longer than the style are two characters that confirm the transfer of *Chaptalia hintonii* into the genus *Gerbera*.

Key words: *Gerbera hintonii*, *Chaptalia*, *Gerbera*-complex, corollas, staminodes, cypsela hairs

RESUMEN

La transferencia de *Chaptalia hintonii* al género *Gerbera* fue rechazada por Nesom (este volumen), quien retiene esta especie en *Chaptalia* sect. *Chaptalia*. *Chaptalia* y *Gerbera* pertenecen al complejo *Gerbera*, un grupo de géneros de hábito herbáceo escaposo, cuya circumscripción no está definida y cuyos géneros más numerosos aún carecen de revisiones taxonómicas. Se discuten los caracteres morfológicos más importantes de corola, estaminodios y pelos de la cipsela, y se provee una clave de los géneros del complejo *Gerbera*. Las corolas cortas y filiformes de las flores más internas del radio y la ausencia de estaminodios son caracteres que permiten la circumscripción de *Chaptalia*. Ciertas especies deben ser excluidas de *Chaptalia*, y las secciones de este género deben ser redefinidas. La presencia de estaminodios y de flores internas del radio con corola bilabiada más larga que el estilo constituyen dos caracteres que confirman la transferencia de *Chaptalia hintonii* al género *Gerbera*.

In a recent paper (this issue), Nesom rejected Katinas' (1998) placement of the south-central Mexican species *Chaptalia hintonii* Bullock (Asteraceae, Mutisieae) in the Old World genus *Gerbera*. He argued that no clear position within *Gerbera* was given for the species in Katinas' paper and that the morphological evidence more strongly supports including *C. hintonii* within *Chaptalia* rather than in *Gerbera*. *Chaptalia* and *Gerbera* belong to the *Gerbera*-complex, a group of seven genera whose limits are as yet in flux.

I agree with Nesom's argument that a taxonomic decision should be made in a broad context. Therefore, I take this opportunity to clarify and extend my earlier remarks on *Gerbera hintonii* (Bullock) Katinas considering here the entire *Gerbera*-complex.

A revision of the genus *Chaptalia* in progress, led me to examine all the species of this taxon and many of the species of the other genera of the *Gerbera*-complex. This broad perspective allowed me to determine the potencial key characters that can be used to circumscribe the genera of the complex. Furthermore, I found ca. 15 species included in *Chaptalia* that are best excluded from this genus (Katinas, in prep.), some of which probably are better placed within *Gerbera*. The transfer of *C. hintonii* to *Gerbera* was a first step toward this goal.

It should be remarked that since the studies on this group are not finished yet (e.g., revisions of *Chaptalia*, *Gerbera*, and *Leibnitzia*), some conclusions presented here should be regarded as provisional. The main purpose of this presentation is to provide an overview of the transfer of *Chaptalia hintonii* to *Gerbera* in the broader context of the *Gerbera*-complex.

The problem

The *Gerbera*-complex or the scapose-complex (Jeffrey 1967; Hansen 1985a, 1990) belongs to Mutisiinae (tribe Mutisieae) a predominantly American subtribe with a few genera and species ocurring in Asia and Africa. The complex, with ca. 100 species characterized by monocephalous scapes, consists of the genera *Chaptalia* Vent. (ca. 35 species), *Gerbera* L. (29 species), *Leibnitzia* Cass. (six species), *Lulia* Zardini (one species), *Perdicium* L. (two species), *Trichocline* Cass. (22 species), and *Uechtritzia* Freyn (three species). Recently, Hind (2001) transferred *Trichocline spathulata*, the only Australian species of the South American genus *Trichocline*, to the genus *Amblysperma*. A re-examination of both genera however, led to return *Amblysperma* to the synonymy of *Trichocline* (Katinas 2004).

The circumscription of taxa within this morphologically homogeneous group, which lacks complete treatments for its largest genera, has been very problematic. Except for the small genera *Lulia*, *Perdicium* and *Uechtritzia*, the only complete systematic revision within the complex is for *Trichocline* (Zardini 1975). The remaining genera still need complete treatements. In the case of *Chaptalia*, Burkart (1944) focused on the Argentinian species, and Nesom (1995) treated the North and continental Central American species. In addition, Nesom (1983) revised the American species of *Leibnitzia*, whereas Hansen (1988) treated the Asiatic ones. Similarly, Hansen (1985a, b, 1988) treated separately the different sections of *Gerbera*, but he did not deal with the genus as a whole.

In all these studies, the authors stated the difficulties in circumscribing each genus due to the small differences among them. In many cases transfers were made from one genus to another, e.g., species from *Trichocline* to *Gerbera* (Zardini 1974), species from *Chaptalia* to *Leibnitzia* (Nesom 1983), species from *Chaptalia* to *Gerbera* (Katinas 1998). One caulescent species of *Trichocline* had the new genus *Lulia* (Zardini 1980) created for it (which may be excluded from the complex).

Contrasting potential solutions were proposed to deal with these conflicting treatments. Some would treat the entire *Gerbera*-complex as a single, large genus (e.g., Hansen 1990), and, then again, some would split the complex into smaller genera (e.g., Jeffrey 1967). Resolution of the problem will probably only be achieved when treatments of all the taxa are completed.

What character?

Nesom referred to some morphological characters when discussing the transfer of *Chaptalia hintonii* to *Gerbera*, and arguing for the inclusion of this species in *Chaptalia* sect. *Chaptalia*. Below I discuss these characters in the context of the entire *Gerbera*-complex.

Vegetative characters allow some distinction among genera of the *Gerbera*-complex, but reproductive ones, mainly florets (number of series per capitulum, type of corollas, style branches, staminodes) and fruits (cypsela apex, cypsela hairs) seem to be more useful for the delimitation of taxa.

A part of *Gerbera*, and the genera *Lulia*, *Trichocline*, and *Uechtritzia* have their capitula biseriate (two types of florets), i.e., ray florets bilabiate and disc florets bilabiate. *Leibnitzia* also has two types of florets, with ray florets ligulate or bilabiate, sometimes with a minute inner lip (e.g., *L. occimadrensis*), and disc florets tubular or bilabiate. *Perdicium* and a part of *Gerbera* have three types of florets, all bilabiate. *Chaptalia* also has triseriate capitula, with the outer ray florets mostly ligulate and in some species (e.g., *C. exscapa*, *C. tomentosa*) an inner lip is developed. The corolla of the inner ray florets is very reduced, filiform, with a narrow tube, and irregularly bilabiate, tubular or ligulate 3-lobed, shorter than the style. This short, reduced corolla separates *Chaptalia* from *Gerbera*. I have found only two species, *C. mandonii* and *C. tomentosa*, where longer corollas of the inner ray florets may exist, but here they are generally mixed with short ones in the same capitulum. I also found in *Gerbera* some specimens (e.g., *G. piloselloides* and *G. viridifolia*) with corollas that approach those of *Chaptalia* in that their inner ray florets are reduced and transitional between the outer ray florets and the disc florets, but here they are bilabiate and as long as the style or longer. This longer, more developed corolla is present in *G. hintonii* as I have already pointed out (Katinas 1998).

A point considered by Nesom is the presence and the degree of development of staminodes in *Chaptalia* and *Gerbera*. Hansen (1990) showed that there is a reduction series in the staminodes of the ray florets from well developed staminodes or sterile anthers (*Lulia*, *Trichocline*, *Uechtritzia*, part of *Gerbera*), vestigial (part of *Gerbera*, part of *Leibnitzia*, part of *Perdicium*) to absent (*Chaptalia*). *Gerbera parva* is the only species in the genus that lacks staminodes. Observations on different specimens of *G. piloselloides* show that staminodes can be present or absent (even in the same capitulum), the same situation that ocurrs in *G. hintonii*. Nesom pointed out that staminodes are found in species of *Chaptalia*, e.g., *C. estribensis*, *C. hololeuca*, *C. incana*, and *C.*

texana. The first three species, which have staminodes and lack the typical inner ray floret of *Chaptalia*, are included in the group that I would exclude from the genus. With respect to *C. texana*, Nesom (1995) reports that certain specimens (*Gentry & Fox 11768*) have staminodes. The approximately 55 specimens of this species that I have seen all lack staminodes. Moreover, the two sheets of *Gentry & Fox 11768* (MEXU, with the numbers 47607 and 132933) that I have seen lack staminodes as well. *Chaptalia texana*, in addition, is a species that has all the typical characters of *Chaptalia* (e.g., the corollas discussed above). Finally, unlike Nesom I do not consider that the vestigial staminodes, present in *G. hintonii* and other taxa, should be interpreted as a plesiomorphic similarity. As I previously pointed out (Katinas 1998: 381) the reduction of staminodes to thread like (or vestigial) structures as well as their complete absence represent apomorphic conditions.

Nesom also discusses cypsela hairs, in particular the twin hairs. According to him, the cypsela vestiture (together with nodding buds) is a synapomorphy (phylogenetic coherence) of *Chaptalia*. He also suggests that variation of the type of hairs (together with erect buds and cleistogamous heads) will allow the separation of a part of *Chaptalia* at generic rank. A complete classification of these hairs can be found in a work on Nassauviinae (Freire & Katinas 1995), the sister subtribe of Mutisiinae, and a discussion and description of the cypsela hairs in the *Gerbera*-complex is found in my previous paper (Katinas 1998: 381). The analysis of the cypsela twin hairs in most species of all genera of the complex led me to the same conclusion that Hansen (1990) came to, namely that this character is mainly useful in the distinction of *Uechtritzia*, with very long, filiform twin hairs (ca. 1 mm long). The type of twin hairs can differentiate *Chaptalia* and *Gerbera* to some degree, due to some sections of *Gerbera* having cypselas covered by filiform hairs, a type of hair that *Chaptalia* lacks. A distinction can also be made between the American *Leibnitzia* with divergent, radiate, and crenate twin hairs and the remaining genera of the *Gerbera*-complex. *Gerbera hintonii*, shares with many species of *Gerbera*, *Chaptalia* and other genera of the complex, the same type of hair (basic, rounded).

The following key delimits the genera of the *Gerbera*-complex using the characters discussed above, together with some others:

1. Caulescent herbs. Leaves parallel-nerved ____ **Lulia**
1. Acaulescent herbs. Leaves reticulate-nerved.
  2. Pappus bristles connate at the base ____ **Perdicium**
  2. Pappus bristles free.
    3. Plants dimorphic: A vernal generation with small leaves, sligthly developed, and chasmogamous capitula, and an aestival generation with large leaves, fully developed, and cleistogamous capitula ____ **Leibnitzia**
    3. Plants not dimorphic.
      4. Cypselas truncate at the apex.
        5. Cypselas shaggy, covered by long hairs, ca. 1 mm long ____ **Uechtritzia**

5. Cypselas papillose, covered by short hairs, 30–50 µm ______ **Trichocline**

4. Cypselas rostrate at the apex.
   6. Capitula dimorphic or trimorphic; when trimorphic, the inner ray florets with corolla bilabiate or filiform bilabiate, as long as the style or longer. Staminodes generally present ______ **Gerbera**
   6. Capitula trimorphic; the inner ray florets with corolla very reduced, filiform (irregularly tubular, ligulate or bilabiate), shorter than the style. Staminodes absent ______ **Chaptalia**

CONCLUSIONS

As mentioned above, these conclusions are provisional, depending on the completion of work on some genera of the *Gerbera*-complex. The exclusion of ca. 15 species currently included in *Chaptalia* will be crucial for the re-definition of this genus, as many of them have characters that approach those of *Gerbera* and may eventually be transferred to that genus.

With the removal of certain species, the sections within *Chaptalia* must be redefined. The controversial *C. hintonii*, which had been put in sect. *Chaptalia*, has already been excluded (Katinas 1998). Now it is necessary to study all the species of this genus to re-evaluate the traditional sections. For instance, the characters mentioned by Nesom defining section *Chaptalia* (monocephalous, ebracteate or few-bracted scapes, heads nodding in bud, broad, cream coloured rays with a purple midstripe, and funcionally staminate disc flowers) are present also in species belonging to other sections established by Burkart (1944), e.g., *C. denticulata* from Brazil (sect. Archichaptalia), *C. meridensis* from Venezuela (sect. Archichaptalia), *C. paramensis* from Colombia.

I agree with Nesom that *Chaptalia* is a natural group, although I disagree that the cypsela vestiture and nodding buds give coherence to the genus. The basic twin hairs differentiate *Chaptalia* and other taxa of the *Gerbera*-complex only to some degree, whereas nodding buds are not present in many species of *Chaptalia* (e.g., *C. dentata*, *C. exscapa*, *C. mandonii*, *C. piloselloides*, *C. runcinata*). The corolla morphology of the inner ray florets, on the other hand, seem to be the most consistent, apomorphic character for circumscribing the genus. The lack of staminodes, a condition found also (though uncommonly) in *Gerbera*, can also help to circumscribe *Chaptalia*.

In contrast, *Gerbera* has proved to be a non monophyletic genus (Hansen 1990). This situation and the potential addition of species from *Chaptalia* makes it necessary to completely revise the genus. For this reason, it is premature to consider if *Gerbera* could be splited in new, small, genera. I believe that at least some genera of the *Gerbera*-complex have characters that allow them to be mantained as independent taxa within the complex, i.e., the parallel-nerved leaves of *Lulia*, the long, filiform twin hairs on the cypselas of *Uechtritzia*, the alternating plant phases of *Leibnitzia*, and the morphology of the inner ray corollas of *Chaptalia*.

Finally, I conclude that the characters exhibited by *Gerbera hintonii*, i.e., bilabiate inner ray florets with corollas surpassing the style, and vestigial staminodes provide good support for positioning it in *Gerbera* rather than in *Chaptalia*.

ACKNOWLEDGMENTS

I thank Guy L. Nesom for access to his manuscript and for insightful comments during my work in this group of plants. I also thank Jorge V. Crisci and Bob Kowal for critical reading of this response. Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) and the National Geographic Society (Grant n. 5776-96) are also acknowledged.

REFERENCES

Burkart, A. 1944. Estudio del género de Compuestas *Chaptalia* con especial referencia a las especies argentinas. Darwiniana 6:505–594.

Freire, S.E. and L. Katinas. 1995. Morphology and ontogeny of the cypsela hairs of Nassauviinae (Asteraceae, Mutisieae). In: D.J. Hind, C. Jeffrey, and G.V. Pope, eds. Advances in Compositae systematics. Royal Botanic Gardens, Kew. Pp. 107–143.

Hansen, H.V. 1985a. A taxonomic revision of the genus *Gerbera* (Compositae-Mutisieae) sections *Gerbera*, *Parva*, *Piloselloides* (in Africa) and *Lasiopus*. Opera Bot. 78:5–36.

Hansen, H.V. 1985b. Notes on *Gerbera* sect. *Pseudoseris* (Compositae-Mutisieae). Nordic J. Bot. 5:451–453.

Hansen, H.V. 1988. A taxonomic revision of the genera *Gerbera* sect. *Isanthus*, *Leibnitzia* (in Asia), and *Uechtritzia* (Compositae, Mutisieae). Nordic J. Bot. 8:61–76.

Hansen, H.V. 1990. Phylogenetic studies in the *Gerbera*-complex (Compositae, tribe Mutisieae, subtribe Mutisiinae). Nordic J. Bot. 9:469–485.

Hind, D. J. N. 2001. A new combination in *Amblysperma* (Compositae: Mutisieae). Kew Bull. 56:711–713.

Jeffrey, C. 1967. Notes on Compositae II. The Mutisieae in east tropical Africa. Kew Bull. 21:177–223.

Katinas, L. 1998. The Mexican *Chaptalia hintonii* is a *Gerbera* (Asteraceae, Mutisieae). Novon 8:380–385.

Katinas, L. 2004. *Amblysperma* should be retained under *Trichocline* (Asteraceae, Mutisieae). Taxon 53:108–112.

Nesom, G.L. 1983. Biology and taxonomy of American *Leibnitzia* (Asteraceae: Mutisieae). Brittonia 35:126–139.

Nesom, G.L. 1995. Revision of *Chaptalia* (Asteraceae: Mutisieae) from North America and continental Central America. Phytologia 78: 153–188.

Zardini, E.M. 1974. Sobre la presencia del género *Gerbera* en América. Bol. Soc. Argent. Bot. 16:103–108.

Zardini, E.M. 1975. Revisión del género *Trichocline* (Compositae). Darwiniana 19:618–733.

Zardini, E.M. 1980. *Lulia*: un nuevo género de Compuestas. Bol. Soc. Argent. Bot. 19: 255–258.

RESPONSE TO "THE *GERBERA* COMPLEX (ASTERACEAE: MUTISIEAE): TO SPLIT OR NOT TO SPLIT" BY LILIANA KATINAS

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

My view is that *Chaptalia hintonii* is artificially segregated from sect. *Chaptalia*, removed from its relatives *C. lyratifolia*, *C. hidalgoensis*, *C. mexicana*, and *C. estribensis*, which appear to me as inseparably close in both geography and morphology. *Chaptalia pringlei* (also of sect. *Chaptalia* in my treatment) has only two whorls of florets (completely lacking an inner series of pistillate florets with reduced corollas) and apparently also would be rejected from *Chaptalia*, following couplet 6 in Katinas's provisional key to genera of the *Gerbera*-complex. Only two other species are in sect. *Chaptalia*: the generitype *C. tomentosa*, and its putative sister species *C. madrensis*, both of which share significant features with the other six. The few South American species sharing morphological features characteristic of sect. *Chaptalia* are reasonably suspected of relationship with North American sect. *Chaptalia* as much as with South American groups that Burkart and others have hypothesized.

Katinas notes that the transfer of *Chaptalia hintonii* was but the first step in adjusting various taxonomic boundaries within the *Gerbera*-complex. She has "found ca. 15 species included in *Chaptalia* that are best excluded from this genus (Katinas, in prep.), some of which probably are better placed within *Gerbera*" (p. 000). Presumably none of these 15 is among the other seven of sect. *Chaptalia* as I have recognized it. Perhaps some of them are in *Chaptalia* sect. *Lieberkuhna* (sensu stricto, incl. *C. graminifolia*, *C. mandonii*, *C. piloselloides*, and *C. runcinata*) and sect. *Loxodon* (*C. exscapa*) as Katinas's key (couplet 3) appears to corroborate my observation that those sections (combined) might be segregated at generic rank—plants of these species are "dimorphic," alternately producing chasmogamous and cleistogamous heads, similar to those in the genus *Leibnitizia*. The first lead of couplet 3, however, separates only *Leibnitzia*, suggesting that this aspect of biology in the *Lieberkuhna* and *Loxodon* species is not given the same taxonomic weight (or does it imply that she views *Lieberkuhna* and *Loxodon* potentially as members of *Liebnitizia*?).

With further consideration, Katinas concludes that morphology of the inner pistillate florets is "the most consistent, apomorphic character for circumscribing [*Chaptalia*]," i.e., for distinguishing it from *Gerbera*, lack of staminodes of lesser significance. She observes that *C. hintonii* has the relatively "longer, more developed corolla" (as does *C. tomentosa*, where mixed with shorter ones) more characteristic of *Gerbera* (she also notes that only part of *Gerbera* has three types of florets, while the other part has two types). But if these inner pistillate corollas show features of developmental intermediacy between the inner, bisexual florets and the outer, ligulate pistillate florets (as noted in my earlier comments), more pronounced development of corolla lips would not be unexpected, nor would the occurrence of staminodes. In any case, hypotheses of homology in these variable features in species groups on different continents seem tenuous, especially when they play a significant role in decisions affecting generic status.

Apart from geographic and morphological evidence, what is gained by transferring *Chaptalia hintonii* or any species of *Chaptalia* to "*Gerbera*," when it is explicitly recognized that *Gerbera* is "non monophyletic," "necessary to completely revise," and has at least the possibility that it "could be split in new, small genera"? *Chaptalia hintonii* apparently is positioned by Katinas within *Gerbera* in the area of infrageneric groups that do not include *Gerbera* sensu stricto, suggesting that the species probably would soon be transferred again to some other genus. Of course, this is only a tangential comment, as evidence indicates to me that the closest relationship of *C. hintonii* is with sect. *Chaptalia*.

DESCRIPTION OF ASEXUAL REPRODUCTION IN A TEXAS SUCCULENT *SEDUM WRIGHTII* (CRASSULACEAE)

Dennis A. Gravatt[1] and Josephine Taylor

Department of Biology
Stephen F. Austin State University
SFA Box 13003, 1936 North Street
Nacogdoches, Texas 75962, U.S.A.
dgravatt@sfasu.edu

ABSTRACT

Sedum wrightii A. Gray, a west Texas native succulent, is one of a growing number of species known to reproduce by vegetative means. Detached leaves of *S. wrightii* produce plantlets on the basal portion of the adult leaf in association with callus tissue from what appears to be thinned-walled parenchyma and epidermal cells of the petiole. Shoot primordia appear first, emerging over lateral regions of the callus tissue by about day 5, with the roots emerging several days later.

RESUMEN

Sedum wrightii A. Gray, planta suculenta nativa de Texas, pertenece al creciente grupo de especies conocidas que se reproducen vegetativamente. Las hojas arrancadas de *S. wrightii* producen plántulas en la porción basal de la hoja adulta, en asociación con callo de lo que parece ser parénquima de paredes finas y células epidérmicas del pecíolo. Primero aparecen los primordios del vástago, emergiendo de las regiones laterales del callo sobre el quinto día, y las raíces emergen varios días más tarde.

INTRODUCTION

Survival of seeds and seedlings in shallow soils of rock outcrops (Sharitz & McCormick 1973) and on the desert soil surface is poor (Jordan & Nobel 1981), resulting in low sexual reproductive success and limiting the establishment of many desert perennials to certain favorable years. The development of young plantlets from vegetative buds borne on a parent plant, or on detached leaves occurs in several groups of plants including *Sedum*, *Bryophyllum* and *Crassula*, either normally or upon wounding (Stoudt 1934, 1938; Yarbrough 1934, 1936; McVeigh 1938). The propagative capacity of species of these genera have interested botanists, and its advantages have been exploited by horticulturists.

The development of plantlets from leaves is an efficient mechanism of vegetative reproduction in many plant families. These vegetative plantlets may be more successful than seedlings because of several factors, including greater water and carbon reserves (Holthe & Szarek 1985). In an examination of *Sedum wrightii* A. Gray, Clausen (1975) noted that after 11 weeks, 82% of detached leaves developed plantlets, each with a small rosette of leaves and well-developed roots. A later study (Gravatt 2003) showed that the additional source of water and

---

[1] Correspondence: Dennis A. Gravatt, e-mail: dgravatt@sfasu.edu

SIDA 21(2): 943–950. 2004

carbohydrates reserves, over an extended period provided by the detached leaf, was an added benefit for the developing propagule. By day 120 of the experiment, detached leaves remained physiologically active, whereas the propagules maintained constant growth. For succulents such as *S. wrightii*, drought survival of propagules may be determined by the amount of water-storing tissue in the detached leaf.

Gravatt (2003) found that detached leaves of *S. wrightii* readily developed propagules at the base of the leaves. Each propagule develops 2 to 3 roots and a small rosette of 3 to 5 leaves. By the end of the experiment nearly 80% (98% of surviving leaves) of the detached leaves had developed propagules. The morphological events associated with asexual reproduction in *S. wrightii* have not been previously characterized. The purpose of this investigation is to describe the development of young propagules from basal callus tissue of detached, adult leaves in this species using scanning electron microscopy.

MATERIALS AND METHODS

Sedum wrightii is a leaf-succulent perennial occurring in the semi-deserts of the southwestern USA and Mexico. Plants were collected on the limestone cliffs overlooking the Devils Arm of the Amistad Reservoir, Val Verde County, Texas at an elevation of 360 m in August 2001. Plants were potted in soil sand: perlite: topsoil (3 : 3 : 3) using plastic pots (10×10 cm) and placed in a plant growth chamber. Environmental conditions were as follows: photosynthetic photon flux density (PPFD) of 900 μmol $m^{-2} s^{-1}$, 25(±1) °C air temperature, and 1.9(±0.2) kPa vapor pressure deficit (vpd) during the day, and 20(±1) °C air temperature and 1.5(±0.2) kPa vpd at night. Environmental conditions were measured using an ADC (Hertfordshire, England) LCA4 CO_2 and H_2O analyzer. After transplanting, plants were kept well-watered and fertilized biweekly with 0.5-strength Peters Professional fertilizer (W.R. Grace and Co., Fogelsville, PA, USA) with trace elements, 15% each of total N, K_2PO_5, and K_2O.

Plants were allowed to grow until mature, as indicated by the presence of floral buds. A voucher specimen (*Gravatt s.n.*) was deposited in the Stephen F. Austin State University Herbarium (ASTC). Leaves were detached from whole plants ("parent leaves") and were placed on moist vermiculite in plastic pots (10×15 cm) and sampled on days 0, 1, 2, 5, 8, 10, and 14. The vermiculite was kept moist in the growth chamber for the duration of the experiment. Environmental conditions inside the chamber were the same as those described for the whole plants.

On each of the sampling days the basal third of *S. wrightii* leaves were excised using a razor blade, fixed in a 1:1 mixture of glutaraldehyde (5%) and 0.1M potassium phosphate buffer and refrigerated overnight. The specimens were rinsed in deionized water and dehydrated in a graded ethanol series to 100%

ethanol (Mims 1981). The leaf pieces were then critical point dried with carbon dioxide as the transitional fluid, mounted on aluminum stubs, and sputter coated with gold or gold-palladium. Basal ends of leaves were examined using a Hitachi S-405A scanning electron microscope operating at 15 KeV.

RESULTS

The leaves of *Sedum wrightii* are spirally arranged, elliptical or oblong and glabrous. Adult leaves are 8 to 12 mm long, 3.5 to 4.5 mm wide, and 1.5 to 2.5 mm thick. Petioles are much reduced, such that they give the appearance of the leaf being nearly sessile. Preliminary findings determined that leaves of *S. wrightii* contain a single leaf trace. The petioles are very brittle, so that the leaves fall from the stem with only slight pressure and take root from the base of the leaf, forming a new plant (Fig. 1).

Scanning electron microscopic examination of the basal portion of parent leaves revealed the sequence of events associated with propagule formation. After detachment from the stem, vascular tissue and the surrounding parenchyma, as well as the epidermis of the petiole can be seen (Fig. 2). Detached leaves lying on moist vermiculite showed signs of wound tissue formation after 24 hours (Fig. 3).

Within 48 to 60 hours, a cicatrate (scar left by a wound or by abscission) meristem forms at the base of the leaf under the region of the leaf trace. The cells of the wounded surface soon collapse, and the cells underneath these divide in a plane parallel to the surface. A small protuberance, visible under a binocular microscope, appears near the region of the petiole of the parent leaf by the second or third day. This region is identified as the zone of shoot emergence in Figure 3.

When detached leaves are maintained on moist vermiculite, young shoots typically emerge from the callus tissue after five to seven days (Fig. 4). The earliest observed emergence of shoots was three days, with the latest recorded emergence at ten days. The shoot primordium arises on the lateral surface of the callus tissue. The shoot apparently originates from peripheral tissue of the petiole, at the base of the leaf, not previously covered by callus. A single shoot arises by day 5, with two primordial leaves easily identifiable (Fig. 4).

The origination of root primordia within the callus tissue follows emergence of leaf primordia and usually occurs by the eighth day (Figs. 5 & 6). Thus, the development of growing points is as follows: callus tissue forms; the shoot appears before the root; and the roots appear as single root or in pairs.

Several root primordia may be organized within a given callus tissue (Fig 6), so that by day 14 the parent leaf may have three to four adventitious roots. The development of root hairs can be seen on leaves kept on moist vermiculite by about day 14 (Fig. 7).

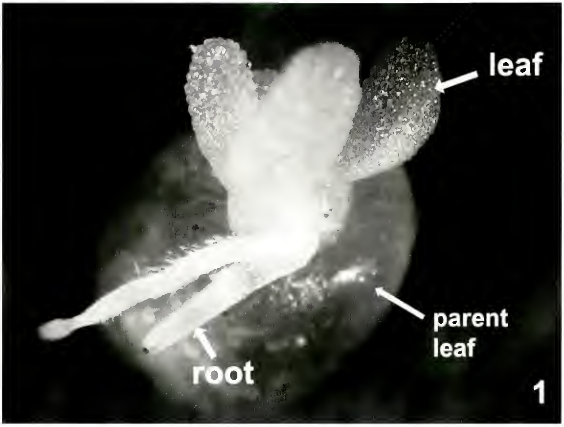


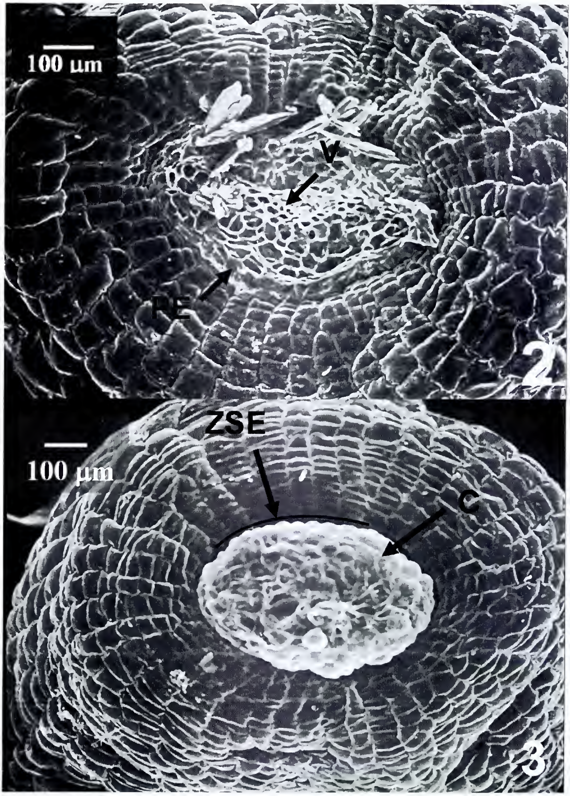
Fig. 1. Stereomicroscope image of *Sedum wrightii* leaf base with 14-day-old propagule (~30×).

DISCUSSION

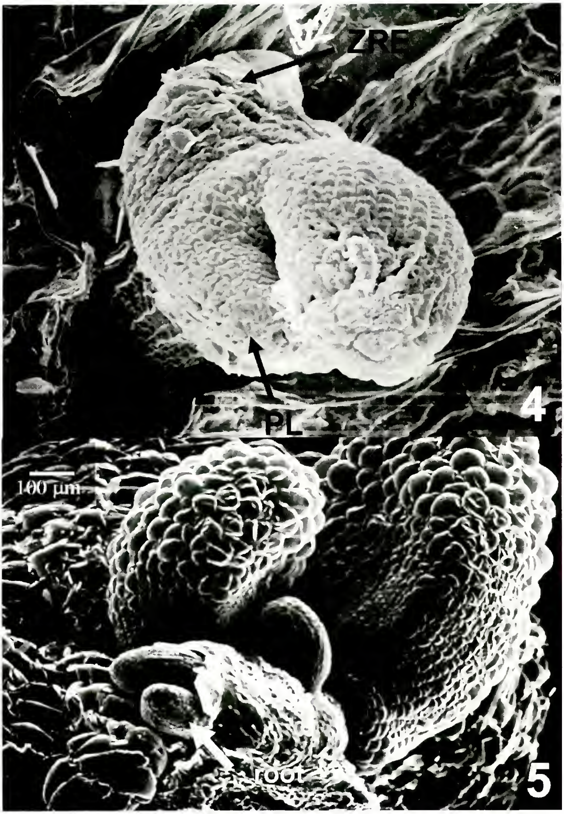
In an earlier study, Gravatt (2003) found that after 11 weeks, 82% of detached leaves developed plantlets, each with a small rosette of leaves and well-developed roots. Furthermore, detached leaves survived for 120 d with a high rate of success for propagule formation, 89% of leaves from the start of the experiment (Gravatt 2003).

Scanning electron microscopic examination of the basal portion of parent leaves revealed a sequence of events associated with propagule formation comparable to that reported in *Crassula multicava* (McVeigh 1938), *Sedum stahlii* (Yarbrough 1936), and *Graptopetalum* (Green & Brooks 1978). The basipetal meristematic activity appears to link the propagule with the vascular system, as found in previous studies (McVeigh 1938; Yarbrough 1936; Green & Brooks 1978). Thus, the propagule is linked with the parent leaf for food and water reserves (see Fig. 4), allowing survival of the young plant (Gravatt 2003).

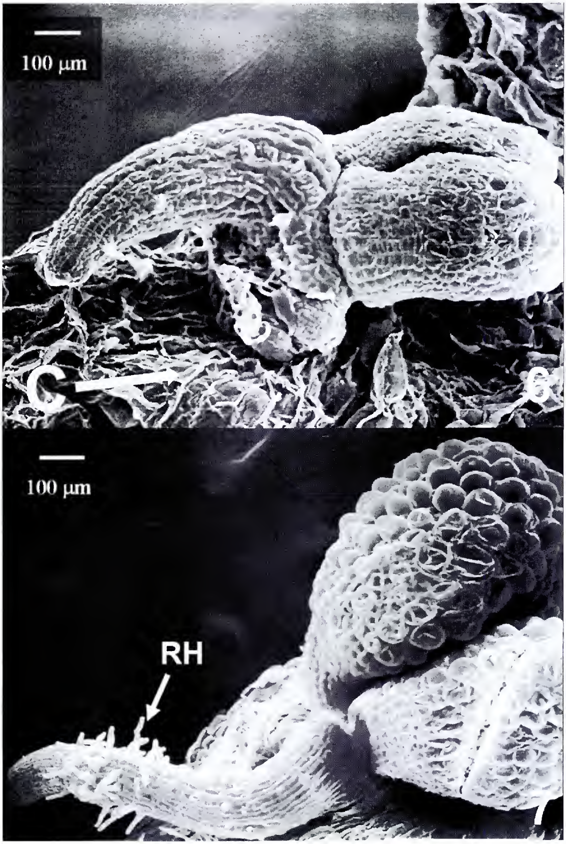
The origination of root primordia within the callus tissue follows emergence of leaf primordia and usually occurs by the eighth day (Figs. 5 & 6). These findings are in contrast to those found by Yarbrough (1936), who observed a different order of development for roots and shoots. In his study, detached leaves



Figs. 2–3. Scanning electron micrographs of *Sedum wrightii* propagules on designated sampling days. **Fig. 2.** Leaf base taken 1 day after leaf removal showing petiole epidermis and vascular tissue, **Fig. 3.** Callus tissue formed over vascular bundle on leaf base taken on day 2. (PE = petiole epidermis; V = vascular tissue; C = callus tissue; ZSE = zone of shoot emergence).



Figs. 4–5. Scanning electron micrographs of *Sedum wrightii* propagules on designated sampling days. **Fig. 4.** Emerging shoot taken on day 5 showing leaves and area of root emergence, **Fig. 5.** Emerging roots and leaves taken on day 8 with remains of callus tissue. (PL = primordial leaf; ZRE = zone of root emergence).



Figs. 6–7. Scanning electron micrographs of *Sedum wrightii* propagules on designated sampling days. **Fig. 6.** Leaf pair and elongating root taken on day 10. **Fig. 7.** Root hair formation, taken on day 14. (C = callus tissue; RH = root hairs).

of *S. stahlii*, left on a dry surface, gave rise to roots first and then shoots. Yarbrough (1936) further observed that in a moist chamber, as used in this study, shoots were not formed and roots only appeared occasionally.

Yarbrough (1936) concluded that production of roots and shoots from leaves of *Sedum stahlii*, which at the time of detachment clearly possess no residual meristem, clearly is an example of regeneration through the formation of adventitious structures. He further stated that the formation of callus tissue by the thinned-walled parenchyma cells of the short petiole involves differentiation. In this study, it appears that this is the case for *Sedum wrightii* as well, and compares well with the findings of Yarbrough (1936). The continued mitotic activity of the cells surrounding the callus makes possible the development of two fundamental growing points, the root and shoot primordia, and the subsequent development of a new plant from the detached leaf.

ACKNOWLEDGMENTS

We would like to thank Guy Nesom (BRIT) and Sherwin Carlquist (SBBG) for various helpful comments on the manuscript.

REFERENCES

Clausen, R.T. 1975. *Sedum* of North America north of the Mexican Plateau. Cornell University Press, Ithaca.

Gravatt, D.A. 2003. Crassulacean acid metabolism and survival of asexual propagules of *Sedum wrightii*. Photosynthetica 41:449–452.

Green, P.B. and K.E. Brooks. 1978. Stem formation from a succulent leaf: Its bearing on theories of axiation. Amer. J. Bot. 65:13–26.

Holthe, P.A. and S.R. Szarek. 1985. Physiological potential for survival of propagules of crassulacean acid metabolism species. Plant Physiol. 79:219–224.

Jordan, P.W. and P.S. Nobel. 1981. Seedling establishment of *Ferocactus acanthodes* in relation to drought. Ecology 62:901–906.

McVeigh, I. 1938. Regeneration in *Crassula multicava*. Amer. J. Bot. 25:7–110.

Mims, C.W. 1981. SEM of aeciospore formation in *Puccinia bolleyana*. Scan. Electron Microscop. 3:299–303.

Sharitz, R.R. and J.F. McCormick. 1973. Population dynamics of two competing annual plant species. Ecology 54:723–740.

Stoudt, H.N. 1934. Gemmipary in *Brynesia weinbergii*. Amer. J. Bot. 21:562–572.

Stoudt, H.N. 1938. Gemmipary in *Kalanchoe rotundifolia* and other Crassulaceae. Amer. J. Bot. 25:106–110.

Yarbrough, J.A. 1934. History of leaf development in *Bryophyllum calycinum*. Amer. J. Bot. 21:467–484.

Yarbrough, J.A. 1936. Regeneration in the foliage leaf of *Sedum*. Amer. J. Bot. 23:303–307.

TAXONOMY, DISTRIBUTION, AND MEDICINAL USES OF LEGUME TREES OF PAKISTAN

Mohammad Athar[1]
California Department of Food and Agriculture
2014 Capitol Avenue, Suite 109
Sacramento, California 95814, U.S.A.
atariq@cdfa.ca.gov

Zahoor Ahmad[1]
National Institute of Agricultural Biotechnology
and Genetic Resources
Pakistan Agricultural Research Council
Islamabad, PAKISTAN

ABSTRACT

A literature search was conducted to determine the medicinal legume trees found in Pakistan and used as remedies for various human disorders or diseases. The taxonomic position of these trees is discussed and their distribution is described to facilitate their collection. There are 40 medicinal, legume tree species belonging to 25 genera of Fabaceae (Leguminosae). Most of these medicinal legume trees belong to Caesalpinioideae (10 genera and 16 species) followed by Mimosoideae (7 genera and 14 species) and Papilionoideae (8 genera and 10 species). This constitutes about half of the Pakistani legume trees possessing medicinal properties used for various ailments. The plant parts used for medicinal purposes included bark, roots, stem, leaves, flowers, fruits and seeds. These medicinal trees have good vegetative growth under cultivated conditions and are in ample supply for commercial exploitation. There is potential for growing medicinal plants in Pakistan as an income generating activity and for sustainable utilization of these medicinal legume trees. However, there is a need for systematic cultivation, commercial extraction using scientific methods and sustainable conservation of endemic medicinal legume trees for substantial utilization through community participation.

RESUMEN

Se realizó una búsqueda bibliográfica para identificar los árboles medicinales de las leguminosas que se encuentran en Pakistán y se usan como medicina para varias enfermedades humanas. Se discute la posición taxonómica de estos árboles y se describe su distribución para facilitar su recolección. Hay 40 especies medicinales de leguminosas arbóreas, pertenecientes a 25 géneros de Fabaceae (Leguminosae). La mayoría de estas leguminosas arbóreas medicinales pertenecen a las Caesalpinioideae (10 géneros y 16 especies) seguidas de Mimosoideae (7 géneros y 14 especies) y Papilionoideae (8 géneros y 10 especies). Esto constituye cerca de la mitad de las leguminosas arbóreas pakistanís que tienen propiedades medicinales usadas para varios remedios. Las partes de la planta usadas con propósitos medicinales incluyen la corteza, raíces, tallos, hojas, flores, frutos y semillas Estos árboles medicinales tienen buen crecimiento vegetativo en condiciones de cultivo y tienen amplio abastecimiento para la explotación comercial. En Pakistán hay potencial para el incremento de las plantas medicinales como actividad generadora de recursos económicos y para uso medicinal sostenible de estas leguminosas arbóreas. Pero, se necesita un cultivo sistemático, extracción comercial mediante métodos científicos y conservación sostenible de leguminosas arbóreas medicinales endémicas para una utilización importante mediante participación de la comunidad.

---

[1] Disclaimer: The views expressed in this article are those of authors and do not necessarily represent those of their respective departments. The publication of this article does not constitute a recommendation or endorsement of the use of these legume trees as herbal medicine. The authors or their departments make no warranty, expressed or implied, and assume no legal liability for the use of these legume trees for medical purposes.

SIDA 21(2): 951–962. 2004

INTRODUCTION

Fabaceae (Leguminosae) is the third largest family of flowering plants comprising of 750 genera and 20,000 species with worldwide distribution (Sprent 2001). In Pakistan legumes form a considerable portion of the flora and are the third largest family in order of abundance (Kirkbride 1986). Ali (1973a, b; 1977) reported 107 genera and 539 species of legumes from Pakistan of which 68 genera have one or more native species (Kirkbride 1986). There are about 82 legume trees in Pakistan of which 27 tree species belong to Caesalpinioideae, 36 to Mimosoideae and 19 to Papilionoideae (Ali 1973a, b; 1977). These trees have considerable significance as source of timber, lumber and fire wood. They are also used as ornamental and shade trees in gardens, orchards and roadside plantations (Malik & Farooq 1984).

Classification of medicinal plants is organized in different ways depending on the criteria used. In general, medicinal plants are arranged according to their active principles in their storage organs, particularly roots, leaves, flowers, seeds and other plant parts (Athar & Nasir 2004; Athar & Siddiqi 2004; Foster & Duke 1990; Moerman 1986, 1991, 1996; Shaheen et al. 2003). These principles are valuable to human for treatment of different diseases (Borchers et al. 2000; Duke 1997; Shaheen et al. 2003; Shinwari & Khan 1998). Reports on the classification of many Pakistani medicinal plants that could be used for remedies and medicinal preparations are sporadic or lacking (Athar & Nasir 2004; Athar & Siddiqi 2004; Durrani et al. 2003; Saeed et al. 2004). Athar and Siddiqi (2004) described the taxonomy, distribution and flowering period of 95 species used as medicinal flowers in Pakistan. In another study, Athar & Nasir (2004) described the taxonomy of 78 plant species yielding vegetable oil used in cosmetics and skin and body care products. This third publication in the series presents the taxonomy of medicinal legume trees of Pakistan and their regional distribution, and summarizes the utilized tree parts and their principal method of application for various ailments.

MATERIALS AND METHODS

A literature search was conducted to determine the legume trees of Pakistan that are used as remedies for various disorders or diseases (Allen & Allen 1981; Athar & Siddiqi 2004; Bach 1994; Baquar 1989; Borchers et al. 2000; Duke 1997; Gunasena & Hughes 2000; Malik & Farooq 1984; Nasir & Rafiq 1995; Palaniswamy 2003; Rasool 1998; Rizvi 1998; Said 1969; Shaheen et al. 2003; Shinwari & Khan 1998; William & Ahmad 1999; Zaman & Khan 1970), and their taxonomic position was determined. The genera were arranged alphabetically within sub-families. The scientific and local names are provided that are commonly associated with these legume trees. Their distribution in various parts of Pakistan is also described to facilitate their collection. The nomenclature and classification followed Polhill and Raven (1994), and author citations followed Brummitt and Powell (1992).

RESULTS AND DISCUSSION

The taxonomic position of 40 species of medicinal legume trees is given in Table 1. These legume trees are distributed in 25 genera and all three sub-families of Fabaceae (Leguminosae). This constitutes about half of the Pakistani legume trees possessing medicinal properties used for various ailments. The list is comprehensive, yet not complete as more tree species could be investigated and added to the list. Most of these medicinal legume trees belong to Caesalpinioideae (10 genera and 16 species) followed by Mimosoideae (7 genera and 14 species) and Papilionoideae (8 genera and 10 species). The plant parts used for medicinal purposes included bark, roots, stem, leaves, flowers, fruits and seeds. Table 1 summarizes the ailments, tree parts and principal methods of application. Specific prescriptions, such as dosage and frequency, are not given, as these are rarely specified in literature and can vary considerably among users according to the recipe. Moreover, the table does not rank the order of the species importance as a medicinal source for the ailments, though this can be found in Hamdard Pharmacopoeia of Eastern Medicine (Said 1969).

Legume trees are amazing natural resources. These trees provide wood for home building, packaging that keeps food fresh during shipment, and natural products like cellulose that are found in everything from the instant soup that we eat to the fabrics that we wear. Legume trees give us food, fodder, fabric, furniture, fatty acids, oils, tannins, gums, medicines, even cosmetics (Allen & Allen 1981), and the list goes on and on expanding to their nitrogen-fixing properties (Allen & Allen 1981; Sprent 2001; Subba Rao & Rodriguez-Barrueco 1993). We get food, clothing and shelter from legume trees all in one environmentally friendly package. Essential oils have been extracted from legume trees for many years for their healing and nurturing properties (Athar & Nasir 2004). Today we use these same essential oils in aromatherapy to promote health, well-being and balance in body, mind and spirit. These plants are ever lasting, easily available and centuries old, tested sources for healing various ailments (Athar & Siddiqi 2004; Athar & Nasir 2004).

An estimated 80% of the rural population in Pakistan depends on traditional medicines for their primary healthcare needs using legumes and other plants or their active principles (William & Ahmad 1999). By trial and error, these people have learnt to employ certain plants, plant parts and extracts to cure diseases and ailments. In this context, certain legume trees also merit consideration for their therapeutic properties, which are being commercialized. It is worth mentioning that nomadic people and rural populations are much more familiar with the use of medicinal plants as compared to people living in the

TABLE 1. Taxonomy, distribution and medicinal uses of legume trees in Pakistan.

Species	Local Name	English Name	Distribution	Medicinal Use
Fabaceae (Leguminosae) Caesalpinioideae				
Bauhinia purpurea L.	Kaliar	Purple Bauhinia	Grown in Punjab, NWFP, Rawalpindi	Flowers are used as purgative. Flowers and buds used for indigestion. Stem bark decoction used for body pain and fever. Paste from bark is given for cancerous growths in stomach.
Bauhinia semla Wunderlin	Kandla	Bauhinia	Jowlian Reserve, Rawalpindi, Hazara	Bark is astringent; used in diarrhea and dysentery. Decoction of leaf is used for headache and malaria.
Bauhinia variegata L.	Kachnar	Mountain ebony	Grown in gardens of Punjab and Sindh	Flowers are aperient.
Caesalpinia bonduc (L.) Roxb.	Fevernut	Gray nicker bean	Grown in gardens of Pakistan	Leaf decoction taken for asthma and mental distress; pulverized seed infusion taken for fever and intestinal worms.
Caesalpinia pulcherrima (L.) Sw.	Gul-e-mohur	Paradise flower	Grown in gardens of Pakistan	Root decoction used for fevers; flowers used for asthma and bronchitis and as anti-pyretic and expectorant.
Cassia fistula L.	Amaltas	Golden shower, Indian laburnum	Naturalized throughout Pakistan	Flowers used for cough, diphtheria, constipation and edema.
Ceratonia siliqua L.	Kharnub	Carob	Introduced and naturalized in Punjab, Islamabad and NWFP	The pods are astringent and are used for coughs. Seed husk is astringent and purgative.
Chamaecrista absus (L.) H.S. Irwin & Barneby	Chasku	Cassia	Wild in open places in NWFP and Punjab	Seeds used for skin diseases.
Delonix regia (Bojer ex Hook.) Raf.	Gulmohar	Peacock flower	Planted in Karachi, Hyderabad and Lahore	Leaf decoction taken for constipation. Flowers are anthelmintic.

Table 1. continued

Species	Local Name	English Name	Distribution	Medicinal Use
Parkinsonia aculeata L.	Valaiti kikar	Jerusalem-thorn	Planted in Sindh, Karachi, Hyderabad, Punjab and Lahore	Leaf, fruit and stem decoctions taken for fever and also are abortive. Flowers and leaf poultice used for rheumatism.
Saraca indica L.	Ashok	Ashok tree	Cultivated in gardens in Punjab and Sindh	Bark is astringent; used in menorrhoea and uterine infections; also used for scorpion-sting.
Senna alata (L.) Roxb.	Dadmurdan	Ringworm cassia	Sometimes cultivated in Pakistan	Flowers are laxative and also useful for softening skin.
Senna alexandrina Mill.	Sennahindi	Indian senna	Wild in Punjab and Sindh	Stem, pods and leaves are useful in habitual costiveness. These lower bowels, increases peristaltic movements of the colon by its local action upon the intestinal wall. Plant is used as expectorant, wound dresser, antidysentric, carminative and laxative.
Senna italica Mill.	Kasordhi	Senna	Found in Punjab and Sindh	Plant useful for malaria and constipation. Pods used as laxative and seed for stomachace.
Senna siamea (Lam.) H.S. Irwin & Barneby	Kasood tree	Siamese shower	Cultivated in Karachi, Sindh	Flowers used as anthelmintic, anti-hypertensive, laxative, tranquilizer and sedative and for asthma, dandruff and insomnia.
Tamarindus indica L.	Imli	Tamarind	Grown in Sindh, Punjab, Jehlum, Karachi	Leaf decoction taken for throat infection, intestinal worms and liver ailments. Flowers used as anti-viral against new castle disease virus and are astringent and sedative. Fruits used for loss of appetite, constipation and rheumatism.

Table 1. continued

Species	Local Name	English Name	Distribution	Medicinal Use
Fabaceae (Leguminosae) Mimosoideae				
Acacia catechu (L.f.) Willd.	Khair, Katha	Black cutch	Distributed in the foothill zone of NWFP and Punjab	Bark is astringent. Root is made into paste and applied on joints for rheumatism.
Acacia farnesiana (L.) Willd.	Kabuli kikar	Sweet acacia	Grows in Sindh, Karachi, Punjab	Leaves used for fever, typhus, tuberculosis, gangrene, bladder infection and wounds; flower tea used for stomachache; crushed fruit juice used for diarrhea and eye and throat infections.
Acacia nilotica (L.) Delile	Kikar	Gum-arabic	Found in Sindh, Punjab, Baluchistan, NWFP	Flowers used for jaundice and palpitation. Leaf juice is taken with fennel for bloody dysentery. Powdered bark given for acute diarrhea. Extracts from root and bark are used as taenifuge, and gum is used as emollient.
Acacia senegal (L.) Willd.	Khor	Gum-arabic acacia	Karachi, Sindh, Balochsitan	Gum demulcent and emollient used internally for intestinal mucosa and externally applied on inflammations
Adenanthera pavonina L.	Barighumchi	Bead tree	Grown in Sindh, Karachi	Wood extract used for migraine and headache; bark and leaf decoction for diarrhea, dysentery and tonsillitis.
Albizia chinensis (Osbeck) Merr.	Ohi		Sub-Himalayan tract, Punjab	Infusion of the bark used as lotion for cuts, scabies and skin diseases.
Albizia julibrissin Durazz.	Ghulabi siris	Silk tree	Outer Himalayan zone	Flowers used for mild constipation, boils, carbuncles and swelling.

TABLE 1. continued

Species	Local Name	English Name	Distribution	Medicinal Use
Albizia lebbeck (L.) Benth.	Siris	Lebbek tree	Found in Sindh, Punjab, Bajaur, Malakand	Similar to *Albizia julibrissin*.
Albizia procera (Roxb.) Benth.	Sufaid-Siris	Lebbek tree	Cultivated and naturalized, Sindh, Karachi, Hasanabdal, Mirpur	Leaves used as poultice on ulcer. Plant has insecticidal properties.
Leucaena leucocephala (Lam.) de Wit	Ipil-Ipil	Ipil-Ipil	Introduced in Sindh, Punjab, NWFP	Root decoction taken for fever; leaf tea taken for typhoid and digestive tract ailment; root and twig decoction used for severe back pain; root and bark are abortive.
Pithecellobium dulce (Roxb.) Benth.	Jungle Jaleebi	Blackbead	Found in Sindh and Karachi	Root bark decoction taken for dysentery; leaf used for indigestion; leaf poultice used for convulsions, venereal lesions and pain; fruit pulp used for hemoptysis; seed used for nasal congestion and internal ulcer.
Prosopis cineraria (L.) Druce	Jhand	Mesquite	Found in Sindh, Baluchistan and Punjab	Flowers are beneficial against miscarriage.
Prospis juliflora (Sw.) DC.	Jhand	Mesquite	Found in Sindh, Baluchistan and Punjab	Eye drops made from leaf juice or cooked leaves and applied or taken orally for eye infections. Gum exudates from trunk used for colds and flu. Fresh root taken orally for diarrhea. Bark and fruit decoction taken for bronchial infection and sinus congestion.

Table 1. continued

Species	Local Name	English Name	Distribution	Medicinal Use
Samanea saman (Jacq.) Merr.	Siris	Lebbek tree	Grown in Sindh, Karachi	Fruit decoction used for anxiety, nervousness; fruit ingested for dysentery and hemorrhage; leaf tea or infusion used for constipation; seed chewed for throat infection.
Fabaceae (Leguminosae) Papilionoideae				
Butea monosperma (Lam.) Taub.	Dhak	Flame of the forest, Bengal Kino	Cultivated in Punjab and NWFP, sporadic in Rawalpindi district	Anti-pyretic, appetizer, aphrodisiac, blood purifier, diuretic, tonic, viral hepatitis. Seed is anthelmintic. Gum is astringent, used in diarrhea and dysentery. Leaves are tonic, astringent; flowers are astringent, diuretic, depurative and aphrodisiac. Bark and seeds are used for snakebites.
Dalbergia sissoo Roxb. ex DC.	Shisham	Sissoo	Widely distributed in Punjab, Sindh and NWFP	Leaves are bitter and stimulant; decoction is used in gonorrhea; root is astringent. Wood is also used in leprosy, boils, eruptions and to stop vomiting.
Erythrina stricta Roxb. var. *suberosa* (Roxb.) Niyomdham	Dhauldak	Coral tree	Sadiqpur Hills, Murree Road, Mirpur	The bark is laxative, diuretic, emmenagogue, expectorant, anthelmintic antibilious and febrifuge, and the decoction is given for dysentery and as a vermifuge and is effective as an eye lotion in ophthalmia. Leaves are anthelmintic, cathartic, glalactagogue and discutient. Leaf juice used externally as a dressing for ulcers and for killing maggots in sores.
Erythrina variegata L.	Pangar	Variegated coral tree	Cultivated as road side tree	Leaves contain a mixture of alkaloid, hyaphorine is present in leaves, seeds and bark. Apart from hyaphorine, betaine and choline are also found.

Table 1. continued

Species	Local Name	English Name	Distribution	Medicinal Use
Gliricidia sepium (Jacq.) Kunth ex Walp.	Sapium/Lal Tali	Madre tree	Only at experimental stations at Karachi and Islamabad	Leaf bath used for fever pain; leaf tea used for sinus inflammation and gonorrhea; root tea used for kidney ailments, edema and hepatitis; leaf poultice used for skin diseases and wounds.
Millettia pinnata (L.) Panigrahi	Karanja	Pongam	Cultivated in Sindh, Punjab	Flowers are used for diabetes.
Ougeinia oojeinensis (Roxb.) Hochr.	Sandan	Sandan	Cultivated in Punjab Gardens; Mirpur east (Sub-Himalayan tract)	The bark is febrifuge. The exudation obtained after incision is used in dysentery and diarrhea. The decoction is given to patients having highly colored urine; also used as fish poison.
Peltophorum pterocarpum (DC) Backer ex K. Heyne	Peela Gulmohar	Copperpod tree	Cultivated in Punjab as road side plantation	In traditional medicine, the bark used in various preparations as a tonic or as a astringent to cure or relieve intestinal disorders like constipation and ringworms, afterpain at childbirth, sprains, bruises and swellings, or as a lotion of eye troubles, muscular pains and sores. Leaves in form of decoction used to wash unhealthy skin.
Sesbania grandiflora (L.) Pers.	Bansa	Sesbania	Planted in Karachi, Kutch, Sindh, Punjab	Root paste used for rheumatism; root resin used for phlegm; bark decoction used for fever and diabetes; flower juice improves vision (as eye drops).
Sesbania sesban (L.) Merr.	Janter	Sesbania	Cultivated in Sindh, Punjab	Leaf compress applied to infected areas for suppuration. Anti-fertility activity of flowers also reported.

cities (Durrani et al. 2003; Saeed et al. 2004; William & Ahmad 1999). It is interesting to note that elderly people, particularly women, were more aware of the value of the medicinal flora than younger generations. Nomadic people and rural populations depend upon legume trees not only as medicinal plants but also for fuel wood and fodder and forage for their livestock. Some of the medicinally important plants are over-harvested due to their extensive use, which may lead to their extinction. Overgrazing and cutting of legume trees for fuel wood and commercial exploitation has also resulted in reduced vegetation cover, promoted soil erosion and deterioration of Pakistani rangelands. However, legume trees cultivated in the gardens, parks, and roadside and riparian plantations in Sindh and Punjab have good vegetative growth and are in ample supply for commercial exploitation.

Pakistan has the potential for sustainable utilization of its medicinal legume trees, and mainly exports crude plant materials that have a low value in the international market (Shaheen et al. 2003). On the other hand countries like China and India export value-added plant extracts standardized on the basis of their active ingredients. There is enormous price difference between crude plant material and properly processed plant extracts. Moreover, developed countries do not allow the import of unprocessed raw plant material due to rigorous phytosanitary regulations (Crockett & Khan 2003; FAH 2003). It is therefore important that Pakistani producers and traders of medicinal plants should consider adding value to their exports by carrying out the initial processing and quality evaluation in Pakistan. However, attention needs to be paid to the systematic cultivation, scientific extraction and sustainable conservation of endemic medicinal legume trees for substantial utilization through community participation.

A team from the Pakistan Forestry Institute, Peshawar has carried out an ethnobotanical study in northern areas of Pakistan (Rasool 1998). This study identified economically valuable trees that can be collected from the wild and medicinal plants that can be grown commercially on common or agricultural land. Several species are no longer found in the area, including *Taxus baccata*, the source of the anti-cancer agent Taxol. There is potential for cultivating medicinal plants as an income-generating activity (Athar & Nasir 2004; Athar & Siddiqi 2004). Further research should be carried out on the floristic composition of medicinal plants and the present status of medicinal cum economic plants, including their market potential within the country and in the international market. The study should also look at the prospects for conserving endemic medicinal and economic species for sustainable use through community participation.

ACKNOWLEDGMENTS

Special gratitude is expressed to Joseph H. Kirkbride, USDA, Agricultural Research Service, Beltsville, MD, for his help in checking the nomenclature and taxonomy of the plants and M. Akmal Siddiqi, Marshfield Clinic Research Foundation, Marshfield, WI, USA for valuable suggestions and helpful criticism on the manuscript. The authors are also grateful to M. Iqbal Choudhary, H. E. J. Research Institute of Chemistry, University of Karachi, Karachi, Pakistan for providing many original reprints used in the preparation of this paper.

REFERENCES

Allen, O.N and E.K. Allen. 1981. The leguminosae. A source book of characteristics, uses, and nodulation. The Wisconsin University Press, Madison, WI.

Ali, S.I. 1973a. Mimosaceae. Flora West Pakistan. 36:1–41.

Ali, S.I. 1973b. Caesalpiniaceae. Flora West Pakistan. 54:1–47.

Ali, S.I. 1977. Papilionaceae. Flora West Pakistan. 100:1–389.

Athar, M. and S.M. Nasir. 2004. Taxonomic perspectives of plant species yielding vegetable oils used in cosmetics and skin care products. Int. J. Biol. Biotechnol. 1(4). In Press.

Athar, M. and M.A. Siddiqi. 2004. Some reflections on the taxonomy of medicinal flowers of Pakistan. Sida 21:357–369.

Bach, E. 1994. Flower remedies. Alternat. Med. 232–243.

Baquar, S.R. 1989. Medicinal and poisonous plants of Pakistan. Printas, Karachi, Pakistan.

Borchers, A.T., C.L. Keen, J.S. Stern, and M.E. Gershwin. 2000. Inflammation and Native American medicine: the role of botanicals. Amer. J. Clinic. Nutr. 72:339–347.

Brummitt, K.R. and C.E. Powell (eds.). 1992. Authors of plant names. Royal Botanic Gardens, Kew, UK.

Crockett, S.L. and I.A. Khan. 2003. Challenges of standardization: Marker compounds in plant species related and unrelated to top-selling herbs. J. Herbs Spices Med. Pl. 10(3): 13–24.

Duke, J.A. 1997. The green pharmacy. Rodale Press, Emmaus, PA.

Durrani, M.J., A.M. Taj and F. Hussain. 2003. Folk medicinal plants of Nushki, District Chagai, Pakistan. J. Sci. & Tech.; Univ. Peshawar. 27:45–51.

FAH (Forschungsvereinigun der Arzneimittel-Hersteller e.V.) [German Research Association of Medicine Manufacturers]. 2003. Standard operating procedures for inspecting cultivated and wild crafted medicinal plants. J. Herbs Spices Med. Pl. 10(3):109–125.

Foster, S. and J.A. Duke. 1990. A field guide to medicinal plants: eastern and central North America. Houghton Mifflin Co., Boston, MA.

Gunasena H.P.M. and A. Hughes. 2000. Fruits for the future 1. Tamarind. *Tamarindus indica* L. International Center for Underutilized Crops (ICUC), UK.

Kirkbride, J. 1986. Phylogeny and classification of Pakistani legumes. Pakistan J. Bot. 18: 287–299.

Malik, S. and S. Farooq. 1984. Cultivated trees, shrub and climbers of gardens of Pakistan. Taxonomic studies. PCSIR, Peshawar Laboratory, Peshawar, Pakistan.

Moerman, D.E. 1986. Medicinal plants of North America. Museum of Anthropology, University of Michigan, Ann. Arbor, MI.

Moerman, D.E. 1991. The medicinal flora of native North America: an analysis. J. Ethnopharmacol. 31:1–42.

Moerman, D.E. 1996. An analysis of the food plants and drug plants of native North America. J. Ethnopharmacol. 52:1–22.

Nasir, Y.J. and R.A. Rafiq. 1995. Wild flowers of Pakistan. Elite Publishers Ltd., Islamabad, Pakistan.

Palaniswamy, U.R. 2003. A guide to medicinal plants of Asian origin and culture. CPL Scientific Publishing Services Ltd., Newbury, UK.

Polhill, R.M. and P.H. Raven. 1981. Advances in legume systematics, part 1. Royal Botanic Gardens, Kew, UK.

Rasool, G. 1998. Medicinal plants of northern areas of Pakistan: Saving the plants that save us. Pakistan Forest Institute, Peshawar, Pakistan.

Saeed, M., M. Arshad, M. Ahmad, E. Ahmad, and M. Ishaque. 2004. Ethnophytotherapy for the treatment of various diseases by the local people of selected areas of NWFP (Pakistan). Pak. J. Biol. Sci. 7:1104–1108

Said, H.M. (ed.). 1969. Hamdard pharmacopoeia of eastern medicine. Time Press, Karachi.

Shaheen, F., M. Attaur Rahman, K. Vasisht and M. Iqbal Choudhary. 2003. The status of medicinal and aromatic plants in Pakistan, In: Medicinal plants and their utilization, UNIDO. Pp. 77–87.

Shinwari, M.I. and M.A. Khan. 1998. Ethonobotany of Margalla Hills National Park of Islamabad. Department of Biological Sciences, Quaid-i-Azam University, Islamabad and PASTIC Press, Pakistan.

Sprent, J.I. 2001. Nodulation in legumes. Royal Botanic Gardens, Kew, UK.

Subba Rao, N.S. and C. Rodriguez-Barrueco (eds.). 1993. Symbioses in nitrogen-fixing trees. International Science Publications, New York, NY.

William, J.T. and Z. Ahmad. 1999. Priorities for medicinal plants research and development in Pakistan. Published by MAPPA, India and IDRC, Canada.

Zaman, M.B. and M.S. Khan. 1970. Hundred drug plants of West Pakistan. Pakistan Forest Institute, Peshawar and Ferozsons Ltd., Lahore, Pakistan.

ABOUT 450 MILES UP THE RED RIVER IN A LARGE PRAIRIE: PETER CUSTIS' SURVIVING BOTANICAL INFORMATION FROM THE RED RIVER EXPEDITION OF 1806

Michael H. MacRoberts and Barbara R. MacRoberts

Bog Research, 740 Columbia
Shreveport, Louisiana 71104, U.S.A.

Herbarium, Museum of Life Sciences and Red River Watershed Management Institute
Louisiana State University-Shreveport, Shreveport, Louisiana 71115, U.S.A.

ABSTRACT

In 1806 Peter Custis, botanist on the Red River Expedition, collected 26 plants mainly in the prairies in what is today Caddo and Bossier parishes, Louisiana. These were sent to Benjamin Smith Barton in Philadelphia. Two of the specimens are still in the Barton Herbarium. They are very unusual for the region today. We have looked for the other 24 specimens but without success. Those 24 specimens would certainly aid in understanding the ecology of the Red River area in 1806.

RESUMEN

En 1806 Peter Custis, botánico en la expedición del Red River, colectó 26 plantas principalmente el lo que hoy son los municipios de Caddo y Bossier, Louisiana. Fueron enviadas a Benjamin Smith Barton en Filadelfia. Dos de los especímenes están aún en el Barton Herbarium. Estas son muy raras en la región actualmente. Hemos buscado los otros 24 especímenes pero no hemos tenido éxito. Estos 24 especímenes ayudarían ciertamente a comprender la ecología del área del Red River en 1806.

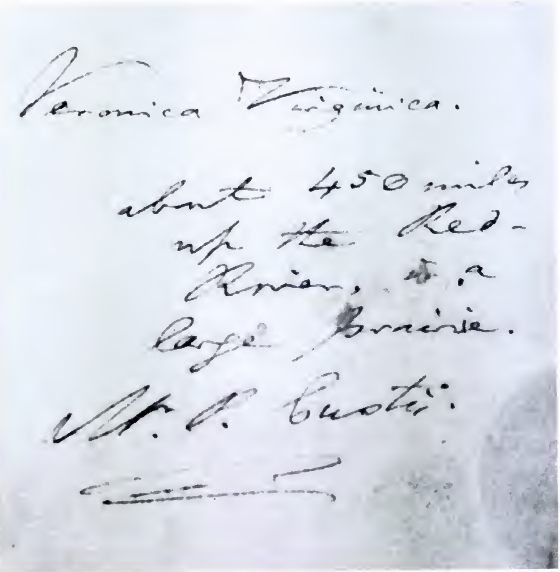
INTRODUCTION

The first part of the title of this paper comes from an herbarium specimen label written by Benjamin Smith Barton for a plant collected by Peter Custis in 1806. The plant comes from "the forgotten expedition"—the ill-fated and suppressed Thomas Jefferson-sponsored 1806 Expedition to the Red River. This expedition was to have been a southern counterpart to the now famous Lewis and Clark expedition (Figs. 1, 2). The specimen, housed in the Barton Herbarium at the Academy of Natural Sciences, Philadelphia, is one of three Peter Custis plant specimens there. It is one of two known surviving plants of 26 that were collected by Custis on the expedition.

This paper has a twofold purpose. First, it makes the Freeman and Custis Red River Expedition of 1806 and its botanical contribution more familiar. The year 2006 will mark the bicentennial of the first botanical expedition into what is now northwestern Louisiana, southwestern Arkansas, and northeastern Texas (Anon 1807). Second, we call attention to an additional 24 collections made by Peter Custis in 1806 on the Red River that are not housed in the Barton Herbarium. These specimens, the identity of which is not known, might be crucial to under-

SIDA 21(2): 963–975. 2004

Fig. 1. *Veronicastrum virginicum* (L.) Farw. collected by Peter Custis in 1806 "450 miles up the Red Rver in a large prairie." Specimen housed in the Barton Herbarium, Academy of Natural Sciences, Philadelphia. Photograph made at the Old Courthouse Museum, Natchitoches, Louisiana.



Veronica Virginica.

about 450 miles
up the Red-
River, & a
large Prairie.
Mr. P. Custis.

FIG. 2. Label information in Barton's hand. Photograph made at the Old Courthouse Museum, Natchitoches, Louisiana.

standing floristic changes that have occurred in the Red River region over the past two centuries.

THE EXPEDITION

Louisiana was purchased from France in 1803. Thomas Jefferson sent probes into the newly acquired territory, the most notable of which was the Lewis and Clark expedition begun in 1804. Other expeditions soon followed: Dunbar and Hunter up the Ouachita, Pike up the Arkansas, and Freeman and Custis up the Red (Jackson 1981). This latter expedition was to skirt the Spanish/United States border, follow the Red River to its source, and test the Spanish resolve to prevent American western expansion.

The Red River expedition, unlike other expeditions, was clearly politically motivated but was disguised as scientific by the inclusion of a naturalist in the company. The purpose was to probe, none too delicately, the resistance of the Spanish beyond the as yet unsettled boundary between Louisiana and Mexico. Peter Custis, a young naturalist and medical student trained at that time by the most knowledgeable American botanist Benjamin Smith Barton, accompanied Thomas Freeman, a surveyor and astronomer and leader of the expedition, during the spring and summer of 1806. They were accompanied by 45 soldiers, interpreters, and guides on the Red River some 615 miles in search of its headwaters, then thought to be in the vicinity of Santa Fe. The expedition entered the Red River on May 2 and left Natchitoches, the northernmost post on the Red River, a month later. Soon after leaving Natchitoches, they encountered the lowest logjam of the Red River raft and had to divert their course to the bayous, "raftlakes," and sloughs that surrounded the River (Figs. 3, 4, 5) (Humphreys 1971; Flores 1984; Triska 1984; Bagur 2001). They reentered the main River just above present day Shreveport to find themselves unobstructed in a land of prairies, cedar forests, river bottomlands, and pine-oak-hickory bluffs and uplands.

The Spanish reaction was immediate and in force far beyond the modest Freeman party. The expedition was stopped on July 28 by Captain Don Francisco Viana and a force of between 200 and 300 mounted soldiers and infantry at a point near what is today Spanish Bluff in Bowie County, Texas, and turned back (Fig. 6). The Red River expedition was a political failure and an embarrassment to President Jefferson, who quietly suppressed it. Knowledge of the expedition was lost to history for almost 200 years. The Red River, north of Bowie County, remained virtually unexplored until the Marcy and McClellan Expedition of 1852, almost fifty years later (Marcy & McClellan 1854).

PETER CUSTIS AND THE BOTANICAL ASPECT OF THE EXPEDITION

Since Jefferson had received some criticism for not including a naturalist on the Lewis and Clark expedition, the Red River expedition was to be the first American-sponsored exploring expedition to include a trained naturalist. Presumably Barton, at the University of Pennsylvania at the time, selected the list of candidates, and Freeman made the final choice. The nod was given to the 25-year old medical student, Peter Custis of Virginia, who had entered the University of Pennsylvania as a medical student in 1804 and was about a year away from his degree. His background for the position consisted in having attended Barton's inclusive lectures on natural history. He had no field experience and was not considered a "naturalist" in any real sense of the word. On this expedition no provision was made for proper scientific preparation to preserve and send specimens to Barton. Consequently, Custis attempted to identify and describe in the field the plants he encountered either by familiarity or by reference to the few floras he took with him, one of which probably was Linnaeus's *Systema Vegetabilium*. As might be expected, there were names of many for-

Fig. 3. Raft with vegetation growing on it on Red River, 1873. Archives Department, Noel Memorial Library, Louisiana State University in Shreveport, Shreveport, Louisiana. R.B. Talfor photographer.

eign species contained in the list of about 190 plants that Custis described (Morton 1967; MacRoberts et al. 1997). Because Custis could not identify all of the plants to his satisfaction, he collected 26 and sent or took them to Philadelphia where two of them are known to survive in the Barton collection (Flores 1984). Custis listed these 26 plants separately in his report, most of which were collected in the extensive prairies that then existed north of present day Shreveport (Fig. 7).

Both Freeman and Custis sent regular reports to President Jefferson, the Secretary of War Henry Dearborn, and to Professor Barton. These were drawn together, and Nicholas King was given the task of redacting the accounts. His redaction was published in a very limited edition in 1807, of which only about a dozen copies survive as stated in an extensive account of this publication by Flores (1984). The King redaction has many errors and some omissions, which Flores (1984), using primary material, has corrected. The redaction in a partial facsimile edition has been reprinted (Adams 1985).

While some historians were aware of the expedition (e.g., Jackson 1981), it did not get full attention until Flores (1984) published his detailed account. In anthropological circles, the expedition was known because of its descriptions of Native Americans encountered above the Great Red River Raft (Morton 1967).

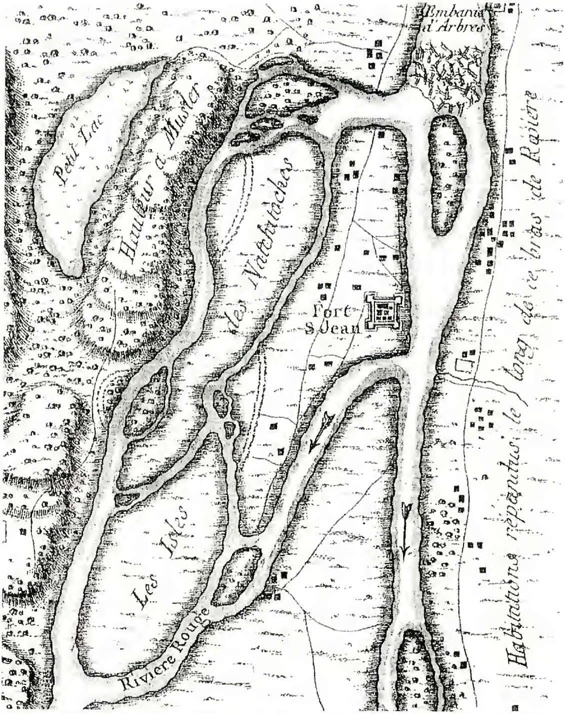


Fig. 4. Jacques Nicholas Bellin 1764 map of Natchitoches region of central Louisiana showing the lowest raft on the Red River in the 18th century. Archives Department, Noel Memorial Library, Louisiana State University in Shreveport, Shreveport, Louisiana.

In botanical, zoological, and ecological circles, the expedition remained unknown (e.g., McKelvey 1955; Ewan 1967; Sundell 1979; Lowery 1974a, 1974b). The expedition was unknown to Joseph Ewan (1952, 1969, 1988), Louisiana botanist and eminent historian of Bartonian Philadelphia. Morton (1967), using the

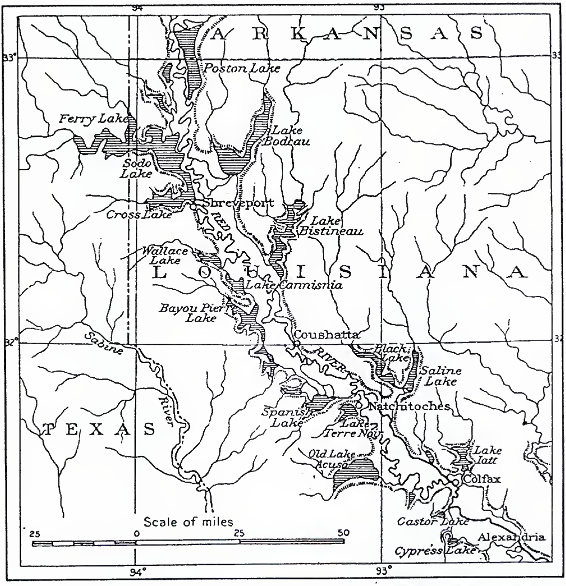


FIG. 5. Map of the "raft lakes" along the Red River created by overflow caused by the Raft. House Document 488, 59th Congress, 1st Session.

King redaction, published the first account of the plants observed by Custis. His aim was to interpret the Custis plant names and notes and provide modern identifications and nomenclature. Flores (1984) made the same attempt with the aid of Morton's (1967) paper. With the help of James Mears at the Academy of Natural Sciences in Philadelphia, Flores also located two of the Custis specimens and made photographic reproductions (Flores 1984:246–247). MacRoberts et al. (1997) reexamined the Custis accounts using, by that time, much better botanical information. Gilmore (2002) in his very important "Foundations of Southeastern Botany: An Annotated Bibliography of Southeastern American Botanical Explorers Prior to 1824" brought together the major works concerning the botanical aspects of the Freeman and Custis expedition. As Morton

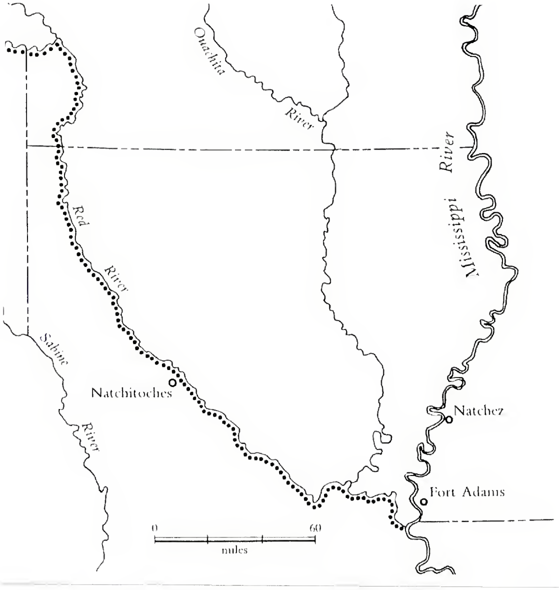
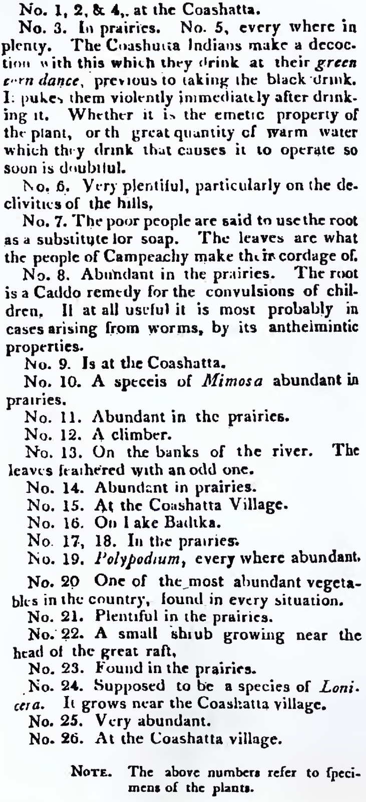


Fig. 6. Freeman-Custis route up the Red River. Modified from Jackson (1981, Fig. 10).

(1967) has rightly pointed out, the botanical part of the narrative is quite informative, being the first published information concerning the native plants of northwestern Louisiana and southwestern Arkansas, as well as the first descriptions of some of the plant communities, several of which have ceased to exist in the area, e.g., canebrakes, prairies, and cedar forests.

THE SPECIMENS

While it is possible to make informed guesses about the identity of the plants that Custis listed and described in his catalogues (Morton 1967; Flores 1984; MacRoberts et al. 1997), it is never possible to be certain without a specimen: thus the importance of the 26 plants collected by Custis that were forwarded to Barton.



No. 1, 2, & 4,. at the Coashatta.

No. 3. In prairies. No. 5, every where in plenty. The Coashutta Indians make a decoction with this which they drink at their *green corn dance*, previous to taking the black drink. It pukes them violently immediately after drinking it. Whether it is the emetic property of the plant, or the great quantity of warm water which they drink that causes it to operate so soon is doubtful.

No. 6. Very plentiful, particularly on the declivities of the hills,

No. 7. The poor people are said to use the root as a substitute for soap. The leaves are what the people of Campeachy make their cordage of.

No. 8. Abundant in the prairies. The root is a Caddo remedy for the convulsions of children. If at all useful it is most probably in cases arising from worms, by its anthelmintic properties.

No. 9. Is at the Coashatta.

No. 10. A speceis of *Mimosa* abundant in prairies.

No. 11. Abundant in the prairies.

No. 12. A climber.

No. 13. On the banks of the river. The leaves feathered with an odd one.

No. 14. Abundant in prairies.

No. 15. At the Coashatta Village.

No. 16. On Lake Badtka.

No. 17, 18. In the prairies.

No. 19. *Polypodium*, every where abundant.

No. 20 One of the most abundant vegetables in the country, found in every situation.

No. 21. Plentiful in the prairies.

No. 22. A small shrub growing near the head of the great raft,

No. 23. Found in the prairies.

No. 24. Supposed to be a species of *Lonicera*. It grows near the Coashatta village.

No. 25. Very abundant.

No. 26. At the Coashatta village.

Note. The above numbers refer to ſpecimens of the plants.

Fig. 7. Facsimile copy of the list of 26 plants collected by Custis from the King redaction of the Freeman-Custis reports.

The two known surviving specimens, which come from above the Great Raft in the prairies along the Red River, are unusual for the present flora. One, *Veronicastrum virginicum* (L.) Farw., is very rare, if extant, in Louisiana today, and the other, *Eustoma russellianum* (Hook.) G. Don, has never been found in the area since. What were the other "prairie" specimens collected by Custis; and, if they were extant, would it be possible to envision the type of prairie where they occurred? Unfortunately, the prairies from which these plants came have long ceased to exist and are now known only from old maps and place names (Fig. 8).

THE SEARCH

On June 12 and 13, 2003, we made a thorough search of all of the specimens in the Barton and Lambert Herbaria at the Academy of Natural Sciences in Philadelphia. The Barton Herbarium, kept separate at the Academy of Natural Sciences, consists of 1674 specimens originally housed at the American Philosophical Society but moved to the Academy in 1898 (Pennell 1926). It consists of many specimens only a few of which were collected by Barton himself. The majority were collected by Frederick Pursh (Barnhart 1926). Barton's collection was previously searched for the same material by James Mears in the early 1980's with the same idea in mind; he found both of the specimens mentioned above (Flores 1984). Our search located three Peter Custis specimens, the same two from the Red River and one apparently from Virginia. These three specimens may have been all that were there in 1926 when both Pennell (1926) and Barnhart (1926) examined the collections or they would have done more than very briefly mention Custis in their papers. We also examined the Aylmer Bourke Lambert collection, which is the remains of Lambert's large collection purchased by Edward Tuckerman and given to the Academy in 1842 (Miller 1970). It has a good deal of American material but no Custis collections. This leaves 24 specimens that have not been located.

We do not know what happened to the other 24 Custis specimens. We only know that two of them did get to Philadelphia, then the hub of American botany (Pennell 1950). If two did, then probably all of them did. If that is so, then, where are they now? It is unlikely they were discarded; collectors and curators prized their herbaria. But, the fragmentation and neglect of plant collections (including minimal labeling) in the early years of American botany is well known (Pennell 1950). For example, Frederick Pursh, Barton's part-time curator and collector between 1805 and 1809, took various specimens from the Barton collection, including a significant portion of the Lewis and Clark collection, first to New York and then to London, and many plants simply disappeared (Ewan 1952; McCourt & Spamer 2003). After Barton's death in 1815, his collections were warehoused for over 80 years at the American Philosophical Society before they were entrusted to the Academy of Natural Sciences (Mears 1981). Por-

Fig. 8. Detail of Land Plat from 1837 of one of the extensive prairies that existed in what is today Caddo Parish, Louisiana. Clerk of Court Office, Caddo Parish, Louisiana.

tions of Pursh's collections that he took to England and left to Lambert were returned to the Academy in the mid-19th century (Miller 1970; Pennell 1950; McCourt & Spamer 2003). But as any browser of the *Index Herbariorum* learns, specimens collected by famous botanists are scattered worldwide. We would like to locate the missing specimens to better interpret the Red River ecology prior to the massive changes that occurred to the area during the subsequent two centuries.

ACKNOWLEDGMENTS

James Macklin, Lucinda McDade, Alfred Ernest Schuyler, and Earle Spamer, at the Academy of Natural Sciences, Philadelphia, aided with this study. Amanda Crnkovic, Jolene Long, Cran Lucas, Steve Lynch, and Glenda Sharbono, Louisiana State University in Shreveport, aided with the figures. Laura Conerly, Domenica Carriere, and Glenda Sharbono, Archives Department, Noel Memorial Library, Louisiana State University, aided with the maps. The research was partly supported by a J. Bennett Johnston Science Foundation Grant that Virginia Simons Lincove, Associate Vice Chancellor, Louisiana State University in Shreveport, was instrumental in securing for the research. Further support and assistance was provided by Gary Hanson and Patricia Peyton of the Red River Watershed Management Institute, Louisiana State University in Shreveport. Carolyn Harrington, Old Courthouse Museum, Natchitoches, Louisiana, allowed us to photograph the Custis specimens then on loan from the Academy of Natural Sciences, Philadelphia. Ron Looney, Clerk of Court Office, Caddo Parish, gave permission to photograph land plats. Reviews by Eric Sundell, University of Arkansas, Monticello, and Ronald L. Stuckey, Ohio State University, Columbus, are greatly appreciated.

REFERENCES

Adams, G. 1985. An account of the Red River in Louisiana, drawn up from the returns of Messrs. Freeman and Custis to the War Office of the United States who explored the same in the year 1806. Ye Galleon Press, Fairfield, Washington.

Anonymous. 1807 (redacted by Nicholas King). An account of the Red River, in Louisiana, drawn from the returns of Messrs. Freeman and Custis, to the War Office of the United States, who explored the same, in the year 1806.

Bagur, J.D. 2001. The history of navigation on Cypress Bayou and the Lakes. Univ. North Texas Press. Denton.

Barnhart, J.H. 1926. Brief sketch of some collectors of specimens in the Barton Herbarium. Bartonia 9:35–42.

Ewan, J. 1952. Frederick Pursh, 1774–1820, and his botanical associates. Proc. Amer. Philos. Soc. 96:599–628.

Ewan, J. 1967. A bibliography of Louisiana botany. Southwestern Louisiana J. 7:1–83.

Ewan, J. 1969. A short history of botany in the United States. Hafner, New York.

Ewan, J. 1988. Benjamin Smith Barton's influence on trans-Allegheny natural history. Bartonia 54:28–38.

Flores, D.L. 1984. Jefferson and Southwestern exploration: The Freeman and Custis accounts of the Red River Expedition of 1806. Univ. Oklahoma Press, Norman.

Gilmore, R.W. 2002. Foundations of Southeastern botany: an annotated bibliography of Southeastern American botanical explorers prior to 1824. Castanea: Occasional Pap. Eastern Bot. 1:1–142.

Humphreys, H. 1971. Photographic views of Red River raft, 1873. Louisiana History 12: 101–108.

Jackson, D. 1981. Thomas Jefferson and the Stoney Mountains: Exploring the West from Monticello. Urbana. Univ. Ill. Press.

Lowery, G.H. 1974a. The mammals of Louisiana and its adjacent waters. Louisiana State University Press, Baton Rouge.

Lowery, G.H. 1974b. Louisiana birds. Louisiana State University Press, Baton Rouge.

MacRoberts, D.T., B.R. MacRoberts, and M.H. MacRoberts. 1997. A floristic and ecological interpretation of the Freeman and Custis Red River Expedition of 1806. Bull. Mus. Life Sci., Louisiana State University 12:1–26.

Marcy, R.B. and G.B. McClellan. 1854. Adventures on Red River. Report on the exploration of the headwaters of the Red River by Captain Randolph Marcy and Captain G.B. McClellan. Grant Foreman (ed.) 1937. Univ. Oklahoma Press, Norman.

McCourt, R.M. and E.E. Spamer. 2003. The botanical legacy of Lewis and Clark: the most famous collection never heard of. Plant Sci. Bull. 49:126–130.

McKelvey, S.D. 1955. Botanical exploration of the Trans-Mississippi West. The Arnold Arboretum of Harvard University. Jamaica Plain, Mass.

Mears, J.A. 1981. Guide to the plant collectors represented in the Herbarium of the Academy of Natural Sciences of Philadelphia. Proc. Acad. Nat. Sci. Philadelphia 133:141–165.

Miller, H.S. 1970. The herbarium of Aylmer Bourke Lambert: notes on its acquisition, dispersal, and present whereabouts. Taxon 19:489–656.

Morton, C.V. 1967. Freeman and Custis' account of the Red River Expedition of 1806, an overlooked publication of botanical interest. J. Arnold Arbor. 48:431–459.

Pennell, F.W. 1926. The elder Barton—his plant collection—and the mystery of his floras. Bartonia 9:17–34.

Pennell, F.W. 1950. Historic botanical collections of the American Philosophical Society and the Academy of Natural Sciences of Philadelphia. Proc. Amer. Philos. Soc. 94: 137–151.

Sundell, E. 1979. A bibliography of Louisiana botany 1951–1975. Tulane Stud. Zool. Bot. 21:1–66.

Triska, F.J. 1984. Role of wood debris in modifying channel geomorphology and riparian areas of a large lowland river under pristine conditions: a historical case study. Verh. Internat. Verein. Limnol. 22:1876–1892.

REFLECTIONS ON WILLIAM CHAMBERS COKER, PASSIONATE BOTANIST[1]

Mary Coker Joslin

c/o William R. Burk, John N. Couch Biology Library
University of North Carolina
CB#3280 Coker Hall
Chapel Hill, North Carolina 27599-3280, U.S.A.

ABSTRACT

The Coker Arboretum at the University of North Carolina in Chapel Hill celebrated its centennial anniversary in the spring of 2003. The festivities began with a talk on botanist William C. Coker, which highlighted his humanistic traits. This paper briefly describes the events of the centennial celebration and provides the full text of the biographical presentation on Professor Coker.

RESUMEN

El Coker Arboretum en la Universidad de Carolina del Norte en Chapel Hill celebró su centenario en la primavera de 2003. Las festividades comenzaron con una charla sobre el botánico William C. Coker, que subrayó sus rasgos humanos. Este artículo describe brevemente los eventos de la celebración del centenario y aporta el texto completo de la presentación biográfica del Profesor Coker.

INTRODUCTION

William Chambers Coker (1872–1953) was a renowned botanist. His legacy includes important contributions in botany as well as in horticulture and landscaping. He arrived at the University of North Carolina at Chapel Hill in 1902 as the newly appointed associate professor of botany in the Department of Biology. When the Department of Botany was established in 1908, Coker became its first chair. He set forward two major objectives: to foster a knowledge and appreciation of nature among people and to advance the discipline of botany. Among Coker's lifelong scientific endeavors, mycology would occupy center stage and bring him international acclaim. Couch and Matthews (1954) described his life and scientific accomplishments.

Coker was regionally known for his expertise in planting trees in Chapel Hill and in landscaping school grounds. Among his efforts to beautify the UNC campus, he began in 1903 to develop a five-acre arboretum on the northeastern edge of campus (Fig. 1). Planting the site with trees, shrubs, and vines native in North Carolina, Coker envisioned the collection as a living laboratory for botany students. Later, he added Asian species of woody plants. Today, nearly 575 species of trees and shrubs provide an inviting refuge and a living tribute to Coker.

---

[1] Edited with an introduction by William R. Burk (John N. Couch Biology Library, University of North Carolina, CB#3280 Coker Hall, Chapel Hill, NC 27599-3280) to whom correspondence should be sent.

Fig. 1. View of the northern side of the William C. Coker Arboretum, University of North Carolina at Chapel Hill, showing the conspicuous Walter's pine (*Pinus glabra* Walter)—in center. (Courtesy of Brian Nalley, 14 April 2003).

On the occasion of the centennial of the Coker Arboretum, the North Carolina Botanical Garden, the UNC Chapel Hill Libraries, and the Chapel Hill Museum hosted a series of events in the spring of 2003. From mid-March until mid-April, the UNC Libraries created several exhibits, all with a William Coker theme. The signature display was "W.C. Coker: Legacy of a Lifelong Botanist" (Fig. 2). On 11-12 April, a two-day celebration took place in Chapel Hill. On the morning of the first day, the staff of the UNC Herbarium presented a reception and gave tours of their facility. Noon-time tours of the arboretum were followed by a birthday party that drew a large group of attendees who watched several distinguished guests plant a seedling of *Crataegus marshallii*, one of Coker's favorites. Moving to the Morehead Planetarium, the group then listened to a number of distinguished speakers.

Later that day, the focus was the Chapel Hill Museum's exhibit "Coker Arboretum: The First Hundred Years." There, Mary Coker Joslin (Coker's niece) and illustrator Sandra Brooks Mathers signed copies of their book, *Essays on William Chambers Coker, Passionate Botanist* (Joslin 2003). Although Dr. Joslin had previously presented a talk on 20 March 2003 to mark the publication of the book, the signing was the official release date. Following this, Mary Jane and Woodrow Burns and Florence and James Peacock graciously opened their homes and gardens (formerly part of Coker's estate in Chapel Hill) with a reception. The first day of celebrations concluded with a formal dinner and a lecture. The next day, noted landscape gardener Chip Callaway entertained a large audience with the Evelyn McNeill Sims Native Plant Lecture entitled "North Carolina Natives—Gardeners and Their Gardens." To close the celebration, nearly 150 people enjoyed a luncheon at the North Carolina Botanical Garden. The festivities aptly commemorated not only the founding of the Coker Arboretum but also Coker's tangible record of service to the university and to botany.

The following commentary presents a humanistic view of William Chambers Coker, as related by Dr. Joslin at her 20 March talk. Filled with warmth, humor, and personal recollections of her uncle, the account provides a glimpse of Coker as a person.

WILLIAM CHAMBERS COKER, PASSIONATE BOTANIST

In these heartbreaking times of world violence and domestic threat to our environment, it is good to celebrate the contributions of someone who passionately loved our world, the real natural world, loved to learn of it, teach of it, and preserve it. It is also good for us to smile and laugh a little, which we may do in these next few minutes. Also, let's celebrate the first day of spring.

Thank you for allowing me to talk about William Chambers Coker (Fig. 3), lately one of my favorite subjects. My obsession with this topic has become so obvious that when I launch into an anecdote about him at a family meal, I hear comments like, "Oh, Oh! Uncle Will again." What a delight to have a captive au-

Fig. 2. Louis Round Wilson Library, University of North Carolina at Chapel Hill, with the library's William C. Coker exhibit banners. (Courtesy of Brian Nalley, 14 April 2003).

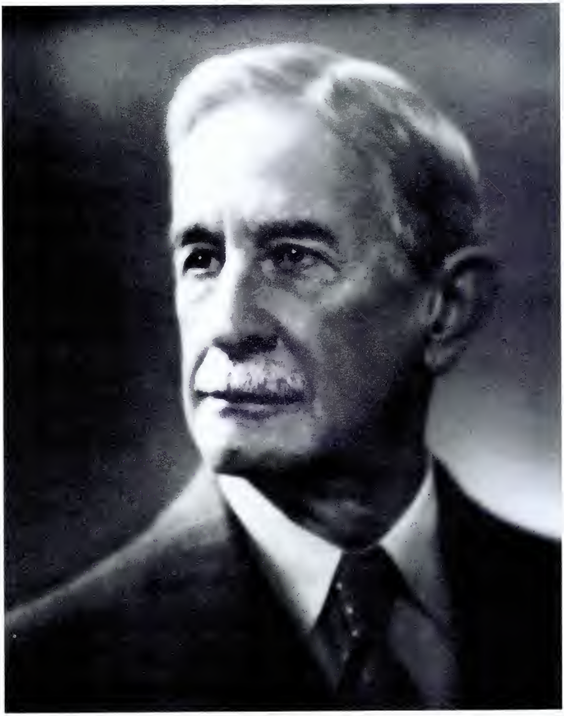


Fig. 3. William Chambers Coker, ca. 1940s. (Courtesy of the John N. Couch Biology Library, Botany Section, University of North Carolina, Chapel Hill).

dience this afternoon who will listen, I hope willingly, to a few stories about W.C. Coker, some of which are not recorded in our recently published *Essays on William Chambers Coker, Passionate Botanist* (Joslin 2003), where other tidbits may be found. Incidentally, I shall be referring to our subject in various ways according to context, using names such as William Chambers Coker, Will, Uncle Will, Professor Coker, Dr. Coker, etc. I hope this will be understandable and appropriate.

We South Carolinians have the reputation of idealizing selected ancestors or family members. I clearly remember an incident that lends some credence to that popular view. Some forty years ago, we were visiting my mother in Hartsville, South Carolina. Two of our young sons were bumbling about to the peril of various objects in their path. The younger child stopped, fixed his eyes on a somber portrait of my grandfather that hung over a fireplace. The artist had clothed him in a dark suit and posed him before an even darker background. His kindly face was bedecked with a flowing white beard. Our son grabbed his brother and asked, "Who is that?" Glancing up, the elder brother gave immediately what was for him a satisfactory answer before they dashed on: "Why that's God, I think."

True, my feelings toward my uncle, whom I knew and loved well, are tinted by admiration and affection. But maybe, even so, I can cast a realistic light on him. There was a real W.C. Coker; very human like ourselves. We need to remember this. His earthy humanity was a great part of his charm. One hundred and thirty years after his birth, Professor Coker has become an historic figure at the University of North Carolina, where he left his mark. What I hope to do today is to humanize him for you.

First, let's look at some of his character traits and then attempt to breathe life into them with anecdotes from family oral tradition and from my own memory's store. William C. Coker possessed a sense of humor that was quietly whimsical. He was brilliant, energetic, determined, tenacious, and even passionate in his work. He was a stickler for accuracy and he expected the same tenacity and accuracy of his students. In his determination to answer a botanical question, he went directly for it. He could ignore completely any inconvenience his floral quest might cause his colleagues, friends, or allies in the family. He took little note of the worldly rank of individuals on a societal scale. He was modest, even shy, not waiting for or even caring about recognition for his work. Rather, he directed his energies toward getting the work at hand done quickly and quietly and moving on to something else. He had no time or inclination to concentrate exclusively on the fields of botany in which he early became world-renowned, the Saprolegniaceae and the fleshy fungi. His interests were broader than these two fields. Nor did he have time regularly to attend meetings, where he would have periodically met with distinguished scholars and scientists.

Though he had no children of his own, he cared deeply about his greater family: his parents, aunts, uncles, cousins, siblings, nieces, and nephews. He was himself a poet and a collector of his favorite poet, Walt Whitman. He deeply appreciated natural beauty. He was a conservationist.

He was interested in literature and the visual arts. He had a good head for business. He was quietly generous. He had a succession of dogs and to each dog he gave his devoted affection.

Several anecdotes, which you may not yet have heard or read may serve to illustrate some of these character traits. Some are in our *Essays*; some are not. First, I will mention his whimsical sense of humor. Those of us who knew him remember his crooked smile and his chuckle, but no uproarious laughter. He could recognize his own foibles.

In recounting a rebellious incident of his early years, Uncle Will smiled at himself and at the same time paid tribute to the wisdom of his father. John Nathaniel Couch and Velma Matthews (1954), two of his former doctoral students, described one of their teacher's reminiscences. As there was no public school at the time, older children in Will's family were usually sent to live for a time with relatives in Society Hill, South Carolina, a community fifteen miles away. There, they prepared for a university education at Saint David's Academy, a good classical school incorporated in 1777 by the Saint David's Society of the Pee Dee River's Welsh Neck. Younger children were taught at home. There was for a time in Will's home in Hartsville, a live-in teacher from Virginia. Will recalled that in his early teens, he took a dislike to this inescapable lady under his roof. His reaction to her was so strong that he refused to pay attention to her instruction or even to do his assignments. The lady reported this rebellion to his father, who summoned Will and calmly offered him a choice: "Will, of course you may continue to pursue your studies respectfully, or, if you prefer, you may report at 6 A.M. tomorrow morning to our farm manager who needs your help in an area essential to our family's wellbeing." Will remained silent, but the next morning he reported for his studies and afterwards behaved himself.

Uncle Will had a way of softening a major personal loss with a whimsical comment. One summer, Professor Coker led a company of colleagues and students on a plant collecting excursion in western North Carolina. At a stop on their return to Chapel Hill, someone took from the expeditionary car a large box containing about one-third of the priceless botanical collection of their foray. Rather than bemoan an irreparable loss to the University Herbarium, Uncle Will chose to defuse the tragedy by understatement and by whimsically assuming the role of the disappointed robber. In 1923, Coker (1923) reported in the introduction of his book on clavarias that about one-third of the collection was lost through the activity of a misguided thief, who fancied he had found for himself something of value.

Professor Coker was a stickler for accuracy when plants were concerned. He had little patience with romantic ignorance. When asked to comment upon an article in the *New York Times* in praise of the Japanese honeysuckle that perfumes late-spring moonlit nights of the South, he waxed indignant, calling the invasive creeper a "first class pest, the worst pest since the chestnut blight." Noted botanist M. L. Fernald would later call it "the yellow peril of the South." The vine, Coker said, reaches out to throttle, not only shrubs but sometimes a considerable area of woodland, if left to its own devices. By this forceful reaction, he effectively dispelled for his interviewer the fanciful daydream of an urban journalist. What would he have said about kudzu? But that plant probably would have no romantic champion.

The native courtesy of Uncle Will was sometimes sorely strained by the inaccuracies of the botanically uninitiated. I remember a campus walk with Uncle Will on a lovely spring day. A talkative lady with our small party remarked several times on "funguses." Each time she used that expression Uncle Will, always a stickler for the correct use of botanical Latin, would mutter in a tone audible to most of us, if not to the lady in question, two clear syllables, "fun´-ji."

William Coker was a modest, even shy individual, avoiding attention to himself if at all possible. Family legends illustrate that this character trait was evident early in his life. Two incidences ring of truth.

When Will was a small boy, someone at the family breakfast table singled him out for praise for some accomplishment or other. There was no means of escape. A child then could not leave the family table unless excused by a parent. So Will picked up the large pancake on his plate to cover his face.

Another delicious family story deals with his arrival back home after receiving his Ph.D. degree from The Johns Hopkins University in Baltimore. That the son of a South Carolina farming region could and did earn a Ph.D. in 1901 was a rarity, a source of pride for the community. Young Dr. Will returned to Hartsville, his home village, by train on the railroad spur built by local citizens to carry manufactured products and supplies to and from the town. As the train slowed to stop, Will spied down the track, to his horror, a considerable crowd of friends and relatives gathered to greet him. He even caught the strains of the local brass band playing "Hail the Conquering Hero Comes." Though seemingly trapped, he quickly devised an escape. Grabbing his baggage, he descended from the train on the side away from the welcoming committee and temporarily vanished.

William Coker tried to ignore or to make light of honors that inevitably came his way and which he was obliged to acknowledge. In 1943, he received a letter informing him of his election as honorary curator of the Charleston (South Carolina) Museum. In his response, he avoided the traditional formula: an expression of gratitude, accompanied by a modest protest of unworthiness. He rather sidestepped the whole issue by diverting attention from himself to specimens in the museum's collection. He vividly recalled his youthful visits there with his father during the years when the family lived for four winters in

Charleston. During these Charleston years, from 1878 to 1882, Will was between five and nine years of age. The honoree simply remarked that on a recent visit to the museum he was struck by the remarkable fact that the expressions on the faces of the great deer and the giant buffalo had not changed at all in over 60 years.

Coker took little note of personal rank in the eyes of the world. He tackled his work in the chronological order of his commitment to it. People had to wait their turn. He had agreed to submit landscape plans for the factory buildings of a prominent industrialist in Durham, North Carolina. On 21 October 1915, the gentleman in question wrote asking him to run over and talk with him about his industrial park at his earliest convenience. Nine days later, the botanist-landscaper answered the letter telling the gentleman that, though he was able to leave the university only at irregular intervals, he hoped to see him on Thursday or Saturday of the following week "as he was going to La Grange for Arbor Day and may have a few minutes in Durham either coming or going." Later, as a volunteer extension agent for the university, he was to design the school grounds of this east Carolina farming community of La Grange.

While pursuing any current subject of his botanical research and writing, Coker left no stone unturned to collect all possible data. His eagle eye was sharp to detect a plant of particular interest. He recruited or pressed into service friends who could help him gather the specimens he needed. While causing these victims no little inconvenience, strangely enough, he often infected them with his own enthusiasm.

On family trips, when Uncle Will was along, we could plan for no rigid schedule, as we expected an abrupt halt along the way if he spotted something special. I well remember one particular occasion. We had traveled some distance across a seven-mile causeway over a marshy area where the driver was forbidden to stop or turn around. The eagle-eyed botanist called a halt and asked us to drive on and return for him presently, as he needed to get something on the edge of the swamp. He left the car, climbed over the guard rail and let himself down into the rich vegetation. On our return, he had not yet finished his collection. We caught sight of him at some distance waving us on. Obliged to continue, we anxiously attempted to note some landmark, such as an extra tall cypress tree, in the pristine vegetation, where we had last seen him. After we had made at least two seven-mile crossings, Coker, pleased with his collection and unapologetic, was ready to climb back over the guard rail and return to Hartsville with his trophies. He then pressed them for eventual addition to the herbarium in old Davie Hall at UNC.

During World War II, when Coker (1944) was preparing his classic article on "The Woody Smilaxes of the United States," gasoline rationing denied him ready access to the South Carolina low country, where he needed to round up some key specimens he lacked. He leaned heavily on good friends there to collect for him. Repeatedly and relentlessly, he wrote his friends G. Robert Lunz of the Charleston Museum and Frank Tarbox, master horticulturalist at Brookgreen Gardens on Pawley's Island, South Carolina, to seek, find, dig up, press, and send to him different species of smilax in various stages of development. This was no small favor to ask. The assignment involved constant vigilance for growth stages of the vines: male and female flowering and subsequent fruiting. It also meant innumerable sorties into a tangled woodland. Any woodsman knows that an encounter with some smilax thickets can be a very prickly experience. After the specimens were gathered, the collector had the time-consuming work of pressing the fresh plants, packing, and mailing them to Chapel Hill. These tasks, strangely enough, did not seem to turn Lunz and Tarbox against him—rather the contrary. Lunz was, during this period, an acting director of the Charleston Museum when Coker was made honorary curator and Tarbox shortly after his ordeal recommended Coker to Mr. Archer Huntington for appointment to a term as a trustee of Brookgreen Gardens, where he served for a period.

The Venus flytrap was another passion of Uncle Will's. He assumed a proprietary role in protecting this indigenous North Carolina carnivorous plant, whose habitat centers around Wilmington. In November of 1920, he sent to the *Georgetown Times*, Georgetown, South Carolina, an ad written in the urgent style of someone in pursuit of a criminal at large (Coker 1920b):

> Wanted: Information about Venus' Flytrap. One of the most remarkable plants in the world, called Venus' Flytrap because it catches and digests living insects, was reported from near Georgetown many years ago by [Stephen] Elliott in his 'Sketch of the Botany of South Carolina and Georgia.' No specimen from South Carolina is now known. Information in regard to the present occurrence of this plant in South Carolina is greatly desired. Address W.C. Coker, Professor of Botany, University of North Carolina, Chapel Hill, N.C.

Coker (1928) subsequently published an article on the "Distribution of Venus's Fly Trap" in 1928, and he was always investigating reports of an extended range.

There was something alluring about the passionate botanist's single-minded devotion to plants, something akin to the medieval Holy Grail spirit. One somehow felt honored to be invited to become a partner in an important quest that could involve discomfort, risk, or danger. On 23 April 1938, Coker wrote his friend, the South Carolina poet Archibald Rutledge, thanking him for his recent hospitality. Coker enclosed for Rutledge one of his own poems. His letter expressed concern at the news that Rutledge had been sick, but quickly moved to the main question. The intrepid botanist greatly needed to know whether the Venus flytrap was indeed to be found in the "big ocean," a local term for a botanically rich area near Rutledge's home, and was counting on his friend to find it. Rutledge wrote to Coker in Chapel Hill of his initial failure. He had indeed searched for the flytrap one day, but instead of his finding the plant, he himself had come face to face with a diamond-back rattler. He bravely assured Coker, though, that he was returning to the area presently, as he knew the plant was there. Though the poet had been sick, and though he had encountered a deadly serpent in his effort to help his friend, the tenacious botanist kept his friend focused on the most important matter at hand, the location and collection of specimens of this plant. In responding to Rutledge four days after the rattlesnake letter, Coker dutifully requested a word from Rutledge on whether or not he had been "bit." He ended the letter with the remark that he was looking forward with much interest to receiving the plants from Rutledge and that he greatly appreciated his continued interest.

In the effort to verify information that he needed for an article, Uncle Will at times demanded the well-nigh impossible of Miss Alma Holland, later Mrs. C. Dale Beers, for numerous years his able research assistant and coauthor. In 1919, he heard that a species of mountain rhododendron had been found growing naturally in sandhill country bordering North and South Carolina. Dr. Coker was then at his research desk in the New York Botanical Garden, where he worked from time to time during university vacations. Checking the report could not be delayed, as Coker's article on rhododendron had been thought to be complete and was already in the hands of the publisher. Hearing that Miss Alma had not yet succeeded in verifying the plant's location by correspondence, he urgently instructed her in a letter to visit the area personally. She was to take the train south to Rockingham, leaving Raleigh at 5 A.M. She was to find the plant, take specimens, and return the same day. Imagine the horror of that trip. The mere prospect of getting to Raleigh to take a train leaving at dawn, combined with the automobile transport of 1919, would have tempted a less dedicated botanist than Miss Alma simply to say, "I quit." The reflected August heat in the sandhills can be hard to take. You have to keep dumping your shoes as the hot sand sifts in. But our heroine succeeded in her quest and the article was published without error. Alan Weakley, our able herbarium curator at UNC, discovered the evidence. He reported two herbarium specimens of *Rhododendron minus* labeled "August 3, 1919, Richmond County, N.C., Collector, Alma Holland," thus providing ample proof of her strict obedience to orders and her success in accomplishing her mission. Weakley also checked the issue of the *Journal of the Elisha Mitchell Scientific Society*, where the article in question was published and found that Miss Holland's proof of the sandhills *Rhododendron minus* did indeed make the article before it was too late (Coker 1919). Our magnificent herbarium is a priceless archival research tool for solving all sorts of botanical mysteries.

Uncle Will was delighted to obtain a new plant and even to read about the wondrous plants of distant climes, epochs, and cultures. Dr. Paul Titman, a retired professor in Chicago who had studied with Coker in the late 1930s and had returned to earn a Master's degree in botany after his service in World War II, recorded for me in December 1998 his recollections of his old professor, which included the following incident illustrative of Coker's enthusiasm for plants.

Titman had described to Coker a particular kind of porcelain vine that grew in his grandmother's garden near Gastonia, North Carolina. Upon request, the student asked his grandmother to send a plant of this coveted vine for the Arboretum. Dr. Titman reminisced: "I still remember Miss Alma and Dr. Coker running through the Arboretum, where I was doing something, I don't know what, calling for me as if they were children at Christmas, to come quickly, that there was a package for me. And the gleam in his eye when that package was opened and he saw the anticipated vine was unforgettable." There is no more effective pedagogical tool than a teacher's own enthusiasm. Titman went on to earn his doctorate in botany at Harvard. He had planned to remain at Chapel Hill for his doctoral studies, but his professor advised him to seek instead, as he expressed it, "the cross-pollination of Harvard." Dr. Coker then pulled strings to assure that Titman was admitted to the doctoral program.

I myself shall never forget Uncle Will's excitement about the present William and I gave to him when he took the place of my late father at our wedding in May of 1946. By a stroke of good fortune, I found for him a beautifully illustrated book on an ancient Aztec herbal, reprinted under the title *The Badianus Manuscript* ([Cruz, Badiano, and Trueblood] 1940). The volume is America's earliest known book on herbal medicine. Ardently hoping that it would please him, I watched with bated breath as he unwrapped his gift. His unfeigned delight with our gift surpassed my wildest dreams. Ignoring the family hurly-burly swirling around us, he sat down to study it with total concentration. I believe that of all the gifts I have ever chosen for an adult, this book was the most appropriate and the most happily received.

Uncle Will had real affection for some of his colleagues on the faculty, and good relations with most of them. Dr. William De Bernière MacNider opened letters to Coker with "Dear Old Man." He closed them with "Affectionately," or "Devotedly," or "Bless your heart." Dr. Dey of Romance Languages and Coker addressed each other as "Colonel," with a complimentary close of "Very sincerely" or "Most sincerely yours." The more formal "Yours truly" was reserved for business-like letters. Among his close friends were Collier Cobb, John Booker, Archibald Henderson, George Coffin Taylor, and our great librarian, Louis Round Wilson.

With the renowned Professor Horace Williams, relations were somewhat less cordial. Professor Williams, it appears, was openly skeptical to his students of the laboratory method of the sciences and of the rigid demands for scholarly documentation in historical and literary research. "Oh those footnotes that Professor Greenlaw requires," he might casually remark. These methods of research he considered far less valuable as tools for learning than the Socratic method, which Professor Williams used so successfully to arouse the curiosity and stimulate the thinking of his students. Naturally this attitude caused some of his colleagues in science, history, and literature to bristle.

The farms of Professors Williams and Coker were adjacent. The Orange County (North Carolina) Register of Deeds records that Coker bought this land from an H.H. Williams in 1906. I feel sure that this is the very gentleman under consideration here, though I have not definitively nailed it down. It would be natural for Professor Williams to retain a proprietary feeling for his former acreage. The following letter from W.C. Coker (1920a) to Professor Horace Williams reveals quite a bit about their relationship. I'll read it for you.

February 21, 1920
Professor Horace Williams,
Chapel Hill, N.C.

Dear Professor Williams:

I find that two of your sheep have been grazing every day on my wheat field for at least a month, - in fact, spend nearly all of their time on my place. I ask that you have your sheep removed to some other pasture, where they will not do constant damage to my crops.

Yours truly,
[W.C. Coker]

When asked by the editor of the *Chapel Hill Weekly*, a local newspaper of Chapel Hill, for advice as to how to reach the ripe old age of seventy, one of Coker's answers was: "Marry the right woman and manage always to have around a congenial dog." Dogs were very important in his life. To each of an almost unbroken succession of canine friends, he gave his utter devotion. And it was amply returned. At their dinner table at "The Rocks," Aunt Louise sat at right angles to him, on his left. When she turned her head to address someone at the other end of the table, one could observe Uncle Will surreptitiously passing a tidbit from his plate to Tinkerbell lying at his feet. Could this dinner-sharing be one reason why Uncle Will remained so pencil slim?

One of his more colorful canine friends, Mickey, strongly resembled the famous Victrola dog of "His Master's Voice," according to our own Laurie Radford, one of Coker's former graduate students and coauthor of the history of the University of North Carolina Herbarium (L. Radford and A. E. Radford, [2000]). Mickey was as much a one-man dog, as his master was a one-dog man. Uncle Will proudly wrote a niece that Mickey was the only dog he had ever owned who would actually bite. This statement reminds me of James Thurber's delightful story, "The Dog that Bit People." Thurber captures Uncle Will's feeling toward Mickey, his beloved friend who could do no wrong. In Thurber's tale, a one-dog lady replied to each victim's complaint with the remark "Yes, he does love to bite but remember this, he never holds a grudge."

There is not enough time to tell other cherished tales and memories of my Uncle Will. I just hope that I have been able to humanize for you this very vital person who walked the paths of our University for more than fifty years and did what he could to make our campus more beautiful, to interest us in a great variety of plants, and to encourage us to understand and conserve the wonders of our native fields and forests. I never think of Uncle Will without a frisson of delight and gratitude for his infectious love for our natural world. He, of course, was but one of the considerable number of extraordinarily gifted faculty members at Chapel Hill during the first half of the twentieth century. If William Coker were magically to return to Chapel Hill this spring, he could scarcely avoid seeing himself prominently displayed. He would doubtless immediately descend from the wrong side of the train, so to speak, and disappear to botanize incommunicado in an unknown North Carolina field or forest, or to study in some remote herbarium until all of this nonsense blows over.

Please do forgive us, dear Uncle Will. We simply cannot help ourselves. You are irresistible.

ACKNOWLEDGMENTS

Many people, too numerous to cite, assisted us in preparing this paper. We particularly thank Laura Cotterman, Rogers McVaugh, and Peter S. White for reading the entire manuscript and providing useful comments for changes. We also acknowledge the expert advice and assistance of Brian Nalley and Susan Whitfield with the creation and preparation of the illustrations. The Southern Historical Collection, University of North Carolina at Chapel Hill kindly provided permission to quote two letters from the William Chambers Coker Papers. The North Carolina Botanical Garden funded this publication.

REFERENCES

Coker, W.C. 1919. The distribution of *Rhododendron catawbiense*, with remarks on a new form. J. Elisha Mitchell Sci. Soc. 35:76–82 and plates 19–22.

Coker, W.C. 1920a. Letter, dated 21 February 1920, to Horace Williams. (From Box 2, Folder 154, in the William Chambers Coker Papers # 3220, Southern Historical Collection, Louis Round Wilson Library, University of North Carolina at Chapel Hill).

Coker, W.C. 1920b. Letter, dated 5 November 1920, to the editor of the *Georgetown Times*, including an enclosure (1 p.). (From Box 2, Folder 181, in the William Chambers Coker Papers # 3220, Southern Historical Collection, Louis Round Wilson Library, University of North Carolina at Chapel Hill).

Coker, W.C. 1923. The Clavarias of the United States and Canada. University of North Carolina Press, Chapel Hill.

Coker, W.C. 1928. The distribution of Venus's fly trap (*Dionaea muscipula*). J. Elisha Mitchell Sci. Soc. 43:221–228 and plate 33.

Coker, W.C. 1944. The woody smilaxes of the United States. J. Elisha Mitchell Sci. Soc. 60:27–69 and plates 9–39.

COUCH, J.N. and V.D. MATTHEWS. 1954. William Chambers Coker. Mycologia 46:372–383.

[CRUZ, M. DE LA, J. BADIANO, and E.W. EMMERT (TRUEBLOOD)]. 1940. The Badianus manuscript (Codex Barberini, Latin 241). Vatican Library. An Aztec herbal of 1552. Introduction, translation, and annotations by E. W. Emmart. With a foreword by H. E. Sigerist. The Johns Hopkins Press, Baltimore.

JOSLIN, M.C. 2003. Essays on William Chambers Coker, passionate botanist. With drawings by S. B. Mathers. University of North Carolina at Chapel Hill Library and Botanical Garden Foundation, Inc., Chapel Hill.

RADFORD, L.S. and A.E. RADFORD. [2000]. The herbarium of The University of North Carolina: 1908–2000; history and perspective. With contributions from P.S. White, J.R. Massey, and J.F. Matthews. The Herbarium (NCU), The University of North Carolina at Chapel Hill.

ALLOZYME DIVERSITY IN *ELEUTHEROCOCCUS SENTICOSUS* AND *E. BRACHYPUS* (ARALIACEAE) FROM CHINA AND ITS IMPLICATION FOR CONSERVATION

Shi-Liang Zhou

Laboratory of Systematic &
Evolutionary Botany
Institute of Botany
The Chinese Academy of Sciences
Xiangshan, Beijing 100093, CHINA
slzhou@ibcas.ac.cn

Jun Wen[1]

Department of Botany
Field Museum of Natural History
1400 S. Lake Shore Dr.
Chicago, Illinois 60605, U.S.A. and
Laboratory of Systematic & Evolutionary Botany
Institute of Botany, The Chinese Academy of Sciences
Beijing 100093, CHINA; wen@fieldmuseum.org

De-Yuan Hong

Laboratory of Systematic & Evolutionary Botany
Institute of Botany
The Chinese Academy of Sciences
Xiangshan, Beijing 100093, CHINA

ABSTRACT

The widespread *Eleutherococcus senticosus* (Rupr. et Maxim.) Maxim. is threatened because of overharvesting of its root bark for medicinal uses. The geographically restricted *E. brachypus* becomes endangered due to habitat loss in the Loess Plateau of China. To facilitate the development of conservation strategies, genetic diversity of both species was measured at 26 isozyme loci (12 enzymes). *Eleutherococcus brachypus* had a low proportion of polymorphic loci (P_s=19.2%; P_p=13.1%) and low genetic diversity (H_{es}=0.063; H_{ep}=0.031). The genetic variability of the widespread *E. senticosus* was higher (P_s=26.9%; P_p=20.76%; H_{es}=0.094; H_{ep}=0.059) than that of the restricted *E. brachypus*. Population differentiation of *E. brachypus* (G_{st}=0.531) was greater than that of *E. senticosus* (G_{st}=0.383). Cluster analysis showed that populations of *E. senticosus* in Northeast or North China are genetically closer within each region than between the two regions. Populations of *E. senticosus* in Northeast China have a higher level of genetic diversity, and these populations need to be conserved with greater priority. Populations of *E. brachypus* in the Loess Plateau have been highly fragmented, and all populations of the species should be protected to maximize its genetic diversity.

CHINESE ABSTRACT

刺五加（*Eleutherococcus senticosus* (Rupr. et Maxim.）Maxim.）分布于华北和东北地区，由于人类的过度利用而使该物种受到威胁；短柄五加由于分布于黄土高原这一植被非常稀少的特殊地理地带同样有绝灭的危险。为了制定这些物种的有效保护措施，我们对这两个物种的遗传多样性进行了分析。我们每个物种各采集了5个居群的样品，共197份；分析了12个酶系统，共得到26位点。数据分析结果表明，短柄五加物种水平的多态位点为19.2%，居群水平的多态位点平均为13.1%；物种水平的期望杂合度为0.063，居群水平的期望杂合度平均为0.031。刺五加物种水平的多态位点为26.9%，居群水平的多态位点平均为20.76%；物种水平的期望杂合度为0.094，居群水平的期望杂合度平均为0.059。短柄五加居群间的分化系数(G_{st}=0.531)高于刺五加(G_{st}=0.383)。聚类分析结果显示，东北地区和华

---

[1] Corresponding author

SIDA 21(2): 993–1007. 2004

北地区的刺五加地区内部的居群之间具有更高的遗传相似性。东北地区的刺五加居群具有比华北地区的居群更高的等位酶多样性，从而更具有保护价值。短柄五加的遗传多样性没有明显的地理规律。考虑到黄土高原非常稀少的植被，短柄五加在水土保持中的重要作用，加上其居群数目少，遗传多样性低，建议保护所有自然群体以维持该物种的遗传多样性。

INTRODUCTION

Understanding of the levels of genetic diversity is important in designing conservation strategies for rare and endangered species (Holsinger & Gottlieb 1991; Hamrick & Godt 1996; Rieseberg & Swensen 1996; Newton et al. 1999; Gitzendanner & Soltis 2001). It is estimated that approximately 3000-4000 species (15%) of the vascular plants in China are endangered or threatened (Fu & Jin 1992). Since the 1970's, major efforts have been made to establish nature reserves to protect rare and endangered species and their communities. At present, few studies have been conducted to examine the genetic diversity of endangered species in China. Genetic data are needed from model plant groups in China to help design conservation efforts when resources are limited.

Eleutherococcus senticosus [= *Acanthopanax senticosus* (Rupr. et Maxim.) Harms] (Araliaceae) distributed in China, North Korea and Far East of Russia, is commonly known as Siberian ginseng (Soejarto & Farnsworth 1978; Farnsworth et al. 1985; Duke 1989) and is considered to be of high medicinal value. It has been used for hundreds of years in China as a tonic (Hu 1980). Studies have been conducted (e.g., Xu et al. 1983; Zhao et al. 1990, 1991, 1993) to analyze its chemical constituents. Polysaccharides extracted from its leaves and roots have been reported to inhibit tumor cell proliferation (Xie et al. 1989; Liang et al. 1994) and to have antiviral activity (Glatthaar-Saalmüller et al. 2001). Glucosides (such as liriodendrin) extracted from root or stem bark have also been reported to have an effect similar to those of that of ginseng (*Panax* spp.) (Slacanin et al. 1991), or as an adaptogen that exerts effects on both sick and healthy people by "correcting" any dysfunctions with no or few side effects (Davydov & Krikorian 2000). Industries have been developed to manufacture herbal products using *E. senticosus*. Herbal and pharmaceutical producers have been using material of the species collected from natural habitats, which has led to rapid destruction of natural populations. Although the species has a wide distribution in China, ranging from the North (Shanxi and Hebei provinces) to the Northeast (Liaoning, Jilin and Heilongjiang provinces) (Fig. 1), it is now listed in the "China Plant Red Data Book" as a vulnerable species (Fu & Jin 1992) for its economical importance.

Eleutherococcus brachypus (Harms) Nakai is a rare endemic species restricted to the Loess Plateau (southeastern Gansu and central Shaanxi provinces) of Northwest China (Fig. 1), which is heavily populated and has highly fragmented vegetation. *Eleutherococcus brachypus* is a clonal species with small populations (Wang et al., 1997), but has suffered from habitat loss, and is thus rare. Seeds of *E. brachypus* are usually not well developed, requiring 1.5 years of after-ripening (Tian et al. 1998). Wang et al. (1997) reported that insect visitation was necessary for seed set. Yan et al. (1997) investigated genetic diversity of this species using three populations from Yanán City, Shaanxi Province, and reported that the percentages of polymorphic RAPD bands were relatively low, 5.4%, 18.5%, and 27.7%, respectively.

Both *Eleutherococcus senticosus* and *E. brachypus* are shrubs with similar ecological preferences of sunny habitats, but different in geographic ranges. *Eleutherococcus senticosus* has a wide distribution, whereas *E. brachypus* is a rare endemic confined to the Loess Plateau of Northwest China (Fig. 1). This paper assesses the genetic diversity of these two congeneric species with allozyme markers using starch gel electrophoresis and discusses the implications for conservation.

MATERIALS AND METHODS

Sampling

Five populations of *E. senticosus* from five provinces in China and five populations of *E. brachypus* from North Shaanxi to South Gansu were sampled, covering nearly the full range of distribution of both species (Fig. 1, Table 1). Three populations of three other congeners: *E. giraldii* (Harms) Nakai, *E. gracilistylus* (W.W. Smith) S.Y. Hu, and *E. sessiliflorus* (Rupr. et Maxim.) S.Y. Hu (Table 1) were included in the UPGMA cluster analysis as comparisons.

One to two year old twigs were collected in the spring from about 20 individuals in each population. Populations of *E. brachypus* were small and the boundaries were easily determined. Samples were collected throughout the populations. Populations of *E. senticosus* were usually large with hundreds of individuals, and samples were collected at an interval of at lest 50 meters to minimize the possibility of collecting two samples from a single clone. The twigs were then kept in sealed moist plastic bags.

Electrophoresis

In the laboratory, the cut surface of each twig was immersed in water and incubated in a humid environment. When the first leaf appeared, the bud was removed and ground on ice with grinding buffer after removing bud scales. The grinding buffer (Tris-malate grinding buffer-PVP solution) was prepared following Soltis et al. (1983) with the substitution of sodium bisulfite for sodium metabisulfite. DMSO was added to the mixture to a final concentration of 10% before adjusting pH to 7.5. The enzyme solution was absorbed onto wicks, which were frozen (-80°C) until electrophoresis. Electrophoresis was carried out on horizontal starch (Sigma cat no. S4501) gels at 4°C. Four buffer systems (electrode buffer / gel buffer) were used to assay12 enzymes (Wang 1998): (1) 0.4M Citric acid trisodium salt (pH adjusted to 7.0 using 1.0M HCl) / 0.02M Histidine•HCl (pH adjusted to 7.0 using 1.0M NaOH) for aconitate hydratase

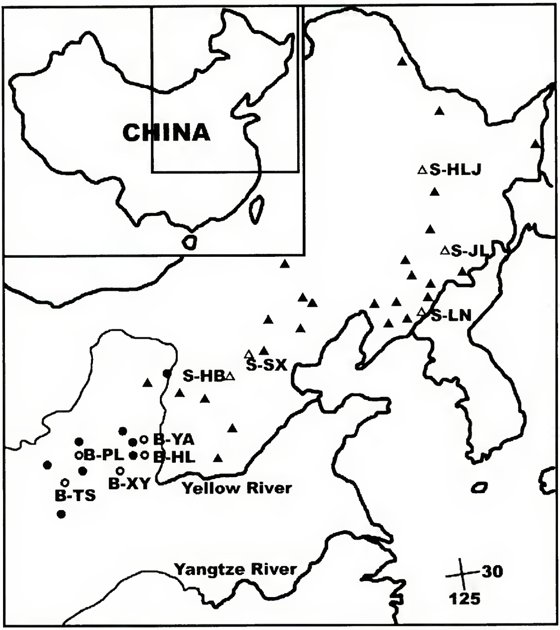


Fig. 1. Distribution of *Eleutherococcus brachypus* (●) and *E. senticosus* (▲) in China. Open triangles and circles indicate populations sampled.

(ACO, E. C. 4.2.1.3), fructose-bisphosphate aldolase (FBA, E. C. 4.1.2.13) and glyceraldehydes-3-phosphate dehydrogenase (G3PD, E. C. 1.2.1.12); (2) 0.3M boric acid (pH adjusted to 8.6 using NaOH) / 0.015M Tris (pH adjusted to 7.8 using citric acid) for aminopeptidase (AMP, E. C. 3.4.11.1), hexokinase (HEX, E. C. 2.7.1.1), phosphoglucomutase (PGM, E. C. 5.4.2.2) and triose-phosphate isomerase (TPI, E. C. 5.3.1.1); (3) 0.374M boric acid (pH adjusted to 8.0 using LiOH) / 0.033M Tris+0.005M citric acid+0.004M LiOH +0.030M boric acid for aspartate aminotransferase (AAT, E. C. 2.6.1.1), alcohol dehydrogenase (ADH, E. C. 1.1.1.1) and

TABLE 1. Population localities, symbols and voucher specimens of *Eleutherococcus brachypus*, *E. senticosus* and close congeners.

Locality	Symbol	Voucher (PE)
Eleutherococcus senticosus (Rupr. et Maxim.) Maxim.		
Mao'ershan, Shangzhi County, Heilongjiang Province	S-HLJ	*Zhou 009*
Changbaishan Nature Reserve of CAS, Antu County, Jilin Province	S-JL	*Zhou 010*
Baishilazi Nature Reserve, Kuandian County, Liaoning Province	S-LN	*Zhou 011*
Mount Wutaishan, Shanxi Province	S-SX	*Zhou 013*
East Lingshan, Hebei	S-HB	*Zhou 014*
Eleutherococcus brachypus (Harms) Nakai		
Nanniwang, Yan'an City, Shaanxi Province	B-YA	*Zhu 950004*
Nanshan, Huanglong County, Shaanxi Province	B-HL	*Zhou 007*
Yangjiadian, Xunyi County, Shaanxi Province	B-XY	*Zhou 003*
Mount Kongtongshan, Pingliang City, Gansu Province	B-PL	*Zhu 95016*
Caijiashan, Lu'ergou, Tianshui City, Gansu Province	B-TS	*Zhou 002*
Eleutherococcus gracilistylus (W.W. Sm.) S.Y. Hu		
Angmenkou, Kanxian County, Gansu Province		*Zhou 006*
Eleutherococcus giraldii (Harms) Nakai		
Mount Lianhuashan, Kanle County, Gansu Province		*Zhou 005*
Eleutherococcus sessiliflorus (Rupr. et Maxim.) S.Y. Hu		
Baishilazi Nature Reserve, Kuandian County, Liaoning Province		*Zhou 012*

NADH-diaphorase (DIA, E. C. 1.6.2.2); and (4) 0.04M citric acid [pH adjusted to 7.5 using N-(3-aminopropyl)-morpholine] / 1:19 dilution of electrode buffer for isocitrate dehydrogenase (IDH, E. C. 1.1.1.42) and shikimate dehydrogenase (SKD, E. C. 1.1.1.25). Enzymes were visualized using stains in agar overlays except for AAT and AMP which were stained in buffer solutions.

Data analysis

Stained gels were photographed and the banding patterns were then drawn. The alleles at each locus were designated with letters a, b, and c, from the longest migration distance to the shortest. The resulting genetic data (genotypes) were analyzed with Biosys-1 (Swofford & Selander 1989) for each species. For each population, the allele frequencies, mean number of alleles per locus, percentage of polymorphic loci, heterozygosity observed and expected under Hardy-Weinberg equilibrium, F-statistics and unbiased genetic similarities/distances (Nei 1978) were computed. All the populations were analyzed to generate a dendrogram using UPGMA.

RESULTS

Twenty-six putative loci from 12 enzyme systems were interpretable on the basis of simple Mendelian genetics (Table 2). Nineteen loci exhibited polymorphisms in one or both species. The frequency of one allele often dominated over the others in a given population (Table 2).

Genetic diversity of *E. senticosus*

There were 13 polymorpic loci in *E. senticosus* (Table 2). The two regions of activity for AAT were designated as *Aat-1* and *Aat-2*. *Aat-1* had 2 alleles, the rare one *Aat-1b* and the common one *Aat-1c*. *Aat-2* had 3 alleles, *Aat-2a*, *Aat-2b*, and *Aat-2c* with *Aat-2b* being the common one. Only one locus was detected for ADH with 2 alleles, *Adh-a* and *Adh-b*, which were present in heterozygosity with low frequencies. Both *Amp-1* and *Amp-2* had 2 alleles, with the allele frequencies varying among populations. *Dia-1* exhibited polymorphism only in the S-JL population. Two alleles were detected on *G3pd-2* and *Hex-1*, respectively. The rare alleles on *Idh-2*, *Skd-1*, *Skd-2*, *Skd-3*, *Tpi-1*, and *Tpi-2* were unique to this species. Locus duplications were observed on PGM and TPI.

Eleutherococcus senticosus maintained a higher level of genetic diversity. The percentages of polymorphic loci ranged from 11.5% to 30.8% with a mean of 26.9% (Table 3). The mean number of alleles averaged over populations was 1.26, and the expected heterozygosity under Hardy-Weinberg equilibrium averaged over populations was 0.059. The population S-JL from Jilin Province (A=1.3; P=30.8%; H_e=0.073) and the population S-LN from Liaoning Province (A=1.3; P=23.1%; H_e=0.077) exhibited the highest genetic diversity. The southwest peripheral population S-SX from Shanxi Province had the lowest (A=1.2; P=11.5%; H_e=0.025).

At the species level, the mean number of alleles per locus was 1.7, and 26.9% of the loci were polymorphic. The expected heterozygosity was 0.094. The genetic diversity was maintained at 13 polymorphic loci, especially at *Amp-1*, *Amp-2*, *G3pd-2*, *Idh-2*, *Skd-3* and *Tpi-1* (Ht>0.2, Table 4). Among these loci only *Amp-1* and *Idh-2* contributed more to interpopulational than to intrapopulational variation (G_{st}>0.5). Of the mean total genetic diversity (H_t=0.094), only 38.3% was maintained within populations (H_s=0.058, D_{st}=0.036).

Genetic diversity of *E. brachypus*

There were 10 polymorphic loci detected in five populations of this species (Table 2). *Aat-1a* was unique to B-XY population. The alleles of *Aat-2a* and *Aat-2c* were infrequent. *Aco-1a* was common in B-XY population but rare or absent in the other populations. The unique allele *Adh-c* was present in heterozygosity with low frequencies. *Dia-2b* and *Dia-2c* were characteristic of this species, which exhibited intrapopulational variation. Nearly complete divergence of alternative allele fixation was found at the three loci of IDH between *E. brachypus* and *E. senticosus*. Locus duplication was not observed at PGM. Instead, both loci *Pgm-1* and *Pgm-2* were polymorphic.

The genetic diversity of *E. brachypus* at the populational level was relatively low compared to that of *E. senticosus* (Table 3). The percentage of polymorphic loci varied from 3.8% to 23.1% with a mean of 13.1%. The mean number of alleles

TABLE 2. Allele frequencies in 10 populations of *Eleutherococcus brachypus* and *E. senticosus* (N indicates sample size).

		Populations									
Locus	**Allele**	**Eleutherococcus brachypus**					**Eleutherococcus senticosus**				
		B-TS	B-PL	B-XY	B-YA	B-HL	S-HLJ	S-JL	S-LN	S-SX	S-BJ
	(N)	20	19	15	14	20	19	20	20	20	20
Aat-1	*a*	–	–	0.033	–	–	–	–	–	–	–
	b	–	–	–	–	–	–	0.200	0.175	–	–
	c	1.000	1.000	0.967	1.000	1.000	1.000	0.800	0.825	1.000	1.000
Aat-2	*a*	–	–	–	0.036	–	0.132	–	–	–	–
	b	0.950	1.000	1.000	0.964	0.900	0.868	0.975	1.000	1.000	1.000
	c	0.050	–	–	–	0.100	–	0.025	–	–	–
Aco-1	*a*	–	–	1.000	0.071	–	–	–	–	–	–
	b	1.000	1.000	–	0.929	1.000	1.000	1.000	1.000	1.000	1.000
Aco-2	*a*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Adh	*a*	0.050	0.026	–	0.071	0.025	–	0.100	–	–	0.075
	b	0.950	0.947	1.000	0.857	0.975	1.000	0.900	1.000	1.000	0.925
	c	–	0.026	–	0.071	–	–	–	–	–	–
Amp-1	*a*	–	0.026	–	–	–	1.000	0.750	0.275	0.150	0.975
	b	1.000	0.974	1.000	1.000	1.000	–	0.250	0.725	0.850	0.025
Amp-2	*a*	–	–	–	–	–	0.447	0.300	–	0.025	–
	b	1.000	1.000	1.000	1.000	1.000	0.553	0.700	1.000	0.975	1.000
Dia-1	*a*	1.000	1.000	1.000	1.000	1.000	1.000	0.925	1.000	1.000	1.000
	b	–	–	–	–	–	–	0.075	–	–	–
Dia-2	*a*	0.850	0.789	0.933	0.286	1.000	1.000	1.000	1.000	1.000	1.000
	b	0.075	0.105	0.033	0.357	–	–	–	–	–	–
	c	0.075	0.105	0.033	0.357	–	–	–	–	–	–
Fba	*a*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
G3pd-1	*a*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
G3pd-2	*a*	0.150	1.000	1.000	–	0.050	–	–	0.300	–	0.350
	b	0.850	–	–	1.000	0.950	1.000	1.000	0.700	1.000	0.650
Hex-1	*a*	1.000	1.000	1.000	1.000	0.950	1.000	0.950	0.950	0.975	1.000
	b	–	–	–	–	0.050	–	0.050	0.050	0.025	–
Hex-2	*a*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Idh-1	*a*	–	–	–	–	–	1.000	1.000	1.000	1.000	1.000
	b	1.000	1.000	1.000	1.000	1.000	–	–	–	–	–
Idh-2	*a*	–	–	–	–	–	1.000	1.000	1.000	0.050	0.175
	b	1.000	1.000	1.000	1.000	1.000	–	–	–	0.950	0.800
	c	–	–	–	–	–	–	–	–	–	0.025
Idh-3	*a*	–	–	–	–	–	1.000	1.000	1.000	1.000	1.000
	b	1.000	1.000	1.000	1.000	1.000	–	–	–	–	–
Pgm-1	*a*	0.300	–	–	–	0.100	–	–	–	–	–
	b	0.700	0.947	1.000	1.000	0.750	1.000	1.000	1.000	1.000	1.000
	c	–	0.053	–	–	0.150	–	–	–	–	–
Pgm-2	*a*	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	b	0.050	–	–	–	–	–	–	–	–	–

Table 2. continued

Locus	Allele	Populations									
		Eleutherococcus brachypus					Eleutherococcus senticosus				
Skd-1	*a*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Skd-2	*a*	–	–	–	–	–	0.053	–	–	–	–
	b	1.000	1.000	1.000	1.000	1.000	0.947	1.000	1.000	1.000	1.000
Skd-3	*a*	–	–	–	–	–	0.132	–	–	0.025	0.500
	b	1.000	1.000	1.000	1.000	1.000	0.868	1.000	1.000	0.900	0.500
	c	–	–	–	–	–	–	–	–	0.075	–
Tpi-1	*a*	–	–	–	–	–	–	–	0.300	–	0.025
	b	1.000	1.000	1.000	1.000	1.000	0.684	0.950	0.400	1.000	0.950
	c	–	–	–	–	–	0.316	0.050	0.300	–	0.025
Tpi-2	*a*	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.950	1.000	1.000
	b	–	–	–	–	–	–	0.100	0.050	–	–
Tpi-3	*a*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Tpi-4	*a*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 3. Genetic variability at 26 loci in the populations of *Eleutherococcus brachypus* and *E. senticosus* (standard errors in parentheses). N indicates the sample size per locus; *A* indicates the mean number of alleles per locus; *P* indicates the percentage of polymorphic loci*; *Ho* indicates the observed heterozygosity; and *He* indicates the expected heterozygosity under Hardy-Weiberg equilibrium.**

Population	N	A	P	H_o	H_e
		Eleutherococcus brachypus			
B-TS	20	1.3(0.1)	23.1	0.013(0.008)	0.048(0.021)
B-PL	19	1.2(0.1)	11.5	0.014(0.009)	0.024(0.015)
B-XY	15	1.1(0.1)	3.8	0.005(0.004)	0.008(0.006)
B-YA	14	1.2(0.1)	11.5	0.047(0.029)	0.045(0.028)
B-HL	20	1.2(0.1)	15.4	0.006(0.004)	0.032(0.018)
Mean		1.2	13.06	0.017	0.031
Species level	88	1.5(0.1)	19.2	0.016(0.009)	0.063(0.026)
		Eleutherococcus senticosus			
S-HLJ	19	1.2(0.1)	19.2	0.030(0.017)	0.059(0.027)
S-JL	20	1.3(0.1)	30.8	0.012(0.007)	0.073(0.025)
S-LN	20	1.3(0.1)	23.1	0.042(0.027)	0.077(0.034)
S-SX	20	1.2(0.1)	11.5	0.019(0.011)	0.025(0.013)
S-BJ	20	1 3(0.1)	19.2	0.012(0.006)	0.062(0.028)
Mean		1.3	20.8	0.023	0.059
Species level	99	1.7(0.1)	26.9	0.023(0.007)	0.094(0.029)

Note. * A locus is considered polymorphic if the frequency of the most common allele does not exceed 0.95

** Unbiased estimate (see Nei 1978)

TABLE 4. Genetic diversity across populations of *E. brachypus* and *E. senticosus*. H_T indicates the total gene diversity; H_S indicates gene diversity within populations; D_{ST} indicates the gene diversity between populations; and G_{ST} is the ratio of D_{ST}/H_T.

Locus	H_t	H_s	D_{st}	G_{st}
Eleutherococcus brachypus				
Aat-1	0.013	0.013	0.000	0.000
Aat-2	0.072	0.069	0.003	0.042
Aco-1	0.337	0.027	0.310	0.920
Adh	0.105	0.101	0.004	0.038
Amp-1	0.010	0.010	0.000	0.000
Dia-2	0.378	0.282	0.096	0.254
G3pd-2	0.493	0.070	0.423	0.858
Hex-1	0.020	0.019	0.001	0.050
Pgm-1	0.218	0.185	0.033	0.151
Pgm-2	0.020	0.019	0.001	0.050
Mean	0.064	0.030	0.034	0.531
Eleutherococcus senticosus				
Aat-1	0.139	0.122	0.017	0.122
Aat-2	0.061	0.055	0.006	0.098
Adh	0.068	0.064	0.004	0.059
Amp-1	0.466	0.215	0.251	0.539
Amp-2	0.261	0.192	0.069	0.264
Dia-1	0.030	0.028	0.002	0.067
G3pd-2	0.226	0.175	0.051	0.226
Hex-1	0.049	0.048	0.001	0.020
Idh-2	0.461	0.085	0.376	0.816
Skd-2	0.021	0.020	0.001	0.048
Skd-3	0.254	0.182	0.072	0.283
Tpi-1	0.342	0.257	0.085	0.249
Tpi-2	0.058	0.055	0.003	0.052
Mean	0.094	0.058	0.036	0.383

averaged over populations was 1.2, and the expected heterozygosity under Hardy-Weinberg equilibrium averaged over populations was 0.031. The population B-TS from Tianshui, Gansu Province, showed the highest genetic diversity (A=1.3; P=23.1%; H_e=0.048), while the population B-XY from Xunyi, Shaanxi Province, showed the lowest diversity (A=1.1; P=3.8%; H_e=0.008).

Eleutherococcus brachypus exhibited an average of 1.5 alleles per locus, and 19.2% of loci were polymorphic (Tables 3 & 4). The expected heterozygosity under Hardy-Weinberg equilibrium was 0.063. The genetic diversity was maintained at 10 polymorphic loci, notably at *Aco-1*, *Dia-2*, *G3pd-2* and *Pgm-1*. The mean total gene diversity (H_t) was 0.064. Nearly half of the total genetic diversity occurred within populations (H_s=0.030). Among the loci with high H_t values, *Dia-2* and *Pgm-1* showed most genetic variation within populations (G_{st}

was 0.254 and 0.151, respectively), while *Aco-1*(G_{st}=0.858) and *G3pd-2* (G_{st}=0.920) showed genetic variation primarily among populations.

Relationships among populations

Genetic identity between populations within each species was higher than 0.9, and the genetic distances were lower than 0.09 (Table 5). The average distances between the populations were 0.043 (±0.028) and 0.047 (±0.019) for *E. brachypus* and *E. senticosus*, respectively. The dendrogram generated from genetic identity data using UPGMA (Fig. 2) showed that populations of *E. senticosus* from Northeast China were more similar to one another than with those from North China. The population B-XY of *E. brachypus* differentiated most significantly from other populations of the species.

DISCUSSION

Overall genetic diversity within species

The levels of allozyme variation in *E. senticosus* and *E. brachypus* were relatively low at both species and populational levels in comparison with those of other species with similar attributes (Hamrick & Godt 1990). For example, P_s (26.9%) and H_{es} (0.094) of *E. senticosus* were about half the averages (64.7% and 0.177, respectively) of woody plants at the species level. Hamrick & Godt (1996) reported an average within species heterozygosity (H_{es}) for widespread and endemic species of 0.202 and 0.096, respectively. The H_{es} for the widespread *E. senticosus* was 0.094 and that of the restricted endemic species *E. brachypus* was 0.063. The allozyme heterozygosity within each of the two *Eleutherococcus* is thus considerably lower than the averages reported in the literature.

The percentages of polymorphic allozyme loci reported in this study correspond well to DNA-RAPD polymorphism in *E. brachypus* (3.8–23.1% vs 5.4–27.2%, Yan et al. 1997), but differ sharply from those of *E. senticosus* (11.5–30.8% vs 91.3–97.6%, Dai et al. 1998). However, the report of highly polymorphic RAPD bands in *E. senticosus* likely represents an overestimate because amplification failure from some individuals was interpreted as a lack of bands by Dai et al. (1998). Our allozyme data seem to be more reliable in presenting the overall genetic diversity of the species investigated.

Levels of genetic diversity between species

There is significant disparity between *E. brachypus* and *E. senticosus* in overall genetic diversity (Tables 3 & 4), with *E. senticosus* maintaining a higher level of genetic diversity than *E. brachypus*. These two species appears to be closely related, but not sister taxa. They differ in several characters that may influence genetic diversity. First, they have highly different distributional ranges. *Eleutherococcus senticosus* is widespread across several thousand kilometers, from North to Northeast China and adjacent countries (North Korea and Far East of Russia). By contrast, *E. brachypus* is restricted to the Loess Plateau of

TABLE 5. Matrix of Nei's (1978) unbiased genetic identity (below diagonal) and distance (above diagonal) between populations of *E. brachypus* and *E. senticosus*.

	B-TS	B-PL	B-XY	B-YA	B-HL	S-HLJ	S-JL	S-LN	S-SX	S-BJ
B-TS		0.032	0.074	0.013	0.002	0.199	0.169	0.154	0.090	0.147
B-PL	0.969		0.040	0.048	0.039	0.239	0.210	0.170	0.128	0.157
B-XY	0.929	0.961		0.089	0.080	0.289	0.258	0.216	0.171	0.204
B-YA	0.987	0.953	0.914		0.017	0.211	0.181	0.170	0.101	0.163
B-HL	0.998	0.962	0.923	0.983		0.193	0.164	0.152	0.086	0.146
S-HLJ	0.820	0.788	0.749	0.810	0.825		0.009	0.039	0.079	0.050
S-JL	0.844	0.811	0.772	0.834	0.848	0.991		0.025	0.057	0.050
S-LN	0.857	0.844	0.806	0.843	0.859	0.962	0.975		0.053	0.070
S-SX	0.914	0.880	0.843	0.904	0.918	0.924	0.944	0.948		0.041
S-BJ	0.863	0.855	0.815	0.849	0.864	0.952	0.951	0.933	0.960	

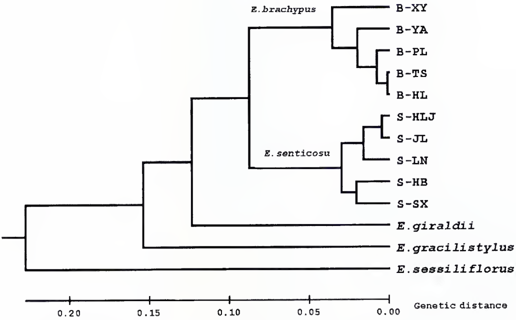


FIG. 2. Cluster analysis (UPGMA) of populations of *Eleutherococcus* based on Nei's unbiased genetic distance.

southeastern Gansu Province and central Shaanxi Province. Another major difference is the breeding system. *Eleutherococcus senticosus* is reported to be trioecious and protandrous (Liu et al. 1997a, 1998). But because individuals with hermaphroditic flowers are very rare (Liu et al. 1997b), this species is functionally dioecious with insect-mediated outcrossing (Liu et al. 1998a). *Eleutherococcus brachypus* has hermaphrodite flowers. Both selfing and insect-mediated outcrossing are important in its sexual reproduction. Similar to *E. senticosus*, anthers of *E. brachypus* start to shed pollen at least five days before the receptivity of stigmas of the same flower (Wang et al. 1997), suggesting outcrossing. Wang et al. (1997) proposed that "outcrossing" within local populations may represent selfing in a broad sense because local populations may be ramets of a single clone. But our study has shown that there is genetic variation within local populations. Thus the interpretation of a local population to be a group of ramets from a single clone is not supported (also see Yan et al. 1997).

The degree of human impact may also explain the difference in genetic diversity between these two species. The populations of *E. senticosus* assayed in this study have not suffered serious disturbance because they were mostly in nature reserves. In contrast, all populations of *E. brachypus* sampled were seriously disturbed, and they were finely fragmented due to land reclamation for farming.

Genetic diversity among populations

Considerable genetic variation was detected among populations (Table 3). The level of genetic diversity varies across localities in *E. senticosus*. The population S-LN in Liaoning Province is the center of the present distribution of this species, and the genetic diversity (*He*) is highest. The population S-SX in Shanxi Province is peripheral and its genetic diversity is the lowest. This pattern has also been reported in many other plant species (see Crawford 1990; Hamrick & Godt 1996).

In *E. brachypus*, however, the Tianshui population (B-TS) near the westernmost range of the species has the highest genetic diversity, whereas the Xunyi population (B-XY) near the distributional center shows the lowest level of genetic diversity. This unusual pattern may be due to a greater impact of human disturbance on *E. brachypus*.

Implications for conservation

In *Eleutherococcus senticosus* in China, populations near the distributional center have a higher level of genetic variation. From this center to the periphery, polymorphism decreases. The low genetic diversity in the populations of North China is expected due to their peripheral positions. When the entire distributional range (including the Far East of Russia) is considered, the population S-HLJ is also central. The relatively low genetic diversity of this population suggests that it may have suffered from genetic loss. Population destruction of *E. senticosus* has been serious in Heilongjiang Province.

Although the genetic structure of *E. senticosus* has not been seriously damaged, overharvesting should be prevented to maintain the sustainability of this species. Recent establishment of nature reserves in Northeast China (the center of genetic variation of this species in China) has been successful in protecting some populations of *E. senticosus*. Demographic investigation outside the reserves every few years is needed to determine the reduction rate of populations.

If it is rapid, use of this species should be controlled, and *ex situ* conservation of special genetic resources may be adopted in nearby nature reserves.

Conservation of *E. brachypus* is urgent because considerable genetic loss has occurred. No significant correlation has been found between genetic differentiation of populations and their geographical distances from the distributional center, suggesting that genetic structure has been altered. The vegetation of the Loess Plateau has been seriously fragmented. In order to maximize the conservation of genetic diversity, all natural populations should be protected. If nature reserves are to be established to conserve populations of this important species, priorities should be given to those in southern Gansu Province, where genetic diversity is high and habitat loss is serious.

ACKNOWLEDGMENTS

We thank Zheng Hongchun for assistance in sample collection, and Pete Lowry and Greg Plunkett for most helpful comments. This study was supported by grants from the National Natural Science Foundation of China (grant 3939150 to D.-Y. Hong), the Excellent Overseas Chinese Research Grant of the Chinese Academy of Sciences (to J. Wen), and the US National Science Foundation (DEB 0108536 to J. Wen).

REFERENCES

Crawford, D.J. 1990. Plant molecular systematics. J. Wiley & Sons, New York.

Dai, S.L., L.H. Wang, and N.H. Wu. 1998. RAPD analysis of *Acanthopanax senticosus* genetic diversity. Prog. Nat. Sci. 8:465–468.

Davydov, M. and A.D. Krikorian. 2000. *Eleutherococcus senticosus* (Rupr. & Maxim.) Maxim. (Araliaceae) as an adaptogen: a closer look. J. Ethnopharmacology 72:345–393.

Duke, J.A. 1989. Ginseng: a concise handbook. Reference Publications, Inc., Algonac, Michigan.

Farnsworth, N.R., A.D. Kinghorn, D.D. Soejarto, and D.P. Waller. 1985. Siberian ginseng (*Eleutherococcus senticosus*): Current status as an adaptogen. In: H. Wagner, H.Z. Hikino, and N.R. Farnsworth, eds. Economic and medicinal plant research. Volume 1. Academic Press, London. Pp. 155–215.

Fu, L.G. and J.M. Jin. 1992. China plant red data book, rare and endangered plants. Volume 1. Science Press, Beijing.

Gitzendanner, M.A. and P.S. Soltis. 2001. Genetic variation in rare and widespread *Lomatium* species (Apiaceae): A comparison of AFLP and SSCP data. Edinb. J. Bot. 58:347–356.

Glatthaar-Saalmuller, B., F. Sacher, and A. Esperester. 2001. Antiviral activity of an extract derived from roots of *Eleutherococcus senticosus*. Antiviral Res. 50:223–228.

Hamrick, J.L. and M.J.W. Godt. 1990. Allozyme diversity in plant species. In: A.H.D. Brown, M.T. Clegg, A.L. Kahler, and B.S. Weir, eds. Plant population genetics, breeding, and genetic resources. Sinauer Associates Inc., Sunderland, Massachusetts. Pp. 43–63.

Hamrick, J.L. and M.J.W. Godt. 1996. Conservation genetics of endemic plant species. In: J.C. Avise and J.L. Hamrick, eds. Conservation genetics: case histories from nature. Chapman & Hall, New York. Pp. 281–304.

Holsinger, K.E. and L.D. Gottlieb. 1991. Conservation of rare and endangered plants: Principles and prospects. In: D.A. Falk and K.E. Holsinger, eds. Genetics and conservation of rare plants. Oxford University Press, Oxford. Pp. 195–223.

Hu, S.-Y. 1980. *Eleutherococcus* vs. *Acanthopanax*. J. Arnold Arbor. 61: 107–111.

Liang, M., B. Wu, N.C. Liang, L. Tong, T.Y. Huang, and J.L. Li. 1994. Antitumor action and mechanism of *Acanthopanax senticosus* polysaccharides. Chinese Pharmacol Bull. 10: 105–109.

Liu, L.D., Z.L. Wang, G.W. Tian, and J.H. Sheng. 1997a. Observation on floral morphology and heteranthery of *Eleutherococcus senticosus* (Araliaceae). Acta Phytotax. Sinica 35:1–6.

Liu, L.D., Z.L. Wang, G.W. Tian, and J.H. Sheng. 1997b. Studies on sexual reproduction and vegetative propagation of *Eleutherococcus senticosus* (Araliaceae). Acta Phytotax. Sinica 35:7–13.

Liu, L.D., Z.L. Wang, G.W. Tian, and J.H. Sheng. 1998. The pollination biology of *Eleutherococcus senticosus* (Araliaceae). Acta Phytotax. Sinica 36:19–27.

Nei, M. 1978. Estimation of average heterozygosity and genetic distance from a small number of individuals. Genetics 89:583–590.

Newton, A.C., T.R. Allnutt, A.C.M. Gillies, A. Lowe, and R.A. Ennos. 1999. Molecular phylogeography, intraspecific variation and the conservation of tree species. Trends Ecol. Evol. 14:140–145.

Riesberg, L.H. and S.M. Swensen. 1996. Conservation genetics of endangered island plants. In: J.C. Avise and J.L. Hamrick, eds. Conservation genetics: case histories from nature. Chapman & Hall, New York. Pp. 305–334.

Soejarto, D. D. and N.R. Farnsworth. 1978. The correct name for Siberian ginseng. Bot. Mus. Leafl. 26:339–343.

Soltis, D. E., C.H. Haufler, D.C. Darrow, and G.J. Gastony. 1983. Starch gel electrophoresis of ferns: a compilation of grinding buffers, gel and electrode buffer and staining schedules. Am. Fern. J. 73:9–27.

Swofford, D.L. and R.B. Selander. 1989. BIOSYS-1, a computer program for the analysis of genetic variation in populational genetic and biochemical systematics. Version 1.7. Illinois Natural History Survey, Champaign, Illinois.

Tian, G.W., Z.L. Wang, L.D. Liu, and J.H. Sheng. 1998. Studies on the structure, afterripening and cytochemistry of seeds in *Eleutherococcus brachypus* Harms. Acta Phytotax. Sinica 36:1–5.

Wang, Z. L., L.D. Liu, G.W. Tian, and J.H. Sheng. 1997. Flowering and pollination biology of *Eleutherococcus brachypus*. Chin. Biodiv. 5:251–256.

Wang, Z.R. 1998. Plant allozyme analysis. Science Press, Beijing.

Xie, C.S., W.R. Zhang, Z.Z. Long, and S.K. Xu. 1989. Immunoregulatory effect of polysaccharide of *Acanthopanax senticosus* (PAS) I: immunological mechanism of PAS against cancer. Zhonghua Zhongliu Zazhi 11:338–340.

Xu, R.S., S.C. Feng, Z.Y. Fan, C.N. Ye, S.K. Zhai, and M.L. Shen. 1983. The study of polysaccharide composition of *Acanthopanax senticosus*. Chinese Sci. Bull. 28:185–187.

Yan, H.J., S.L. Dai, and N.H. Wu. 1997. RAPD analysis of natural populations of *Acanthopanax brachypus*. Cell Res. 7:99–106.

Zhao, Y.Q., L.J. Wu, and X. Li. 1990. Structure studies of liriodendrin, active principle in *Acanthopanax senticosus*. Chinese Trad. Herb. Drugs 21:140–141.

Zhao, Y.Q., S.S. Yang, J.H. Liu, and G.R. Zhao. 1993. Studies on the chemical constituents of *Acanthopanax senticosus* (Rupr. et Maxim.) Harms. J. Chinese Materia Medica 18: 428–429.

Zhao, Y.Q., S.S. Yang, Y.D. Sun, and Y. Hao. 1991. Isolation and identification of isofraxidin and stilbene compound in *Acanthopanax senticosus*. Chinese Trad. Herb. Drugs 22: 516–525.

POTENTIAL BIOLOGICAL CONTROL OF *LANTANA CAMARA* IN THE GALAPAGOS USING THE RUST *PUCCINIA LANTANAE*

Jorge Luis Rentería B.

Introduced Plants Program
Botany Department
Charles Darwin Research Station
Galapagos, ECUADOR
jrenteria@fcdarwin.org.ec

Carol Ellison

Invasive Species Management
CABI Bioscience UK Center (Ascot)
Silwood Park, Ascot
Berkshire, SL5 7TA, UK
c.ellison@cabi.org

ASBTRACT

Laboratory experiments were carried out in England to test the specificity and environmental requirements of a Peruvian isolate of the fungus *Puccinia lantanae* Farlow, known to attack the invasive plant *Lantana camara* L. a serious problem in Galapagos. Eight species of plants representing five families were inoculated with the fungus and kept in a dew chamber for 48 hours. *Lantana peduncularis* Andersson and *Lantana camara* were sourced from Galapagos; other species related to *Lantana* were sourced from other places. Dew periods of 5, 8, 11, 14, and 20 hours were tested to determine the period necessary for basidiospore formation and host infection. Only *Lantana camara* from Galapagos and Peru developed visible symptoms 6 days after inoculation and after 15 days sori were fully developed. No non-target species developed macroscopic symptoms. Most importantly the rust did not attack the closest host relative from Galapagos, the endemic *Lantana peduncularis*. Eight hours in the dew chamber was enough to induce basidiospore formation and host infection, but times up to 20 hours induced progressively more sori. Although we have not completed yet the experiments to determine the host range specificity, *P. lantanae* shows promise as a biocontrol agent for *Lantana camara* in Galapagos.

Key words: *Lantana peduncularis, Lantana camara, Puccinia lantanae*, rust, biocontrol, Galapagos

RESUMEN

Se realizaron experimentos de laboratorio en Inglaterra para determinar el nivel de especificidad y requerimientos ambientales del hongo *Puccinia lantanae* Farlow como potencial agente de control biológico de la especie invasora *Lantana camara* L. en Galápagos. Ocho especies de plantas pertenecientes a cinco familias relacionadas a *L. camara*, fueron inoculadas con pústulas del hongo y mantenidas durante 48 horas en la cámara de roció. *Lantana peduncularis* Andersson y *Lantana camara* fueron colectadas en Galápagos, las otras especies relacionadas con Lantana se obtuvieron en otros lugares. Para determinar el periodo de roció necesario para la producción de basidioesporas, las plantas de *L. camara* fueron inoculadas y sometidas a diferentes periodos de rocio (5, 8, 11, 14, 20 horas). *Puccinia lantanae* se desarrollo y afectó únicamente a *L. camara* proveniente de Galapagos y Perú. Los síntomas aparecieron seis días después de la inoculación y a los 15 días las pústulas estuvieron completamente desarrolladas. No se detectaron síntomas macroscopicos en las otras especies, principalmente en la endémica *L. peduncularis* que es la especie mas cercana. *Puccinia lantanae* fue capaz de esporular e infectar *L. camara luego* de ocho horas de roció; el mayor grado de infección y desarrollo de pústulas se obtuvo dentro de las 20 horas de roció. No se han realizado todas las pruebas necesarias para determinar si el nivel de especificidad es adecuado para liberar el agente, sin embargo hasta el momento, *P. lantanae* se muestra como un potencial agente de control biológico de *L, camara* para Galápagos.

SIDA 21(2): 1009–1017. 2004

INTRODUCTION

Lantana camara (Verbenaceae), an ornamental shrub, native to tropical America, is now found in most tropical and subtropical regions of the world. It is not only widespread but it is also generally considered to be a major pest of agricultural and natural areas (Thaman 1974). The *L. camara* complex will tolerate a wide range of climates. It can be found at altitudes between sea level and up to 2000 meters, and between 45° N to 45° S. It flourishes in both dry and wet regions, growing on mountain slopes, along coastal areas and in valleys. It is somewhat shade tolerant and thus can become the dominant understory plant in open forest and tropical tree crops in its weedy range (Holm et al. 1977). Reproduction is by seeds that are spread via frugivorous birds, and short distance spread is by the rooting of horizontal stems in contact with the soil.

Lantana camara was first introduced as an ornamental into Floreana Island in the Galapagos Archipelago in 1938 (Cruz et al. 1986), and has since spread or been carried to other islands, including Santa Cruz. The dense thickets created by this invasive weed impact not only the indigenous flora but also fauna (Hamann 1984; Cruz et al. 1986). There is evidence, for example, that it is affecting the nesting habitats of the endangered dark-rumped petrel, *Pterodroma phaeopygia* (Cruz et al. 1986).

Lantana camara was the first weed ever targeted for classical biological control at the turn of the century. The first attempt at the biological control of lantana began in 1902, when 23 insect species were imported into Hawaii from Mexico. Eight of these species were established (Perkins & Swezey 1924). A total of 36 insect species has since been released in 33 countries (Julien & Griffiths 1998), but control in Hawaii, as well as in other parts of the world, has only been partially successful (Taylor 1989). This has mainly been due to the genetic diversity, and hence environmental adaptability, of the weedy biotypes which outstrip those of its natural enemies. New biocontrol agents are still being evaluated and released, including pathogens. A broad range of pathogens has been recorded infecting *L. camara* in its native range (Barreto et al. 1995). Three fungal agents have been released so far: a species of *Septoria* was released in Hawaii, originally from Ecuador (Trujillo 1995), a rust *Prospodium tuberculatum* (ex Brazil) was released in Australia in 2001, and a leaf spot pathogen, *Mycovellosiella lantanae* var. *lantanae* (ex Florida, USA) was released in South Africa, also in 2001. The impact of these agents is still pending. *Puccinia tuberculatum* was screened against the invasive and native species of Lantana from the Galapagos at CABI Bioscience, but it was found to infect, albeit mildly, the native lantana, and was discounted as a potential agent. A number of other candidate pathogens have been identified with excellent potential, including a stem and leaf rust, *Puccinia lantanae* (Barreto et al. 1995).

Puccinia lantanae Farlow (Basidiomycotina, Uredinales) occurs in tropical and subtropical regions of America: From Mexico and Florida, through the Caribbean and as far South as Argentina. *Puccinia lantanae* has been recorded from a number of *Lantana* spp., but there is evidence of distinct races that are only capable of attacking single species, and are even specific to biotypes within that species. This rust is recorded as a microcyclic (only teliospores and basidiospores in the life cycle) and autoecious (completes life cycle on one host species) species. The teliospores remain in the sorus on the host plant, and are not released. Under conditions of high humidity, teliospores germinate and produce basidiospores that are released from the teliospores. These infect fresh plant material, from which more teliospores result, and hence complete the life cycle.

METHODS

Plant material and fungal inoculations

Plants species used in the experiment were grown from stem cuttings from the CABI Bioscience stock plant collection. *Lantana camara* and *Lantana peduncularis* were collected originally from the Galapagos Islands (Santa Cruz). Using rooting powder, stem cuttings were planted in pots containing substrate (John Innes no. 2). Plants were kept in a quarantine glasshouse set at a minimum temperature of 20 °C with 12 hours of artificial light and watered everyday.

The rust *Puccinia lantanae* used was taken from the CABI Bioscience specimen collection held on living plants (isolate reference number W1914). The fungus, like all rusts is a biotroph and therefore culturing can only be done *in vivo*.

To inoculate the experimental plants for host range testing and assessment of the minimum dew period requirement, sori of *Puccinia lantanae* were suspended over new shoots; between two to four shoots were targeted for each potted plant. The small piece of plant tissue containing the sori of teliospores, was attached to small Petri dish using petroleum jelly (Vaseline). Care was taken that no Vaseline was deposited on the fungal material. Petri dishes were attached to a small stick a distance of 2 cm above the young leaves, making sure that the teliospores were directly above the leaf, so the basidiospores are released onto the potentially susceptible part of the plant. (Koutsidou 2000). The target area was usually the four youngest leaves of any given stem. The inoculated stems were marked by tying a string to the stem. Target plants were watered and the leaves were wetted with a fine mist of sterile distilled water before putting them in the artificial dew chamber (Mercia Scientific, Birmingham, UK). All *in vivo* experiments were done in a quarantine greenhouse at CABI Bioscience, Ascot. United Kingdom.

There were two experiments described below:

Symptom Development and Host Range Specificity

For the host range specificity experiments, eight species from five families were used (Table 1). All test plants species were inoculated with the rust *Puccinia*

Table 1. Host range test species list and results of host specificity testing of *Puccinia lantanae*.

Family	Species	Provenance	Native in	Susceptibility rating
Bignonaceae	*Tecomanthe hilli*	Australia	Australia	0
Boraginaceae	*Cordia dichotoma*	Australia	Australasia	0
Lamiaceae	*Plectranthus parviflorus*	Australia	Australasia	0
Lamiaceae	*Vitex triflora*	Australia	South America	0
Lamiaceae	*Gmelina leichhardtii*	Australia	Australia	0
Verbenaceae	*Lantana camara*	Galapagos	South America	3
Verbenaceae	*Lantana camara*	Peru	South America	3
Verbenaceae	*Lantana montevidensis*	Australia	South America	0
Verbenaceae	*Lantana peduncularis*	Galapagos	Galapagos	0

lantanae using the method described above. At least three replicate plants were inoculated per species. Plants were incubated at 20° C for 48 hours in a dew simulation chamber to induce teliospore germination, basidiospores formation, and provide an optimum environment for potential plant infection.

Symptoms were recorded according to a rating system devised to assess the susceptibility of plant species to *P. lantanae* based on the visible symptoms (Koutsidou 2000): **0** No macroscopic symptoms; **1** Chlorosis on the leaf surface; **2** Restricted sporulation (sorus diameter <2mm), and; **3** Abundant sporulation (Sorus diameter >2mm).

Dew Period Requirements

Lantana camara plants (from Galapagos) were inoculated with the rust *Puccinia lantanae* using the method described above, although one sorus per shoot was used as the standard inoculum, of 5 mm diameter. Three or more shoots were inoculated per replicate plant and a mean number of sori per shoot taken for each plant. Dew period treatments of 5, 8, 11, 14, and 20 hours were compared, with two replicate plants per treatment. The dew chamber was set at 20° C. After this treatment, the inoculum was removed and plants moved into the quarantine glasshouse and pots watered normally avoiding the wetting of leaves. Plants were checked regularly for macrosymptoms and sorus development.

RESULTS

Symptom Development and Host Range Specificity

The first appearance of symptoms of *P. lantanae* infection on the *L. camara* from Galapagos, occurred 6-7 days after the inoculation, as small chlorotic spots. These spots enlarged, and after approximately 13-15 days the first symptom of sporulation i.e. sori became apparent. The size of the sori on leaves differed from between 1 mm to 6 mm in diameter. In general, the younger the leaves (approximately <5mm diameter) were at inoculation the larger the sori that formed. Leaves that had already partially expanded before infection produced the smaller sori. However, high densities of sori on a leaf also resulted in smaller average sorus size. No sporulation was observed on leaves that were fully expanded at inoculation. Sporulation occurred mainly on the lower surface of the leaf. When the density of sori was high, very premature leaf abscission was observed (around 13 days after inoculation). If the density of sori was lower, a necrotic area formed around them, which increased until earlier than normal leaf fall, but after full rust symptom expression. Infection often occurred on stems and petioles also.

Table 1 gives the results of the host specificity testing. Although this is a limited host range test, the results suggest that *P. lantanae* is host specific to *L. camara*. *Puccinia lantanae* was not able to infect nor sporulate on any of the other seven related species used in the experiments. Even the most closely related species *L. peduncularis* (Galapagos) and *L. montevidensis* were resistant to *P. lantanae*, suggesting strong host-specificity.

Dew Period Requirements

Puccinia lantanae was able to sporulate and infect *L. camara* plants after only 8 hours of dew. Maximum infection and sori development was obtained at or after 20 hours of dew (see Fig. 1).

Figure 2 shows the different levels of infection by *P. lantanae* after different lengths of dew period. Clearly, more basidiospores are released over a longer period of time in humid conditions.

DISCUSSION

Puccinia lantanae isolate W1914 from Peru seems to be significantly more destructive to *Lantana camara* than other pathotypes of *P. lantanae*, that are frequently observed throughout the native range of the plant. Previous records of isolates of *P. lantanae* report that the pathogen only infects leaves (Barreto et al. 1995). The fact that the isolate W1914 can also infect petioles and stem means that the rust is much more damaging to the weed and is therefore a better potential biological control agent than originally estimated. Whole branches may drop as a result of stem infection and infection of the leaves can be very severe. Disease symptoms start to appear 5-7 days after inoculation and sori can grow up to 6 mm in diameter suggesting a rapid and destructive infection of this rust. This rust is able to release the basidiospores that can infect fresh host tissue within the first 8 hours of a dew period however longer periods of humidity favor it.

Puccinia lantanae seems to be a promising biological control agent to target *L. camara* from the Galapagos Islands. Nevertheless it is necessary to continue with the host range specificity test using the related native and endemic species from Galapagos to avoid doubts about non-target species effects.

In addition, more collections of *L. camara* from Galapagos need to be made

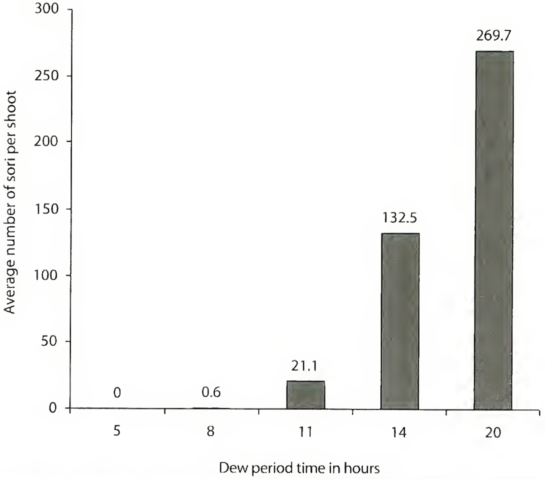


Fig. 1. Average number of sori per shoot developed within the five dew period time treatments.

to ensure that the rust is able to attack all the possible forms of the weed that may occur in Galapagos. There is evidence (from observations on flower color and plant growth form), that this weed has a narrow genetic base on the islands, and hence this rust is likely to infect all populations. Although only limited host specificity testing has been undertaken, the results suggest that this isolate is specific to *L. camara*.

Classical releases of rusts with the same type of life cycle as *P. lantanae* (e.g. microcyclic), show that such short-cycled rusts spread swiftly through and between plant populations (Morin et al. 1996.). The impact of successful classical biological control agents on woody weed species, such as *L. camara*, has tended to take a decade or more to be demonstrated, and often a suite of natural enemies is required. It is anticipated that due to the damaging nature of the rust and the short generation time, the impact may be observed sooner than is normal, and that this single agent may provide effective control.

In the subsequent glasshouse based tests of this agent, untreated (not inoculated) plants of *L. camara* should be compared with treated individuals, in

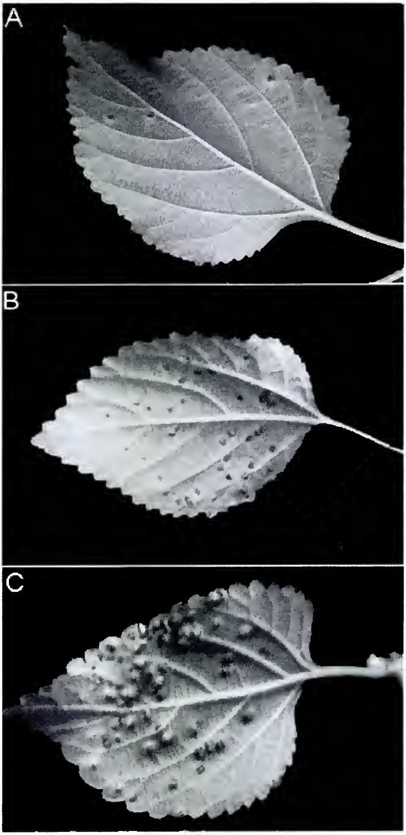


Fig. 2. Levels of infection of *Puccinia lantanae* as result of the different dew period treatments. A. eight hours, B. fourteen hours, C. twenty hours in the dew chamber.

order to investigate the effect of the rust on plant growth and survival. This may help give an indication of the possible level of impact of the agent in the field, although this is known to be quite difficult to study with woody species in controlled conditions.

Lantana camara is difficult to control and appears impossible to eradicate due to the wide range it occupies in the Galapagos. Biological control is a realistic management option. This weed has been studied for over a century as a classical biological control target. Although success has been limited, the rust *Puccinia lantanae* constitutes a new method and a potentially effective agent to try in Galapagos Islands.

ACKNOWLEDGMENTS

We gratefully acknowledge the following organizations and people for their financial support and help: Global Environment Facility (GEF) Invasive species project, through UNDP-ECU/00/G31, CABI Bioscience International, the Botany Department of the Charles Darwin Research Station, Richard Shaw, Harry Evans, Sarah Thomas, Djamila Djeddour, Marion Seier, Keith Holmes, Rob Tanner and Lynn Hill. Alan Tye and Chris Buddenhagen provided detailed comments on the manuscript. Joe Hennen (BRIT) and an anonymous reviewer provided valuable comments.

REFERENCES

Barreto, R.W., H.C. Evans, and C.A. Ellison. 1995. The mycobiota of the weed *Lantana camara* in Brazil, with particular reference to biological control. Mycological Research 99:769-782

Cruz, F., J. Cruz, and J. Laweson. 1986. *Lantana camara* L., a threat to native plants and animals. Noticias de Galápagos 43:10-11

Hamann, O. 1984. Changes and threats to the vegetation. In: R. Perry, ed. Key environments: Galápagos. Pergamon Press, Oxford, UK. Pp. 115-131

Holm, L.G., D.L. Plucknett, J.V. Pancho, and J.P. Herberger. 1977. The worlds worst weeds. Distribution and biology. University Press of Hawaii, Honolulu, Hawaii.

Julien, M.H. and M.W. Griffiths. 1998. Biological control of weeds: A world catalogue of agents and their target weeds (Fourth edition). CABI Publishing: Wallingford, Oxon, UK.

Koutsidou C. 2000. Studies on *Puccinia lantanae*, a potential biocontrol agent for *Lantana camara*. Msc Thesis, Imperial College, London. Pp. 16-68.

Morin, L., B.A. Auld, and H.E. Smith. 1996 Rust epidemics, climate and control of *Xanthium occidentale*. In: V.C. Moran and J.H. Hoffmann, eds. Proceedings of the IX International symposium on biological control of weeds. University of Cape Town, Cape Town, South Africa. Pp. 385-391.

Perkins, R.C.L. and O.H. Swezey. 1924. The introduction into Hawaii of insects that attack lantana. Bull. Exp. Sta. of the Hawaiian Sugar Planters' Assoc. 16:1-83

Taylor, E.E. 1989. A history of biological control of *Lantana camara* in New South Wales. Plant Protection Quart. 4:61-65.

THAMAN, R.R. 1974. *Lantana camara*: Its introduction, dispersal and impact on islands of the tropical Pacific Ocean. Micronesica 10:17-39.

THOMAS S.E. and C.A. ELLISON 2000. A century of classical biological control of *Lantana camara*: can pathogens make a significant difference? In: N.R. Spencer, ed. Proceeding of the X International symposium on biological control of weeds. Montana State University, Bozeman. Pp. 97-104.

TRUJILLO, E.E. 1995. *Septoria* leaf spot of lantana from Ecuador: A potential biological control for bush lantana in forests of Hawaii. Plant Disease 79:819-821.

ISOLATION AND IDENTIFICATION OF FUNGI ASSOCIATED WITH THE RHIZOSPHERE AND RHIZOPLANE OF WILD AND CULTIVATED PLANTS OF PAKISTAN

Shamim Akhtar Qureshi

Department of Biochemistry
University of Karachi
Karachi-75270, PAKISTAN

Viqar Sultana

Department of Biochemistry
University of Karachi
Karachi-75270, PAKISTAN

Syed Ehteshamul-Haque

Department of Botany
University of Karachi
Karachi-75270, PAKISTAN

Mohammad Athar

California Department of Food and Agriculture
2014 Capitol Avenue, Suite 109
Sacramento, California 95814, U.S.A.
atariq@cdfa.ca.gov

ABSTRACT

Fifty-seven species of fungi belonging to 23 genera were isolated and identified from the rhizosphere and rhizoplane of 65 plant species, belonging to 58 genera and 19 families from Sindh and Baluchistan, (Pakistan). A greater number of fungi were isolated from the rhizosphere than from the rhizoplane. In the rhizosphere, *Fusarium solani* and *Aspergillus* spp. were dominant followed by *Drechslera australiensis*. In the rhizoplane, *Fusarium solani* was also dominant. Biocontrol agents like *Trichoderma harzianum, T. koningii, T. viride, V. chlamydosporium*, and *Stachybotrys atra* were isolated in low frequency suggesting their poor competence in the rhizosphere. *Memnoniella echinata* from *Zea mays* and *Sorghum bicolor* and *Stachybotrys parvispora* from *Zea mays* were reported for the first time from Pakistan. Microorganisms in agricultural soils are known to exert profound influences on the soil fertility status as well as on the suppression of soil-borne plant diseases. Multiple microbial interactions involving bacteria and fungi in the rhizosphere are shown to provide enhanced biocontrol in many cases in comparison with biocontrol agents used singly. Importantly, a soil that is suppressive to one pathogen is not necessarily suppressive to another, and so specificity in soil-plant-microbe interactions for disease suppression exists. Modern methods for analyzing microbial community structures may prove particularly valuable to help define the key organisms or groups of organisms responsible for such natural suppression as well as for monitoring the spread and impact of introduction of specific biocontrol agents or other management practices on natural microbial populations.

RESUMEN

Cincuenta y cinco especies de hongos pertenecientes a 23 géneros, fueron aisladas e identificadas en la rizosfera y rizoplana de 65 especies vegetales, pertenecientes a 58 géneros y 19 familias de Sindh y Baluchistan, (Pakistán). Fue aislado un número mayor de hongos en la rizosfera que en el rizoplana. En la rizosfera, *Fusarium solani* y *Aspergillus* spp. fueron los dominantes seguidos de *Drechslera australiensis*. En el rizoplana, *Fusarium solani* fue dominante también. Agentes de biocontrol como *Trichoderma harzianum, T. koningii, T. viride, V. chlamydosporium*, y *Stachybotrys* se aislaron en baja frecuencia lo que sugiere una competencia pobre en la rizosfera. *Memnoniella echinata* de *Zea mays* y *Sorghum bicolour*, y *Stachybotrys parvispora* de *Zea mays* se citan por primera vez de Pakistán. Los microorganismos de los suelos agrícolas ejercen profundas influencias en la fertilidad del suelo así

SIDA 21(2): 1019–1053. 2004

como en la supresión de enfermedades de las plantas originadas en el suelo Las interacciones microbianas múltiples que implican bacterias y hongos en la rizosfera se ve que ejercen un biocontrol incrementado en muchos casos en comparación con los agentes de biocontrol usados aisladamente. Es importante, que un suelo que es supresivo para un patógeno no es necesariamente supresivo para otro, y así la especificidad en las interacciones suelo-planta-microbio para la supresión de la enfermedad existe. Los métodos modernos para analizar la estructuras de la comunidad microbiana pueden ser muy valiosos para ayudar a definir los organismos clave o grupos de organismos responsables de tal supresión natural así como para la supervisión de la extensión y el impacto de la introducción de agentes de biocontrol específicos u otras prácticas de gestión de poblaciones microbianas naturales.

INTRODUCTION

The rhizosphere has become an important area to test and evaluate new opportunities being developed in biotechnology. The rhizosphere is the portion of soil directly influenced by substances issuing from roots into the soil solution, favoring certain microorganisms, harmful around roots of unthrifty plants and beneficial around roots of healthy plants (Atkinson & Watson 2000; Curl 1982). There is an exchange of materials between the plant root and the surrounding micro-population within the rhizosphere. These materials may inhibit or promote growth of the plant or the microorganisms (Bazin et al. 1990; Filion et al. 2004; Katan 2002). Rhizosphere is therefore the site where biological control of soilborne pathogens takes place. Pathogen population (inoculum density), growth and survival and infection or pathogenesis are all influenced by the rhizosphere (Abawi & Widmer 2000; Curl & Truelove 1986; Manka & Kacprzak 1999). Infection of roots by a soilborne plant pathogen is influenced by the physical and chemical properties of the rhizosphere environment and interaction of the pathogen with other microorganisms in that environment (Dix & Webster 1995; Tate 1995). Saprophytic fungi and bacteria in the rhizosphere and root surface create a competitive deterrent to the colonization of rhizoplane and invasion of the plant roots by pathogens (Abawi & Widmer 2000; Tate 1995). It has been reported that more competitive fungal species are found in rhizosphere than soil away from roots (Tate 1995).

Another special habitat or site of microbial activity is rhizoplane or the root surface which supports relatively high biologic activity than rhizosphere (Abawi & Widmer 2000; Atkinson & Watson 2000). It has been reported that legumes support larger rhizosphere population than non-leguminous plants (Subba Rao 1977). Similarly, rhizosphere of resistant cultivars of pigeon-pea (*Cajanus cajan*) harbored more *Streptomyces* and *Trichoderma* antagonistic to *Fusarium udum* causal agent of pigeon pea wilt, than susceptible cultivars and *Trichoderma viride* in the rhizosphere of varieties of tomato resistant to *Verticillium* wilt (Subba Rao 1977). *Trichoderma* spp. and *Paecilomyces lilacinus* are known as effective biocontrol agents against root infecting fungi and have shown promising results in microplot experiments (Boland & Kuykendall 1998; Burges 1998; Lewis et al. 1998; Whipps 1997, 2001). The opportunity to improve crop productivity by introduc-

TABLE 1. Some of the soil characteristics of the collection sites.

Province/Location	Soil Type	Soil pH
Sindh Province		
Darsano Chano	Surface and sub-surface of soil sandy loam	8.0–8.2
Gharo	Surface and sub-surface of soil clay loam	8.2–8.5
Karachi University Campus	Surface and sub-surface of soil silty loam	8.0–8.1
Kathor	Surface coarse sand and sub-surface sandy loam	8.0–8.05
Memon Goth	Surface and sub-surface of soil silty-sandy loam	8.05–8.1
Shah Faisal Colony	Surface and sub-surface of soil sandy loam	8.0–8.1
Thatta	Surface and sub-surface of soil clay loam	8.3–8.5
Baluchistan Province		
Hub	Surface and sub-surface of soil sandy loam	8.0–8.2

ing organisms to the rhizosphere is highlighting a major need for the study of fungal community on and around the roots of plants. The present report describes the occurrence of fungal species on rhizosphere and rhizoplane of different plant species collected from different parts of Sindh and Baluchistan (Pakistan).

MATERIALS AND METHODS

Sites and Collection of Samples

Eight sites were chosen for the collection of samples; seven from Sindh and one from Baluchistan. Details of collection sites along with some of the soil characteristics are provided in Table 1. Overall rainfall of these areas is very scanty ranging from 25mm to 102 mm per year. Average summer temperature is 50° C (maximum) and 25° C (minimum), and average winter temperature 25° C (maximum) and 8° C (minimum).

Young healthy plants were carefully dug out up to a depth of 15 cm and root samples with adhering soil (25–50 g depending upon root size) were collected in polyethylene bags. Roots of cultivated crops were collected from agricultural fields. Roots of wild plants were collected from adjacent uncultivated fellow fields. Five replicates of each plant species were collected from each location. Samples were kept under refrigeration at 4° C until the isolation of fungi made within 24 hours. Potato dextrose agar was used for the isolation of fungi in this study, since it supports the growth of most of the fungi from rhizoplane and rhizosphere (van Elsas et al. 2002) and also for endophytes (Halleen et al. 2003), except obligate parasites and those which have special growth requirements.

Isolation of Fungi from Rhizosphere

Volume displacement technique was used for the isolation of fungi from rhizosphere soil as described by Reyes and Mitchell (1962). Root pieces with adhering soil were placed in a graduated cylinder containing 18 mL sterilized distilled water and shaken vigorously. The roots were removed and the process was repeated

Table 2. Fungi isolated from rhizoplane and rhiosphere of wild and cultivated plants growing in Sindh and Baluchistan, Pakistan.

No and Host	Rhizoplane	Location	Rhizosphere	Location
AMARANTHACEAE				
1. *Amaranthus virides* L.	*Alternaria alternata* (Fr.) Keissler	4	*Alternaria alternata* (Fr.) Keissler	4,6
	Aspergillus flavus Link ex Gray	4,5	*Aspergillus flavus* Link ex Gray	4,5
	A.fumigatus Fres.	4	*A.fumigatus* Fres.	2
	A. niger van Tieghem	4,5	*A. nidulans* (Eidam) Winter	5
	A. nidulans (Eidam) Winter	5	*A. niger* van Tieghem	5
	A.terreus Thom	4	*A. terreus* Thom	2,4,5,6
	Chaetomium indicum Corda	2,6	*Chaetomium indicum* Corda	2,6
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2,4,6
	Macrophomina phaseolina (Tassi) Goid.	2	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6
	Rhizopus stolonifer (Ehrenb.ex Link) Lind.	5	*F. oxysporum* Schlecht emend. Snyd & Hans.	4
	Unidentified black sterile mycelium	2,4	*Penicillium crysogenum* Thom.	4
			P. rugulosum Thom	2
			Trichoderma viride Pers. ex Gray	4,5
			Unidentified black sterile mycelium	2,4
			Unidentified yellow sterile mycelium	2,4
2. *Aerva javanica* (Burm. f.) Merrill	*Alternaria alternata* (Fr.) Keissler	5	*Aspergillus flavus* Link ex Gray	5
	Aspergillus flavus Link ex Gray	5	*A. niger* van Tieghem	5
	A. niger van Tieghem	5	*A. terreus* Thom	5
	Fusarium oxysporum Schlecht emend. Snyd.& Hans	5	*Cunninghamella echinulata* (Thaxt.) Thaxt.	5
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
	Rhizoctonia solani Kuhn	5	*Penicillium luteum* Zukel	5
3. *Digera muricata* (L.) Mart.	*Aspergillus flavus* Link ex Gray	1	*Alternaria alternata* (Fr.) Keissler	1
	A. niger van Tieghem	1	*Aspergillus flavus* Link ex Gray	1

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	A. terreus Thom	1	*A. niger* van Tieghem	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*A. terreus* Thom	1
	Macrophomina phaseolina (Tassi) Goid	1	*Cladosporium* sp.	1
	Penicillium waksmanni Zaleski	1	*Fusarium culmurum* (W.G. Sm.) Sacc.	1
			Myrothecium cinctum (Corda) Sacc.	1
			Penicillium waksmanni Zaleski	1
ASCLEPIADACEAE				
4. *Calotropis procera* (Ait.) Ait.f. (Rooster tree)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link	2	*Aspergillus flavus* Link	2,5
	A. niger van Tieghem	2	*A. niger* van Tieghem	2,5
	A. terreus Thom	2	*A. terreus* Thom	2,5
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*Cephalosporium* sp.	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*Chaetomium flavum* Omvik	2
	Trichoderma viride Pers. ex Gray	2		
BORAGINACEAE				
5. *Heliotropium europeam* L. (European heliotrope)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link ex Gray	2,6	*Aspergillus flavus* Link ex Gray	2,6
	A. nidulans (Eidam) Winter	2	*A. fumigatus* Fres.	2,6
	A. niger van Tieghem	2,6	*A. nidulans* (Eidam) Winter	2
	Chaetomium indicum Corda	2	*A. terreus* Thom	2
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis.	6	*Cephalosporium* sp.	2
	D. hawaiiensis (Bugni) Subram. & Jain ex M.B. Ellis	2	*Chaetomium indicum* Corda	2
	D. halodes (Drechslera) Subram.		*Cunninghamella echinulata* (Thaxt.) Thaxt.	2
	Fusarium solani (Mart.) Appel & Wollenw. & Jain ex M.B. Ellis	2	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	6
			emend. Snyd. & Hans	2,6
			Fusarium solani (Mart.) Appel & Wollenw.	

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	emend. Snyd. & Hans	2,6	*Penicillium luteum* Zukal	2
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	Unidentified sclerotial fungus	2
	Unidentified sclerotial fungus	2	Unidentified white sterile mycelium	2,6
CANNACEAE				
6. *Canna indica* L. (Common Lilly)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1	*Alternaria alternata* (Fr.) Keissler	1
	Fusarium oxysporum Schlecht emend. Snyd & Hans.	1	*Aspergillus flavus* Link	1
	F solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*A. niger* van Tieghem	1
	Macrophomina phaseolina (Tassi) Goid	1	*A. sulphureus* (Fres.) Thom & Church	1
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
			Macrophomina phaseolina (Tassi) Goid	1
			Penicillium luteum Zukal	1
CARICACEAE				
7. *Carica papaya* L. (Papaya)	*Aspergillus flavus* Link ex Gray	2	*Aspergillus flavus* Link ex Gray	2
	A. niger van Tieghem	2	*A. glaucus* Link	2
	A. nidulans (Eidam) Winter	2	*A. niger* van Tieghem	2
	A. terreus Thom	2	*A. nidulans* (Eidam) Winter	2
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	*A. terreus* Thom	2
			Penicillium luteum Zukal	2
			Trichoderma harzianum Rifai	2
CHENOPODIACEAE				
8. *Beta vulgaris* L. (Sugar beet)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis	3	*Alternaria alternata* (Fr.) Keissler	6
	Fusarium solani (Mart) Appel & Wollenw. emend. Snyd. & Hans	3,6	*Aspergillus flavus* ex Gray	3,6
	Macrophomina phaseolina (Tassi) Goid.	3,6	*A. niger* van Tieghem	3,6
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	6

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Rhizoctonia solani Kuhn	3,6	*Fusarium solani* (Mart) Appel & Wollenw. emend. Snyd. & Hans	6
9. *Chenopodium album* L. (PIGWEED)	*Alternaria alternata* (Fr.) Keissler	7	*Alternaria alternata* (Fr.) Keissler	7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	7	*Aspergillus flavus* Link ex Gray	7
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7	*A. niger* van Tieghem	7
			A. terreus Thom	7
			Chaetomium globosum Kunze ex Steud.	7
			C. indicum Corda	7
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	7
			Fusarium semitectum Berk. & Rav.	7
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
			Penicillium rugulosum Thom	7
10. *Spinacea oleracea* L. (SPINACH)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2,6
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*Aspergillus niger* van Tieghem	2,6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis	2,6	*A. terreus* Thom	2
	Fusarium oxysporum Schlecht. emend. Synd. & Hans	2	*Cladosporium* sp.	2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	2,6
	Macrophomina phaseolina (Tassi) Goid.	2,6	*Fusarium oxysporum* Schlecht. emend. Snyd & Hans	2
	Rhizoctonia solani Kuhn	2,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6
			Rhizoctonia solani Kuhn	2
			Unidentified white sterile mycelium	2,6
COMPOSITAE				
11. *Conyza bonariensis* (L.) Cronquist	*Alternaria alternata* (Fr.) Keissler	5	*Aspergillus flavus* Link ex Gray	5
	Aspergillus flavus Link ex Gray	5	*A. niger* van Tieghem	5

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	A. niger van Tieghem	5	*A. terreus* Thom	5
	A. terreus Thom	5		
	Cunninghamella echinulata (Thaxt.) Thaxt.	5		
	Rhizopus stolonifer (Ehrenb.ex Link) Lind	5		
12. *Helianthus annuus* L. (Sunflower)	*Alternaria alternata* (Fr.) Keissler	1,8	*Aspergillus flavus* Link ex Gray	1,8
	Drechslera australiensis (Bugni) Subram.& Jain ex M.B.Ellis.	1,8	*A. niger* van Tieghem	1,8
	Fusarium oxysporum Schlecht emend. Snyd. & Hans	1,8	*A. terreus* Thom	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Macrophomina phaseolina (Tassi) Goid	1,8	*Macrophomina phaseolina* (Tassi) Goid	1,8
	Rhizoctonia solani Kuhn	1,8	*Pencillium luteum* Zukal	1
	Unidentified white sterile mycelium	1	Unidentified white sterile mycelium	2
13. *Lactuca sativa* L. (Lettuce)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans	2	*Aspergillus flavus* Link ex Gray	2,6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6	*A. niger* van Tieghem	2,6
	Macrophomina phaseolina (Tassi) Goid	2,6	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6
	Rhizoctonia solani Kuhn	2,6		
14. *Launea nudicaulis* Hook. f.	*Aspergillus niger* Van Tieghem	1	*Aspergillus flavus* Link ex Gray	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*A. niger* van Tieghem	1
	Macrophomina phaseolina (Tassi) Goid.	1	*A. nidulans* (Eidam) Winter	1
	Rhizoctonia solani Kuhn	1	*A. terreus* Thom	1
	Unidentified black sterile mycelium	1,2	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			Fusarium semitectum Berk. & Rav.	1
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
			Macrophomina phaseolina (Tassi) Goid.	1
			Unidentified black sterile mycelium	1,2
CONVOLVULACEAE				
15. *Convolvulus arvensis* L.	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	1,2
	Aspergillus flavus Link ex Gray	1,7	*Aapergillus flavus* Link ex Gray	1
	A. niger van Tieghem	1,2,7	*A. niger* van Tieghem	1
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*A. nidulans* (Eidan) Winter	2
	Cladosporium sp.	1,2	*A. sulphureus* (Fres.) Thom & Churh	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*A. terreus* Thom	1,2
	F. oxysporum Schlecht. emend. Snyd. & Hans	2	*Cladosporium* sp.	1,2
	Macrophomina phaseolina (Tassi) Goid.	1	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
	Rhizoctonia solani Kuhn	7	*F. oxysporum* Schlecht. emend. Snyd. & Hans	2
	Rhizopus stolonifer (Ehrenb.ex Link) Lind.	2	*Macrophomina phaseolina* (Tassi) Goid.	1
			Rhizoctonia solani Kuhn	7
			Unidentified sterile fungus	7
CRUCIFERAE				
16. *Brassica juncea* (L.) Czern. & Coss (Mustard)	*Fusarium solani* (Mart) Appel & Wollenw. emend. Snyd.& Hans	7,8	*Alternaria alternata* (Fr.) Keissler	7
	Macrophomina phaseolina (Tassi) Goid	8	*Aspergillus niger* van Tieghem	7
	Rhizoctonia solani Kuhn	7,8	*Drechslera .australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	7
			Fusarium solani (Mart) Appel & Wollenw. emend. Snyd. & Hans	7
17. *Brassica oleracea* L. var. *capitata* L. (Cabbage)	*Aspergillus flavus* Link ex Gray	4	*Aspergillus flavus* Link ex Gray	4
	A. terreus Thom	4	*A. terreus* Thom	4

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Chaetomium globosum Kunze ex Staud.	3	*Chaetomium globosum* Kunze ex Staud.	3
	Cunninghamella echinulata (Thaxt.) Thaxt.	4	*Cunninghamella echinulata* (Thaxt.) Thaxt.	4
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3,4	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4
	Macrophomina phaseolina (Tassi) Goid.	3,4	*Macrophomina phaseolina* (Tassi) Goid.	3
	Rhizoctonia solani Kuhn	3	*Penicillium waksmanni* Zaleski	4
18. *Brassica rapa* L. (Rapifera group) (TURNIP)	*Curvalaria lunata* (Wakker) Boedijn	7	*Alternaria alternata* (Fr.) Keissler	7
	Fusarium. oxysporum Schlecht emend. Snyd. & Hans.	7	*Fusarium solani* (Mart) Appel & Wollenw. emend. Synd. & Hans.	7
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7	*Paecilomyces varioti* Bain	7
			Unidentified sterile mycelium	7
	Rhizoctonia solani Kuhn	7	Unidentified yeast	7
19. *Raphanus sativus* L. (RADISH)	*Alternaria alternata* (Fr.) Keissler	4	*Alternaria alternata* (Fr.) Keissler	4
	Aspergillus nidulans (Eidam) Winter	4	*Aspergillus flavus* Link ex Gray	6
	A. niger van Tieghem	4	*A. nidulans* (Eidam) Winter	4
	Drechslera australiensis (Bugni) Subram.& Jain ex. M.B.Ellis	6	*A. niger* van Tieghem	6
			Cladosporium sp.	4
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4,6	*Drechslera australiensis* (Bugni) Subram.& Jain ex. M.B.Ellis	6
	Macrophomina phaseolina (Tassi) Goid.	6	*Fusarium oxysporum* Schlecht. emend. Snyd. & Hans	4
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	4	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4
	Rhizoctonia solani Kuhn	6	*Macrophomina phaseolina* (Tassi) Goid.	6
CUCURBITACEAE				
20. *Citrullus lanatus* (Thunb.) Matsum. & Nakai (WATERMELON)	*Aspergillus nidulans* (Eidam) Witner	5	*Articulospora* sp.	5
	A. niger van Tieghem	5	*Aspergillus flavus* Link ex Gray	5
	Drechslera hawaniesis (Bugni) Subram. & Jain		*A. glaucus* Link	5

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	ex M.B.Ellis.	5	*A. nidulans* (Eidam) Witner	5
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans.	5	*A. niger* van Tieghem	5
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*A. terreus* Thom	5
			Cephalosporium sp.	5
			Drechslera hawaiiensis (Bugni) Subram. & Jain ex M.B. Ellis	5
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
			Myrothecium cinctum Tode	
			Paecilomyces lilacinus (Thom) Samson	5
			Penicillium javanicum Van Beijma	5
			Scopulariopsis brumptii Salvanet-Duval	5
			Trichoderma viride Pers. ex Grey	5
21. *Cucumis sativus* L. (Cucumber)	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7	*Alternaria alternata* (Fr.) Keissler	7
	Rhizoctonia solani Kuhn	7	*Aspergillus niger* van Tieghem	7
	Unidentified sterile fungus	7	*A. terreus* Thom	7
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
			Unidentified sterile mycelium	7
22. *Cucurbita moschata* L. (Pumpkin)	*Chaetomium globosum* Kunze ex. Staud.	7	*Aspergillus flavus* Link ex Gray	7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	7	*A. niger* van Tieghem	7
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,7	*Chaetomium globosum* Kunze ex. Staud.	7
	Macrophomina phaseolina (Tassi) Goid.	1,7	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
	Rhizoctonia solani Kuhn	1,7		
23. *Lagenaria siceraria* (Mol.) Standl. (Bottle gourd)	*Aspergillus flavus* Link ex Gray	1,2,5	*Aspergillus flavus* Link ex Gray	1,2,5
	A. niger van Tieghem	1,2,5	*A. niger* van Tieghem	1,2,5

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Chaetomium indicum Corda	2	*A. nidulans* (Eidam) Winter	5
	Curvularia lunata (Wakker) Boedijn	1	*A. sulphureus* (Fres.) Thom. & Church	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*A. terreus* Thom	2,5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,5	*Fusarium moniliforme* Sheld	2
	Macrophomina phaseolina (Tassi) Goid	1,5	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,5
	Rhizoctonia solani Kuhn	1	*Myrothecium roridum* Tode	5
	Paecilomyces lilacinus (Thom) Samson	5		
24. *Luffa aegyptiaca* Mill. (Sponge gourd)	*Chaetomium indicum* Corda	2,6	*Aspergillus flavus* Link ex Gray	2,5,6
	Curvularia lunata (Wakker) Boedijn	2,6	*A. fumigatus* Fres.	5
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2,5,6	*A. nidulans* (Eidam) Winter	2,5,6
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6	*A. niger* van Tieghem	2,5,6
	Macrophomina phaseolina (Tassi) Goid.	2,6	*A. terreus* Thom	2,5,6
	Paecilomyces lilacinus (Thom) Samson	5	*Chaetomium indicum* Corda	5
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	5	*Cunninghamella echinulata* (Thaxt.) Thaxt.	5
	Rhizoctonia solani Kuhn	2,6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	5
	Unidentified white sterile mycelium	2,6	*Fusarium moniliforme* Sheld	2
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5,6
			Macrophomina phaseolina (Tassi) Goid.	2,6
			Paecilomyces lilacinus (Thom) Samson	5
			Penicillium purpurogenum Stoll	2
			Trichoderma viride Pers.ex Gray	2
			Unidentified sclerotial fungus	2
			Unidentified white sterile mycelium	6
			Unidentified yeast	6

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
25. *Momordica charantia* L. (Bitter gourd)	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*Aspergillus candidus* Link ex Link	2
	Macrophomina phaseolina (Tassi) Goid.	2	*A. niger* van Tieghem	2
	Rhizoctonia solani Kuhn	2	*Chaetomium indicum* Corda	2
			Drechslera australiensis (Bugni) Subram & Jain ex M.B.Ellis	2
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
			Penicillium funiculosum Thom	2
CYPERACEAE				
26. *Cyperus rotundus* L.	*Aspergillus flavus* Link ex Gray	1,5	*Alternaria alternata* (Fr.) Keissler	5
	A. niger van Tieghem	5	*Aspergillus flavus* Link ex Gray	1,5
	Chaetomium globosum Kunze ex Staud	1,5	*A. niger* van Tieghem	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*A. terreus* Thom	5
	Drechslera australiensis (Bugni) Subram. & Jain ex. M.B. Ellis	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex. M.B. Ellis	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd.& Hans.	5	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,5
			Trichoderma viride Pers. ex Gray	5
EUPHORBIACEAE				
27. *Euphorbia hirta* L.	*Aspergillus niger* van Tieghem	5	*Aspergillus flavus* Link ex Gray	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*A. niger* van Tieghem	5
	Drechslera australiensis (Bugni) Subram. & Jain ex. M.B. Ellis	5	*A. terreus* Thom	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd.& Hans.	5		
	Macrophomina phaseolina (Tassi) Goid.	5		
	Penicillium purpurogenum Stoll	5		

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
FABACEAE				
28. *Alhaji murorum* Medik	*Drechslera halodes* (Drechlera) Subram. & Jain	7	*Aspergillus flavus* Link ex Gray	7,8
	Fusarium solani (Mart) Appel & Wollenw. emend. Snyd & Hans	7,8	*A. niger* van Tieghem	7,8
29. *Arachis hypogaea* L. (Peanut)	*Chaetomium indicum* Corda	1	*Aspergillus flavus* Link ex Gray	1
	Curvalaria clavata (Wakker) Boedijn	1	*A. nidulans* (Eidam) Winter	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	1	*A. niger* van Tieghem	1
			A. terreus Thom	1
	Fusarium oxysporum Schlecht emend. Snyd. & Wollenw	1	*Fusarium oxysporum* Schlecht emend.. Snyd.& Wollenw	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*F.solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
	Macrophomina phaseolina (Tassi) Goid.	1	*Penicillium rugulosum* Thom	2
	Nigrospora oryzae (Berk. & Br.) Petch	1	Unidentified yellow sterile mycelium	2
	Rhizoctonaia solani Kuhn	1	Unidentified white sterile mycelium	1
	Unidentified yellow sterile mycelium	2		
	Unidentified white sterile mycelium	1		
30. *Cicer arietinum* L. (Chickpea)	*Chaetomium globosum* Kunze ex Steud.	8	*Aspergillus niger* van Tieghem	8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	8	*A. terreus* Thom	8
	D. halodes (Drechslera) Subram. & Jain	8	*Chaetomium globosum* Kunze ex Steud.	8
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hanse	8	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	8
	Macrophomina phaseolina (Tassi) Goid	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hanse	8
31. *Cyamopsis tetragonoloba* (L.) Taub. (Guar)	*Chaetomium globosum* Kunze ex Staud.	1	*Alternaria alternata* (Fr.) Keissler	6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1	*Aspergillus flavus* Link ex Gray	6
			A. niger van Tieghem	6

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Fusarium semitectum Berk. & Rav.	6	*Chaetomium globosum* Kunze ex Staud.	6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	1,6	*Curvularia clavata* Jain	6
	Macrophomina phaseolina (Tassi) Goid.	1	*Fusarium semitectum* Berk. & Rav.	6
	Rhizoctonia solani Kuhn	1,4,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	6
	Unidentified white sterile mycelium	6	*Penicillium citrinum* Thom.	6
			Trichoderma viride Pers. ex Gray	6
			Unidentified white sterile mycelium	6
			Unidentified yeast	6
32. *Glycine max* (L.) Merr. (Soybean)	*Alternaria alternata* (Fr.) Keissler	1,8	*Aspergillus flavus* Link ex Gray	1,8
	Aspergillus candidus Link	1	*A. niger* van Tieghem	1,8
	A. flavus Link ex Gray	1,8	*A. terreus* Thom	1,8
	A. niger van Tieghem	1,8	*Curvularia lunata* (Wakker) Boedijn	8
	A. terreus Thom	1,8	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1,8
	Curvularia lunata (Wakker) Boedijn	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1,8	*Macrophomina phaseolina* (Tassi) Goid.	1,8
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*Monodictys putredinis* (Wallr.) Hughes	1
	Macrophomina phaseolina (Tassi) Goid.	1,8	*Myrothecium roridum* Tode	1
	Myrothecium roridum Tode	1	*Nigrospora oryzae* (Berk. & Br.) Petch	1
	Rhizoctonia solani Kuhn	1,8	*Penicillium purpurogenum* Stoll	1
			Trichoderma harzianum Rifai	1
			Unidentified Basidomycetes	1
33. *Lens culinaris* Medic (Lentil)	*Alternaria alternata* (Fr.) Keissler	1,8	*Alternaria alternata* (Fr.) Keissler	2
	Curvularia lunata (Wakker) Boedijn	8	*Aspergillus flavus* Link ex Gray	1,8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	8	*A. niger* van Tieghem	1,8
			A. terreus Thom	8

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	D. halodes (Drechslera) Subram. & Jain ex M.B. Ellis	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Fusarium oxysporum Schlecht emend. Snyd. & Hans.	8	Unidentified Basidomycetes	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8		
	Macrophomina phaseolina (Tassi) Goid.	1,8		
	Rhizoctonia solani Kuhn			
	Stachybotrys atra Corda	8		
	Unidentified Basidiomycetes	1		
34. *Leucaena leucocephala* (Lam.) de Wit (Ipil-ipil)	*Aspergillus flavus* Link ex Gray	5	*Aspergillus flavus* Link ex Gray	5
	A. terreus Thom	5	*A. niger* van Tieghem	5
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	5	*A. nidulans* (Eidam) Winter	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*A. sulphureus* (Fres.) Thom. & Church.	5
	Helicocephalum sp.	5	*A. terreus* Thom	5
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	5
35. *Medicago sativa* L. (Alfalfa)	*Alternaria alternata* (Fr.) Keissler	5,6	*Alternaria alternata* (Fr.) Keissler	5,6
	Aspergillus flavus Link ex Gray	5	*Aspergillus flavus* Link ex Gray	3,5,6
	A. niger van Tieghem	5	*A. niger* van Tieghem	3,5,6
	A. terreus Thom	5	*A. terreus* Thom	5,6
	Curvalaria lunata (Wakker) Boedijn	6	*Fusarium semitectum* Berk & Rav.	6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	3,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3,6
	Fusarium semitectum Berk & Rav.	6	*Macrophomina phaseolina* (Tassi) Goid.	3,6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5,6	Unidentified sclerotial fungus	3,6
			Unidentified white sterile mycelium	3

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Macrophomina phaseolina (Tassi) Goid.	3,6		
	Rhizoctonia solani Kuhn	3,6		
	Unidentified sclerotial fungus	3,6		
36. *Melilotus alba* Medik. (White sweet-clover)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link ex Gray	2	*Aspergillus flavus* Link ex Gray	5
	A. fumigatus Fres.	2	*A. niger* van Tieghem	2,5
	A. niger van Tieghem	2	*A. terreus* Thom	2
	A. nidulans (Eidam) Winter	2	*Cephalosporium* sp.	2
	Chaetomium flavum Omvik	2	*Chaetomium flavum* Omvik	2
	Drechslera australiensis (Bugni) Subram & Jain ex M.B.Ellis.	2,5	*Drechslera australiensis* (Bugni) Subram & Jain ex M.B.Ellis.	5
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans	2	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,5	*F. oxysporum* Schlecht. emend. Snyd. & Hans	2
37. *Phaseolus vulgaris* L. (Common bean)	*Alternaria alternata* (Fr.) Keissler	4,6	*Alternaria alternata* (Fr.) Keissler	4,6
	Aspergillus niger van Tieghem	4	*Aspergillus niger* van Tieghem	4,6
	A. terreus Thom	6	*A. sulphureus* (Fres.) Thom. & Church.	6
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	6	*A. terreus* Thom	6
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4,6	*Cladosporium* sp.	4
	Macrophomina phaseolina (Tassi) Goid.	6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	6
	Rhizoctonia solani Kuhn	4,6	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4,6
			Macrophomina phaseolina (Tassi) Goid.	6
			Rhizopus stolonifer (Ehrenb. ex Link) Lind.	4

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			Scopulariopsis Brumptii Salvanet-Duval	4
			Trichoderma harzianum Rifai	6
			T. koningii Oudem	6
38. *Pisum sativum* L. (Pea)	*Alternaria alternata* (Fr.) Keissler	8	*Alternaria alternata* (Fr.) Keissler	8
	Chaetomium globosum Kunze ex. Staud	8	*Aspergillus flavus* Link ex Gray	8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	8	*A. niger* van Tieghem	8
	D. halodes (Drechslera) Subram. & Jain	8	*Chaetomium globosum* Kunze ex. Staud	8
	Fusarium solani (Mart) Appel & Wollenw. emend. Snyd. & Hans	8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	8
	Macrophomina phaseolina (Tassi) Goid.	8		
39. *Sesbania sesban* (L.) Merr. (European river hemp)	*Aspergillus niger* van Tieghem	3	*Aspergillus flavus* Link ex Gray	3
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3	*A. niger* van Tieghem	3
	Unidentified yellow sterile mycelium	3	*A. terreus* Thom	3
	Unidentified white sterile mycelium	3	*Fusarium monoliforme* Sheld.	3
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3
			Macrophomina phaseolina (Tassi) Goid	3
			Unidentified yellow sterile mycelium	3
			Unidentified white sterile mycelium	3
40. *Trifolium alexandrium* (L.) Spergue ex. Turrill (Clover)	*Alternaria alternata* (Fr.) Keissler	8	*Alternaria alternata* (Fr.) Keissler	8
	Chaetomium globosum Kunze ex. Staud.	8	*Aspergillus flavus* Link ex Gray	5,8
	Curvalaria lunata (Wakker) Boedijn	8	*A. niger* van Tieghem	5,8
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis	5,8	*A. terreus* Thom	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5,8	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	5
			Fusarium solani (Mart.) Appel & Wollenw. emend.	

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Macrophomina phaseolina (Tassi) Goid.	5,8	Snyd. & Hans	5,8
	Rhizoctonia solani Kuhn	5,8	*Macrophomina phaseolina* (Tassi) Goid.	5,8
41. *Trigonella foenum-graecum* L. (Fenugreek)	*Alternaria alternata* (Fr.) Keissler	2,7,8	*Alternaria alternata* (Fr.) Keissler	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,8	*Aspergillus flavus* Link ex Gray	2,8
	Macrophomina phaseolina (Tassi) Goid.	2,8	*A. niger* van Tieghem	2,8
	Rhizoctonia solani Kuhn	2	*A. terreus* Thom	8
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,8
42. *Vigna mungo* (L.) Hepper (Urid bean)	*Curvularia lunata* (Wakker) Boedijn	1	*Aspergillus flavus* Link ex Gray	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis.	1	*A. niger* van Tieghem	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	1	*A. terreus* Thom	1
	Macrophomina phaseolina (Tassi) Goid.	1	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	1
	Rhizoctonia solani Kuhn	1	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	1
43. *Vigna radiata* (L.) Wilczek (Mung bean)	*Alternaria alternata* (Fr.) Keissler	1,8	*Alternaria alternata* (Fr.) Keissler	1
	Aspergillus niger van Tieghem	1	*Aspergillus flavus* Link ex Gray	1,8
	Chaetomium globosum Kunze ex Staud.	1,8	*A. fumigatus* Fres.	1
	Curvularia lunata (Wakker) Boedijn	8	*A. nidulans* (Eidam) Winter	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis.	1,8	*A. niger* van Tieghem	1
	D.halodes (Drechslera) Subram. & Jain	8	*A. terreus* Thom	1,8
	Fusarium moniliforme Sheld.	8	*Chaetomium globosum* Kunze ex Staud.	1,8
	F.solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Macrophomina phaseolina (Tassi) Goid.	1,8	*Penicillium purpurogenum* Stoll	1
	Rhizoctonia solani Kuhn	1,8	*Macrophomina phaseolina* (Tassi) Goid.	1,8
			Myrothecium roridum Tode	1

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Unidentified Ascomycetes	1	Unidentified white sterile mycelium	2
	Unidentified white sterile mycelium	1		
GRAMINEAE				
44. *Avena sativa* L. (Oat)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	5	*Aspergillus flavus* Link ex Gray	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*A. niger* van Tieghem	5
	Rhizoctonia solani Kuhn	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis	5
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
45. *Cenchrno setigerus* Vahl	*Aspergillus flavus* Link ex Gray	5	*Aspergillus flavus* Link ex Gray	5
	A. niger van Tieghem	5	*A. niger* van Tieghem	5
	A. terreus Thom	5	*A. terreus* Thom	5
	Cunninghamella echinulata (Thaxt.) Thaxt.	5	*Cunninghamella echinulata* (Thaxt.) Thaxt.	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*Curvularia clavata* Jain	5
			Paecilomyces lilacinus (Thom) Samson	5
46. *Cynodon dactylon* (L.) Pers. (Bermuda grass)	*Aspergillus flavus* Link ex Gray	2	*Aspergillus candidus* Link	5
	A. niger van Tieghem	2	*A. flavus* Link ex Gray	1,2,5
	A. terreus Thom	2	*A. niger* van Tieghem	1,2,5
	Curvularia lunata (Wakker) Boedijn	1	*A. nidulans* (Eidam) Winter	2
	Drechslera australiensis(Bugni) Subram. & Jain ex. M.B.Ellis	1	*A. terreus* Thom	2,5
	Fusarium proliferatum (Matsushima) Nirenberg	5	*Cephalosporium* sp.	2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hanse	2	*Chaetomium flavum* Omvik	5
	Macrophomina phaseolina (Tassi) Goid	2	*Cunninghamella echinulata* (Thaxt.) Thaxt.	2,5
	Nigrospora oryzae (Berk.& Br.) Petch	1	*Curvularia lunata* (Wakker) Boedijn	1
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	*Drechslera australiensis* (Bugni) Subram. & Jain ex.M.B.Ellis	1
			Fusarium proliferatum (Matsushima) Nirenberg	5

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
			Myrothecium roridum Tode	5
			Nigrospora oryzae (Berk.& Br.) Petch	1
			Paecilomyces lilacinus (Thom) Samson	5
			Rhizopus stolonifer (Ehrenb. ex Link) Lind.	5
47. *Oryzae sativa* L. (Rice)	*Chaetomium globosum* Kunze ex. Staud.	7	*Aspergillus flavus* Link ex Gray	7
	Curvularia lunata (Wakker) Boedijn	7	*A. niger* van Tieghem	7
	Drechslera hawaiiensis (Bugni) Subram. & Jain ex M.B. Ellis	7	*Chaetomium globosum* Kunze ex. Staud.	7
	Fusarium solani (Mart.) Appel & Wollenw. Emend. Snyd. & Hans	7	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	7
	Macrophomina phaseolina (Tassi) Goid.	7		
48. *Pennisetum americanum* (L.) Leeve (Millet)	*Alternaria alternata* (Fr.) Keissler	6	*Alternaria alternata* (Fr.) Keissler	6
	Aspergillus niger van Tieghem	5	*Aspergillus candidus* Link ex Link	2
	A. nidulans (Eidam) Winter	5	*A. flavus* Link ex Gray	2,5,6
	A. terreus Thom	5	*A. niger* van Tieghem	2,5
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2	*A. terreus* Thom	5,6
	D. hawaiiensis (Bugni) Subram. & Jain ex M.B. Ellis.	5	*Drechslera australiensis* (Bugni) Subram. & Jain ex. M.B. Ellis	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,6	*Fusarium moniliforme* Sheld.	2
	Macrophomina phaseolina (Tassi) Goid.	1,2,6	*F. semitectum* Berk. & Rav.	6
	Rhizoctonia solani Kuhn	2,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6
	Unidentified yellow sterile mycelium	1	*Macrophomina phaseolina* (Tassi) Goid.	1,2,6
			Monodictys putredinis (Wallr.) Hughes	1
			Penicillium rugulosum Thom	6

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
			Unidentified Ascomycetes	2
			Unidentified sclerotial fungus	1,2,6
			Unidentified yellow sterile mycelium	1
			Unidentified white sterile mycelium	1
49. *Setaria verticilata* (L.) Beauv. (Hooked bristle grass)	*Alternaria alternata* (Fr.) Keissler	1,4	*Alternaria alternata* (Fr.) Keissler	1,4
	Aspergillus flavus Link ex Gray	4	*Aspergillus flavus* Link ex Gray	4
	A. niger van Tieghem	4	*A. terreus* Thom	1,4
	A. terreus Thom	1,4	*A. nidulans* (Eidam) Winter	4
	Cladosporium sp.	1	*Cladosporium* sp.	1
	Curvularia clavata Jain	4	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	4
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	4	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4
	Rhizopus stolonifer (Ehrenb. ex Link) Lind	1	*Myrothecium cinctum* (Corda) Sacc.	1
50. *Sorghum bicolor* (L.) Moench. (Sorghum)	*Curvularia clavata* Jain	3	*Aspergillus flavus* Link ex Gray	3
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	3	*A. sulphureus* (Fres.) Thom. & Church	3
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3	*Curvularia clavata* Jain	3
	Macrophomina phaseolina (Tassi) Goid.	3	*Drechslera. australiensis* (Bugni) Subram. & Jain M.B.Ellis.	3
	Memnoniella echinata (Riv.) Galloway	3	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	3
			Macrophomina phaseolina (Tassi) Goid.	3
			Memnoniella echinata (Riv.) Galloway	3
			Unidentified white sterile mycelium	3
51. *Triticum aestivum* L. (Wheat)	*Alternaria alternata* (Fr.) Keissler	5,6	*Alternaria alternata* (Fr.) Keissler	6
	Chaetomium globosum Kunze ex. Staud.	5,6	*Aspergillus flavus* Link ex Gray	5,6
	Curvularia lunata (Wakker) Boedijn	6	*A. niger* van Tieghem	5,6

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis	5	*A. terreus* Thom	5
	Fusarium moniliforme Sheld.	6	*Chaetomium globosum* Kunze ex. Staud.	6
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	5,6	*Fusarium moniliforme* Sheld.	6
	Unidentified white sterile mycelium	5	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans.	5,6
			Penicillium rugulosum Thom	6
			Unidentified white sterile mycelium	5
52. *Zea mays* L. (CORN)	*Alternaria alternata* (Fr.) Keissler	2,6	*Alternaria alternata* (Fr.) Keissler	2,4,6
	Aspergillus flavus Link ex Gray	4	*Aspergillus flavus* Link ex Gray	1,2,4,6
	A. niger van Tieghem	2	*A. fumigatus* Fres.	1,2
	A. terreus Thom	2	*A. nidulans* (Eidam) Winter	1
	Cunninghamella echinulata (Thaxt.) Thaxt.	2	*A. sulphureus* (Fres.) Thom. & Church	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1,2,6	*A. terreus* Thom	2,4,6
	D. halodes (Drechslera) Subram. & Jain	6	*Cephalosporium* sp.	2,4
	Fusarium moniliforme Sheld.	6	*Chaetomium indicum* Corda	2
	F. oxysporum Schlecht. emend. Snyd. & Hans	4	*Curvularia lunata* (Wakker) Boedijn	4
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,4,6	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2
	Macrophomina phaseolina (Tassi) Goid.	1	*Fusarium moniliforme* Sheld.	2
	Rhizoctonia solani Kuhn	6	*F. oxysporum* Schlecht. emend. Snyd. & Hans	2,4
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2,4,6	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,4,6
			Macrophomina phaseolina (Tassi) Goid.	1
			Penicillium purpurogenum Stoll	1
			Rhizopus stolonifer (Ehrenb. ex Link) Lind.	4
			Stachybotry parvispora Hughes	6
			Unidentified yeast	1,4

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
MALVACEAE				
53. *Abelmoschus esculentus* (L.) Moench (Okra)	*Alternaria alternata* (Fr.) Keissler	8	*Alternaria alternata* (Fr.) Keissler	7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	7	*Aspergillus flavus* Link ex Gray	1,7,8
	Fusarium solani (Mart.) Appl & Wollenw. emend.Snyd. & Hans	1,7,8	*A. niger* van Tieghem	1,7,8
	Macrophomina phaseolina (Tassi) Goid.	1,7	*A.terreus* Thom	1,8
	Rhizoctonia solani Kuhn	1,7,8	*Drechslera australiensis* (Bugni) Subram. M.B.Ellis.	7
			Fusarium solani (Mart.)Appl & Wollenw. emend.Snyd. & Hans	1,7,8
54. *Abutilon indicum* (L.) Sweet (Monkey bush)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Aspergillus flavus Link ex Gray	2	*Aspergillus flavus* Link ex Gray	2
	A. niger van Tieghem	2	*A. nidulans* (Eidam) Winter	2
	A. terreus Thom	2	*A. niger* van Tieghem	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*A. terreus* Thom	2
	Rhizopus stolonifer (Ehrenb. ex Link) Lind.	2	*Cephalosporium* sp.	2
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
			Macrophomina phaseolina (Tassi) Goid.	2
55. *Gossypium arboreum* L. (Cotton)	*Alternaria alternata* (Fr.) Keissler	1,8	*Aspergillus flavus* Link ex Gray	1,8
	Chaetomium globosum Kunze ex. Staud.	1	*A. niger* van Tieghem	1,8
	Curvularia lunata (Wakker) Boedijn	1	*A. terreus* Thom	1,8
	Drechslera australiensis (Bugni) Subram.& Jain ex M.B. Ellis.	1	*Fusarium oxysporum* Schlecht emend. Snyd. & Hans	1
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,8
	Macrophomina phaseolina (Tassi) Goid	8	*Penicillium luteum* Zukal	1
	Rhizoctonia solani Kuhn	1,8	*Trichoderma viride* Pers. ex Gray	1
	Trichoderma viride Pers. ex Gray	1	Unidentified sterile fungus	2
			Unidentified yeast	1

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
PEDELIACEAE				
56. *Sesamum indicum* L. (SESAME)	*Aspergillus niger* van Tieghem	5	*Aspergillus candidus* Link	5
	Curvularia lunata (Wakker) Boedijn	1	*A.flavus* Link ex Gray	1
	Cunninghamella echinulata (Thaxt.) Thaxt	5	*A.nidulans* (Eidam) Winter	1
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	1	*A. niger* van Tieghem	5
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*A. sulphureus* (Fres.) Thom. & Church.	5
	Rhizoctonia solani Kuhn	1	*A. terreus* Thom	5
			Drechslera australiensis (Bugni) Subram. & Jain ex M.B.Ellis.	1
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
			Paecilomyces lilacinus (Thom.) Samson	5
			Penicillium purpurogenum Stoll	1
			Rhizoctonia solani Kuhn	1
			Unidentified white sterile mycelium	1,2
PIPERACEAE				
57. *Piper betel* L. (BETEL)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	2
	Chaetomium globosum Kunze ex. Staud	2	*Aspergillus flavus* Link ex Gray	2
	Curvularia lunata (Wakker) Boedijn	2	*A. niger* van Tieghem	2
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis.	2	*Chaetomium globosum* Kunze ex. Staud	2
	Fusarium moniliforme Sheld	2	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis.	2
	F .oxysporum Schlecht emend. Snyd & Hans.	2	*Fusarium moniiforme* Sheld	2
	F. semitectum Berk. & Rav.	2	*F. oxysporum* Schlecht emend. Snyd & Hans.	2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*F. semitectum* Berk. & Rav.	2
	Macrophomina phaseolina (Tassi) Goid.	2	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
	Rhizoctonia solani Kuhn	2		

TABLE 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
SOLANACEAE				
58. *Capsicum annuum* L. (PEPPER)	*Alternaria alternata* (Fr.) Keissler	1,2,6,7	*Alternaria alternata* (Fr.) Keissler	1,2,6,7
	Aspergillus flavus Link ex Gray	2	*Aspergillus flavus* Link ex Gray	2
	A. niger van Tieghem	1,2,6,7	*A. niger* van Tieghem	1,2,6,7
	A. nidulans (Eidam) Winter	1,2,6	*A. nidulans* (Eidam) Winter	1,2,6
	A. terreus Thom	2	*A. terreus* Thom	2
	Chaetomium indicum Corda	2	*Cephalosporium* sp.	2
	Curvularia clavata Jain	2	*Chaetomium indicum* Corda	2
	C. lunata (Wakker) Boedijn	7	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2	*Fusarium culmurum* (W.G. Sm.) Sacc.	2
	Fusarium culmurum (W.G. Sm.) Sacc.	2	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7
	F. oxysporum Schlecht emend. Snyd. & Hans	2,7	*Macrophomina phaseolina* (Tassi) Goid.	2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7	*Penicillium funiculosum* Thom	1
	Macrophomina phaseolina (Tassi) Goid.	1,2	*P. rugulosum* Thom	2,6
	Rhizoctonia solani Kuhn	1,2	*Trichoderma harzianum* Rifai	2
	Trichoderma viride Pers. ex Gray	6	Unidentified black sterile mycelium	1,2
	Unidentified black sterile mycelium	1,2		
59. *Capsicum annuum* L. var. *shimla* (PEPPER)	*Alternaria alternata* (Fr.) Keissler	2	*Alternaria alternata* (Fr.) Keissler	7
	Aspergillus niger van Tieghem	1,2,6	*Aspergillus flavus* Link ex Gray	1,2
	A. terreus Thom	1,2	*A. niger* van Tieghem	2,7
	Fusarium moniliforme Sheld.	1,2,7	*A. terreus* Thom	1,2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	2
	Trichoderma viride Pers. ex Gray	2	*Fusarium moniliforme* Sheld	2

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Unidentified scleotial fungus	1	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1,2,6,7
			Penicillium funiculosum Thom	1,7
			Trichoderma viride Pers. ex Gray	2
			Unidentified sclerotial fungus	1,2
60. *Lycopersicon esculentum* Mill. (Tomato)	*Alternaria alternata* (Fr.) Keissler	1,2,5	*Alternaria alternata* (Fr.) Keissler	1,5
	Aspergillus niger van Tieghem	1	*Aspergillus niger* van Tieghem	1
	Cladosporium sp.	1	*A. candidus* Link ex Link	1
	Curvularia lunata (Wakker) Boedijn	1,2	*A. flavus* Link ex Gray	1,2,5,7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	1	*A. niger* van Tieghem	1,2,5
	Fusarium moniliforme Sheld.	2	*A. terreus* Thom	1
	F.oxysporum Schlecht. emend. Snyd. & Hans.	1,2	*Cladosporium* sp.	1
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B. Ellis	1
	Humicola grisea Traaen	5	*Fusarium oxysporum* Schlecht emend.snyd.&Hans	1
	Macrophomina phaseolina (Tassi) Goid.	1	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	1
	Rhizoctonia solani Kuhn	1,2,5,7	*Macrophomina phaseolina* (Tassi) Goid.	1
	Unidentified sclerotial fungus	1,2	*Stachybotrys atra* Corda	1
			Unidentified sclerotial fungus	1,2
61. *Solanum melongena* L. (Egg plant)	*Alternaria alternata* (Fr.) Keissler	4	*Aspergillus flavus* Link ex Gray	1,2,4,6
	Aspergillus flavus Link ex Gray	4	*A. fumigatus* Fres.	1,4
	A. niger van Tieghem	4	*A.niger* van Tieghem	1,2,6
	A. terreus Thom	4	*A. terreus* Thom	4
	Fusarium oxysporum Schlecht. emend. Snyd. & Hans	1,2,6	*Fusarium oxysporum* Schlecht. emend. Snyd. & Hans	1,2
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4	*F. solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	4
			Macrophomina phaseolina (Tassi) Goid.	4

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	Macrophomina phaseolina (Tassi) Goid.	1,2,4,6	*Myrothecium roridum*	4
	Rhizoctonia solani Kuhn	1,2,4,6	*Rhizoctonia solani* Kuhn	1,2
	Verticillium chlamydosporium Goddard	1		
62. *Solanum nigrum* L. (Black Nightshade)	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B Ellis.	2	*Aspergillus flavus* Link ex Gray	2
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*A.niger* van Tieghem	2
	Rhizoctonia solani Kuhn	2	*Drechslera australiensis* (Bugni) Subram. & Jain ex M.B.Ellis.	2
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2
			Rhizoctonia solani Kuhn	2
63. *Solanum surrenttense* Burm. f.	*Aspergillus flavus* Link ex Gray	5	*Alternaria alternata* (Fr.) Keissler	5
	Fusarium oxysporum Schlecht, emend. Snyd. & Hans	5	*Aspergillus flavus* Link ex Gray	5
	F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5	*A. nidulans* (Eidam) Winter	5
	Macrophomina phaseolina (Tassi) Goid.	5	*A. niger* van Tieghem	5
			A. sulphureus (Fres.) Thom. & Church	5
			A. terreus Thom	5
			Chaetomium flavum Omvik	5
			Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	5
			Myrothecium roridum Tode	5
			Penicillium raistrickii Gilman & Abbott	5
UMBELLIFERAE				
64. *Coriandrum sativum* L. (Coriander)	*Aspergillus flavus* Link ex Gray	2	*Alternaria alternata* (Fr.) Keissler	7
	A. niger van Tieghem	2,7	*Aspergillus flavus* Link ex Gray	2
	Curvularia lunata (Wakker) Boedijn	2	*A. niger* van Tieghem	2,7
	Drechslera australiensis (Bugni) Subram. & Jain ex M.B. Ellis	2	*A. nidulans* (Eidan) Winter	2
			A. terreus Thom	2

Table 2. continued

No and Host	Rhizoplane	Location	Rhizosphere	Location
	D. halodes (Drechslera) Subram. & Jain ex M.B. Ellis.	7	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,7
	Fusarium solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2,7	*Macrophomina phaseolina* (Tassi) Goid.	2
	Macrophomina phaseolina (Tassi) Goid.	2	*Stachybotrys parvispora* Hughes	7
	Unidentified white sterile mycelium	7	Unidentified sclerotial fungus	2
65. *Daucus carota* L. ssp. *sativus* (Haffm.) Acrang (Carrot)	*Fusarium solani* (Mart.) Appel & Wollenw. emend. Snyd. & Hans	2	*Alternaria alternata* (Fr.) Keissler	2
			Aspergillus flavus Link ex Gray	2,6
			A. niger van Tieghem	2,6
			A. nidulans (Eidam) Winter	2
			A. terreus Thom	2
			Cladosporium sp.	2
			Fusarium semitectum Berk. & Rav.	6
			F. solani (Mart.) Appel & Wollenw. Emend. Snyd. & Hans	2
			F. oxysporum Schlecht. emend. Snyd. & Hans	2
			Macrophomina phaseolina (Tassi) Goid	6
			Stachybotrys atra Corda	5
			Unidentified sterile fungus	2
			Unidentified yeast	2

1 = Karachi University Campus, **2** = Memon Goth, **3** = Darsano Chano, **4** = Shah Faisal Colony, **5** = Hub, **6** = Kathor, **7** = Gharo, **8** = Thatta with additional roots until the total volume of soil and water become 20 mL, assumed to be 1:10 dilution. From this other dilutions 1:100, 1:1000, 1:10,000, 1:100,000 were made. One mL aliquot from each of the last two highest dilutions were poured in sterilized petri plate containing potato dextrose agar (PDA) incorporated with penicillin (100,000 units/L) and streptomycin (0.2 g/L) to check bacterial growth. Plates were incubated for 5 days at room temperature (25–30° C) under 12 hours light and dark conditions. Fungi that grew and sporulated on plates were identified with reference to Barnett and Hunter (1998), Dix and Webster (1995), Domsch et al. (1993) and Nelson et al. (1983). Special attention was paid towards the occurrence of root infecting and well known biocontrol agents like *Trichoderma*, *Paecoilomyces lilacinus*, *Verticillium chlamydosporium*. Fungi that did not show morphological characters were included as unidentified.

Isolation of Fungi from Rhizoplane

Roots were washed under running tap water. Tap and lateral roots were cut into 1 cm long pieces, washed with sterilized water and transferred onto PDA plates containing penicillin (100,000 units/L) and streptomycin (0.2 g/L). Plates were incubated for 5 days at 28° C. Fungi grown on plates were identified as described above.

RESULTS AND DISCUSSION

The ecological relationships between host, pathogen and population of soil microbes have been represented by a triangle of interactions (Subba Rao 1977). Root infection by a parasite must be affected and often decisively by the microbial activity of the root surface and rhizosphere microflora (Abawi & Widmer 2000; Boland & Kuykendall 1998; Filion et al. 2004; Manka & Kacprzak 1999; Marschner et al. 2002; Subba Rao 1977; Whipp 2001). In the present study, 57 species of fungi belonging to 23 genera were isolated and identified from rhizoplane and rhizosphere of 65 plant species (Table 2). These comprised 58 genera within 19 families collected from from Sindh and Baluchistan (Table 2). Most of the fungi isolated from rhizosphere and rhizoplane belonged to ascomycota and fungi imperfecti. Few genera belonged to zygomycotina and mycelia sterilia. Host plants are arranged under their families and associated fungi.

A greater number of fungi was isolated from the rhizosphere than from the rhizoplane. In rhizosphere, *Aspergillus flavus* and *A. niger* were predominant along with *Fusarium solani* (Table 2). Population of aspergilli like *A. flavus*, *A. niger* and *A. terrus* was high as compared to other fungal species (data not presented). It is interesting to note that *A. niger* was found in the rhizosphere of the all the members of families Cucurbitaceae, Fabaceae, Solanaceae and Umbliferae. Various studies have also reported the occurrence of greater number of fungal species in rhizosphere than in rhizoplane (Abawi & Widmer 2000; Curl & Truelove 1986; Dix & Webster 1995; Frey et al. 1999; McLean & Huhta 2002)). It has been shown that microbial population is stimulated in rhizosphere (Manka & Kacprzak 1999). Organic and inorganic substances exuded from roots and sloughed off root cells enhanced the microbial population in the region (Tate 1995). Microorganisms in agricultural soils are known to exert profound influences on the soil fertility status as well as on the suppression of soil-borne plant diseases (Kennedy & Smith 1995). In fact, the health of soil can be defined in terms of its microbiological capacity to counteract (suppress) the activity of plant pathogenic or plant deleterious microorganisms (Katan 2002; van Bruggen & Semenov 2000). It is well known that some soils are naturally suppressive to some soil-borne plant pathogens such as *Fusarium oxysporum*, *Pythium* and *Phytophthora* species and this suppression relates to both physicochemical and microbiological features of the soil (Whipps 1997; 2001). Importantly, a soil that is suppressive to one pathogen is not necessarily suppressive to another, and so specificity in soil-plant-microbe interactions for disease suppression exists (Filion et al. 2004; Katan 2002; Marschner et al. 2002; Shiomi et al. 1999). Modern methods for analyzing microbial community structures may prove particularly valuable to help define the key organisms or groups of organisms responsible for such natural suppression as well as for monitoring the spread and impact of introduction of specific biocontrol agents or other management practices on natural microbial populations (Gamo & Shoji 1999; Smit et al. 1999; Postma et al. 2000; Whipps 2001).

In the rhizoplane, root-infecting fungi like *Fusarium solani*, *Drechslera australiensis*, *Macrophomina phaseolina* and *Rhizoctonia solani* were found to be predominant. *Aspergillus flavus* and *A. niger*, *Alternaria alternata*, *Chaetomium globosum*, *Curvularia clavata* and *Fusarium oxysporum* showed an intermediate frequency while remaining isolates were found in low frequency (Fig. 1; Table 2). Among the species of *Aspergillus* encountered frequency of *Aspergillus flavus*, *A. niger* was higher than for other fungi except *F. solani*. This is presumably due to their high sporulating ability and tolerance for different physico-chemical conditions of soil (Domsch et al. 1993). It is interesting to note that *Fusarium solani* was found predominant in both the rhizosphere and rhizoplane of most of the plant species reflecting their high competence in both rhizosphere and rhizoplane of different plant species in different ecological conditions. Characteristics like resistant nature, tolerance to a wide range of moisture, pH and temperature, and parasitic as well as saprophytic mode of life make *F. solani* ubiquitous (Hussain et al. 1966). *Fusarium solani* produces many antibiotics and mycotoxins (Whipps 1997, 2001). *Fusarium solani* is also reported to possess cytotoxic effect on root knot nematode *Meloidogyne javanica*, besides parasitizing its eggs (Hameed et al. 2001). These characteristics play a significant role in its establishment in the rhizosphere and rhizoplane. *Chaetomium*

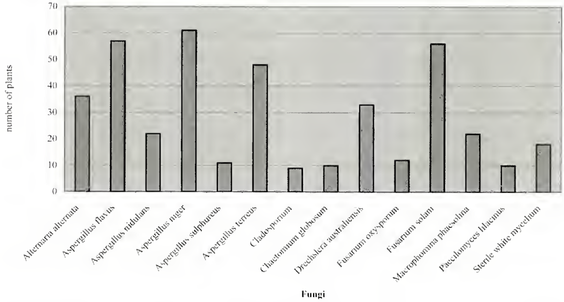


Fig. 1. Major fungi isolated from rhizosphere of 65 plants showing their incidence on hosts.

globosum, *C. indicum* and *Macrophomina phaseolina* had a moderate frequency while *Aspergillus fumigatus*, *A. nidulans*, *Fusarium moniliforme*, *F. oxysporum*, *F. semitectum*, *Penicillium* spp., showed low frequency (Table 2). *Penicillium* spp. are generally abundant in soil and are often among the readily isolated species (Qureshi & Khan 1971). There are reports that *Penicillium*, *Trichoderma*, and *Cladosporium* are most common genera associated with rhizosphere of resistant varieties of flex to *Fusarium* wilt, while *Alternaria*, *Cephalosporium*, *Fusarium*, *Helminthosporium* and *Verticillium* were relatively common in the rhizosphere of susceptible variety (Subba Rao 1977). Chesters and Parkinson (1959) reported that *Penicillium* spp. are abundant in the rhizosphere of very young roots while in older roots they are replaced by members of family Hypocreaceae (e.g. *Fusarium*) and family Dematiaceae (e.g. *Alternaria* and *Drechslera*). In this study six sterile mycelium and one ascomycetous fungi were not identified. Sterile mycelium did not produced reproductive structure on agar media. Might be they required special condition for reproduction. Oligonucleotide finger printing of rRNA genes for analysis of fungal community in soil (Valensky et al. 2002) would be helpful for their identification. It is interesting to note that, in general cultivated plants and common weeds of families Fabaceae and Compositae showed more fungi than wild plants. Presumably roots exudates of cultivated plants and common weeds are more attractive to microbes than exudates of wild plants.

In the present study well known biocontrol agents like *Trichoderma* spp., and *Paecilomyces lilacinus* were found in very low frequencies. Species of *Tri-*

choderma are known to produce antibiotics (Tate 1995; Domsch et al. 1993). Their fewer occurrences reflect their weak competence in the rhizosphere, presumably their sensitivity to metabolites of competeting microorganisms. There are reports that a bacterium with a high level of resistance to a range of antibiotics is more likely to be successful competitor in the rhizosphere than a bacterium producing large quantities of highly active antibiotics but has a marked sensitivity to even a single antibiotic molecules (Bazin et al. 1990). Multiple microbial interactions involving bacteria and fungi in the rhizosphere are shown to provide enhanced biocontrol in many cases in comparison with biocontrol agents used singly (Boland & Kuykendall 1998; Whipps 1997, 2000). A wide range of fungi with antagonistic activity against root pathogens are discovered each year. However, ecological success of the antagonist on the plant roots is governed by its ability to colonize and utilize substrates on plant root surface, allowing it to compete effectively with pathogens and other competitive microorganisms. Otherwise the success of a biocontrol agent with poor rhizosphere competence seems very remote.

ACKNOWLEDGMENTS

This work was carried out under a research grant from the Pakistan Science Foundation, Islamabad, Pakistan. We are thankful to William Campbell, Utah State University, Logan, Utah; M. A. Bari Mallik, Langston University, Langston, Oklahoma and Riaz Ahmad, University of Central Oklahoma, Edmond, Oklahoma for their critical comments and helpful suggestions on the manuscript.

REFERENCES

Abawi, G.S. and T.L. Widmer. 2000. Impact of soil health management practices on soilborne pathogens, nematodes and root diseases of vegetable crops. Appl. Soil Ecol. 15:37–47.

Atkinson, D. and C.A. Watson. 2000. The beneficial rhizosphere: a dynamic study. Appl. Soil. Ecol. 15:99–104.

Barnett, H.L. and B.B. Hunter. 1998. Illustrated genera of imperfect fungi. 4th ed. APS Press, St. Paul, MN.

Bazin, M.J., P. Markham, E.M. Scott, and J.M. Lynch. 1990. Population dynamics and rhizosphere interaction. In: J.M. Lynch, ed. The rhizosphere. John Wiley & Sons, Inc., New York. Pp. 99–127.

Boland, G.J. and L.D. Kuykendall (eds.). 1998. Plant-microbe interactions and biological control. Marcel Dekker, New York, NY.

Burges, H.D. (ed.). 1998. Formulation of microbial pesticides. Kluwer Acad. Publishers, Boston, MA.

Chesters, C.G.C. and D. Parkinson. 1959. On the distribution of fungi in the rhizosphere of oats. Pl. & Soil 11:145–156.

Curl, E.A. 1982. The rhizosphere: relation to pathogen behavior and root disease. Plant Dis. 66:624–630.

Curl, E.A. and B. Truelove. 1986. The rhizosphere. Springer-Verlag, Berlin.

Dix, N.J. and J. Webster. 1995. Fungal ecology. Chapman and Hall, London.

Domsch, K.H., W. Gams and T-H. Anderson. 1993. Compendium of soil fungi. Vol. 1, IHW, Eching.

Filion, M., R.C. Hamelin, L. Bernier, and M. St-Arnaud. 2004. Molecular profiling of rhizosphere microbial communities associated with healthy and diseased black spruce *(Picea mariana)* seedlings grown in nursery. Appl. Envir. Microbiol. 70:3541–3551.

Frey, S.D., E.T. Eliott, and K. Paustian. 1999. Bacterial and fungal abundance and biomass in conventional and no-tillage agro-ecosystems along two climatic gradients. Soil Biol. Biochem. 31:573–585.

Gamo, M. and T. Shoji. 1999. A method of profiling microbial communities based on a most-probable-number assay that uses BIOLOG plates and multiple sole carbon sources. Appl. Envir. Microbiol. 65:4419–4424.

Halleen, F., P.W. Crous, and O. Petrini. 2003. Fungi associated with healthy grapevine cuttings in nurseries, with special reference to pathogens involved in the decline of young vines. Austral. Pl. Path. 32:47–52.

Hameed, S., R. Riaz, V. Sultana, S. Ehteshamul-Haque, and J. Ara. 2001. Variation in nematicidal activity of *Fusarium solani* (Mart.) Appel and Wollenw emend. Snyd and Hans strains. Pak. J. Biol. Sci. 4:423–425.

Hussain, S.S., S.M. Hassany and S.I. Ahmed. 1966. A study of fungus flora of Karachi soils. Pak. J. Sci. Ind. Res. 9:265–268.

Katan, J. 2002. Interactions of soil borne pathogens with roots and above ground plant organs. In: Y. Waisel, A. Eshel and U. Kafkafi, eds. Plant roots: the hidden half. Marcel Dekker, New York.

Kennedy, A.C. and K.L. Smith. 1995. Soil microbial diversity and the sustainability of agricultural soils. Pl. Soil 170:75–86

Lewis, J.A., R.P. Larkin, and D.L. Rogers. 1998. A formulation of *Trichoderma* and *Gliocladium* to reduce damping-off caused by *Rhizoctonia solani* and saprophytic growth of the pathogen in soilless mix. Plant Dis. 85:501–506.

Manka, M and M. Kacprzak. 1999. Evaluation of rhizoshere biocontrol agent efficacy and communities of rhizosphere fungi. Bull. Pol. Acad. Sci., Biol. Sci. 47:105–112.

Marschner, P., W. Marino, and R. Lieberei. 2002. Seasonal effects on microorganisms in the rhizosphere of two tropical plants in apolyculture agroforestry system in central Amazonia, Brazil. Biol. Fertil. Soils 35:68–71.

McLean, M. and V. Huhta 2002. Microfungal community structure in anthropogenic birch stands in central Finland. Biol Fertil. Soils 35:1–12.

Nelson, P.E., T.A. Toussoum, and W.F.O. Marasas. 1983. *Fusarium* species. An illustrated manual for identification. The Pennsylvania State University Press, University Park.

Postama, J. and A.J.G. Luttikholt. 2000. Effect of the indigenous microflora on the development of root and crown rot caused by *Pythium aphanidermatum* in cucumber grown on rookwool. Phytopath. 90:125–133.

Qureshi, M.A. and A.S. Khan. 1971. Fungi from the rhizosphere of *Pinus roxburghii* Sarg. Pak. J. Forest. 21:75–384.

Reyes, A.A. and J.E. Mitchell. 1962. Growth response of several isolates of *Fusarium* in rhizosphere of host and non-host plants. Phytopathology 52:1196–1200.

Shiomi, Y., M. Nishiyama, T. Onizuka, and T. Marumoto. 1999. Comparison of bacterial community structures in rhizoplane of tomato plants grown in soils suppressive and conducive towards bacterial wilt. Appl. Envir. Biol. 65:3996–4001.

Smit, E., P. Leeflang, B. Glandorf, J.D. van Elsas, and K. Wernars 1999. Analysis of fungal diversity in the wheat rhizosphere by sequencing of cloned PCR-amplified genes encoding 18S rRNA and temperature gradient gel electrophoresis. Appl. Environm. Microbiol. 65:2614–2621.

Subba Rao, N.S. 1977. Soil microorganisms and plant growth. Oxford and IBH Publishing Co., New Delhi.

Tate, R.L. 1995. Soil microbiology. John Wiley & Sons Inc., New York.

Valensky, L., G.D. Vedova, T. Jiang, and J. Borneman. 2002. Oligonucleotide fingerprinting of rRNA genes for analysis of fungal community composition. Appl. Environm. Microbiol. 68:5999–6004.

van Bruggen, A.H.C. and A.M. Semenov. 2000. In search of biological indicators for soil health and disease suppression. Appl. Soil Ecol. 15:13–24.

van Elsas, J.D., P. Garbeva, and J. Salles. 2002. Effect of agronomical measures on the microbial diversity of soils as related to the suppression of soil-borne plant pathogens. Biodegradation 13:29–40.

Whipps, J.M. 1997. Interactions between fungi and plant pathogens in soil and the rhizosphere. In: A.C. Gange and V.K. Brown, eds. Multitrophic interactions in terrestrial systems. Blackwell Science, Oxford. Pp. 47–63.

Whipps, J.M. 2001. Microbial interactions and biocontrol in the rhizosphere. J. Expt. Bot. 52:487–511.

THE FLORISTIC ECOLOGY OF XERIC LIMESTONE PRAIRIES IN KENTUCKY, AND A COMPARISON TO LIMESTONE CEDAR GLADES AND DEEP-SOIL BARRENS

P.J. Lawless
Department of Biology
University of Kentucky
Lexington, Kentucky 40506, U.S.A.

J.M. Baskin
Department of Biology
University of Kentucky
Lexington, Kentucky 40506, U.S.A.

C.C. Baskin
Department of Biology
University of Kentucky
Lexington, Kentucky 40506, U.S.A.
and
Department of Agronomy
University of Kentucky
Lexington, Kentucky 40546, U.S.A.

ABSTRACT

The flora of 18 xeric limestone prairies in the Interior Low Plateaus physiographic province in Kentucky was surveyed and a checklist of vascular plants prepared for each site. Nine of the 18 sites are in the Knobstone Escarpment and Knobs, four in the Mammoth Cave Plateau, two in the Pennyroyal Plain and three in the Outer Blue Grass. Life form, photosynthetic pathway, geographic affinity, conservation status and presence were determined for each taxon. Community coefficients were calculated from site floristic lists, and the physiography, geology and soils associated with each site were documented. The flora of xeric limestone prairies in Kentucky was compared to that of limestone cedar glades of the southeastern United States and of deep-soil barrens of the southwestern Pennyroyal Plain in Kentucky and Tennessee. Three hundred and thirty-five taxa were identified in this plant community type, of which 20 are nonnative and 24 state-listed. Families with the highest number of taxa were Asteraceae (70), Poaceae (32) and Fabaceae (29); genera with the highest number of taxa were *Symphyotrichum* (15), *Panicum* sensu lato (=*Panicum* + *Dichanthelium*) (10), *Carex* (7), *Solidago* (7) and *Hypericum* (6). Intraneous C_3 hemicryptophytes make up the majority of the flora. Community coefficients indicate high similarity among all sites except those in the eastern outer Blue Grass, which belong to a second association or community type. Endemic species, a higher percentage of therophytes (i.e. annuals, especially winter annuals) and a higher number of taxa with western and northwestern geographic affinities distinguish the limestone cedar glade flora from those of xeric limestone prairies and deep-soil barrens.

RESUMEN

La flora de 18 praderas calcáreas xéricas en la provincia fisiográfica Interior Low Plateaus en Kentucky fue estudiada y se preparó un catálogo de plantas vasculares en cada lugar. Nueve de los 18 puntos están en el Knobstone Escarpment y Knobs, cuatro en el Mammoth Cave Plateau, dos en la Pennyroyal Plain, y tries en el Outer Blue Grass. Se determinó el tipo biológico, ruta fotosintética, afinidad geográfica, estado de conservación y presencia de cada taxon. Se calcularon los coeficientes de comunidad a partir de las listas florísticas del punto, y se documentó la fisiografía, geología y suelos asociados con cada punto. La flora de las praderas calcáreas xéricas en Kentucky se compara con la de los claros calcáreos de cedro del Sureste de los Estados Unidos y con la de los eriales de suelos profundos del Suroeste de la Pennyroyal Plain en Kentucky y Tennessee. Se identificaron trescientos treinta y cinco taxa en este tipo de comunidad vegetal, de los que 20 no son nativos y 24 están listados en el estado. Las familias con el mayor número de taxa fueron Asteraceae (70), Poaceae

---

SIDA 21(2): 1055–1079. 2004

(32) y Fabaceae (29), los géneros con el mayor número de taxa fueron *Symphyotrichum* (15), *Panicum* sensu lato (=*Panicum* + *Dichanthelium*) (10), *Carex* (7), *Solidago* (7) e *Hypericum* (6). Los hemicriptófitos C_3 característicos de la comunidad forman la mayor parte de la flora. Los coeficientes de comunidad indican alta similitud entre todos los puntos excepto los de Northeastern Blue Grass, que pertenecen a una segunda asociación o tipo de comunidad. Las especies endémicas, un alto porcentaje de terófitos (ej. anuales, especialmente anuales de invierno) y un alto número de taxa con afinidades geográficas occidentales y noroccidentales diferencian la flora de los claros calcáreos de cedro de la de las praderas calcáreas xéricas y eriales de suelos profundos

INTRODUCTION

Xeric limestone prairies are characterized by high cover of C_4 perennial grasses (*Schizachyrium scoparium*, *Andropogon gerardii*, *Sorghastrum nutans* and *Bouteloua curtipendula*), moderate to steep slopes with south to west aspects and shallow rocky soils derived from calcareous substrates (Baskin & Baskin 2000). In Kentucky, these herbaceous plant communities occur in the western mesophytic forest region (sensu Braun 1950) and are rare at the landscape scale. The flora of xeric limestone prairies in Kentucky has not been adequately characterized, and the soils, geology and physiography associated with this community type have not been documented systematically. Thus, the primary objectives of the present study were to: 1) provide a checklist of vascular plants in xeric limestone prairies in Kentucky based upon field work conducted by the first author; 2) determine the geographic relationships, life forms and photosynthetic pathways of the constituent taxa; and 3) document the soils, geology and physiography associated with xeric limestone prairies in Kentucky. A fourth objective was to further compare xeric limestone prairies to limestone cedar glades and deep-soil barrens, both of which also are developed on calcareous substrates and occur in the western mesophytic forest region.

In their comparison of xeric limestone prairies, limestone cedar glades and deep-soil barrens in the Kentucky Karst Plain and adjacent areas, Baskin et al. (1994) focused primarily on vegetation, edaphic characteristics and origins. Like xeric limestone prairies, deep-soil barrens are characterized by high cover of C_4 perennial grasses (*Schizachyrium scoparium*, *Andropogon gerardii* and *Sorghastrum nutans*). However, deep-soil barrens originated from periodic burning by Native Americans prior to European settlement, whereas xeric limestone prairies resulted from clearing of land for agricultural purposes, overgrazing and subsequent soil erosion (Baskin et al. 1994). Conversely, limestone cedar glades are an edaphic climax community and typically have high cover of the C_4 summer annual grass *Sporobolus vaginiflorus* (Baskin & Baskin 1999).

Baskin and Baskin (2003) published the flora of limestone cedar glades of the southeastern United States, and Chester et al. (1997) published the flora of deep-soil barrens in the southwestern Pennyroyal Plain of Kentucky and Tennessee. By providing a flora of xeric limestone prairies in Kentucky, the current study affords the opportunity for floristic comparisons among these three herb-dominated community types. Comparative data on species richness, geographic affinities, photosynthetic pathways, life form and taxonomic distribution of the three respective floras are essential for accurate characterization of these community types and will provide further insight into their ecological differences.

SITE CHARACTERISTICS

A site was defined as a single forest opening (Fig. 1), many of which contained small patches of woody vegetation. In two sample areas (Crooked Creek Barrens and Fort Knox Military Reservation), two forest openings occurred on the same land parcel. However, in both of these properties the two openings are separated by at least 100 m, and thus each opening was considered a site. An attempt was made to determine the exact area of each site using GIS software. However, the large perimeter to area ratios and patches of woody vegetation in many sites prevented accurate measurement. In general, sample sites ranged from less than 0.5 to approximately 2.25 hectares. Site characteristics are summarized in Table 1.

Physiography

In Kentucky, xeric limestone prairies occur in the Blue Grass, Shawnee and Highland Rim sections of the Interior Low Plateaus physiographic province (sensu Quarterman & Powell 1978) (Fig. 2). The Knobstone Escarpment and Knobs subsection of the Blue Grass supports the largest number of xeric limestone prairies in the state, containing nine of the 18 sites surveyed in this study. The relatively high number of xeric limestone prairies in this area is most likely due to the rugged terrain in the region, since moderate to steep slopes with fine-textured soils are particularly susceptible to soil erosion. Xeric limestone prairies also occur in the western (Pine Creek Barrens) and eastern (Crooked Creek Barrens 1 and 2) Outer Blue Grass. In the Shawnee Hills section, all four sample sites (Grayson County Barren, Knight's Barren, Lapland Barrens and Lapland Road Barrens) are located in the Mammoth Cave Plateau. Logan County Glade and Logan County Barrens also are shown in the Mammoth Cave Plateau on the map of Quarterman and Powell map (Fig. 1, page 30). However, we consider them to be in the Pennyroyal Plain subsection of the Highland Rim, which is in agreement with Fenneman (1938, Figure 123, page 436) and an unpublished map of the Pennyroyal Plain by Baskin and Baskin.

Geology

The xeric limestone prairies in Kentucky occur on Upper Silurian and Upper Mississippian calcareous substrates including limestone, dolomite and shale (Fig. 3). The sample sites in the Knobstone Escarpment and Knobs, Mammoth Cave Plateau and Pennyroyal Plain all occur on Upper Mississippian limestones, many of which also contain shale and/or dolomite. All nine xeric limestone prairies surveyed in the Knobstone Escarpment and Knobs are developed on

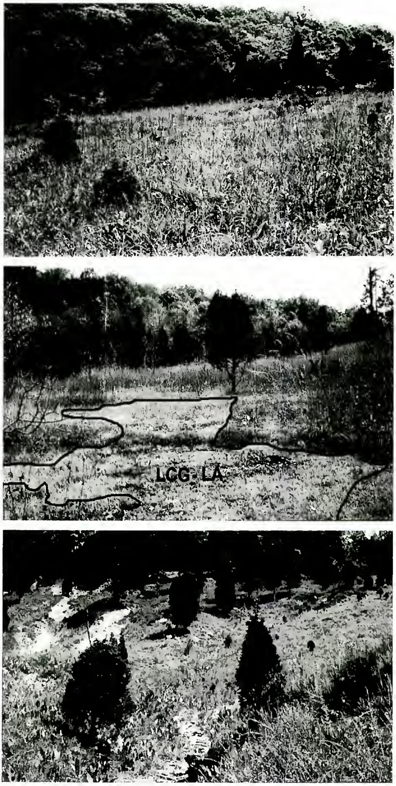


Fig. 1. Three xeric limestone prairies in the Interior Low Plateaus physiographic province in Kentucky. Top, Scudder Glade State Nature Preserve, Hardin County (photo by Carol Baskin, August 1980); middle, Pine Creek Barrens (The Nature Conservancy), Bullitt County (photo by Patrick Lawless, October 2003), XLP = xeric limestone prairie and LCG-LA = limestone cedar glade-like area, ; bottom, Crooked Creek Barrens State Nature Preserve, Lewis County (photo by Patrick Lawless, May 2002).

Fig. 2. Locations of sample sites in the Interior Low Plateaus physiographic province (map from Quarterman & Powell 1978). Subsections of Highland Rim Section: **H1**=Eastern Highland Rim, **H2**=Southern Highland Rim, **H3**=Western Highland Rim, **H4**=Southwestern Highland Rim, **H5**=Little Mountain, **H6**=Moulton Valley, **H7**=Pennyroyal Plain, **H8**=Elizabethtown [Plain], **H9**=Mitchell Plain, **H10**=Greensburg Upland, **H11**=Cumberland Enclave, **H12**=Norman Upland. Subsections of Central Basin Section: **C1**=Cumberland River Basin, **C2**=Harpeth River Basin, **C3**=Duck River Basin, **C4**=Elk River Basin. Subsections of Blue Grass Section: **B1**=Knobstone Escarpment and Knobs, **B2**=Northeastern Blue Grass, **B3**=Outer Blue Grass, **B4**=Eden Shale Belt, **B5**=Inner Blue Grass. Subsections of Shawnee Hills Section: **S1**=Mammoth Cave Plateau, **S2**=Marion [Area], **S3**=Illinois Ozarks, **S4**=Ohio River Hills & Lowlands, **S5**=Brush Creek Hills.

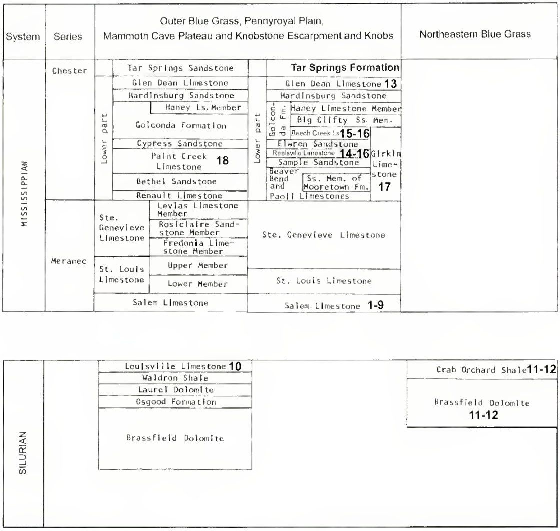

System
Series
Outer Blue Grass, Pennyroyal Plain, Mammoth Cave Plateau and Knobstone Escarpment and Knobs
Northeastern Blue Grass
MISSISSIPPIAN
Chester
Tar Springs Sandstone
Lower part
Glen Dean Limestone
Hardinsburg Sandstone
Haney Ls. Member
Golconda Formation
Cypress Sandstone
Paint Creek Limestone 18
Bethel Sandstone
Renault Limestone
Tar Springs Formation
Lower part
Glen Dean Limestone 13
Hardinsburg Sandstone
Golconda Fm.
Haney Limestone Member
Big Clifty Ss. Mem.
Beech Creek Ls 15-16
Elwren Sandstone
Reelsville Limestone 14-16
Sample Sandstone
Beaver Bend and Paoli Limestones
Ss. Mem. of Mooretown Fm.
Girkin Limestone 17
Meramec
Ste. Genevieve Limestone
Levias Limestone Member
Rosiclaire Sandstone Member
Fredonia Limestone Member
Ste. Genevieve Limestone
St. Louis Limestone
Upper Member
Lower Member
St. Louis Limestone
Salem Limestone
Salem Limestone 1-9
SILURIAN
Louisville Limestone 10
Waldron Shale
Laurel Dolomite
Osgood Formation
Brassfield Dolomite
Crab Orchard Shale 11-12
Brassfield Dolomite 11-12

Fig. 3. Bedrock geology of xeric limestone prairies in the Outer Blue Grass (western and eastern), Pennyroyal Plain, Mammoth Cave Plateau, and Knobstone Escarpment and Knobs subsections of the Interior Low Plateaus physiographic province in Kentucky (from McDowell 1981). Numbers refer to site numbers in Table 1. The break between Upper Mississippian and Upper Silurian is for the Upper Devonian upon which xeric limestone prairies do not occur in Kentucky.

Salem Limestone, of the Meramecian Series (Keperfele 1966, 1967; Peterson 1966). Keperfele (1967) defines two main units within the Salem Limestone and describes the second unit in association with characteristic surface and vegetation features of xeric limestone prairies as follows: "an argillaceous limestone and shale" with a "surface marked by rounded gullied slopes barren except for scattered junipers."

All sample sites in the Mammoth Cave Plateau and Pennyroyal Plain occur on Upper Mississippian limestones of the Chesterian Series, many of which contain a significant shale component. Three of the four xeric limestone prairies in the Mammoth Cave Plateau (Lapland Road Barrens, Lapland Barrens and Knight's Barren) are on Reelsville Limestone, and two of the three sites (Lapland

TABLE 1. Site characteristics of 18 xeric limestone prairies surveyed in the Interior Low Plateaus physiographic province in Kentucky.

	Site	County	Physiographic Subsection of Interior Low Plateaus	Ownership	Soil Order(s)	Geologic Formation(s) (System)	Site Richness
1	Fort Knox Military Reservation 1	Hardin	Knobstone Esc. & Knobs	Dept of Defense	Alfisols, Mollisols	Salem Limestone (UM)	99
2	Fort Knox Military Reservation 2	Hardin	Knobstone Esc. & Knobs	Dept of Defense	Alfisols	Salem Limestone (UM)	126
3	Cedar Creek Farms	Hardin	Knobstone Esc. & Knobs	Private	Alfisols	Salem Limestone (UM)	123
4	Scudder Glade	Hardin	Knobstone Esc. & Knobs	KSNPC	Alfisols	Salem Limestone (UM)	125
5	Hardin Co. Cedar Glade	Hardin	Knobstone Esc. & Knobs	Private*	Alfisols	Salem Limestone (UM)	99
6	Muldraugh's Barren	Hardin	Knobstone Esc. & Knobs	Private	Alfisols	Salem Limestone (UM)	93
7	Mixed Grass Barrens	Larue	Knobstone Esc. & Knobs	Private	Alfisols	Salem Limestone (UM)	104
8	Spalding Glade	Larue	Knobstone Esc. & Knobs	KSNPC,Private **	Alfisols, Inceptisols	Salem Limestone (UM)	129
9	Thompson Creek Glade	Larue	Knobstone Esc. & Knobs	KSNPC	Alfisols	Salem Limestone (UM)	88
10	Pine Creek Barrens	Bullitt	Outer Blue Grass	TNC	Alfisols	Louisville Limestone (US)	151
11	Crooked Creek Barrens 1	Lewis	Outer Blue Grass	KSNPC	Alfisols	Upper Part of Crab Orchard (US), Lower Part of Crab Orchard (US) and Brassfield (US)	121
12	Crooked Creek Barrens 2	Lewis	Outer Blue Grass	KSNPC	Alfisols	Upper Part of Crab Orchard (US), Lower Part of Crab Orchard (US) and Brassfield (US)	114

Table 1. continued

	Site	County	Physiographic Subsection of Interior Low Plateaus	Ownership	Soil Order(s)	Geologic Formation(s) (System)	Site Richness
13	Grayson Co. Barren	Grayson	Mammoth Cave Plateau	Private	Alfisols	Glen Dean Limestone (UM)	117
14	Knight's Barren	Hardin	Mammoth Cave Plateau	Private*	Alfisols	Reelsville Limestone (UM)	95
15	Lapland Barrens	Meade	Mammoth Cave Plateau	Private*	Alfisols, Ultisols	Reelsville Limestone (UM), Beech Creek Limestone (UM)	108
16	Lapland Road Barrens	Meade	Mammoth Cave Plateau	Private	Alfisols	Reelsville Limestone (UM), Beech Creek Limestone (UM)	104
17	Logan Co. Glade	Logan	Pennyroyal Plain	KSNPC	Alfisols	Girkin Limestone (UM)	131
18	Logan Co. Barrens	Logan	Pennyroyal Plain	Private	Alfisols	Paint Creek Limestone (UM)	98

Ownership: KSNPC = Kentucky State Nature Preserves Commission **TNC** = The Nature Conservancy - Kentucky Chapter
*Under management agreement with The Nature Conservancy **Portion of site owned by KSNPC, remainder under private ownership
Geologic System: UM = Upper Mississippian, US = Upper Silurian

Road Barrens and Lapland Barrens) extend onto Beech Creek Limestone (Amos 1972; Moore 1965). The fourth site in the Mammoth Cave Plateau (Grayson County Barren) is restricted to Glen Dean Limestone (Gildersleeve 1978). The two sites in the Pennyroyal Plain are developed on Paint Creek Limestone (Logan County Barrens) and Girkin Limestone (Logan County Glade) (Miller 1968; Rainey 1965).

The single sample site in the western Outer Blue Grass (Pine Creek Barrens) is on Louisville Limestone (Upper Silurian), which is composed of dolomite and dolomitic limestone (Keperfele 1968). The two xeric limestone prairies in the eastern Outer Blue Grass (Crooked Creek Barrens 1 and 2) are formed on the Upper Part of the Crab Orchard formation, a variegated clay-shale, and the Lower Part of the Crab Orchard and Brassfield formations (undivided, Upper Silurian), which is composed of dolomite, dolomitic limestone and interbedded clay-shale (Peck & Pierce 1966).

Soils

Soils of xeric limestone prairies in Kentucky have mixed mineralogy, are fine-textured (Table 2), moderately to severely eroded and shallow to moderately deep (0 to ca. 1 m, Baskin et al. 1994). Forty-two percent of 376 soil depth measurements in the 18 sites were $\leq$ 10 cm, 76% $\leq$ 30 cm, 91% $\leq$ 60 cm, and only 6% $>$ 1 m (Lawless, unpublished). Ten of the 13 soil series upon which xeric limestone prairies occur are Alfisols, and the remaining three series are Mollisols (Corydon), Ultisols (Gilpin) and Inceptisols (Garmon). Nine of the 18 sample sites are developed on the Caneyville series, a Typic Hapludalf (Fig. 4). In addition, many of the soil mapping units in xeric limestone prairies are rock outcrop complexes (e.g. Caneyville-Rock Outcrop Complex, Rock Outcrop-Corydon Complex and Rock Outcrop-Fredonia-Colbert Complex). All soil mapping units associated with sample sites in the Knobstone Escarpment and Knobs are members of the Garmon-Caneyville-Lenberg Soil Association, which in this region also includes the Corydon, Cumberland, Hagerstown and Vertrees series (Arms et al. 1979). Three of the four sites in the Mammoth Cave Plateau (Grayson County Barren, Lapland Road Barrens and Knight's Barrens) occur on the Caneyville series (Arms et al. 1979; Haagen 2001; Whitaker et al. 1972), and the fourth (Lapland Barrens) is the only site on the Rosine-Gilpin-Lenberg complex (Haagen 2001). Both sites in the Pennyroyal Plain (Logan County Barrens and Logan County Glade) are restricted to the Rock Outcrop-Fredonia-Colbert complex (Dye et al. 1975). The sample sites in the Outer Blue Grass occur on the Caneyville series (Pine Creek Barrens) (Whitaker & Waters 1986) and Beasley and Shrouts series (Crooked Creek Barrens 1 and 2) (USDA, NRCS, Soil survey of Lewis County, Kentucky. unpublished).

METHODS

In 2002 and 2003, each of 18 sites was visited a minimum of once per season in spring, summer and autumn. All vascular plant species were recorded and a

TABLE 2. Series, family, and great group of soils in the 18 xeric limestone prairies sampled in Kentucky. For site identification, see Table 1.

Soil Series	Family	Great Group	Site(s)
Beasley	Fine, mixed, active, mesic	Typic Hapludalfs	11, 12
Caneyville	Fine, mixed, active, mesic	Typic Hapludalfs	2, 3, 7, 8, 9, 10, 13, 14, 16
Colbert	Fine, smectitic, thermic	Vertic Hapludalfs	17, 18
Corydon	Clayey, mixed, superactive, mesic	Lithic Argiudolls	1, 5
Cumberland	Fine, mixed, semi-active, thermic	Rhodic Paleudalfs	6
Fredonia	Fine, mixed, active, mesic	Typic Hapludalfs	17, 18
Garmon	Fine-loamy, mixed, semi-active, mesic	Dystric Eutrudepts	8
Gilpin	Fine-loamy, mixed, active, mesic	Typic Hapludults	15
Hagerstown	Fine, mixed, semi-active, mesic	Typic Hapludalfs	3
Lenberg	Fine, mixed, semi-active, mesic	Ultic Hapludalfs	15
Rosine	Fine-silty, mixed, semi-active, mesic	Ultic Hapludalfs	15
Shrouts	Fine, mixed, mesic	Typic Hapludalfs	11, 12
Vertrees	Fine, mixed, semi-active mesic	Typic Paleudalfs	2,4, 6

species list prepared for each site. Gleason and Cronquist (1991) was used for field identification, and taxa not identified in the field were collected and determined in the University of Kentucky Herbarium (KY) with the aid of a stereomicroscope. Each taxon was assigned a presence value based on the percentage of sites in which it was recorded and placed in one of the following five presence classes (Cain & Castro 1959): 1 (1–20%), 2 (21–40%), 3 (41–60%), 4 (61–80%) and 5 (81–100%) . *Sporobolus vaginiflorus* was treated as a single taxon, since the two varieties found in this study are primarily distinguished by microscopic characters in both vegetative and reproductive states (FNEC 2003). Community coefficients (CC) were calculated for all possible pair-wise site comparisons using PC-ORD (McCune and Mefford 1999). Community coefficients [CC= 2W/(A+B)] are based on the number of taxa shared between sample sites (W) and the total number of taxa in site A and in site B. The life form (sensu Raunkiaer 1934) of each taxon was obtained from Gibson (1961), Hansen (1952), Ennis (1928) and Baskin and Baskin (1978) and the photosynthetic pathway from Baskin and Baskin (2003) and Waller and Lewis (1978). Life form and photosynthetic pathway also were determined for each of the 342 taxa reported by Chester et al. (1997) in the deep-soil barrens of the southwestern Pennyroyal Plain of Kentucky and Tennessee for comparisons with the floras of xeric limestone prairies in Kentucky and limestone cedar glades of the southeastern United States (Baskin & Baskin 1999). We reviewed the list of state endangered, threatened and special concern species published by the Kentucky State Nature Preserves Commission (2002) and noted all state-listed taxa occurring in the xeric limestone prairies of Kentucky.

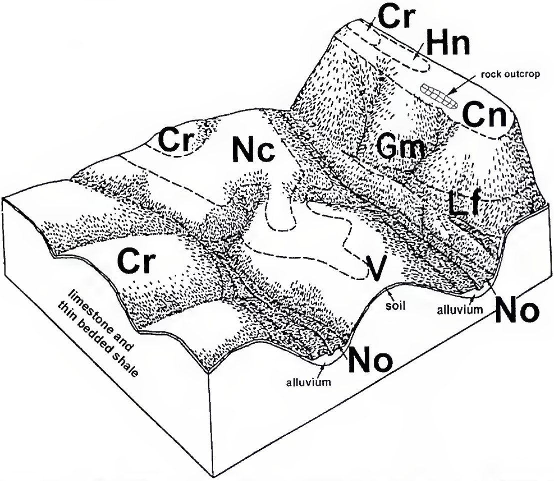


FIG. 4. A block diagram of the topography and soil series in the Knobs and Knobstone Escarpment section of the Interior Low Plateaus physiographic province in Hardin and Larue counties Kentucky. Soil series: **Cn**=Caneyville, **Cr**=Crider, **Gm**=Garmon, **Hn**=Hagerstown, **Lf**=Lenberg-Frondorf, **No**=Nolin-Newark-Melvin, **V**=Vertrees.

The geographic relationships of all taxa were determined by examining distribution maps obtained from Plants (USDA, NRCS 2004). Taxa in which Kentucky is in the central region of their current distribution were defined as intraneous, and those in which Kentucky is at the edge of their current distribution were defined as extraneous. When considering the geographic relationships of taxa in which Kentucky is near the edge of their range, the conservation status or rank and/or county distribution in the adjacent state was (were) considered, if available. If Kentucky is near the edge of the taxon's current distribution and the taxon is listed (endangered, threatened or special concern) in the adjacent state or only distributed in counties adjacent to the Kentucky border, the taxon was considered extraneous. The extraneous species were divided further into extraneous northern, southern, eastern and western groups in accordance with the position of Kentucky in relation to the center of distribution of the taxon of interest.

RESULTS

A total of 335 vascular plant taxa representing 333 species, 215 genera and 72 families were recorded in the 18 xeric limestone prairies surveyed (Appendix). The genera *Crataegus* and *Rubus* were each treated as a single taxon, because no flowering individuals were observed in either genus, both of which are characterized by intergradation of vegetative characters between/among species and high taxonomic diversity. Three hundred and fifteen (94.0%) of the 335 taxa are native to Kentucky, and the remaining 20 (6.0%) nonnative (Fig. 5). Asteraceae, Poaceae and Fabaceae had the highest richness values of all families, containing 70 (20.9%), 32 (9.6%) and 29 (8.7%) taxa, respectively. Genera with the largest number of taxa were *Symphyotrichum* (15), *Panicum* sensu lato (=*Panicum* + *Dichanthelium*) (10), *Carex* (7), *Solidago* (6) and *Hypericum* (6). The xeric limestone prairies in Kentucky support 24 state-listed taxa (9 endangered, 8 threatened and 7 special concern), including three species (*Delphinium carolinianum* ssp. *calciphilum*, *Leavenworthia exigua* var. *laciniata* and *Talinum calcaricum*) listed by Baskin and Baskin (1999) as cedar glade endemics. However, none of these state-listed taxa is federally listed, and none of the taxa recorded in this study is endemic to xeric limestone prairies in Kentucky. Furthermore, the three cedar glade endemics occur in areas of xeric limestone prairies that fit the description of limestone cedar glades when categorized at small spatial scales (Fig. 1).

The flora of xeric limestone prairies in Kentucky is composed primarily of native C_3 hemicryptophytes with broad geographical distributions encompassing Kentucky. Ninety-two and eight-tenths percent of the taxa are C_3 plants, and with the exception of *Manfreda virginica*, *Opuntia compressa* (CAM plants) and *Cuscuta cuspidata* (nonphotosynthetic), the remaining taxa are C_4 plants. The hemicryptophyte life form group contains more taxa (52.9% of native species) than all other life form groups combined (Fig. 5). Seventy-three and five-tenths percent of the native taxa in the xeric limestone prairie flora in Kentucky (230 taxa) is intraneous (Fig. 6), and taxa with southern geographic affinities (44 taxa, 14.1%) make up the largest extraneous component of the flora.

Although species richness values varied considerably across the 18 xeric limestone prairie sites surveyed, species composition among the sites was quite similar. Average site richness was 113 taxa (CV=13%) and ranged from 88 (Thompson Creek Glade) to 151 (Pine Creek Barrens) (Table 1). Calculation of community coefficients (CC's) for all possible pair-wise site comparisons determined that the majority of xeric limestone prairies surveyed form a single association or community type. Only 11 of the 153 CC's calculated were less than 0.50, the generally accepted association criterion (Barbour et al. 1999). Nine of the 11 CC's less than 0.50 included either site 1 or site 2 in Crooked Creek Barrens, and the CC resulting from comparison of Crooked Creek Barrens site 1 and site 2 is high

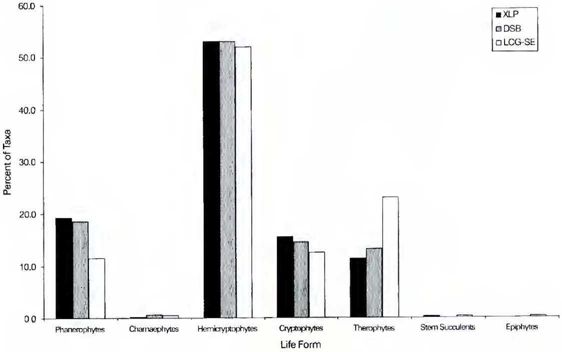


FIG. 5. Life form distribution of native species in the floras of xeric limestone prairies in Kentucky (XLP), deep-soil barrens of the southwestern Pennyroyal Plain (DSB) and limestone cedar glades of the southeastern U.S. (LCG-SE).

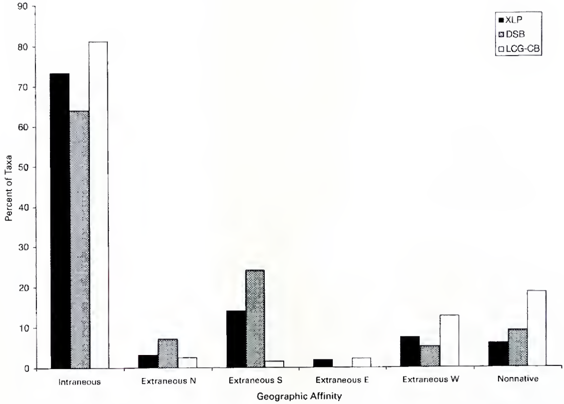


FIG. 6. Geographic affinities of the floras of xeric limestone prairies in Kentucky (XLP), deep-soil barrens of the southwestern Pennyroyal Plain (DSB) and cedar glades in the Central Basin of Tennessee (LCG-CB).

(0.71). These data suggest the two sites in Crooked Creek Barrens may belong to a second association or community type. Particularly noteworthy was the absence of *Echinacea simulata* and *Hypericum dolabriforme* in both Crooked Creek Barrens sites, since these taxa had high frequency values in the majority of the remaining sites (Lawless, unpublished). CC's ranged from 0.39 to 0.80, and the average CC (x=0.58) minus one standard deviation (s = 0.07) exceeds the generally accepted 0.50 association criterion.

As expected, the presence diagram for the xeric limestone prairie flora in Kentucky (Fig. 7) shows that the majority of species are in presence classes 1 and 2. However, the percentage of taxa in presence class four (15.3%) is similar to that in presence class two (18.0%), and thus class four approaches a second maximum (Oosting 1956). Only 13 taxa were present in all 18 sites, and all of them are native. Five of these 13 taxa are broadly distributed phanerophytes (*Cercis canadensis*, *Diospyros virginiana*, *Fraxinus americana*, *Juniperus virginiana* and *Rhamnus caroliniana*), two are dominant perennial (*Schizachyrium scoparium*) and annual (*Sporobolus vaginiflorus*) grass species in this community type (Baskin & Baskin 2000; Lawless, unpublished), and the remaining six species (*Euphorbia corollata*, *Helianthus hirsutus*, *Lobelia spicata*, *Physostegia virginiana*, *Ruellia humilis* and *Solidago nemoralis*) are relatively abundant forbs in the xeric limestone prairies in Kentucky (Lawless, unpublished).

DISCUSSION

The taxonomic distribution of the flora of xeric limestone prairies in Kentucky is very similar to that in the floras of cedar glades of the southeastern United States (Baskin & Baskin 1999) and of the deep-soil barrens of the Southwestern Pennyroyal Plain in Kentucky and Tennessee (Chester et al. 1999). However, the percentage of nonnative taxa in the xeric limestone prairie flora of Kentucky (6.0%) is considerably less than the percentages of nonnative taxa in the floras of the state of Kentucky (21.8%, Jones in press) of cedar glades of the Central Basin of Tennessee (18.7%, Baskin & Baskin 2003) and of southeastern United States (17.9%, Baskin & Baskin 1999) and of deep-soil barrens of the southwestern Pennyroyal Plain in Kentucky and Tennessee (9.1%, Chester et al. 1997) (Fig. 6). Furthermore, the vast majority of nonnative species in the xeric limestone prairie flora in Kentucky have low presence values. Nine of 20 taxa were present in only one site, and 18 occurred in four sites or less. The low percentage of nonnative taxa in the flora of xeric limestone prairies in Kentucky may be due to erosion of the organic horizon in these sites, which presumably has reduced nutrient availability in the surface layer. This reduction in surface layer nutrient availability may significantly decrease survivorship of nonnative seedlings, as these taxa typically are adapted to nutrient-rich sites (Grime 1974).

Asteraceae and Poaceae have the highest richness values of all families in the floras of xeric limestone prairies in Kentucky, cedar glades of the south-

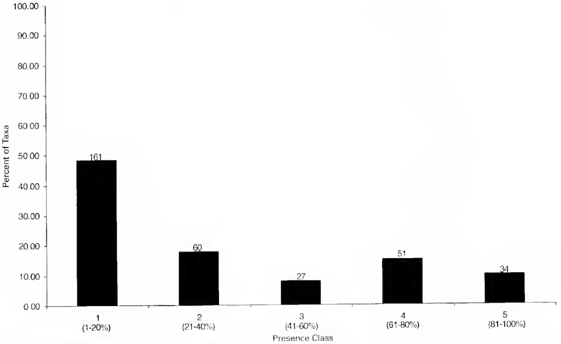


Fig. 7. Percent of taxa in each of five presence classes in 18 xeric limestone prairies surveyed in the Interior Low Plateaus physiographic province in Kentucky. Presence classes are as follows: 1=1–20%, 2=21–40%, 3=41–60%, 4=61–80% and 5=81–100%. Number of taxa in presence class above each bar.

eastern United States and deep-soil barrens of the southwestern Pennyroyal Plain, collectively accounting for 30.4%, 20.9% and 33.3%, respectively, of taxa in these floras. The Fabaceae ranks third in species richness in the floras of xeric limestone prairies in Kentucky and deep-soil barrens, whereas species richness in the Cyperaceae exceeds that in the Fabaceae in the flora of cedar glades of the southeastern United States. The flora of cedar glades also is distinguished by 19 endemic and two near-endemic taxa. The genus *Panicum* sensu lato contains the largest number of taxa in the floras of cedar glades (16 taxa) and deep-soil barrens (10 taxa). The flora of xeric limestone prairies in Kentucky also is rich in *Panicum* species sensu lato (10 taxa); however, *Symphyotrichum* had the highest richness of all genera (15 taxa).

The geographic affinities, photosynthetic pathway and life form distributions among the floras of xeric limestone prairies in Kentucky, limestone cedar glades and deep-soil barrens are similar. However, the flora of limestone cedar glades differs from that of the other two community types in three important aspects. The floras of xeric limestone prairies and deep-soil barrens contain a strong extraneous southern component (14.1 % and 24.0% of floras, respectively). In contrast, taxa with western or northwestern geographical affinities make up the largest percentage of extraneous taxa (12.6% of flora) in the limestone cedar glade flora (Baskin & Baskin 1999). The phanerophyte life form group contains a considerably smaller percentage of native taxa in the flora of limestone cedar glades (11.5%) in comparison with the floras of xeric limestone prairies in Kentucky (19.4%) and deep-soil barrens (18.6%) (Fig. 5). The flora of limestone cedar glades also is distinguished by a relatively high percentage of native therophytes (23.0%), many of which are winter annuals. The cedar glade flora contains eight winter annuals in the genus *Leavenworthia* alone, which partially accounts for the richness of the Brassicaceae (17 taxa) in this community type and for the near endemic status of the genus *Leavenworthia* in the southeastern United States (Baskin & Baskin 2003; Estill & Cruzan 1999). Conversely, the xeric limestone prairie flora in Kentucky contains only two native winter annuals, *Leavenworthia uniflora* and *Leavenworthia exigua* var. *laciniata*, both of which occur in cedar glade-like areas of the perennial grassland matrix (Fig. 1), and this life cycle type is absent in the deep-soil barrens flora.

The winter annual life cycle is an adaptive phenological strategy in limestone cedar glades. It assures completion of the life cycle prior to summer-dry conditions, which winter annuals pass in the drought-tolerant seed stage (Baskin & Baskin 1985). The paucity of winter annuals in the floras of xeric limestone prairies in Kentucky and deep-soil barrens of the southwestern Pennyroyal Plain suggest the edaphic conditions in these habitats are considerably less severe, and/or these communities have not existed for a sufficient period to allow for evolution of the annual life cycle in a comparable proportion of resident taxa.

Although the xeric limestone prairies surveyed support no endemic or federally listed taxa, this community type is the primary habitat in Kentucky for almost all of the 24 state-listed species recorded in the present study. Therefore, preservation of these species in Kentucky is dependent upon conservation of the xeric limestone prairie community type. Presently, nine of the 18 sites surveyed are owned by conservation organizations (Kentucky State Nature Preserves Commission and The Nature Conservancy) or by the federal government (Fort Knox Military Reservation). Three of the remaining nine sites (Hardin County Cedar Glade, Knight's Barrens and Lapland Barrens) are under management agreement with The Nature Conservancy, and the Logan County NRCS office is currently in the process of purchasing Logan County Barrens, one of the two sites surveyed in the Pennyroyal Plain. The most significant threat to xeric limestone prairie conservation is all terrain vehicle (ATV) usage, which damages or destroys vegetation, thus promoting further erosion of denuded soils.

Baskin et al. (1994) proposed the following sequence of events for the origin of xeric limestone prairies in Kentucky: clearing of marginal agricultural lands by European settlers → cultivation and/or grazing → significant erosion of the topsoil → abandonment → colonization of these degraded areas by the xeric limestone prairie flora → succession to hardwood forest in the absence of disturbance or maintenance of xeric limestone prairie with periodic management (i.e. disclimax). Forest succession is retarded by the highly eroded soils of these abandoned hillsides and by large heat loads (sensu McCune and Grace 2002) associated with the moderate to steep slopes with south to west aspects. However, succession to hardwood forest eventually occurs in the absence of management, which typically consists of mechanical removal of large trees, particularly *Juniperus virginiana*, and periodic prescribed fire (2-5 year burning interval, David Skinner, KSNPC Eastern Preserve Manager, personal communication).

The species composition of this community type is relatively consistent despite 1) their relatively recent origin, 2) the rarity of xeric limestone prairies at the landscape scale and 3) the small area occupied by these communities in the matrix of deciduous forests and agricultural lands. The richness of Asteraceae and Poaceae in the xeric limestone prairie flora of Kentucky is primarily responsible for the relatively high community coefficients (x = 0.58) observed in this study, since both of these families are characterized by large regional species pools and high proportions of wind-dispersed taxa. Furthermore, we have observed many taxa in the xeric limestone prairie flora (e.g. *Schizachyrium scoparium, Panicum flexile, Liatris squarrulosa, Ratibida pinnata, Croton monanthogynous, Hypericum dolabriforme*, etc.) in open forests with shallow rocky soils, on rock ledges and on rocky stream banks. These habitats, in addition to deep-soil barrens and limestone cedar glades, are the likely sources of the xeric limestone prairie flora in Kentucky, since they existed prior to European settlement.

CONCLUSIONS

Xeric limestone prairies are broadly distributed throughout the Interior Low Plateaus physiographic province in Kentucky and are most frequent in the Knobstone Escarpment and Knobs, where they primarily occur on eroded Alfisols derived from the Upper Mississippian Salem Limestone. The flora is rich in species of Asteraceae and Poaceae and contains 24 state-listed species, many of which are restricted to xeric limestone prairies in this part of their geographic range. Community coefficients suggest that all sample sites except those in the eastern Outer Blue Grass (Crooked Creek Barrens 1 and 2) belong to a single community type. Xeric limestone prairies are relatively well protected in Kentucky; the majority of sites are owned and/or managed by conservation organizations and the federal government.

The majority of taxa in the floras of xeric limestone prairies in Kentucky, limestone cedar glades of the southeastern United States and deep-soil barrens of the southwestern Pennyroyal Plain in Kentucky and Tennessee are intraneous C_3 hemicryptophytes. The very low percentage (6.0) of nonnative species in the xeric limestone prairie flora of Kentucky is noteworthy. Among xeric limestone prairies, limestone cedar glades and deep-soil barrens, the flora of limestone cedar glades is particularly unique due to 1) 21 endemic/near endemic taxa, 2) relatively high percentage of therophytes and 3) an extraneous component with strong western and northwestern affinities (Baskin & Baskin 1999).

In contrast, the floras of xeric limestone prairies in Kentucky and deep-soil barrens of the southwestern Pennyroyal Plain 1) contain no endemic taxa, 2) have higher percentages of phanerophyte taxa and 3) have an extraneous component with strong southern geographic affinities.

APPENDIX

Taxonomy is in accordance with USDA, NRCS (2004), with the exception of *Elymus glabriflorus* var. *australis*, which is based on the treatment by Campbell (1995). The name and authority for each taxon is followed, in parentheses, by the photosynthetic pathway (C3, C4 or CAM), life form (Ph=phanerophyte, Ch=chamaephyte, H=hemicryptophyte, Cr=cryptophyte and Th=therophyte; HP=holoparasite), geographic affinity (I=intraneous, EN=extraneous northern, ES=extraneous southern, EE=extraneous eastern, EW=extraneous western and X=introduced) and conservation status in the state of Kentucky (E=endangered, T=threatened and S=special concern) (KSNPC 2002) in bold-faced type. Number in bold-faced type following the final parenthesis refers to number of sites in which species was recorded.

DIVISION PTERIDOPHYTA, FERNS AND FERN ALLIES

ADIANTACEAE

Pellaea atropurpurea (L.) Link (C3, H, I) **5**

ASPLENIACEAE

Asplenium platyneuron (L.) B.S.P. (C3, H, I) **3**

OPHIOGLOSSACEAE

Ophioglossum englemannii Prantl (C3, Cr, ES) **2**

DIVISION PINOPHYTA, CONIFERS

CUPRESSACEAE

Juniperus virginiana L. (C3, Ph, I) **18**

PINACEAE

Pinus virginiana Mill. (C3, Ph, I) **5**

DIVISION MAGNOLIOPHYTA, FLOWERING PLANTS

CLASS MAGNOLIOPSIDA (DICOTS)

ACANTHACEAE

Ruellia humilis Nutt. (C3, H, I) **18**

ACERACEAE

Acer rubrum L. (C3, Ph, I) **9**
Acer saccharum Marshall (C3, Ph, I) **11**

ANACARDIACEAE

Rhus aromatica Aiton (C3, Ph, I) **7**
Rhus copallinum L. (C3, Ph, I) **12**
Rhus glabra L. (C3, Ph, I) **2**
Toxicodendron radicans (L.) Kuntze (C3, Ph, I) **9**

APIACEAE

Daucus carota L. (C3, H, X) **1**
Eryngium yuccifolium Michx. (C3, Cr, ES) **10**
Oxypolis rigidior (L.) Raf. (C3, Cr, I) **1**
Sanicula canadensis L. (C3, Cr, I) **7**
Thaspium barbinode (Michx.) Nutt. (C3, Cr, I) **12**
Zizia aptera (Gray) Fernald (C3, H, I) **10**
Zizia aurea (L.) W.D.J. Koch (C3, Cr, I) **6**

APOCYNACEAE

Apocynum cannabinum L. (C3, H, I) **14**

ARISTOLOCHIACEAE

Aristolochia serpentaria L. (C3, H, I) **12**

ASCLEPIADACEAE

Asclepias tuberosa L. (C3, H, I) **1**
Asclepias verticillata L. (C3, H, I) **12**
Asclepias viridiflora L. (C3, H, I) **17**
Matelea obliqua (Jacq.) Woodson (C3, I, ES) **4**

ASTERACEAE

Achillea millefolium L. (C3, H, I) **1**
Ageratina altissima (L.) King & H.E. Robins. (C3, H, I) **1**
Ambrosia artemisiifolia L. (C3, Th, I) **10**
Ambrosia trifida L. (C3, Th, I) **2**

Arnoglossum atriplicifolium (L.) H.E. Robins. (C3, H, I) **2**
Antennaria plantaginifolia (L.) Richards (C3, Ch, I) **2**
Brickellia eupatoriodies (L.) Shinners (C3, H, I) **16**
Centaurea biebersteinii DC. (C3, H, X) **1**
Cirsium discolor (Muhl. ex Willd.) Spreng. (C3, H, I) **6**
Conoclinium coelestinum (L.) DC. (C3, H, ES) **3**
Conyza canadensis (L.) Cronquist (C3, Th, I) **8**
Coreopsis tripteris L. (C3, H, EN) **14**
Echinacea simulata McGregor (C3, H, EW) **14**
Erigeron strigosus Muhl. ex Willd. (C3, H, I) **6**
Eupatorium altissimum L. (C3, H, ES) **13**
Eupatorium hyssopifolium L. (C3, H, ES) **1**
Eupatorium perfoliatum L. (C3, H, I) **2**
Euthamia graminifolia (L.) Nutt. (C3, H, EN) **4**
Helenium autumnale L. (C3, H, I) **7**
Helianthus divaricatus L. (C3, Cr, I) **4**
Helianthus hirsutus Raf. (C3, Cr, I) **18**
Helianthus microcephalus Torr. & Gray (C3, H, ES) **5**
Helianthus mollis Lam. (C3, Cr, I) **4**
Helianthus occidentalis Riddell (C3, Cr, I) **3**
Heliopsis helianthoides (L.) Sweet (C3, Cr, I) **3**
Leucanthemum vulgare Lam. (C3, H, X) **4**
Liatris aspera Michx. (C3, Cr, EW) **10**
Liatris cylindracea Michx. (C3, Cr, EW, **T**) **2**
Liatris spicata (L.) Willd. (C3, Cr, I) **8**
Liatris squarrosa (L.) Michx. var. *squarrosa* (C3, Cr, ES) **15**
Liatris squarrulosa Michx. (C3, Cr, ES) **3**
Lonactis linariifolius (L.) Greene (C3, H, I) **4**
Oligoneuron rigidum (L.) Small var. *glabratum* (E.L. Braun) Nesom (C3, H, EW) **11**
Packera anonyma (Wood) W.A. Weber & A. Löve (C3, H, ES) **5**
Parthenium integrifolium L. (C3, H, I) **12**
Prenanthes aspera Michx. (C3, H, EW, **E**) **1**
Ratibida pinnata (Vent.) Barnhart (C3, H, EW) **10**
Rudbeckia fulgida Aiton (C3, H, I) **12**
Rudbeckia hirta L. (C3, H, I) **1**
Senecio glabellus Poir. (C3, Th, ES) **1**
Sericocarpus asteroides (L.) B.S.P. (C3, H, EE) **1**
Silphium laciniatum L. (C3, H, EW, **E**) **1**
Silphium pinnatifidum Elliott (C3, H, ES, **S**) **3**
Silphium terebinthinaceum Jacq. (C3, H, EW) **5**
Silphium trifoliatum var. *trifoliatum* L. (C3, H, EE) **17**
Solidago bicolor L. (C3, H, I) **1**
Solidago canadensis L. (C3, H, I) **6**
Solidago juncea Aiton (C3, H, I) **1**
Solidago nemoralis Aiton (C3, H, I) **18**
Solidago speciosa Nutt. var. *erecta* (Pursh) MacMill. (C3, H, ES) **3**
Solidago sphacelata Raf. (C3, H, ES) **1**
Solidago ulmifolia Muhl. ex Willd. var. *ulmifolia* (C3, H, I) **11**
Symphyotrichum cordifolium (L.) Nesom (C3, H, I) **2**
Symphyotrichum dumosum (L.) Nesom (C3, H, I) **1**
Symphyotrichum laeve (L.) A. & D. Löve var. *concinum* (Willd.) Nesom (C3, H, I) **2**
Symphyotrichum laeve (L.) A. & D. Löve var. *laeve* (C3, H, I) **12**
Symphyotrichum laterifolium (L.) A. & D. Löve (C3, H, I) **1**
Symphyotrichum novae-angliae (L.) Nesom (C3, H, I) **4**
Symphyotrichum oblongifolium (Nutt.) Nesom (C3, H, I) **2**
Symphyotrichum oolentangiense (Riddell) Nesom (C3, H, EW) **2**
Symphyotrichum patens (Aiton) Nesom var. *patens* (C3, H, I) **12**
Symphyotrichum pilosum (Willd.) Nesom var. *pilosum* (C3, H, I) **4**
Symphyotrichum pilosum (Willd.) Nesom var. *pringlei* (Gray) Nesom (C3, H, EN) **12**
Symphyotrichum sericeum (Vent.) Nesom (C3, H, ES, **S**) **6**
Symphyotrichum shortii (Lindl.) Nesom (C3, H, I) **1**
Symphyotrichum undulatum (L.) Nesom (C3, H, EE) **1**
Symphyotrichum urophyllum (Lindl.) Nesom (C3, H, I) **12**
Taraxacum officinale G.H. Weber ex Wiggers (C3, H, X) **2**
Verbesina virginica L. (C3, H, I) **4**
Vernonia gigantea (Walter) Trel. (C3, H, I) **4**

BETULACEAE

Corylus americana Walter (C3, Ph, EN) **2**
Ostrya virginiana (Mill.) Koch (C3, Ph, I) **16**

BIGNONIACEAE

Bignonia capreolata L. (C3, Ph, I) **1**
Campsis radicans (L.) Seem. ex Bureau (C3, Ph, ES) **1**

BORAGINACEAE

Heliotropium tenellum (Nutt.) Torr. (C3, Th, ES) **9**

Lithospermum canescens (Michx.) Lehm. (C3, H, I) **16**

BRASSICACEAE

Arabis laevigata (Muhl. ex Willd.) Poir. var. *laevigata* (C3, H, I) **1**
Cardamine hirsuta L. (C3, Th, X) **1**
Draba verna L. (C3, Th, X) **1**
Leavenworthia exigua Rollins var. *laciniata* Rollins (C3, Th, ES, **T**) **1**
Leavenworthia uniflora (Michx.) Britton (C3, H, I) **2**

CACTACEAE

Opuntia humifusa (Raf.) Raf. (CAM, S, ES) **3**

CAMPANULACEAE

Lobelia spicata Lam. (C3, H, I) **18**

CAPRIFOLIACEAE

Lonicera japonica Thunb. (C3, Ph, X) **4**
Symphoricarpos orbiculatus Moench (C3, Ph, I) **6**
Viburnum prunifolium L. (C3, Ph, I) **4**
Viburnum rufidulum Raf. (C3, Ph, ES) **6**

CARYOPHYLLACEAE

Dianthus armeria L. (C3, Th, X) **1**
Minuartia patula (Michx.) Mattf. (C3, Th, I) **1**

CELASTRACEAE

Celastrus scandens L. (C3, Ph, I) **7**

CLUSIACEAE

Hypericum denticulatum Ellis (C3, H, EE) **2**
Hypericum dolabriforme Vent. (C3, H, ES) **14**
Hypericum hypericoides (L.) Crantz (C3, H, ES) **2**
Hypericum prolificum L. (C3, Ph, I) **6**
Hypericum punctatum L. (C3, H, I) **5**
Hypericum sphaerocarpum L. (C3, H, EW) **2**

CONVOLVULACEAE

Calystegia spithamaea (L.) Pursh (C3, H, I) **1**
Ipomoea pandurata (L.) G.F. Mey. (C3, Cr, I) **12**

CORNACEAE

Cornus drummondii C. A. Mey. (C3, Ph, EW) **4**
Cornus florida L. (C3, Ph, I) **10**

CRASSULACEAE

Sedum ternatum Michx. (C3, Th, I) **2**

CUSCUTACEAE

Cuscuta cuspidata Engelm. (HP, Th, EW) **1**

EBENACEAE

Diospyros virginiana L. (C3, Ph, I) **18**

ERICACEAE

Vaccinium arboreum Marshall (C3, Ph, ES) **4**
Vaccinium pallidum Aiton (C3, Ph, I) **1**

EUPHORBIACEAE

Acalypha gracilens Gray (C3, Th, I) **6**
Acalypha virginica L. (C3, Th, I) **1**
Chamaesyce nutans (Lag.) Small (C3, Th, I) **8**
Croton capitatus Michx. (C3, Th, I) **12**
Croton monanthogynous Michx. (C3, Th, ES) **7**
Euphorbia corollata L. (C3, Cr, I) **18**
Euphorbia dentata Michx. (C3, Th, I) **3**

FABACEAE

Cercis canadensis L. (C3, Ph, I) **18**
Chamaecrista fasciculata (Michx.) Greene var. *fasciculata* (C3, Th, I) **11**
Coronilla varia L. (C3, Th, X) **1**
Dalea candida Michx. ex Willd. var. *candida* (C3, H, EW) **1**
Dalea purpurea Vent. var. *purpurea* (C3, H, EW, **S**) **5**
Desmodium canescens (L.) DC. (C3, H, I) **2**
Desmodium ciliare (Muhl. ex Willd.) DC. (C3, H, I) **12**
Desmodium glabellum (Michx.) DC. (C3, H, ES) **4**
Desmodium paniculatum (L.) DC. var. *paniculatum* (C3, H, I) **1**
Desmodium rotundifolium DC. (C3, H, I) **1**
Desmodium sessilifolium (Torr.) Torr. & Gray (C3, H, I) **1**
Desmanthus illinoensis (Michx.) MacMill. ex B.L. Robins. & Fern. (C3, Ph, EW) **1**
Galactia volubilis (L.) Britton (C3, H, I) **15**
Gleditsia triacanthos L. (C3, Ph, I) **3**
Lespedeza capitata Michx. (C3, H, I, **S**) **3**
Lespedeza cuneata (Dum.Cours.) G. Don (C3, H, X) **2**
Lespedeza procumbens L. (C3, H, I) **3**
Lespedeza repens (L.) W. Bartram (C3, H, I) **1**
Lespedeza violacea (L.) Pers. (C3, H, I) **2**
Lespedeza virginica (L.) Britton (C3, H, I) **16**
Melilotus alba Medikus (C3, H, X) **8**
Orbexilum pedunculatum (Mill.) Rydb. var. *psoralioides* (Walt.) Isley (C3, Cr, ES) **1**
Robinia pseudoacacia L. (C3, Ph, I) **2**
Senna marilandica (L.) Link (C3, H, I) **4**
Strophostyles umbellata (Muhl. ex Willd.) Britton (C3, Cr, ES) **3**
Stylosanthes biflora (L.) B.S.P. (C3, H, ES) **6**
Tephrosia virginiana (L.) Pers. (C3, H, I) **8**

Trifolium repens L. (C3, H, X) **1**
Vicia villosa Roth (C3, H, X) 2

FAGACEAE

Fagus grandifolia Ehrh. (C3, Ph, I) **5**
Quercus alba L. (C3, Ph, I) **2**
Quercus imbricaria Michx. (C3, Ph, I) **3**
Quercus marilandica Muenchh. (C3, Ph, ES) **13**
Quercus muehlenbergii Engelm. (C3, Ph, I) **13**
Quercus prinus L. (C3, Ph, I) **1**
Quercus rubra L. (C3, Ph, I) **10**
Quercus stellata Wangenh. (C3, Ph, I) **15**
Quercus velutina Lam. (C3, Ph, I) **6**

GENTIANACEAE

Frasera caroliniensis Walters (C3, H, I) **2**
Gentiana flavida Muhl. ex Nutt. (C3, H, I, **E**) **1**
Gentianella quinquefolia (L.) Small ssp. *occidentalis* (Gray) J. Gillett (C3, H, I) **9**
Sabatia angularis (L.) Pursh (C3, H, I) **15**

JUGLANDACEAE

Carya alba (L.) Nutt. ex Ellis (C3, Ph, I) **3**
Carya tomentosa Nutt. (C3, Ph, I) **3**
Juglans nigra L. (C3, Ph, I) **13**

LAMIACEAE

Blephilia ciliata (L.) Benth. (C3, H, I) **13**
Isanthus brachiatus B.S.P. (C3, Th, I) **13**
Lycopus americanus Muhl. ex W. Bartram (C3, H, I) **1**
Monarda fistulosa L. (C3, H, I) **13**
Physostegia virginiana (L.) Benth. (C3, H, I) **18**
Prunella vulgaris L. var. *lanceolata* (Barton) Fernald (C3, H, I) **16**
Pycnanthemum pycnanthemoides (Leavenw.) Fernald (C3, H, ES) **2**
Pycnanthemum tenuifolium Schrad. (C3, H, I) **11**
Salvia lyrata L. (C3, H, I) **5**
Scutellaria elliptica Muhl. (C3, H, I) **3**
Scutellaria parvula Michx. var. *australis* Fassett (C3, Cr, I) **8**
Scutellaria parvula Michx. var. *missouriensis* (Torr.) Goodman & Lawson (C3, Cr, I) **2**
Trichostema dichotomum L. (C3, Th, I) **1**

LAURACEAE

Sassafrass albidum (Nutt.) Nees (C3, Ph, I) **11**

LINACEAE

Linum medium (Planch.) Britton (C3, H, I) **1**
Linum sulcatum Riddell (C3, Th, EW) **16**
Linum virginianum L. (C3, H, I) **2**

LYTHRACEAE

Cuphea viscosissima Jacq. (C3, Th, ES) **2**

MAGNOLIACEAE

Liriodendron tulipifera L. (C3, Ph, I) **6**

MALVACEAE

Malvastrum hispidum (Pursh) Hochr. (C3, Th, EW, **T**) **1**

OLEACEAE

Forestiera ligustrina (Michx.) Poir. (C3, Ph, ES, **T**) **1**
Fraxinus americana L. (C3, Ph, I) **18**
Ligustrum sinense Lour. (C3, Ph, X) **1**

ONAGRACEAE

Gaura biennis L. (C3, H, EE) **4**
Gaura filipes Spach (C3, H, ES) **13**
Oenothera biennis L. (C3, H, I) **1**

OXALIDACEAE

Oxalis stricta L. (C3, H, I) **1**
Oxalis violacea L. (C3, H, I) **1**

PAPAVERACEAE

Sanguinaria canadensis L. (C3, Cr, I) **1**

PASSIFLORACEAE

Passiflora lutea L. (C3, H, I) **2**

PLANTAGINACEAE

Plantago aristata Michx. (C3, Th, I) **1**
Plantago patagonica Jacq. (C3, Th, X) **1**
Plantago virginica L. (C3, Th, I) **4**

PLATANACEAE

Platanus occidentalis L. (C3, Ph, I) **1**

POLEMONIACEAE

Phlox pilosa L. ssp. *pilosa* (C3, H, I) **8**

POLYGALACEAE

Polygala verticillata L. (C3, Th, I) **13**

PORTULACACEAE

Talinum calcaricum Ware (C3, H, ES, **E**) **1**

PRIMULACEAE

Anagallis arvensis L. (C3, Th, X) **3**
Dodecatheon meadia L. (C3, H, I) **1**
Lysimachia lanceolata Walter (C3, H, I) **6**

RANUNCULACEAE

Anemone virginiana L. (C3, H, I) **13**
Clematis pitcheri Torr. & Gray var. *pitcheri* (C3, Ph, EW) **1**
Delphinium carolinianum Walter ssp. *calciphilum* Warnock (C3, H, ES, **T**) **1**

Thalictrum revolutum DC. (C3, H, I) **3**
Thalictrum thalictroides (L.) Eames & Boivin (C3, Cr, I) **2**

RHAMNACEAE

Ceanothus americanus L. (C3, Ph, I) **3**
Rhamnus caroliniana Walter (C3, Ph, ES) **18**

ROSACEAE

Agrimonia rostellata Wallr. (C3, H, I) **6**
Amelanchier arborea (Michx. f.) Fernald (C3, Ph, I) **6**
Crataegus L. [sp(p).] (C3, Ph) **5**
Fragaria virginiana Duchesne (C3, H, I) **5**
Porteranthus stipulatus (Muhl. ex Willd.) Britton (C3, H, I) **1**
Potentilla simplex Michx. (C3, H, I) **17**
Prunus americana Marshall (C3, Ph, I) **1**
Prunus serotina Ehrh. (C3, Ph, I) **7**
Rosa carolina L. (C3, Ph, I) **16**
Rosa multiflora Thunb. (C3, Ph, X) **4**
Rubus L. [sp(p).] (C3, Ph) **9**

RUBIACEAE

Diodia teres Walter (C3, Th, I) **4**
Galium circaezans Michx. (C3, H, I) **11**
Galium pilosum Aiton (C3, H, I) **7**
Galium triflorum Michx. (C3, H, I) **1**
Hedyotis nigricans (Lam.) Fosberg (C3, Th, EW) **11**
Houstonia canadensis Willd. ex Roemer & J.A. Schultes (C3, H, EN) **13**

SALICACEAE

Salix humilis Marshall (C3, Ph, I) **1**

SANTALACEAE

Comandra umbellata (L.) Nutt. (C3, Cr, I) **1**

SCROPHULARIACEAE

Agalinis auriculata (Michx.) Blake (C3, Th, EW, **E**) **1**
Agalinis gattingeri (Small) Small (C3, Th, EW) **4**
Agalinis tenuifolia (Vahl) Raf. (C3, Th, I) **9**
Aureolaria flava (L.) Farw. (C3, Cr, I) **2**
Buchnera americana L. (C3, H, ES) **1**
Castilleja coccinea (L.) Spreng. (C3, Th, I, **E**) **3**
Pedicularis canadensis L. (C3, H, I) **3**
Penstemon digitalis Nutt. ex Sims (C3, H, I) **1**
Penstemon hirsutus (L.) Willd. (C3, H, I) **2**

SIMAROUBACEAE

Ailanthus altissima (Mill.) Swingle (C3, Ph, X) **1**

SOLANACEAE

Physalis virginiana Mill. (C3, Cr, ES) **12**
Solanum carolinense L. (C3, Cr, I) **1**

ULMACEAE

Celtis occidentalis L. (C3, Ph, I) **1**
Celtis tenuifolia Nutt. (C3, Ph, I) **17**
Ulmus alata Michx. (C3, Ph, ES) **6**
Ulmus rubra Muhl. (C3, Ph, I) **3**

VERBENACEAE

Phryma leptostachya L. (C3, H, I) **1**
Verbena simplex Lehm. (C3, H, I) **6**

VIOLACEAE

Hybanthus concolor (T. Forst.) Spreng. (C3, H, I) **3**
Viola egglestonii Brainerd (C3, H, ES, **S**) **9**
Viola palmata L. (C3, H, I) **7**
Viola pedata L. (C3, H, I) **12**
Viola sagittata Aiton (C3, H, I) **2**

VITACEAE

Parthenocissus quinquefolia (L.) Planch. (C3, Ph, I) **9**
Vitis aestivalis Michx. (C3, Ph, I) **11**

DIVISION MAGNOLIOPHYTA, FLOWERING PLANTS
CLASS LILIOPSIDA (MONOCOTS)

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose (CAM, H, ES) **16**

CYPERACEAE

Carex complanata Torr. & Hook. (C3, Cr, I) **9**
Carex crawei Dewey (C3, Cr, I, **S**) **14**
Carex glaucodea Tuckerman ex Olney (C3, H, I) **8**
Carex juniperorum Catling, Reznicek & Crins (C3, H, EN, **E**) **2**
Carex meadii Dewey (C3, Cr, I) **16**
Carex pensylvanica Lam. (C3, Cr, I) **2**
Carex umbellata Schkuhr ex Willd. (C3, H, I) **12**
Eleocharis compressa Sullivant (C3, Cr, ES) **3**
Eleocharis tenuis (Willd.) J.A. Schultes (C3, Cr, I) **3**
Fimbristylis puberula (Michx.) Vahl var. *puberula* (C4, Cr, I, **T**)
Scirpus pendulus Muhl. (C3, H, I) **8**
Scleria olgantha Michx. (C3, Cr, I) **13**
Scleria pauciflora Muhl. (C3, Cr, I) **2**

DIOSCOREACEAE

Dioscorea quaternata J.F. Gmel (C3, Ph, I) **2**

IRIDACEAE

Hypoxis hirsuta (L.) Coville (C3, Cr, I) **2**

Iris cristata Aiton (C3, Cr, I) **1**
Sisyrinchium albidum Raf. (C3, H, I) **13**

LILIACEAE

Allium cernuum Roth (C3, Cr, EN) **8**
Maianthemum stellatum (L.) Link (C3, Cr, I, **E**) **1**
Nothoscordum bivalve (L.) Britton (C3, Cr, I) **1**
Polygonatum biflorum (Walter) Elliott (C3, Cr, I) **10**
Uvularia perfoliata L. (C3, Cr, I) **1**

ORCHIDACEAE

Cypripedium candidum Muhl. ex Willd. (C3, Cr, EN, **E**) **2**
Cypripedium pubescens Willd. var. *pubescens* (C3, Cr, I) **2**
Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Leur (C3, H, I) **4**
Spiranthes magnicamporum Sheviak (C3, H, EW, **T**) **9**
Tipularia discolor (Pursh) Nutt. (C3, Cr, I) **1**

POACEAE

Andropogon gerardii Vitman (C4, H, I) **17**
Aristida longispica Poir. (C4, Th, I) **1**
Aristida oligantha Michx. (C4, Th, I) **2**
Aristida purpurascens Poir. var. *purpurascens* (C4, H, I) **13**
Bouteloua curtipendula (Michx.) Torr. (C4, H, I, **S**) **3**
Brachyeletrum erectum (Schreb. ex Spreng.) Beauvis. (C3, H, I) **1**
Bromus pubescens Muhl. ex Willd. (C3, H, I) **1**
Danthonia spicata (L.) Beauvis. ex Roemer & J.A. Schultes (C3, H, I) **14**
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann (C3, H, I) **15**
Dichanthelium boscii (Poir.) Gould & C.A. Clark (C3, H, I) **12**
Dichanthelium commutatum (J.A. Schultes) Gould (C3, H, I) **1**
Dichanthelium dichotomum (L.) Gould var. *dichotomum* (C3, H, I) **6**
Dichanthelium sphaerocarpon (Ellis) Gould (C3, H, I) **3**
Dichanthelium villosissimum (Nash) Freckman (C3, H, I) **1**
Elymus glabriflorus Scribn. & C.R. Ball var. *australis* (Scribn. & C.R. Ball) J.J.N. Campb. (C3, H, I) **5**
Lolium arundinaceum (Schreb.) J.J. Darbyshire (C3, H, X) **3**
Muhlenbergia capillaris (Lam.) Trin. (C4, H, I) **2**
Muhlenbergia cuspidata (Torr. ex Hook.) Rydb. (C4, H, EW, **T**) **2**
Muhlenbergia sylvatica Torr. ex Gray (C4, H, I) **2**
Panicum anceps Michx. (C4, Cr, ES) **2**
Panicum capillare L. (C4, Th, I) **2**
Panicum flexile (Gattinger) Scribn. (C4, Th, I) **14**
Panicum linearifolium (Scribn. ex Nash) Gould (C3, H, I) **13**
Paspalum leave Michx. (C4, H, I) **1**
Schizachyrium scoparium (Michx.) Nash (C4, H, I) **18**
Setaria glauca (L.) P. Beauvis. (C4, Th, X) **2**
Sorghastrum nutans (L.) Nash (C4, Cr, I) **16**
Sporobolus compositus (Poir.) Merr. var. *compositus* (C4, H, I) **14**
Sporobolus heterolepis (Gray) Gray (C4, H, EW) **1**
Sporobolus vaginiflorus (Torr. ex Gray) Wood, including varieties *ozarkanus* (Fernald) Shinners (C4, Th, I) and *vaginiflorus* (C4, Th, I) **18**
Tridens flavus (L.) Hitchcock (C4, H, I) **12**

SMILACACEAE

Smilax bona-nox L. (C3, Ph, ES) **16**

ACKNOWLEDGMENTS

The authors sincerely thank the Kentucky State Nature Preserves Commission, The Nature Conservancy and all private landowners for granting the first author access to the field sites studied in this project.

REFERENCES

Amos, D.H. 1972. Geologic map of the New Amsterdam Quadrangle, Kentucky-Indiana and part of the Mauckport Quadrangle, Kentucky. USGS Geologic Quadrangle Map GQ-990.

Arms, F.S., M.J. Mitchell, F.C. Watts, and B.L. Wilson. 1979. Soil survey of Hardin and Larue counties, Kentucky. USDA, Soil Conservation Service, Washington, D.C.

Barbour, M.G., J.H. Burk, W.D. Pitts, F.S. Gilliam, and M.W. Schwartz. 1999. Terrestrial plant ecology, third ed. Benjamin Cummings, Menlo Park, California.

Baskin, J.M. and C.C. Baskin. 1985. Life cycle ecology of annual plant species of cedar glades of southeastern United States. In: J. White, ed. The population structure of vegetation. Dr. W. Junk, Dordrecht. Pp. 371–398.

Baskin, J.M. and C.C. Baskin. 1999. Cedar glades of the southeastern United States. In: R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds. Savannas, barrens, and rock outcrop plant communities of eastern North America. Cambridge Univ. Press, Cambridge. Pp. 206–219.

Baskin, J.M. and C.C. Baskin. 2000. Vegetation of limestone and dolomite glades in the Ozarks and Midwest regions of the United States. Ann. Missouri Bot. Gard. 87: 286–294.

Baskin, J.M. and C.C. Baskin. 2003. The vascular flora of cedar glades of the southeastern United States and its phytogeographical relationships. J. Torrey Bot. Soc. 130: 101–118.

Baskin, J.M., C.C. Baskin, and E.W. Chester. 1994. The Big Barrens Region of Kentucky and Tennessee: further observations and considerations. Castanea 59:226–254.

Braun, E.L. 1950. Deciduous forests of eastern North America. Blakiston, Philadelphia.

Cain, S.A. and G.M de Oliveira Castro. 1959. Manual of vegetation analysis. Harper & Brothers, New York.

Campbell, J.N.N. 1995. New combinations in eastern North American *Elymus* (Poaceae) Novon 5:128.

Chester, E.W., B.E. Wofford, J.M. Baskin, and C.C. Baskin. 1997. A floristic study of barrens on the southwestern Pennyroyal Plain, Kentucky and Tennessee. Castanea 62: 161–172.

Dye, J.W., A.J. Barton, and R.D. Froedge. 1975. Soil survey of Logan County, Kentucky. USDA, Soil Conservation Service, Washington, D.C.

Ennis, B.E. 1928. The life forms of Connecticut plants and their significance in relation to climate. Connecticut State Geol. Nat. Hist. Surv. Bull. 43.

Estill, J.C. and M.B. Cruzan. 2001. Phytogeography of rare plant species endemic to the southeastern United States. Castanea 66:3–23.

Fenneman, N.M. 1938. Physiography of eastern United States. McGraw-Hill, New York.

Flora of North America Editorial Committee [FNEC]. 2003. Flora of North America North of Mexico, Volume 25, Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Oxford University Press. New York.

Gibson, D. 1961. Life-forms of Kentucky flowering plants. Amer. Midl. Naturalist. 66:1–60.

Gildersleeve, B. 1978. Geologic map of the Leitchfield Quadrangle, Grayson

County, Kentucky. USGS Geologic Quadrangle Map GQ-1316.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. Second edition. New York Botanical Garden, Bronx.

Grime, J.P. 1974. Vegetation classification by reference to strategies. Nature 250:26–31.

Haagen, J.E. 2001. Soil Survey of Breckenridge and Meade Counties, Kentucky. USDA, Soil Conservation Service, Washington, D.C.

Hansen, C.E. 1952. The life-forms of the flowering plants of Illinois. M.S. thesis. Northwestern Univ., Evanston, Illinois.

Jones, R.L. In Press. Plant life of Kentucky, an illustrated guide to the vascular flora. University Press of Kentucky, Lexington.

[KSNPC] Kentucky State Nature Preserves Commission. 2002. Endangered, threatened, special concern, and historical biota of Kentucky. unpublished. Frankfort.

Keperfele, R.C. 1966. Geologic map of the Elizabethtown Quadrangle, Hardin and Larue Counties, Kentucky. USGS Geologic Quadrangle Map GQ-559.

Keperfele, R.C. 1967. Geologic map of the Colesburg Quadrangle, Hardin and Bullitt Counties, Kentucky. USGS Geologic Quadrangle Map GQ-602.

Keperfele, R.C. 1968. Geologic map of the Shepherdsville Quadrangle, Bullitt County, Kentucky. USGS Geologic Quadrangle Map GQ-740.

McCune, B. and J.B. Grace. 2002. Analysis of ecological communities. MJM Software Design, Gleneden Beach, Oregon.

McCune, B. and M.J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data, version 4. MJM Software Design, Gleneden Beach, Oregon.

McDowell, R.C. 1981. Correlation chart for units on the geologic map of Kentucky. USGS Miscellaneous Field Studies Map MF-21.

Miller, R.C. 1968. Geologic map of the Russellville Quadrangle, Logan County, Kentucky. USGS Geologic Quadrangle Map GQ-714.

Moore, F.B. 1965. Geology of the Millerstown Quadrangle, Kentucky. USGS Geologic Quadrangle Map GQ-417.

Oosting, H.J. 1956. The study of plant communities. Second edition. Freeman, San Francisco.

Peck, J.H. and K.L. Pierce. 1966. Geologic map of part of the Manchester Islands Quadrangle, Lewis County, Kentucky. USGS Geologic Quadrangle Map GQ-581.

Peterson, W.L. 1966. Geologic map of the Nelsonville Quadrangle, central Kentucky. USGS Geologic Quadrangle Map GQ-564.

Quarterman, E. and R.L. Powell. 1978. Potential ecological/geological natural landmarks of the Interior Low Plateaus. United States Department of the Interior, Washington, D.C.

Rainey, H.C. 1965. Geologic map of the Dennis Quadrangle, Logan County, Kentucky. USGS Geologic Quadrangle Map GQ-450.

Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Clarendon Press, Oxford.

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (plants.usda.gov). National Plant Data Center, Baton Rouge.

Waller, S.S. and J.K. Lewis. 1979. Occurrence of C_3 and C_4 photosynthetic pathways in North American grasses. J. Range Manage. 32:12–28.

Whitaker, O.J., F.R. Cox, H.T. Converse, J.L. Taylor, J.V. Bentley, and E.H. Jacobs. 1972. Soil survey of Grayson County, Kentucky. USDA, Soil Conservation Service, Washington, D.C.

Whitaker, O.J. and B.A. Waters. 1986. Soil survey of Bullitt and Spencer Counties, Kentucky. USDA, Soil Conservation Service, Washington, D.C.

A FLORISTIC SURVEY OF FORT MATANZAS NATIONAL MONUMENT, ST. JOHNS COUNTY, FLORIDA

Wendy B. Zomlefer

Department of Plant Biology
University of Georgia
2502 Plant Sciences
Athens, Georgia 30602-7271, U.S.A.

David E. Giannasi

Department of Plant Biology
University of Georgia
2502 Plant Sciences
Athens, Georgia 30602-7271, U.S.A.

Walter S. Judd

Department of Botany
University of Florida
P.O. Box 118526
Gainesville, Florida 32611-8526, U.S.A.

Lisa M. Kruse

Department of Plant Biology
University of Georgia
2502 Plant Sciences
Athens, Georgia 30602-7271, U.S.A.

Kelly A. Bettinger

Department of Plant Biology
University of Georgia
2502 Plant Sciences
Athens, Georgia 30602-7271, U.S.A.

ABSTRACT

Fort Matanzas National Monument, administered by the National Park Service, U.S. Department of the Interior, comprises 127 ha (313 acres) that includes portions of two barrier islands in St. Johns County, Florida: northern Rattlesnake Island, where the historic Fort Matanzas is located, and southern Anastasia Island. A floristic survey was conducted to provide Park Service personnel with a vouchered checklist of vascular plant species, supplemented with salient information such as relative abundance, locality data, and community type. Four intensive collecting trips conducted in 2003–2004 yielded 237 species of vascular plants in 189 genera of 73 families. The four largest families are Poaceae, Asteraceae, Fabaceae, Amaranthaceae, and Euphorbiaceae. A map, descriptions, and photographs of the various plant communities are also provided.

RESUMEN

El Monumento Nacional Fuerte Matanzas, administrado por el Servicio de Parques Nacionales del Departamento del Interior, tiene una extensión de 127 ha e incluye dos islas de barrera localizadas en el condado de St. Johns, Florida: al Norte la Isla Rattlesnake donde se encuentra el Fuerte Matanzas, y al Sur la Isla Anastasia. Fue realizado un monitoreo florístico por el personal del Servicio de Parques Nacionales, utilizando una lista de especies testigo, que presenta información sobre la descripción, abundancia relativa, localidad y el tipo de comunidad florística de las especies de plantas vasculares de la zona. Se realizaron cuatro viajes de colecta intensiva entre 2003 y 2004, de los cuales se obtuvieron un total de 237 especies de plantas vasculares, pertenecientes a 189 géneros y 75 familias. Las cinco familias más representadas son Poaceae, Asteraceae, Fabaceae, Amaranthaceae y Euphorbiaceae. Se presentan mapas, descripciones y fotografías de varias de las comunidades de plantas muestreadas.

SIDA 21(2): 1081–1106. 2004

INTRODUCTION

Study Area

Fort Matanzas National Monument, administered by the National Park Service (NPS; U.S. Department of the Interior), is located 14 mi (22.5 km) south of St. Augustine along State Road (S. R.) A1A in St. Johns County, Florida (Fig. 1A). The park comprises 313 acres (127 ha; Fig. 1B): the southern tip of Anastasia Island (138 acres, 56 ha) and the northern third of Rattlesnake Island (175 acres, 71 ha; NPS 2004). Both islands are separated from mainland Florida by the Matanzas River and the Intracoastal Waterway. These linear shaped barrier islands of quartz sand parallel the gently sloping Atlantic coastline and occur on underlying coquina (the Anastasia formation), a soft whitish limestone formed primarily of coarsely broken shells naturally cemented together (Waterbury 1993). The historic Fort Matanzas (discussed below), built from quarried coquina stone, is situated on northeast Rattlesnake Island overlooking the Matanzas River. A comprehensive and vouchered survey of the vascular flora had not previously been conducted for this NPS controlled land.

Anastasia Island.—The Anastasia Island portion of the park [1.0 mi (1.6 km) long; minimum width 0.02 mi (0.03 km), maximum width 0.4 mi (0.6 km)] consists of stabilized beach dunes rising as much as 27 ft (8.2 m) above sea level and is bisected by S. R. A1A that becomes a bridge over the southernmost tip of the island (Fig. 1B). Park property borders along A1A are 50 ft (15.2 m) from the center line of the highway on each side (east and west). The park is hemmed in by dense beachfront housing development to the north, and the Summer Haven community across the S. R. A1A bridge, to the south.

Most NPS land here is accessible to the public. Along southwest S. R. A1A are two entrance points to the Matanzas River (main visitor center and a dune boardwalk, numbered 1 and 4, respectively, in Fig. 1B), and across S. R. A1A to the east, two points of easy access to the Atlantic Ocean [beach ramp (2 in Fig. 1B) and dune boardwalk (5)]. The visitor center encompasses a parking lot/gift shop/picnic area, park headquarter offices/maintenance areas, boat dock, and a nature trail/boardwalk [through dense forest (3)]. A small parking lot for a boardwalk (4) through the dunes out to the Matanzas River is 0.35 mi (0.56 km) further south along west S. R. A1A. Directly across the highway to the east is another parking lot for the third, much longer boardwalk (5) over the fragile dune system, which terminates in an overlook of the Atlantic Ocean. Another parking area opposite the visitor center entrance (2) cuts through the dunes and allows vehicle access to the Atlantic Ocean. This popular beach even has traffic "lanes" along the shore (speed limit 10 mi/hr) policed by NPS personnel; however, only four-wheel drive vehicles are allowed along the southwest "hook" of the island bordering Matanzas Inlet where the sand is less compacted and where Least Terns nest for part of the year.

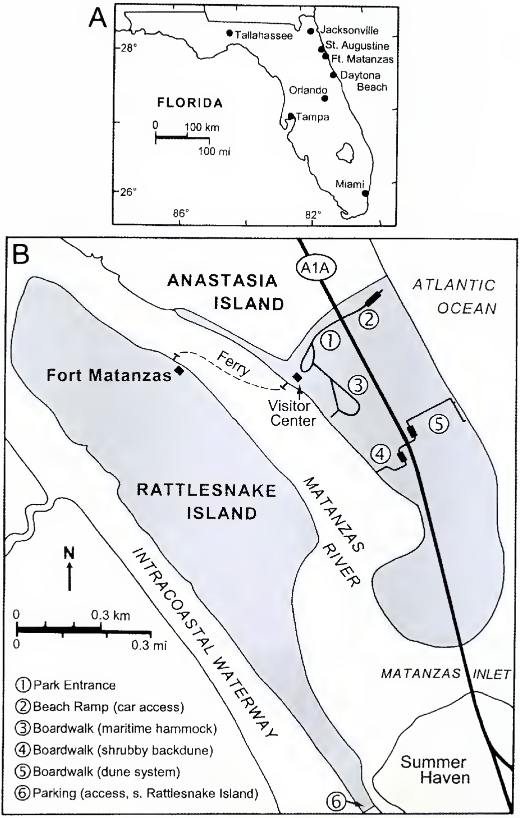


Fig. 1. Location and boundaries of Fort Matanzas National Monument. A. General location of Fort Matanzas, ca. 14 mi (22.5 km) south of St. Augustine, Florida. **B.** Fort Matanzas National Monument park property (shaded), comprising the northern third of Rattlesnake Island and the southern tip of Anastasia Island. Modified from NPS (2004).

Rattlesnake Island.—When Fort Matanzas was built in 1740, the island it occupied totaled less than two acres, and a soldier on the gun deck could look directly out over the ocean. Erosion and shifting tidal deposits have altered the inlet, and the fort is now about 0.5 mi (0.8 km) farther from the Atlantic Ocean (Fig. 2). In the early 1900's the Army Corps of Engineers dug the channel for the Intracoastal Waterway west of the fort (Fig. 1B), and the little island was joined with other islets, creating a much larger isle now called Rattlesnake Island (Chandler 2002).

The Rattlesnake Island park area [1.28 mi (2.1 km) long; minimum width 0.03 mi (0.05 km), maximum width 0.31 mi (0.50 km)] is bordered to the south by exclusive waterfront homes. The northern and southern ends of the park have been created mainly by dredged spoil from the Intracoastal Waterway, and tidal creeks and a labyrinth of mosquito control ditches fragment the low-lying central portion (Fig. 3). Most of the island is less than 5 ft (1.5 m) above sea level, although the central fill area at the northern end rises to ca. 17 ft (5.2 m).

The majority of NPS land on Rattlesnake Island is closed to the public. Fort Matanzas on the northeast coast is accessible for brief (ca. 45 min.) guided tours via a forty-two passenger boat that crosses the river eight times daily from the visitor center on Anastasia island. Annually, over 50,000 tourists visit the fort (NPS 2004). A parking area at the southeastern park border (6 in Fig. 1B) allows access for fishing, although we noted very little activity along the jetties, especially in comparison to the popular southwestern beaches of Anastasia island along the river and inlet.

Brief History of Fort Matanzas National Monument

Spanish colonial history in Florida (mid-sixteenth to early nineteenth centuries) involved crucial events around the Matanzas Inlet (Manucy 1943; Schesventer et al. 1980; Chandler 2002). The name Matanzas, the Spanish word for slaughters, reflects the violent history of the area – specifically, the massacre of 245 French soldiers in 1565 under the orders of Pedro Menéndez de Avilés. On two occasions, soldiers trying to reach Fort Caroline (near present-day Jacksonville) had shipwrecked in the inlet and surrendered to the Spanish. As "heretics" (Huguenots or Protestants) and a threat to Catholic Spanish colonization in Florida, they were subsequently executed behind the dunes on Anastasia Island.

A sentry post at Matanzas with no armament was erected by 1569 as part of a series of lookouts along the uninhabited Matanzas Inlet. The wooden watchtower was not optimal for weathering the warm temperatures and high humidity. The well preserved stone-masonry fort standing on present-day Rattlesnake Island (see photograph in lower right of Fig. 3) was constructed in 1740–1742. Fort Matanzas, designed by engineer Pedro Ruiz de Olano, is a simple, two-story, square structure: 49.5 ft (15.0 m) on each side with a 12 ft (3.7 m) gundeck with two 4 ft (1.2 m) tall parapets (east and west sides) and 30 ft (9.1

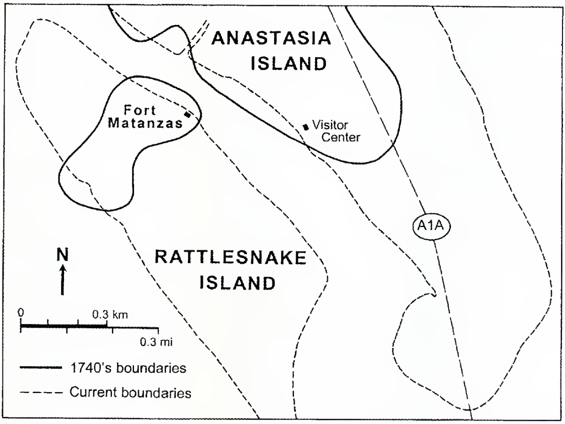


FIG. 2. Perimeter changes of Rattlesnake and Anastasia Islands over 250 years. Island boundaries in the 1740's (when Fort Matanzas was built) modified from Schesventer et al. (1980); present-day boundaries based on St. Johns County GIS Division (2002; also see Fig. 3).

m) tower (north side; Schesventer et al. 1980). The foundation originally comprised a system of closely-set pine pilings, driven deeply into the marshy substrate. The walls are coquina blocks comprising native shellstone (mainly *Donax variabilis*) probably quarried from El Peñón (within present-day Summer Haven) and originally were covered with mortar made of lime from burnt oyster shells, mixed with sand and water.

Fort Matanzas was armed with five cast iron cannon and usually manned by seven to 10 soldiers but could accommodate a planned maximum of 50 soldiers. The men were assigned to the fort for one-month duty tours as part of their regular rotation among the outposts and missions near St. Augustine. They had to bring supplies to last the whole month on small boats from St. Augustine; drinking water was either transported by boat or collected into a cistern as rainwater fell on the observation deck of the fort.

The strategic location of Fort Matanzas at the mouth of Matanzas Inlet helped maintain Spanish control of the waterway and served as a sentry to warn garrisons at St. Augustine about potential enemies approaching from the south

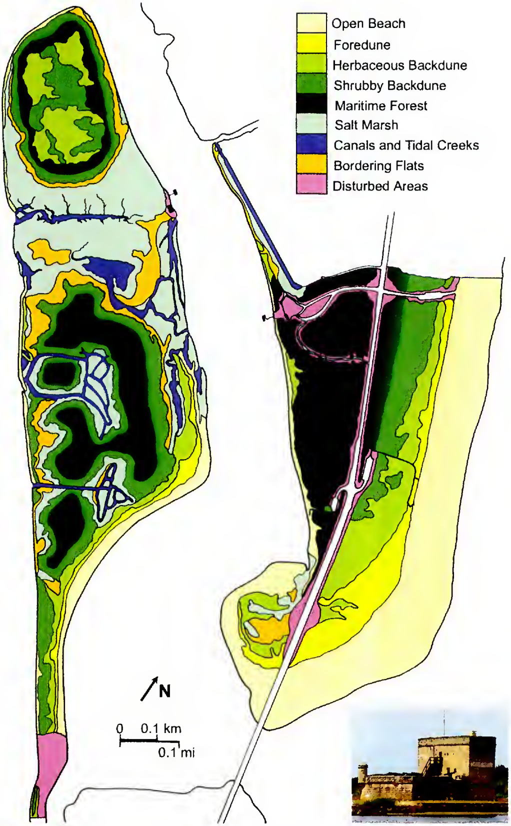


FIG. 3. General vegetation map of Fort Matanzas National Monument based on satellite imagery (St. Johns County GIS Division 2002) and field observations. Lower right: photograph of east face of Fort Matanzas. Photo credit: Wendy B. Zomlefer.

via the Matanzas River. The fort also functioned as a rest stop, coast guard station, and a place where Spanish vessels headed to St. Augustine could be advised on navigating the river. The inlet was close enough to Fort Matanzas that ships trying to enter the inlet came within range of the fort's guns. However, soldiers fired the fort cannons in battle only once, in 1742, thwarting two British vessels attempting to gain the inlet.

Over the next hundred years, Florida became a diplomatic pawn (Gold 1969). Fort Matanzas suffered periods of neglect during subsequent British (1763–1784) and second Spanish (1784–1821) occupations. The aging fort posed serious maintenance problems (Krakow 1986). By the late 1700's, the east foundation, facing the Matanzas River, was eroding. By the time Spain deeded Florida to the United States in 1819, the fort was so badly deteriorated that soldiers could no longer live inside.

The United States formally took possession in 1821 but never occupied the fort. At this time Fort Matanzas became the administrative property of the War Department as a national military park. By the turn of the twentieth century, the fort was overgrown with vegetation, including mature shrubs and trees, such as *Juniperus virginiana*, *Myrica cerifera*, and *Quercus virginiana* growing from the gundeck (Bryant 1872; Schesventer et al. 1980). The walls were cracked, and the south side leaned precariously on a weakened foundation undermined by the tides. In 1916, funds were granted by Congress for management and stabilization of the structure under a contract between the War Department and the St. Augustine Historical Society and Institute of Science (Krakow 1986). In 1924 President Calvin Coolidge proclaimed Fort Matanzas a national monument (Executive Proclamation No. 1713), and three years later the land around the fort was assigned to the Department of Agriculture as a bird refuge (Executive Order No. 4704).

President Franklin D. Roosevelt issued Executive Order No. 6166 in 1933, transferring Fort Matanzas (and other military parks and cemeteries) to the National Park Service, Department of the Interior. Over the past seventy years, the NPS has overseen extensive restoration, including installation of stainless steel rods that hold the upper portion of the fort together (Schesventer et al. 1980; Chandler 2002). As a result of these preservation efforts, Fort Matanzas, a unique relic of military architecture in the United States, retains its basic historic structure. Shoreline stabilization also requires constant vigilance. The original national monument site consisted of only the fort on Rattlesnake Island, but through the years, NPS has acquired additional land on both Rattlesnake and Anastasia Islands (see Krakow 1986), thereby preserving an intact (and imperiled) barrier island ecosystem.

MATERIALS AND METHODS

The first authors, PI Giannasi and coPI Zomlefer, lead four intensive field trips in 2003 (28–30 May, 29–31 July, 26–27 September) and 2004 (12–13 April) to collect vascular plant specimen vouchers in triplicate using standard field and herbarium techniques (under NPS collecting permit #FOMA-2003-SCI-0005) with assistance of the coauthors and other personnel listed in the acknowledgments. Plant associations were also assessed. A complete set of vouchers is deposited at GA, and one duplicate set at FLAS. The second duplicate set has not yet been distributed pending resolution of issues concerning NPS ownership of voucher specimens. The floras of Wunderlin & Hansen (2000, 2003) were primary sources for plant identification, supplemented by Godfrey & Wooten (1979, 1981). The majority of plants were identified by WBZ and DEG; coauthor LMK identified most ferns, grasses, and sedges; and coauthor WSJ confirmed other problematic determinations.

RESULTS AND DISCUSSION

Floristics

The 485 numbered collections (194 from Rattlesnake Island, 291 from Anastasia Island) comprise 237 species (plus two varieties): 125 species from Rattlesnake Island and 197 from Anastasia Island (see ANNOTATED CHECKLIST OF SPECIES below). Included in the list are 14 species planted around park headquarter buildings on Anastasia Island (indicated as "CULT"); *Zamia pumila*, a native species, occurs naturally in the park and is also cultivated there, and *Severinia buxifolia* is cultivated and has also escaped to the nearby hammock. The largest families are Poaceae (32 spp.), Asteraceae (28 spp.), Fabaceae (14 spp.), Amaranthaceae s.l. (9 spp.), Euphorbiaceae (9 spp.), and Rubiaceae (8 spp.). With completion of this survey, we have vouchered 57 new county records (53 species and four varieties) for St. Johns County, Florida, according to Wunderlin and Hansen (2004). No Florida endemics (Wunderlin & Hansen 2003) nor any state/federally listed endangered/threatened plants (Coile & Garland 2003; U.S. Fish and Wildlife Service 2004) were found. However, *Zamia pumila* (Florida arrowroot, coontie), which occurs naturally in the backdune/maritime hammock habitats (also planted around park headquarters), is a state listed "commercially exploited plant" (Coile & Garland 2003). In addition, harvesting *Uniola paniculata* (seaoats) is prohibited by Florida Statute 370.041 (State of Florida 2004) because of this species' crucial role as a dune builder and stabilizer.

Excluding the 12 cultivated exotics, the remaining 46 introduced species represent 20.4% of the total and include five listed as invasive exotics (FLEPPC 2004). Four (*Asparagus aethiopicus*, *Cinnamomum camphora*, *Nephrolepis cordifolia*, *Lantana camara*) are ranked as Category I (invasive exotics altering native plant communities by displacing native species, changing community structures/ecological functions, or hybridizing with natives), and one, *Pteris vittata*, as Category II (invasive exotics increasing in abundance/frequency but not yet altered Florida plant communities to the extent shown by Category I plants). In addition, *Schinus terebinthifolius* (Brazilian pepper), another Category I plant, had recently been extirpated by NPS personnel from the southern portion of Rattlesnake Island; reinvasion is possible, however, from fruiting plants observed by the authors near some homes adjacent to the park boundary. The one colony of *Nephrolepis cordifolia* (tuberous sword fern) growing on the edge of the forest near park headquarters (Anastasia Island) was sprayed by park personnel with herbicide the day after we collected vouchers; aggressive efforts to eradicate *Asparagus aethiopicus* (Sprenger's asparagus-fern) from the boat dock area were also underway. The relatively few plants of *Lantana camara* (lantana) occur sporadically in disturbed areas and occasionally in the backdune community. The one cultivated tree of *Cinnamomum camphora* (camphortree) is near maintenance buildings adjacent to the hammock. The cliff fern *Pteris vittata* (Chinese ladder brake), a significant arsenic hyperaccumulator (Ma et al. 2001), grows on the outer walls of Fort Matanzas and would require careful, probably mechanical, removal since the rhizomes deeply penetrate the precious coquina.

Plant Communities

The six major community types of the study area (open beach, foredune, backdune, maritime forest, salt marsh, and disturbed areas), discussed below and depicted in Figs. 3 to 5, are based upon satellite imagery (St. Johns County GIS Division 2002), our field observations, and classifications of similar areas by FNAI (1990), Johnson and Barbour (1990), Montague and Wiegert (1990), and Easley and Judd (1993). Barrier islands are dynamic habitats: zonation of species from the coast inland is controlled by the tolerance of plant growth habits to salt spray and sand burial, as well as wave-driven erosion and overwash (Leatherman 1988; Johnson & Barbour 1990). Overall species diversity is low, and several species may occur in more than one community. These maritime habitats are fairly uniform but may intergrade in the study area. We, therefore, have also designated several habitat subcategories to accommodate certain ecotones (Fig. 3): herbaceous backdune, shrubby backdune/maritime forest, and bordering flats (of the salt marsh).

Open Beach.—This area, also referred to as upper beach (e.g., Johnson & Barbour 1990), comprises exposed sandy beach up to the high tide line. High energy waves pound the shoreline and deposit sand grains, forming the beach. Anastasia Island has a well-developed open beach along the Atlantic Ocean, Matanzas Inlet, and the southwestern tip bordering Matanzas River (Figs. 3, 4A). The open beach along Rattlesnake Island, however, is more limited and is best developed along the southeastern shore along the river. Coastal perimeter and sandbar development varies with the tides and sand deposition, especially along the southern hook of Anastasia Island (Fig. 3). This habitat is generally

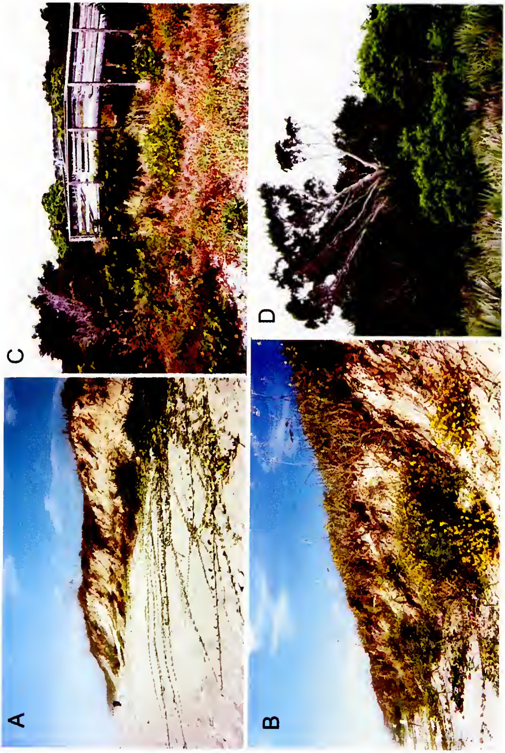


Fig. 4. Plant communities of Fort Matanzas National Monument Park. **A.** Open beach (eastern Anastasia Island): ramets of *Ipomoea pres-caprae* and *I. imperati* growing perpendicular to the ocean shore. **B.** Foredune (eastern Anastasia Island): *Ipomoea pes-caprae* and *Chamaecrista fasciculata* (below); *Croton punctatus*, *Heterotheca subaxillaris*, and *Uniola paniculata* (above). **C.** Herbaceous backdune (western Anastasia Island) at boardwalk entrance, west S. R. A1A: *Gaillardia pulchella*, *Helianthus debilis*, *Muhlenbergia capillaris*, and *Polypremum procumbens* (foreground); shrubby backdune vegetation (background). **D.** Shrubby backdune (eastern Rattlesnake Island): *Iva frutescens* and *Serenoa repens* (foreground); *Juniperus virginiana* and *Ilex vomitoria* (background). Photo credits: **A,** David E. Giannasi; **B–D,** Wendy B. Zomlefer.

unvegetated with the exception of ramets of *Ipomoea imperati* and *I. pes-caprae* that may trail over the high tide line on Anastasia Island (Fig. 4A) where vehicles are allowed on the beachfront but not near inland dune vegetation.

Foredune.—This plant community, also called beach dune (FNAI 1990) or ocean beach (Easley & Judd 1993), includes terraces, overwash, and blowout sites adjacent to the beach itself (Johnson & Barbour 1990) and is a mobile and harsh environment sparsely to densely vegetated with pioneer species, especially seaoats ("seaoats zone," *Uniola paniculata*). The foredune forms as sand accumulates around plants. These sand particles, compared to those of the adjacent open beach, are smaller due to selective uplifting by wind. The vegetation must, therefore, tolerate burial by sand, as well as exposure to wind, salt spray, intense sunlight, and storms. Dune height is determined by wind strength and growth habits of certain dune-forming plants. Plants continuously recolonize the habitat due to periodic disturbance by waves from storms and high tides (Oertel & Larsen 1976). This community is particularly vulnerable to human impact: large gaps or blowouts in the foredune from footpaths or off-road vehicle trails destabilize the substrate, thereby providing opportunities for erosion by wind and water.

The foredune community is best developed as a distinct border between the open beach and much higher backdune (described below) along the Atlantic coast and southern hook of Anastasia Island (Figs. 3, 4B). The fragile system on Anastasia Island is protected from trampling by two boardwalks over the dunes (Fig. 1B); direct public access by foot or vehicle is forbidden. On Rattlesnake Island, this vegetation often intergrades with backdune and occurs mainly along the river beach (Fig. 3).

Foredune habitats in the study area have been usually built by *Uniola paniculata*, as well as two other dune grasses, *Panicum amarum* and *Spartina patens*. The growth of these species is stimulated by sand burial, with vertical growth keeping pace with burial, and lateral growth via runners forming a continuous dune ridge (Wagner 1964). The colonial and succulent morning-glories, *Ipomoea imperati* and *I. pes-caprae*, are usually the first invaders of foredune and beach after storm erosion. The plants produce long stolons that creep across the barren sands at right angles to the coast (Fig. 4A), ensuring ramets both on the old and newest foredunes (Johnson & Barbour 1990). Other pioneer species (often succulent), consistently found seaward of the foredune, include: *Atriplex cristata*, *Cakile edulenta*, *Cakile lanceolata*, *Cenchrus tribuloides*, *Chamaesyce bombensis*, *Gaillardia pulchella*, *Helianthus debilis*, *Iva imbricata*, *Salsola kali*, *Sesuvium portulacastrum*, and *Sporobolus virginicus*. *Croton punctatus*, *Hydrocotyle bonariensis*, *Oenothera humifusa*, *Phyllanthus abnormis*, and *Physalis walteri* are examples of wider-ranging species also characteristic of this zone. Several common weedy species, such as *Chenopodium ambrosioides*, *Chamaesyce maculata*, and *Heterotheca subaxillaris* also thrive on the foredunes; dense patches of *Distichlis spicata* occur in several wetter areas. Shrubby plants with lower salt tolerance, such as *Ilex vomitoria* and *Serenoa repens*, typically grow on the lee side of the foredunes where they are somewhat protected from sand burial and salt spray.

Backdune.—The backdune, also called the transitional zone (Johnson & Barbour 1990), coastal strand (FNAI 1990), open shrubby interior, maritime thicket, and coastal scrub (FNAI 1990; Easley & Judd 1993), is an ecotonal community generally occurring between foredune and maritime hammock and shares many species of both. These deep, stabilized, wind-deposited coastal dunes are covered with variable, often patchy, vegetation. Backdune communities are generally stable, and as prime beachfront real estate property, comprise one of the most rapidly disappearing community types in Florida (FNAI 1990). Originally a nearly continuous band along the Atlantic coast, backdune now occurs in isolated short stretches.

Along eastern Anastasia and Rattlesnake Islands, backdune comprises herbs to low shrubs (Fig. 4C, D) plus adjacent regions covered with low, dense, often impenetrable woody vegetation intergrading with maritime hammock community to the west (Fig. 5A). Therefore, the backdune habitat of the study area is here divided into two, more or less, well-demarcated subzones (discussed below), herbaceous backdune and shrubby backdune.

Herbaceous backdune zone.—This backdune zone, immediately bordering the foredune (Fig. 4C), is characteristically a broad flat area occupied by a mixture of herbs, often low-growing, including *Chamaecrista fasciculata*, *Gaillardia pulchella*, *Helianthus debilis*, *Heterotheca subaxillaris*, *Hydrocotyle bonariensis*, *Ipomopsis rubra*, *Iresine rhizomatosa*, *Opuntia pusilla*, *Opuntia stricta*, *Solanum chenopodioides*, and *Strophostyles helvola*, as well as several predominant grasses: *Andropogon glomeratus*, *Muhlenbergia capillaris*, *Spartina patens*, and *Uniola paniculata*. Some low shrubby plants, such as *Borrichia frutescens* and *Iva imbricata* may also occur. As in the foredune, many backdune species are succulent, have thickened cuticles, root readily from fragments, produce floating seeds, and/or spread by runners.

Shrubby backdune zone/maritime hammock.—Further inland, the backdune community commonly comprises a low, dense, often impenetrable thicket of salt-tolerant shrubs and small trees. The characteristic pruned and dwarfed form of these woody plants (see *Juniperus* in Fig. 4D) results from salt-spray laden winds that kill terminal buds on twigs facing the sea (Johnson & Barbour 1990). In the study area, this shrubby backdune zone (Figs. 3, 4D) gradually intergrades with maritime hammock, especially on the northwestern Anastasia Island portion of the park. Characteristic shrubby species (also often in forest understory) include: *Baccharis halimifolia*, *Ilex vomitoria*, *Iva frutescens*, *Myrica cerifera*, and *Sideroxylon tenax*; *Serenoa repens* commonly favors the

Fig. 5. Plant communities of Fort Matanzas National Monument Park, continued. **A.** Maritime forest (western Anastasia Island): *Serenoa repens* (understory); *Quercus virginiana* branches covered with *Tillandsia usneoides* and *Vitis* spp. vines (overstory). **B.** Salt marsh at high tide (central Rattlesnake Island): pure stand of *Spartina alterniflora*; Fort Matanzas (distant background). **C.** Tidal creek (central Rattlesnake Island) bordered by *Spartina alterniflora* (left) and *Batis maritima* (right). **D.** Bordering flats along salt marsh (east-central Rattlesnake Island): *Muhlenbergia capillaris* and *Eragrostis elliottii* (foreground); *Juniperus virginiana* (right background); Fort Matanzas (central background); *Avicennia germinans* in saltmarsh (small "shrubs," center and far left, distant background). Photo credits: **A,** Alexander Reynolds; **B–D,** Wendy B. Zomlefer.

protected lee slopes and flats behind steeply eroded dunes. *Juniperus virginiana, Persea borbonia, Prunus serotina, Sabal palmetto,* and *Zanthoxylum clava-herculis* are common tree associates. On the northwestern side of the Anastasia Island park area, portions of shorter shrubby backdune are almost completely covered by dense mats of tangled woody vines of *Ampelopsis arborea, Cissus trifoliata, Parthenocissus quinquefolia, Smilax auriculata, Vitis aestivalis,* and *Vitis rotundifolia,* as well as the herbaceous vine, *Mikania cordifolia.* Along the west border of the disturbed area comprising south Rattlesnake Island (see Fig. 3), a narrow strip of shrubby backdune vegetation includes species such as *Chiococca alba, Teucrium canadense, Vigna luteola,* and *Zamia pumila.*

Maritime Hammock.—This vegetation type, the terminal succession stage in these coastal areas, is defined as the impenetrable band of "hardwood" forest just inland of the dune community (Laessle & Monk 1961; Stalter & Dial 1984; FNAI 1990). The habitat is also referred to as coastal hammock (Easley & Judd 1993), stable dune zone, and maritime forest (Johnson & Barbour 1990). The dense wind-pruned canopy over the old, stabilized, white sand-dunes combined with humus buildup contributes to some moisture retention, but soils generally remain well-drained because of underlying deep sand. Many species overlap with those characteristic of the shrubby backdune. As with backdune, maritime hammock is prime resort and residential property and originally was an almost continuous band (with the dune system) along the coast of Florida but is now fragmented by development into short segments (FNAI 1990).

Typical mature maritime forest, best developed along the western coast of Anastasia Island (Figs. 3, 5A), forms a continuum with the shrubby backdune zone to the east (described above). The forest often covers relatively steep terrain, and sometimes the tops of large trees are near eye-level as one stands on the peak of an old dune. The dominant species are *Quercus virginiana* and *Q. geminata,* whose branches are characteristically covered with epiphytes *Pleopeltis polypodioides, Tillandsia recurvata,* and *Tillandsia usneoides. Persea borbonia* is a principal understory tree, along with *Asimina parviflora, Juniperus virginiana, Quercus myrtifolia, Prunus serotina,* and *Sabal palmetto. Callicarpa americana, Ilex vomitoria, Myrica cerifera, Sideroxylon tenax, Serenoa repens, Rhus copallinum,* and *Zamia pumila* are common understory shrubs (or shrubby trees). As in the backdune, woody vines are prevalent (i.e., *Parthenocissus quinquefolia, Smilax auriculata, Smilax bona-nox, Vitis aestivalis, Vitis rotundifolia*); herbaceous understory plants include *Galium hispidulum, Oplismenus hirtellus, Rivina humilis, Ruellia caroliniensis,* and *Teucrium canadense.*

The northern tip and western coastline of Rattlesnake Island, along the Intracoastal Waterway, support a much different maritime forest vegetation lacking oaks and dominated by *Celtis laevigata, Juniperus virginiana, Persea* *borbonia, Pinus elliottii*, and *Sabal palmetto. Pinus elliottii* (10–12 m tall) is more common on the northern portion of the island. Numerous snags of slash pine along the western coast indicate that this once dominant species has been declining and has been replaced by the more common juniper, cabbage palm, and large trees of *Celtis laevigata* that reach heights of over 12 m (0.5–1.0 m dbh). Common understory shrubs (to small trees) include *Ilex vomitoria* (4–5 m tall), *Myrica cerifera, Serenoa repens, Sideroxylon tenax, Zamia pumila*, and *Zanthoxylum clava-herculis. Smilax auriculata* is also common throughout the hammock. The dark forest floor supports little herbaceous understory except for occasional plants of species such as *Bacopa monnieri, Galium hispidulum*, and *Pilea microphylla* in exposed damp areas.

Salt Marsh.—The salt marsh system includes tidal marsh (FNAI 1990), tidal creeks, and bordering flats (Easley & Judd 1993) – distinguished as separate habitat subtypes in Fig. 3 for the study area. Salt marshes in Florida, most abundant north of the normal freeze line, are coastal communities of nonwoody salt-tolerant plants occupying intertidal zones at least occasionally inundated with salt water (Montague & Wiegert 1990). These plants must tolerate poorly aerated saline substrate, frequent submersion, and intense sunlight. Salt marshes develop at the land-marine water interface, especially in regions with low relief, high tidal range, and low wave energy. Therefore, the elevation varies from slightly below to slightly above sea level, with vegetation growing in intertidal and supertidal zones. Salt marsh ecotone functions in sediment stabilization and coastline storm protection. Dense stems and roots of colonizing plants trap sediments from upland runoff, and decaying marsh plant detritus accumulates to form anaerobic layered soils.

Within the park, the salt marsh system is best developed in the north-central portion of Rattlesnake Island, as well as some smaller areas along the east-central and south-central coastlines (Figs. 3, 5B). The salt marsh system here also includes a distinct network of drainage gullies, tidal creeks, and pools (Fig. 5C). Smaller salt marshes also occur within the southwestern tip of Anastasia Island (Fig. 3), as well as the northwestern most strip of the park property along the Matanzas River.

Salt marsh proper (tidal marsh).—Although salt marsh vegetation is often distinctively zoned in other locations (each zone dominated by a different species), large expanses of dense monotypic stands of *Spartina alterniflora* characterize the study area (Fig. 5B). *Juncus roemerianus*, another important indicator species in salt marshes elsewhere in Florida (Montague & Wiegert 1990), only occurs occasionally in a few small patches. *Spartina alterniflora* tends to grow along the deepest portions, grading subtly to other salt-tolerant plants, such as *Batis maritima* (Fig. 5C), *Distichlis spicata, Limonium carolinianum, Sarcocornia perennis (Salicornia perennis), Sesuvium portulacastrum*, and

Suaeda linearis along the edges. Small shrubby trees of *Avicennia germinans* (black mangrove) to 3 m tall (see background in Fig. 5D) also are well established within *Spartina* stands on both Rattlesnake and Anastasia Island. We observed little flowering and fruit set, however: our collections represent the northernmost limit of this tropical species along the east coast of Florida (Wunderlin & Hansen 2004).

***Bordering flats*.**—A distinct flora also characterizes the slightly elevated ridges bordering the salt marsh proper and associated tidal waterways in the study area (Fig. 3; Easley & Judd 1993). These flat sandy meadows (Fig. 5D) are vegetated with scattered herbs (mainly grasses and sedges), including: *Chamaecrista fasciculata, Cynanchum angustifolium, Cyperus esculentus, Cyperus polystachyos, Cyperus retrorsus, Distichlis spicata, Eragrostis elliottii, Fimbristylis spadicea, Juncus dichotomus, Limonium carolinianum, Muhlenbergia capillaris, Opuntia pusilla, Paronychia herniarioides, Pluchea odorata, Portulacca pilosa, Scleria triglomerata, Setaria parviflora, Solidago stricta, Sporobolus virginicus*, and *Triplasis purpurea*, as well as occasional woody species, such as *Borrichia frutescens, Iva frutescens, Juniperus virginiana, Pinus palustris, Prunus serotina*, and *Zanthoxylum clava-herculis*.

Disturbed areas (ruderal community).—On Anastasia Island, disturbed habitats have developed around public-access areas, and on Rattlesnake Island, consist of large Intracoastal Waterway dredge fill areas, land within the network of mosquito control ditches, and Fort Matanzas itself (see Fig. 3). Disturbed areas associated with construction and heavy human use on Anastasia Island (i.e., land bordering S. R. A1A, visitor center/picnic tables, parking lots, park headquarters/roads) have few species in common with the habitats discussed in the preceding sections. Common weedy plants occurring primarily in these disturbed areas include: *Acalypha graciliens, Andropogon glomeratus, Cenchrus spinifex, Chamaesyce hirta, Chamaesyce hyssopifolia, Conyza canadensis, Croton glandulosus, Cynodon dactylon, Dactyloctenium aegyptium, Indigofera spicata, Lepidium virginicum, Malvastrum corchorifolium, Paspalum setaceum, Phyla nodiflora, Pteridium aquilinum, Salvia lyrata, Sida rhombifolia, Sonchus asper, Spermacoce assurgens, Triodanis perfoliata, Verbena bonariensis*, and *Verbena officinalis*.

The sandy dune-like fill area comprising the northern tip of Rattlesnake island (Fig. 3) has a distinct ring of shrubby backdune/maritime hammock vegetation (e.g., *Celtis laevigata, Iva frutescens, Juniperus virginiana, Pinus elliottii, Sabal palmetto*; discussed above under maritime hammock) enclosing an open center of patchy, herbaceous to shrubby, backdune plants, including *Myrica cerifera, Baccharis halimifolia, Opuntia pusilla, Phyllanthus abnormis, Prunus serotina, Sideroxylon tenax, Uniola paniculata*, and *Zanthoxylum clava-herculis*. Small specimens of *Oxalis corniculata* and *Pteris vittata* were the only plants growing on the coquina walls of Fort Matanzas (northeastern coast) – a stark comparison to the varied and lush flora of 56 species we found covering the walls of Castillo de San Marcos in St. Augustine during the same study period (Zomlefer & Giannasi 2005). The small mowed lawn surrounding the fort comprises *Cynodon dactylon*, *Hydrocotyle bonariensis*, and *Stenotaphrum secundatum*.

The labyrinth of mosquito control ditches in the central southwest portion of the Rattlesnake Island park area (Fig. 3), excavated circa 1950–1960's (D. Parker, pers. comm.), drained large expanses of salt marsh, allowing growth of shrubby backdune and maritime forest (discussed above). The narrow fill area [ca 0.13 mi (0.21 km) long, 0.06 mi (0.10 km) wide, tapering to 0.03 mi (0.05 km); see Fig. 3] forming the southernmost portion Rattlesnake Island park property is an exposed flat ridge of very compact sand bordered by the Matanzas Inlet to the east and the Intracoastal Waterway to the west. This harsh, severely windblown habitat supports an odd flora of stunted plants (e.g., *Opuntia pusilla*, *O. stricta*) and compressed forms of normally upright plants (*Cnidoscolus stimulosus*, *Gaillardia pulchella*, *Oenothera humifusa*, *Phyllanthus abnormis*), as well as sand-hugging rosettes of *Chamaesyce bombensis* and *C. maculata*, large cushions of *Stenaria nigricans*, depauperate strings of *Galactia volubilis*, and hardy scattered tufts of grasses, such as *Cenchrus echinatus* and *Eragrostis secundifolia*.

ANNOTATED CHECKLIST OF VASCULAR PLANT TAXA

A list of 237 vascular plant species representing 189 genera in 73 families is here compiled from *Giannasi & Zomlefer* specimens (collection numbers in *italic*) in alphabetical order by family within three major groups (ferns, gymnosperms, and angiosperms). Genera, species, and infraspecific taxa are alphabetical within each family. Scientific nomenclature and common names follow Wunderlin & Hansen (2003); exceptions are vernacular names of a few horticultural plants (not included in their flora) that conform to Huxley (1992). Family circumscriptions for ferns and gymnosperms follow FNA (1993), and for the angiosperms, APG (2003).

Non-boldface collection number = collection from Anastasia Island; ***boldface collection number*** = collection from Rattlesnake Island; underlined taxa = new vouchered St. Johns County records according to on-line species list by Wunderlin & Hansen (2004); * = exotic (Wunderlin & Hansen 2003); invasive exotics (FLEPPC 2004): [CAT I] = Category I; [CAT II] = Category II; CULT = cultivated, i.e., planted on park grounds. Habitat data: DA = disturbed areas; FD = foredune; HB = herbaceous backdune; MH = maritime hammock; OB = open beach; SB = shrubby backdune; SB/MH = shrubby backdune/maritime hammock ecotone; SM = salt marsh; SM/BF = salt marsh/bordering flats. Relative abundance: c = common (generally abundant throughout a particular habitat; species easily found); o = occasional (locally common and/or several individuals distributed within a habitat; species not too difficult to locate); i = infrequent (sporadic occurrence of a small number of individuals; species relatively scarce and not easily found); r = rare (very few individuals encountered).

FERNS

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) Clute ex A. Heller, Bracken fern, DA; o; *127*

NEPHROLEPIDACEAE

**Nephrolepis cordifolia* (L.) C. Presl, Tuberous sword fern, [CAT I], DA; o; *92*

POLYPODIACEAE

Phlebodium aureum (L.) J.Sm., Golden polypody, FD; r; ***547***

Pleopeltis polypodioides (L.) E. G. Andrews & Windham var. *michauxiana* (Weath.) E. G. Andrews & Windham, Resurrection fern, MH; c; *281*

PTERIDACEAE

Pteris vittata* L., Chinese ladder brake, [CAT II], DA; c; ***55*

GYMNOSPERMS

CUPRESSACEAE

Juniperus virginiana L., Red cedar, MH, SB/MH; c; *11*, ***46***

PINACEAE

Pinus elliottii Engelm., Slash pine, MH, SB/MH; c; *427*, ***544***, ***670***

ZAMIACEAE

Zamia pumila L., Florida arrowroot, MH, SB/MH; o; *284* [CULT], ***391***, *647*

ANGIOSPERMS

ACANTHACEAE

Avicennia germinans (L.) L., Black mangrove, SM; o; ***51***, ***247***, ***392***, *477*

**Justicia brandegeana* Wassh. & L. B. Sm., Shrimpplant, CULT; *529*

Ruellia caroliniensis (J. F. Gmel.) Steud., Carolina wild petunia, MH; i; *276*

ADOXACEAE

Sambucus nigra L. subsp. *canadensis* (L.) R. Bolli, American elder, DA; o; *130*

**Viburnum odoratissimum* Ker Gawl., Sweet viburnum, CULT; *593*

AGAVACEAE

Yucca aloifolia* L., Spanish bayonet, HB, MH, SM/BF; r; ***268*, *516*, *645*

AIZOACEAE

Sesuvium portulacastrum (L.) L., Shoreline seapurslane, FD, SM/BF; o; *16*, ***409***, *439*

AMARANTHACEAE

Atriplex cristata Humb. & Bonpl. ex Willd., Crested saltbush, FD, SM/BF; o; ***244***, ***402***, ***413***, *440*

Blutaparon vermiculare (L.) Mears, Samphire, FD; i; ***659***

**Chenopodium album* L., Lamb'squarters, DA; i; *602*

**Chenopodium ambrosioides* L., Mexican tea, DA; o; *128*

**Gomphrena serrata* L., Globe amaranth, DA; r; *603*

Iresine rhizomatosa Standl., Rootstock bloodleaf, FD, HB; o; *431*, *468*

Salsola kali* L. subsp. *pontica* (Pall.) Mosyakin, Prickly Russian thistle, FD; o; ***64*, ***72***, *115*, *452*, ***543***

Sarcocornia perennis (Mill.) A. J. Scott, Perennial glasswort, SM, SM/BF; c; ***21***, *480*, ***545*** [= *Salicornia perennis* Mill.: The segregation of the perennial from the annual species of *Salicornia* may render *Sarcocornia* paraphyletic, and *Salicornia* s.l. (including both perennial and annual species) is likely monophyletic on the basis of the truncate perianth apices, pubescent nonperispermous seeds, and membranous testa (Judd & Ferguson 1999).]

Suaeda linearis (Elliott) Moq., Sea blite, SM, SM/BF; o; *475*, *476*

AMARYLLIDACEAE

**Crinum asiaticum* L., Poisonbulb, CULT; *280*

ANACARDIACEAE

Rhus copallinum L., Winged sumac, MH; o; *321*, *519*

ANNONACEAE

Asimina parviflora (Michx.) Dunal, Smallflower pawpaw, MH; o; *3*, *319*, *518*

APIACEAE

Ptilimnium capillaceum (Michx.) Raf., Mock bishopsweed, DA; i; *600*

APOCYNACEAE

Cynanchum angustifolium Pers., Gulf coast swallowwort, SM, SM/BF; i; ***26***, ***70***, ***404***
**Nerium oleander* L., Oleander, CULT; *410*

AQUIFOLIACEAE

Ilex vomitoria Aiton, Yaupon, MH, SB, SB/MH; c; *13*, ***59***, *110*, *323*, *621*, *624*, *648*

ARALIACEAE

Hydrocotyle bonariensis Comm. ex Lam., Largeleaf marshpennywort, DA, FD; c; ***52***, *90*, *113*, *122*

ARECACEAE

Sabal palmetto (Walter) Lodd. ex Schult. & Schult. f., Cabbage palm, MH, SB/MH; c; ***49***
Serenoa repens (W. Bartram) Small, Saw palmetto, MH, SB, SB/MH; c; ***50***, *324*, *465*

ASPARAGACEAE

**Asparagus aethiopicus* L., Sprenger's asparagus-fern, DA; o; [CAT I]; *19*

ASTERACEAE

Ageratina jucunda (Greene) Clewell & Wooten, Hammock snakeroot, MH; i; *504*
Ambrosia artemisiifolia L., Common ragweed, DA; c; *290*
Baccharis angustifolia Michx., Saltwater falsewillow, SB; r; ***657***
Baccharis halimifolia L., Groundsel tree, DA, MH, SB; o; *494*, ***682***
Bidens alba (L.) DC. var. *radiata* (Sch. Bip.) R. E. Ballard ex Melchert, Beggarticks, DA; o; *133*
Borrichia frutescens (L.) DC., Bushy seaside oxeye, FD, SB, SM/BF; o; ***54***, ***407***, *626*
**Calyptocarpus vialis* Less., Straggler daisy, DA; r; *509*
Cirsium horridulum Michx., Purple thistle, DA, SB; o; *500*, *623*
Conyza canadensis (L.) Cronquist var. *canadensis*, Canadian horseweed, DA, HB; o; ***251***, *490*, ***535***
Erechtites hieracifolius (L.) Raf. ex DC., American burnweed, DA; o; ***25***, *446*
Erigeron quercifolius Poir., Oakleaf fleabane, DA, HB; o; *611*
Eupatorium capillifolium (Lam.) Small ex Porter & Britton, Dogfennel, SM/BF; r; ***538***
Gaillardia pulchella Foug., Firewheel, FD, HB; c; ***80***, *102*, *454*
Gamochaeta antillana (Urban) A. Anderberg, Narrowleaf purple everlasting, DA; o; *608*, ***651*** [*Gamochaeta falcata* (Lam.) Cabrera, misapplied (R. Wunderlin, pers. comm.), as in Wunderlin & Hansen (2003): The correct name for the species in the southeastern United States is clarified by Nesom (2004).]
Helianthus debilis Nutt. subsp. *debilis*, East coast dune sunflower, FD, HB; c; ***79***, *103*
Heterotheca subaxillaris (Lam.) Britton & Rusby, Camphorweed, DA, FD, HB; c; ***389***, *497*, *503*
Iva frutescens L., Bigleaf sumpweed, SB, SB/MH; c; ***267***
Iva imbricata Walter, Seacoast marshelder, FD, HB; o; ***246***, ***398***
Krigia virginica (L.) Willd., Virginia dwarfdandelion, HB; r; ***652***
Lactuca graminifolia Michx., Grassleaf lettuce, DA; r; ***634***
Mikania cordifolia (L. f.) Willd., Florida Keys hempvine, SB; o; *470*
Pluchea odorata (L.) Cass., Sweetscent, SM/BF; i; ***397***
Solidago odora Aiton var. *chapmanii* (A. Gray) Cronquist, Chapman's goldenrod, DA; r; *502*
Solidago stricta Aiton, Wand goldenrod, DA, SM/BF; i; *530*, ***560***
**Sonchus asper* (L.) Hill, Spiny sowthistle, DA; i; *510*, *607*
Sonchus oleraceus* L., Common sowthistle, DA; i; ***635*
**Taraxacum officinale* Weber ex F. H. Wigg., Common dandelion, DA; r; *663*, *672*
**Youngia japonica* (L.) DC., Oriental false hawksbeard, DA; i; *644*

BATACEAE

Batis maritima L., Saltwort, SM; c; ***20***, ***248***, *479*

BORAGINACEAE

Heliotropium curassavicum L., Seaside heliotrope, FD; r; ***245***

BRASSICACEAE

Cakile edulenta (Bigelow) Hook. subsp. *harperi* (Small) Rodman, American searocket, FD, HB, SM/BF; c; ***73***, *114*, *618*, *627*, ***661***
Cakile lanceolata (Willd.) O. E. Schultz, Coastal searocket, FD; i; *98*

**Coronopus didymus* (L.) Sm., Lesser swinecress, DA; r; *604*
Descurainia pinnata (Walter) Britton, Western tansymustard, DA; r; *606*
Lepidium virginicum L., Virginia pepperweed, DA, HB, SM/BF; i; ***24***, ***35***, ***548***, *620*

BROMELIACEAE

**Neoregelia spectabilis* (Moore) L.B Sm., Painted fingernail, CULT; *523*
Tillandsia recurvata (L.) L., Ballmoss, MH; o; *522*
Tillandsia usneoides (L.) L., Spanish moss, MH; c; *309*

CACTACEAE

Opuntia pusilla (Haw.) Haw., Cockspur pricklypear, DA, FD, SM/BF; c; ***48***, ***266***, *492*
Opuntia stricta (Haw.) Haw., Erect pricklypear, DA, HB, SB, SM/BF; c; ***71***, ***75***, *116*, *438*

CAMPANULACEAE

Triodanis perfoliata (L.) Nieuwl., Clasping Venus' lookingglass, DA; r; *605*

CANNABACEAE

Celtis laevigata Willd., Sugarberry, MH; c; ***660***

CARYOPHYLLACEAE

Paronychia baldwinii (Torr. & A. Gray) Fenzl ex Walp., Baldwin's nailwort, SM/BF; r; ***537***
Paronychia herniarioides (Michx.) Nutt., Coastalplain nailwort, SM/BF; i; ***259***
Stellaria media* (L.) Vill., Common chickweed, DA; o; ***637*, *643*, *665*

COMMELINACEAE

**Commelina diffusa* Burm. f. var. *diffusa*, Common dayflower, DA; r; *673*
Commelina erecta L., Whitemouth dayflower, DA, HB; i; ***61***, *96*, *243*
Tradescantia ohiensis Raf., Bluejacket, DA; o; *1*, *458*

CONVOLVULACEAE

Dichondra caroliniensis Michx., Carolina ponysfoot, HB; i; ***654***, *671*
Ipomoea batatas* (L.) Lam., Sweetpotato, DA; r; ***460*
Ipomoea cordatotriloba Dennst., Tievine, DA; i; *505*
Ipomoea imperati (Vahl) Griseb., Beach morning-glory, FD, OB; c; *95*
Ipomoea pandurata (L.) G. Mey., Man-of-the-earth, DA; r; *459*
Ipomoea pes-caprae (L.) R. Br., Railroad vine, FD, OB; c; *97*
**Merremia dissecta* (Jacq.) Hallier f., Noyau vine, DA; r; *101*, *289*

CYPERACEAE

Cyperus esculentus* L., Yellow nutgrass, SM/BF; o; ***29*, ***69***
Cyperus polystachyos Rottb., Manyspike flatsedge, DA, SM/BF; o; ***28***, ***419***, *455*
Cyperus retrorsus Chapm., Pinebarren flatsedge, HB, SM/BF; o; ***36***, ***37***, ***38***, ***260***, ***261***, ***557***
Cyperus tetragonus Elliott, Fourangle flatsedge, DA; i; *310*, *521*
Fimbristylis spadicea (L.) Vahl, Marsh fimbry, DA, SM/BF; o; ***31***, ***264***, *424*, ***540***
Scleria triglomerata Michx., Tall nutgrass, DA, SM/BF; r; ***263***, *312*

EBENACEAE

Diospyros virginiana L., Common persimmon, MH; r; *501*

ERICACEAE

**Rhododendron simsii* Planch., Indian azalea, CULT, *642*

EUPHORBIACEAE

Acalypha gracilens A. Gray, Slender threeseed mercury, DA; i; *526*
Chamaesyce bombensis (Jacq.) Dugand, Dixie sandmat, DA, OB, FD; c; ***62***, ***422***, *463*
Chamaesyce hirta (L.) Millsp., Pillpod sandmat, DA; i; *301*
Chamaesyce hyssopifolia (L.) Small, Hyssopleaf sandmat, DA, HB; o; *491*, *508*
Chamaesyce maculata (L.) Small, Spotted sandmat, HB; c; ***39a***
Cnidoscolus stimulosus (Michx.) Engelm. & A. Gray, Tread softly, DA, FD; c; ***76***, *106*
Croton glandulosus L. var. *glandulosus*, Vente conmigo, DA, HB; o; *302*, ***399***, *428*, *482*, *527*
Croton punctatus Jacq., Gulf croton, FD; c; ***45***, *112*, *441*
Poinsettia cyathophora (Murray) Bartl., Paintedleaf, DA, HB; i; *17*, *94*, *135*, ***406***, *447*, *493*

FABACEAE

Centrosema virginianum (L.) Benth., Spurred butterfly pea, DA, HB; o; *291*, ***405***
Chamaecrista fasciculata (Michx.) Greene, Partridge pea, FD, HB; c; ***65***, *105*, ***258***
**Desmodium tortuosum* (Sw.) DC., Dixie ticktrefoil, DA; r; *478*

Erythrina herbacea L., Coralbean, DA, HB; r; *430, 616, 628*

Galactia volubilis (L.) Britton, Downy milkpea, DA; o; ***81***, *288*, ***396***

**Indigofera hirsuta* L., Hairy indigo, DA; r; *481*

**Indigofera spicata* Forssk., Trailing indigo, DA; i; *303, 425*

Medicago lupulina* L., Black medick, DA; o; *601*, ***631*

Medicago polymorpha* L., Burrclover, DA; o; ***630*, *667*

Melilotus albus* Medik., White sweetclover, DA; o; ***82*, *617, 629*

Meliotus indicus* (L.) All., Indian sweetclover, DA; i; *614*, ***633*

**Senna obtusifolia* (L.) H.S. Irwin & Barneby, Coffeeweed, HB, r; *597*

Strophostyles helvola (L.) Elliott, Trailing fuzzybean, DA, FD, HB, SM/BF; c; ***32***, ***86***, *119*, ***390***, *437, 471, 487*

Vigna luteola (Jacq.) Benth., Hairypod cowpea, DA; o; ***388***, *483*

FAGACEAE

Quercus chapmanii Sarg., Chapman's oak; MH; i; *669*

Quercus geminata Small, Sand live oak, MH, SB/MH; c; *318, 644*

Quercus myrtifolia Willd., Myrtle oak, MH, SB/MH; o; *275, 316*

Quercus virginiana Mill., Live oak, MH, SB/MH; c; *317*

GERANIACEAE

Geranium carolinianum L., Carolina cranesbill, DA; i; *619*

HYPERICACEAE

Hypericum gentianoides (L.) Britton et al., Pineweed, SM/BF; r; ***534***

Hypericum hypericoides (L.) Crantz, St. Andrew's-cross, SB, MH, SM/BF; i; *277, 436*, ***536***

JUGLANDACEAE

**Carya illinoinensis* (Wangenh.) K. Koch, Pecan, CULT; *2*

JUNCACEAE

Juncus dichotomus Elliott, Forked rush, SM/BF; o; ***272***

Juncus roemerianus Scheele, Black rush, SM, SM/BF; o; ***27***, ***394***

LAMIACEAE

Callicarpa americana L., American beautyberry, MH; o; *6*

**Hyptis mutabilis* (Rich.) Briq., Tropical bushmint, DA; i; *296*

Monarda punctata L., Spotted beebalm, DA, HB; o; *283, 297, 472, 484*

Salvia lyrata L., Lyreleaf sage, DA; o; *5, 495, 594*

Stachys floridana Shuttlew. ex Benth., Florida hedgenettle, DA; i; *598*

Teucrium canadense L., Wood sage, SB, MH; o; *311*, ***423***

Trichostema dichotomum L., Forked bluecurls, HB, SM/BF; i; ***249***, ***421***, *485*

LAURACEAE

**Cinnamomum camphora* (L.) J. Presl, Camphortree, [CAT I], CULT; *638*

Persea borbonia (L.) Spreng., Red bay, MH, SB/MH; c; *7*, ***89***, *107*, ***255***, *322, 467, 486*

MAGNOLIACEAE

Magnolia grandiflora L., Southern magnolia, MH; r; *677*

MALVACEAE

Malvastrum corchorifolium (Desr.) Britton ex Small, False mallow, DA; i; *131*

**Malvastrum coromandelianum* (L.) Garcke, Threelobe false mallow, DA; i; *294, 512*

**Malvaviscus penduliflorus* DC., Turkscap mallow, CULT; *517* (Persisting after cultivation near maintanence road entrance.)

Sida rhombifolia L., Cuban jute, DA; o; *295, 511*

MORACEAE

Morus rubra L., Red mulberry, MH; r; *552*

MYRICACEAE

Myrica cerifera L., Southern bayberry, MH, SB, SB/MH; c; *279, 448, 514*, ***656***

NYCTAGINACAE

Boerhavia diffusa* L., Red spiderling, DA; o; *304

OLEACEAE

Forestiera segregata (Jacq.) Krug & Urb., Florida swampprivet, SB; i; ***416***

**Jasminum mesnyi* Hance, Japanese jasmine, CULT; *675*

ONAGRACEAE

Gaura angustifolia Michx., Southern beeblossom, DA, FD; c; *313*, ***395***

Oenothera humifusa Nutt., Seabeach eveningprimrose, DA, FD; c; *18*, ***87***, *124*

Oenothera laciniata Hill, Cutleaf eveningprimrose, DA; r; *609*

**Oenothera speciosa* Nutt., Pinkladies, DA; i; *595*

OXALIDACEAE

Oxalis corniculata L. (incl. *O. stricta* L.), Common yellow woodsorrel, DA, HB; c; ***56***, *461*

**Oxalis rubra* A. St.-Hil., Windowbox woodsorrel, DA; i; *596*, *674*

PHYLLANTHACEAE

Phyllanthus abnormis Baill., Drummond's leafflower, DA, FD, HB; c; ***39b***, ***88***, *104*, ***253***, *293*, *434*

**Phyllanthus tenellus* Roxb., Mascarene Island leafflower, DA, HB; i; *91*, *462*

PHYTOLACCACEAE

Phytolacca americana L. var. *rigida* (Small) Caulkins & Wyatt, American pokeweed, DA, HB; i; *15*, *429* [This distinct geographical race, previously included in the flora by Wunderlin (1998) but not in the recent edition (Wunderlin & Hansen 2003), merits recognition (see Caulkins & Wyatt 1990).]

Rivina humilis L., Rougeplant, MH; i; *282*

PLANTAGINACEAE

Bacopa monnieri (L.) Pennell, Herb-of-grace, SM/BF; o; ***400***, ***546***

Linaria canadensis (L.) Chaz., Canada toadflax, HB; i; ***74***, ***662***

Plantago virginica L., Virginia plantain, DA; i; *615*, ***649***

Scoparia dulcis L., Sweetbroom, HB, SM/BF; i; ***408***, *498*

PLUMBAGINACEAE

Limonium carolinianum (Walter) Britton, Carolina sealavender, SM, SM/BF; o; ***252***, ***539***

POACEAE

Andropogon glomeratus (Walter) Britton et al. var. *hirsutior* (Hack.) C. Mohr, Bushy bluestem, DA; c; *457*

Andropogon glomeratus var. *pumilus* (Vasey) Vasey ex L. H. Dewey, Bushy bluestem, DA, HB; c; *506*, ***658***

Andropogon virginicus L. var *virginicus*, Broomsedge bluestem, DA; i; *507*

Cenchrus echinatus L., Southern sandbur, DA, FD; i; ***66***, ***411***, *451*

Cenchrus gracillimus Nash, Slender sandbur, DA; o; ***53***, ***84***, *117*

Cenchrus spinifex Cav., Coastal sandbur, DA; o; *305*

Cenchrus tribuloides L., Sanddune sandbur, FD; i; *123*, *450*

**Cynodon dactylon* (L.) Pers., Bermudagrass, DA; c; *307*

Dactyloctenium aegyptium* (L.) Willd. ex Asch. & Schweinf., Durban crowfootgrass, DA; o; ***420*, *466*

Dicanthelium scabriusculum (Elliott) Gould & C. A. Clark, Woolly witchgrass, DA; o; *520*, *646*

**Digitaria bicornis* (Lam.) Roem. & Schult., Asia crabgrass, DA; i; *126*

Digitaria filiformis (L.) Koeler var. *filiformis*, Slender crabgrass, DA; o; ***417***

Distichlis spicata (L.) Greene, Saltgrass, HB; o; ***556***

**Eleusine indica* (L.) Gaertn., Indian goosegrass, DA; o; *286*

Eragrostis elliottii S. Watson, Elliott's lovegrass, SM/BF; o; ***562***

Eragrostis secundiflora J. Presl subsp. *oxylepis* (Torr.) S. D. Koch, Red lovegrass, DA, HB; o; ***77***, *121*

Eustachys petraea (Sw.) Desv., Pinewoods fingergrass, DA, HB; o; ***41***, ***83***, *499*

**Lolium perenne* L., Italian ryegrass, DA; i; *613*

Muhlenbergia capillaris (Lam.) Trin. var. *filipes* (M. A. Curtis) Chapm. ex Beal, Gulf hairawn muhly, HB; c; *488*, *489*, ***549***

Muhlenbergia capillaris var. *trichopodes* (Elliott) Vasey, Cutover muhly, SM/BF; o; ***561***

Oplismenus hirtellus (L.) P. Beauv., Woodsgrass, MH; o; *525*

Panicum amarum Elliott, Bitter panicgrass, FD, HB; c; *464*, *515*, ***551***

**Paspalum notatum* Flüggé var. *saurae* Parodi, Bahiagrass, DA; o; *265*

Paspalum setaceum Michx., Thin paspalum, DA; o; *287*, *308*, *528*

Poa annua* L., Annual bluegrass, DA; o; ***650*, *668*

Setaria parviflora (Poir.) Kerguélen, Yellow bristlegrass, SM/BF; o; ***22***, ***63***

Spartina alterniflora Loisel., Saltmarsh cordgrass, SM; c; *474*, ***542***, ***554***

Spartina patens (Aiton) Muhl., Marshhay cordgrass, FD; o; ***23***, ***393***, ***550***, ***555***

Sphenopholis obtusata (Michx.) Scribn., Prairie wedgescale, DA; o; *622*, ***636***

*_Sporobolus indicus_ (L.) R. Br. var. _pyramidalis_ (P. Beauv.) Veldkamp, West Indian dropseed, DA; i; _456_

Sporobolus virginicus (L.) Kunth, Seashore dropseed, FD, SM/BF; c; ***256***, ***271***, ***412***, _443_, ***558***

Stenotaphrum secundatum (Walter) Kuntze, St. Augustinegrass, SB; r; ***30*** [This common lawn grass is listed in Wunderlin & Hansen (2003) as native, and our collections in remote areas are likely not escapes from cultivation.]

Triplasis purpurea (Walter) Chapm., Purple sandgrass, DA, SM/BF; i; ***532***, ***559***

Uniola paniculata L., Seaoats, FD, HB; c; ***67***, ***68***, _125_, ***262***

POLEMONIACEAE

Ipomopsis rubra (L.) Wherry, Standingcypress, HB; r; _432_

POLYGALACEAE

Polygala incarnata L., Procession flower, SM/BF; i; ***533***

POLYGONACEAE

Rumex hastatulus Baldwin, Heartwing dock, DA, HB; i; _610_

PORTULACACEAE

Portulaca oleracea L., Little hogweed, DA, r; _298_

Portulaca pilosa L., Pink purslane, DA, SM/BF; i; ***273***, _299_, ***415***, _444_

ROSACEAE

*_Eriobotrya japonica_ (Thunb.) Lindl., Loquat, MH, r; _274_ (A colony of several saplings naturalized in the hammock.)

Prunus caroliniana (Mill.) Aiton, Carolina laurelcherry, DA; i; _640_

Prunus serotina Ehrh. var. _serotina_, Black cherry, MH, SB/MH; o; ***44***, ***541***, _641_, ***655***

*_Rhaphiolepis indica_ (L.) Lindl., Indian hawthorn, CULT; _676_

Rubus trivialis Michx., Southern dewberry, DA, HB, SB/MH; i; _612_, ***680***

RUBIACEAE

Chiococca alba (L.) Hitchc., Snowberry, HB; r; ***401***, ***531***

Diodia teres Walter, Poor joe, DA; r; _666_

Galium hispidulum Michx., Coastal bedstraw, DA, HB, MH; o; ***58***, ***414***, _433_, _524_

Houstonia procumbens (J.F.Gmel.) Standl., Innocence, HB; i; _442_, _473_, ***653***, ***679***

*_Oldenlandia corymbosa_ L., Flattop mille graines, DA; i; _300_

*_Richardia brasiliensis_ Gomes, Tropical Mexican clover, DA; i; _306_

Spermacoce assurgens Ruiz & Pav., Woodland false buttonweed, DA; r; _292_, _513_

Stenaria nigricans (Lam.) Terell var. _nigricans_, Diamondflowers, DA; o; ***57***

RUTACEAE

*_Severinia buxifolia_ (Poir.) Ten., Chinese boxorange, MH; _278_, _678_ [CULT] (Cultivated near park maintenance buildings and also escaped and apparently established in the nearby hammock.)

Zanthoxylum clava-herculis L., Hercules-club, MH, SB/MH; c; ***47***, ***257***, ***403***, _453_, ***632***

SANTALACEAE

Phoradendron leucarpum (Raf.) Reveal & M.C. Johnst., Oak mistletoe, MH; i; ***418***

SAPOTACEAE

Sideroxylon tenax L., Tough bully, MH, SB/MH; c; _9_, ***42***, _108_, ***270***, _435_, _469_

SMILACACEAE

Smilax auriculata Walter, Earleaf greenbrier, MH, SB, SB/MH; c; _4_, ***43***, _109_, _426_, _496_

Smilax bona-nox L., Saw greenbrier, o; MH, SB/MH; _8_

SOLANACEAE

Lycium carolinianum Walter, Christmasberry, SM/BF; r; ***553***, _625_

Physalis walteri Nutt., Walter's groundcherry, FD, HB; c; ***33***, ***60***, _111_

Solanum chenopodioides Lam., Black nightshade, HB; i; _445_

TETRACHONDRACEAE

Polypremum procumbens L., Rustweed, DA, HB; o; _118_, _134_, ***254***

URTICACEAE

Parietaria praetermissa Hinton, Clustered pellitory, DA; r; _93_

Pilea microphylla (L.) Liebm., Artillery plant, MH; i; ***681***

VERBENACEAE

*_Lantana camara_ L., Lantana, [CAT I], DA, HB; o; ***85***, _100_, _599_

Phyla nodiflora (L.) Greene, Turkey tangle fogfruit, DA, HB; o; _120_, _136_, _285_

**Verbena bonariensis* L., Purpletop vervain, DA; i; *132*

Verbena officinalis L. subsp. *halei* (Small) S. C. Barber, Texas vervain, DA; o; *99, 129*

VITACEAE

Ampelopsis arborea (L.) Koehne, Peppervine, DA, MH, SB; o; *14*, ***34***, ***250***

Cissus trifoliata (L.) L., Sorrelvine, SB; i; *314*

Parthenocissus quinquefolia (L.) Planch., Virginia creeper, DA, SB, MH; o; *12*, ***78***, *449*

Vitis aestivalis Michx., Summer grape, MH, SB; c; ***40***, *315*

Vitis rotundifolia Michx., Muscadine, MH, SB; o; *10, 320*

ZINGIBERACEAE

**Alpinia zerumbet* (Pers.) B.L. Burtt & R.M. Sm., Shellflower, CULT; *639*

ACKNOWLEDGMENTS

We thank William Carromero and Alexander Reynolds for enthusiastic assistance in the field. We greatly appreciate the invaluable support and cooperation of National Park Service personnel: Joe DeVivo, Network Coordinator; Gordon (Gordie) Wilson, Superintendent; David Parker, Site Supervisor and Chief of Resource Management; Andrew Rich, Park Ranger; and Ronnie Dean, Biological Science Technician. Park Guides Ray Hamel and Thomas Birmingham expertly commandeered the Matanzas Queen II around Rattlesnake Island, allowing our amphibious landings to otherwise inaccessible shores. Kent D. Perkins and Richard P. Wunderlin provided essential constructive criticisms of the manuscript; Kerik D. Cox created the electronic version of our vegetation map and assisted with the other figures; J. Steve Davis at the University of Florida generously lent us NPS structure study documents on Fort Matanzas; and Eric Fuchs translated the abstract into Spanish. We are also grateful to the Department of Plant Biology, University of Georgia, for the use of a departmental vehicle for three trips to transport supplemental field supplies and personnel. This survey was funded by National Park Service contract agreement J2114-03-0006 (PI D. E. Giannasi & coPI W. B. Zomlefer).

REFERENCES

Angiosperm Phylogeny Group [APG]. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Bot. J. Linn. Soc. 141:399–436.

Bryant, W.C. (ed). 1872. Picturesque America, Vol. I. D. Appleton and Company, New York, New York.

Caulkins, D.B. and R. Wyatt. 1990. Variation and taxonomy of *Phytolacca americana* and *P. rigida* in the southeastern United States. Bull. Torrey Bot. Club 17:357–367.

Chandler, L. (ed.). 2002. Fort Matanzas National Monument park handbook. Historic Map and Print Co., St. Augustine, Florida.

Coile, N.C. and M.A. Garland. 2003. Notes on Florida's endangered and threatened plants. Botany Contribution 38, ed. 4. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida.

Easley, M.C. and W.S. Judd. 1993. Vascular flora of Little Talbot Island, Duval County, Florida. Castanea 58:162–177.

Flora of North America Editorial Committee [FNA]. 1993. Flora of North America, vol. 2, Pteridophytes and gymnosperms. Oxford University Press, New York, New York.

Florida Exotic Pest Plant Council [FLEPPC]. 2004. Florida Exotic Pest Plant Council's 2003 list of invasive species. URL: www.fleppc.org/Plantlist/03list.htm/.

Florida Natural Areas Inventory [FNAI]. 1990. Guide to the natural communities of Florida. Tallahassee, Florida.

Godfrey, R.K. and J.W. Wooten. 1979. Aquatic and wetland plants of the southeastern United States. Monocotyledons. University of Georgia Press, Athens, Georgia.

Godfrey, R.K. and J.W. Wooten. 1981. Aquatic and wetland plants of the southeastern United States. Dicotyledons. University of Georgia Press, Athens, Georgia.

Gold, R.L. 1969. Borderline empires in transition: the triple-nation transfer of Florida. Southern Illinois University Press, Carbondale, Illinois.

Huxley, A. (ed). 1992. The new Royal Horticultural Society dictionary of Gardening. Stockton Press, New York, New York.

Johnson, A.F. and M.G. Barbour. 1990. Dunes and maritime forests. In: Ecosystems of Florida, R. L. Myers and John J. Ewel, eds. University of Central Florida Press, Orlando, Florida. Pp. 429–480.

Judd, W.S. and I.K. Ferguson. 1999. The genera of Chenopodiaceae in the southeastern United States. Harvard Pap. Bot. 4:365–416.

Krakow, J.L. 1986. Administrative history of Castillo de San Marcos National Monument and Fort Matanzas National Monument. United States Department of the Interior, National Park Service, Washington, D. C.

Laessle, A.M. and C.D. Monk. 1961. Some live oak forests of northeastern Florida. Quart. J. Florida Acad. Sci. 24:39–55.

Leatherman, S.P. 1988. Barrier island handbook, 3rd ed. Coastal Publication Series, Laboratory for Coastal Research, University of Maryland, College Park, Maryland.

Ma, L.Q., K.M. Komar, C. Tu, W. Zhang, Y. Cai, and E.D. Kennelley. 2001. A fern that hyperaccumulates arsenic. Nature 409:579.

Manucy, A.C. (ed). 1943. The history of Castillo de San Marcos & Fort Matanzas, from contemporary narratives and letters. Source Book Series, No. 3. United States Department of the Interior, National Park Service, Washington, D. C.

Montague, C.L. and R.G. Wiegert. 1990. Salt marshes. In: Ecosystems of Florida, R. L. Myers and John J. Ewel, eds. University of Central Florida Press, Orlando, Florida. Pp. 481–516.

National Park Service [NPS]. 2004. Fort Matanzas online. URL: www.nps.gov/foma/home/home.htm/.

Nesom, G.L. 2004. New distribution records for *Gamochaeta* (Asteraceae: Gnaphalieae) in the United States. Sida 21:1175–1185.

Oertel, G.F. and M. Larsen. 1976. Developmental sequences in Georgia coastal dunes and distribution of dune plants. Bull. Georgia Acad. Sci. 34:35–48.

Schesventer, G., C.C. Frazier, L.A. Arana, E.C. Bearss, R.W. Copeland, G. Cummins, J.C. Paige, and T.L. Wong [Fort Matanzas Stabilization Team]. 1980. Historic structure report for Fort Matanzas National Monument, St. Johns County, Florida. Historic Preservation Branch, National Park Service, United States Department of the Interior, Denver, Colorado.

St. Johns County GIS Division. 2002. Fort Matanzas National Monument 2002 aerial imagery [map]. St. Johns County Geographic Information Systems, St. Augustine, Florida.

Stalter, R. and S.C. Dial. 1984. Hammock vegetation of Little Talbot Island State Park, Florida. Bull. Torrey Bot. Club 111:494–497.

State of Florida. 2004. Online sunshine: official internet site of the Florida legislature. URL: www.leg.state.fl.us/.

U.S. Fish and Wildlife Service. 2004. Species information: threatened and endangered animals and plants. URL: endangered.fws.gov/wildlife.html#Species/.

Wagner, R.H. 1964. The ecology of *Uniola paniculata* L. in the dune-strand habitat of North Carolina. Ecol. Monogr. 34:79–96.

Waterbury, J.P. 1993. Coquina. Townet Press, Inc., St. Augustine, Florida.

Wunderlin, R.P. 1998. Guide to the vascular plants of Florida. University Press of Florida, Gainesville, Florida.

Wunderlin, R.P. and B.F. Hansen. 2000. Flora of Florida, vol. 1, Pteridophytes and gymnosperms. University Press of Florida, Gainesville, Florida.

Wunderlin, R.P. and B.F. Hansen. 2003. Guide to the vascular plants of Florida, ed. 2. University Press of Florida, Gainesville, Florida.

Wunderlin, R.P. and B.F. Hansen. 2004. Atlas of Florida vascular plants. URL: www.plantatlas.usf.edu/.

Zomlefer, W.B. and D.E. Giannasi. 2005 [in press]. Floristic survey of Castillo de San Marcos National Monument, St. Augustine, Florida. Castanea 70.

JUNIPERUS ASHEI (CUPRESSACEAE): PHYSIOGNOMY AND AGE STRUCTURE IN THREE MATURE TEXAS STANDS

Caren McLemore

University of North Texas
Department of Biological Sciences
Denton, Texas 76203, U.S.A.
and
Botanical Research Institute of Texas
509 Pecan Street, Fort Worth, Texas 76102-4060, U.S.A.

Glenn C. Kroh

Texas Christian University
Department of Biology
Fort Worth, Texas 76129, U.S.A.

John E. Pinder III

Colorado State University
Department of Environmental and Radiological Health
Fort Collins, Colorado 80523, U.S.A.

ABSTRACT

Despite the abundance of *Juniperus ashei* Buchholz in Texas, mature, intact stands are relatively rare. This study compares structural patterns and growth dynamics among three mature stands on the Edwards Plateau and documents relationships between structural changes and temporal development of these forests. Each stand has varied physiognomic characteristics and age-related structure. By identifying and comparing these properties, this study provides information relevant to conservation and management decisions relating to *J. ashei*.

RESUMEN

A pesar de la abundancia de *Juniperus ashei* Buchholz en Texas, las agrupaciones maduras e intactas son relativamente raras. Este estudio compara los modelos estructurales y la dinámica de crecimiento entre tres agrupaciones maduras en el altiplano Edwards y se documentan las relaciones entre los cambios estructurales y el desarrollo temporal de estos bosques. Cada agrupación tiene diversas características fisonómicas y una estructura relacionada con su edad. Al identificar y comparar estas propiedades, este estudio provee información pertinente para la conservación y decisiones de supervisión relacionadas con *J. ashei*.

INTRODUCTION

Background

Juniperus ashei Buchholz (Ashe juniper), one of the nine Texas species of the genus *Juniperus* (Correll & Johnston 1970; Simpson 1999), has dense populations from the Ozark Mountains in Missouri and Arkansas, to the Arbuckle Mountains of northeastern Oklahoma, and is found throughout central Texas particularly on southern and eastern portions of the Edwards Plateau where it is the dominant woody species and forms a significant component of the state's vegetation (Van Auken 1988; Diamond et al. 1995; Jackson & Van Auken 1997; Smeins et al. 1997). It also occurs in northeastern Mexico (Little 1992). Although

SIDA 21(2): 1107–1120. 2004

J. ashei has an overlapping distribution with both *J. virginiana* L. (eastern red cedar) and *J. pinchotii* Sudw. (redberry juniper), chemical analyses suggest that hybridization does not occur (Adams 1972, 1975; Kelley 1976; Flake et al. 1978).

Juniperus ashei is typically found on thin, calcareous limestone- or dolomite-derived soils (Vines 1960) and also grows in deeper, sandier soils often in association with *Quercus fusiformis* Small (plateau live oak), *Diospyros texana* Scheele (Texas persimmon), *Q. stellata* Wang. (post oak), *Q. sinuata* var. *breviloba* (Torr.) C.H. Müll. (scaly-bark oak) and *Q. buckleyi* Nixon & Dorr (Texas oak) (Van Auken et al. 1978; Riskind & Diamond 1986; Diggs et al. 1999). Co-occurrence of *J. ashei* with broadleaf trees constitutes prime habitat for *Dendroica crysoparia* (golden-cheeked warbler), an endangered species which nests solely in juniper/oak woodlands and uses the bark from mature (>30 yrs old) *J. ashei* trees as nesting material (Doughty & Parmenter 1989; Beardmore et al. 1995).

Mature, second-growth *J. ashei* stands are rapidly disappearing due to high rates of urban and suburban expansion (Doughty & Parmenter 1989; Diamond et al. 1995; Patoski 1999). Effective land and endangered species management must include an understanding and appreciation of *J. ashei*'s role in establishing and maintaining stable, mature communities (Diamond et al. 1995) and its importance to the endangered golden-cheeked warbler.

This study investigates the structure and dynamics of three mature *J. ashei* stands and provides information regarding the establishment and persistence of these stands. By identifying and comparing several structural and age-related characteristics, it provides information relevant to conservation and management decisions. Structural patterns and growth dynamics are compared among stands to document relationships between structural changes and temporal development of these forests.

METHODS

Study Areas

The three study areas are on the Edwards Plateau of central Texas (Fig. 1) where eroded marine sandstones, limestones, shales, and dolomites are covered by thin soil deposits (Riskind & Diamond 1988) on upland areas deeply dissected by streams. Precipitation, which averages 85 cm per year in the region of the study sites (Riskind & Diamond 1988), percolates downward to the water table, expands fissures in the limestone, and forms the sinkholes, caves, and underground drainages characteristic of 'karst' topography (Spearing 1991).

Two study sites are in Guadalupe River State Park, a 769 ha park in Comal and Kendall counties. The first site (hereafter Guadalupe South) is located south of the Guadalupe River on a 35 ha 'karst dome' (elevation = 385 m; N 29° 51' W 98° 30'). The second site (hereafter Guadalupe North) is north of the Guadalupe River atop the river's escarpment (elevation = 342 m; N 29° 52' W 98° 28').

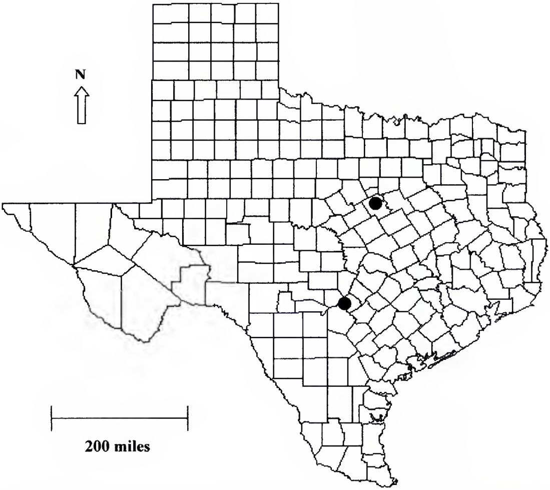


Fig. 1. Map of Texas with locations of study sites in Bosque and Comal counties.

Both stands are on undulating, well drained, cherty clay loam soils where chert and limestone cobbles cover >20 percent of the surface and subsoil layers below 15–20 cm are 75%, by volume, limestone fragments (U.S. Department of Agriculture 1984). Soils at both locations are typical of the region.

The third study site is on moderately deep, well-drained, loamy soil in Meridian State Park, a 204 ha reserve in Bosque County (elevation = 326 m; N 31° 53' W 97° 41'). Surface soil and subsoil layers are up to 38 and 94 cm deep, respectively, over a karst bedrock (U.S. Department of Agriculture 1980).

Sampling Procedures

Circular, 100 m^2 plots were established at 20 m intervals along transects in each stand. Transects differed in length according to stand dimensions. All trees were identified to species, mapped by their distance and bearing to the plot center, and their diameter breast height (dbh) recorded. Trees with dbh >8 cm were marked with individually numbered aluminum tags and cored at the base using a 4.3 mm diameter increment borer. Dead or unhealthy trees were not cored. Cores were glued to wooden mounting boards and sanded to a flat surface. Rings were counted under 37.5× magnification.

Because *J. ashei* forms false rings in response to environmental changes, ring number does not accurately reflect tree age. Therefore a formula for estimating age using ring counts was developed with cores from a separate set of trees of approximate known age from Meridian State Park. Photographs dating back to the park's development in 1933–34 were analyzed to isolate specific areas devoid of *J. ashei*. Trees now present in these areas were assumed to have germinated immediately after the park's establishment, giving them a maximum age (at the time of the study) of sixty-seven years. Cores from these trees were analyzed and a formula was derived by (1) counting rings of each tree, (2) dividing approximate age by ring count, and (3) pooling results and computing a mean. Approximate age of each *J. ashei* in this study was then calculated using the resulting formula: ring count × 0.67. Large rays and the diffuse porous nature of the deciduous hardwoods made it impossible to accurately determine ages of those trees. Ring count information was used to determine forest age structure.

Tree numbers, dbh, and height were used to determine mean height, mean basal area, size distribution, relative density (number of *J. ashei* as a proportion of the total number of individuals of all species), relative frequency (frequency of *J. ashei* as a proportion of the sum of the frequencies for all species), and relative basal area of each tree species. Importance values (Brower et al. 1998) were calculated.

Measurements for height, basal area, and age were tested for normality and homogeneity of variance (Sokal & Rohlf 1973) in order to determine the appropriate method of statistical analysis. All variables were normally distributed but displayed heterogeneity of variance, therefore non-parametric analysis of variance (ANOVA) was chosen to test for significant differences between stands.

RESULTS

Tree Species Identified and Importance Values

Table 1 provides numbers of each tree species found at each study site. Only *Juniperus ashei* was common to all three sites.

Relative density, frequency, and basal area of species may be summed to produce importance values (ranging from 0–3). Importance values integrate these separate measures to provide an indication of species influence in the community (Smith 1974). High importance values occurred for *J. ashei* at all three sites, with Guadalupe South at 2.70 and Meridian and Guadalupe North at 2.36 and 1.93, respectively (Table 2). These values indicate the dominance of this species in these communities.

TABLE 1. Summary counts of trees sampled.

Scientific Name	Common Name	Guadalupe South	Guadalupe North	Meridian
Juniperus ashei	Ashe juniper	138	131	86
Diospyros texana	Texas persimmon	3	38	0
Celtis laevigata	hackberry	0	5	0
Ulmus crassifolia	cedar elm	1	6	0
Quercus texana	Texas oak	1	0	2
Quercus fusiformis	plateau live oak	0	4	12
Quercus stellata	post oak	2	1	0
Quercus sinuata	scaly-bark oak	1	6	0
Fraxinus texensis	Texas ash	0	0	4
Sideroxylon lanuginosum	gum bumelia	0	0	1
Total Sampled		146	191	105

TABLE 2. Relative density, relative frequency, relative basal area and importance values.

	Relative Density	Relative Frequency	Relative Basal Area	Importance Values
Guadalupe South				
Juniperus ashei	.95	.79	.96	2.70
Diospyros texana	.02	.07	.01	.10
Ulmus crassifolia	.01	.03	.01	.05
Quercus texana	.01	.03	.02	.06
Quercus stellata	.01	.03	.01	.06
Quercus sinuata	.01	.03	.003	.04
Guadalupe North				
Juniperus ashei	.69	.39	.85	1.93
Diospyros texana	.20	.27	.01	.48
Ulmus crassifolia	.03	.06	.04	.13
Quercus sinuata	.03	.04	.003	.07
Celtis laevigata	.03	.10	.01	.14
Quercus fusiformis	.02	.12	.07	.21
Quercus stellata	.01	.02	.01	.04
Meridian				
Juniperus ashei	.82	.62	.92	2.36
Quercus fusiformis	.11	.19	.07	.37
Fraxinus texensis	.04	.10	.003	.14
Quercus texana	.02	.05	.01	.08
Sideroxylon lanuginosum	.01	.05	.001	.06

Basal Area and Size Class Distribution

Mean basal area of *J. ashei* was calculated for each site. Data indicate 29.58 m^2ha^{-1} (±11.41), 33.89 m^2ha^{-1} (±12.13), and 39.30 m^2ha^{-1} (±10.63) for Guadalupe South, Guadalupe North, and Meridian, respectively. Analysis of variance (Table 3) showed no significant differences between basal area of the three stands.

TABLE 3. Kruskal-Wallace one-way multisample non-parametric ANOVA with ties correction and χ^2 approximation for tree basal area, height, and age at three sites. Mean sums of ranked scores are shown. Letters indicate significant differences at $p<0.05$ via Student-Newman-Keuls Multiple Range Test.

	Guadalupe South (n=84)	**Guadalupe North (n=77)**	**Meridian (n=66)**	
Basal Area (cm^2)	111.42 (a)	108.73 (a)	123.43 (a)	$\chi^2 = 1.99_{(2)}$, $p<0.3704$
Age (yrs)	128.2 (a)	134.5 (a)	72.0 (b)	$\chi^2 = 38.53_{(2)}$, $p<0.0001$
Height (m)	71.89 (a)	154.03 (b)	120.89 (c)	$\chi^2 = 63.89_{(2)}$, $p<0.0001$

Highest percentages of *J. ashei* at each site were in the smallest size class category (>30-300 cm^2) with Guadalupe South at 45.3%, Guadalupe North at 48.5%, and Meridian at 36.5% (Fig. 2). Fewer than 5% of *J. ashei* at each site were in each of the four largest size class categories.

Age Structure

Ages of cored *J. ashei* were calculated and divided into five equal groups, 27–56 years, 57–86 years, 87–116 years, 117–146, and 147–177 years. At all sites most trees were younger than 86 years and few were over 147 years (Fig. 3).

Mean ages for the stands ranged from 80.4 years at Guadalupe North to 55.5 years at Meridian (Table 4), and these differences were statistically significant (Table 3). There was no significant difference in mean ages between Guadalupe North and Guadalupe South. However, this result is believed to be due to the inability to determine ages of the many dead trees at Guadalupe North. Pattern for mean ages was reflected in the pattern for oldest trees (Table 4). The oldest trees at Guadalupe North and Guadalupe South sites were >150 years old. The oldest tree at Meridian was about the same age as the mean trees at both Guadalupe sites and was less than half the age of Guadalupe North's oldest tree.

Height

Mean heights were calculated for each tree species comprising >3 percent of each community. *Juniperus ashei* occupied the canopy at all three sites. At Guadalupe South and Guadalupe North, where the canopy was shared with other species, only *Ulmus crassifolia* (cedar elm) at Guadalupe North was taller than *J. ashei* (Table 5). Mean heights of *J. ashei* differed significantly among all sites with the greatest heights at Guadalupe North and the least at Guadalupe South (Table 3). Meridian had the highest rate of height increase (cm yr^{-1}), growing approximately 35% faster than Guadalupe South over the lifetime of the two stands (Table 6).

DISCUSSION

Mature *Juniperus ashei* dominated all three sites in this study; however, each stand had varied physiognomic characteristics and age-related structure.

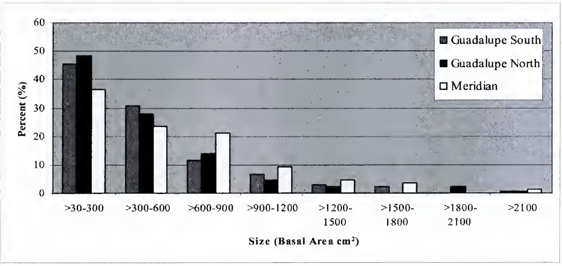


Fig. 2. Size class distribution of *Juniperus ashei* based on basal area.

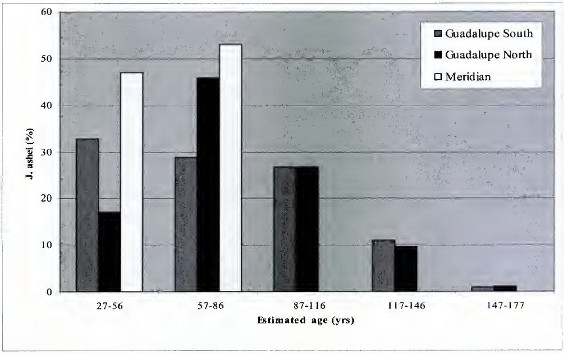


Fig. 3. *Juniperus ashei* estimated age class distribution.

Table 4. Mean *Juniperus ashei* ages and oldest trees.

Location	Mean Age *J. ashei* (yrs)	S.D.	Oldest *J. ashei* (yrs)
Guadalupe South	77.3	± 29.6	158
Guadalupe North	80.4	± 27.7	177
Meridian	55.5	± 12.4	82

Table 5. Mean heights (m) of trees comprising >3 percent of each stand.

	Mean Height (m)	Standard Deviation
Guadalupe South		
Juniperus ashei	6.19	±1.37
Guadalupe North		
Juniperus ashei	7.93	±2.10
Diospyros texana	3.71	±0.50
Ulmus crassifolia	10.47	±3.45
Quercus sinuata	4.97	±0.53
Meridian		
Juniperus ashei	7.19	±1.11
Quercus fusiformis	6.79	±2.36
Fraxinus texensis	6.23	±1.92

Table 6. *Juniperus ashei* mean height increase (cm yr^{-1}).

Location	Mean Increase (cm yr^{-1})	S.D.
Guadalupe South	9.05	±4.17
Guadalupe North	11.57	±4.99
Meridian	13.81	±3.23

Tree Species Identified and Importance Values

Importance values were determined at all three locations (Table 2). The lowest *J. ashei* value occurs at Guadalupe North. Also present at this site is *Diospyros texana* (Texas persimmon), a small tree usually less than 12 m tall (Little 1992). *Diospyros texana* is exclusively an understory tree at this location, with the tallest individual measuring 4.7 m. At Guadalupe South, with the highest *J. ashei* importance value, *D. texana* is rare (Table 1). Shading conditions make no significant difference in germination rates of *D. texana* (Everitt 1984). However, *Diospyros* species are reported to require full sun for optimum growth (Crockett 1972). At Guadalupe North these trees are often found clustered near dead *J. ashei*. These gaps in the canopy appear to provide ideal locations for the continued growth of this species. Few *D. texana* occur under the canopy at Guadalupe South, but may become more abundant as the stand ages and gaps are opened by tree death.

Basal Area and Size Class Distribution

Van Auken (1988) reported *J. ashei* mean basal areas of 38.6, 21.4, 43.2, and 18.4 m^2 ha^{-1} in four mature, undisturbed, woodlands computed from diameters measured at 0.1 m above ground surface. These results are consistent with those for this study where mean basal areas of 29.6 (±11.4), 33.9 (±12.1), and 39.3 (±10.6)

m^2 ha^{-1} for *J. ashei* were measured at the Guadalupe South, Guadalupe North, and Meridian sites, respectively.

Analysis of variance (Table 3) showed no significant differences between basal areas of the three stands. However, since Meridian is a significantly younger stand (Table 4), this indicates a faster basal growth rate at that location. Some of this difference may be accounted for by the faster growth rate of younger trees. However, deeper surface soil with its associated greater moisture-holding capacity is probably the most important factor (Bockheim 1982) influencing tree growth and may have led to a faster growth rate at Meridian than at the two Guadalupe River State Park locations where soils are thinner and rockier.

Highest percentages of *J. ashei* were in the smallest size class category (>30-300 cm^2) at all three locations with Guadalupe South at 45.3%, Guadalupe North at 48.5%, and Meridian at 36.5% (Fig. 2). Less than 5% of *J. ashei* at each site were in each of the four largest size class categories. This arrangement results in a negative exponential size distribution, usually representing relatively early successional establishment (Van Auken 1993). However, size distribution does not necessarily reflect age distribution in forest age class studies. A generalization may be made that larger trees are likely to be old. However, it cannot be assumed that a small tree is young (Harper 1977). Many of the smaller *J. ashei* in this study were older than expected and size class distributions, in this case, do not indicate early successional stages, expanding populations, or relative youth of the majority of trees.

However, size class distribution is useful in describing the condition of a population in terms of its future and may offer insights into reproductive performance. While reproduction is often analyzed in terms of age structure, quite often it is a function of size and can best be studied using size distributions (Harper 1977). *Juniperus ashei* cone production is partially determined by environmental conditions, particularly rainfall, but is also dependent on tree size with trees reaching reproductive maturity at about 1.5 m height and about 50 cm^2 basal area. Results from this study indicate the majority of trees are reproductively mature and playing an important role in the reproductive dynamics of the population.

Age Structure

False rings formed by many species of *Juniperus* (Panshin & Dezeeuw 1964) cause considerable difficulty in age determination. Van Auken (1993) believes it is impossible to accurately determine ages of junipers from growth rings due to formation of several rings each year in response to fluctuating rainfall. Fuhlendorf (1992; pers. comm.) reported an inability to differentiate true and false annual rings while determining *J. ashei* ages from ring counts. Adams (pers. comm.) expressed doubt concerning dating method accuracy for *J. ashei* (Adams et al. 1998).

Methodology devised for age determination of *J. ashei* in this study is a novel approach based on ring counts of trees of known age. Although some conifers have a propensity to produce relatively more false rings when young and fewer when old, Grissino-Mayer has found no indication that Juniperus species have a tendency to do this (pers. comm.). Therefore, although the trees from Meridian were only 67 years old, the rate of false ring production should be similar to that of even the oldest trees in Guadalupe North. Although the trees were sampled at Meridian State Park, similar precipitation patterns at both parks also help validate use of the same formula constant for all three sites.

Forest populations often progress as a sequence of even-aged cohorts initiated by disturbance. However, the mixed-aged structure characterized in this study (Fig. 3) indicates rarity of disturbance and infers continuous recruitment over the life of the stands (Kelly & Larson 1997). These stands appear to have escaped the relatively frequent fires that historically occurred in Texas at the time of their establishment (Smeins et al. 1997) and apparently have been fire-free throughout their existence.

Interpreting age structure is complicated by the fact that there is no way to determine past mortality rates of a population. Age structure determination usually considers only survivors (as in this study) and does not utilize recruitment and mortality data (Harper 1977). However, accurate determination of stand age is dependent on mortality, as the oldest trees may be dead. This difficulty played a major role in determining the true age of Guadalupe North, where much of the forest was composed of dead trees. Despite these limitations, generalizations can be made concerning age structure of these stands.

Analysis of variance (Table 3) results indicated no significant differences between the ages of the two stands at Guadalupe River State Park. However, the stand at Meridian was significantly younger with a mean tree age of 55.5 years and no tree sampled older than 82 years (Table 4). All *J. ashei* at Meridian were in the two youngest age categories (Fig. 3). Stand age broadly corresponds to the establishment of the park in 1934. Much of the area now occupied by this stand was historically midgrass prairie (Riskind, pers. comm.), and the woodland's presence demonstrates the ability of *J. ashei* to colonize many terrain types in the absence of fire.

Mean ages for *J. ashei* were similar for Guadalupe South and Guadalupe North, with Guadalupe North results indicating a slightly (but not significantly) older stand (Table 4). Guadalupe South's age distribution is typical of an aging population, with trees in age categories of 27–56 yr, 57–86 yr, and 87–116 yr almost equally distributed (Fig. 3). Guadalupe North is the oldest stand with its establishment dating back to at least 170 years ago. Its greater age is reflected in the shift toward older trees (Fig. 3). It appears to be a declining population with relatively few individuals in the youngest 27–56 yr age category. Field observations indicated many large, old, dead trees for which ages could not be determined. This difficulty caused an underestimate of the stand's true age. Therefore, despite ANOVA results, Guadalupe North is believed to be older than Guadalupe South. Both Guadalupe North and Guadalupe South met some criteria for old-growth *J. ashei* stands as proposed by Diamond (1997) and perhaps could serve in refining the definition.

Height

Although *J. ashei* was the most abundant tree and dominated the canopy structure, other species, notably *Ulmus crassifolia*, *Quercus fusiformis*, and *Fraxinus texensis* were present in the canopy. At Guadalupe North the *J. ashei* canopy, at 7.93 m, is overtopped by a number of *U. crassifolia* (Table 5). Whether the taller *U. crassifolia* are older or whether they grow more quickly than *J. ashei* could not be determined. Presence of *Diospyros texana* is also significant at Guadalupe North. This species is primarily an understory tree as indicated by its mean height that is approximately half that of *J. ashei*.

Quercus fusiformis and *Fraxinus texensis* have mean heights shorter than *J. ashei* but still share the canopy at Meridian (Table 5). This stand developed in a grassland or savanna environment and records indicate that the area was a cotton field prior to establishment of the park (Riskind, pers. comm.). Therefore, trees sharing the canopy with *J. ashei* probably established concurrently.

ANOVA results indicated significantly different canopy heights between sites (Table 3). Although younger, Meridian had a greater mean height (7.19 m) than Guadalupe South (6.19 m). Reasons for this pattern are not known. However, deeper soils with greater moisture-holding capacity at Meridian could be one explanation for the observed height differences (Table 6). Tallest mean *J. ashei* height (7.93 m) is at Guadalupe North and differences between that site and Guadalupe South may be due to Guadalupe North's greater proportion of older trees.

Information is lacking concerning height growth rates of *J. ashei* but it is historically considered slow-growing (Blomquist 1990). Based on tree ring analysis, *J. pinchotii* grows in height an average of 6.01 cm yr^{-1} for the first thirty years (McPherson & Wright 1989; Ueckert 1997). *Juniperus ashei* height growth rates may be expected to be similar to those of *J. pinchotii* but data from this study indicated greater mean height increases at 9.05, 11.57, and 13.81 cm yr^{-1} for Guadalupe South, Guadalupe North, and Meridian, respectively (Table 6). If *J. ashei* height growth rates are similar to those of *J. pinchotii*, discrepancies may be due, in part, to previous studies overestimating tree age from faulty interpretation of annual ring counts.

Jackson and Van Auken (1997) recorded that *J. ashei* seedlings in edge habitats grow an average of 13.98 cm yr^{-1}. Their data are similar to height growth rates reported for Meridian. Deeper soils and the high light environment of open grassland during stand establishment may have resulted in relatively high rates of increase at this location.

Guadalupe South and Guadalupe North receive similar amounts of precipitation and have similar soil depths. Growth rate discrepancies between the two sites are probably due to underestimating the true age of Guadalupe North. If the Guadalupe North stand is older than data from this study indicate, an adjustment downward in height growth rate would result, giving Guadalupe North a growth rate more similar to that obtained for Guadalupe South.

ACKNOWLEDGMENTS

We would like to thank David Riskind for suggesting this project and Texas Parks and Wildlife Department funding the research. Two anonymous reviewers provided helpful reviews.

REFERENCES

Adams, R.P. 1972. Chemosystematic and numerical studies of natural populations of *Juniperus pinchotii* Sudw. Taxon 21:407–425.

Adams, R.P. 1975. Gene flow versus selection pressure and ancestral differentiation in the composition of species: analysis of populational variation of *Juniperus ashei* Buch. using terpenoid data. J. Molec. Evol. 5:177–185.

Adams, R.P., L.E. Flournoy, R.L. Singh, H. Johnson, and H. Mayeux. 1998. Invasion of grasslands by *Juniperus ashei*: a new theory based on random amplified polymorphic DNAs (RAPDs). Biochem. System. & Ecol. 26:371–377.

Beardmore, C., J. Hatfield, and J. Lewis. 1995. Golden-cheeked warbler population and habitat viability assessment report. Grant Rept. U.S. Nat. Biol. Serv., Grant No. 80333–1423.

Blomquist, K.W. 1990. Selected life history and synecological characteristics of Ashe juniper on the Edwards Plateau of Texas. Unpublished M.S. Thesis, Texas A&M Univ., College Station.

Bockheim, J.G. 1982. Forest soils. In: R.A. Young, ed. Introduction to forest science. John Wiley & Sons, New York. Pp. 93–111.

Brower, J.E., J.H. Zar, and C.N. von Ende. 1998. Field and laboratory methods for general ecology (fourth edition). McGraw-Hill Companies, Inc.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Res. Found., Renner.

Crockett, J.U. 1972. Trees. Time-Life Books, New York.

Diamond, D.D. 1997. An old-growth definition for western juniper woodlands: Texas Ashe juniper dominated or codominated communities. Forest Service, U.S. Department of Agriculture. Gen. Tech. Rep. SRS–15.

Diamond, D.D., G.A. Rowell, and D.P. Keddy-Hector. 1995. Conservation of Ashe juniper (*Juniperus ashei* Buchholz) woodlands of the central Texas hill country. Nat. Areas J. 15:189–197.

Diggs, G.M., Jr., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners & Mahler's illustrated flora of north central Texas. Sida, Bot. Misc. 16.

Doughty, R.W. and B.M. Parmenter. 1989. Endangered species. Texas Monthly Press, Austin, Texas.

Everitt, J.H. 1984. Germination of Texas persimmon seed. J. Range Manag. 37: 189–192.

Flake, R.H., L. Urbatsch, and B.L. Turner. 1978. Chemical documentation of allopatric introgression in *Juniperus*. Syst. Bot. 3:129–144.

Fuhlendorf, S.D. 1992. Influence of age/size and grazing history on understory relationships of Ashe juniper. Unpublished M.S. Thesis, Texas A&M Univ., College Station.

Harper, J.L. 1977. Population biology of plants. Academic Press, Inc., New York.

Kelley, W.A. 1976. Isoenzyme investigations in *Juniperus* L. Unpublished Ph.D. Thesis, Colorado State Univ., Fort Collins.

Kelly, P.E. and D.W. Larson. 1997. Dendroecological analysis of the population dynamics of an old-growth forest on cliff-faces of the Niagara Escarpment, Canada. J. Ecol. 85: 467–478.

Jackson, J.T. and O.W. Van Auken. 1997. Seedling survival, growth and mortality of *Juniperus ashei* (Cupressacae) in the Edwards Plateau region of central Texas.Texas J. Sci. 49: 267–278.

Little, E.L. 1992. The Audubon Society field guide to North American trees. Chanticleer Press, Inc., New York.

McPherson, G.R. and H.A. Wright. 1989.Direct effects of competition on individual juniper plants: a field study. J. Appl. Ecol. 26:979–988.

Panshin, A.J. and C. Dezeeuw. 1964. Textbook of wood technology, volume 1 (second edition). McGraw-Hill, New York.

Patoski, J.N. 1999. The war on cedar. Texas Month. 25(12):114–117.

Riskind, D.H. and D.D. Diamond. 1986. Plant communities of the Edwards Plateau of Texas: an overview emphasizing the Balcones Escarpment zone between San Antonio and Austin with special attention to landscape contrasts and natural diversity. In: P.L. Abbott and C.M. Woodruff, Jr., eds. The Balcones Escarpment, central Texas: geological society of America. Pp. 21–32.

Riskind, D.H. and D.D. Diamond. 1988. An introduction to environments and vegetation. In: B.B. Amos and F.R. Gehlbach, eds. Edwards Plateau vegetation: plant ecological studies in central Texas. Baylor Univ. Press, Waco, Texas. Pp. 1–15.

Simpson, B.J. 1999. A field guide to Texas trees. Gulf Publishing Company, Houston, Texas.

Smeins, F., S. Fuhlendorf, and C. Taylor, Jr. 1997. Environmental and land use changes: a long-term perspective. In: 1997 Juniper Symposium (Chapter 1). Texas A&M Univ. Press, San Angelo. Pp. 3–21.

Sokal, R.R. and F.J. Rohlf. 1973. Introduction to biostatistics. W.H. Freeman & Company, San Francisco.

Spearing, D. 1991. Roadside geology of Texas. Mountain Press Publishing Company, Missoula, Montana.

Ueckert, D.N. 1997. Biology and ecology of redberry juniper. In: 1997 Juniper Symposium (Chapter 3). Texas A&M Univ. Press, San Angelo, Texas. Pp. 3–10.

United States Department of Agriculture. 1980. Soil survey of Bosque County, Texas.

United States Department of Agriculture. 1984. Soil survey of Comal and Hays Counties, Texas.

Van Auken, O.W. 1988. Woody vegetation of the southeastern escarpment and plateau. In: B.B. Amos and F.R. Gehlbach, eds. Edwards Plateau vegetation: plant ecological studies in central Texas. Baylor Univ. Press, Waco, Texas. Pp. 43–55.

Van Auken, O.W. 1993. Size distribution patterns and potential population change of some dominant woody species of the Edwards Plateau region of Texas. Texas J. Sci. 45: 199–210.

Van Auken, O.W., A.L. Ford, A. Stein and A.G. Stein. 1978. Woody vegetation of upland plant communities in the southern Edwards Plateau. Texas J. Sci. 32:23–35.

Vines, R.A. 1960. Trees, shrubs, and woody vines of the southwest. Univ. of Texas Press, Austin.

HIGH RESOLUTION GIS MAPPING AND CURRENT STATUS OF THE TEN VIABLE POPULATIONS OF SHORT'S GOLDENROD (*SOLIDAGO SHORTII*–ASTERACEAE) IN KENTUCKY

Brent D. Smith

Department of Biological Sciences
Eastern Kentucky University
Richmond, Kentucky 40475, U.S.A.

Andrew T. Denham

Department of Biological Sciences
Eastern Kentucky University
Richmond, Kentucky 40475, U.S.A.
Current address: 2266 Ard Ridge Rd.
Nancy, Kentucky 42544 U.S.A.

James B. Beck

Department of Biological Sciences
Eastern Kentucky University
Richmond, Kentucky 40475, U.S.A.
Current address: Department of Biology
Washington University
St. Louis, Missouri 63130-4899 U.S.A.

Patrick J. Calie[1]

Department of Biological Sciences
Eastern Kentucky University
Richmond, Kentucky 40475, U.S.A.
pat.calie@eku.edu

ABSTRACT

Short's goldenrod (*Solidago shortii* Torr. & A. Gray) is an endemic species with a highly restricted distribution, the Kentucky populations occurring in and around the vicinity of Blue Licks in the northeastern portion of the state. The general occurrence of the species was first mapped in 1987, with several similar maps being published from 1989–2000. Due to changes in local land use practices the status of the populations has rapidly changed rendering these maps obsolete. A census of all populations was conducted and the precise topographic location and physical boundaries of each extant population was mapped using field reconnaissance techniques and GIS mapping technology. Between 1989 and 2003 four of the original populations were extirpated, eight declined in number of stems present, and one increased in both number of stems and area coverage.

RESUMEN

La "Espiga de oro de Short" (*Solidago shortii* Torr. & A. Gray) es una especie con poblaciones altamente restringidas en y a los alrededores de Blue Licks, al norteste de Kentucky. La distribución general de las poblaciones de esta especie fue cartografiada por primera vez en 1987 y varios mapas han sido publicados entre 1989-2000. Debido a cambios locales en el uso de tierra para cultivo, la distribución original de las poblaciones de la especie se han modificado en gran medida, y en consecuencia los mapas existentes están obsoletos. Un censo de todas las poblaciones, observaciones de campo, y técnicas del Sistema de Información Geográfica (SIG) han permitido la ubicación topográfica precisa y la delimitación física de cada población. De 1989 a 2003 cuatro de las poblaciones originales han desaparecido, ocho disminuyeron en número de tallos y una población aumentó en número de tallos y en área de cobertura

---

[1] Author for correspondence: Department of Biological Sciences, 235 Moore Science Bldg, 521 Lancaster Ave., Richmond, Kentucky 40475-3124, U.S.A. Ph: 859-622-1505; fax: 859-622-1399; e-mail: pat.calie@eku.edu

SIDA 21(2): 1121–1130. 2004

INTRODUCTION

Solidago shortii (Asteraceae) is listed as an Endangered Species in the Federal Register (Anonymous 1985). Charles Wilkens Short originally discovered specimens of the species growing on boulders at the Falls of the Ohio River in Jefferson County, Kentucky, in 1837. All remnants of those populations were either destroyed by inundation resulting from the construction of the McAlpine locks and dam to facilitate navigation on the Ohio River in 1925 (Buchele et al. 1989) or were extirpated in the latter half of the 19th century (Baskin et al. 2000). The species was "rediscovered" by E.L. Braun in 1939, in the vicinity of Blue Licks, KY (Braun 1941) (Fig. 1). The first map showing the spatial distribution of the Blue Licks populations was constructed in 1986 (Evans 1987). Several subsequent reports contained maps of similar resolution (e.g. Buchele et al. 1989), with a new population being noted in Baskin et al. (2000).

During the course of our field investigations from 1995-2003, we observed marked changes in the spatial size and occurrence of specific populations, due in part to local land-use practices and to local successional changes in several habitats. It became very clear that updated maps were needed to facilitate management practices involving this species.

This study was undertaken with two objectives in mind: 1) to develop higher resolution maps of each known Kentucky population of Short's goldenrod using Geographic Information Systems (GIS) cartographic technology; and 2) to update the status of each population first demarcated by Evans in 1987. Given the demonstrated utility of Geographic Information Systems technology in land use management (Longley et al. 1999) and species inventory applications (DeMers 1996), this application was a logical choice for developing accurate maps.

MATERIALS AND METHODS

Field Work-Population Census.—During the 2000 field season the boundary of each population first documented by Evans (1987) and Buchele et al. (1989) was defined through field surveys. Multiple transects through each population were established, dividing the population into parallel 3-meter-wide strips. The space between successive transects was then traversed, each individual *S. shortii* stem being counted. The majority of populations exhibit a linear rather than a polygonal distribution, which made this direct count approach technically feasible. This represents at best a minimal estimate, as undoubtedly some stems within the population boundaries escaped our detection, and some scattered plants do exist outside the demarcated boundaries.

Field Work-GPS Coordinates.—GPS Lat/Long coordinates, taken in the degrees/minutes/seconds format, were determined with a Magellan 2000 handheld GPS device at 50-meter intervals along the established perimeter of each population. Reference maps for each population were drawn in the field, using

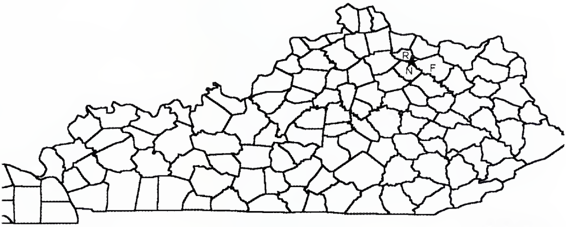


FIG. 1. Location of the populations of Short's goldenrod in Kentucky. The "star" indicated the approximate location of the majority of populations at the intersection of Fleming (F), Robertson (R), and Nicholas (N) counties.

measurements taken from local landmarks to orient field maps with aerial photographs and topographic maps (described below). Area estimates for each population were calculated from field measurements and combined with stem counts taken in 2001 to obtain density estimates for each population.

GIS Mapping.—An Event Theme using the GPS data points was created in ArcView 3.0. The X coordinate was set to Longitude, the Y coordinate to Latitude, and the Projection was set to Lambert Conformal Conic. Aerial and topographic images of the field research area were downloaded from the Kentucky Office of Geographic Information Systems (KYOGIS) website (ogis.state.ky.us/). The KYOGIS download included a file containing georeferencing information.

A Line Theme was created to show the plants' distribution. The plants' locations and their proximity to landmarks visible on the aerial photo were verified and corrected based on our field observations. Other data sets were combined with the images and population lines. For example, a State Highways theme and Counties theme from Environmental Systems Research Institute (ESRI) were added to show the locations of highways and county boundaries. Finally, we created the included maps (Fig. 2) using the ArcView Layout tool. All data and map files are available to appropriate scientific investigators and state and federal agencies upon request.

RESULTS

The ArcView system allows us to superimpose the GPS-derived data points for each population onto a number of high resolution cartographic interfaces, e.g., an aerial photograph (Fig. 2A) or a topographic map (Fig. 2B). Comparisons with earlier maps are not quantitative due to differences in cartographic methodologies. Likewise, exact comparisons of surface area coverage for each popu-

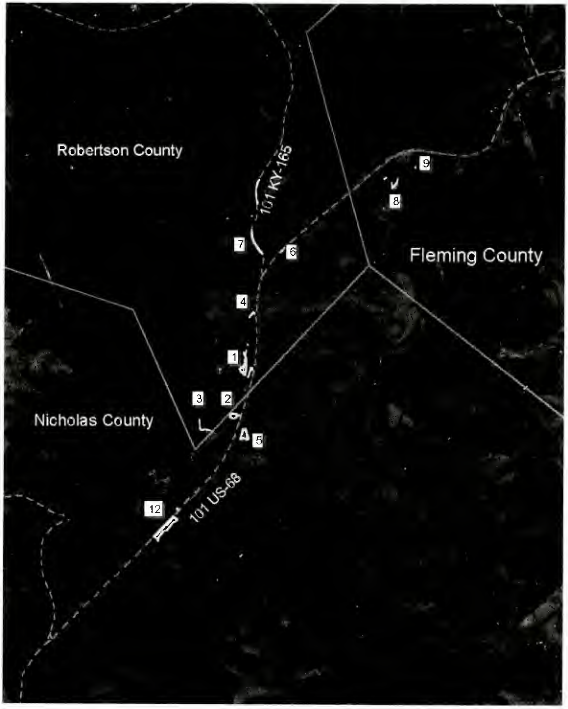


Fig. 2A. Example of a GIS-generated map showing the location of the known extant Kentucky populations of Short's goldenrod, with the exception of populations #11 and #15. Boxed numbering of populations follows Evans (1987). Solid white lines are county boundaries, dashed white lines are state and federal highways, the serpentine figure traversing the map is the Licking River, and population boundaries are shown in red. Only those populations found on properties in either state or federal agency ownership are shown.

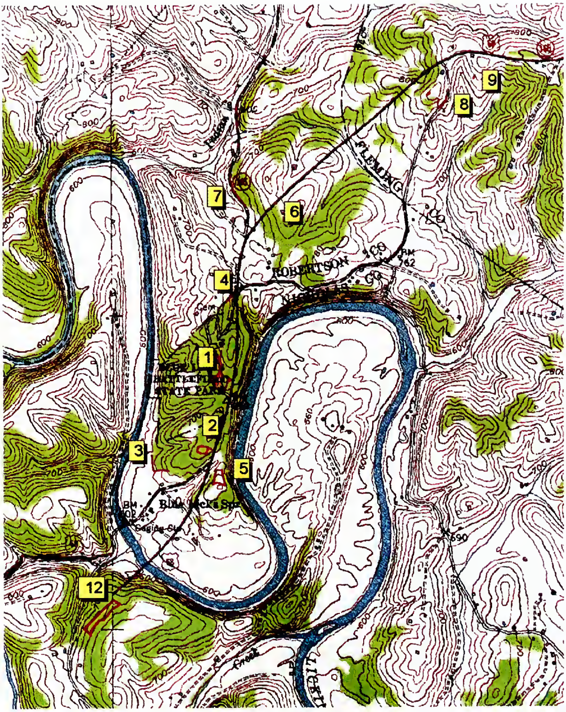


FIG. 2B. The identical shape file in figure 2A, now superimposed over a USGS topographic map.

lation relative to an earlier study (Buchele et al. 1989) are difficult due to differences in sampling techniques. However, we are confident that both sampling methodologies are of sufficient accuracy to allow for general comparisons. Two populations found on lands in private ownership (#11 and #15) are not shown on our maps to provide those populations with some measure of protection.

The census results, rather dramatic when compared to earlier stem counts, are summarized in Table 1. Based upon comparison with earlier stem counts and surface area estimates (Buchele et al. 1989) the populations cluster into the following categories.

Decline.—This is the status of populations #1–4, #7, #11 and #12, all having declined in stem numbers ranging from a 1.25-fold to 33-fold. Population #6 exhibits a larger fold decrease, now consisting of only one stem. We consider this population to be extirpated. A concomitant decrease in surface area is also seen in population #1–4, #7 and #8. While experiencing a slight decline in stem number (1.25-fold), population #12 has expanded its surface area by 13-fold. Census data for population #11 are not available for 2002, as we were unable to obtain permission from the private property owner to examine this site. GIS data were obtained for this population along a bordering road, and mapped from prior field observations.

Extirpated.—Population #6 occurs along a highway right-of-way, and is a remnant of a once larger population that was intentionally destroyed by a local landowner. There is now a single stem remaining. The original population #10 (Evans 1987) was destroyed by a local landowner (Mr. Allison, pers. comm.). We discovered a remnant set of eight plants in 1998, ca. 100 meters east of the original locality. This set is now extirpated due to local successional changes, e.g., increased canopy cover from arborescent species (primarily *Quercus* spp.).

Increase.—Population #5 is the only population that has increased in stem number, from 530 in 1989 to an estimated 3,488 in 2001. This is accompanied by an increase in coverage area from 870 m^2 in 1989 to 5,380 m^2 in 2001. This is now the largest Kentucky population of Short's goldenrod in terms of both area and stem number.

Doubtful reports.—Population #14, located on private property (the Kingsolver farm near Blue Licks Battlefield State Park) has been of doubtful determination since its "discovery". There are no voucher specimens from this site, and repeated efforts by the authors in 1998 and 1999 and by D. White (Kentucky State Nature Preserves Commission, pers. comm.) to locate *S. shortii* plants met with failure. This population, if ever extant, is now extirpated

Recently discovered population.—Population #15 was discovered by Mr. Nick Drozda of the KSNPC during a survey of a bison trace (trail) in 1998. This population was revisited in 2003 and found to have increased in number of stems and distribution.

Table 1. Summary of population census and area of coverage of all known verified populations of Short's goldenrod in Kentucky. Data from 1989 are those of Buchele et al. (1989), from 2001–2003 are from this study. The numbering of populations #1–13 is that of Evans (1987). Population #14 was designated and first mapped by Baskin et al. (2001), and #15 is the recent discovery by N. Drozda. The "First Report" entry refers to the earliest notation in status records maintained by the USFWS and provided by D. White of the KSNPC. KSNPC = Kentucky State Nature Preserves Commission; P = private ownership; KSPC = Kentucky State Parks Commission; KHC = Kentucky Highway Commission; ROW = Right-of-Way; USFWS = United States Fish and Wildlife Service. **extirpated* = population consisting of 1 plant, but in essence extirpated; **14 = dubious report; ***15 = stem number estimate provided by N. Drozda (pers. comm.).

Population #	**Stem # 1989/2001**	**Fold increase/ decrease**	**Area m2 1989/2002**	**Fold increase/ decrease**	**Density (# stems/m2)**	**Ownership**	**First Report**
1	42,000 / 2,549	16-fold decrease	4,600 / 3,027	1.5-fold decrease	9.13 / 0.842	KSNPC/KSPC	1936
2	10,150 / 573	18-fold decrease	12,840 / 1,367	9.4-fold decrease	0.790 / 0.419	KSPC	1983
3	3,500 / 193	18-fold decrease	4,500 / 300	15-fold decrease	0.778 / 0.642	P	1987
4	1,400 / 42	33-fold decrease	1,290 / 193	7-fold decrease	1.08 / 0.217	KSNPC / KSPC	1936 (?)
5	530 / 3,488	7-fold increase	870 / 5,380	6-fold increase	0.609 / 0.648	KSNPC	1983
6	2,100 / 10 (00), 1 (02)	**extirpated*	515 / 1	NA	NA	P / KDOT (ROW)	1986
7	6,300 / 1,000	6-fold decrease	6,230 / 524	12-fold decrease	1.01 / 1.91	KDOT (ROW)	1957
8	1,780 / 672	3-fold decrease	2,570 / 766	3-fold decrease	0.692 / 0.877	KSNPC	1934
9	640/<25 (00), 3 (02)	**extirpated*	2,485 / 1	NA	NA	P (ROW)	1987
10	240 / 13 (00), 0 (02)	*extirpated*	15 / 0	NA	16.0 / 0	P / KDOT (ROW)	1985
11	2,500 / 800	3-fold decrease	265 / NA	NA	9.43 / NA	P	1985
12	2,300 / 1,846	1.25-fold decrease	390 / 4,877	13-fold increase	5.89 / 0.378	USFWS (ROW)	1939
13	180 / 0	*extirpated*	Feb-00	NA	90.0 / 0	P	1987
**14	15-20(?) / 0	*extirpated(?)*	NA	NA	NA	P	1989
***15	NA / 100 (03)	*NA*	NA/120	NA	NA / 0.83	P	1998

DISCUSSION

Given the state of mapping technology in 1987 (and the passage of time) it is not surprising that maps derived through GIS applications are different from the original maps. What is of particular note is the general numeric decline in all but one population (#5) of *S. shortii*. Populations #1, 2, and 4 have been within the jurisdiction of the Kentucky State Parks Commission during this period of comparison, yet all three have suffered massive decline. An unequivocal cause for the decline of these three and/or any other populations under protection (i.e., populations #5 and 8, under the jurisdiction of the KSNPC, and population #12, under the USFWS) is not clear.

The spatial distribution patterns of the populations fall into two categories. The first we term "linear" (populations #1, 3–4, 6–9, 11 and 12). Several of these populations occur along either power line or highway rights-of-way (Table 1), but others occur in what appears to be uninterrupted habitat (e.g. #4) conforming to a linear pattern. This could be due to localized edaphic conditions, as the preferred habitat is one with shallow soils. The second category we refer to as "polygonal" (populations #2 and #5). These habitats are continuous areas uninterrupted by roads. The plants, however, are distributed discontinuously throughout the mapped area, the perimeter of the populations assuming an irregular geometric outline. The precise reasons for this difference in spatial distribution patterns is at present unknown but could be due to subterranean factors, e.g., rock shields underlying shallow soils and providing an unsuitable habitat for competing species. Alternatively, the plants' distribution could be due to seed dispersal patterns of those specific populations. At present both of these postulates remain untested.

The results of the stem count comparison are dramatic. Numbers of stems has decreased since 1989 for all observed populations except #5. This population exists in an old field that is currently under the management and ownership of the Kentucky State Nature Preserves Commission. The results of the area estimates are equally dramatic, since all of the observed populations except for #5 have decreased in area since 1989. Population #1 has experienced the most marked decline, most likely due to improper management and increased development and use of park recreation facilities by visitors. This population is now dissected into several distinct groups, each following either a road or a power line right-of-way or a former bison trace remnant. The glade area within the park where the plants were previously observed in abundance is now populated primarily by *S. nemoralis*. A similar situation exists in population #2. The impact of *S. nemoralis* on the long-term persistence of *S. shortii* is not known, although we have observed a steady decline in these two populations (Table 1).

Three populations have been extirpated, one by natural means and two by human intervention. Population #13 occurred in an open field and consisted of 180 stems in 1989 (Buchele et al. 1989). The field was subjected to mowing in the early years of the 1990s, but in the latter half of the decade the field was not cultivated. Competition from non-native grasses (e.g, *Festuca*) and forbs (e.g., *Lespedeza*) have contributed to the loss of this population. Population #6 grew in an actively grazed pasture and was removed by the landowner in 1988 by bulldozing the habitat (USFWS records and D. White, pers. comm.). In discussions with the local landowner it was revealed that population #10 was eliminated through extensive mowing of caulescent stems and the deposition of concrete debris on the persistent rosettes, beginning prior to 1995. Population #11 occurs along a woodland edge and appeared rather stable over the period of this study.

The status of a questionable population has also been resolved. Population #14 was first cited in Baskin et al. (2000). We were unable to locate plants in the field during 1998 and 1999, and there was confusion regarding the accuracy of the original species determination (D. White, pers. comm.). Records maintained by the USFWS indicated ca.15–20 stems of "Short's goldenrod" in 1989, but none was found in either 1997 or 1998. Independent efforts by D. White (pers. comm.) were also unsuccessful. If this population of Short's goldenrod ever existed, it is clear that it is now extirpated.

In 2000, a new population was discovered by N. Drozda of the KSNPC along a former bison trace (trail) in Fleming County. This population consisted of ca.25 stems, and the plants were described as "depauperate" (USFWS records). The population, designated as #15 in Table 1, persisted into 2003 and now consists of ca. 100 stems concentrated along the bison trace with a few individuals scattered in the adjacent woods.

In 1995 seven "clumps" of cultivated *S. shortii* (originally obtained from a Blue Licks population) were planted on the Indiana shoreline of the Ohio River, across from the type locality at the Falls of the Ohio River in an effort to reintroduce the species into suitable riparian habitat (Homoya 1996). These plants were lost in the following year due to increased water flow from winter runoff (D. White, pers. comm.). A recent report describes a population of Short's goldenrod in Indiana (www.in.gov/dnr/public/novdec01/news1.htm). This is the first verified record of Short's goldenrod outside of Kentucky (a voucher specimen has been deposited at MOBOT), the site occurring within a former migration pattern of the extinct eastern woodland bison (*Bison bison* L.). This could represent a very old population that has been genetically isolated from the Kentucky populations for perhaps several centuries. Alternatively, this population could consist of escaped colonizers from the 1995 effort to reintroduce the plants in Indiana, as the newly discovered population is ca. 50 nautical miles downstream from the attempted reintroduction. Genetic analyses of samples from both the Kentucky and Indiana populations are now underway in an effort to resolve this issue.

ACKNOWLEDGMENTS

Appreciation is extended to the Wilderness Road Girl Scout Council Troop #1265 for their mapping of population #4, and to Bruce Davis and the GIS Map Laboratory of Eastern Kentucky University for assistance with GIS software and map generation. Funding in support of field and computational activities was obtained through a Sigma Xi Grant-in-Aid of Research (JBB), through contracts #20379 and #99161405 from the Kentucky State Nature Preserves Commission and the US Fish and Wildlife Service, two EKU Faculty Research Awards and NIH/NCRR Award #P20 RR16481-S1 (PJC). Discussions with Marc Evans and Deborah White, and the field assistance of Tiffany Carpenter and Christina Shackleford are gratefully acknowledged. Nick Drozda escorted PC to population #15 and provided critical background information. The comments and reviews of Moriah Beck and Rob Naczi on the manuscript, and assistance from Sara Fuentes and Lupita Sanchez with Spanish translation are appreciated.

REFERENCES

Anonymous. 1985. Listing of threatened and endangered species. Fed. Reg. 50:36085–36089.

Baskin, J.M, J.L. Walck, C.C. Baskin, and D.E. Buchele. 2000. Ecology and conservation of the endangered plant species *Solidago shortii* (Asteraceae). Native Pl. J. 1:35–41.

Beck, J.B., R.F.C Naczi, and P.J. Calie. 2001. Insights into the species delineation and population structure of *Solidago shortii* (Asteraceae) through morphometric analysis. Rhodora 103:151–171.

Buchele, D.E., J.M. Baskin, C.C. Baskin. 1989. Ecology of the endangered species *Solidago shortii* I. Geography, populations and physical habitat. Bull. Torrey Bot. Club 116:344–355.

Braun, E.L. 1941. A new locality for *Solidago shortii*. Rhodora 43:484.

DeMers, T. 1996. Remote sensing and geographical information systems: Spatial technologies for preserving phytodiversity. In: T.F. Stuessy and S.H. Sohmer, eds. Sampling the green world. Innovative concepts of collection, preservation, and storage of plant diversity. Pp. 125–139.

Evans, M. 1987. Short's goldenrod recovery plan. Unpublished Technical Agency Draft. USFWS, Southeast Region, Atlanta, GA.

Homoya, M. 1996. The return of Short's goldenrod. Endang. Spec. Tech. Bull. 21:24–25.

Longley, P.A., M.F. Goodchild, D.J. Maguire, and D.W. Rhind (eds.). 1999. Geographic Information Systems: Principles, Techniques, Applications and Management. Second ed. John Wiley and Sons, New York.

AN ANNOTATED, PRELIMINARY CHECKLIST OF THE VASCULAR FLORA OF CAMP BUTNER, NORTH CAROLINA

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

Carlyle Franklin

Department of Forestry
North Carolina State University
Raleigh, North Carolina 27695-8006, U.S.A.
Carlyle_Franklin@ncsu.edu

ABSTRACT

For the past five years, the Woodlot Forestry Research and Development Program at North Carolina State University has been assisting with the implementation of the Land Condition Trend Analysis (LCTA) program at Camp Butner. A plant inventory has been an ongoing aspect of associated research. This checklist represents a preliminary inventory of the flora of the site, comprising 78 families, 178 genera, and 241 species.

RESUMEN

En los cinco años anteriores, el Woodlot Forestry Research and Development Program de la Universidad del Estado de Carolina del Norte ha estado ayudando con la implementación del programa Land Condition Trend Analysis (LCTA) en Camp Butner. El inventario vegetal ha sido un aspecto de la investigación asociada. Este listado representa un inventario preliminar de la flora local, que comprende 78 familias, 178 géneros, y 241 especies.

The Camp Butner National Guard Training Site ('Camp Butner') in Durham and Granville counties, North Carolina comprises 1975 hectares and includes pine plantations, mixed pine-hardwood forests, and bottomland hardwood forests. For the past five years, the Woodlot Forestry Research and Development Program at North Carolina State University has been assisting with the implementation of the Land Condition Trend Analysis (LCTA) program at Camp Butner (WFRDP 2003). The Land Condition Trend Analysis (LCTA) inventory was instituted by the US Army Construction Engineering Research Laboratory (USACERL) in order to monitor the natural resources on military installations and to provide information for making sound training and land management decisions (Tazik et al. 1992). In association with annual vegetation monitoring, land use assessment, and wildlife monitoring, a plant inventory has also been an ongoing aspect of research at Camp Butner since 2001. This checklist represents a preliminary inventory of the flora of the site.

METHODS

To inventory the vascular plants of Camp Butner, the site was visited numerous times between 2001–2003. Principal collectors of the flora associated with our project include: C. Wiecek, V. Miller, C. Sheats, and K. Summitt. Batson (1952)

SIDA 21(2): 1131–1139. 2004

also collected in the area. Collected specimens were pressed and dried using standard herbarium techniques and identified using the collections of the North Carolina State University Herbarium (NCSC).

RESULTS AND DISCUSSION

Seventy-eight families, 178 genera, and 241 species are currently known from Camp Butner (Table 1). *Ruellia purshiana* Fern. (Acanthaceae) is known from the site (M. Franklin, pers. comm.), but has not been collected. Taxa are arranged alphabetically within the major subgroups of ferns, gymnosperms, dicots, and monocots. The number of genera, then species follows each family name. Brief habitat descriptions follow each species entry when available. Landscape features for the site are discussed by Hall (1995). Taxonomy follows APGII (APG 2003). Nomenclature primarily follows USDA, NRCS (2002). Specimens are deposited at NCSC, unless otherwise indicated.

The composition of the flora is typical for central North Carolina—the site hosts mixed second growth woodlands, pine plantations, and clearcuts (see also Palmer 1990; Hall 1995). However, compared to other near sites, the flora of Camp Butner is noticeably depauperate (Table 2). The flora of Umstead State Park, which is somewhat larger than Camp Butner, includes about three times as many species (Sawyer 1968). Even floras of sites smaller by an order of magnitude comprise 1.5 to 2 times as many species (Table 2). We suspect two main reasons to explain the relative species poorness of the Camp Butner flora. The majority of the site was not forested as late as 1950 based on black and white (1 to 60,000) photography flown by the US Army in November, 1950. The site now hosts forests that are under higher disturbance regimes from military land use than "nature preserves" such as Durant Park (Skean 1982) or Umstead State Park (Sawyer 1968). Prior to its current ownership, Camp Butner lands were in tobacco cultivation and pastures, as well as host to a WWII prisoner of war camp and artillery range.

Sampling intensity could also be an important factor. Based on comparisons with other floras (Table 3), it appears evident that several large families, including Asteraceae, Fabaceae, Cyperaceae, and Poaceae, remain undersampled in our study and that future efforts must concentrate on increasing representation.

FERNS AND ALLIES

ASPLENIACEAE 1/1

Asplenium platyneuron (L.) B.S.P. (*Sheats 106*; *Wiecek 68*) Pine-hardwood mix.

BLECHNACEAE 1/1

Woodwardia areolata (L.) T. Moore (*Sheats 107*) Pine-hardwood mix.

DENNSTAEDTIACEAE 2/2

Dennstaedtia punctilobula (Michx.) T. Moore (*Sheats 92*)

Pteridium aquilinum (L.) Kuhn (*Sheats 138*) Pine forest.

DRYOPTERIDACEAE 3/3

Athyrium filix-femina (L.) Roth ssp. *asplenioides* (Michx.) Hultén (*Summitt 148*) Near stream.

Table 1. Summary of numbers of families, genera, and species of Camp Butner.

	Ferns and allies	Gymnosperms	Dicotyledons	Monocotyledons	Total
Families	8	2	58	10	78
Genera	11	2	139	26	178
Species	11	4	192	34	241

Table 2. Comparative floristics of Camp Butner to other sites (F = families; G = genera; S = species).

	Camp Butner[1] (ca. 4880 ac)			Yates Mill Pond[2] (ca. 180 ac)			Durant Nature Park[3] (ca. 237 ac)			White Pines Natural Area[4] (ca. 242 ac)			Umstead State Park[5] (ca. 5439 ac)		
	F	G	S	F	G	S	F	G	S	F	G	S	F	G	S
Ferns and allies	8	11	11	8	11	15	8	13	18	8	14	19	9	14	15
Gymnosperms	2	2	4	2	2	4	2	2	4	2	2	6	2	2	4
Dicotyledons	58	139	192	72	164	247	83	206	337	86	241	398	92	290	529
Monocotyledons	10	26	34	11	56	96	11	75	128	14	73	139	15	90	186
Total	78	178	241	93	233	362	104	296	487	110	330	562	118	396	734

[1]Present study; [2]Jones (1971); [3]Skean (1982); [4]Swab (1990); [5]Sawyer (1968).

Table 3. Comparison of species richness of four large families at Camp Butner and other sites.

	Camp Butner[1]	Yates Mill Pond[2]	Durant Nature Park[3]	White Pines Natural Area[4]
Asteraceae	36	35	54	66
Fabaceae	22	21	30	30
Cyperaceae	3	16	24	28
Poaceae	20	47	62	64

[1]Present study; [2]Jones (1971); [3]Skean (1982); [4]Swab (1990).

Onoclea sensibilis L. (*Summitt 153*) Near stream.

Polystichum acrostichoides (Michx.) Schott (*Summitt 163*; *Wiecek 63*) Near stream; Pine plantation.

LYCOPODIACEAE 1/1

Lycopodium digitatum Dill. ex A. Braun (*Sheats 95*) Pine-hardwood mix.

OSMUNDACEAE 1/1

Osmunda cinnamomea L. (*Summitt 222*) Near stream.

POLYPODIACEAE 1/1

Pleopeltis polypodioides (L.) Andrews & Windham (*Sheats 203*) Bottomland hardwoods.

THELYPTERIDACEAE 1/1

Thelypteris noveboracensis (L.) Nieuwl. (*Summitt 223*) Near stream.

GYMNOSPERMS

CUPRESSACEAE 1/1

Juniperus virginiana L. (*Sheats 98*) Pine-hardwood mix.

PINACEAE 1/3

Pinus echinata P.Mill. (*Sheats 94*) Pine-hardwood upland mix.

Pinus taeda L. (*Sheats 136*) Pine forest.

Pinus virginiana P. Mill. (*Sheats 127*) Pine forest.

ANGIOSPERMS
BASAL ANGIOSPERMS AND EUDICOTS

ACANTHACEAE 1/1

Ruellia caroliniensis (J.F. Gmel.) Steud. (*Summitt 218*) Roadside.

ADOXACEAE 1/3

Viburnum acerifolium L. (*Summitt 213*) Near lake.

Viburnum prunifolium L. (*Batson 1274*, DUKE)

Viburnum rafinesquianum J.A. Schultes (*Sheats 147*) Bottomland hardwoods.

ALTINGIACEAE 1/1

Liquidambar styraciflua L. (*Sheats 77*) Upland hardwood mix.

ANACARDIACEAE 2/2

Rhus copallina L. (*Sheats 115*) Upland hardwoods.

Toxicodendron radicans (L.) Kuntze (*Sheats 101*) Pine-hardwood mix.

ANNONACEAE 1/1

Asimina parviflora (Michx.) Dunal (*Wiecek 15*) Bottomland hardwood forest.

APOCYNACEAE 2/2

Apocynum cannabinum L. (*Summitt 210*) Roadside.

Asclepias tuberosa L. (*Sheats 175*) Roadside/pine mix.

AQUIFOLIACEAE 1/2

Ilex decidua Walt. (*Batson 1029*, DUKE)

Ilex opaca Sol. (*Sheats 113*) Upland hardwoods.

ARISTOLOCHIACEAE 1/4

Hexastylis lewisii (Fern.) H.L. Blomq. & Oost. (*Batson s.n.*) Bluff.

Hexastylis minor (Ashe) H.L. Blomq. (*Wiecek 14*) Bottomland hardwood forest.

Hexastylis shuttleworthii (Britten & Baker f.) Small (*Summitt 131*) Lake edge.

Hexastylis virginica (L.) Small (*Sheats 75*)

ASTERACEAE 27/36

Achillea millefolium L. (*Sheats 125*, *Sheats 176*; *Summitt 125*) Roadside.

Ambrosia artemisiifolia L. (*Wiecek 39*) Upland hardwoods.

Antennaria plantaginifolia (L.) Richards (*Batson 1314*, DUKE)

Anthemis arvensis L. (*Sheats 212*) Roadside.

Bidens aristosa (Michx.) Britt. (*Miller 27*) Xeric site, near erosion monitoring plot.

Chrysogonum virginianum L. (Sheats 81; Summitt 81) Roadside slopes; near stream.

Chrysopsis mariana (L.) Ell. (*Miller 26*; *Wiecek 47*) Upland hardwoods; Xeric site, near erosion monitoring plot; clearing.

Cirsium horridulum Michx. (*Summitt 204*; *Sheats 126*) Roadside.

Conyza canadensis (L.) Cronq. (*Sheats 221*)

Coreopsis auriculata L. (*Sheats 86*) Alluvial forest.

Elephantopus tomentosus L. (*Batson 1290*, DUKE)

Erechtites hieracifolia (L.) Raf. ex DC. (*Sheats 222*)

Erigeron annuus (L.) Pers. (*Sheats 108*) Upland hardwoods.

Eupatorium capillifolium (Lam.) Small (*Wiecek 71*) Pine-hardwood mix.

Eupatorium hyssopifolium L. (*Batson 655*, DUKE)

Eupatorium rotundifolium L. (*Sheats 183*; *Wiecek 3*) Pine plantation/roadside.

Helenium amarum (Raf.) H. Rock (*Sheats 167*, *Sheats 179*; *Summitt 220*) Roadside, pine mix.

Helenium autumnale L. (Sheats 178) Roadside/pine-hardwood mix.

Hieracium gronovii L. (*Wiecek 5*, *Wiecek 48*) Loblolly pine plantation and clearings; Upland hardwoods.

Hieracium venosum L. (*Sheats 73*) Pine-hardwood mix.

Krigia virginica (L.) Willd. (*Summitt 206*) Roadside.

Leucanthemum vulgare Lam. (*Summitt 60*; *Wiecek 60*) Roadside; Pine plantation.

Liatris squarrosa (L.) Michx. (*Sheats 199*) Pine-hardwood mix/roadside.

Packera anonyma (Wood) W.A. Weber & A. Löve (*Summitt 166*) Roadside.

Pluchea foetida (L.) DC. (*Sheats 140*) Pine forest.

Pseudognaphalium obtusifolium (L.) Hilliard & Burtt (*Summitt 117*; *Wiecek 7*) Roadside; loblolly pine plantation

Sericocarpus asteroides (L.) B.S.P. (*Sheats 137*, *Sheats 172*; *Summitt 221*) Roadside/pine-mix.

Solidago caesia L. var. *curtisii* (Torr. & Gray) Wood (*Wiecek 52*) Upland hardwoods.

Solidago canadensis L. var. *scabra* Torr. & A. Gray (*Batson 640*, DUKE)
Solidago nemoralis Ait. (*Batson 625*, DUKE)
Solidago odora Ait. (*Sheats 207*) Roadside.
Solidago pinetorum Small (*Sheats 163*) Roadside.
Solidago roanensis Porter (*Miller 23*) Xeric site, near erosion monitoring plot.
Solidago speciosa Nutt. var. *erecta* (Pursh) MacM. (*Wiecek 58*) Slope near creek
Symphyotrichum dumosum (L.) Nesom (*Wiecek 44*) Upland hardwoods.
Taraxacum officinale G.H. Weber ex Wiggers (*Summitt 183*) Roadside.

BALSAMINACEAE 1/1

Impatiens capensis Meerb. (*Sheats 223*) Creekside.

BETULACEAE 5/5

Alnus serrulata (Ait.) Willd. (*Summitt 207*) Streamside.
Betula nigra L. (*Sheats 193*; *Summitt 211*) Bottomland hardwoods; streamside.
Carpinus caroliniana Walt. (*Sheats 91*) Pine-hardwood upland mix.
Corylus americana Walt. (*Miller 20*) Xeric site, near erosion monitoring plot
Ostrya virginiana (P. Mill.) K. Koch (*Summitt 214*) Near lake.

BIGNONIACEAE 1/1

Campsis radicans (L.) Seem. ex Bureau (*Sheats 103*, *Sheats 194*) Pine-mix.

BRASSICACEAE 4/4

Barbarea verna (P. Mill.) Aschers. (*Summitt 129*) Roadside.
Cardamine hirsuta L. (*Summitt 187*) Roadside near stream-crossing.
Draba verna L. (*Summitt 185*) Roadside.
Teesdalia nudicaulis (L.) Ait.f. (*Summitt 186*) Roadside.

CAMPANULACEAE 1/4

Lobelia cardinalis L. (*Wiecek 35*) Knap of Reeds Creek.
Lobelia inflata L. (*Wiecek 4*) Loblolly pine plantation.
Lobelia puberula Michx. (*Wiecek 38*) Knap of Reeds Creek
Lobelia spicata Lam. (*Sheats 109*) Upland hardwoods.

CAPRIFOLIACEAE 1/1

Lonicera japonica Thunb. (*Sheats 96*) Pine-hardwood mix.

CARYOPHYLLACEAE 2/2

Cerastium fontanum Baumg. ssp. *vulgare* (Hartman) Greuter & Burdet (*Summitt 179*) Roadside.
Scleranthus annuus L. (*Sheats 214*) Roadside/pine-mix.

CISTACEAE 1/1

Lechea pulchella Raf. (*Sheats 198*)

CLUSIACEAE 1/4

Hypericum gentianoides (L.) B.S.P. (*Sheats 197*) Quarry.
Hypericum hypericoides (L.) Crantz (*Sheats 144*, *Sheats 186*; *Wiecek 6*, *Wiecek 19*) Loblolly pine plantation; bottomland hardwood forests/roadside.
Hypericum nudiflorum Michx. ex Willd. (*Sheats 201*) Bottomland hardwoods.
Hypericum punctatum Lam. (*Sheats 189*; *Summitt 217*) Bottomland hardwoods; roadside.

CONVOLVULACEAE 1/1

Ipomoea pandurata (L.) G.F.W. Mey. (*Miller 32*; *Sheats 173*) Xeric site, near erosion monitoring plot; roadside/pine mix.

CORNACEAE 1/1

Cornus florida L. (*Sheats 80*; *Summitt 156*) Pine-hardwood mix; roadside.

EBENACEAE 1/1

Diospyros virginiana L. (*Sheats 218*) Pine mix.

ERICACEAE 6/8

Chimaphila maculata (L.) Pursh (*Sheats 111*; *Summitt 82*) Upland hardwoods.
Gaylussacia frondosa (L.) Torr. & Gray ex Torr. (*Summitt 215*)
Leucothoe racemosa (L.) Gray (*Wiecek 16*) Bottomland hardwood forest
Oxydendrum arboreum (L.) DC. (*Sheats 88*, *Sheats 142*, *Sheats 220*) Pine-hardwood upland mix; bottomland hardwoods.
Rhododendron periclymenoides (Michx.) Shinners (*Sheats 89*)
Vaccinium fuscatum Ait. (*Summitt 84*) Upland hardwoods.
Vaccinium pallidum Ait. (*Sheats 119*, *Sheats 209*) Pine forest.

Vaccinium stamineum L. (*Summitt 145*; *Wiecek 62*) Roadside; Pine plantation.

EUPHORBIACEAE 2/3

Chamaesyce maculata (L.) Small (*Sheats 165*) Upland hardwoods.

Euphorbia corollata L. (*Sheats 188*) Bottomland hardwoods.

Euphorbia marginata Pursh (*Wiecek 37*) Knap of Reeds Creek

FABACEAE 16/22

Albizia julibrissin Durazz. (*Sheats 177*) Roadside.

Amphicarpaea bracteata (L.) Fern. (*Wiecek 40*) Upland hardwoods.

Centrosema virginianum (L.) Benth. (*Sheats 211*)

Cercis canadensis L. (*Sheats 104*)

Chamaecrista fasciculata (Michx.) Greene (*Sheats 157*) Pine forest.

Chamaecrista nictitans (L.) Moench (*Miller 21*) Xeric site, near erosion monitoring plot.

Cytisus scoparius (L.) Link (*Sheats 168*) Pine mix.

Desmodium nudiflorum (L.) DC. (*Summitt 216*) Roadside near lake.

Desmodium paniculatum (L.) DC. (*Batson 929*, DUKE)

Desmodium rotundifolium DC. (*Wiecek 43*) Upland hardwoods.

Galactia volubilis (L.) Britt. (*Batson 980*, DUKE)

Gleditsia triacanthos L. (*Sheats 123*) Pine-hardwood mix.

Lespedeza bicolor Turcz. (*Sheats 174*, *Sheats 210*; *Wiecek 8*) Clearcut; roadside/pine-mix.

Lespedeza cuneata (Dum.-Cours.) G. Don (*Miller 22*; *Sheats 161*) Roadside; xeric site, near erosion monitoring plot.

Lespedeza procumbens Michx. (*Miller 31*) Xeric site, near erosion monitoring plot.

Lespedeza virginica (L.) Britt. (*Miller 30*) Xeric site, near erosion monitoring plot.

Pueraria montana (Lour.) Merr. (*Sheats 164*) Upland hardwoods.

Robinia pseudoacacia L. (*Sheats 192*) Bottomland hardwoods.

Strophostyles umbellata (Muhl. ex Willd.) Britt. (*Miller 28*; *Sheats 187*) Xeric site, near erosion monitoring plot; bottomland hardwoods/roadside.

Stylosanthes biflora (L.) B.S.P. (*Sheats 180*) Roadside.

Tephrosia virginiana (L.) Pers. (*Summitt 172*) Roadside.

Wisteria sinensis (Sims) DC. (*Summitt 89*) Roadside.

FAGACEAE 2/9

Fagus grandifolia Ehrh. (*Sheats 78*) Upland slopes.

Quercus alba L. (*Sheats 76*) Upland hardwood mix.

Quercus falcata Michx. (*Sheats 134*) Pine forest.

Quercus marilandica Muenchh. (*Sheats 181*) Pine-hardwood mix.

Quercus montana Willd. (*Sheats 87*) Dry oak-hickory mix.

Quercus phellos L. (*Sheats 128*) Pine forest.

Quercus rubra L. (*Sheats 79*) Upland hardwood mix.

Quercus stellata Wangenh. (*Sheats 135*) Pine forest.

Quercus velutina Lam. (*Sheats 213*)

GENTIANACEAE 1/1

Sabatia angularis (L.) Pursh (*Sheats 190*; *Wiecek 1*) Bottomland hardwoods; loblolly pine plantation.

HAMAMELIDACEAE 1/1

Hamamelis virginiana L. (*Wiecek 17*) Bottomland hardwood forest

JUGLANDACEAE 2/3

Carya alba (L.) Nutt. ex Ell. (*Sheats 97*, *Sheats 149*, *Sheats 225*) Upland forest; bottomland hardwood forest; pine forest.

Carya glabra (P. Mill.) Sweet (*Summitt 212*) Roadside near lake.

Juglans nigra L. (*Sheats 122*, *Sheats 151*) Pine forest; pine-hardwood mix.

LAMIACEAE 4/7

Prunella vulgaris L. (*Miller 24*; *Summitt 24*) Xeric site, near erosion monitoring plot; roadside.

Pycnanthemum muticum (Michx.) Pers. (*Sheats 185*) Bottomland hardwoods.

Pycnanthemum pycnanthemoides (Leavenworth) Fern. (*Wiecek 10*) Bottomland hardwood forest

Pycnanthemum tenuifolium Schrad. (*Sheats 184*) Pine plantation/roadside.

Salvia lyrata L. (*Summitt 209*) Roadside.

Scutellaria elliptica Muhl. ex Spreng. (*Sheats 110*) Upland hardwoods.

Scutellaria integrifolia L. (*Wiecek 69*) Pine-hardwood mix.

LAURACEAE 1/1

Sassafras albidum (Nutt.) Nees (*Sheats 112*, *Sheats 146*) Bottomland hardwoods; upland hardwoods.

LINACEAE 1/1

Linum sulcatum Riddell var. *sulcatum* (*Batson 1013*, DUKE)

MAGNOLIACEAE 1/1

Liriodendron tulipifera L. (*Sheats 83*) Upland oak-hickory mix.

MELASTOMATACEAE 1/1

Rhexia mariana L. (*Sheats 171; Summitt 171*) Pine mix; roadside.

MORACEAE 2/2

Maclura pomifera (Raf.) Schneid. (*Sheats 102*) Pine-hardwood mix.

Morus rubra L. (*Sheats 124*) Pine-hardwood mix.

NYSSACEAE 1/1

Nyssa sylvatica Marsh. (*Sheats 226; Summitt 219*) Pine hardwood mix; near stream.

OLEACEAE 1/1

Fraxinus americana L. (*Batson 1141*, DUKE)

ONAGRACEAE 2/3

Ludwigia decurrens Walt. (*Sheats 224*)

Oenothera biennis L. (*Summitt 132*) Ditch.

Oenothera fruticosa L. (*Sheats 93*) Roadsides.

OROBANCHACEAE 3/3

Agalinis purpurea (L.) Pennell (*Wiecek 46*) Upland hardwoods.

Aureolaria virginica (L.) Pennell (*Sheats 191*) Bottomland hardwoods.

Epifagus virginiana (L.) W. Bart. (*Wiecek 56*) Slope near creek

OXALIDACEAE 1/3

Oxalis corniculata L. (*Wiecek 54*)
Upland hardwoods.

Oxalis stricta L. (*Sheats 205; Summitt 170*) Roadside.

Oxalis violacea L. (*Summitt 191; Wiecek 36*) Knap of Reeds Creek; near stream.

PAULOWNIACEAE 1/1

Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud. (*Sheats 150*) Pine forest.

PHRYMACEAE 1/1

Mimulus alatus Ait. (*Sheats 200*) Bottomland hardwoods.

PHYTOLACCACEAE 1/1

Phytolacca americana L. (*Sheats 139*) Pine forest.

PLANTAGINACEAE 2/4

Nuttallanthus canadensis (L.) D.A. Sutton (*Summitt 195*) In clearcut.

Plantago aristata Michx. (*Sheats 152*) Pine forest.

Plantago rugelii Dcne. (*Sheats 206*) Roadside.

Plantago virginica L. (*Summitt 208*) Roadside.

PLATANACEAE 1/1

Platanus occidentalis L. (*Sheats 90*) Alluvial forest (streamside).

POLYGALACEAE 1/1

Polygala curtissii Gray (*Sheats 169; Summitt 9; Wiecek 9*) Clearcut; roadside.

PORTULACACEAE 1/1

Claytonia virginica L. (*Summitt 193*) Along creek.

RANUNCULACEAE 4/4

Hepatica nobilis Schreb. var. *obtusa* (Pursh) Steyermark (*Sheats 114; Summitt 188*) Upland hardwoods; along streambank.

Ranunculus abortivus L. (*Summitt 182*) Grass/pine border.

Thalictrum thalictroides (L.) Eames & Boivin (*Summitt 189*) Streambank

Xanthorhiza simplicissima Marshall (*Sheats 202*) Creekside.

ROSACEAE 10/12

Amelanchier arborea (Michx. f.) Fern. (*Summitt 114, Summitt 224*) Forest edge.

Crataegus flava Ait. (*Sheats 133*) Pine forest.

Fragaria virginiana Duchesne (*Batson 744*, DUKE)

Malus angustifolia (Ait.) Michx. (*Sheats 208*) Pine-hardwood mix.

Porteranthus trifoliatus (L.) Britt. (*Sheats 74*) Pine-hardwood mix.

Potentilla canadensis L. (*Sheats 84, Summitt 85*) Roadside.

Potentilla simplex Michx. (*Batson 738*, DUKE)

Prunus serotina Ehrh. (*Sheats 162*) Roadside.

Pyrus communis L. (*Sheats 154*) Pine forest.

Rosa carolina L. (*Batson 878*, DUKE)

Rubus argutus Link (*Summitt 137*) Roadside.

Rubus trivialis Michx. (*Sheats 82*)

RUBIACEAE 4/6

Diodia teres Walt. (*Miller 29; Sheats 204*) Roadside. Xeric site, near erosion monitoring plot

Galium circaezans Michx. (*Wiecek 11, Wiecek 41*) Bottomland hardwood forest; Upland hardwoods.

Galium pilosum Ait. (*Sheats 130*) Bottomland hardwoods.

Galium triflorum Michx. (*Wiecek 42*) Upland hardwoods.

Houstonia caerulea L. (*Summitt 180, Summitt 181*) Roadside.

Mitchella repens L. (*Wiecek 64*) Pine plantation.

SALICACEAE 1/1

Salix nigra Marsh. (*Sheats 141*) Bottomland hardwoods.

SAPINDACEAE 1/1

Acer rubrum L. (*Sheats 72*) Pine-hardwood mix.

SAXIFRAGACEAE 1/1

Heuchera americana L. (*Summitt 159*) Near streambank.

SIMAROUBACEAE 1/1

Ailanthus altissima (P. Mill.) Swingle (*Sheats 160*) Roadside.

SOLANACEAE 1/1

Solanum carolinense L. (*Sheats 116*) Pine forest.

SYMPLOCACEAE 1/1

Symplocos tinctoria (L.) L'Hér. (*Sheats 196*) Pine-hardwood mix/roadside.

ULMACEAE 1/1

Ulmus alata Michx. (*Batson 797*, DUKE)

VIOLACEAE 1/2

Viola × *primulifolia* L. (pro sp.) [*lanceolata* × *macloskeyi*] (*Summitt 143*) Roadside.

Viola tricolor L. (*Summitt 184*) Roadside.

VITACEAE 2/3

Parthenocissus quinquefolia (L.) Planch. (*Batson 1043*, DUKE)

Vitis aestivalis Michx. (*Batson 1044*, DUKE)

Vitis rotundifolia Michx. (*Wiecek 65*) Pine-hardwood mix.

MONOCOTS

ALLIACEAE 1/2

Allium ampeloprasum L. (*Sheats 159*)

Allium vineale L. (*Summitt 158*) Near streambank.

AMARYLIDACEAE 1/1

Narcissus sp. (*Summitt 75*) Roadside.

COMMELINACEAE 1/1

Commelina communis L. (*Wiecek 34*) Knap of Reeds Creek

CYPERACEAE 3/3

Carex crinita Lam. (*Wiecek 18*) Bottomland hardwood forest

Cyperus retrorsus Chapman (*Sheats 219*)

Scirpus cyperinus (L.) Kunth (*Wiecek 55*) Upland hardwoods.

IRIDACEAE 2/2

Iris verna L. (*Sheats 156, Sheats 182*) Pine plantation/roadside.

Sisyrinchium angustifolium P. Mill. (*Summitt 205*) Roadside.

LILIACEAE 1/1

Erythronium americanum Ker-Gawl. (*Summitt 190*) Lake edge.

MELANTHIACEAE 1/1

Trillium catesbaei Ell. (*Sheats 85*)

ORCHIDACEAE 2/3

Goodyera pubescens (Willd.) R. Br. ex Ait. f. (*Summitt 192*) Along creek.

Spiranthes cernua (L.) L.C. Rich. (*Wiecek 59*) Pine plantation.

Spiranthes praecox (Walt.) S. Wats. (*Wiecek 57*) Slope near creek

POACEAE 13/20

Andropogon ternarius Michx. (*Wiecek 70*) Pine-hardwood mix.

Chasmanthium latifolium (Michx.) Yates (*Wiecek 12*) Bottomland hardwood forest.

Chasmanthium laxum (L.) Yates (*Wiecek 49*) Upland hardwoods.

Chasmanthium sessiliflorum (Poir.) Yates (*Wiecek 53*) Upland hardwoods.

Danthonia sericea Nutt. (*Sheats 118*) Pine forest/roadside.

Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes (*Batson 338*, DUKE)

Dichanthelium laxiflorum (Lam.) Gould (*Sheats 215; Batson 475*, DUKE)

Dichanthelium sphaerocarpon (Ell.) Gould (*Wiecek 2*) Loblolly pine plantation.

Echinochloa crus-galli (L.) Beauv. (*Sheats 227*)

Elymus hystrix L. (*Sheats 120*) Pine forest.

Holcus lanatus L. (*Sheats 153*)

Microstegium vimineum (Trin.) A. Camus (*Sheats 100; Wiecek 67*) Pine-hardwood mix; Pine-hardwood mix.

Panicum anceps Michx. (*Sheats 217; Wiecek 51*) Upland hardwoods; roadside.

Panicum dichotomiflorum Michx. (*Wiecek 61*) Pine plantation.

Paspalum floridanum Michx. (*Miller 33*) Xeric site, near erosion monitoring plot.

Paspalum notatum Flueggé (*Sheats 216*) Roadside.

Pennisetum glaucum (L.) R. Br. (*Wiecek 66*) Pine-hardwood mix.

Saccharum brevibarbe (Michx.) Pers. var. *contortum* (Ell.) R.Webster (*Wiecek 50*) Upland hardwoods.

Schizachyrium scoparium (Michx.) Nash (*Wiecek 45; Batson 406*, DUKE) Upland hardwoods.

SMILACACEAE 1/1

Smilax rotundifolia L. (*Sheats 99*) Pine-hardwood mix.

ACKNOWLEDGMENTS

We thank C. Wiecek, V. Miller, C. Sheats, and K. Summitt for their collecting efforts and, in part, identification assistance; H. Davis and M. Kruger for mounting and organizing the specimens; Sherri Herndon for pulling respective specimens at DUKE; and Misty Franklin (NC Natural Heritage Program) for supplying information on rare species.

REFERENCES

Angiosperm Phylogeny Group. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Bot. J. Linn. Soc. 141: 399–436.

Batson, W., Jr. 1952. Floristics of the Iredell soil series in the central Piedmont of North Carolina. Ph.D. dissertation, Duke University, Durham.

Hall, S. 1995. Inventory of the wildlife habitats, movement corridors, and rare animal population of Durham County, North Carolina. North Carolina Natural Heritage Program, Raleigh.

Jones, S.I. 1971. Floristic survey and vegetational analysis of Yates Pond Biological Area in Wake County, North Carolina. M.S. Thesis, North Carolina State University, Raleigh.

Palmer, M.W. 1990. Vascular flora of the Duke Forest, North Carolina. Castanea 55:229–244.

Sawyer, G.P., Jr. 1968. The vascular flora of William B. Umstead State Park, Wake County, North Carolina. M.A. Thesis, University of North Carolina-Chapel Hill.

Skean, J.D., Jr. 1982. The vascular flora and plant community types of Durant Nature Park, Wake County, North Carolina. North Carolina State University, Raleigh. M.S. Thesis, North Carolina State University, Raleigh.

Swab, E.C. 1990. The flora and vegetation of White Pines Natural Area, Chatham County, North Carolina. North Carolina State University, Raleigh. M.S. Thesis, North Carolina State University, Raleigh.

Tazik, D.J., S.D. Warren, V.E. Diersing, R.B. Shaw, R.J. Brozka, C.F. Bagley, and W.R. Whitworth. 1992. U.S. Army land condition-trend analysis (LCTA) plot inventory field methods. USACERL Tech. Rep. N-92/93. U.S Army Corps of Engineers.

USDA, NRCS. 2002. The PLANTS Database, Version 3.5 (plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Woodlot Forestry Research and Development Program. 2003. Camp Butner Training Site Land Condition Trend Analysis (LCTA) Program: Progress Report for the 2002 Field Season. NC State University, Raleigh.

A VASCULAR FLORA SURVEY OF EMERGENT CREEK BED MICROHABITATS OF KISATCHIE BAYOU TRIBUTARIES IN NATCHITOCHES PARISH, LOUISIANA

Ray Neyland and Melissa Hennigan

Department of Biological and
Environmental Sciences
McNeese State University
Lake Charles, Louisiana 70609, U.S.A.
rneyland@mail.mcneese.edu

Lowell E. Urbatsch

Department of Plant Biology
Louisiana State University
Baton Rouge, Louisiana, 70803, U.S.A.

ABSTRACT

Tributaries flowing into Kisatchie Bayou in southwestern Natchitoches Parish, Louisiana are characterized by clear flowing water and white sand bottoms. In places, sandstone or siltstone creek beds emerge during normal water levels but quickly become inundated during periods of rain. These emergent creek beds provide a unique microhabitat that hosts a distinctive flora. A total of 70 species representing 30 families and 52 genera were discovered in this base-line vascular plant survey of these emergent creek beds. With few exceptions, the plant species here appear to be well-adapted for life in this challenging microhabitat.

Key Words: Kisatchie Bayou, plant microhabitat, vascular flora survey

RESUMEN

Los afluentes que discurren por Kisatchie Bayou en el sudoeste de Natchitoches Parish, Luisiana se caracterizan por el agua clara que fluye y los fondos de arena blanca. En algunos lugares, los bancos de arenisca o aluviones emergen con niveles de agua normales pero se inundan rápidamente durante los períodos de lluvia. Estos bancos inesperados proporcionan un microhábitat único que alberga una flora distinta. Un total de 70 especies que representan a 30 familias y 52 géneros se descubrieron en un muestreo de la flora vascular de estos bancos inesperados, con pocas excepciones, estas especies parecen estar bien adaptadas para la vida en este microhábitat desafiante.

Tributaries flowing into Kisatchie Bayou in southwestern Natchitoches Parish, Louisiana are characterized by clear flowing water and white sand bottoms. In places, sandstone or siltstone creek beds emerge during normal water levels. Their surfaces are devoid of sand and soil except in small crevices and fissures. The emergent creek beds remain perpetually damp because water permeates these fissures.

The physiographic expression of the sector where Kisatchie Bayou and its tributaries reside reflects the lithologies of the Miocene Epoch (Andersen 1993). Andersen (1993) designates the physiography of the creeks draining the area as recent alluvium (undifferentiated) of the Holocene.

Martin et al. (1990) designated the soil along the stream banks, which ultimately washes into these tributaries as "Kisatchie-Oula." This soil type is broadly

SIDA 21(2): 1141–1147. 2004

defined as a very strongly acidic fine sandy loam occurring on 5–40% slopes. Additionally, this soil is low in fertility and runoff is rapid (Martin Jr. et al. 1990).

Some emergent creek beds are inhabited by a small number of vascular plants, bryophytes (mosses and liverworts) and lichens. Plants are rooted in the crevices and fissures. However, lichens are directly attached to the rock substrate. Only those plants that manage to remain rooted during periods of inundation survive in this unique and challenging microhabitat.

The purpose of this study is to survey the vascular flora of the emergent creek beds of Kisatchie Bayou tributaries. This survey provides a base-line inventory of this distinctive plant community that can be used for comparison to monitor changes that may occur due to natural or human perturbance.

METHODS

Several tributaries to Kisatchie Bayou were located by examining Natchitoches Parish aerial soil survey maps (Martin Jr. et al. 1990). Study sites were discovered by exploring these tributaries on foot.

Each study site was surveyed periodically throughout the entire year of 2002. At least one voucher specimen was collected for each species; voucher numbers are indicated in Table 1. All vouchers are housed at McNeese State University Herbarium (MCN). Nomenclature follows Kartesz (1999) with the exception of *Aletris lutea* (Narthecicaceae), where nomenclature follows Angiosperm Phylogeny Group (1998).

RESULTS

Vascular plants are not present in all emergent creek beds. However, they typically occur in areas where the creeks are broadened and the water levels are comparatively low. Additionally, these areas are often associated with small waterfalls and rippled currents. The forest canopy is more open in these broadened areas with consequent increased light levels. A detailed description of each study site follows. The location of each site is indicated in Figure 1.

Site 1 occurs in *Little Bayou Pierre*. This area is characterized by sandstone islets and peninsulas that lie just above the normal water level. Small waterfalls are present. The site is about 85 m long and about 18m at its widest point. The site is just south of the bridge along Hwy. 118 near Mink, 31° 23' 38" north and 93° 03' 52" west.

Site 2 occurs in *Little Sandy*. This area is characterized by islets and a few small peninsulas. The substrate here appears to be siltstone which is softer and darker than the sandstone found in the three other study sites. There are no waterfalls here; however, the creek bed topology produces turbulence and rippling. The area is about 73 m long and about 19m at its widest point. The site is about 1 km north of the bridge on Hwy. 118 and about 2.5 km east of the town of Kisatchie, 31° 24' 37" north and 93° 09' 7" west.

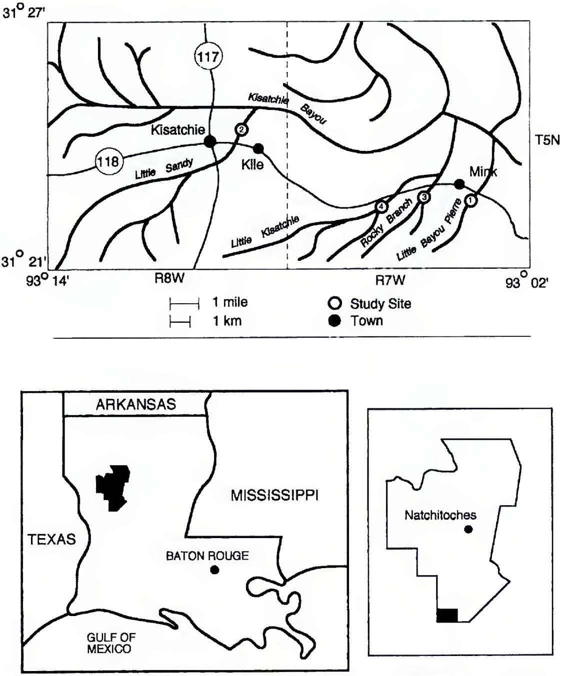


FIG. 1. Detailed map of the emergent creek bed study sites is depicted in the upper illustration; Louisiana State Highways 117 and 118 are indicated. The lower right illustration shows the study area in relation to Natchitoches Parish. The position of Natchitoches Parish within Louisiana is indicated in the lower left illustration.

Site 3 occurs in *Rocky Branch*. This area is characterized by a mixture of islets and peninsulas. A small waterfall is present. The area is about 38 m long and about 14 m at its widest point. The site is about 100 m south of the bridge on Hwy. 118 and about 3.6 km east of the town of Kisatchie, 31° 23' 50" north and 93° 05' 40" west.

Site 4 occurs in *Little Kisatchie Bayou*. The area is characterized by a mixture of peninsulas and islets. Rippled water flow occurs here but no waterfall is present. The area is about 49m long and about 9m at its widest point. The site is about 100 meters south of the bridge on Hwy. 118 about 3km east of the town of Kisatchie, 31° 23' 49" north and 93° 06' 29" west.

A total of 70 vascular plant species representing 30 families and 52 genera were discovered in this survey (Table 1). Of these, 32 species were found in two or more study sites. With a total of 57 species discovered, study site 1 was the most diverse. In study sites 2, 3 and 4, a total of 23, 20 and 21 species were discovered, respectively (Table 1).

DISCUSSION

Emergent creek beds within the Kisatchie Bayou tributaries provide a distinctive plant microhabitat. Observations made during this study suggest that this flora is stable. Periods of submergence had little impact on the overall health of the flora. For example, the effects of heavy rainfall from the remnants of hurricanes Lili and Kenna in October 2002 were minimal. Although larger plants were lodged by the strong force of rapidly moving water, they appeared to suffer no irreparable damage and recovered rapidly.

Although most species appeared to be thriving on the emergent creek beds, there were two notable exceptions. Of the several individuals of *Pinus taeda* that were discovered, all were seedlings or juveniles. It appears that the small fissures in which they were rooted had insufficient soil or space for plants to reach maturity. The one individual of *Baccharis halimifolia* appeared to have been repeatedly damaged by high water. Although individuals of these two species had managed to germinate and survive for a time, they do not appear to be adapted well for survival on the emergent creek beds.

Additionally, observations made during this study suggest that this flora is fertile. Specifically, all discovered species, with the exception of *Pinus taeda* and *Baccharis halimifolia*, produced spores or seeds during 2002.

ACKNOWLEDGMENTS

We thank Mark Paulissen for his review of an earlier version of this paper and the Kisatchie District of the U.S. Forestry Service.

Table 1. Species found listed by family and division with voucher numbers indicated. Presence of a species at each study site is indicated by an "X." Specimens curated at McMeese State University (MCN).

Taxon	Study Site				Voucher
	1	2	3	4	
DIVISION LYCOPODIOPHYTA					
Lycopodiaceae					
Lycopodiella appressa (Chapm.) Cranfill	X				1964
DIVISION FILICOPHYTA					
Dryopteridaceae					
Onoclea sensibilis L.	X	X			1987
Lygodiaceae					
Lygodium japonicum (Thunb.) Sw.	X				1996
Osmundaceae					
Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray	X		X		1997
DIVISION CONIFEROPHYTA					
Pinaceae					
Pinus taeda L.	X		X		1968
DIVISION MAGNOLIOPHYTA					
CLASS MAGNOLIOPSIDA (DICOTS)					
Apiaceae					
Eryngium integrifolium Walt.	X	X		X	2035
Ptilimnium capillaceum (Michx.) Raf.	X			X	1993
Asteraceae					
Baccharis halimifolia L.		X			2060
Coreopsis linifolia Nutt.	X				2053
Coreopsis tripteris L.	X			X	2038
Elephantopus carolinianus Raeusch	X	X	X		1988
Helianthus hirsutus Raf.	X			X	2055
Pityopsis graminifolia (Michx.) Nutt.	X				2057
Pluchea camphorata (L.) DC.	X	X	X		2063
Solidago rugosa P. Mill.	X	X	X	X	2041
Symphyotrichum lateriflorum (L.) A. & D. Löve	X	X		X	2065
Betulaceae					
Alnus serrulata (Ait.) Willd.	X	X	X	X	1787
Buddlejaceae					
Polypremum procumbens L.		X			
Campanulaceae					
Lobelia puberula Michx. var. *pauciflora* Bush	X			X	2054
Clusiaceae					
Hypericum mutilum L.	X	X	X	X	1973
Hypericum brachyphyllum (Spach.) Steud.	X	X	X		2019
Droseraceae					
Drosera brevifolia Pursh	X				1998

Table 1. continued

Taxon	Study Site				Voucher
	1	2	3	4	
Ericaceae					
Rhododendron canescens (Michx.) Sweet	X			X	1999
Vaccinium elliottii Chapm.	X			X	1994
Fabaceae					
Desmodium lineatum DC.	X				2057
Desmodium paniculatum (L.) DC.	X		X		2058
Lespedeza virginica (L.) Britt.			X		2045
Lamiaceae					
Lycopus virginicus L.	X	X	X	X	2039
Scutellaria integrifolia L.	X			X	2007
Lentibulariaceae					
Pinguicula pumila Michx.	X				2000
Utricularia cornuta Michx.	X				1956
Utricularia juncea Vahl	X				1955
Loganiaceae					
Mitreola sessilifolia (J.F. Gmel.) G. Don	X				2023
Lythraceae					
Didipilis diandra (DC.) Wood.		X			2028
Melastomataceae					
Rhexia virginica L.	X				1965
Myricaceae					
Myrica cerifera L.	X			X	2001
Narthicaceae					
Aletris lutea Small	X				2002
Onagraceae					
Ludwigia alternifolia L.	X	X	X		2016
Rubiaceae					
Mitchella repens L.	X		X		2003
Scrophulariaceae					
Mecardonia procumbens (P. Mill.) Small		X			1990
Gratiola pilosa Michx.	X	X			2005
Violaceae					
Viola _primulifolia L. (pro. sp.)	X		X	X	2059
CLASS LILIOPSIDA (MONOCOTS)					
Burmanniaceae					
Burmannia capitata (Walt.) Mart.	X				958
Cyperaceae					
Carex amphibola Steud.	X				1960
Carex tribuloides Wahlenb.	X				2026
Cyperus haspan L.	X	X			2011
Eleocharis microcarpa Torr.	X				2015
Fimbristylis autumnalis (L.) Roem. & Schult.		X			2044
Fuirena simplex Vahl		X			2043
Fuirena squarrosa Michx.	X				2025

Table 1. continued

Taxon	Study Site				Voucher
	1	2	3	4	
Rhynchospora corniculata (Lam.) A. Gray		X			1985
Rhynchospora glomerata (L.) Vahl			X	X	2017
Rhynchospora inexpansa (Michx.) Vahl			X		2018
Juncaceae					
Juncus coriaceus Mackenzie	X	X		X	1961
Juncus nodatus Coville		X			2027
Juncus scirpoides Lam.	X				1959
Juncus tenuis Willd.		X			2020
Poaceae					
Chasmanthium laxum (L.) Yates	X		X		2030
Dichanthelium dichotomum (L.) Gould var. *ensifolium* (Baldw. ex Ell.) Gould & C. A. Clark	X	X	X	X	1958
Dichanthelium sphaerocarpon (Ell.) Gould var. *isophyllum* (Scribn.) Gould & C. A. Clark	X		X	X	1957
Dichanthelium scoparium (Lam.) Gould	X				2010
Panicum virgatum L.				X	2042
Paspalum setaceum Michx.	X				2032
Paspalum urvillei Steud.	X				2009
Steinchisma hians (Ell.) Nash	X				2008
Xyridaceae					
Xyris ambigua Bey. ex Kunth	X				2031
Xyris baldwiniana Schult.	X				1962
Xyris difformis Chapm. var. *curtisii* (Malme) Kral	X				1967
Xyris laxifolia Mart. var. *iridifolia* (Chapm.) Kral	X			X	1963
Xyris torta Sm. in Rees	X				2006

REFERENCES

Andersen, H.V. 1993. Geology of Natchitoches Parish. Geological Bulletin No. 44 Louisiana Geological Survey, Baton Rouge.

Angiosperm Phylogeny Group. 1998. An ordinal classification for the families of flowering plants. Ann. Missouri Bot. Gard. 85:531–553.

Kartesz, J.T. 1999. A synonomized checklist of the vascular flora of the United States, Canada and Greenland. 1st. ed. In: Kartesz, J.T. and C.A. Meacham, eds. Synthesis of North American flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill.

Martin Jr., P.G., C.L. Butler, E. Scott, J.E. Lyles, M. Mariano, J. Ragus, P. Mason, and L. Schoelerman. 1990. Soil Survey of Natchitoches Parish, Louisiana. United States Department of Agriculture, Soil Conservation Service. U.S. Government Printing Office, Washington, DC.

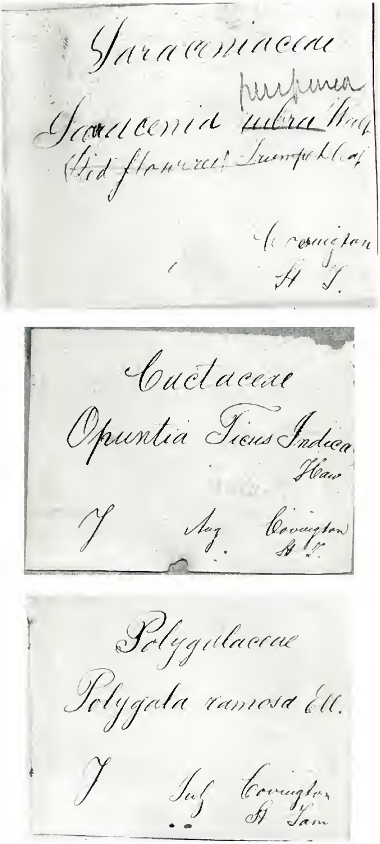
SARRACENIA PURPUREA (SARRACENIACEAE) IN LOUISIANA

Michael H. MacRoberts and Barbara R. MacRoberts

Bog Research, 740 Columbia
Shreveport, Louisiana 71104, U.S.A.
and
Herbarium, Museum of Life Sciences
Louisiana State University in Shreveport, Shreveport, LA 71115, U.S.A.

Sarracenia purpurea L. was once thought to extend from British Columbia along the Canadian-United States border to the Atlantic coast, down the coast to Georgia and Florida, and west along the Gulf Coastal Plain to Louisiana. However, Naczi et al. (1999) have recently separated the Gulf Coastal Plain population as a distinct species, *S. rosea* Naczi, F.W. Case & R.B. Case, which does not reach Louisiana but occurs in southwest Georgia, north Florida, south Alabama, and southeast Mississippi. However, two specimens—one collected in 1842 by William Marbury Carpenter (*s.n.* U.S.) and the other collected in 1870 by Americus Featherman (*s.n.* LSU)—both of which have been identified as *S. purpurea* by Naczi et al. (1999) and both reported from southeast Louisiana west of the range of *S. rosea*, are anomalous; they leapfrog *S. rosea* and are disjunct from the nearest *S. purpurea* population in eastern Georgia (see MacRoberts and MacRoberts [1988] for a detailed review of *S. purpurea* in Louisiana). Naczi et al. (1999) suggest possible labeling error to account for these anomalous specimens.

The label of the Featherman *Sarracenia purpurea* specimen, along with other Featherman collections from the same locality, is shown in Figure 1. MacRoberts and MacRoberts (1988) originally interpreted the script just below "Covington" on the *Sarracenia* specimen to read "AF," the collector's initials. Naczi et al. (1999:1200) question this interpretation: "The script leaves determination of the final pair of letters equivocal. Instead of ... Covington/AF. [Americus Featherman]' ... the label may actually read '... Covington/AL. [Covington, Alabama].'" According to this assessment, the specimen is from Covington Co., Alabama, not Covington, St. Tammany Parish, Louisiana. On reexamination, this interpretation fails for two reasons. First, the script following "Covington" is neither "AF" nor "AL," but "St T." Of the Featherman specimens with "Covington" on the label, some read "Covington" only, but others have something written below "Covington." We (and Diane Ferguson, pers. comm.) examined these and found that what was written was either "St Tam." or "St T.", abbreviations for "St. Tammany." Second, corroborative evidence that this specimen comes from Louisiana is to be found in Featherman's (1871) published description of



Sarraceniaceae

purpurea

Sarracenia rubra Walt.

(Red flowered Trumpet leaf)

Covington

St T.

Cactaceae

Opuntia Ficus Indica.

Haw

7 Aug Covington

St T.

Polygalaceae

Polygala ramosa Ell.

7 Jul Covington

St Tam

Fig. 1. Label information for *Sarracenia purpurea* and two other Featherman specimens from Covington, St. Tammany Parish, Louisiana.

its provenance. In 1869 the Louisiana State Legislature passed Act. No. 72 in which professors of the Louisiana State Seminary of Learning and the Military College (later Louisiana State University) were to spend four months each year in survey work in their respective fields. Americus Featherman traveled extensively throughout Louisiana and produced three reports on the botany (Brown 1944). In his (Featherman 1871:78) list of species collected during his botanical survey of southern and central Louisiana in 1870, Featherman gives the following entry: "*Sarracenia rubra* Walt, [this is what Featherman called the species] Red Flowered, Trumpet-Leaf, Covington, St. Tammany," which, except for the abbreviation of St. Tammany, is exactly what is written on the specimen label. Reading Featherman's (1870, 1871, 1872) accounts of his extensive botanical surveys of Louisiana leaves no doubt of his competence as a careful botanist and researcher (see brief account of his Louisiana botanical career in MacRoberts [1984] and of his Louisiana botanical publications in Ewan [1967]).

The provenance of the Carpenter specimen is less certain. The original label reads "*Sarracenia purpurea*, wet pine woods, St. Helen, La." This was annotated by Charles Mohr who purchased Carpenter's collection some years after his death: "*Sarracenia purpurea* L., St Helena Parish, Carpenter 1842." Because in 1842 St. Helena Parish encompassed not only the present parish but also the northwestern quarter of Tangipahoa Parish, it is impossible to know from which present-day parish the specimen may have come. Carpenter was a prominent Louisiana botanist during the first half of the nineteenth century who collaborated with the leading botanists and naturalists of his time, including Charles Lyell and John James Audubon (Cocks 1914). He collaborated with J.L. Riddell and Josiah Hale on a work entitled "Plants of Louisiana," which, unfortunately, was never published and is now lost. However, J.L. Riddell in 1852 published an abridged version "Catalogus Florae Ludovicianae," and in his introductory remarks, Riddell writes: "The following systematic list, embodying the results of a great many years of observation, by Dr. Josiah Hale, by the late Professor W.M. Carpenter, and by the author, has been abridged from a manuscript work, contributed by the author, in 1851, to the Smithsonian Institution. The MS. work alluded to is entitled, 'Plants of Louisiana.' It comprises the technical and the vulgar names of the flowering and filicoid species of plants, well ascertained as growing within the limits of the State of Louisiana, [nearly all of which are represented by specimens in the author's herbarium],—with special localities, times of flowering, and full descriptions of the new species." Unfortunately, this manuscript no longer exists and we are simply left with the bare list, which contains about 1800 taxa and which remained the most extensive compilation for Louisiana until 1982 (MacRoberts 1984). As MacRoberts (1984:13) says: "an examination of Riddell's list leaves one with a feeling of confidence in his reports." Interestingly, *S. purpurea* is on the list but, of course, without provenance or collector identification. But it seems likely that this was the Carpenter specimen.

While labeling error, as Naczi et al. (1999) suggest, is always possible, there is no evidence of such in these cases, and there is strong corroborative evidence that the Featherman specimen came from Louisiana. As to the Carpenter specimen, there is corroborative evidence of its provenance, not strong but suggestive. Thus, there seems no reason to remove *Sarracenia purpurea* from the Louisiana flora.

ACKNOWLEDGMENTS

Diane Ferguson, Collections Manager, LSU Herbarium was instrumental in interpreting the Featherman labels and in providing scanned copies for our use. Amanda Crnkovic aided with the figure. Two anonymous reviewers provided useful comments.

REFERENCES

Brown, C.A. 1944. Historical commentary on the distribution of vegetation in Louisiana and some recent observations. Proc. Louisiana Acad. Sci. 8:35–47.

Cocks, R.S. 1914. William M. Carpenter, a pioneer scientist of Louisiana. Tulane Graduates Mag. 3:122–127.

Ewan, J. 1967. Bibliography of the botany of Louisiana. SouthW. Louisiana J. 7:1–83.

Featherman, A. 1870. Report on the botany of Louisiana. In: Annual report of the board of supervisors of the Louisiana State Seminary of Learning and Military Academy for the year ending December 31, 1869 to the governor. New Orleans. Pp. 111–122.

Featherman, A. 1871. Report on the botanical survey of southern and central Louisiana made during the year 1870. In: Annual report of the board of supervisors of the Louisiana State University. The Republican Press, New Orleans. Pp. 1–131.

Featherman, A. 1872. Third annual report of botanical survey of southwest and northwest Louisiana made during the year 1871. In Annual report of Prof. D.F. Boyd, superintendent, Louisiana State University, for the year 1871, to the governor of the state of Louisiana. Pp. 101–161.

MacRoberts, D.T. 1984. The vascular plants of Louisiana. An annotated checklist and bibliography of the vascular plants reported to grow without cultivation in Louisiana. Bull. Mus. Life Sci. 6:1–165.

MacRoberts, M.H. and B.R. MacRoberts. 1988. A note on *Sarracenia purpurea* L. in Louisiana. Phytologia 65:191–194.

Naczi, R.F.C., E.M. Soper, F.W. Case, and R.B. Case. 1999. *Sarracenia rosea* (Sarraceniaceae), a new species of pitcher plant from the southeastern United States. Sida 18:1183–1206.

Riddell, J.L. 1852. Catalogus florae Ludovicianae. New Orleans Med. Surg. J. 8:743–763.

ELEOCHARIS MUTATA (CYPERACEAE) NEW TO THE FLORA OF NORTH AMERICA NORTH OF MÉXICO

David J. Rosen

S.M. Tracy Herbarium
Department of Rangeland Ecology & Management
Texas A&M University
College Station, Texas 77843-2126, U.S.A.

Stanley D. Jones

Herbarium, Botanical Research Center
P.O. Box 6717
Bryan, Texas 77805-6717, U.S.A.

ABSTRACT

Eleocharis mutata (L.) Roem. & Schult. is reported new to the flora of North America north of México based on recent collections from Brazoria Co., Texas, U.S.A. A key to separate *E. mutata* from other species of *Eleocharis* subg. *Limnochloa* in North America north of México as well as a technical description and ecological notes are provided.

RESUMEN

Se cita *Eleocharis mutata* (L.) Roem. & Schult. Nueva para la flora de Norte América al norte de México en base a recientes colecciones de Brazoria Co., Texas, U.S.A. Se ofrece una clave para separar *E. mutata* de otras especies de *Eleocharis* subg. *Limnochloa* en Norte América al norte de México así como una descripción técnica y notas ecológicas.

Recent field work in Texas produced collections of a member of *Eleocharis* R. Br. subg. *Limnochloa* (P. Beauv. ex T. Lestib.) Torr. (= *Eleocharis* ser. *Mutatae* Svenson) with triquetrous culms. These specimens keyed to *E. fistulosa* Schult. (= *E. acutangula* [Roxb.] Schult.) in *Manual of the Vascular Plants of Texas* (Correll & Johnston 1970) and *Aquatic and Wetland Plants of Southwestern United States* (Correll & Correll 1975). Correll and Johnston (1970) report *E. fistulosa* from the Rio Grande plains of Texas without mentioning any specific county. González-Elizondo et al. (2002) discussed the misapplication of *E. fistulosa* in North America, referring to Texas specimens as *E. obtusetrigona* (Lindl. & Nees) Steud. A review of pertinent manuals and treatments of subg. *Limnochloa* (Svenson 1929; Adams 1972; Hooper 1972; Kern 1974; Haines & Lye 1983; Koyama 1985; Wilson 1993; González-Elizondo 1994; Browning et al. 1997; González-Elizondo et al. 2002) and a critical examination of numerous herbarium specimens confirm our collections are of *Eleocharis mutata* (L.) Roem. & Schult.

Eleocharis subg. *Limnochloa* comprises over 20 species of perennial, rhizomatous, aquatic herbs distributed in tropical, subtropical, and warm temperate areas worldwide, and recognized by indurate and prominently to obscurely longitudinally many-veined scales and cylindrical spikelets (González-Elizondo & Peterson 1997; González-Elizondo 2002). Despite the usually coarse and conspicuous habit of this group, new species have recently been described from Venezuela (González-Elizondo & Reznicek 1996) and

SIDA 21(2): 1153–1160. 2004

México (Roalson 1999). *Eleocharis mutata* has not been previously reported for Texas (Hatch et al. 1990; Jones et al. 1997). In *Flora of North America*, González-Elizondo (2002) reports six species belonging to subg. *Limnochloa*: *E. cellulosa* Torr., *E. elongata* Chapm., *E. equisetoides* (Elliott) Torr., *E. interstincta* (Vahl) Roem. & Schult., *E. obtusetrigona* (Lindl. & Nees) Steud., *E. quadrangulata* (Michx.) Roem. & Schult., and *E. robbinsii* Oakes. A dichotomous key modified from Svenson (1929) and González-Elizondo (2002) and a technical description of *E. mutata* follow.

KEY TO *ELEOCHARIS* SUBG. *LIMNOCHLOA* IN NORTH AMERICA, NORTH OF MÉXICO

1. Culms without septa.
    2. Culms triquetrous to terete, not distinctly quadrangular.
        3. Culms relatively coarse, (2–)3–5(–8.5) mm thick at leaf sheath summit; spikelets 3.5–8 mm thick; achene 1.4–1.8 mm wide.
            4. Culms triquetrous (rarely distally obscurely 3 angled); achene apex slightly constricted at the summit into a hard annular thickening (see Fig. 1d); perianth bristles irregularly retrorsely spinulose **Eleocharis mutata**
            4. Culms more or less terete or distally obscurely 3–5-angled, never triquetrous; achene apex gradually to markedly constricted, but without hard annular thickening; perianth bristles smooth to coarsely retrorsely spinulose.
                5. Achene apex gradually narrowed into a stout spongy region; perianth bristles usually smooth or sometimes finely retrorsely spinulose (see Fig. 1e) **Eleocharis cellulosa**
                5. Achene apex markedly constricted to a short neck; perianth bristles coarsely retrorsely spinulose **Eleocharis obtusetrigona**
        3. Culms slender, 0.5–1.5 mm thick above leaf sheath summit; spikelets 3 mm or less thick; achene 0.5–1.4 mm wide.
            6. Achene 0.65–1.4 long × 0.5–0.8 wide; floral scales 3.5–4.5 mm long; tubers absent **Eleocharis elongata**
            6. Achene 1.9–2.6 long × 1–1.4 mm wide; floral scales 5–7.8 mm long; tubers sometimes present **Eleocharis robbinsii**
    2. Culms distinctly quadrangular (4-angled) **Eleocharis quadrangulata**
1. Culms septate.
    7. Perianth bristles longer than the achene, coarsely retrorsely spinulose; achenes conspicuously sculptured at 10–15×; culm septa extending up the culm to immediately below spikelet **Eleocharis interstincta**
    7. Perianth bristles much shorter than the achene, thin and soft, without teeth; achenes not conspicuously sculptured at 10–15×, appearing nearly smooth; culm septa extending up the culm to well short of spikelet **Eleocharis equisetoides**

Eleocharis mutata (L.) Roem. & Schult. (**Fig. 1 a–d**). *Scirpus mutatus* L., Syst. Nat. (ed. 10) 2:867. 1759. *Eleocharis mutata* (L.) Roem. & Schult., Sys. Veg. 2:155. 1817. *Limnochloa mutata* (L.) Nees, Fl. Bras. 2(1):101. 1842. Type: JAMAICA. (Lectotype, typified by Browning et al. [1997]: LINN photo!).

Eleocharis scariosa Steud., Syn. Pl. Glumac. 80. 1855. Type: BRASIL: Martius Herb. Fl. Bras. 229 (isotypes: GH!, M, NY!).

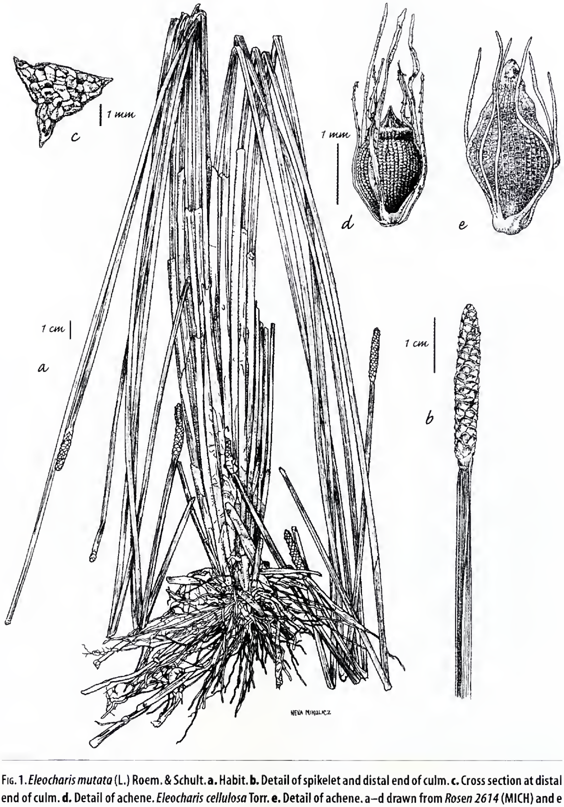


Fig. 1. *Eleocharis mutata* (L.) Roem. & Schult. **a.** Habit. **b.** Detail of spikelet and distal end of culm. **c.** Cross section at distal end of culm. **d.** Detail of achene. *Eleocharis cellulosa* Torr. **e.** Detail of achene. a–d drawn from *Rosen 2614* (MICH) and e drawn from *Rosen 2698* (SBSC) by Neva Mikulicz.

Plants perennial, rhizomes long, 2–5 mm thick, scales to 8 mm, tubers absent; roots coarse fibrous, gray-brown to maroon. **Culms** triquetrous, usually conspicuously so distally (rarely in the field Texas plants on dryer sites obscurely 3 angled), sometimes twisted, (31–)53.8–93(–116) cm × (2.2–)2.6–5.1(–8.5) mm, soft to hard, internally spongy, with incomplete transverse septa, longitudinally striate when dry, shinny and smooth when fresh, dark green. **Leaf sheaths** 2, apically notched, apex acute to acuminate, membranous, loose, friable, maroon-chestnut to cinnamon brown; blade reduced to a mucro to 5 mm long. **Spikelets** cylindric, obtuse (acute), proximal 2–3 scales empty, the first amplexicaul and appearing as a continuation of the culm, (12–)23–44(–66) × (3–)3.8–5.4(–8) mm; floral scales appressed to weakly spreading upon drying, ovate to broadly ovate, apex broadly rounded, the distal 0.2–0.3 mm hyaline-erose, central area broadly keeled from base for ca. 1/3–1/2 scale length, (2.8–)3.2–4(–4.8) × (1.9–)2.5–3.4(–4.8) mm, finely many veined, mid-vein evident only in adaxial view, cartilaginous, stramineous, abaxially red-maculate or more frequently with a dark band near apex, adaxially red-maculate. **Flowers** with (5–)6–8 perianth bristles, irregularly oriented, narrow to somewhat broad and strap-shaped proximally, irregularly retrorsely spinulose nearly to the base, mostly exceeding the achene, stramineous, the margins and spinules sometimes dark reddish; stamens 3; anthers 1.3–2.0 mm, reddish-brown; style trifid. **Achene** biconvex, more or less obpyriform, obovate, or sometimes broadly elliptic, the apex constricted to about 0.6 the width of the achene, broadening again into a hard annulus of the same texture and color as the achene, (1.2–)1.3–1.6(–1.9) mm (not including annulus or tubercle) × (1–)1.1–1.4(–1.8) mm, with ca. 20 longitudinal rows of deeply pitted horizontally rectangular cells visible through transparent periclinal layer on each achene face, dull, cream colored, maturing to lustrous olive-yellow (amber); annulus oblong or tapering apically, (0.05–)0.09–0.18(–0.3) mm high; tubercle dorsoventrally compressed, triangular, well formed to withered, distinct or sometimes appearing to merge with the annulus or shouldered by it, (0.15–) 0.3–0.5(–0.9) mm × 0.4–0.8 mm, dark brown.

Phenology and Ecology.—In Texas, flowering from early June through early November. *Eleocharis mutata* forms large monotypic colonies in dark gray, clay-loam soils of a shallow, semi-permanently flooded freshwater marsh near the coast, associated in the dryer fringes of the marsh with *Cyperus elegans* L., *C. oxylepis* Steud., *C. polystachyos* Rottb., *Eleocharis cellulosa*, *E. olivacea* Torr., *E. quadrangulata*, *Juncus roemerianus* G. Scheele, *Paspalum floridanum* Michx. *P. vaginatum* Sw., and *Spartina patens* (Ait.) Muhl. (Fig. 2). The nativity of *Eleocharis mutata* in Texas is uncertain; as we encountered it in Brazoria County, it was ecologically dominant, forming pure stands in a habitat usually more diverse.

Distribution.—In North America north of México, currently known from Brazoria County, Texas, on the eastern edge of the Gulf Prairies and Marshes.

Fig. 2. Fresh marsh in late August 2003 at Hoskins Mound near the Brazoria National Wildlife Refuge in Brazoria County, Texas, with *Eleocharis mutata* (L.) Roem. & Schult. in foreground.

Expected also in similar habitat from Jefferson County, SW to Goliad County, S through the Rio Grande Valley. There is an immature specimen at TAES with triquetrous culms (*Glazener s.n.*, collected 16 miles W of Goliad in 1941) annotated as *Eleocharis acutangula*. Unlike *E. acutangula*, however, this specimen has broadly ovate, finely many veined floral scales which fits our concept of *E. mutata*. It is possible that *E. mutata* is more widespread in southern Texas, and has been overlooked because of its affinity for aquatic habitats and its superficial similarity to *E. cellulosa* and *E. quadrangulata* with which it occurs. Coastal habitats in United States, México, Belize, Guatemala, Honduras, Nicaragua, Costa Rica, Panama, Cuba, Jamaica, Haiti, Dominican Republic, throughout the West Indies, tropical South America, and tropical Africa.

Vernacular name.—**scallion grass** (Adams 1972).

Representative specimens examined: **NORTH AMERICA. U.S.A.. TEXAS. Brazoria Co.:** Hoskin's Mound within the Brazoria National Wildlife Refuge, 3.8 km SE of the intersection of FM 2004 and Co. Rd 277, locally abundant in shallow water along roadside ditch and marsh S of perimeter oil-field service road, N of the mound, 21 Oct 2002, *Rosen & Jones 2382* (MO, TAES, TEX, VSC), 29 Aug 2003, *Rosen 2606* (GH, SBSC, NY, US, WIS, Z), *Rosen 2614* (CIIDIR, K, MICH). **Goliad Co.:** 16 mi. W of Goliad, in water, 23 Aug 1941, *Glazener s.n.*, (TAES). **BARBADOS. Christ Church:** Gruene Hill Swamp, dominant understory herb, forming a lawn throughout much of the swamp, 09 Nov 1996, *Rogers 96-128* (MICH). **BELIZE. Belize District:** roadside through mangrove swamp, 11 Mar 1933, *Lundell 1816* (MICH); Belize City, vacant lots, roadsides, disturbed sites about town, 1 m elev., swamp on S side of town, 09 Aug 1992, *Worthington 21439* (MO). **COSTA RICA. Limon:** Limon airport, beach at mouth of Rio Banano, near sand dunes and shallow ponds 35 m from shore, 07 Jul 1966, *Denton 1139a* (MICH). **Guanacasta:** Palo Verde National Park, swamp ca. 2 km from park headquarters at Catalina, along transect to Laguna Nicaragua, abundant, 07 Sep 1984, *Crow & Rivera 5981* (MO). **DOMINICAN REPUBLIC. Prov. Maria:** Llanura de Nagua, Trinidad Sanchez, Las Gordas, 18.7 km, Llanuras plantadas de arroz, zona pantanosa, con muchas malezas despues de la ultima cosecha (en el camino de Las Gordas a Mata Bonita), 19°25N, 70°00W, 05 Oct 1982, *Mejia & Pimentel 23601* (MO). **Prov. Peravia:** very common in muddy sites at roadside, Galeon, Bani, 29 Oct 1976, *Cicero 8276* (NY, TAES). **HAITI:** shallow pond and swamp area between Terrier Rouge and Fort Libertr, northeastern alluvial plain, 26 Jun 1941, *Bartlett 17480* (MICH, NY, US). **HONDURAS. Atlantida:** in boggy area near the seashore, vicinity of Ceiba, 06 Jul 1938, *Yuncker et al.* 8243 (MICH, NY); Sibun River, 28 Nov 1934, *Gentle 1429* (MICH, NY); Hector Creek, Sibun River, 28 Nov 1934, *Gentle 1432* (K, MICH, NY, US). **Toledo:** in wet area on river bank, Monkey River, 18 Oct 1941, *Gentle 3708* (MICH, NY, US); Monte Redondo lake, vicinity of Yeguare river, El Eamorano, 23 Jan 1970, *Molina 25403* (MO, NY); commonly found along the edge of brackish lagoons also thrives where it receives continuous sea spray, All Pines, 23 Jan 1970, *Schipp 786* (MICH, NY, Z). **JAMAICA.** St. Thomas, just N of Grant Pen, off of road A-4, a little above sea level, at edge of and growing in open water at roadside, 21 Jul 1963, *Crosby et al. 822* (MICH, NY, US); Port Antonio, Dec 1890, *Hitchcock s.n.* (MO). **MEXICO. Jalisco:** about 2 km N of Puerto Vallarta in cultivated areas west of the airport, near sea level, very common in wet depressions beside road, 13 Nov 1963, *Feddema 2533* (MICH); La Huerta, Rancho Cuixmala, Gargollo farm, on E side of Cerro de la Alborada, Lat. 19°24'N, Long. 104°59'W, elev. below 50 m, highly disturbed remnants of tropical semi-deciduous forest now used for cattle, locally common perennial with feet in water, mostly emergent, some plants recently exposed and in mud, 04 Nov 1991, *Lott et al. 4116* (K, MICH, NY, WIS); 3 km al N de Puerto Vallarta, sobre el camino al aeropuerto, terrenos planos, salobres, en suelo humedo, escaso, 16 Nov 1963, *Rzedowski 17829* (MICH). **Yucatan:** pequenta zona inundada a 8 kms al SE de Sisal, 11 Aug 1978, Lot 2582 (MO). **Montserrat:** dominant sedge in center of Chance's pond, alt. 2700 ft, 14–18 Jun 1950, *Howard 11894* (MICH). **NICARAGUA. Zelaya:** in wet sand, El Bluff near Bluefields, 14 Dec 1968, *Seymour 642* (BRIT); dense stands covering many acres, brackish inlet, Corn Island, 06 Mar 1971, *Svenson 4317* (BRIT). **Managua:** near the mouth of Rio El Carmen, 30 km NW of Masachapa, freshwater marsh 1 km from shore, 16 Nov 1976, *Neill 1276* (MO). **PANAMA. San Blas:** Comarca de San Blas, Rio Urgandi (Rio Sidra), elev. 0–30 m, in marsh by airport, 27 Jun 1986, *de Nevers & Herrera* 8105 (MO). **Canal Zone:** Farfan Beach road, growing in water, 03 Aug 1967, *Kirkbride & Elias* 69 (MO, NY). **Bocas del Toro:** out along road W Almirante, 17 Oct 1965, *Blum 1415* (MO). **PUERTO RICO:** 1.3 mi S on Rte 687 from junction with Rte 686, elev. 10 m, E end of Laguna Tortuguero, sandy soil in marsh, 31 Dec 1980, *Solomon 5749* (MO); Yabucoa, su paludosis justa flumen guayjanes, 10 Feb 1886, *Sintenis 4942* (GH, NY, Z-2 sheets, ZT).

SOUTH AMERICA. BRAZIL. Ceara: brackish marshes, Barra do Ceara, municipio de Fortalega, 25 Sep 1935, *Drouet 2503* (MICH, NY). **COLOMBIA. Antioquia:** swampy area on the peninsula approx. 1 km W of Turbo, probable lat. ca. 8° 5' N, long ca. 76° 43' W, elevation sea level, common growing in mud at edge of brackish slough in sun, 31 Mar 1962, *Feddema 2111* (MICH); Santa Marta, 100 ft, Sep 1898–1901, *Smith 245* (MICH, NY). **ECUADOR. Costa:** Prov. Esmeraldas, km 102, Esmeraldas-La Tola, a lado de la carretera, en pantano en un sabana grande, 27 Jul 1984, *Dodson et al.* 14564 (MO). **PARAGUAY:** no date, *Reugger s.n.* (ZT). **TOBAGO:** Buccoo Bay, 20 Apr 1939, *Elmore 510* (MICH). **TRINIDAD:** ca. 2–3 mi E of Trinidad along the Beetham Hwy., low lying sedge marshes, 04 Aug 1970, *Davidse 2546* (MO, NY). **VENEZUELA. Sucre:** Laguna La Bodega, inmediatamente al Este de Santa Fe, 17 Sep 1973, *Steyermark et al. 108552* (MO).

AFRICA. ANGOLA. Moxico: Ikula hot springs by R. Zambezi, plentiful in rock pools in 1–1.5 ft of water, tufted and stoloniferous perennial; lower sheaths pale brown; upper and stem green, triangular, glumes green, edged red-brown, turning pale brown, 17 Jan 1938, *Milne-Redhead 4195* (K). **LIBERIA:** Crew Town, Monrovia, in water, 27 Jun 1909, *Massey 82* (NY). **SENEGAL:** Lyndiane, 30 Sep 1956, *Jacques-Georges 12460* (MO); Ziguinchor, km 54-57 Cap Skiring-Bignona, vicinity of Nyassia, moist area in mangrove-area, 11 Sep 1994, *Laegaard et al. 16891* (K, US); Basse-Casamance, Fegroum, 08 Nov 1990, *Berghen 9301* (MO); 10 Apr 1946, *Roberty 6209* (Z). **SIERRA LEONE:** emplodered (sic) swamp, Rokupr, 03 Jul 1947, *Jordan 42* (K). **TANZANIA. Pemba:** Makongwe Is, in shallow water on the edge of a pond, leaves and stems (hand drawn triangle symbol) and flower spikes sessile at the apex of the stem, 16 Dec 1930, *Greenway 2730* (K). **TOGO:** Agwegan, entre route et lagune, depression sale, savane herbense inonde eau sale 9 gr Natt/litre, 26 Jun 1985, *Schafer 8629* (MO, US).

ACKNOWLEDGMENTS

We thank the curatorial staff at the herbaria listed. We thank Mark Spencer (LINN) for making excellent images of the type specimen available for study, Hajo Esser (M) for assisting with nomenclatural uncertainties of *E. scariosa*, and Mary Stiffler and Linda Oestry with the Missouri Botanical Garden Library for assistance locating certain literature items. We thank Richard Carter for providing many helpful suggestions and critical review of this manuscript, and for alerting the first author to certain important literature items. Thanks to Socorro González-Elizondo and Galen Smith for their critical review and many helpful comments. The first author is grateful to Brian Cain and Ron Brinkley (USFWS) for presenting specimens they discovered during their survey of Hoskins Mound, and to Mr. Tommy Thompson and Mr. Nathan Gutowsky with ChevronTexaco for facilitating access to the site which led to this discovery. Special thanks to Neva Mikulicz for preparing the illustration.

REFERENCES

ADAMS, C.D. 1972. Flowering plants of Jamaica. University of the West Indies, Mona.

BROWNING, J., K.D. GORDON-GRAY, and C.J. WARD. 1997. Studies in Cyperaceae in Southern Africa 32: *Eleocharis* subgenus *Limnochloa* section *Limnochloa*. S. Afr. J. Bot. 63:172–184.

CORRELL, D.S. and H.B. CORRELL. 1975. Aquatic and wetland plants of southwestern United States. Vol. 1. Stanford University Press. Stanford.

CORRELL, D.S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

GONZÁLEZ -ELIZONDO, M.S. 1994. *Eleocharis*. In: G. Davidse, M.S. Sousa, and A.O. Chater, eds. Flora Mesoamericana, Vol. 6: Alismataceae a Cyperaceae. Universidad Nacional Autónoma de México, Ciudad Universitaria. Pp. 458–464.

GONZÁLEZ -ELIZONDO, M.S. 2002. *Eleocharis* subg. *Limnochloa*. In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico, Vol. 23. Oxford Univ. Press, New York. Pp. 116–120.

GONZÁLEZ-ELIZONDO, M.S., M. GONZÁLEZ-ELIZONDO, and S.G. SMITH. 2002. *Eleocharis obtusetrigona* (Cyperaceae) new to North and Central America. Acta Bot. Mexicana 60:7–11.

González-Elizondo, M.S. and P.M. Peterson. 1997. A classification of and key to the supraspecific taxa in *Eleocharis* (Cyperaceae). Taxon 46:433–449.

González-Elizondo, M.S. and A.A. Reznicek. 1996. New *Eleocharis* (Cyperaceae) from Venezuela. Novon 6:356–365.

Haines, R.W. and K.A. Lye. 1983. The sedges and rushes of East Africa. East African Natural History Society. Nairobi.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Bull. MP-1655.

Hooper, S.S. 1972. *Eleocharis* (Cyperaceae). In: J. Hutchinson and J.M. Dalziel, eds. Flora of West Tropical Africa, 2nd ed. Whitefriars Press, Ltd., London. Pp. 311–314.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas: a comprehensive checklist including synonymy, bibliography, and index. University of Texas Press, Austin.

Kern, J.H. 1974. Cyperaceae. In: C.G.G.J. van Steenis, ed. Flora Malesiana, Ser. 1, 7(3). Noordhoff, Leyden. Pp. 435–753.

Koyama, T. 1985. Cyperaceae. In: M.D. Dassanayake and F.R. Fosberg, eds. Flora of Ceylon, Vol. 5. Amerind Publishing Co. Pvt. Ltd., New Delhi. Pp. 125–405 (*Eleocharis* Pp. 255–268).

Roalson, E.H. 1999. *Eleocharis yecorensis* (Cyperaceae), a new species of spike-sedge from Mexico. Aliso 18:57–60.

Svenson, H.K. 1929. Monographic studies in the genus *Eleocharis*. Rhodora 31:121–135; 152–163 (plate 188).

Wilson, K.L. 1993. Cyperaceae. In: G.J. Harden, ed. Flora of New South Wales, Vol. 4. New South Wales University Press, Kensington. Pp. 293–396.

COMMENTS ON THE REDISCOVERY AND DISTRIBUTION OF *CUNILA ORIGANOIDES* (LAMIACEAE) IN TEXAS

Jason R. Singhurst
Wildlife Diversity Program
Texas Parks and Wildlife Department
3000 South IH-35, Suite 100
Austin, Texas 78704 U.S.A.

Walter C. Holmes
Department of Biology
Baylor University
Waco, Texas 76798-7388 U.S.A.

ABSTRACT

Cunila origanoides has been rediscovered in Texas based on recent herbarium and field studies.

RESUMEN

Cunila origanoides ha sido redescubierta en Texas mediante estudios recientes de herbario y campo.

Herbarium and field studies on the Texas flora have yielded the following records pertaining to the occurrence and distribution of *Cunila origanoides* within the state.

Cunila origanoides (L.) Britt. (Lamiaceae)—Small (1933), Cory and Parks (1937), Correll and Johnston (1970), Hatch et al. (1990), and Jones et al. (1997) attributed this species to Texas. Correll and Johnston (1970) cited the distribution as north central Texas, while Hatch et al. (1990) gave the distribution as the Post Oak Savannah, Blackland Prairies, and Cross Timbers and Prairies vegetational areas. The latter mentioned distribution was cited by Diggs et al. (1999) who included *Cunila* in the Flora of North Central Texas. Gould (1962, 1969) and Turner et al. (2003) did not include the species in their respective works. The exclusion from the latter work seems to have effectively removed *Cunila* from being known as a part of the state's flora. Most likely, the ambiguity in the literature is a consequence of no cited voucher specimen. Recently, we have uncovered the two specimens cited below, thus are able to resolve the matter.

Specimens examined. **Kaufman Co.:** vicinity of Terrell, 6 Sep 1904, *Tyler s.n.* (BAYLU (photo), US). **Lamar Co.:** 1.4 mi E of jct of St. Rt. 906 and Hwy 271 at Midcity on St. Rt. 906, slope forest below Pat Mayse Lake Dam, 18 Oct 2002, *Singhurst & Harris 11344* (BAYLU).

It may be assumed that Small (1933) had reference to a specimen, thus its inclusion in his manual, but under the genus *Mappia* House. The Kaufman County specimen was annotated by Donovan S. Correll in 1967, hence its inclusion in Correll and Johnston (1970). However, neither the Small (1933) nor Correll and Johnston (1970) reports give precise location data or indicate the source of their information. The other literature citations concerning the occurrence of the species in Texas seem to have originated from these two reports. Without loca-

SIDA 21(2): 1161–1163. 2004

tion data at least to county, it is understandable, and certainly correct, for Turner et al. (2003) to not include the species in the *Atlas of the Vascular Plants of Texas*.

Cunila is a New World genus of about 15 species native from eastern North America to Uruguay (Diggs et al. 1999). *Cunila origanoides* is a native to eastern North America that is distributed from New York, south to Georgia, west to Kansas and Texas (USDA, NRCS 2004). The occurrence of *C. origanoides* in Texas is very significant. In eastern Texas, calcareous disjuncts, such as *C. origanoides*, have been receding in distribution and are evidence of calciphile relics of an earlier cooler climate (Kral 1963). The real significance of the occurrence of *C. origanoides* is in the disjunct nature of the sites. It is not known what the 1904 location of *C. origanoides* in Kaufman County was like and whether such habitat still exists there. There are still a few remnant hardwood sites, such as Cedar Creek Island (the big island) in Cedar Creek Lake, in Kaufman County that contain old growth oak stands with eastern taxa like *Corallorhiza wisteriana*, *Erythronium albidum*, *Phryma leptostachya* and *Verbesina helianthoides*. In Lamar County, *C. origanoides* occurs in rich hardwoods on slopes along a spring fed creek where the Woodbine and Eagleford shale formations merge. This is cretaceous geology, which is of rather restricted occurrence in northeast Texas. It does, however, support other disjunct and peripheral species such as the rare [in Texas] *Prenanthes barbata* and the more eastern *Heuchera americana*. Therefore, the presence of *C. origanoides* in northeast Texas is significant as this native species is persisting in remnant mature hardwood habitat. This habitat type is dwindling from land use practices and the resulting fragmentation. Potential habitat for *C. origanoides* also occurs in Fannin, Hunt, Delta, Hopkins, Franklin, Titus, Red River, and Bowie counties. This information is valuable as an indicator of calcareous slope hardwood forests that may contain other peripheral and disjunct taxa and its discovery aids the understanding regional plant communities and their floristic make-up.

ACKNOWLEDGMENTS

We wish to thank the curators of GH, NY, TEX, and US for their search for and use of specimens that made this study possible. During the study, the junior author visited US and is grateful for the assistance and kindnesses extended. We are grateful to Margie Knowles of US who arranged to have a digital photo of the Kaufman Co. specimen sent to the authors. We are very grateful to Barney Lipscomb for his comments and suggestions in producing this manuscript.

REFERENCES

CORRELL, D.S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

CORY, V.L. and H.B. PARKS. 1937. Catalogue of the flora of Texas. Texas Agricultural Experimental Station Bulletin 550, College Station.

DIGGS, G.M., B.L. LIPSCOMB, and R.J. O'KENNON. 1999. Shinners & Mahler's illustrated flora of north central Texas. Sida, Bot. Misc. 16, Botanical Research Institute of Texas, Fort Worth.

GOULD, F.W. 1962. Texas plants—a checklist and ecological summary. Texas Agricultural Experimental Station publication MP-585, College Station.

GOULD, F.W. 1969. Texas plants—a checklist and ecological summary. Texas Agricultural Experimental Station publication MP-585/ revised, College Station.

HATCH, S.L., K.N. GANDHI, and L.E. BROWN. 1990. Checklist of the vascular plants of Texas. Texas Agricultural Experimental Station publication MP-1655, College Station.

JONES, S.D., J.K. WIPFF, and P.M. MONTGOMERY. 1997. Vascular plants of Texas. A comprehensive checklist including synonymy, bibliography, and index. University of Texas Press, Austin.

KRAL, R. 1966. Observations of the flora southeastern United States with special reference to northern Louisiana. Sida 2:395–408.

SMALL, J.K. 1933. Manual of the southeastern flora. Published by the author. New York.

TURNER, B.L., H. NICHOLS, G. DENNY, and O. DORON. 2003. Atlas of the vascular plants of Texas. Vol. 1. Sida, Bot. Misc. 24. Botanical Research Institute of Texas, Fort Worth.

USDA, NRCS. 2004. The PLANTS database (plants.usda.gov/cgi_bin/plant_search.cgi). National Plant Data Center, Baton Rouge, LA.

GEOCARPON MINIMUM (CARYOPHYLLACEAE), NEW TO TEXAS

Eric L. Keith

Raven Environmental Services
P.O. Box 6482
Huntsville, Texas 77342, U.S.A.
ek7275@cox-internet.com

Jason R. Singhurst

Texas Parks and Wildlife Dept.
4200 Smith School Road
Austin, Texas 77342, U.S.A.

Stan Cook

Temple-Inland Forest Products
700 N. Temple Dr.
Diboll, Texas 7594, U.S.A.

ABSTRACT

Geocarpon minimum, a federally threatened species, is documented for the flora of Texas for the first time. Approximately 200 plants were found in an extensive saline prairie near the floodplain of the Neches River in Anderson County, Texas. Included is a general description of the habitat, known distribution of the species, and associated flora in Texas.

RESUMEN

Geocarpon minimum, una especie de la lista federal de plantas amenazadas de extinción se documenta para la flora de Texas por primera vez. Se encontraron aproximadamente 200 plantas en una llanura salada cerca de la llanura de inundación del Neches River (o Río Neches) en el condado de Anderson, Texas. Se incluye una descripción general del hábitat, la distribución conocida de la especie, y la flora asociada en Texas.

Geocarpon minimum MacKenzie (geocarpon, tiny Tim, earth fruit) is listed as a federally threatened species by the U.S. Fish and Wildlife Service and is currently known from Arkansas, northwestern Louisiana, and southwestern Missouri (MacKenzie 1914; Moore 1958; McInnis et. al. 1993; USDA, NRCS 2004; USFWS 1993). In Missouri, *Geocarpon minimum* occurs in glades and other open, sparsely vegetated areas on shallow soils over sandstone outcrops, often in shallow depressions (Morgan 1980; Palmer & Steyermark 1950; Steyermark, et. al 1959; Thurman 1989; USFWS 1993). In Arkansas it is typically found in sparsely vegetated areas on saline prairies (Moore 1958; Orzell & Bridges 1987; Pittman 1988; Rettig 1983; Shepherd 1987; USFWS 1993). Soils in both habitat types are high in magnesium or sodium (Rettig 1983). This species was brought to the attention of the former Texas Natural Heritage Program in 1993 by Peggy Horner of the Missouri Department of Conservation as potentially occurring in northeast Texas. Several surveys were then conducted on saline prairies in East Texas, including the Davy Crockett National Forest, Temple-Inland Forest Products Corp. (Temple) property, and other private lands.

In summer of 2003, we discovered a large saline prairie complex occurring on Temple property in Anderson County, Texas, just above the floodplain of the Neches River. This prairie was surveyed in the summer and fall of 2003 and found to contain several halophytes typically associated with *Geocarpon minimum*. In surveys conducted in early March 2004, approximately 200 plants of *Geocarpon minimum* were discovered at eight stations throughout the 75 acre saline barren complex. All of the plants occurred on the edge of sparsely vegetated areas commonly referred to a "slick spots" (USFWS 1993). These slick spots vary in size from one to approximately thirty square meters. They have very high sodium content and are typically devoid of any vegetation, with the exception of *Sibara virginica*, *Talinum parviflorum*, *Plantago pusilla*, and *Cleomella angustifolia*. This vegetative edge around the slicks is referred to as a "cryptogamic lip," where a spongy, leathery crust of moss protonemata, lichens, liverwort thalli, *Nostoc* sp., and the associated micro-flora interact to cement the lip in place (Shepherd pers. comm.; USFWS 1993). Woody species associated with *Geocarpon* adjacent to these slicks includes, *Celtis laevigata* spp. *laevigata*, *Crataegus* spp., *Juniperus virginiana*, *Opuntia macrorhiza*, *Pinus taeda*, *Quercus similis*, *Sabal minor*, *Smilax bona-nox*, *Vaccinium arboreum*, and *Ulmus crassifolia*. Associated herbaceous species include *Anagallis minima*, *Aphanostephus skirrhobasis*, *Astranthium integrifolium*, *Chaetopappa asteroides*, *Cleomella angustifolia*, *Coreopsis tinctoria*, *Crassula aquatica*, *Draba brachycarpa*, *Evolvulus sericeus*, *Gratiola flava*, *Houstonia rosea*, *Houstonia micrantha*, *Houstonia pusilla*, *Hypericum drummondii*, *Isolepis carinata*, *Krigia occidentalis*, *Lepuropetalon spathulatum*, *Ophioglossum crotalophoroides*, *Plantago pusilla*, *Portulaca* spp., *Rumex hastatulus*, *Sagina decumbens*, *Schoenolirion wrightii*, *Sedum nuttallianum*, *Sibara virginica*, *Sporobolus vaginiflorus*, and *Talinum parviflorum*. The surrounding topography also includes mima mounds with micro highs and lows. The Brimstone Silt Loam described in McInnis et. al. (1993) may be represented in this saline prairie. However, in Coffee (1975), this area is not differentiated from the surrounding bottomland soil type, and saline soils are not mentioned. The mapped soil series for the prairie area is classified as Nahatche-Wehadke Soil Series with typically loamy bottomland soils. However, in an older soil survey of Anderson County from 1890, the Anderson County saline areas are briefly described (Department of Agriculture, Insurance, Statistics, and History 1890). Collection data for *Geocarpon minimum* follow:

UNITED STATES. Texas. Anderson Co.: 120 m NE of a roadside park, 0.1 mi E of the jct. of U.S. Hwy 84 and Neches River; saline barren complex, 8 Mar 2004, *J. Singhurst 12921, E. Keith, S. Cook, & B. Shepherd* (BAYLU, TEX)

Fig. 1. Close up of *Geocarpon minimum*.

Fig. 2. Habitat of *Geocarpon minimum*. Plant found along edges of "slick spots."

TAXONOMIC DESCRIPTION

Glabrous winter annual, stems simple or branched at the base, the branches few, erect or spreading ascending, mostly 3–4 cm high and less than 0.5 mm thick, often a bright reddish or pale purplish color. **Leaves** simple, opposite, green or reddish in color, 3–4 mm long, narrowly oblong or ovate-oblong, the margins entire, and the apex acute. **Flowers** usually axillary, regular, funnelform-campanulate; sepals 5, 3–4 mm long, reddish or reddish-green; petals absent; stamens 5; staminodes 5; ovary superior, lance-ovoid, somewhat trigonous, about the length of the sepals. **Fruit** is a capsule containing numerous, funicular seeds, 0.5 mm long (NatureServe 2004; Steyermark 1963).

ACKNOWLEDGMENTS

Appreciation is given to Temple-Inland Forest Products Corp., which currently owns the entire saline prairie complex and is conserving the habitat. We would also like to thank Bill Shepherd, retired biologist from the Arkansas Natural Heritage Commission, for accompanying us on the collecting trip and sharing his expertise on *Geocarpon minimum* and its habitats. We would also like to thank Guy Nesom of the Botanical Research Institute of Texas and Monique Reed, Herbarium Botanist at Texas A&M University, for critical review of the paper.

REFERENCES

Coffee, D.R. 1975. Soil Survey of Anderson County, Texas. United States Department of Agriculture Soil Conservation Service In Cooperation with Texas Agricultural Experiment Station.

Department of Agriculture, Insurance, Statistics, and History. 1890. Papers Accompanying the Annual Report of the Geological Survey of Texas 1890. www.lib.utexas.edu/books/dumble/publications/08/08b315a.html

MacKenzie, K.K. 1914. A new genus from Missouri. Torreya 14:67–68.

McInnis, N.C., L.M. Smith, and A.B. Pittman 1993. *Geocarpon minimum* (Caryophyllaceae), new to Louisiana. Phytologia 75:159–162.

Moore, D. 1958. New records for the Arkansas flora. IV. Proc. Arkansas Acad. Sci. 12:12.

Morgan, S. 1980. Status report on *Geocarpon minimum* in Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

NatureServe. 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.0. NatureServe, Arlington, Virginia. Available www.natureserve.org/explorer. (Accessed: August 22, 2004).

Orzell, S.L. and E.L. Bridges. 1987. Further additions and noteworthy collections in the flora of Arkansas, with historical, ecological, and phytogeographical notes. Phytologia 64: 81–144.

Palmer, E.J. and J. Steyermark. 1950. Notes on *Geocarpon minimum* MacKenzie. Bull. Torrey Bot. Club 77:266–273.

PITTMAN, A.B. 1988. Identification, survey and evaluation of potential habitats of *Geocarpon minimum* MacKenzie in Arkansas. Arkansas Natural Heritage Commission, Little Rock, Arkansas.

RETTIG, J.H. 1983. A new Arkansas station for *Geocarpon minimum* MacKenzie (Caryophyllaceae). Bull. Torrey Bot.Club 110:213.

SHEPHERD, W. 1987. Monitoring of *Geocarpon minimum* at Warren Prairie Natural Area in the spring of 1987. Arkansas Natural Heritage Commission, Little Rock, Arkansas.

SHEPHERD, W. 2004. Personal communication on the ecology of *Geocarpon minimum*.

STEYERMARK, J., J.W. VOIGT, and R.H. MOHLENBROCK. 1959. Present biological status of *Geocarpon minimum* MacKenzie. Bull. Torrey Bot. Club 86:228–235.

STEYERMARK, J.A. 1963. Flora of Missouri. Iowa State Press. Ames, Iowa.

THURMAN, C.M. 1989. A Missouri survey of six species of federal concern. Final report. Missouri Department of Conservation.

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874–4490 USA.

U.S. FISH AND WILDLIFE SERVICE (USFWS). 1993. Recovery plan for *Geocarpon minimum* MacKenzie. Atlanta, Georgia.

SOLANUM VIARUM (SOLANACEAE)—TROPICAL SODA-APPLE—CONFIRMED FROM TEXAS

Monique Dubrule Reed

Biology Department Herbarium
TAMU 3258
Texas A&M University
College Station, Texas 77845-3258, U.S.A.

Mary Ketchersid

115 Agronomy Field Lab
TAMU 2488
Texas A&M University
College Station, Texas 77845-2488, U.S.A.

Richard L. Thompson

Jasper County
271 East Lamar
Jasper, Texas 75951, U.S.A.

ABSTRACT

Solanum viarum, Tropical Soda-Apple (Solanaceae), is an aggressive weed from South America. Since it is known from the southern U.S., including Louisiana, it has been watched for in Texas. A population has now been confirmed and vouchered from Jasper County, Texas. Other populations probably exist.

RESUMEN

Solanum viarum, manzana de soda tropical (Solanaceae), es una mala hierba agresiva de Sur América. Desde que es conocida del Sur de Estados Unidos, incluyendo Louisiana, ha sido buscada en Texas. Se ha confirmado ahora una población y se han tomado testigos del condado de Jasper, Texas.

Solanum viarum Dunal, Tropical Soda-Apple, is a perennial native to South America. It was first found in the U.S. in Florida in 1988 (Wunderlin et al. 1993), though it may have been present as early as 1981 (Coile 1993.) It can be aggressively weedy in warmer areas and is now also known from Alabama, Georgia, Mississippi, North Carolina, South Carolina, Pennsylvania, and Tennessee (USDA, NRCS 2004). It is also present in Louisiana and Arkansas (Medal et al. 2003). Medal et al. (2003) also listed the plant for Texas, but we have been unable to locate any voucher specimens or specific collection site information. (It is possible they were referring to the Jasper County population documented here.) The species was not listed for Texas by Correll and Johnston (1970) or by Jones et al. (1997).This is the first vouchered report of its occurrence in the state.

In 2002, plants were found growing in a cattle pasture in Jasper County. The land owner cleared as many of the plants as he could but left the dead plants (with mature fruit) on the property. By 2004, the infestation was much worse (hundreds of individuals on ca. 40 to 60 acres), and he sought identification of the weed. We determined that it was indeed *Solanum viarum*. The land owner suspects the seeds may have been introduced in a shipment of hay from Louisiana.

SIDA 21(2): 1171–1174. 2004

Voucher specimen: **U.S.A. TEXAS. Jasper Co:** Ranch, entrance on TX Hwy 63, ca. 1 mi N jct. TX Hwy 190, pasture. *Mary Ketchersid 5-2004-1*, 24 May, 2004 (TAMU).

Images of the Jasper County plants may be seen at www.csdl.tamu.edu/FLORA/cgi/gallery_query?q=solanum+viarum

In October, 2004, a live specimen was sent to Texas A&M from Edna in Jackson Co. This represents a second confirmed infestation and underscores the possibility that *S. viarum* is already more widespread in Texas than is currently known. We have also seen photographs of what appears to be another population *S. viarum* in Texas, but the property owner has declined to disclose the location of the plants.

Solanum viarum (Fig. 1) somewhat resembles *S. carolinense* L. or *S. dimidiatum* Raf., both native to North America, but it has unbranched rather than stellate hairs on the upper leaf surfaces. The plant may reach 1 m or more tall, with a branched, prickly stem. The leaves are ovate to ovate-triangular, to 15 cm long and 12 cm wide, sinuate, and with sharp prickles to 1 cm or longer on both the upper and lower surfaces. The flowers are white (vs. purple to white in *S. carolinense* or *S. dimidiatum*), with the corolla lobes proportionately narrow and strongly recurved. The fruit are globose, 1.5–2(–3) cm in diameter, striped light and dark green when young, becoming yellow at maturity. A full description can be found in Wunderlin et al. (1993) and Bryson and Byrd (1994.)

This plant has the potential to be a serious weed in Texas, and it has already been proposed for the Texas Noxious Weed List, as per Texas Agricultural Code rule 4TAC § 19.300(a.)(Texas Register 2004). Cattle avoid eating the foliage, allowing the plant to persist in grazed pastures. The fruit, however, is eaten by cattle and small mammals, which distribute the seeds in their feces. Small infestations may be controlled by herbicides, but this may be prohibitively expensive over large areas, where mowing before flowering stage is the first line of defense. Trials are underway in Florida to determine the efficacy of the beetle *Gratiana boliviana* as a biocontrol agent (Medal et al. 2003).

Anyone finding what they know or believe to be *Solanum viarum* in Texas should contact their county agent and/or Mary Ketchersid at the above address for confirmation of identification and specific control instructions.

ACKNOWLEDGMENTS

Thanks go to Rodney Young, National Plant Identifier for USDA-APHIS-PPQ, for his confirmation of the identification. We thank two anonymous reviewers for helpful comments.

REFERENCES

Bryson, C.T. and J.D. Byrd. 1994. *Solanum viarum* (Solanaceae) new to Mississippi. Sida 16:382–385.

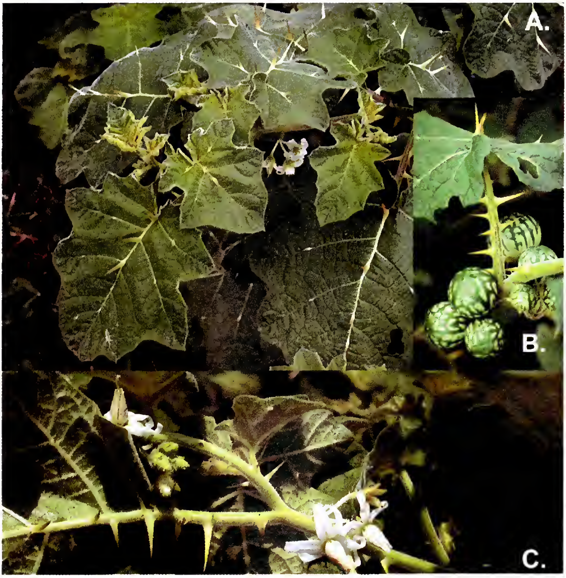


Fig. 1. *Solanum viarum*. A. prickly leaves and flowers, **B.** immature fruit, **C.** flowers.

Coile, N.C. 1993. Tropical soda apple, *Solanum viarum* Dunal: the plant from hell. Florida Dept. Agric. & Consumer Services, Div. Pl. Industr. Bot. Circ. No. 27.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas: a comprehensive checklist including synonymy, bibliography, and index. University of Texas Press, Austin.

Medal, J.C., D. Gandolfo, and J.P. Cuda. 2003. Biology of *Gratiana boliviana*, the first biocontrol agent released to control tropical soda apple in the USA. Document ENY-826, IFAS Extension, University of Florida.

Texas Register. May 21, 2004. 29(21):5003-5150. www.sos.state.tx.us/texreg/archive/May212004/index.html

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (plants.usda.gov). National Plant Data Center, Baton Rouge, LA.

Wunderlin, R.P., K.R. DeLaney, M. Nee, and J.J. Mullahey. 1993. *Solanum viarum* and *S. tampicense* (Solanaceae): two weedy species new to Florida and the United States. Sida 15:605–611.

NEW DISTRIBUTION RECORDS FOR *GAMOCHAETA* (ASTERACEAE: GNAPHALIEAE) IN THE UNITED STATES

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Gamochaeta stagnalis is reported for the first time for the United States (Arizona and New Mexico). In Arizona these plants have previously been identified as *Gamochaeta purpurea* and *Gamochaeta falcata*. The species is common in Mexico and apparently is at the northern limit of its distribution in Cochise, Pima, and Santa Cruz cos., Arizona, and Hidalgo Co., New Mexico. *Gamochaeta purpurea* sensu stricto also occurs in Arizona, disjunct from its main range in the eastern U.S.A. Plants of the southeastern U.S.A. previously identified in some treatments as *Gamochaeta falcata* are separated into two species: *Gamochaeta calviceps* and *Gamochaeta antillana*. A lectotype is chosen for *G. antillana*. *Gamochaeta calviceps* is known primarily from the southeastern U.S.A. but is reported from two collections in California. *Gamochaeta coarctata* is first reported for Arkansas and Virginia and further documented for California. *Gamochaeta stachydifolia*, a South American native, is reported from two counties in California. For each of the 12 *Gamochaeta* species recorded for the U.S.A., a hypothesis of nativity is given, with a brief rationale.

RESUMEN

Se cita *Gamochaeta stagnalis* por primera vez para los Estados Unidos (Arizona y Nuevo México). En Arizona estas plantas han sido identificadas previamente como *Gamochaeta purpurea* y *Gamochaeta falcata*. La especie es común en México y aparentemente tiene su límite Norte de distribución en los condados de Cochise, Pima, y Santa Cruz, en Arizona, y condado de Hidalgo, en Nuevo México. *Gamochaeta purpurea* sensu stricto aparece también en Arizona, disyunta de su área principal en el Este de U.S.A. Las plantas del Sureste de U.S.A. a veces identificadas previamente como *Gamochaeta falcata* se separan en dos especies: *Gamochaeta calviceps* y *Gamochaeta antillana*. Se escoge un lectotipo para *G. antillana*. *Gamochaeta calviceps* se conoce primariamente del Sureste de U.S.A. pero se citan dos colecciones en California. *Gamochaeta coarctata* se cita por primera vez de Arkansas y Virginia, y se documentan otras citas para California. *Gamochaeta stachydifolia*, nativa de Sur América, se cita de dos condados de California. Para cada una de las 12 especies de *Gamochaeta* citadas para U.S.A., se ofrece una hipótesis de la posibilidad de ser nativas, con un informe razonado.

In connection with preparation of a taxonomic treatment of the genus *Gamochaeta* Wedd. for the developing Flora of North America volumes, various range extensions and new records have come to light.

***Gamochaeta purpurea* sensu stricto in Arizona**

Plants of *Gamochaeta* in Arizona have been identified as *G. purpurea* (L.) Cabr. (as *Gnaphalium purpureum* L.: Kearney & Peebles 1960; Lehr 1978) and *G. falcata* (Lam.) Cabr. (Nesom 1990). *Gamochaeta purpurea* sensu stricto does

SIDA 21(2): 1175–1185. 2004

indeed occur in Arizona, but further study shows that the more common plants are instead a species widespread in Mexico but previously unreported for the United States (see below). The native range of *G. purpurea* sensu stricto apparently is the eastern U.S.A., including eastern Texas, but it occurs as an adventive in many parts of the world. In the U.S.A., Arizona is the only other state in which *G. purpurea* is known to occur.

Specimens examined. **ARIZONA. Cochise Co.:** Chiricahua Mts., Rucker Canyon, streambank near upper road crossing, scarce, ca. 6300 ft, 8 Jun 1980, *Toolin 797* (ARIZ). **Pima Co.:** Rincon Mts., Speed Ranch, 7400 ft, 23 Aug 1909, *Blumer 3301* (GH, MO); Spud Rock Spring, wet meadow, 7200 ft, 17 Sep 1982, *Bowers R828* (ARIZ); Rincon Mts., 7500 ft, 1891, *Neally 230* (TEX, US); Santa Catalina Mts., Bear Canyon, near Tucson, 27 Apr 1930, *Cory s.n.* (ARIZ, GH); Mt. Lemmon, control road, 23 Aug 1931, *Harrison and Kearney 8128* (ARIZ, LL); Sabino Canyon, 26 Mar 1926, *Loomis 1410* (ARIZ); 10 mi NE of Tucson in Sabino Canyon, frequent along banks of small stream, 15 May 1965, *Matthews 387* (ARIZ, ASU); Sabino Canyon near Tucson, 26 March 1926, *Peebles et al. 1410* (US); old Sawmill on Apache Camp Trail, 6800 ft, 24 Jul 1914, *Shreve s.n.* (ARIZ); Sabino Canyon, moist alluvial soil, 2800 ft, 2 May 1903, *Thornber 416* (US), Sabino Canyon, moist alluvial soil, 3000 ft, 2 May 1903, *Thornber 468* (ARIZ, MO, NMC, US); Sabino Canyon, 5 May 1903, *Thornber s.n.* (ARIZ); Saw Mill, 24 Jul 1914, *Thornber 7303* (ARIZ).

The plant of *Harrison and Kearney 8128* (ARIZ; the LL specimen has a single stem with drawing of the habit) produced numerous decumbent, rhizome-like or caudex-like branches arising from a central axis and apparently was distinctly perennial. At least one of the plants collected by Shreve (s.n., ARIZ) also appears to have been perennial. It will be interesting to investigate whether the highly unusual modification of *Harrison and Kearney 8128* is phenotypic or whether a distinct genetic race might be present.

Gamochaeta purpurea probably is native to eastern North America (see below), where it is the least weedy of its congeners, but the species apparently occurs widely through the world as a adventive. Plants of *G. purpurea* in southern Arizona (Pima Co.) occur along sandy banks of perennial streams in Sabino Canyon and Bear Canyon at the base of the Santa Catalina Mountains east of Tucson. The first known collections were made in these long-popular recreation areas in 1903, perhaps accidentally established there through heavy visitation, as the same sites are heavily infested by other, more aggressive non-native species. On the other hand, collections of *G. purpurea* also have been made in the Rincon Mts. (Pima Co.) and the Chiricahua Mts. (Cochise Co.), where the species is less likely to have been introduced by human activity. It also seems unlikely that plants of *G. purpurea* sensu stricto in scattered Mexican localities were introduced there by human activity.

A record of *Gamochaeta purpurea* from New Mexico (Allred 2003) was attributed to documentation in McIntosh (1996), which instead reported records for *Pseudognaphalium leucocephalum* (A. Gray) Anderb. The voucher for the *Gamochaeta* record in New Mexico is identified here as *Gamochaeta stagnalis* (see citation below). Documentation for a report of *Gamochaeta purpurea* from

Montana (Dorn 1984, as *Gnaphalium purpureum*) has not been verified. Reports of *Gamochaeta purpurea* from California, Oregon, Washington, and British Columbia are primarily based on *G. ustulata* (Nutt.) Holub (a native and relatively common species), although three other species (non-native, relatively uncommon) of the genus are now known from California: *G. calviceps*, *G. stachydifolia*, and *G. coarctata*.

The status of *Gamochaeta stagnalis*

The present report documents the occurrence of *Gamochaeta stagnalis* in the U.S.A., where it occurs in Arizona and New Mexico. These plants have previously been identified in Arizona mostly as *Gamochaeta purpurea*. In the U.S.A., *G. stagnalis* does not geographically overlap with any other species and its identity should now be easily ascertained. A full description is given here, since one apparently does not exist elsewhere.

Gamochaeta stagnalis (I.M. Johnst.) Anderb., Opera Bot. 104:157. 1991. *Gnaphalium stagnale* I.M. Johnston, Contr. Gray Herb. ser. 2, 68:99. 1923. TYPE: MEXICO. SAN LUIS POTOSÍ: marshes about San Luis Potosí ("in palustris circa urbem"), Aug 1876, *J.G. Schaffner 225* (HOLOTYPE: GH!). A specimen at US, *Schaffner 666* (with "225" and "212" also written on the label), collected in Sep 1879, is the same species but apparently not a duplicate of the type.

Plants annual from a short, very slender to filiform taproot, less commonly from very shallow fibrous roots. **Stems** single and erect or 2–8 and decumbent-ascending, 2.5–20(–35) cm long, densely and loosely arachnoid-tomentose. **Leaves** mostly cauline, oblanceolate-spatulate to narrowly oblanceolate or nearly linear, 1–4 cm long, 2–6(–10) mm wide, basal usually not persistent, cauline oblanceolate, slightly reduced upward in size, equally loosely tomentose above and beneath or the adaxial surface glabrescent and greener. Capitulescence a capitate cluster (in smallest plants) of heads or an interrupted series of small glomerules subtended by divergent-ascending bracts similar to the upper cauline leaves, sometimes branching at lower nodes. **Involucres** campanulate, 2.5–3 mm high, conspicuously imbedded in loose tomentum, the outer bracts basally hairy; inner phyllaries narrowly oblong-lanceolate, with rounded-obtuse, whitish lamina, usually purple above the stereome and along proximal margins of the lamina, outer phyllaries ovate-triangular, translucent; receptacles deeply concave to crateriform. **Florets**: bisexual (2–)3(–4); all corollas purplish-tipped.

Flowering (Mar–)Apr(–May). Sandy, often moist soil, washes and permanent streams, canyon bottoms, flower beds, riparian, desert grassland, juniper-grassland, creosote bush-mesquite-cholla, oak woodland; 900–1750 m; Ariz., N.Mex.; Mexico (Sonora, Chihuahua, Coahuila, Nuevo León, Baja California Sur, Sinaloa, Durango, Zacatecas, San Luis Potosí, and other states to the south).

Specimens examined: **ARIZONA. Cochise Co.:** floodplain of Miller Canyon, 0.8 mi by road W of Hwy 92, under *Quercus emoryi* in open woodland, 14 Apr 1991, *Bowers 3426* (ARIZ); Dragoon Mts., Noonan Canyon, SE slope of S-facing saddle, 5080 ft, with *Fouquieria*, 29 Apr 1983, *Caffey-Moquin 396* (UNM) and 399 (UNM); Whetstone Mountains, rocky draw, 27 Apr 1952, *Goodding 58-52* (ARIZ); Huachuca Mountains, Coronado National Memorial, rocky bench in wash, E end of park, 5000 ft, 20 Apr 1991, *McLaughlin 6233* (ARIZ); San Bernardino Ranch, 18 mi E of Douglas, moist area around Middle Well, 3800 ft, 25 May 1981, *Marrs-Smith 561* (ASU); SW corner of Chiricahua National Monument, grassland, juniper, 5400 ft, 19 Apr 1975, *Reeves R2595* (ASU). **Pima Co.:** Rincon Mountains, along the Manning Camp trail, moist draws in desert grassland, 4500 ft, 27 Apr 1983, *Bowers R1124* (ARIZ); Rincon Mts., unnamed canyon at W base of Tanque Verde Ridge, 3200 ft, moist soil in streambed, 29 April 1984, *Bowers R1433* (ARIZ, LL); Altar Valley, 8 airline mi SSW of Robles Junction (Three Points), creosote bush-mesquite-cholla woodland, infrequent in disturbed areas, 2900 ft, 6 Apr 1973, *Holmgren 6668* (NY); Baboquivari Canyon, 11 Mar 1926, *Leding and Thackery 1123* (ARIZ); Forestry Cabin at W base of Baboquivari Peak, Papago Indian Reservation, permanent stream in oak-Sonoran desert zone, grazed, 6–7 Apr 1973, *Lehto et al. 10660* (NY, US); Pagago Indian Reservation, 0.3 mi E of Topawa, mesquite-cactus, bur-sage desert, roadside washes, 6 Apr 1973, *Lehto et al. 10749* (ARIZ); 22.0 mi S of Robles Jct. at Las Delicias Ranch Road along Hwy 286, desert grassland with mesquite, burroweed, *Opuntia* spp., 3200 ft, 14 May 1988, *McLaughlin 4568* (ARIZ); Buenos Aires National Wildlife Refuge, along Brown wash, with hackberry and mesquite, 3600 ft, 25 Apr 1991, *McLaughlin 6253* (ARIZ), Lower Bear Canyon, moist sand along stream, 3200 ft, 13 Apr 1961, *Mason 1908* (ARIZ); along Santa Cruz River at Cortaro Road, NW of Tucson, 5 Apr 1976, *Mason 3171a* (ARIZ); Little Tucson, Ascencio floodwater field section last plowed summer 1978, 17 Apr 1979, *Nabham 540* (ARIZ); Pima Co.: Coyote Mts., Mendoza Canyon, 3200 ft, abundant on canyon floor, 22 April 1945, *Parker 5797a* (ARIZ, BRIT, LL, NY); wet banks of the Rillita, 14 Apr 1881, *Pringle 13744* (GH, MO); Santa Catalina Mountains, Ventana Canyon, 1908, *Shreve s.n.* (ARIZ); Fort Lowell, Rillito, 23 Apr 1903, *Thornber s.n.* (ARIZ); Tucson, First Avenue at Roger Road, irrigated flower bed around parking lot, 14 Aug 1994, *Van Devender 94-444* (TEX). **Santa Cruz Co.:** Nogales-Lochiel Road, 6 mi from Ariz. Hwy 82, 9 airline mi E of downtown Nogales, sandy soil around oak tree, 4200 ft, 18 Apr 1973, *Holmgren 6866* (ARIZ, NY); Agua Caliente Canyon, along stream near road crossing, riparian vegetation with *Celtis*, *Baccharis*, *Fraxinus*, 3800 ft, 2 Apr 1978, *Reeves 6640* (ASU); Santa Rita Mountains, Gardner Canyon, 5700–5800 ft, 8 May 1975, *Van Devender s.n.* (ARIZ). **NEW MEXICO. Hidalgo Co.:** Peloncillo Mts., Granite Gap, occasional on W-facing granitic slope with *Ericameria laricifolia*, *Fouquieria splendens*, *Agave palmeri*, *Opuntia phaeacantha* var. *discata*, 21 Apr 1993, *McIntosh 2665* (NMC).

Localities for *Gamochaeta stagnalis* in Arizona and New Mexico are at the northwestern extremity of its overall range, where flowering is restricted to the end of the cool season. The species is common and widespread in Mexico, from Baja California Sur, Sonora, and Chihuahua southward and eastward to Jalisco and Colima, Nuevo León, San Luis Potosí, and Veracruz, where it occurs at elevations of 200–1800(–2600) meters in rocky or gravelly soil, including stream beds and other periodically wet sites, in areas of thorn-scrub, tropical deciduous, or oak woodland, usually in open or disturbed sites. In Mexico it flowers December through May but sometimes continues longer in wet seasons.

Plants of *Gamochaeta stagnalis* are recognized by their annual duration, usually from a filiform taproot, oblanceolate leaves equally tomentose on the lower and upper surfaces, interrupted capitulescence, small, basally tomentose heads, and phyllaries conspicuously purplish at the stereome/lamina junction and along the proximal margins of the lamina. It is similar to and probably closely related to *G. antillana* (below).

The status of *Gamochaeta antillana*

Gamochaeta antillana (Urb.) Anderb., a common species in the southeastern U.S.A., was combined in concept with *Gamochaeta calviceps* (Fern.) Cabr. and identified as *Gamochaeta falcata* (Lam.) Cabr. by Nesom (1990). Godfrey (1958) separated *G. calviceps* and identified the other species as *G. falcata*. It is now clear that two taxa occur in this region, and they are now known to be widely sympatric, countering Godfrey's notion that they might be treated as geographic varieties.

Gamochaeta antillana (Urb.) Anderb., Opera Bot. 104:157. 1991. *Gnaphalium antillanum* Urban, Repert. Spec. Nov. Regni Veg. 13:482. 1915. TYPE: CUBA. "In insula Saba ad Great Hill et Gumbeygut, m. April, fruct. delapsis, *Suringar*" (holotype: B, apparently destroyed). Two paratype collections cited by Urban (*Britton 10009*; *Britton 9619*) are at NY, with internet-posted photographs on the NY type database. Peter Michael, in May 1982, annotated *9619* as follows: "Urban designated a Suringar specimen as type and listed 2 additional specimens—*Britton 10009* and *Britton, Britton and Cowell 9619*. The Suringar specimen no longer exists; I believe that the fruiting specimen, *Britton, Britton and Cowell 9619* should be designated lectotype." It obviously is somewhat arbitrary, but I suggest that the features of the species are better shown by plants of *10009* and designate it here as the LECTOTYPE: Cuba. Prov. Pinar del Rio, Boca de Galafre, hillside, 15 Mar 1911, *N.L. Britton 10009* (NY).

Gnaphalium subfalcatum Cabr., Rev. Mus. La Plata (n.s.) Bot. 4:174. 1941. *Gamochaeta subfalcata* (Cabr.) Cabr., Bol. Soc. Argent. Bot. 9:383. 1961. TYPE: ARGENTINA. PROV. BUENOS AIRES: Pdo. Avellaneda, Isla Maciel, 12 Oct 1920, *Cabrera 944* (HOLOTYPE: LP).

Cabrera (1961) cited collections of *Gamochaeta subfalcata* from Texas and Florida, extending the range far from northeastern Argentina, as circumscribed by the original citations (Cabrera 1941). Freire and Iharlegui (1997) also identified this species in the U.S.A. as *G. subfalcata*, and it seems inescapable that *C. antillana* and *G. subfalcata* are synonyms. *Gamochaeta antillana* is known to occur in Alabama, Arkansas, Florida, Georgia, Louisiana, North Carolina, Oklahoma, Mississippi, South Carolina, Tennessee, Texas, and Virginia; also in South America, Europe, and New Zealand.

Gamochaeta antillana is closely similar to *G. stagnalis* but the plants often are generally taller (6–40 cm vs. 2.5–20(–35) cm in *G. stagnalis*) and the basal leaves are oblanceolate with the cauline quickly becoming linear (in *G. stagnalis*, the cauline leaves and those subtending the clusters of heads are oblanceolate). *Gamochaeta antillana* occurs in humid climates and habitats while *G. stagnalis* is a species of arid climate and habitat. Further study of the distinction between these two taxa is needed.

a. Involucres 3–3.5 mm, lightly arachnose only at the base or not at all; capitulescence interrupted at least distally, main axis visible to terminal heads; phyllaries in 5–7 series, outer and middle ovate-triangular with sharply acute-acuminate apices, 1/3–1/2 as long as the inner, none with purplish color; flowering May–Jul ________ **Gamochaeta calviceps**

a. Involucres 2.5–3 mm, seated in tomentum; capitulescence initially cylindric and uninterrupted, at least distally, main axis obscured by clustered heads; phyllaries in

3–4(–5) series, outer and middle ovate-lanceolate with narrowly to broadly acute apices, outer 1/2–2/3 as long as inner, at least innermost commonly tinged with purple at stereome-lamina junction; flowering (Feb–)Mar–May, sometimes later with moisture __________ **Gamochaeta antillana**

Gamochaeta calviceps in California

Gamochaeta calviceps occurs widely in the southeastern U.S.A. The first known North American records outside of that region are reported here. It is known to occur in Alabama, Arkansas, California, Florida, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Texas, Virginia, as well as South America, Europe, and New Zealand. As noted above, *G. calviceps* and *G. antillana* constitute the plants in the eastern U.S.A. most commonly identified in the past as *Gamochaeta falcata*.

CALIFORNIA. Contra Costa Co.: Tilden Regional Park Botanic Garden, Wildcat Canyon; a rapidly spreading weed [that] probably came with plant material from Delano, Kern Co., 27 Jun 1975, *True 7872A* (TEX). **San Diego Co.:** Peninsular Ranges, near Riverside Co. line, E of I-15 off Pala Road along Rancho Heights Rd, 1364 ft, chaparral, mostly past flower, 24 Jun 2003, *Spjut and Marin 15384* (BRIT, UCR).

Gamochaeta stachydifolia in California

This species is known to me by two collections from central California, the localities separated by about 200 kilometers. The 1990 collection suggests that it has probably is naturalized in that region and should be expected at more localities. The plants are recognized by their slender-taprooted habit (probably annual), oblanceolate and concolorous leaves, cylindric capitulescence, acute to acute-acuminate outer and middle phyllaries, inner phyllaries with brownish-hyaline, rounded-apiculate lamina, and yellowish-tipped florets. The GH collection (*Mason 6991*) was annotated by Peter Michael in 1990 as *Gamochaeta berteriana* (DC.) Cabr., but this identification is problematic, as *G. berteriana* apparently is perennial, thicker stemmed, and bears heads in capitate clusters; it is native to high elevation habitats in Chile (type: Chile, 1833, *Bertero 8222*, B, photo-TEX!). Freire and Iharlegui (1997) noted that the range of *G. stachydifolia* includes Argentina, Brasil, and Uruguay.

Gamochaeta stachydifolia (Lam.) Cabr., Bol. Soc. Argent. Bot. 9:382. 1961. *Gnaphalium stachydifolium* Lam., Encycl. 2:757. 1786. *Gnaphalium purpureum* L. var. *stachydifolium* (Lam.) Baker in Martius, Fl. Bras. 6(3):125. 1882. Probable HOLOTYPE (see comments by Cabrera 1961): Uruguay or Argentina. "Des environs de Montevideo et de Buenos Aires," without date, *Commerson s.n.* (P, photo-F, photo-LL). Lamarck noted that "Commerson a trouvé cette espèce à Monte-Video. (v.s.)."

Plants annual, slender taprooted. **Stems** 4–15 cm high, erect, single from the base, densely and loosely gray-white tomentose-arachnoid. **Leaves** basal and cauline, basal mostly withered and withering by flowering, oblanceolate, 1–2 cm long, 2–4 mm wide, cauline similar to basal, oblanceolate, commonly folded, subclasping but not auriculate, 2–3 cm long, 3–6 mm wide, continuing nearly unreduced into lower inflorescence but none longer than heads, dark apical mucro often evident, evenly gray-white tomentose-arachnoid on both surfaces. **Capitulescence** a continuous cylinder 2–3(–4) cm long, 10–12 mm wide (pressed). **Involucres** campanulate, 3.5–4 mm high; phyllaries in 4–5 gradate series, outer ca. 1/3 as long as innermost, outer and middle narrowly ovate-triangular, apically acute to acute-acuminate, lightly tomentose at the very base, innermost oblong, stereome ca. 1/2 length, lamina brownish-hyaline, apically rounded-apiculate; receptacles shallowly concave. **Florets:** bisexual 2–4; all corollas yellowish. **Cypselae:** mature fruits not seen.

Collections examined. **CALIFORNIA. Amador Co.:** Sierra Nevada foothills, hill above Ione, 25 Apr 1932, *Mason 6991* (GH, LL). **Butte Co.:** ca. 1/4 mi S of the Feather River, ca. 0.4 mi W of Pacific Heights Road, ca. 4.5 mi SW of Oroville, T18, R3E, ne/S3, riparian woodland (destroyed), 100 ft, uncommon, inconspicuous, growing on dry, bare disturbed, sandy soil in the borrow area, 28 Apr 1990, *Ahart 6466* (MO).

Gamochaeta coarctata in Arkansas, California, and Virginia

Gamochaeta coarctata (Willd.) Kerg. was previously noted to occur in California (Nesom 1990), but it was identified as *Gamochaeta americana*. In view of the rapid spread and pervasive occurrence of this species in the southeastern U.S.A., it seems likely that it also is becoming increasingly common in California. It is common throughout Louisiana, and its representation in southern Arkansas probably is already significantly greater in herbaria than the single record reported here. I have seen the following specimens.

ARKANSAS. Bradley Co.: "Southern Bluff" ca. 2.3 mi NW (by air) of the center of Warren, 26 Jun 1976, *Locke 2002* (BRIT). **CALIFORNIA. Humboldt Co.:** Canyon Creek, 6 mi SE of Blue Lake, hillside pasture in logged area, local and scarce, 1200 ft, 1 Aug 1936, *Tracy 15057* (NCU, TEX). **Sacramento Co.:** weed in irrigated alfalfa field, Aschwanden farm, 3 mi W of Galt, 10 Aug 1953, *Tucker 2674* (SMU). **Stanislaus Co.:** San Joaquin Valley, near Ceres and Turlock, 2 mi WSW of Keyes, uncommon annual weed in almond orchard, 80 ft, 8 Jul 2000, *Sanders 23532* (BRIT). **VIRGINIA. Northampton Co.:** north end of Hog Island, inner dune, 1 Jul 1996, *McAvoy 1603* (DOV).

Further comments on biology and nomenclature of *Gamochaeta coarctata* are given in two other papers in this issue (Nesom 2004; Pruski & Nesom 2004).

Nativity of North American *Gamochaeta* species

Assessment of the nativity of North American species of *Gamochaeta* is problematic. Most *Gamochaeta* species are native to South America, and most of the North American species characteristically occur in ruderal habitats, commonly in company of known non-native species of various families. Some, if not all, of the North American *Gamochaeta* species occur as weeds in parts of the world other than South America (although inconsistencies in identification and application of names make it difficult to accurately evaluate overall distributions of the widespread species). Thus by behavior and association, all ruderal *Gamochaeta* species in North America might also be expected to be non-native. The mode of introduction of those clearly non-native is not known.

Circumstantial evidence, however, suggests that some of the North American *Gamochaeta* species are native. *Gamochaeta purpurea* and *G. ustulata* were described from collections made early in the history of the U.S.A., presumably before non-native colonizers became abundant; others are known only from more recent collections. Several species are distributed over broad latitudinal and ecological range, suggesting that geographic differentiation may have occurred; the geographic range (and presumed genetic variability) of others is more restricted. Four of the species suggested as native on a geographic-ecological basis form two species pairs (the two of each pair with strong morphological similarities: *G. purpurea* and *G. sphacilata*, *G. argyrinea* and *G. ustulata*), suggesting that the evolutionary differentiation was autochthonous. *Gamochaeta pensylvanica*, *G. antillana*, and *G. stagnalis* are similar among themselves and possibly closely related; their nativity is uncertain, but at least it seems likely that *G. stagnalis* is native. For those non-native, evidence is strong that they are naturalized (sensu Nesom 2000a).

For each of the *Gamochaeta* species recorded for North America (north of Mexico), a hypothesis of nativity is given, with a brief rationale. Distribution maps for *G. purpurea*, *G. argyrinea*, *G. ustulata*, *G. chionesthes*, *G. simplicicaulis*, and *G. coarctata* are provided in Nesom (2004).

Gamochaeta purpurea (L.) Cabr.—Native: widespread in the eastern U.S.A. over a broad latitudinal and ecological range; early collections from known range in the U.S.A.; possibly closely related to *G. sphacilata*, which apparently occurs natively over a wide area, including South America and Mexico, into southwest Texas. *Gamochaeta purpurea* sensu stricto is found over a wide area of peninsular Florida, but *G. argyrinea* and *G. chionesthes*, both segregated from the concept of *G. purpurea* in the U.S.A., are restricted to the northern counties of the state (a loan of specimens from USF was extremely helpful in establishing this).

Gamochaeta sphacilata (Kunth) Cabr.—Native: widespread from South America to the U.S.A., occurs in essentially undisturbed habitats at mid and relatively high-elevation in Mexico and the northern extension of its range in trans-Pecos Texas; possibly closely related to *G. purpurea*, which apparently is native to the eastern U.S.A.

Gamochaeta argyrinea Nesom—Native(?): widespread in the eastern U.S.A. over a considerable latitudinal and ecological range and also known from Puerto Rico; early collections from known range in the U.S.A.; probably closely related to *G. ustulata*, which apparently is native to the western U.S.A.

Gamochaeta ustulata (Nutt.) Holub—Native: distinctive habitat and geographic range in Pacific coast states, over a wide latitude, mostly in coastal and near-coastal habitats; early collections from known range in the western U.S.A.; closely similar and probably closely related to *G. argyrinea*, which perhaps is native to the eastern U.S.A.

Gamochaeta chionesthes Nesom—Non-native: relatively scattered and recent collections in the southeastern U.S.A. (see Nesom 2004). It possibly has been identified in South America by a misapplied name (*G. americana*?); possibly closely related to *G. simplicicaulis*, a native of South America.

Gamochaeta simplicicaulis (Willd. ex Spreng.) Cabr.—Non-native: scattered and recent collections in the southeastern U.S.A., the earliest known in 1957–1959, when it was discovered in nine counties of North Carolina and South Carolina (Nesom 1999, 2000b). Widely distributed in South America and known from early collections there; recorded as adventive in other parts of the world before its discovery in North America.

Gamochaeta coarctata (Willd.) Kerg.—Non-native: collections from the U.S.A. before about 1970 are rare. Small (1933) did not include this distinctive species in his treatment of the Southeastern flora. Godfrey (1958) noted that he knew the species (as *Gnaphalium spicatum* Lam.) from collections from around Wilmington, North Carolina, and from Florida, "in and around Tallahassee, thence westward to Pensacola." Perhaps the earliest collection or one of the earliest was made in 1949 in Wilmington (*Godfrey 49341*, originally identified as *Gnaphalium purpureum*, SMU, NCU), where it was "abundant in vacant lots and weedy places"; it was collected again in Wilmington in 1950 (*Godfrey 50362*, SMU), identified as an "unusual form" of *Gnaphalium purpureum*. The range of *G. coarctata* in the southeastern U.S.A. is now apparently much more continuous than indicated by existing collections (personal observation), suggesting a recent and rapid expansion. The type of *Gnaphalium coarctatum* and its synonym *Gnaphalium spicatum* was described from Uruguay from a collection made in the 1700s (Pruski & Nesom 2004), and it seems likely that the species is native to South America. It is documented as adventive in other parts of the world.

Gamochaeta pensylvanica (Willd.) Cabr. (synonyms: *Gnaphalium spathulatum* Lam. [non Burm. f.], *Gnaphalium peregrinum* Fernald)—Non-native(?): common in the southeastern U.S.A. (nearly restricted to Atlantic Coast and Gulf Coast states); common in eastern South America and throughout the world as a weed. Similar and perhaps related to *G. antillana*, for which the nativity also is uncertain but suggested to be North American and Antillean. On balance, however, it seems likely that *G. pensylvanica* arrived early as an adventive in North America, especially in view of its apparent complete fidelity to ruderal habitats on this continent and its near-cosmopolitan occurrence as a weed. In Willdenow's proposal of the name *Gnaphalium pensylvanicum*, he noted that the 'habitat' was in Virginia and in Pennsylvania, north of its characteristic range in the U.S.A. My guess is that it was collected as a ballast waif in Philadelphia prior to 1809, the year of Willdenow's proposal. The species is shown only in Pennsylvania County by Wherry et al. (1979), who noted that it is "introduced" in the state; it was not included at all in a later summary of the

Pennsylvania flora (e.g., Rhoads & Block 2000). The type of *Gnaphalium spathulatum*, described by Lamarck in 1788, was from plants cultivated at the "Jardin du Roi" in Paris; Lamarck noted that he did not know the origin of the garden plants but that Commerson had found a similar form near Buenos Aires. In his description of *Gnaphalium peregrinum*, Fernald (1943) noted that *G. spathulatum* was a later homonym (non Burm. f. 1768) and probably the same species as *G. peregrinum*, but because of his uncertainty regarding the identity of the plant in the type photo (*G. spathulatum* Lam.), he chose a new type for the new name. Burman's name (Prodromus florae capensis 25. 1768) is validated by citation of a figure in Breyne's Prodromi (tab. 18, fig. 3. 1738) and accompanying legend (p. 29)—it apparently is a species of *Helichrysum*.

Gamochaeta antillana (Urb.) Anderb.—Native(?): common in the southeastern U.S.A., most in coastal states; described from Cuba in 1915, known from most islands of the Antilles, South America, and apparently weedy in other parts of the world. Closely similar to and possibly closely related to *G. stagnalis*.

Gamochaeta stagnalis (I.M. Johnst.) Anderb.—Native(?): common in northern Mexico and reaching southern Arizona and southwestern New Mexico, where it flowers in early spring in desert habitats. Probably closely related to *G. antillana* but different in geography and ecology.

Gamochaeta calviceps (Fern.) Cabr.—Native(?): described in 1935 from Virginia and known mostly from recent collections in eastern North America (states of the Atlantic Coast and Gulf Coast); apparently widespread in South America other parts of the world.

Gamochaeta stachydifolia (Lam.) Cabr.—Non-native: known in North America only from two counties in central California. Native to South America.

ACKNOWLEDGMENTS

I am grateful to Alan Weakley and Carol McCormick for checking locality data of NCU collections and to John Pruski and Susana Freire for reviews. Loans of specimens were studied from ARIZ, ASU, DOV, MO, NMC, and USF. Data also were obtained on visits to MO, NCU, NY, GH, TEX, and US.

REFERENCES

Allred, K. 2003. A working index of New Mexico vascular plant names. <web.nmsu.edu/~kallred/herbweb/Working%20Index-title.htm> Accessed 1 Mar 2004.

Cabrera, A.L. 1941. *Gnaphalium*. In: Compuestas Bonaerenses. Rev. Mus. La Plata (n.s.), Secc. Bot., 4:1–450. Pp. 161–180

Cabrera, A.L. 1961. Observaciones sobre las Inuleae-Gnaphalinae (Compositae) de América del Sur. Bol. Soc. Arg. Bot. 9:359–386.

Dorn, R.D. 1984. Vascular plants of Montana. Mountain West Publishing, Cheyenne, Wyoming.

Fernald, M.L. 1943. Virginian botanizing under restrictions. Rhodora 45:357–413, 445–480.

Freire, S.E. and L. Iharlegui. 1997. Sinopsis preliminar del género *Gamochaeta* (Asteraceae, Gnaphalieae). Bol. Soc. Argent. Bot. 33:23–35.

Godfrey, R.K. 1958. A synopsis of *Gnaphalium* (Compositae) in the southeastern United States. Quart. J. Florida Acad. Sci. 21: 177–184.

Kearney, T.H. and R.H. Peebles. 1960. Arizona flora and supplement. Univ. of California Press, Berkeley.

Lehr, J.H. 1978. A catalogue of the flora of Arizona. Desert Botanical Garden, Phoenix, Arizona.

McIntosh, L. 1996. Seven additions to the flora of New Mexico. Phytologia 81:365–368.

Nesom, G.L. 1990. The taxonomic status of *Gamochaeta* (Asteraceae: Inuleae) and the species of the United States. Phytologia 68:186-198.

Nesom, G.L. 1999. *Gamochaeta simplicicaulis* (Asteraceae: Gnaphalieae) in four southeastern states and new for North America. Sida 18:1259–1264.

Nesom, G.L. 2000a. Which non-native plants are included in floristic accounts? Sida 19: 189–193.

Nesom, G.L. 2000b. *Gamochaeta simplicicaulis* (Asteraceae: Gnaphalieae) in Georgia. Sida 19:413.

Nesom, G.L. 2004. New species of *Gamochaeta* (Asteraceae: Gnaphalieae) from the eastern United States and comments on similar species. Sida 21:717–741.

Pruski, J. and G.L. Nesom. 2004. *Gamochaeta coarctata,* the correct name for *Gamochaeta spicata* (Asteraceae: Gnaphalieae). Sida 21:711–715.

Rhoads, A.F. and T.A. Block. 2000. The plants of Pennsylvania: An illustrated manual. Univ. of Pennsylvania Press, Philadelphia.

Small, J.K. 1933. Manual of the southeastern flora. Univ. of North Carolina Press, Chapel Hill.

Wherry, E.T., J.M. Fogg, Jr., and H.A. Wahl. 1979. Atlas of the flora of Pennsylvania. Morris Arboretum of the Univ. of Pennsylvania, Philadelphia.

VASCULAR FLORA OF WASHITA BATTLEFIELD NATIONAL HISTORIC SITE, ROGER MILLS COUNTY, OKLAHOMA

Bruce W. Hoagland

Oklahoma Biological Survey
and Department of Geography
University of Oklahoma
Norman, Oklahoma 73019, U.S.A.
bhoagland@ou.edu

Amy Buthod

Oklahoma Biological Survey
University of Oklahoma
Norman, Oklahoma 73019, U.S.A.

Wayne Elisens

Oklahoma Biological Survey
and Department of Botany and Microbiology
University of Oklahoma
Norman, Oklahoma 73019, U.S.A.

ABSTRACT

This article reports the results of a vascular plant inventory of the Washita Battlefield National Historic Site in western Oklahoma. Two hundred and seventy-two species of vascular plants were collected from 201 genera and 62 families. The most specious families were the Poaceae (53), Asteraceae (48), Fabaceae (22) and Euphorbiaceae (22). One hundred and seventy-five species were perennials, ninety-five annuals, and 2 biennials. Twenty-eight woody plant species were present. Twenty-one species exotic to North America were collected representing 7.7% of the flora. Five species tracked by the Oklahoma Natural Heritage Inventory were found. This study reports 205 species previously not documented in Roger Mills County.

ABSTRACT

Este artículo presenta los resultados de un inventario de flora vascular del Washita Battlefield National Historic Site en el Oeste de Oklahoma. Se colectaron doscientas setenta y dos especies de plantas vasculares pertenecientes a 201 géneros y 62 familias. Las familias con más especies fueron Poaceae (53), Asteraceae (48), Fabaceae (22) y Euphorbiaceae (22). Ciento setenta y cinco especies eran perennes, noventa y cinco anuales, y 2 bianuales. Estaban presentes veintiocho especies leñosas. Se colectaron veintiuna especies exóticas para Norte América que representan el 7.7% de la flora. Se encontraron cinco especies seguidas por el Oklahoma Natural Heritage Inventory. Este estudio cita 205 especies no documentadas previamente en el condado de Roger Mills.

INTRODUCTION

The objectives of this study were twofold; to fill a gap in floristic data for western Oklahoma and provide resource managers at the Washita Battlefield National Historic Site (WBNHS) a comprehensive species list. Prior to 2002, when collecting began for this study, 446 specific and intraspecific taxa were reported from Roger Mills County (Hoagland 2004). *Erigeron bellidiastrum* Nutt., collected by J. Engleman on 3 July 1919, was the first botanical specimen gathered in Roger Mills County. There are no subsequent collection records until 1929.

SIDA 21(2): 1187–1197. 2004

Peak collecting years in Roger Mills County were 1939 (261 specimens), with the return of J. Engleman, and 1976 by Susan Barber and Rahmona Thompson (124 specimens) on behalf of the Robert Bebb Herbarium at the University of Oklahoma (Hoagland 2004). During the course of this research, Freeman et al. (2003) published a floristic list from the Thurman Ranch in Roger Mills County, located south of WBNHS, which documented 470 species from 85 families.

Study Area

The WBNHS was established on 12 November 1996 and encompasses 136 hectares in Roger Mills County (Fig. 1). Latitudinal extent ranges from 35.63°N to 35.62°N and longitudinal extent from 99.70°W to 99.71°W. The WBNHS is located within the subtropical humid (Cf) climate zone (Trewartha 1968). Summers are warm (mean July temperature = 27.7°C) and humid, whereas winters are relatively short and mild (mean January temperature = 1.9°C). Mean annual precipitation is 105.6 cm, with periodic severe droughts (Oklahoma Climatological Survey 2004). Physiographically, the study area is located in the Osage Plains section of the Central Lowlands province (Hunt 1974) and within the High Plains province of Oklahoma (Curtis & Ham 1979). Elevation in the study area ranges from 588 m along the Washita River to 610 m. The surface geology is primarily Permian red sandstone in the uplands to the south of the Washita River, and Quaternary silt, sand and clay adjacent to and north of the river (Branson & Johnson 1979). The primary soil association at WBFNHS is the Yahola-Port, which is composed of alluvial soils on bottomlands and terraces. The Woodward-Quinlan association occurs on uplands and is level to very steep loamy soils underlain by red sandstone (Burgess et al. 1959). The predominant potential vegetation types are mixedgrass prairie with a smaller component of bottomland forests and stabilized dunes (Duck & Fletcher 1943). Much of the Washita River bottomlands were cleared for agriculture and pasturage.

METHODS

Eight collection sites were established at WBNHS for intensive floristic sampling. Sites were selected following a review of US Geological Survey 1:24,000 topographic maps and field reconnaissance. The predominant vegetation association at these sites was classified according to Hoagland (2000). Collection effort was not limited to established sites. Collections were made on a monthly basis from March through October 2002. Vouchers for species exotic to North America were made from naturalized populations only, thus excluding cultivated and ornamental plants. Specimens were processed at the Robert Bebb Herbarium of the University of Oklahoma (OKL) following standard herbarium techniques. Manuals used for specimen identification included Correll and Johnston (1970), Gould (1975), Waterfall (1969) and Great Plains Flora Association (1986). Origin, whether native to introduced to North America, was deter-

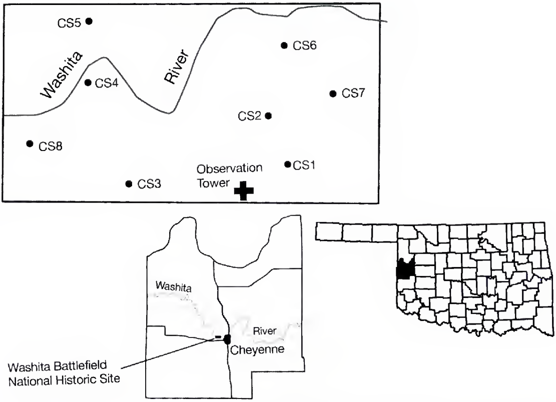


Fig. 1. Location of Washita Battlefield National Historic Site, Roger Mills County, Oklahoma.

mined using Taylor and Taylor (1991) and the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS 2004). The nomenclature used is in concordance with USDA-NRCS (2004). Voucher specimens were deposited at OKL.

RESULTS AND DISCUSSION

A total of 272 vascular plants in 201 genera and 62 families were collected (Table 1). Among the angiosperms, 66 were monocots and 205 were dicots. One gymnosperm was found. The most species were collected from the families Poaceae (53), Asteraceae (48), Fabaceae (22), and Euphorbiaceae (14). The genera *Chamaesyce* (5), *Eragrostis* (4), *Dalea* (4), and *Solanum* (4) had the most species. Ninety-seven species were annual or biennials, and 178 perennial.

Twenty-one exotic species from 14 families were collected, representing 7.7% of the flora. The greatest number of exotic species were in the families Poaceae (11) and Asteraceae (4). This is higher than the 10% exotic flora reported from the Thurman Ranch (Freeman et al. 2002), but is comparable to recent floristic inventories from other areas in Oklahoma. For example, a flora of the Chickasaw National Recreation Area reported 12% exotic species (Hoagland & Johnson

TABLE 1. Summary of floristic collections at the Washita Battlefield National Historic Site, Roger Mills County, Oklahoma. Table format follows Palmer et al. (1995).

Taxonomic Group	Species	Native spp.	Introduced spp.
Equisetophyta	0	0	0
Pteridophyta	0	0	0
Coniferophyta	1	1	0
Magnoliophyta			
Magnoliopsida	205	184	21
Liliopsida	66	56	10
Total	271	240	31

2001), 9% at Oologah Wildlife Management Area (Hoagland & Wallick 2003), 15% at Keystone Wildlife Management Area, and 11% for an inventory of Tillman County (Hoagland et al., in press). However, the percentage was lower, 6.6%, at Red Slough and Grassy Slough in southeastern Oklahoma (Hoagland & Johnson, in press).

Five species tracked by the Oklahoma Natural Heritage Inventory were found: *Argythamnia humilis* (G5S2S3), *Gaura brachycarpa* (G4G5 S1S2), *Solanum triflorum* (G5S1S2), *Sporobolus giganteus* (G5S1S3), and *Zinnia grandiflora* (G5S?). Species are ranked according to level of imperilment at the state (S) and global (G) levels on a scale of 1–5; 1 representing a species that is imperiled and 5 one that is secure (Groves et al, 1995).

As a result of this study, 651 species are now known to occur in Roger Mills County. Of the 361 species reported in this study, 156 had been previously collected in the county (Hoagland 2004). This study documented 205 species not previously reported from Roger Mills County. When compared with the Dempsey Divide site (Freeman et al. 2002), there were 219 species found at both sites. However, 53 species were documented at WBNHS that were not reported at Dempsey Divide. Two hundred and fifty-one additional species were found on the Dempsey Divide that were not found at the WBNHS. The difference in total area of the two sites may account for this discrepancy; the Thurman Ranch is 3,755 hecatres in area and contains 19 vegetation types whereas WABA is only 136 hectares with four vegetation types. (Freeman et al. 2002).

The 8 collection sites occurred within four vegetation associations. A brief description of each follows:

Sapindus saponaria woodland association

This association was limited to large sand dunes located on the northside of the Washita River. Although *S. saponaria* was abundant, dominance was locally variable. *Celtis laevigata* var. *reticulata* was a common woody species in this vegetation association, as was *Ulmus pumila*, a species introduced to western Oklahoma for shelterbelt plantings. Other common woody species included *Forestiera* *pubescens, Gymnocladus dioicus, Prunus angustifolia, Ribes aureum,* and *Sideroxylon lanuginosum.* Associated herbaceous species included *Andropogon hallii, Argemone polyanthemos, Asclepias arenaria, Cyclanthera dissecta, Dimorphocarpa candicans, Froelichia gracilis,* and *Funastrum cynanchoides.*

Schizachyrium scoparium—Bouteloua hirsuta herbaceous association

Occurred on Permian red sandstone in the uplands overlain by the Woodward-Quinlan soil association. Associated species included *Aristida oligantha, Ambrosia psiolstachya, Bouteloua curtipendula, Eriogonum annuum, Penstemon albidus, Sphaeralcea coccinea, Thelesperma megapotamicum,* and *Yucca glauca.*

Disturbed areas and old-field vegetation

This includes much of the Washita River floodplain, which had been under cultivation for many years. It also includes roadsides and areas visited by WBNHS visitors and other areas exhibiting signs of physical disruption. Common plants in disturbed areas and old fields included *Ambrosia trifida, Bothriochloa ischaemum, Chenopodium simplex, Cynodon dactylon, Digitaria ciliaris, Melilotus officinalis,* and *Sorghum halepense.*

APPENDIX 1

Annotated species list for the Washita Battlefield National Historic Site. The first entry indicates life history (**A**=annual, **P**=perennial), species not native to North America (designated with an asterisk), habitat (**DAOF**=disturbed area/old-field; **MGP**=mixed grass prairie; **RA**=riparian area; **SW**=sandy woodland), and collection number. Voucher specimens were deposited at the Robert Bebb Herbarium at the University of Oklahoma (OKL).

PINOPHYTA

Cupressaceae

Juniperus virginiana L.–P; SW; WAS193

MAGNOLIOPHYTA
MAGNOLIOPSIDA

Amaranthaceae

Amaranthus albus L.–A; MGP; WAS322
Amaranthus palmeri S. Wats.–A; DAOF; WAS093
Froelichia gracilis (Hook.) Moq.–A; SW; WAS103

Anacardiaceae

Rhus aromatica L.–P; MGP; WAS230
Rhus glabra L.–P; MGP; WAS044
Toxicodendron radicans (L.) Kuntze–P; RA; WAS183

Apiaceae

Chaerophyllum tainturieri Hook.–A; MGP; WAS222
Cymopterus macrorhizus Buckl.–P; MGP; WAS171

Apocynaceae

Apocynum cannabinum L.–P; SW; WAS192

Asclepiadaceae

Asclepias arenaria Torr.–P; MGP, SW; WAS071
Asclepias asperula (Dcne.) Schlechter–P; MGP; WAS195
Asclepias stenophylla A. Gray–P; MGP; WAS050
Asclepias syriaca L.–P; MGP; WAS280
Funastrum cynanchoides (Dcne.) Schlechter–P; SW; WAS100

Asteraceae

Ambrosia psilostachya DC.–P; MGP; WAS148
Ambrosia trifida L.–A; MGP; WAS295
Amphiachyris dracunculoides (DC.) Nutt.–A; MGP; WAS283
Aphanostephus skirrhobasis (DC.) Trel.–A; MGP; WAS323
Artemisia dracunculus L.–P; MGP; WAS293
Artemisia filifolia Torr.–P; MGP; WAS116

Artemisia ludoviciana Nutt.–P; MGP; WAS289
Baccharis salicina Torr. & A. Gray–P; RA; WAS118
Brickellia eupatorioides (L.) Shinners–P; MGP; WAS294
Chaetopappa ericoides (Torr.) Nesom–P; MGP; WAS015
Cirsium undulatum (Nutt.) Spreng.–P; MGP; WAS248
Cirsium vulgare (Savi) Ten.–B; MGP; WAS247
Conyza canadensis (L.) Cronq.–A; DAOF; WAS141
Eclipta prostrata (L.) L.–A; RA; WAS133
Engelmannia peristenia (Raf.) Goodman & Lawson–P; MGP; WAS034
Erigeron bellidiastrum Nutt.–A; MGP, SW; WAS188
Eupatorium serotinum Michx.–P; RA; WAS129
Euthamia gymnospermoides Greene–P; DAOF; WAS314
Gaillardia pulchella Foug.–A; MGP; WAS228
Gaillardia suavis (A. Gray & Engelm.) Britt. & Rusby–P; MGP; WAS229
Grindelia papposa Nesom & Suh–A; MGP; WAS153
Helianthus annuus L.–A; DAOF; WAS080
Helianthus maximiliani Schrad.–P; DAOF; WAS309
Helianthus petiolaris Nutt.–A; DAOF; WAS084
Heterotheca subaxillaris (Lam.) Britt. & Rusby–A; MGP; WAS144
Heterotheca villosa (Pursh) Shinners–P; MGP; WAS028
Hymenopappus flavescens A. Gray–B; MGP; WAS258
Iva annua L.–P; DAOF, RA; WAS317
Lactuca serriola L.*–A; MGP; WAS022
Liatris pycnostachya Michx.–P; MGP; WAS282
Lygodesmia juncea (Pursh) D. Don ex Hook.–P; MGP; WAS285
Machaeranthera pinnatifida (Hook.) Shinners–P; MGP; WAS277
Pluchea odorata (L.) Cass. var. *odorata*–A; RA; WAS108
Ratibida columnifera (Nutt.) Woot. & Standl.–P; MGP; WAS276
Solidago canadensis L.–P; DAOF; WAS113
Solidago gigantea Ait.–P; DAOF; WAS139
Solidago petiolaris Ait.–P; MGP; WAS306
Symphyotrichum ericoides (L.) Nesom–P; DAOF; WAS311
Symphyotrichum oblongifolium (Nutt.) Nesom–P; MGP; WAS303
Symphyotrichum subulatum (Michx.) Nesom–A; RA; WAS132
Taraxacum officinale G.H. Weber ex Wiggers*–P; DAOF; WAS302
Tetraneuris scaposa (DC.) Greene–P; MGP; WAS226
Thelesperma megapotamicum (Spreng.) Kuntze–P; MGP; WAS051
Tragopogon dubius Scop.*–A; DAOF; WAS182
Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray–A; DAOF; WAS087
Vernonia baldwinii Torr.–P; DAOF; WAS105
Xanthium strumarium L.–A; RA; WAS135
Zinnia grandiflora Nutt.–P; MGP; WAS271

Boraginaceae

Heliotropium convolvulaceum (Nutt.) A. Gray–A; SW; WAS095
Lithospermum incisum Lehm.–P; MGP; WAS172

Brassicaceae

Camelina rumelica Velen.–A; MGP; WAS231
Capsella bursa-pastoris (L.) Medik.*–A; DAOF; WAS176
Descurainia pinnata (Walt.) Britt.–A; MGP; WAS177
Dimorphocarpa candicans (Raf.) Rollins–A; SW; WAS120
Draba reptans (Lam.) Fern.–A; MGP; WAS161
Lepidium oblongum Small–A; MGP; WAS175
Lesquerella gordonii (A. Gray) S. Wats.–A; MGP; WAS179

Cactaceae

Escobaria vivipara (Nutt.) Buxbaum–P; MGP; WAS315
Opuntia macrorhiza Engelm.–P; MGP; WAS159

Campanulaceae

Triodanis holzingeri McVaugh–A; MGP; WAS266

Caryophyllaceae

Arenaria serpyllifolia L.*–A; DAOF; WAS163
Paronychia jamesii Torr. & A. Gray–P; MGP; WAS055
Stellaria media (L.) Vill.*–A; DAOF; WAS174

Chenopodiaceae

Chenopodium album L.*–A; MGP; WAS287
Chenopodium simplex (Torr.) Raf.–A; MGP; WAS150
Cycloloma atriplicifolium (Spreng.) Coult.–A; MGP; WAS264
Kochia scoparia (L.) Schrad.*–A; MGP; WAS009

Convolvulaceae

Convolvulus arvensis L.*–P; MGP; WAS196
Evolvulus nuttallianus J. A. Schultes–P; MGP; WAS215
Ipomoea leptophylla Torr.–P; MGP; WAS260

Cucurbitaceae

Cucurbita foetidissima Kunth–P; MGP; WAS018
Cyclanthera dissecta (Torr. & A. Gray) Arn.–A; SW; WAS140

Euphorbiaceae

Acalypha ostryifolia Riddell–A; MGP; WAS031
Argythamnia humilis (Engelm. & A. Gray) Muell.-Arg.–P; MGP; WAS068
Chamaesyce fendleri (Torr. & A. Gray) Small–P; MGP; WAS060
Chamaesyce glyptosperma (Engelm.) Small–A; MGP, SW; WAS090
Chamaesyce maculata (L.) Small–A; DAOF; WAS122
Chamaesyce missurica (Raf.) Shinners–A; MGP, DAOF; WAS304
Chamaesyce stictospora (Engelm.) Small–A; DAOF; WAS069
Croton glandulosus L.–A; MGP; WAS037
Croton texensis (Klotzsch) Muell.-Arg.–A; MGP; WAS011
Euphorbia dentata Michx.–A; MGP; WAS012
Euphorbia hexagona Nutt. ex Spreng.–A; MGP; WAS112
Euphorbia longicruris Scheele–A; MGP; WAS160
Euphorbia marginata Pursh–A; DAOF; WAS142
Tragia ramosa Torr.–P; MGP; WAS058

Fabaceae

Amorpha fruticosa L.–P; RA; WAS086
Astragalus lotiflorus Hook.–P; MGP; WAS180
Astragalus plattensis Nutt.–P; MGP; WAS181
Baptisia australis (L.) R. Br. ex Ait. f.–P; MGP; WAS191
Caesalpinia jamesii (Torr. & A. Gray) Fisher–P; SW; WAS102
Cercis canadensis L.–P; DAOF; WAS065
Chamaecrista fasciculata (Michx.) Greene–A; MGP; WAS047
Dalea aurea Nutt. ex Pursh–P; MGP; WAS274
Dalea candida Michx. ex Willd.–P; MGP; WAS267
Dalea enneandra Nutt.–P; MGP; WAS057
Dalea purpurea Vent.–P; MGP; WAS250
Desmodium illinoense A. Gray–P; MGP; WAS032
Gleditsia triacanthos L.–P; SW; WAS300
Gymnocladus dioicus (L.) K. Koch–P; SW; WAS016
Indigofera miniata Ortega–P; SW; WAS091
Medicago minima (L.) L.*–A; DAOF; WAS224
Melilotus officinalis (L.) Lam.*–A; DAOF; WAS246
Mimosa borealis A. Gray–P; MGP; WAS199
Mimosa nuttallii (DC.) B.L. Turner–P; MGP; WAS201
Pediomelum linearifolium (Torr. & A. Gray) J. Grimes–P; MGP; WAS048
Sophora nuttalliana B.L. Turner–P; MGP; WAS243
Strophostyles leiosperma (Torr. & A. Gray) Piper–A; MGP; WAS042

Fumariaceae

Corydalis micrantha (Engelm. ex A. Gray) A. Gray–A; MGP; WAS178

Geraniaceae

Erodium cicutarium (L.) L'Her. ex Ait.*–A; DAOF; WAS169
Geranium pusillum L.*–A; MGP; WAS218

Grossulariaceae

Ribes aureum Pursh–P; SW; WAS167

Juglandaceae

Juglans microcarpa Berl.–P; SW; WAS101

Krameriaceae

Krameria lanceolata Torr.–P; MGP; WAS039

Lamiaceae

Lamium amplexicaule L.*–A; DAOF; WAS168
Lycopus americanus Muhl. ex W. Bart.–P; RA; WAS128
Monarda clinopodioides A. Gray–A; MGP; WAS251
Monarda punctata L.–A; MGP; WAS254
Salvia azurea Michx. ex Lam.–P; MGP; WAS301
Scutellaria resinosa Torr.–P; MGP; WAS040
Scutellaria wrightii A. Gray–P; MGP; WAS214
Teurcium canadense L.–P; RA; WAS075
Teurcium laciniatum Torr.–P; MGP; WAS221

Linaceae

Linum pratense (J.B.S. Norton) Small–A; MGP; WAS212
Linum rigidum Pursh–A; MGP; WAS204

Loasaceae

Mentzelia nuda (Pursh) Torr. & A. Gray–P; MGP; WAS155

Lythraceae

Ammania coccinea Rottb.–A; RA; WAS143

Malvaceae

Callirhoe involucrata (Torr. & A. Gray) A. Gray–P; MGP; WAS279

Hibiscus trionum L.*–P; MGP; WAS269

Sphaeralcea coccinea (Nutt.) Rydb.–P; MGP; WAS219

Menispermaceae

Cocculus carolinus (L.) DC.–P; SW; WAS078

Molluginaceae

Mollugo verticillata L.–A; DAOF, SW; WAS024

Moraceae

Morus alba L.*–P; DAOF; WAS061

Nyctaginaceae

Mirabilis albida (Walt.) Heimerl–P; MGP; WAS298

Mirabilis linearis (Pursh) Heimerl–P; MGP; WAS030

Mirabilis nyctaginea (Michx.) MacM.–P; MGP, SW; WAS189

Oleaceae

Forestiera pubescens Nutt.–P; SW; WAS036

Onagraceae

Calylophus berlandieri Spach–P; MGP; WAS207

Calylophus hartwegii (Benth.) Raven–P; MGP; WAS237

Calylophus serrulatus (Nutt.) Raven–P; MGP; WAS049

Gaura brachycarpa Small–A; MGP; WAS202

Gaura parviflora Dougl. ex Lehm.–A; MGP; WAS010

Oenothera jamesii Torr. & A. Gray–P; RA; WAS125

Oenothera laciniata Hill–P; MGP; WAS206

Oenothera rhombipetala Nutt. ex Torr. & A. Gray–P; MGP; WAS265

Oxalidaceae

Oxalis stricta L.–P; SW; WAS110

Papaveraceae

Argemone polyanthemos (Fedde) G.B. Ownbey–A; SW; WAS098

Pedaliaceae

Proboscidea louisianica (P. Mill.) Thellung–A; MGP; WAS041

Plantaginaceae

Plantago patagonica Jacq.–A; MGP; WAS197

P. rhodosperma Dcne.–A; MGP; WAS225

Polygonaceae

Eriogonum annuum Nutt.–A; DAOF, MGP; WAS088

Eriogonum longifolium Nutt.–P; MGP; WAS054

Polygonum aviculare L.*–A; MGP; WAS014

Polygonum lapathifolium L.–A; RA; WAS136

Rumex crispus L.*–P; MGP; WAS185

Portulacaceae

Portulaca oleracea L.–A; OF; WAS066

Primulaceae

Androsace occidentalis Pursh–A; MGP; WAS162

Ranunculaceae

Delphinium carolinianum Walt. ssp. *virescens* (Nutt.) Brooks–P; MGP; WAS240

Rosaceae

Prunus angustifolia Mars.–P; SW; WAS291

Rubiaceae

Cephalanthus occidentalis L.–P; RA; WAS106

Galium pilosum Ait.–P; DAOF; WAS089

Hedyotis nigricans (Lam.) Fosberg–P; MGP; WAS273

Salicaceae

Populus deltoides Bartr. ex Marsh.–P; RA; WAS117

Salix exigua Nutt.–P; RA; WAS111

Salix nigra Marsh.–P; RA; WAS085

Sapindaceae

Sapindus saponaria L.–P; SW; WAS070

Sapotaceae

Sideroxylon lanuginosum Michx.–P; SW; WAS046

Scrophulariaceae

Castilleja purpurea (Nutt.) G. Don var. *citrina* (Pennell) Shinners–P; MGP; WAS232

Penstemon albidus Nutt.–P; MGP; WAS213

Veronica arvensis L.*–A; DAOF; WAS165

Solanaceae

Chamaesaracha conioides (Moric. ex Dunal) Britt.–P; MGP; WAS238

Physalis cinerascens (Dunal) A.S. Hitchc.–P; MGP; WAS205

Physalis longifolia Nutt.–P; MGP; WAS019

Quincula lobata (Torr.) Raf.–P; DAOF; WAS203

Solanum dimidiatum Raf.–P; DAOF; WAS194

Solanum elaeagnifolium Cav.–P; DAOF, MGP; WAS234

Solanum rostratum Dunal–A; DAOF, MGP; WAS025

Solanum triflorum Nutt.–A; MGP; WAS029

Tamaricaceae

Tamarix ramosissima Ledeb.*–P; RA; WAS115

Ulmaceae

Celtis laevigata Willd. var. *reticulata* (Torr.) L. Benson–P; SW; WAS045

Ulmus pumila L.*–P; SW; WAS268

Ulmus rubra Muhl.–P; SW; WAS154

Urticaceae

Parietaria pensylvanica Muhl. ex Willd.–A; DAOF, SW; WAS190

Verbenaceae

Glandularia pumila (Rydb.) Umber–A; DAOF, MGP; WAS198

Phyla lanceolata (Michx.) Greene–P; RA; WAS096

Violaceae

Hybanthus verticillatus (Ortega) Baill.–P; MGP; WAS242

Vitaceae

Ampelopsis cordata Michx.–P; RA; WAS121

Cissus incisa auct. non Des Moulins–P; SW; WAS072

Vitis acerifolia Raf.–P; RA; WAS109

Zygophyllaceae

Kallstroemia parviflora J.B.S. Norton–A; DAOF; WAS004

Tribulus terrestris L.*–A; DAOF; WAS308

LILIOPSIDA

Agavaceae

Yucca glauca Nutt.–P; MGP; WAS200

Commelinaceae

Commelina erecta L.–P; MGP; WAS052

Tradescantia occidentalis (Britt.) Symth–P; MGP; WAS217

Cyperaceae

Carex gravida Bailey–P; MGP; WAS241

Cyperus odoratus L.–A; MGP; WAS145

Cyperus schweinitzii Torr.–P; MGP; WAS023

Cyperus setigerus Torr. & Hook.–P; RA; WAS126

Fimbristylis vahlii (Lam.) Link–A; RA; WAS137

Schoenoplectus pungens (Vahl) Pall–P; RA; WAS077

Iridaceae

Sisyrinchium angustifolium P. Mill.–P; MGP; WAS236

Juncaceae

Juncus torreyi Coville–P; RA; WAS083

Liliaceae

Allium canadense L.–P; MGP; WAS227

Allium drummondii Regel–P; MGP; WAS173

Poaceae

Andropogon hallii Hack.–P; MGP, SW; WAS073

Aristida oligantha Michx.–A; MGP; WAS325

Aristida purpurea Nutt.–P; MGP; WAS053

Bothriochloa ischaemum (L.) Keng*–P; MGP; WAS299

Bothriochloa laguroides (DC.) Herter–P; MGP; WAS257

Bouteloua curtipendula (Michx.) Torr.–P; MGP; WAS020

Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths–P; DAOF, MGP; WAS272

Bouteloua hirsuta Lag.–P; MGP; WAS005

Bromus japonicus Thunb. ex Murr.*–A; DAOF, SW; WAS239

Buchloe dactyloides (Nutt.) Engelm.–P; DAOF, MGP; WAS223

Cenchrus spinifex Cav.–P; SW; WAS097

Chloris verticillata Nutt.–P; DAOF, MGP; WAS263

Cynodon dactylon (L.) Pers.*–P; DAOF; WAS255

Dichanthelium malacophyllum (Nash) Gould–P; MGP; WAS261

Dichanthelium oligosanthes (J.A. Schultes) Gould–P; MGP; WAS253

Digitaria ciliaris (Retz.) Koel.–P; DAOF; WAS001

Digitaria cognata (J.A. Schultes) Pilger–P; MGP; WAS256

Distichlis spicata (L.) Greene–P; DAOF; WAS062

Echinochloa crus-galli (L.) Beauv.*–A; RA; WAS127

Elymus canadensis L.–P; MGP; WAS297

Elymus virginicus L.–P; RA; WAS076

Eragrostis barrelieri Daveau*–A; DAOF; WAS307

Eragrostis cilianensis (All.) Vign. ex Janchen*–A; DAOF; WAS007

Eragrostis curvula (Schrad.) Nees*–P; MGP; WAS281

Eragrostis spectabilis (Pursh) Steud.–P; SW; WAS099

Erioneuron pilosum (Buckl.) Nash–P; MGP; WAS318

Hordeum pusillum Nutt.–A; DAOF; WAS208

Leptochloa fusca (L.) Kunth ssp. *fasicularis* (Lam.) N. Snow–A; RA; WAS134

Lolium perenne L.*–P; MGP; WAS252

Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi–P; SW; WAS158

Muhlenbergia racemosa (Michx.) B.S.P.–P; MGP; WAS152

Muhlenbergia sobolifera (Muhl. ex Willd.) Trin.–P; MGP; WAS151

Panicum capillare L.–A; MGP; WAS026

Panicum obtusum Kunth–P; MGP, RA; WAS124

Panicum virgatum L.–P; MGP; WAS319

Pascopyrum smithii (Rydb.) A. Love–P; MGP; WAS064

Paspalum setaceum Michx.–P; DAOF; WAS081

Poa arachnifera Torr.–P; RA; WAS244

Saccharum giganteum (Walt.) Pers.–P; RA; WAS147

Schedonnardus paniculatus (Nutt.) Trel.–P; DAOF; WAS063

Schizachyrium scoparium (Michx.) Nash–P; MGP; WAS156

Setaria parviflora (Poir.) Kerguelen–P; DAOF; WAS114

Setaria viridis (L.) Beauv.*–A; MGP; WAS021

Sorghastrum nutans (L.) Nash–P; MGP; WAS130

Sorghum halepense (L.) Pers.*–P; DAOF; WAS270

Spartina pectinata Bosc ex Link–P; RA; WAS074

Sporobolus cryptandrus (Torr.) A. Gray–P; MGP, SW; WAS079

Sporobolus giganteus Nash–P; MGP; WAS321

Sporobolus vaginiflorus (Torr. ex A. Gray) Wood–A; SW; WAS138

Tridens flavus (L.) A.S. Hitchc.–P; DAOF; WAS119

Triplasis purpurea (Walt.) Chapman–A; MGP; WAS288

Triticum aestivum L.*–A; DAOF; WAS187

Vulpia octoflora (Walt.) Rydb.–A; MGP; WAS211

ACKNOWLEDGMENTS

This project was funded by a grant from the National Park Service. We thank Adam K. Ryburn and anonymous review for their helpful comments on an earlier draft.

REFERENCES

BRANSON C.C. and K.S. JOHNSON. 1979. Generalized geologic map of Oklahoma. In: K.S. Johnson, C.C. Branson, N.M. Curtis, W.E. Ham, W.E. Harrison, M.V. Marcher, and J.F. Roberts, eds. Geology and earth resources of Oklahoma. Oklahoma Geological Survey, Norman. P.4.

BURGESS, D.L., J.D. NICHOLS, and O.G. HENSON. 1959. Soil survey of Love County, Oklahoma. United States Department of Agriculture, Washington D.C.

CORRELL, D. S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

CURTIS N.M. and W.E. HAM. 1979. Geomorphic provinces of Oklahoma. In: K.S. Johnson, C.C. Branson, N.M. Curtis, W.E. Ham, W.E. Harrison, M.V. Marcher, and J.F. Roberts, eds. Geology and earth resources of Oklahoma. Oklahoma Geological Survey, Norman. P. 45.

Duck L.G. and J.B. FLETCHER. 1943. A game type map of Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City.

Freeman, C.C., C.A. MORSE, and J.P. THURMOND. 2003. The vascular flora of the Ogallala ecotone on the Dempsey Divide, Roger Mills County, Oklahoma. Sida 20:1217–1245.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence.

GROVES C.R., M.L. KLEIN, and T.F. BREDEN. 1995. Natural heritage programs: public-private partnerships for biodiversity conservation. Wildlife Soc. Bull. 23:784–790.

GOULD, F.W. 1975. The grasses of Texas. Texas A&M University Press, College Station.

Hoagland BW. 2000. The vegetation of Oklahoma: a classification of landscape mapping and conservation planning. Southwest Nat. 45:385–420.

Hoagland, BW. 2004. Atlas of the flora of Oklahoma [online]. Available: www.biosurvey.ou.edu. (Accessed on 14 January 2004).

Hoagland B.W. and A. Buthod. 2003. Vascular flora of the Keystone Wildlife Management Area, Creek, Pawnee, and Osage counties, Oklahoma. Oklahoma Native Pl. Record 3: 23–37.

Hoagland B.W. and F.L. Johnson. In press. The vascular flora of Red Slough and Grassy Slough Wildlife Management Areas, Gulf Coastal Plain, McCurtain County, Oklahoma. Castanea 69.

Hoagland B.W. and F.L. Johnson. 2001. Vascular flora of the Chickasaw National Recreation Area, Murray County, Oklahoma. Castanea 66:383–400.

Hoagland B.W. and K. Wallick. 2003. Vascular flora of Oologah Wildlife Management Area, Nowata County, Oklahoma. Proceedings of the Oklahoma Academy of Science 83: 47–62.

Hoagland B.W., P. Crawford-Callahan, P. Crawford, and F.L. Johnson. 2004. Vascular flora of Hackberry Flat, Frederick Lake, and Suttle Creek, Tillman County, Oklahoma. Sida 21: 429–445.

Hunt C.B. 1974. Natural Regions of the United States and Canada. W.H. Freeman, San Francisco.

Oklahoma Climatological Survey. 2004. Oklahoma Climatological Data [online]. Available: www.ocs.ou.edu/. (Accessed on 1 March 2004).

Oklahoma Natural Heritage Inventory. 2004. ONHI working list of rare Oklahoma plants [online]. Available: www.biosurvey.ou.edu/publicat.html. (Accessed on 1 March 2004).

Palmer M.W., G.L. Wade, and P. Neal. 1995. Standards for the writing of floras. Bioscience 45:339–345.

Taylor R.J. and C.S. Taylor. 1991. An annotated list of the ferns, fern allies, gymnosperms, and flowering plants of Oklahoma. Southeastern Oklahoma State University, Durant.

Trewartha G.T. 1968. An introduction to Climate. McGraw-Hill, New York.

USDA-NRCS 2004. The PLANTS database [online]. Available: plants.usda.gov/plants. National Plant Data Center, Baton Rouge, LA. (Accessed on 14 January 2004).

Waterfall, U.T. 1969. Keys to the flora of Oklahoma. 4th edition. Published by the author, New York.

ALTERNANTHERA PARONICHYOIDES (AMARANTHACEAE) AND *RUMEX MARITIMUS* (POLYGONACEAE) NEW TO OKLAHOMA

Bruce W. Hoagland

Oklahoma Biological Survey
and Department of Geography
University of Oklahoma
Norman, Oklahoma 73019, U.S.A.
bhoagland@ou.edu

Amy Buthod

Oklahoma Biological Survey
University of Oklahoma
Norman, Oklahoma 73019, U.S.A.

ABSTRACT

This paper reports the occurrence of two species previously unknown to the flora of Oklahoma. *Alternanthera paronichyoides* St. Hil., which occurs in Texas, was discovered in Pushmataha County in southeastern Oklahoma. *Rumex maritimus* L., a species found in all states adjoining Oklahoma, was collected in Washita County in western Oklahoma.

RESUMEN

Este artículo cita la ocurrencia de dos especies previamente desconocidas de la flora de Oklahoma. *Alternanthera paronichyoides* St. Hil., que vive en Texas, fue descubierta en el condado de Pushmataha en el Sureste de Oklahoma. *Rumex maritimus* L., una especie que se encuentra en todos los estados adyacentes de Oklahoma, se colectó en el condado de Washita en el Oeste de Oklahoma.

Alternanthera paronichyoides St. Hil.(Amaranthaceae) is a perennial plant species native to the old world tropics. It has been reported from Texas and several Gulf Coastal Plains and Atlantic Seaboard states (USDA-NRCS 2004). The population reported below was robust and growing in a ditch which drains into the Kiamichi River in southeastern Oklahoma. Associated species included *Arundinaria gigantea* (Walter) Muhl., *Eleocharis obtusa* (Willd.) Schult, and *Symphyotrichum subulatum* (Michx.) Nesom.

Voucher specimen: **OKLAHOMA. Pushmataha Co.:** 4.0 mi W of Rattan on Hwy. 3 at Rattan Landing on the Kiamichi River, T4S, R17E, sec 14, 5 May 2001, *Hoagland and Buthod hugo509* (OKL).

Rumex maritimus L. (Polygonaceae) is a native annual species that has been reported from all states adjoining Oklahoma (USDA-NRCS 2004). It was growing in the drawdown zone of a municipal reservoir. Associated species included *Ammannia coccinea* Rottb., *Cyperus setigerus* Torr. & Hook., *C. squarrosus* L., *Echinochloa crus-galli* (L.) Beauv., *Leptochloa fusca* (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow, *Symphyotrichum subulatum* (Michx.) Nesom.

Voucher specimen: **OKLAHOMA. Washita Co.:** Clinton Lake, ca. 4.4 mi NE of Canute, shoreline habitat, T11N, R19W sec. 16, 23 Aug 2002, *Hoagland and Buthod AB-2867* (OKL).

SIDA 21(2): 1199–1200. 2004

ACKNOWLEDGMENTS

We appreciate the comments of Adam K. Ryburn and an anonymous reviewer.

REFERENCE

USDA-NRCS 2004. The PLANTS database [online]. Available: plants.usda.gov/plants. National Plant Data Center, Baton Rouge, LA. (Accessed on 1 March 2004).

SCHOENOPLECTUS HALLII (CYPERACEAE), A GLOBALLY THREATENED SPECIES NEW FOR TEXAS

Robert J. O'Kennon

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102, U.S.A.
okennon@brit.org

Caren McLemore

Botanical Research Institute of Texas and
University of North Texas
Denton, Texas 76203, U.S.A.
clm0093@unt.edu

ABSTRACT

Schoenoplectus hallii (A. Gray) S. Galen Smith, Hall's bulrush, has been discovered in the Lyndon B. Johnson National Grasslands, Wise County, Texas. Previous reports of this species in Texas were based on misidentified specimens, and the current report apparently represents the first record for the state.

RESUMEN

Schoenoplectus hallii (A. Gray) S. Galen Smith, ha sido descubierto en los Lyndon B. Johnson National Grasslands, Wise County, Texas. Las citas Previas de esta especie en Texas estaban basadas en especímenes mal identificados, y la presente cita es aparentemente la primera para el estado.

Schoenoplectus hallii (A. Gray) S. Galen Smith, Hall's bulrush, has been discovered during an extensive floristic survey of the Lyndon B. Johnson National Grasslands (LBJGL), 15.6 km north of Decatur, Wise County, Texas. The LBJGL are managed by the U.S. National Forest Service and comprise numbered "units" scattered throughout much of north-central Wise County. *Schoenoplectus hallii* grows in Unit 66 primarily along the moist sandy-clay margins of three small ponds that merge during periods of high water. The populations are approximately 100 meters apart and comprise about two hundred individuals each.

Specimens of *Schoenoplectus hallii* were collected in May 2003 through April 2004 and their identity was confirmed by Galen Smith of the University of Wisconsin. Earlier reports of the species in Texas (Correll & Johnston 1970; Hatch et al. 1990) and various herbarium vouchers (later correctly annotated) were based on misidentifications of *S. saximontanus* (Fern.) Raynal and *S. erectus* (Poir.) Palla ex Raynal (Schuyler 1969, Smith 1995). Because *S. hallii* had not been confirmed for Texas, it was not included in the recently published Illustrated Flora of North Central Texas (Diggs et al. 1999). Smith (2002) reported the occurrence of the species in Georgia, Illinois, Indiana, Kansas, Kentucky, Massachusetts, Michigan, Missouri, Oklahoma, and Wisconsin.

Schoenoplectus hallii (A. Gray) S. Galen Smith, Novon 5:101. 1995. *Scirpus hallii* A. Gray; *Scirpus supinus* L. var. *hallii* (A. Gray) A. Gray.

Voucher specimens. **TEXAS. Wise Co.:** Along margin of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 12", W097° 32' 28", 17 May 2003, *O'Kennon and McLemore 18344* (BRIT, WIS); Along margin of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 12", W097° 32' 28", 23 August 2003, *O'Kennon and McLemore, 18853*(BRIT); Along margin of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 29 August 2003, *O'Kennon and McLemore, 18892* (BRIT, WIS); Along margin of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 12", W097° 32' 27", 3 Oct 2003, *O'Kennon and McLemore, 19070 and 19071* (BRIT) Along margin of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 12", W097° 32' 28", 1 Nov 2003, *O'Kennon and McLemore, 19141 and 19142* (BRIT); Submerged plants at bottom of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 19 Dec 2003, *O'Kennon and McLemore 19180* (BRIT); Submerged plants at bottom of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 23 Jan 2003, *O'Kennon and McLemore 19191* (BRIT); Submerged plants at bottom of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 28 Feb 2004, *O'Kennon and McLemore 19197* (BRIT); Submerged plants at bottom of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 17 Mar 2004, *O'Kennon and McLemore 19223* (BRIT); Emergent plants at bottom of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 9 Apr 2004, *O'Kennon and McLemore 19256* (BRIT); Muddy pond margin (previously submerged) in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 21 Apr 2004, *O'Kennon and McLemore 19279* (BRIT); Muddy pond margin (previously submerged since Sept. 2003) in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 21 Apr 2004, *O'Kennon and McLemore 19290* (BRIT); Seedling along margin of pond in Unit 66 of the Lyndon B. Johnson National Grasslands, N33° 22' 15", W097° 32' 26", 21 Apr 2004, *O'Kennon and McLemore 19291* (BRIT). Duplicates to be distributed.

Identification of the Texas plants.—The following key to species of *Schoenoplectus* sect. *Supini* in Texas is modified from Smith (2002). *Schoenoplectus hallii* found elsewhere are usually annual, but in Texas many perennial plants have been observed.

1. Achenes in spikelets nearly equilaterally sharply trigonous; styles all 3-fid; from panhandle to central and far south Texas ____ **Schoenoplectus saximontanus**
1. Achenes in spikelets biconcave to plano-convex or obscurely compressed-trigonous; styles 2-fid or a few 3-fid.
   2. Achenes adaxially longitudinally convex or horizontally slightly convex with convex center; spikelet scale flanks often distally orange- or red-brown; in Texas known only from south coastal counties inland to Atascosa Co. ____ **Schoenoplectus erectus**
   2. Achenes adaxially concave or sometimes nearly plane; spikelet scale flanks pale orange to nearly colorless; known from one site in north central Texas ____ **Schoenoplectus hallii**

Habitat of the Texas plants.—*Schoenoplectus hallii* has a narrow habitat tolerance (Beatty et al. 2004). Although it is found in various soil types in other states, in Texas it is found along widely fluctuating margins of small sandy clay ponds where conditions apparently are more suitable for *S. hallii* than for many of its associates (Schuyler 1969). Many plant species occur with *S. hallii* in Texas (Table 1). These associates appear and disappear throughout the year as water levels fluctuate, but *S. hallii* can be found along pond margins from April to December. It is most closely associated nearly year-round with the rare *Pilularia americana* (Marsiliaceae). During periods of normal water levels *P. americana*

TABLE 1. Species associated with *Schoenoplectus hallii* in Texas, ranked by abundance.

Pilularia americana A. Braun
Eleocharis obtusa (Willd.) J.A. Schultes
Rotala ramosior (L.) Koehne
Cyperus acuminatus Torr. & Hook. ex Torr.
Fimbristylis vahlii (Lam.) Link
Ludwigia peploides (Kunth) Raven
Ammannia coccinea Rottb.
Eleocharis palustris (L.) Roem. & Schult.
Fuirena simplex Vahl
Eleocharis quadrangulata (Michx.) Roem.
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperrider
Eleocharis coloradoensis (Britt.) Gilly
Callitriche heterophylla Pursh
Ammannia robusta Heer & Regel
Eleocharis engelmannii Steud
Najas guadalupensis (Spreng.) Magnus
Veronica peregrina L. var. *xalapensis* (Kunth) Pennell
Ludwigia glandulosa Walter
Heteranthera limosa (Sw.) Willd.
Eleocharis atropurpurea (Retz.) J.& K. Presl
Potamogeton diversifolius Raf.
Cyperus retrorsus Chapm. var. *cylindricus* (Ell.) Fern. & Grisc.
Cyperus squarrosus L.
Panicum rigidulum Nees
Juncus texanus (Engelm.) Coville
Echinodorus berteroi (Spreng.) Fassett
Juncus diffusissimus Buckl.
Spirodela polyrhiza (L.) Scheid.
Limnosciadium pinnatum (DC.) Mathias & Constance
Anagallis minima (L.) Krause
Marsilea vestita Hook. & Grev

is a submergent and can be conspicuous just below the surface around the entire margin of the pond. However, during periods of extended drawdown it becomes a marginal plant. The ponds occur in the West Cross Timbers of north central Texas at an elevation of 254 meters.

During the first year of our LBJGL survey, twelve other species undocumented for Texas, in addition to *S. hallii*, were discovered (O'Kennon et al. 2003; O'Kennon & McLemore in prep.). We believe that this probably reflects previous undercollecting rather than particularly unique habitats in this area.

Overall distribution.—*Schoenoplectus hallii* is a globally threatened species (Nature Conservancy ranking of G-2) known recently from only 8 states and fewer than 100 sites in the U.S.A. Texas Parks and Wildlife Department has assigned a ranking of S-1 (critically imperiled) for the species (Jackie Poole, pers. comm.), based on the discovery in Wise County. The closest populations of *S. hallii* to the Wise Co. populations are in Comanche Co., Oklahoma, about 190 kilometers northwest.

Prior to 1973, *Schoenoplectus hallii* was reported in 9 states, 15 counties, and 29 sites. During 1973–1997, it was reported in 8 states, 17 counties, and 46 sites. During 1993–1997, it was reported in only 6 states, 11 counties, and 37 sites (McKenzie 1998). Since not all sites are being monitored each year, it is difficult to ascertain the actual number of existing populations.

Plants in Massachusetts have not been seen since 1931 and are considered extirpated. *Schoenoplectus hallii* has not been collected in Georgia since 1966. It has not been confirmed in Iowa since 1890. There is a record from Iowa from 1960, but that specimen has not been seen nor confirmed (McKenzie 1998). Populations in these states are considered "possibly extirpated."

ACKNOWLEDGMENTS

We thank Guy Nesom of BRIT for assistance in identifying the original specimens and reviewing the manuscript. We gratefully acknowledge Galen Smith of the University of Wisconsin for assistance in confirming the identity of this plant. We thank James Crooks, Jimmy Dickerson, and Alfred Sanchez of the Lyndon B. Johnson National Grasslands and the U.S. Forest Service for assistance and cooperation in our work on this threatened species and for preserving the site.

REFERENCES

Beatty, L.B., W.F. Jennings, and R.C. Rawlinson. 2004. *Schoenoplectus hallii* (Hall's bulrush): a technical conservation assesment. USDA, Forest Service, Rocky Mountain Region, Species Conservation Project. Denver, Colorado.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, Texas.

Diggs, G.M. Jr., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners & Mahler's illustrated flora of North Central Texas. Sida, Bot. Misc. 16.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Misc. Publ. No. 1655.

McKenzie, P.M. 1998. Hall's bulrush (*Schoenoplectus hallii*) status assessment. U.S. Fish and Wildlife Service. Columbia, Missouri.

O'Kennon, RJ., C. McLemore, and A. Neill. 2003. *Fagopyrum esculentum*, (Polygonaceae), new for Texas. Sida 20:1717–1720.

Schuyler, A.E. 1969. Three new species of *Scirpus* (Cyperaceae) in the southern United States. Notulae Naturae 423:1–12.

Smith, S.G. 1995. New combinations in North American *Schoenoplectus, Bulboshoenus, Isolepis* and *Trichophorum* (Cyperaceae). Novon 5:97–102.

Smith, S.G. 2002. *Schoenoplectus* sect. Supini, In: Vol. 23 (Cyperaceae) Flora of North America North of Mexico, Flora of North America Association, Oxford Univ. Press, N.Y. Pp. 58–60.

NEW RECORDS IN *PSEUDOGNAPHALIUM* (ASTERACEAE: GNAPHALIEAE) FROM NEBRASKA AND CALIFORNIA

Steven B. Rolfsmeier
High Plains Herbarium
Chadron State College
Chadron, Nebraska 69337, U.S.A.

Guy L. Nesom
Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Pseudognaphalium jaliscense is first reported from Nebraska, documented here from twelve counties; an earlier report of this species from California was based on collections of a form of *P. stramineum*. *Pseudognaphalium roseum* is first documented as occurring in the U.S.A., where it has been collected in southern California.

RESUMEN

Pseudognaphalium jaliscense se cita por primera vez de Nebraska, se documenta aquí de doce condados; una cita previa de esta especies de California estaba basada en colecciones de una forma de *P. stramineum*. *Pseudognaphalium roseum* se documenta por primera vez de U.S.A., donde ha sido colectado en el Sur de California.

In connection with taxonomic studies of Gnaphalieae, preparation of treatments for the Flora of North America volumes of Asteraceae, and floristic studies in Nebraska, we report new distribution records for two species of *Pseudognaphalium* Kirp.

Pseudognaphalium jaliscense in Nebraska

Pseudognaphalium jaliscense (Greenm.) Anderb. was recently reported for the U.S.A., based on collections from Arizona, New Mexico, Texas, and Colorado (Nesom 2001, including details of typification and description). The current report documents its occurrence in twelve counties of Nebraska. It was first collected in the state in 1968 by Steve Stephens (Custer Co.) but was not recollected until 1991 by Herb Karcher (Hayes Co.). It has since been recollected in both counties in addition to numerous other sites in the southwest and the Nebraska Sandhills in the north central part of the state. The recency of the collections and the common roadside habitat suggest recent introduction, but other collections are from apparently natural habitats, and the nativity of *P. jaliscense* in Nebraska is not clear.

Distribution of the species is shown in Figure 1 for northwestern Mexico and the U.S.A., based on the Nebraska citations below and those in Nesom (2001). Additional records for New Mexico also are cited below and suggest that the species may be even more common in that state, where habitats do not suggest that the species is a recent colonizer. If the distribution of *Pseudognaphalium*

SIDA 21(2):1205–1208. 2004

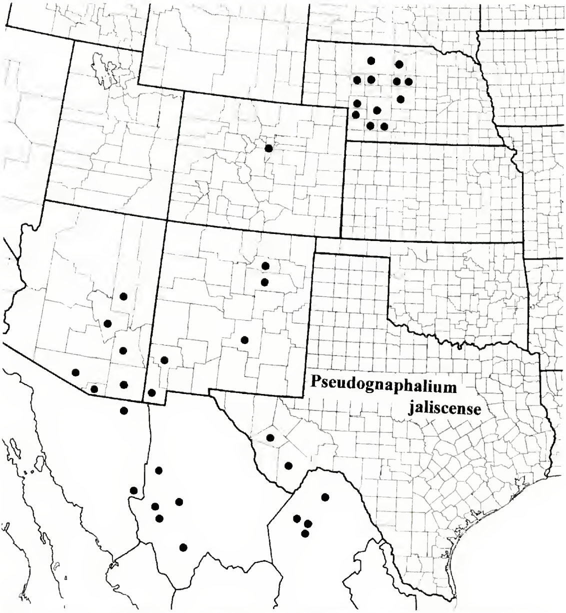


FIG. 1. Distribution of *Pseudognaphalium jaliscense* in the U.S.A. and northwestern Mexico. The species ranges further southward into Jalisco, Nayarit, and Aguascalientes, and localities in south-central Nuevo León are not shown. The records for Mexico are from collections studied by Nesom from various herbaria.

jaliscense is native in the U.S.A., it apparently should be expected in counties of northeastern Colorado and northwestern Kansas.

With further perspective, collections reported as *Pseudognaphalium jaliscense* from Mendocino, Marin, and Del Norte counties, California (Nesom 2001), prove to be the form of *Pseudognaphalium stramineum* (Kunth) A. Anderb. sometimes identified as *Gnaphalium stramineum* var. *confertifolium* Greene. These plants have larger heads with more numerous, more opaque phyllaries and often more florets than typical *P. stramineum*, which is abundant in California.

U.S.A. NEBRASKA. Blaine Co.: T24N R25W Sec 26, 1 Aug 1998, *Morris 899* (CSCN). **Brown Co.:** Long Pine, 12 mi S, 6 mi W, prairie in interdunal Sandhills valley, 2 Aug 2000, *Rolfsmeier 15780 & R. Steinauer* (NEB). **Cherry Co.:** 2.5 mi N of Hooker Co. line, sandy road ditches along Nebr. 97, 13 Sep 1995, *Rolfsmeier 12053* (BRIT, CSCN, KANU, NEB); S of Merritt Reservoir, sandy roadside, 13 Sep 1995, *Rolfsmeier 12056* (BRIT, CSCN, KANU, NEB); near turnoff to Marsh Ranch on Nebr. 97, ca. 3.5 mi N of Hooker Co. line, sandy roadside ditch and adjacent pasture, 22 Aug 1996, *Rolfsmeier 12911* (BRIT, CSCN, KANU, NEB). **Custer Co.:** Anselmo, 4 mi NW, margin of prairie slough, moist, sandy soil, several plants, 28 Aug 1968, *Stephens 28200* (KANU); Oconto, 0.25 mi N, 3.5 mi E, ravine bottom in mixed-grass prairie, 22 Jul 1999, *Rolfsmeier 14903 & Parker* (BRIT, NEB). **Frontier Co.:** T7N R30W Sec 18, heavily-grazed sand prairie near Hayes Co. line, 6 Sep 1992, *Rolfsmeier 11117* (BRIT, KANU, NEB, CSCN), S of Curtis, T7N R28W Sec 11, prairie pasture, 29 Sep 1992, *John s.n.* (CSCN). **Grant Co.:** 0.1 mi W of Hooker Co. line, scattered at base of railroad embankment, 22 Aug 1996, *Rolfsmeier 12913* (BRIT, CSCN, KANU). **Hayes Co.:** 13.5 mi S of junction of Nebr. Hwys 23 & 25, roadbank, 21 Jul 1991, *Karcher 820* (CSCN, KANU); Hayes Center Wildlife Management Area, upland prairie on east side of lake, 6 Sep 1992, *Rolfsmeier 11109* (BRIT, KANU, NEB, CSCN). **Hooker Co.:** 6.25 mi E of Grant Co. line, base of railroad embankment, 22 Aug 1996, *Rolfsmeier 12912* (BRIT, CSCN, KANU, NEB). **Keith Co.:** Paxton, 3.3 mi W, sandy road ditch between U.S. 30 and railroad, 25 Sep 1992, *Rolfsmeier 11282* (CSCN, KANU, NEB). **Lincoln Co.:** several miles north of Hayes Co. line, sandy prairie along Nebr. 25, 6 Sep 1992, *Rolfsmeier 11133* (CSCN, NEB); Dickens, 9 mi E, sandy roadbank along Nebr. 23, 11 Sep 1992, *Rolfsmeier 11199* (BRIT, CSCN, KANU, NEB); T12N R34W Sec 26, sandy bank of ditch, W side of hwy 25, 7 Aug 1997, *G. Steinauer* 253 (NEB); Wallace, 6 mi N, sandy slope along highway 23, 20 Sep 1998; *Davis 51* (CSCN). **Loup Co.:** Taylor, 7.5 mi ESE, sandy roadbank, 28 Jul 1999, *Rolfsmeier 14974 & Parker* (CSCN, NEB). **Perkins Co.:** Elsie, 0.25 mi E, sandy prairie in roadside ditch, 11 Sep 1992, *Rolfsmeier 11193* (BRIT, CSCN, KANU). NEW MEXICO. **Grant Co.:** Ft. Bayard, open woodland, 6300 ft, 18 Sep 1967, *Gierisch 3284* (UNM). **Hidalgo Co.:** Cloverdale, grassy hillside, 22 Aug 1955, *Castetter 9959* (UNM); Gray Ranch, Howe Camp, cienega, 20 Aug 1993, *Ivey s.n.* (UNM). **Lincoln Co.:** Sacramento (White) Mts., Gavilan Ridge at trail to Blue Lake, burned area that was originally mostly ponderosa pine, 7300 ft, 30 Sep 2001, *Worthington 30728* (UNM).

Pseudognaphalium roseum in California

Pseudognaphalium roseum (Kunth) A. Anderb. is widespread in Central America and Mexico, from Panama northward through Chiapas to Chihuahua, Veracruz, Nuevo Leon, Tamaulipas, and southeastern Coahuila. It occurs mostly above 1000 m elevation in a variety of habitats. The closest collections of *P. roseum* southward from California are from Sinaloa and southern Chihuahua, but the species is abundant only in eastern and southern Mexico. It is recognized by its persistently tomentose stems and leaves, the leaves subclasping and non-decurrent, weakly bicolored and sessile-glandular beneath the tomentum, often thick stems, large capitula with numerous, opaque-white or sometimes pink phyllaries, numerous florets, and smooth-surfaced cypselae. It has been confused with the smaller-headed *P. canescens* (DC.) A. Anderb., but plants of *P. roseum* with relatively few bisexual florets can be distinguished from *P. canescens* by their subclasping leaves commonly with closely wavy margins, broader and more numerous phyllaries, and smooth-surfaced cypselae. A key with diagnostic characters for these taxa is provided below. Collections of *P. roseum* cited from San Mateo Co. and Santa Barbara Co. may be atypical in their slightly smaller capitula.

U.S.A. CALIFORNIA. Orange Co.: Catalina Island, 16 Jun 1920, *Fisher s.n* (SMU). **San Diego Co.:** Border Field State Park, southwesternmost acre of continental U.S.A., 16 Mar 1989, *Turner 15925* (TEX); Tia Juana, 24 Apr 1913, *Eastwood 2918* (GH). **San Mateo Co.:** Pebble Beach, Pescadero, 29 June 1927, *Wolf 563* (TEX). **Santa Barbara Co.:** Purissima Canyon, 26 Mar 1925, *Munz 4737* (TEX). **Ventura Co.:** North Signal Street, Ojai, 8 Oct 1946, *Pollard 20331* (SMU).

a. Mid-cauline leaves mostly 3–7 cm long, (3–)6–15(–20) mm wide, subclasping, the margins often closely sinuate-wavy; pistillate florets 45–90(–110); bisexual florets (5–)6–12(–18); cypsela surfaces smooth (non papillate) _______ **Pseudognaphalium roseum**

a. Mid-cauline leaves mostly 1–4 cm long, 2–8(–15) mm wide, not clasping, the margins usually straight; pistillate florets (16–)24–44; bisexual florets (1–)2–5(–6); cypsela surfaces densely and minutely papillate _______________ **Pseudognaphalium canescens**

Pseudognaphalium roseum (Kunth) A. Anderb., Opera Bot. 104:148. 1991. *Gnaphalium roseum* Kunth in H.B.K., Nov. Gen. & Sp. 4 [folio]:63. 1818; 4 [quarto]:81. 1820. TYPE: MEXICO. GUANAJUATO: *Humboldt and Bonpland s.n.* (HOLOTYPE: P fiche!).

Taprooted annual to short-lived perennial herbs, the stems 5–20 dm tall, persistently woolly-tomentose. Leaves oblong-lanceolate to oblanceolate, the mid-cauline 3–7 cm long, (3–)6–15(–20) mm wide, subclasping to clasping but not basally ampliate, not decurrent, the margins often closely sinuate-wavy, persistently woolly-tomentose or sometimes tardily glabrescent above, with short-stipitate to sessile glands beneath the tomentum. Involucres 4–4.5 mm high; phyllaries ovate, in 5–6 graduate series, usually opaque-white but sometimes pink. Pistillate florets 45–90(–110). Bisexual florets (5–)6–12(–18), the corollas often pink on the lower half. Cypselae shallowly longitudinally ridged, smooth.

ACKNOWLEDGMENTS

We gratefully acknowledge loans from UNM, the staff at TEX for helps in visits there, staff at NEB and KANU for confirming collection data for specimens deposited there, and Caleb Morse for a review of the manuscript.

REFERENCE

NESOM, G.L. 2001. New records in *Pseudognaphalium* (Gnaphalieae: Asteraceae) for the United States. Sida 19:1185–1190.

THE REDISCOVERY OF THE SOUTH AMERICAN *HYBANTHUS PARVIFLORUS* (VIOLACEAE) IN NORTH AMERICA

B. Eugene Wofford

Dept. of Botany
The University of Tennessee
Knoxville, Tennessee 37996, U.S.A.

Juliana de Paula-Souza

Universidade de São Paulo-Herbário ESA
Av. Pádua Dias 11, C.P. 09
13418-900 Piracicaba-São Paulo–BRASIL
jupsouza@esalq.usp.br

Alan S. Weakley

University of North Carolina Herbarium (NCU)
North Carolina Botanical Garden
Campus Box #3280, University of North Carolina
Chapel Hill, North Carolina 27599-3280, U.S.A.
weakley@unc.edu

Thomas E. Govus

3711 Big Creek Road
Ellijay, Georgia 30536, U.S.A.

ABSTRACT

An unknown plant collected in 1998 at Fort Pulaski, Chatham County, Georgia has been identified as *Hybanthus parviflorus* (Violaceae), a South American native. The Georgia collection represents only the third report of this species in North America, and the first since the 1880s, when it was collected on ship's ballast at two port cities in New Jersey. It is possible that the introduction of the species to Georgia was also via ship's ballast, as Fort Pulaski would have been a port of call for ships going to and from Savannah, a major seaport in the 18th and 19th centuries; if the Georgia plant was introduced on ballast, it is apparently established. It is also possible that it is a more recent introduction; if so, however, the means of introduction of this species is obscure, as it is not typically an agricultural weed, nor of horticultural interest. The use of digital imagery and electronic mail facilitated the rapid and accurate identification of this alien species, which should now be considered an established, though rare, component of the North American flora.

RESUMEN

Una planta desconocida colectada en 1998 en Fort Pulaski, Chatham County, Georgia ha sido identificada como *Hybanthus parviflorus* (Violaceae), nativa de Sur América. La colección de Georgia es la tercera cita de esta especie en Norte América, y la primera desde los 1880s, cuando fue colectada en lastre de barcos en dos ciudades portuarias de New Jersey. Es posible que la introducción de la especie en Georgia haya sido también mediante lastre de barco, ya que Fort Pulaski podría haber sido un Puerto de llamada para barcos que van o regresan de Savannah, un gran puerto en los siglos XVIII y XIX; si la planta de Georgia fue introducida en el lastre, está aparentemente establecida. Es también posible que sea una introducción más reciente; en este caso, sin embargo, el sistema de introducción de esta especie no está claro, ya que típicamente no es una mala hierba agrícola, ni de interés hortícola. El uso de imágenes digitales y correo electrónico facilitó la identificación rápida y precisa de esta especie invasora, que podría ahora ser considerada como un componente establecido, aunque raro, de la flora de Norte América.

The University of Tennessee Herbarium (TENN) recently received a loan of selected *Gratiola* (Scrophulariaceae) from the University of Georgia Herbarium

(GA). Included within the loan were a few unidentified specimens of either unrequested *Gratiola* or the closely related *Lindernia*, and an undetermined specimen (Figs. 1, 2) collected by Govus (1998) from Ft. Pulaski National Monument, Chatham Co., Georgia, as part of a catalog of the vascular flora of that U.S. National Park Service unit (Govus 1998). At GA, this last specimen had been tentatively identified by an unknown individual as *Gratiola virginiana*, and then that identification had been crossed through, but the specimen was apparently left in a *Gratiola* folder and sent out with the *Gratiola* loan to TENN. Upon receipt of the loan at TENN, Wofford immediately eliminated this specimen as a member of Scrophulariaceae based on overall morphology. A few flowers were rehydrated and upon dissection its floral morphology unequivocally placed it in Violaceae, i.e., flowers zygomorphic, sepals 5, subequal, petals 5, unequal, the lower one slightly spurred at the base and wider than the others; stamens 5, the lower two provided with nectariferous appendages, the connective prolonged into a membranous appendage; ovary superior, unilocular, 3-valved, placentation parietal.

TENN houses only two genera of Violaceae (*Viola* and *Hybanthus*); this specimen obviously was not a *Viola* but the flowers were strikingly similar to the common eastern North American *Hybanthus concolor* (T.F. Forst.) Spreng. and the southwestern North American *H. verticillatus* (Ortega) Baill. Wofford developed the hypothesis that this might be an introduction of an extracontinental species of *Hybanthus*, a pantropical genus (extending into warm temperate areas, as in eastern North America) of about 85 species (Ballard, in press), though sometimes credited with as many as 150 species (Mabberley 1997). Additional specimens from Mexico and Cuba available at TENN were examined, but none remotely fit the overall morphology of this specimen.

Digital images of the unknown plant were then sent to Weakley at the University of North Carolina Herbarium (NCU). Two NCU specimens of *Hybanthus* (from Paraguay and Argentina) closely resembled the unknown from Georgia; unfortunately, both specimens were labeled only "*Hybanthus*" and lacked an identification to the species level.

Finally, an electronic image of the Georgia specimen was sent to Paula-Souza, who has research interests in Violaceae, especially *Hybanthus*. She immediately responded that "this plant is *Hybanthus parviflorus* (Mutis ex L.f.) Baill. This is a very common plant here in South America, and although it is considered a weed in some places, I have never seen a record of it from the United States."

Further investigation revealed that *H. parviflorus* had indeed been reported previously from North America, by Dowell (1906), as *Calceolaria glutinosa* (Vent.) Kuntze, based on several specimens collected "on ballast at Communipaw Ferry," New Jersey, in July and September 1880 (see specimens cited below). *H. parviflorus* is additionally represented by a specimen at the Academy of Natural Sciences in Philadelphia (PH), identified as *Ionidium glutinosum* Vent.

Fig. 1. Image of Govus collection of *Hybanthus parviflorus* from Fort Pulaski, Georgia. Photograph by Gene Wofford.

Fig. 2. Closeup of portion of Govus collection of *Hybanthus parviflorus* from Fort Pulaski, Georgia. Photograph by Gene Wofford.

and labeled "Herbarium of Isaac Burk, Philadelphia; Pa., on ballast, Kaigns Pt., N.J., October 1885." However, catalogs of the flora of New Jersey (Britton 1889), and the various manuals covering the Northeastern United States (Fernald 1950; Gleason 1952; Gleason & Cronquist 1991) do not include this taxon, presumably considering it a ballast waif, and it is also not included in the recent checklist of the Flora of North America (Kartesz 1999).

Hybanthus parviflorus is widely distributed over South America, from Venezuela through southern Brazil (Figs. 3, 4), Chile, and Argentina, occurring preferentially in cold regions and at higher altitude places in warmer regions. The species is commonly found in open sites, frequently behaving as a weed in pastures and roadsides, though not as a weed of cultivated crops. The 1880 New Jersey specimens came from ship's ballast, at the ferry landing of the Communipaw Ferry, one of several busy ferries between Jersey City and New York City. The 1885 specimen also came from ballast, at Kaighn's Point on the Delaware River in Camden, also a busy ferry landing serving Camden, New Jersey and Philadelphia, Pennsylvania, in operation from 1806 until at least 1926. It seems plausible that *H. parviflorus* was introduced to Fort Pulaski, Georgia, via ballast as well. Fort Pulaski has been actively used by ships since at least the mid 1700s, and would have been a regular docking area for sailing ships through much of the late 18th and early 19th centuries, including use by ships going to and from the large and active port city of Savannah, Georgia (ca. 20 miles away) to destinations around the world. If *H. parviflorus* were introduced to Georgia on ballast, it is apparently established, as the 1998 collection is long after the use of solid ballast material was discontinued. It is also possible that this represents a more recent introduction, but how and why this species would have arrived at Fort Pulaski is obscure, as the species in neither typically a weed of agricultural crops nor an object of horticultural interest.

Fig. 3. Habit of *Hybanthus parviflorus*. Photograph by Juliana de Paula-Souza, from live material in Itararé, São Paulo, Brazil.

Given this more recent occurrence of *H. parviflorus*, found 118 years after its initial collection in North America, it appears that *H. parviflorus* should be considered a rare, alien component of the North American flora, and collectors should be aware of its potential occurrence, especially in the vicinity of old seaports. It does not appear, at least at this time, that it is likely to be an aggres-

Fig. 4. Detail of flower of *Hybanthus parviflorus*. Photograph by Juliana de Paula-Souza from live material in Itararé, São Paulo, Brazil.

sive alien weed. Below, we present a description to aid in its recognition, should it occur elsewhere in North America. We also note that the increased use of digital imagery and electronic mail in herbarium work greatly facilitates international collaboration and the identification of an unknown, extracontinental, and potentially invasive species; "virtual annotation" can provide rapid results without the expense and risk of loaning uniquely valuable specimens.

Hybanthus parviflorus (Mutis ex L.f.) Baill., Bot. Med. 2:841. 1884.

Herbs up to 30 cm high, branched, erect or suberect, internodes (1.7–)4–20 mm long; leaves alternate or opposite, frequently opposite only at the base of the branches, petiole ca. 0.5–4 mm long, blade (3.5–)6–30 mm long × 2–10(–15) mm wide, elliptic, lanceolate or oblong, less frequently oblanceolate, widely elliptic, ovate or obovate, acute to obtuse at apex, margin serrate, base acute, attenuate, rounded or obtuse, glabrous to pubescent or puberulent on the midrib; stipules narrowly lanceolate; flowers white, frequently with purplish lines on the anterior petal, solitary, axillary or arranged in poorly defined racemose inflorescences; floral pedicel 3–11(–24) mm long, bracteoles absent; sepals equal or subequal, ca. 1–1.7 mm long × ca. 0.5 mm wide, narrowly lanceolate or rarely ovate to suborbicular, subfalcate, acuminate or rarely round or obtuse at apex, margin entire; posterior petals ca. 1 mm wide × ca. 0.5 mm long, oblong, lateral petals ca. 1.5–1.8 mm long × ca. 0.7 mm wide, oblong to lanceolate, falcate, anterior petal (1.5–)3–3.7 mm long × 1.2–1.4 mm wide, clawed; stamens subsessile, anthers ca. 0.5 mm long, connective appendages orange-brown, ca. 0.3 mm long, frequently asymmetric, anterior stamens provided with noduliform nectariferous appendages; style 0.6–0.8 mm long, straight or subsigmoid, ovary ca. 0.6 mm long, glabrous, capsule 3–4 mm long × 3.5 mm wide, ovoid to globose, seeds ca. 1.5 mm long × ca. 1–1.2 mm wide.

Voucher specimens: **GEORGIA. Chatham Co.**: growing in grassy area along road near the picnic area, south central Cockspur Island, 7 Apr 1998, *Govus 946* (GA!). **NEW JERSEY. Camden Co.**: on ballast, Kaigns Pt., N.J., Oct 1885, *Isaac Burk s.n* (PH!). **Hudson Co.**: ballast, near Communipaw Ferry, N.J., Sep 1880, *Addison Brown s.n.* (GH!, NY!, US!), Communipaw, N.J. (ballast), 20 Jul 1880, *Jos. Schrenk s.n.* (NY!).

ACKNOWLEDGMENTS

We thank the curators of GA, GH, NY, PH, and US for access to collections. We thank Harvey Ballard for pointing out the existence of the 1885 PH collection, and Harvey Ballard and Julie Ballenger for helpful reviews of the manuscript.

REFERENCES

BALLARD, H.E., JR. [submitted] Violaceae. In: Kubitzki, K., ed. Families and genera of vascular plants. Institut für Allgemeine Botanik, Hamburg, Germany.

BRITTON, N.L. 1889. Catalogue of plants found in New Jersey. Final Report of the State Geologist, vol. II, Trenton, N.J.

DOWELL, P. 1906. North American species of *Calceolaria*. Bull. Torrey Bot. Club 33:547–556.

Fernald, M.L. 1950. Gray's manual of botany, eighth (centennial) edition. D. Van Nostrand Co., New York, N.Y.

GLEASON, H.A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. New York Botanical Garden, Bronx, NY.

GLEASON, H.A. and A. CRONQUIST. 1991. Manual of vascular plants of northeastern United States and adjacent Canada, second edition. New York Botanical Garden, Bronx.

GOVUS, T.E. 1998. Fort Pulaski National Monument inventory final report, Part A: Vascular plants. National Park Service, Southeast Region, Atlanta, GA.

KARTESZ, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill.

MABBERLEY, D.J. 1997. The plant-book: a portable dictionary of the vascular plants. Second edition. Cambridge Univ. Press, Cambridge, England.

ASTERACEAE FROM WOOL MILL SITES IN SOUTH CAROLINA, INCLUDING NEW RECORDS FOR NORTH AMERICA

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Documentation is given for 73 taxa of Asteraceae collected in 1957–1960 from wool mill sites in Berkeley County and Florence County, South Carolina. Twenty-eight (28) of these taxa are first reports for the flora of South Carolina; seventeen (17) others represent the first documentation for earlier reports for the state. Six (6) are first reports for North America: *Chevreulia sarmentosa*, *Gamochaeta argentina*, and *Panphalea heterophylla* (native to South America), and *Peripleura arida*, *Stuartina hamata*, and *Vittadinia sulcata* (native to Australia). *Calotis cuneifolia* (native to Australia) is reported for North America for the second time. Fifty-nine (59) of the 73 taxa are not native to South Carolina; of these, 29 are native to continents other than North America, while 30 are native to North America but from regions outside of the state.

RESUMEN

Se ofrece documentación de 73 taxa de Asteraceae colectados en el intervalo 1957–1960 en los condados de Berkeley y Florence County, Carolina del Sur. Veintiocho (28) de estos taxa son primeras citas para la flora de Carolina del Sur; otros diez y siete (17) representan los primeros testigos para citas previas en el estado. Seis (6) son primeras citas para Norte América: *Chevreulia sarmentosa*, *Gamochaeta argentina*, and *Panphalea heterophylla* (nativa de Sur América), y *Peripleura arida*, *Stuartina hamata*, y *Vittadinia sulcata* (nativa de Australia). *Calotis cuneifolia* (nativa de Australia) se cita para Norte América por segunda vez. Cincuenta y nueve (59) de los 73 taxa no son nativos de Carolina del Sur; de estos, 29 son nativos de otros continentes diferentes de Norte América, mientras que 30 son nativos de Norte América pero de regiones fuera del estado.

In the years 1957 through 1960, as part of the Flora of the Carolinas project and working from the University of North Carolina-Chapel Hill herbarium, Harry Ahles and companion John Haesloop made repeated collecting trips to two 'wool combing mills' in South Carolina. One of these was in Jamestown in Berkeley Co., the other north of Johnsonville in Florence Co.; both sites are located on the coastal plain, 40–50 kilometers from the coast and about 60 kilometers from each other. Some of the collections were identified and incorporated into the general collections at NCU several decades ago; others were mounted but were not identified or inserted into the general collections until 2001. Only a few of these were included in the account of the Flora of the Carolinas (Radford et al. 1968). Some have been the basis of recent reports (without documentation) for distribution records (Kartesz 1999 and others).

SIDA 21(2): 1215–1223. 2004

The wool combing mills received raw fleece and processed it toward production of clean wool for spinning. Early stages in the process are mechanical shaking (removes dirt and some plant matter), "scouring" (removes chemical substances and sand), and "combing" (removes finer plant material as well as shorter, weaker fibers). Waste from these processes at the South Carolina mills was the source of propagules for species collected by Ahles and Haesloop. Delivery of the raw wool probably was by railroad, because both of the sites are along the CSX Railroad, which runs roughly parallel to the coast. Both mills apparently are still in operation.

Seventy-three taxa (73) of Asteraceae in 54 genera are represented in the collections identified here. Twenty-eight (28) of these are first reports for the flora of South Carolina; seventeen (17) others represent the first documentation for earlier reports for the state. Six (6) are first reports for North America: *Chevreulia sarmentosa*, *Gamochaeta argentina*, and *Panphalea heterophylla* are native to South America; *Peripleura arida*, *Stuartina hamata*, and *Vittadinia sulcata* are native to Australia. *Calotis cuneifolia* (native to Australia) is reported for North America for the second time. Fifty-nine (59) of the species are not native to South Carolina; of these, 29 are native to continents other than North America, while 30 are native to North America but from regions outside of the state.

It would be useful to reinvestigate the status of these taxa in South Carolina, in order to determine which have persisted or increased their distribution. A number of the taxa reported here may have the potential to spread and become damaging weeds, or they may simply be waifs (sensu Nesom 2000).

Collections by Ahles and Haesloop were made in 1957 (April, May, July, September, October), 1958 (April, May, June, July, September), 1959 (May, July), and 1960 (May, July). From each of the two wool mill sites, collections were provided with essentially the same label data, except for the collection number and date.

SOUTH CAROLINA. Berkeley Co.: waste ground around Santee Wool Combing Mill, Jamestown on S.C. Rte. 45, [**Apr–Oct 1957–1960**], *H.E. Ahles* [**collection number**] with J.G. Haesloop.

SOUTH CAROLINA. Florence Co.: waste ground around the Wellman Wool Combing Mill, north of Johnsonville on S.C. Rte. 41, [**Apr–Oct 1957–1960**], *H.E. Ahles* [**collection number**] with J.G. Haesloop.

PLANT LIST

The genera and species are arranged alphabetically. If more than one collection was made for a single species, the citations are arranged chronologically. Vouchers are located at NCU, unless otherwise indicated.

Achillea millefolium L.
Berkeley Co.: 13 Jun 1958, *Ahles 42939*
Berkeley Co.: 27 May 1959, *Ahles 52717*
Native to western Asia, widely naturalized in the U.S.A.; previously known from South Carolina (Radford et al. 1968).

Amblyolepis setigera DC.
Berkeley Co.: 8 Apr 1957, *Ahles 22614*

Native to Texas and Mexico; first report for South Carolina.

Ambrosia artemisiifolia L.
Berkeley Co.: 27 May 1959, *Ahles 52805*
Native to North America and widely distributed; previously known from South Carolina (Radford et al. 1968).

Amphiachyris dracunculoides (DC.) Nutt.
Berkeley Co.: 28 Sep 1957, *Ahles 35585*
Berkeley Co.: 30 Oct 1957, *Ahles 38195*
Berkeley Co.: 22 Sep 1958, *Ahles 49216*
Native to the south-central U.S.A. as far east as Alabama and Tennessee; reported for South Carolina by Kartesz (1999), documented here.

Anthemis cotula L.
Berkeley Co.: 20 May 1957, *Ahles 25827*
Florence Co.: 28 May 1957, *Ahles 26690*
Berkeley Co.: 27 May 1959, *Ahles 52797*
Florence Co.: 11 Jul 1960, *Ahles 53756*
Native to Europe and Asia, widely naturalized in the U.S.A.; previously known from South Carolina (Radford et al. 1968).

Arctium minus Bernh.
Berkeley Co.: 11 Jul 1960, *Ahles 53824*
Native to Europe, widely naturalized in the U.S.A.; previously known from South Carolina (Radford et al. 1968).

Artemisia annua L.
Berkeley Co.: 11 Jul 1960, *Ahles 53848*
Native to eastern Europe and Asia, naturalized in various states of the USA; first report for South Carolina.

Artemisia biennis Willd. var. **biennis**
Berkeley Co.: 20 May 1957, *Ahles 25897*
Berkeley Co.: 27 May 1959, *Ahles 52762*
Berkeley Co.: 11 Jul 1960, *Ahles 53814*
Native to western and northern U.S.A. and Canada; first report for South Carolina.

Artemisia vulgaris L. var. **vulgaris**
Berkeley Co.: 25 May 1960, *Ahles 53402*
Berkeley Co.: 25 May 1960, *Ahles 53403*
Native to Europe and Asia, widely naturalized in Canada and the eastern U.S.A.; previously known from South Carolina (Radford et al. 1968).

Bidens bipinnata L.
Berkeley Co.: 20 May 1957, *Ahles 25836* (NCU, SMU)
Berkeley Co.: 14 May 1958, *Ahles 40488*
Native to the southern and eastern U.S.A. and Mexico; previously known from South Carolina (Radford et al. 1968).

Bidens pilosa L.
Florence Co.: 14 May 1958 *Ahles 40446*
Florence Co.: 30 Oct 1957, *Ahles 38153*
Florence Co.: 28 May 1957, *Ahles 26699*
Florence Co.: 22 Sep 1958, *Ahles 49139*
Native to Mexico and Central America, naturalized in the southwestern and southeastern U.S.A. and a few other states; previously known from South Carolina (Radford et al. 1968).

Bidens polylepis Blake
Berkeley Co.: 5 Jul 1957, *Ahles 30809*
Native to the eastern U.S.A.; previously known from South Carolina (Radford et al. 1968).

Bidens frondosa L.
Berkeley Co.: 22 Sep 1958, *Ahles 49204*
Native and widespread in North America; previously known from South Carolina (Radford et al. 1968).

Calotis cuneifolia R. Br.
Berkeley Co.: 8 Apr 1957, *Ahles 22537*
Berkeley Co.: 14 May 1958, *Ahles 40564*
Berkeley Co.: 13 Jun 1958, *Ahles 42935, 42973*
Native to Australia, reported in the U.S.A. only for Massachussetts (Sorrie 1992); first report for South Carolina.

Carduus pycnocephalus L.
Berkeley Co.: 8 Apr 1957, *Ahles 22550*
Native to northern Africa and western Asia, naturalized in scattered states of western and Gulf coast U.S.A.; reported for South Carolina by Kartesz (1999), documented here.

Carthamus baeticus (Boiss. & Reut.) Lara (syn = *Carthamus lanatus* L. subsp. *baeticus* (Boiss. & Reut.) Nyman
Berkeley Co.: 13 Jun 1958, *Ahles 42899*
Berkeley Co.: 27 May 1959, *Ahles 52774* (det. D.J. Keil 1997)
Berkeley Co.: 27 May 1959, *Ahles 52854*
Berkeley Co.: 25 May 1960, *Ahles 53372*
Native to southern Europe and northern Africa,

naturalized in scattered states, mostly along the Pacific coast; reported for South Carolina by Kartesz (1999), documented here.

Centaurea americana Nutt.
Berkeley Co.: 27 May 1959, *Ahles 52776*
Berkeley Co.: 27 May 1959, *Ahles 52843*
Berkeley Co.: 25 May 1960, *Ahles 53492*
Native primarily to the central U.S.A.; reported for South Carolina by Kartesz (1999), documented here.

Centaurea melitensis L.
Berkeley Co.: 8 Apr 1957, *Ahles 22624*
Berkeley Co.: 14 May 1958, *Ahles 40542* (det. L. Shinners)
Berkeley Co.: 13 Jun 1958, *Ahles 42919*
Native to southern Europe and northern Africa, naturalized in the western U.S.A. and various other states; reported for South Carolina by Cronquist (1980), documented here.

Centaurea solstitialis L.
Berkeley Co.: 25 May 1960, *Ahles 53487*
Berkeley Co.: 11 Jul 1960, *Ahles 53846* (det. L. Shinners)
Native to western Asia and the Mediterranean region of Europe, naturalized and weedy in most of the U.S.A.; reported for South Carolina by Hill and Horn (1997).

Chaetopappa asteroides (Nutt.) DC. var. **asteroides**
Berkeley Co.: 8 Apr 1957, *Ahles 22551*
Native to northern Mexico and the south-central U.S.A.; first report for South Carolina.

Chevreulia sarmentosa (Pers.) Blake
Berkeley Co.: 14 May 1958, *Ahles 40509*
Native to South America (Brazil, Paraguay, Uruguay, Bolivia, Argentina); first report for the U.S.A. and South Carolina.

Conyza bonariensis (L.) Cronq.
Berkeley Co.: 14 May 1958, *Ahles 40568*
Berkeley Co.: 21 Jul 1958, *Ahles 46996*
Native to South America, naturalized in most southern states of the U.S.A.; previously known from South Carolina (Radford et al. 1968).

Coreopsis tinctoria Nutt. var. **tinctoria**
Berkeley Co.: 27 May 1959, *Ahles 52825*
Berkeley Co.: 11 Jul 1960, *Ahles 53822*
Native and widespread in North America; previously known from South Carolina (Radford et al. 1968).

Coreopsis verticillata L.
Berkeley Co.: 13 Jun 1958, *Ahles 42900*
Native to the southern U.S.A.; previously known from South Carolina (Radford et al. 1968).

Cotula australis (Sieber) Hook. f.
Berkeley Co.: 8 Apr 1957, *Ahles 22592*
Native to Australia and New Zealand; naturalized in various western U.S.A. states and Florida; first report for South Carolina.

Dittrichia graveolens (L.) W. Greuter
Berkeley Co.: 28 Sep 1957, *Ahles 35595*
Native to the Mediterranean region, naturalized in various regions, including Australia, New Zealand, and California (Preston 1997), and reported from various other localities in the U.S.A. (Gleason & Cronquist 1991; Mitchell & Tucker 1997; Preston 1997; Tucker 1995); first report for South Carolina. In view of the other species reported here from Australia, it seems likely that the wool mill plants of *Dittrichia graveolens* also originated from there rather than from the native region of the species.

Dracopis amplexicaulis (Vahl) Cass.
Berkeley Co.: 20 May 1957, *Ahles 25840*
Berkeley Co.: 25 May 1960, *Ahles 53369*
Native primarily to the south-central U.S.A.; reported for South Carolina by Kartesz (1999), documented here.

Dyssodia papposa (Vent.) A.S. Hitchc.
Berkeley Co.: 8 Apr 1957, *Ahles 22620*
Berkeley Co.: 20 May 1957, *Ahles 25892*
Berkeley Co.: 14 May 1958, *Ahles 40483*
Berkeley Co.: 14 May 1958, *Ahles 40553*
Native to the southwestern and central U.S.A.; first report for South Carolina.

Eupatorium dubium Willd.
Berkeley Co.: 15 Jul 1959, *Ahles 52950*
Native to Atlantic coast states of the U.S.A., from South Carolina northward; previously known from South Carolina (Radford et al. 1968).

Evax multicaulis DC.
Berkeley Co.: 8 Apr 1957, *Ahles 22591*
Berkeley Co.: 14 May 1958, *Ahles 40511*

Native to Mexico and various states of the southern U.S.A.; reported for South Carolina by Cronquist (1980), documented here.

Evax prolifera Nutt. ex DC.
Berkeley Co.: 14 May 1958, *Ahles 40512, 40513*
Berkeley Co.: 27 May 1959, *Ahles 52737*
Native to Mexico and various states of the Great Plains and southern U.S.A.; first report for South Carolina.

Facelis retusa (Lam.) Schultz-Bip.
Berkeley Co.: 27 May 1959, *Ahles 52731*
Berkeley Co.: 27 May 1959, *Ahles 52858*
Native to South America and naturalized in states of the Gulf coast and southern Atlantic coast; previously known from South Carolina (Radford et al. 1968).

Flaveria trinervia (Spreng.) Mohr
Berkeley Co.: 28 Sep 1957, *Ahles 35584*
Berkeley Co.: 21 Jul 1958, *Ahles 47035*
Berkeley Co.: 22 Sep 1958, *Ahles 49172*
Berkeley Co.: 22 Sep 1958, *Ahles 49215*
Native to northwestern Mexico and the southwestern United States, naturalized in a few states of eastern U.S.A.; first report for South Carolina.

Gaillardia pulchella Foug. var. **drummondii** (Hook.) B.L. Turner
Berkeley Co.: 8 Apr 1957, *Ahles 22528*
Berkeley Co.: 20 May 1957, *Ahles 25852*
Berkeley Co.: 14 May 1958, *Ahles 40460*
Berkeley Co.: 13 Jun 1958, *Ahles 42902*
Berkeley Co.: 13 Jun 1958, *Ahles 42950*
Berkeley Co.: 13 Jun 1958, *Ahles 42969*
Berkeley Co.: 25 May 1960, *Ahles 53367*
Native primarily to the south-central U.S.A. but naturalized in various other states; reported for South Carolina by Kartesz (1999), documented here. The collections were determined by annotation as var. *drummondii* by B.L. Turner & T.J. Watson in 1995.

Gamochaeta antillana (Urb.) Anderb.
Berkeley Co.: 8 Apr 1957, *Ahles 22529*
Florence Co.: 8 Apr 1957, *Ahles 22628*
Probably native to the Caribbean region and perhaps South America, perhaps southeastern USA; first recognized by this name and circumscription in the U.S.A. by Nesom (2004).

Gamochaeta argentina Cabr.
Berkeley Co.: 8 Apr 1957, *Ahles 22594*
Native to South America (Argentina and Uruguay); first report for the U.S.A. and South Carolina.

Gamochaeta calviceps (Fern.) Cabr.
Berkeley Co.: 27 May 1959, *Ahles 52842*
Perhaps native to the southeastern USA, apparently naturalized worldwide; recognized by this name and circumscription in the U.S.A. by Nesom (2004).

Gamochaeta pensylvanica (Willd.) Cabr.
Berkeley Co.: 8 Apr 1957, *Ahles 22590*
Probably native to South America (Nesom 2004), naturalized in the southern U.S.A. and throughout the world; previously known from South Carolina (Radford et al. 1968).

Gamochaeta simplicicaulis (Willd. ex Spreng.) Cabr.
Berkeley Co.: 5 Jul 1957, *Ahles 30825*
Berkeley Co.: 21 Jul 1958, *Ahles 47038*
Berkeley Co.: 15 Jul 1959, *Ahles 52959*
Berkeley Co.: 11 Jul 1960, *Ahles 53783*
Native to South America, naturalized in a few states of Atlantic gulf coast U.S.A.; previously known from South Carolina, first reported by Nesom (1999).

Grindelia lanceolata Nutt. var. **lanceolata**
Berkeley Co.: 13 Jun 1958, *Ahles 42920*
Native to the south-central U.S.A.; first report for South Carolina. The plant is sterile, but the identification is probably correct. The plant has relatively broad leaves like plants from east Texas.

Gutierrezia sarothrae (Pursh) Britt. & Rusby
Berkeley Co.: 28 Sep 1957, *Ahles 35269*
Native to Mexico and the western U.S.A.; first report for South Carolina.

Gutierrezia texana (DC.) Torr. & A. Gray var. **texana**
Berkeley Co.: 11 Jul 1960, *Ahles 53821*
Berkeley Co.: 22 Sep 1958, *Ahles 49193*
Native to Mexico and Texas, naturalized or possibly native in a few other states of central U.S.A.; first report for South Carolina.

Helenium amarum (Raf.) H. Rock var. **badium** (A. Gray ex S. Wats.) Waterfall

Berkeley Co.: 20 May 1957, *Ahles 25829*
Berkeley Co.: 20 May 1957, *Ahles 25834*
Berkeley Co.: 14 May 1958, *Ahles 40478*
Berkeley Co.: 13 Jun 1958, *Ahles 42936*
Berkeley Co.: 27 May 1959, *Ahles 52727*
Native to Texas and Oklahoma; reported for South Carolina by Kartesz (1999), documented here.

Helenium elegans DC. var. **elegans**
Berkeley Co.: 25 May 1960, *Ahles 53357*
Native to Texas, Oklahoma, and Louisiana; reported for South Carolina by Kartesz (1999), documented here.

Helenium microcephalum DC. var. **microcephalum**
Berkeley Co.: 20 May 1957, *Ahles 25844* (NCU, SMU)
Berkeley Co.: 5 Jul 1957, *Ahles 30803*
Berkeley Co.: 21 Jul 1958, *Ahles 47002*
Berkeley Co.: 27 May 1959, *Ahles 52719*
Berkeley Co.: 25 May 1960, *Ahles 53405*
Florence Co.: 26 May 1960, *Ahles 53560*
Florence Co.: 11 Jul 1960, *Ahles 53750* (NCU, SMU)
Berkeley Co.: 11 Jul 1960, *Ahles 53816*
Native to Texas, Oklahoma, New Mexico, and Colorado; reported for South Carolina by Kartesz (1999), documented here.

Helianthus annuus L.
Berkeley Co.: 20 May 1957, *Ahles 25862*
Berkeley Co.: 13 Jun 1958, *Ahles 42987*
Florence Co.: 22 Sep 1958, *Ahles 49145*
Berkeley Co.: 27 May 1959, *Ahles 52777*
Berkeley Co.: 25 May 1960, *Ahles 53456*
Berkeley Co.: 11 Jul 1960, *Ahles 53770*
Berkeley Co.: 11 Jul 1960, *Ahles 53820*
Native or naturalized across the entire U.S.A., previously known from South Carolina (Radford et al. 1968).

Heliomeris multiflora (Nutt.) Blake var. **multiflora** (syn = *Viguiera multiflora* (Nutt.) Blake)
Berkeley Co.: 14 May 1958, *Ahles 40541*
Berkeley Co.: 27 May 1959, *Ahles 52778*
Native to the western USA and Mexico; first report for South Carolina.

Hymenoxys odorata DC.
Berkeley Co.: 8 Apr 1957, *Ahles 22512*
Berkeley Co.: 8 Apr 1957, *Ahles 22603*
Native to the southwestern U.S.A.; first report for South Carolina.

Hypochaeris brasiliensis (Less.) Griseb. var. **tweedei** (Hook. & Arn.) Baker
Berkeley Co.: 8 Apr 1957, *Ahles 22623*
Berkeley Co.: 28 Sep 1957, *Ahles 35593*
Berkeley Co.: 27 May 1959, *Ahles 52730*
Native to South America, naturalized in states along the Gulf coast and southern Atlantic; previously known from South Carolina, first reported by Shinners (1966) from a wool mill collection.

Hypochaeris glabra L.
Berkeley Co.: 14 May 1958, *Ahles 40469*
Berkeley Co.: 13 Jun 1958, *Ahles 42954*
Berkeley Co.: 27 May 1959, *Ahles 52738*
Native to South America, naturalized in states along the Gulf coast and southern Atlantic and various others; previously known from South Carolina (Radford et al. 1968).

Iva annua L.
Berkeley Co.: 28 Sep 1957, *Ahles 35606*
Berkeley Co.: 30 Oct 1957, *Ahles 38194*
Probably native to the central and eastern U.S.A.; previously known from South Carolina (Anonymous 1997), documented here.

Iva axillaris Pursh
Berkeley Co.: 13 Jun 1958, *Ahles 42961*
Native to western North America; first report for South Carolina.

Iva xanthifolia Nutt.
Berkeley Co.: 14 May 1958, *Ahles 40531*
Berkeley Co.: 27 May 1959, *Ahles 52803*
Native to most states of the U.S.A. except the Southeast; first report for South Carolina.

Krigia virginica (L.) Willd.
Berkeley Co.: 8 Apr 1957, *Ahles 22627*
Florence Co.: 8 Apr 1957, *Ahles 22546*
Florence Co.: 9 Apr 1958, *Ahles 38274*
Native to the eastern U.S.A.; previously known from South Carolina (Radford et al. 1968).

Lactuca graminifolia Michx.
Berkeley Co.: 13 Jun 1958, *Ahles 42968*
Native to coastal states of the southeastern U.S.A.; previously known from South Carolina (Radford et al. 1968).

Panphalea heterophylla Less. (identification by John Pruski)
Berkeley Co.: 8 Apr 1957, *Ahles 22585*
Native to South America (Brazil, Uruguay, Argentina); first report for the U.S.A. and South Carolina (Pruski & Nesom 2004).

Parthenium hysterophorus L.
Berkeley Co.: 20 May 1957, *Ahles 25850*
Berkeley Co.: 5 Jul 1957, *Ahles 30810*
Berkeley Co.: 22 Sep 1958, *Ahles 49161*
Berkeley Co.: 15 Jul 1959, *Ahles 52960*
Apparently native to the West Indies and adjacent North America and South America, naturalized in various states of south-central U.S.A. and elsewhere; first report for South Carolina.

Peripleura arida (Burbidge) Nesom (syn = *Vittadinia arida* Burbidge)
Berkeley Co.: 14 May 1958, *Ahles 40547*
Native to Australia; first report for the U.S.A. and South Carolina.

Pseudognaphalium stramineum (Kunth) Anderb.
Berkeley Co.: 11 Jul 1960, *Ahles 53825*
Native to Mexico and the western U.S.A., naturalized in Virginia, North Carolina, and South Carolina; previously known from South Carolina (Radford et al. 1968).

Ratibida columnifera (Nutt.) Woot. & Standl.
Berkeley Co.: 20 May 1957, *Ahles 25830*
Berkeley Co.: 14 May 1958, *Ahles 40468*
Berkeley Co.: 27 May 1959, *Ahles 52712*
Berkeley Co.: 27 May 1959, *Ahles 52801*
Berkeley Co.: 27 May 1959, *Ahles 52860*
Berkeley Co.: 25 May 1960, *Ahles 53370*
Berkeley Co.: 25 May 1960, *Ahles 53371*
Berkeley Co.: 25 May 1960, *Ahles 53491*
Florence Co.: 11 Jul 1960, *Ahles 53753*
Native to Mexico and the central U.S.A., widely naturalized; reported for South Carolina by Kartesz (1999), documented here.

Rudbeckia hirta L. var. **angustifolia** (T.V. Moore) Perdue
Berkeley Co.: 20 May 1957, *Ahles 25863*
Berkeley Co.: 13 Jun 1958, *Ahles 42916*
Berkeley Co.: 27 May 1959, *Ahles 52830*
Native to the coastal states of southeastern U.S.A.; previously known from South Carolina (Anonymous 1997), documented here.

Soliva sessilis Ruiz & Pavon (syn = *Soliva pterosperma* (Juss.) Less.)
Berkeley Co.: 27 May 1959, *Ahles 52718*
Native to South America, naturalized in the southeastern U.S.A.; previously known from South Carolina (Radford et al. 1968).

Sonchus oleraceus L.
Berkeley Co.: 8 Apr 1957, *Ahles 22615*
Native to Europe, northern and western Asia, and northern Africa, widely naturalized in North America; previously known from South Carolina (Radford et al. 1968).

Stuartina hamata Philipson
Berkeley Co.: 8 Apr 1957, *Ahles 22593*
Native to Australia; first report for the U.S.A. and South Carolina.

Symphyotrichum divaricatum (Nutt.) Nesom (syn = *Aster subulatus* Michx. var. *ligulatus* Shinners)
Berkeley Co.: 30 Oct 1957, *Ahles 38169*
Native to northern Mexico and the south-central U.S.A.; first report for South Carolina.

Tagetes minuta L.
Berkeley Co.: 20 May 1957, *Ahles 25845*
Berkeley Co.: 28 Sep 1957, *Ahles 35609*
Berkeley Co.: 22 Sep 1958, *Ahles 49188*
Native to South America, in the U.S.A. naturalized mainly in Atlantic coastal states; previously known from South Carolina (Radford et al. 1968).

Tetraneuris linearifolia (Hook.) Greene var. **linearifolia** (syn = *Hymenoxys linearifolia* Hook.)
Berkeley Co.: 8 Apr 1957, *Ahles 22513*
Native to Texas, New Mexico, Oklahoma, and Kansas; first report for South Carolina.

Thymophylla tenuiloba (DC.) Small var. **tenuiloba**) (syn = *Dyssodia tenuiloba* (DC.) B.L. Robins. var. *tenuiloba*)
Berkeley Co.: 8 Apr 1957, *Ahles 22580*
Native to Mexico and Texas, naturalized in a few Gulf coast states (e.g. Florida and Mississippi, Cronquist 1980; Alabama, Lelong 1988); first report for South Carolina.

Uropappus lindleyi (DC.) Nutt.
Florence Co.: 26 May 1960, *Ahles 53543*
Native to the southwestern U.S.A.; first report for South Carolina.

Verbesina encelioides (Cav.) var. **encelioides**
Berkeley Co.: 20 May 1957, *Ahles 25548*
Florence Co.: 28 May 1957, *Ahles 26719*
Berkeley Co.: 5 Jul 1957, *Ahles 30812*
Berkeley Co.: 14 May 1958, *Ahles 40486, 40554*
Florence Co.: 21 Jul 1958, *Ahles 46950*
Berkeley Co.: 22 Sep 1958, *Ahles 49180*
Berkeley Co.: 27 May 1959, *Ahles 52810*
Berkeley Co.: 15 Jul 1959, *Ahles 52945*
Florence Co.: 26 May 1960, *Ahles 53546*
Florence Co.: 11 Jul 1960, *Ahles 53762*
Native to Mexico and the western U.S.A., naturalized in several states of the southeastern U.S.A.; previously known from South Carolina, reported by Coleman (1974), documented here.

Vittadinia sulcata N. Burbidge
Berkeley Co.: 8 Apr 1957, *Ahles 22538*
Native to Australia; first report for the U.S.A. and South Carolina.

Xanthium spinosum L.
Berkeley Co.: 8 Apr 1957, *Ahles 22608*
Berkeley Co.: 20 May 1957, *Ahles 25872*
Florence Co.: 28 May 1957, *Ahles 26689*
Berkeley Co.: 30 Oct 1957, *Ahles 38199*
Berkeley Co.: 13 Jun 1958, *Ahles 42924*
Native to South America, widely naturalized in North America; reported for South Carolina by Kartesz (1999), documented here.

Xanthium strumarium L. var. **canadense** (P. Miller) Torr. & A. Gray
Berkeley Co.: 5 Jul 1957, *Ahles 30848*
Native to North America and widely distributed as a weed; previously known from South Carolina (Radford et al. 1968).

ACKNOWLEDGMENTS

I am grateful for help from the staff of herbarium NCU and for comments on the manuscript by Linda Lee (USCH). John Pruski (MO) provided the identification of *Panphalea heterophylla*.

REFERENCES

ANONYMOUS. 1997. South Carolina plant atlas. <http://cricket.biol.sc.edu/herb/>. Accessed June 2004.

COLEMAN, J.R. 1974. *Verbesina* section *Ximenesia* (Compositae): Biosystematics and adaptive radiation. Amer. J. Bot. 61:25–35.

CRONQUIST, A. 1980. Flora of the southeastern United States. Vol. 1. Asteraceae. Univ. of North Carolina Press, Chapel Hill.

GLEASON, H.A. and A. CRONQUIST. 1991. Manual of vascular plants of the northeastern United States and adjacent Canada. New York Botanical Garden, Bronx.

HILL, S.R. and C.N. HORN. 1997. Additions to the flora of South Carolina. Castanea 62: 194–208.

KARTESZ, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

LELONG, M.G. 1988. Noteworthy dicots of Mobile and Baldwin counties, Alabama. Sida 13:223–240.

MITCHELL, R.S. and G.C. TUCKER. 1997. Revised checklist of New York state plants. New York State Museum Bull. 490. New York State Museum, Albany.

Nesom, G.L. 1999. *Gamochaeta simplicicaulis* (Asteraceae: Gnaphalieae) in four southeastern states and new for North America. Sida 18:1259–1264.

Nesom, G.L. 2000. Which non-native plants are included in floristic accounts? Sida 19: 189–193.

Nesom, G.L. 2004. New distribution records for *Gamochaeta* (Asteraceae: Gnaphalieae) in the United States. Sida 21:1175–1185.

Preston, R.E. 1997. *Dittrichia graveolens* (Asteraceae), new to the California weed flora. Madrono 44:200–203.

Pruski, J. and G.L. Nesom. 2004. *Panphalea heterophylla* (Compositae: Mutisioideae: Nassauvieae), a genus and species new for the flora of North America. Sida 21: 1225–1227.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill.

Shinners, L.H. 1966. *Hypochoeris microcephala* var. *albiflora* (Compositae) in southeastern Texas: New to North America. Sida 2:393–394.

Sorrie, B.A. and P. Somers. 1999. The vascular plants of Massachusetts: a county checklist. Massachusetts Division of Fisheries and Wildlife, Natural Heritage & Endangered Species Program. Westborough, MA.

Tucker, G.C. 1995. The vascular flora of southeastern Connecticut: an annotated checklist. Mem. Connecticut Bot. Soc. 3:1–205.

PANPHALEA HETEROPHYLLA (COMPOSITAE: MUTISIOIDEAE: NASSAUVIEAE), A GENUS AND SPECIES NEW FOR THE FLORA OF NORTH AMERICA

John F. Pruski

Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166-0299, U.S.A.

ABSTRACT

Panphalea heterophylla (Compositae) is a new genus and species for the United States. This also is the first known occurrence of the genus from outside of its native range in southern South America.

RESUMEN

Panphalea heterophylla (Compositae) es un género y especie nueva para los Estados Unidos. Este es también el primer reporte del género fuera de su área de ocurrencia nativa en Sur América.

Determinations of Compositae in conjunction with the study of Nesom (2004) identify *Ahles & Haesloop 22585* (NCU) as *Panphalea heterophylla* Less. (Compositae: Mutisioideae: Nassauvieae), a genus and species new for the flora of North America. This is the first known occurrence of *Panphalea* Lag. from outside of its native range in Argentina, Brazil, Paraguay, and Uruguay and increases to three the number of genera of Nassauvieae known in North America. In this paper I amplify comments on the taxonomic significance of the record, past the summary provided in Nesom (2004), with a description and typification of the species, U.S.A. voucher, and a key to the genera of Mutisioideae that occur in North America north of Mexico.

Nassauvieae Cass. were treated as Mutisieae subtribe Nassauviinae (Cass.) Benth. & Hook.f. by Bentham and Hooker (1873) and placed in Compositae subfamily Mutisioideae (Cass.) Lindl. [syn. Nassauvioideae (Cass.) Lindl.] by Pruski and Sancho (2004). Nassauvieae were resurrected from synonymy of Mutisieae and reinstated at the tribal level by Pruski (2004). Nassauvieae differ from Mutisieae Cass. by longer style branches with truncate tips commonly covered by a tuft of collecting hairs, by anthers with a well-defined appendage and shorter broader thecae, but they have bilabiate corollas and caudate anthers typical of most Mutisioideae [tribe Stifftieae D. Don is characterized by discoid capitula with short, abaxially rugulose style branches and mutisioid anthers (Pruski 2004)]. Nassauvieae are centered in South America, but two genera were previously known to occur in North America (Simpson & Anderson 1978): *Trixis* P. Browne is largely South American, but extends northward into the West Indies, Mesoamerica, Mexico, and the southwestern United States; *Acourtia* D. Don occurs from Mesoamerica northwards into the southwestern United States.

Panphalea heterophylla differs by epappose cypselae from the species of the five genera of Mutisioideae treated by Simpson and Anderson (1978) in North America north of Mexico [*Acourtia* D. Don (5 spp.), *Chaptalia* Vent. (4 spp.), *Gochnatia* H.B.K. (1 sp.), *Hecastocleis* A. Gray (1 sp.), and *Trixis* P. Browne (2 spp.)]. Additionally, the combination of the following features serves to further distinguish *Panphalea heterophylla* from these 13 species of Mutisioideae: annual herbaceous habit; glabrous herbage; leaves basal and cauline, lyrate to sharply lobed; corymbiform capitulescences; few-flowered, bilabiate capitula; thinly chartaceous, apiculate phyllaries; homogamous florets; and bilabiate, isomorphic corollas with an apically shortly bidentate inner lip.

KEY TO MUTISIOIDEAE IN NORTH AMERICA NORTH OF MEXICO

1\. Style branches short, apically rounded, glabrous or sparsely papillose; cypselae pappose (Mutisieae).

  2\. Plants rosulate herbs; capitula bilabiate-heteromorphic ________ **Chaptalia** Vent.

  2\. Plants subshrubs to shrubs; capitula discoid.

    3\. Leaves abaxially tomentose, entire; capitula many-flowered, not glomerate, not subtended by spiny subinvolucral bracts; pollen tricolporate ________ **Gochnatia hypoleuca** (DC.) A. Gray

    3\. Leaves not abaxially tomentose, at least some leaves with spiny margins; capitula uniflorous, glomerate, subtended by spiny subinvolucral bracts; pollen tricolpate ________ **Hecastocleis shockleyi** A. Gray

1\. Style branches elongate, apically truncate, crowned by a tuft of collecting hairs; cypselae pappose or epappose (Nassauvieae).

  4\. Glabrous annual herbs; inner corolla lip undivided proximally, bidentate apically; cypselae epappose ________ **Panphalea heterophylla** Less.

  4\. Perennial pubescent herbs to shrubs; inner corolla lip bifid, divided to base; cypselae pappose.

    5\. Rosulate perennial herbs, caudex commonly tomentose; corollas violet, pinkish, or white ________ **Acourtia** D. Don

    5\. Subshrubs to shrubs, corollas yellow ________ **Trixis** P. Browne

Panphalea heterophylla Less., Linnaea 5:8. 1830. TYPE: BRAZIL: In humidis Brasiliae meridionalis. 1823–1828 [sic], *Sello 1328* (HOLOTYPE: B, destroyed, photographs. MO!, NY!, US!, all photographs from C.B.G.N. negative 16096).

Glabrous annual herbs; stems slender, few to several, branched at base, spreading to ascending, 5–17 cm long. **Leaves** basal and cauline, alternate, chartaceous; basal leaves petiolate, oblong to oblong-lyrate, petiole 7–12 mm long, blade orbicular or more commonly lyrate with about 3 pairs of lobes, 4–15 mm long, 4–7 mm wide, margins entire; cauline leaves commonly sessile and clasping, ovate-lyrate, palmatifid, pedate, or lanceolate, 4–12 mm long, 4–6 mm wide. **Capitulescence** corymbiform, few-headed; peduncles 10–30 mm long. **Capitula** 8–12-flowered, bilabiate, homogamous; involucre 1–2-seriate, ca. 2.2 × 2 mm; phyllaries subequal, ovate-lanceolate, thinly chartaceous, apically truncate-apiculate, apiculum to ca. 0.5 mm long, margins broad, hyaline; receptacle epaleate. **Florets** bisexual; corollas bilabiate, isomorphic, white, ca. 5 mm long, weakly puberulent with scattered uniseriate, 5–7-celled trichomes, apical cell larger but neither bulbous nor inflated, tube ca. 2 mm long, outer lip ovate, ca. 3 × 1.5 mm, minutely tridentate apically, adaxial epidermal cells longitudinally elongated (mutisioid epidermal pattern), outer wall acute-ridged in transverse section, inner lip ca. 1.2 mm long, coiled, undivided proximally, shortly bidentate apically; style branches ca. 0.7 mm long, apically truncate, papillate with many collecting hairs; anthers ca. 2 mm long, caudate, apical appendage well-defined, obtuse, ca. 0.5 mm long, tails broadly lanceolate, ca. 0.4 mm long, smooth, tips rounded, not tapered. **Cypselae** obconical, ca. 1.5 mm long, densely pubescent, apically truncate; pappus absent. **Pollen** spheroidal, tricolporate, tectum minutely granular (subpsilate).

Specimen examined: UNITED STATES. **South Carolina. Berkeley Co.:** Jamestown on SC route 45, waste ground around the Santee Wool Combing Mill, 8 Apr 1957, *Ahles & Haesloop 22585* (NCU!).

Panphalea contains nine species (Cabrera 1953; Cabrera & Klein 1973) found in northeastern Argentina, adjacent Brazil, Paraguay, and Uruguay. Three species are annual herbs, and among these only the smallest, *Panphalea heterophylla*, is glabrous. Cypselae of this species were presumably imported into the United States in fleece brought from South America for processing. Species of tribe Nassauvieae are not commonly weedy, and it is unlikely that this subtropical species will become a pest, if it has persisted at all in South Carolina.

ACKNOWLEDGMENT

I would like to thank Dra. Gisela Sancho (LP) for helpful discussion.

REFERENCES

Bentham, G. and J.D. Hooker. 1873. Compositae. In: Genera Plantarum, vol. 2, part I. Reeve and Co., London. Pp. 163–533.

Cabrera, A.L. 1953. Las especies del género *Pamphalea* [sic] (Compositae). Notas Mus. La Plata 16:225–237.

Cabrera, A.L. and R.M. Klein. 1973. Compostas, 1 tribo: Mutisieae. In: P.R. Reitz, ed. Flora Illustrada Catarinense, I Parte: As Plantas, Fasc. COMP:1–124.

Nesom, G.L. 2004. Asteraceae from wool mill sites in South Carolina, including new records from North America. Sida 21:1215–1223.

Pruski, J.F. 2004. Missouri Botanical Garden, Research: Asteraceae (Compositae). Missouri Botanical Garden, St. Louis.

Pruski, J.F. and G. Sancho. 2004. Asteraceae or Compositae (Aster or Sunflower family). In: Smith, N.P., S.V. Heald, A. Henderson, S.A. Mori, and D.W. Stevenson, eds. Flowering plants of the Neotropics. Princeton University Press, Princeton., NJ. Pp. 33–39 + pl. 5.

Simpson, B. and C. Anderson. 1978. Compositae tribe Mutisieae. North Amer. Flora, ser. 2, 10:1–13.

CUSCUTA INDECORA (CONVOLVULACEAE) NEW FOR CANADA

Mihai Costea[1]

Department of Plant Agriculture
University of Guelph
Guelph, Ontario, N1G 2W1, CANADA
coste_amihai@hotmail.com

François J. Tardif

Department of Plant Agriculture
University of Guelph
Guelph, Ontario, N1G 2W1, CANADA
ftardif@uoguelph.ca

Vernon L. Harms

W.P. Fraser Herbarium
Department of Plant Sciences
University of Saskatchewan,
51 Campus Dr., Saskatoon
Saskatchewan, S7N 5A8, CANADA
vharms@shaw.ca

Cuscuta indecora Choisy is frequent in southern U.S.A. (Yuncker 1932, 1965) and extends northward to Michigan, Minnesota, North Dakota, Montana and Idaho (USDA NRCS 2004). The species also occurs in Mexico, Central and South America (Yuncker 1932, 1965). We are reporting here the first record of this species for southern Saskatchewan, Canada. Its presence in the Canadian Provinces adjacent to its northern range was to be expected, and further floristic research may reveal its occurrence in southern Alberta, Manitoba and Ontario. Although *C. indecora* has definite weedy tendencies (Parker & Riches 1993), taking into account the natural habitats it was found in, the species may be considered native to southern Canada as well. The species was cultivated experimentally in Ontario and Alberta (vouchers at DAO and ALTA, respectively), but it has never spread (see also Crins & Ford 1988). The host range of *C. indecora* is wide, including numerous herbaceous and woody plants (Yuncker 1965).

Cuscuta indecora and *C. coryli* Engelm from subsection *Indecorae* Yuncker are probably sister species (Costea et al. unpublished). *Cuscuta coryli* in Canada, is rare in Saskatchewan, Manitoba, Ontario and Québec (Argus & Pryer 1990). Both species have in common the fleshy, papillate flowers with corolla lobes acute and inflexed. *Cuscuta indecora* differs from *C. coryli* mainly through the 5-merous flowers, 2–5 mm long, having usually large and abundantly fringed intrastaminal scales. *Cuscuta coryli* has flowers commonly 4-merous, ca. 2 mm long, and infrastaminal scales are reduced to winged or toothed ridges. Descriptions, identification keys and iconography can be found in Yuncker (1932, 1965).

Voucher specimens: **CANADA. Saskatchewan. District of Rosetown-Biggar:** Canton Bernard, ca 12 mi SE of Demaine, ca. 50° 40' N, 107° 20'W, battures sablonneuses de la riviere Saskatchewan du Sud, 30

---

[1] Corresponding author.

SIDA 21(2): 1229–1230. 2004

Jul 1956, *B. Boivin et al. 11648* (SASK- 2 collections; ALTA, DAO, MT, NY); Crooked Lake Provincial Park, 50° 35' N, 102° 40'W, in bog on sow thistle and sunflower, 12 Aug 1976, *VJ Huffen s.n.* (SASK).

ACKNOWLEDGMENTS

Appreciation is extended to Luc Brouillet and an anonymous reviewer for their helpful suggestions on an earlier version of the manuscript. We thank directors/curators from ACAD, ALTA, DAO, HAM, MT, MTMG, NFLD, NSPM, NY, OAC, QFA, QUE, RBG, SASK, SFS, TUP, UBC, UNB, USAS, UWO, UWPG, WAT, WIN, and WIS for the herbarium loans.

REFERENCES

Argus, G.W. and K.M. Pryer. 1990. Rare vascular plants in Canada: our national heritage. Canadian Museum of Nature, Ottawa.

Crins, W.J. and B.A. Ford. 1988. The parasitic dodders (*Cuscuta*: Cuscutaceae) in Ontario. Canad. Field-Nat. 102:209–215.

Parker, C. and C.R. Riches 1993. Parasitic weeds of the world. Biology and control. CAB International, Wallingford, UK.

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (plants.usda.gov). National Plant Data Center, Baton Rouge, LA.

Yuncker, T.G. 1932. The genus *Cuscuta*. Mem. Torrey Bot. Club 18:113–331.

Yuncker, T.G. 1965. *Cuscuta*. North American flora, Ser. 2, 4:1–51.

CONTRIBUTIONS TO THE MOSS FLORA OF THE AMAZONIAN LOWLANDS OF MADRE DE DIOS, PERU

Piers Majestyk

Institute of Systematic Botany
The New York Botanical Garden (NY)
200th St. and Kazimiroff Blvd
Bronx, New York 10458, U.S.A.
pmajestyk@nybg.org

John P. Janovec

Botanical Research Institute of Texas (BRIT)
509 Pecan St.
Fort Worth, Texas 76102-4060, U.S.A.
jjanovec@brit.org
(corresponding author)

ABSTRACT

A recent collection of mosses from the Department of Madre de Dios in the lowlands of southeastern Peru contains 58 different species. Fifty-four taxa are new to the district and four species are reported new to Peru. Previous collections from the district are listed which brings the total species known from the area to 74. This is the first major study of mosses from Madre de Dios, Peru, and it provides a foundation for continued work and production of a field guide for the region.

RESUMEN

Una colección reciente de musgos del Departamento de Madre de Dios en la zona baja del Sureste de Perú contiene 58 especies diferentes. Cincuenta y cuatro taxa son nuevos para el distrito y se citan cuatro especies nuevas para Perú. Se listan las colecciones previas del distrito que elevan el total de especies conocidas del área a 74. Este es el primer estudio amplio de musgos de Madre de Dios, Perú, y aporta un inicio para la continuación del trabajo y la producción de una guía de campo para la región.

INTRODUCTION

The southwestern Amazon of the trinational corner of SW Brazil, NW Bolivia, and SE Peru contains what is probably the largest and least disturbed area remaining of Upper Amazonian and Lower Andean ecosystems (Foster et al. 1994). Threats to the forest occur in the form of hunting, gold mining, timber extraction, impending road construction, and slash and burn agriculture. The Department of Madre de Dios (12°–14.5°S), Peru, dominated by the Madre de Dios River basin and tributaries, is an important geopolitical region in the pristine SW Amazon, which is divided equally between lowland, premontane, and montane forest (Davis et al. 1997). Madre de Dios is located at the southwestern edge of the Amazon basin near the Andean foothills and is covered primarily by lowland tropical/subtropical moist forest (Gentry & León 1997). The region has a distinct six month dry season and receives 2000–2500 mm of rain annually (Gentry & León 1997). Madre de Dios has been recognized as an epicenter of botanical diversity and holds world record numbers of other organisms, such as birds, tabanid flies, tiger beetles, damselflies and dragonflies, and butterflies (Stewart 1988).

Botanical research over the past 25 years in Madre de Dios, Peru, has been

SIDA 21(2): 1231–1238. 2004

important for identifying the extent and significance of the region's plant diversity, producing various publications and datasets (e.g., Gentry 1982; Phillips & Gentry 1993a–b; Foster et al. 1994; Terborgh & Andersen 1998; Pitman et al. 1999, 2001). There have been two geographic areas of botanical investigations in Madre de Dios, with most of the resources focused on quantitative inventory of trees (trunk diameter > 10 cm) in scattered one-hectare forest plots and 0.1-hectare transects. The Cocha Cashu Biological Station in Manu National Park has been the focus of significant field research during the last three decades (Terborgh 1994), producing one of the most comprehensive plant checklists for the region. The Tambopata-Candamo Reserved Zone (Foster et al. 1994) in lower Madre de Dios near the Peru-Bolivian border has been the focus of long-term monitoring of one-hectare forest plots and complementary 0.1-hectare transect work (Phillips et al. 2003), plus associated programs of general botanical collection.

Despite the research that has been focused on these selected areas, there has been no major, long-term systematic inventory of plants and habitats, and no flora has been published for the region. Between July 11 and August 19, 2002, as part of a long-term program of botanical inventory and monitoring, the authors conducted expeditions in the Amazonian lowlands of the Department of Madre de Dios. Led by the first author, cryptogamic collections were made from several localities in the region (Table 1, Fig. 1). Fifty-eight species of mosses were identified from approximately 226 collections. Of the 58 taxa identified, 54 are new records for the district and four of these are new records for Peru (Table 2).

The only previously published records of moss collections for Madre de Dios, as far as we know, were made by Vargas (1974) and recorded in a checklist of mosses for Peru by Menzel (1992). Vouchers of the Vargas material were searched for but not located in either of the two larger Peruvian herbaria—the Herbarium of the Museo de Historia Natural, Universidad Nacional Mayor de San Marcos (USM) and the Herbario Vargas, Facultad de Ciencia Biológicas, Universidad Nacional San Antonio Abad del Cuzco (CUZ).

We conclude that future work should be focused on comparative studies of the diversity of mosses and other bryophytes in time and space between different sites in the lowlands of Madre de Dios, and along the altitudinal gradient from the lowlands up the slopes of the Andes into the Department of Cusco. This work is produced as a component of long-term botanical exploration and collaboration in the Andes-Amazon region of southeastern Peru and it will serve as a foundation for the production of field guides to serve the multidisciplinary science, education, and conservation programs that are ongoing in the region.

ANNOTATED LIST OF SPECIES

Species are listed alphabetically by family. New records for the country are marked with an asterisk (*). The nomenclature for the species follows Crosby et al. (2000). Voucher collections are deposited at NY. Duplicates of some taxa are

Table 1. Summary of nine collection sites in Madre de Dios, Peru, and the corresponding moss collections made between July 11 and August 19, 2002.

Locality	Elevation	Geographic Coordinates (P. Majestyk)	Collection Numbers
1. Manu Province, Puerto Maldonado	300 m	12°36' S, 69°11' W	3720-3727
2. Manu Province, Los Amigos field station, ca. 3 km N of the jct of the Madre de Dios and Los Amigos rivers.	280 m	12° 34' S, 70° 06' W	3728-3902; 3951.5-4178; 4301-*4364*
3. Manu Province, Community of Boca Amigo, ca. 1.6 km N of the jct of the Los Amigos and Madre de Dios rivers on the W side of the river	220 m	12° 36' S, 70° 05' W	*3903-3951*
4. Tambopata Province, E side of the Los Amigos River	300 m	12° 28' 50" S, 70° 11' 01" W	*4179-4209*
5. Tambopata Province, E side of the Los Amigos River, small waterfall emptying into river	300 m	12° 27' 48" S, 70° 13' 09" W	*4210-4215*
6. Tambopata Province, E side of the Los Amigos River	300 m	12° 25' 37" S, 70° 15' 35" W	*4218-4231*
7. Tambopata Province, E side of the Los Amigos River, from banks of river to inland	230–250 m	12° 31' 52"-12° 32' 05"S 70° 05' 24"-70° 05' 29"W	*4240-4265*
8. Manu Province, Inambari River ca. 2 km from jct of Madre de Dios River	220 m	12°43'87" S, 69°45'51" W	*4266-4267*
9. Manu Province, ca. 13 km W of Puerto Maldonado in small park dominated by *Mauritia flexuosa* L (Arecaceae).	300 m	12°40' S, 69°20' W	*4268-4300*

also deposited at BRIT, CUZ, MO, SMF, and the first author's personal herbarium. Numbers following the species name are the first author's collection numbers.

Bartramiaceae

Philonotis uncinata (Schwägrichen) Bridel; *3743, 3820, 3876, 3882, 3885, 3997, 4145, 4165, 4180, 4213, 4215, 4231, 4267*

Brachytheciaceae

Rhynchostegium conchophyllum (Taylor) A. Jaeger; *4220*

Bruchiaceae

Trematodon longicollis Michx.; *4245*

Bryaceae

Bryum apiculatum Schwägrichen; *3875, 3888, 3995, 4134, 4151*

**Bryum renauldii* Röll ex Renauld & Cardot; *4212*

Calymperaceae

Calymperes afzelii Swartz; *3948, 4205, 4303, 4310, 4314*

Calymperes palisotii Schwägrichen; *4336*

Syrrhopodon cryptocarpos Dozy & Molkenboer; *3825, 3984, 4120*

Syrrhopodon incompletus Schwägrichen; *3838, 3981, 3982, 3985, 4017, 4018, 4108, 4110, 4141, 4168, 4264, 4301*

Syrrhopodon parasiticus (Swartz ex Bridel) Bescherelle; *4038, 4309*

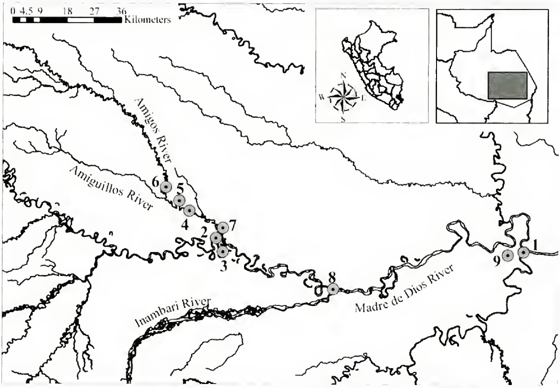


Fig. 1. Map showing nine collection sites where the study was focused in Madre de Dios, Peru. Table 1 provides descriptions of these localities by the corresponding number of each site.

Dicranaceae

Dicranella hilariana (Montagne) Mitten; *3722, 3728, 3730, 3781, 4102, 4130, 4197*

Ditrichaceae

Ditrichum rufescens (Hampe) Hampe; *4118, 4202*

Fissidentaceae

Fissidens guianensis Montagne; *3939, 4023, 4036, 4041.5, 4061, 4062, 4096, 4100, 4101, 4109, 4119, 4125, 4195, 4262*

Fissidens flaccidus Mitten; *4211, 4226*

Fissidens intramarginatus (Hampe) Mitten; *3750*

Fissidens pellucidus Hornschuch; *3756, 3881, 4246*

Fissidens prionodes Montagne; *3777, 3783, 3966, 4162*

Fissidens submarginatus Bruch; *3873, 4138, 4259*

Fissidens zollingeri Montagne; *3871, 3928, 4132, 4139*

Hypnaceae

Chryso-hypnum diminutivum (Hampe) W.R. Buck; 4188

Isopterygium subbrevisetum (Hampe) Brotherus; *4067, 4116, 4192*

Isopterygium tenerum (Swartz) Mitten; *3751, 3775, 3780, 3828, 3852, 3973, 4004, 4277, 4286, 4302*

Mittenothamnium reptans (Hedwig) Cardot; *4358, 4359*

Rhacopilopsis trinitensis (C. Müller) E. Britton & Dixon; *4169, 4252*

Vesicularia sp.; *4344*. We were unable to identity this collection from South American material in NY. This species has branch leaves measuring ca. 2.5 mm in length. It is perhaps a new species but we cannot without further study of the genus make that decision now.

Vesicularia vesicularis (Scwägrichen) Brotherus var *vesicularis*; *3784, 3877, 4072, 4104, 4183*

Vesicularia vesicularis var. *rutilans* (Bridel) W.R. Buck; *4064*

Leucobryaceae

Leucobryum martianum (Hornschuch) Hampe ex C. Müller; *3847, 3861, 4149, 4153, 4159, 4167, 4328*

**Leucobryum subobtusifolium* (Brotherus) B.H. Allen; *4092*

TABLE 2. A summary of moss collections made by family, species, and localities in Madre de Dios, Peru.

Family	Number of Species	Number of Collections	Collection Localities (see map, Fig. 1)
Bartramiaceae	1	13	1,2,4,5,6,8
Brachytheciaceae	1	1	6
Bruchiaceae	1	1	7
Bryaceae	2	6	2
Calymperaceae	5	23	2,4,7
Dicranaceae	1	7	1,2,4
Ditrichaceae	1	2	2,4
Fissidentaceae	7	31	2,3,4,5,6,7
Hypnaceae	8	25	2,4,7,9
Leucobryaceae	5	28	2,4,7
Meteoriaceae	2	9	2,3,4,7
Neckeraceae	2	7	2
Othotrichaceae	2	2	2
Pilotrichaceae	4	18	2,4
Pottiaceae	2	2	6
Pterobryaceae	2	5	2,3
Sematophyllaceae	7	23	2,3,4,7,9
Splachnobryaceae	1	2	2
Stereophyllaceae	1	9	2
Thuidiaceae	3	12	2
Total	55	212	

Octoblepharum albidum Hedwig; *3738, 3755, 3778, 3859, 3965, 3969, 4013, 4081, 4121, 4155, 4201, 4299, 4291, 4253*

Octoblepharum cylindricum W.P. Schimper ex Montagne; *4075*

Octoblepharum pulvinatum (Dozy & Molkenboer) Mitten; *3874, 3961, 4005, 4107, 4161*

Meteoriaceae

Zelometeorium patulum (Hedwig) Manuel; *3724, 3917, 4099, 4115, 4117, 4200, 4204, 4254*

Zelometeorium recurvifolium (Hornschuch in Martius) Manuel; *3950*

Neckeraceae

Neckeropsis disticha (Hedwig) Kindberg; *3935, 4207*

Neckeropsis undulata (Hedwig) Reichardt; *3762, 3909, 4078, 4085, 4249*

Orthotrichaceae

Groutiella tomentosa (Hornschuch) Wijk & Margadant; *3880*

Schlotheimia rugifolia (W.J. Hooker) Schwägrichen; *4307*

Pilotrichaceae

Callicostella pallida (Hornschuch in Martius) Ångström; *3757, 3759, 3869, 3872, 3968, 4026, 4097, 4103, 4136, 4184, 4186, 4203, 4315, 4322*

Crossomitrium patrisiae (Bridel) C. Müller; *4187*

Lepidopilum affine C. Müller; *4179, 4190*

Lepidopilum surinamense C. Müller; *3752*

Pottiaceae

Barbula indica (W.J. Hooker) Sprengel in Steudel; *4223*

Dolotortula mniifolia (Sullivant) R.H. Zander; *4225*

Pterobryaceae

Henicodium geniculatum (Mitten) W.R. Buck; *3930, 3988, 4127, 4137*

Pireella pohlii (Schwägrichen) Cardot; *4152*

Sematophyllaceae

**Potamium lonchophyllum* (Montagne) Mitten; *4251*

**Sematophyllum adnatum* (Michx.) E. Britton; *4242, 4289*

Sematophyllum subpinnatum (Bridel) E. Britton; *3737*

Sematophyllum subsimplex (Hedwig) Mitten; *3827, 3952, 3960, 3967, 4008, 4025, 4329*

Taxithelium planum (Bridel) Mitten; *3933, 3934, 4142, 4150, 4206, 4208, 4260, 4317*

Trichosteleum cf. *pusillum* (Hornschuch) A. Jaeger; *4027*

Trichosteleum subdemissum (Schimper ex Bescherelle) A. Jaeger; *4123, 4129, 4279*

Splachnobryaceae

Splachnobryum obtusum (Bridel) C. Müller; *3996, 3998*

Stereophyllaceae

Pilosium chlorophyllum (Hornschuch) C. Müller in Brotherus; *3956, 4003, 4012, 4034, 4037, 4087, 4256, 4305, 4312*

Thuidiaceae

Cyrto-hypnum involvens (Hedwig) W.R. Buck & H. Crum; *3938, 4124, 4147, 4198*

Cyrto-hypnum leptocladum (Taylor) W.R. Buck & H. Crum; *4035*

Cyrto-hypnum scabrosulum (Mitten) W.R. Buck & H. Crum; *3761, 3857, 3951, 4010, 4084, 4128, 4319.*

Taxa recorded in Vargas (1974):

Anomobryum julaceum (Schrader ex P.G. Gärtner, B. Meyer & Scherbius) W.P. Schimper, *Bryum apiculatum* Schwägrichen, *Dicranella hilariana* (Montagne) Mitten, *Entodon jamesonii* (Taylor) Mitten, *Leucobryum martianum* (Hornschuch) Hampe ex C. Müller, *Philonotis longiseta* (Michx.) Britton, *P. uncinata* (Schwägrichen) Bridel, *Pilopogon guadalupensis* (Bridel) Frahm , *Thamnobryum fasciculatum* (Hedwig) I. Sastre, *Sematopyllum subpinnatum* (Bridel) E. Britton, *Sphagnum subsecundum* Nees in Sturm, *Squamidium nigricans* (W.J. Hooker in Kunth) Brotherus.

Taxa listed as occurring in Madre de Dios in the Tropicos database with collector and collection number (mobot.mobot.org/W3T/Search/most.html):

Fissidens allionii Brotherus (*Matthews B-86580*, MO); *Fissidens lagenarius* Mitten (*Matthews B-86577*, COLO, PAC); *Fissidens perfalcatus* Brotherus (*Matthews B-85860*, MO); *Phyllogonium viscosum* (P. Beauv.) Mitten (*Chavez 857*, MO).

ACKNOWLEDGMENTS

We would like to thank the Gordon and Betty Moore Foundation and the Beneficia Foundation for their support of botanical studies in Madre de Dios, Peru. The first author thanks William Buck and the New York Botanical Garden for financial assistance which made this trip possible. The second author thanks Scott Mori for support during postdoctoral studies at the New York Botanical Garden. For aiding in the identification of several collections we thank William Buck, Robert Ireland, and Ron Pursell. We thank Asha McElfish for her assistance in preparation of tables and for helpful comments to improve the original manuscript. And we thank Barney Lipscomb for his excellent editorship and the two reviewers (Robert E. Magill and William R. Buck) who helped us improve the manuscript. Fieldwork would not have been possible without the logistical support provided by the Amazon Conservation Association (ACA), the Asociación para la Conservación de la Cuenca Amazonica (ACCA), and the staff of the Los Amigos Biological Station, including Jorge Herrera, Juan Carlos Flores, Giovana Espino, and Sonia Guerra. We also thank Asunción Cano of USM, Carlos Reynel of MOL, and staff of the Peruvian Ministry of Natural Resources (INRENA) for their support of our ongoing botanical research in Peru. Fernando Cornejo, Piher Maceda, Mathias Tobler, and Euridice Honorio provided essential assistance and collaboration during the field expeditions that made moss collections possible.

REFERENCES

Crosby, M.R., R.E. Magill, B. Allen, and S. He. 2000. A checklist of the mosses. Missouri Botanical Garden, St. Louis.

Davis, S.D., V.H. Heywood, O. Herrera-MacBryde, J. Villa-Lobos, and A.C. Hamilton. 1997. The Americas. Volume 3. V.H. Heywood and S.D. Davis, eds. Centres of plant diversity, a guide and strategy for their conservation. World Wildlife Fund for Nature (WWF) and IUCN–The World Conservation Union.

Foster, R., T.A. Parker III, A.H. Gentry, L.H. Emmons, A. Chicchón, T. Schulenberg, L. Rodríguez, G. Lamas, H. Ortega, J. Ocochea, W. Wust, M. Romo, J. A. Castillo, O. Phillips, C. Reynel, A. Kratter, P. K. Donahue, and L. J. Barkley. 1994. The Tambopata-Candamo Reserved Zone of southeastern Perú: A biological assessment. RAP Working Papers, Vol 6. Conservation International.

Gentry, A. H. 1982. Patterns of neotropical plant species diversity. Evol. Biol. 15:1–84.

Gentry, A. H. and B. León. 1997. Tambopata region, Peru. In: S.D. Davis, V.H. Heywood, O. Herrera-MacBryde, J. Villa-Lobos, and A.C. Hamilton, eds. Centres of plant diversity: a guide and strategy for their conservation, Volume 3–The Americas. WWF and IUCN, Oxford, England. Pp. 355–259.

Menzel, M. 1992. Preliminary checklist of the mosses of Peru (Studies on Peruvian bryophytes IV). J. Hattori Bot. Lab. 71:175–254.

Phillips, O. and A.H. Gentry. 1993a. The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. Econ. Bot. 47:15–32.

Phillips, O. and A.H. Gentry. 1993b. The useful plants of Tambopata, Peru: II. Additional hypotheses testing in quantitative ethnobotany. Econ. Bot. 47:15–32.

Phillips, O.L., R. Vásquez Martínez, P. Núñez Vargas, A. Lorenzo Monteagudo, M.-E. Chuspe Zans, W. Galiano Sánchez, A. Peña Cruz, M. Timaná, M. Yli-Halla, and S. Rose. 2003. Efficient plot-based tropical forest floristic assessment. J. Trop. Ecol. 19:629–645.

Pitman, N.C.A., J.W. Terborgh, M.R. Silman, and P. Núñez V. 1999. Tree species distributions in an upper Amazonian forest. Ecology 80:2651–2661.

Pitman, N.C.A., J.W. Terborgh, M.R. Silman, P. Núñez V., D.A. Neill, C.E. Cerón, W.A. Palacios, and M. Aulestia. 2001. Dominance and distribution of tree species in upper Amazonian terra firme forests. Ecology 82:2101–2117.

Stewart, P.D. 1988. Tambopata Reserved Zone, southeast Peru. Oryx 22:95–99.

Terborgh, J. 1994. An overview of research at the Cocha Cashu Biological Station. In: A.H. Gentry, ed. Four Neotropical Rainforests. Yale University Press, New Haven and London. Pp. 48–59.

Terborgh, J. and E. Anderson. 1998. The composition of Amazonian forests: patterns of local and regional scales. J. Trop. Ecol. 14:645–664.

Vargas, C. 1974. La flora del departamento de Madre de Dios (Perú). Lima, Perú.

KATHLEEN M. PETERSON
1948–2003

James L. Reveal[1]

University of Maryland
College Park, Maryland 20742, U.S.A.
The New York Botanical Garden
Bronx, New York 10458-5126, U.S.A.

ABSTRACT

Kathleen M. Peterson (1948–2003) is remembered as a student, gifted teacher, skilled botanist, lawyer, and friend all as an introduction of a new species of *Scutellaria* (*Lamiaceae*) from Mexico named in her honor.

KEY WORDS: *Scutellaria*, Lamiaceae, Mexico, obituary

RESUMEN

Kathleen M. Peterson (1948–2003) es recordada como una estudiante, profesora con talento, botánica de pericia, abogada, y amiga, todo como una introducción de una nueva especie de *Scutellaria* (*Lamiaceae*) de México nombrada en su honor.

The notice in the Harrisburg, Pennsylvania, paper, the *Patriot-News*, published on November 26, 2003 was short: "Kathleen M. Peterson, 55, of Camp Hill, died Monday, November 24, 2003 at Hospice of Central Pennsylvania, Carolyn Croxton Slane Residence. She was an attorney for the Pennsylvania Treasury Department. Services will be held at the convenience of the family. Arrangements are by the Cremation Society of Pennsylvania, Harrisburg." Nothing was mentioned of the person or her life as a botanist; we hope our words and actions in proposing *Scutellaria petersoniae* (Turner & Reveal 2004) in some way, will rectify the oversight for it is with sadness that we note to the botanical community the passing of Kathy Margaret Peterson.

Kathy Peterson was a graduate student at the University of Maryland from 1973 until 1978, where she received her doctoral degree, working on a portion of the mint genus *Salvia*. Her master's thesis was done with Dr. Willard Payne (The genus *Hymenoclea* (*Compositae: Ambrosieae*), *Brittonia* 25:243–256. 1973) at the University of Illinois (1969–1971) where she took her undergraduate degree in 1969. The two of them also published "Observations of the hypodermises of ferns" in the *American Fern Journal* (63:34–42. 1973). Based on her work at Maryland, she published "*Salvia reptans. Labiatae*" with Raymond M. Harley of the Royal Botanical Garden, Kew, England, in *Curtis's Botanical Magazine*

---

[1] Mailing address: 18625 Spring Canyon Road, Montrose, Colorado 81401-7906, U.S.A.

(182:13–16. 1978). As in all papers published in that journal, their comments were accompanied by a beautiful, full-page colored painting of the species.

Her research on *Salvia* was supported by a grant from the National Geographic Society and a Doctoral Dissertation Improvement Grant from the National Science Foundation. Together, she and Reveal presented a report entitled "Biosystematic and evolutionary studies of *Salvia* subgenus *Calosphace*" that was published in the Society's *Research Reports* (15:557–564. 1983). Of a more personal nature was an article of their travels in Mexico ("Exploring the green frontier" by Broome, Reveal and Peterson published in the *University of Maryland's Graduate School Chronicle* 10(4):3–6. 1977). C. Rose Broome and Kathy spent a month collecting prior to being joined by Reveal and Harley at the silver mining town of Toluca. Together they explored a portion of Guerrero that had not been visited botanically for several decades. The new finds were numerous. Among them were *Bouvardia hintoniorum*, *Galium iltisii*, *Hansteinia harleyi*, *Montanoa revealii*, *Salvia turneri*, *Sinclairia broomeae*, *Tibouchina patens*, and a new genus *Revealia*.

The most beautiful addition made during their joint trip across the Sierra Madre del Sur was a wonderful new species named *Utricularia petersoniae* by Peter Taylor (*Kew Bull.* 41:8.1986). It was a fitting tribute to Kathy, tall and slender yet graceful with an elegant beauty.

Kathy was born in Oak Park, Illinois, on March 10, 1948. Here she spent her youth, attending local grade and high schools before entering the University of Illinois in 1965. There she majored in botany with minors in chemistry and geology. As a youngster she was tall, taller than most boys her age, and this would continue to be the case throughout her life. She had elegance about her, borne by her height so that in the classroom she was a presence. At Maryland she tutored struggling athletes, and was most effective as she could intimidate the largest football player and look many a basketball player in the eye. Her wit was appreciated but her strength was as a teacher. In 1978 she received the Carroll E. Cox award as the outstanding graduate student; during the 1978–1979 academic year she was appointed an instructor at College Park. She departed soon thereafter to accept a position as an assistant professor at the University of Montana. Her skill in the classroom continued, for Kathy taught a variety of classes and soon had a small group of students working on graduate degrees, being named "KP" to distinguish her from the other Kathys in the group. Augmented by grants from the National Science Foundation and National Geographic Society she continued her work on *Salvia*. Other funding allowed her and her students to work on various rare and endangered species in Montana. Among her students were Jeffrey Strachan now with the Plant Variety Protection Office, U.S. Department of Agriculture, Lisa Campbell of The New York Botanical Garden, Jennifer Ramstetter, a professor of biology at Marlboro College, and Kathy Ahlenslager of the U.S. Forest Service who wrote a recent obituary (Ahlenslager 2004). Perhaps her greatest contribution to the University of Montana came in the form of her effort to upgrade the herbarium by hiring a collections manager, finding volunteers to mount and file thousands of plant specimens, and to distribute a large backlog accumulated over the decades.

Professionally Kathy moved upward. Besides her teaching duties she directed the operations of the University's natural history museum, wrote several research papers, served on the editorial board of *Systematic Botany*, and was president of the University of Montana Sigma Xi chapter. In 1984 she was promoted to the rank of associate professor, and in 1986 she received tenue. Along with tenure the University awarded her a "meritorious teaching and research salary increase." Most of her publications at this time dealt with rare plant species in Montana. They include "Vascular plants of limited distribution in Montana" (Lesica, P., G. Moore, K.M. Peterson, and J.H. Rumley, *Montana Acad. Sci. Monogr.* 2:1–61. 1984) and a summary report on rare plants in the state (Peterson, K.M., P. Lesica & J.S. Shelly, *Proceedings of the 1986 Natural Areas Conference*, pp. 97–113).

Then, in 1987, she suddenly resigned her position, left Montana, and botany as well, all for what proved to be an unfortunate, short-lived marriage which ended formally in divorce in 1994.

Finding herself in Pennsylvania, Kathy began a new career. She was certified as a paralegal by Pennsylvania State University in March of 1989 and then attended The Dickinson School of Law where she was awarded her J.D. in 1992. During this time she was a member of the *Dickinson Law Review* and the Appellate Moot Court Board; she also served on the editorial board of the *Dickinson Journal of Environmental Law and Policy*. In the *Review* she published an article entitled "Federal regulation of artificial insemination donor screening practices: An opportunity for law to co-evolve with medicine," a title only a biologist would think of. Her interest initially was in environmental law, working as an intern for the Department of Environmental Resources (1991–1992) and as a law clerk for the state's Treasury Department. In August of 1992, two months before being admitted to the Pennsylvania Bar, she became the Assistant General Counsel for Treasury.

As a lawyer, Kathy drafted banking service contracts between the Treasury and banks, prepared white papers on State Workers' Insurance Fund and the Federal Reserve System, did general legal research on banking and ethics issues, and provided litigation support for the General Counsel. In September of 1995 she was promoted to the Department's Associate General Counsel. In this position, she represented the State Treasurer on various committees, including the Board of Directors of Pennsylvania's chapter of The Nature Conservancy.

In 1999, Kathy discovered that she had ovarian cancer. Initially the combination of chemotherapy and radiation was successful, and during most of this time she continued to serve the citizens of Pennsylvania. In 2001 her doctors

Kathleen M. Peterson (1948–2003).

found a lesion on the brain. It was removed surgically, and she returned to work determined to beat the newly found cancer. Two weeks after surgery she fell and a MRI found more lesions. A second round of surgery was performed, but her chances of survival were greatly diminished. Up to the end, Kathy was a strong, stalwart woman, loosing a battle to cancer that two and half years early claimed her brother, and months before her own death, took her mother. It is in Kathy's memory that we dedicate the following new species.

ACKNOWLEDGMENTS

We are grateful to Carl Peterson, Kathy Ahlenslager and Jeff Strachan for providing us with insights into Kathy's life.

REFERENCES

Ahlenslager, K. 2004. Kathy Peterson (1948–2003). Friends Univ. Montana Herb. Spring 2004:1, 5.

Turner, B.L. and J.L. Reveal. 2004. *Scutellaria petersoniae* (*Lamiaceae*), a new species from Guerrero, Mexico. Sida 21:679–681.

BOOK REVIEWS

ANDREW PARKER. 2003. **In the Blink of an Eye**. (ISBN 0-465-05438-2 pbk.). Basic Books, 387 Park Avenue S., New York, N.Y. 10016, U.S.A. (Orders: 800-255-1514 or special.markets@perseusbooks.com). $15.00, 316 pp., b/w figures, index, 5" × 8".

In the new book *In The Blink Of An Eye*, author Andrew Parker puts a new spin on why animals first developed body armor during the Cambrian era. Parker contends that the discernable and sudden development of hard body coverings about 543 million years ago occurred to take advantage of the simultaneous development of higher-order vision in some animals. It was useful in attracting mates, and fighting off enemies, and being an effective predator.

This book takes the reader on an interesting expedition, through numerous fossil beds and to examine creatures living today throughout the world to discover the role of color and light in the evolution of Cambrian-era organisms. Parker presents a powerful and evidence-packed argument suggesting the cause of the Cambrian explosion, the sudden formation of body coverings, armament and distinct shapes around 543 million years ago, as the onset of organisms producing true vision and the ability to pursue prey.

The opening chapters present a well-organized mini "history of life" book and discussion of how fossils are investigated to give researchers clues on the appearance of and the living environment of those fossil organisms. These introductory chapters are helpful for the reader to get a good understanding of the argument about to be discussed. Following the background chapters, a good deal of information and numerous interesting examples are presented on the importance of visual appearance and behavior of various creatures as a response to light. For instance, examples included multilayer reflectors of Messel fossil beetles and Hercules beetles that alter the color of their appearance as humidity conditions change within layers of their body. Adaptations discussed included pigments, structural colors (such as iridescent film on wings), natural liquid crystals, diffraction, reflection layers and bioluminescence, all of which cause specific visual appearances. The uses of these visual appearances include camouflage, warning coloration, defense, and mating attractants. Information and examples presented included both fossil and extant organism evidence. Many of the adaptations discussed can only be seen if light is present. Therefore, many of the color, shape and behavior adaptations presented give clues as to the environment an organism could be found.

Vision as the cause of the Cambrian explosion is supported by evidence of the potential evolution of the eye in a short period of time (geologically speaking), and the ability of organisms to see their environment and more importantly (their) prey. It was determined possible for true eyes, eyes which not only vaguely perceive light and darkness, but form a true visual image in which the organism can "see" its surroundings, could evolve over less than half a million years. In addition, the strongest evidence for the author's theory is the occurrence of soft-bodied trilobites with no eyes in the Pre-Cambrian, then the abundance of trilobites with eyes and body armor in the Cambrian. The development of the first true eyes was followed by a rapid evolution of body color, body structure and behavior; all of these increased the capacity to be a predator and the avoidance of becoming prey through the formation of body armor and deterrents such as spines. The author does leave the reader with a parting question: "What prompted the development of the eye in the first place?"

Andrew Parker has presented a well-organized argument for vision as a trigger for the Cambrian explosion. He managed to explain the theory in a logical pattern while using both an educational and entertaining writing style. However, because each chapter entails so many details, I recommend you read each chapter beginning to end nonstop; doing so helps keep the ideas together.

One small complaint is the occasional reference to image plates that are not in the book. These plates would have enhanced the understanding of the information presented. This book is recommended for those interested in the Cambrian age, evolution, the development of vision, and body structural colors in insects and aquatic life.—*Lee Luckeydoo, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Grape Man of Texas

SHERRIE S. MCLEROY and ROY E. RENFRO, JR. 2004. **Grape Man of Texas: The Life of T.V. Munson.** (ISBN 1-57168-819-6, hbk.) Eakin Press, P.O. Drawer 90159, Austin, Texas 78709-0159, U.S.A. (Orders: 512-288-1771; 800-880-8642; 512-288-1813 fax; Service and Sales: sales@eakinpress.com). $39.95, 296 pp., color and b/w figures, 7" × 10".

Grape Man of Texas: The Life of T.V. Munson is the first biography written about this eminent Texas horticulturist. He became one of the leading experts in native American grape species, and his studies were instrumental in saving the European grape and wine industry from disaster in the late nineteenth century. Munson developed over 300 new grapes but is perhaps best known for his efforts in fighting the phylloxera epidemic of the late 19th century, for which he received the Chevalier du Merite Agricole and inducted into the French Legion of Honor. He was also a leader in the viniculture movement of the period for his cutting-edge work in breeding new grape and plant varieties. His articles, experiments, correspondence, speeches, exhibits, grape classifications, and numerous inventions reveal his scientific thirst for knowledge and his wide-ranging interests.

Over 100 years ago Cognac, France and Denison, Texas shared two of it's citizens with the world to solve a major destructive force—the grapevine destroyer, phylloxera. It was 1880 and the phylloxera plague was rampant in France, especially in the Charante Region where Cognac is located. The phylloxera root louse was destroying the prestigious French winegrapes and therefore, destroying the economy of France. France assigned the preeminent French scientist, Pierre Viala the task of finding a cure for the phylloxera plague. This investigation brought him to the United States and to the home of Thomas Volney Munson in Denison, Texas. The two scientists collaborated on the problem for several days in Denison and various other locations in Texas to view the native grapes of Texas in their natural habitat. The soils of the Charante, in France, and Denison are very similar and therefore should support grape species capable of growing in either location. T.V. Munson suggested that the only way to save the French vineyards was to graft the *Vitis vinifera* varieties to resistant rootstocks. Munson knew that the Texas rootstocks were resistant to phylloxera and at his suggestion, Pierre Viala agreed that it was a good plan of action. Thousands of bundles of Texas rootstocks were shipped to France where Pierre Viala and other French scientists started educating the French winegrowers on the enormous grafting tasks that lay ahead. The grafting literally continues to this day.

For his monumental contributions to France, T.V. Munson was awarded the highest award that could be given a foreign civilian, the Chevalier du Merite Agricole and was inducted into the Legion of Honor in 1888. In 1898 he was elected as a foreign corresponding member of the Societe Nationale d'Agriculture de France and as an honorary member in the Societe des Viticulteurs de France. Several statues honoring Munson have been erected in France.

Nearly 300 pages long, the *Grape Man of Texas* includes more than 100 illustrations, many never before published; the first listing compiled since Munson's death of his 300+ grape hybrids and their parentages; a list of his wild grape discoveries, several of which remain important in modern viticulture and research; and a list of all of Munson's known speeches and publications.

Released in June 2004, *Grape Man of Texas* soon received its first international accolade when it was awarded a prestigious three stars from the Gourmand World Cookbook Awards, which recognize the finest in international food and wine books. The organization inaugurated the rating system this summer to rank the 4,000-plus books entered each year in its "Best in the World" competition. Gourmand defines these 3-star books as "masterpieces—buy and read immediately." *Grape Man*, the Gourmand press release states, is "a very important book for wine history." It is one of only four American books and 19 worldwide to be honored on the inaugural list.

The book was co-written by award-winning Texas author and historian Sherrie S. McLeRoy and by Dr. Roy E. Renfro, Jr., director of the T.V. Munson Viticulture and Enology Center in Denison, Texas.—*Gary L. Jennings, Librarian, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

Preservation of the Big Thicket

James J. Cozine, Jr. 2004. **Saving the Big Thicket: From Exploration to Preservation, 1685–2003.** (ISBN 1-57441-175-6, hbk.). University of North Texas Press, P.O. Box 311336, Denton, TX 76203-1336, U.S.A. (Orders: 1-800-826-8911, 940-565-4590 fax, rchrisman@unt.edu, www.unt.edu/untpress). $34.95, 272pp, 5 maps, 25 illustrations, 6" × 9".

Saving the Big Thicket: From Exploration to Preservation, 1685-2003 is the fourth in the Temple Big Thicket Series published by University of North Texas Press. Originally written by Cozine in 1976 as part of a dissertation literature entitled *Assault on a Wilderness*, the work has been updated to the present time and now includes a foreword and afterword by Pete A.Y. Gunter, author of another book in this series, *The Big Thicket: An Ecological Reevaluation*. *Saving the Big Thicket* is an account of the regional history and "play-by-play" of the political fight for the Big Thicket National Preserve (BTNP) with the afterword by Gunter detailing the more recent issues in the area since Cozine's original 1976 manuscript was published.

The foreword by Gunter describes the work of the author and his involvement and perseverance on this work, presents a general construction of the book and provides some insight into the process of constructing an overview of a region with such a long and complicated history. Introductory material gives a brief description of the units that make up the preserve, general ecosystems and plant diversity found in each, along with information about the creation of the units, trails and structures. Two maps from Cozine's original work accompany this first section. Cozine divides the history of the region into six time periods of human involvement: early Native American use, French and Spanish arrival and attempted settlement, the coming of early American backwoods settlers, initiation of logging railroads (for large-scale timbering) and oil exploration, the beginning of an early conservation movement and finally the formation of the second Big Thicket Association and creation of BTNP. Each section provides great detail and historical information on the people, organizations and industries that became involved with the land, how they used it, settled it (or attempted to), helped destroy it and eventually helped save it. The first few chapters involve pre-industry human effects on the Big Thicket, outlining the Native American tribes that lived in the area leaving a minimal impact, the arrival of the Spanish and French explorers that interacted with the Native American tribes, and finally the greater impact of backwoodsmen, escaped slaves, criminals and hunters seeking refuge in the Big Thicket. The following chapters address the arrival of timber railways, oil exploration and the incredible environmental damage to the region that came with them, the rise and fall of the original East Texas Big Thicket Association who first raised the environmental flag in the Big Thicket and the eventual creation of the Big Thicket National Preserve with the aid of the second (and successful) Big Thicket Association in 1974. Each of these chapters is riddled with political and social struggles among the groups involved and with the tale of destruction and human impact on the region's incredible biodiversity.

Throughout the book there are a total of 5 maps from Cozine's 1976 publication. The quality of these maps is that of the original publication era and they are somewhat difficult to interpret. There is also a central section containing 19 black and white photographs from Cozine's original work These photographs depict scenes from the early 1900's of bear hunts and early scenes in the big thicket, but the section mostly contains portraits and casual photographs of prominent politicians, activists, industry representatives and other people involved in the history of the area. These photographs are of poor quality and add little useful information or perspective to the book, besides presenting a pictorial record of the prominent figures in the Big Thicket's history.

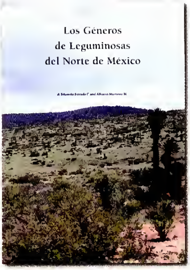
The afterword by Gunter is a well-written account of the political, environmental and park management struggles since the creation of the park. It is a detailed account of complications that have arisen since the initial creation of the BTNP. Gunter divides this afterword into five sections addressing the bureaucratic beginnings of the park, the acquisition of new units and river property, further development of the park and facilities, and what Gunter calls a "New Big Thicket Crisis" about a struggle to add controversial new tracts of land, and finally what he calls a "postscript to a postscript" introducing, but not expounding on, peripheral issues affecting the Big Thicket.

Each section discussed above ends with a set of notes and references and a thorough index makes for easy location of subjects, organizations and persons mentioned in this book. *Saving the Big Thicket* provides a well-written historical account of the Big Thicket and is a good addition to the UNT Press series on the region. This work could be useful to historians, scientific researchers, restoration project managers, students, and the casual reader alike interested in the region's complex and "entangled" history.—*J. Hayley Gillespie, University of Texas at Austin, Integrative Biology, Austin, TX 78712, U.S.A., hayleygillespie@mail.utexas.edu*

This illustrated monograph is the most comprehensive generic treatment of legumes for any geographical area of Mexico. The book covers the genera of legumes known to be present in northern Mexico from Tamaulipas to Baja California Sur. The introductory material covers topography, climate, and vegetation types of northern Mexico. Included are 121 genera treated in three families: Fabaceae, Mimosaceae, and Caesalpiniaceae. The Fabaceae is the most abundant family with 87 genera followed by Mimosaceae (19) and Caesalpiniaceae (15). Keys to the families, tribes (only in Fabaceae), genera, and detailed line drawings of distinguishing characteristics are included for most of the genera to facilitate identification. Each genus is provided with a description, followed by distributional information, species number, chromosome number, and economic, ecological, and potential food importance.

Available from
Botanical Research Institute of Texas Press
509 Pecan Street
Fort Worth, TX 76102-4060, USA
E-mail: sida@brit.org • Fax 1-817-332-4112
www.brit.org/Sida/Sida25.htm

Sida, Bot. Misc. No. 25, 2004
issn 0833-1475, isbn 1-889878-13-8 • 7" · 10", x + 134 pp,
over 500 individual drawings.
$25 + p&h • (USA $3; International $7)
Texas residents add $2.06 sales tax



**Los Géneros
de Leguminosas
del Norte de México
(The Genera of Legumes
of Northern Mexico)**

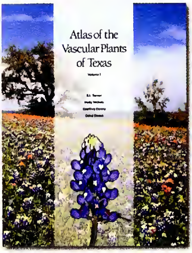
By
A. Eduardo Estrada C.
and
Alfonso Martínez M.

BRIT
PRESS

The Atlas of Texas covers about 6000 taxa. This is the result of 54 years of herbarium and fieldwork by B.L. Turner, beginning in 1948 at Sul Ross State University, Alpine, Texas. In short, the senior author has examined personally, touched, or "pored over" an estimated several hundred thousand sheets in the preparation of the forthcoming Atlas volumes. Contents include an introduction, atlas of Texas plants arranged alphabetically by family, by genus, by species, and an index.

Available from
Botanical Research Institute of Texas Press
509 Pecan Street
Fort Worth, TX 76102-4060, USA
E-mail: sida@brit.org • Fax 1-817-332-4112
www.brit.org/Sida/Sida/24.htm

Sida, Bot. Misc. No. 24, 2003, issn 0833-1475,
isbn (vol. 1) 1-889878-08-1 • isbn (vol. 2) 1-889878-09-X • 7 1/2" × 10"
Vol. 1 approx. 630 pp. • Vol. 2 approx. 275 pp.
Vol. 1 $50 + p&h* • Vol. 2 $40 + p&h* • Set $80 + p&h*
*USA: $10 (vol. 1); $9.50 (vol. 2); $12 (set)
*International: $12.50 (vol. 1) • $11.50 (vol. 2); $25 (set)
Texas residents add sales tax: $4.13 (vol. 1) • $3.30 (vol. 2) • $7.43 (set)



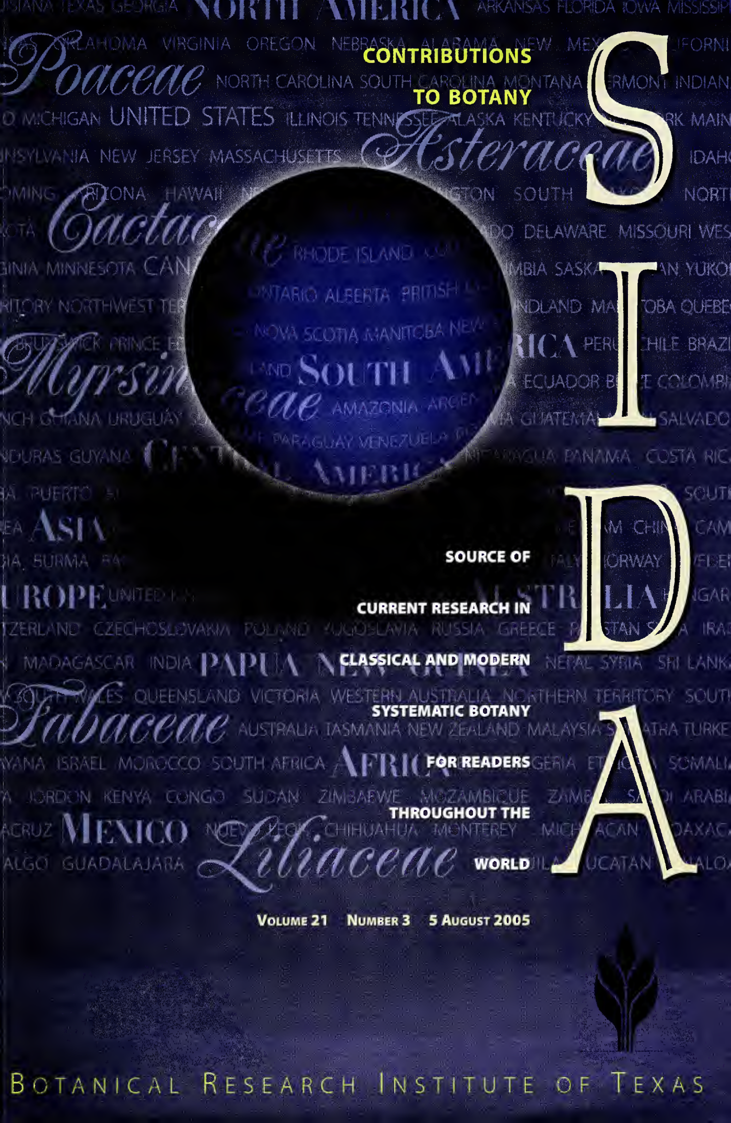
**Atlas of the
Vascular Plants of Texas**

By
B.L. Turner,
Holly Nichols, Geoffrey Denny,
Oded Doron

BRIT
PRESS

UISIANA TEXAS GEORGIA NORTH AMERICA ARKANSAS FLORIDA IOWA MISSIS
ANSAS OKLAHOMA VIRGINIA OREGON NEBRASKA ALABAMA NEW MEXICO CALIFO
Poaceae NORTH CAROLINA SOUTH CAROLINA MONTANA VERMONT INDI
HIO MICHIGAN UNITED STATES ILLINOIS TENNESSEE ALASKA KENTUCKY NEW YORK MA
ENNSYLVANIA NEW JERSEY MASSACHUSETTS *Asteraceae* IDA
YOMING ARIZONA HAWAII NEVADA UTAH WASHINGTON SOUTH DAKOTA NO
AKOTA *Cactaceae* RHODE ISLAND COLORADO DELAWARE MISSOURI W
RGINIA MINNESOTA CANADA ONTARIO ALBERTA BRITISH COLUMBIA SASKATCHEWAN YU
RRITORY NORTHWEST TERRITORIES NOVA SCOTIA MANITOBA NEWFOUNDLAND MANATOBA CU
EW BRUNSWICK PRINCE EDWARD ISLAND SOUTH AMERICA PERU CHILE BR
Myrsinaceae AMAZONIA ARGENTINA ECUADOR BELIZE COLO
RENCH GUIANA URUGUAY SURINAME PARAGUAY VENEZUELA BOLIVIA GUATEMALA SAN SALVA
ONDURAS GUYANA CENTRAL AMERICA NICARAGUA PANAMA COSTA
UBA PUERTO RICO DOMINICAN REPUBLIC HAITI BAHAMAS JAMAICA NORTH & SO
OREA ASIA TAIWAN JAPAN *Orchidaceae* VIETNAM CHINA C
ODIA BURMA BANGLADESH MALAYSIA IRELAND FRANCE GERMANY ITALY NORWAY SWE
EUROPE UNITED KINGDOM PHILIPPINES FINL
AUSTRALIA HUNGARY SWITZERLAND CZECHOSLOVAKIA POLAND YUGOSLAVIA
A GREECE PAKISTAN SYRIA IRAQ IRAN MADAGASCAR INDIA PAPUA NE
GUINEA NEPAL SYRIA SRI LANKA NEW SOUTH WALES QUEENSLAND VICTORIA WES
USTRALIA NORTHERN TERRITORY SOUTH *Fabaceae* AUSTRALIA TA
A NEW ZEALAND MALAYSIA SUMATRA TU
UAYANA ISRAEL MOROCCO SOUTH AFRICA AFRICA EGYPT NIGERIA ETHIOPIA SO
A LIBYA JORDON KENYA CONGO SUDAN ZIMBABWE MOZAMBIQUE ZAMBIA SAUDI A
RACRUZ MEXICO NUEVO LEON CHIHUAHUA MONTEREY MICHOACAN OA
IDALGO GUADALAJARA *Liliaceae* COAHUILA YUCATAN SIN

ISSN 0036-1488



CONTRIBUTIONS
TO BOTANY

SIDA

SOURCE OF
CURRENT RESEARCH IN
CLASSICAL AND MODERN
SYSTEMATIC BOTANY
FOR READERS
THROUGHOUT THE
WORLD

VOLUME 21 NUMBER 3 5 AUGUST 2005

BOTANICAL RESEARCH INSTITUTE OF TEXAS

Sida Contributions to Botany was founded by Lloyd H. Shinners (left) in 1962. Inherited by William F. Mahler (right), Director Emeritus of BRIT in 1971, and since 1993, it has been published by BRIT Press.

Barney L. Lipscomb, Editor

Botanical Research Institute of Texas

509 Pecan Street

Fort Worth, Texas 76102-4060, USA

817 332 4441 / 817 332-4112 FAX

Electronic mail: sida@brit.org

Home page at the URL: http://www.brit.org/sida/

John W. Thieret, Associate Editor

Dept. of Biological Sciences

Northern Kentucky University

Highland Heights, KY 41099 USA

Félix Llamas, Contributing Spanish Editor

Dpto de Botánica, Facultad de Biologia

Universidad de León

E-2471 León, SPAIN

The views expressed in this journal do not necessarily reflect those of the editors or of the Botanical Research Institute of Texas

Guidelines for contributors are available upon request and on our SIDA home page as well as the last pages of each volume.

Subscriptions for year 2005:

$37. Individual

$65. USA Institutions

$75. Outside USA

numbers issued twice a year

BRIT
PRESS

©Sida, Contributions to Botany

Volume 21, Number 3, pages 1249–1954.

5 August 2005

Printed in the United States of America

ISSN 0036-1488

TABLE OF CONTENTS

SYSTEMATICS

CHROMOSOME NUMBERS

DEVELOPMENT AND STRUCTURE

FLORISTICS, ECOLOGY, AND CONSERVATION

COMMEMORATIVE

Index to new names and new combinations in Sida 21(3), 2005

A NEW SPECIES OF *SABATIA* (GENTIANACEAE) FROM SALINE COUNTY, ARKANSAS

James S. Pringle

Royal Botanical Gardens
P.O. Box 399
Hamilton, Ontario
CANADA L8N 3H8
jpringle@rbg.ca

Theo Witsell

Arkansas Natural Heritage Commission
1500 Tower Building
323 Center St.
Little Rock, Arkansas 72201, U.S.A.
theo@arkansasheritage.org

ABSTRACT

Sabatia arkansana, a new species from shale and igneous glades in central Arkansas, is described. It differs from *S. campestris* in its narrower leaves and narrower, more deeply colored corolla lobes rounded at the apex.

RESUMEN

Se describe **Sabatia arkansana,** especie nueva de claros de esquistos y de rocas ígneas en Arkansas central. Se diferencia de *S. campestris* por las hojas más angostas y por los lóbulos de la corola más angostos, coloreados más intensamente, y redondeados en el ápice.

HISTORY OF THE DISCOVERY

In June 2001, while collecting plants for the Flora of Arkansas Project and for his Master's thesis, the junior author was shown a small shale glade (Womble Formation) northwest of Owensville, Saline County, Arkansas, by nature photographer and amateur botanist John Pelton. Pelton, a long-time student of the flora of Arkansas and of Saline County in particular, was especially interested in showing Witsell plants of a *Sabatia* that he was unable to identify to species. Witsell collected specimens of this plant, as well as specimens of *Sabatia campestris* Nutt., which occurred in the same area.

Studies using all relevant botanical references available at the Arkansas Natural Heritage Commission and the University of Arkansas at Fayetteville Herbarium (UARK) supported the idea that this species was significantly different from any described in the literature. In any of the regionally appropriate keys, specimens of this plant keyed out to *S. campestris*. However, seeing *S. campestris* and this new species occurring at the same site made the differences between the two obvious (Fig. 3).

Conversations with the landowner at this site revealed the existence of another, larger glade opening 0.2 mile (0.3 km) northwest of the known glade. This glade was impressive in its botanical diversity and in that two intermittent spring-fed streams flow into the glade and join before flowing out of the glade downslope. More plants of this new *Sabatia* were found in this opening, which should be considered part of the same complex rather than a completely separate site.

In June 2002, while conducting surveys for the rare small-headed pipewort (*Eriocaulon kornickianum*) on igneous glades near Bauxite, Saline County, Arkansas, Witsell and Pelton located several more populations of this *Sabatia*.

Witsell compared the Saline County specimens with *Sabatia* specimens from a broader region at the herbarium of the Missouri Botanical Garden (MO) in July 2002. When no matches were found at MO, the Saline County specimens were sent to the senior author for confirmation that this was indeed a species new to science.

DESCRIPTION OF THE SPECIES

Sabatia arkansana J.S. Pringle & C.T. Witsell, sp. nov. **(Figs. 1–5)**. TYPE: ARKANSAS: Saline Co.: Alcoa Lake Glades Natural Area, 3.5 mi (5.6 km) SE of Bauxite, NE 1/4 of SW 1/4 of Section 26, T2S R14W, northernmost glade opening on W shore of lake, 18 Jun 2002, *Witsell 02-0832* (HOLOTYPE: UARK; ISOTYPE: MO).

Sabatia campestri affinis sed foliis linearibus vel anguste lanceolatis et corollis atroroseis lobis anguste spathulatis apicem versus rotundatis differens.

Annuals; roots fibrous. Plants 7–25 cm tall, single-stemmed at base. Stems ± terete but narrowly 4-winged; proximal diameter 0.4–1.3 mm, wings ca. 0.1–0.2 mm high; branching generally alternate (rarely opposite proximally), mostly at 30–50°, lowest branching ca. mid-height. Proximal internodes 0.8–2× as long as subtending leaves, distal internodes 0.6–1× as long. Leaves all cauline, bright green, membranous, spreading, linear to lanceolate; most leaves 7–30 × 1–4.5(–6) mm; bases narrowed, not clasping, apices obtuse (proximal leaves) to acute or acuminate (mid-stem and distal leaves); leaves smaller near base of stem, lowermost leaves minute. Inflorescence a ± corymboid, monochasial cyme; flowers 1–12(–18) per plant. Pedicels (2–)10–40 mm. Perianth and androecium pentamerous. Calyx (0.7–)1.0–1.4× as long as corolla; tube turbinate, green along commissural veins, otherwise whitish and nearly hyaline, 2.8–5.5 mm, 0.7–0.9× as long as corolla tube; ridges present along commissural veins of tube, triangular in cross-section, rounded or distally acute along apex but not winged, widening from 0.2–0.5 mm at base to 0.5–0.8 mm at summit of tube, where there is sometimes a minute protuberance, dividing into lower ridges along submarginal veins of lobes; lobes green, spreading at 60–90°, nearly filiform to linear, 9–13 × 0.6–1.2 mm, apices acute. Corolla deep but bright magenta-pink, with an oblong-triangular, sometimes apically notched yellow zone extending from tube into each lobe along midrib, alternating with shorter, yellowish-white zones flanking sinuses; tube 3–7 mm; lobes narrowly spatulate-obovate, 8–18 × 3–6 mm, apices rounded. Filaments (3–)4–5.5 mm, ca. 1.5× as long as uncoiled anthers; anthers yellow, 2.3–3.5 mm long before coiling. Pollen grains subprolate, 33–38 µm long, 27–34 µm in diameter. Uncleft portion of style 2–3.5 mm, style

Fig. 1. ***Sabatia arkansana*, holotype.**

branches plus stigmas when uncoiled (3–)4.5–6 mm, 1.7–2.5× as long as uncleft portion.

Paratypes: **ARKANSAS: Saline Co.:** Bauxite, sandy outwash on rock outcrop, 6 Jun 1950, *Moore 50-0161* (UARK); locality and date uncertain (see note below), *Moore 50-0168* (UARK); Womble Shale glade on W side of Burk Rd. NW of Owensville, 21 Jun 2001, *Witsell 01-0474*; Alcoa Clear Lake Glade, 2.5 mi (4.0 km) ESE of Bauxite, N 1/2 of NW 1/4 of NW 1/4 of Section 23, T2S R14W, 18 Jun 2002, *Witsell 02-0829*; Womble Shale glade E of Burk Road and W of the Middle Fork of the Saline River, NW of Owensville, NE 1/4 of SE 1/4 of Section 17, T1S R17W, 18 Jun 2002, *Witsell 02-0825*; International

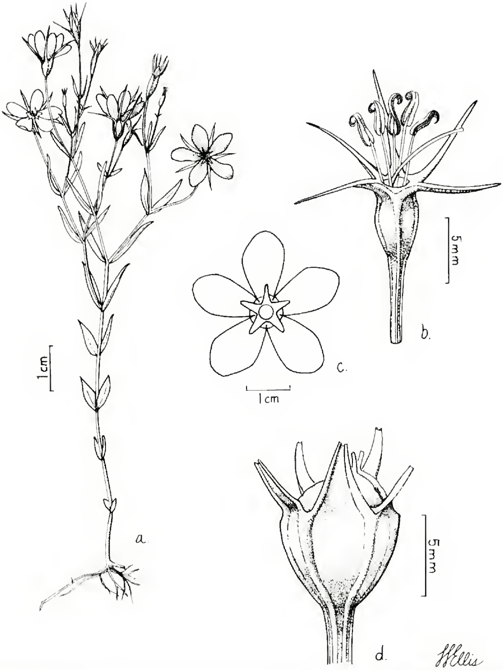


Fig. 2. ***Sabatia arkansana*****. A.** Plant (*Witsell 02-0829*, UARK). **B.** Flower, lateral view with petals removed, anthers newly dehisced and the stigma not yet receptive (*Witsell 02-0832*, UARK). **C.** Flower, adaxial view with stamens and sepals removed (*Witsell 02-0832*, UARK). **D.** Capsule, largely enclosed in persistent calyx (*Witsell 02-1125*, UARK).

Paper Pipewort Glades Preserve [now Dunnahoo Preserve, The Nature Conservancy], 3.5 mi (5.6 km) SE of Bauxite, NE 1/2 of NE 1/4 of Section 34, T2S R14W, 19 Jun 2002, *Witsell 02-0838*; Dry Lost Creek Glades, 1.75 mi (2.8 km) SE of Bauxite, E 1/2 of SE 1/4 of Section 21, T2S R14W, 19 Jun 2002, *Witsell 02-0840*, Womble Shale glades E of Burk Road and W of the Middle Fork of the Saline River, NW of Owensville, NE 1/4 of SE 1/4 of Section 17, T1S R17W, 10 Aug 2002, *Witsell 02-1125*. Unless otherwise indicated, specimens are in the herbarium of the Arkansas Natural Heritage Commission

The two specimens collected by D.M. Moore in 1950 were originally identified as *Sabatia campestris*. *Moore 50-0161* was labeled as being collected at Bauxite 6 June. *Moore 50-0168*, although bearing a higher number, was labeled as being collected 15 miles south of Little Rock, near Ferguson Lake, the previous day. Ferguson Lake is in extreme southeastern Saline County, on unconsolidated Tertiary and Quaternary sediments (Haley et al. 1976). No rock outcrops or glades—that is, no suitable habitats for *S. arkansana*—are known from the area. It is unlikely that *S. arkansana* actually occurred at this site, and it may be that specimens from the two sites were mixed up.

The genus *Sabatia* Adans. and its sections and subsections have been described by Wilbur (1955). *Sabatia arkansana* is unequivocally a species of sect. *Campestria* J.D. Perry. This section, which is well defined morphologically and isolated genetically, is most readily recognizable by its calyx morphology (Wilbur 1955; Perry 1971). In all species in the section, prominent ridges extend along the commissural (fused lateral) veins from the base of the calyx to the sinuses between the lobes. At the sinuses they divide and extend along the submarginal veins of the adjacent lobes. The commissural and submarginal veins, therefore, are more prominent than the midveins, which are not ridged. In the other sections the calyx tubes either lack ridges along the veins or have low-ridged commissural veins that are no more prominent than the midveins. Plants in sect. *Campestria* are annuals, and the branching is entirely or predominantly alternate. The flowers are pedicellate and are pentamerous except for the carpels. Except in *S. arenicola*, the eye of the corolla is of the shape and pattern described above for *S. arkansana*, as contrasted with the more widely triangular yellow zones of most species with pink corollas in the other sections. The stamens are inserted immediately below the sinuses of the corolla. The combinations of style branches plus stigmas are linear. The morphology of *S. arkansana* is consistent with that of the section in all of these respects.

Sabatia arkansana exhibits the syndrome of floral morphology associated with predominantly allogamous pollination in *Sabatia* (Hill 1891; Perry 1971). The corollas are showy and brightly colored, with sharply contrasting eyes. The flowers are protandrous. Initially the styles and stigmas are bent nearly horizontally to one side, and the style branches are helically coiled around each other, so that the stigmatic surfaces are not exposed. At this stage the stamens are nearly erect. The anthers, when mature, coil circinately at the tip, with the rest of the anther still being straight and nearly erect when the pollen sacs dehisce. Subsequently the stamens diverge and the whole anther curves into a bass-clef shape. The stigmas then become receptive. The uncleft portion of the style becomes erect, and the branches diverge and uncoil more or less completely.

Etymology and common name.—We name this new species *Sabatia arkansana* for the state to which it is apparently endemic. We propose the common name

Fig. 3. *Sabatia arkansana* (right), with *Sabatia campestris* (left) at the Womble Shale glade site. Photo by John Pelton.

"Pelton's rose-gentian" in honor of John Pelton, who first noticed that this species was distinct from *S. campestris*, but was too humble to allow a scientific name to be given in his honor. He has done much to further our knowledge and appreciation of the flora of Arkansas through his insight, his photography, and his encouragement and tutelage of younger students of the flora.

COMPARISON WITH RELATED SPECIES

Only three species, or in some treatments only two, have generally been recognized in sect. *Campestria* (Wilbur 1955; Perry 1971; Bell & Lester 1980). The leaves of *S. arkansana* are narrower than those of any other species in the section. The mid-stem leaves of the largest plants of *S. arkansana* are linear to narrowly lanceolate, 4–8× times as long as wide, with three primary veins. Except for one pair of leaves on one plant that were 6 mm wide, the maximum width of any leaf seen was 4.5 mm. All leaves of the smaller plants are linear, 1–2 mm wide, with one primary vein. Also uniquely in the section, the corolla lobes of *S. arkansana* are narrowly spatulate-obovate, generally more than 1.8× and often more than 2.2× as long as wide. They are widest at ca. 0.8× their length. The apex is rounded.

Sabatia campestris Nutt., the most widespread species in sect. *Campestria*, is the most similar to *S. arkansana*. Both *S. arkansana* and *S. campestris* (*Witsell 01-0473*) were found at the locality where *Witsell 01-0474* was collected. At this

Fig. 4. *Sabatia arkansana*, habit. Photo by John Pelton.

Fig. 5. *Sabatia arkansana*, detail of inflorescence. Photo by John Pelton.

site as elsewhere *S. arkansana* appears distinctly different in the field, and does not intergrade with *S. campestris*. Plants of *S. campestris* are larger than those of *S. arkansana* in nearby sites. Its leaves are ovate to lance-elliptic, 8–40 mm long × 5–20 mm wide, with clasping, rounded to subcordate bases. The ridges on its calyx tube have a distinct wing or keel along the apex, ca. 1.0 mm high, which projects slightly above the sinus. Its corollas are a paler, less purplish shade of pink. Its corolla lobes are obovate, less than 1.8× as long as wide, and are widest at ca. 0.6× their length. The apex is usually abruptly acute, occasionally obtuse.

The pollen grains of *Sabatia* are tricolporate, with a finely reticulate exine. Perry (1971) concluded that pollen size was not useful as an indicator of ploidy or as a species characteristic, and that neither shape nor exine sculpturing differed significantly among the species. The pollen of *S. arkansana*, however, is subprolate, and grains in equatorial view are as numerous as those in polar view or more so on a microscope slide. That of *S. campestris*, as seen in the present study, is more nearly spherical, 26–30 μm in diameter, i.e., slightly smaller than that of *S. arkansana*, and, as noted by Perry (1971), nearly always appears in polar view when placed on a slide.

At the Womble Formation locality near Owensville, *S. arkansana* is confined to open, flat, seasonally wet, narrow floodplains and seepage areas, whereas *S. campestris* grows in better-drained, steeper, drier microhabitats. Each of the two species occupies a distinct zone within the glades. Occasional plants of *S. campestris* occur within the microhabitat occupied by *S. arkansana* (Fig. 3) and, as noted above, no intergradation has been observed. *Sabatia campestris* is apparently absent from all of the glades on the nepheline syenite batholith near Bauxite. The two species also differ distinctly in phenology. Based on observations from 2001 through 2004, *S. arkansana* typically begins flowering 7 to 10 days before *S. campestris*, and *S. campestris* continues flowering at least 7 days after *S. arkansana*.

Sabatia formosa Buckley is known from Louisiana, Oklahoma, and Texas. It is recognized here following Bell and Lester (1978, 1980), but has often been included in *S. campestris* (Wilbur 1955). *Sabatia arkansana* is more similar to *S. formosa* than to *S. campestris* in its corolla color and markings but not in other respects. *Sabatia formosa* has closely spaced basal and near-basal leaves, which are larger than the mid-stem leaves and are generally present at flowering time, whereas in *S. arkansana* there is no evidence from crowded leaf-scars that a basal rosette is present at any stage. The proximal and mid-stem leaves of *S. formosa* are lanceolate to ovate, 8–25 × 3–13 mm. Its calyces are usually shorter than the corollas. Its corolla lobes are elliptic-rhombic, less than 1.8× as long as wide, and are widest near the middle, tapering to an obtuse to acute apex.

Sabatia arenicola Greenm. (including *S. carnosa* Small) is a seabeach species, native along the Gulf Coast from Louisiana to Tamaulipas. Unlike *S.*

arkansana it frequently branches from near the base, and its relatively copious and dense branching is proximally more often opposite than that of the other species in section *Campestria*. Its leaves are succulent when fresh and blacken upon drying. They are elliptic to ovate or obovate, 6–27 × 2–13 mm. Its calyx lobes are oblong-lanceolate to narrowly ovate-triangular. It differs further in exhibiting the floral morphology associated with autogamy in *Sabatia*. It has relatively small corollas, which are white or light pink with the eyes whitish and less sharply defined than those of the allogamous species. The styles are nearly erect when the flowers open, and the stigmas are receptive concurrently with rather than after the dehiscence of the anthers.

Only two other validly published names have been associated with sect. *Campestria*, and it is evident that neither was based on specimens of *S. arkansana*. *Sabatia nervosa* Raf. was included in *S. campestris* by Wilbur (1955). Its leaves were described as ovate-lanceolate and its corolla lobes as broadly obovate. The identity of *S. concinna* Alph.Wood, which presumably was based on specimens from Indiana, is uncertain. It was described as having opposite branching, which would be inconsistent with its inclusion in sect. *Campestria*, and calyces only half as long as the corollas.

Small plants of *S. campanulata* (L.) Torr., in sect. *Sabatia* subsect. *Campanulatae* S.F.Blake, are somewhat similar to *S. arkansana* in aspect. *Sabatia campanulata* is an extremely rare (S1) species in Arkansas. It has narrow leaves and calyx lobes, but the plants are perennial, usually with clustered stems, and the pedicels are mostly 40–70 mm. The calyx tube of *S. campanulata* is obconic, only 1–3 mm long and less than 0.5× as long as the corolla tube. Ridges along the commissural veins are absent or low and no more prominent than those along the midveins.

Sabatia arkansana cannot plausibly be interpreted as a recurrently produced interspecific hybrid. In most populations it is the only *Sabatia* species present. Other than *S. campestris*, the only *Sabatia* that has been found in the vicinity of *S. arkansana* is *S. angularis* (L.) Pursh, in sect. *Sabatia* subsect. *Angulares* S.F.Blake. *Sabatia angularis* does not intergrade with *S. arkansana*, and its morphology, which includes opposite branching, stem wings 0.2–0.3 mm high, and lanceolate to ovate leaves 5–30(–40) mm wide, does not suggest that it might be a parent of *S. arkansana*. The only other *Sabatia* species known from Arkansas are *S. brachiata* Ell., in sect. *Sabatia* subsect. *Angulares*, and *S. gentianoides* Ell., in sect. *Pseudochironia* Griseb. The first is uncommon in Arkansas, and the latter is extremely rare (S1) in the state. No intersectional hybrids in *Sabatia* are known in nature (Wilbur 1955; Perry 1971). All of Perry's (1967) attempts to make intersectional crosses involving species in sect. *Campestria*, including *S. campestris* × both *S. angularis* and *S. campanulata*, were unsuccessful.

KEY TO THE SPECIES OF *SABATIA* SECT. *CAMPESTRIA*

1. Leaves succulent when fresh, blackening in drying, elliptic to ovate or obovate; corolla lobes 4–10(–13) mm ____ **Sabatia arenicola**
1. Leaves not succulent nor blackening, linear to ovate; corolla lobes 8–25 mm.
  2. Basal leaves usually present at flowering time; calyces usually shorter than corollas; corolla lobes elliptic-rhombic, widest near mid-length ____ **Sabatia formosa**
  2. Basal leaves absent at flowering time; calyces usually as long as or longer than corollas; corolla lobes spatulate to obovate, widest distally.
    3. Leaves all lanceolate to linear, generally less than 5 (rarely to 6) mm wide; corolla lobes deep magenta-pink, more than 1.8× as long as wide, widest at ca. 0.8× or more of their length, rounded at apex ____ **Sabatia arkansana**
    3. Leaves except in distal portions of inflorescence lance-elliptic to ovate, more than 5 mm wide; corolla lobes light pink or occasionally white, less than 1.8× as long as wide, widest at ca. 0.6× their length, ± acute at apex ____ **Sabatia campestris**

HABITAT AND ASSOCIATED SPECIES

Sabatia arkansana is a plant of flat, seasonally wet microhabitats in shale and igneous glades in the eastern Ouachita Mountains and igneous batholiths of the Upper West Gulf Coastal Plain of central Arkansas. It appears to be restricted to small flat areas along the narrow floodplains of intermittent streams or along seepage areas within these glades. These habitats are typically wet in the winter and spring but usually become dry by July and remain so until the late fall. The substrate consists of thin soil over bedrock and of loose, weathered fragments of the same type as the local bedrock. No standing water was observed around the plants at the time of flowering.

Sabatia arkansana is known from glades with two different geologic substrates: shale from the Womble Formation and the igneous rock nepheline syenite (Fig. 6). The Womble Formation was deposited during the Middle Ordovician and consists of mostly black shale with thin layers of limestone, silty sandstone, and some chert (McFarland 2004). It is confined to the Central Ouachita Mountains physiographic province, a subsection of the Ouachita Mountains (Foti & Bukenhofer 1998). Large igneous intrusions of Late Cretaceous age outcrop in the Upper West Gulf Coastal Palin (Saline and Pulaski counties) and consist largely of nepheline syenite. These intrusions consist of light gray or bluish feldspathic and feldspathoidal igneous rocks in a batholith containing pendants of altered rocks of Paleozoic age, and are weathered locally to kaolin or bauxite (Haley et al. 1976; Gordon et al. 1958). These are the largest outcroppings of igneous rocks in Arkansas and are located within the Upper West Gulf Coastal Plain physiographic province, an area consisting of mostly unconsolidated surface geology of Cretaceous age and younger (McFarland 2004).

Associated species include *Talinum calycinum*, *Croton wildenowii*, *Croton capitatus*, *Croton monanthogynus*, *Euphorbia cyathophora*, *Bulbostylis capillaris*, *Fimbristylis autumnalis*, *Valerianella nuttallii*, *Calamintha arkansana*, *Allium*

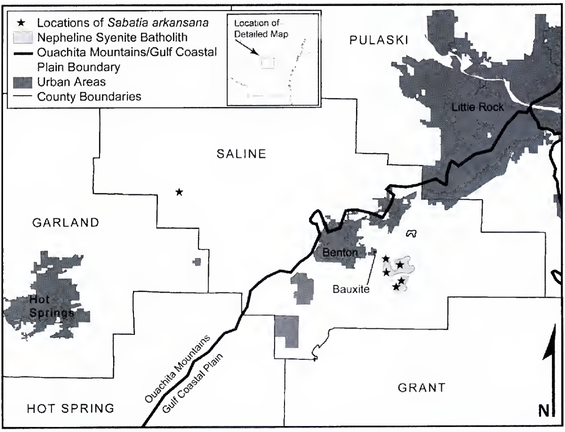


Fig. 6. Map showing the locations of collections of *Sabatia arkansana* in Saline County Arkansas and the nepheline syenite batholith southeast of Bauxite.

canadense var. *mobilense*, *Hedyotis nigricans*, *Asclepias longifolia* var. *hirtella*, *Sedum pulchellum*, *Polygonum tenue*, *Aristida dichotoma* var. *curtissii*, *Digitaria cognata*, *Sporobolus ozarkanus*, *Panicum flexile*, *Chamaesyce missurica*, *Nemastylis nuttallii*, *Silphium laciniatum*, *Ptilimnium nuttallii*, *Amsonia hubrichtii*, *Aster oblongifolius*, *Eriocaulon kornickianum*, *Isoetes butleri*, *Grindelia lanceolata*, *Mimosa quadrivalis* var. *nuttallii*, *Astragalus distortus* var. *engelmannii*, *Selenia aurea*, *Ranunculus pusillus*, *Astranthium integrifolium*, *Minuartia patula*, *Eryngium yuccifolium*, *Spiranthes vernalis*, and *Nostoc* sp. (Nomenclature follows Kartesz 1999).

Of these associates, the following (given with their conservation status ranks) are tracked as elements of special concern by the Arkansas Natural Heritage Commission: *Valerianella nuttallii* (G1G2S1), *Nemastylis nuttallii* (G4S2), *Amsonia hubrichtii* (G3S3), *Eriocaulon kornickianum* (G2S2), *Chamaesyce missurica* (G5S2), and *Bulbostylis capillaris* (G5S3) (Arkansas Natural Heritage Commission 2002). *Valerianella nuttallii* and *Amsonia hubrichtii* are endemic to the Ouachita Mountains and Arkansas Valley of Arkansas and Oklahoma.

This new species of *Sabatia* is one of more than 15 endemic plant taxa from the Ouachita Mountains (including upland portions of the Arkansas River Valley and the igneous batholith that outcrops in the Upper West Gulf Coastal Plain near the edge of the Ouachita Mountains in Saline and Pulaski counties, Arkansas). In addition to *V. nuttallii* and *A. hubrichtii*, these endemic taxa include *Amorpha ouachitensis*, *Carex latebracteata*, *Galium arkansanum* var. *pubiflorum*, *Liatris compacta*, *Hydrophyllum brownei*, *Polymnia cossatotensis*, *Monarda stipatoglandulosa*, *Houstonia ouachitana*, and *Quercus acerifolia* (Zollner et al. 2005).

CONSERVATION STATUS

Though *S. arkansana* has been collected from a number of glade openings, all of these are components of only two larger glade complexes, the nepheline syenite complex near Bauxite and the Womble Formation (shale) complex near Owensville. Therefore it can accurately be stated that this species is known from just two sites in the world, both in Saline County, Arkansas. Glades with appropriate microhabitat in adjacent counties (Pulaski, Garland, and Montgomery) were searched in 2003 and 2004 and no new sites for *S. arkansana* were found. Because *S. arkansana* is an annual, population size fluctuates from year to year. Two shale glade openings at the Womble Formation site support populations of *S. arkansana*, which ranged from approximately 200 to more than 1000 individuals per opening from 2001 to 2004. Five glade openings in the nepheline syenite complex support populations on *S. arkansana*, which ranged from hundreds to thousands of plants per opening from 2001 to 2004.

These glades have historically been the sites of mines (in the case of the economically important nepheline syenite) and borrow pits for road fill material (in the case of the shale glades). The absence of significant past mining at the Womble Formation locality makes it an especially rare site among shale glades in the Ouachita Mountains. The open character of these glades is maintained in part edaphically by the thin soil and in part, at least historically, by fire. The absence of fire in recent years has allowed glades throughout the region to be invaded by woody plants, particularly eastern redcedar (*Juniperus virginiana*). This encroachment has led to the decline of many plant species dependent upon open glade habitat.

These factors, along with significant pressure from encroaching residential development, make these glades a high conservation priority. Several glades immediately west of the Womble Formation locality (and part of the same glade complex) have recently been destroyed for an addition to a large gated residential golf course community. Fortunately, the Arkansas Natural Heritage Commission was recently able to acquire and protect 136 acres (55 ha) that include the *S. arkansana* locality, several other glades, and associated woodlands and forest. Meanwhile, all of the known *S. arkansana* sites on the nepheline syenite batholith are being protected by joint efforts of the Arkansas Field Office of The Nature Conservancy and Alcoa Corporation.

ACKNOWLEDGMENTS

Theo Witsell extends special thanks to John Pelton for sharing his enthusiasm and knowledge of the flora of Arkansas, and for showing him that beautiful pink flower in the glade back in the summer of 2001. Thanks also to Linda Ellis for the illustration and to Tanya Miller-Witsell for spending a day of our honeymoon in the herbarium at the Missouri Botanical Garden. Jim Peck (LRU), Johnnie Gentry (UARK), and George Yatskievych (MO) all helped facilitate this research. Seth Young, Chris Tracey, and Bill Shepherd reviewed and improved earlier versions of this manuscript. Thanks also to Meryl Hattenbach, Scott Simon, and Doug Zollner of the Arkansas Field Office of The Nature Conservancy, Jarvis Harper of Alcoa Corporation, and the staff of the Arkansas Natural Heritage Commission. Special recognition should go to Hugh and Steve Davis for granting permission to collect on their land at the Womble Formation site and for agreeing to sell a portion of that land for dedication as the Middle Fork Barrens Natural Area. James S. Pringle thanks the curators and staff of the herbaria of the Arkansas Natural Heritage Commission and the University of Arkansas at Fayetteville for the loan of specimens, and those at Harvard University and the Missouri Botanical Garden for the opportunity to study and compare specimens at those institutions.

REFERENCES

Arkansas Natural Heritage Commission. 2002. State species of special concern—plants. Arkansas Natural Heritage Commission, Little Rock.

Bell, N.B. and L.J. Lester. 1978. Genetic and morphological detection of introgression in a clinal population of *Sabatia* section *Campestria* (Gentianaceae). Syst. Bot. 3:87–104.

Bell, N.B. and L.J. Lester. 1980. Morphological and allozyme evidence for *Sabatia formosa* (Gentianaceae) in the section *Campestria*. Amer. J. Bot. 67:327–336.

Foti, T.L. and G.A. Bukenhofer. 1998. A description of the sections and subsections of the Interior Highlands of Arkansas and Oklahoma. J. Arkansas Acad. Sci. 52:53–62.

Gordon, M., J.I. Tracey, and M.W. Ellis. 1958. Geology of the Arkansas bauxite region. Geological Survey Professional Paper 299. U. S. Government Printing Office, Washington, D.C.

Haley, B.R., E.E. Glick, W.V. Bush, B.F. Clardy, C.G. Stone, M.B. Woodward, and D.L. Zachary. 1976. Geologic map of Arkansas. Arkansas Geological Commission and U.S. Geological Survey, Little Rock.

Hill, E.J. ["E.G."]. 1891. The fertilization of three native plants. Bull. Torrey Bot. Club 18: 111–118.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenand. First edition. In: Kartesz, J.T., and C.A. Meacham. 1999. Synthesis of the North American flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill. Compact disc.

McFarland, J.D. 2004. Stratigraphic summary of Arkansas. Arkansas Geological Commission Information Circular 36. Arkansas Geological Commission, Little Rock.

Perry, J.D. 1967. Biosystematic studies in the North American genus *Sabatia* (Gentianaceae). Ph.D. dissertation, Duke University, Durham, North Carolina.

Perry, J.D. 1971. Biosystematic studies in the North American genus *Sabatia* (Gentianaceae). Rhodora 73: 309–369.

Wilbur, R.L. 1955. A revision of the North American genus *Sabatia* (Gentianaceae). Rhodora 57:1–33, 43–71, 78–104.

Zollner, D., M. MacRoberts, B. MacRoberts, and D. Ladd. 2005. Endemic vascular plants of the Interior Highlands, U.S.A. Sida 21:1781–1791.

AULONEMIA NITIDA (POACEAE: BAMBUSOIDEAE: BAMBUSEAE), A NEW SPECIES FROM GUYANA

Emmet J. Judziewicz

Department of Biology
University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
emmet.judziewicz@uwsp.edu

ABSTRACT

A new species, **Aulonemia nitida** Judz., is described from the Pakaraima Mountains of Guyana, South America. It is a large-leaved species that differs from the Mesoamerican species *A. laxa* and *A. patriae* in its smooth, shining, non-striate, non-maculate foliage leaf sheaths. An illustration of the new species and a key to the species of *Aulonemia* from the Guayana Highlands are provided.

RESUMEN

Se describe una especie nueva, **Aulonemia nitida** Judz., de las montañas de Pakaraima, Guyana, América del Sur. Es una especie con láminas foliares grandes y anchas parecida a las especies Mesoamericanas *A. laxa* y *A. patriae*, pero se distingue por sus vainas foliares lisas y lustrosas, sin estriaciones o manchitas. Se incluyen una ilustración de la nueva especie y una clave de las especies de *Aulonemia* de las montañas de Guayana.

Since the publication of the grass treatment for the "Flora of the Guianas" project (Judziewicz 1991), several more specimens of a new bamboo (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae) species from the Guayana Highlands have come to light. The name *Aulonemia nitida* has long been in print, appearing as a *nomen nudum* in Boggan et al. (1997: 168) checklist of Guianas plants, and, based on the Boyan specimen, was recognized as a likely new species as long ago as 1988. Even though all five known collections are sterile, the taxon is so distinctive that I have chosen to propose it here as a new species, following the example of Clark (1989, 1992) who has named several distinctive species in the bamboo genus *Chusquea* Kunth based on material lacking inflorescences. Specimens were examined from the following herbaria: F (2002), FDG (1988), K (1989), MO (2004), NY (1989), US (2004), UWSP (2004), and WIS (2004).

Aulonemia nitida Judz., sp. nov. (**Fig. 1**). Type: GUYANA. Potaro-Siparuni Region: upper slopes of Mt. Wokomung, 5°05'N-59°50"W, 1530 m, *Hedyosmum*-bamboo dominated moist forest, bamboo with culms at base to 2 cm diam., overall height 4 m, common and at times dense on upper slopes, sterile, 14 Jul 1989, *B.M. Boom & G.J. Samuels 9224* (holotype: FDG!; isotypes: MO-3 sheets!, NY!).

Graminum cespitosum. Culmi usque ad 5 m longi, 2.5 cm lati. Vaginae foliorum glabrae, nitidae, fimbriatae ad apicem tantum; fimbriae 7–10 cm longae; laminae foliorum 25–37 cm longae, 7–10.5 cm latae, lanceolatae-ovatae. Inflorescentia non vidi.

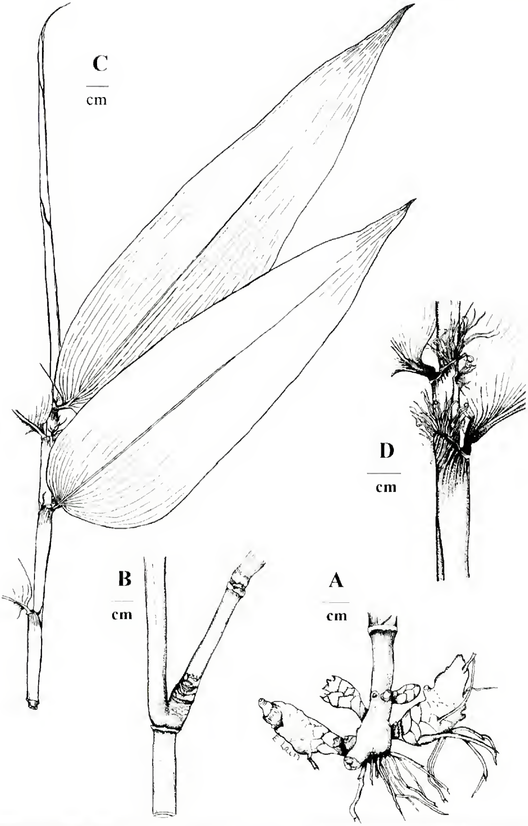


Fig. 1. A. Base of plant showing sympodial rhizomes (nodes and internodes decayed or indistinct in available material). **B.** Culm and branch. **C.** Branch with foliage leaves. **D.** Detail of ligular area. Scale bar = 1 cm. Illustration by Emily Lain. A and B based on *Boom & Samuels 9224* (MO), C and D based on *Henkel, Williams, Fratello & Williams 4493* (WIS).

Cespitose perennial, thicket-forming woody bamboo from short, sympodial rhizomes; glabrous throughout. Culms up to 5 m long and at least 2.5 cm in diameter, shiny, hollow, the walls only ca. 1 mm thick with a 1–1.5 mm thick annular ring present at the lower nodes; buds and branches one per node. Culm leaves not seen, perhaps not differentiated from foliage leaves. Foliage leaves at least 5 per complement; sheaths glabrous, smooth, shiny, and stramineous throughout most of their length, strongly keeled 3–5 cm below the apex, striate only in the area 0.5–1 cm below the apex; fimbriae ca. 12–20, each 7–10 mm long, pale, flexuous and spreading, confluent basally and forming an indurate rim at the summit of the leaf sheath; outer ligules ca. 0.2 mm long, indurate, rim-like; inner ligules 1–1.5 mm long, membranous; pseudopetioles 7–10 mm long, pale; blades 25–37 × 7–10.5 cm, narrowly ovate to broadly lanceolate, rounded to very slightly oblique or subcordate at the base, acuminate at the apex, not evidently tessellate, the abaxial surface slightly whitened or bluish green. Inflorescence not seen.

Additional collections examined (PARATYPES): **GUYANA Cuyuni-Mazaruni Region:** Ayanganna [a sandstone mountain with a summit elevation of over 2100 m] slope, among rocks in low forest, sterile, 2 Mar 1960, *R. Boyan 120* [= FD7944] (FDG, NY); Pakaraima Mts., 2 km transect along summit ridge of Mt. Ayanganna, 5°23'N-59°59'W, 1800–2000 m, low sclerophyllous community, organic soils on sandstone, 3 Nov 1992, *B. Hoffman & T. Henkel 3209* (US, WIS). **Potaro-Siparuni Region:** Mt. Wokomung, E-most pinnacle of massif, 5°05'34"N-59°50'13"W, 1524 m, coarse herb 4 m, sterile, 13 Jul 2003, *H.D. Clarke, R. Williams, C. Perry, E. Tripp, D. Gittens & S. Stern 10808* (US, WIS); Mt. Wokomung, summit ridge of Ka-mie-wah pinnacle NE to S pinnacle, "Little Ayanganna," 5°04'N-59°52'W, 1550–1650 m, mixed hardwood cloud forest grading to Guyana scrub forest on pinnacle escarpments; on sandstone, stout bambusoid grass from 1–5 m tall, forming thickets on rocky ridges, sterile, 17 Nov 1993, *T.W. Henkel, R. Williams, S. Fratello, L. Williams 4493* (FDG, MO, US, WIS).

DISCUSSION

Aulonemia nitida is endemic to elevations of 1500–2100 m in cloud forests on sandstone tepuis in the Pakaraima Mountains (Mt. Ayanganna and Mt. Wokomung; all collections come from an area of about 30 km in length) of Guyana near the Brazilian frontier. The species epithet derives from the nitid or shiny foliage leaf sheaths. A vernacular name is "reroballi" (*Boyan 120*).

There are 35 described species of *Aulonemia* throughout tropical America (Clark et al. 1997; Judziewicz et al. 1999, 2000) and I am currently working on a revision of the genus. *Aulonemia nitida* appears to be most closely related to the Mesoamerican species *A. laxa* (F. Maek.) McClure and *A. patriae* R. Pohl (Pohl & Davidse 1994). All three taxa have broad, fimbriate foliage leaves with distinctive keeled sheaths, but *A. laxa* and *A. patriae* have sheaths that are striate and maculate their entire lengths. *Aulonemia nitida* differs in its smooth, shiny, non-maculate sheaths that are striate, if at all, only in the final 1 cm or so below the ligular area. The two Mesoamerican species also differ in their generally longer (10–32 mm) fimbriae; those of *A. laxa* are straight and appressed to the culm, not spreading as in *A. nitida* and *A. patriae*.

There are eight species of the *Aulonemia* in the Guayana Highlands (Judziewicz 2004). In the "Flora of the Venezuelan Guayana" (Judziewicz et al. 1991; Judziewicz 2004) *Aulonemia nitida* would key to either *A. deflexa* (N.E. Brown) McClure, *A. chimantaensis* Judz. & Davidse, or *A. jauaensis* Judz. & Davidse. However, these three taxa have smaller foliage leaf blades (a maximum of 22 × 4.5 cm versus at least 25 × 7 cm in *A. nitida*), longer fimbriae (10–20 mm long versus 7–10 mm in *A. nitida*), and completely striate foliage leaf sheaths. *Aulonemia deflexa*, the only other species known from Guyana, is present at higher elevations on Mt. Roraima (ca. 2800 m), as well as on several Venezuelan tepuis. *Aulonemia patula* (Pilg.) McClure from Andean Colombia and Ecuador has similarly large foliage leaves, but the sheaths are non-keeled, non-striate, and the fimbriae are conspicuous all along the sheaths margins as well as at the sheath summit. A key differentiating the species of *Aulonemia* found in the Guayana Highlands follows.

KEY TO THE SPECIES OF *AULONEMIA* FROM THE GUAYANA HIGHLANDS

1. Foliage leaf sheaths with marginal fimbriae.
  2. Foliage leaf blades with midrib excentric, placed 5–7 mm from one margin of a blade 22–25 mm wide; 600–700 m, Cerro Huachamacari, Amazonas, Venezuela ____ **A. sp. A** (Judziewicz 2004)
  2. Foliage leaf blades with midrib placed centrally on a blade 30–60 mm wide; 2200 m, Bolívar and Amazonas, Venezuela ____ **A. aff. subpectinata** (Kuntze) McClure
1. Foliage leaf sheaths lacking marginal fimbriae.
  3. Foliage leaf sheath summits prominently auriculate; 1000–2000 m, Cerro Duida, Amazonas, Venezuela ____ **A. sp. B** (Judziewicz 2004)
  3. Foliage leaf sheath summits lacking auricles.
    4. Dwarf plants ca. 0.5 m tall; foliage leaf blades ca. 4 cm long, 0.7 cm wide; 2600 m, Cerro Marahuaka, Amazonas, Venezuela ____ **A. sp. C** (Judziewicz 2004)
    4. Plants 1–3 or more m tall; foliage leaf blades 11—37 cm long, 1.8–10.5 cm wide.
      5. Foliage leaf sheaths smooth and shiny, the blades 25–37 cm long, 7–10.5 cm wide; fimbriae 7–10 mm long, 1500–2100 m, Guyana ____ **A. nitida** Judz.
      5. Foliage leaf sheaths striate and dull, the blades 11–20 cm long, 1.8–4.5 cm wide; fimbriae 10–20 mm long.
        6. Spikelets 12–20 mm long, 4–5-flowered; 2100–2800 m, Bolívar, Venezuela and adjacent Guyana ____ **A. deflexa** (N.E. Brown) McClure
        6. Spikelets 22–70 mm long, 9–23-flowered.
          7. Spikelets 22–40 mm long, 9–15-flowered; lemmas 8–10 mm long, obtuse, slightly tridentate at apex, glabrous to sparsely puberulent on the back, the margins short-ciliate; 2100–2200 m, Macizo de Chimantá, Bolívar, Venezuela ____ **A. chimantaensis** Judz. & Davidse
          7. Spikelets (20–)40–70 mm long, 11–23-flowered; lemmas 10–13 mm long, acute, densely puberulent throughout with prickle-like hairs; 1900–2100 m, Cerro Jaua, Bolívar, Venezuela ____ **A. jauaensis** Judz. & Davidse

ACKNOWLEDGMENTS

I thank Lynn G. Clark for encouraging me to publish this paper; the curators of MO, US, and WIS for loans; Emily Lain for the illustration; and Paul M. Peterson for a thorough and helpful review.

REFERENCES

Boggan, J., V. Funk, C. Kelloff, M. Hoff, G. Cremers, and C. Feuillet. 1997. Checklist of the plants of the Guianas. 2nd ed. Biological Diversity of the Guianas Program, Smithsonian Institution, Washington, DC.

Clark, L.G. 1989. Systematics of *Chusquea* section *Swallenochloa* sect. *Swallenochloa*, section *Verticillatae*, section *Serpentes*, and section *Longifoliae* (Poaceae: Bambusoideae). Syst. Bot. Monogr. 27:1–127.

Clark, L.G. 1992. *Chusquea* sect. *Swallenochloa* (Poaceae: Bambusoideae) and allies in Brazil. Brittonia 44:387–422.

Clark, L.G., X. Londoño, and M. Kobayashii. 1997. *Aulonemia bogotensis* (Poaceae: Bambusoideae), a new species from the Cordillera Oriental of Colombia. Brittonia 49:503–507.

Judziewicz, E.J. 1991. Family 187. Poaceae. 1991 [as 1990]. In: A.R.A. Gorts-Van Rijn, ed., Flora of the Guianas, Series A: Phanerogams. Koeltz Scientific Publications, Königstein, Germany.

Judziewicz, E.J. 2004. *Aulonemia*. In: Steyermark, J.A., P.E. Berry, K. Yatskievych, and B.K. Holst, eds. Flora of the Venezuelan Guayana, Vol. 8: Poaceae-Rubiaceae. Missouri Botanical Garden Press, St. Louis. Pp. 40–45.

Judziewicz, E.J., L.G. Clark, X. Londoño, and M.J. Stern. 1999. American Bamboos. Smithsonian Institution Press, Washington, DC.

Judziewicz, E.J., G. Davidse, and L.G. Clark. 1991. Six new bamboos (Poaceae: Bambusoideae: Bambuseae) from the Venezuelan Guayana. Novon 1:76–87.

Judziewicz, E.J., R.J. Soreng, G. Davidse, P.M. Peterson, T.S. Filgueiras, and F.O. Zuloaga. 2000. Catalogue of New World grasses (Poaceae): I. Subfamilies Anomochlooideae, Bambusoideae, Ehrhartoideae, and Pharoideae. Contr. U.S. Natl. Herb. 39:1–128.

Pohl, R.W. and G. Davidse. 1994. *Aulonemia*. In: Davidse, G., M. Sousa-S., and A.O. Chater, eds. Flora Mesoamerica. Vol. 6, Alismataceae a Cyperaceae. Universidad Autónoma de México, Mexico, D.F. Pp. 198–199.

BOOK REVIEWS

ROLAND H. WAUER. 2001. **Naturally…South Texas: Nature Notes from the Coastal Bend.** (ISBN 0-292-79144-5, hbk.). The University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (**Orders:** 800-252-3206, fax 800-687-6046, www.utexas.edu/utpress). $22.95, 240 pp., 6" × 9".

This is a collection of brief essays arranged chronologically as a "natural history calendar" and sorted into 12 chapters, January through December. All were originally published in the Victoria Advocate, the regional newspaper. After the author retired from the National Park Service, he moved to Victoria (about halfway between Houston and Corpus Christi) in south Texas, which "undoubtedly is the best birding area anywhere in the United States." This region "encompasses four rather distinct ecosystems, all within a mile circle of Victoria: the northeastern edge of the South Texas Plains, the southern edges of the Post Oak Savannah and Blackland Prairie, and the heart of the Gulf Prairie and Marshes." Wauer's attention is strongly turned to birds, but various plants, insects, and other animals are highlighted. The essays are built around his own observations and interpretations and are supported by "technical" insertions from various sources—all easily readable and enjoyable.—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

JASON F. SHOGREN (Ed.). 2005. **Species at Risk: Using Economic Incentives to Shelter Endangered Species on Private Lands.** (ISBN 0-292-70597-2, pbk.). The University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (**Orders:** 800-252-3206, fax 800-687-6046, www.utexas.edu/utpress). $21.95, 271 pp., 6" × 9".

Regarding the rapid decline and loss of species: "The stakes are high, and they go to the heart of our collective responsibility to leave this land a better place than we found it. This book is an attempt to develop and refine a workable, practical, and equitable set of incentives for preserving species and the habitat they need for survival" (from the Foreword). About half of all endangered species rely on private land for their habitat, but private landowners have often opposed the regulations of the Endangered Species Act, which, they argue, unfairly limits their right to profit from their property. "In this book, lawyers, economists, political scientists, historians, and zoologists come together to assess the challenges and opportunities for using economic incentives as compensation for protecting species at risk on private property."

1. Introduction

Part I. Current and proposed incentive options for species protection on private lands.

2. The Endangered Species Act and its current set of incentive tools for species protection.

3. An economic review of incentive mechanisms to protect species on private lands.

Part II. Challenges to using economic incentives for species protection

4. Endangered species protection and ways of life: Beyond economy and ecology.

5. A critical examination of economic incentives to promote conservation

6. Appraising the conservation value of private lands.

7. Markets for conserving biodiversity habitat: Principles and practice.

8. The role of private information in designing conservation incentives for property owners.

Part III. Economic incentives for ESA reauthorization

9. Evaluating the incentive tools

FOUR NEW SPECIES OF ERICACEAE (VACCINIEAE) FROM ECUADOR

James L. Luteyn

Institute of Systematic Botany
The New York Botanical Garden
Bronx, New York 10458-5126, U.S.A.
jluteyn@nybg.org

ABSTRACT

Four new species of endemic blueberries from montane Ecuador, **Ceratostema oyacachiensis, Ceratostema pendens, Ceratostema pubescens**, and **Disterigma bracteatum**, are described, illustrated, and their relationships discussed.

RESUMEN

Se describen y se discuten cuatro especies nuevas endemicas de mortiños de la sierra del Ecuador, **Ceratostema oyacachiensis, Ceratostema pendens, Ceratostema pubescens**, y **Disterigma bracteatum**, con sus ilustraciones y relaciones.

INTRODUCTION

In Ecuador, the Ericaceae, with 21 genera and about 222 species, are one of the largest and most conspicuous montane, flowering plant families (Luteyn 1996, 1998, 2002). Despite the recent treatment of the family in the *Flora of Ecuador* series, the number of new species continues to increase due to additional collecting efforts in previously unexplored or underexplored regions. This paper documents some of these new species and emphasizes, once again, that our basic knowledge of the numbers of species in this family, even in a country as well collected and studied as Ecuador, is still uncertain.

CERATOSTEMA Jussieu

Ceratostema is a montane genus of about 35 species of blueberries that is characterized by stamens usually as long as the corolla and of equal lengths, pedicels usually articulate with the calyx, anther thecae that are coarsely papillate, anther tubules that are elongate and about half the diameter of the thecae, and large corollas with lobes that are proportionately elongate. It ranges from Venezuela and Guyana south through the Andes to northern Peru. Luteyn (1984, 1986) considered the genus morphologically related to *Semiramisia* Klotzsch, although recent molecular studies (Powell & Kron 2003) place it in a clade with *Macleania* Hook. and *Psammisia* Klotzsch. The genus is currently being investigated by the author.

SIDA 21(3): 1269–1282. 2005

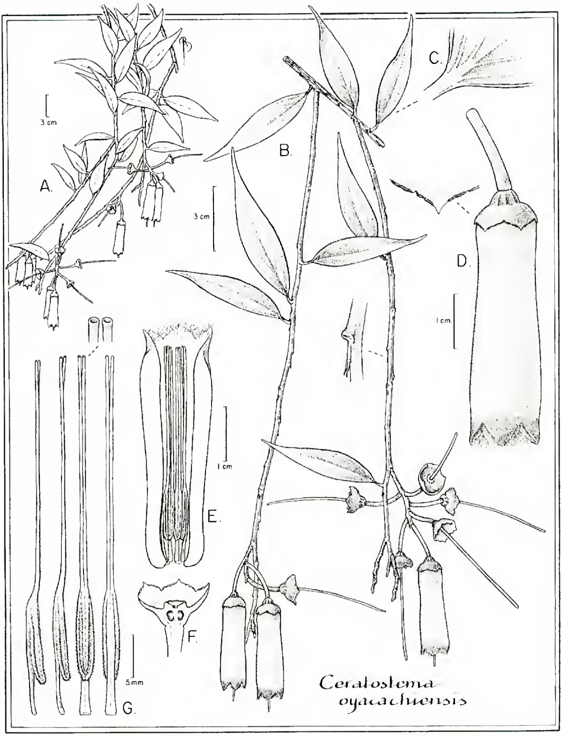


Fig. 1. *Ceratostema ayacachiensis*. A, habit. B, detailed habit showing close-up of axillary bud. C, detail of leaf base (undersurface). D, flower showing pedicel, calyx, corolla, and detail of calyx lobe margins. E, longitudinal section of corolla showing relative position of stamens. F, longitudinal section of calyx. G, stamens showing lateral, ventral and dorsal views with close-up of terminal dehiscence pores (drawn from holotype, *Ståhl et al. 2512*).

Ceratostema oyacachiensis Luteyn, sp. nov. **(Fig. 1).** TYPE: ECUADOR. NAPO: Río Chalpi at confluence with Río Oyacachi, 00°15'S, 77°58'W, 2500–2550 m, 21 May 1996 (fl), *B. Ståhl, P. Asimbaya & H. Navarrete 2512* (HOLOTYPE: NY; ISOTYPES: AAU, K n.v., MO n.v., QCA n.v., QCNE n.v.).

Species nova ab congeneribus differt foliis quoad venationem plinerviis, base late cuneatis vel obtusis, calycibus ad pedicellos articulatis, tubo calycino 10-costato, limbo calycino inconspicuo, rotato, lobis calycinis brevibus ad basem glandulis circularibus carentibus sed ad margines lacerato-glandulosis, atque corollis magnis crasso-carnosis lobis earum brevibus latisque.

Epiphytic **shrubs**; mature stems terete or subterete and bluntly angled, glabrous, the bark grayish, cracking longitudinally and exfoliating in thin strips; twigs terete to subterete, striate, glabrous, reddish-brown; axillary buds arising up to 3. 5 mm above leaf-nodes, the outer pair of scales 2, valvate, relatively obscure, narrowly triangular, acuminate, up to 2.5 mm long. **Leaves** alternate, flat, the blades thick-coriaceous, lanceolate, 5.2–11 × 1.2–2.4 cm, basally broadly cuneate to obtuse, apparently decurrent onto petiole, apically long-acuminate, glabrous, the venation weakly 3–5-plinerved from near base, the midrib thickened and raised in proximal ca. 5 mm then plane to weakly impressed distally adaxially, raised and conspicuous abaxially, the lateral nerves plane to very weakly impressed adaxially and raised abaxially, the reticulate veinlets obscure adaxially and weakly raised abaxially; petioles subterete, slightly flattened adaxially, slightly winged to blade, ca. 4–11 mm long, glabrous. **Inflorescences** axillary, sometimes located along tips of branches where leaves have fallen, racemose, 2–8-flowered, somewhat short-pedunculate with flowers congested distally; rachis subterete, striate, 1.5–2.5 cm long, glabrous; floral bract caducous, not seen; pedicel terete, striate, 15–18 mm long, glabrous, articulate with calyx; bracteoles 2, located near base, caducous, ovate, ca. 2.2 mm long, apically long-acuminate, marginally glandular-fimbriate. **Flowers** 5-merous, pendent; calyx 6–9 mm long, glabrous, the tube obconic, truncate, terete to bluntly 10-ribbed, 2.5–3 mm long, the limb open, spreading to rotate, 5–6 mm long, the lobes broadly ovate, short-acuminate, 3–4 × 5 mm, with margins thin and seemingly lacerate-glandular, the sinuses acute; corolla thick-carnose, bistratose, cylindrical but slightly broadening distally, terete in cross-section, ca. 37–46 mm long, 7–9 mm basal diam. and 9–14 mm diam. at throat, orange, glabrous externally, the lobes broadly deltate, bluntly acute, 4–7 × 6–7 mm, green, densely floccose internally with flat, translucent trichomes to 2 mm long; **stamens** 10, ± equaling corolla in overall length, equal with each other, ca. 36–43 mm long, the filaments distinct, glabrous, ca. 4–6 mm long, the anthers ca. 33-39 mm long, the thecae ca. 9.5–11 mm long, basally conspicuously granular-papillate, the tubules ca. 24–28 mm long, seemingly connate in proximal 2/3, dehiscing by terminal pores ca. 0.2 mm diam.; style exserted, to 56 mm long, glabrous. **Fruit** not seen.

Distribution.—Endemic to northeastern Ecuador, where it occurs in both primary and disturbed forest, at ca. 1500–2550 m.

Ceratostema oyacachiensis is characterized by having leaf blades that are basally broadly cuneate to obtuse with plinerved venation, calyces that are articulate with the pedicels, calyx tubes that are terete to 10-ribbed, calyx limbs that are inconspicuous and rotate, calyx lobes that are short and lack basal, circular glands but do possess instead lacerate-glandular margins, corollas that are large and thick-carnose, broadening slighty distally and having short and broad lobes. In Luteyn's (1996) key to the Ecuadorean species of *Ceratostema*, this new species would be found in the vicinity of *C. pedunculatum* Luteyn, *C. prietoi* A.C. Sm., *C. nubigenum* (A.C. Sm.) A.C. Sm., and *C. ventricosum* Luteyn. It is distinct from all those species, however, based on its combination of characters mentioned above. If it were not for the articulate calyx/pedicel, this new species might be placed in the genus *Semiramisia* due to its rotate calyx limb and corolla that broadens slightly distally with relatively short, broad lobes. Additional collections of this species are needed to determine its morphological range of variation and relationships.

Additional collections examined: **ECUADOR. Sucumbíos:** Sinangoe Station, Shishicho Ridge, Alto Aguarico drainage, above (south of) Río Cofanes, W of Puerto Libre, NW of Lumbaqui, 00°12'N, 77°32'W, 1500–1570 m, 13 Aug 2001 (fl), *Aguinda, Pitman & Foster 1673* (F, QCA n.v., QCNE n.v.).

Ceratostema pendens Luteyn, sp. nov. **(Fig. 2).** TYPE: ECUADOR. MORONA-SANTIAGO: Limón-La Unión road, trail beyond end of road (beginning at 13.6 km from Limón) towards La Unión, ca. 2°59'S, 78°25'W, 1340–1370 m, 18 Nov 1998 (fl, fr), *J.L. Luteyn & H. Mogollón 15376* (HOLOTYPE: NY; ISOTYPES: AAU, CAS, MO, QCA, QCNE, US).

Ab *C. auriculato* Luteyn foliis breve pilosis (non glabris), calice breviore 8–9 mm longo (non 12–14 mm), tubo calycis tereti vel quinquangulo (non 5-alato), limbo calycis pro ratione inconspicuo lobis calycinis brevioribus 4.8–5 mm longis (non 9–10 mm) fimbriis eorum glanduliferis carentibus differt.

Epiphytic **shrubs**, arising from lignotubers; mature stems long-pendent, terete, striate, glabrous, the bark thin, reddish, cracking longitudinally; twigs subterete to terete, striate, brownish, densely spreading short-pilose with simple (uniseriate, unicellular) trichomes ca. 1–1.3 mm long, glabrate; axillary buds not seen. **Leaves** alternate, petiolate, flat, amplexicaul, involute at base so as to conceal flowers and fruits, the blades broadly ovate, 7–10 × 4–7 cm, basally deeply cordate and slightly auriculate with the lobes imbricate when fresh, apically acuminate to short-acuminate, densely soft, white, short-pilose on both surfaces with simple trichomes ca. 1 mm long, the venation pinnate with 2–4 lateral veins **or** weakly 5(–7)-plinerved with inner pair of lateral nerves arising in the proximal 1 cm, the midrib thickened and raised in proximal 1 cm then plane to weakly impressed distally adaxially, weakly raised abaxially, the lateral nerves anastomosing distally and along with reticulate veinlets weakly raised but obscure on both surfaces; petioles terete, rugose, 2–3 mm long, densely short-white-pilose with simple trichomes. **Inflorescences** axillary, racemose,

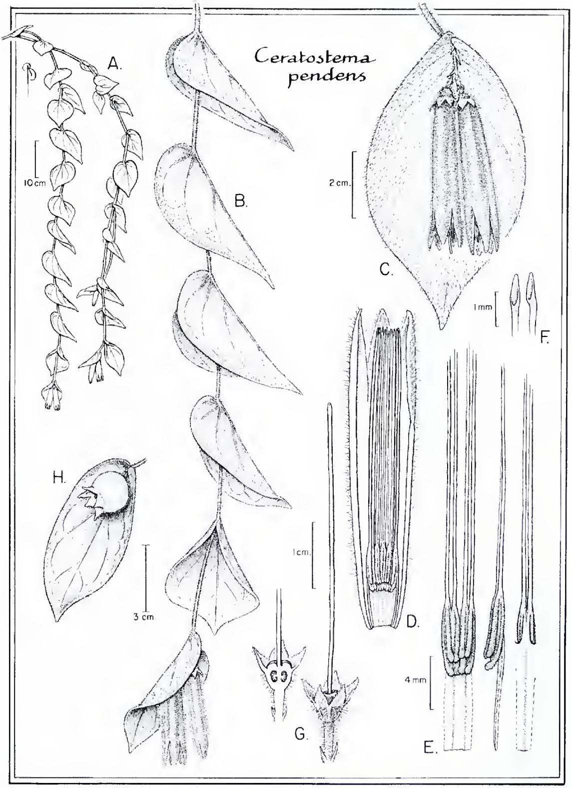


FIG. 2. *Ceratostema pendens*. A, habit. B, portion of stem showing involute leaves and two flowers. C, leaf spread open to show flowers. D, longitudinal section of corolla showing relative position of stamens. E, stamens in ventral, lateral, and dorsal views. F, close up of staminal dehiscence pores. G, calyx whole and in longitudinal section showing bracteoles and style. H, leaf spread open to show mature fruit (drawn from holotype, *Luteyn & Mogollón 15376*).

1–4-flowered but evidently only 1–2 flowers develop per rachis; rachis subterete, ca. 8–10 mm long, short-pilose with white, simple trichomes; floral bract 1, triangular, acuminate, ca. 2 mm long, densely short-pilose with simple trichomes; pedicel subterete, 5–6 mm long, articulate with calyx, short-pilose with simple trichomes; bracteloles 2, located near base, ovate, acute, ca. 1.3 mm long, short-pilose with simple trichomes. **Flowers** 5-merous; calyx ca. 8–9 mm long, short-pilose with white, simple trichomes, the tube terete to slightly pentagonal in cross-section, obconic, ca. 2.7–3.5 mm long, densely matted short-pilose, the limb spreading, ca. 5.3–5.5 mm long, moderately short-pilose, the lobes triangular-ovate, short-acuminate, ca. 4.8–5 mm long, striate, eglandular, moderately short-pilose externally and weakly so internally, the sinuses acute; corolla carnose, bistratose, cylindric to broadly and bluntly pentagonal in cross-section, slightly widening distally, ca. 45–48 mm long and 11 mm diam. at throat, dark maroon-red to pinkish-red, densely short-pilose with white, simple trichomes ca. 1 mm long, the lobes narrowly triangular, long-acuminate, ca. 12–13 × 3 mm; **stamens** 10, ± equaling corolla in overall length, alternately slightly unequal with each other, ca. 45 mm and 46.5 mm, the filaments equal, connate into a tube ca. 8–8.5 mm long, glabrous, the anthers 39.5 mm and 41 mm long, the thecae equal, ca. 7 mm long, conspicuously papillate, the tubules 2, alternately slightly unequal, distinct to base, ca. 34 mm and 35.5 mm long, dehiscing by introrse, oblique, oval pores ca. 0.6–0.8 mm long. **Fruit** a spherical, translucent cream-colored to waxy white, juicy berry, 15–22 mm diam., weakly short-pilose; seeds numerous, surrounded by translucent, mucilaginous sheath.

Distribution.—Endemic to Ecuador, where it occurs in primary forest on sandstone substrates, at 1000–1600 m.

Ceratostema pendens is characterized by its long-pendent, epiphytic habit with generally short-pilose vegetative and floral organs, amplexicaul leaves with cordate blades that are basally involute thus concealing the flowers and fruits when living, short floral bracts, terete to slightly pentagonal calyx tube, relatively inconspicuous calyx limb and lobes, and translucent whitish berry. In Luteyn's (1996) key to the Ecuadorean species of *Ceratostema*, this new species would be found in the final couplet containing *C. silvicola* and *C. amplexicaule*. It may be easily distinguished from those species by its involute leaves, fewer-flowered inflorescences, connate staminal filaments, and white berry (although berry color is unknown for *C. silvicola*). It is morphologically most similar to *C. auriculatum* Luteyn, having in common a long-pendent, epiphytic habit, amplexicaul leaves with blades that are cordate and pinnately-nerved, and few-flowered inflorescences that are hidden by the leaves. *Ceratostema pendens* differs from *C. auriculatum*, however, by having leaves that are short-pilose (vs. glabrous), shorter calyces (8–9 mm vs. 12–14 mm long), terete to pentagonal calyx tubes (vs. conspicuously 5-winged), and calyx limbs that are relatively inconspicuous possessing shorter lobes (4.8–5 mm vs. very conspicuous and 9–10 mm long) that lack glandular fimbriae. There are very few collections of these species, however, and so interspecific relationships are uncertain at this time.

In *Flora of Ecuador* (Luteyn 1996), the sterile collection *van der Werff & Palacios 10428* (MO, NY) was determined as *Ceratostema macbrydiorum* Luteyn, but the pubescence of its young leaves now characterizes it as an example of this new species. This points out further that sterile material of *C. pendens*, *C. auriculatum*, and maybe *C. cutucuense* Luteyn may be confused, due primarily to their having in common amplexicaul leaves with blades that are rounded to broadly ovate and deeply cordate basally, and short-acuminate apically. Table 1 compares and contrasts these species.

Additional collections examined: **ECUADOR. Morona-Santiago:** Limón Indanza, Cordillera de Huaracayo, E of Cordillera del Cóndor and Río Coangos, E of Shuar village of Tinkimints, 3°15'S, 78°11'W, 1600 m, 24 Mar 2001 (fl, fr), *Neill & Manzanares 13192* (MO, NY); along unfinished road E of Limón, 1000 m, 5 Feb 1989 (ster), *van der Werff & Palacios 10428* (MO, NY).

Ceratostema pubescens Luteyn, sp. nov. **(Fig. 3).** TYPE: ECUADOR. EL ORO: Manu-Chilla road, Km 36, 10 km W of Guanasan, 3°28'S, 79°33'W, 2600 m, 4 Oct 1996 (fl), *G.P. Lewis, P. Lozano, N. Aguirre & I. Aldaz 2640* (HOLOTYPE: NY; ISOTYPES: AAU n.v., E n.v., K n.v., LOJA n.v., QCNE n.v.).

Ab *C. fasciculato* Luteyn foliis ad basem cuneatis breve attenuatisque (non rotundatis vel subcordatis), inflorescentia e fasciculis 4–6-floris (non e racemis usque 30-floris) composita, bracteis floralibus longioribus 20–26 mm longis (non 17–20 mm), corolla breviori 38–43 mm longa (non 45–57 mm), staminibus brevioribus 36–40 mm longis (non 45–51 mm) differt.

Coarse, terrestrial **shrubs**, sometimes semi-scandent, 2–3 m tall with stems to 10–12 cm diam., arising from lignotubers; mature stems somewhat contorted, erect or pendulous, subterete, coarsely and bluntly angled, densely short-pilose with whitish, simple trichomes, the bark grayish; twigs subterete, bluntly angled, striate, reddish-brown, densely pilose with whitish, simple trichomes to ca. 2 mm long; axillary buds with outer scales 2, valvate, pseudostipular, narrowly lanceolate, long-acuminate, 6–11.5 × 1.5–2 mm, carinate, short-pilose with whitish, simple trichomes. **Leaves** alternate, congested, petiolate, the blades coriaceous, flat to slightly revolute, sometimes slightly bullate, ovate, 4–10.5 × 2.5–6.5 cm, basally rounded and often subcordate, apically short-acuminate, glabrous to weakly short-pilose with whitish, simple trichomes adaxially and there also bearing multicellular-multiseriate, reddish, glandular-fimbriate trichomes, densely white pilose abaxially and there also reddish, glandular-fimbriate, discolorous (when fresh dark to yellowish-green adaxially and whitish-green abaxially, when dry olive-green adaxially and reddish-brown abaxially), the venation 3–5(–7)-plinerved with inner lateral nerves arising 1–2 cm above the base, the midrib thickened and raised in proximal 1 cm then plane to slightly impressed distally adaxially, raised and conspicuous abaxially, the lateral nerves plane to impressed adaxially and raised abaxially, the reticulate

Table 1. Salient features that characterize and distinguish four closely related species of *Ceratostema* – *C. auriculatum*, *C. cutucuense*, *C. macbrydiorum*, and *C. pendens*.

	Ceratostema auriculatum	***Ceratostema cutucuense***	***Ceratostema macbrydiorum***	***Ceratostema pendens***
Twig pubescence	Glabrous	Glabrous	Densely hirsute	Short-pilose
Leaf				
Posture	Amplexicaul, flat to somewhat incurved thus hiding flowers	Amplexicaul, flat	Amplexicaul, flat	Amplexicaul, involute
Apex	Acuminate	Cuspidate to acute	Short-acuminate	Acuminate
Pubescence	Glabrous	Glabrous	Pilose (glabrate adaxially)	Pilose both surfaces
Venation	Pinnate	5-plinerved	5–7(–9)-plinerved	Pinnate to weakly plinerved
Calyx				
Overall length (mm)	12–14	8.5–10	ca. 28	8–9
Tube cross-section	5-winged	5-winged	5-winged	Terete to 5-angled
Tube length (mm)	3–4.5	6.5–7	6	2.7–3.5
Lobe length (mm)	9–10	<0.5	ca. 21 mm	4.8–5
Lobe glands	Glandular-fimbriate	Eglandular	Eglandular	Eglandular
Pedicel				
Length (mm)	5–8	12–13	9	5–6
Pubescence	Pilose	Glabrous	Pilose	Pilose
Corolla				
Length (mm)	45–47	ca. 50	n.v.	45–48
Cross-section	Terete to bluntly 5-angled	5-winged over entire length	n.v.	Terete to bluntly 5-angled
Pubescence	Glabrous to sparsely pilose along angles	Short-pilose	n.v.	Glabrous
Stamens				
Length (mm)	ca. 43	ca. 50	n.v.	45–46.5
Filaments	Connate	Connate	n.v.	Connate

veinlets inconspicuous to obscure, weakly impressed adaxially and weakly raised abaxially; petioles subterete, rugose 4–10 × 2–4 mm, densely long-pilose with simple trichomes. **Inflorescences** axillary, racemose, pendent, to (10–)ca. 30-flowered; rachis persistent, subterete, bluntly angled, ca. 4–8 cm long, the

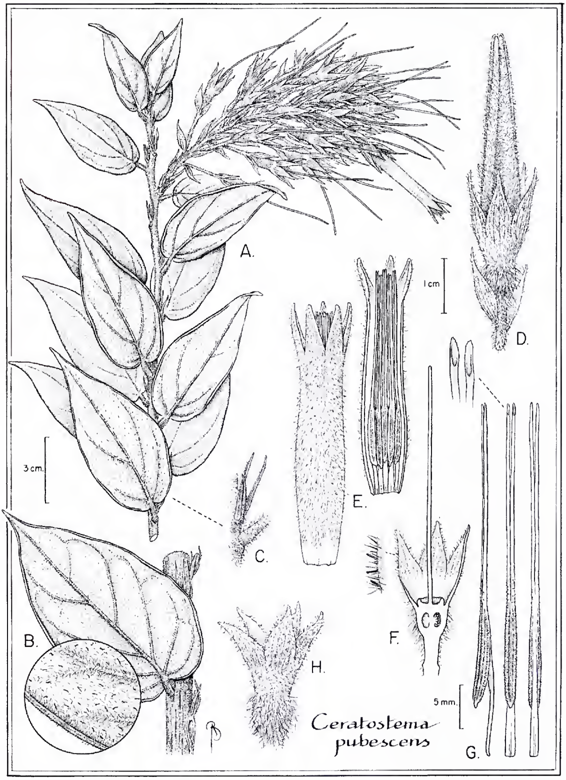


FIG. 3. *Ceratostema pubescens*. A, habit. B, portion of stem showing leaf undersurface and inset of pubescence. C, portion of stem showing leaf petiole and pseudostipular bud scales. D, flower bud with calyx and bracteoles. E, corolla with longitudinal section showing relative position of stamens. F, longitudinal section of calyx and inset of lobe margin showing simple hairs and glandular fimbriae. G, stamens showing lateral, dorsal, ventral views with inset of dehiscence pores (drawn from holotype, *Lewis et al. 2640*).

proximal several (to 4) nodes bearing sterile bracts; floral bract 1, lanceolate, long-acuminate, 11–16 × 3–5 mm, the venation conspicuous, moderately short-pilose with simple trichomes, marginally glandular-fimbriate with multicellular, multiseriate trichomes; pedicel subterete, striate, 10–14 mm long, densely short-pilose with simple trichomes and also short-glandular-fimbriate with multicellular, multiseriate trichomes, articulate with calyx; bracteoles 2, alternate, located basally to distally along pedicel, similar to floral bract but 6–16 × 2.5–3 mm. **Flowers** 5-merous, pendulous; calyx 17–20 mm long, short-pilose with simple trichomes and also sometimes short-glandular-fimbriate with multicellular, multiseriate trichomes, the tube cylindric to obconic, terete in cross-section, 4–6 mm long, densely short-pilose with white to yellowish trichomes, the limb slightly spreading, 13–17 mm long, moderately short-pilose, the lobes membranous, concave, ovate, acuminate, 11–13 × 4–5 mm with venation conspicuous, the sinuses acute; corolla membranous (fleshy when fresh), weakly bistratose, broadly and bluntly pentagonal in cross-section, cylindric and only slightly expanded basally, 45–57 × 6–9 mm, red to scarlet when fresh, short-pilose with whitish to reddish simple trichomes, also short-glandular-fimbriate with multicellular, multiseriate trichomes, the lobes wide-spreading and slightly reflexed exposing the stamens, lanceolate, bluntly acute, 7.5–13.5 × 2–5 mm, green when fresh; **stamens** 10, nearly equaling corolla in overall length, alternately slightly unequal with each other, 45–51 mm and 46.5–53.5 mm long, the filaments distinct, alternately 9–11 mm and 9.5–13 mm long, glabrous, the anthers alternately 38–42 mm and 40–44 mm long, the thecae alternately 12–13 mm and 13–14 mm long, the tubules 2, alternately 25–29 mm and 28–31 mm long, distinct in distal 1/2–1/3, dehiscing by introrse, oblique, short clefts ca. 1.5–2 mm long; style shortly exserted, 48–59 mm long, glabrous, red to pink with green apex when fresh. **Fruit** a spherical, short-pilose berry at least 13 mm diam., apparently translucent pale greenish when mature.

Distribution.—Endemic to Ecuador, where it occurs in rocky outcrops of "Southern Ecuadorean Scrub" vegetation along a very narrow and local cloud belt zone, at ca. 2600–3100 m. Common associates include *Puya* and *Pitcairnia* (Bromeliaceae), *Macleania* (Ericaceae), and lichen-covered boulders. Some corollas have holes at their bases made by nectar robbing birds. The fruit is said to be edible and a local common name is "salapa blanca grande."

Ceratostema pubescens is characterized by having a coarsely shrubby habit, densely pubescent leaf blades, long and narrow bud scales that appear pseudostipular, multi-flowered and racemose inflorescences, elongate bracteoles, large calyces and corollas, terete calyx tubes, conspicuously veined calyx lobes, and bluntly 5-angled corollas with proportionately short lobes. In Luteyn's (1996) key to the Ecuadorean species of *Ceratostema*, this new species would be found nearest *C. fasciculatum* Luteyn, which differs morphologically by its basally cuneate and short-attenuate leaf blades (vs. rounded to subcordate), fasciculate and

4–6-flowered inflorescences (vs. racemose and to 30-flowered), longer floral bracts (20–26 mm vs. 11–16 mm), longer bracteoles (15–24 mm vs. 6–16 mm), overall longer calyx (20–27 mm vs. 17–20 mm), shorter corolla (38–43 mm vs. 45–57 mm), shorter stamens (36–40 mm vs. 45–51 mm), and eastern slope geographical distribution (i.e., Zamora-Chinchipe vs. western slope El Oro). The exact phylogenetic relationship of the new species awaits further study.

Additional collections examined: **ECUADOR. El Oro:** same as type, 6 Nov 1997 (fl), *Lewis et al. 3687* (AAU, E n.v., GB n.v., K n.v., LOJA n.v., MO n.v., NY, P n.v., QCA n.v., QCNE n.v., US n.v.), 1 May 1997 (ster), *Luteyn et al. 15066* (NY, QCA); Chilla, Km 7, track to the antennas and páramo, 3°27'S, 79°36'W, 3100 m, 7 Nov 1997 (fl), *Lewis et al. 3700* (AAU, E n.v., GB n.v., K n.v., LOJA n.v., MO n.v., NY, QCA n.v., QCNE n.v., US n.v.); Chilla-Pueblo Viejo road, trail above Pueblo Viejo, 3°28'S, 79°36'W, ca. 2800 m, 2 May 1997 (im fr), *Luteyn et al. 15071* (NY, QCA); Chilla-Pueblo Viejo, 3°28'S, 79°43'W, 2780 m, 28 Feb 1996 (fr), *Van den Eynden & Cueva 630* (LOJA n.v., NY).

DISTERIGMA (Klotzsch) Niedenzu

Disterigma is a montane genus of about 35 species that is characterized by its usually small leaves, sessile to subsessile flowers, and pedicellary bracteoles that are apical and surround (sometimes tightly clasp) the calyx and sometimes the proximal parts of the corolla. It ranges from Guatemala south to Bolivia and east to Guyana. The genus has been considered related to *Vaccinium* on the basis of morphology, although recent molecular studies (Powell & Kron 2003) place it in a clade with *Sphyrospermum*. The genus is currently being monographed by graduate student Paola Pedraza at The New York Botanical Garden.

Disterigma bracteatum Luteyn, sp. nov. **(Fig. 4).** TYPE: ECUADOR. AZUAY: Jesus María-Molleturo-Cuenca road, 22.3–25.2 km E of Coastal Highway at Jesus María, ca. 2°37'S, 79°14'W, 975–1160 m, 23 Nov 1998 (fl), *J. L. Luteyn & H. Mogollón 15401* (HOLOTYPE: NY; ISOTYPES: AAU, CAS, G, K, MO, QCA, QCNE, S, US).

Species nova congeneris omnibus distinguenda in combinatione notarum sequente: foliis succulentis, bracteis inflorescentiae numerosis, circa 23, lanceolatis brunneolis persistentibus usque 11 mm longis, lobis calycinis anguste lanceolatis usque 5–6 mm longis atque staminibus 5 geniculatis.

Terrestrial to epilithic, spreading **shrubs** with branches somewhat pendent to 3 m long; mature stems terete, striate, glabrous, brownish, the bark cracking longitudinally into parallel strips; twigs subterete, bluntly and broadly angled, glabrous to weakly puberulent, grayish-brown; axillary buds with outer pair of scales 2, valvate, ovate, acuminate, glabrous, ca. 2.5 mm long, the inner series of scales numerous, lanceolate to ovate-lanceolate, acuminate, striate, glabrous, brown, to 20 × 7 mm, persistent at base of stems for at least three seasons. **Leaves** alternate, congested, the blades succulent and thick-coriaceous when fresh, wrinkled when dry, slightly revolute, elliptic to ovate-elliptic, 1.8–3.5 × 1.2–2.5 cm, basally rounded to broadly obtuse, apically rounded to broadly acute, glabrous on both surfaces, the venation obscurely 3–5-plinerved from the base with only the midrib scarcely visible adaxially; petioles terete, rugose, 2.5–5 mm long, weakly

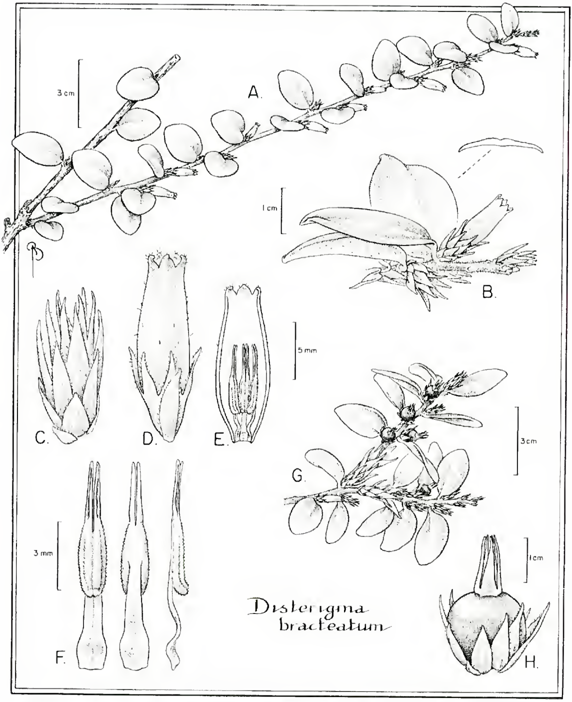


Fig. 4. *Disterigma bracteatum*. **A,** habit. **B,** portion of stem showing leaves and inflorescences, with detail of leaf cross-section. **C,** inflorescence bud. **D,** flower showing one bracteole, calyx and corolla. **E,** longitudinal section of corolla showing geniculate stamens. **F,** stamens showing ventral, dorsal, and lateral views. **G,** portion of stem showing fruits and immature inflorescences. **H,** details of mature berry showing persistent bracts and calyx lobes (drawn from *Luteyn & Magollón 15401* & *15404*).

puberulent. **Inflorescences** fusiform in shape, of solitary flowers, seemingly arising from the axils of each leaf of a current season's growth, circumscribed by a series of numerous (ca. 23), ovate to lanceolate, acuminate to long-acuminate, weakly striate, scarious or brownish, glabrous but deciduously fimbriate-margined bracts up to ca. 11 × 4 mm that cover the calyx and lower ca. half of the corolla and persist at least until the fruits mature, the third innermost bract (i.e., the floral bract) morphologically indistinguishable from the other inflorescence bracts ca. 11 × 4 mm, the two innermost bracts (i.e., the bracteoles) also morphologically indistinguishable from the other inflorescence bracts ca. 7–9 × 3–4 mm; pedicel none, replaced by a series of overlapping nodes covering <0.5 mm length. **Flowers** 5-merous; calyx ca. 8–11.5 mm long, glabrous or sometimes weakly short-pilose (especially the lobe tips), the tube barrel-shaped, ca. 2–4.5 mm long, the limb cylindric, ca. 6–7 mm long, the lobes narrowly lanceolate, long-acuminate, ca. 5–6 mm long, marginally fimbriate, the sinuses acute; corolla cylindric, narrowing at base and to throat, somewhat pentagonal to 5-angled in cross-section, ca. 7.7–15 × 6.5 mm, bright red, glabrous, the lobes deltate, ca. 1.2–2 mm long, bluntly acute; **stamens** 5, shorter than corolla in overall length, equal with each other, ca. 10–11 mm long, the filaments geniculate, distinct, ca. 4–4.5 mm long, glabrous, the anthers ca 7–7.4 mm long, the thecae ca. 3.6–3.9 mm long, the tubules 2, distinct to base, ca. 3.4–3.5 mm long, dehiscing by introrse, elongate clefts ca. 2.5–3 mm long; style included, ± equaling corolla. **Fruit** a spherical, dark purple berry, 7–8 mm diam., crowned by persistent calyx lobes.

Distribution.—Endemic to Ecuador, where it occurs on rocks and rock outcrops as a low, spreading shrub within montane cloud forest habitats, at ca. 975–2600 m.

Disterigma bracteatum is characterized by having succulent leaves, numerous (ca. 23), lanceolate, brownish, persistent bracts to 11 mm long that surround the vegetative branches, inflorescences and fruits, calyx lobes that are narrowly lanceolate to 5–6 mm long, and five geniculate stamens. In Luteyn's (1996) key to the Ecuadorean species of *Disterigma*, this new species would be found near *D. pentandrum* S.F. Blake and *D. rimbachii* (A.C. Sm.) Luteyn, all three species characterized by possessing succulent leaves, solitary flowers surrounded by a series of brownish bracts, and five stamens. *Disterigma bracteatum* differs from *D. rimbachii*, which has few, caducous bracts to 2 mm long, calyx lobes deltate ca. 1 mm long, and bracteoles 1–2 mm long, and from *D. pentandrum*, which has about six persistent bracts to 7 mm long, calyx lobes ca. 3.5 mm long, and bracteoles ca. 7 mm long.

Additional collections examined: **ECUADOR. Azuay:** Jesus María-Molleturo-Cuenca road, 0.9 km towards Molleturo from turn-off from highway that is 56 km E of Jesus María, ca. 2°42'S, 79°13'W, ca. 2438 m, 23 Nov 1998 (fr), *Luteyn & Mogollón 15404* (AAU, COL, GB, NY, QCA, QCNE, W), 2600 m, 27

Dec 2003 (fl), *Pedraza & Pedraza 1016* (COL, NY, QCA, QCNE), 10 kms before Molleturo, ca. 2°46'N, 79°24'W, 2600 m, 27 Dec 2003 (fl), *Pedraza & Pedraza 1017* (NY, QCA, QCNE).

ACKNOWLEDGMENTS

I wish to thank Gwilym P. Lewis and Veerle Van den Eynden for making special efforts to collect *Ceratostema pubescens* for me and guiding me to its location; Bertil Ståhl for providing pickled floral material; Robin B. Foster for providing beautiful photos of *C. oyacachiensis*; Bobbi Angell for the wonderful illustrations; and Patricia Eckel for providing the Latin diagnoses. The National Science Foundation (grants BSR-9024221 and DEB 9628841) provided funds for field work in Ecuador, and the Missouri Botanical Garden provided facilities to write portions of this paper. Thanks to Walter Judd and Larry Dorr who made helpful review comments.

REFERENCES

Luteyn, J.L. 1984. Revision of *Semiramisia* (Ericaceae: Vaccinieae). Syst. Bot. 9:359–367.

Luteyn, J.L. 1986. New species of *Ceratostema* (Ericaceae: Vaccinieae) from the northern Andes. J. Arnold Arbor. 67:485–492.

Luteyn, J.L. 1996. Ericaceae. In: G. Harling and L. Andersson, eds. Flora of Ecuador 54:1–404, color plates I–VIII.

Luteyn, J.L. 1998 [ver. 2002]. Neotropical blueberries: The plant family Ericaceae. www.nybg.org/bsci/res/lut2.

Luteyn, J.L. 2002. Diversity, adaptation, and endemism in neotropical Ericaceae: biogeographical patterns in the Vaccinieae. Bot. Rev. 68:55–87.

Powell, E.A. and K.A. Kron. 2003. Molecular systematics of the northern Andean blueberries (Vaccinieae, Vaccinioideae, Ericaceae). Int. J. Plant Sci. 164:987–995.

NOMENCLATURE OF *IPOMOEA ARBORESCENS* (CONVOLVULACEAE) IN SONORA, MEXICO

Daniel F. Austin

Arizona-Sonora Desert Museum
2021 N. Kinney Road
Tucson, Arizona 85743, U.S.A.

Richard Felger

Drylands Institute
PMB 405, 2509 N. Campbell Avenue
Tucson, Arizona 85719, U.S.A.

Thomas R. Van Devender

Arizona-Sonora Desert Museum
2021 N. Kinney Road
Tucson, Arizona 85743, U.S.A.

ABSTRACT

Ipomoea arborescens (tree morning glory) has two varieties in the state of Sonora, Mexico. Author citation of *I. arborescens* var. *glabrata* (a nomenclatural synonym of *I. arborescens* var. *arborescens*) is corrected. The second taxon, *I. arborescens* var. *pachylutea*, was named by Howard Scott Gentry from the Río Mayo region. These plants differ considerably from *I. arborescens* var. *arborescens* in having different bark morphology and corolla tube colors.

RESUMEN

En el estado de Sonora, México, *Ipomoea arborescens* (palo santo) tiene nombres para dos variedades. Se corrige la citación del autor de *Ipomoea arborescens* var. *glabrata*, sinónimo de *Ipomoea arborescens* var. *arborescens*. Howard Scott Gentry nombró *I. arborescens* var. *pachylutea* de la región del Río Mayo, la cual se distingue principalmente de la var. *arborescens* por su corteza amarillenta y corolas con tubos morados.

During studies of the Convolvulaceae for both the *Flora Mesoamericana* (Austin et al. in prep.), and the *Trees of Sonora, Mexico* (Felger et al. 2001), it became apparent that there is nomenclatural confusion with plants called *Ipomoea arborescens*. In addition, there is biological uncertainty about the taxonomic delimitations of these Mexican trees. This paper will address the nomenclatural problems.

When Gentry (1942) was studying the plants of the Río Mayo region of southern Sonora, he encountered two different varieties of this tree. One of these he called *I. arborescens* var. *glabrata*, and the other he named *I. arborescens* var. *pachylutea*. Although the most recent revision of the group by McPherson (1981) does not mention either variety, subsequent field studies by various botanists (e.g., Martin et al. 1998; Van Devender et al. 2000; Felger et al. 2001) make it clear that in Sonora there are indeed two distinct morphotypes subsumed by the binomial *I. arborescens*. There is as well a third morphotype farther south for which we have insufficient data to completely compare with Sonoran plants.

SIDA 21(3): 1283–1292. 2005

The species is widespread and may be characterized by the following:

Ipomoea arborescens (Humb. & Bonpl. ex Willd.) G. Don, Gen. Syst. 4:267. 1838. *Convolvulus arborescens* Willd., Enum. Pl. 1:204. 1809. TYPE: MÉXICO. GUERRERO: between Acaguisotla and Chilpancingo, *Humboldt & Bonpland 3927* (HOLOTYPE: P; microfiche seen).

Trees 5–15 m tall; the trunk thick, often 50–70 cm diameter, the bark gray, whitish or pale yellowish, stems with abundant latex, tomentose when young with trichomes 0.1–2.5 mm long, glabrescent. **Leaves** 9–27 cm long, 6–9+ cm wide, ovate to lanceolate, glabrescent, the apex acuminate, the base cordate, with trichomes longer that those on the branches, velvety at least below, the midrib base (just above the petiole) with a pair of blisterlike glands 1–3 mm in diam., turgid on young, enlarging leaves (these glands are the same color as the midrib and may be difficult to see, especially on older or dried specimens). **Inflorescences** terminal or axillary, monochasial, racemose. **Flowers** 1(–2); sepals 6–14 mm long, ovate to rarely orbicular, more or less equal, tomentose, the apex obtuse to obtuse-mucronate; corollas 4–4.3 cm long, often 6.5–9.5 cm wide, funnelform, tomentose at least on the lobes, white, tube green without. Fruits 17–25 mm long, capsular, 4-valvate, brown, glabrous; seeds 1–4, 9–16 mm long, brown, pilose on the margins with trichomes 10–15 mm long.

Illustrations.—Martínez (1969: 237), Felger et al. (2001: 139–141).

Common names.—Tree morning glory; *cazahuate* (from Distrito Federal to Oaxaca), *jútuguo* (Mayo, southern Sonora), *osí* (Tarahumara, Chihuahua), *palo blanco* (Sonora), *palo santo* (Sonora), *patancán blanco* and *rosí* (Durango, Jalisco, Michoacán, Guerrero), *tochiyó* (Guarijío, SE Sonora).

Flowering November–April; near sea level–1800 m; Sonoran desertscrub, thornscrub, tropical deciduous forest, and oak woodland or rarely at the lower edge of "tropical" pine-oak forest (Fig. 1).

The type locality is between Acapulco and Cd. México, in a mid-elevation seasonally dry tropical zone. The original vegetation at the type locality was probably tropical deciduous forest. That region is the southern part of the "typical" habitat of the modern known range of *I. arborescens*, although the species ranges into the highlands of Edo. México, Michoacán, and Morelos.

Gentry (1942) called the "smaller, less pubescent-leaved form characteristic of the species throughout the foothill regions of southern and central Sonora" var. *glabrata*. The trees that extend into the Sonoran Desert North of Hermosillo are probably the same taxon as Gentry's variety *glabrata*. Trees of the lowland and northern Sonora populations have conspicuously lighter-colored (whiter) bark, and flowers with the purple coloration much reduced or lacking when compared with var. *pachylutea*.

Fig. 1. Distribution of *Ipomoea arborescens* in Mexico. **Dots** = herbarium specimens; squares = sight records reported by Turner et al. 1995; **R** = report by Torres-R. (2004). Based on Rose (1894), Matuda (1963, 1966), McPherson (1981), Cowan (1983), Torres-R. (2004), and herbarium specimens at MEXU, MO, and ARIZ.

KEY TO SYNOPTIC TRAITS

Habitat Sonoran desert-scrub to tropical deciduous forest and lower oak woodland. Bark white. Flowers white with yellow or diffuse pale purple dots and short bands within the tube (Figs. 2, 3). Flowers in Sonora visited by bees, hawkmoths, and hummingbirds, south of Sonora by bats ______ **Ipomoea arborescens** var. **arborescens**

Habitat humid tropical deciduous forest and oak woodland. Bark yellowish. Flowers solid or almost solid dark-purplish within the tube. Flower visitors unknown ______ **Ipomoea arborescens** var. **pachylutea**

NOMENCLATURE

Ipomoea arborescens (Humb & Bonpl. ex Willd.) G. Don var. **arborescens.** *Ipomoea arborescens* (Humb & Bonpl. ex Willd.) G. Don var. *glabrata* Gentry, Carnegie Inst. Wash. Publ. 527:212. 1942. TYPE: MÉXICO. SONORA: Arroyo Cuchijaqui, *Gentry 870* (SYNTYPE: DS, n.v., cited by McPherson); San Bernardo, *Gentry 1158* (LECTOTYPE, here chosen: ARIZ!; ISOLECTOTYPE: MO!).

Ipomoea murucoides var. *glabrata* Rose, Contr. U.S. Natl. Herb. 1:107. 1891, non A. Gray (1887). TYPE: MÉXICO. SONORA: Alamos, *Palmer 316* (HOLOTYPE: US!).

FIG. 2. Corollas of *Ipomoea arborescens* var. *arborescens* as they are in plants in Sonora. The small and spotted areas of purple in the corolla throats are distinctive.

FIG. 3. Corollas of *Ipomoea arborescens* var. *pachylutea* in Sonora. The large and almost continuous areas of purple in the corolla throats are distinctive.

When Gentry made this combination, he cited the correct protologue by Rose, but incorrectly listed Gray as the author. Since the varietal name by Rose was a later homonym of var. *glabrata* A. Gray, we are interpreting Gentry's action as creation of a new name (Article 58). Tentatively, we consider this a nomenclatural synonym of *I. arborescens*. McPherson (1981) also considered the glabrous forms of the plants as a synonym, because he cited the type of *I. murucoides* var. *glabrata* Rose in synonymy with *I. arborescens*. As pointed out by Gentry (1942), there are differences between these northern plants and those farther south, but we do not have enough data on the southern populations to determine if the two should be considered nomenclaturally distinct.

These are the plants that Soderholm and Gaskins (1963) called *I. wolcottiana*. The USDA collection forming the basis of their report grows in Miami at both the Plant Introduction Station and the Fairchild Tropical Garden and its identity has been verified as *I. arborescens* var. *glabrata*. Presumably that report is also the basis of the incorrect report of *I. wolcottiana* from Sonora. That species has not been documented in Sonora.

Ipomoea arborescens (Humb & Bonpl. ex Willd.) G. Don var. **pachylutea** Gentry, Carnegie Inst. Wash. Publ. 527:213. 1942. TYPE: MÉXICO. SONORA: Sierra de Alamos. *Gentry 3000* (LECTOTYPE: ARIZ!, ISOTYPES: MO!, UC, n.v., US!). PARATYPE: MÉXICO. SONORA: Algodones, Sierra Charuco, *Gentry 2299* (ARIZ!).

Selected additional specimens seen: Sonora, Sierra de Alamos, rocky slopes and canyon bottoms, 2000–3000 ft [610–915 m]. Vernacular: *palo santo amarillo*. Large trees with massive trunks & yellowish bark browning with age; 8–15 m high. Petioles and twigs with milky juice, *Gentry 4888* (ARIZ); Sinaloa, Las Mesas, Sierra Surotato, 25 Aug 1941. Oak-*Ipomoea* savanna; volcanic ash, elev. ca. 3000 ft [915 m]. Vernacular: *palo blanco*. Tree with yellow bark. Co-dominant with oak. *Gentry 6144* (ARIZ). Additional specimens were cited by Martin et al. (1998), McPherson (1981), and Turner et al. (1995) mapped the species.

Common name.—Palo santo amarillo.

Gentry (1942) named the higher elevation or montane populations in southeastern Sonora and adjacent southwestern Chihuahua var. *pachylutea*, and distinguished these trees from *I. arborescens* var. *glabrata* in having "...yellowish bark, larger and more pubescent leaves, longer and stouter pedicels, larger and more numerous flowers, larger sepals, and generally heavier inflorescences." Other differences include wood that is apparently not as soft, corollas with a prominently maroon-purple throat, and pale lavender filaments. *Ipomoea arborescens* var. *pachylutea* occurs at ca. 500–1220 m in tropical deciduous forest and the lower oak zones. To date, variety *pachylutea* is known only from Sonora and Chihuahua, but no comparison has been made with living plants farther south.

The southern limits of var. *pachylutea* remain unknown. Both varieties occur in southeastern Sonora, but do not occur intermixed with minor exceptions. Near Alamos, Sonora, a single tree of var. *pachylutea* was found in an area of var. *arborescens* trees. Such trees, however, are in disturbed, partially cleared areas at elevations near the usual lower elevational limits of var. *pachylutea*. Trees of intermediate character are not known, and the varieties abruptly replace each other. We suspect that the two "varieties" are actually cryptic species.

Grown side-by-side at the Arizona-Sonora Desert Museum in Tucson from seed collected in Sonora, plants of var. *pachylutea* bear leaves nearly twice as large as those of var. *arborescens* (var. *glabrata* sensu Gentry 1942). In the field, Sonoran populations of these varieties exhibit overlap in leaf sizes. In Arizona plantings, variety *pachylutea* tends to branch near the base of the plant with large horizontal branches, while living specimens of var. *arborescens* generally do not share these features and develop a thick trunk at an earlier age. However, in dense forests near Alamos, *Ipomoea arborescens* var. *pachylutea* is an upright tree.

One of the difficulties in applying these names to herbarium specimens is that there typically are few obvious traits retained that can be used in distinguishing the two taxa, even though living trees are quite distinctive. When flowers are present, dissection of the corollas will reveal the needed 'comparative' differences in purple within the base of the tube. Even when both forms are not available, the two may be separated relatively easily. The inside of the tube of var. *pachylutea* is solid or nearly solid purple throughout; tubes of var. *arborescens* are variable but usually lighter in color—diffusely colored with bands and dots of light purple. Beyond that trait, we have found no consistent herbarium differences in the sizes of leaves or flowers that Gentry noted, as there is considerable variation throughout the range of the species.

Although no field phenology data are available for Sonora, trees grown in Tucson flower at different times. Data taken over 10 seasons on var. *arborescens* indicate that its beginning flowering dates vary from the third week in October to the third week in January. However, the trees cease flowering before the third week in February. By contrast, two season's data show that var. *pachylutea* does not begin flowering until the second week in March. Thus, a full two weeks separate the flowering periods. Based on herbarium specimens at ARIZ, these differences do not hold for wild plants in Sonora where flowering seasons of both varieties overlap.

The floral biology is variable and is largely temperature-dependent (Alberto Búrquez M., pers. comm. 1998; Francisco Molina F., pers. comm. 2001). The flowers commonly open in the late afternoon. During warmer weather, the corollas fall the next morning with warming daytime temperatures, but on cooler days they often do not fall until the second night. This is consistent with a number of matinal and/or nocturnal species in the family (Austin, unpubl. data). The trees are self-incompatible (Alberto Búrquez M., pers. comm. 1998); buds attract both red and black large ants (Felger et al. 2001), perhaps *Camponotus*.

In Sonora, *Hyles lineata* (white-lined sphinx moth) and perhaps other hawkmoths and hummingbirds are the primary pollinators of var. *arborescens* (Felger et al. 2001). The flowers are visited by hummingbirds in tropical deciduous forest and foothills thornscrub from the Alamos area north to Santa Ana de Yécora and Tepoca, and northwest to the Hermosillo area in the Plains of Sonora subdivision of the Sonoran Desert (Van Devender et al. 2004). *Cynanthus latirostris* (broad-billed hummingbird) and *Calypte costae* (Costa's hummingbird) are the most common visitors to *I. arborescens* while *Calpyte anna* (Anna's hummingbird) are sporadically seen. Other avian visitors such as montane species that come down from the pine-oak forest and oak woodland of the Sierra Madre Occidental into the tropical deciduous forest for the winter, include *Amazilia beryllina* (berylline hummingbird), *Heliomaster constantii* (plain-capped starthroat), and *Hylocharis leucotis* (white-eared hummingbird). Bees also visit the plants near Hermosillo (Francisco Molina, pers. comm., 2004).

While agaves (*Agave* spp.), ceibas (*Ceiba grandiflora*), yuccas (*Yucca* spp.), saguaros (*Carnegiea gigantea*), organ pipe cactus (*Stenocereus thurberi*), cardón (*Pachycereus pringlei*), and other cacti are famous for being pollinated by bats (Arizaga et al. 2000; Casas et al. 1999; Fleming et al. 1998; Nassar et al. 1997; Quesada et al. 2003; Stoner et al. 2003; Valiente-B. et al. 1997), these flying mammals do not visit only these plants exclusively. Indeed, flowers on tree *Ipomoea* may supply nectar during the season when few other bat-pollinated plants are in bloom (Hevly 1979; Turner et al. 1995).

Pollinators of *Ipomoea arborescens* var. *pachylutea* are not known, although the white limb and lavender throat may suggest bat-pollination, but bats have not been seen visiting the flowers of *I. arborescens* in Sonora. Farther south in Guerrero, México (Baker et al. 1977; Butanda C. et al. 1978), *I. arborescens* and some other species of tree morning glory are visited and presumably pollinated by *Choeronycteris mexicana* (Mexican long-tongued bat), *Glossophaga soricinia* (long-tongued bat; Villa R. 1966), and *Leptonycteris curasoae* (lesser long-nosed bat). Although *L. curasoae* is reported feeding from '*I. arborescens*' in Hidalgo (Baker et al. 1977), that species does not occur there (Carranza-G. et al. 1998); instead the plants probably are *I. rzedowskii*, although *I. murucoides* also grows there. *Leptonycteris curasoae* is known to consume *Ipomoea* pollen in Sonora (Hevly 1979) and *I. arborescens* is one of the few species of *Ipomoea* sturdy enough for bats in the state.

Because the mammals migrate north from central and southern Mexico to southern Arizona and back south during different seasons (Moreno-Valdez et al. 2000; Newton et al. 2003; Wilkinson et al. 1996), a variety of food sources are critical for their survival and reproduction. It is noteworthy that the flowering seasons of the two varieties of *I. arborescens* are different in the Arizona-grown plants because they correspond with the migration dates of the bats. *Leptonycteris* arrives in Organ Pipe Cactus National Monument in April and

May (Hoffmeister 1986; K. Krebbs & T. Tibbitts pers. comm., Sep 2004) just after var. *pachylutea* has flowered in Sonora. Adult female *Leptonycteris* have left Arizona by late September, and the juveniles leave later (K. Krebbs pers. comm., Sep 2004). *Ipomoea arborescens* var. *arborescens* in Sonora is in flower from October through the end of the year. Therefore, when the bats leave Arizona and fly through northern Sonora, the tree *Ipomoea* are not in flower.

However, in about the southern half of Sonora, there are at least a few animals present during the winter. Francisco Molina (pers. comm., 2004) informed us that "we have captured *Leptonycteris* in Hermosillo (Centro Ecológico) in mid-February visiting Agaves. We have also captured *Leptonycteris* in February at Rancho San Francisco (between San Jose de Pimas and Tecoripa) visiting etchos [*Pachycereus pecten-aboriginum*]." These winter resident *Leptonycteris* apparently are not present much north of Hermosillo (K. Krebbs, pers. comm. 2004); hence they are absent from most of the October to January flowering period of *I. arborescens* var. *arborescens*. On the other hand, *Choeronycteris* is present throughout the year in northern Sonora.

Much less is known about *Choeronycteris* because it is not a colonial species gathering in maternity colonies like *Leptonycteris* (Hoffmeister 1986; K. Krebbs, pers. comm., Sep 2004). Some individuals remain in Arizona and northern Sonora throughout the winter (K. Krebbs, pers. comm., Nov 2004), although it appears that the majority migrate southward. Their young are born in late June (Hoffmeister 1986), and presumably the migrants arrive from Mexico near the same time as *Leptonycteris*. Thus, bats may utilize *I. arborescens* on their migration north through Sonora, but do not appear to do so when going south.

ACKNOWLEDGMENTS

We thank Alberto Búrquez M., Karen Krebbs, Ana Lilia Reina-G., Curtis McCasland, Rodrigo A. Medellín, Francisco Molina F., Guillermina Murguía S., Yar Petryszyn, Tim Tibbitts, and Michael F. Wilson for information and aid in examining these plants, herbarium material, and photographs. RSF thanks the Wallace Research Foundation for support. Ana Lilia Reina G. kindly provided the Spanish abstract. Andrew McDonald and an anonymous reviewer provided helpful comments on an earlier draft of the manuscript.

REFERENCES

Arizaga, S., E. Ezcurra, E. Peters, F.R. de Arellano, and E. Vega. 2000. Pollination ecology of *Agave macroacantha* (Agavaceae) in a Mexican tropical desert. II. The role of pollinators. Amer. J. Bot. 87:1011–1017.

Austin, D.F., J.A. McDonald, and G. Murguia-S. (in prep.). Convolvulaceae In: Flora Mesoamericana.

Baker, R.J., J. Knox Jones, Jr., and D.C. Carter (eds.). 1977. Biology of bats of the New World family Phyllostomatidae, Part II. Texas Tech Press, Lubbock.

Butanda-C., A., C. Vásquez-Y., and L. Trejo. 1978. La polinización quiropterófila: una revisión bibliográfica. Biotica 3:29–35.

Carranza-G., E., S. Zamudio-R., and G. Murguía-S. 1998. Una especie nueva de *Ipomoea* (Convolvulaceae), de los Estados de Guanajuato, Hidalgo y Querétaro, México. Acta Bot. Mex. 45:31–42.

Casas, A., A. Valiente-Banuet, A. Rojas-Martínez, and P. Davila. 1999. Reproductive biology and the process of domestication of the columnar cactus *Stenocereus stellatus* in central Mexico. Amer. J. Bot. 86:534–542.

Cowan, C.P. 1983. Listados floristicos de México. I. Flora de Tabasco. Instituto de Biología, Universidad Nacional Autónoma de México, D.F.

Felger, R.S., M.B. Johnson, and M.F. Wilson. 2001. Trees of Sonora, Mexico. Oxford University Press, New York, NY.

Fleming, T.H., S. Maurice, and J.L. Hamrick. 1998. Geographic variation in the breeding system and the evolutionary stability of trioecy in *Pachycereus pringlei* (Cactaceae). Evol. Ecol. 12:279–289.

Gentry, H.S. 1942. Río Mayo plants. A study of the flora and vegetation of the Valley of the Río Mayo, Sonora. Carnegie Inst. Wash. Publ. 527, Washington, DC.

Hevly, R.H. 1979. Dietary habits of two nectar and pollen feeding bats in southern Arizona and northern Mexico. J. Arizona-Nevada Acad. Sci. 14:13–18.

Hoffmeister, D.F. 1986. Mammals of Arizona. Univeristy of Arizona Press and Arizona Game and Fish Department, Tucson.

Martin, P.S., D. Yetman, M. Fishbein, P. Jenkins, T.R. Van Devender, and R.K. Wilson (eds.). 1998. Gentry's Río Mayo Plants. The tropical deciduous forest & environs of northwest México. University of Arizona Press, Tucson.

Martínez, M. 1969. Las plantas medicinales de México. Ediciones Botas, México.

Matuda, E. 1963. El genero *Ipomoea* en Mexico (I). Anal. Inst. Biol. Univ. Nac. Méx. 34(1–2): 85–145.

Matuda, E. 1966. Las Convolvulaceas del Estado de Mexico. Govierno del Estado de Mexico, Direccion de Agricultura y Ganaderia, Toluca, Mexico.

McPherson, G. 1981. Studies in *Ipomoea* (Convolvulaceae) I. The *Arborescens* group. Ann. Missouri Bot. Gard. 68:527–545.

Moreno-Valdez, A., W.E. Grant, and R.L. Honeycutt. 2000. A simulation model of Mexican long-nosed bat (*Leptonycteris nivalis*) migration. Ecol. Modelling 134:117–127.

Nassar, J.M., N. Ramirez, and O. Linares. 1997. Comparative pollination biology of Venezuelan columnar cacti and the role of nectar-feeding bats in their sexual reproduction. Amer. J. Bot. 84:918–927.

Newton, L.R., J.M. Nassar, and T.H. Fleming. 2003. Genetic population structure and mobility of two nectar-feeding bats from Venezuelan deserts: inferences from mitochondrial DNA. Molec. Ecol. 12:3191–3198.

Parra-Tabla, V. 2002. *Ipomoea wolcottiana* Rose (Convolvulaceae). Ozote. In: F.A. Noguera, J.H. Vega Rivera, A.N. García Aldrete, and Q. Avendaño. Historia Natural de chamela. Universidad Nacional Autónoma de México, D.F., México. Pp. 159–161.

Quesada, M., K.E. Stoner, V. Rosas-Guerrero, C. Palacios-Guevara, and J.A. Lobo. 2003. Effects of habitat disruption on the activity of nectarivorous bats (Chiroptera: Phyllostomidae) in a dry tropical forest: implications for the reproductive success of the neotropical tree *Ceiba grandiflora*. Oecologia 135:400–406.

Rose, J.N. 1894. Some notes on the tree Ipomoeas of Mexico. Gard. and Forest 7:364–367.

Soderholm, P.K. and M.H. Gaskins. 1963. *Ipomoea wolcottiana*, a tree morningglory. Amer. Hort. Mag. 42:111–113.

Stoner, K.E., K.A.O. Salazar, R.C. Fernández, and M. Quesada. 2003. Population dynamics, reproduction, and diet of the lesser long-nosed bat (*Leptonycteris curasoae*) in Jalisco, Mexico: implications for conservation. Biodivers. & Conservation 12:357–373.

Torres Rojo, J.M. 2004. Especies con usos no maderables en bosques tropicales y subtropicales en los estados de Durango, Chihuahua, Jalisco, Michoacán, Guerrero y Oaxaca. URL: http://148.233.168.204/pfnm2/fichas/ipomoea_arborescens.htm.

Turner, R.M., J.E. Bowers, and T.L. Burgess. 1995. Sonoran Desert plants. An ecological atlas. University of Arizona Press, Tucson.

Valiente-Banuet, A., A. Rojas-Martinez, M. del Coro Arizmendi, and P. Davila. 1997. Pollination biology of two columnar cacti (*Neobuxbaumia mezcalaensis* and *Neobuxbaumia macrocephala*) in the Tehuacan Valley, central Mexico. Amer. J. Bot. 84:452–455.

Van Devender, T.R., A.C. Sanders, R.K. Wilson, and S.A. Meyer. 2000. Vegetation, flora and seasons of the Río Cuchujaqui, a tropical deciduous forest near Alamos, Sonora. In: R.H. Robichaux and D. Yetman, eds. The tropical deciduous forest of Alamos. biodiversity of a threatened ecosystem in México. University of Arizona Press, Tucson. Pp. 36–101.

Van Devender, T.R., W.A. Calder, K. Krebbs, A.L. Reina-G., S.M. Russell, and R.O. Russell. 2004. Hummingbird plants and potential nectar corridors for the rufous hummingbird in Sonora, Mexico. In: G.P. Nabhan, R.C. Brusca, and L. Holter, eds. Conserving migratory pollinators and nectar corridors in western North America. Arizona-Sonora Desert Museum and University of Arizona Press, Tucson.

Villa-R., B. 1966. Los Murciélagos de México. Universidad Nacional Autónoma de México. Instituto de Biologia, México, D.F.

Wilkinson, G.S., T.H. Fleming, and J. Wilkinson. 1996. Migration and evolution of lesser long-nosed bats *Leptonycteris curasoae*, inferred from mitochondrial DNA. Molec. Ecol. 5: 329–339.

IPOMOEA SEAANIA, A NEW SPECIES OF CONVOLVULACEAE FROM SONORA, MEXICO

Richard Felger

Drylands Institute
PMB 405, 2509 N. Campbell Ave.
Tucson, Arizona 85719, U.S.A.

Daniel F. Austin

Arizona-Sonora Desert Museum
2021 N. Kinney Road
Tucson, Arizona 85743, U.S.A.

ABSTRACT

Ipomoea seaania is described as a new species from the vicinity of Guaymas, Sonora. These plants are confined to the Sierra El Aguaje, although they perhaps grow in other nearby unexplored mountains. The relationships of this species to the other members of *Ipomoea* series *Arborescentes* are discussed, and all taxa in the group are listed and ranges given. *Ipomoea seaania* brings the total number of taxa in the series to 13 species, with *I. arborescens* having two varieties and *I. pauciflora* and *I. wolcottiana* each having two disjunct subspecies.

RESUMEN

Se describe **Ipomoea seaania** de las cercanías de Guaymas, Sonora, como una especie nueva. Estas plantas se encuentran restringidas a la Sierra El Aguaje, aunque quizás se encuentren en otras sierras cercanas sin explorar. Se discuten las relaciones de esta especie con otros miembros de *Ipomoea* serie *Arborescentes*; del mismo modo se listan todos los taxa del grupo y se proporcionan sus rangos de distribución. Con el reconocimiento de *Ipomoea seaania* como nueva especie, se reconocen un total de 13 especies en el grupo, de las cuales *Ipomoea arborescens* presenta dos variedades e *I. pauciflora* e *I. wolcottiana* dos subespecies.

When Old World botanists began discovering morning glories in the New World, most species they found had life forms like the twiners *Calystegia*, *Convolvulus*, and *Cuscuta* they knew at home. Their concept of the family was somewhat broadened when they found erect and sprawling herbs in the Americas, and they were amazed when they found morning glory trees (Austin 2004). In 1809, Humboldt, Bonpland and Willdenow called the first known tree species *Convolvulus arborescens*, the distinctions between *Convolvulus* and *Ipomoea* being unclear at the time. These trees still are considered "odd" or "unusual" in the family, and the only other genus in the family that achieves tree stature is the Malagasian *Humbertia* (cf. Pichon 1947; Deroin 1992). Anatomically, these American trees are distinct from other shrubby and woody members of the family (Austin 1971; Carlquist & Hanson 1991; McDonald 1992; Deroin 2001).

The arborescent species of *Ipomoea* in the New World have long been of interest to the people who lived with them. Indigenous people use several species (Hersch-M. 1995; Yetman & Felger 2002; Yetman & Van Devender 2001), and the chemistry of the group is somewhat distinctive (Pérez-A. et al. 1982, 1983, 1992a, b). Three of these alkaloids (3a-(4-hydroxybenzoyloxy)tropane, 3a-

(4-methoxybenzoyloxy)nortropane, phyllalbine) are considered rare constituents, especially in the genus *Ipomoea* (E. Eich, pers. comm., 26 Jul. 2004). Of additional interest was the discovery that nectar-feeding bats are at least seasonal flower-visitors and pollinators in some species (Butanda-C. et al. 1978; Carranza-G. et al. 1998; Casas et al. 1999; Fleming et al. 1998; Hevly 1979; Moreno-V. et al. 2000; Nassar et al. 1997; Newton et al. 2003; Quesada et al. 2003; Stoner et al. 2003; Turner et al. 1995; Valiente-B. et al. 1997; Wilkinson et al. 1996). These bats are *Choeronycteris mexicana*, *Glossophaga soricina*, and *Leptonycteris curasoae* (= *L. sanborni*, *L. yerbabuenae*). The *Leptonycteris* has been listed as endangered in the United States (Reid 1997; U.S. Fish and Wildlife Service 1997) since 30 September 1988. (See accompanying paper by Austin, Felger & Van Devender p. 1283–1292 for discussion.)

As summarized in Table 1, there are 13 species in the American series *Arborescentes* (Austin & Huaman 1996; McDonald 1991; McPherson 1981; Murguía-S. et al. 1995; Carranza-G. & McDonald 2004). Most of the species are confined to Mexico and nearby Mesoamerica (Austin 2001; Austin & Huaman 1996, Austin et al. in preparation), but there are two with disjunct subspecies in western South America (Austin 1982; McPherson 1981).

The first author found *I. seaania* in Sonora during 1980 and again in 1985 and located additional herbarium specimens. Although we talked about the plants in 1989, neither of us had the opportunity to pursue them further. Finally, we have been able to compare the known taxa with these plants.

Regarding morphology and range, this is a markedly distinct species (Table 1). Using the key in McPherson (1981) these plants come out at *I. chilopsidis*. Leaves on the two are the most obvious distinction on herbarium specimens. Both have narrow leaves, often less than one cm wide, but they are 10–20 cm long in *I. chilopsidis* and only 4–8 cm in *I. seaania*. Flowers are large (8–9.5 cm long) in *I. chilopsidis*, but only 4–6 cm in *I. seaania*. Furthermore, the overall architecture of the plants is profoundly different.

Ranges and altitudinal differences also are pronounced. *Ipomoea chilopsidis* is a plant of "high and arid craigs" (*Gentry 2391*, ARIZ) of the Sierra Madre Occidental, ranging from the eastern border of southeastern Sonora through about half of the southern end of Chihuahua. Near the border between Chihuahua and Sonora *I. chilopsidis* grows at 1100–1800 m in oak and pine-oak forest (Gentry 1942, Martin et al. 1998). On the other hand, *I. seaania* is known only from the vicinity of Guaymas in west-central Sonora where it grows near the southern margin of the desert on rocky slopes near the Gulf of California. The Guaymas region uplands are more than 1,000 m lower than those of Chihuahua.

All records for *I. seaania* are from essentially the same locality, below ca. 20 m elevation and near a road, except one collection (*Felger 80-36 et al.*) which is from a nearby canyon probably one kilometer eastward. The rugged slopes immediately above this area have yet to be explored. The canyons where the

TABLE 1. Taxa in series *Ipomoea* series *Arborescentes* and their geographic distributions.

Ipomoea arborescens (Humb. & Bonpl. ex Willd.) G. Don var. *arborescens*	Mexico (Chiapas, Colima, Durango, Guerrero, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, Sinaloa, Sonora)
Ipomoea arborescens var. *pachylutea* Gentry	Mexico (Chihuahua, Sonora)
Ipomoea chilopsidis Standley	Mexico (Chihuahua, Sonora)
Ipomoea cuprinacoma E. Carranza & J.A. McDonald	Mexico (Guerrero, Jalisco, Michoacán)
Ipomoea intrapilosa Rose	Mexico (Jalisco, Nayarit, Sinaloa, Zacatecas)
Ipomoea murucoides Roemer & Schultes	Mexico (Aguascalientes, Chiapas, Distrito Federal, Distrito Federal, Durango, Guanajuato, Jalisco, Edo. México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Queretaro, Zacatecas), Guatemala
Ipomoea pauciflora Martens & Galeotti ssp. *pauciflora*	Mexico (Guerrero, Edo. México, Michoacán, Morelos, Oaxaca, Pubela, Veracruz), Guatemala, Honduras, Nicaragua
Ipomoea pauciflora ssp. *vargasiana* (O'Donell) McPherson	Ecuador (Loja), Peru (Apurimac, Ayacucho, Cuzco), Bolivia?
Ipomoea populina House	Mexico (Chiapas, Guerrero, Oaxaca), Guatemala, Honduras, Nicaragua
Ipomoea praecana House	Mexico (Chiapas, Colima, Guerrero, Edo. México, Michoacán, Morelos, Oaxaca), Guatemala, Honduras, Nicaragua
Ipomoea pulcherrima van *ooststrstroom* (perhaps not a member of series Arborescentes)	Peru (Apurimac)
Ipomoea rzedowskii Carranza, Zamudio & Murguía	Mexico (Guanajuato, Hidalgo, Querétaro)
Ipomoea seaania Felger & D.F. Austin	Mexico (Sonora)
Ipomoea teotitlanica McPherson	Mexico (Oaxaca)
Ipomoea wolcottiana Rose var. *wolcottiana*	Mexico (Chiapas, Colima, Guerrero, Hidalgo, Jalisco, Michoacán, Morelos, Oaxaca, Puebla, Sinaloa, Tabasco, Veracruz), Guatemala, El Salvador, Honduras
Ipomoea wolcottiana ssp. *calodendron* (O'Donell) McPherson	Peru (Piura, Tumbez)

new species occurs are at the lower, southwestern flanks of the extremely rugged Sierra El Aguaje (Gentry 1949 called it the Guaymas Monadnoc, see Felger 1999). Although there has been extensive botanical exploration in the region (e.g., Felger 1999; Felger et al. 2001; Gentry 1949), the higher elevations are difficult to access and remain nearly unexplored botanically. These higher elevations, as well as the nearby and vegetationally similar Sierra Libre and Sierra El Bacatete, contain extensive areas of non-desert vegetation resembling tropical deciduous forest (Búrquez et al. 1999; Felger & Lowe 1976).

In general appearance, *I. seaania* is most similar to *I. wolcottiana* and *I. intrapilosa*, even though the latter two species are trees and *I. seaania* is a multi-stemmed shrub to 4 m. *Ipomoea wolcottiana* grows to 13 m tall, and ranges from Jalisco to El Salvador, whereas *Ipomoea intrapilosa* reaches 10 m tall, and grows from southern Sinaloa to Jalisco. McPherson (1981) pointed out that *I. wolcottiana*, *I. pauciflora*, and *I. populina* have unusual cylindrical stigmas. Murguía-S. (1995) confirmed only the presence of cylindrical stigmas (longer than wide) in only *I. pauciflora* and *I. populina*. Instead of having two appressed lobes that create an elongate stigma like the other two species, *I. wolcottiana* has lobes that are elongated laterally. Thus, while technically "cylindrical," it is wider than long. *Ipomoea seaania* exhibits two globose stigmatic lobes, which is typical of the genus, and other members of series *Arborescentes*. The cylindrical stigmas of *I. wolcottiana* and *I. pauciflora* seem to indicate a more distant relationship.

As Búrquez et al. (1999) and Felger (1999) have pointed out, the Sierra El Aguaje is notable for containing endemic species largely allied with, and presumably derived from, taxa farther south. Climatic variations and isolation were probably the driving forces behind divergence of those numerous endemic species. In addition, many species in the Sierra El Aguaje region are otherwise known only from the Baja California peninsula (Felger 1999). However, no arborescent *Ipomoea* are known from Baja California.

There are four taxa of arborescent *Ipomoea* in the state of Sonora (Table 1), which is the northernmost extension of the series (Búrquez et al. 1999; Felger 1999; Felger et al. 2001; Felger & Lowe 1976; Gentry 1949). *Ipomoea seaania* and *I. arborescens* are the only two taxa growing in the Sonoran Desert, primarily at the southern and southeastern "subtropical" margin of the desert.

Ipomoea seaania Felger & Austin, sp. nov. (**Fig. 1**). TYPE: MEXICO. SONORA: Municipio de Guaymas, broad canyon, ca. 1 km N of Bahía San Carlos on old road to Bahía Algodones; 27°57'32"N, 111°03'45"W, rhyolitic hillside, ca. 5 m above canyon bottom with riparian vegetation; shrub 2 to 3 m tall; in full flower, corollas white; locally common on steep rock hillsides, 27 Feb 1985, *Felger with Robert S. Devine 85-301* (HOLOTYPE: UA, ISOTYPES: ARIZ, ASU, BRIT, CAS, HCIB, IEB, K, MEXU, MO, NY, RSA, SD, TEX, UC, US, USON).

Frutex ad 4 m altus, ramulis dense vel sparsim breve-pilosis vel glabris. Folia ovato-lanceolata vel ovata, 2–8 cm longa, 1.5–2 cm lata, basi obtusa vel subtruncata, apice obtusa vel emarginata, margine integra, glabra. Inflorescentiae a brachyblastis lateralis productae, uniflorae rarus biflorae vel triflorae, pedunculis ad 5 mm longis, pedicellis florum 8–22 mm longis. Sepalis 12–17 mm longis, 6–8 mm latis. Corolla alba, infundibiliformis, glabra, 4–6(–7) cm longa, 7–8 cm diametro; stamina 5, antheris oblongis, sagittiformibus, 6–7 mm longis, stylus glaber, 3.6–4 cm longus, stigma biglobosum.

Openly-branched **shrubs** 1–4 m tall, with many woody stems branching from the base, the upper twigs sometimes sinuous or moderately spiraling, sometimes becoming extremely slender. Herbage largely glabrous or glabrate except newest growth densely to sparsely short-pilose, the trichomes mostly spreading.

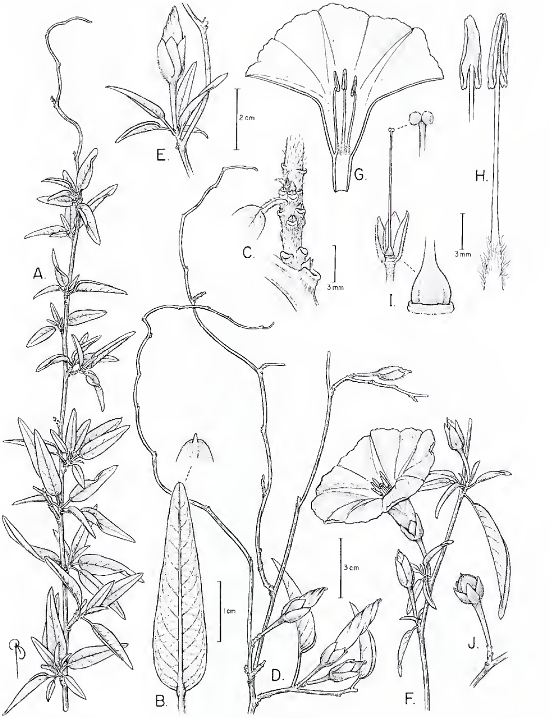


Fig. 1. *Ipomoea seaania.* **A.** Distal branch. **B.** A spur-branch leaf. The usual long-shoot leaves, lower on the stems and present during the summer rainy season, are usually broader, more ovate rather than lanceolate. **C.** Detail of spur-branch. **D.** Flowering branch. **E.** Detail of bud on spur-branch. **F.** Detail of open flower on spur-branch. **G.** Open corolla. **H.** Detail of stamen. **I.** Details of gynoecium. **J.** Young fruit. Drawn from the Holotype (*Felger with Robert S. Devine 85-301*).

Leaves drought deciduous, lanceolate to ovate, long-shoot leaves often 2–8 cm long, the blades lanceolate to ovate, 1.5–2 cm wide, with 6–8(–10) lateral pairs of primary veins, the base obtuse to subtruncate, the apex obtuse to emarginate, the midrib often ending in a short mucrone, blade glabrous; petioles 8–15(–20) mm long, with a pair of glands, usually conspicuous, at junction of petiole and blade on the lower leaf surface. Spur-branch leaves linear to linear lanceolate, often 4–8 cm long, to 4–11 mm wide, with 6–10 lateral pairs of primary veins, base obtuse to subtruncate, the apex obtuse or blunt, or sometimes shallowly emarginate, the midrid often ending as a short mucrone, the petioles to 2–9(–13.5) mm long. **Inflorescences** of 1–2(–3) flowers, appearing solitary but cymose on short-shoots 2–5 mm long, these sometimes with a few small leaves; bracts 5–8 mm long, quickly deciduous, broadly oblong with an obtuse tip; peduncles very short, to 5 mm, the pedicel 8–22 mm long. **Sepals** 12–17 mm long, 6–8 mm wide, broadly lanceolate to mostly ovate, puberulous to villous, the inner surfaces generally more densely hairy than the outer surfaces, the trichomes white, appressed to mostly ascending, and curly to straight. Inner (adaxial) sepals obtuse, the surfaces with trichomes 0.15–0.6 mm long; outer (abaxial) 2 sepals acute, slightly narrower and more sparsely pubescent than the inner 3, the trichomes 0.1–0.5 mm long, the sepal margins scarious and glabrous or glabrate. **Corollas** showy, funnelform, glabrous, 4–6 cm long and 7–8 cm wide, white with yellowish interplicae and a maroon band at inside base of the tube. **Stamens** 5, with 4 filaments 25–26 mm long, the fifth stamen 23–24 mm long, basal 4 mm of filaments pubescent, anthers oblong, sagittitate, 6–7 mm long, pollen spheroidal, spinulose. **Ovary** glabrous, 3 mm long, the style glabrous, 37–38 mm long, the stigma 2-globose. Flowering January–March.

Other specimens examined: **Municipio de Guaymas:** Along partially paved road between San Carlos Bay and Catch-22 airstrip NW of Guaymas, desert scrub with *Stenocereus, Bursera, Pachycereus, Jatropha*, and *Acacia*, elevation near sea level, shrub to 3 m, corolla white, infrequent, 5 Jan 1983, *T.F. Daniel 2360* (ASU 128321); on road outside Bahía San Carlos, open shrub, 1–1.5 m tall, cliff base in hardened volcanic soil, NW slope in association with *Euphorbia ceroderma, Mascagnia macroptera, Acacia willardiana*, elevation 10 m, 21 Feb 1977, *Ames 77-60* (ARIZ 211499); 0.1 mi N of north end of San Carlos Bay, west-facing slopes above bay, elevation 15 m, 27°57'N, 111°03'W, Sonoran Desertscrub, shrub 2–3 m tall, 10 Oct 1985, *Felger 85-1232, with Frank W. Reichenbacher* (ARIZ 332087); San Carlos Bay, W of Guaymas; a canyon one mi N of the bay near Cerro Los Algodones, along the road to Rancho La Manga, near 27°58'N, 111°04'W, rocky volcanic ridge and adjacent stony canyon bottom, associated with *Bursera, Prosopis, Jatropha, Croton sonorae, Acacia willardiana*, etc., scarce large shrub about 12 ft high with many stems from base, on floor of canyon above wash, fls white with yellowish star pattern and maroon band in throat, ± 300 ft, 22 Mar 1983, *A.C. Sanders 3616* (ARIZ 245472, TEX); canyon, ca. 4 km NW of Bahía San Carlos, steep rocky canyon with dense desertscrub, shrub 1.8 m tall, scattered, not common, 6 Sep 1980, *Felger 80-36, with L. Findley, S. Findley* (ARIZ 200443); road between San Carlos Bay and Catch-22 airstrip, collected in desertscrub with *Stenocereus, Bursera, Pachycereus, Jatropha, Acacia, Fouquieria, Opuntia, Ferocactus*; elevation near sea level, small tree to 3 m, corolla white, rare, 8 Mar 1985, *Daniel 3986* (CAS).

The plants are locally common on rugged, lower slopes of the Sierra El Aguaje just North of Bahía San Carlos; on rocky volcanic ridges, steep colluvium, and rhyolite slopes of canyon sides and cliff bases. The San Carlos region is undergoing rapid tourist development and extensive areas of natural vegetation are being destroyed. The canyon bottom immediately below the *Ipomoea seaania* population once supported a dense stand of subtropical riparian vegetation; this was destroyed several decades ago to build a road to the site for the filming of "Catch 22." There are no other records for this unusual shrub.

These plants grow in dense desertscrub with ca. 60% cover of perennials. Species associated with the type collections include *Abutilon incanum, Acacia willardiana, Agave angustifolia, Antigonon leptopus, Ayenia jaliscana, Bursera laxiflora, B. microphylla, Cardiospermum corindum, Colubrina viridis, Cordia parvifolia, Coursetia glandulosa, Croton sonorae, Cylindropuntia versicolor, Desmanthus covillei, Diphysa occidentalis, Euphorbia ceroderma, Ferocactus emoryi, Fouquieria diguetii, Haematoxylon brasiletto, Hechtia montana, Holographis virgata, Ibervillea sonorae, Jatropha cuneata, Krameria sonorae, Lantana velutina, Lippia palmeri, Mammillaria johnstonii, M. swinglei, Manihot* sp., *Melochia tomentosa, Mimosa distachya, Nissolia schottii, Opuntia gossiliniana, Randia thurberi, Ruellia californica, Sebastiania bilocularis, Stenocereus thurberi,* and *Trixis californicus.*

Ipomoea seaania plants are generally leafy and produce vegetative growth only during the brief summer-early fall monsoonal rainy season, when sporadic thunderstorms occur. Occasional late summer and fall hurricane-fringe storms extend the growing season. Otherwise the plants are leafless or nearly so. As with *I. arborescens* in the Sonoran Desert, flowering occurs when the plants are essentially leafless. Other species in the series typically retain their leaves while flowering.

Summer monsoon rains and occasional hurricane-fringe rains at the end of summer and early fall come at a time of hot weather, but these hot-weather rains are highly variable. It is during the monsoon season when most long-shoot growth occurs, and leaves on the long-shoots are the largest, broadest, and have the longest petioles (even relative lengths). Other arborescent *Ipomoea* in Sonora likewise do not flower during this season (Table 1). Also during the wet season, abundant leaf production of *I. seaania* occurs on numerous short-shoots, and these leaves are smaller, narrower, and with shorter petioles in comparison to leaves on long-shoot branches.

Winter-spring rains are unpredictable, and if they occur when the weather is warm enough, short-shoots and leaves and some long-shoot development may occur. However, these long-shoots are generally small in comparison to those of monsoon-season growth. Flowering may occur from fall (October and November) through spring (late March, perhaps April).

Although minor frosts may occur in the region, the habitat on the rocky slopes where *I. seaania* grows is undoubtedly frost free. The weather is very hot during the long summer, and very mild even in winter, and warm to even hot during the rest of the year. Mean annual rainfall for the nearby city of Guaymas is around 275 mm, based on data taken from September 1968 to February 1987. However, as is usual in deserts, there is considerable variation in annual rainfall. Maximum temperature occurs in August (mean 40°C) and minimum temperature is in January (mean 7°C, with absolute minima of 1°C in 1973 and 1987) (Comisión Nacional de Agua, Hermosillo).

Some herbarium curators have the view that non-flowering specimens lack value. For the general user, perhaps the curators are correct, but for the specialist, sterile specimens often provide data that otherwise are available only on living plants at specific seasons. Without preserved examples of these temporal variations the data derived from fertile herbarium specimens is often limited at best. We lament the general lack of good vegetative specimens of arborescent morning glories.

The new species occurs at the northern boundary of the original homelands of the Yoeme (Yaqui) people. The species name derives from *Sea Ania*, the Yoeme concept of the Flower World, the place where life begins. *Sea Ania* was created after *Yo Ania* (the Enchanted World) and after people. *Sea Ania* is in all life, in all creatures, overseeing nature, including the rivers, the wind, the clouds, ocean, rain, sun, moon, sky, and stars. *Sea Ania* is *Huya Ania* (Wilderness World) in flower. The Flower World is the living beauty of this world, the natural world. *Sea Ania* is the final resting place of the Yoemen (Yaqui people). Yoeme artists use flowers in their artwork to represent *Sea Ania* (Evers & Molina 1987).

ACKNOWLEDGMENTS

We thank Phil Jenkins at ARIZ, Shannon Doan at ASU, Lloyd Findley, Francisco Molina F., Ana Lilia Reina G., Tom Van Devender, and Michael Wilson for herbarium material, comments, and other support. RSF thanks the Wallace Research Foundation for support. Ana Lilia Reina G. kindly provided the Spanish abstract. Andrew McDonald provided helpful comments on an earlier draft of the manuscript. We thank Bobbi Angell for the magnificent drawing.

REFERENCES

Austin, D.F. 1971. A monograph of the American Erycibeae (Convolvulaceae): *Maripa, Dicranostyles & Lysiostyles*. Ph.D. Diss., Washington University, St. Louis.

Austin, D.F. 1982. Convolvulaceae, Fam. 165. In: G. Harling and B. Sparre, eds. Flora of Ecuador No. 15:1–99.

Austin, D.F. 2001. Convolvulaceae. In: D. Stevens, ed. Flora de Nicaragua. Volume 85, Tomo I, Missouri Botanical Garden Press, St. Louis. Pp. 653–679.

Austin, D.F. 2004.Convolvulaceae. In: N.P. Smith, S.A. Mori, A. Henderson, D.W. Stevenson, and S.V. Heald, eds. Families of neotropical flowering plants. New York Botanical Garden, Bronx, and Princeton University Press, Princeton, NJ. Pp. 113–115.

Austin, D.F. and Z. Huaman. 1996. A synopsis of *Ipomoea* (Convolvulaceae) in the Americas. Taxon 45:3–38.

Austin, D.F., J.A. McDonald and G. Murguía-S. (in preparation). Convolvulaceae In: Flora Mesoameriana.

Búrquez, A., A. Martínez-Yrízar, R.S. Felger, and D. Yetman. 1999. Vegetation and habitat diversity at the southern edge of the Sonoran Desert. In: R.H. Robichaux, ed. Ecology of Sonoran Desert Plants and Plant Communities. University of Arizona Press, Tucson. Pp. 36–67.

Butanda-Cervera, A., C. Vásquez-Yanes, and L. Trejo. 1978. La polinización quiropterófila: una revisión bibliográfica. Biotica 3:29–35.

Carlquist, S. and M.A. Hanson. 1991. Wood and stem anatomy of Convolvulaceae: A survey. Aliso 13:51–94.

Carranza-G., E., S. Zamudio Ruíz, and G. Murguía S. 1998. Una especie nueva de *Ipomoea* (Convolvulaceae), de los Estados de Guanajuato, Hidalgo y Queretarto, Mexico. Acta Bot. Mex. 45:31–42.

Carranza-G., E. and J.A. McDonald. 2004. *Ipomoea cuprinacoma* (Convolvulaceae): A new morning glory from southwestern Mexico. Lundellia 7:1–4.

Casas, A., A. Valiente-Banuet, A. Rojas-Martínez, and P. Davila. 1999. Reproductive biology and the process of domestication of the columnar cactus *Stenocereus stellatus* in central Mexico. Amer. J. Bot. 86:534–542.

Deroin, T. 1992. Anatomie florale de *Humbertia madagascariensis* Lam. Contribution à la morphologie comparée de la fleur et du fruit des Convolvulaceae. Bull. Mus. Natl. Hist. Nat. Sect. B, Adansonia, Sér. 4 14:235–255.

Deroin, T. 2001. Famille 117—Convolvulaceae. In: P. Morat, ed. Flore de Madascar et des Comores. Muséum National d'Histoire Naturelle, Paris. Pp. 11–287.

Evers, L. and F.S. Molina. 1987. Yaqui Deer Songs. Sun Tracks and The University of Arizona Press, Tucson.

Felger, R.S. 1999. The flora of Cañón del Nacapule: A desert-bounded tropical canyon near Guaymas, Sonora, Mexico. Proc. San Diego Soc. Nat. Hist. 35:1–42.

Felger, R.S. and C.H. Lowe. 1976. The island and coastal vegetation and flora of the Gulf of California, Mexico. Nat. Hist. Mus. Los Angeles County, Contr. Sci. 285. 59 pp.

Felger, R.S., M.B. Johnson, and M.F. Wilson. 2001. Trees of Sonora, Mexico. Oxford University Press, New York.

Fleming, T.H., S. Maurice, and J.L. Hamrick. 1998. Geographic variation in the breeding system and the evolutionary stability of trioecy in *Pachycereus pringlei* (Cactaceae). Evol. Ecol. 12:279–289.

Gentry, H.S. 1942. Rio Mayo plants–a study of the flora and vegetation of the valley of the Rio Mayo, Sonora. Carnegie Institution of Washington, Publication 527. Washington, D.C.

Gentry, H.S. 1949. Land plants collected by the Vallero III, Allan Hancock Pacific Expeditions 1937–1951. Allan Hancock Pacific Expeditions 13. University of Southern California Press, Los Angeles.

Hersch-Martínez, P. 1995. Commercilization of wild medicinal plants from southwest Puebla, Mexico. Econ. Bot. 49:197–206.

Hevly, R.H. 1979. Dietary habits of two nectar and pollen feeding bats in southern Arizona and northern Mexico. J. Arizona-Nevada Acad. Sci. 14:13–18.

Martin, P.S., D. Yetman, M. Fishbein, P. Jenkins, T.R. Van Devender, and R.K. Wilson. 1998. Gentry's Río Mayo plants. University of Arizona Press, Tucson.

McDonald, J.A. 1991. Origin and diversity of Mexican Convolvulaceae. Anales Inst. Biol. Univ. Nac. Autón. México, Sér. Bot. 62:65–82.

McDonald, J.A. 1992. Evolutionary implications of typical and anomalous secondary growth in arborescent *Ipomoea* (Convolvulaceae). Bull. Torrey Bot. Club 119:262–267.

McPherson, G.D. 1981. Studies in *Ipomoea* (Convolvulaceae) I. the Arborescens group. Ann. Missouri Bot. Gard. 68:527–545.

Moreno-Valdez, A., W.E. Grant, and R. L. Honeycutt. 2000. A simulation model of Mexican long-nosed bat (*Leptonycteris nivalis*) migration. Ecol. Modelling 134:117–127.

Murguía-S., G. 1995. Morfología y anatomía reproductiva de nueva especie de la serie *Arborescens* (*Ipomoea*: Convolvulaceae). Universidad Nacional de México, tesis de Maestría.

Murguía-S., G., J. Marquez-Guzman, G., Laguna Hernandez, and M. Ponce Salazar. 1995. Estudio de frutos y semillas de *Ipomoea teotitlanica* McPherson (Convolvulaceae). Acta Bot. Mex. 32:69–77.

Nassar, J.M., N. Ramirez, and O. Linares. 1997. Comparative pollination biology of Venezuelan columnar cacti and the role of nectar-feeding bats in their sexual reproduction. Amer. J. Bot. 84:918–927.

Newton, L.R., J.M. Nassar, and T.H. Fleming. 2003. Genetic population structure and mobility of two nectar-feeding bats from Venezuelan deserts: inferences from mitochondrial DNA. Molec. Ecol. 12:3191–3198.

Pérez-Amador, M.C., D. Amor Prats, and G. Murguía-S. 1992b. Análisis comparativo de marcadores taxonómicos en perfiles cromatográficos de hojas de algunas especies arborescentes del género *Ipomoea* (Convolvulaceae). Phyton 53:1–4.

Pérez-Amador, M.C., A. García Argáez, S. Alcantara, F. García Jimenez, and O. Collera. 1983. Estudio comparativo de aceites de semillas de Convolvulaceae. II. Análisis de aceites de semillas de *Ipomoea murucoides* Roemer et Schultes e *I. arborescens* Humb. et Bonpl. Phyton 43:103–108.

Pérez-Amador, M.C., A. Garcia-Argaez, D. Amor Prats, G. Murguia-S., G. Garcia Jiménez, and L.C. Márquez Alonzo. 1992a. Estudio comparativo de aceites de semillas de Convolvulaceae III. Análisis de aceites de semillas de seis especies de *Ipomoea* del grupo *Arborescentes* y de *I. carnea* Jacq. Phyton 53:71–75.

Pérez-Amador, M.C., A. Gonzalez-E., D. Saloma, F. Garcia Jimenez, and O. Collera. 1982. Estudio comparativo de acietes de semillas de Convolvulaceae. Phyton 42:93–101.

Pichon, M. 1947. Le genre *Humbertia*. Muséum National d'Histoire Naturelle, Notulae Syst. 12–13: 13–25.

Quesada, M., K.E. Stoner, V. Rosas-Guerrero, C. Palacios-Guevara, and J.A. Lobo. 2003. Effects of habitat disruption on the activity of nectarivorous bats (Chiroptera: Phyllostomidae) in a dry tropical forest: implications for the reproductive success of the neotropical tree *Ceiba grandiflora*. Oecologia 135:400–406.

Reid, F.A. 1997. A field guide to the mammals of Central America & southeast Mexico. Oxford University Press, New York.

Stoner, K.E., K.A.O. Salazar, R.C. Fernández, and M. Quesada. 2003. Population dynamics, reproduction, and diet of the lesser long-nosed bat (*Leptonycteris curasoae*) in Jalisco, Mexico: implications for conservation. Biodivers. Conservation 12:357–373.

Turner, R.M., J.E. Bowers, and T.L. Burgess. 1995. Sonoran Desert plants: an ecological atlas. University of Arizona Press, Tucson.

U.S. Fish and Wildlife Service. 1997. Listed vertebrate animal species index.endangered.fws.gov/mammals1.html/ Accessed June 2004.

Valiente-Banuet, A., A. Rojas-Martínez, M. del Coro Arizmendi, and P. Davila. 1997. Pollination biology of two columnar cacti (*Neobuxbaumia mezcalaensis* and *Neobuxbaumia macrocephala*) in the Tehuacan Valley, central Mexico. Amer. J. Bot. 84:452–455.

Wilkinson, G.S., T.H. Fleming, and J. Wilkinson. 1996. Migration and evolution of lesser long-nosed bats *Leptonycteris curasoae*, inferred from mitochondrial DNA. Mol. Ecol. 5: 329–339.

Yetman, D. and R.S. Felger. 2002. Ethnoflora of the Guarajíos. In: D. Yetman. The Guarjíos of the Sierra Madre. Hidden People of Northwestern Mexico. University of New Mexico, Albuquerque. Pp. 174–230.

Yetman, D. and T.R. Van Devender. 2001. Mayo ethnobotany. Land, history, and traditional knowledge in northwest Mexico. University of California Press, Berkeley.

BOOK REVIEWS

ROY L. LEHMAN, RUTH O'BRIEN, and TAMMY WHITE drawings by EVELINE MAY JACKSON and KIM KEPLAR. 2005. **Plants of the Texas Coastal Bend.** (ISBN 1-58544-408-1, hbk.). Texas A&M University Press, John H. Lindsey Bldg., Lewis St. 4354 TAMU, College Station, TX 77843-4354, U.S.A. (**Orders:** wlawrence@tamu.edu, http://www.tamu.edu/upress, 800-826-8911). $40.00 hbk., 352 pp., ca. 70 b/w line drawings, CD with over 750 color photos, index, 6 1/8" × 9 1/8".

This is an update of Fred Jones' "*Flora of the Texas Coastal Bend*" (Edition 2, 1977)—additional species are included and nomenclature is amended to follow more recent taxonomic concepts. "About 1,150 species and varieties, exclusive of the grasses, are included," users are referred to three recent volumes treating the Poaceae from the Coastal Bend region. Many recent generic segregates are recognized, following the 1997 Texas checklist and overview by [Stan] Jones, Wipff, and Montgomery, but others are not (e.g., why not *Thymophylla* and *Rayjacksonia*?). Families, genera, and species are now treated alphabetically. Keys remain highly abbreviated but are no longer indented. More intense botanical editing could have avoided various small errors.

Copyright of the publication is held by the Welder Wildlife Foundation (as with the original Jones volumes), perhaps because the keys and descriptions are identical in large part to the first. The book is dedicated to the memory of Fred Jones, and it is curious that Lehman, O'Brien, and White changed the title slightly, included updates and changed formats, and supplanted Jones's authorship. Legal necessities with change of press?

Accompanying the volume is a CD with many hundreds of photos of Coastal Bend species. They vary in quality and a surprising number are not identified to species, but at least the latter are useful for confirming identities at generic level.—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

JAMES A. FOWLER. Introduction by PAUL MARTIN BROWN. 2005. **Wild Orchids of South Carolina: A Popular Natural History.** (ISBN 1-57003-566-0, hbk.). University of South Carolina Press, 718 Devine St., Columbia, SC 29208, U.S.A. (**Orders:** 800-768-2500, www.sc.edu/uscpress/). $39.95, 242 pp., color photos, 6" × 9".

"Although this work is neither intended to be a comprehensive treatise nor a technical, scientifically oriented field guide, it is a popular account of one man's intoxicating obsession with wild orchids. As such, it becomes a valuable contribution to the knowledge of the orchids of South Carolina and an aesthetic presentation of the beauty and intricacies of these captivating flowers" (from the introduction by Paul Martin Brown (author of "Wild Orchids of the southeastern United States, north of peninsular Florida," 2004). The forte of this book surely is the photography—for each of the 55 species currently known from the state, there is a full page color photo—details and variants are often included. For each species, there also is a county-level map and notes on pollinators, flowering time, and habitat. Because the county maps seem to be identical or nearly so with those shown by the South Carolina Plant Atlas <http://cricket.biol.sc.edu/herb/>, Fowler's maps probably are taken from the former—there is no formal attribution or acknowledgement, although the SC Plant Atlas is listed in the Bibliography.—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

SIDA 21(3): 1304. 2005

INFRAGENERIC CLASSIFICATION OF *LIATRIS* (ASTERACEAE: EUPATORIEAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

The 37 currently recognized species of *Liatris* are placed in formal positions within an infrageneric taxonomic system modified from one proposed by Gaiser in 1946. Five sections are recognized: (1) sect. *Liatris* (including ser. *Liatris*, ser. *Punctatae*, and ser. *Elegantes*), (2) sect. **Vorago** Nesom, sect. nov., (3) sect. *Suprago* (Gaertner) DC., (4) sect. **Pilifilis** Nesom, sect. nov., and (5) sect. **Graminifolium** Nesom, sect. nov. (including ser. *Garberae*, ser. *Pauciflorae*, ser. *Virgatae*, ser. *Graminifoliae*, and ser. *Scariosae*).

RESUMEN

Las 37 especies usualmente reconocidas de *Liatris* se colocan en posiciones formales en un sistema taxonómico infragenérico modificado a partir del propuesto por Gaiser en 1946. Se reconocen cinco secciones: (1) sect. *Liatris* (que incluye las ser. *Liatris*, ser. *Punctatae*, y ser. *Elegantes*), (2) sect. **Vorago** Nesom, sect. nov., (3) sect. *Suprago* (Gaertner) DC., (4) sect. **Pilifilis** Nesom, sect. nov., y (5) sect. **Graminifolium** Nesom, sect. nov. (including ser. *Garberae*, ser. *Pauciflorae*, ser. *Virgatae*, ser. *Graminifoliae*, y ser. *Scariosae*).

Gaiser (1946) provided the only taxonomic overview of the genus *Liatris* since reviews by de Candolle (1836) and Gray (1884). Regional treatments by Alexander (1933), Fernald (1950), and Cronquist (1980) included most or many of the species, and recent studies have investigated various taxonomic problems (Godfrey 1948; Menhusen 1963; Cruise 1964; Johnson 1971; Thomas 1975; Bowles et al. 1988; Pyne & Stucky 1990; Stucky & Pyne 1990; Stucky 1991, 1992; Godt & Hamrick 1996; Allison 2001; Nesom & O'Kennon 2001; Anderson 2002; Mayfield 2002; Kral & Nesom 2003; Gandhi et al. 2003; Nesom & Stucky 2004; Ward 2004; Nesom 2005a, 2005b). Apart from Gaiser's monograph, however, only Alexander and Fernald formally arranged species into infrageneric groups. King and Robinson (1987) offered pertinent observations regarding possible relationships within the genus but did not attempt to provide a formal infrageneric taxonomic structure. Observations made in connection with preparation of a species-level taxonomic treatment of *Liatris* (Nesom 2005a) for the Flora of North America volumes are formalized here toward additional perspective on interrelationships within the genus.

The closest relatives of *Liatris* are *Carphephorus* Cass. (7 species; including *Litrisa* Small—1 species and *Trilisa* (Cass.) Cass.—2 species), *Garberia* A.

SIDA 21(3): 1305–1321. 2005

Gray (1 species), and *Hartwrightia* A. Gray ex S. Wats. (1 species), which (with *Liatris*) constitute subtribe Liatrinae King & H. Robinson of tribe Eupatorieae Cass. (King & Robinson 1987). Specializations of *Hartwrightia* apparently obscured an understanding of its relationship until the study of Robinson and King (1977). The Liatrinae is essentially restricted to the eastern and southeastern U.S.A.; one species (*Liatris garberi*) occurs on the Bahama islands as well as in Florida and several species are essentially Great Plains entities, one of them reaching into northern Mexico. The subtribe is a well-defined group, characterized by the following features: base chromosome number of $x = 10$; leaves alternate, usually in a basal rosette, at least in early stages (fide King & Robinson 1987); corollas rose-purple, with cells laxly subquadrate to short-oblong and usually without sinuous walls, lobes mamillose or papillose on inner surfaces; carpopodium indefinite or lacking; cypselar duplex trichomes with cells diverging from near the base; and pappus bristles with barbels indefinitely (vs. linearly) arranged. Within the Liatrinae, *Liatris* is characterized by its usually cormose habit, usually spiciform to racemiform capitulescence, relatively long corolla lobes (long lobes also are characteristic of *Garberia*), and oblong-ovate and apically rounded (non-retuse) anther appendages (also found in *Trilisa*). Concepts of the other genera have been generally accepted, except for *Carphephorus*.

Most recent authors (e.g., Hebert 1968; Correa & Wilbur 1969; Cronquist 1980) have treated *Carphephorus* broadly to include *Litrisa* and *Trilisa*. Radford et al. (1968), in contrast, treated *Carphephorus* and *Trilisa* separately, and King and Robinson (1987) opted for narrower generic concepts, observing that (p. 279) "the broader concept of *Carphephorus* [sensu lato], though natural, is difficult to define in contrast to *Liatris*" and that "actual differences between *Carphephorus*, *Trilisa*, and *Litrisa* have been underestimated by the various authors favoring synonymy." A molecular-phylogenetic study (Schmidt & Schilling 2000), which included two species of *Trilisa* (*C. odoratissimus* and *C. paniculatus*), two of *Carphephorus* sensu stricto (*C. pseudoliatris* and *C. corymbosus*), and three of *Liatris*, suggests that *C. pseudoliatris* is more closely related to *Liatris* than to the others, but too few species of Liatrinae were included to make this a reliable conclusion. A preliminary report on Liatrinae phylogeny (Schilling & Cox 2000) appears to confirm the phylogenetic distinction of *Trilisa* and *Litrisa*. King and Robinson (1987, p. 272), observed that "the genus *Liatris* stands unmistakably outside of the complex including *Carphephorus*, *Litrisa*, and *Trilisa*."

The evolutionary and taxonomic coherence of *Liatris* is supported by the apparent ease with which hybrids are formed between species. A pattern of occurrence is not evident. Interspecific hybrids within *Liatris* have been reported across sectional boundaries (as delimited here) within *Liatris*: *Suprago-Graminifolium* (Gaiser 1946; Hadley & Levin 1967; Levin 1967); *Liatris-Graminifolium*, *Liatris-Pilifilis*, and *Liatris-Suprago* (Gaiser 1951; Hadley &

Levin 1967; Levin 1973); and *Liatris-Vorago* (Allison 2001; Mayfield 2002; Hardig et al. submitted). A list of *Liatris* interspecific hybrids and their putative parents is given in the FNA treatment (Nesom 2005a). There is no readily apparent morphological evidence, however, that hybridization has occurred between species of any of the generic-level taxa of Liatrinae, including the segregates of *Carphephorus*.

Overview of *Liatris* infrageneric taxonomy

Alexander (1933) did not assign rank to species groups that he recognized for *Laciniaria* (= *Lacinaria* = *Liatris*). Gaiser (1946) used the conventions initiated by Alexander (plural adjectives for group names) but modified the species constitution for some of the groups. Although she specifically referred to the species groups as "series" (placed within two sections) (Table 1), Gaiser did not validate the infrageneric nomenclature by providing Latin diagnoses for the groups, nor did she make direct or indirect reference to Alexander's names. Fernald (1950) credited Gaiser as combining author of the names she had proposed at the rank of series, using unranked basionyms of Alexander from 1933.

The current study arranges 37 species of *Liatris* in five sections. Figure 1 is essentially a diagrammatic representation of the classification presented below, or it might be read as an essentially unresolved cladogram. A few phyletic generalizations are noted in the following discussion, but lack of morphological evidence limits resolution of relationships.

Among the five sections, sects. *Liatris* and *Vorago* have a more western distribution (essentially extra-Floridian, extra-Atlantic) and constitute a lineage characterized by a distinctive foliar feature—the margins are distinctly whitish-thickened and the surface of this tissue is minutely pebbly-scabrous, an apparently specialized feature not occurring elsewhere in the genus or Liatrinae. Sect. *Liatris* is the only group within the Liatrinae with plumose pappus bristles and is interpreted here as monophyletic on the basis of this apparent synapomorphy. The level of morphological differentiation among the three series of sect. *Liatris*, however, is greater than among the groups treated here as series within sect. *Graminifolium*.

Sects. *Graminifolium*, *Suprago*, and *Pilifilis* have been considered together to constitute sect. *Suprago* (Gaiser 1946; King & Robinson 1987; presumably characterized by the shared plesiomorphy of barbellate pappus bristles), but no specialized morphological feature is evident that would link these groups as a single clade. Gaiser recognized ser. *Pycnostachyae*, ser. *Spicatae*, and ser. *Tenuifoliae* as distinct groups, but the first two are treated here without formal rank within sect. *Suprago*. The two species of ser. *Tenuifoliae* are treated here as sect. *Pilifilis*. Sect. *Graminifolium* includes the species that have an internally pilose corolla tube (with exceptions, as noted below): within the section, ser. *Scariosae* and ser. *Graminifoliae* were recognized as formal groups by Gaiser,

Table 1. Gaiser's classification (1946) of *Liatris*.

Section **Euliatris**
    Ser. **Elegantes**: *L. elegans*
    Ser. **Punctatae**: *L. punctata, L. densispicata, L. mucronata, L. angustifolia, L. bracteata*
    Ser. **Cylindraceae**: *L. cymosa, L. ohlingerae, L. cylindracea*
    Ser. **Squarrosae**: *L. squarrosa*

Section **Suprago**
    Ser. **Spicatae**: *L. spicata, L. lancifolia, L. microcephala, L. acidota, L. garberi*
    Ser. **Pycnostachyae**: *L. pycnostachya*
    Ser. **Graminifoliae**: *L. graminifolia, L. helleri, L. regimontis, L. gracilis, L. turgida*
    Ser. **Pauciflorae**: *L. chapmanii, L. pauciflora, L. secunda*
    Ser. **Tenuifoliae**: *L. tenuifolia, L. laevigata*
    Ser. **Scariosae**: *L. scariosa, L. aspera, L. scabra, L. ligulistylis, L. borealis, L. earlei*

although the species compositions of both are modified here; additionally, ser. *Virgatae*, ser. *Pauciflorae*, and ser. *Garberae* are recognized as constituents of sect. *Graminifolium* in the current classification.

Morphological trends

Parallel trends in morphological specialization can be observed within *Liatris*. Although the other genera of Liatrinae produce heads in corymbiform arrangements, the ancestral arrangement within *Liatris* apparently is spiciform to racemiform, and the open, broadly corymbiform capitulescences of *L. ohlingerae* (sect. *Graminifolium*) and *L. cymosa* (sect. *Liatris*) are interpreted here as independently and secondarily derived. As observed by King and Robinson (1987), a nearly complete reduction of the anther appendages seems to have been correlated with these modifications in head arrangement (appendage reduction also has occurred in *L. elegans*); increase in head size also has been a concomitant. Marked increase in head size also has occurred in ser. *Punctatae*, and size of heads (especially as gauged by number of florets) often varies widely among species, particularly in sect. *Graminifolium*. Parallel foliar venation apparently has developed independently in sect. *Liatris* and sect. *Suprago*. Reduction or loss of glandular punctation has occurred in sect. *Suprago*, several groups of sect. *Graminifolium*, sect. *Liatris*, and sect. *Vorago*. Elongation of the putatively primitive corm has occurred independently in sect. *Liatris* (e.g., L. *elegans*, L. *punctata*), sect. *Suprago* (e.g., *L. pycnostachya* var. *lasiophylla*, *L. spicata*), and sect. *Graminifolium* (e.g., *L. garberi*, *L. savannensis*). Chromosome numbers in *Liatris* and Liatrinae are mostly $2n = 20$ (Gaiser 1949, 1950a, 1950b); within *Liatris*, polyploidy occurs in ser. *Punctatae* (see below) and perhaps other groups.

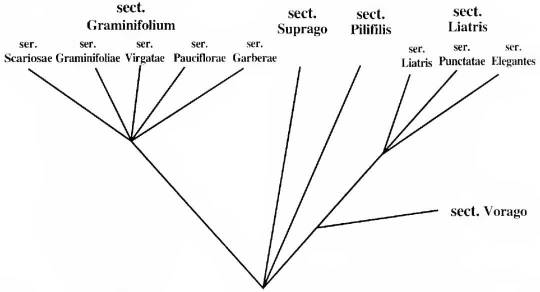


Fig. 1. Infrageneric taxonomic structure of *Liatris*.

Corms or roots?

Interpretation of the morphological nature of the perennating structures of *Liatris* and their descriptive terminology have been inconsistent. Gaiser (1946, p. 168–169) interpreted them as thickened underground stems and referred to them as corms. She noted that "During the first summer of the seedling's growth there develop a few radical leaves above what appears as a slightly thickened tap-root, but at the end of the season an apical bud is developed from a small crown and this, in the second year, produces the first flowering stalk. During successive summers the stem thickens, becoming globular or remaining ovoid in most species. ..." She referred to the more elongate structures, such as produced by *L. punctata*, both as "rhizomes" and as "rootstocks" and also was inconsistent in description of the globose structures: for example, she noted for *L. spicata* (p. 178) "Rootstock globose in young plants, enlarged and shallow in old plants by separation of parts permitting considerable vegetative propagation." Other botanists also have described them variously: Gray (1884), "a tuberous or mostly globose and corm-like stock;" Fernald (1950), "a roundish corm or tuber ... ;" Bailey and Bailey (1976), "a corm, or less often ... a rhizome or an elongated root crown;" Cronquist (1980), "a thickened, usually cormlike rootstock" but noting that they appear to have characteristics of both corm and root; King and Robinson (1987), "a thickened, usually corm-like, penetrating rootstock ..." Kerster (1968) and Levin (1973) made age estimates of *Liatris* individuals by counting annual growth rings from radial sections of "corms," but they did not detail their interpretation of them as stems rather than roots; annular secondary growth may occur in both kinds of organs.

While these structures quickly become woody and nodes are difficult to discern, they are here regarded as corms and rhizomes, rather than roots with adventitious buds, because of several reasons. (1) New, ascending-erect stems may be produced from various lateral points (nodes) of somewhat elongated, vertically oriented corms. From the somewhat flattened tops of older, much enlarged corms (e.g., in *L. punctata* var. *mucronata*), up to 30 buds (stems) are sometimes produced. (2) In some taxa there are various stages of transition between the globose structures and much-elongated structures, which appear to function as horizontal rhizomes. Such elongation can be observed in *Liatris pycnostachya* var. *lasiophylla* and *L. punctata* var. *punctata*. Some of the longer rhizomes produce new erect stems at intervals; the lowermost portions of such new stems may expand in circumference, become woody, and appear like caudex branches. (3) All of the other Liatrinae (except perhaps the shrubby *Garberia*) apparently produce rhizomes with fibrous roots. In some species of *Carphephorus*, there is little if any rhizome and the stems and fibrous roots originate from the highly condensed crown area. A taproot is never evident, except perhaps very early in ontogeny, as noted above by Gaiser for *Liatris*.

CLASSIFICATION

Liatris Gaertner ex Schreb., Gen. Pl. 2:542. 1791 (nom. cons.). Type species: *Liatris squarrosa* (L.) Michx. = *Serratula squarrosa* L. (typ. cons.)

Lacinaria J. Hill, Veg. Syst. 4 (ed. 2):49, t. 46. 1762 (nom. rej.), non *Laciniaria* J. Hill (1769), an orthographic variant. Lectotype (J. Hill, Hort. Kew. 70. 1769), *Liatris squarrosa* (L.) Michx.

Psilothamnus Necker, Elem. Bot. 1:69. 1790 (nom. inval.).

Suprago Gaertner, Fruct. Sem. Pl. 2(3):402. 1791. Lectotype. (Cassini, Dict. Sci. Nat. 51:384. 1827), *Liatris spicata* (L.) Willd.

Calostelma D. Don in Sweet, Brit. Flower Gard. ser. 2, 2:184. 1833. Type species: *Liatris elegans* (Walter) Michx.

Ammopursus Small, Bull. Torrey Bot. Club 51:392. 1924. Type species: *Liatris ohlingerae* (Blake) B.L. Rob.

KEY TO THE SECTIONS

1\. Leaf margins whitish, thickened, and minutely scabrous; phyllaries foliaceous and subequal to weakly or strongly graduate, hyaline margins absent or extremely narrow (apices hyaline in ser. *Elegantes*); pappus bristles plumose or barbellate.

    2. Pappus bristles plumose. **1.** Sect. **Liatris**

    2. Pappus bristles barbellate. **2.** Sect. **Vorago**

1\. Leaf margins greenish, slightly thickened or not, smooth; phyllaries not foliaceous, usually strongly graduate, usually completely bordered by purplish, hyaline margins; pappus bristles barbellate.

    3. Basal and lower cauline leaves 3–5-veined, parallel venation of basal leaf bases persistent as fibrous vestiges; corolla tubes glabrous within. **3.** Sect. **Suprago**

    3. Basal and lower cauline leaves 1-veined, parallel venation of leaf bases usually not persistent-fibrous; corolla tubes glabrous or pilose within.

        4. Corolla tubes glabrous within, stems glabrous; staminal filaments pilose. **4.** Sect. **Pilifilis**

4. Corolla tubes pilose within, or if glabrous (in *L. ligulistylis*, *L. scariosa*, *L. microcephala*, *L. ohlingerae*, and *L. garberi*) then stems puberulent to puberulent-pilose; staminal filaments glabrous. ____________ **5.** Sect. **Graminifolium**

1. Section **Liatris.** Type species: *Liatris squarrosa* (L.) Michx.

Leaves 3–5-veined; leaf margins thickened, whitish, and minutely pebbly-scabrous; parallel venation of leaf bases not fibrous-persistent; laminae punctate-glandular to weakly punctate-glandular. Capitulescence mostly racemoid-spiciform, cymoid in one species of ser. *Punctatae* (heads commonly solitary in *L. compacta*). Heads sessile to subsessile or pedunculate. Involucres cylindric to campanulate-cylindric; phyllaries indurate to thin-herbaceous, appressed to loose or spreading, apices rounded to acute or acuminate, green or petaloid, margins usually without a scarious border. Corolla lobes hispid-hirsute or glabrous on adaxial surface; corolla tubes glabrous within; staminal filaments glabrous. Pappus bristles plumose.

Species of sect. *Liatris* are characterized by white-indurate, minutely scabrous leaf margins, cylindric heads with foliaceous, subequal phyllaries (strongly to weakly graduate in ser. *Punctatae*), plumose pappus bristles, and a primarily central North American distribution.

KEY TO THE SERIES

1. Leaves with 3–5 parallel nerves; leaves and phyllaries weakly glandular-punctate or not at all; phyllaries weakly graduate to subequal, usually loose and spreading (strongly graduate and appressed in *L. cylindracea*), apices green; corolla lobes hispid on adaxial surface. ____________ **1a.** Ser. **Liatris**
1. Leaves 1-nerved; leaves and phyllaries glandular-punctate; phyllaries strongly graduate and appressed or subequal and loose or spreading; corolla lobes glabrous.
    2. Phyllaries not foliaceous, strongly to weakly graduate, mostly appressed, apices green. ____________ **1b.** Ser. **Punctatae**
    2. Phyllaries somewhat foliaceous, weakly graduate to subequal, loose or spreading, apices petaloid. ____________ **1c.** Ser. **Elegantes**

1a. Series **Liatris.** Type species: *Liatris squarrosa* (L.) Michx.

Lacinaria unranked *Squarrosae* Alexander in Small, Man. Southeastern Fl. 1331. 1933. *Liatris* ser. *Squarrosae* (Alexander) Gaiser ex Fernald, Gray's Man. ed. 8, 1375. 1950. Type species: *Liatris squarrosa* (L.) Michx.

Liatris sect. *Euliatris* series *Squarrosae* Gaiser, Rhodora 48:393. 1946 (nom. nud., without Latin descr.).

Liatris sect. *Euliatris* series *Cylindraceae* Gaiser, Rhodora 48:373. 1946 (nom. nud., without Latin descr.).

Liatris ser. *Cylindraceae* Gaiser ex Fernald, Gray's Man. ed. 8, 1375. 1950 (nom. nud., without Latin descr.).

Leaves 3–5-nerved. Phyllaries foliaceous, weakly graduate to subequal, loose or spreading, apices green. Corolla lobes hispid on adaxial surface.

Species included.—*Liatris compacta* (Torrey & A. Gray) Rydb., *L. cylindracea* Michx., *L. hirsuta* Rydb., *L. squarrosa* (L.) Michx.

The strongly graduate, appressed phyllaries of *Liatris cylindracea* are similar to those of ser. *Punctatae*, but the 3–5-veined leaves and hirsute corolla lobes of ser. *Liatris* make this a strongly defined and easily recognizable group within the 'western' clade (which has white-indurate, minutely scabrous leaf margins and plumose pappus bristles).

1b. Series **Punctatae** (Alexander) Gaiser ex Fernald. *Lacinaria* unranked *Punctatae* Alexander in Small, Man. Southeastern Fl. 1331. 1933. *Liatris* ser. *Punctatae* (Alexander) Gaiser ex Fernald, Gray's Man. ed. 8, 1375. 1950. TYPE: *Liatris punctata* Hook.

Liatris sect. *Euliatris* series *Punctatae* Gaiser, Rhodora 48:346. 1946 (nom. nud., without Latin descr.).

Leaves 1-nerved. Phyllaries not foliaceous, strongly to weakly graduate, appressed to slightly loose, apices green. Corolla lobes glabrous.

Species included.—*Liatris aestivalis* Nesom & O'Kennon, *L. bracteata* Gaiser, *L. cymosa* (H. Ness) K. Schum., *L. glandulosa* Nesom & O'Kennon, *L. punctata* Hook. (including *L. mucronata* DC. and *L. densispicata* [Bush] Gaiser).

Ser. *Punctatae* apparently is the only group of Liatrinae in which polyploidy is prevalent (Gaiser 1950b, 1954). Except for *L. punctata*, which ranges from Canada into northern Mexico, the species are largely Texas-centered. Several taxonomic problems remain to be resolved within *L. punctata* sensu lato.

1c. Series **Elegantes** (Alexander) Gaiser ex Nesom, comb. et stat. nov. BASIONYM: *Lacinaria* unranked *Elegantes* Alexander in Small, Man. Southeastern Fl. 1331. 1933. TYPE SPECIES: *Liatris elegans* (Walter) Michx.

Liatris sect. Euliatris series Elegantes Gaiser, Rhodora 48:340. 1946 (nom. nud., without Latin descr.).
Calostelma D. Don in Sweet, Brit. Flow. Gard. ser. 2, 2:184. 1833. TYPE SPECIES: Liatris elegans (Walter) Michx.

Leaves 1-nerved. Phyllaries foliaceous, weakly graduate to subequal, loose or spreading, apices petaloid. Corolla lobes glabrous.

Species included.—*Liatris elegans* (Walter) Michx.

2. Section **Vorago** Nesom, sect. nov. TYPE SPECIES: *Liatris oligocephala* J. Allison.

Folia 1-nervia (*L. oligocephala*) vel leniter 1–3-nervia (*L. tenuis*); margines incrassati, candidi, scabrelli; nervatura parallella basium foliorum non fibrosi-persistens. Capitulescentia spiciformis (*L. tenuis*) aut cymiformis capitulis 1-aliquot (*L. oligocephala*). Capitula sessiles vel subsessiles vel pedunculata. Involucra campanulati-cylindrica; phyllaria indurata, virida, plerumque incohaerentia vel patentia, sine marginibus angustis hyalinis, apicibus acutis vel acuminatis. Corollae lobis glabris, tubis glabris interne; stamina filamentis glabris. Pappus setis plerumque barbellatis.

Leaves 1-veined (*L. oligocephala*) or 1- to weakly 3-veined (*L. tenuis*); leaf margins thickened, whitish, and minutely pebbly-scabrous; parallel venation of leaf bases not fibrous-persistent; lamina not punctate-glandular or only weakly punctate. Capitulescence spiciform (*L. tenuis*) or heads solitary to few and in a cymoid arrangement (*L. oligocephala*). Heads sessile to sessile or pedunculate. Involucres campanulate-cylindric; phyllaries indurate, green, usually loose or spreading, apices acute to acuminate, margins without a hyaline border. Corolla lobes glabrous; corolla tubes glabrous within; staminal filaments glabrous. Pappus bristles mostly barbellate.

Species included.—Liatris oligocephala J. Allison, *L. tenuis* Shinners.

These species are similar to some in sect. *Liatris* in their whitish, thickened, and minutely scabrous leaf margins, cylindric heads, and indurate and loose or spreading, subequal to weakly graduate, somewhat foliaceous, triangular phyllaries with acute to acuminate apices and without hyaline margins. Their generally western (non-Floridian) geographical position within the genus also suggests ancestry similar to sect. *Liatris*. Pappus bristles of both species, however, are barbellate.

In the original description of *Liatris tenuis*, Shinners (1959) noted its general similarity to *L. squarrosa* (ser. *Liatris*) but rejected a hypothesis of close relationship because of the disparity in pappus bristle morphology. Still, the weakly 3-veined leaves of *L. tenuis* suggest that it may be closest to species of ser. *Liatris*, perhaps as a sister element.

Liatris oligocephala is similar to *L. tenuis* in features of the involucre, corolla, and pappus, but because no synapomorphy is evident, it seems likely that these two species originated independently from the ancestral stock of sect. *Liatris*. Thus, sect. *Vorago*, as delimited here, may not be monophyletic. As noted by Allison (2001), the glabrous achene surfaces of *L. oligocephala* represent a specialized state unique in the genus. Leaf margins are thickened and whitish but vary from "pebbly" (*Allison 7817*, VDB) to smooth (*Allison 8134*, VDB). Phyllary margins are mostly without a hyaline border, but a weakly developed proximal border sometimes is evident.

The name of the section ("vorago," Latin, gulf) alludes to the range of the two species on the Gulf Coastal Plain as well as to the considerable morphological "gulf" between them.

3. Section **Suprago** (Gaertner) DC. *Suprago* Gaertner, Fruct. Sem. Pl. 2(3):402. 1791. *Liatris* section *Suprago* (Cass.) DC., Prodr. 5:129. 1836. LECTOTYPE: (Cassini, Dict. Sci. Nat. 51:384. 1827), *Liatris spicata* (L.) Willd.

Lacinaria unranked *Spicatae* Alexander in Small, Man. Southeastern Fl. 1332. 1933. *Liatris* ser. *Spicatae* (Alexander) Gaiser ex Fernald, Gray's Man. ed. 8, 1372. 1950. TYPE SPECIES: *Liatris spicata* (L.) Willd.

Liatris sect. *Suprago* series *Spicatae* Gaiser, Rhodora 48:177. 1946 (nom. nud., without Latin descr.).

Lacinaria unranked *Pycnostachyae* Alexander in Small, Man. Southeastern Fl. 1331. 1933. *Liatris* ser. *Pycnostachyae* (Alexander) Gaiser ex Fernald, Gray's Man. ed. 8, 1373. 1950. TYPE SPEICES: *Liatris pycnostachya* Michx.

Liatris sect. *Suprago* series *Pycnostachyae* Gaiser, Rhodora 48:237. 1946 (nom. nud., without Latin descr.).

Leaves 3–5 veined; leaf margins slightly thickened, green, smooth; parallel venation of bases of basal leaves conspicuously persisting as fibrous vestiges;

lamina punctate-glandular to weakly punctate-glandular. Capitulescence spiciform to narrowly racemiform. Heads sessile to subsessile. Involucres cylindric; phyllaries thin-herbaceous, appressed to loose or spreading, apices rounded to acute, green (petaloid-recurving in *L. pycnostachya*), margins usually with a narrow scarious border. Corolla lobes glabrous; corolla tubes glabrous within; staminal filaments glabrous. Pappus bristles barbellate (subplumose in *L. acidota*). Type species: *Liatris spicata* (L.) Willd.

Species included.—*Liatris acidota* Engelm. & A. Gray, *L. lancifolia* (Greene) Kittell, *L. pycnostachya* Michx., *L. spicata* (L.) Willd.

Sect. *Suprago* is distinct in its 3–5-veined leaves, parallel veins at the bases of the basal leaves conspicuously persisting as fibers, and internally glabrous corolla tubes. The species are relatively scattered in geographic distribution but are mostly "western" like those of sect. *Liatris*; none are primarily "Floridian." In addition to features of sect. *Suprago* noted in the description, cauline leaves tend to be abruptly reduced to bracts above midstem. Even within *L. spicata*, however, the distal cauline leaves of *L. spicata* var. *resinosa* are abruptly reduced while those of var. *spicata* are only gradually reduced. Similar reduction of distal cauline leaves also occurs in other groups of *Liatris*.

4. Section **Pilifilis** Nesom, sect. nov. *Lacinaria* unranked *Tenuifoliae* Alexander in Small, Man. Southeastern Fl. 1331. 1933. Type species: *Liatris tenuifolia* Nutt.

Liatris sect. *Suprago* series *Tenuifoliae* Gaiser, Rhodora 48:286. 1946 (nom. nud., without Latin descr.).

Folia 1-nervia; margines leniter incrassati, virides, laeves; nervatura parallella basium foliorum plerumque non fibrosi-persistens. Capitulescentia spiciformis vel leniter racemiformis. Capitula sessiles vel subsessiles vel pedunculata. Involucra cylindrica; phyllaria tenuiter herbacea, virida (non petaloidea), appressa, apicibus obtusis vel retusis plerumque apiculatis, marginibus angustis hyalinis. Corollae lobis glabris, tubis glabris interne, stamina filamentis pilosis. Pappus setis barbellatis.

Leaves 1-veined; leaf margins slightly thickened, green, smooth; parallel venation of leaf bases usually not fibrous-persistent but sometimes weakly so; lamina punctate-glandular to weakly punctate-glandular. Capitulescence spiciform to slightly racemiform. Heads sessile to subsessile or pedunculate. Involucres cylindric; phyllaries thin-herbaceous, green (not petaloid), appressed, apices obtuse to retuse and usually apiculate, margins with a narrow scarious border. Corolla lobes glabrous; corolla tubes glabrous within; staminal filaments pilose. Pappus bristles barbellate.

Species included.—*Liatris laevigata* Nutt., *L. tenuifolia* Nutt.

The pilose staminal filaments of these two species set them apart from others in the genus. It seems reasonable to speculate that this is homologous with production of hairs from internal petal tissue near the corolla base in sect. *Graminifolium*. Basal leaves of *L. laevigata* and *L. tenuifolia* show a tendency to be fibrous-persistent, like those in sect. *Suprago*, but the leaves are 1-veined.

5. Section **Graminifolium** Nesom, sect. nov. TYPE SPECIES: *Liatris pilosa* (Aiton) Willd. (= *Liatris graminifolia* Willd.).

Folia 1-nervia. (leniter 3–5-nervia in *L. savannensi*); margines leniter incrassati, virides, laeves; nervatura parallella basium foliorum non fibrosi-persistens. Capitulescentia racemi-spiciformis, raro cymiformis. Capitula sessiles vel subsessiles vel pedunculata. Involucra cylindrica vel campanulata; phyllaria tenuiter herbacea, virida, appressa, apicibus rotundatis vel acutis, marginibus angustis hyalinis Corollae lobis glabris, tubis plerumque pilosis interne (glabris in *L. garberi*, *L. ligulistyli*, *L. microcephala*, ac *L. ohlingerae*); stamina filamentis glabris. Pappus setis barbellatis.

Leaves 1-veined (weakly 3–5 veined in *L. savannensis*); leaf margins slightly thickened, green, smooth; parallel venation of leaf bases not fibrous-persistent; lamina punctate-glandular to weakly punctate-glandular. Capitulescence racemoid-spiciform, rarely cymoid. Heads sessile to subsessile or pedunculate. Involucres cylindric to campanulate; phyllaries thin-herbaceous, green, appressed, apices rounded to acute, margins with a narrow scarious border. Corolla lobes glabrous; corolla tubes usually pilose within (glabrous in *L. ligulistylis*, *L. ohlingerae*, *L. microcephala*, and *L. garberi*); staminal filaments glabrous. Pappus bristles barbellate.

Section *Graminifolium* is characterized by the distinctive pilose vestiture produced within the corolla tubes in the region of filament insertion. This vestiture is hypothesized to have been lost in four species, each of which apparently is specialized in other features: *Liatris ohlingerae* and *L. ligulistylis* produce particularly large heads; *L. microcephala* has exceptionally short pappus bristles and short corollas, mostly due to loss of tube length; *L. garberi* is hypothesized to have reverted to a characteristically primitive root system (see comments below).

KEY TO THE SERIES

1. Phyllaries acute to obtuse (angular) at the apex.
2. Stems glabrous; phyllaries oblong-triangular. **5c.** Ser. **Virgatae**
2. Stems hirtellous or pilose-puberulent (usually glabrous in *L. pauciflora*); phyllaries usually obovate.
3. Corms globose; stems hirtellous or glabrous; corolla tubes pilose within. **5a.** Ser. **Pauciflorae**
3. Corms irregularly shaped, short-rhizomiform with tuberous-thickened fibrous roots; stems pilose-puberulent; corolla tubes glabrous within. **5b.** Ser. **Garberae**
1. Phyllaries rounded to obtuse-rounded at the apex.
4. Stems glabrous or uncommonly sparsely pilose; basal leaves mostly oblanceolate; heads sessile to short-pedunculate in a spiciform capitulescence. **5d.** Ser. **Graminifoliae**
4. Stems puberulent; basal leaves obovate-spatulate; heads usually pedunculate in a racemiform to corymbiform capitulescence. **5e.** Ser. **Scariosae**

5a. Series **Pauciflorae** (Alexander) Gaiser ex Nesom, comb. et stat. nov. BASIONYM: *Lacinaria* unranked *Pauciflorae* Alexander in Small, Man. Southeastern Fl. 1331. 1933. TYPE SPECIES: *Liatris pauciflora* Pursh.

Liatris sect. *Euliatris* series *Pauciflorae* Gaiser, Rhodora 48:279. 1946 (nom. nud., without Latin descr.).

Corms globose. Stems hirtellous or glabrous. Basal leaves mostly oblanceolate. Heads sessile to short-pedunculate in a spiciform capitulescence. Phyllaries obovate, apically acute to obtuse (angular). Corolla tubes pilose within.

Species included.—*Liatris chapmanii* Torrey & A. Gray, *L. pauciflora* Pursh (including *L. secunda* Ell.), *L. provincialis* Godfrey

5b. Series **Garberae** Nesom, ser. nov. TYPE: *Liatris garberi* A. Gray

Cormi forma irregulares, brevi-rhizomiformes radicibus fibris crassis. Caules pilosi-puberuli. Folia basalia plerumque oblanceolata. Capitula sessiles vel brevipedunculata capitulescentia spiciformis. Phyllaria obovata, ad apices angulata, acuta vel obtusa. Corollae tubis interne glabris.

Corms irregularly shaped, short-rhizomiform with tuberous-thickened fibrous roots. Stems pilose-puberulent. Basal leaves mostly oblanceolate. Heads sessile to short-pedunculate in a spiciform capitulescence. Phyllaries obovate, apically acute to obtuse (angular). Corolla tubes glabrous within.

Species included.—*Liatris garberi* A. Gray

The thickened, fibrous roots of *Liatris garberi*, arising from an abbreviated crown or short and irregular rhizome, are distinct in the genus and are similar to those of *Carphephorus* and *Hartwrightia*, presumably a primitive feature for the Liatrinae. If corms are an ancestral feature of *Liatris*, as seems to be the case, then the root system of *L. garberi* may be secondarily derived. The internally glabrous corolla tubes of *L. garberi*, in the interpretation here, also are specialized (loss of pubescence). *Liatris garberi* is more similar in stem vestiture to *L. pycnostachya* and *L. acidota* of sect. *Suprago* than to any species of sect. *Graminifolium*. Leaf bases of *L. garberi*, however, are not like those of sect. *Suprago* and the phyllaries are similar to those of ser. *Pauciflorae*. The restricted Floridian geography of *L. garberi* also suggests that its closest relatives are more likely found in the same area (i.e., ser. *Pauciflorae*, especially).

5c. Series **Virgatae** Nesom, ser. nov. TYPE SPECIES: *Liatris virgata* Nutt.

Cormi globosi. Caules glabres. Folia basalia plerumque oblanceolata. Capitula sessiles vel brevipedunculata capitulescentia spiciformis. Phyllaria oblongi-triangulares, ad apices angulata. Corollae tubis interne pilosis.

Corms globose. Stems glabrous. Basal leaves mostly oblanceolate. Heads sessile to short-pedunculate in a spiciform capitulescence. Phyllaries oblong-triangular, apically acute to obtuse (angular). Corolla tubes pilose within.

Species included.—*Liatris cokeri* Pyne & Stucky, *L. virgata* Nutt.

As suggested by Nesom and Stucky (2004), *Liatris cokeri* and *L. virgata* may be sister taxa. Their angular phyllary apices possibly indicate relatively close ancestry with ser. *Pauciflorae*, although some plants in the northern range of *L. pilosa* also produce angular phyllaries. The glabrous stems of *L. cokeri* and *L. virgata* are similar to those of ser. *Graminifoliae*.

5d. Series **Graminifoliae** Gaiser ex Nesom, ser. nov. *Liatris* sect. *Suprago* series *Graminifoliae* Gaiser, Rhodora 48:246. 1946 (nom. nud., without Latin descr.). *Liatris* ser. *Graminifoliae* Gaiser ex Fernald, Gray's Man. ed. 8, 1373. 1950 (nom. nud., without Latin descr.). Fernald attributed the basionym to Alexander, but "Graminifoliae" was not among the group-names used by Alexander. TYPE SPECIES: *Liatris pilosa* (Aiton) Willd. (= *Liatris graminifolia* Willd.).

Cormi globosi. Caules glabres vel sparsim pilosi. Folia basalia plerumque oblanceolata. Capitula sessiles vel brevipedunculata capitulescentia spiciformis. Phyllaria oblongi-triangulares, ad apices rotundata vel obtusi-rotundata. Corollae tubis interne pilosis.

Corms globose. Stems glabrous to sparsely pilose. Basal leaves mostly oblanceolate. Heads sessile to short-pedunculate in a spiciform capitulescence. Phyllaries oblong-triangular, apically rounded to obtuse-rounded. Corolla tubes pilose within.

Species included.—*Liatris elegantula* (Greene) K. Schum., *L. helleri* Porter (synonym = *L. turgida* Gaiser), *L. microcephala* (Small) K. Schum., *L. pilosa* (Aiton) Willd. (synonym = *L. graminifolia* Willd.), *L. savannensis* Kral & Nesom.

Prior to recent recognition of *Liatris savannensis* (Kral & Nesom 2003), plants of that species had been identified mostly as *L. spicata* (sect. *Suprago*). The leaves of *L. savannensis* are weakly 3-nerved, a feature of *L. spicata* and its close relatives but one not otherwise found in sect. *Graminifolium*, and *L. savannensis* might be investigated toward the possibility that genes from sect. *Suprago* were involved in its evolutionary origin.

Basal leaves of *Liatris helleri* (sensu lato, Nesom 2005b) range to relatively large size, similar to those of ser. *Scariosae*. *Liatris helleri*, however, is most similar overall to *L. pilosa*, and the geographic juxtaposition of *L. virgata* between *L. pilosa* and *L. elegantula* (Nesom & Stucky 2004) is perhaps indicative of a more distant relationship of the the latter two species.

Liatris microcephala is very similar to other species of ser. *Graminifoliae* but lacks the diagnostic pilose vestiture within the corolla tube. The tube, however, is much shortened (the whole head is shortened), and it is assumed here that loss of the vestiture accompanied other specializations toward reduction in corolla size. The characteristic tendency for short pappus bristles in *L. microcephala* also occurs in some populations of *L. helleri* (Nesom 2005b) but not elsewhere in the genus.

5e. Series **Scariosae** (Alexander) Gaiser ex Fernald. *Lacinaria* unranked *Scariosae* Alexander in Small, Man. Southeastern Fl. 1332. 1933. *Liatris* ser. *Scariosae* (Alexander) Gaiser ex Fernald, Gray's Man. ed. 8, 1374. 1950. TYPE SPECIES: *Liatris scariosa* (L.) Willd.

Liatris sect. *Euliatris* series *Scariosae* Gaiser, Rhodora 48:293. 1946 (nom. nud., without Latin descr.).

Ammopursus Small, Bull. Torrey Bot. Club 51:392. 1924. TYPE SPECIES: *Liatris ohlingerae* (Blake) B.L. Rob.

Corms globose. Stems hirtellous or pilose-puberulent (variably glabrous in *L. squarrulosa*). Basal leaves mostly obovate-spatulate. Heads sessile to short-pedunculate in a spiciform capitulescence or usually pedunculate in a racemiform to corymbiform capitulescence. Phyllaries oblong-triangular, apically rounded to obtuse-rounded. Corolla tubes usually pilose within (glabrous in *L. ligulistylis* and *L. ohlingerae*).

Species included (in three informal groups): **1)** southern range, linear basal leaves, large heads: *L. ohlingerae* (Blake) B.L. Rob.; **2)** southern range, smaller basal leaves, smaller heads: *Liatris gholsonii* L. Anderson, *L. gracilis* Pursh, *L. patens* Nesom & Kral; **3)** northern range, larger basal leaves, large heads: *Liatris aspera* Michx., *L. ligulistylis* (A. Nels.) K. Schum., *L. scariosa* (L.) Willd. (including *L. borealis*), *L. squarrulosa* Michx. (including *L. scabra* (Greene) K. Schum.)

Series *Scariosae* is separated here into three subgroups, generally differing in head size and in basal leaf morphology. Addition of *L. ohlingerae* and the apparently interrelated *L. gracilis*, *L. gholsonii*, and *L. patens* expands Gaiser's concept of ser. *Scariosae*. The latter three species range widely in head size (3–6[–9], 3–5[–6], and 7–12 florets, respectively). *Liatris ohlingerae* has 20–30 florets, glabrous corolla tubes, basal leaves hardly wider than the cauline, and may not belong with ser. *Scariosae*. Heads of *L. squarrulosa* also are markedly variable—11–26(–28) florets. *Liatris scariosa*, *L. ligulistylis*, and *L. aspera* are larger-headed—ca. 19–ca. 80, ca. 30–70, and (14–)18–24(–30) florets, respectively—and have more northern geographic distributions. *Liatris scariosa* and *L. ligulistylis* usually produce heads on long peduncles, as in *L. ohlingerae* and *L. patens*, and there is a tendency in the first three species for the corolla tubes to be glabrous.

Liatris ohlingerae is distinct in its relatively few, broadly campanulate heads in a cymiform arrangement. Small (1924, 1933) considered the species so remarkable that he treated it as the monotypic genus *Ammopursus*, emphasizing (1924, p. 393) the "succulent foliage, the open inflorescence, the somewhat zygomorphic corollas with inflated throats, and the short pappus." Gaiser placed *L. ohlingerae* in "series *Cylindraceae*" (a group treated here within sect. *Liatris*) because of its similarity in habit (mostly the arrangement of heads) to *L. cymosa*, but the pappus bristles of *L. ohlingerae* are barbellate rather than plumose as in sect. *Liatris*. Blake's original description (1923) of the species apparently emphasized the campanulate heads, noting that the species was nearest *L. scariosa*. The puberulent vestiture and long-pedunculate heads of *L. ohlingerae* also are shared similarities with ser. *Scariosae*, but the internally glabrous corolla tubes are unusual for sect. *Graminifolium*.

ACKNOWLEDGMENTS

Reviews and nomenclatural advice from K.N. Gandhi, Dick Wunderlin, and Ed Schilling are greatly appreciated—the manuscript has been much improved by their input.

REFERENCES

Alexander, E.J. 1933. *Laciniaria*. In: J.K. Small. Manual of the southeastern flora. Published by the author, New York. Pp. 1331–1335.

Allison, J.R. 2001. Vascular flora of Ketona dolomite outcrops in Bibb County, Alabama. Castanea 66(1–2):154–205.

Anderson, L.C. 2002. *Liatris gholsonii* (Asteraceae: Eupatorieae), a new blazing star from the Apalachicola River bluffs and ravines in Florida. Sida 20:97–103.

Bailey, L.H. and E.Z. Bailey. 1976. Hortus third: A concise dictionary of plants cultivated in the United States and Canada (revised and expanded by the staff of the L.H. Bailey Hortorium). MacMillan, New York, NY.

Blake, S.F. 1923. Two new composites from Florida. Bull. Torrey Bot. Club 50:203–205.

Bowles, M., G. Wilhelm, and S. Packard. 1988. The Illinois status of *Liatris scariosa* (L.) Willd. var. *nieuwlandii* Lunell, a new threatened species for Illinois. Erigenia 10:1–26.

Candolle, A.P. de. 1836. Prodromus systematis naturalis regni vegetabilis. Vol. 5.

Correa, A.M. and R.L. Wilbur. 1969. A revision of the genus *Carphephorus* (Compositae–Eupatorieae). J. Elisha Mitchell Sci. Soc. 85:79–91.

Cronquist, A. 1980. Vascular flora of the southeastern United States, Vol. I. Asteraceae. Univ. of North Carolina Press, Chapel Hill.

Cruise, J.E. 1964. Biosystematic studies in three species of the genus *Liatris*. Canad. J. Bot. 42:1445–1455.

Fernald, M.L. 1950. Gray's manual of botany (ed. 8). American Book Co., New York.

Gaiser, L.O. 1946. The genus *Liatris*. Rhodora 48:165–183, 216–263, 273–326, 331–382, 393–412.

Gaiser, L.O. 1949. Chromosome studies in *Liatris*. I. *Spicatae* and *Pycnostachyae*. Amer. J. Bot. 36:122–135.

Gaiser, L.O. 1950a. Chromosome studies in *Liatris*. II. *Graminifoliae* and *Pauciflorae*. Amer. J. Bot. 37:414–423.

Gaiser, L.O. 1950b. Chromosome studies in *Liatris*. III. *Punctatae*. Amer. J. Bot. 37:763–777.

Gaiser, L.O. 1951. Evidence for intersectional field hybrids in *Liatris*. Evolution 5:52–67.

Gaiser, L.O. 1954. Studies in the Kuhniinae (Eupatorieae), II. J. Arnold Arbor. 35:87–133.

Gandhi, K.N., S.M. Young, and P. Somers. 2003. A reassessment of the taxonomy and nomenclature of *Liatris borealis* Nutt. ex J. McNab and *Lacinaria scariosa* var. *novae-angliae* Lunell (Asteraceae). Taxon 52:313–317.

Godfrey, R.K. 1948. Studies in the Compositae of North Carolina. I. *Liatris*. J. Elisha Mitchell Sci. Soc. 64:241–249.

GODT, M.J.W. and J.L. HAMRICK. 1996. Genetic diversity and morphological differentiation in *Liatris helleri* (Asteraceae), a threatened plant species. Biodiv. and Conserv. 5:461–471.

GRAY, A. 1884. Synoptical flora of North America. Vol. 1, part 2. Ivison, Blakeman, Taylor & Co., New York.

HADLEY, E.B. and D.A. LEVIN. 1967. Habitat differences in three species of *Liatris* and their derivatives in an interbreeding population. Amer. J. Bot. 54:550–559.

HARDIG, T.M., J.R. ALLISON, and E.E. SCHILLING. Submitted. Conservation of rare plant species: molecular evidence of hybridization between *Liatris oligocephala* (Asteraceae) and a more-widespread congener: Assessing the potential for extinction. Castanea.

HEBERT, H.J.-C. 1968. Generic considerations concerning *Carphephorus* and *Trilisa* (Compositae). Rhodora 70:474–485.

JOHNSON, M.J. 1971. The genus *Liatris* in Virginia. Castanea 36:137–147.

KERSTER, H.W. 1968. Population age structure in the prairie forb, *Liatris aspera*. Bioscience 18:430–432.

KING, R.M. and H. ROBINSON. 1987. The genera of the Eupatorieae (Asteraceae). Monogr. Syst. Bot., Missouri Bot. Gard. 22:1–581.

KRAL, R. and G.L. NESOM. 2003. Two new species of *Liatris* ser. *Graminifoliae* (Asteraceae: Eupatorieae) from the southeastern United States. Sida 20:1573–1584.

LEVIN, D.A. 1967. An analysis of hybridization in *Liatris*. Brittonia 19:248–260.

LEVIN, D.A. 1973. The age structure of a hybrid swarm in *Liatris* (Compositae). Evolution 27:532–535.

MAYFIELD, M.H. 2002. The varieties of *Liatris elegans* (Asteraceae). Sida 20:597–603.

MENHUSEN, B.R. 1963. Variation in the *Punctatae* series of the genus *Liatris*. Ph.D. diss., Univ. of Kansas, Lawrence.

NESOM, G.L. 2005a. *Liatris*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 12+ vols. New York and Oxford. Vol. 21.

NESOM, G.L. 2005b. Broadened concept of *Liatris helleri* (Asteraceae: Eupatorieae). Sida 21:1323–1333.

NESOM, G.L. and R.J. O'KENNON. 2001. Two new species of *Liatris* series *Punctatae* (Asteraceae: Eupatorieae) centered in north-central Texas. Sida 19:767–787.

NESOM, G.L. and J.M. STUCKY. 2004. Taxonomy of the *Liatris pilosa* (*graminifolia*) group (Asteraceae: Eupatorieae). Sida 21:815–826.

PYNE, M. and J.M. STUCKY. 1990. Lectotypification of *Laciniaria carinata* (Asteraceae). Sida 14:209–213.

RADFORD, A.E., H.E. AHLES, and C.R. BELL. 1968. Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill.

ROBINSON, H. and R.M. KING. 1977. Eupatorieae – systematic review. In: V.H. Heywood, J.B. Harborne, and B.L. Turner, eds. The Biology and Chemistry of the Compositae. Academic Press, New York. Pp. 437–485.

SCHILLING, E.E. and P.B. COX. 2000. Systematic analysis of Liatrinae (Asteraceae). Botany 2001 Abstracts. www.botany2001.org/section12/abstracts/98.shtml

Schmidt, G.J. and E.E. Schilling. 2000. Phylogeny and biogeography of *Eupatorium* (Asteraceae: Eupatorieae) based on nuclear ITS sequence data. Amer. J. Bot. 87:716–726.

Shinners, L.H. 1959. *Liatris tenuis* n. sp. (Compositae), another endemic in southeastern Texas. Southwestern Nat. 4:207–208.

Small, J.K. 1924. Plant novelties from Florida. Bull. Torrey Bot. Club 51:379–393.

Stucky, J.M. 1991. Affinity of *Liatris cokeri* Pyne & Stucky (Asteraceae), a sandhills endemic of the Carolinas, and its widely distributed relative, *L. graminifolia* Willd. Amer. Midl. Nat. 125:323–330.

Stucky, J.M. 1992. *Liatris virgata* (Asteraceae) in the southeastern United States. Sida 15: 177–183

Stucky, J.M. and M. Pyne. 1990 A new species of *Liatris* (Asteraceae) from the Carolina sandhills. Sida 14:189–208

Thomas, A.D. 1975. A numerical study of *Liatris* ser. *Squarrosae*. Diss. Abstr. Int., B 36(1):68.

Ward, D.B. 2004. New combinations in the Florida flora II. Novon 14:365–371.

ANNOUNCEMENT

THE RUPERT BARNEBY AWARD

The New York Botanical Garden is pleased to announce that Vidal de Freitas Mansano, of the Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, and Benjamin M. Torke, currently a graduate student in the Department of Biology, Washington University, St. Louis, are the joint recipients of the Rupert Barneby Award for the year 2005. They will be studying the systematics and diversification of *Swartzia* (Leguminosae, Papilionoideae, Swartzieae), a prominent neotropical tree genus of approximately 140–180 species, with species diversity concentrated in lowland rainforests of the Guianas and Amazonia.

The New York Botanical Garden now invites applications for the Rupert Barneby Award for the year 2006. The award of US$ 1,000.00 is to assist researchers to visit The New York Botanical Garden to study the rich collection of Leguminosae. Anyone interested in applying for the award should submit their curriculum vitae, a detailed letter describing the project for which the award is sought, and the names of 2–3 referees. Travel to the NYBG should be planned for sometime in the year 2006. The application should be addressed to Dr. James L. Luteyn, Institute of Systematic Botany, The New York Botanical Garden, 200th Street and Kazimiroff Blvd., Bronx, NY 10458-5126 USA, and received no later than December 1, 2005. Announcement of the recipient will be made by December 15.

Anyone interested in making a contribution to THE RUPERT BARNEBY FUND IN LEGUME SYSTEMATICS, which supports this award, may send their check, payable to The New York Botanical Garden, to Dr. Luteyn.

BOOK REVIEWS

Tree Books

Owen Johnson (text) and David More (illustrations). 2004. **Collins Tree Guide.** (ISBN 0-00-71963-4, hbk.). HarperCollins*Publishers*, Ltd., 77-85 Fulham Palace Road, London W6 8JB, UK. (**Orders:** HarperCollins UK, Trafalgar Square, No. Pomfret, Vermont 05053, U.S.A.; www.trafalgarsquarebooks.com). $65.00, 464 pp., 8 1/2" × 12 1/2".

For those interested in cultivated trees in the U.S.A., this is a prime reference. In fact, as far as I know from the BRIT library, this is among the best, even though the book is aimed primarily at a different continent. Up front is a list of "the 63 species and microspecies that seem most likely to have got [to Britain and northern Europe] without human agency," but the book covers nearly 1600 taxa of "trees in the countryside, parks, and gardens of Britain and of non-Mediterranean Europe"—"those trees which, however rarely, may be found in the general run of gardens." Realistic color paintings show growth habits, bark, fruits, and close-ups of branches and leaves. Distinctive hybrids and cultivars abound. For example, illustrations are provided for 18 distinctively shaped cultivars of Lawson Cypress (*Chamaecyparis lawsoniana*)—"a uniform tree in the wild, but after its arrival in Europe it immediately began to throw more 'sports' than any other species."

In a review (Sida 19:642. 2001) of the "field guide-sized" (but thick) *A photographic guide to the Trees of Britain and Europe* (Keith Rushforth 1999, also published by HarperCollins), with color photos of many taxa and small-print descriptions and commentaries, I found it extremely useful for North American identifications. The Johnson and More volume, with larger format, less technical descriptions, narrower geographic scope, and greater emphasis on cultivars, is an exceptionally good complement to the Rushforth book.—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

Fred Wampler (text) and Maryrose Wampler (paintings). 2001. **Trees of Indiana.** (ISBN 0-253-32885-3, hbk.). Indiana University Press, 601 North Morton Street, Bloomington, IN 47404-3797, U.S.A. (**Orders:** 800-842-6796, 812-855-7931 fax; iuporder@indiana.edu, www.indiana.edu/~iupress). $49.95, 152 pp., 72 watercolor paintings, 11 1/4" × 13 1/4".

A showcase of watercolor paintings of Indiana trees by Maryrose Wampler, in large ('coffee table') format—11 1/4 _ 13 1/4 inches—with brilliant greens, reds, oranges, and yellows. For each of the 72 species, a full tree is shown along with details of stems, leaves, flowers, and fruits.

"First and foremost, this is an art book." "While care has been taken to be as scientifically accurate as possible, we are not botanists, but generalists interested in trees. Our selection policy was somewhat subjective. We have covered most common trees and also others that 'lit the light,' ... including at least one representative of each genus that grows naturally in the state, commonly reaches a height of 20 feet or more, and has a single trunk."

Commentaries were researched "from secondary sources in order to give Hoosiers an appropriate introduction and background."—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

BROADENED CONCEPT OF *LIATRIS HELLERI* (ASTERACEAE: EUPATORIEAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Liatris helleri T.C. Porter (1891) previously has been regarded as a rare, narrowly distributed endemic of North Carolina. The present investigation, in the context of a study of the whole genus, presents a broadened concept of *L. helleri*, including plants in West Virginia, Virginia, and North Carolina previously identified as *L. turgida* Gaiser (1946) and many from the same region misidentified as *L. graminifolia* var. *smallii*. A lectotype (NY) is selected for *L. helleri*. The diagnostic feature of *L. helleri* sensu stricto, a shortened pappus, has been the primary distinction between it and *L. turgida*, but pappus length varies among populations in the small region of *L. helleri* sensu stricto and a short pappus also occurs in some populations of *L. turgida*. If this broadened concept is followed, it may have the effect of lessening legal protections for *L. helleri*, but some of the North Carolina populations occur with other rare species in a rare natural community, and the species and habitat are a focus of continuing conservation concerns.

RESUMEN

Liatris helleri T.C. Porter (1891) ha sido vista previamente como un endemismo raro escasamente distribuido en Carolina del Norte. En la presente investigación, en el contexto de un estudio de todo el género, se presenta un concepto más amplio de *L. helleri*, incluyendo plantas del Oeste de Virginia, Virginia, y Carolina del Norte identificadas previamente como *L. turgida* Gaiser (1946) y muchas de la misma región identificadas incorrectamente como *L. graminifolia* var. *smallii*. Se ha seleccionado un lectotipo (NY) para *L. helleri*. El carácter diagnóstico de *L. helleri* sensu stricto, un vilano corto, ha sido la diferencia principal entre éste y *L. turgida*, pero la longitud el vilano varía entre poblaciones de la pequeña región de *L. helleri* sensu stricto y un vilano corto se da también en algunas poblaciones de *L. turgida*. Si se sigue este concepto ampliado, puede tener como efecto la pérdida de protecciones legales de *L. helleri*, pero algunas de las poblaciones de Carolina del Norte conviven con otras especies en una comunidad natural rara, y tanto las especies como el hábitat tienen implicaciones permanentes en la conservación.

Liatris helleri T.C. Porter previously has been regarded as a endemic of montane habitats in North Carolina, restricted to a few populations in Avery, Burke, Caldwell, Mitchell, and Watauga (the type) counties. It has been said to be characterized by high-elevation habitats, although within its restricted range, it occurs over a range of 1020–1750 meters elevation. Because of its perceived rarity, *L. helleri* is federally listed as a threatened species (G1, critically imperiled), and a recovery plan (USF&WS 1989, 1999 First Revision) is available. It is listed as threatened in North Carolina (NCDA&CS 2005). Comprehensive information on the species (sensu stricto), including conservation and management summaries, protective rankings, and references and technical reports, is provided on the Center for Plant Conservation website (CPC 2005). Studies of the mating system (Godt & Hamrick 1995) and genetic diversity (Godt & Hamrick 1996) of *L. helleri* have been published. Photographs and illustrations of the species can be found on the CPC website and others.

A markedly shortened pappus has been used as the primary diagnostic feature of *Liatris helleri* to distinguish it from taxa of the *L. pilosa* (Ait.) Willd. (synonym = *L. graminifolia* Willd.; Nesom & Stucky 2004) group. Pappus bristles of typical *L. helleri* are about half to two-thirds the length of the corolla tube, compared to the characteristic condition in the *L. pilosa* group and most of the rest of the genus, where the bristles are as long or slightly longer than the corolla tube.

Pappus length, however, is variable in *Liatris helleri*. In conservation-oriented surveys of the species, Sutter and Murdock (1984) observed that pappus length was not consistent among populations, and they subsequently undertook a more detailed taxonomic analysis to compare various features of *L. helleri* (3 native populations) with *L. pilosa* (4 native populations, localities noted only as "across North Carolina," identified as *L. graminifolia*). Data were taken from field measurements and common garden studies, augmented by specimens from four herbaria. They found that for stem height, number of leaves, capitulescence length, and number of heads per plant, *L. helleri* (all populations) differed from *L. pilosa*. In pappus length and pappus/corolla length ratios, however, Linville and Blowing Rock populations of *L. helleri* had significantly shorter pappus, while the Grandfather Mountain population of *L. helleri* was not different from *L. pilosa*. Sutter and Murdock (1984, p. 8) concluded that "the Grandfather Mountain population of *L. helleri* should be considered an infraspecific taxon within *L. graminifolia*." Neither their taxonomic study or its conclusion, however, is cited or mentioned in recovery plans written by the same authors (USF&WS 1999, 1989), which is surprising, since the Grandfather Mountain plants have continued to be recognized within *L. helleri*.

Pappus variation in *Liatris helleri* also was observed in the genetic study by Godt and Hamrick (1996), who noted (p. 467) that the populations sampled in their work were "recognized by the U.S. Fish and Wildlife Service and by the North Carolina Heritage programme as populations of *L. helleri*, although they cannot all be keyed to *L. helleri* on the basis of pappus length." Observations of the present study, corroborating Kral (1983), indicate that pappus length varies from about half to two-thirds the corolla tube length among populations of typical *L. helleri*, apart from the longer pappus in the Grandfather Mountain series.

Liatris turgida and *L. helleri* compared

Liatris turgida Gaiser has been considered to be an Appalachian species primarily at low elevations in montane Virginia and West Virginia (e.g., Johnson

1971; Strausbaugh & Core 1977), with rare populations in North Carolina (Godfrey 1948; Ahles 1968) and perhaps in northern Alabama and Georgia (Cronquist 1980; Duncan & Kartesz 1981; Gleason & Cronquist 1994). In a taxonomic study of the whole genus (Nesom 2005a), the only difference between *L. turgida* and *L. helleri* is one of pappus length. Over most of the geographic range of *L. turgida*, pappus bristles equal or slightly surpass the corolla tubes in length. In several areas of Virginia, however, the pappus sometimes is shortened to a length approaching typical populations of *L. helleri* (e.g., Amherst Co., *Freer 2007*; Bedford Co., *Freer 12226*; Roanoke Co., *Uttal 10883*; full citations below). The Grandfather Mountain population series (Avery Co., North Carolina) of *Liatris helleri*, as included in the study by Sutter and Murdock (1984), technically would be identified as *L. turgida*.

Gaiser (1946, p. 263) noted that *Liatris helleri* (sensu stricto) was distinguished from *L. turgida* by "the short pappus, the few, though closely spaced heads, and usually quite glabrous leaves" (the same contrast repeated almost identically on p. 259). Species descriptions by Cronquist (1980) contrast *L. helleri* with *L. turgida* by shorter pappus and otherwise only by several, strongly overlapping features: stems shorter, vestiture consistently glabrous, leaves shorter and narrower and eciliate, heads fewer, and florets fewer per head. Length of pappus was the only difference noted by Ahles (1968, p. 1049, 1050). In the present study, I find that no character or combination of characters is able to separate the two taxa. As variability of the single character defining *L. helleri* (pappus length) has become apparent, recent practice has been to continue to recognize the species primarily on the basis of its short stature and its occurrence in exposed rock outcrop situations at high elevations in northwestern North Carolina, in association with other narrow endemics and arctic-alpine disjuncts, notably *Geum radiatum*, *Huperzia appalachiana*, *Trichophorum caespitosum*, *Houstonia montana*, *Hudsonia montana*, *Juncus trifidus*, *Carex misera*, and *Solidago spithamaea* (Weakley pers. comm.). This distinctive assemblage of species has been described as a rare plant community, called High Elevation Rocky Summit by Schafale and Weakley (1990) and studied in detail by Wiser (Wiser 1994; Wiser et al. 1996).

While ecological and distributional considerations can help make the case for the taxonomic distinction of two entities when morphological characters are weak, *Liatris helleri* and *L. turgida* are not separable by any reliable characters. I am simply unable to recognize more than a single entity, as documented by the technical description below. Plants of *L. turgida* may be relatively short and the heads few and distantly spaced or taller with up to 40 heads borne in a relatively dense spike. Leaves of *L. turgida* vary from sparsely pilose to glabrous. Other features, including leaf morphology, head size, and floret number, also are broadly or completely overlapping.

Gaiser's direct and repeated comparisons (1946) of *Liatris helleri* and *L.*

turgida imply that she regarded these two taxa as most similar to each other. Comparison of species descriptions by Cronquist (1980) also indicate that he found *L. helleri* and *L. turgida* most similar between themselves. Ahles (1968, p. 1050) observed that *L. helleri* is "Similar to no. 5 [*L. turgida*] and perhaps not specifically distinct from it." Sutter and Murdock (1984) and Godt and Hamrick (1996) encountered difficulties in the definition of *L. helleri*, but the taxonomic study by Sutter and Murdock compared *L. helleri* with *L. pilosa*, noting (without other comment) that *L. turgida* was "obviously unrelated to the *L. helleri* complex."

Godt and Hamrick (1996) found that local populations of *Liatris helleri* sensu stricto are genetically isolated and significantly differentiated among themselves. Common garden experiments suggested to Sutter and Murdock (1984, p. 6) that "strong selection for short stature and size" in the Grandfather Mountain and Linville area plants may be effected by the "exposed nature of the habitats ... and the intensity of wind at these elevations." They also noted (p. 8) that "many of the characters that relate *L. helleri*—Grandfather to *L. helleri*—Linville appear to have a genetic basis but also may have arisen several times under the selective forces of the environment at high elevations."

Broadened concept of *Liatris helleri* to include *L. turgida*

In view of the lack of distinction between the two taxa, the concept of *Liatris helleri* (described in 1891) is expanded here morphologically and geographically (Fig. 1) to include plants in West Virginia, Virginia, and North Carolina identified as *L. turgida* (described in 1946). Details regarding the nomenclatural priority of *L. helleri* are given below. Additionally, a number of collections previously identified by the misapplied names *L. graminifolia* Willd. (= *L. pilosa*) and *L. graminifolia* var. *smallii* (Britton) Fern. & Grisc. (= *L. virgata* Nutt.) also have been recognized as *L. helleri* in the present study.

A study of allozymic variation of *Liatris helleri* sensu stricto (Godt & Hamrick 1996) supports the broadened concept of the species. Based on samples from nine North Carolina populations occurring within a 30 kilometer radius, Godt and Hamrick found relatively high levels of genetic diversity in *L. helleri*, in exception to a general trend for reduced diversity in geographically restricted species. The diversity in *L. helleri* is "about three times the mean genetic diversity found for endemic plants" (p. 466) and is comparable to that found in the widespread *Liatris cylindracea* (Schall 1975, 1976). In the present interpretation of broadened geographic range and greater abundance of *L. helleri*, the allozymic variability observed by Godt and Hamrick no longer appears unusual.

Taxonomic rank and relationships of *Liatris helleri* sensu lato

Quantitative variation in a single character (pappus length, in this case) might justify recognition of a varietal taxon if the variant feature were consistent and geographically coherent. In *Liatris helleri*, however, these conditions do not hold

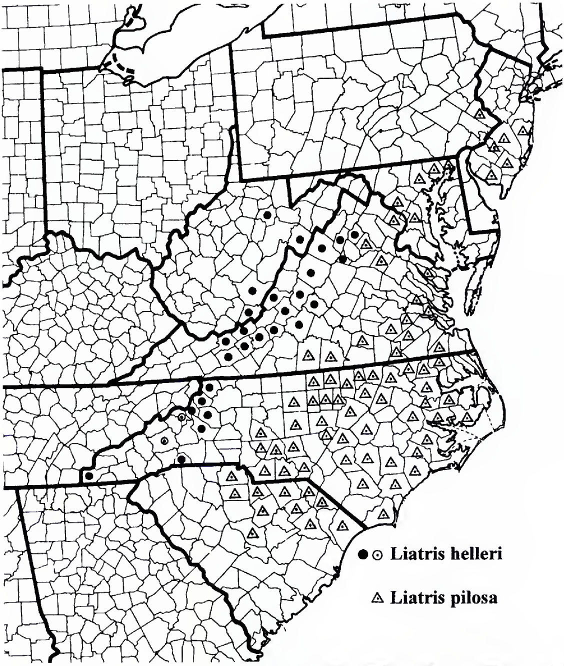


Fig. 1. Geographic distribution of *Liatris helleri* and *L. pilosa*. Localities for *L. pilosa* are from Nesom and Stucky (2004). Open circles represent collections cited by Gaiser (1946) but not seen in the present study.

and it is more consistent with taxonomic practice to informally recognize the North Carolina cluster of short-pappus populations. In fact, in view of the close similarity and presumed relationship of *L. helleri* sensu lato with *L. pilosa*, it would not be unreasonable to treat *L. helleri* sensu lato at varietal rank within *L. pilosa*.

Recognition of *Liatris helleri* at specific rank, apart from *L. pilosa*, emphasizes their distinct geography and habitat and their generally consistent, though small, differences in morphology (see key below). The two varieties of *L. spicata* (L.) Willd. have an essentially allopatric distribution (coastal plain and montane/inland) nearly analogous to that of *L. helleri* and *L. pilosa*, but the morphological overlap between the varieties of *L. spicata* is greater than between *L. helleri* and *L. pilosa*.

Liatris helleri is a member of *Liatris* ser. *Graminifoliae* (sensu Gaiser 1946; sect. *Graminifolium* ser. *Graminifoliae* sensu Nesom 2005b)—this species would have been appropriately treated by Nesom and Stucky (2004) as a member the *L. pilosa* group. In fact, *L. pilosa* and *L. helleri* (sensu lato) are more similar to each other than *L. pilosa* is to *L. elegantula* (Greene) K. Schum. (the latter two were regarded as most closely related to each other by Nesom and Stucky 2004). *Liatris microcephala* (Small) K. Schum. also is treated as a member of ser. *Graminifoliae* (Nesom 2005b); it is the only other species of *Liatris* with short pappus, but in contrast to *L. helleri*, bristle length in *L. microcephala* is relatively consistent over the range of the species.

Distinctions among these closely related taxa of ser. *Graminifoliae* are given in the key and comments below.

1. Stems glabrous; heads loosely arranged, on internodes (2–)5–10(–14) mm; peduncles 0–2(–7) mm; involucres 6–8 mm; phyllaries in 3–4(–5) series ____ **Liatris elegantula**
1. Stems glabrous to sparsely or moderately pilose; heads densely arranged, on internodes (1–)2–5(–7) mm; peduncles 0–10(–17,–80 in proximal part of capitulescence) mm; involucres (7–)8–10 mm, phyllaries in (3–)4–5(–6) series.
    2. Stems 15–55 cm; leaves and phyllaries not at all punctate-glandular or weakly so, the punctations evident only as tiny black dots (no glandular hairs evident); involucres 6–8(–10) mm wide; pappus bristles 1/2–2/3 to equal the corolla tube length; montane, 650–1600(–1850) m ____ **Liatris helleri**
    2. Stems 40–120 cm; leaves and phyllaries usually weakly punctate-glandular, phyllaries sometimes eglandular or the glands weakly developed and superficial; involucres 5–6 mm wide; pappus bristles equal the corolla tube length; coastal plain and piedmont, ca. (0–)10–500 m ____ **Liatris pilosa**

Also, compared to *L. pilosa*, stems of *L. helleri* are shorter, basal leaves average larger and cauline leaves tend to be more abruptly reduced distally, heads tend to be slightly more separated, and cypselae are slightly larger (Nesom 2005a). It would be useful to study these taxa in detail where their ranges closely approach each other in northern Virginia and Maryland (Fig. 1). Rare plants in the northernmost geographic range of *Liatris pilosa* might be identified as *L. helleri* (e.g., DELAWARE, Newcastle Co., Saint Georges, no collector or date, DOV; NEW JERSEY, Cape May Co., Belleplain, dry sandy pinewoods, 20 Sep 1974, *Moldenke 29024*, MO). Presumably, this could be interpreted as incomplete differentiation or as the result of gene flow in this area where the mountains closely approach the coastal plain.

Liatris helleri T.C. Porter, Bull. Torrey Bot. Club 18:147. 1891. *Lacinaria helleri* (T.C. Porter) T.C. Porter ex Heller, Muhlenbergia 1:6. 1900. TYPE: U.S.A. NORTH CAROLINA. Watauga

Co.: Blowing Rock Mt., 18 Aug 1890, *A.A. Heller 81* (LECTOTYPE, designated here: NY 180685!; ISOLECTOTYPES: MO! ND, NY 180687!). Porter (1891) did not specify the herbarium of deposition for the type; Gaiser (1946) noted that the "type" was at NY, but neither of the NY sheets cited here was annotated by her. Both of the NY sheets have recently been annotated as isotypes.

Liatris turgida Gaiser, Rhodora 48:261. 1946. TYPE: U.S.A. VIRGINIA. Nelson Co.: vicinity of Afton in the Blue Ridge Mts., road to Royal Orchard, rocky woods, 600 m, 31 Aug 1912, *E.S. Steele 24* (HOLOTYPE: US internet image!).

Corms globose, sometimes knotty. **Stems** 15–55 cm tall, glabrous. **Leaves**: basal and lower cauline spatulate-oblanceolate to narrowly lanceolate or linear-oblanceolate, 1-nerved, (5–)6–10(–18, –22) cm long (usually at least reaching the level of the heads), 3–8(–15) mm wide, usually quickly to gradually reduced in size above midstem, glabrous to sparsely pilose abaxially (especially in Va.), not glandular-punctate or only weakly so and without evident glandular hairs. **Heads** sessile to subsessile, peduncles rarely to 12 mm long, usually in a densely to loosely spiciform arrangement. **Involucres** turbinate-campanulate, 7–10 mm long, 6–8(–10) mm wide; phyllaries in 3–4(–5) graduate series, oblong, apically rounded, margins with a hyaline border, ciliolate, otherwise glabrous, without glandular punctations. **Florets** 7–13(–17) per head; corolla tubes sparsely pilose within in the region of filament insertion. **Cypselae** (2.5–)3.5–5 mm long, hairy; pappus bristles 1/2–2/3 or equaling the corolla tube length, barbellate. Chromosome number, $2n = 20$.

Flowering July through mid September. Rock outcrops (often shale in Virginia and West Virginia), cliff faces and ledges, ridges, shallow soil pockets, rocky openings in heath balds, roadside banks, oak, dry pine-oak, and pitch pine woods; 650–1600(–1850) m. North Carolina, Virginia, and West Virginia. Reported from Alabama and Georgia as *L. turgida* (Cronquist 1980; Duncan & Kartesz 1981; Gleason & Cronquist 1994) but not confirmed in this study; more intensive study of collections may corroborate the reports.

Additional collections examined: **NORTH CAROLINA. Ashe Co.:** summit of Paddy Mountain, E of Bluff Mountain, 22 May 1994, *Sorrie 7971* (NCU); summit of Paddy Mountain, E of Bluff Mountain, 22 May 1994, *Weakley s.n.* (NCU). **Avery Co.:** seepage area on bluffs of Big Lost Cove Cliffs, 3400 ft, 1 Aug 1986, *Bradshaw s.n.* (SMU); summit of Grandfather Mountain, 25 Sep 1898, *Canby 70* (MO); soil pockets in granitic summit of Grandfather Mt., by observatory, 3 Aug 1977, *Kral 60747* (VDB); summit of Four Diamond Ridge, grass-forb bald, 4800 ft, 25 Jul 1978, *Rohrer 2188* (NCU); Grandfather Mt., NW corner of swinging bridge away from visitor's center, upper slope of rock outcrop, meta-arkose, bordering Spruce-Fir Forest, 30 degree slope facing NNW, 1611 m, 10 Sep 1989, *Wiser 89-2* (NCU); Hanging Rock, NW-facing slope of highest peak, lower slope of rock outcrop, meta-basalt, 1562 m, 27 Jun 1989, *Wiser 89-30* (NCU); 20 m ESE of highest peak of Ship Rocks, Rough Ridge, adjacent to Tanawha trail, top of rock outcrop, 1426 m, 15 Sep 1990, *Wiser 90-175* (NCU); Grandfather Mt., Linville Bluffs, mid slope of rock outcrop, on 42 degree slope facing NNW, 1427 m, 18 Sep 1990, *Wiser 90-180* (NCU). **Burke Co.:** Hawk's Bill Mountain, 11 Sep 1982, *Frizzell 229* (NCU); vicinity of Table Rock Mountain, 3 Aug 1890, *Heller 81* (MO); gneissic summit of Table Rock Mt., above Linville gorge, 2 Aug 1977, *Kral 60704* (VDB); Shortoff Mt., dry pine-oak woods, 18 Aug 1949, *Radford 4888* (NCU); bald on Table Rock, 24 Aug 1952, *Radford 6515* (NCU); Table Rock, 29 Aug 1936, *Wherry s.n.* (LL).

Caldwell Co.: E of Blowing Rock, 3500–4000 ft, 24 Aug 1893, *Heller s.n.* (VDB); Blowing Rock observ. area, locally abundant on granitic ledges, 3 Aug 1977, *Kral 60759* (VDB); Blowing Rock, 17 Aug 1891, *Seymour 91-8-17-30* (MO, SMU, TEX); ledges of Blowing Rock, 4200 ft, 6 Aug 1891, *Small and Heller 344* (DOV, MO, NCU, SMU, TEX, WVU). **Cherokee Co.:** Topton, edge of woods, 29 Aug 1947, *Moldenke 19293* (SMU). **Polk Co.:** Melrose Mt., 14 Oct 1936, *Blake s.n.* (NCU); Melrose Mt., 14 Oct 1936, *Peattie TR147* (NCU). **VIRGINIA. Alleghany Co.:** shaly, W-facing slope of ridge above Smith Creek, McGraw's Gap, 6 Aug 1959, *Kral 9310* (NCU, VDB). **Amherst Co.:** along road between Pera and Robinson's Gap, between Brown's Creek and Beverleytown, 5 Sep 1949, *Freer 2007* (NCU). **Augusta Co.:** top of Big Bald Knob, 4500 ft, 3 Sep 1933, *Allard s.n.* (LL); Little Bald Knob, 2500 ft, 3–4 Sep 1933, *Allard s.n.* (LL); Big Bald Knob, 4400 ft, 27 Aug 1934, *Allard s.n.* (LL); Augusta Springs, steep, rocky/shaley bank off road to Deerfield, ca. 300 m on W side of crest of Elliot Knob, S of knob proper, 29 Sep 1991, *Churchill 91-250* (VDB); Mt. Rogers (Elliott's Knob), 9 Aug 1893, *Heller and Halbach 1179* (DOV, MO, NCU, VDB, WVU). **Bedford Co.:** Blue Ridge Fire Trail 4900 to Curry Gap, dry roadside bank, in Hampton shale, 27 Aug 1968, *Freer 12226* (NCU, SMU); Hwy 24 at the Otter River bridge, roadsides, 23 Sep 1967, *Ramsey et al. 16106* (SMU). **Bland Co.:** Brushy Mountain, 1 Sep 1931, *Core 3860* (WVU); Brushy Mt., dry rocky soil, 1 Sep 1931, *Sharp 3860* (LL). **Botetourt Co.:** Blue Ridge Parkway at Iron Mine Hollow, milepost 96.2, 9 Sep 1964, *Freer 2831* (NCU); Craig's, 600 m, 30 Aug 1903, *Steele 166* (MO). **Giles Co.:** Summit of Bald Knob, 5 Aug 1940, *Fox s.n.* (WVU); Salt Pond Mt., top of Bald Knob, 3/4 mi S of Mt. Lake P.O., dry, open, exposed, rocky soil, 4363 ft, 1 Aug 1943, *Iltis 2005* (SMU); Salt Pond Mt., 19 Aug 1876, *Redfield 5593* (MO). **Greene Co.:** Shenandoah Natl. Park, Skyline Drive, NW of Pine Fields leanto, rocky road cut, 19 Aug 1945, Fosberg 23821 (MO). **Montgomery Co.:** ca. 5 mi NW of Blacksburg, shaley SW slopes of Brush Mt., 5 Sep 1961, *Kral 14038* (SMU, VDB); 3.5 mi W of Blacksburg, Brush Mt., immediately N of Rd 777 (old Hwy 460), *Quercus alba*, *Q. velutina*, *Castanea pumila*, Muskingham soil, very low pH, 21 Sep 1974, *Musselman 4820* (NCU); Brushy Mountain, Va. 777, 1 mi W of US 460, 30 Sep 1969, *Uttal 6800* (NCU). **Page Co.:** Stony Man Mountain, near Luray, 3500 ft, 28 Aug 1901, Steele 241 (MO). **Pulaski Co.:** 4 mi S of Poplar Hill, shaley, open woods, 31 Aug 1961, *Kral 13972* (SMU). **Rappahannock Co.:** Shenandoah Natl. Park, Crescent Rocks, rock ledges, 24 Oct 1996, *Fosberg 23797a* (MO). **Roanoke Co.:** S of Roanoke, near top of Poor Mountain, 5 Sep 1967, *Harvill 17679* (NCU); Poor Mountain, Rd 612, common on shaly banks in thin oak-pine woods, ca. 3000–4000 ft, 3 Sep 1968, *Uttal 6529* (WVU); Rte 612, 2 mi S of 639, Poor Mt., road bank at edge of dry woods, ca. 2800 ft, 28 Aug 1974, *Uttal 10883* (NCU); Poor Mt., ca. 3 1/4 mi S of Wabun, dryish shaly woods, 10 Jul 1942, *Wood 3812* (TEX). **Rockbridge Co.:** North Mountain, near Lexington, 26 Aug 1924, *Churchill 786* (MO-2 sheets); shale bank near S boundary of county, 10 Aug 1966, *Crooks 469* (VDB); Forest Service Road 76 below Whites Gap on Blue Ridge Pkwy. MP 44.2, roadside, on Hampton shale, 30 Aug 1966, *Freer 4468* (NCU). **Rockingham Co.:** Hone Quarry Mt., 3000 ft, 7 Sep 1935, *Allard s.n.* (LL); Manganese Mountain, vicinity of Elkton, rocky slope, 1600 ft, 23 Aug 1918, *Steele 28* (WVU) and 27 Aug 1918, *Steele 50* (WVU). **Wythe Co.:** Walker Mountain, 1 Sep 1931, *Core 3872* (WVU); 8 mi w of Wytheville, sunny, shaley SW slope, 28 Jul 1960, *Kral 10833* (NCU); Walker Mt., 1 Sep 1931, *Sharp 3872* (LL, MO). **County unknown**: no locality data, 1868, *Curtiss 1179* (NCU); Skyline Drive, near Crescent Ridge, old field, 6 Sep 1955, *Hicks 2165* (BRIT). **WEST VIRGINIA. Barbour Co.:** Arden, 15 Aug 1972, *Bush s.n.* (WVU). **Greenbrier Co.:** Monongahela Natl Forest, 1959, *Clarkson 2789* (WVU); White Sulphur Springs, Kate's Mt., dry shaley soil, 6 Aug 1953, *Hunnewell 20.067* (WVU); near White Sulphur Springs, dry woods, 27 Aug 1903, *Mackenzie 359* (MO); Cole's Knob, Alvon, 2500 ft, 24 Jul 1947, *Smith s.n.* (WVU); Neola, North Fork of Anthony Creek 2200 ft, 1 Aug 1947, *Smith s.n.* (WVU); Neola, 2300 ft, 13 Aug 1947, *Smith s.n.* (WVU). **Monroe Co.:** Chocolate Drop, 25 Jul 1930, *Berkley 1291* (MO); Slaty Mountain, 29 Jul 1927, *Strausbaugh and Core 988* (WVU). **Pendleton Co.:** Panther Knob, 11 Aug 1964, *Duppstadt s.n.* (WVU); Panther Knob, 11 Aug 1964, *Clarkson s.n.* (WVU).

Two collections cited by Gaiser (1946) probably represent additional North Carolina counties for *Liatris helleri*. These are mapped on Figure 1 with open symbols.

North Carolina. Buncombe Co.: near Black Mt., rocky roadside banks, 23 Aug 1927, *Wiegand & Manning 3176* (GH, cited by Gaiser as *Liatris turgida*, not seen in present study). **Mitchell Co.:** Roan Mt., mountain meadows, 10 Jul 1894, *Mohr s.n.* (US, cited by Gaiser as *L. helleri*, not seen in present study). It is likely that at least some collections cited by her as *L. graminifolia* var. *dubia* (W.P.G. Barton) Gray from Avery, Buncombe, Burke, and McDowell counties, North Carolina, also are *L. helleri*.

CONSERVATION IMPLICATIONS

The taxonomic hypothesis forwarded here presumably may have the effect of lessening legal protections for *Liatris helleri*. In this broadened concept, the species probably will not call for such urgent conservation measures (e.g., Kral 1983; Massey et al. 1983; USF&WS 1999) as might be accorded more threatened taxa. I have not taken this lightly, especially in view of the good will and generosity of many in efforts to conserve and restore populations of this beautiful species. The biological and taxonomic realities, however, seem unequivocal, and it is possible to see the wider distribution of the species and its conceptual escape from threat and endangerment as a happy consequence. Even so, *L. helleri* apparently is nowhere common and it remains a rare species within North Carolina. Commercial and recreational development, and especially trampling by outdoor enthusiasts, pose immediate threats to the species and the natural communities in which it occurs. Efforts toward ensuring its continued existence are critical. As mentioned above, some of the North Carolina populations of *L. helleri* occur with other rare species in a rare natural community, and the species and habitat remain a focus of conservation concern and activity.

ACKNOWLEDGMENTS

Specimens were studied from DOV, NCU, and WVA (loans), MO, NCU, NY, and TEX,LL (visits), and BRIT/SMU and VDB. I am grateful to Carol Ann McCormick (NCU) for assistance with specimen data, Nancy Cole (USFWS, Asheville) for sending a copy of the study by Sutter and Murdock, and Rob Sutter, Alan Weakley, and Zack Murrell for comments and review of the manuscript.

REFERENCES

Ahles, H.E. 1968. Asteraceae. In Radford, A.E., H.E. Ahles, and C.R. Bell. Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill. Pp. 1009–1139.

CPC. 2005. *Liatris helleri*. Center for Plant Conservation National Collection Plant Profile. www.centerforplantconservation.org Accessed January 2005.

Cronquist, A. 1980. Vascular flora of the southeastern United States, Vol. I. Asteraceae. Univ. of North Carolina Press, Chapel Hill.

Duncan, W.H. and J.T. Kartesz. 1981. Vascular flora of Georgia. Univ. of Georgia Press, Athens.

Gaiser, L.O. 1946. The genus *Liatris*. Rhodora 48:165–183, 216–263, 273–326, 331–382, 393–412.

Gleason, H.A. and A. Cronquist. 1994. Manual of vascular plants of northeastern United States and adjacent Canada (ed. 2). New York Botanical Garden, New York.

Godfrey, R.K. 1948. Studies in the Compositae of North Carolina. I. *Liatris*. J. Elisha Mitchell Sci. Soc. 64:241–249.

Godt, M.J.W. and J.L. Hamrick. 1995. The mating system of *Liatris helleri* (Asteraceae), a threatened plant species. Heredity 75:398–404.

Godt, M.J.W. and J.L. Hamrick. 1996. Genetic diversity and morphological differentiation in *Liatris helleri* (Asteraceae), a threatened plant species. Biodivers. and Conserv. 5: 461–471.

Johnson, M.J. 1971. The genus *Liatris* in Virginia. Castanea 36:137–147.

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South. Vol. II. Aquifoliaceae though Asteraceae and Glossary. U.S. Dept. of Agriculture Forest Service, Southern Region, Techn. Publ. R8-TP2, Atlanta, GA.

Massey, J.R., D.K.S. Otte, T.A. Atkinson and D.R. Whetsone (illustrations by S. Sizemore). 1983. An atlas and illustrated guide to the threatened and endangered vascular plants of the mountains of North Carolina and Virginia. [*Liatris helleri* Porter (Heller's Blazing Star)]. U.S. Forest Service General Technical Report SE-20. Southeastern Forest Experiment Station, Asheville, N.C.

Nesom, G.L. 2005a. *Liatris*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 12+ vols. New York and Oxford. Vol. 21, in press.

Nesom, G.L. 2005b. Infrageneric classification of *Liatris* (Asteraceae: Eupatorieae). Sida 21:1305–1321.

Nesom, G.L. and J.M. Stucky. 2004. Taxonomy of the *Liatris pilosa* (*graminifolia*) complex (Asteraceae: Eupatorieae). Sida 21:815–826.

NCDA&CS. 2005. *Liatris helleri*. North Carolina Department of Agriculture & Consumer Services, Plant Industry Division, Plant Protection Section, Plant Conservation Program. www.agr.state.nc.us/plantind/plant/conserv/Blazstar.htm Accessed March 2005.

Porter, T.C. 1891. A new *Liatris* from North Carolina. Bull. Torrey Bot. Club 18:147–148.

Schaal, B.A. 1975. Population structure and local differentiation in *Liatris cylindracea*. Amer. Naturalist 109:511–528.

Schaal, B.A. 1976. Genetic diversity in *Liatris cylindracea*. Syst. Bot. 1:163–168.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. N.C. Dept. of Environment, Health, and Natural Resources, Raleigh.

Strausbaugh, P.D. and E.L. Core. 1977. Flora of West Virginia (ed. 2). Part 4 (Rubiaceae through Compositae). Seneca Books Inc., Morgantown, W.VA.

Sutter, R.D. and N. Murdock. 1984. Taxonomic analysis of *Liatris helleri*, a North Carolina endemic. U.S. Fish & Wildlife Service Endangered Species Field Office, Asheville, North Carolina.

U.S. Fish and Wildlife Service. 1999. Recovery Plan for *Liatris helleri* Porter (Heller's Blazing

Star). First Revision (N. Murdock; original by N. Murdock and R.D. Sutter, 1989). U.S. Fish and Wildlife Service. Atlanta, Ga. Available as pdf file: southeast.fws.gov Accessed January 2005.

Wiser, S.K. 1994. High-elevation cliffs and outcrops of the Southern Appalachians: vascular plants and biogeography. Castanea 59:85–116.

Wiser, S.K., R.K. Peet, and P.S. White. 1996. High-elevation rock outcrop vegetation of the Southern Appalachian Mountains. J. Veg. Sci. 7:703–722.

MEETING ANNOUNCEMENT

To celebrate the 25th Anniversary of the herbarium CIIDIR and the starting of our graduate program, the CIIDIR Unidad Durango of the National Polytechnic Institute, in conjunction with the Sociedad Botánica de México, will present the Symposia:

1) The Role of the Botany in the Management and Conservation of Ecosystems

2) 2nd Botanical Symposium of Northern Mexico

The Symposia will be held on September 13-14, 2005 in Durango, México. The event includes a meeting of the Sociedad Botánica de México with Dra. Laura Arriaga Cabrera giving the keynote lecture.

On the 15th there is an optional field trip to the Sierra Madre Occidental, along the Durango-Mazatlán Hwy.

—Dr. Miguel Martínez Ramos, Presidente, Sociedad Botánica de México, A.C.
—Dra. Socorro González Elizondo, Por el CIIDIR IPN Durango, sgonzalez53@prodigy.net.mx

BOOK REVIEW

RON LANCE. 2004. **Woody plants of the Southeastern United States: A Winter Guide.** (ISBN 0-8203-2524-4, hbk.). University of Georgia Press, Athens, GA 30602, U.S.A. (**Orders:** 800-266-5842, books@ugapress.uga.edu, www.ugapress.org). $54.95, 441 pp., 587 b/w line drawings, 6" × 9 1/4".

For anyone identifying woody plants from the southeastern U.S.A., this book ought to be at hand. There are so many 'tree books' but Lance's volume is extraordinary—so many taxa, excellent illustrations, good keys, and useful comments from someone obviously with deep first-hand experience. It's hard to imagine how it could be improved, much less approached by a competing facsimile. It's a classic and surely will be in use for a long time—perhaps to be used as companion to the Duncans' "Trees" and "Woody Vines" of the southeastern United States and Carl Hunter's "Trees, Shrubs, and Vines of Arkansas," personal favorites of mine.

The volume treats "native plants, as well as naturalized exotic species known to occur in at least two locations in the Southeast," from east Texas and northern Florida (excluding peninsular Florida) to southeastern Kansas and southern Delaware. "Some 900 species" are included; about 600 original illustrations by the author show distinguishing characteristics of twigs and buds. These are "all the trees, shrubs, and woody ground covers that grow without the aid of cultivation"—the last category is broad, including species of *Calamintha*, *Euonymus*, *Hypericum*, *Ilex*, *Iva*, *Parthenocissus*, *Rubus*, *Ribes*, *Vaccinium*, and *Vitis* (for a few examples among many). For species without reliable winter diagnostic features, spring and summer features are shown and described.

With that brief overview and unqualified recommendation, here are wonderful comments from the author's own preface. "For many years, botanical bait has lured me across the southeastern United States. This pull has been on many occasions a consuming quest to find and inspect, to collect and study, to photograph, illustrate, and record, as nearly as personally possible the totality of our native woody flora. Doing this amid and between jobs, during vacations, and at nearly every other available opportunity, I ultimately came to the realization that this assignment would have no end. Therefore, to see finally at least part of a lifelong interest rendered into this publication is a joy and a relief.... For that minority of people that marvel and cheer internally each time they see a species in its place in the world for their very first time, this book is presented not only as a guide of what can be seen but also as an enticement to see differently.... Bare twigs and dormant buds are merely another dimension in the appearance of our woody plants, a dimension often overlooked yet perfectly distinctive if viewed with an eye for detail."—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

BOOK NOTICE

SUSAN L. WOODWARD. 2003. **Biomes of Earth: Terrestrial, Aquatic, and Human-Dominated.** (ISBN 0-313-31977-4, hbk.). Greenwood Press, 88 Post Road West, Westport, CT 06881, U.S.A. (**Orders:** 800-225-5800, fax 603-431-2214, www.greenwood.com). $79.95, 435 pp., b/w figs, maps, 7" × 10".

In this *Biomes of the Earth* book, Woodward divides the world's biomes into four principal types: **Terrestrial, Freshwater, Marine,** and **Human-dominated.** "Comprehensive discussions enable readers to obtain a thorough understanding of each biome, and the convenient one-volume format allows easy comparison between aspects of each region."

A REVISION OF THE *PSIDIUM GRANDIFOLIUM* COMPLEX (MYRTACEAE)

Leslie R. Landrum

School of Life Sciences
Arizona State University
Tempe, Arizona 85287-4501, U.S.A.
les.landrum@asu.edu

ABSTRACT

The *Psidium grandifolium* complex is revised with keys, descriptions, maps, and illustrations and is considered to consist of *P. grandifolium*, *P. missionum*, and *P. australe*, the last with three varieties. The complex is mainly confined to eastern interior South America, ranging from Venezuela to Argentina. Lectotypes for the following taxa are chosen: *Psidium argenteum* O. Berg, *Psidium argenteum* var. *purpureum* O. Berg, *Psidium cinereum* var. *grandifolium* O. Berg, *Psidium cinereum* var. *intermedium* O. Berg, *Psidium grandifolium* var. *intermedium* O. Berg, *Psidium mucronatum* Barb. Rodr. ex Chodat et Hassl., *Psidium sericeum* O. Berg, *Psidium suffruticosum* O. Berg, *Psidium incanescens* var. *rotundifolium* O. Berg. Two new combinations are made: *Psidium australe* var. *argenteum* (O. Berg) Landrum and *Psidium australe* var. *suffruticosum* (O. Berg) Landrum

RESUMEN

Se hace una revisión del complejo *Psidium grandifolium* con claves, descripciones, mapas, e ilustraciones. El complejo incluye *P. grandifolium*, *P. missionum*, y *P. australe*, la última con tres variedades. El complejo crece principalmente en el interior del este de Sud América, desde Venezuela hasta Argentina. Se seleccionan lectotipos para los siguientes taxa: *Psidium argenteum* O. Berg, *Psidium argenteum* var. *purpureum* O. Berg, *Psidium cinereum* var. *grandifolium* O. Berg, *Psidium cinereum* var. *intermedium* O. Berg, *Psidium grandifolium* var. *intermedium* O. Berg, *Psidium mucronatum* Barb. Rodr. ex Chodat et Hassl., *Psidium sericeum* O. Berg, *Psidium suffruticosum* O. Berg, *Psidium incanescens* var. *rotundifolium* O. Berg. Se hacen las siguientes combinaciones nuevas: *Psidium australe* var. *argenteum* (O. Berg) Landrum y *Psidium australe* var. *suffruticosum* (O. Berg) Landrum.

The *Psidium grandifolium* complex is a group of small, fire resistant shrubs of the grasslands (campos) and shrubby vegetation (cerrado) of central Brazil and northeastern Argentina, Paraguay, eastern Bolivia, Venezuela, and Guyana. It presents some of the most difficult taxonomic problems in the genus due to variation within species, apparent hybridization between species in the complex, and hybridization of *P. grandifolium* and *P. australe* with *P. guineense* Sw. Especially perplexing is the fact that there exist regions in which species limits are well-defined and other areas where they breakdown. The species have in common a shrubby habit, ability to resprout from underground stems after fires; young twigs that are usually square or 4-winged in cross-section; leaf venation that is usually eucamptodromous proximally to brochidodromous distally with a poorly defined marginal vein; a placenta that protrudes little and that is com-

SIDA 21(3): 1335–1354. 2005

pletely hidden by numerous ovules at anthesis; and seeds that are relatively smooth and rounded. A similar group, the *P. salutare* complex (Landrum 2003), has the same habit and ability to resprout vigorously after fires, and smooth, round seeds, but the twigs are not winged, the venation is entirely brochidodromous and the peltate placenta is clearly visible in dissections with one or two rows of ovules on each side.

Calyx structure is often taxonomically important in *Psidium*, but in the *P. grandifolium* complex it is quite variable and not useful in defining the group. The calyx may be fused and closed except for a terminal pore or it can be quite open in the in the flower bud. The calyx-lobes may be scarcely developed, or quite evident. Calyx structure is generally helpful at the specific level in the complex.

There is considerable variation among members of the *Psidium grandifolium* complex and two or three distinct morphological entities may grow together or near to one another. For instance I have seen *P. grandifolium*, *P. australe* var. *australe* and *P. missionum* growing together at two localities in southern Paraguay. In the municipality of Mogi-Guaçu of São Paulo quite distinct forms of *P. grandifolium*, *P. australe* var. *australe* and *P. australe* var. *suffruticosum* all grow. Unfortunately intergradation among these typical forms is common, and in some areas distinctions seem to disappear. Thus, drawing species limits is quite difficult. I have chosen to accept three species, but all can be expected to intergrade with at least one other in the complex. *Psidium australe* I divide into three varieties, but others might consider these entities species. Intergradation between *P. australe* and *P. grandifolium* is common and I have found it expedient to accept numerous specimens between these species as "intermediates" without applying one name or the other to them. It is possible that the group that I accept as *P. australe* var. *argenteum* has originated through introgression from *P. grandifolium*.

Hybridization with the more distantly related *Psidium guineense* also seems to be common and further complicates taxonomy. Therefore a key is provided that distinguishes that species from the *P. grandifolium* complex.

1. Anthers elongate, 1–3 mm long, usually 3–6 times as long as wide; placenta laminar, sometimes peltate; tertiary veins often producing a ladder-like pattern; calyx closed or nearly so; hairs of lower leaf surface usually more or less erect, mostly nearly straight, usually reddish brown ____ **P. guineense**
1. Anthers not elongate, 0.5–1 mm long, about 2 times as long as wide; placenta mound-like, not laminar or peltate; tertiary veins reticulate; calyx closed or open; hairs of lower leaf surface generally appressed and straight to densely tangled, usually gray to white ____ **P. grandifolium** complex

When studying the *Psidium grandifolium* complex it is important to consider the following characteristics: 1) type and density of hair covering or its absence; 2) peduncle length; 3) calyx-lobe shape and degree of calyx closure; 4) presence or absence of dichasia; 5) leaf size and shape; 6) leaf texture. The differences are outlined in the key below. Not one of the characteristics is entirely reliable, but consideration of them all seems to work well in distinguishing these species in Argentina, Paraguay, and usually in Paraná, São Paulo, and Bahia, Brazil. In Minas Gerais, Goiás and the Distrito Federal, Brazil distinctions are less clear.

Perret (1999) proposed that the numerous names published by Chodat and Hassler (1907) and attributed to Barbosa Rodrigues, some of which appear as synonyms in this paper, should not be accepted because their original descriptions are brief and appear to be a mere list of names with minimal information. I believe that these descriptions, although brief, are in accordance with the International Code of Botanical Nomenclature (Greuter et al. 2000). Fortunately they are usually represented by good type collections and may be identified accurately.

For illustrations I have used portions of scanned herbarium specimens. These images can be viewed in their entirety in color in the Image Library on the ASU Herbarium website http://lifesciences.asu.edu/herbarium/. A list of exsiccatae will also be made available at the same website once this paper is published.

Ecology.—The species of *Psidium* vary from forest trees to savanna shrubs and grow in coastal vegetation to mountainous habitats. The great majority of the collections of the *P. grandifolium* complex have been made below 1200 m elevation and in the interior of South America. Species of the complex are shrubs and subshrubs and grow in grasslands or in shrubby vegetation (cerrado) and are resistant to fires or other disturbance (but perhaps not grazing), resprouting from underground or surface level stems, being similar to the *P. salutare* complex in ecology (Landrum 2003). During field studies in Argentina and Paraguay I have noticed that these species persist in the narrow strip of natural vegetation between roads and pastures, but do not do well in the pastures themselves.

The climates in which the *P. grandifolium* complex grows often have distinct dry and wet seasons, with freezing temperatures being rare or non-existent. Commonly associated with them are other genera of Myrtaceae (e.g., *Campomanesia, Eugenia,* and *Myrcia*); Poaceae, Fabaceae, and Asteraceae often dominate the vegetation.

Suggestions for future work.—Why do these species seem to merge in some areas and remain distinct in others? In areas where the distinctions continue, some sort of isolating mechanisms must exist. What are the barriers to hybridization and under what circumstances do they break down? What are the pollinators, the phenological patterns, and breeding systems of these species? These are all questions that can best be answered by field studies and perhaps concurrent laboratory work in South America and offer interesting opportunities for biologists. The habitats supporting species of the *P. grandifolium* complex are unfortunately rapidly being converted to pasture and agriculture. A better understanding of their biology is urgently needed for the long-term conservation of these species.

KEY TO THE SPECIES OF THE *PSIDIUM GRANDIFOLIUM* COMPLEX

1. Calyx of flower bud with lobes about triangular, 2–5 mm long, about as long as wide.
    2. Leaves thinly pubescent to glabrous ____ **P. missionum**
    2. Leaves densely tomentose below ____ **P. grandifolium** (populations of southern Paraguay and Argentina)
1. Calyx of flower bud nearly closed or the lobes truncate to broadly triangular, about 2 times wider than long.
    3. Flower bud just before anthesis 6–15 mm long, densely lanate, the underlying surface of hypanthium hidden, the calyx usually nearly closed; leaves whitish lanate below, generally at least some widest near the middle ____ **P. grandifolium**
    3. Flower bud just before anthesis 5–10 mm long, moderately covered with hairs to glabrous, the underlying surface of hypanthium visible through hairs (if present), the calyx open or nearly closed; leaves glabrous to densely short pubescent below, generally widest above the middle ____ **P. australe**

Psidium australe Cambess., in A. St.-Hil., Fl. Bras. Merid. 2: 283. 1833. *Guajava australis* Kuntze, Revis. Gen. Pl. 1: 239. 1891. Type: BRAZIL: "Prope vicum vulgo Capella de Sta. Maria ad fines provinciarum Rio Grande de S. Pedro do Sul et Missionum," *Saint-Hilaire s.n.* (holotype: P!, =F-36406!, =ASU photo!).

Shrub or subshrub to ca. 1(–1.5) m high, essentially glabrous (except for inner calyx-lobe surface), subglabrous to densely hairy on young growth, sometimes densely covered with appressed hairs on lower leaf surfaces, arising from a fire resistant underground stem; hairs whitish, appressed, to ca. 0.5 mm long; young twigs square in cross section, with four wings, reddish-brown to gray-green, glabrous to moderately pubescent, glandular, with age the bark becoming gray to light brown, the bark flaking off to reveal smooth reddish-brown to gray bark. **Leaves** obovate, oblanceolate, narrowly elliptic, or elliptic, 3.5–11 cm long, 1.3–6 cm wide, 1.6–5.4 times as long as wide, glabrous to moderately pubescent, sometimes densely pubescent below; apex round, truncate, to acute, less often with a cuspidate tip; base cuneate, acute, acuminate, or rounded; petiole shallowly channeled, 0–4 mm long, 1.2–2 mm wide; midvein impressed to flat above, prominent below, the venation usually eucamptodromous proximally to brochidodromous distally, the lateral veins usually 4–8, a clear marginal vein not present, the tertiary veins obscure or forming an irregular reticulate pattern; blades coriaceous to subcoriaceous, drying light to dark olive green to dark reddish brown, usually darker above than below, lustrous or dull above. **Flower buds** pyriform, 5–10 mm long; peduncles sparsely hairy, 1-flowered or 3-flowered, 0.1–3.7 cm long, 0.8–1.5 mm wide, the arms of the dichasia 2–13 mm long; bracteoles narrowly deltoid-lanceolate, 1–3 mm long, clasping the hypanthium, usually falling before anthesis; calyx glabrous to sparsely pubescent without, apically pubescent within, connate as a cup-like tube for 2–4 mm, with deltoid lobes along the edge of the tube or merely with a sinuate margin, or nearly (rarely completely) closed, tearing more or less irregularly between the lobes to the staminal ring at anthesis, the lobes before anthesis to ca. 1 mm long, to ca. 3 mm wide; petals obovate to suborbicular, elliptic, oblanceolate, 7–10 mm long, glabrous; hypanthium obconic to subhemispheric, 2.5–4 mm long; disk 5–10 mm across, glabrous to pubescent; stamens 100–300, 6–10 mm long, reflexed in bud so that anthers reach the disk; anthers 0.5–0.8 mm long, with 1 apical gland in the connective; style 5–8 mm long, the stigma somewhat peltate; ovary 3–4-locular, usually with a central hollow area; ovules 20–95 per locule, the placenta hidden by ovules. **Fruit** globose to subpyriform, 1.5–3 cm long; seeds subreniform, 3–5 mm long, rounded, 6–50.

Psidium australe may be divided into three more or less distinct varieties distinguished in the key below.

1. Leaves densely covered with hairs beneath, the underlying leaf surface (except for larger veins) hidden by hairs ________ **P. australe** var. **argenteum**
1. Leaves sparsely covered with hairs to glabrous beneath
    2. Leaves often 3 or more times as long as wide, lustrous above; peduncles usually more than 2 cm long, usually 3-flowered; calyx usually nearly closed in young bud; seeds up to ca. 10. ________ **P. australe** var. **suffruticosum**
    2. Leaves usually less than 3 times as long as wide, usually dull above; peduncles commonly all less than 2 cm long, usually 1-flowered; calyx usually open in young bud; seeds up to ca. 50 ________ **P. australe** var. **australe**

Psidium australe Cambess var. **australe**

Psidium australe Cambess in A. St.-Hil., Fl. Bras. Merid. 2: 283. 1833, as to type. (**Figs. 1, 2**).

Psidium triphyllum Barb. Rodr., Myrt. Paraguay 12. 1903. TYPE: PARAGUAY. "Ipê-hú... Sierra de Maracayu," *Hassler 4990* (HOLOTYPE: G, =ASU photo!)

Psidium mucronatum Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7: 798. 1907. TYPE: PARAGUAY. "Ipé-hu Sierra de Maracayu," *Hassler 5082* (HOLOTYPE: G [4 sheets], =ASU photos!; sheet in G photo 105 [LECTOTYPE, here designated]; ISOLECTOTYPE: NY!).

Psidium piribebuiense Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7:797. 1907. TYPE: PARAGUAY: "Cordillera de Piribebuy," *Hassler 6632* (HOLOTYPE: G [2 sheets], =ASU photos!).

Psidium submetrale McVaugh, Mem. New York Bot. Gard. 18:261. 1969. TYPE: VENEZUELA. "Bólivar: Entre San Félix y Puerto Ordaz ... elev 20 m, 26-27 Jun 1964 (fl)," *Steyermark 94275* (HOLOTYPE: MICH!).

Shrub or subshrub ca. 1(-1.5) m high; leaves mainly obovate to oblanceolate, 1.6–3.5 times as long as wide, glabrous to sparsely pubescent beneath, the upper surface usually dull; peduncles mostly under 2 cm long, 1(–3)-flowered; calyx usually quite open in the flower bud before anthesis and before tearing between lobes begins; fruit 1.5–3 cm long; seeds up to ca. 50.

ARGENTINA. Misiones: 7 km de B. de Irigoyen, camino a San Pedro, Dep. Bernardo de Irigoyen, 17 Feb 1973 (fr), *Krapovickas et al 23378* (CTES, MO), Candelaria, 3 km S of Arroyo Yabebiry, 4 km S of San Ignacio on ruta 12 (27°15'S, 55°35'W), 11 Dec 1987 (fr), *Landrum 5741* (ASU, CTES); Cainguás, Monte

Fig. 1. A–B. *Psidium australe* var. *australe, Landrum 3909* (NY). **A.** Flower buds, twig and portions of leaves. **B.** Twigs, leaves and flower buds. **C–D.** *Psidium australe* var. *argenteum*. **C.** *Mattos 10620* (US), flower buds and leaves; buds are nearly glabrous on hypanthium and calyx; lower leaf surface densely covered with hairs. **D.** *Silva 736* (ASU), twigs, leaves and flower buds. In both varieties the calyx is cup-like and open in the flower bud.

Carlo, 205 m, 28 Feb 1955 (fr), *Montes 14782* (NY), Cainguás, ruta 8, 1 km S de Campo Grande, camino a Alba Posse, 1 Aug 1987 (fr), *Vanni et al. 973* (ASU, CTES).

BRAZIL. Distrito Federal: 500 m da margem do lago Paranoa, 9 Nov 1978 (fl), *Heringer et al. 699* (NY). **Goiás:** Serra do Caiapó, ca. 60 km S of Caiaponia on road to Jatai, 800–1000 m, 30 Oct 1964 (fl), *Irwin & Soderstrom 7574* (CAS, MICH, NY). **Maranhão:** Imperatriz, Bananal, 15 km S of Imperatriz along BR 010 (ca. 5°40'S, 47°26'W), 290 m, 29 Feb 1980 (fl), *Plowman et al. 9351* (NY). **Minas Gerais:** Uberlandia, arredores, 6 Nov 1991 (fl), *Hatschbach 55798* (ASU, MBM). **Parana:** Estr. do Cerne, Km 116–117, Campos de Castro, Mun. Castro, 9 Jan 1947 (fl), *Hatschbach 581* (MBM, MICH); Ipiranga, Faxinal do Tanque, 20 Dec 1970 (fl), *Hatschbach 25899* (ASU); Bocaiuva do Sul, arredores, 5 Dec 1978 (fl), *Hatschbach 41850* (MBM, MO); Mun. Balsa Nova, S. Luis do Puruna, 14 Dec 1979 (fl), *Hatschbach 42641* (NY); Rio Branco do Sul, Quebrada Fundo, 5 Dec 1995 (st), *Kawasaki et al. 935* (ASU, MBM, SP); Vila Velha, detrás de la iglesia, 15 Jan 1987 (fr). *Krapovickas & Cristóbal 40895* (ASU, CTES); Mun. Piraquara, ca. 10 km E of Curitiba (ca. 25°30'S, 49°10'W), 1 Dec 1981 (fl), *Landrum 3909* (NY); Mun. Palmeira, Fazenda Santa Rita, ca. 65 km W of Curitiba on rd to Ponta Grossa (ca. 25°25'S, 49°50'W), 2 Dec 1981 (fl), *Landrum 3953* (NY); ca. 85 km SW of Guarapuava in campo near Rio Reserva, ca. 1000

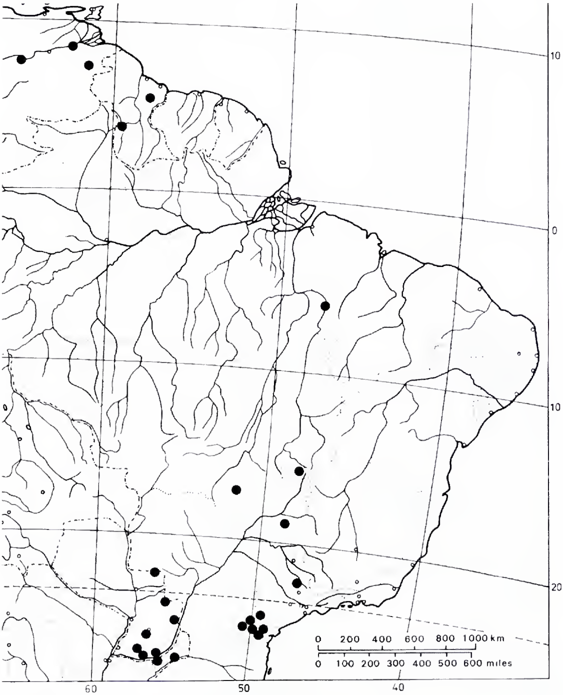


Fig. 2. Distribution of *Psidium australe* var. *australe*.

m, 13 Mar 1967 (fr), *Lindeman & de Haas* 4834 (MBM, MICH, NY); entre Senges e Jaguariaiva, 20 Nov 1962 (fl), *Mattos* 10647 (ASU, SP); Mun. Palmeira, Fda. Sta. Rita, 21 Jan 1982 (fr), *Oliveira* 318 (ASU, MBM); Buraco do Padre, Mun. Ponta Grossa, 24 Nov 1989 (fl), *Silva & Nicolack* 739 (ASU, MBM). **Roraima:** Normandia, Alto Rio Branco, 11 Jun 1954 (fl), *Rodrigues* 4475 (MICH). **São Paulo:** Mun. Mogi-Guaçu, 10 km NNW of Padua Sales (22°11-18'S, 47°7-10'W), 650 m, 22 Sep 1960 (fr), *Eiten & Eiten* 2394 (NY).

GUYANA. upper Demerara-Berbice region, ca. 27 km from Ituni along Ituni-Kwakwani road (5°22'N, 58°7'W), 30–60 m, 17 Jan 1990 (fr), *Gillespie* 3000 (ASU); Rupununi Savana, Marakanata Old

Village, ca. 350 ft, 13 Oct 1963 (fl), *Goodland 989* (MICH, NY); Rupununi Savana, Nappi Village (3°25'N, 59°35'W), 110 m, 29 Nov 1987 (fl), *Jansen-Jacobs et al. 1319* (MO).

PARAGUAY. Alto Parana: Rva. Tati Yupi, 14 Feb 1979 (fr), *Itaipu Binacional 161* (MO). **Amambay:** P. N. Cerro Corá (ca. 22°35'S, 56°5'W), road to Lorito, ca. 150 m, 20 Aug 1995 (st), *Landrum 8700* (ASU, FCQ). **Caazapá:** Tavai, destacamento militar (26°10'S, 55°20'W), 30 Oct 1988 (fl), *Basualdo 1734* (MO). **Canendiyu:** circa Ype-jhu, 1 Nov 1978 (fl), *Bernardi 18306* (NY); Ygatimi, Reserva Natural del Bosque Mbaracayú (ca. 24°10'S, 55°40'W), Nandurocai, 19 Nov 1995 (fr), *Landrum 8859* (ASU, FCQ). **Itapúa:** Capt. Miranda, 4.2 km N of entrance to Hotel Tirol near CONAVI project (27°12'S, 55°45'W), ca. 210 m, 9 Nov 1995 (fl), *Landrum 8798* (ASU, FCQ); Capt. Miranda, road to Jesús ca. 0.6 km from main highway (ca. 27°12'S, 55°45'W), ca. 185 m, 9 Nov 1995 (fl), *Landrum 8816* (ASU, FCQ). **Misiones:** 12 km W de San Ignacio, camino a Pilar, 15 Nov 1978 (fr), *Arbo et al. 1925* (CTES, MICH, MO); San Juan Bautista, ca. 8.5 km along road to Pilar, ca. 170 m, 8 Nov 1995 (fl), *Landrum 8789* (ASU, FCQ); rt. 1 between San Ramón to San Patricio at KM A262, ca. 4 km E of rd to Ayolas (ca. 27°5'S, 56°40'W), ca. 240 m, 8 Nov 1995 (fl, fr), *Landrum 8795* (ASU, FCQ), rt. 1, km A218, E147, between Asunción and Encarnación, ca. 210 m, 10 Nov 1995 (fl), *Landrum 8825* (ASU, FCQ); Ea. La Soledad, 3 km S de Santiago (56°46'W, 27°10'S), 3–4 Feb 1988 (fr), *Schinini & Vanni 26054* (ASU). **Paraguari:** Parque Nacional Ybycui, Campo cerrado en NE corner of the park on Arroyo Corrientes (26°03'S, 56°50'W), 21 Dec 1988 (fl), *Zardini et al. 8980* (MO, PY).

VENEZUELA. Bolivar: Mun. Asc. Farreras, Maripa-Aripao (7°29'N, 65°20'W), 80 m, Feb 1990 (yfr), *Elcoro 759* (MO); Distr. Roscio, ca. 50 km al N de Tumeremo, 450 m, 7 May 1986 (fl), *Huber 11627* (MO); km 111 on Puerto Ordaz-Cerro Bolivar railroad, 300–350 m, 26 Oct 1953 (fl), *Maguire et al. 36006* (NY).

The four specimens of *Psidium mucronatum* at G of *Hassler 5082* are a mixture of entities. The one specimen most certainly belonging to *P. australe* is chosen as the lectotype. The type of *Psidium triphyllum* might best be placed under *P. australe* var. *suffruticosum*, but I cannot say with certainty based on the photo I have.

Psidium australe var. **argenteum** (O. Berg) Landrum, comb. nov. (**Fig. 3**). *Psidium argenteum* O. Berg, in Mart., Fl. Bras. 14(1):388. 1857. *Psidium argenteum* var. *purpureum* O. Berg, in Mart., Fl. Bras. 14(1):388. 1857, inadmissible name to be replaced by *P. argenteum* var. *argenteum*, the type serving to typify the species. *Guajava argentea* (O. Berg) Kuntze, Revis. Gen. Pl. 1:239. 1891. Type: BRAZIL: Isotype of *P. argenteum* var. *purpureum* O. Berg, here designated as LECTOTYPE of species, "in campis prov. Rio Grande do Sul," *Sellow s.n.* (SYNTYPE: B, lost; ISOSYNTYPE: P! [LECTOTYPE, here designated], =F-36405!, =ASU photo!).

Psidium cuneatum Cambess., in A. St.-Hil., Fl. Bras. Merid. 2:283. 1833. *Psidium cuneatum* var. *niveum* O. Berg, in Mart., Fl. Bras. 14(1):405. 1857, inadmissible name to be replaced by *P. cuneatum* var. *cuneatum*. *Guajava cuneata* Kuntze, Revis. Gen. Pl. 1:239. 1891. Type: BRAZIL: "Prope urbem S. João del Rey in provincia Minas Geraes," *Saint-Hilaire s.n.* (HOLOTYPE: P!, =F-36409!, =ASU photo!).

Psidium argenteum var. *angustifolium* O. Berg, in Mart., Fl. Bras. 14(1):388. 1857. Type: BRAZIL: "ad pagum Formigas in parte deserta prov. Minarum," *Pohl [287, 534]* (SYNTYPES: W, B, M; syntype at W, =F-31417!).

?*Psidium argenteum* var. *grandifolium* O. Berg, in Mart., Fl. Bras. 14(1):388. 1857. Type: BRAZIL: "in campis prov. S. Pauli," *Sellow s.n.* (HOLOTYPE: B, lost).

?*Psidium argenteum* var. *pumilum* O. Berg, in Mart., Fl. Bras. 14(1):388. 1857. Type: BRAZIL: "ad S. Ignacio," *Sellow s.n.* (HOLOTYPE: B, lost).

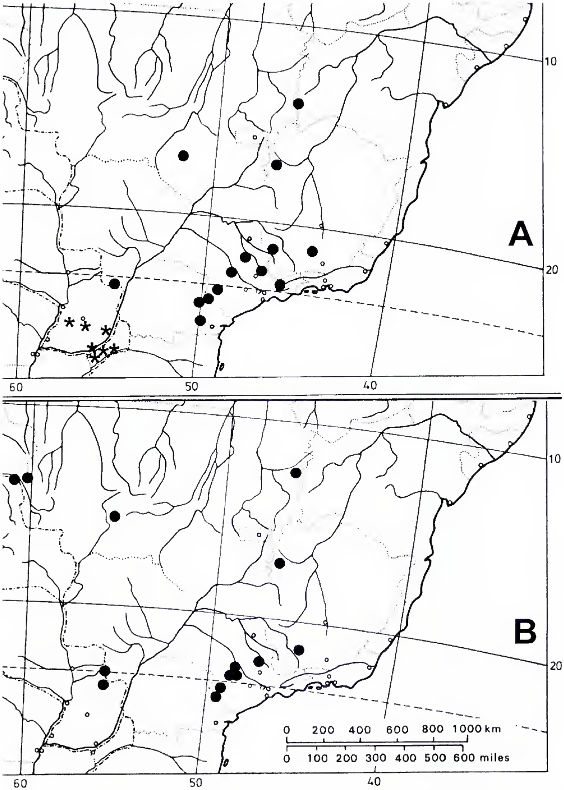


Fig. 3. **A.** Distribution of *P. australe* var. *argenteum* (dots) and *P. missianum* (stars). **B.** Distribution of *P. australe* var. *suffruticosum*.

Shrub or subshrub ca. 1(–1.5) m high; leaves mainly obovate to oblanceolate, 1.6–3.5 times as long as wide, densely pubescent beneath, the hairs hiding the underlying surface except for larger veins, the upper surface usually dull; peduncles mostly under 2 cm long, 1(–3)-flowered; calyx usually quite open in the flower bud before anthesis and before tearing between lobes begins; fruit 1.5–3 cm long; seeds up to ca. 50.

BRAZIL. Goias: Serra do Caiapó, ca. 60 km S of Caiaponia on road to Jatai (17°12'S, 51°47'W), 800–1000 m, 27 Oct 1964 (fl), *Irwin & Soderstrom 7432* (MICH, MO, NY); Serra Geral de Goiás, ca. 6 km S of Posse (14°S, 46°W), 800 m, 5 Apr 1966 (fr), *Irwin et al. 14393* (NY); Contraforte Central, ca. 26 km NE of Catalão, 875 m, 23 Jan 1970 (fr), *Irwin et al. 25224* (NY). **Minas Gerais:** Serinha, (fl), *Chiea 480* (ASU, SP); Mun. Tijucal, Pedro Less, 13 Mar 1982 (fr), *Hatschbach 44706* (ASU); ca. 35 km NW of Paracatú, 1000 m, 8 Feb 1970 (fr), *Irwin et al. 26330* (NY); Tiradentes, Serra de São José, 1300–1400 m, 03 Oct 1987 (fl), *Peron 320* (ASU). **Parana:** Mun. Jaguariaiva, Fazenda Chapada Santo Antonio, 27 Nov 1968 (fl), *Hatschbach 20410* (ASU, MBM); Buraco do Padre, Mun. Ponta Grossa, 24 Nov 1989 (fl), *Silva & Cordeiro 736* (ASU, MBM); Mun. Castro, Carambei by Rio São João (ca. 24°30'S, 50°2'W), 950 m, 15 Jan 1965 (yfr), *Smith et al. 14494* (MICH, NY); Mun. Pirai do Sul, near Pirai do Sul (ca. 24°20'S, 50°10'W), 1000–1100 m, 16 Jan 1965 (fr), *Smith et al. 14555* (MICH, NY). **São Paulo:** São Carlos, 3.5 km NNW of center of São Carlos (21°59'S, 47°55'W), 825 m, 14 Jun 1961 (fr), *Eiten et al. 2907* (MICH, SP); Botucatu, 18 km N, 14 km E of São Manuel (48°25'0"W, 22°45'0"S), 550 m, 28 Sep 1972 (fl), *Gottsberger 196R-28972* (ASU); Itirapina, Cerrado do Valerio, 19 Oct 1994 (fl), *Kinoshita et al. 32196* (ASU); Mun. Itaberaba, Rio Verde, 17 Feb 1982 (fr), *Kummrow 1786* (ASU); Mogi-Guaçu, Martinho Prado, Reserva Biológica da Fazenda Campininha, 15 Oct 1980 (fl), *Mantovani 1163* (ASU, RB, SP); São José dos Campos, a 3 km leste da cidade, 29 Apr 1961 (fr), *Mattos 8903* (ASU, SP); Aguas de Santa Barbara, ca. 11 km da cidade em direcão a Lençóis, 19 Dec 1995 (fl), *Souza & Souza 9634* (ASU); Mogi-Mirim, 9 Dec 1945 (yfr), *Viegas 7967* (ASU).

PARAGUAY. Canindeyu: Sierra de Maracayú, Oct 1900 (fl), *Hassler 5076* (NY).

Psidium australe var. **suffruticosum** (O. Berg) Landrum, comb. nov. (**Fig. 4**). *Psidium suffruticosum* O. Berg, in Mart., Fl. Bras. 14(1):387. 1857. *Guajava suffruticosa* (O. Berg) Kuntze, Revis. Gen. Pl. 1:239. 1891. TYPE: BRAZIL: "in pascuis desertorum Brasiliae," *Pohl 1021* (HOLOTYPE: B, lost; ISOTYPES: M!, = F-19727!, W! [LECTOTYPE, here designated], = ASU photo!).

Psidium alatum O. Berg, in Mart., Fl. Bras. 14(1):604. 1859. TYPE: BRAZIL: "Serra da Chapada prov. Minarum," *Riedel s.n.* (HOLOTYPE: LE, = ASU photo!).

Psidium suffruticosum var. *alata* Kiaersk., Enum. Myrt. bras. 27. 1893. TYPE: BRAZIL: "Lagoa Santa," "São Simão," *Warming s.n.*, *Lofgren 212*; *Glaziou 16972* (SYNTYPES: C; ISOSYNTYPE: *Glaziou 16972*, R!, = ASU photo!; ISOSYNTYPE: *Lofgren 212*, SP!, = ASU photo!).

Shrub or subshrub to ca. 0.3 m high; leaves obovate, oblanceolate or narrowly elliptic, mainly 2–6 times as long as wide, mostly glabrous, the upper surface usually somewhat lustrous; peduncles mostly 1–4 cm long, often 3-flowered (1-flowered peduncles generally present as well); calyx usually nearly closed in the flower bud before anthesis and before tearing between lobes begins; fruit mostly up to 1 cm long; seeds up to ca. 10.

BOLIVIA. Santa Cruz: Velasco, Parque Nacional Noel Kempff Mercado (13°53'41"S, 60°48'46"W), 500 m, 28 Jan 1997 (fl), *Soto et al. 424* (ASU).

BRAZIL. Mato Grosso: Between Buriti and Chapada dos Guimaraes, 720 m, 19 Oct 1973 (fl),

Fig. 4. ***Psidium australe*** **var.** ***suffruticosum*****. A–B.** ***Gottsberger 11-121079*** **(ASU). A. Dichasial inflorescences with buds, the youngest and uppermost nearly closed; the oldest and lowest with calyx having opened by tears. B. Shoots arising from partially burnt base. Relatively narrow leaves, dichasia and a closed calyx are typical in this variety. C.** ***Heringer & Rizzini 17549*** **(NY). Apex of flower bud showing nearly closed calyx.**

Prance et al. 19225 (NY); (13°50'S, 60°08'W), 29 Nov 1977 (fr), *Silva Costa 1300* (ASU). **Minas Gerais:** Patos de Minas, 800 m, 19 Aug 1950 (fl), *Duarte 2825* (NY); Mun. Carmo da Cachoeira, Rod. Fernão Dias, 30 Nov 1985 (fl), *Hatschbach 50322* (ASU, MBM); João Pinheiro-Cristalina, 6 Sep 1979 (fl), *Heringer & Rizzini s.n.* (NY, US); Serra da Anta, ca. 10 km NW of Paracatu, ca. 900 m, 3 Feb 1970 (fr), *Irwin et al. 25885* (CAS, F, MO, NY). **Paraná:** Jaquariaiva, road to Arapoti near boundary (ca. 24°08'S, 49°20'W), 850–1000 m, 17 Jan 1965 (fr), *Smith et al. 14684* (MICH). **São Paulo:** 18 km ao N de Botucatu, 14 km a leste de São Manuel (22°45'S, 48°25'W), perto da Estac. 13 de Maio, 550 m, 22 Nov 1974 (st), *Gottsberger & Campos 24-221174 24* (ASU, UB), Itaberaba, Rio Verde, 17 Feb 1982 (fr), *Kummrow 1787* (ASU); Itapetininga, 15 km ao N da cidade, 13 Nov 1961 (yfr), *Mattos 9576* (ASU, SP), a 37 km de Avaré, rodovia Avare-São Manoel, 15 Mar 1967 (fr), *Mattos 14527* (ASU, SP); São José dos Campos, 7,5 km SW em linha recta da praça principal, 200 m NW da Via Dutra, 600 m, 25 Oct 1961 (fl), *Mimura 59* (MICH, NY, SP); Mogi-Guaçu, Padua Sales, Res. Biológica da Fazenda Campininha, 24 Nov 1977 (fr), *Sakane 698* (ASU); Itararé, Estacão Ecológica de Itapeva (24°04'25"S, 49°03'09"W), 12 Nov 1994 (fl), *Souza et al. 7037* (ASU, SP); Angatuba, Estrada para Itatinga, ca. 29 km de Angatuba (23°18'48.1"S, 48°31'35.1"W), 610 m, 2 Jan 1996 (yfr), *Souza et al. 10752* (ASU).

PARAGUAY. Amambay: Sierra de Amambay, Oct 1912 (fl), *Hassler 11401* (F, LIL, NY). **Canindeyu:** Ygatimí, Res. Natural del Bosque Mbaracayú, Nandurocai (ca. 24°10'S, 55°40'W), 19 Nov 1995 (fl), *Landrum 8857* (ASU, FCQ).

Psidium grandifolium DC., Prodr. 3:234. 1828. (**Figs. 5, 6**). *Psidium grandifolium var. genuinum* O. Berg, in Mart., Fl. Bras. 14(1):406. 1857, inadmissible name to be replaced by *P. grandifolium* var. *grandifolium*. *Guajava grandifolia* (DC.) Kuntze, Rev. Gen. Pl. 1:239. 1891. Type: BRAZIL: "ad Ypanema prov. S. Pauli," *Martius s.n.* (holotype: M, =F-19713!).

Psidium cinereum DC., Prodr. 3:234. 1828. *Guajava cinerea* (DC.) Kuntze, Revis. Gen. Pl. 1:239. 1891. *Psidium cinereum* var. *angustifolium* O. Berg, in Mart., Fl. Bras. 14(1):403. 1857, inadmissible name to be replaced by *P. cinereum var. cinereum*. Type: BRAZIL: "prov. Sancti Pauli," *Martius s.n.* (holotype: M!, =F-19723!, = ASU photo!).

Psidium incanescens DC., Prodr. 3:234. 1828. *Guajava incanescens* (DC.) Kuntze, Revis. Gen. Pl. 1:239. 1891. *Psidium incanescens* var. *cuneatum* O. Berg, in Mart., Fl. Bras. 14(1):403. 1857, inadmissible name to be replaced by *P. incanesens* var. *incanescens*. *Psidium cinereum* DC. var *incanescens* (DC.) D. Legrand, Fl. Illustr Catarin., Mirtáceas, 692. 1977. Type: BRAZIL: "prope Taubate prov. S. Pauli," *Martius s.n.* (holotype: M, =ASU photo!).

Psidium ternatifolium Cambess., in A. St.-Hil., Fl. Bras. Merid. 2:278. 1833. *Psidium grandifolium* var. *ternatifolium* (Cambess.) O. Berg, in Mart., Fl. Bras. 14(1):407. 1857. Type: BRAZIL: "Fazenda das Lages in provincia S. Pauli," *Saint-Hilaire s.n.* (holotype: P!, =ASU photo!).

Psidium cinereum var. *brevipes* O. Berg, in Mart., Fl. Bras. 14(1):404. 1857. Type: BRAZIL: "in prov. Minarum," *Claussen 527* (holotype: BR; isotype: G, = F-23492!).

Psidium grandifolium var. *intermedium* O. Berg, in Mart., Fl. Bras. 14(1):407. 1857. Type: BRAZIL: "prov. Rio Grande do Sul," *Sellow s.n.* (holotype: B, lost; isotype: P! [LECTOTYPE, here designated], =ASU photo!).

Psidium grandifolium var. *heterophyllum* O. Berg, in Mart., Fl. Bras. 14(1).407. 1857. Type: BRAZIL: "prov. Minarum," *Claussen 1527* (holotype: W; isotype: LE, =ASU photo!).

Psidium grandifolium var. *tenuinerve* O. Berg, in Mart., Fl. Bras. 14(1):407. 1857. Type: BRAZIL: "prov. Minarum prope urbem S. João," *Pohl 3630* (holotype: W, = ASU photo!)

Psidium cinereum var. *intermedium* O. Berg, in Mart., Fl. Bras. 14(1):404. 1857. Type: BRAZIL: "prope urbem Barbacena prov. Minarum ...ad Urbem Ypanema prov. S. Pauli." *St. Hilaire, Martius, Sellow s.n.* (syntypes:B, lost; isotype: P! [lectotype, here designated], =ASU photo!).

Psidium incanescens var. *parvifolium* O. Berg, in Mart., Fl. Bras. 14(1):403. 1857. Type: BRAZIL: "prov. Minarum...S. João del Rey...Chapeo d'Uvas," *St. Hilaire, Widgren 529, White 4163* (syntypes.M, MEL; possible isosyntypes:LE, P!, = ASU photo!, R!).

Psidium incanescens var. *rotundifolium* O. Berg, in Mart., Fl. Bras. 14(1):403. 1857. Type: BRAZIL: "prov. Rio Grande do Sul.. S. Rita et S. João Baptista...ad Paracatu," *Sellow, Pohl 500 & 729* (syntypes: B, lost; isosyntype: [*Pohl 500*], W! [LECTOTYPE, here designated] = F-31423!, = ASU photo!; isosyntype: [*Pohl 729*], W!, = ASU photo!).

Psidium cuneatum var. *incanescens* O. Berg, in Mart., Fl. Bras. 14(1):405. 1857. Type: BRAZIL: "in eadem prov." [i.e., Minas Gerais] *Regnell I-129* (holotype: MEL, = ASU photo!).

Psidium grandifolium var. *albidum* O. Berg, in Mart., Fl. Bras 14(1):603. 1859. Type: BRAZIL: "Prope Pindamonhangaba et Taubate," *Riedel s.n.* (holotype: LE, =ASU photo!).

Psidium grandifolium var *incanescens* O. Berg, in Mart., Fl. Bras. 14(1):603. 1859 Type: BRAZIL: "Prope Pindamonhangaba et Taubate," *Riedel s.n.* (holotype: LE, =ASU photo!).

Psidium riedelianum O. Berg, in Mart., Fl. Bras 14(1):603. 1859. Type: BRAZIL: "prope villam Jaguara prov. Minarum," *Riedel s.n.* (apparent holotype: LE, =ASU photo!).

Psidium eriophyllum Barb. Rodr., Myrt. Paraguay 12. 1903. Type: PARAGUAY: "vicine Rio Igatemy, prope Yerbales Serra Maracayu," *Hassler 5659* (holotype: [2 sheets], G, = ASU photos!).

Psidium lanatum Barb. Rodr., Myrt. Paraguay 13. 1903. Type: PARAGUAY: "Ipe hu.....Serra Maracayu," *Hassler 5263* (holotype: G, = ASU photo!)

Psidium spodophyllum Barb. Rodr., Myrt. Paraguay 14. 1903. Type: PARAGUAY: "prope Rio Corrientes," *Hassler 4521* (holotype: G, = ASU photo!).

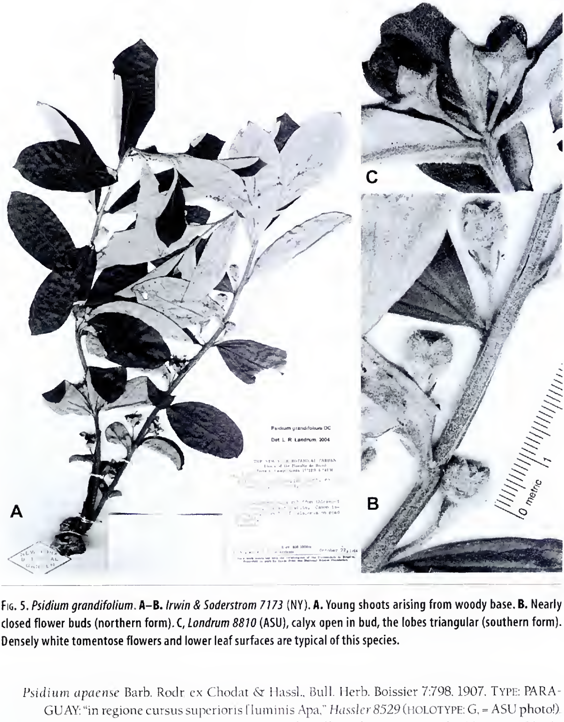


Fig. 5. ***Psidium grandifolium*****. A–B.** ***Irwin & Soderstrom 7173*** **(NY). A. Young shoots arising from woody base. B. Nearly closed flower buds (northern form). C,** ***Londrum 8810*** **(ASU), calyx open in bud, the lobes triangular (southern form). Densely white tomentose flowers and lower leaf surfaces are typical of this species.**

Psidium apaense Barb. Rodr ex Chodat & Hassl., Bull. Herb. Boissier 7:798. 1907. Type: PARAGUAY: "in regione cursus superioris fluminis Apa," *Hassler 8529* (holotype: G, = ASU photo!).

Psidium apaense Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7:798. 1907. Type: PARAGUAY: "pr. Curuguaty," *Hassler 4648* (holotype: [2 sheets], G, = ASU photos!).

Psidium paraguayense Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7:798. 1907. Type: PARAGUAY: "pr. Igatimi," *Hassler 4831* (holotype: [3 sheets], G, = ASU photos!).

Psidium psychrophyllum Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7:797. 1907 Type: PARAGUAY: "in alta-planitie Loma guazu in valle fluminis Y-aca," *Hassler 6805* (holotype: [2 sheets], G, = ASU photos!).

Psidium yacaense Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7:797. 1907. Type: PARAGUAY: "pr. Valenzuela," *Hassler 7099* (holotype: G, = ASU photo!).

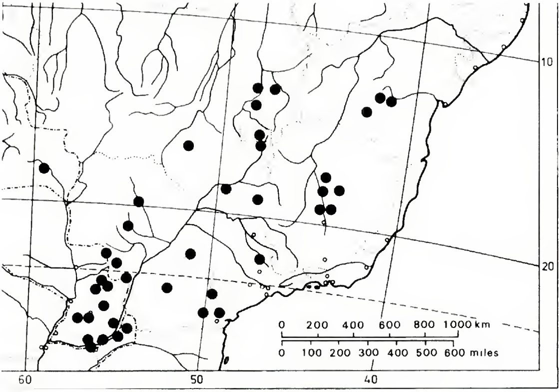


Fig. 6. Distribution of *Psidium grandifolium*.

Psidium cinereum var. *paraguariae* D. Legrand, Fl. Illustr. Catarin., Mirtáceas 694. 1977. Type: PARAGUAY: *Rosengurtt 5407* (holotype: MVM); *Pedersen 4366* (isoparatypes MO!, NY!, =ASU photo!).

Shrub to ca. 1.5 m high, densely white tomentose or pubescent on young growth; hairs white (sometimes with a reddish-brown tinge), simple, up to ca. 1.5 mm long; young twigs often square in cross section, especially in vigorous growth, densely white tomentose. **Leaves** elliptic, obovate, oblanceolate, lanceolate, (rarely suborbicular), 3.6–12 cm long, 2–5.8 cm wide, 1.7–3 times as long as wide, densely white tomentose below, sparsely hairy to glabrescent above when mature, often with somewhat longer, persistent hairs along the midvein above; apex acute, rounded, acuminate, often with a cuspidate tip; base acute, obtuse, rounded, or cuneate; petiole 1–6 mm long, 1–2 mm thick, channeled or not; midvein impressed to flat above, prominent below, the venation usually eucamptodromous proximally to brochidodromous distally, the lateral veins usually 4–7, ascending, a clear marginal vein not present, the smaller tertiary veins obscure or forming an irregular reticulate pattern, sometimes impressed above; blades subcoriaceous to stiffly coriaceous, dull to lustrous above, drying dark reddish brown to gray-green. **Flower buds** pyriform, 6–15 mm long; peduncles 0.2–5 cm long, 1–2 mm thick; bracteoles linear to narrowly elliptic, 2–8 mm long, pubescent to tomentose without, glabrous to tomentose within; calyx connate as a tube for 1–4 mm, tearing between the lobes or irregularly at anthesis, the lobes before anthesis deltoid, much wider than long, or about as wide as long (sometimes scarcely perceptible along the rim of the closed calyx), densely covered with hairs within and without; petals elliptic to obovate, 9–10 mm long, glabrous within, pubescent without; hypanthium obconic to subhemispheric, (2–)3–7 mm long, densely tomentose; disk 5–9 mm across, subglabrous to pubescent; stamens (80–)260–560, 4–11 mm long; anthers oblong, 0.8–1 mm long, with 1–3 glands in the connective; style 5–10 mm long; ovary 2–5-locular; ovules 25–80 per locule, ca. 6-seriate, the placenta not peltate, hidden by an obconic mass of ovules. **Fruit** subglobose, 1–2.5 cm in diameter; seeds (2–)3–4(–6) mm long, smooth, rounded, 19–85 per fruit.

ARGENTINA. Corrientes: Depto. Ituzaingo, 7 km S of Río Aguapey on Ruta 39 (ca. 27°35'S, 56°15'W), ca. 120 m, 9 Dec 1987 (fl), *Landrum 5704* (ASU, CTES). **Misiones:** San Ignacio, new road to Loreto, ca. 1 km from Ruta 12, 11 Dec 1987 (fl), *Landrum 5731* (ASU, CTES); Eldorado, 180 m, 12 Jan 1955 (fr), *Montes 14743* (CAS, NY); Cainguás, Monte Carlo, 205 m, 12 Apr 1955 (ofl), *Montes 14794* (CAS, NY).

BOLIVIA. Chiquitos: 3–5 km al NE de Santiago de Chiquitos (18°20'S, 59°35'W), 500–700 m, 22 Oct 1994 (fl), *Vargas 3496* (ASU).

BRAZIL. Bahia: Mun. Caetité, 6 km S de Caetité camino a Brejinho das Ametistas (ca. 14°2'S, 42°32'W), ca. 1090 m, 20 Nov 1992 (fl), *Arbo et al. 5627* (ASU, CTES, SPF); Mun. Ibiquara, 25 km ao N de Barra da Estiva na estrada nova para Mucuge (13°25'S, 41°18'W), 1100–1200 m, 20 Nov 1988 (fl), *Harley et al. 26964* (ASU, CEPEC); Piatã, proximo a serra do Gentio (Gerais, entre Piatã e Serra da Tromba), 21 Dec 1984 (fl), *Stannard et al. 7418* (ASU). **Distrito Federal:** Brasilia, Zoobotânico, 10 Oct 1961 (fr), *Heringer 8912* (NY). Goiás: Minacu, a 8.9 km do norte do canteiro de obras (13°29'S, 48°24'W), 950 m, 11 Mar 1992 (fr), *Cavalcanti et al. 1155* (ASU); Niquelandia, ca. de 6 km da Vila Macedo em direccão a mina de níquel (14°21'27"S, 48°24'20"W), 30 May 1996 (fl), *Fonseca et al. 976* (ASU); Rod. GO-118, 2–5 km O de Alto Paraíso, 15 Oct 1990 (fl), *Hatschbach 54567* (MBM); Mun. de Luziania, 5 Jul 1979 (fr), *Heringer 17352* (NY); Serra do Caiapó, ca. 37 km S of Caiaponia on rd. to Jatai, 800–1000 m, 22 Oct 1964 (fl), *Irwin & Soderstom 7173* (MICH, MO, NY); Chapada dos Veadeiros, 19 km N of Alto do Paraíso, ca. 1250 m, 20 Mar 1971 (fr), *Irwin et al. 32824* (NY). **Mato Grosso do Sul:** Amambai, 10 Dec 1982 (fl), *Hatschbach 45864* (MBM); Rod. MT-624, 5 km W de Tacuru, 16 Dec 1983 (fl, yfr), *Hatschbach 47309* (ASU, MBM); Rio Brilhante, Rod. BR-167, 14 Aug 1970 (fl), *Hatschbach 24632* (MBM); Bandeirante, Rod. Br 163, 11 Nov 1973 (fl), *Hatschbach 33044* (MBM). **Minas Gerais:** Joaquim Felicio, Serra do Cabral, Bocaina, 23 Nov 1984 (fl), *Giulietti et al. CFCR 6399* (ASU); Melo, 3 km N of Herto, Paraopeba, 30 Nov 1965 (fl), *Goodland 265* (NY); Mun. Indianopólis, Fazenda Bela Tanda (19°3'S, 47°57'W), 850 m, 27 Sep 1990 (fl), *Gottsberger 11- 27990* (ASU); Serra do Espinhaço, ca. 7 km NE of Diamantina, road to Mendanha, 1300 m, 29 Jan 1969 (fr), *Irwin et al. 22839* (MO, NY); BR-365, Corrego Fundo, 25 km E de Ituiutaba, 4 Jan 1989 (fr), *Krapovickas & Cristóbal 42785* (ASU); Serra do Cipó, between Veu da Noiva and Alto do Palacio (ca. 19°15'S, 43°40'W), 1000–1400 m, 31 Jan 1984 (yfr), *Landrum 4245* (NY); Diamantina, Area de Proteção Ambiental Pau de Fruta (18°15'29"S, 43°38'54"W), 14 Feb 2001 (fl), *Lombardi 4259* (ASU); Datas, Morro do Coco, estrada para Diamantina, 18°26'S, 1300 m, 21 Mar 1989 (fr), *Mello-Silva & Pirani CFCR 12206* (SPF). **Paraná:** Jaguariaiva, Lageado 5 Reis, 860 m, 3 Dec 1964 (fl), *Hatschbach 11939* (HB, MBM); Ponta Grossa, Parque V. Velha, 25 Feb 1967 (fr), *Hatschbach 16076* (MBM); Bocaiuva do Sul, arredores, 5 Dec 1978 (fl), *Hatschbach 41927* (CTES, MBM); Alm. Tamandaré, Rod. dos Mineros, rio Barigui, 9 Feb 1982 (fl), *Hatschbach 44566* (MBM); Campo Mourão, 8 Dec 1965 (buds), *Hatschbach et al. 13293* (MBM); Rio Branco do Sul, Serra do Caeté, 5 Dec 1995 (fl), *Kawasaki et al. 929* (ASU, MBM, SP). **São Paulo:** Mun. Mogi-Guaçu, 3.7 km NNW of Padua Sales (22°11-18'S, 47°7-10'W), 575–650 m, 13 Dec 1962 (fr), *Eiten & Eiten 5069* (MO, SP); Capão Bonito, rodovia para Itararé, Sep 1967 (fl), *Handro 1197* (SPF); Mun. Mogi-Guaçu, Martinho Prado, Reserva

Biológica da Fazenda Campininha, 17 Oct 1980 (fl), *Mantovani 1234* (SP); Rancharia, Rod. Raposo Tavares, km 515,5 (22°24'52.9"S, 51°2"35.2"W), 430 m, 14 Feb 1996 (fr), *Souza & Souza 10896* (ASU).

PARAGUAY. Amambay: camino a Colonia Estrella, 1 km W del Hito (55°45'W, 22°22'S), 500 m, 10 Dec 1997 (fr), *Schinini & Dematteis 33633* (ASU); Estancia San Victor, Potrero Toro, 25 Oct 1991 (fl), *Soria 4929* (CTES). **Caaguazu:** Arroyo Yuquyry-Arroyo Taruma, 4 km N of Arroyo Yuquyry (25°13'S, 55°55'W), 12 Jan 1991 (fr), *Zardini & Velazquez 25882* (ASU). **Caazapa:** Tavai, destacamento militar (26°10'S, 55°20'W), 30 Oct 1988 (fl), *Basualdo 1732* (ASU, FCQ). **Canindeyu:** Ygatimí, Res. Natural del Bosque Mbaracayú, Nandurocai (ca. 24°10'S, 55°40'W), 19 Nov 1995 (fl), *Landrum 8855* (ASU, FCQ). **Itapúa:** Capitán Miranda, 4.2 km N of entrance to Hotel Tirol beside CONAVI project (ca.27°12'S, 55°45'W), ca. 210 m, 13 Aug 1995 (fr), *Landrum 8661* (ASU, FCQ); road to Jesús, 0.6 km from main highway (ca. 27°12'S, 55°45'W), ca. 185 m, 9 Nov 1995 (fl), *Landrum 8810* (ASU, FQ); San Juan Bautista, 8.5 km along road to Pilar, ca. 170 m, 8 Nov 1995 (st), *Landrum 8792* (ASU, FCQ); route 1 ca. 4 km E of road to Ayolas at km A262 (ca. 27°5'S, 56°40'W), ca. 240 m, 8 Nov 1995 (fl), *Landrum 8794* (ASU, FCQ); Ea. La Soledad, 3 km S de Santiago (56°46'W, 27°10'S), 3–4 Feb 1988 (fr), *Schinini & Vanni 26053* (ASU). **Paraguari:** Salto de Pirareta, 14 Nov 1978 (fr), *Arbo et al. 1754* (NY); route 1 near km 246, ca. 0.5 N or road to Lago Ypoa (26°S, 57°15'W), ca. 250 m, 7 Nov 1995 (fl), *Landrum 8766* (ASU, FCQ); National Park Ybycuí, Arroyo Corrientes (26°00'S, 56°46'W), 10 Feb 1993 (fr), *Zardini & Guerrero 34974* (ASU). **San Pedro:** 36 km N de Tacuara, Ea. La Manina (24°22'S, 56°24'W), 21 Oct 1994 (fl), *Krapovickas et al. 45798* (ASU, CTES); 70 km N de Tacuara (24°1'S, 56°5'W), 15 Dec 1986 (fr), *Perez et al. 1465* (ASU).

De Candolle (1828) simultaneously described three species of *Psidium* in his Prodromous based on Martius collections and using names applied by Martius in his herbarium: *P. grandifolium*, *P. cinereum*, and *P. incanescens*. De Candolle expressed doubt that *P. incanescens* and *P. cinereum* were distinct. In fact all three type specimens are similar and I think it is best to consider them a single species. Legrand (Legrand & Klein 1977) united *P. cinereum* with *P. incanescens* [i.e., *Psidium cinereum* var. *incanescens* (O. Berg) D. Legrand], but no one has united *P. grandifolium* with either of the others. As I discussed before there are a continuum of forms of *Psidium* in this complex and I choose the name *P. grandifolium* because the type is most clearly distinct from its relatives *P. australe*, *P. missionum* and intermediates. The name *P. cinereum*, the other alternative, has been applied to a wide variety of forms, some of which I now include in *P. australe*.

Psidium grandifolium is a variable species. In the southern part of its range (Argentina and southern Paraguay) there are individuals with clearly deltoid triangular calyx-lobes 2–5 mm long that are longer than wide and longer than the calyx-tube (Fig. 5C). These often have narrowly elliptic leaves that are subcoriaceous. Mixed with these are others with broader subcoriaceous leaves and shorter, broader calyx-lobes. Towards the north of Paraguay and into Brazil the leaves become more coriaceous and the calyx-lobes less prominent, in some cases being scarcely perceptible along the rim of the calyx-tube, and the calyx-tube becomes longer (Fig. 5B). These forms may warrant recognition at a subspecific level.

The name *Psidium cuneatum* Cambess. has been applied to this species in Argentina by Rotman (1976) who was apparently following the opinions of Legrand and Kausel (both cited in Rotman). I have been able to carefully study the type of *P. cuneatum* and believe that it is a synonym of *P. australe* var. *argenteum*.

From a broad area of Brazil (Bahia to Paraná), there exist collections of plants intermediate between *P. australe* and *P. grandifolium*. In other areas these species remain quite distinct and do not intermix. After several years of consideration of this situation I believe that it is best to simply accept some specimens as belonging to the complex but as intermediates. The alternative would be to unite the whole group in to one extremely variable species with subspecific groups that act as separate species over much of their distribution. Intermediates include types of the following taxa:

Psidium microcarpum Cambess., in A. St.-Hil., Fl. Bras. Merid. 2:284. 1833. TYPE: BRAZIL: "Prope urbem S. João del Rey in provincia Minas Geraes," *Saint-Hilaire s.n.* (HOLOTYPE: P!, =F-36416!, =ASU photo!).

Psidium sericeum O. Berg, in Mart., Fl. Bras. 14(1):389. 1857. TYPE: BRAZIL: "in campis ad Carambey in prov. S. Pauli," *Sellow s.n.* (HOLOTYPE: B, lost; ISOTYPES: LE, =ASU photo!, P! [LECTOTYPE, here designated], =F-36421!, =ASU photo!).

Psidium grandifolium var. *parvifolium* O. Berg, in Mart., Fl. Bras. 14(1):407. 1857. TYPE: BRAZIL: "prov. Minarum," *Regnell I-129* (HOLOTYPE: MEL; ISOTYPE: P!, = ASU photo!).

Psidium cinereum var. *grandifolium* O. Berg, in Mart., Fl. Bras. 14(1):404. 1857. TYPE: BRAZIL: "in prov. S. Pauli," *Sellow s. n.* (HOLOTYPE: B, lost; ISOTYPE: P! [LECTOTYPE, here designated], = ASU photo!, W!,= ASU photo!).

Specimens that I consider intermediate between *Psidium grandifolium* and *P. australe* include the following.

BRAZIL. Bahia: Serra da Agua de Rega, 23 km N of Seabra, road to Agua de Rega, ca. 1000 m, 24 Feb 1971 (fr), *Irwin et al. 30894* (HB, MBM, MO, NY). **Distrito Federal:** Horto do Guará, Brasilia, 15 Dec 1961 (fl), *Heringer 8773* (ASU, HB); na Rod. da RECOR no trecho entre a RECOR e DNER, 20 Nov 1978 (fl), *Heringer et al 17180* (ASU, HB); Brasilia, Bacia do São Bartolomeu, alto do Ribeirao Papuda, 18 Feb 1981 (fr), *Heringer et al. 6221* (MO, NY); near Sobradihno, 1100 m, 27 Sep 1965 (fl), *Irwin et al. 8717* (CAS, MICH, MO, NY); ca. 12 km W of Taguatinga on road to Brasilandia, 1250 m, 26 Nov 1965 (fl), *Irwin et al. 10692* (NY); Chapada da Contagem, ca. 15 km E of Brasilia, 1050 m, 30 Jan 1966 (fr), *Irwin et al. 12154* (MICH, MO, NY). **Goiás:** São Gabriel, arredores, 7 Nov 1991 (fl), *Hatschbach 55874* (ASU, MBM); Luziânia, 11 Feb 1982 (fl), *Heringer 18279* (MO, NY); Serra dos Cristais, 5 km W of Cristalina (17°S, 48°W), 1175 m, 2 Nov 1965 (fl), *Irwin et al. 9766* (MICH, NY); Serra do Rio Preto, ca. 10 km E of Cabeceiras (16°S, 47°W), 1000 m, 17 Nov 1965 (fl), *Irwin et al. 10377* (HB, MICH, MO, NY, SP); Serra do Pirineus, ca 12 km S of Corumbá de Goiás (16°S, 49°W), 1000 m, 1 Dec 1965 (fl), *Irwin et al. 10855* (MICH, MO, NY); Mun. de Alexania, 5–7 km from BR060 on road to Rio Corumbá, ca. 12 km W of Alexania, 1000 m, 21 Jul 1984 (fl), *Mori et al. 16920* (NY); Morrinhos, fazenda proxima da cidade (17°49'22"S, 49°3'39"W), 6 Sep 1998 (fr), *Proença 1987* (ASU). **Mato Grosso do Sul:** Rod. BR-267, 20 km W de Maracajú, 25 Oct 1988 (fl), *Hatschbach 52614* (ASU). **Minas Gerais:** 6 km NE of Indianopólis (19°13'0"S, 47°57'0"W, 850 m, 2 Nov 1985 (fl), *Gottsberger 16-21185 16* (ASU); Morro das Pedras, ca. 40 km NE of Patrocinio, 1000 m, 29 Jan 1970 (fr), *Irwin et al. 25696* (NY); Serra da Anta, ca. 5 km NW of Paracatú, 800 m, 4 Feb 1970 (fr), *Irwin et al. 25998* (MO, NY); Rio Bicudo, ca. 20 km W of Corinto, ca. 525 m, 3 Mar 1970 (fr), *Irwin et al. 26826* (CAS, NY); Ituiutaba, 24 Oct 1956 (fl), *Macedo 4853* (US); Diamantina, proximo a Guinda, 9 Jan 1988 (fl), *Mello-Silva et al. 11758* (ASU). **Paraná:** Parque Iguaçú, Mun. Curitiba, 14 Jan 1986 (fr), *Cordeiro & Silva 217* (ASU, HRB, MBM); Mun. Colombo, Capivari, 4 Nov 1971 (fl), *Hatschbach 27710* (ASU, MBM); Mun. Jaguariaiva, Rio das Mortes, 25 Nov 1980 (fl), *Hatschbach 43870* (ASU, MBM); Mun. Palmeira, Rod. BR-277, descida rio Capivara, 8 Mar 1984 (fl), *Hatschbach 47837* (ASU, MBM); Mun. Mandirituba, Cachoeira and surroundings to Rio Barigui (ca. 25°45'S, 49°15'W), 30 Nov 1981 (fl), *Landrum 3887* (MICH, NY); Curitiba, Parque Iguaçú (ca. 25°30'S, 49°15'W), ca. 900 m. 2 Jan 1982 (fl, yfr), *Landrum 4044* (MBM, NY); Rio Branco do Sul, along rd. to Cerro Azul (ca. 25°S, 49° 20'W), 900 m, 5 Jan 1982 (fr), *Landrum 4053* (MBM); Br. 476, 5 km O de Lapa, 30 Nov 1989 (fl), *Ribas 199* (ASU, MBM). **São Paulo:** Mococa, 7 Nov 1994 (fl), *Kinoshita & Galvao 94-144 144* (ASU); Cassia dos Coqueiros, 9 Nov 1994 (fl), *Kinoshita & Galvao 94-217 217* (ASU); Botucatu, 22 Nov 1968 (fl), *Sendulsky 867* (ASU, NY, SP).

Psidium missionum D. Legrand, Darwiniana 9:284. 1950. (**Fig. 7**). TYPE: ARGENTINA. "Misiones, Depto. Candelaria, Santa Ana," *Rodriguez 16* (HOLOTYPE: MVM; ISOTYPES: F!, = ASU photo!, LIL!, SI).

Shrub or subshrub to ca. 1 m high, with a persistent underground stem from which shorter lived above ground shoots arise, resprouting after being burnt or cut to the ground, glabrous to moderately pubescent on young growth; hairs when present whitish, up to ca. 1 mm long but usually shorter; young twigs reddish brown, glabrous to pubescent, less often pubescent, reddish-brown, smooth, the older twigs at first scaly, later smooth, gray. **Leaves** oblanceolate, obovate, or elliptic, 2.5–8.8 cm long, 1.1–4 cm wide, 1.8–3.5 times as long as wide; apex abruptly acuminate to acute; base cuneate to acute; petiole 1–2 mm long, 1–1.5 mm thick, flat or channeled above; midvein flat to slightly impressed above, prominent below; lateral veins usually 4–6 pairs ascending and arching upwards, connecting to form a weaker marginal vein in the upper half, the smaller tertiary veins between the laterals forming a reticulate pattern; blades lustrous or not above, drying olive green, gray-green, to blackish brown, nearly concolorous, coriaceous. **Flower buds** pyriform, 7–12 mm long; peduncles 1(–3)-flowered, 1–2.3 cm long, ca. 1 mm wide, flattened, pubescent to glabrous; bracteoles linear to narrowly lanceolate, 3–8 mm long, ca. 1 mm wide, glabrous to pubescent, deciduous at about anthesis; calyx open in the bud, tearing up to ca. 1 mm between the lobes after anthesis, the lobes triangular, 2–4 mm long, 3–4 mm wide, subglabrous to pubescent, the apex acute to acuminate; petals obovate to oblanceolate, ca. 9 mm long, glabrous to subglabrous; hypanthium obconic, 3–5 mm long, glabrous to pubescent; disk 4–6 mm across, the staminal ring pubescent; stamens 130–235, 9–11 mm long; anthers subglobose to oblong, ca. 0.5–1 mm long; style 7–9 mm long, usually with a few scattered hairs, the stigma only slightly wider than style; ovary 3–4-locular; ovules 43–70 per locule, about 8-seriate, the placenta not peltate, hidden by ovules. **Fruit** globose, ca. 1–1.5 cm long; seeds 14–20 in fruits seen, ca. 5 mm long, the seed coat several cells thick.

ARGENTINA. Misiones: San Ignacio, ca. 3 km along road to Peña Victoria, Teyu Cuaré (ca. 27°15'S, 55°35'W), 10 Dec 1987 (fr), *Landrum 5718* (ASU, CTES), Candelaria, 4 km S of Santa Ana on ruta 12 (27°25'S, 55°40'W), 11 Dec 1987 (fl), *Landrum 5735* (ASU); San Ignacio, new road to Loreto, ca. 1 km from ruta 12, 11 Dec 1987 (fr), *Landrum 5738* (ASU); Candelaria, 3 km S of Arroyo Yabebiry, 4 km S of San Ignacio on ruta 12 (27°15'S, 55°35'W), 11 Dec 1987 (st), *Landrum 5740* (ASU, CTES); Cainguás, Monte Carlo, 205 m, 2 Feb 1955 (fr), *Montes 14806* (CAS, NY).

PARAGUAY. Caazapá: Tavai, destacamento militar (26°10'S, 55°20'W), 1988 (fl), *Basualdo 2076* (FCQ). **Guairá:** Del Guaira Iturbe, 0.50–0.80 m, 3 Oct 1952 (fl), *Montes 1260* (CTES). **Itapua:** Capitán Miranda, 4.2 km N of entrance to Hotel Tirol, behind CONAVI project (27°12'S, 55°45'W), 9 Nov 1995

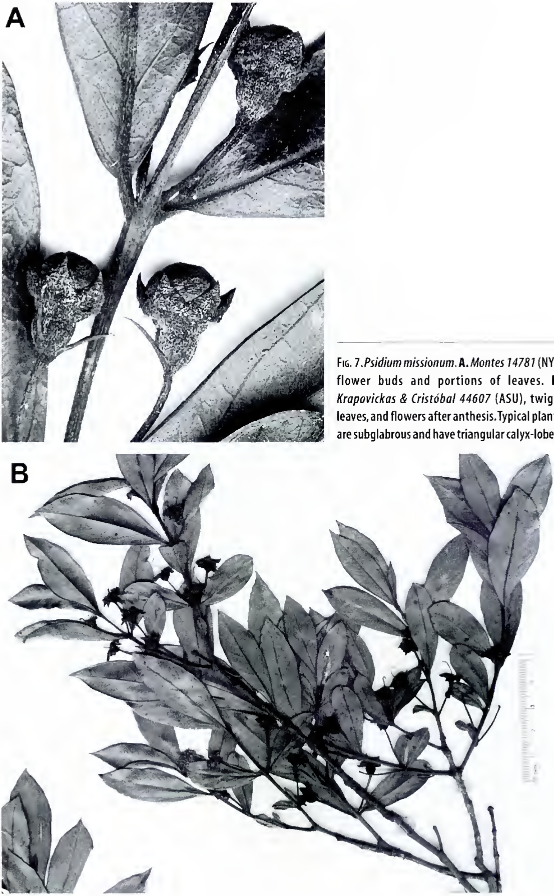


Fig. 7. *Psidium missionum*. **A.** *Montes 14781* (NY), flower buds and portions of leaves. **B.** *Krapovickas & Cristóbal 44607* (ASU), twigs, leaves, and flowers after anthesis. Typical plants are subglabrous and have triangular calyx-lobes.

(fl), *Landrum 8808* (ASU, FCQ); Capitán Miranda, road to Jesús ca. 0.6 km from main highway (ca. 27°12'S, 55°45'W), 9 Nov 1995 (fl), *Landrum 8812* (ASU, FCQ); **Paraguari:** road to Lago Ypoa, ca. 23 km N of Caapucú, 3.5 km W of main Asunción-Encarnación highway, ca. 250 m, 10 Nov 1995(fl), *Landrum 8838* (ASU, FCQ).

Psidium missionum frequently grows with *Psidium salutare* var. *mucronatum* (Cambess.) Landrum [=*Psidium luridum* (Spreng.) Burret] and can be confused with that entity. The two are contrasted in the key below.

1. Leaves 2–4.5 cm long, 0.7–2.3 cm wide, 1.5–5 times as long as wide; marginal vein distinct, closely following the margin; placenta protruding, peltate; style 5–6 mm long, glabrous __________ **P. salutare** var. **mucronatum**
1. Leaves 2.5–8.8 cm long, 1.1–4 cm wide, 1.8–3.5 times as long as wide; marginal vein evident only in distal portion of leaf, arching broadly between laterals; placenta protruding only slightly, not peltate; style 7–9 mm long, usually with a few scattered hairs __________ **P. missionum**

ACKNOWLEGMENTS

I am grateful to the curators of the following herbaria who kindly allowed me to study their specimens on loan, as images, or as a visitor (ALCB, BR, CAS, CEPEC, CTES, F, FCQ, G, GH, HB, K, LE, LIL, MBM, MEL, MICH, MO, NY, OXF, P, R, RB, SP, UB, UC, US, USP, VEN, WIS). Alexander N. Sennikov has been especially helpful in providing images of types at LE. My Latin American colleagues I. Basualdo, E. Zardini, C. Proença, M. L. Kawasaki, A. Krapovickas, G. Hatschbach, and M. Sobral have helped in many ways. A Fulbright American Republics grant supported herbarium visits and fieldwork. Many thanks to my wife Sonia S. Landrum for her help in the field and at home. B. Holst and J. Salazar reviewed this paper and offered many helpful suggestions.

REFERENCES

Candolle, A.P. de 1828. Myrtaceae. In: Prodr. Syst. Nat. reg. Veg. 3:207–296.

Chodat, R. and E. Hassler. 1907. Plantae Hasslerianae: Myrtaceae. Bull. Herb. Boissier ser. 2, 7:795–796.

Greuter, W., J. McNeill, F.R. Barrie, H.-M. Burdet, V. Demoulin, T.S. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth. 2000. International code of botanical nomenclature (Saint Louis code). Regnum Vegetabile 138. Koeltz Scientific Books, Königstein.

Landrum, L.R. 2003. A revision of the *Psidium salutare* complex (Myrtaceae). Sida 20: 1449–1469.

Legrand, C.D. and R.M. Klein. 1977. *Psidium*. Flora Ilustrada Catarinense, Mirtáceas: 684–724.

Perret, P. 1999. Validez de los nombres publicados por J. Barbosa Rodrigues a partir de las colecciones de la familia Myrtaceae efectuadas en Paraguay por E. Hassler. Candollea 54:442–447.

Rotman, A. 1976. Revisión del género *Psidium* en la Argentina. Darwiniana 20:418–444.

PTILAGROSTIS LUQUENSIS (POACEAE: POOIDEAE: STIPEAE: STIPINAE), A NEW SPECIES FROM CHINA

Paul M. Peterson
and Robert J. Soreng

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.
peterson@si.edu; sorengr@si.edu

Zhen-Lan Wu

Northwest Plateau Institute of Biology
Chinese Academy of Sciences
59 Xiguan Street
Xining 810001, Qinghai
PEOPLE'S REPUBLIC OF CHINA

ABSTRACT

Ptilagrostis luquensis P.M. Peterson, Soreng & Z.L. Wu from the People's Republic of China is described and illustrated. The new species was found in dense thatch, mollisol soils on nearly level grassy plains surrounded by low hills in Gansu Province. *Ptilagrostis luquensis* is morphologically similar to *P. dichotoma* but differs by having glabrous anthers (1–1.4 mm long), shorter spikelets (2.6–3.5 mm long), shorter glumes (2.6–3.5 mm long), shorter lemmas (2.2–2.7 mm long), shorter and narrower panicles (2–5.2 x 1–3 cm), and lower nodes with 1 or 2 sheathing lanceolate hyaline bracts (1–5 mm long) on the culm inserted immediately below the lowest branches. A key to the species of *Ptilagrostis* in China is provided.

摘 要 (CHINESE ABSTRACT)

本文描述了采自中国的一新种短花细柄茅*Ptilagrostis luquensis* P.M. Peterson, Soreng & Z.L. Wu。该新种采自甘肃省碌曲县，生长在山间草地的密集草丛中。短花细柄茅*Ptilagrostis luquensis*与双叉细柄茅*P. dichotoma*在形態上相似，但区别在于光滑的花藥，长1–1.4毫米，短的小穗，长2.6–3.5毫米，短的颖，长2.6–3.5毫米，短的外稃，长2.2–2.7毫米，短而狭窄的圆锥花序，长2–5.2厘米，宽1–3厘米，在杆上紧接最下部分枝处具1或2枚鞘状的、披针形、透明的苞片，长1–5毫米。本文同时作出细柄茅属的分种检索表。

Ptilagrostis Griseb. is characterized as having chartaceous lemmas with awns that are geniculate and plumose throughout their length, lemma apices with two lobes or teeth, non-overlapping lemma margins, an obtuse callus (≤6 mm long), caryopses with non-glossy surfaces, and shoots arising intravaginally (Barkworth 1983; Freitag 1985; Lomonosova 2001; Tzvelev 1983, 2001). There has been much controversy over the interpretation of the taxonomic status and generic limits among species of *Achnatherum* P. Beauv. (syn. *Lasiagrostis* Link), *Ptilagrostis*, and *Stipa* L. *Achnatherum* can be separated from *Ptilagrostis* by having lemmas with awns that are scabrous at least in the terminal portion. *Stipa* generally has florets with a sharp-pointed cylindrical callus (≥0.7 mm long) and lemmas that have completely overlapping margins (Tzvelev 1983, 2001). There are approximately 11 species of *Ptilagrostis* currently recognized worldwide and the following six species are treated in the Chinese Floras: *P. concinna* (Hook. f.) Roshev., *P. dichotoma* Keng ex Tzvelev, *P. junatovii*, Grubov,

SIDA 21(3): 1355–1362. 2005

mongholica (Turcz. ex Trin.) Griseb., *P. pelliotii* (Danguy) Grubov, and *P. yadongensis* Keng f. & J.S. Tang (Cui 1996; Keng 1965; Lu 1987; Lu & Kuo 1987; Qian 2002; Wu & Phillips, In prep.). In addition to these six species the following three species, described from outside China, have been reported in China and adjacent regions: *Ptilagrostis alpina* (F. Schmidt) Sipliv. from northeastern China (Liaoning), Japan, and Russia (Eastern Siberia and Far East); *P. malyschevii* Tzvelev from Xinjiang (Tien Shan), Kazakhstan, Kyrgystan, Tajikistan (Tien Shan and central Pamirs); and *P. schischkinii* (Tzvelev) Czer. (= *P. concinna* subsp. *schischkinii* Tsvelev) from Xinjiang (Tien Shan and Pamirs), Kazakhstan, Kyrgystan (Tien Shan) [Lomonosova 2001; Probatova 2003; Tzvelev 1983].

While collecting grasses on an extended trip to China in 1997 RJS and PMP found this small *Ptilagrostis* and were unsuccessful finding other specimens with similar morphological features while reviewing specimens at KUN and PE. Recently, RJS sent *Soreng, Peterson & Sun 5383* to Sylvia Phillips at Kew who was preparing (with Wu Zhen-Lan) the treatment of *Ptilagrostis* for the Flora of China. We conclude this specimen represents an undescribed species. The new species is clearly a member of the subtribe Stipinae, tribe Stipeae, and subfamily Pooideae (Soreng et al. 2003, 2004).

Ptilagrostis luquensis P.M. Peterson, Soreng & Z.L. Wu, sp. nov. (**Fig. 1**). TYPE: CHINA. GANSU PROVINCE. Luqu Co. Ca. 30–40 km N of Gansu/Sichuan border on road from Chengdu to Lanzhou, ca. 20 km S of Waxu and 10 Km E of Gahai, ca. 230 km SSW of Lanzhou at kilometer post 394 [34°24'N-102°17'E (corrected from original estimate)], 3440 m, 18 Sep 1997, *R.J. Soreng, P.M. Peterson & H. Sun 5383* (HOLOTYPE: US!, ISOTYPES: HNWP!, K!, KUN!, MO!, PE!).

A *Ptilagrostis dichotoma* Keng ex Tzvelev antheris apice glabris 1–1.4 mm longis, spiculis 2.6–3.5 mm longis, glumis 2.6–3.5 mm longis, lemmatibus 2.2–2.7 mm longis, paniculis 2–5.2 cm longis 1–3 cm latis apertis, nodis inferioribus (1)2 lanceolatis hyalinis bracteis 1–5 mm longis differt.

Caespitose perennial with intravaginal shoot initiation; roots 0.2–0.3 mm diameter. Culms 5–23 cm tall, 0.5–0.8 mm diameter near base, erect, smooth, glabrous, 1-noded, nodes basal, not visible. Sheaths (0.5–)2–8 cm long, shorter than the internodes, glabrous, smooth, the old sheaths forming tight clusters at base; margins hyaline near summit, often excurrent. Blades 2–6 cm long, 0.2–0.5 mm wide, involute, filiform, glabrous, abaxially smooth or scaberulous along keel; margins scabrous; flag blades 1–2 cm long. Ligules 0.4–1.2 mm long, hyaline, purplish to brownish below; apex truncate, obtuse or retuse, usually ciliate, the cilia ca. 0.1 mm long; flag ligules 0.7–1.2 mm long. Panicles 2–5.2 cm long, 1–3 cm wide, open, exerted with 10–15 spikelets; lowest internodes 0.9–1.7 mm long; branches 0.7–2.8 cm long, capillary, loosely ascending to sinuous, spreading 10–50° from the culm axis, smooth, glabrous, purplish; lower nodes usually with 1 or 2 sheathing linear-lanceolate hyaline bracts 1–5 mm long on the culm inserted immediately below the lowest branches, the lowest node with (1)2 branches, each branch often twined or immediately re-branched at the base on the lower nodes; pulvini inflated, smooth, glabrous, present at all branching

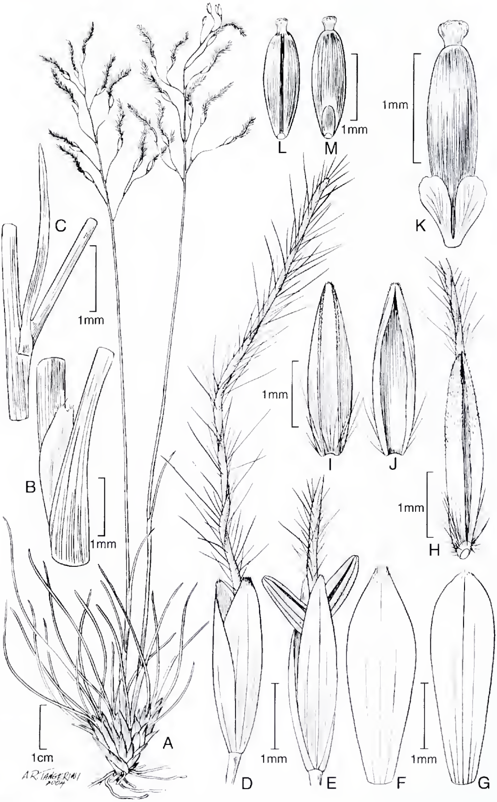


Fig. 1. *Ptilagrostis luquensis* (*Soreng, Peterson & Sun 5383*). **A.** Habit. **B.** Blade, ligule, and sheath. **C.** Lowest panicle node with hyaline bract. **D.** Spikelet. **E.** Spikelet with anthers. **F.** Lower glume, dorsal view. **G.** Upper glume, dorsal view. **H.** Lemma, ventral view. **I.** Palea, dorsal view. **J.** Palea, ventral view. **K.** Lodicules and caryopsis. **L.** Caryopsis, ventral view. **M.** Caryopsis, dorsal view.

points. Spikelets 2.6–3.5 mm long, 1-flowered; pedicels 3–12 mm long, mostly longer than the spikelets, smooth, glabrous or with a few scattered hairs. Glumes 2.6–3.5 mm long, oblanceolate to elliptic-oblong, subequal, longer than the floret, glabrous and smooth below, whitish with the base purplish; apex obtuse, usually erose and ciliate; lower glume faintly1–3-veined, slightly broader than the upper; upper glume faintly 3–5-veined. Floret callus short, obtuse, shortly bearded, the white hairs 0.5–1 mm long. Lemmas 2.2–2.7 mm long, lanceolate, chartaceous, terete, 5-veined, awned, scattered pilose on lower 1/4–1/3, the hairs 0.2–0.6 mm long, smooth in the middle, densely scaberulous above; apex acute with lateral triangular lobes ca. 0.6 mm long; awn 6–10 mm long, 1-geniculate, column twisted, sometimes sinuous above, plumose with hairs 1.2–2 mm long throughout, the hairs slightly shorter near apex. Paleas 2.2–2.7 mm long, slightly shorter or equal to the lemma, not overlapped by the lemma margins, distinctly 2-veined, with a few hairs below, scaberulous along the nerves above; apex acute. Stamens 3, anthers 1–1.4 mm long, yellowish; apex glabrous. Lodicules 3, obovate, unequal; abaxial lodicules ca. 0.7 mm long; adaxial lodicule ca. 1 mm long. Ovary 0.5–1 mm long, glabrous; styles 2, separate; stigmas 2 feathery. Caryopses 1.6–1.9 mm long, fusiform, terete, minutely-beaked, grayish, translucent; hilum linear nearly as long as the grain; embryo ca. 1/4 as long as the grain.

Phenology.—Flowering in August through September.

Distribution.—*Ptilagrostis luquensis* is known from Gansu, Qinghai, Xizang, and Sichuan Provinces between 3350–4800 m. At the type locality the new species was found in dense thatch, mollisol soils on nearly level grassy plains surrounded by low hills, associated with *Poa*, *Calamagrostis*, and *Koeleria*.

Etymology.—The specific epithet 'luquensis' is given to this species since the type was found growing in this county.

Additional specimens examined (PARATYPES): **CHINA. Qinghai:** Maduo, 4600m, 7 Jul 1980, *Y.H. Wu 1108* (HNWP), Qumalai, 4400m, 8 Aug 1966, *S.W. Liu 00765* (HNWP); Zhiduo, 4700m, 15 Aug 1966, *L.H. Zhou 322* (HNWP). **Xizang:** Zhongba, 4800m, 14 Aug 1975, *Qinghai-Xizang Exped. 6758* (HNWP). **Sichuan:** Ruoergai, 3350 m, Jul 1975, *Sichuan Exped. 10225* (HNWP).

DISCUSSION

Species delimitation within *Ptilagrostis* is problematical and authors have had difficulty differentiating *P. mongholica*, *P. dichotoma*, and *P. concinna*. Noltie (2000) and Cope (1982) may have misapplied *P. mongholica* (treated as *Stipa mongholica* Turcz. ex Trin.) for *P. dichotoma*. Their descriptions include small-flowered (lemmas 3.7–5.5 mm long) and short-awned (12–30 mm long) with short hairs (0.75–2 mm long) forms. Wu & Phillips (In prep.) placed *P. tibetica* (Mez) Tzvelev, a form with lemmas hairy throughout, as a synonym of *P. mongholica*. Noltie (2000) also reduced *P. concinna* (*Stipa concinna* Hook.f.) to a synonym of *P. mongholica*.

Ptilagrostis schischkinii is morphologically similar with *P. luquensis* since it is a diminutive plant with glabrous anthers. However, from Roshevitz (1963) description, the spikelets are 5–7 mm long (verses 2.6–3.5 mm) and the lemmas are 3–5 mm long (verses 2.2–2.7 mm). *Ptilagrostis concinna* sensu stricto, is more southern in its distribution (type from Sikkim Himalaya) and differs from *P. luquensis* by having longer glumes (4–6.3 mm), longer lemmas (3.5–5 mm), and longer anthers (1.5–2.2 mm) with a tuft of hairs at the apex. *Ptilagrostis mongholica* subsp. *minutiflora* (V.S. Titov ex Roshev.) Tzvelev [= *P. minutiflora* (V.S. Titov ex Roshv.) Czer.] is another small form from Central Siberia that has small spikelets 4.5–5 mm long and lemmas 3.3–4 mm long with awns 15–20 mm long (versus 6–10 mm in *P. luquensis*) [Tzvelev 1983].

Ptilagrostis alpina is another species with small spikelets (3.6–4.5 mm long) and short culms (15–35 cm tall). However, it differs from *P. luquensis* by having scabrous panicle branches, hairy anthers, and longer lemma awns [15–20 (–30) mm long].

Much confusion has also surrounded the use of *Ptilagrostis dichotoma* var. *roshevitsiana* Tzvelev since this too has small spikelets 3.2–4 mm long. However, Tzvelev (2001) indicates that the panicles have dense, short hairs (spinules) on the branches (glabrous in *P. luquensis*), the anthers are hairy, and the plants are large. It is possible that *P. alpina* and *P. dichotoma* var. *roshevitisiana* represent the same entity since both have small spikelets, scabrous panicles, and hairy anthers. The illustration in Lu and Kuo (1987) of *P. dichotoma* var. *roshevitsiana* shows the anthers as having tufts of hairs at the apex. A specimen at Kew (Y.L. *Keng & Keng f. 5468* from Qinghai Province, Hüang-yuan Hsien, Harakutur) is problematical since it has glabrous anthers and smooth panicle branches but otherwise seems to match the description of *P. dichotoma* var. *roshevitsiana*. Since this specimen does not have short hairs (spinules) on the panicle branches and does not have inflated pulvini, i.e., it has contracted panicles, we think it falls within the range of variation of *P. schischkinii* (with glabrous anthers). If the *Keng and Keng f. 5468* specimen is included within the range of variation of *P. schischkinii* then one must allow for smaller spikeleted forms ranging from (3.8–)4–7 mm long.

Two herbarium specimens from Qinghai: *P.C. Kuo 12317* (HNWP) and *P.C. Kuo et al. 331* (HNWP) are problematical since they both have hairy anthers but otherwise seem to exhibit the morphology of *P. luquensis*. It is possible that only a few genes control the expression of this trait and that these specimens represent different populations of *P. luquensis*. At this time we do not have enough information to make this distinction and prefer to recognize the new species as only having anthers that are glabrous at the apex.

The North American disjunctions, *Ptilagrostis kingii* (Bol.) Barkworth from the Californian Sierra Nevada and *P. porteri* (Rydb.) W.A. Weber [syn. *P. mongholica* subsp. *porteri* (Rydb.) Barkworth] from the central Rocky Mountains in Colorado are the only other two species in this genus. *Ptilagrostis porteri* has open, smooth-branched panicles, larger spikelets (4.5–6 mm long), and glabrous anthers, whereas *P. kingii* has contracted, scabrous-branched panicles, smaller spikelets (3.2–4.5 mm long), hairy anthers, and lemmas that are hairy throughout with short-pubescent awns (Barkworth 1983).

A key for separating the new species from all other reported species of *Ptilagrostis* in China follows:

KEY TO THE SPECIES OF *PTILAGROSTIS* IN CHINA

1. Lemmas 2.2–2.7 mm long; glumes 2.6–3.5 mm long; anthers 1–1.4 mm long, glabrous at the apex ____ **Ptilagrostis luquensis**
1. Lemmas 3.0–8 mm long, glumes 4–12.5 mm long, anthers 1.3–4 mm long, glabrous or hairy at the apex.
    2. Ligules truncate, ca. 1 mm long, ciliate; leaf blades fairly stiff; glumes lanceolate, sharply acuminate; gravelly and rocky places on desert plains ____ **Ptilagrostis pelliotii**
    2. Ligules oblong or lanceolate, rounded, 0.5–6 mm long, glabrous rarely ciliate; leaf blades softer; glumes elliptic or oblong lanceolate, obtuse to acute; alpine meadows and high hilly steppe.
        3. Panicles contracted, 0.7–2 cm wide; branches 0.3–2.8 cm long, suberect or narrowly ascending.
            4. Spikelets 8–12 mm long; glumes unequal ____ **Ptilagrostis yadongensis**
            4. Spikelets (3.8–)4–7 mm long; glumes subequal.
                5. Anthers glabrous or with a solitary hair at the apex; lemma awns 6–10 mm long ____ **Ptilagrostis schischkinii**
                5. Anthers with a tuft of hairs at the apex; lemma awns 1–2 mm long.
                    6. Panicles with sheathing membranous bracts at base of lowest branches; spikelets purple; lemmas 3.5–5 mm long; awns 1–1.5 cm long ____ **Ptilagrostis concinna**
                    6. Panicles without membranous bracts at base of lowest branches; spikelets brownish mauve; lemmas 4.5–6 mm long; awns 1.5–2 cm long ____ **Ptilagrostis junatovii**
        3. Panicles open, 3–5 cm wide; branches up to 6 cm long, spreading.
            7. Anthers 1.8–4 mm long, glabrous at the apex ____ **Ptilagrostis mongholica**
            7. Anthers 1–2 mm long, with a tuft of hairs at the apex.
                8. Lemma awns 23–42 mm long; ligules 2.5–6 mm long ____ **Ptilagrostis malyschevii**
                8. Lemma awns 1–20(–30) mm long (if over 20 mm long then branches scabrous); ligules 1–3 mm long.
                    9. Panicle branches scabrous; 7–13 spikelets per panicle; plants 15–35 cm tall ____ **Ptilagrostis alpina**
                    9. Panicle branches smooth; 15–25 spikelets per panicle; plants 15–50 cm tall ____ **Ptilagrostis dichotoma**

ACKNOWLEDGMENTS

We wish to thank curators at the following herbaria for their help: HNWP, K, KUN, PE; and the Smithsonian Institutions, National Museum of Natural History, Biodiversity and Inventory Program for supporting the fieldwork. Appreciation is extended to Alice R. Tangerini for providing the illustration; Alain Touwaide for correcting the Latin diagnosis; Sylvia M. Phillips for providing us with an annotated copy of her unpublished Flora of China account and key; and SMP and William A. Weber for reviewing the manuscript.

REFERENCES

Barkworth, M.E. 1983. *Ptilagrostis* in North America and its relationship to other Stipeae (Gramineae). Syst. Bot. 8:395–419.

Cope, T.A. 1982. No. 143 Poaceae. In: E. Nasir and S.I. Ali, eds. Flora of Pakistan. Herbarium Royal Botanic Gardens, Kew. Pp. 1–678.

Cui, D.F. 1996. 47. *Ptilagrostis* Griseb., In: Cui, N.R., ed. Flora Xinjiangensis, Tomus 6 Angiospermae Monocotyledoneae. Xinjiang Science & Technology & Hygiene Publishing House, Ürümqi. Pp. 318–321.

Freitag, H. 1985. The genus *Stipa* (Gramineae) in southwest and south Asia. Notes Roy. Bot. Gard. Edinburgh 43:355-489.

Keng, Y.L. 1965. Flora illustrata plantarum primarum Sinicarum: Gramineae. K'o hsüeh ch'u pan shê, Beijing.

Lomonosova, M.N. 2001. 57. *Ptilagrostis* Griseb. In: L.I. Malyschev and G.A. Peschkova, eds. Flora of Siberia, Volume 2, Poaceae (Gramineae). Science Publishers, Inc., Enfield, Hew Hampshire. Pp. 226–227.

Lu, S.L. 1987. 72. *Ptilagrostis* GrisebIn: C.Y. Wu, ed. Flora Xizangica, Vol. 5. Science Press, Beijing., Pp. 263–268.

Lu, S.L. and P.C. Kuo. 1987. 9. *Ptilagrostis* Griseb. In: P.C. Kuo, ed. Flora Reipublicae Popularis Sinicae, Tomus 9 Angiospermae Monocotyledoneae, Gramineae (3) Pooideae. Science Press, Beijing. Pp. 310–316.

Noltie, H.J. 2000. Flora of Bhutan, including a record of plants from Sikkim and Darjeeling, Volume 3, Part 2, The Grasses of Bhutan. The Charlesworth Group, Huddersfield, UK. 456–883 Pp.

Probatova, N.S. 2003. Genus 63. *Ptilagrostis* Griseb. In: N.N. Tzvelev, ed. Vascular plants of the Russian Far East, Volume I, Lycopodiophyta, Juncaceae, Poaceae (Gramineae). Science Publishers, Inc., Enfield, New Hampshire. Pp. 435–436.

Qian, J. 2002. 5. *Ptilagrostis* Griseb. In: Editorial committee of Flora Yunnanica, eds. Flora Yunnanica Tomas 9 (Spermatophyta). Science Press, Beijing. Pp. 245–247.

Roshevits, R.Y. 1963. Order 4. Glumiflorae, Family XXIV. Gramineae Juss. In: R.Y. Roshevits and B.K. Shishkin, eds. Flora of the U.S.S.R. (Flora SSSR), Vol. II. Israel Program for Scientific Translations, Jerusalem. Pp. 1–622.

Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone. 2003. Catalogue of New World grasses (Poaceae): IV: subfamily Pooideae. Contr. U.S. Natl. Herb. 48:1–730.

Soreng, R.J., G. Davidse, P. M. Peterson, F. O. Zuloaga, E. J. Judziewicz, T. S. Filgueiras, and O. Morrone. 2004. Catalogue of New World grasses (Poaceae). mobot.mobot.orgW3T/Search/nwgc.html and classification of New World Grasses. mobot.mobot.org/W3T/Search/nwgclass.html

Tsvelev, N.N. 1983. Grasses of the Soviet Union (Zlaki SSSR), Parts 1 & 2. In: A.A. Fedorov, ed. Akademiya Nauk SSSR, Botanicheskii Institut im. V.L. Komarova. Amerind Publishing Co., New Delhi.

Tsvelev, N.N. 2001. Volume 4, Gramineae (grasses). In: V.I. Grubov, ed. Plants of Central Asia, plant collections from China and Mongolia. Science Publishers, Inc., Enfield, New Hampshire.

Wu, Z.L. and S.M. Phillips. 200?. *Ptilagrostis*. In: Flora of China Editorial Committee, eds. Flora of China: Poaceae, Volume 22. Missouri Botanical Garden Press, St. Louis. In prep., 4 manuscript pp.

ERAGROSTIS (POACEAE: CHLORIDOIDEAE: ERAGROSTIDEAE: ERAGROSTIDINAE) FROM NORTHEASTERN MÉXICO

Paul M. Peterson

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.
peterson@si.edu

Jesus Valdés-Reyna

Departamento de Botánica
Universidad Autonoma Agraria "Antonio Narro"
Buenavista, Saltillo
Coahuila 25315, MÉXICO
jvaldes@uaaan.mx

ABSTRACT

A taxonomic treatment of *Eragrostis* Wolf for northeastern México (Coahuila, Nuevo León, and Tamaulipas), is given. Twenty-six species and four varieties or subspecies of *Eragrostis* are recognized in the study area. Twenty of these species are native to the Flora region and six are introduced and adventive. Keys for determining the species, descriptions, distributions, specimens examined, illustrations, synonymies, and a brief discussion indicating relationships among all native and adventive species of *Eragrostis* in northeastern México are provided.

RESUMEN

Se presenta un estudio taxonómico de *Eragrostis* Wolf para el noreste de México (Coahuila, Nuevo León y Tamaulipas). Un total de veintiséis especies y cuatro variedades o subespecies de *Eragrostis* se reconocen en el área del estudio. Veinte de estas especies son nativas de la flora de la región y seis son introducidas y adventicias. Se incluyen claves para determinar las especies, descripciones, distribuciones, especimenes examinados, ilustraciones, sinonimias, y una discusión breve indicando las relaciones entre todas las especies nativas y adventicias de *Eragrostis* para el noreste de México.

Coahuila, Nuevo León, and Tamaulipas or northeastern México covers an area of 291,955 km^2 or 15 % of the total land of México. This area includes portions of two natural regions known as the Chihuahuan and Tamaulipan Deserts. These regions are considered a center of origin and diversification of arid and semi-arid plant species (Dávila-Aranda et al. 2004; Peterson et al. 2005). As part of the current revision of the grass flora of northeastern México, an examination of the taxonomy and distribution of the species of *Eragrostis* was begun to aid the agriculture and livestock industries. This study treats 26 species and four varieties or subspecies, for a total of 30 taxa.

Eragrostis is a large genus of more than 350 species occurring in tropical, subtropical, and warm temperate regions throughout the World (Clayton & Renvoize 1986; Peterson et al. 1995, 1997, 2001; Watson & Dallwitz 1992). There are 111 species of *Eragrostis* found in North, Central, and South America; 25 native in the United States and Canada; and 36 native in México (Beetle et al. 1991; Espejo-Serna et al. 2000; Peterson et al. 2001, 2003, 2005). The genus is charac-

SIDA 21(3): 1363–1418. 2005

terized by having many-flowered spikelets where the disarticulation of the lemma and palea occurs separately, lemmas that are usually 3-nerved and unawned, longitudinally bowed-out paleas with ciliolate keels, paniculate inflorescences, and leaves with ciliate ligules (Peterson et al. 1997). Most species of *Eragrostis* occupy open habitats with poor soils and many occur in disturbed localities (Clayton & Renvoize 1986; Van den Borre & Watson 1994).

All species of *Eragrostis* that have been examined anatomically exhibit "kranz" or C_4 leaf anatomy [except the C_3, *E. walteri* Pilg from South Africa, see Ellis (1984)] and species have either chloridoid bicellular microhairs (broad, short terminal cell the same thickness as the basal cell) or panicoid bicellular microhairs-like (long, thin-walled terminal cell) [Amarasinghe & Watson 1990]. Apparently three C_4 biochemical types exist in *Eragrostis*: NAD-ME (nicotinamide adenine dinucleotide co-factor malic enzyme), PCK (phosphoenolpyruvate carboxykinase), and intermediates (Prendergast et al. 1986).

The classification of the tribe Eragrostideae has been problematic, primarily because no one has been able to define this group and select diagnostic characters that exclusively delimit this tribe from other tribes in the Chloridoideae (Hilu & Alice 2000; 2001; Van den Borre & Watson 1997; 2000). Historic accounts of the ever changing opinions of systematists on the classification of the Eragrostideae can be found in Peterson et al. (1995) and Van den Borre and Watson (1994). Peterson et al. (1997) recognized 38 Eragrostideae genera occurring in the New World, then later placed many of these same genera in the tribe Cynodonteae without delineating an Eragrostideae. Based on results of a DNA sequence study of the Chloridoideae (Columbus et al. 2005), Peterson et al. (2005) has proposed a completely new classification of the New World Chloridoideae. Here, the Eragrostideae is narrowly interpreted to include only three small subtribes (Cotteneinae, Uniolinae, and the Eragrostidinae) that diverge as a clade at the base of the chloridoids (Peterson et al. 2005). Character trends in the Eragrostideae include spikelets with many florets, lemmas with 3–13-nerves, and many species adapted to xeric habitats.

The subtribe Eragrostidinae as treated here includes three genera: *Cladoraphis cyperoideae* (Thunb.) S.M. Phillips introduced from Africa; *Eragrostis* with 112 species (86 native NW spp.); and *Steirachne* with two species (Peterson 2003; Peterson et al. 2005). The Eragrostidinae is characterized by having hairy or glabrous culm nodes; hairy or glabrous rachillas; entire lemma apices that are awnless, mucronate or short-awned (only in the latter two genera); glabrous or scabrous lemmas that are (1) 3 (5)-nerved lemmas; and short basal microhair cells (15–75 microns) on the abaxial epidermis of the leaf blade.

Recent systematic treatments of *Eragrostis* from Argentina (Nicora 1998), Australia (Lazarides 1997), Brazil (Boechat & Longhi-Wagner 2001), Ecuador (Peterson 2001), Mesoamerica (Davidse 1994), México (Beetle et al. 1991), the United States and Canada (Peterson 2003), and Zambesiaca (Cope 1998) have given us a good understanding of the species limits and their distribution. Based on nuclear and plastid DNA sequences, Ingram and Doyle (2004, 2005) tested the monophyly of *Eragrostis* and found that with inclusion of *Acamptoclados* Nash (*E. sessilispica* Buckley), *Diandrochloa* de Winter, *Neeragrostis* Bush, and *Pogonarthria* Stapf the genus is indeed monophyletic. However, only 37 species of *Eragrostis* were included in their analysis so any subgeneric interpretations were beyond the scope of their work. What is lacking is a definitive treatment of the subgeneric classification of the entire genus. Based on spikelet disarticulation Clayton (1974) and Clayton and Renvoize (1986) have arrived at a "first approximation to natural groups" and have presented a key to sections *Psilantha*, *Eragrostis*, *Lappula*, and *Platystachya*. In most native New World species the lemmas fall acropetally (from the base towards the apex) from the persistent rachilla, and with the paleas persistent on the rachilla. The other major pattern of spikelet disarticulation in *Eragrostis* is when the lemmas fall basipetally (from the apex towards the base). Van den Borre and Watson (1994) investigated 53 species of *Eragrostis* and found that anatomical characters, among others, support the recognition of two distinct groups: subgenus *Eragrostis* and subg. *Caesiae*. The most comprehensive attempt so far is Lazarides (1997) treatment of the Australian *Eragrostis* where he recognized six groups primarily based on spikelet disarticulation. Lazarides (1997) correlates his classification with Van den Borre and Watson (1994) who recognized subgenus *Eragrostis* and subg. *Psilantha*, and with Amarasinghe and Watson (1990) who investigated microhair morphology within the genus. Cope's (1998) subgeneric treatment of *Eragrostis* for the flora of Zambesiaca is also comprehensive since he delineates nine groups based on panicle, lemma, and palea morphology in addition to spikelet disarticulation.

The following taxonomic treatment contains a key for determining the species, descriptions, distribution, specimens examined, illustrations, synonymies, and a brief discussion indicating hypothesized relationships among all native and adventive species of *Eragrostis* in northeastern México. This study is based on the examination of herbarium specimens from ANSM, COCA, MEXU, MO, TEX, UAT, and US, including the type specimens of most of the species studied.

TAXONOMIC TREATMENT

Eragrostis Wolf, Gen. Pl. 23. 1776. TYPE: *Eragrostis minor* Host (LECTOTYPE: designated by R. Ross, Acta Bot. Neerl. 15:157. 1966).

Plants annual or perennial; usually synoecious, sometimes dioecious; caespitose, stoloniferous, or rhizomatous. Flowering culms (2–)5–170 cm tall, not woody, erect, decumbent, or geniculate, sometimes rooting at the lower nodes, simple or branched; internodes solid or hollow; bud initiation intravaginal, rarely extravaginal. Leaf sheaths open, often with tufts of hairs at the apices, hairs 0.3–8 mm long; ligules usually membranous and ciliolate or ciliate, cilia sometimes longer than the membranous base, occasionally of hairs or membranous and non-ciliate; blades flat, folded, or involute. Inflorescences terminal, sometimes also axillary, simple panicles, open to contracted or spike-like, terminal panicles usually exceeding the upper leaves; pulvini in the axils of the primary branches glabrous or hairy; branches not spike-like, not disarticulating. Spikelets 1–18(–23) mm long, 0.6–9 mm wide, laterally compressed, with 2–45 florets; disarticulation below the fertile florets, sometimes also below the glumes, acropetal with deciduous glumes and lemmas but persistent paleas, or basipetal with the glumes often persistent and the florets usually falling intact; glumes usually shorter than the adjacent lemmas, (1)3(5)-veined, not lobed, apices obtuse to acute, unawned; calluses glabrous or sparsely pubescent; lemmas usually glabrous, obtuse to acute, 3(5)-veined, usually keeled, unawned or mucronate; paleas shorter than the lemmas, longitudinally bowed-out by the caryopses, 2-keeled, keels usually ciliate, intercostal region membranous or hyaline; anthers 2 or 3; ovaries glabrous; styles free to the bases. Cleistogamous spikelets occasionally present, sometimes on the axillary panicles, sometimes on the terminal panicles. Caryopses variously shaped; hilum short; embryo with an epiblast, scutellar tail, and elongated mesocotyl internode (formula P+PF), endosperm hard. Base chromosome number, $x = 10$.

The origin of the name is somewhat obscure. Nathaniel Wolf (1776), who first named *Eragrostis*, made no statement concerning the origin of its name. Clifford (1996) provides three possible derivations: from eros, 'love', and *Agrostis*, the Greek name for an indeterminate herb; from the Greek er, 'early' and *agrostis*, 'wild', referring to the fact that some species of *Eragrostis* are early invaders of arable land; or the Greek eri-, a prefix meaning 'very' or 'much', suggesting that the name means many-flowered *Agrostis*. Watson and Dallwitz (2003) indicate that the derivation of *Eragrostis* is "from the Greek *eros* (love) or *era* (earth) and *agrostis* (a grass), probably alluding to the characteristic, earthy (human) female aroma of the inflorescences of many species."

Comments.—As taxonomists we know little about the true limits or boundaries among species of *Eragrostis* but hope our treatment using gross morphological features will allow determination of most of the 26 species. We also want to familiarize the user with the morphological features that are used to infer relationships among this group of grasses. Therefore, we present a review of the affinities or "hypothesized relationships" of the 26 species of *Eragrostis* from Northeastern México for readers to more thoroughly understand their classification and to point out problem areas that will require further analysis. The following four paragraphs outline our current thoughts on four hypothesized lineages within these 26 species of *Eragrostis*: the Old World group, *Eragrostis intermedia* complex, *E. pectinacea* complex, and *E. spectabilis*-*E. secundiflora* group.

The Old World group consists of *E. barrelieri*, *E. cilianensis*, *E. curvula*, and *E. lehmanniana*. Based on acropetal floret disarticulation, persistent rachillas, deciduous lemmas, persistent paleas, and the presence of laterally compressed spikelets, Lazarides (1997) placed: *E. barrelieri, E. cilianensis, E. curvula*, and *E. mexicana* in his"group 2." In addition to these species, Cope (1998) placed *Eragrostis lehmanniana* in his "group 9" which corresponds to sect. *Eragrostis*. It is also interesting to note that two (*E. curvula* and *E. lehmanniana*) of these five species have dorsally compressed caryopses while the others have laterally compressed caryopses. The only species native to the New World in this assemblage is *E. mexicana*, a weedy taxon naturalized in Australia and South Africa.

Preliminary DNA sequence evidence suggests that *E. mexicana* might be aligned with some members of the subsect. *Hirsutae* (Ingram & Doyle 2004) as proposed by Harvey (1948) and later investigated and expanded by Witherspoon (1975) as the "*Eragrostis intermedia* complex." Based on having wide, open panicles with spreading branches, disarticulating rachillas, and caryopses with surface reticulations, Witherspoon included the following species from the Flora region in the *E. intermedia* complex: *E. erosa, E. intermedia, E. hirsuta, E. hirta, E. lugens*, and *E. palmeri*. We feel the *Eragrostis intermedia* complex is a young assemblage of species that is rapidly evolving since the morphological limits among the species are small.

We feel that *E. mexicana* is perhaps better aligned with *E. pectinacea* and *E. pilosa* in the *E. pectinacea* complex as proposed by Harvey (1948) who emphasized the deeply-grooved ventral surface of the caryopses and the presence of glandular tissue below the nodes in his subsect. *Pectinaceae*. Harvey also included *E. tef* (Zucc.) Trotter, the economically important cereal crop grown primarily in Ethiopia, in the *Pectinaceae* group. Ingram and Doyle (2003) recently investigated the origin and evolution of *E. tef* and presented evidence that supports *E. pilosa* as a close relative and potential progenitor to the tef genome.

Based on the presence of stiffly spreading panicle branches and flattened, coriaceous spikelets that usually appear distant, Harvey (1948) recognized the following four species in subsect. *Spectabiles*: *E. curtipedicellata, E. elliottii, E. silveana*, and *E. spectabilis*. Three of these species (excluding *E. elliottii*) have short, knotty rhizomes. *Eragrostis secundiflora*, also with coriaceous spikelets, was placed by Harvey (1948) in subsect. *Oxylepides* based on densely flowered panicles, conspicuous lateral nerves on the lemma, and spikelets several times wider than thick. We feel these five species in the *E. spectabilis-E. secundiflora* group perhaps represent a lineage within the New World *Eragrostis*.

Other species in the Flora region without immediate sisters include *E. spicata* in sect. *Sporoboloides* with spiciform panicles with short branches, small 2–4-flowered spikelets, and grains falling free like the dropseeds (*Sporobolus*); *E. capillaris* in subsect. *Capillares* with large robust panicles 1/2 or more the length of the culm, capillary branches, and hyaline, few-flowered spikelets; *E. ciliaris* in subsect. *Amabiles* with ciliate (tuberculate) paleas ["group 6" of Lazarrides (1997); "group 3" of Cope (1998)]; *E. sessilspica* in sect. *Acamptocladus* with sessile or nearly so spikelets, stiffly spreading panicle branches, and appressed spikelets; and *E. superba* in sect. *Platystachya* with the entire spikelets that fall with the glumes and florets attached ["group 5" of Lazarides (1997); "group 6" of Cope (1998)] (Harvey 1948). The enigmatic, *Eragrostis obtusiflora* is currently being investigated by Travis Columbus (per. comm.) and Maricela Sanchez, where it appears members of the Monanthochloinae are more closely related than other species of *Eragrostis* (see comments under this species).

KEY TO THE SPECIES OF *ERAGROSTIS* IN NORTHEASTERN MÉXICO

1\. Plants annual, caespitose or mat-forming, without innovations at the basal nodes.

  2\. Palea keels prominently ciliate, the cilia 0.2–0.8 mm long.

    3\. Spikelets 1.8–3.2 mm long, 1–2 mm wide, with 6–11 florets; lemmas 0.8–1.3 mm long without glands on the keels; anthers 2 ____ **1. E. ciliaris**

    3\. Spikelets 6–20 mm long, 2–4 mm wide, with 10–40 florets; lemmas 2–2.8 mm long with 1–3 crateriform glands on the keels; anthers 3 ____ **3. E. cilianensis**

  2\. Palea keels smooth or scabrous, the cilia less than 0.2 mm long.

    4\. Plants mat-forming; panicles 1–3.5 cm long; erect portion of culms (2–)5–20 cm tall, the basal portion prostrate and rooting at the nodes.

      5\. Spikelets bisexual; anthers 2, 0.2–0.3 mm long ____ **11. E. hypnoides**

      5\. Spikelets and plants unisexual; anthers 3, 1.4–2.2 mm long ____ **20. E. reptans**

    4\. Plants usually not forming mats; panicles 3–55 cm long; culms (5–)8–130 cm tall, not prostrate or rooting at the lower nodes.

      6\. Caryopses with a shallow or deep ventral groove, ovoid to rectangular-prismatic, the surface striate.

        7\. Spikelets 4–11 mm long, with 5–11(–15) florets; pedicels 1–6(–7) mm long, somewhat divergent to appressed; panicles less than 1/2 the height of the plant ____ **15. E. mexicana**

        7\. Spikelets (1.4–)2–5 mm long, with 2–5(–7) florets; pedicels (4–)5–25 mm long, divergent; panicles 2/3 or more the height of the plant ____ **2. E. capillaris**

      6\. Caryopses without a ventral groove, usually globose, pyriform, ovoid to prism-shaped, or ellipsoid, the surface smooth to faintly striate.

        8\. Plants without glandular pits or bands.

          9\. Lower glumes 0.5–1.5 mm long, at least 1/2 as long as the lowest lemmas; spikelets 1.2–2.5 mm wide; panicle branches solitary or paired at the lowest 2 nodes; lemmas with moderately conspicuous lateral veins ____ **18. E. pectinacea**

          9\. Lower glumes 0.3–0.6(–0.8) mm long, usually less than 1/2 as long as the lowest lemmas; spikelets 0.6–1.4 mm wide; panicle branches usually whorled at the lowest 2 nodes; lemmas with inconspicuous lateral veins ____ **19. E. pilosa**

        8\. Plants with glandular pits or bands somewhere, the location(s) various, including any or all of the following: below the cauline nodes, on the sheaths, blades, rachises, panicle branches, or pedicels, or on the keels of the lemmas.

          10\. Spikelets 0.6–1.4 mm wide; pedicels 1–10 mm long, lax, appressed or divergent ____ **19. E. pilosa**

          10\. Spikelets 1.1–4 mm wide; pedicels 0.2–4 mm long, stiff, straight, usually divergent.

            11\. Lemmas 2–2.8 mm long, with 1–3 crateriform glands along the keels; spikelets 6–20 mm long, 2–4 mm wide, with 10–40 florets;

disarticulation below the florets, the rachillas persistent; anthers yellow ____________ **3. E. cilianensis**

11. Lemmas 1.4–1.8 mm long, without crateriform glands along the keels; spikelets 4–7(–11) mm long, 1.1–2.2 mm wide, with 7–12(–20) florets; disarticulation below the lemmas, both the paleas and rachillas usually persistent; anthers reddish-brown ____________ **1. E. barrelieri**

1. Plants perennial, sometimes rhizomatous, forming innovations at the basal nodes.

12. Paleas with a broad lower portion forming a wing or tooth on each side, these often projecting beyond the lemmas ____________ **26. E. superba**

12. Paleas without a broad lower portion forming a wing or tooth, the bases never projecting beyond the lemmas.

13. Plants rhizomatous; disarticulation always below the florets, the paleas falling with the lemmas and caryopses.

14. Plants with long, scaly rhizomes, 4–8 mm thick; spikelets 8–14 mm long; lemmas 3.8–4.5 mm long, 3–5-veined, the apices acute to obtuse, usually erose; caryopses 1.6–2 mm long ____________ **16. E. obtusiflora**

14. Plants with short, knotty rhizomes less than 4 mm thick, often stout but never elongated; spikelets 2.5–7.6 mm long; lemmas 1–2.5 mm long, 3-veined, the apices acute, usually entire; caryopses 0.5–0.8 mm long.

15. Sheaths, blades, and culms not viscid or glandular; caryopses strongly flattened, the ventral surface with 2 prominent ridges separated by a groove; anthers 0.3–0.5 mm long; lemmas leathery ____________ **24. E. spectabilis**

15. Sheaths, blades, and/or culms often viscid, sometimes glandular; caryopses terete, the ventral surfaces without 2 ridges separated by a groove; anthers 0.2–0.4 mm long; lemmas membranous.

16. Pedicels 0.2–1.2 mm long, appressed; lemmas 1.5–2.2 mm long; caryopses 0.6–0.8 mm long ____________ **5. E. curtipedicellata**

16. Pedicels (1–)1.5–12 mm long, divergent or appressed; lemmas 1.1–1.4 mm long; caryopses 0.5–0.6 mm long ____________ **23. E. silveana**

13. Plants not rhizomatous; disarticulation often below the lemmas, the paleas persistent, sometimes below the florets and the paleas falling with the lemmas and caryopses.

17. Panicles 0.3–0.6 cm wide, spicate, dense; spikelets with 2 or 3 florets ____________ **25. E. spicata**

17. Panicles 1–45 cm wide, ovate to obovate or elliptic, open to somewhat condensed and glomerate; spikelets with 1–45 florets.

18. Caryopses with shallowly to deeply grooved adaxial surfaces, rectangular-prismatic to ellipsoid, ovoid, or obovoid in overall shape.

19. Caryopses strongly dorsally compressed, translucent, mostly light brown, bases sometimes greenish.

20. Lemmas 1.8–3 mm long; panicles 16–35(–40) cm long, (4–)8–24 cm wide; blades 12–50(–65) cm long; caryopses 1–1.7 mm long; ligules 0.6–1.3 mm long ____________ **6. E. curvula**

20. Lemmas 1.5–1.7 long; panicles 7–18 cm long, 2–8 cm wide; blades 2–12 cm long; caryopses 0.6–0.8 mm long; ligules 0.3–0.5 mm long ____________ **13. E. lehmanniana**

19. Caryopses laterally compressed, terete, or slightly dorsally compressed, usually opaque, usually reddish-brown.

21. Lemmas 1.2–1.6 mm long; culms (20–)30–50(–60) cm tall; sheaths usually glabrous **14. E. lugens**

21. Lemmas 1.6–3 mm long; culms (30–)40–170 cm tall; sheaths usually hairy.

22. Sheaths with papillose-based hairs near the apices and margins.

23. Spikelets with 2–4 florets, 1–1.5 mm wide, lanceolate, greenish with a purplish tinge; bud initiation usually intravaginal **9. E. hirsuta**

23. Spikelets with 4–7 florets, 1.4–2.0 mm wide, ovate to linear-ovate, plumbeous to reddish-purple; bud initiation usually extravaginal **10. E. hirta**

22. Sheaths without papillose-based hairs near the apices and margins.

24. Lemmas 1.6–2.2 mm long; anthers 0.5–0.8 mm long, purplish **12. E. intermedia**

24. Lemmas 2–3 mm long; anthers 0.6–1.7 mm long, purplish to yellowish.

25. Caryopses 0.8–1.6 mm long; lemmas 2.4–3 mm long **8. E. erosa**

25. Caryopses 0.6–0.8 mm long; lemmas 2 2.6mm long **17. E. palmeri**

18. Caryopses not grooved on the adaxial surfaces, ellipsoid, ovoid, obovoid, globose, to pyriform, prism-shaped, and rectangular-prismatic in overall shape.

26. Anthers 2.

27. Panicles 15–45 cm wide, diffuse, broadly ovate to obovate, open, diffuse; primary branches lax; pedicels (4–)10–35 (–50) mm long, the pedicels longer than the spikelets; spikelets 1.4–3 mm wide **7. E. elliottii**

27. Panicles 1–15 cm wide, narrowly oblong to ovate and open; primary branches stiff; pedicels absent or 0–1(–3) mm long, always shorter than the spikelets; spikelets 2.4–5 mm wide **21. E. secundiflora**

26. Anthers 3.

28. Primary panicle branches not rebranched; proximal spikelets on each branch sessile or subsessile, the pedicels shorter than 0.4 mm **22. E. sessilispica**

28. Primary panicle branches with secondary branches; proximal spikelets on each branch pedicellate, the pedicels longer than 0.4 mm.

29. Spikelets 2–5.5 mm long.

30. Lemmas 1.2–1.6 mm long; culms (20–)30–50(–60) cm tall **14. E. lugens**

30. Lemmas 1.6–3 mm long; culms (30–)40–170 cm tall.

31. Spikelets with 2–4 florets, 1–1.5 mm wide, lanceolate, greenish with a purplish tinge; bud initiation usually intravaginal **9. E. hirsuta**

31. Spikelets with 4–7 florets, 1.4–2.0 mm wide, ovate to linear-ovate, plumbeous to reddish-

purple; bud initiation usually extravaginal ______ **10. E. hirta**

29. Spikelets 4–12 (–14) mm long.
    32. Lemmas 1.8–3 mm long; panicles 16–35(–40) cm long, (4–)8–24 cm wide; blades 12–50(–65) cm long; caryopses 1–1.7 mm long; ligules 0.6–1.3 mm long ______ **6. E. curvula**
    32. Lemmas 1.5–1.7 long; panicles 7–18 cm long, 2–8 cm wide; blades 2–12 cm long; caryopses 0.6–0.8 mm long; ligules 0.3–0.5 mm long ______ **13. E. lehmanniana**

1. Eragrostis barrelieri Daveau, J. Bot. (Morot) 8:289. 1894. (**Fig. 1, A & B**). *Eragrostis poaeoides* var. *barrelieri* (Daveau) Fiori, F. Italia 1:82. 1908. *Eragrostis vulgaris* ssp. *barrelieri* (Daveau) R.C.V. Douin, Fl. Ill. France 12:32. 1927–1932. TYPE: Plantae per Galliam, Hispaniam et Italiam observatae (type not indicated in the prologue): EGYPT: *Ascheron s.n.* (SYNTYPE: P; ISOSYNTYPE: K); ALGERIA. *Balansa 734* (SYNTYPE: P; ISOSYNTYPE: K); ITALY. SICILY: *Todaro s.n.* (SYNTYPE: P; ISOSYNTYPE: K); SOUTH EUROPE: *Barrelier s.n.* (SYNTYPE: ?).

Caespitose annuals, without innovations. Culms (5–)10–60 cm tall, erect or sprawiling to decumbent and prostrate, much-branched near the base, somewhat glaucous, with a ring of glandular tissue below the nodes, rings often shiny or yellowish. Leaf sheaths1/2–7/8 the length of the internodes, hairy at the apices, hairs to 4 mm long; ligules 0.2–0.5 mm long, ciliate; blades 1.5–10 cm long, 1–3(–5) mm wide, flat, abaxial surfaces glabrous, adaxial surfaces glabrous, sometimes scabridulous, occasionally with white hairs to 3 mm long, margins without crateriform glands. Panicles 4–20 cm long, 2.2–8(–10) cm wide, ovate, open to contracted, rachises with shiny or yellowish glandular spots or rings below the nodes; primary branches 0.5–6 cm long, diverging 20–100° from the rachises; pulvini glabrous; pedicels 1–4 mm, stout, stiff, divergent, without glandular bands. Spikelets 4–7(–11) mm long, 1.1–2.2 mm wide, narrowly ovate, reddish-purple to greenish, occasionally grayish, with 7–12(–20) florets; disarticulation acropetal, paleas persistent; glumes broadly ovate, membranous, 1-veined; lower glumes 0.9–1.4 mm long; upper glumes 1.2–1.6 mm long; lemmas 1.4–1.8 mm long, broadly ovate, membranous, lateral veins evident, apices acute to obtuse; paleas 1.3–1.7 mm long, hyaline, keels scabrous, scabridities to 0.1 mm long, apices obtuse to acute; stamens 3; anthers 0.1–0.2 mm long, reddish-brown. Caryopses 0.4–0.7 mm long, ellipsoid, not grooved, smooth to faintly striate, light brown. $2n = 40, 60$.

Distribution and habitat.—*Eragrostis barrelieri* is an introduced European species that is now naturalized in the Flora region. It grows on gravelly roadsides, in gardens, and other disturbed, sandy sites, especially near railroad yards, at 10–1800 m.

Comments.—The ring of glandular tissue is most conspicuous below the upper cauline nodes.

Specimens examined **MÉXICO. Coahuila:** Municipio de Acuña, 13.2 km NE of San Miguel on road towards Boquillas, *P.M. Peterson & C.R. Annable 10614* (US); 13 km from Rancho El Jardín and 5 km S of Mina El Popo, E slope of the Sierra del Carmen, *M.C. Johnston et al. 11862* (MEXU); Rancho Las

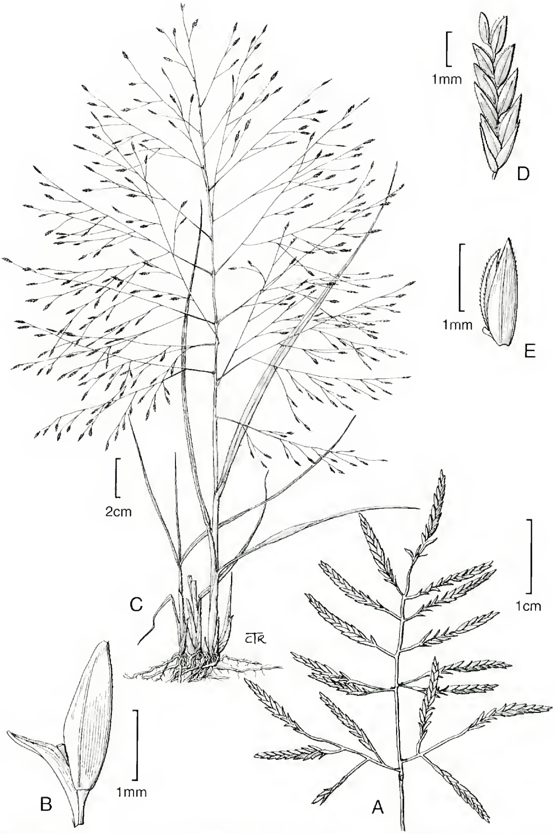


Fig. 1. *Eragrostis barrelieri*. **A.** Inflorescence. **B.** Floret with palea below. *Eragrostis spectabilis*. **C.** Habit. **D.** Spikelet. **E.** Floret.

Norias, *J.A. Villarreal-Quintanilla et al. 6919* (ANSM); Municipio de Castaños, 20.3 km S of Monclova on MEX Hwy 57 towards Saltillo, *P.M. Peterson et al. 10019* (ANSM, US); 32.3 km S of Monclova on MEX Hwy 57 towards Saltillo, *P.M. Peterson et al. 10022* (ANSM, US); La Muralla km 135 carretera Saltillo-Monclova, *H.M. Garza-Cantú s.n.* (MEXU); La Muralla, Sierra de la Gavia, *A. Rodríguez-Gámez et al. 1299* (ANSM); Municipio de Cuatrociénegas, Rancho Cerro de la Madera, *S.D. Koch & M. González L. 8666* (ANSM); Municipio de General Cepeda, Ejido La Rosa, carretera 40 Saltillo-Torreón, @ 20 km NE de General Cepeda, *S. Vásquez-A. & A.García 95* (ANSM); Municipio de Monclova, Orilla de carretera Saltillo-Monclova, @8 km de Castaños, *R. Vásquez-Aldape s.n.* (ANSM); Municipio de Múzquiz, El Sauz, 32 km S de Sabinas, *R. Vásquez-Aldape 211* (ANSM); Sierra La Encantada, cuesta de Malena, @170 km NW of Múzquiz, *M.A. Carranza-Pérez et al. 834* (ANSM, MEXU), 195 km NW of Múzquiz, *R. Vásquez-Aldape 232* (ANSM); 135.4 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson & C.R. Annable 10585* (US); Municipio de Ramos Arizpe, Cañada el Diente, Sierra de la Paila, *J.A. Villarreal-Quintanilla & M. A. Carranza P. 5194* (ANSM); Sierra de la Paila (Lado Norte) Cañada Becerros, *J.A. Villarreal-Quintanilla et al. 5447* (ANSM); Municipio de Saltillo, Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Valdés-Reyna & M.A.Carranza P. 1131* (ANSM, MEXU); Ciudad de Saltillo, colonia los Arcos, *J. Espinosa-Aburto 33* (ANSM); Universidad Autónoma Agraria Antonio Narro, 7 km S of Saltillo, *F. Cárdenas & M. A Bernal s.n* (MEXU); Municipio de San Buenaventura, Sierra La Encantada, Rancho Carrizalejo, *R. Vásquez-Aldape, et al. 244* (ANSM); 12 mi W of San Buenaventura, *J.R. Reeder & C.G. Reeder 3929* (US). **Nuevo León:** Municipio de Bustamante, En el Cañón de Bustamante, *P. Jauregui-Ramírez 61* (COCA); Municipio de Cadereyta Jiménez, Orilla del Río San Juan, *P.A. García-Martínez 1809* (COCA); Municipio de Cienega de Flores, 2 km S of Cienega de Flores, *S.D. Koch & I. Sánchez-Vega 7868* (US); Municipio de Doctor González, 1 km al SE de Doctor González, *N. Bazaldua-Bazaldua 72* (COCA); Municipio de García, Límites de Coahuila-Nuevo León por la carretera a Saltillo, *J.A. Ochoa-Guillemar 1216* (COCA); Municipio de Los Ramones, Los Ramones, *J.A. Villarreal-Quintanilla 7246* (ANSM); Municipio de Marín, Facultad de Agronomía, Universidad Autónoma de Nuevo León, km 17, *M.M. Castillo-Badillo 16* (COCA); Municipio de Mina, 3 km N of Rancho Lechuguillal, *M.C. Johnston et al. 10211* (MEXU, TEX-LL); Municipio de Pesquería, Santa María la Floreña, a 2 km del municipio de Pesquería, *P. Jauregui-Ramírez 59* (COCA); Municipio de Salinas Victoria, km 69 carretera Monterrey-Sabinas Hidalgo, *N. Bazaldua-Bazaldua 51* (COCA); Sierra de Mamulique, M.M. *Castillo-Badillo 33* (COCA); Municipio de Santiago, km 20 Carretera Monterrey-Villa de Santiago, *P. Jauregui-Ramírez 29* (COCA); Sin Municipio, Carretera a Trinidad China, *J.A. Ochoa-Guillemar 1229* (COCA); Carretera Monterrey-Marín entronque con la carretera a Zuazua, *P.A. García-Martínez 1844* (COCA). **Tamaulipas:** Municipio de Casas, Ejido Las Tortugas, *C.R. López-Aguilar 121* (COCA); Mesa La Pitaya, *J.F. Iribe-Duarte 280* (COCA); Municipio de Guerrero, El Puerto, *R.A. Carranco-Rendon 408* (COCA); Municipio de Gustavo Díaz Ordaz, Camino Díaz Ordaz-General Bravo, *J.A. Franco-López 127* (COCA); Municipio de Hidalgo, Ejido Nicolás Bravo, *J. Cantú 42* (COCA); San Francisco, *R. Díaz-Pérez 289* (UAT); Municipio de Llera, Camino al Ejido Lucio Blanco, *J.L. Ramos-Delgado 221* (COCA); Llera-Guayalejo, *J.E. López de la Cruz 130* (COCA); Municipio de Matamoros, Buenavista, *M.H. Cervera-Rosado 43* (COCA); Municipio de Miguel Alemán, Brecha de Pemex, *C.R. López-Aguilar 209* (COCA); Municipio de Nuevo Morelos, Rancho El Tampiquito, *J.A. Barrientos-B. 35* (COCA); Municipio de Reynosa, Ejido Llorona, *M. Herrera s.n.* (UAT); Municipio de San Fernando, 15 km carretera a Carboneros, *R.A. Carranco-Rendon 350* (COCA); Carretera a Carboneros, *R.A. Carranco-Rendon 349* (COCA); Municipio de Soto la Marina, Rancho El Trece, *J.A. Franco-López 86* (COCA); Rancho San Francisco, *P. Moya-Salgado 275* (COCA); Municipio de Tula, Camino al Ejido Tanque Blanco, *J.G. Galván-Infante Guadalupe 184* (COCA); Municipio de Victoria, Avenida 16 en las calles de Coahuila, *M. Yañez-Pacheco 435* (COCA); Cañón del Novillo, *J.A. Mortera s.n.* (UAT); Unidad Dep. Rev. Verde, Ciudad Victoria, *P. Moya-Salgado 66* (COCA); Municipio de Villagrán, La Antena de la Secretaría de Comunicaciones y Transportes, *J.A. Franco-López 96* (COCA), *M.H. Cervera-Rosado 363* (COCA); Municipio de Xicoténcatl, Ejido Pedro José Méndez, *R.A. Carranco-Rendon 359* (COCA).

2. Eragrostis capillaris (L.) Nees, Fl. Bras. Enum. Pl. 2:505. 1829. (**Fig. 2, A–D**). *Poa capillaris* L., Sp. Pl. 68. 1753. *Eragrostis capillaris* (L.) Steud., Syn. Pl. Glumac. 1:273. 1854, *nom. illeg. hom. Eragrostis pilosa* var. *capillaris* (L.) Kuntze, Revis. Gen. Pl. 3:353. 1898. TYPE: NORTH AMERICA: *Kalm s.n.* (LECTOTYPE: LINN-87.27, designated by Hitchcock. Contr. U.S. Natl. Herb 12:121. 1908.).

Aira capillacea Lam., Tabl. Encycl. 1:177. 1791. TYPE: U.S.A. E. Carolina, *D. Fraser s.n.* (HOLOTYPE: P-LAM; ISOTYPE: US-76301 fragm. ex P-LAM!).

Poa tenuis Elliott, Sketch Bot. S. Carolina 1(2):156. 1816, nom. illeg. hom. *Eragrostis tenuis* Steud., Syn. Pl. Glumac. 1:273. 1854, nom. nov. as comb. TYPE: U.S.A. SOUTH CAROLINA. Greenville Co.: Aug, *Moulins s.n.* (HOLOTYPE: CHARL-3985).

Caespitose annuals, without innovations. Culms (15–)20–50(–60) cm tall, erect, glabrous, often shiny below the nodes. Leaf sheaths overlapping, 1–2 1/2 as long as the internodes, pilose along the margins, apices hirsute, hairs to 7 mm long; ligules 0.2–0.5 mm long, ciliate; blades (6–)8–20(–30) cm long, (1–)2–5 mm wide, flat, abaxial surfaces smooth, glabrous, adaxial surfaces scabridulous, with long scattered hairs. Panicles (10–)15–45(–55) cm long, (7–)10–25 cm wide, to 2/3 the height of the plants, elliptic to ovate, open, rachises without glandular pits; primary branches (2–)5–15 cm long, diverging 20–90° from the rachises, capillary, naked basally; pulvini glabrous; pedicels (4–)5–25 mm long, divergent, scabridulous. Spikelets (1.4–)2–5 mm long, 1–1.3(–1.4) mm wide, ovate to lanceolate, plumbeous, occasionally reddish-purple, with 2–5(–7) florets; disarticulation acropetal, paleas persistent; glumes narrowly lanceolate to lanceolate, hyaline; lower glumes 1–1.2 mm long, narrower than the upper glumes; upper glumes 1.2–1.4 mm long; lemmas 1.2–1.7 mm long, broadly ovate, membranous, keels scabridulous, lateral veins inconspicuous, apices acute; paleas 1.2–1.6 mm long, hyaline, keels almost smooth to scabrous, scabridities to 0.1 mm long, apices acute to obtuse; stamens 3; anthers 0.2–0.3 mm long, reddish-brown. Caryopses 0.4–0.7 mm, ovoid to rectangular-prismatic, adaxial surfaces deeply grooved, striate, bases reddish-brown, distal 2/3 opaque. $2n = 50, 100$.

Distribution and habitat.—*Eragrostis capillaris* is native to the eastern portion of the Flora region. It grows in open, dry, sandy riverbanks, floodplains, rocky roadsides, and gravel pits, usually in association with *Pinus*, *Quercus*, *Carrya*, and *Liquidambar styraciflua*. Its range extends into the eastern United States; 300–600 m.

Comments.—Distinguishing features of *E. capillaris* include the panicle which is often 2/3 or more the height of the plant and the pedicels that are widely divergent and longer than the spikelets.

Specimen examined. **MEXICO. Tamaulipas:** Municipio de Casas, El Pirulí, *J.F. Iribe-Duarte 238* (COCA).

3. Eragrostis cilianensis (All.) Vignolo ex Janch., Mitt. Naturwiss. Vereins Univ Wien, n.s., 5:110. 1907. (**Fig. 3, A–C**). *Poa cilianensis* All., Fl. Pedem. 2:246. 1785. *Eragrostis megastachya* var. *cilianensis* (All.) Asch. & Graebn., Syn. Mitteleur. Fl. 2.371. 1900. *Eragrostis cilianensis* (All.) Vignolo, Malpighia 18:386. 1904, nom. inval. *Eragrostis cilianensis* (All.) Link ex Vignolo, Malpighia 18:386. 1904, *nom. inval. Eragrostis cilianensis* (All.) F.T.

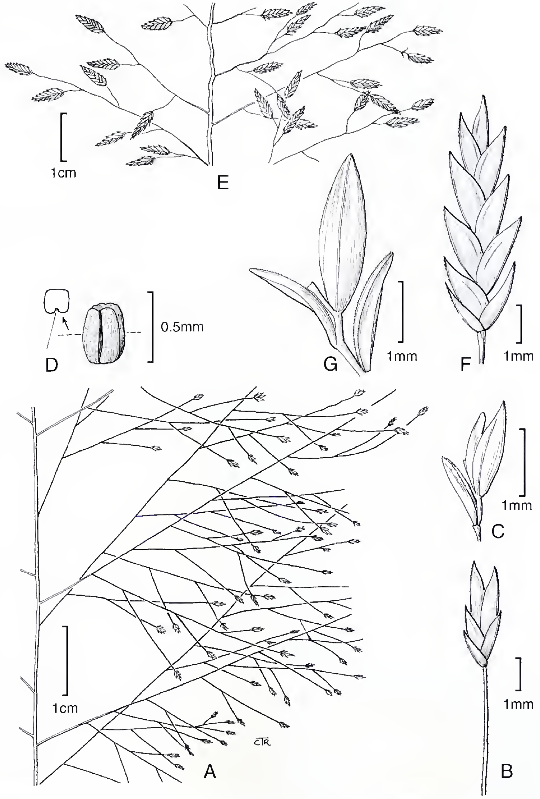


Fig. 2. *Eragrostis capillaris*. **A.** Inflorescence. **B.** Spikelet. **C.** Floret with palea below. **D.** caryopsis. *Eragrostis mexicana* subsp. *mexicana*. **E.** Inflorescence. **F.** Spikelet. **G.** Floret with two paleas below.

Hubb., Philipp. J. Sci. 8:159–161. 1913. *Erosion cilianense* (All.) Lunell, Amer. Midl. Naturalist 4:221. 1937. *Eragrostis multiflora* var. *cilianensis* (All.) Maire, Bull. Soc. Hist. Nat. Afrique N. 30:369. 1939. TYPE: ITALY: Ciliani, *Bellardi s.n.* (SYNTYPE: K-photo!, TO-8242); *Balbi s.n.* (SYNTYPE: TO).

Caespitose annuals, without innovations. Culms 15–45(–65) cm tall, erect or decumbent and prostrate, sometimes with crateriform glands below the nodes. Leaf sheaths overlapping below, 2/3 the length of the internodes above, glabrous, occasionally glandular, apices hairy, hairs to 5 mm long; ligules 0.4–0.8 mm long, ciliate; blades (1–)5–20 cm long, (1–)3–5(–10) mm wide, flat to loosely involute, abaxial surfaces glabrous, sometimes glandular near margins, adaxial surfaces scabridulous, occasionally also hairy. Panicles (3–)5–16(–20) cm long, 2–8.5 cm wide, oblong to ovate, condensed to open; primary branches 0.4–5 cm long, appressed or diverging 20–80° from the rachises; pulvini glabrous or hairy; pedicels 0.2–3 mm long, stout, straight, stiff, usually divergent, occasionally appressed. Spikelets 6–20 mm long, 2–4 mm wide, ovate-lanceolate, plumbeous, greenish, with 10–40 florets; disarticulation below the florets, each floret falling as a unit, rachillas persistent; glumes broadly ovate to lanceolate, membranous, usually glandular; lower glumes 1.2–2 mm long, usually 1-veined; upper glumes 1.2–2.6 mm long, often 3-veined; lemmas 2–2.8 mm long, broadly ovate, membranous, keels with 1–3 crateriform glands, apices obtuse to acute; paleas 1.2–2.1 mm long, hyaline, keels scabrous, sometimes also ciliate, cilia to 0.3 mm long, apices obtuse to acute; stamens 3; anthers 0.2–0.5 mm long, yellow. Caryopses 0.5–0.7 mm long, globose to broadly ellipsoid, smooth to faintly striate, not grooved, reddish-brown or translucent. $2n = 20$.

Distribution and habitat.—*Eragrostis cilianensis* is an introduced European species that now grows in disturbed sites such as pastures and roadsides through most of the North America; 0–2300 m.

Comments.—The nomenclature of *E. cilianensis* has been a bit chaotic, and the conclusions of Simon (1983) have been adopted. The most prominent feature of this species is the presence of 1–3 crateriform glands on the keel of the lemma.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Acuña, 13.2 km NE of San Miguel on road towards Boquillas, *P.M. Peterson & C.R. Annable 10615* (US); Municipio de Cuatrociénegas, Rancho Cerro de la Madera, *S.D. Koch & M. González L. 8659* (ANSM); Municipio de Nadadores, 7.2 mi W of Nadadores on Mex Hwy 30 towards Cuatrocienegas, *P.M. Peterson et al. 10015* (US); Municipio de Nava, @10 km W of Nava, *A. Rodriguez-Gámez et al. s.n.* (ANSM); Municipio de Ocampo, Sierra El Pino, 18.8 km SW of Rancho El Cimarron, *P.M. Peterson & C.R. Annable 10644* (US); Rancho Las Gallinas, @ 43 km de Ocampo rumbo a Sierra Mojada, *M.A. Carranza-Pérez & F.J. Carranza P. 507* (ANSM, TEX); Sierra de la Madera, Rancho Laguna de la Leche, @62 km de Ocampo rumbo a Sierra Mojada, *M.A. Carranza-Pérez & F.J. Carranza P. 613* (ANSM); Sierra de las Cruces, between San Rafael and San Vicente, *I.M. Johnston & C.H. Miller 1038* (US); 4 km W of Santa Elcana, *R.M. Stewart 828* (US); 7 mi S of Jaco, *I.M. Johnston & C.H. Miller 1110* (US); Municipio de Parras, Carretera Saltillo-Torreón, *C. Castillo s.n.* (ANSM); Municipio de Ramos Arizpe, Estación Paredón, *A. Rodriguez-Gámez et al. 904* (ANSM); Municipio de Sabinas, Sabinas, *E.W. Nelson 6823* (US); Municipio de Saltillo, Saltillo, *E. Palmer 389*, *A.S. Hitchcock 5633* (US); Buenavista, 7 km N of Saltillo, *F.W. Gould & D. Watson 10494* (US);

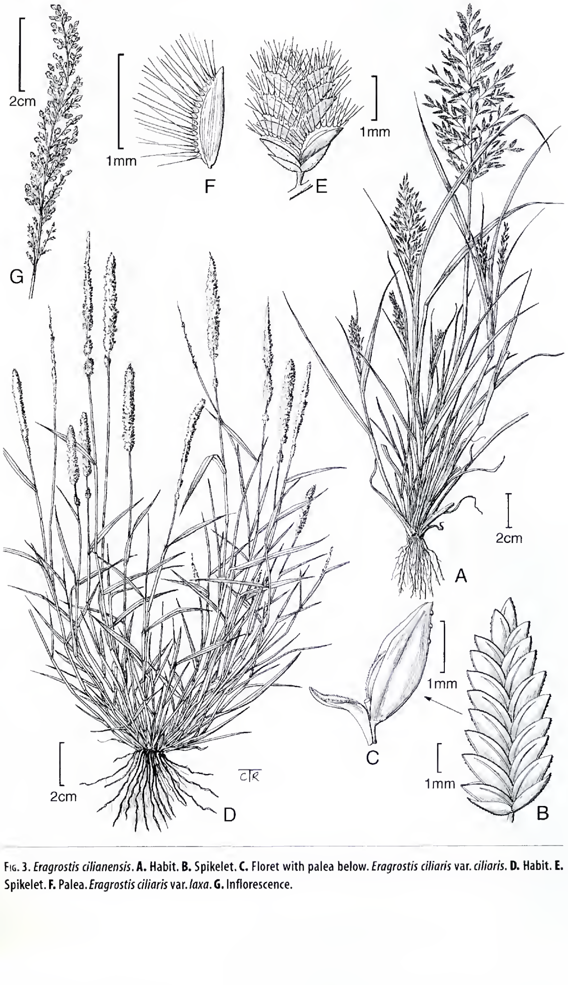


Fig. 3. *Eragrostis cilianensis*. **A.** Habit. **B.** Spikelet. **C.** Floret with palea below. *Eragrostis ciliaris* var. *ciliaris*. **D.** Habit. **E.** Spikelet. **F.** Palea. *Eragrostis ciliaris* var. *laxa*. **G.** Inflorescence.

Municipio de San Buenaventura, Sierra La Encantada, Rancho Carrizalejo, entrada S al rancho Puerto del Aire, *R. Vásquez-Aldape et al. s.n.* (ANSM); Municipio de San Pedro, 10 km NE of Las Margaritas in Valle del Sobaco, *M.C. Johnston et al. 9488* (MEXU); Municipio de Torreón, S of Torreón, canyon between Jimilco and Juan Eugenio, *P.M. Peterson & J. Valdés-Reyna 8468* (US); unknown Municipio, 16 km E of Puerto Caballo towards Tanque Jerico, *M.C. Johnston 8330* (MEXU). **Nuevo León:** Municipio de Allende, Río Ramos, 1 km S de Allende, carretera 85, *J.A. Villarreal-Quintanilla et al. 6794* (ANSM); Municipio de Cadereyta Jiménez, Orilla del Río San Juan a 1 km del poblado San Juan, *P. García-Martínez 1810* (COCA); Municipio de Galeana, 32 km N of San Roberto, 8 km S de San Rafael, *S. L. Hatch et al. 4586* (ANSM); Municipio de Linares, 2 km E del Ejido El Sauz, *J.J. Ortíz-Díaz 7* (ANSM); Municipio de Monterrey, Monterrey at Campo Agricola Experimental, *A. Cuevas 250* (US); Municipio de Salinas Victoria, La Soledad Salinas Victoria, *J.A. Ochoa-Guillemar 1153* (COCA); Municipio de San Nicolás de los Garza, Ciudad Universitaria, *I.A. Jiménez-Valdés s.n.* (ANSM). **Tamaulipas:** Municipio de Jiménez, 10 km from Santander Jiménez on the road to San Fernando, *F. Martínez-Martínez & G. Borja L. 2453* (TEX-LL); Municipio de Gonzalez, Sierra de Tamaulipas between La Chona and Rio Santa Olaya, *F. Martínez-Martínez & G. Borja L. F-2146* (US); Municipio de Llera, La Herradura, *G. Bores-Kulman 3* (COCA); Municipio de San Carlos, Cerro del Diente, *R. Sandoval-Hernández 16* (COCA); Cerro Tres Vetas, *H.H. Bartlett 10363* (US); Cerro Parreña, *H.H. Bartlett 10290* (US); Municipio de San Fernando, 5 km from San Fernando on the Victoria highway, *F. Martínez-Martínez & G. Borja L. 2398* (TEX-LL, US); ; Municipio de Soto la Marina, Rancho Los Tripones, J.A. *Franco-López 36* (COCA); Tramo San José de las Rusias-Ejido 5 de Mayo, *J.A. Franco-López 73* (COCA); Municipio de Tula, Ejido Alfonso Terrones Benitez, *J.G. Galván-Infante 190* (COCA); Municipio de Victoria, Libramiento Portes Gil, *M.H. Cervera-Rosado 313* (COCA); Vicinity of Victoria, *E. Palmer 473* (US); Municipio de Xicoténcatl, Ejido La Esperanza, *J.A. Franco-López F. Martínez-Martínez & G. Borja L. 51* (COCA).

4. Eragrostis ciliaris (L.) R. Br., Narr. Exped. Zaire 478. 1818. *Poa ciliaris* L., Syst. Nat (ed. 10) 875. 1759. *Megastachya ciliaris* (L.) P. Beauv., Ess. Agrostogr. 74, 167, 174. 1812. *Cynodon ciliaris* (L.) Raspail, Ann. Sci. Nat., Bot 5:302 1825 *Eragrostis ciliaris* (L.) Nees, Fl. Bras. Enum. Pl. 2:512-514. 1829. TYPE: JAMAICA: *Browne s.n.* (LECTOTYPE: LINN-87.66, designated by Hitchcock, Contr. U.S. Natl. Herb. 12:121. 1908.).

Caespitose annuals, without innovations. Culms (3–)9–75 cm tall, erect or geniculate in the lower portion, not rooting at the lower nodes, glabrous. Leaf sheaths 1/2–3/4 as long as the internodes, hairy on the margins and at the apices, hairs to 4 mm long; ligules 0.2–0.5 mm long; blades 1.8–12(–15) cm long, 2–5 mm wide, usually flat, occasionally involute, glabrous or ciliate basally. Panicles 1.7–17 cm long, 0.2–5 cm wide, cylindrical, contracted or open, spike-like, branches forming glomerate lobes or sometimes more open, often interrupted in the lower portion; primary branches 0.4–4 cm, appressed or diverging up to 50° from the rachises; pulvini usually glabrous, occasionally sparsely pilose; pedicels 0.1–1 mm long, erect, shorter than the spikelets, glabrous. Spikelets 1.8–3.2 mm long, 1–2 mm wide, elliptical-ovate to ovate-lanceolate, yellowish-brown, sometimes with a purple tinge, with 6–11 florets, densely packed next to one another or widely separated; disarticulation basipetal, glumes persistent; glumes ovate to lanceolate, keels scabridulous, veins commonly green, apices acute; lower glumes 0.7–1.2 mm long; upper glumes 1–1.6 mm long; lemmas 0.8–1.3 mm long, elliptical-ovate to lanceolate, membranous, keels scabridulous, lateral veins evident, apices obtuse to acute; paleas 0.8–1.3 mm long, membranous, keels prominently ciliate, cilia 0.2–0.8 mm long, apices obtuse to acute; anthers 2, 0.1–0.3 mm long, purplish. Caryopses 0.4–0.5 mm long, ovoid, reddish-brown. $2n = 20, 40$.

Distribution and habitat.—*Eragrostis ciliaris* is apparently native to the paleotropics and introduced and naturalized in México and the United States, growing along roadsides, on waste sites, in xerothermic vegetation, and sometimes in saline habitats; 0–1950 m. It may be more widespread than indicated. *Eragrostis ciliaris* var. *ciliaris* is more common than *E. ciliaris* var. *laxa* in the *Flora* region.

KEY TO THE VARIETIES OF *ERAGROSTIS CILIARIS*

1. Panicles 0.2–1.5 cm wide, contracted, the branches mostly appressed to the rachises, congested, forming glomerate lobes; spikelets densely packed _____ **4a. E. ciliaris** var. **ciliaris**
1. Panicles 1.5–5 cm wide, open, the branches spreading 20–50° from the rachises; spikelets widely separated from each other _____ **4b. E. ciliaris** var. **laxa**

4a. Eragrostis ciliaris (L.) R. Br. var. ciliaris (Fig. 3, D–F).

Panicles 0.2–1.5 cm wide, contracted; primary branches mostly appressed to the rachises, forming glomerate lobes. Spikelets densely packed.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, Sierra de Arteaga, 50 km SE de Saltillo, *M.A. Madrigal-A. s.n.* (ANSM). **Tamaulipas:** Municipio de Aldama, between La Concepcion and Aldama, *F. Martínez-Martínez & G. Borja L. F-2176*; Municipio de Bustamante, El Capulín, *C.R. López-Aguilar 197* (COCA); Municipio de Gonzalez, Sierra de Tamaulipas between La Chona and Rio Santa Olaya, *F. Martínez-Martínez & G. Borja L. F-2148* (US); Municipio de Mante, El Mante to Limon, *J.R. Swallen 1614* (US); Municipio de Nuevo Laredo, 20 km W of Ciudad Guerrero, *F. González-Medrano et al. 6320* (MEXU); Municipio de Palmillas, Las Enramadas, *C.R. López-Aguilar 194* (COCA); Municipio de Soto La Marina, Chamal, *J.R. Swallen 1643* (US); Municipio de Tampico, vicinity of Tampico, *E. Palmer 147* (US); Tampico, *A.S. Hitchcock 5791* (US); 8 km E of Tampico, *E. Palmer 591* (US); Municipio de Victoria, Ejido La Libertad, *J.F. Iribe-Duarte 404* (COCA); vicinity of Victoria, *E. Palmer 481* (US).

4b. Eragrostis ciliaris var. laxa Kuntze (Fig. 3, G).

Panicles 1.5–5 cm wide, open; primary branches spreading 20–50° from the rachises. Spikelets widely separated from each other.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de Soto La Marina, San José de las Rusias, *M.H. Cervera-Rosado 85* (COCA); Municipio de Victoria, Ciudad Victoria, *M.H. Cervera-Rosado 287* (COCA).

5. Eragrostis curtipedicellata Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:97. 1862. (Fig. 4, A & B).

Eragrostis brevipedicellata A. Gray, Proc. Acad. Nat. Sci. Philadelphia 14:336. 1862, *nom. inval.* TYPE: U.S.A. NORTHERN TEXAS: *Buckley s.n.* (LECTOTYPE: PH, designated by Hitchcock, Man. Grasses U.S. 849. 1935, but without citing a specific sheet in a specific herbarium).

Eragrostis viscosa Scribn., Bull. Div. Agrostol., U.S.D.A. 11:51, t. 7. 1898, nom. illeg. hom. TYPE: U.S.A. TEXAS: Midland, 2 Aug 1897, *J.G. Smith s.n.* (SYNTYPE: US-1768944!); Laredo, *Mrs. Anna B. Nickels s.n.* (SYNTYPE: US!).

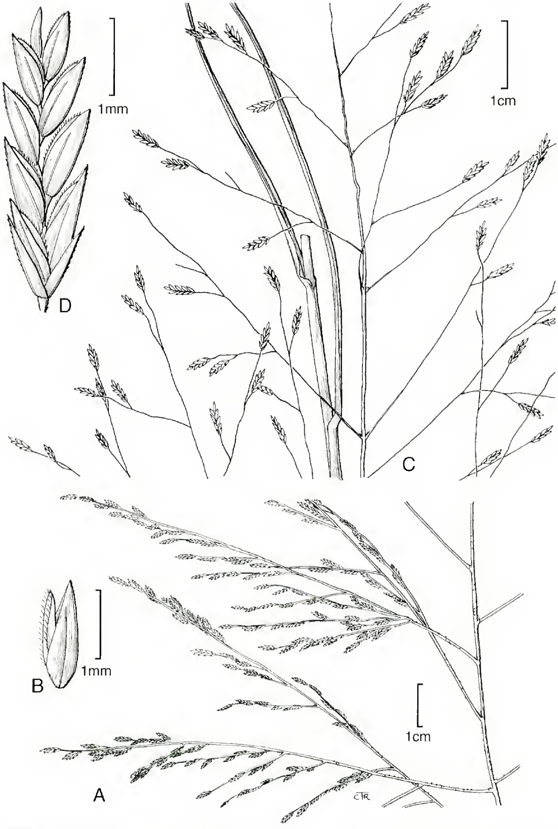


Fig. 4. *Eragrostis curtipedicellata*. **A.** Inflorescence. **B.** Floret. *Eragrostis silveana*. **C.** Inflorescence with portion of culm. **D.** Spikelet.

Caespitose perennials with innovations and short, knotty rhizomes less than 4 mm thick. Culms 20–65 cm tall, erect, viscid or gummy below the nodes, usually with particles of soil adhering to the surface. Leaf sheaths overlapping, 1-1/2 times as long as the internodes, usually viscid, hairy at the apices and on the collars and margins, hairs to 6 mm long; ligules 0.1–0.3 mm long; blades 5-18 cm long, 2–4(–5) mm wide, flat to involute, sometimes viscid, densely hairy behind the ligules, hairs to 8 mm long. Panicles 18–35 cm long, 10–30 cm wide, broadly ovate, open, sometimes partly enclosed by the sheath below; primary branches 3–18 cm long, diverging 10–90° from the rachises, stiff, viscid, naked basally; pulvini hairy, hairs to 6 mm long; pedicels 0.2–1.2 mm long, appressed. Spikelets 3.5–6(–7.6) mm long, 1–1.5 mm wide, linear-lanceolate, stramineous to reddish-purple, with 4–10 florets; disarticulation basipetal, glumes persistent; glumes lanceolate, membranous; lower glumes 0.9–1.8 mm long; upper glumes 1.2–2 mm long, 1–3-veined; lemmas 1.5–2.2 mm long, ovate to lanceolate, membranous, 3-veined, lateral veins evident, apices acute; paleas 1.2–2 mm long, hyaline, not wider than the lemmas, apices obtuse; stamens 3; anthers 0.2–0.4 mm long, purplish. Caryopses 0.6–0.8 mm long, ellipsoid, terete in cross section, neither ridged nor grooved, faintly striate, reddish-brown. $2n = 40$.

Distribution and habitat.—*Eragrostis curtipedicellata* extends from southern Colorado, Kansas, and Missouri, to northeastern Mexico. It is native to the Flora region and grows near fields, along roadsides, and in the margins of woods; 10–1525 m.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Juárez, 2 mi NW of Juárez on road to Sabinas, *L.H. Harvey & J.T. Witherspoon 9190* (US, TEX-LL); Don Martín Dam, *L.H. Harvey 932* (US). **Nuevo León:** Municipio de General Bravo, 23 mi E of General Bravo on the Reynosa highway, *M.C. Johnston 6063* (TEX-LL); Municipio de Lampazos de Naranjo, Rancho Santa Elena, *G. Nava-Villarreal s.n.* (ANSM, MEXU); Municipio de Montemorelos, near Río Ramos, 2 km NW of Montemorelos, *N.J. Weaver 1024* (TEX-LL).

6. Eragrostis curvula (Schrad.) Nees, Fl. Afr. Austral. Ill. 397. 1841. (**Fig. 5, A–C**). TYPE: SOUTH AFRICA. CAPE PROVINCE: Cape of Good Hope, *Hesse s.n.* (HOLOTYPE: LE; ISOTYPE: LE-TRIN-2327.01, lower middle specimen!).

Caespitose perennials forming innovations at the basal nodes. Culms (45–)60–150 cm tall, erect, glabrous or glandular. Leaf sheaths 1/3–2/3 the length of the internodes, with scattered hairs, hairs to 9 mm long; ligules 0.6–1.3 mm long; blades 12–50(–65) cm long, 1–3 mm wide, flat to involute, abaxial surfaces glabrous, sometimes scabridulous, adaxial surfaces with scattered hairs basally, hairs to 7 mm long. Panicles 16–35(–40) cm long, (4–)8–24 cm wide, ovate to oblong, open; primary branches 3–14 cm long, diverging 10–80° from the rachises; pulvini glabrous or not, the hairs up to 3 mm long; pedicels 0.5–5 mm long, appressed, flexible. Spikelets 4–8.2(–10) mm long, 1.2–2 mm wide, linear-lanceolate, plumbeous to yellowish, with 3–10 florets; disarticulation irregular to acropetal, proximal rachilla segments persistent; glumes lanceolate, hyaline;

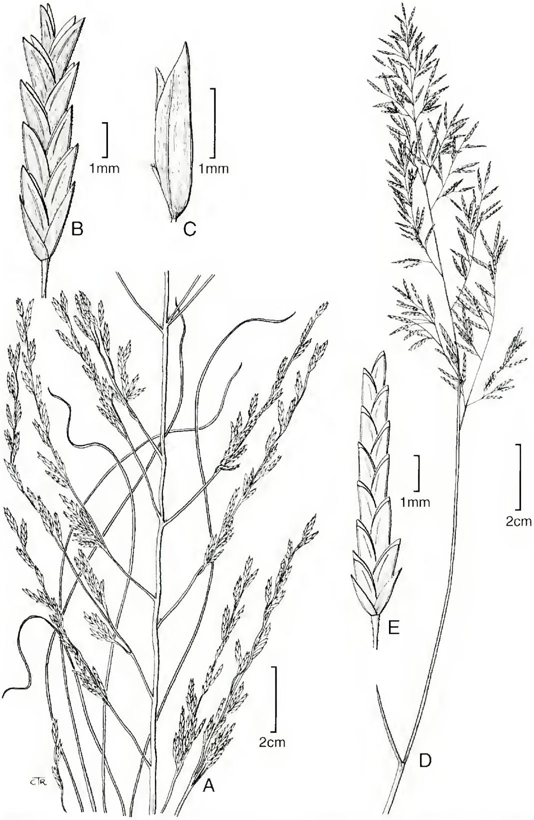


Fig. 5. *Eragrostis curvula*. **A.** Inflorescence with blades. **B.** Spikelet. **C.** Floret. *Eragrostis lehmanniana*. **D.** Inflorescence and culm. **E.** Spikelet.

lower glumes 1.2--2.6 mm long; upper glumes 2–3 mm long; lemmas 1.8–3 mm long, ovate, membranous, lateral veins conspicuous, apices acute; paleas 1.8–3 mm long, hyaline to membranous, apices obtuse; stamens 3; anthers 0.6–1.2 mm long, reddish-brown. Caryopses 1–1.7 mm long, ellipsoid to obovoid, dorsally compressed, adaxial surfaces with a shallow, broad groove or ungrooved, smooth, mostly translucent, light brown, bases often greenish. $2n = 40, 50$.

Distribution and habitat.—*Eragrostis curvula* is native to southern Africa and introduced in the Flora region. It is often used for reclamation because it provides good ground cover but, once introduced, it easily escapes. In the Flora region, it grows on rocky slopes, at the margins of woods, along roadsides, and in waste ground, usually in pine-oak woodlands, and yellow pine and mixed hardwood forests; 10–2000 m.

Comments.—*Eragrostis curvula* is one of two species in the Flora region that has strongly dorsally compressed and translucent caryopses. It can be separated from *E. lehmanniana* (also with dorsally compressed and translucent caryopses) by having longer lemmas (1.8–3 mm verses 1.5–1.7 mm) and taller culms (60–150 cm verses 40–80 cm).

Specimens examined. **MÉXICO. Coahuila:** Municipio de Cuatrociénegas, Rancho La Zacatosa, *M.A. Carranza-Pérez & L. García S. 996* (ANSM); Municipio de Muzquiz, 138 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson & C.R. Annable 10592* (US); Municipio de Saltillo, Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *S.L. Hatch 4549* (ANSM); Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Valdés-Reyna & M. A. Carranza P. 922* (ANSM); **Nuevo León:** Municipio de Juárez, Rancho San Marcos, km 7 camino a San Mateo, carretera Villa de Juárez-Cadereyta, *J. Garza-Covarrubias 32* (COCA). **Tamaulipas:** Municipio de Ciudad Madero, Carretera al recreativo, km 1.5, *M.G. Torres-Guzmán s.n.* (ANSM).

7. Eragrostis elliottii S. Watson, Proc. Amer. Acad. Arts 25:140. 1890. (**Fig. 6, A–C**). *Poa nitida* Elliott, Sketch Bot. S. Carolina 1(2):162. 1816, *nom. illeg. hom. Eragrostis nitida* (Elliott) Chapm., Fl. South. U.S. 564. 1860, nom. illeg. hom. TYPE: U.S.A. SOUTH CAROLINA: Paris Island, *Elliott s.n.* (HOLOTYPE: CHARL; ISOTYPE: LE).

Eragrostis macropoda Pilg., Symb. Antill. 4:106. 1903. TYPE: PUERTO RICO: CATAÑO. Bayamón, 27 Mar 1885, *P.E.E. Sintenis 1233* (HOLOTYPE: B?; ISOTYPES: NY-70977!, US-821975!, US-2941525 fragm!).

Eragrostis acuta Hitchc., Proc. Biol. Soc. Wash. 41:159. 1928. TYPE: U.S.A. FLORIDA: Punta Rassa, Jul-Aug 1900, *A.S. Hitchcock 263* (HOLOTYPE: US-731236!; ISOTYPE: US-1503824!).

Caespitose perennials, with innovations. Culms 25–80 cm tall, erect, glabrous and shiny below the basal nodes. Leaf sheaths overlapping, 1.3–3 times as long as the internodes below, sparsely hairy at the apices, hairs to 6 mm long; ligules 0.2–0.4 mm long; blades 6–30(–52) cm long, 2–4.5 mm wide, flat, abaxial surfaces glabrous, adaxial surfaces scabridulous, sometimes with a few scattered hairs near the base. Panicles (25–)30–60 cm long, 15–45 cm wide, broadly ovate to obovate, open, diffuse; primary branches mostly 5–25(–32) cm long, diverging 20–90° from the rachises, capillary, lax; pulvini sparsely hairy; pedicels (4–)

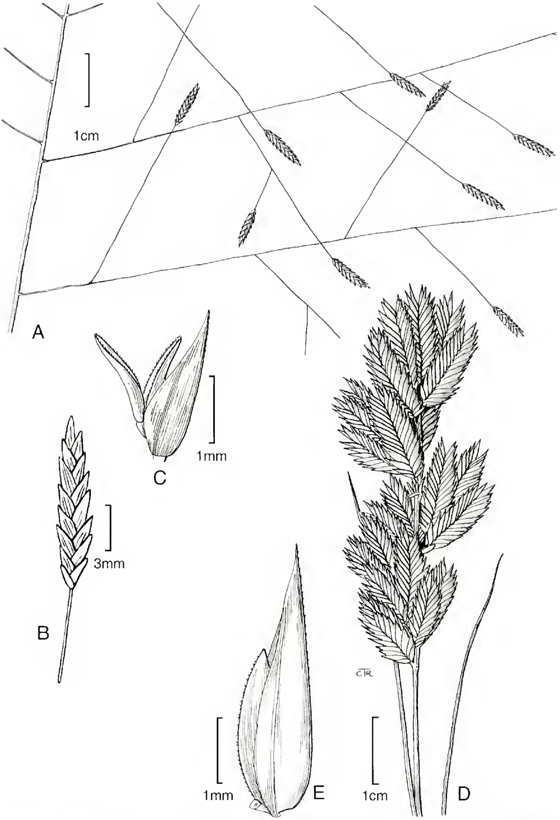


Fig. 6. *Eragrostis elliottii*. **A.** Inflorescence. **B.** Spikelet. **C.** Floret with palea below. *Eragrostis secundiflora* subsp. *oxylepis*. **D.** Inflorescence with blades. **E.** Floret.

10–35(–50) mm long, widely diverging, capillary, all the pedicels on each branch longer than the spikelets. Spikelets 4–18 mm long, 1.4–3 mm wide, linear-lanceolate, grayish-green or stramineous to purplish, with (6–)9–30 florets; disarticulation acropetal, below the lemmas, paleas persistent; glumes narrowly lanceolate, membranous; lower glumes 1.1–3.4 mm long; upper glumes 1.6–3.4 mm long, apices acuminate; lemmas 1.8–4.4 mm long, lanceolate, membranous, lateral veins evident to inconspicuous, sometimes greenish, apices acute to acuminate; paleas 1.1–3.5 mm long, hyaline to membranous, narrower than the lemmas, apices obtuse; stamens 2; anthers 0.3–0.8 mm long, purplish or brownish. Caryopses 0.6–0.8 mm long, ovoid to ellipsoid, finely striate, reddish-brown.

Distribution and habitat.—*Eragrostis elliottii* is native to the Flora region and grows in sandy pinelands and live-oak woodlands on the coastal plain; 0–150 m. Its range extends from the southeastern United States through the West Indies and Gulf coast of Mexico to Central and South America.

Comments.—*Eragrostis elliottii* is characterized by diffuse panicles 15–45 cm wide, lax primary branches, and pedicels longer than the spikelets.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de Tampico, Tampico, *A.S. Hitchcock 5799* (US-911146).

8. Eragrostis erosa Scribn. ex Beal, Grass. N. Amer. 2:483. 1896. (**Fig. 7, A–C**). TYPE: MÉXICO. CHIHUAHUA: Santa Eulalia Mountains, Oct 1885, *C.G. Pringle 415* (HOLOTYPE: MSC; ISOTYPES: MO-3728015!, US-821925!, US-1749578!).

Caespitose perennials with innovations, not glandular. Culms 70–110 cm tall, erect, glabrous below the nodes. Leaf sheaths overlapping, 1/2 to about as long as the internodes below, hairy at the apices and sometimes on the upper margins, hairs to 4 mm long, not papillose-based; ligules 0.2–0.4 mm long; blades (8–)12–30 cm long, 1.5–3.8 mm wide, flat to involute, abaxial surfaces glabrous, adaxial surfaces scabridulous, glabrous or sparsely hairy, hairs to 4 mm long. Panicles 25–45 cm long, (5–)12–30 cm wide, broadly ovate, open; primary branches mostly 4–20 cm long, diverging 20–90° from the rachises, capillary, sinuous; pulvini glabrous or hairy; pedicels 1–18 mm long, appressed or divergent, proximal spikelets on each branch usually with pedicels shorter than 5 mm long. Spikelets 5–9 mm long, 1–3 mm wide, lanceolate, plumbeous, with 5–12 florets; disarticulation acropetal, glumes first, then the lemmas, paleas persistent; glumes lanceolate to ovate, membranous; lower glumes 1.3–2.4 mm long; upper glumes 1.6–2.6 mm long; lemmas 2.4–3 mm long, ovate, mostly membranous, hyaline near the margins and apices, lateral veins inconspicuous, apices acute; paleas 1.5–3 mm long, hyaline, narrower than the lemmas, apices obtuse to truncate; stamens 3; anthers 0.6–1.7 mm long, purplish. Caryopses 0.8–1.6 mm long, subellipsoid, terete to somewhat laterally compressed, with a well-developed adaxial groove, faintly striate, opaque, reddish-brown.

Distribution and habitat.—*Eragrostis erosa* is native to the Flora region and

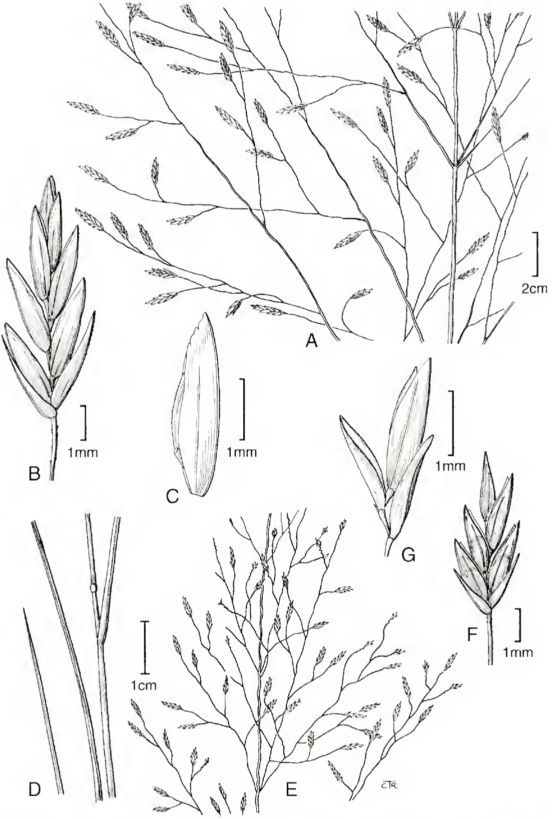


FIG. 7. *Eragrostis erosa*. **A.** Inflorescence. **B.** Spikelet. **C.** Floret. *Eragrostis palmeri*. **D.** Portion of culm and blades. **E.** Inflorescence. **F.** Spikelet. **G.** Floret with two paleas below.

grows on rocky slopes and hills, often in association with *Pinus edulis*, *Juniperus monosperma*, and *Bouteloua gracilis*; 1100–2300 m. Its range extends from northern México to New Mexico and western Texas.

Comments.—*Eragrostis erosa* is morphologically similar to *E. palmeri* but differs from the latter by having longer caryopses (0.8–1.6 mm verses 0.6–0.8 mm) and longer lemmas (2.4–3 mm verses 2–2.6 mm). These two species are sometimes very hard to differentiate; apparently *E. erosa* is much more restricted since it is known from only four locations in the Flora region.

Specimens examined. **MÉXICO. Coahuila:** western base of Picacho del Fuste, NE of Tanque Vaionetta, *I.M. Jonston 8413* (MEXU, US). **Nuevo León:** 3 km S of El Salero, *P.M. Peterson et al. 17832* (US). **Tamaulipas:** Municipio de Llera, La Gloria II, *J.L. Ramos-Delgado 249* (COCA); Municipio de San Carlos, Cerro del Diente, *J.A. Barrientos-B. 81* (COCA).

9. Eragrostis hirsuta (Michx.) Nees, Fl. Bras. Enum. Pl. 2:508. 1829. (**Fig. 8, A–D**)
Poa hirsuta Michx., Fl. Bor.-Amer. 1:68. 1803. TYPE: U.S.A. SOUTH CAROLINA: *Michaux s.n.* (HOLOTYPE: P!, ISOTYPE: US-77389 fragm!).

Eragrostis hirsuta var. *laevivaginata* Fernald, Rhodora 41(490):500–501. 1939. TYPE: U.S.A. VIRGINIA. Southhampton Co.: from wooded alluvial bottomland of Meherrin River, near Haley's Bridge, *M.L. Fernald & B.H. Long 9273* (HOLOTYPE: GH; ISOTYPE: PH).

Eragrostis sporoboloides J.G. Sm. & Bush, Annual Rep. Missouri Bot. Gard. 6:116, t. 54. 1895. TYPE: U.S.A. OKLAHOMA: Sapula, Indian Territory, Jul 1894, *B.F. Bush 766* (HOLOTYPE: ?).

Caespitose perennials with innovations and hardened bases, not glandular. Culms (30–)45–100 cm tall, erect, glabrous below the nodes; bud initiation usually intravaginal. Leaf sheaths overlapping, 1/2–1.5 times as long as the internodes below, rarely glabrous, apices and distal margins usually hairy, sometimes also densely hairy basally, dorsally, and on the collars, hairs to 6 mm long, papillose-based; ligules 0.2–0.4 mm long; blades 25–60 cm long, 4–8(–11) mm wide, flat to loosely involute, usually glabrous, adaxial surfaces sometimes hairy basally. Panicles 25–85 cm long, 15–40 cm wide, broadly ovate, open; primary branches mostly 4–35(–45) cm long, diverging 20–90° from the rachises, capillary; pulvini glabrous or hairy; pedicels 2–28 mm long, divergent. Spikelets 2–4(–5) mm long, 1–1.5 mm wide, lanceolate, greenish with purplish tinges, with 2–4 florets; disarticulation acropetal, paleas persistent; glumes lanceolate, hyaline to membranous; lower glumes 1.1–2 mm long; upper glumes 1.5–2.8 mm long, apices acuminate to acute; lemmas 1.6–2.4 mm long, ovate, membranous, hyaline near the margins, lateral veins inconspicuous, apices acute; paleas 1.2–2.2 mm long, hyaline, bases not projecting beyond the lemmas, apices acute to obtuse; stamens 3; anthers 0.3–0.8 mm long, purplish. Caryopses 0.8–1 mm long, rectangular-prismatic, somewhat laterally compressed, with or without a well-developed adaxial groove, striate, opaque, reddish-brown. $2n = 100$.

Distribution and habitat.—*Eragrostis hirsuta* is native to the Flora region and grows in sandy clay loams on the coastal plain and along roadsides, usually in association with *Pinus* and *Quercus*; 1–1750 m. Its range extends from

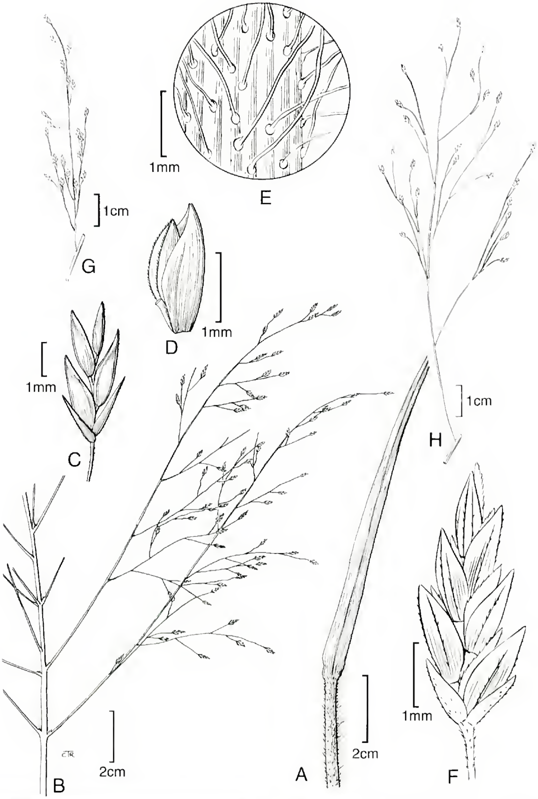


Fig. 8. *Eragrostis hirsuta*. **A.** Sheath and blade. **B.** Inflorescence. **C.** Spikelet. **D.** Floret. *Eragrastis hirta* var. *hirta*. **E.** Portion of the sheath. **F.** Spikelet. **G.** Primary panicle branch. *Eragrostis hirta* var. *longiramea*. **H.** Primary panicle branch.

the southeastern United States through eastern Mexico to Guatemala and Belize.

Comments.—*Eragrostis hirsuta* (along with *E. hirta*) is characterized by having papillose-based hairs near the apices and margins of the sheaths. The distinction between *E. hirsuta* and *E. hirta* is tentative and depends on the number of florets (2–4 in the former verses 4–7 in the latter), floret width (1–1.5 mm verses 1.4–2.0 mm), and floret color (greenish with a purplish tinge verses plumbeous to reddish-purple).

Specimens examined. **MÉXICO. Nuevo León:** Municipio de Bustamante, km 2 carretera Bustamante, *A. Bendeck s.n.* (ANSM). **Tamaulipas:** Municipio de Abasolo, Ejido La Esperanza, *J.F. Iribe-Duarte 48* (COCA); Municipio de Guémez, Ejido Los San Pedros, *G. Bores-Kulman 66* (COCA); Municipio de Hidalgo, El Chorrito, *G. Bores-Kulman 20* (COCA); Municipio de Jaumave, Sierra Madre rumbo a Jaumave, *J. Brito 43* (COCA); Municipio de Mainero, Adelante de Charco Dicha, Ejido Camarones, *M.H. Cervera-Rosado 359* (COCA); Municipio de Soto La Marina, Rancho El Saúz, *A. Brito 170* (COCA); Municipio de Victoria, Ejido Vicente Guerrero, *P. Moya-Salgado 139* (COCA); El Asbesto, *G. Bores-Kulman 80* (COCA).

10. Eragrostis hirta E. Fourn., Mexic. Pl. 2:115. 1886. TYPE: MEXÍCO. SAN LUIS POTOSÍ: Aug 1851, *Virlet de Aoust 1390* (HOLOTYPE: P!; ISOTYPE: US-77382 fragm. & photostat ex P!).

Eragrostis praetermissa L.H. Harv., Bull. Torrey Bot. Club 81:408. 1954. *Eragrostis intermedia* var. *praetermissa* (L.H. Harv.) Witherspoon, Ann. Missouri Bot. Gard. 64:327. 1977. TYPE: GUATEMALA. BAJA VERAPAZ: Santa Rosa, Jul 1887, *H. von Tuerckheim 1292* (HOLOTYPE: US-821939!).

Caespitose perennials, with innovations. Culms 60–170 cm tall, erect or ascending, glabrous or hairy below the nodes, internodes mostly glabrous; bud initiation usually extravaginal. Leaf sheaths overlapping below, 2/3 the length of the internodes above, pilose along the margins and at the apices, hairs to 4 mm long, papillose-based; ligules 0.2–0.4 mm long; blades 20–65 cm long, 2–8(–9) mm wide, flat to loosely folded or involute, mostly glabrous, scabrous above, sometimes with papillose-pilose near the base, the hairs up to 5 mm long; margins scabrous. Panicles 26–70 cm long, 4–40 cm wide, somewhat condensed or open, ovate, elliptic to lanceolate, branches whorled below, solitary or opposite above; primary branches mostly 4–25 cm long below, appressed, ascending and spreading up to 80° from the rachises; pulvini glabrous or pilose; pedicels 2.5–15 mm long, erect, longer than the spikelets, glabrous. Spikelets 3–5.5 mm long, 1.4–2.0 mm wide, ovate to linear-ovate, plumbeous to reddish-purple, with 4–7 florets; disarticulation acropetal with deciduous glumes and lemmas; glumes lanceolate, keel scabridulous, apices acute; lower glumes 1–1.8 mm long; upper glumes 1.6–2.2 mm long; lemmas 1.6–2.2 mm long, ovate, membranous, glabrous or with a few scattered hairs along the margins, lateral veins inconspicuous, keels scabridulous towards apex, apices acute; paleas 1.5–2.0 mm long, membranous, keels scabridulous; stamens 3; anthers 0.5–0.8 mm long, purplish. Caryopses 0.6–0.9 mm long, rectangular-prismatic, laterally compressed, striate, adaxially grooved, reddish-brown.

Distribution and habitat.—*Eragrostis hirta* is native to the Flora region.

KEY TO THE VARIETIES OF *ERAGROSTIS HIRTA*

1. Panicles 26–45(–50) cm long, 4–10 cm wide, somewhat condensed; primary branches 4–10 cm long below, appressed to ascending spreading; leaf blades 2–5 mm wide, mostly involute; culms 60–100 cm tall __________ **10a. E. hirta var. hirta**
1. Panicles 50–70 cm long, 18–40 cm wide, open; primary branches 15–25 cm long below, ascending spreading to reflexed; leaf blades 4–8(–9) mm wide, flat or loosely folded; culms (95–)110–170 cm tall __________ **10b. E. hirta var. longiramea**

10a. Eragrostis hirta var. **hirta** (**Fig. 8, E–G**).

Culms 60–100 cm tall. Leaf blades 20–45 cm long, 2–5 mm wide, mostly involute. Panicles 26–45(–50) cm long, 4–10 cm wide, somewhat condensed; primary branches 4–10 cm long below, appressed to ascending spreading.

Distribution and habitat.—*Eragrostis hirta* var. *hirta* occurs in rocky of sandy soils in oak-pine forests and along ravines and streams; 0–2100 m.

Specimens examined. **MEXICO. Tamaulipas:** Municipio de Casas, Sierra de Tamaulipas, Santa María de Los Nogales, *F. Martínez-Martínez 1949* (TEX-LL), *2081* (TEX-LL, US); Municipio Nuevo Laredo, 3 km S of El Huisachal, Standlford et al. 2115 (US); Municipio de Soto La Marina, Rancho Enramadas, *G. Villegas-Durán 499* (COCA); without Municipio, between Ciudad Victoria and Soto La Marina, *A.A. Beetle M-4437* (COCA).

10b. Eragrostis hirta var. **longiramea** (Swallen) Witherspoon, Ann. Missouri Bot. Gard. 64:328. 1977. (**Fig. 8, H**). *Eragrostis longiramea* Swallen, J. Wash. Acad. Sci. 21:437. 1931. TYPE: MÉXICO. TAMAULIPAS: Sierra de San Carlos, Pico del Diablo, vicinity of Marmolejo, 12 Aug 1930, *H.H. Bartlett 10910* (HOLOTYPE: US-1501524!; ISOTYPES: GH!, MICH!, US-1611156!, US-3160925!).

Culms (95–)110–170 cm tall. Leaf blades 25–64 cm long, 4–8(–9) mm wide, flat or loosely folded. Panicles 50–70 cm long, 18–40 cm wide, open; primary branches 15–25 cm long below, ascending spreading to reflexed.

Distribution and habitat.—*Eragrostis hirta* var. *longiramea* occurs in dry, rocky soils along oak forest borders and streams known only from Tamaulipas, Nuevo León, and San Luis Potosí; 50–2300 m.

Specimens examined. **MEXICO. Nuevo León:** Municipio de Galeana, Sierra Madre Oriental, Pablillo, *F.W. Pennell 17033* (MEXU), Municipio de Garza García, road to Chipinque Mesa, *I.K. Langman 2855* (MEXU, PH, US). **Tamaulipas:** Municipio de Casas, road to Rancho "Las Yucas" and Santa María de Los Nogales, *F. Martínez Martínez & G. Borja Luyando F-1938* (TAES, US); Municipio de Soto La Marina, Ejido Verde Grande, *J.F. Iribe-Duarte 330* (COCA).

11. Eragrostis hypnoides (Lam.) Britton, Sterns & Poggenb., Prelim. Cat. 69. 1888. (**Fig. 9, A–C**). *Poa hypnoides* Lam., Tabl. Encycl. 1: 185. 1791. *Megastachya hypnoides* (Lam.) P. Beauv., Ess. Agrostogr. 74, 167, 175. 1812. *Neeragrostis hypnoides* (Lam.) Bush, Trans. Acad. Sci. St. Louis 13:180. 1903. *Erosion hypnoides* (Lam.) Lunell, Amer. Midl. Naturalist 4:221. 1915. TYPE: Tropical America, *D. Richard s.n.* (HOLOTYPE: P-LAM!; ISOTYPES: BAA-1041!, NY fragm. ex P, US-2850742 fragm. ex P!).

Stoloniferous annuals, mat-forming, without innovations, without glands. Culms decumbent and rooting at the lower nodes, erect portion (2–)5–12(–20) cm tall, often branched, glabrous or hairy on the lower internodes. Leaf sheaths

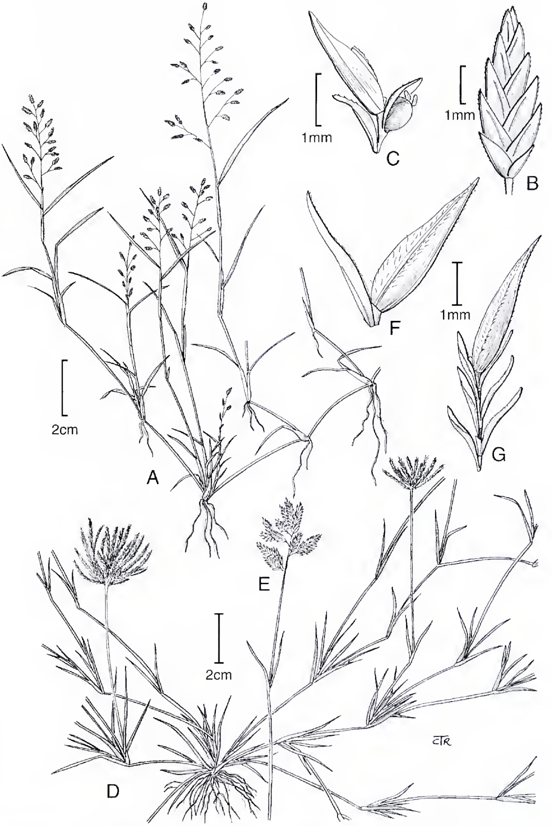


Fig. 9. *Eragrostis hypnoides*. **A.** Habit. **B.** Spikelet. **C.** Floret with two paleas below and caryopsis. *Eragrostis reptans*. **D.** Habit (female). **E.** Inflorescence (male) and culm. **F.** Floret (male) with palea below. **G.** Floret (female) with paleas below.

overlapping below, usually 1/3–1/2 as long as the internodes above, pilose on the margins, collars, and at the apices, hairs 0.1–0.6 mm long; ligules 0.3–0.6 mm long; blades 0.5–2.5 cm long, 1–2 mm wide, flat to involute, abaxial surfaces glabrous, adaxial surfaces appressed pubescent, hairs about 0.2 mm long. Panicles 1–3.5 cm long, 0.7–2.5 cm wide, terminal and axillary, ovate, open to somewhat congested; primary branches 0.1–0.5 cm long, appressed to strongly divergent, glabrous; pulvini sparsely pilose or glabrous; pedicels 0.2–1 mm long, ciliate. Spikelets 4–13 mm long, 1–1.5 mm wide, linear-oblong, often arcuate, loosely imbricate, greenish-yellow to purplish, with 12–35 florets; disarticulation acropetal, paleas persistent; glumes linear-lanceolate to lanceolate, hyaline; lower glumes 0.4–0.7 mm long; upper glumes 0.8–1.2 mm long; lemmas 1.4–2 mm long, ovate, strongly 3-veined, veins greenish, apices acuminate; paleas 0.7–1.2 mm long, hyaline, keels scabridulous, apices acute to obtuse; stamens 2; anthers 0.2–0.3 mm long, brownish. Caryopses 0.3–0.5 mm long, ellipsoid, somewhat translucent, light brown. $2n = 20$.

Distribution and habitat.—*Eragrostis hypnoides* grows along muddy or sandy shores of lakes and rivers and in moist, disturbed sites; 10–1600 m. It is native to the Americas, extending from southern Canada to Argentina.

Comments.—*Eragrostis hypnoides* is characterized by having a mat-like growth form only 5–20 cm tall with stoloniferous branches that root at the nodes. It is morphologically similar to *E. reptans* but differs by having bisexual florets and only two anthers 0.2–0.3 mm long.

Specimens examined **MÉXICO. Coahuila:** Municipio de Castaños, Presa Rodríguez, *E. Pérez-Torres* (COCA). **Nuevo León:** Municipio de Linares, Presa El Porvenir, *J.J. Ortíz-Díaz 8* (ANSM). **Tamaulipas:** Municipio de Aldama, km 15 carretera Estación Manuel-Aldama (Instituto Nacional de Investigaciones Forestales Agropecuarias y Pesqueras-Secretaria de Agricultura y Recursos Hidráulicos), *A. Brito s.n.* (UAT); Municipio de Soto La Marina, Chamal, *J.R. Swallen 1723* (US), Municipio de Tula, Joya de la Escondida, *G. Bores-Kulman 74* (COCA); Municipio de Victoria, area de la Torre de la Forestal, *J.G. Galván-Infante 307* (COCA).

12. Eragrostis intermedia Hitchc., J. Wash. Acad. Sci. 23:450. 1933. (**Fig. 10, A–C**). TYPE: U.S.A. TEXAS: Bexar Co.: San Antonio, 3 Jul 1910, *A.S. Hitchcock 5491* (HOLOTYPE: US-1535749!; ISOTYPES: US-908993!, US-1535750!).

Caespitose perennials, with innovations, not glandular. Culms (30–)40–90(–110) cm tall, erect, glabrous below the nodes. Leaf sheaths overlapping, 1/2 to about as long as the internodes below, sparsely pilose on the margins, apices hairy, hairs to 8 mm long, not papillose-based; ligules 0.2–0.4 mm long; blades (4–)10–20(–30) cm long, 1–3 mm wide, flat or involute, abaxial surfaces glabrous, adaxial surfaces densely hairy behind the ligules, elsewhere usually glabrous, occasionally sparsely hairy. Panicles 15–40 cm long, (8.5–)15–30 cm wide, ovate, open; primary branches 4–25 cm long, diverging 20–90° from the rachises, capillary; pulvini hairy or glabrous; pedicels 2–14 mm long, divergent. Spikelets 3-

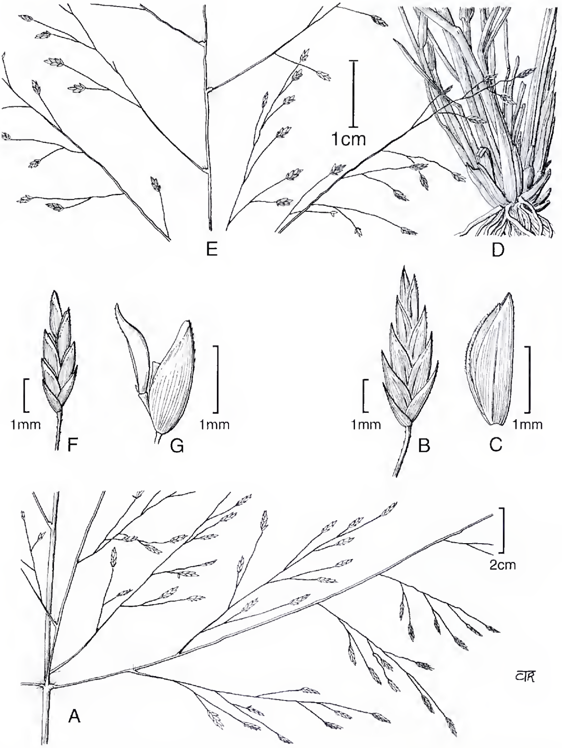


Fig. 10. *Eragrostis intermedia*. **A.** Inflorescence. **B.** Spikelet. **C.** Floret. *Eragrostis lugens*. **D.** Base of plant. **E.** Inflorescence. **F.** Spikelet. **G.** Floret with palea above.

7 mm long, 1–1.8 mm wide, narrowly lanceolate, olivaceous to purplish, with (3–)5–11 florets; disarticulation acropetal, paleas persistent; glumes lanceolate to ovate, hyaline to membranous; lower glumes 1.1–1.7 mm long, narrower than the upper glumes; upper glumes 1.3–2 mm long, apices acuminate to acute; lemmas 1.6–2.2 mm long, ovate, membranous, hyaline near the margins, lateral veins inconspicuous, apices acute; paleas 1.4–2.1 mm long, hyaline, narrower than the lemmas, apices obtuse to acute; stamens 3; anthers 0.5–0.8 mm long, purplish. Caryopses 0.5–1.0 mm long, rectangular-prismatic, somewhat laterally compressed, with a well-developed adaxial groove, striate, opaque, reddish-brown. $2n$ = ca. 54, 60, 72, ca. 74, 80, 100, 120.

Distribution and habitat.—*Eragrostis intermedia* is native to the Flora region and grows in clay, sandy, and rocky soils, often in disturbed sites; 0–2500 m. Its range extends from the United States through Mexico and Central America to South America. *Eragrostis intermedia* is similar to the more widespread *E. lugens*, but differs from that species in having wider spikelets, longer lemmas, and caryopses with a prominent adaxial groove.

Comments.—A numerical taxonomic study of the *Eragrostis intermedia* complex was completed by Witherspoon (1975) where he found much phenotypic overlap of individuals in his principal component and UPGMA cluster analyses of *E. intermedia* with *E. palmeri*, *E. erosa*, and *E. hirta*. Determination of these species is often problematic and examination of this group, which additionally includes *E. lugens* and *E. hirsuta*, is needed to clarify species boundaries. Presence or absence of papillose-based hairs near the apices and margins of the sheaths is the most reliable character to separate *E. hirta* and *E. hirsuta* from the others in this complex. Even though our key emphasizes the length of the lemma to separate *E. intermidia* (1.6–2.2 mm long), *E. erosa* (2.4–3 mm long), and *E. palmeri* (2–2.6 mm long), this character is somewhat variable in these species, and without the use of anther and caryopses length, it can be misleading. Our treatment is still very tentative and we encourage other agrostologists to investigate the evolutionary history within this group of species.

Specimens examined. **MEXICO. Coahuila:** Municipio de Acuña, Acuña, without collector (MEXU); near Santo Dominigo, *L.F. Wynd & C.H. Mueller* (ANSM, US), Serranías del Burro, Rancho El Bonito in Cañón El Bonito, *J. Valdés-Reyna & D. H. Risknind 1232* (ANSM); Municipio de Allende, 13 mi SW of Ciudad Allende toward Sabinas, *M.C. Johnston & J. Graham 4175A* (MEXU); Municipio de Arteaga, 12 km S of Saltillo towards Matehuala, *M A. Madrigal-A. s.n.* (MEXU); 17 mi SE of Saltillo and 7.4 mi NW of Jamé, *P.M. Peterson et al. 10075* (ANSM, US); suburb of Cerritos, NE of Saltillo, *P.M. Peterson et al. 10086* (US); Rancho El Carmen, *P. Moya-Salgado 437* (COCA); Sierra de Arteaga, Cañón de Jamé, 12 km E of Jamé, *J. Valdés-Reyna & M. A. Carranza P. 1930* (ANSM); Municipio de Castaños, 2 km SW of Restaurant La Muralla, *M.C Johnston et al. 10282* (MEXU); La Muralla, carretera 57, Saltillo-Monclova, *J.A. Villarreal-Quintanilla et al. 4225* (ANSM); near Rancho Santa Teresa, S of Castaños, *L.F. Wynd & C.H. Mueller 200* (ANSM, US); Paso de San Lázaro, Sierra de la Gavia, 37.6 mi S of Monclova on Hwy 57, *P.M. Peterson et al. 9989* (ANSM, US); Rancho de Santa Teresa, S of Castaños, without collector (MEXU); Municipio de Cuatrociénegas, Sierra de San Marcos, Cañón Grande, Ejido Estanque de Norias, *M.A. Carranza-Pérez et al. 1715* (ANSM); Municipio de Múzquiz, 8 km SE of Palaú, *J. Valdés-Reyna 928, 949, 953* (ANSM); Las Rusias, Río Santa María, carretera Múzquiz-Boquillas del Carmen, 10 km NW of Múzquiz, *R. Vásquez-Aldape 226* (ANSM); 13.4 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson & C.R. Annable 10564* (US); 85.4 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson & C.R. Annable 10567* (US); 135.4 km NW of Muzquiz on Hwy 53 towards Boquilla del Carmen, *P.M. Peterson & C.R. Annable 10579* (US); Rancho La Peña, Sierra de Santa Rosa, *R.J.C. Martínez s.n.* (ANSM); Sierra La Encantada, 140 km N of Múzquiz at Flourita de México Unidad Minera, 6 km SW of the tunel, *M.A. Carranza-Pérez et al. 707* (ANSM); Municipio de Nava, 10 km W of Nava, *A. Rodríguez-Gámez 1031* (ANSM); Municipio de Ocampo, Sierra El Pino, 18.8 km SW of Rancho El Cimarron, *P.M. Peterson & C.R. Annable 10643* (US); Rancho La Rueda, 87 km NW of Ocampo, *J.A. Villarreal-Quintanilla et al. 3294* (ANSM); Municipio de Piedras Negras, 13 mi S of Piedras Negras, *F.W. Gould 11126* (US); Municipio de Progreso, 34 mi N of Monclova on Hwy 57, *P.M. Peterson & J. Valdés-Reyna 8378* (ANSM, MEXU, US); Municipio de Ramos Arizpe, El Cedral, Sierra de la Paila, *J.A. Villarreal-Quintanilla et al. 3626* (ANSM), *J.A. Villarreal-Quintanilla & M.A. Carranza P. 4806* (ANSM); Paso de San Lázaro, N of Ramos Arizpe on Hwy 57, @3 mi S of restaurante La Muralla, *P.M. Peterson & J. Valdés-Reyna 8356* (ANSM); Puerto de San Lázaro, Sierra de la Gavia, *J.A. Villarreal-Quintanilla et al. 3179* (ANSM); Sierra de la Paila, Ejido El Cedral camino hacia el Valle de Parreños, *J.A. Villarreal-Quintanilla 5384* (ANSM); Sierra de la Paila, Ejido El Cedral por el camino El Carmen, *J. Valdés-Reyna 2167a* (ANSM), *J.A. Villarreal-Quintanilla et al. 5324* (ANSM, MEXU); Municipio de Saltillo, 14 mi S of Saltillo, *F.A. Barkley et al. 7204* (MEXU); 8.5 km carretera Saltillo-Concepción del Oro, *J. Espinosa-Aburto 20* (ANSM), 6 km S of Saltillo; *P.M. Peterson & J. Valdés-Reyna 8345* (US); 0.8 km SE of Universdidad Autonoma Agraria "Antonio Narro", *P.M. Peterson & J. Valdés-Reyna 8350* (US); Buenavista, 7 km S of Saltillo on Hwy 54 towards Concepción del Oro, *J. Valdés-Reyna & M.A. Carranza P. 1124, 1892* (ANSM), *J.A. Villarreal-Quintanilla 1768* (ANSM), *J.A. Villarreal-Quintanilla & M.A. Carranza P. 1407* (ANSM); 0.3 km E of Hwy to Zacatecas up road to Canyon San Lorenzo, *P.M. Peterson & C.R. Annable 10551* (US); Cañón de San Lorenzo, en la Sierra de Zapalinamé, 8 km S de Saltillo, 3.2 km E de la Universidad Autónoma Agraria Antonio Narro, *R. López-Aguillón s.n.* (ANSM); Cerro del Pueblo, W of Ciudad Saltillo, *J. Valdés-Reyna et al. 2050* (ANSM); Lomas las Tetillas, *P. Moya-Salgado 414* (COCA); Poblado Los Ramones, *F. Alcalá-Ayala 20* (COCA); Rancho experimental Los Angeles, 48 km S of Saltillo on Hwy 54 towards Concepción del Oro, *J.S. Sierra-Tristán s.n.* (ANSM); Saltillo, *E. Palmer 408* (MEXU, US), *412* (MEXU), *A.S. Hitchcock 5597* (US), *G.L. Fisher 30011* (US); 1 mi S of Saltillo, *L.H. Harvery 8472* (US); 25 mi S of Saltillo, *L.H. Harvey 8736* (US); Sierra de Zapalinamé, frente al Cañón Boca Negra, *R. López-Aguillón s.n.* (ANSM); 7 mi N of Saltillo, *F.W. Gould 11198* (US); 5 km E of Saltillo (Las Palapas) up Camino de Quatro, *P.M. Peterson et al. 17859* (US). **Nuevo León:** Municipio de Allende, 6.1 km S f Allende on Mex 85 towards Montemorelos, *P.M. Peteson & R.M. King 8338* (US); Municipio de Aramberri, Sierra La Lagunita, 9.5 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson et al. 16697* (US); Municipio de Cadereyta Jiménez, Cadereyta, *N. Bazaldua-Bazaldua 20* (COCA); Municipio de Galeana, Cañón de San Francisco, without collector (MEXU); 6 mi SE of Galeana, *J.R. Reeder & C.G. Reeder 4990* (US); El Peñuelo, *G. Villegas-Durán 206* (COCA); Cañón de San Francisco, 15 mi SW of Galeana, *C.H. Mueller & M.T. Mueller 1116* (MEXU); Municipio de General Zaragoza, 4 km S of Zaragoza at Junction of road to Cerro Viejo-Tepehuanes, *P.M. Peterson & J. Valdés-Reyna 15853* (US); 12 km al NE de la Encantada, *J.A. Villarreal-Quintanilla et al. 5132* (ANSM, MEXU); Sierra El Soldado, camino a San Antonio de Peña Nevada-Puerto Pinos, *J.A. Villarreal-Quintanilla et al. 4947* (ANSM); Municipio de Guadalupe, Guadalupe, *E. Cantú-Peña s.n.* (MEXU); Municipio de Iturbide, Ejido Santa Rosa, *E.A. Estrada-Castillón 1676* (ANSM); Municipio de Linares, 11 mi NW of Linares, *M.C. Johnston & J. Graham 4642* (MEXU); El Pinal-Las Palmas, *J.J. Ortíz-Diaz s.n.* (ANSM); Los Pinos, *J.J. Ortíz-Díaz s.n.* (ANSM); Rancho El Nogalar, *M.M. Castillo-Badillo 86-A* (COCA); Rancho La Loma, *P. Jauregui-Ramírez 14* (COCA); Rancho San José de los Hoyos, km 15 carretera Linares-Iturbide, *J. Garza-Covarrubias 21* (COCA); Municipio de Monterrey, Sierra

Madre mountains, *C.H. Mueller & M.T. Mueller 371-2-3* (MEXU), Municipio de Salinas Victoria, Cuesta de Mamulique, *J.S. Marroquín-de la Fuente 2836* (ANSM); La Soledad Salinas Victoria, *J.A. Ochoa-Guillemar 1129* (COCA); Municipio de Santiago, 9 km N of Los Cavazos, near Río San Juan, *I. Cabral-Cordero 76* (ANSM); Santiago, *P. Jauregui-Ramírez 47* (COCA), Ojos de Agua, *I. Cabral-Cordero 322* (ANSM); unknown Municipio, Dulces Nombres, *F.G. Meyer & D.J. Rogers 2557* US). **Tamaulipas:** Municipo de Aldama, 16 km NW of Rancho El Coyote, *E. Martínez-Ojeda 247* (MEXU); Municipio de Casas, 64 km from Soto La Marina on the (old, winding) road to Casas a Victoria, *F.F. Martínez-Martínez & G. Borja L. 2360* (MEXU); Municipio de Cruillas, 4 km E de la carretera San Fernando-Victoria, desviación hacia Temascal, *R. Díaz-Pérez 259* (UAT); Municipio Hidalgo, 40 km W of Hwy 85 towards Dulce Nombres, *P.M. Peterson & J. Valdés-Reyna 15893* (US); Municipio de Matamoros, Palo Blanco, *H. LeSueur 653* (US); Municipio de Miquihuana, 2 km SW of Miquihuana, *A. Mora-Olivo 977* (UAT); Municipio de Palmillas, 88.7 km SW of Ciudad Victoria on Mex 101 towards San Luis Potosí, *P.M. Peterson & R.M. King 8331* (US); Ejido El Capulín, *M. Martínez Díaz de Salas 403* (UAT); Municipio de San Carlos, Piedra Imán, 2 km ESE of San José, *O.L. Briones-Villarreal 1211* (ANSM); Municipio de San Fernando, 23 mi from the San Fernando-Matamoros highway junction on the gravel road to Reynosa, *M.C. Johnston & J. Graham 4714A* (MEXU), Municipio de Tula, km 78 carretera Jaumave-Tula, *P. Moya-Salgado 171* (COCA); Municipio de Victoria, San Juan, *J.F. Iribe-Duarte 418, 421* (COCA); unknown Municipio, 5 km S of Hoja Verde, *Stanford et al. 2214* (US).

13. **Eragrostis lehmanniana** Nees, Fl. Afr. Austral. Ill. 402. 1841. (**Fig. 5, D & E**).

TYPE: SOUTH AFRICA: Cabo de Buena Esperanza, *J.F. Drège s.n.* (ISOTYPES: BM, LE).

Caespitose perennials, forming innovations at the basal nodes, without glands. Culms (20–)40–80 cm, erect, commonly geniculate, sometimes rooting at the lower nodes, glabrous, lower portions sometimes scabridulous. Leaf sheaths 1/3–2/3 the length of the internodes, sometimes shortly silky pilose basally, hairs less than 2 mm long, apices sparsely hairy, hairs to 3 mm long; ligules 0.3–0.5 mm long, ciliate; blades 2–12 cm long, 1–3 mm wide, flat to involute, glabrous, abaxial surfaces sometimes scabridulous, adaxial surfaces scabridulous. Panicles 7–18 cm long, 2–8 cm wide, oblong, open; primary branches 1–8 cm long, appressed or diverging to 40° from the rachises; pulvini glabrous; pedicels 0.5–4 mm long, diverging or appressed, flexible. Spikelets 5–12(–14) mm long, 0.8–1.2 mm wide, linear-lanceolate, plumbeous to stramineous, with 4–12(–14) florets; disarticulation irregular to basipetal, paleas usually persistent; glumes oblong to lanceolate, membranous; lower glumes 1–1.5 mm long; upper glumes 1.3–2 mm long; lemmas 1.5–1.7 mm long, ovate, membranous, lateral veins inconspicuous, apices acute to obtuse; paleas 1.4–1.7 mm long, obtuse; stamens 3; anthers 0.6–0.9 mm long, yellowish. Caryopses 0.6–0.8 mm long, ellipsoid to obovoid, dorsally compressed, sometimes with a shallow adaxial groove, smooth, translucent, mostly light brown, embryo region dark brown with a greenish ring. $2n = 40, 60$.

Distribution and habitat.—*Eragrostis lehmanniana* is introduced in the Flora region and native to southern Africa, where it grows in sandy, savannah habitats. In the Flora region, it grows in sandy flats, along roadsides, on calcareous slopes, and in disturbed areas; 1500–1830 m. It is commonly found in association with *Larrea tridentata*, *Opuntia*, *Quercus*, *Juniperus*, and *Bouteloua gracilis*.

Comments.—*Eragrostis lehmanniana* was introduced for erosion control in the southern United States, and now it often displaces native species throughout the New World.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Ramos Arizpe, Estación Experimental Forestal Z. A. "La Sauceda", *J.A. De la Cruz-Breton s.n.* (MEXU); Ramos Arizpe, *R. Palomo-Garza s.n.* (ANSM); Municipio de Saltillo, Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Valdés-Reyna & M. A. Carranza P. 912, 915, 1819* (ANSM); 6 km S de Saltillo, entrada a la Universidad Autonoma Agraria Antonio Narro, J. Valdés-Reyna 2337 (US). **Nuevo León:** Municipio de Galeana, Navidad, carretera 57, km 85 al N de Saltillo, *F. Cárdenas & M. A. Bernal s.n.* (MEXU).

14. Eragrostis lugens Nees, Fl. Bras. Enum. Pl. 2:505-506. 1829. (**Fig. 10, D–G**). *Poa lugens* (Nees) Kunth, Enum. Pl. 1:331. 1833. *Eragrostis pilosa* var. *lugens* (Nees) Griseb., Abh. Königl. Ges. Wiss. Göttingen 24:290. 1879. TYPE: URUGUAY: Montevideo, *F. Sellow s.n.* [LECTOTYPE: US-732957!, designated by Witherspoon (1975) and not effectively published, accepted by Davidse (1994), and clarified by Boechat & Longhi-Wagner (2001); ISOLECTOTYPES: B, BM?, BAA-2932].

Caespitose perennials, with innovations, not glandular. Culms (20–)30–50 (–60) cm tall, erect, sometimes geniculate, glabrous below the nodes. Leaf sheaths overlapping, 1/2–2/3 as long as the internodes above, mostly glabrous, apices hairy, hairs 2–5 mm long, papillose-based, this sometimes not readily seen; ligules 0.2–0.3 mm long; blades (4–)8–22 cm long, 1–3.5 mm wide, involute to flat, both surfaces glabrous, margins sometimes with scattered hairs, hairs to 7 mm long. Panicles 16–28 cm long, 10–21 cm wide, ovate, open; primary branches 0.6–15 cm, diverging up to 100° from the rachises, naked basally; pulvini hairy; pedicels 1.4–5(–7) mm long, diverging, wiry, present on all spikelets. Spikelets 2–4.5(–5) mm long, 0.5–1(–1.3) mm wide, narrowly lanceolate, plumbeous to reddish-purple, with 2–7 florets; disarticulation acropetal, paleas persistent; glumes broadly ovate to narrowly lanceolate, hyaline, sometimes reddish-purple; lower glumes 0.6–1 mm long; upper glumes 1.1–1.4 mm long, usually broader than the lower glumes; lemmas 1.2–1.6 mm long, broadly ovate, mostly membranous but the distal margins hyaline, lateral veins inconspicuous, apices acute; paleas 1.1–1.7 mm long, membranous to hyaline, apices obtuse; stamens 3; anthers 0.2–0.7 mm long, reddish-purple. Caryopses 0.5–0.6 mm long, obovoid to somewhat prism-shaped, terete to somewhat laterally compressed, with an adaxial groove, finely striate, usually opaque, faintly reddish-brown to whitish. $2n = 40, 80$, ca. 108.

Distribution and habitat.—*Eragrostis lugens* is native to the Flora region and grows in montane areas along roadsides and waste places; 0–2500 m. Its range extends from the southern United States to Peru and Argentina.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Saltillo, Cañón El Cuatro, *J.A. García 24* (COCA). **Nuevo León:** Municipio de Aramberri, Sierra La Lagunita, 13.5 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson et al. 16712* (US); Municipio de Bustamante, Grutas de Bustamante, *P. Jauregui-Ramírez 74* (COCA); Municipio de Galeana, E slope of Cerro Potosí, *R.L. McGregor et al. 405*

(US); Municipio de General Zaragoza, Ejido Tepehuanes, *P.M. Peterson & J. Valdés-Reyna 15876* (US); Municipio de Linares, Rancho El Nogalar, *M.M. Castillo-Badillo 86* (COCA); Municipio de Montemorelos, between Montemorelos and Allende, *F.W. Gould 9823* (TAES), *A.A. Beetle M-630* (US); unknown Municipio, Dulces Nombres, *F.G. Meyer & D.J. Rogers 2573* (US); unknown Municipio, S of Monterrey, *T. Tateoka 1094* (US). **Tamaulipas:** Municipio de Casas, Sierra de Tamaulipas, on road from Las Yucas towards Santa Maria de los Nogales, *F. Martínez-Martínez & G. Borja L. F 2006* (US); Municipio de Gomez Farias, El Julilo, *J.F. Iribe-Duarte 424* (COCA); Municipio de Guémez, El Chihue, *J.G. Galván-Infante 108* (COCA); Rancho Nuevo, *J.L. Ramos-Delgado 25* (COCA); Municipio de Hidalgo, Caballos, *G. Bores-Kulman 62* (COCA); Municipio de Méndez, San Tomás I, *J.A. Barrientos-B. 2* (COCA); Municipio de San Carlos, Sierra Chiquita, *G. Villegas-Durán 403* (COCA); Municipio de Soto La Marina, near San José de las Rusias, *J.A. Franco-López 60, 63* (COCA); Municipio de Tula, Ejido La Laguna, *P. Moya-Salgado 168* (COCA) Municipio de Victoria, Altas Cumbres, *M.H. Cervera-Rosado 474* (COCA); Camino a Altas Cumbres, Ejido El Huizachal, *J.G. Galván-Infante 336* (COCA); Camino al Molino, *J.E. López de la Cruz 26* (COCA); Carretera Victoria-Tula, *J.F. Iribe-Duarte 116* (COCA).

15. Eragrostis mexicana (Hornem.) Link subsp. **mexicana,** Hort. Berol. 1:190. 1827. **(Fig. 2, E–G).** *Poa mexicana* Hornem., Hort. Bot. Hafn. 2:953. 1815. TYPE: MÉXICO: Cultivated from seed collected in México, *Sessé s.n.* (SYNTYPE: MA). BRAZIL: *Sessé & M. Lacasta* (SYNTYPE: US-2891498 fragm!).

Eragrostis limbata E. Fourn., Mexic. Pl. 2:116. 1886. TYPE: MÉXICO. 1833, *A.J.A. Bonpland 4573* [LECTOTYPE: P, designated by McVaugh (1983) but a specific herbarium not indicated!; ISOLECTOTYPE: US-2941517 fragm!].

Eragrostis neomexicana Vasey ex L.H. Dewey, Contr. U.S. Natl. Herb. 2(3):542. 1894. TYPE: U.S.A. NEW MEXICO: Organ Mountains, 1881, *G. Vasey 474* [LECTOTYPE: US-176631, designated by Koch and Sánchez-Vega (1985)!; ISOLECTOTYPES: K, US-822049!, US-909912!].

Caespitose annuals, without innovations. Culms 10–130 cm tall, erect, sometimes geniculate, glabrous, sometimes with a ring of glandular depressions below the nodes. Leaf sheaths 1/2–2/3 as long as the internodes, sometimes with glandular pits, pilose near the apices and on the collars, hairs to 4 mm long, papillose-based; ligules 0.2–0.5 mm long, ciliate; blades 5–25 cm long, 2–7(–9) mm wide, flat, abaxial surfaces glabrous, adaxial surfaces scabridulous, occasionally pubescent near the base. Panicles (5–)10–40 cm long, (2–)4–18 cm wide, less than 1/2 the height of the plant, ovate, rachises angled and channeled; primary branches 3–12(–15) cm, solitary to whorled, appressed or diverging to 80° from the rachises; secondary branches somewhat appressed; pulvini glabrous; pedicels 1–6(–7) mm long, almost appressed to narrowly divergent, stiff. Spikelets (4–)5–10(–11) mm long, 1.5–2.4 mm wide, ovate to oblong, gray-green to purplish, with 5–11(–15) florets; disarticulation acropetal; glumes subequal, 1.2–2.3 mm long, ovate to lanceolate, membranous; lemmas 1.2--2.4 mm long, ovate, membranous, glabrous or with a few hairs, gray-green, lateral veins evident, often greenish, apices acute; paleas 1–2.2 mm long, hyaline, keels scabrous, apices obtuse to truncate; stamens 3; anthers 0.2–0.5 mm long, purplish. Caryopses 0.5–0.8(–1) mm long, ovoid to rectangular-prismatic, laterally compressed, shallowly to deeply grooved on the adaxial surface, striate, reddish-brown, distal 2/3 opaque. $2n = 60$.

Distribution and habitat.—*Eragrostis mexicana* is native to the Flora region and grows along roadsides, near cultivated fields, and in disturbed open areas; 100–3000 m. *Eragrostis mexicana* subsp. *mexicana* grows from Ontario through the midwestern United States to California, South Carolina, and Texas and southwards to México, Central America, and northern South America to Argentina (Sanchéz Vega & Koch 1988).

Comments.—We follow Koch and Sánchez-Vega (1985) in the placement of *E. neomexicana* as a synonym of *E. mexicana* subsp. *mexicana*.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Acuña, El Jardin del Sur, *E.G. Marsh Jr 766* (MEXU); Municipio de Arteaga, Rancho El Carmen, *P. Moya-Salgado 438* (COCA); 1 mi SE of San Antonio de las Alazanas, *F.W. Gould & D. Watson 10512* (US); 14 mi SE of Saltillo, *J.R. Reeder & C.G. Reeder 3638* (US); Municipio de Parras, Parras de la Fuente, *W.A. Archer 3404, 3997* (US); Municipio de Ramos Arizpe, Ramos Arispe, *W.A. Archer 3401*; Sierra de la Paila (Lado Norte) Cañada Becerros, *J.A. Villarreal-Quintanillal & M. A. Carranza P. 5470A* (ANSM); Municipio de Saltillo, Buenavista, *J.O. Gutiérrez-Castillo, s.n.* (MEXU); Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *F.W. Gould & D. Watson 10498* (US), *A. Aznar-Ruíz s.n.* (ANSM), *J. Valdés-Reyna & M. A. Carranza P. 1120* (ANSM), *M.G. Villaseñor s.n.* (ANSM), *J.S. Marroquín-de la Fuente s.n.* (ANSM), *J.A. Villarreal-Quintanilla & M. A. Carranza P. 1477* (ANSM), *J.A. Villarreal-Quintanilla 1691* (ANSM); Cañón de San Lorenzo, en la Sierra de Zapalinamé, 8 km S de Saltillo, 3.2 km E de la Universidad Autónoma Agraria Antonio Narro, *R. López-Aguillón s.n.* (ANSM), *R. López-Aguillón s.n.* (ANSM); Entrada del Cañón San Lorenzo, *R. López-Aguillón s.n.* (ANSM); Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *A. Aguirre-Sifuentes s.n.* (ANSM), *R. Gaytán-Gil s.n.* (ANSM); *J.A. Villarreal-Quintanilla et al. 6719* (ANSM), *C.E. Ruíz-Rocha s.n* (ANSM); Saltillo, *G. Arsène 10630* (US), *A.S. Hitchcock 5629, 5642, 5643* (US), *E. Palmer 376* (US), *409* (MEXU, US), *410* (US), *411* (MEXU, US), *412* (US), *710* (US, MEXU); 27 mi SW of Saltillo, *E. Palmer 334*, 335 (US); Universidad Autónoma Agraria Antonio Narro a 7 km al S de Saltillo, F.M. *Cárdenas s.n.* (MEXU), *J. Valdés-Reyna 2336* (US); Vivero Forestal Secretaría de Agricultura y Recursos Hidraulicos, *F. Alcalá-Ayala 37, 68* (COCA); Municipio de Torreón, S of Torreón, canyon between Jimilco and Juan Eugenio, *P.M. Peterson & J. Valdés-Reyna 8475* (US); Torreón, *E. Palmer 510* (MEXU); Municipio de Zaragoza, Río San Rodrigo, @ 25 km N de la Cabecera Municipal, *A. Rodríguez-Gámez et al. 1234* (ANSM). **Nuevo León**. Municipio de Aramberri, Sierra La Lagunita, 13.5 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson et al. 16713* (US); 17 mi SE of Aramberri on road towards Agua Fria, *P.M. Peterson et al. 16725* (US); Municipio de Galeana, *V.H. Chase 7732* (US); 13 km S of the border of Coahuila and Nuevo León along highway 57, *S.L. Hatch et al. 4588* (ANSM); Carretera Galeana-Ascensión, a la altura del poblado Santa Fe, *N. Bazaldua-Bazaldua 101* (COCA); Cerro Potosi, 5 km W of Rancho 18 de Marzo (carretera to Galeana), *S.D. Koch & M. González L. 8629* (ANSM); Galeana, *V.H. Chase 7732* (ANSM); Municipio de General Zaragoza, 6 km S of Zaragoza on road towards Tepehuanes, *P.M. Peterson & J. Valdés-Reyna 15856* (US); 4 km W of Tepehuanes on road towards Zaragoza, *P.M. Peterson & J. Valdés-Reyna 15868* (US); Municipio de Santa Catarina, Cuesta de Los Muertos, carretera Monterrey-Saltillo, *R. Palomo-Garza s.n.* (ANSM); unknown Municipio, 32 mi S of San Roberto on Hwy 57, *R.L. McGregor et al. 494* (US). **Tamaulipas:** Municipio de Bustamante, Ejido Felipe Angeles 2 km NW of Bustamante, *R. Díaz-Pérez* (UAT); Municipio de González, Ejido Guadalupe Victoria, *G. Bores-Kulman 139* (COCA); Municipio de Jaumave, 7 km N of Magdaleno Aguilar (Santiaguillo) *F. González-Medrano et al. 9799* (MEXU); Municipio de Llera, La Gloria II, *J.E. López de la Cruz 154* (COCA); Municipio de Miquihuana, near Aserradero, *R.A. Carranco-Rendon 73* (COCA); Municipio de Tula, Ejido La Laguna, *J.F. Iribe-Duarte 122* (COCA); Municipio de Victoria, area de la Torre de la Forestal, *J.G. Galván-Infante 330* (COCA).

16. Eragrostis obtusiflora (E. Fourn.) Scribn., Bull. Div. Agrostol. U.S.D.A. 8:10, t.5. 1897. (**Fig. 11, A–C**). *Brizopyrum obtusiflorum* E. Fourn., Mexic. Pl. 2:120. 1886. MÉXICO. VERACRUZ: Orizaba (in ora occidentali), *Émy s.n.* (HOLOTYPE: P!).

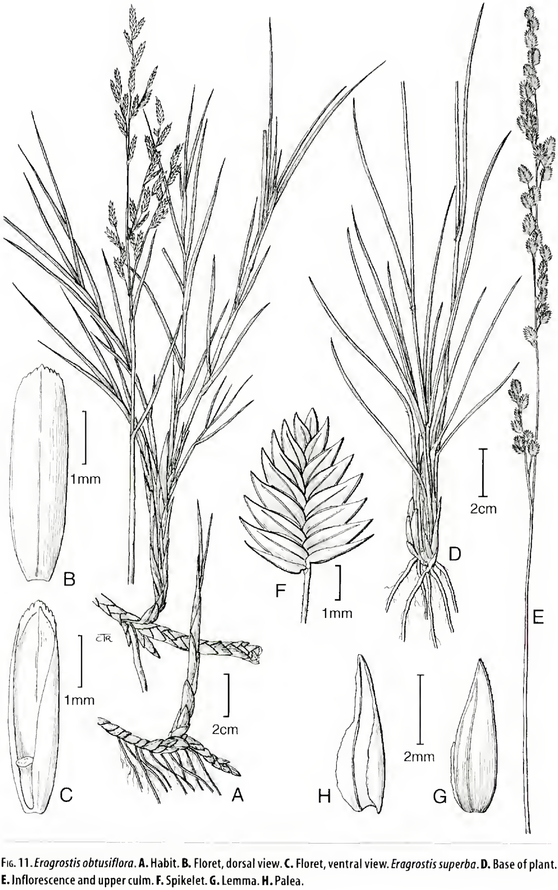


Fig. 11. *Eragrostis obtusiflora*. **A.** Habit. **B.** Floret, dorsal view. **C.** Floret, ventral view. *Eragrostis superba*. **D.** Base of plant. **E.** Inflorescence and upper culm. **F.** Spikelet. **G.** Lemma. **H.** Palea.

Perennials with scally, sharp-pointed rhizomes, with innovations, sometimes stoloniferous, the sharp-tipped rhizomes 4–8 mm thick. Culms 15–40(–50) cm tall, erect, stiff, hard, glaucus below the nodes. Leaf sheaths hairy at the apices, hairs to 2 mm long; ligules 0.2–0.4 mm long, membranous, ciliate; blades 2–15 cm long, (1–)2–4 mm wide, involute, arcuate, glabrous abaxially, scabrous adaxially, apices sharply pointed. Panicles 6–20(–24) cm long, 2–8(–12) cm wide, ovate, open or contracted; primary branches 1–8(–15) cm long, appressed or diverging up to 50° from the rachises; pulvini glabrous or not; pedicels 0–8 mm long, appressed, lower pedicels on each branch shorter than 1 mm long. Spikelets 8–14 mm long, 1.4–3 mm wide, ovate to lanceolate, stramineous with a reddish-purple tinge, with 5–10 florets; disarticulation basipetal, glumes persistent; glumes unequal, chartaceous; lower glumes 2.4–3.6 mm long; upper glumes 3–4.5 mm long, sometimes 3-veined; lemmas 3.8–4.5 mm long, ovate, leathery, 3–5-veined, lateral veins evident, greenish, upper margins hyaline, apices acute to obtuse, usually erose; paleas 3.8–4.5 mm long, membranous, keels scabridulous, apices obtuse to truncate; stamens 3; anthers 2–2.4 mm long, purplish to yellowish. Caryopses 1.6–2 mm long, ellipsoid, dorsally flattened, with a shallow adaxial groove, striate, reddish-brown. $2n = 40$.

Distribution and habitat.—*Eragrostis obtusiflora* is native to the southwestern United States and México. It grows in dry or wet alkali flats, often in association with *Distichlis* and *Sarcobatus*; 900–1400 m.

Comments.—*Eragrostis obtusiflora* was first described by Fournier (1886) in the genus *Brizopyrum* Link along with other species that are now included in *Distichlis* (*D. spicata* ssp. *stricta* Thorne), *Jouvea* [*J. pilosa* (J. Presl) Scribn.], and *Uniola* (*U. pittieri* Hack.). Ogden (1896) performed an anatomical survey of four grasses, *E. obtusiflora*, *Jouvea pilosa*, *J. straminea* E. Fourn., and *Distichlis spicata* (L.) Greene, all inhabitants of saline environments in southwestern North America. Ogden had originally thought that *E. obtusiflora* was conspecific with *Jouvea*. While all three of these species appear to be C_4 NAD-ME grasses, there are few unique anatomical features among each of these species. *Eragrostis obtusiflora* has a crown of colorless cells above each vein that separates it from the other three species. Even though Fournier (1886) and later Ogden (1896) noticed affinities of *E. obtusiflora* with *Distichlis*, *Jouvea*, and *Uniola*, all American agrostologists have followed Scribner's placement of this species in *Eragrostis*. Travis Columbus (per. comm.) has preliminary molecular sequence data that suggests *E. obtusiflora* is closely related to members of the Monanthochloinae that currently includes: *Distichlis*, *Monanthochloe*, and *Reederochloa* (Peterson et al. 2005).

Specimens examined. **MÉXICO. Coahuila:** Municipio de Ramos Arizpe, Predio La Esmeralda, *P. Moya-Salgado 440* (COCA); Municipio de Sierra Mojada, 80 (air) mi E of Saucillo, Chihuahua, W side of Laguna Jaco, *J. Henrickson 14202* (TEX-LL).

17. Eragrostis palmeri S. Watson, Proc. Amer. Acad. Arts 18:182. 1883. (**Fig. 7, D–G**). Type: MÉXICO. Coahuila: Juárez, on the Sabinas River, Sep-Oct 1880, *E. Palmer 1368* (holotype: GH; isotypes: US-1761635!, US-821984!).

Eragrostis caudata E. Fourn., Mexic. Pl. 2:115. 1886, nom. illeg. hom. Type: MÉXICO: Consoquitla, Aug 1841, *F.M. Liebmann 520* (syntypes: C, US-207543 fragm!); near Matamoras, Sep 1851, *J.L. Berlandier 2345* (syntypes: MO-129490!, US-911405 fragm!, US-77390 fragm!).

Caespitose perennials, with innovations and knotty bases, not glandular. Culms 50–90(–120) cm tall, glabrous below the nodes. Leaf sheaths overlapping, 1/2 to about as long as the internodes below, villous and the hairs not papillose-based, or mostly glabrous, apices hairy, hairs to 5 mm long, not papillose-based; ligules 0.2–0.4 mm long; blades (14–)20–35 cm long, 1–2.4 mm wide, involute, abaxial surfaces glabrous, adaxial surfaces scabridulous, sometimes sparsely hairy. Panicles 12–40 cm long, 4–20 cm wide, oblong, open; primary branches 2–20 cm long, diverging 20–70° from the rachises, capillary; pulvini glabrous or sparsely hairy; pedicels (0.4–)1–4(–14) mm long, appressed or diverging, only the terminal pedicels on each branch longer than 4 mm. Spikelets 4–6(–7.3) mm long, 1–2 mm wide, linear-lanceolate, plumbeous, with 5–12 florets; disarticulation acropetal, paleas persistent; glumes lanceolate to ovate, hyaline; lower glumes 1.1–1.8 mm long; upper glumes 1.2–2.2 mm long, exceeded by the basal lemmas; lemmas 2–2.6 mm long, ovate, membranous, hyaline towards the apices and margins, keels weak or strong, without glands, lateral veins from inconspicuous to conspicuous, apices acute; paleas 1.7–2.4 mm long, hyaline, bases not projecting beyond the lemmas, apices truncate, often notched; stamens 3; anthers 0.6–1.3 mm long, yellowish to purplish. Caryopses 0.6–0.8 mm long, rectangular-prismatic to subellipsoid, laterally compressed, with a well-developed adaxial groove, faintly striate, opaque, reddish-brown. $2n = 40$.

Distribution and habitat.—*Eragrostis palmeri* is native to the Flora region and grows on rocky slopes and hills generally in association with *Pinus edulis*, *Juniperus monosperma*, *Bouteloua gracilis*, and *Prosopis*; 300–2150 m. Its range extends from the Oaxaca to the southwestern United States.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Canstaños, Paso de San Lázaro, Sierra de la Gavia, 37.6 mi S of Monclova on Hwy 57, *P.M. Peterson et al. 9981* (US); 15 mi S of Canstaños, *J.R. Reeder & C.G. Reeder 3953* (US); Municipio de Cuatrociénegas Cuatrociénegas, Sierra de la Madera, vicinity of 'La Cueva' in Corte Blanco fork of Charretera Canyon, *I.M. Johnston 9062* (MEXU, US); Municipio de Múzquiz, Rincon de María on Hacienda La Babia, *T.L. Wendt et al. 950* (MEXU); Sierra La Encantada, @170 km NW of Múzquiz, cuesta de Malena, *M.A. Carranza-Pérez et al. 836* (ANSM); Cuesta de Malena, 195 km NW of Múzquiz, *R. Vasquez-Aldape 229, 233* (ANSM); Municipio de Ocampo, Sierra El Pino, 9.6 km SW of Rancho El Cimarron, *P.M. Peterson & C.R. Annable 10636* (US); 39.5 km W of Rancho El Cimarron, *P.M. Peterson & C.R. Annable 10695* (US), Cuesta de Zozoya, @38 km de Ocampo rumbo a Sierra Mojada, *M.A. Carranza-Pérez & F.J. Carranza P. 669* (ANSM); Sierra del Pino, Ejido Acebuches, Cañón La Vaca, *M.A. Carranza-Pérez et al. 965* (ANSM MEXU); Municipio de Parras, 30 km W of General Cepeda on road towards Parras, *J. Valdés-Reyna & L.E. Rodríguez G. 1579* (ANSM), Municipio de Saltillo, 18 mi S of Saltillo on Hwy 54 and 1.3 mi W on road to microondas, *P.M. Peterson & M.A.*

Carranza P. 8424 (ANSM, US); 2 mi S of Saltillo, *F.W. Gould & D. Watson 10542* (US); unknown Municipio, 2 km N of Puerto Colorado near Aguaje del Pajarito, *I.M. Johnston 8676* (US). **Nuevo León:** Municipio de Aramberri, 3 mi NE of Dulce Nombres, *P.M. Peterson & J. Valdés-Reyna 15935* (US); Municipio de General Zaragoza, 6 km S of Zaragoza on road towards Tepehuanes, *P.M. Peterson & J. Valdés-Reyna 15862* (US); Municipio de Linares, 5 mi S of Linares toward Victoria, *M.C. Johnston & J. Graham 4647* (MEXU). **Tamaulipas:** Municipio de Aldama, between La Concepción and Aldama, *F. Martínez-Martínez & G. Borja L. F-2190, F-2192* (MEXU, US); Playa Barra del Tordo, *D. Baro-Peruyero et al. 392* (UAT); Municipio de Casas, 35 km from Victoria on the road to Casas and Soto La Marina, *F. Martínez-Martínez & G. Borja L. F-2334* (MEXU, US), *F-2339* (US); 64 km from Soto La Marina on the (old, winding) road to Casas a Victoria, *F.F. Martínez-Martínez & G. Borja L. 2358* (MEXU, US); Municipio de Hidalgo, 42 km W of Hwy 85 on road towards Dulce Nombres, *P.M. Peterson & J. Valdés-Reyna 15906* (US); Municipio de Palmillas, 11 mi S of Palmillas on road to Tula, *M.C. Johnston & J. Crutchfield 5632B, 5632C* (US); Municipio de Tula, 101.6 km SE of Ciudad Victoria on Mex 101 toward San Luis Potosí, *P.M. Peterson & R.M. King 8321* (US); unknown Municipio, Rio del Pilno, *V. Grant 513* (US); Hacienda Buena Vista, *E.O. Wooton s.n.* (US); 90 mi NW of Sabinas and 25 mi NW of Rancho Margareta, *F.W. Gould 10698* (US); 65 mi NW of Sabinas, near Rancho Margareta, *F.W. Gould 10641* (US).

18. Eragrostis pectinacea (Michx.) Nees, Fl. Afr. Austral. Ill. 406. 1841. *Poa pectinacea* Michx., Fl. Bor.-Amer. 1:69. 1803. *Eragrostis pectinacea* (Michx.) Steud., Syn. Pl. Glumac. 1:272. 1854, *isonym*. TYPE: U.S.A. ILLINOIS: *Michaux s.n.* (HOLOTYPE: P-MICH!; ISOTYPE: US-2851264 fragm. ex P!).

Caespitose annuals, without innovations, without glandular pits. Culms 10–80 cm tall, erect to geniculate or decumbent below, glabrous. Leaf sheaths overlapping below, 1/2–3/4 as long as the internodes above, hirsute at the apices, hairs to 4 mm long; ligules 0.2–0.5 mm long; blades 2–20 cm long, 1–4.5 mm wide, flat to involute, abaxial surfaces glabrous and smooth, adaxial surfaces scabridulous. Panicles 5–25 cm long, 3–12(–15) cm wide, ovoid to pyramidal, usually open, sometimes contracted; primary branches 0.6–8.5 cm long, appressed or diverging to 80° from the rachises, solitary or paired at the lowest 2 nodes; pulvini glabrous or sparsely hairy; pedicels 1–7 mm long, flexible, appressed to widely divergent, sometimes capillary. Spikelets 3.5–11 mm long, 1.2–2.5 mm wide, linear-oblong to narrowly lanceolate, plumbeous, yellowish-brown, or dark reddish-purple, with 6–22 florets; disarticulation acropetal, paleas persistent; glumes subulate to ovate-lanceolate, hyaline; lower glumes 0.5–1.5 mm long, at least 1/2 as long as the adjacent lemmas; upper glumes 1–1.7 mm long, usually broader than the lower glumes; lemmas 1–2.2 mm long, ovate-lanceolate, hyaline to membranous, grayish-green proximally, reddish-purple distally, lateral veins moderately conspicuous, apices acute; paleas 1–2 mm long, hyaline to membranous, keels scabridulous, apices obtuse; stamens 3; anthers 0.2–0.4 mm long, purplish. Caryopses 0.5–1.1 mm long, pyriform, slightly laterally compressed, smooth, faintly striate, brownish. $2n = 60$.

Distribution and habitat.—*Eragrostis pectinacea* is native from southern Canada to Argentina. In the Flora region, it grows in disturbed sites such as roadsides, railroad embankments, gardens, and cultivated fields; 0–2400 m.

KEY TO THE VARIETIES OF *ERAGROSTIS PECTINACEA*

1. Pedicels appressed, rarely diverging to 20° from the rachises ____________ **18a. E. pectinacea** var. **pectinacea**
1. Pedicels widely divergent, usually diverging 20–60° from the rachises ______ **18b. E. pectinacea** var. **miserrima**

18a. Eragrostis pectinacea (Michx.) Nees var. **pectinacea (Fig. 12, A–C)**.

Eragrostis diffusa Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:97. 1862. *Eragrostis purshii* var. *diffusa* (Buckley) Vasey, Contr. U.S. Natl. Herb. 1:59. 1890. Type: U.S.A. Texas: *S.B. Buckley* (lectotype: PH; isolectotype: US-91621, designated by Hitchcock, Man, Grasses U.S. 849. 1935 without citing a specific sheet or a specific herbarium!).

Pedicels appressed or diverging to 20° from the branch axes.

Distribution and habitat.—*Eragrostis pectinacea* var. *pectinacea* grows throughout the range of the species, including most of the states within México.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Cuatrociénegas, Sierra de San Marcos, áreas cercanas a la Poza de La Becerra, *A. Zarate-Lupercio 13* (ANSM); Sierra de San Marcos, Cañón Grande, Ejido Estanque de Norias, @43 km W of Hwy 57, *M.A. Carranza-Pérez et al. 1701* (ANSM); Municipio de Múzquiz, Sierra La Encantada, 140 km N de Múzquiz at Flourita de México Unidad Minera, *R. Vásquez-Aldape et al. 245* (ANSM); Sierra Maderas del Carmén, *E.A. Estrada-Castillón 1838, 1840* (ANSM); Municipio de Ocampo, Sierra de la Madera, Rancho Laguna de la Leche, @ 62 km from Ocampo, *M.A. Carranza-Pérez & F.J. Carranza-Pérez 619* (ANSM); Municipio de Ramos Arizpe, Campo experimental de Zonas Áridas La Sauceda, *J.S. Marroquín-de la Fuente 2999* (ANSM); Municipio de Saltillo, Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Espinosa-Aburto 7* (ANSM); Rancho experimental Los Angeles, 48 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Espinosa-Aburto 49* (ANSM), *J. Santos s.n.* (ANSM), *R. Vásquez-Aldape s.n.* (ANSM). **Nuevo León:** Municipio de Doctor Arroyo, La Chona, near Hwy 57, *P.M. Peterson et al. 17822* (US); Municipio de Galeana, km 63.6 carretera Galeana-San Roberto, *I. Cabral-Cordero 1086* (ANSM, MEXU); Municipio de Lampazos de Naranjo, Rancho El Campanero, 2 km NE de la casa, *O.L. Briones-Villarreal 238* (ANSM); Municipio de Linares, Las Palmas-El Pinal, *J.J. Ortíz-Díaz 9* (ANSM); Municipio de San Nicolás de los Garza, Ciudad Universitaria, *I.A. Jiménez-Valdés s.n.* (ANSM); Municipio de Santiago, 3 km N de Los Cavazos, *I. Cabral-Cordero 331* (ANSM). **Tamaulipas:** Municipio de Abasolo, 2 km from Ejido Morelos, *R. Díaz-Pérez 275* (UAT).

18b. Eragrostis pectinacea var. **miserrima** (E. Fourn.) Reeder, Phytologia 60:154. 1986. (**Fig. 12, D**). *Eragrostis parvula* Steud., Syn. Pl. Glumac. 1:277. 1854. *Eragrostis purshii* var. *miserrima* E. Fourn., Mexic. Pl. 2:116. 1886. Type: MÉXICO: M. Parreyss, 1845, *Parry 172* [lectotype: CN, designated as holotype by Koch (1974), isolectotype: US-79704 fragm!].

Eragrostis tephrosanthos Schult., Mant. 2:316. 1824. *Poa tephrosanthos* Spreng. ex Schult., Mant. 2:316. 1824, *nom. inval.* *Poa polymorpha* Sieber ex Schultes, Mant. 2:316. 1824, nom. inval. *Eragrostis purshii* var. *genuina* E. Fourn, *nom. inval.* Type: MARTINIQUE: *F.W. Sieber 33* (holotype: M; isotypes: K, MO-2011170!, P, US-1127056!, US-1127055!, W).

Eragrostis delicatula Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 2(1):73. 1836. *Eragrostis pilosa* var. *delicatula* (Trin.) Hack., Anales Mus. Nac. Buenos Aires 11:133. 1904. Type: BRAZIL. In cultis prope Rio de Janeiro, May-Jun 1823, *L. Riedel* (holotype: LE-TRIN-2330.01!; isotypes: LE!, US-2891464 fragm!).

Eragrostis arida Hitchc., J. Wash. Acad. Sci. 23(10):449. 1933. *Eragrostis diffusa* var. *arida* (Hitchc.) Beetle, Phytologia 37:317. 1977. Type: U.S.A. Texas. Val Verde Co.: Del Rio, 14 Sep 1915, *A.S. Hitchcock 13650* (holotype: US-905937!)

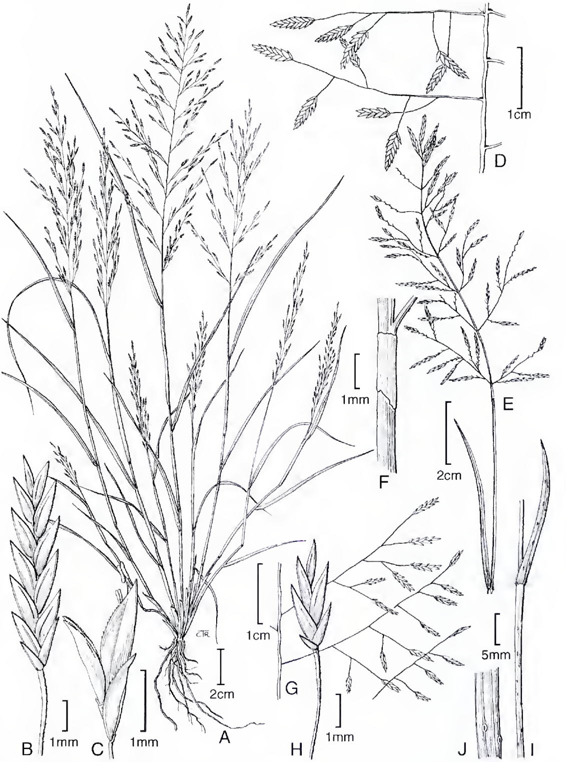


Fig. 12. *Eragrostis pectinacea* var. *pectinacea*. **A.** Habit. **B.** Spikelet. **C.** Florets, upper one with two exerted anthers and palea below. *Eragrostis pectinacea* var. *miserrima*. D. Inflorescence. *Eragrostis pilosa* var. *pilosa*. **E.** Inflorescence and upper culm with a blade. **F.** Rachis just below first inflorescence branch showing glandular band. **G.** Inflorescence. **H.** Spikelet. *Eragrostis pilosa* var. *perplexa*. **I.** Sheath and blade with glands. **J.** Portion of the blade with glands.

Pedicels widely divergent, usually spreading 20–60° from the branches.

Distribution and habitat.—*Eragrostis pectinacea* var. *miserrima* grows in the southern United States, from Texas to Florida, and south throughout México to the lowland tropics of Brazil.

Comments.—We follow Reeder (1986) in the placement of *E. arida*, *E. delicatula*, and *E. tephrosanthos* as synonyms of *E. pectinacea* var. *miserrima*.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Arteaga, 1 mi SE of San Antonio de las Alazanas, *F.W. Gould & D. Watson 10513* (US); Municipio de Ramos Arizpe, El Cedral, Sierra de la Paila, *J.A. Villarreal-Quintanillal et al. 3630-3* (ANSM), Municipio de Saltillo, Buenavista, 7 km S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J. Espinosa-Aburto 6* (ANSM); Saltillo, *E. Palmer 811, 812* (US), *A.S. Hitchcock 5621* (US). Municipio de Rastro, S de Saltillo, carretera 54 Saltillo-Concepción del Oro, Zacatecas, *J.F. Cano-Siller s.n.* (ANSM). **Nuevo León:** Municipio de Doctor Arroyo, Doctor Arroyo, *J.A. Ochoa-Guillemar 1279* (COCA); Municipio de Galeana, Galeana, *J.A. Ochoa-Guillemar 999* (COCA). **Tamaulipas:** Municipio de Jiménez, 10 km from Santander Jiménez on the road to San Fernando, *F.F. Martínez-Martínez & G. Borja L. 2458* (TEX-LL); Municipio de Jiménez, 6 mi N of Santander Jiménez, *M.C. Johnston 4906-B* (TEX-LL); Municipio de Matamoros, Santa Niño Aguanaval, *W.A. Archer 3408* (US); Municipio de Monclova, Monclova, *L.H. Harvey 1146* (US); Municipio de San Carlos, Cerro del Diente, *J.J. Barrientos-B. 92* (COCA); Municipio de Victoria, vicinity of Victoria, *E. Palmer 474, 555* (US); road to mountains W of Victoria, *J.R. Swallen 1625* (US); Municipio de Villagrán, 1 mi E Ejido San Lázaro, *M.C. Johnston & A.J. Graham 4299* (TEX-LL); unknown Municipio, Tampico to Tamaulipas, *J.L. Berlandier 24, 43* (US).

19. Eragrostis pilosa (L.) P. Beauv., Ess. Agrostogr. 71:162, 175. 1812. *Poa pilosa* L., Sp. Pl. 1:68. 1753. TYPE: ITALY. 9–10 Aug 1902, *A. Kneucker, Gram. Exsicc. XII, 344* (EPITYPES: B, designated by H. Scholz in Cafferty et al., Taxon 49:256. 2000; US-557051!).

Poa eragrostis Walter, Fl. Carol. 80. 1788, nom. illeg. hom. TYPE: U.S.A. SOUTH CAROLINA.

Eragrostis filiformis Link, Hort. Berol. 1:191. 1827. *Poa linkii* Kunth, Révis. Gramin. 1:113. 1829. *Eragrostis linkii* (Kunth) Steud., Syn. Pl. Glumac. 1:273. 1854, nom. illeg. superfl. TYPE: America Boreali (ISOTYPE: US-91380 fragm. ex herb. Elliott!).

Caespitose annuals, without innovations. Culms 8–45(–70) cm tall, erect or geniculate, glabrous, occasionally with a few glandular depressions. Leaf sheaths overlapping below, about 1/2 as long as the internodes, mostly glabrous, occasionally glandular, apices hirsute, hairs to 3 mm long; ligules 0.1–0.3 mm long, ciliate; blades 2–15(–20) cm long, 1–2.5(–4) mm wide, flat, abaxial surfaces glabrous, occasionally with glandular pits along the midrib, adaxial surfaces scabridulous. Panicles 4–20(–28) cm long, 2–15(–18) cm wide, ellipsoid to ovoid, diffuse; primary branches 1–10 cm long, diverging 10–80°(–110°) from the rachises, capillary, whorled on the lowest 2 nodes, rarely glandular; pulvini glabrous or hairy; pedicels 1–10 mm long, flexible, appressed or divergent. Spikelets (2–)3.5–6(–10) mm long, 0.6–1.4 mm wide, linear-oblong to narrowly ovate, plumbeous, with (3–)5–17 florets; disarticulation acropetal, paleas tardily deciduous, rachillas persisting longer than the paleas; glumes narrowly ovate to lanceolate, hyaline; lower glumes 0.3–0.6(–0.8) mm long; upper glumes 0.7–1.2(–1.4) mm long; lemmas 1.2–2 mm long, ovate-lanceolate, membranous to hyaline, grayish-green proximally, reddish-purple distally, lateral veins inconspicuous, apices acute; paleas 1–1.6 mm long, membranous to hyaline, keels scabridulous to scabrous, apices obtuse; stamens 3; anthers 0.2–0.3 mm long, purplish. Caryopses 0.5–1 mm long, obovoid to prism-shaped, adaxial surfaces flat, smooth to faintly striate, light brown. 2*n* = 40.

KEY TO THE VARIETIES OF *ERAGROSTIS PILOSA*

1. Plants with numerous glandular pits scattered over the whole plant, especially on the midribs of the sheaths and blades; lemmas 1.8–2 mm long ____________ **19a. E. pilosa** var. **perplexa**
1. Plants with a few glandular pits scattered on the culms or without any glandular pits; lemmas 1.2–1.8 mm long ______________________________ **19b. E. pilosa** var. **pilosa**

19a. Eragrostis pilosa var. **perplexa** (L.H. Harv.) S.D. Koch, Illinois Biol. Monogr. 48:28. 1974. (**Fig. 12, I & J**). *Eragrostis perplexa* L.H. Harv., Bull. Torrey Bot. Club 81:409. 1954. TYPE: U.S.A. SOUTH DAKOTA. Mellette Co.: 30 Aug 1935, *W.L. Tolstead s.n.* (HOLOTYPE: US-1645027!; ISOTYPE: US-1649186!).

Culms with numerous glandular pits. Leaf sheaths with glandular pits; blades with glandular pits. Spikelets 0.6–1.4 mm wide; upper glumes 1–1.4 mm long; lemmas 1.8–2 mm long. Caryopses 0.8–1 mm long.

Distribution and habitat.—*Eragrostis pilosa* var. *perplexa* is a native variety known from widely scattered locations on moist soils in Wyoming, North Dakota, Nebraska, Colorado, northwestern Texas, and Tamaulipas; 10–300 m.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de Victoria, Camino a Santa Clara y Santa Rosa, *J.F. Iribe-Duarte 188* (COCA).

19b. Eragrostis pilosa var. **pilosa** (**Fig. 12E–H**).

Culms with few or no glandular pits. Leaf sheaths and blades without glandular pits. Spikelets 0.6–1.3 mm wide; upper glumes 0.7–1.2 mm long; lemmas 1.2–1.8 mm long. Caryopses 0.5–0.9 mm long.

Distribution and habitat.—*Eragrostis pilosa* var. *pilosa* is native to Eurasia but has become naturalized in many parts of the world. It is more common than *E. pilosa* var. *perplexa* in the Flora region and occurs along forest margins and disturbed sites such as roadsides, railroad embankments, gardens, and cultivated fields; 0–2100 m.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Saltillo, Poblado Los Ramones, *F. Pérez-Torres 32* (COCA); Terrenos de la Secretaría de Agricultura y Recursos Hidráulicos, *M.E. Rodríguez-Moreno 16* (COCA); **Nuevo León:** Municipio de Galeana, km 63.6 carretera Galeana-San Roberto, *I. Cabral Cordero 1088* (ANSM); Municipio de Santiago, 4 km N of Los Cavazos, *I. Cabral-Cordero 219* (ANSM). **Tamaulipas:** Municipio de Gomez Farías, Cabecera *M.E. Crespo-Ovalle 109* (ANSM); Municipio de Llera, @30 mi S of Ciudad Victoria on Hwy 85, toward Ciudad Mante, *F.W. Gould 14820* (ANSM); Municipio de San Carlos, Cerro Bufa, El Diente, Sierra San Carlos, *O.L. Briones-Villarreal 1965* (ANSM); Municipio de Soto La Marina, Chamal, *J.R. Swallen 1695* (US); Municipio de Tula, Poblado El Pino, *G. Bores-Kulman 123* (COCA); Municipio de Villagrán, Garza Valdéz, *J.G. Galván-Infante 193* (COCA).

20. Eragrostis reptans (Michx.) Nees, Fl. Bras. Enum. Pl. 2:514. 1829. (**Fig. 9, D–G**). *Poa reptans* Michx., Fl. Bor.-Amer. 1:69–70, t. 11. 1803. *Poa dioica* Michx. ex Poir., Encycl.

5:87. 1804, *nom. inval. Megastachya reptans* (Michx.) P. Beauv., Ess. Agrostogr. 74, 167, 175. 1812. *Poa weigeltiana* Rchb. ex Trin., Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 6, Sci. Math. 1(4):410. 1830, *nom. inval. Neeragrostis reptans* (Michx.) Nicora, Revista Argent. Agron. 29:5 1963. Type: U.S.A. Illinos: riviere Kaskaskia in limosis ripariis hujus amnii, *Michaux s.n.* (syntype: P-MICH!; isosyntype: US-2767401 fragm.!).

Megastachya fasciculata E. Fourn., Mexic. Pl. 2:120. 1886. Type: MÉXICO: Matamoros, *J.L. Berlandier 2325* (isotype: US-2821451 fragm!).

Neeragrostis weigeltiana Bush, Trans. Acad. Sci. St. Louis 13(7):178. 1903. *Eragrostis weigeltiana* Bush, Trans. Acad. Sci. St. Louis 13: 180. 1903, *nom. altern.* Type: SURINAM: 1827, *Weigelt s.n.* (isotype: MO-116197 fragm. ex herb Bernhardi!).

Eragrostis capitata (Nutt.) Nash, Man. Fl. N. States 1042. 1901. *Poa capitata* Nutt., Trans. Amer. Philos. Soc., n.s., 5:146. 1835. Type: U.S.A. Arkansas: sand beaches of the Arkansas, *N. Nuttall* s.n. (isotype: US-2821449 fragm!).

Annuals; unisexual, pistillate and staminate plants morphologically similar; mat-forming, without innovations, without glands. Culms 5–20 cm tall, rooting at the lower nodes, erect or decumbent, glabrous, pilose, or villous, particularly below the panicles. Leaf sheaths mostly scabrous, margins sometimes with hairs 0.1–0.4 mm long; ligules 0.1–0.6 mm long; blades 1–4 cm long, 1–4.5 mm wide, flat or conduplicate, abaxial surfaces glabrous, adaxial surfaces appressed pubescent, hairs about 0.2 mm long. Panicles 1–3 cm long, 0.6–2.5 cm wide, terminal, ovate, contracted, exerted or partially included in the upper leaf sheaths, rachises somewhat viscid, pilose or glabrous; primary branches 0.5–1.5 cm long, appressed to the rachises, each terminating in a spikelet; pulvini sparsely pilose or glabrous; pedicels 0.2–2 mm long, shorter than the spikelets, glabrous or hairy. Spikelets 5–26 mm long, 1.5–4.7 mm wide, linear to ovate, greenish to stramineous, with 16–60 florets; disarticulation in the pistillate florets basipetal, the lemmas falling separately, staminate spikelets not or tardily disarticulating; glumes unequal, ovate, hyaline, glabrous or sparsely hirsute; lower glumes 0.8–1.6 mm long, 1-veined; upper glumes 1.5–2.5 mm long, 1–3-veined; lemmas (1.5–)1.8–4 mm long, ovate, hyaline to membranous, lateral veins conspicuous, greenish, apices acute to acuminate, sometimes prolonged into a mucro, mucros to 0.4 mm long; paleas 0.7–3.8 mm long, hyaline, about 1/2 as long as the lemmas in pistillate florets, as long as the lemmas in staminate florets, keels scabridulous; stamens 3; anthers 1.4–2.2 mm long, reddish to yellowish. Caryopses 0.4–0.6 mm long, ellipsoid, somewhat laterally compressed, smooth, light reddish-brown. $2n = 60$.

Distribution and habitat.—*Eragrostis reptans* is native to the Flora region and grows in wet sand, gravel, and clay soils along rivers and lake margins from southcentral United States to northeastern México, frequently with *Cynodon dactylon* and *Heliotropium*; 0–1350 m.

Comments.—*Eragrostis reptans* is unique among the species of *Eragrostis* in the Flora region because it is unisexual with male and female plants that can easily be mistaken for two separate species. The male plants have florets with well developed anthers (1.4–2.2 mm long), lack caryopses, and have spikelets that are arranged in a loose panicle. The female plants have florets that lack stamens or have stamens with rudimentary anthers, develop mature caryopses, and have spikelets that are arranged in a tight panicle, at first glance appearing to be inserted digitately.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Juárez, Presa Don Martín, *L.H. Harvey 927 & 929*(US), *F.W. Gould 11242* (TEX-LL), *Valdés-Reyna & L.E. Rodríguez G. 1926* (ANSM); Municipio de Progreso, 38 mi SE of Sabinas along Hwy 22, NE side of Venustiano Carranza Lake, *P.M. Peterson & J. Valdés-Reyna 8375* (ANSM, US). **Nuevo León:** 48 km S of Nuevo Laredo on road to Monterrey, *T.C. & E.M. Frye 2345* (US). **Tamaulipas:** Municipio de Matamoros, Ejido El Soliseño, *J. Cantu 32* (COCA).

21. Eragrostis secundiflora subsp. **oxylepis** (Torr.) S.D. Koch, Rhodora 80(823):397. 1978. (**Fig. 6, D & E**). *Poa interrupta* Nutt., Trans. Amer. Philos. Soc., n.s., 5:196. 1837, *nom. illeg. hom. Poa oxylepis* Torr., Explor. Red River Louisiana 301, t. 19. 1853. *Eragrostis oxylepis* (Torr.) Torr., Pacif. Railr. Rep. 4:156. 1857. *Megastachya oxylepis* (Torr.) E. Fourn., Mexic. Pl. 2:118. 1886. TYPE: U.S.A. ARKANSAS: near the sandy banks of the Arkansas River, *Nuttall s.n.* (HOLOTYPE: PH).

Caespitose perennials, with innovations, not glandular. Culms 30–75 cm tall, erect, glabrous below. Leaf sheaths overlapping below, 1/2 as long as the internodes above, mostly glabrous, hairy at the apices, hairs to 4 mm long; ligules 0.2–0.3 mm long; blades 10–25(–40) cm long, 1–5 mm wide, involute, glabrous abaxially, scabridulous adaxially, sometimes also sparsely pilose. Panicles (3–) 5–30 cm long, 1–15 cm wide, from narrowly oblong, glomerate, and interrupted below to ovate and open; primary branches 0.5–12(–16) cm, appressed or diverging up to 40° from the rachises, stiff; pulvini glabrous or sparsely hairy; pedicels 0–1(–3) mm, appressed, flattened. Spikelets 6–16(–23) cm long, 2.4–5 mm wide, ovate to linear-elliptic, flattened, stramineous, with reddish-purple margins or completely reddish-purple, with 10–45 florets; disarticulation basipetal, florets falling intact and before the glumes; glumes ovate-lanceolate to lanceolate, membranous; lower glumes 1.7–3 mm long; upper glumes 2.2–4 mm long, apices acuminate; lemmas 2–6 mm long, ovate, membranous to leathery, apices usually acuminate or attenuate, sometimes acute; paleas 1.5–3 mm long, membranous to leathery, narrower than the lemmas, apices obtuse, sometimes bifid; stamens 2; anthers 0.2–0.5 mm long, brownish. Caryopses 0.8–1.3 mm long, ellipsoid, somewhat laterally flattened, smooth, reddish-brown. $2n = 40$.

Distribution and habitat.—There are two subspecies of *E. secundiflora*; plants from the Flora region belong to *E. secundiflora* subsp. *oxylepis* (Torr.) S.D. Koch. It is native to the Flora region and grows in sandy soils, dunes, grasslands, beaches, and roadsides; 0–300 m. The range of *E. secundiflora* extends into southern United States.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de Abasolo, 2 km from Ejido Morelos, *R. Díaz-Pérez 272* (UAT); Municipio de Aldama, Playa Rancho Nuevo, *R. Díaz-Pérez 27* (ANSM, UAT), Rancho La Fortuna, *R. Sandoval-Hernández 39* (COCA); Rancho Nuevo, *J.L. Ramos-Delgado* (COCA); Rancho

Santa Rosa, *G. Bores-Kulman 6* (COCA); Barra del Tordo, *M.H. Cervera-Rosado 95* (COCA); Municipio de Altamira, Bocatoma, *Brigada de Dunas 695, 708* (COCA, MEXU); S of Lomas del Real, 7 mi N of main Hwy on dirt road just N of Altamira, *M.C. Johnston* (TEX-LL, US); Municipio de Ciudad Madera, Beach at Tampico, *A.A. Bettle M-534* (US); Municipio de Jiménez, Ejido Sor Juana Inés de la Cruz, *J.G. Galván-Infante 324* (COCA); Municipio de Matamoros, 7 km NW of Mezquital of road to Matamoros, *A. Mora-Olivo & J.L. Mora L. 5502* (MEXU, UAT); 25 km S of Playa Lauro Villar, *D. Baro-Peruyero et al. 257* (UAT); Playa Bagdad, 16 km N of Playa Lauro Villar, *D. Baro-Peruyero et al. 454* (UAT); Playa Lauro Villar, *A. Brito 58* (COCA); Municipio de Méndez, Rancho Guadalupe, *J.F. Iribe-Duarte 209* (COCA); Municipio de Nuevo Laredo, 30 km W of Nuevo Laredo, *without collector* (COCA); Laredo, *H. LeSueur 656* (US); Municipio de San Fernando, Carbonera, *R.A. Carranco-Rendon 379* (COCA); Municipio de Soto La Marina, Barra de Soto La Marina, E del Carrizo, *D. Baro-Peruyero et al. s.n.* (ANSM); Ejido Los Arroyos, *A. Brito 152* (COCA); Ex-Hacienda Santa Rosita, Rancho del Licenciado, *A. Mora-Olivo 592* (UAT); Marina Playa de La Pesca, *M. Alfaro s.n.* (UAT); Rancho San Alfonso, *J. Cantu 14* (COCA); 13 mi E of Abasolo turnoff on the Santander Jiménez-Pesca road, *J. Crutchfield 6141-A* (TEX-LL); 20 mi E of the San Fernando-Santander Jiménez Hwy on the road to Loreto, *J. Crutchfield 5541-BK* (TEX-LL); Papalote de la Micrandena, Rancho Loreto, *J. Crutchfield 5554-A* (TEX-LL); Municipio de Soto La Marina, Chamal, *J.R. Swallen 1661, 1689, 1740* (US); Municipio de Tampico, sand dunes, Tampico, *A.S. Hitchcock 5794* (US); unknown Municipio, Hacienda Buena Vista, *E.O Wooton s.n.* (US).

22. Eragrostis sessilispica Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:97. 1862. **(Fig. 13, A–C).** *Acamptoclados sessilispicus* (Buckley) Nash, Fl. S.E. U.S. 140. 1903. TYPE: U.S.A. TEXAS: near Austin, *Buckley s.n.* (LECTOTYPE: PH, designated by Hitchcock, Man. Grasses U.S. 852. 1935, but without citing a specific sheet in a specific herbarium).

Diplachne rigida Vasey, U.S.D.A. Div. Bot. Bull. 12(2):t. 44. 1891. *Leptochloa rigida* Munro ex Vasey, U.S.D.A. Div. Bot. Bull. 12(2):t. 44. 1891. *Eragrostis rigida* (Vasey) Scribn., Proc. Acad. Nat. Sci. Philadelphia 43(2):304. 1891. *Rhabdochloa rigida* (Munro ex Vasey) Kuntze, Revis. Gen. Pl. 2:788. 1891. TYPE: U.S.A. TEXAS: *J. Reverchon 30* (HOLOTYPE: US-908831!).

Caespitose perennials, with innovations, not glandular. Culms 30–90 cm tall, erect or decumbent, glabrous below the nodes. Leaf sheaths overlapping below, 1/2 to as long as the internodes above, hairy at the apices and on the collars, sometimes also on the distal portion of the margins, hairs to 5 mm long; ligules 0.4–0.5 mm long; blades 5–30 cm long, 1–3 mm wide, usually involute, sometimes flat, abaxial surfaces glabrous or sparsely pilose, hairs to 5 mm long, adaxial surfaces scabridulous. Panicles 20–65 cm long, 10–35 cm wide, ovate, open; primary branches 2–20(–24) cm long, widely spaced, diverging 20–100° from the rachises, not rebranched, naked basally; pulvini hairy; pedicels 0–12 mm long, appressed, proximal spikelets on each branch sessile or subsessile, the pedicels shorter than 0.4 mm long. Spikelets 5–13 mm long, 1.4–3 mm wide, oblong to oblanceolate, stramineous to reddish-purple, with 3–12 florets; disarticulation tardy, basipetal, in the rachilla below the florets, glumes persistent; glumes lanceolate, broad basally, indurate; lower glumes 2.5–6 mm long; upper glumes 3–6 mm long, apices acuminate; lemmas 3–5 mm long, narrowly ovate to lanceolate, indurate, apices acuminate; paleas 2.4–4.6 mm long, indurate, gibbous basally but the sides not projecting beyond the lemmas, keels ciliolate, apices obtuse; stamens 3; anthers 0.3–0.5 mm long, reddish-brown. Caryopses

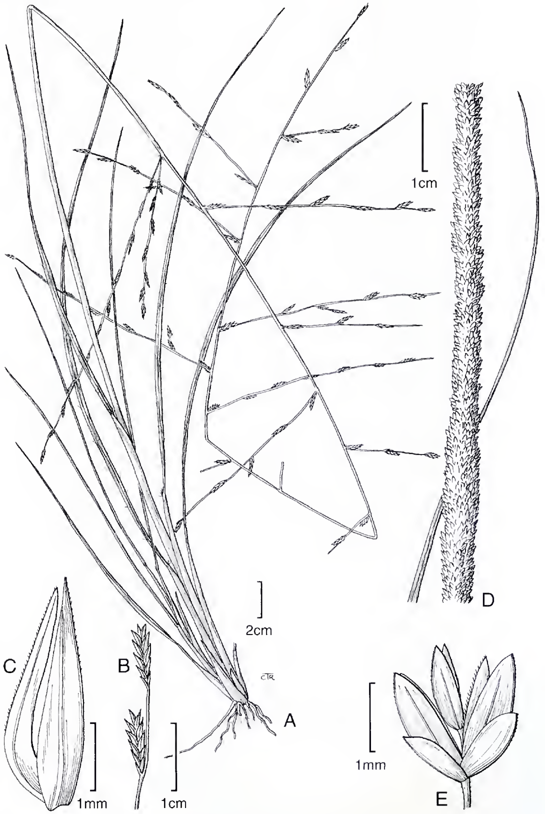


Fig. 13. *Eragrostis sessilispica*. **A.** Habit. **B.** Panicle branch with two spikelets. **C.** Floret. *Eragrostis spicata*. **D.** Infloresence (portion) and blade. **E.** Spikelet.

0.9–1.5 mm long, ovoid to pyriform, laterally flattened, tapering distally, smooth to faintly striate, brownish. $2n = 40$.

Distribution and habitat.—*Eragrostis sessilispica* is native to the Flora region and grows in prairies, limestone mesas, thorn forest openings, and grasslands, generally in sandy soils, at 0–300 m, often in association with *Prosopsis* and *Quercus*. Its range extends into Texas, New Mexico, Oklahoma, and Kansas.

Comments.—*Eragrostis sessilispica* is characterized by having panicle branches that are not rebranched and sessile or subsessile spikelets on the lower portions of each branch.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de Soto La Marina, Chamal, *J.R. Swallen 1739* (US-1502972); unknown Municipio, Buena Vista Hacienda, *E.O. Wooton s.n.* (US-1061799).

23. Eragrostis silveana Swallen, Amer. J. Bot. 19(5):438, f. 3. 1932. (**Fig. 4, C & D**).
TYPE: U.S.A. TEXAS Bexar Co.: 1–31 Oct 1931, *W.A. Silveus 360* (HOLOTYPE: US-1501596!; ISOTYPES, US-1501597!, US-1501598!, US-1501599!, US-1501600!).

Caespitose perennials, with innovations and short, knotty rhizomes less than 4 mm thick. Culms 45–60 cm tall, erect, often glandular below the nodes, sometimes viscid. Leaf sheaths overlapping, 1–2 times as long as the internodes, often viscid, sometimes sparsely pilose, hairy at the apices, hairs to 6 mm long; ligules 0.2–0.3 mm long; blades 8–25 cm long, 2–4 mm wide, flat to involute, glabrous, sometimes viscid. Panicles 20–35(–42) cm long, 10–22 cm wide, broadly ovate, open, bases included in the uppermost leaf sheaths; primary branches 5–14 cm long, diverging 20–90° from the rachises, capillary, sometimes viscid, naked basally; pulvini hairy, hairs to 6 mm long; pedicels (1–)1.5–12 mm, diverging or appressed. Spikelets (2.5–)3–4.8 mm long, 0.9–1.4 mm wide, linear-lanceolate, reddish-purple, with 4–9 florets; disarticulation basipetal, glumes persistent; glumes lanceolate, membranous; lower glumes 0.9–1.2 mm long; upper glumes 1–1.3 mm long; lemmas 1.1–1.4 mm long, ovate to lanceolate, membranous, lateral veins conspicuous, apices acute; paleas 1–1.4 mm long, hyaline, not wider than the lemmas, apices obtuse; stamens 3; anthers 0.2–0.3 mm long, purplish. Caryopses 0.5–0.6 mm long, ellipsoid, terete in cross section, neither ridged nor grooved, faintly striate, reddish-brown.

Distribution and habitat.—*Eragrostis silveana* is native to the Flora region and grows in various open habitats, from sandy prairies to clay loam flats, near roadsides, railroads, and fields; 0–1310 m. Its range is limited to the coastal plain of Texas and higher plains of eastern México.

Comments.—Morphologically, *E. silveana* is somewhat intermediate between *E. spectabilis* and *E. curtipedicellata*, and grows where the distribution of these two species overlaps. *Eragrostis silveana* can be separated from *E. curtipedicellata* by having long pedicels (1.5–12 mm long in the former verses 0.2–1.2 mm long in the latter), shorter lemmas (1.1–1.4 mm long verses 1.5–2.2 mm long), and shorter caryopses (0.5–0.6 mm long verses 0.6–0.8 mm long).

Eragrostis silveana differs from *E. spectabilis* by having viscid to glandular sheaths or blades, terete caryopses, and leathery lemmas.

Specimens examined. **MÉXICO. Nuevo León:** Municipio de Linares, 11 mi N of Linares, *M.C. Johnston & A.J. Graham 4642* (TEX-LL). **Tamaulipas:** Municipio de Casas, 64 km from Soto La Marina towards Casas and Victoria, *F. Martinez Martinez & G. Borja Luyando F-2360* (TEX-LL, US), 35 km from Victoria on road to Soto La Marina, *F. Martinez Martinez & G. Borja Luyando F-2336* (US); Municipio de Jaumave, 4 mi S of Jaumave, *Stanford, Lauber & Tayler 2318* (US); Municipio de Llera, 26 mi S of Ciudad Mante on Hwy 85, *L.H. Harvey & T.J. Witherspoon 9220* (TEX-LL; US); Chamal, *J R Swallen 1645, 1674, 1687, 1704* (US).

24. Eragrostis spectabilis (Pursh) Steud., Nomencl. Bot. (ed. 2) 1:564. 1840. (**Fig. 1, C–E**). *Poa amabilis* Walter, Fl. Carol. 80. 1788, nom. illeg. hom. *Poa spectabilis* Pursh, Fl. Amer. Sept. 1:81. 1814. *Megastachya spectabilis* (Pursh) Roem. & Schult., Syst. Veg. 2:589. 1817. *Poa hirsuta* var. *spectabilis* (Pursh) Torr., Fl. N. Middle United States 1(1):114. 1823. *Eragrostis pectinacea* var. *spectabilis* (Pursh) A. Gray, Manual (ed. 2) 565. 1856. *Erochloe spectabilis* (Pursh) Raf. ex B.D. Jacks., Index Kew. 1:886. 1893. TYPE: U.S.A. SOUTH CAROLINA: *Clayton 580* (ISOTYPE: US-2891488 fragm!).

Eragrostis geyeri Steud., Syn. Pl. Glumac. 1:272. 1854. *Poa pectinacea* Geyer ex Steud., Syn. Pl. Glumac. 1:272. 1854, hom. illeg. et nom. inval. TYPE: U.S.A. ILLINOIS: *C.A. Geyer s.n.* (ISOTYPE: US-2891474 fragm!).

Eragrostis spectabilis var. *sparsihirsuta* Farw., Amer. Midl. Naturalist 10:306. 1927. TYPE: U.S.A. MICHIGAN.

Eragrostis velutina Schrad., Linnaea 12:451. 1838. *Poa villosa* Beyr. ex Schrad., Linnaea 12(4):451. 1838, *nom. inval.* TYPE: U.S.A. CAROLINA: *Beyrich s.n.*

Caespitose perennials, with innovations and short, knotty rhizomes less than 4 mm thick. Culms 30–70(–85) cm tall, erect to ascending, often sprawling, glabrous. Leaf sheaths overlapping, hairy on the margins and at the apices, hairs to 7 mm long; ligules 0.1–0.2 mm long; blades 10–32 cm long, 3–8 mm wide, flat to involute, both surfaces usually pilose, sometimes glabrous on both surfaces or glabrous abaxially and sparsely pilose adaxially, often with a line of hairs behind the ligules, hairs to 8 mm long. Panicles (15–)25–45(–60) cm long, 15–35 cm wide, broadly ovate to oblong, open, basal portions sometimes included in the uppermost leaf sheaths; primary branches (6–)12–20 cm long, diverging 20–90° from the rachises, capillary, naked below; pulvini hairy, hairs to 6 mm long; pedicels 1.5–17 mm long, divergent or appressed. Spikelets 3–7.5 mm long, 1–2 mm wide, linear-lanceolate, reddish-purple, sometimes olivaceous, with (4–) 6–12 florets; disarticulation basipetal, glumes persistent; glumes (1–)1.3–2.3 mm long, subequal to equal, lanceolate, membranous to chartaceous; lemmas (1–) 1.3–2.5 mm long, ovate to lanceolate, leathery, 3-veined, apices acute; paleas (1–) 1.2–2.4 mm long, membranous, keels sometimes shortly ciliate, apices obtuse to truncate; stamens 3; anthers 0.3–0.5 mm long, purplish. Caryopses 0.6–0.8 mm long, ellipsoid, strongly flattened, adaxial surfaces with 2 prominent ridges separated by a groove, reddish-brown. $2n = 20, 40, 42$.

Distribution and habitat.—*Eragrostis spectabilis* is native in the Flora region, extending from southern Canada through the United States, México, and Belize.

It grows in fields and on the margins of woods, along roadsides, and in other disturbed sites, usually in sandy to clay loam soils, and is associated with hardwood forests, *Prosopsis-Acacia* grasslands, and shortgrass prairies; 0–1000 m.

Comments.—A showy species, *E. spectabilis* is available commercially for planting as an ornamental.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Nava, Río Grande Valley, just N of Río Escondido, 18 km SW of Piedras Negras on México Hwy 57, *H.H. Iltis & A. Lasseigne 16* (COCA); Municipio de Saltillo 18 km W of Saltillo, *A.A. Beetle M-418* (COCA). **Nuevo León:** Municipio de General Bravo, General Bravo, *J.A Ochoa-Guillemar 1166* (COCA); Municipio de Linares, Cañón Los Pinos, *T.S.P. s/n* (ANSM); without Municipio, Lampazos-Bustamante, *J.A. Ochoa-Guillemar 1224* (COCA). **Tamaulipas:** Municipio de Aldama, Ejido Lauro Aguirre, *P. Moya-Salgado 253* (COCA); km 10 a Barra del Tordo, *M.H. Cervera-Rosado 30* (COCA); Municipio de Casas, Predio González, *M.H. Cervera-Rosado 303* (COCA); Municipio de Victoria, Colonia La Estrella, Ciudad Victoria, *M. Cisneros 52* (COCA).

25. Eragrostis spicata Vasey, Bot. Gaz. 16(5):146. 1891. (**Fig. 13, D & E**). TYPE: MÉXICO. BAJA CALIFORNIA SUR: San José del Cabo, 12 Sep 1890, *T.S. Brandegee 10* (HOLOTYPE: US-1761638!).

Sporobolus tenuispica Hack., Repert. Spec. Nov. Regni Veg. 6(21–26):344. 1909. TYPE: PARAGUAY. GRAN CHACO: Pilcomayo, Jun, *T. Rojas 258* (HOLOTYPE: W; ISOTYPES: BAA-2931 fragm. ex herb. Hassler; US-2891485 fragm!).

Caespitose perennials, with innovations. Culms 75–100 cm tall, erect, glabrous. Leaf sheaths overlapping, about as long as the internodes above, hirtellous on the margins when immature, apices glabrous or hairy, the hairs shorter than 0.5 mm long; ligules 0.2–0.3 mm long; blades 20–40 cm long, 2–5(–6) mm wide, flat to involute, glabrous abaxially, scabrous adaxially. Panicles 22–40 cm long, 0.3–0.6 cm wide, spike-like, dense; primary branches shorter than 1.2 cm long, closely appressed, spikelet-bearing to the base; pulvini glabrous; pedicels 0.1–0.6 mm long, mostly appressed, hirtellous. Spikelets 1.4–2.2 mm long, 0.9–1.2 mm wide, ovate, stramineous to light greenish, with 2 or 3 florets; disarticulation basipetal, in the rachilla below the individual florets or at the base of the florets, glumes persistent; glumes elliptic to ovate, hyaline, keels ciliolate; lower glumes 0.7–1 mm long; upper glumes 0.9–1.3 mm long, apices obtuse; lemmas 1.5–2.1 mm long, ovate, membranous to hyaline, apices acute to obtuse; paleas 1.1–1.6 mm long, hyaline, not wider than the lemmas, apices obtuse; stamens 2; anthers 0.3–0.4 mm long, reddish-brown. Caryopses 0.7–1 mm long, ellipsoid, somewhat ventrally flattened, smooth to faintly striate, reddish-brown. $2n = 40$.

Distribution and habitat.—*Eragrostis spicata* is native to the Flora region and grows in moist areas in prairies, usually in deep, sandy, clay loam soils; 0–130 m. It is native from southern Texas to México and also found in Paraguay and Argentina. In North America, *E. spicata* grows with *Andropogon*, *Quercus stellata*, *Prosopsis glandulosa*, and *Acacia*.

Comments.—*Eragrostis spicata* is characterized by having a spike-like, narrow panicle (0.3–0.6 mm wide) with short closely appressed branches and 2- or 3-flowered spikelets.

Specimens examined. **MÉXICO. Tamaulipas:** Municipio de San Fernando, 23 mi from San Fernando-Matamoros Hwy, at Junction of road to Reynosa, *M.C. Johnston & A.J. Graham 4714* (TEX-LL); near Santa Teresa, 50 mi S of Matamoros, *M.C. Johnston & J. Crutchfield 5495* (TEX-LL, US); Municipio de Tampico, Tampico, *M.A. Madrigal-A. s.n.* (ANSM).

26. Eragrostis superba Peyr., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl. 38:584. 1860. (**Fig. 11, D–H**). TYPE: ANGOLA. Benguela, *Wawra 244* (HOLOTYPE: W).

Caespitose perennials, with innovations, without glands. Culms 45–95 cm tall, erect, glabrous. Leaf sheaths overlapping below, 1/3–1/2 the length of the internodes above, hairy at the apices and on the margins, hairs to 6 mm long; ligules 0.5–1.2 mm long; blades 7–30 cm long, 2.5–7 mm wide, flat to loosely involute, glabrous abaxially, scabrous adaxially, margins sharply scabrous. Panicles 10–30 cm long, 1–6 cm wide, oblong, condensed, interrupted below; primary branches 1–11 cm long, appressed or diverging to 40° from the rachises, naked basally; pulvini glabrous; pedicels 0.5–25 mm long, with a narrow band or abscission line below the apices. Spikelets 5.5–16 mm long, 2.7–9 mm wide, ovate, flattened, greenish to stramineous, sometimes with a reddish-purple tinge, with 4–22 florets; disarticulation below the glumes, spikelets falling intact; glumes equal, 3–4.5 mm long, ovate, chartaceous; lemmas 3–5 mm long, broadly lanceolate, chartaceous to leathery, lateral veins green, apices acute; paleas 3–5 mm long, chartaceous to hyaline, keels broadly winged below, forming a' wing or tooth on each side that often projects beyond the lemma bases, apices acuminate; stamens 3; anthers 1.4–2.8 mm long, golden-yellow. Caryopses 1–2 mm long, ellipsoid, adaxial surfaces flattened, reddish-brown. $2n = 40$.

Distribution and habitat.–*Eragrostis superba* is introduced to the Flora region and native to Africa, where it is grown for hay, being fairly palatable and drought resistant. It is also used for erosion control and re-vegetation. In the Flora region, *E. superba* grows on rocky slopes, in sandy flats, and along roadsides, often with *Acacia, Prosopsis, Fouquieria splendens, Juniperus*, and *Quercus*; 480–1900 m.

Comments.—In addition to having very large spikelets (5.5–16 mm long and 2.7–9 mm wide), *Eragrostis superba* has winged paleas that often project beyond the lemmas when viewed laterally.

Specimens examined. **MÉXICO. Coahuila:** Municipio de Ramos Arizpe, Campo experimental de Zonas Áridas La Sauceda, *L. Luan-Olague s.n.* (ANSM); Municipio de Saltillo, Buenavista, 7 km S de Saltillo, *Valdés-Reyna s.n.* (ANSM); Cañón de San Lorenzo, 5 km de Saltillo hacia Zacatecas, *M.A. Madrigal-A. s.n.* (MEXU). **Tamaulipas:** Municipio de Llera, La Angostura, Llera-Victoria, *J.F. Iribe-Duarte 376* (COCA).

EXCLUDED SPECIES

Eragrostis swallenii Hitchc. has been reported from the Flora region (Beetle et al. 1991; Espejo-Serna et al. 2000), but no specimens supporting its presence have been located.

ACKNOWLEDGMENTS

We wish to thank the curators at the following herbaria for help locating specimens: COCA, MEXU, MO, TEX, UAT; the Smithsonian Institutions, Fellowships and Grants for supporting research visits by JVR to the United States National Herbarium; the Scholarly Studies Program, Research Opportunities, Atherton Seidell Foundation, and Biodiversity Surveys and Inventories Program all at the Smithsonian Institution for financial support; Utah State University for permission to use illustrations that appeared in Flora of North America, Volume 25, prepared by Linda A. Vorobik and Cindy Roché; Alice R. Tangerini for preparing illustrations for *Eragrostis hirta* and for preparing all the plates; Miguel Carranza for help preparing the specimens examined; and Kelly W. Allred, Yolanda Herrera Arrieta, and Barney Lipscomb for reviewing the manuscript.

REFERENCES

Amarasinghe, V. and L. Watson. 1990. Taxonomic significance of microhair morphology in the genus *Eragrostis* Beauv. (Poaceae). Taxon 39:59–65.

Beetle, A.A. E. Manrique Forceck, J.A. Miranda Sánchez, V. Jaramillio Luque, A. Chimal Hernández, and A.M. Rodríguez Rodriguez. 1991. *Eragrostis* V. Wolf. In: Las Gramineas de Mexico, Tomo III. COTECOCA, S.A.R.H., México, DF., México. Pp. 50–97.

Boechat, S.C. and H.M. Longhi-Wagner. 2001. O gênero *Eragrostis* (Poaceae) no Brasil. Iheringia, Bot. 55:23–169.

Clayton, W.D. 1974. 56. *Eragrostis*. In: Clayton, W.D., S.M. Phillips, and S.A. Renvoize, Gramineae (part 2), Flora of Tropical East Africa. A.A. Balkema, Rotterdam. Pp. 188–244.

Clayton, W. D. and S. A. Renvoize. 1986. Genera Graminum: Grasses of the World. Her Majesty's Stationary Office, London.

Clifford, H.T. 1996. Etymological Dictionary of Grasses, Version 1.0 (CD-ROM). Expert Center for Taxonomic Identification, Amsterdam, The Netherlands.

Columbus, J.T., R. Cerros-Tlatilpa, M.S. Kinney, M.E. Siqueiros-Delgado, H.L. Bell, and M.P. Griffith. 2005. Molecular phylogenetics of the Chloridoideae (Gramineae). In: J.T. Columbus, E.A. Friar, J.M. Porter, L.M. Prince and M.G. Simpson, eds. Monocots: Comparative biology and evolution, 2 vols. Rancho Santa Ana Botanic Garden, Claremont, In Press.

Cope, T.A. 1998. A synopsis of *Eragrostis* Wolf (Poaceae) in the flora Zambesiaca area. Kew Bull. 53:129–164.

Davidse, G. 1994. 83. *Eragrostis* Wolf. In: G. Davidse, M Sousa S., and A.O. Chater, eds. Flora Mesoamericana Vol. 6 Alismataceae a Cyperaceae. Universidad Nacional Autónoma de México, México D.F., Missouri Botanical Garden, and The Natural History Museum (London). Pp. 263–272.

Dávila-Aranda, P., R. Lira-Saade, and J. Valdes-Reyna. 2004. Endemic species of grasses in Mexico: A phytogeographic approach. Biodivers. & Conservation 13:1101–1121.

Ellis, R.P. 1984. *Eragrostis walteri*–A first record on non-Kranz leaf anatomy in the subfamily Chloridoideae (Poaceae). South Africa J. Bot. 3:380–386.

Espejo-Serna, A., A.R. López-Ferrari, and J. Valdés-Reyna. 2000. Poaceae. In: A. Espejo Serna and A.R. López-Ferrari, eds. Las Monocotyledóneas Mexicanus: una synopsis florística, Partes IX–XI. Consejo Nacional de la Flora de México, A.C., Univerisidad Autónoma Metropolitana-Izapalapa, and Comisión Nacional para el conocimiento y uso de la Biodiversidad, México, D.F. Pp. 10:8–236.

Fournier, E. 1886. Mexicanas plantas. Pars secunda: Gramineae 2:1–160.

Harvey, L.H. 1948. *Eragrostis* in North and Middle America. PhD dissertation, University of Michigan, 269 pp.

Hilu, K.W. and L.A. Alice. 2000. Phylogenetic relationships in subfamily Chloridoideae (Poaceae) based on *mat*K sequences. A preliminary assessment. In: S.W.L. Jacobs and J. Everett, eds. Grasses: Systematics and evolution. CSIRO, Melbourne. Pp. 184–188.

Hilu, K.W. and L. A. Alice. 2001. A phylogeny of Chloridoideae (Poaceae) based on *mat*K sequences. Syst. Bot. 26:386–405.

Ingram, A.L. and J.J. Doyle. 2003. The origin and evolution of *Eragrostis tef* (Poaceae) and related polyploids: evidence from nuclear *waxy* and plastid *rps*16. Amer. J. Bot. 90:116–122.

Ingram, A.L. and J.J. Doyle. 2004. Is *Eragrostis* (Poaceae) monophyletic? Insights from nuclear and plastid sequence data. Syst. Bot. 29:545–552.

Ingram, A.L. and J.J. Doyle. 2005. *Eragrostis* (Poaceae): Monophyly and infrageneric classification. In: J.T. Columbus, E.A. Friar, J.M. Porter, L.M. Prince and M.G. Simpson, eds. Monocots: Comparative biology and evolution, 2 vols. Rancho Santa Ana Botanic Garden, Claremont, In Press.

Koch, S.D. 1974. The *Eragrostis pectinacea-pilosa* complex in North and Central America (Gramineae: Eragrostideae). Illinois Biol. Monogr. 48:1–75.

Koch, S.D. and I. Sánchez-Vega. 1985. *Eragrostis mexicana, E. neomexicana, E. orcuttiana,* and *E. virescens*: the resolution of a taxonomic problem. Phytologia 58:377–381.

Lazarides. M. 1997. A revision of *Eragrostis* (Eragrostideae, Eleusininae, Poaceae) in Australia. Austral. Syst. Bot. 10:77–187.

McVaugh, R. 1983. Flora Novo-Galiciana. A descriptive account of the vascular plants of western México. Gramineae. 14:1–436. University of Michigan Press, Ann Arbor.

Nicora, E.G. 1998. Revisíon del género *Eragrostis* Wolf (Gramineae-Eragrostideae) para Argentina y países limítrofes. Boissiera 54:8–109.

Ogden, E.L. 1896. II. Leaf structure of *Jouvea* and of *Eragrostis obtusiflora*. Bull. Torrey Bot. Club. 23:10–20, 22, plate XIII, IX.

Peterson, P.M. 2001. 7. *Eragrostis* Wolf, pp. 25–55. In: Laegaard, S. and P.M. Peterson, 214(2). Gramineae (part 2) subfam. Chloridoideae. Flora of Ecuador 68:1–131.

Peterson, P.M. 2003. *Eragrostis*. In: M.E. Barkworth, K. M. Capels, S. Long and M. B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Flora of North America North of Mexico, volume 25. Oxford University Press, New York. Pp. 65–105.

Peterson, P.M, J.T. Columbus, and S.J. Pennington. 2005. Classification and biogeography of New World grasses: Chloridoideae. In: J.T. Columbus, E.A. Friar, J.M. Porter, L.M. Prince and M.G. Simpson, eds. Monocots: Comparative biology and evolution, 2 vols. Rancho Santa Ana Botanic Garden, Claremont, In Press.

PETERSON, P.M., R. J. SORENG, G. DAVIDSE, T. FILGUERIAS, F. O. ZULOAGA, and E. JUDZIEWICZ. 2001. Catalogue of New world grasses (Poaceae): II. subfamily Chloridoideae. Contr. U.S. Natl. Herb. 41:1–255.

PETERSON, P.M., R. D. WEBSTER, and J. VALDÉS-REYNA. 1995. Subtribal classification of the New World Eragrostideae (Poaceae: Chloridoideae). Sida 16:529–544.

PETERSON, P.M., R. D. WEBSTER, and J. VALDÉS-REYNA. 1997. Genera of the New World Eragrostideae (Poaceae: Chloridoideae). Smithsonian Contr. Bot. 87:1–50.

PRENDERGAST, H.D.V., P.W. HATTERSLLEY, N.E. STONE, and M. LAZARIDES. 1986. C_4 acid decarboxylation type in *Eragrostis* (Poaceae): patterns of variation in chloroplast position, ultrastructure and geographical distribution. Pl. Cell Environm. 9:333–344.

REEDER. J.R. 1986. Another look at *Eragrostis tephrosanthos* (Gramineae). Phytologia 60: 153–154.

SÁNCHEZ VEGA, I. and S.D. KOCH. 1988. Estudio biosistemático de *Eragrostis mexicana*, *E. neomexicana*, *E. orcuttiana*, y *E. virescens* (Gramineae: Chloridoideae). Bol. Soc. Bot. 48: 95–112.

SIMON, B.K. 1983. Nomenclatural notes on *Eragrostis cilianensis* (All.) Vign. ex Janchen. Austral. Syst. Bot. Soc. Newslett. 37:6–7.

VAN DEN BORRE, A. and L. WATSON. 1994. The infrageneric classification of *Eragrostis* (Poaceae). Taxon 43:383–422.

VAN DEN BORRE, A. and L. WATSON. 1997. On the classification of the Chloridoideae (Poaceae). Austral. Syst. Bot. 10:491–531.

VAN DEN BORRE, A. and L. WATSON. 2000. On the classification of the Chloridoideae: Results from morphological and leaf anatomical data analyses. In: S.W.L. Jacobs and J. Everett, eds. Grasses: Systematics and evolution. CSIRO, Melbourne. Pp. 180–183.

WATSON, L. and M. J. DALLWITZ. 1992. The grass genera of the World. C.A.B. International, Wallingford, U.K.

WATSON, L. and M.J. DALLWITZ. 2003. Grass genera of the World: descriptions, illustrations, identification, and information retrieval; including synonyms, morphology, anatomy, physiology, phytochemistry, cytology, classification, pathogens, World and local distribution, and references. delta-intkey.com.

WITHERSPOON, J.T. 1975. A numerical taxonomic study of the *Eragrostis intermedia* complex (Poaceae). PhD dissertation, University of Montana, 479 pp.

WOLF, N.M. VON. 1776. Genera plantarum vocabulis characteristicis definita. Published by the author, Königsberg.

A REVISION OF *TRISETUM* AND *GRAPHEPHORUM* (POACEAE: POOIDEAE: AVENINAE) IN NORTH AMERICA NORTH OF MÉXICO

Víctor L. Finot

Universidad de Concepción
Facultad de Agronomía
Departamento de Producción Animal
Casilla 537, Chillán, CHILE
vifinot@udec.cl

Paul M. Peterson and
Robert J. Soreng

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, (DC) 20013-7012, U.S.A.
peterson@si.edu; sorengr@si.edu

Fernando O. Zuloaga

Instituto de Botánica Darwinion
Labardén 200
San Isidro 1642, ARGENTINA
fzuloaga@darwin.edu.ar

ABSTRACT

A taxonomic treatment of *Trisetum* Pers. and *Graphephorum* Desv. in North America north of México is given. Eight species of *Trisetum* are recognized. Two species are endemic to the United States: *T. orthochaetum* (Montana) and *T. projectum* (California, Montana, and Nevada); *Trisetum cernuum* subsp. *cernuum*, *T. cernuum* subsp. *canescens*, *T. montanum*, *T. sibiricum*, *T. spicatum* var. *spicatum*, and *T. spicatum* var. *pilosiglume* are found in Canada and the United States; and *T. spicatum* var. *spicatum* and *T. spicatum* var. *pilosiglume* are found in Greenland. Two species, *T. aureum* and *T. flavescens*, are introduced. *Trisetum floribundum* Pilg. is chosen as a lectotype for *Trisetum* sect. *Aulacoa* Louis-Marie. The genus *Graphephorum* comprises only two species: *G. melicoides* ranging from Canada to the United States and *G. wolfii* endemic to the United States.

RESUMEN

En el presente artículo se presenta un tratamiento taxonómica para *Trisetum* Pers. y *Graphephorum* Desv. en Norteamérica norte de México. Se reconocen ocho especies de *Trisetum*. Dos de estas especies son endémicas de los Estados Unidos: *T. orthochaetum* (Montana) y *T. projectum* (California, Montana y Nevada). *Trisetum cernuum* subsp. *cernuum*, *T. cernuum* subsp. *canescens*, *T. montanum*, *T. sibiricum*, *T. spicatum* var. *spicatum* y *T. spicatum* var. *pilosiglume* se encuentran en Canadá y los Estados Unidos; y *T. spicatum* var. *spicatum* y *T. spicatum* var. *pilosiglume* se encuentran en Groenlandia. Dos especies, *T. aureum* y *T. flavescens*, han sido introducidas. *Trisetum floribundum* Pilg. se elige como lectotipo para *Trisetum* secc. *Aulacoa* Louis-Marie. El género *Graphephorum* comprende sólo dos especies: *G. melicoides*, que se encuentra desde Canadá hasta los Estados Unidos y *G. wolfii*, endémico de los Estados Unidos.

Trisetum includes approximately 40 species and several infraspecific taxa in the Americas and is distributed from Greenland (70°N) to southern South America (55°S) [Clebsch 1960; Hultén 1959; Nicora 1978, Finot 2003a, Finot et al. 2004). There are two endemic species of *Trisetum* in the Hawaiian Islands: *T. glomeratum* (Kunth) Trin. ex Steud. and *T. inaequale* Whitney (O'Conner 1990). We recognize eight species and two varieties in North America (excluding México), 17 species in México and Central America, and 18 species and seven varieties in South America (Finot 2003a; Finot 2004; Finot et al. 2004). *Trisetum* is also present in Europe, Asia, Australia, and New Zealand (Jonsell 1980; Tsvelev 1983; Clayton & Renvoize 1986; Pohl & Davidse 1994; Tucker 1996; Edgar 1998; Soreng et al. 2003; Finot et al. 2004, 2005). The genus seems to be absent in Africa (Clayton & Renvoize 1986). Although several species were described for Africa (Steudel 1854), they were later transferred to *Helictotrichon* Besser ex Schult. & Schult. f. (Hubbard 1936; Schweickerdt 1939).

TAXONOMIC HISTORY OF NORTH AMERICAN SPECIES

One of the earliest treatments of *Trisetum* was made by Steudel (1854), who recognized five North American taxa: *T. cernuum* Trin., *T. groenlandicum* Steud. [=*T. spicatum* (L.). K. Richt. var. *spicatum*], *T. labradoricum* Steud. (*T. spicatum* var. *spicatum*), *T. molle* Kunth (*T. spicatum* var. *spicatum*), and *T. palustre* (Michx.) Torr. [=*Sphenopholis pensylvanica* (L.) Hitchc.]. Buckley (1862) described three new species for North America: *Trisetum glabrum* Buckley [= *Deschampsia danthonioides* (Trin.) Munro], *T. interruptum* Buckley [= *Sphenopholis interrupta* (Buckley) Scribn.], and *T. canescens* Buckley, sometimes referred to as a variety or subspecies of *T. cernuum* (Beal 1896; Calder & Taylor 1965), or to *Helictotrichon canescens* (Buckley) Clayton. A new species described by Scribner (1884), *T. hallii* Scribn., is now considered a synonym of *Sphenopholis interrupta* (Buckley) Scribn. (Finot et al. 2004). Beal (1896) presented a treatment of *Trisetum* in North America (those found only in México and/or countries south are marked with an asterisk) that included the following 15 species: *T. cernuum*, *T. deyeuxioides* (Kunth) Kunth*, *T. elongatum* (Kunth) Kunth, *T. filifolium* Scribn. ex Beal*, *T. hallii* Scribn., *T. ludovicianum* Vasey, *T. montanum* Vasey, *T. palustre*, *T. paniculatum* E. Fourn. [= *Trisetum viride* (Kunth) Kunth]*, *T. pratense* Pers. [= *Trisetum flavescens* (L.) P. Beauv.], *T. sandbergii* Beal, *T. sesquiflorum* Trin., *T. spicatum*, *T. tolucense* (Kunth) Kunth (= *Trisetum spicatum* var. *spicatum*), and *T. virletii* E. Fourn.* Five of these species included in Beal's treatment were later transferred to other genera: *Trisetum palustre*, *T. ludovicianum*, and *T. hallii* to *Sphenopholis* (Scribner 1906; Erdman 1965); *T. deyeuxioides* to *Peyritschia* (Finot 2003b); and *T. sesquiflorum* to *Calamagrostis* (Rozhevits 1962; Soreng & Greene 2003). Beal (1896) also described a new species, *T. sandbergii* from Mt. Stuart, Washington, now considered a synonym of *T. cernuum* Trin. (Hitchcock 1939; Hitchcock 1950; Finot 2003a). Beal (1896) recognized *T. montanum* as a valid species. It was later treated, however, as a synomym of *T. spicatum* by several authors (Hitchcock 1928; Weber 1976).

Karl Richter (1890), an Austrian botanist recognized that *Trisetum* *subspicatum* (L.) P. Beauv. was an illigitimate homonym since it was based on *Aira spicata* L., and therefore, made the combination, *Trisetum spicatum*. Beal (1896) was the first North American agrostologist to use *Trisetum spicatum*. Scribner and Merril (1902) described a new species for the flora of North America, *T. congdonii* Scribn. & Merr., a synonym of *T. spicatum* in modern treatments. Several differences between *T. congdonii* and *T. spicatum* listed by the authors included more rigid leaves, narrower glumes, more scabrous lemmas and longer awns. Since the extent of variation of *T. spicatum* is great, we feel these differences do not warrant recognition at the species level. For the central Rockies (Colorado) three species: *T. spicatum* (as *T. subspicatum*), *T. majus* Vasey ex Rydb. (= *T. spicatum*), and *T. montanum* Vasey, were reported by Rydberg (1906).

Louis-Marie (1928-29) in his taxonomic revision of *Trisetum* in America, included 15 species with several varieties in North America. In *Trisetum* subgen. *Heterolytrum* Louis-Marie sect. *Anaulacoa* Louis-Marie subsect. *Trisetum* (as "*Eutriseta*"), he included *Trisetum montanum* [including two varieties: *T. montanum* var. *pilosum* Louis-Marie and *T. montanum* var. *shearii* (Scribn.) Louis-Marie], *T. cernuum* [including *T. cernuum* var. *luxurians* Louis-Marie, *T. cernuum* var. *luxurians* fo. *pubescens* Louis-Marie, and *T. cernuum* var. *sandbergii* (Beal) Louis-Marie], *T. canescens* Buckley (including *T. canescens* fo. *tonsum* Louis-Marie and *T. canescens* fo. *velutinum* Louis-Marie), *T. projectum* Louis-Marie, *T. sesquiflorum*, *T. bongardii* Louis-Marie [= *Calamagrostis sesquiflora* (Trin.) Tzvelev], *T. williamsii* Louis-Marie [= *Danthonia intermedia* Vasey], *T. spicatum* [including *T. spicatum* var. *laxius* (Lange) Louis-Marie, *T. spicatum* var. *majus* Farwell, *T. spicatum* var. *molle* (Michx.) Piper, *T. spicatum* var. *brittonii* (Nash) Louis-Marie, *T. spicatum* var. *pilosiglume* Fern., *T. spicatum* var. *alaskanum* (Nash) Malte ex Louis-Marie, *T. spicatum* var. *villosissimum* Lange], and *T. congdonii*. In *Trisetum* subsect. *Sphenophoidea* Louis-Marie he included *T. pennsylvanicum* (L.) P. Beauv. ex Roem. & Schult., *T. interruptum*, and *T. hallii*, now transferred back to *Sphenopholis* by Erdman (1965). In *Trisetum* subsect. *Graphephorum* (Desv.) Louis-Marie, Loius-Marie included *T. melicoides* (Michx.) Scribn. and *T. wolfii* Vasey [including *T. wolfii* var. *brandegei* (Scribn.) Louis-Marie and *T. wolfii* var. *brandegei* fo. *muticum* (Boland.) Louis-Marie], and in *Trisetum* Sect. *Aulacoa* Louis-Marie he included *T. floribundum* Pilg. [Lectotype here designated: = *Dielsiochloa floribunda* (Pilg.) Pilg.], and *T. trinii* (Trin.) Louis-Marie [= *Bromus berteroanus* Colla].

Hitchcock (1934) described a new species from Montana, *T. orthochaetum*. Later, Hitchcock (1939) gave a detailed account of the genus for the North American flora (including México), where 19 species were recognized under *Trisetum*. Eleven of the species listed by Hitchcock are from México and Central America, and the following eight range from the United States, Canada, and Greenland: *T. melicoides* and *T. wolfii* (here treated under genus *Graphephorum*), *T. spicatum*, *T. orthochaetum*, *T. canescens*, *T. cernuum*, *T. flavescens*, and *T.*

montanum. Finot et al. (2004) recognized 17 species of *Trisetum* in México and Central America: *T. angustum* Swallen, *T. barbatipaleum* (Hultén ex Veldkamp) Finot, *T. curvisetum* Morden & Valdes-Reyna, *T. durangense* Finot, P.M. Peterson, *T. filifolium*, *T. irazuense* (Kuntze) Hitchc., *T. ligulatum* Finot & Zuloaga, *T. martha-gonzaleziae* P.M. Peterson & Finot, *T. palmeri*, *T. pinetorum* Swallen, *T. pringlei* (Scribn. ex Beal) Hitchc., *T. rosei* Scribn. & Merr., *T. spellenbergii* Soreng, Finot & P.M. Peterson, *T. spicatum*, *T. tonduzii* Hitchc., *T. viride*, and *T. virletti*.

Hultén (1959) studied the *Trisetum spicatum* complex on a world-wide basis, and recognized several North American infraspecific taxa: *T. spicatum* subsp. *alaskanum* (Nash) Hultén, *T. spicatum* subsp. *pilosiglume* (Fernald) Hultén, *T. spicatum* subsp. *molle* (Michx.) Hultén, *T. spicatum* subsp. *majus* (Vasey) Hultén, *T. spicatum* subsp. *congdonii* (Scribn. & Merr.) Hultén, and *T. spicatum* subsp. *congdonii* var. *spicatiforme* Hultén. Later authors concluded that *T. spicatum* is polymorphic (Randall & Hilu 1986), and most of the infraspecific taxa were placed in synonymy.

Graphephorum is a small genus endemic to North America, closely related to *Trisetum*. It differs from this genus in having the apex of the lemma entire and the dorsal awn reduced to a subapical mucro. *Graphephorum* comprises only two species, *G. melicoides* (Michx.) Desv. and *G. wolfii* (Vasey) Vasey (Finot & Soreng 2003), sometimes treated under *Trisetum*. Clayton and Renvoize (1986) indicate *Graphephorum* has three species but only the type species was given. One species from México, originally described as *Graphephorum altijugum* E. Fourn. is currently accepted as *Peyritschia koelerioides* (Peyr.) E. Fourn. (Finot 2003b; Finot et al. 2004). *Graphephorum pringlei* Scrib. ex Beal, from México, Guatemala, Costa Rica, and Panamá, was transferred to *Trisetum* by Hitchcock (1927).

MATERIAL AND METHODS

Type specimens and general collections from the following herbaria were studied: BA, BAA, BAF, C, CR, CIIDIR, CONC, F, LP, MERL, P, PR, QCA, SGO, S, SI and US. For micromorphological studies, ligules were collected from upper and basal culm leaves with a sharp razor blade and mounted in lactophenol. For leaf anatomical studies, hand cross sections and abaxial epidermis preparations were made following Metcalfe (1960). The terminology for ligule description is based mainly on Chaffey (1983, 1984). Transverse sections and abaxial epidermis of leaves were described following the terminology proposed by Ellis (1976, 1979). Observations were made with a Zeiss MC-80 microscope equipped with objectives 20×, 40×, 63×, and 100×. All grass names mentioned in this manuscript, including those in the introduction are treated in Appendix 2.

In the morphological descriptions the length given for florets was usually taken from the first or lowest floret. If there were three or more florets per spikelet then the second floret was sometimes used to calculate the range. Therefore, when using our keys to determine North American specimens of *Trisetum* it is best to measure only the first or lowest floret.

TAXONOMIC TREATMENT

KEY FOR DISTINGUISHING THE GENERA *TRISETUM* AND *GRAPHEPHORUM* IN NORTH AMERICA

1. Lemma with lateral nerves not prolonged into apical setae, the apex entire to slightly bilobate; dorsal awn absent or reduced to a short subapical mucro; palea not gaping (palea tightly enclosed by the margins of the lemma); panicle lax, open or contracted, never spiciform ________ **Graphephorum**
1. Lemma with lateral nerves prolonged into 2(4) apical setae, the apex bidentate; dorsal awn well developed, borne on the upper half or third of the lemma; palea gaping (palea not tightly enclosed by the margins of the lemma); panicle lax or densely-flowered, contracted or open, and ovate or pyramidal, often spiciform ________ **Trisetum**

Graphephorum Desv., Nouv. Bull. Sci. Soc. Philom. Paris 2:189. 1810. Type: *Graphephorum melicoides* (Michx.) Desv.

Perennials, loosely caespitose or with short rhizomes. Culms 50–100 cm tall, glabrous or pilose. Leaf sheaths glabrous, scabrous, and/or pilose; blades flat, glabrous or pilose; ligule membranous. Inflorescence in panicles open or contracted, glabrous below the panicle. Spikelets 2- or 3-flowered; rachilla pilose; disarticulation above the glumes and between the florets; glumes slightly unequal, slightly shorter than the spikelet; first glume 1-nerved, lanceolate to linear-lanceolate; second glume 1- or 3-nerved, lanceolate to oval-lanceolate; lemmas with apex entire to slightly bilobate, muticous or with a reduced awn (mucro), borne inmediately below the apex, the mucro not reaching the apex of the lemma; palea not gaping; stamens 3; ovary glabrous or with short apical hairs.

KEY TO THE SPECIES OF *GRAPHEPHORUM* IN NORTH AMERICA

1. Panicles 2–4 cm wide, open, lax; ovary glabrous; callus hairs about 2.5 mm ____ **1. G. melicoides**
1. Panicles 1–1.5 cm wide, contracted; ovary glabrous or with short hairs at the apex; callus hairs 0.5 mm long ________ **2. G. wolfii**

1. Graphephorum melicoides (Michx.) Desv., Nouv. Bull. Sci. Soc. Philom. Paris 2:189. 1810. *Aira melicoides* Michx., Fl. Bor. Amer. 1:62. 1803. *Poa melicoides* (Michx.) Nutt., Gen. N. Amer. Pl. 1:68. 1818. *Triodia melicoides* (Michx.) Spreng., Syst. Veg. 1:331. 1825. *Trisetum melicoides* (Michx.) Scribn., Bot. Gaz. 9:169. 1884. Type: CANADA. America Boreal, *Michaux* s.n. (HOLOTYPE: P!; ISOTYPE: LE-TRIN 1864.01!).

Arundo airoides Poir., Encycl. 6:270. 1804. *Deyeuxia airoiodes* (Poir.) P. Beauv., Ess. Agrostogr. 44, 152, 160. 1812. *Agrostis airoides* (Poir.) Raspail, Ann. Sci. Nat. (Paris) 5: 449. 1825, *nom. illeg. hom. Calamagrostis airoides* (Poir.) Steud., Nomencl. Bot. (ed. 2) 1:249. 1840. Type: U.S.A. America Septentrionalis, *Michaux* s.n. (HOLOTYPE: Herb. Juss., not seen).

Dupontia cooleyi A. Gray, Manual (ed. 2) 556. 1856. *Graphephorum melicoides* var. *majus* A. Gray, Proc. Amer. Acad. Arts 5:191. 1861. *Graphephorum melicoides* var. *cooleyi* (A. Gray) Scribn., Mem. Torrey Bot. Club 5(4):53. 1894. *Trisetum melicoides* subsp. *cooleyi* (A. Gray) Scribn., Rhodora 8(89):87. 1906. *Trisetum melicoides* var. *majus* (A. Gray) Hitchc., Rhodora 10(112):65. 1908. *Graphephorum cooleyi* (A. Gray) Farw., Pap. Michigan Acad. Sci. 1:88. 1923. TYPE: U.S.A. MICHIGAN: (HOLOTYPE: not found).

Perennials. Culms 50–100 cm tall, glabrous. Leaf sheaths scabrous or pubescent; ligules 1.3–2 mm long, oval, glabrous dorsally, apex dentate with short cilia; blades 80–150 × 2–8 mm, flat, glabrous, sometimes pubescent adaxially. Panicles 8–20 × 2–4 cm, lax, open, nodding; branches ascending; rachis scabrous. Spikelets 6–7 mm long; rachilla hairy; the hairs 1–1.5 mm long; glumes unequal, shorter than the spikelet; keel smooth or scabrous on the upper half; first glume 4–4.5 × 0.5 mm, shorter and narrower than the second glume, lanceolate, 1-nerved; second glume 6–7 × 0.8 mm, oval-lanceolate, 3-nerved; lemmas with short and straight subapical awn (mucro), intermediate nerves not reaching the apex; apex acute, entire, not setulate or aristulate; callus hairy, the hairs about 2.5 mm long; palea shorter than the lemma, 2-nerved; apex entire; lodicules about 0.6 mm long, with the apex entire to slightly bilobate; ovary glabrous. Caryopses 3.2–3.8 mm long, glabrous; endosperm semi-liquid.

Anatomy and Micromorphology.—Ligule apices without hairs or papillate cells, composed of long cells with rounded ends; ligule epidermis composed of rectangular long cells with straight side walls, without prickle hairs or macrohairs; blades in transverse section flat to weakly keeled; adaxial face with rounded ribs, the ribs not very prominent; furrows wider than the adjacent ribs; abaxial face with ribs similar in size and shape to the adaxial ribs; vascular bundles 15, rounded, situated in the median portion of the blade; vascular bundles with adaxial and abaxial girders; marginal sclerenchyma present, small; epidermis in transverse section larger than the mesophyll, the adaxial epidermis with epidermal cells more or less rounded, thin; bulliform cells inconspicous; prickles scarce, present only in the adaxial epidermis; stomata present in both adaxial and abaxial surfaces; abaxial epidermis with costal-intercostal zones well differentiated; intercostal zones with long cells rectangular to fusiform, with straight side walls and vertical to oblique terminal walls; intercostal short cells absent; stomata in two intercostal rows; prickles scarce; macrohairs absent; costal zone 2 or 3 cells wide, with long cells similar to the intercostal epidermal cells but shorter and narrower; short cells rectangular, with sinuous walls; prickles in rows on the costal zones.

Distribution.—Canada (Newfoundland, Ontario, Québec) and United States (Maine, Michigan, New Hampshire, New York, Vermont, Wisconsin) [Hitchcock 1939; Kartesz 1998].

Specimens examined. **CANADA. Ontario:** Township, 20 mi S of Moonbeam, 14 Aug 1959, *Morton 11449* (US). **Newfoundland:** Valley of Exploits River, Grand Falls, 12 Aug 1911, *M.L. Fernald & Wiegand 4591* (US). **U.S.A. Maine: Aroostook Co.:** along St. John River, St. Francis, 5 Aug 1893, *M.L. Fernald 187* (P); Northern Maine, St. Francis River, Aug 1902, *Eggleston 3136* (P); Woosehead Lake, 1 Sep 1868, *A.E. Smith & C.E. Smith s.n.* (P).

2. Graphephorum wolfii (Vasey) Vasey ex Coult., Man. Bot. Rocky Mt. 423. 1885. *Trisetum wolfii* Vasey, Monthly Rep. Dept. Agric. 1874:156. 1874. TYPE: U.S.A. Colorado: Lake Co.: Twin Lakes, 1873, *J. Wolfe s.n.* (ISOTYPES: NY-232367!, US-81781!).

Trisetum subspicatum var. *muticum* Bol., Bot. California 2:296. 1880. TYPE: U.S.A. California: on the upper Tuolumne, 7500 ft, 1866, *H.N. Bolander 5019* (ISOTYPES: NY-232371!, US-867860!, US-344201!).

Perennials. Culms 50–100 cm tall, with short rhizomes. Leaf sheaths glabrous or pilose; ligules 1.5–2 mm long, truncate, glabrous dorsally, apex dentate; blades 60–200 × 3–7 mm, flat, soft; lower blades pilose abaxially, sparsely pilose adaxially; upper blades glabrous to sparsely pilose abaxially, sparsely pilose adaxially. Panicle 8–15 × 1–1.5 cm, contracted, dense, erect, tinged with purple; rachis strongly scabrous. Spikelets 6–7.5 mm long, 2- or 3-flowered; rachilla 1.5 mm long, hairy, the hairs 0.5–1.5 mm long; glumes unequal, nearly as long as the spikelet; keel scabrous towards the apex; apex acute; first glume 4.2–6 × 0.5–0.7 mm, shorter and narrower than the second glume, lanceolate, 1-nerved; second glume 5–6.5 × 0.8–0.9 mm, as long or shorter than adjacent floret, 3-nerved; lower floret 5–5.5 mm long,; upper florets shorter; lemma glabrous to slightly scabrous towards the apex; apex acute to slightly bidentate, hyaline, muticous or with a short subapical mucro 1–2.2 mm long, borne at 1–1.3 mm below the apex; callus short hairy, the hairs about 0.5 mm long; palea about 4 mm long, shorter than the lemma, 2-nerved, the nerves scabrous; lodicules 0.7–0.8 mm long; apex with two 2 teeth, sometimes with a third smaller tooth between them; anthers 0.7–0.8 mm long; ovary glabrous, sometimes with hairs near the apex. Caryopses 2.4–3 mm long, with or without hairs at the apex; endosperm solid.

Anatomy and *micromorphology.*—Ligule apices with stiff hairs and papillate cells; ligule epidermis composed of rectangular long cells; short cells present; prickle hairs scarce; stomata and macrohairs absent; blades in transverse section V-shaped, symmetric, keeled, the keel with a well developed sclerenchymatic tissue; adaxial ribs absent; central vascular bundle free, without adaxial sclerenchyma; second order vascular bundles with I-shaped sclerenchyma girders; third order vascular bundles free, with small strands of adaxial or abaxial sclerenchyma; marginal sclerenchyma small; bulliform cells conspicuous, in fan-shaped groups; macrohairs absent; abaxial epidermis with costal-intercostal zonation present; intercostal zones with fusiform to rectangular long cells, with lateral walls straight; short cells and stomata present; prickles and macrohairs absent; costal zones with long cells rectangular, narrower than the intercostal cells; short cells rectangular, with sinuous side walls.

Distribution.—A species endemic to western United States (California, Colorado, Idaho, Montana, New México, Nevada, Oregon, Utah, Washington, and Wyoming) [Hitchcock 1939; Kartesz 1998).

Specimens examined. **U.S.A. CALIFORNIA: Mono Co.:** Ravine Creek, 3200 m, 21 Aug 1954, *Krapovickas 8102* (SI); Yosemite National Park, 9600 ft, 1 Aug 1934, *Bartholomew s.n.* (US); *J.R. Swallen 1937* (P). **COLORADO: Sequachi Co.:** Marshall Pass, 10800 ft, 27 Jul 1896, *Clements 200* (US); Buffalo Pass, 10500 ft, 14 Aug 1898, *Shear & Bessey 1482* (US). **NEVADA: Elko Co.:** just above Angel Lake, East Humboldt Mountain, 8000 ft, 24 Jun 1958, *P.H. Raven & O.T. Solbrig 1340* (SI); Ponderosa Mountain, above Leiglis Lake, 7000 ft, 26 Jul 1901, *Merril & Wilcox 348* (P). **NEW MÉXICO:** Castilla Valley, 4 Sep 1913, *E.O. Wooton s.n.* (US). **WASHINGTON: Spokane Co.:** 21 Jun 1889, *W. Suksdorf s.n.* (P); *W. Suksdorf 949* (P).

Trisetum Pers., Syn. Pl. 1:97. 1805. *Trisetarium* Poir., Encycl. Suppl. 5: 365. 1817, *nom. superfl.*, *Rebentischia* Opiz, Lotos 4:104. 1854, *nom. superfl.*, non P.A. Karsten 1869. TYPE: *Trisetum flavescens* (L.) P. Beauv., Ess. Agrostogr. 88, 153, t. 18, f. 1. 1812.

Acrospelion Besser ex Schult. & Schult. f., Syst. Veg. Mant. 3:526, 1827. LECTOTYPE (designated by L.K.G. Pfeiffer, Nom. 1:38. 8 Dec. 1781.): *Avena distichophylla* Vill. [= *Trisetum distichophyllum* (Vill.) P. Beauv.]

Rupestrina Prov., Fl. Canad.:689. 1862. TYPE: *Rupestrina pubescens* Prov. [= *Trisetum spicatum* (L.) Richt.].

Perennials and annuals, caespitose, sometimes shortly rhizomatous and/or stoloniferous. Culms 16–120 cm tall, erect to geniculate at base, glabrous or pubescent. Leaf sheaths glabrous or pubescent, longer or shorter than the internodes; blades flat, conduplicate, convolute or involute, soft rarely rigid; ligule membranous. Inflorescence in panicles contracted or open, lax or densely-flowered, spiciform, ovate, or pyramidal; the rachis glabrous, scabrous or pubescent. Spikelets (1-)2- to 4-flowered, short pedicellate; rachilla pubescent or glabrous, usually prolonged beyond the upper floret; disarticulation above the glumes and between the florets; glumes heteromorphic, lanceolate to ovate-lanceolate, equal or unequal, first glume 1-nerved, usually shorter and narrower than the second, second glume 1- or 3-nerved; lemmas lanceolate, (3-)5-(7-) nerved, usually awned dorsally or muticous, with apex and margins hyaline, glabrous or pubescent, slightly keeled and compressed, rarely terete; apex with 2- to 4 apical setae or short awns, bidentate, or 2-toothed; central awn from the upper third, rarely the middle, of the subapical portion of the lemma; awn exserted, geniculate or merely divaricate; callus short pilose; palea not tightly enclosed by the margins of the lemma (gaping), 2-keeled, hyaline, usually shorter than the lemma; stamens 3, anthers 0.5–3 mm long; lodicules 2, membranous, often apically lobed; ovary glabrous or with short and shining trichomes near the apex; endosperm solid or liquid, soft or hard. Caryopses compressed, soft; hilum short, punctiform. Basic chromosome number $x = 7$.

KEY TO SPECIES OF *TRISETUM* IN NORTH AMERICA

1. Plants delicate annuals; known only from a single introduction in Camden, New Jersey ____ **3. T. aureum**
1. Plants perennial; widespread.
    2. Panicles lax, open; glumes shorter than the spikelet (Sect. *Trisetum*).
        3. Ovary and caryopsis hairy near the apex.

4. Awns 3.5–4 mm long, straight, shorter than the lemma; apex of the lemma shortly bidentate; first glumes 4–6 mm long, never rudimentary ______ **7. T. orthochaetum**
4. Awns 6–16 mm long, geniculate, one to three times as long as the lemma; apex of the lemma ending in two setae 0.5–1.5 mm long; first glumes 0.5–5 mm long, sometimes rudimentary.
    5. Panicles few-flowered, loose; branches capillary, the lower ones usually naked on the lower third; leaf blades glabrous ______ **4a. T. cernuum** subsp. **cernuum**
    5. Panicles densely-flowered, narrow; branches closely appressed, the lower ones with spikelets to near base; leaf blades canescent to sparsely pilose ______ **4b. T. cernuum** subsp. **canescens**

3. Ovary and caryopsis glabrous near the apex
    6. Spikelets 2–4-flowered; panicles usually gold-yellowish, somewhat contracted; spikelets 5–9 mm long; lemmatal awns 5–9 mm long; anthers 2–3 mm long.
        7. Lemmas only dorsally scabrous ______ **9. T. sibiricum**
        7. Lemmas uniformily scabrous ______ **5. T. flavescens**
    6. Spikelets 2- or 3-flowered; panicles green sometimes tinged with purple, loose; spikelets 4.5–6 mm long; lemmatal awns 3.5–4 mm long; anthers 0.8–1.2 mm long ______ **6. T. montanum**

2. Panicles contracted, spiciform to narrow but always densely-flowered; glumes only a little shorter than the spikelet (Sect. *Trisetaera*, in part).
    8. Panicles 2.5–7(–10) cm long, densely spiciform ______ **10. T. spicatum**
    8. Panicles 8–23 cm long, open, loose, few-flowered to spiciform and interrupted with short ascending branches.
        9. Lemmatal awns 7–12 mm long, weakly twisted, geniculate; ligules about 2.5 mm long, glabrous or scabrous dorsally; ovary hairy near apex ______ **4b. T. cernuum** subsp. **canescens**
        9. Lemmatal awns about 5.5 mm long, not twisted or geniculate, diversely curved; ligules 0.35–1.5 mm long, densely pilose dorsally; ovary glabrous ______ **8. T. projectum**

3. Trisetum aureum (Ten.) Ten., Fl. Napol. 2:378. 1820. *Koeleria aurea* Ten., Tratt. Fitogn. 1:58. 1806. *Trisetaria aurea* (Ten.) Pignatti, Arch. Bot. (Forli) 31: 51. 1955. Type: (holotype: NAP?).

Delicate annuals, caespitose; culms 18–30 cm tall, erect, spreading or geniculate at base, glabrous. Leaf sheaths glabrous or pubescent, shorter than the internodes; ligule 0.8–1.3 mm long, hyaline, apex obtuse, margins decurrent; blades 2–8 cm long, 1.2–3 mm wide, glabrous to pubescent, the hairs less than 0.2 mm long. Panicles 1–5 × 0.8–3 cm, pyramidal to ovoid, contracted, densely flowered, often lobed, shining yellowish or light brownish; branches 0.6–3 cm long, closely appressed and ascending, naked below; rachis glabrous. Spikelets 2.6–3.3 mm long, 2- or 3-flowered; pedicels 0.2–1.6 mm long; rachilla 0.6–1.5 mm long, covered with stiff hairs, the hairs 0.3–1.2 mm long; glumes unequal, the second glume longer than the spikelet, scaberulous on the keel; first glume 2.1–2.6 mm long, linear-lanceolate, shorter and narrower than the second glume, 1-nerved, apex acuminate; second glume 2.8–3.3 mm long, ovate-lanceolate, 1- or

3-nerved, apex acute; lemmas 1.8–3 mm long, glabrous or scattered pilose, rarely scaberulous, ovate, hyaline, the apex bidentate with two setae 0.1–0.3 mm long; awn 1.3–3.5(–6) mm long, slightly bent, scaberulous, borne just above the middle; callus obtuse, mostly glabrous; paleas 1.5–2.8 mm long, shorter than the lemma, hyaline, 2-nerved, the apex bidentate with two teeth 0.2–0.4 mm long; anthers 1.2–1.6 mm long; ovary with a few short hairs near the apex. Caryopsis not seen.

Distribution.—*Trisetum aureum* is introduced in North America and occurs natively in the Mediterranean Region of Europe in Greece, Italy, Jugoslavia, and Sicilia.

Comments.—We are not in a position to critically evaluate the generic status of the assemblage of approximately 15 species that are sometimes segregated as *Trisetaria* Forssk. (sensu Clayton & Renvoize 1986). This taxon is treated as *Trisetum aureum* in the Flora of France by Kerguélen (1999) and as *Trisetaria aurea* by Doğan (1985) in the Flora of Turkey.

Specimens examined. **U.S.A. New Jersey:** Camden, ballast, *I.C. Martindale s.n.* (US)

4a. Trisetum cernuum Trin. subsp. **cernuum**, Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 6, Sci. Math. 1:61. 1830. *Avena cernua* (Trin.) Kunth, Rev. Gen. 1, suppl. 26, 1833. TYPE: U.S.A. ALASKA: Sitka, 1826, *J.F.G. von Eschscholtz s.n.* (HOLOTYPE: LE-TRIN 1889-01!; ISOTYPES: BAA-3366!, NY-232366!, P!, US-81779 fragm. ex LE-TRIN!).

Avena nutkaensis J.Presl, Reliq. Haenk. 1(4–5):254. 1830. *Trisetum nutkaensis* (J.Presl) Scribner & Merr. ex Davy, Univ. Calif. Publ. Bot. 1:63. 1902. TYPE: CANADA. BRITISH COLUMBIA: Vancouver Island, Nootka, *T. Haenke s.n.* (ISOTYPES: LE-TRIN-1929.01!; US- 865598 fragm.!).

Trisetum sandbergii Beal, Grasses N. Amer. 2:378. 1896. *Trisetum cernuum* var. *sandbergii* (Beal) Louis-Marie, Rhodora 30:214. 1928. TYPE: U.S.A. WASHINGTON: Mt. Stuart, 7000–8000 ft, *Sandberg & Leiberg 823* (HOLOTYPE: MSC?; ISOTYPES, NY-431712!, GH, WS).

Trisetum cernuum var. *luxurians* Louis-Marie, Rhodora 30:213. 1928. TYPE: U.S.A. OREGON: Seaside, 11 Aug 1899, *C.L. Shear & F.L. Scribner 1705* (HOLOTYPE: US-867917!).

Trisetum cernuum fo. *pubescens* Louis-Marie, Rhodora 30:213. 1928. *Trisetum cernuum* fo. *pubescens* G. Jones, Univ. Wash. Publ. Biol. 5:108. 1936, hom. illeg. superfl. TYPE: U.S.A. CALIFORNIA: Humboldt Co.: Eureka, 30 May 1920, *Anonymous s.n.* (HOLOTYPE: UC-212883).

Perennials, with stolons and rhizomes. Culms 35–85 cm tall, glabrous, sometimes geniculate, with 2–4 nodes. Leaf sheaths longer or shorter than the internodes, glabrous or rarely pilose; ligules 1.3–7 mm long, membranous, longer in the upper leaves, oval, fimbriate, ciliate at the apex, glabrous or pilose dorsally; blades 100–220 × 3.5–12 mm, flat, soft, glabrous or sparsely pubescent on the adaxially. Panicles 6–30 × 2–5 cm, lax, open, loose, few-flowered, green or purplish; branches capillary, the lower ones usually naked on lower third; rachis glabrous. Spikelets 4.5–12 × 2–4 mm, 2- or 3-flowered, not overlapping; pedicels 1–4.5 mm long, capillary, flexuous, glabrous or scabrous; rachilla 1.5–2 mm long, covered with stiff hairs, the hairs 1–2 mm long; glumes shorter than the spikelet, very unequal to subequal in length and very unequal in width; first glumes 0.5–5 × 0.1–0.5 mm, linear-lanceolate, attenuate, 1-nerved, sometimes rudimentary, narrower than the second glume, the margins hyaline; second glumes 3–7.5 × 0.5–1 mm, oval-lanceolate, 3-nerved; first florets 5–8.5 × 0.7–1 mm; lemma linear-lanceolate, glabrous, scabrous towards the apex, sometimes tinged with purple; apex with two setae 0.5–1.5 mm long; awns 6–16 mm long, curved, not twisted nor geniculate, scabrous, borne on the upper third at 2–2.5 mm below the apex; callus obtuse, hairy, the hairs 0.2–0.7 mm long; paleas 4–5.7 mm long, shorter than the lemma, hyaline, 2-nerved, the nerves scabrous; apex bidentate; lodicules 0.7–0.8 mm long, bilobulate at the apex; anthers 0.5–1.5 mm long; ovary with short, curved and shining hairs near the apex; ovary hairy near the apex. Caryopses 3.5–5 × 1 mm, hairy at the apex; endosperm semi-liquid.

Anatomy and micromorphology.—Ligule apices composed of hairs and papillate cells; ligule epidermis composed of rectangular long cells, rarely fusiforms, with straight walls; short cells present; prickle hairs present; stomata absent; blades in transverse section flat, keeled; adaxial side with rounded ribs; furrows less than one half the leaf thickness; sclerenchyma as adaxial and abaxial I-shaped girders in the first and second order vascular bundles; marginal sclerenchyma present; bulliform cells in fan-shaped groups between vascular bundles; abaxial leaf epidermis composed of fusiform to hexagonal long cells, with straight side walls; short cells present in intercostal zones; prickle hairs absent to very few, often limited to the costal zones; macrohairs absent; stomata in 0–2 intercostal rows.

Distribution.—*Trisetum cernuum* subsp. *cernuum* is found in North America and southern South America (southern Chile and Argentina, from 38°S to 55°S south of the Strait of Magellan). In North America it is found in southern Alaska (Chicagof Islands, Yakutat Bay, 59°32'N,139°37'W), Canada (Alberta, British Columbia) and the continental United States (Washington, Oregon, Idaho, Montana and northern California, 36°N).

Specimens examined. **CANADA. Alberta:** 10 mi SW of Pincher Creek, 9 Aug 1950, *W.G. Dore 12479* (US); Waterton Lakes National Park, 5500 ft, 20 Aug 1939, *Mosg 555* (US); Waterton Lakes National Park, Spruce trail to Carthew Pass, 5500 ft, E shore of Cameron Lake, 1 Aug 1956, *Hermann 13048* (US); moist coniferous woods near Cameron Lake, 5450 ft, 26 Jul 1953, *Breitung 16778* (US). **British Columbia**: Mainland opposite Kaien Island, 19 Jun 1937, *McLake 4329* (US); Mts. near Ainsworth, Kootenay Lake, 2800 ft, 7 Jul 1890, *Macoun 107* (US); Mt. Revelstoke Road, 3 mi NE Revelstoke, 22 Jul 1956, *Hermann 12914* (US); Stikine Glacier, 8 Aug 1916, *Cooper 16* (US); Galloway Rapids a few miles S of Prince Rupert, 18 Jul 1954, *Calder, Saville & Ferguson 13166* (US); Maroon Mountain Trail, 54°48'24.1"N, 128°44'01.8"W, 600–1600 m, 23 Jul 2004, *Peterson, Saarela & Smith 18723* (US); Cypress Provincial Park, N of Vancouver, 49°23'37.3"N, 123°11'43.9"W, 896 m, 29 Jul 2004, *Peterson & Saarela 18754* (US); Vancouver Island, vicinity of Ucleulet, 13 Jul 1909, *Macoun s.n.* (US); vicinity of Namaimo, 23 Jun 1908, *Macoun s.n.* (US); Vancouver Island, *Macoun 28* (US); Jun-Jul 1901, *Rosendahl & Brand 129* (US); Queen Charlotte Islands, Skidigate, 29 Jul 1910, *Spreadborough s.n.* (US). **U.S.A. Alaska:** Sitka, 16 Jul 1905, *Piper 4649* (US); 22 Jun 1909, *Hitchcock 4042* (US); Chichagof Island, Hoonah., 15 Jul 1932, *Norberg 211* (US); Yes Bay, 9 Jul 1895, *Howell 1716* (US); Alaska, 25 Jul 1899, *Coville & Kearney 2512* (US); Yakutat, 2 Sep 1904, *Piper 4650* (US); Lituya Bay, 10 ft, 20 Jun 1932, *Taylor T-119* (US); Juneau, 25

Jun 1909, *Hitchcock 4065* (US); Cordova, 1–3 Jul 1909, *Hitchcock 4121* (US). **California:** *Bolander 29* (P); 1870, *Bolander 4* (P). **Humboldt Co.:** Eureka. 22 May. 1900, *Tracy 800* (US); Open woods, E shore of Fallen Leaf Lake, Mt. Tallac, Lake Tahoe, 7000–9500 ft, 6–8 Aug 1908, *Hitchcock 3161* (US); Mts. about the head waters of the Sacramento River, 7500 ft, 1 Sep 1882, *Pringle 509* (US); Seqouia National Park and Sierra National Forest, near spring, S of Alta Meadow, 3 Aug–9 Sep 1908, *Hitchcock 3359* (US). **Siskiyou Co.:** S of Happy Camp, wooded banks of Swillup Creek at point of junction with Klamath River, 1 Jun 1942, *Beetle & Stebbins Jr. 3450* (US); **Mendocino Co.:** near Mendocino, 0–500 ft, May 1898, *Brown 764* (US). **Humboldt Co.:** Northern Coast Ranges of California, Eureka, in woods, 200 ft, 30 May 1920, *Tracy 5335* (US); Humboldt Bay, 100 ft, May 1901, *Chandler 1176* (US); Spruce Cove, Trinidad, 200 ft, n.d., *H.E. & S.T. Parks 7551* (US); Redwood forest, 5 mi N of Orik on US Hwy 101, 26 May. 1941, *Stebbins Jr. & Church 3107* (US); Bald Mountain, between High Prairie and Snow Camp, 3500 ft, 5 Jul 1914, *Tracy 4546* (US). **Idaho: Nez Perce Co.:** Nez Perce National Forest, Poet Creek Campground and vicinity, 5000 ft, 22 Jul 1988, *Peterson 4794* (US); just N of Idaho boundary, 21 Jun 1938, *Eastham 39* (US); Moist meadows, Jun 1892, *Sandberg 369* (US); Lolo trail and junction of White Sandy Creek with Lochsa Fork of Clearwater River, 25–29 Jul 1908, *Chase 5163* (US); Coeur D'Alène Range of the Bitterroot Mountains, 2728–4000 ft, *Chase 5003* (US); between Burke & Upper Glidden Lake, 20 Jul 1908, *Chase 5062* (US). **Montana:** MacDonald Creek, Little Kootenai, Glacier National Park, 8 Jul 1914, *Hitchcock 12274* (US), *Hitchcock 1447* (P); moist ditch, edge of forest, 7 Jul 1940, *Swallen 6466* (US). **Missoula Co.:** Lolo Hot Springs, 3900–4000 ft, 23–24 Jul 1908, *Chase 5080* (US). **Oregon:** 1880, *Howell s.n.* (US); 1881, *Howell 79* (US); western Oregon, small mountains streams, Jun 1880, *Howell s.n.* (P); Seaside, 11 Aug 1899, *Shear 1785* (P). **Siskiyou Co.:** S of Happy Camp Wooded banks of Swillup Creek at junction with Klamath River, 1 Jun 1942, *Beetle & Stebbins, Jr. s.n.* (US); moist woods, 24 Oct 1881, *Pringle 130* (US); Dales Blue Mts., Jul 1902, *Griffiths & Hunter 128* (US). **Coos Co.:** wooded hillside, 16–18 Jul 1908, *Hitchcock 2807* (US); Gearhart, *Hitchcock s.n.* (US); border of damp coniferous woods, small tufts, 25–50 ft, 1–2 Jul 1908, *Chase 4904* (US); Gearhart to Tillamook Head, west moist side of hill, 25–50 ft, 1–2 Jul 1908, *Chase 4920* (US); Cascade Mts., 4000 ft, Jul 1887, *Cusick 6* (US); Jun–Aug 1881, *Howell 869* (US); Camas Prairie, shady places, 9 Jul 1902, *Griffiths & Hunter 53* (US); Jacksonville, 8 Jun 1904, *Hunter 542* (US); Mountain stream banks, 1900, *Cusick 2426* (P). **Washington:** 1889, *Piper 846* (US); Cascade Mts., 1889, *Vasey s.n.* (US); upper valley of the Nesqually, 8 Sep 1893, *Allen 42* (US); Seattle, May 1890, *Piper s.n.* (US). **Klickitat Co.:** Bingen, 5 Jun 1919, *Suksdorf 10226* (US); open woods, Jun 1885, *Suksdorf s.n.* (P). **St. Chelan Co.:** along Peshastin Creek below Blewett, 2000 ft, 25 Jun 1932, *Thompson 8582* (US). **Chehalis Co.:** near Montesano, 200 ft, 7 Jun 1898, *A.A. & E.G. Heller 3904* (US). **Clallam Co.:** Olympic Mts., Jun 1900, *Elmer 1946* (US).

KEY TO SUBSPECIES OF *TRISETUM CERNUUM*

1. Panicles few-flowered, loose; branches capillary, the lower ones usually naked on the lower third; leaf blades glabrous ______ **4a. T. cernuum** subsp. **cernuum**
1. Panicles densely-flowered, narrow; branches closely appressed, the lower ones with spikelets to near base; leaf blades canescent to sparsely pilose ______ **4b. T. cernuum** subsp. **canescens**

4b. Trisetum cernuum subsp. **canescens** (Buckley) Calder & R.L. Taylor, Canad. J. Bot. 43:1389. 1965. *Trisetum canescens* Buckley, Proc. Acad. Nat. Sci. Philadelphia 1862:100 1862. *Trisetum elatum* Nutt. ex A. Gray, Proc. Acad. Nat. Sci. Philadelphia 14:337 1862, *nom. inval. Trisetum cernuum* var. *canescens* (Buckley) Beal, Grass. N. Amer. 2:380. 1896 *Helictotrichon canescens* (Buckley) Clayton, Kew Bull. 40:728. 1985. Type: U.S.A. Oregon: Columbia Plains, *T. Nuttall s.n.* (holotype: PH).

Trisetum canescens fo. *tonsum* Louis-Marie, Rhodora 30:216. 1928. Type: U.S.A. California: Trinity Co.: Buckeye Mt., 15 Jul 1914, *H.S. Yates 522* (holotype: UC; isotype: US-893773!).

Trisetum canescens fo. *velutinum* Louis-Marie, Rhodora 30:216. 1928. TYPE: U.S.A. CALIFORNIA: Lassen's Peak, Jul 1879, *R.M. Austin s.n.* (HOLOTYPE: GH).

Perennials. Culms 40–120 cm tall, glabrous, nodes 3. Leaf sheaths pubescent or upper portions glabrous; ligules about 2.5 mm long, dentate, glabrous or scabrous dorsally; blades 45–300 × 2–8 mm, flat, scabrous or canescent, sometimes sparsely pilose and ciliate on the margins. Panicles 8–23 × 1–3 cm, contracted, narrow, densely-flowered; rachis scaberulous; branches closely appressed, the lower ones with spikelets to near base. Spikelets 7.5–9 mm long, 2- or 3-flowered; pedicels scaberulous; rachilla 1.5–2 mm long, covered with stiff hairs, the hairs 1.5–2 mm long; glumes shorter than the spikelet, unequal, green or tinged with purple; first glumes 3.2–6 × 0.2–0.4 mm, linear-lanceolate, subulate, usually × as long as than the second glume, narrower than second, 1-nerved; second glumes 4.5–7 × 0.8–1 mm, oval to oval-lanceolate, 3-nerved; first floret 5–9 mm long; lemma glabrous, minutely scabrous towards the apex, with the margins and apex hyaline; apex 2-awned, the apical awns 0.7 mm long; awns 7–12 mm long, weakly twisted, geniculate, borne on the dorsal upper third, at 2–3 mm from the apex; callus pilose, the hairs 0.5–1 mm long, rachilla 1.7–3 mm long, pilose; paleas about 6.5 mm long, 2-nerved, the nerves scabrous; anthers 1.2–1.8 mm long; ovary hairy near the apex. Caryopses hairy at the apex.

Anatomy and micromorphology.—Ligule apices truncate, minutely dentate with hairs and papillate cells, the epidermis is composed of rectangular to fusiform long cells, with straight side walls; short cells present; dorsal surface of the ligule densely covered with hooks; macrohairs absent; blades V-shaped in transverse section, symmetric, slightly keeled; bulliform cells in fan-shaped groups; adaxial side with rounded ribs and furrows less than one half of the blade thickness; vascular bundles with adaxial and abaxial I-shaped girders; marginal sclerenchyma not well developed; abaxial epidermis with fusiform long cells and straight side walls; short cells on the costal zones with rectangular and sinuose side walls; stomata in two rows near the costal zones; hooks present; macrohairs present only on the adaxial epidermis.

Distribution.—Western Canada and United States. It reaches its boreal distribution at Vancouver (50° 55'N) and its austral distribution in California, U.S.A. (34°N). In the United States it is found in the states of Washington, Montana, Oregon, Idaho, Nevada, Utah, Arizona, and California, primarily between 47° N in Washington St. and 34° N in California.

Comments.—Clayton (1985) transferred *T. canescens* to *Helictotrichon*, probably because of the presence of hairs at the apex of the ovary. This character, however, is also present in the following species of *Trisetum*: *T. ambiguum* Rúgolo & Nicora, *T. cernuum* subsp. *cernuum*, *T. caudulatum* var. *correae* Nicora, *T. durangense*, and *T. longiglume* Hack. var. *longiglume*. All other characters in *Trisetum cernuum* subsp. *canescens* (hilum punctiform, lodicules apically lobed) distinguish it from *Helictotrichon* (hilum linear, lodicules acute at the apex).

The strong affinity between *T. cernuum* and *T. canescens* was first noticed by Beal (1896), who subordinated *T. canescens* to *T. cernuum* with the varietal rank. Louis-Marie (1928-29) did not accept Beal's treatment and suggested *T. canescens* was allied with *T. flavescens* rather than with *T. cernuum*. Nevertheless, *T. flavescens* has glabrous ovaries and caryopses whereas *T. cernuum* subsp. *cernuum* and *T. cernuum* subsp. *canescens* both have short hairs near the apex of the ovaries and caryopses.

Specimens examined **CANADA. British Columbia:** Kaslo, Kootenay, 27 Jun 1914, *McHenry 9130* (US); 15 May 1889, *Macoun 42* (US); Vancouver Island, 27 Jun 1887, *Macoun 141* (US); Vicinity of Victoria, 2 Jul 1908, *Macoun 80985* (US); on damp soil, 13 Jun 1887, *Macoun 50* (US); Vicinity of Victoria, 18 Jun 1908, *Macoun s.n.* (US). **U.S.A. California:** San Francisco, *Bolander s.n.* (US); Santa Cruz, 1887, *Anderson s.n.* (US). **San Bernardino Co.:** San Bernardino Mts., 21 Jul 1902, *Abrams 2772* (P); Mts. near head waters of the Sacramento River, 7500 ft, 1 Sep 1882, *Pringle s.n.* (P). **Butte Co.:** Jonesville, 1600 m, 21 Jul 1932, *Copeland s.n.* (CONC). **Inyo Co.:** Pine Creek, Sierra Nevada, near Round Valley, 8000 ft, 10 Jul 1932, *Duran 3333* (CONC). **Santa Clara Co.:** Congress Springs, shady ravine, 22 Jun 1908, *Hitchcock 2645* (US); Yosemite National Park, 17–25 Aug 1908, *Hitchcock 3347* (US); Angel Island, 13 Apr 1901, *Davy 6899* (US). **Marin Co.:** Mt. Tamalpais, 26 Apr 1893, *Davy 139* (US); Point Reyes Peninsula, Jun–Jul 1900, *Davy 6779* (US). **Trinity Co.:** Head of Rush Creek, 20 Jul 1914, *Yates 536* (US); Davis Creek, 5 Jul 1894, *Davy s.n.* (US). **Humboldt Co.:** Eureka, Samoa, open woods, fixed dunes, 13 Jul 1915, *Hitchcock 13078* (US). **Syskiyou Co.:** South Fork of Shasta River, Mount Eddy, Shasta Forest, 11-12 Aug 1915, *Eggleston 11636* (US); Dry soil, pine and cedar woods, 10 Jul 1927, *Swallen 727* (US); Buck's Ranch, 5000 ft, 13 Jul 1900, *Leiberg 5124* (US); Near seashore in unprotected places, 1860–67 Geological Survey of Califonia, *Bolander 6077* (US). **Idaho:** Moscow Mts., moist slope, edge of woods, 8 Jun 1940, *Swallen 6016* (US); Coeur D'Alène Mts., 950 m, 1 Jul 1895, *Leiberg 1132* (US). **Latah Co.:** in open woods, 6 Jul 1894, *Piper 1924* (US). **Montana:** Belton, Rocky woods, 2 Jul 1914, *Hitchcock 1446* (P), *Hitchcock 11222* (US); E Fork of Bitterroot River, 4–5 Aug 1908, *Chase 5208* (US). **Missoula Co.:** Granite Creek drainage, ca. 3.1 air mi SW of Lolo Hot Springs, 4480 ft, 18 Jul 1986, *Shelly & King 1229* (US); Bitterroot Mts., shaded place in pine woods, 23–24 Jul 1908, 3900–4000 ft, *Chase 5196* (US); Glacier National Park, damp woods, McDonald Creek, Little Kootenai, 6000 ft, 8 Jul 1914, *Hitchcock 11264* (US); Columbia Falls, moist places in dry woods, 17 Sep 1909, *Hitchcock 4946* (US). **Flathead Co.:** 1 3/4 mi NE of Rogers Ranch, Douglas fir–lodgepole pine slope above Camas Creek, 4000 ft, 5 Sep 1955, *Hermann 12460* (US); Columbia Falls, 1892, *Williams 958* (US). **Nevada. Amador Co.:** 18 Jun 1896, *Hansen 1748* (P), 25 Jun 1896, *Hansen 1763* (P), 30 Jun 1896, *Hansen 2088* (P). **Oregon:** Sauvie's Island, May 1886, *Howell s.n.* (P); Willamette Slough, 31 May 1881, *Howell s.n.* (P); Crater Lake, 25 Aug 1902, *Cusick 2976* (P); Columbia River, Bridal Veil to Multnomah Falls, 46–100 ft, 27–28 Jun 1908, *Chase 4840* (US). **Klamath Co.:** moist ground in pine woods, 4 Jun 1904, *Applegate 3151* (US), Portland, 6 Jul 1902, *Sheldon 9.10811* (US); Siskiyou, 21 Jul 1908, *Hitchcock 2925* (US). **Douglas Co.:** exposed rocky summit of Harshberger Mt., 6200 ft, 13 mi NW Union Creek, 29 Jul 1955, *Hermann 119779* (US); Hood River, 1 Jul 1908, *Hitchcock 2757* (US); Sheep Ranch between Remote and Camas Valley, 19 Jul 1908, *Hitchcock 2859* (US); Fort Klamath, low ground, open woods, 29 Jul 1908, *Hitchcock 3005* (US); Camas Prairie, Jul 1902, *Griffiths & Hunter 52* (US). **Utah: Salt Lake Co.:** Salt Lake City, Red Butte Canyon, 21 Jul 1909, *Piper 1906* (US). **Washington: Clallam Co.:** Olympic Mts., Aug 1900, *Elmer 1944* (P, US); Head of Mainen Creek, Olympic National Forest, 5500 ft, 20 Jun 1934, *Cliff 106* (US); Olympie Mts., Aug 1900, *Elmer 1945* (P); Washington, 1898, *A.A. & E.G. Heller 3931b* (P). **Grays Harbor Co.:** Montesano, 200 ft, 11 Jun 1898, *A.A. & E.G. Heller 3931* (P, US); Columbia River, 17 Jun 1883, *Suksdorf s.n.* (P), Washington Territory, 1883, *Suksdorf 57* (US). **Klickitat Co.:** dry grounds, Columbia River, 17 Jun 1883, *Suksdorf 611 or 967* (US); Swamp near Seattle, 20 May 1890, *Talcott s.n.* (US); 1883, *Vasey 30* (US); 1889, *Vasey s.n.* (US); Cascade Mts., 1889, *Vasey s.n.* (US), 1889, *Suksdorf 1104* (US). **Klickitat Co.:** Bingen, 5 Jun 1919, *Suksdorf 10221* (US); Seattle, 12 Jun 1891, *Piper s.n.* (US); Blue Mountains, 23 Jun 1897, *Horner 540* (US); Browns Island, Friday Harbor, 28 Jun 1909, *Beattie 3334* (US); Dry point, SE of Friday Harbor, 22 Jun 1909, *Beattie 3319* (US); 1883, *Vasey 19* (US); 1883, *Suksdorf 58* (US); Mt. Baker, rocky slope on upper pass of Church Mt. Glacier, 11–12 Aug 1914, *Hitchcock 11633* (US). **Klickitat Co.:** Mt. Stuart, Aug 1898, *Elmer 1143* (P, US); Blue Mountains, 17 Jul 1897, *Horner 654* (US); Blue Mts., near Walla Walla, 29 Jun 1899, *Shear 1612* (US); Seattle, Jun 1890, *Piper s.n.* (US), 1889, *Piper 845* (US). **Chelan Co.:** moist creek bottoms near Leavenworth, 16 Jun 1931, *Thompson 6752* (US). **Spokane Co.:** east of Rockford, pine woods along road, 20 Jun 1940, *Swallen 6242* (US). **Ferry Co.:** moist banks of Barnaby Creek at its confluence with the Columbia River, 1290 ft, 30 May 1940, *Rogers 573* (US). **Kitsap Co.:** Port Orchard, 29 May 1938, *Eyerdam 1524* (US). **Chelan Co.:** yellow pine slopes of Tip Top, 4000 ft, *Thompson 10785* (US). **Whitman Co.:** near Pullman, *Swallen 6242c* (US); Ashford, wood border, 7–11 Jul 1908, *Chase 4947* (US); Eastern Washington, 13 Jun 1902, *Griffiths & Cotton 238* (US). **Walla Walla Co.:** Blue Mts., 29 Jun 1899, *Shear 1600* (US); 22 Jun 1895, *Cloud s.n.* (US); low ground, 21 Jun 1897, *Suksdorf 2665* (US).

5. Trisetum flavescens (L.) P. Beauv., Ess. Agrostogr. 88, 153, t. 18, f.1, 1812. *Avena flavescens* L., Sp. Pl. 80. 1753. *Trisetaria flavescens* (L.) Baumg., Enum. Stirp. Transsilv. 3:263. 1816. *Rebentischia flavescens* (L.) Opiz, Lotos 4:104. 1854, *nom. inval. Trisetaria flavescens* (L.) Maire, Bull. Soc. Hist. Nat. Afrique N. 33(4):92. 1942, *nom. illeg. hom.* TYPE: *Herb. A. Van Royen no. 913.7-458* (LECTOTYPE: LINN-97.14, designated by Cope in Cafferty et al., Taxon 49:247. 2000).

Trisetum pratense Pers., Syn. Pl. 1:97. 1805. *Trisetum flavescens* subsp. *pratense* (Pers.) Asch. & Graebn., Syn. Mitteleur. Fl. 2:265. 1899. TYPE: Europe.

Perennials. Culms (20–)80–110 cm tall, glabrous, with 2–5 nodes. Leaf sheaths shorter than the internodes, glabrous or the lower ones sparsely pilose; ligules 0.5–2 mm long, minutely dentate, ciliate, glabrous dorsally, truncate; blades (3–)100–160 × 2–4 mm, flat, glabrous abaxially, scabrous and sparsely pilose adaxially. Panicles 5–18 × 2–8 cm, lax, open or contracted, golden-yellow, bright. Spikelets 5–7(–8.5) mm long, (1–)2–3(–4)-flowered; rachilla about 1.2 mm long, pilose, the hairs 1–1.5 mm long; glumes shorter than the spikelet, unequal, bright, scabrous on the keel; first glumes 2–4 × 0.1–0.2 mm, linear-lanceolate, subulate, usually about one half of the length of the adjacent floret, 1-nerved; second glumes 4–6.6 × 1 mm, oval-lanceolate, 3-nerved, covering about two thirds of the adjacent floret, rarely as long as the spikelet; lemmas 4–6 mm long, scabrous; apex 2-dentate and 2-awned, awned dorsally on the upper 1/3–1/4; dorsal awns 5–9 mm long, geniculate and twisted; callus with short hairs, the hairs about 0.5 mm long; palea shorter than the lemma, hyaline, 2-nerved, the nerves scabrous; apex 2-dentate or 2-setulate; ovary glabrous; anthers 2–3 mm long. Caryopses 2–3 mm long, compressed, glabrous; endosperm liquid.

Anatomy and micromorphology.—Ligule apices composed mostly of hairs, papillate cells only rarely present (Chaffey 1994); blades in transverse section flat, symmetric, without a well developed keel; adaxial side with wide, low ribs; furrows as wide as the adjacent ribs, less than one half of the leaf thickness; first order vascular bundles with adaxial and abaxial girders; smaller bundles with adaxial and abaxial sclerenchymatic strands; marginal sclerenchyma very small; bulliform cells in fan-shaped groups of 5–7 cells situated at the bases of the furrows; abaxial epidermis with the intercostal zone composed of rectangular to slightly fusiform long cells, with side walls slightly undulate; stomata in two rows in each intercostal zone; prickles present; macrohairs absent; costal zones with short cells in silico-suberose couples and long cells shorter and narrower than the long intercostal cells.

Distribution.—Canada and the United States. Native to Europe, *T. flavescens* was introduced in North and South America (Argentina, Chile). This species has been reported in California, Kansas, Massachusetts, Mississippi, Missouri, New Jersey, New York, Oklahoma, Vermont, and Washington (Kartesz 1998).

Specimens examined. **CANADA. Yukon:** Arctic Coast west of Mackenzie River Delta, 69°12'N, 138°30'W, 23–25 Jul 1938, *Porsild 7122* (S). **U.S.A. California: Humboldt Co.:** edge of field at Blue Lake, 12 Jul 1911, *Tracy 3527* (US). **Missouri:** Introduced along railroad at Coutney, 6 Jun 1891, *Bush s.n* (US). **Vermont:** Charlotte, *Pringle 242* (US), Jun 1978, *Hosford s n.* (US). **Washington:** Walla Walla, seed farm, 31 May 1900, *Leckenby 19a* (US).

6. Trisetum montanum Vasey, Bull. Torrey Bot. Club 13:118. 1886. *Trisetum canescens* unranked *montanum* (Vasey) Hitchc., Proc. Biol. Soc. Wash. 41:160. 1928. *Trisetum spicatum* subsp. *montanum* (Vasey) W.A. Weber, Phytologia 33(2):106. 1976. TYPE: U.S.A. NEW MÉXICO: San Miguel Co.: Las Vegas, Jul 1881, *G.R. Vasey s.n.* (ISOTYPES: NY-232365!, NY-232368!, NY-232369!, US-81777!, US-156883!, US-868271!).

Trisetum argenteum Scribn., Bull. Div. Agrostol., U.S.D.A. 11:49-50, f. 8. 1898, nom. illeg. hom. *Trisetum shearii* Scribn., Cir. Div. Agrostol. U.S.D.A. 30:8. 1901. *Graphephorum shearii* (Scribn.) Rydb., Bull. Torrey Bot. Club 32(11):602. 1905. *Trisetum montanum* Vasey var. *shearii* (Scribn.) Louis-Marie, Rhodora 30: 213. 1928. TYPE: U.S.A. COLORADO: below Silverton, among rocks, Las Animas Canyon, 2700 m, 4 Aug 1897, *C.L. Shear 1214* (HOLOTYPE: US-747299!; ISOTYPES: US-747298!, US-747300!, US-868267!).

Trisetum montanum var. *pilosum* Louis-Marie, Rhodora 30:212. 1928. TYPE: U.S.A. New México. San Miguel Co.: near Cowels, 8200 ft, 26 Jul 1908, *Standley 4536* (HOLOTYPE: GH; ISOTYPES: US fragm. ex GH!, S!).

Perennials. Culms 50–70 cm. tall, glabrous. Leaf sheaths shorter than the internodes, glabrous or pilose; ligules about 3 mm long, truncate, dentate, glabrous dorsally; blades 100–150 × 3–10 mm, flat, glabrous or pilose. Panicles 10–24 cm long, lax, open to more or less contracted; rachis and pedicels scaberulous. Spikelets 4.5—6 mm long, 1–5 cm wide, 2–3(–4)-flowered; pedicels up to 2.5 mm long; rachilla about 0.8 mm, pilose, the hairs less than 0.5 mm long; glumes shorter than the spikelet, unequal, thin, hyaline; first glumes 3–3.5 × 0.4–0.5 mm, linear-lanceolate to lanceolate, about two thirds the length of the second glume, 1-nerved; second glumes 4–4.5 × 0.6–0.8 mm, oval to oval-lanceolate, 3-nerved; lower florets about 4 × 0.6 mm; lemmas glabrous; apex shortly two-awned, hyaline, awned on the upper third or fourth, approximately at 1–1.5 mm below the apex; awns 3.5–4 mm long, scabrous, diversely curved but not strongly twisted nor geniculate; callus with short hairs, the hairs about 0.1 mm long; paleas about 4 mm long, shorter than the lemma, 2-nerved, the nerves scabrous; apex shortly bisetulate; lodicules 0.5–0.8 mm long, apex bilobulate; anthers 0.8–1.2 mm long; ovary glabrous. Caryopses glabrous; endosperm semi-liquid.

Distribution.—Canada and United States. *Trisetum montanum* occurs in Arizona, California, Colorado, Idaho, Montana, New México, Utah, and Wyoming at 7500–11000 ft.

Comments.—This species is related to *T. cernuum*. Beal (1896) mentioned that *T. montanum* has been erroneously interpreted as an opened-panicle form of *T. spicatum*. Hitchcock (1928) considered this species as a variety of *T. canescens*, but later, (Hitchcock 1939, 1950) treated it as a valid species. Hitchcock (1950) distinguished it from *T. canescens* by its smaller culms with shorter and denser panicles, narrower blades, thinner glumes and lemmas, and more delicate awns. It also differs from *T. cernuum* var. *canescens* by having a glabrous ovary.

Specimens examined. **CANADA. Alberta**: Waterton Lakes National Park, 6000–7500 ft, 5 Aug 1950, *Breitung 14039* (S); 30 Jul 1950, *Breitung 13955* (S); crevices in argillite bluff, 5600 ft, Bertha Lake trail, W of Waterton Lake, 3 Aug 1956, *Hermann 13080* (US); Banff National Park, Johnson Valley Trail Head, 51°15'24.6"N, 115°51'26.3"W, 1443 m, 3 Jul 2004, *Peterson, Saarela & Smith 18397* (US). **Yukon**: 3600 ft, upper Rose River Valley, 17 Jul 1944, *Porsild & Breitung 10468* (S). **U.S.A. Arizona:** Mt. Graham, 32°48'N, 109°45'W, 9500 ft, 12 Aug 1934, *Kearney & Peebles 9970* (US). **Apache Co.:** wet, black, loam soil near edge of Milk Creek, aspen, yellow pine, Engelmann spruce association; Milk Canyon, Escudilla Mountain, 8 mi E of Nutrioso; 8500 ft, 24 Aug 1951, *Parker 7533 & McClintock* (US). **California:** Yosemite National Park, Tioga Pass, 14 Jul 1926, *Kraus s.n.* (S). **Colorado:** 1892, *Patterson s.n.* (US); 8000–9000 ft, 1875, *Patterson 26* (US); Rocky Mts., 40-41°S, 1868, *Vasey 636* (US); Aspen zone, Silverplume Clear Creek Cañon, 10000 ft, 18 Aug 1896, *Holm s.n.* (S); Idaho Springs, shady canyon, 27 Aug 1895, *Shear 720* (US), 28 Aug 1895, *Rydberg 2481* (US); Twin Lakes, 1873, *Wolfe 669* (US); Animas Canyon below Silverton, 9100 ft, open rocky slopes, in moist sandy soil, 4 Aug 1897, *Shear 1218* (US); Near Pagosa Peak, 11 Aug 1899, *Baker 95C* (US); Ouray, springy ground, above Box Canyon, 30–31 Aug 1906, *Hitchcock 2229* (US); Around Minnehaha, Pikes Peak, 3 Sep 1906, *Hitchcock 2330* (US); 2600 m, 13 Aug 1901, *FE & ES Clements 261* (US); Jack Brook, above Minnehaha, lower slopes of Pikes Peak, 8800 ft, 14 Aug 1924, *Bacigalupi s.n.* (US); Castle Canyon, near Minnehaha, 10000 ft, 16 Aug 1913, *Dachkowski-Stokes s.n.* (US). **Chaffe Co.:** Buena Vista, Cottowood Lake, 7700 ft, 15 Aug 1916, *Shear 1001* (US). **Clear Creek Co.:** Rocky, wooded slope, Chicago Creek, 9000 ft, 4 Sep 1944, *J.H. Ehlers & L.S. Ehlers 8297* (US). **Gunnison Co.:** Gothic, road to Judd Falls lookout, 1 Jul 1954, *Wilkens 10084a* (US); Saguache and Hinsdale Cos., Gunnison Basin, damp lodgepole-pine woods, valley of the Slate River, about four mi NW of Crested Butte, 13 Jul 1960, *Barrell 10260* (US). **Hinsdale Co.:** E facing slope of Wager Gulch, a 1–2 mi S of the road up the Lake Fork and some 6 miles SW of Lake San Cristobal, 10800 ft, 14 Aug 1965, *Barrel & Spongberg 270a-65* (US); mountains near the head waters of Clear Creek, near Empire, 8500—11000 ft, 6 Sep 1892, *Patterson s.n.* (US); Athens, Rocky Mts., 1862, *Hall s.n.* (US); Pen Gulch, 1884, *Vasey s.n.* (US); Colorado, 1878, *Jones s.n.* (US); South Park, 1873, *Wolf & Rothrock s.n.* (US); Idaho Springs, 28 Aug 1895, *Rydberg 2481, 2491* (US); Pikes Peak, moist soil, 10000 ft, 24 Jul 1896, *Williams 2223* (US); Moist soil, in shade along stream, Spanish Peaks, 25 Jul 1928, *Swallen 1296* (US); Rocky fir wood, Dark Canyon, trail to Cameron's Cone from Calfway, 9000 ft, 28 Aug–3 Sep 1908, *Chase 5320* (US); Near Pagosa Peak, 9000 ft, Aug 1899, *Baker 223* (US); Moist woods near Pagosa Peak, 8 Aug 1899, *Baker 27* (US); Pikes Peak, 14 Jul 1896, *Williams 2177* (US); Georgetown, 17–20 Aug 1895, *Rydberg 2394 ×* (US); Garland, moist shady gulch, 30 Jul 1900, *CL & Wm Shear 71* (US); Idaho Springs, moist soil, mountain side, 27 Aug 1895, *Shear 718* (US). **La Plata Co.:** spruce woods near Lewis Creek, 2 mi W of Eagle Pass, La Plata Mountains, 11000 ft, 14 Aug 1936, *Rollins 1522* (US). **Idaho:** Payette National Forest, 9 mi E of McCall, frequent in loam soil, *Pinus, Pseudotsuga, Larix* forest across stream from Lake Fork campsite, 12 Jul 1953, *Holmgren & Tillet 9561* (US); **Montana:** Glacier National Park, McDonald Creek and Little Kootenai, 17 Jul 1914, *Hitchcock 1441* (S). **Madison Co.:** in aspens, Cottonwood Road, Gravelly

Range, 12 Jul 1940, *Swallen 6509* (US). **New Mexico:** 17-21 Aug. 1915, *Hitchcock 1445*(S); Mts of Las Vegas, 1881, *Vasey 21* (P); Las Vegas, Jul 1881, *Vasey s.n.* (P); Vicinity of Santa Fe, Sandia Mt., 3200 m, 19 Aug 1926, *Arsène & Benedict 16376* (P). **Taos Co.:** Rio Pueblo, 8500 ft, 11 Aug 1910, *Wooton s.n.* (US). **San Miguel Co.:** Indian Creek, Santa Fe Forest, 2400 m, 16 Aug 1923, *Eggleston 19051* (US); Cloudcroft, rich soil, open pine woods, 17-21 Aug 1915, *Hitchcock 13287* (US); Pecos River National Forest, Winsor Creek, 8500 ft, 28 Jul 1908, *Standley 4576* (US); Sandia Mountains, Las Apuestas Canyon, in woods, 7900 ft, in woods, *Ellis 40* (US). **Utah:** Wasatch Mt., 2700 m, 4 Sep 1907, *Tidestrom 482-a* (S); Abajo Mts., near Spring Creek, 2700–3000 m, 17–20 Aug 1911, *Rydberg & Garrett 9825* (US).

7. Trisetum orthochaetum Hitchc., Amer. J. Bot. 21:134, f.3. 1934. TYPE: U.S.A. MONTANA: Missoula Co.: Bitterroot Mts., near Lolo Hot Springs, collected in boggy meadow, 23-24 Jul 1908, *A. Chase 5129* (HOLOTYPE: US-1535753!).

Perennials. Culms up to 110 cm tall, glabrous, with 3 nodes, erect. Leaf sheaths glabrous; ligules 1.5–3.4 mm long, truncate, dentate to erose, sparsely ciliate; blades 80–200 × 3–7 mm, flat, scabrous. Panicles 17–19 × 2–3 cm, lax, the branches in distant whorls; rachis glabrous. Spikelets 6.5–9 mm long, 2- or 3-flowered; pedicels 2–4 mm long, scabrous; rachilla 1–1.5 mm long, hairy, the hairs up to 2 mm long; glumes shorter than the spikelet, 1/2–3/4 as long as the spikelet, unequal; first glumes 4–6 × 0.4–0.6 mm, lanceolate, 1-nerved; second glumes 5–6.5 × 1–1.2 mm, oval-lanceolate, 3-nerved; first floret 5–6 mm long, the upper ones 4.5–4.7 mm long; lemma glabrous to slightly scabrous, obscurely 5-nerved; apex bidentate, awned dorsally on the upper third or fourth, about 1.5 mm from the apex; awn 3.5—4 mm long, nearly straight, scabrous, purple; callus obtuse with short hairs, the hairs 0.3–0.4 mm long; paleas 4–5.5 mm long, as long as 3/4 the length of the lemma, hyaline, 2-nerved, the nerves scabrous; anthers 0.8–1 mm long; ovary densely hairy at the apex. Caryopses not seen.

Anatomy.—Leaf blades in transverse section expanded, flat or U-shaped, the keel not well developed; adaxial surface with low ribs, the furrows between them as wide as the ribs; median vascular bundle with sclerenchyma strongly developed towards the keel and adaxial girders I-shaped; first order bundles with adaxial and abaxial girders, alternating with second order bundles without sclerenchyma associated with strands in both epidermises; marginal sclerenchyma small; bulliform cells inconspicuous; abaxial epidermis with intercostal zones composed of fusiform long cells; stomata in two rows in each intercostal zone; costal zones with long cells narrower than intercostal long cells; short cells with sinuous walls; macrohairs absent.

Distribution.—Endemic to the United States, known only from northwestern Montana.

Comments.—*Trisetum orthochaetum* is easily recognized by its nearly straight awn. It is closely related to *T. cernuum*, in having a lax, open inflorescence with the glumes shorter than the spikelet and a hairy ovary.

Specimens examined. **U.S.A. Montana: Missoula Co.:** Bitterroot Mts., Granite Creek drainage, SW of Lolo Hot Springs, E of Granite Creek Rd., about 2 mi S of junction with road 4209, 4480 ft, 18 Jul 1986, *Shelley & King 1230* (US).

8. Trisetum projectum Louis-Marie, Rhodora 30(359):217–218. 1928. *Trisetum cernuum* Trin. var. *projectum* (Louis-Marie) Beetle, Leafl. W. Bot. 4:228. 1946. *Trisetum spicatum* (L.) K.Richt. var. *projectum* (Louis-Marie) J.T. Howell, Wasmann J. Biol. 37(12):22. 1979. TYPE: U.S.A. CALIFORNIA: Fresno Co.: Sierra Nevada, Dinkey Cr., 5300 ft, 25 Jun 1900, *H. M. Hall & H. P. Chandler 359* (HOLOTYPE: UC; ISOTYPES: GH, NY, US-390573!).

Perennials, caespitose. Culms 35–90 cm tall, glabrous; nodes 2. Leaf sheaths pilose; ligules 0.35–1.5 mm long, oval, dentate and ciliate at the apex, densely pilose dorsally; blades 80–130 × 2–3 mm, flat, soft, involute towards the apex, densely pilose on both surfaces, the hairs about 1.2 mm long. Panicles 9–23 × 2–3 cm, spiciform, interrupted, with short ascending branches, exserted, pale-yellow, shiny; rachis scabrous. Spikelets 6–6.5 mm long, 2-flowered, open at the apex; pedicels scabrous; rachilla about 1.5 mm long, pubescent, the hairs about 0.5 mm long; glumes acute, translucid; first glumes 5–5.5 × 0.5–0.7 mm, as long as or shorter than the spikelet, 1-nerved; second glumes 6.5–8 × 0.8–1 mm, longer than the spikelet, 3-nerved; first florets about 5 mm long; lemma glabrous, delicate and hyaline; apex ending in two setae about 1 mm long; awns about 5.5 mm long, borne on the upper third at 2 mm below the apex, not twisted nor geniculate, diversely curved; paleas about 3.5 mm long, shorter than the lemma, 2-nerved, the nerves scabrous; apex 2-dentate; lodicules 0.6–0.8 mm long; apex 2-lobulate; anthers 1–1.5 mm long; ovary glabrous. Caryopses not seen.

Anatomy and micromorphology.—Ligule apices with stiff hairs; ligule epidermis composed of long cells with straight walls, prickle hairs and macrohairs; short cells and stomata not observed; blades in transverse section expanded, flat, keeled; ribs present in both sides, rounded, low, separated by wide furrows; first order bundles with I-shaped girders; second order bundles alternating with the first order bundles, with or without sclerenchymatous strands; marginal sclerenchyma very small; bulliform cells inconspicuous; macrohairs present in both epidermises, abundant; abaxial epidermis composed of long cells somewhat fusiform, with straight lateral walls; intercostal short cells absent; stomata in four rows in each intercostal zone.

Distribution.—Endemic to the United States (California, Montana, and Nevada). This is the first report of *T. projectum* for Montana.

Comments.—*Trisetum projectum* has been treated as a variety of *T. canescens* (Hitchcock 1950), *T. cernuum* (Beetle 1946), and *T. spicatum* (Howell 1979). *Trisetum projectum* differs from *T. cernuum* subsp. *canescens* by having glabrous ovaries and spiciform panicles. Louis-Marie (1928-29) noted that *T. projectum* had been mistaken for *T. canescens*, from which it differs by its denser, interrupted, bright and pale-yellow panicles, glabrous lemmas, pilose blades, and glabrous ovaries. Hitchcock (1950) considered *T. projectum* to be a synonym of *T. canescens* because he thought there were intermediate forms, however, spiciform panicles and the glabrous ovaries are consistent characters of the former species. *Trisetum projectum* differs from *T. spicatum* by having less dense panicles, glabrous culms below the panicles (hairy in *T. spicatum*), and very unequal glumes, first glumes narrower than the second (glumes subequal in width in *T spicatum*), and second glumes usually longer than the spikelet (shorter than the spikelet in *T. spicatum*). Howell (1979) separated *T. projectum* from *T. spicatum* by its densely pubescent or velutinous foliage.

Specimens examined **U.S.A. California:** two mi NE of Mather, on trail to Cottonwood Meadow, dry woods of *Pinus ponderosa* and *Quercus kellogii*, 5500 ft, 9 Jul 1947, *Stebbins Jr. 3827* (US); Soda Springs, 9 Aug 1901, *Kennedy & Doten 264*, 265 (US); Sequoia National Forest, mountain meadow, 15 Jul 1927, *Swallen 790* (US), above Cahoon Meadow, 16 Jul 1927, *Swallen 797* (US); Lake Tahoe Region, 600 ft, 25 Jul 1907, *Pendleton & Reed 1247* (US); Near Donner Creek, vicinity of Truckee, 14–16 Jul 1913, *Hitchcock 10500* (US); Yosemite National Park, Upper Loyall Canyon, 9500 ft, 17–25 Aug 1908, *Hitchcock 3307* (US); Tahoe, open dry woods, 6225–7000 ft, 5 Aug 1908, *Hitchcock 3082* (US). Lake Tahoe, Jul 1901, *Hitchcock* s.n. (US); Southeastern California to Southern Utah, 9400 ft, 1987, *Purpus 5264* (US); Sierra Nevada, near Donner Lake, 1865, *Torrey 584* (US); Summit Lake, 6695 ft, 27 Aug 1948, *H & V. Bailey 2924b* (US); Yosemite Valley, 4060 ft, 5 Jul 1909, *Jepson 3136* (US); dry woods along Line Creek, Huntington Lake, 23 Jul 1923, *Swallen 853* (US). **Montana:** Spanish Creek Basin, moist woods, 16 Jul 1896, *Williams 2060* (US). **Nevada:** Glenbrook, Lake Tahoe, 6000–8000 ft, 8 Aug 1908, *Hitchcock 3184* (US).

9. Trisetum sibiricum Rupr., Beitr. Pflanzenk. Russ. Reiches 2:65. 1845. *Avena ruprechtii* Griseb., Fl. Ross. 4(13):418. 1852. *Trisetum ruprechtii* (Griseb.) Steud., Syn. Pl. Glumac. 1:226. 1854, *nom. superfl. Trisetum flavescens* var. *sibiricum* (Rupr.) Ohwi, Bot. Mag (Tokyo) 45 (532):192. 1931. *Trisetum bifidum* subsp. *sibiricum* (Rupr.) T. Koyama, Grass. Jap. Neighb. Reg. 533. 1987. TYPE: MALAYA. Zemlya tundra (LECTOTYPE: LE, designated by Tsvelev p. 384. 1983 as "Terra parva Samojedorum, fl. Belaja, leg. Ruprecht").

Trisetum sibiricum subsp. *litorale* Rupr. ex Roshev., Izv. Bot. Sada Akad. Nauk. SSSR 21:90. 1922. *Trisetum sibiricum* var. *litorale* (Rupr. ex Roshev.) Rupr. ex Roshev., Fl. URSS 2:254. 1934. *Trisetum litorale* (Rupr. ex Roshev.) Czer., Sosud. Rast. SSSR 390. 1981, hom. illeg. TYPE: RUSSIA. Litt. Oceani., glac. Kambalnitza, Peninsula Kanin, 13–14 Aug, *Ruprecht s.n* (LECTOTYPE: LE, designated by Tsvelev p.385. 1983; ISOLECTOTYPE: LE).

Perennials with small short rhizomes. Culms 16–40(–100) cm tall, erect, glabrous below the panicles, nodes 4, glabrous or subglabrous. Leaf sheaths glabrous, ciliate at the apex; ligules 1–1.5 mm long, truncate, dentate, ciliate, dorsally glabrous; blades 25–150 × 1.5–4 mm, flat, glabrous abaxially, scabrous to sparsely pilose adaxially, ciliate at the margin, with prominent adaxial ribs. Panicles 3–5.5(–20) × 1.5–2.5 cm, contracted, not spiciform, golden-yellow, not very dense, bright, somewhat lax and drooping; rachis glabrous. Spikelets 7–9 mm long, 2- or 3-flowered; pedicels scabrous; rachilla 1.2–1.4 mm long, densely hairy, the hairs 0.5–2 mm long; glumes shorter than the spikelet or the upper glumes equaling the florets, unequal both in length and width, hyaline towards the apex; first glumes (2.5–)4.5–5.5 × 0.3 mm, linear-lanceolate, 1-nerved; second glumes (4.5–)6.8–7 × 0.8–1 mm, oval-lanceolate, 3-nerved; first florets 5–8 mm long; lemma glabrous, keeled, dorsally scabrous only along the midnerve; apex ending in two setae; callus with hairs about 0.2 mm long; awns 6—8 mm long, borne dorsally on the upper third of the lemma, twisted, 1 or 2 times geniculate; paleas about 6 mm long, shorter than the lemma in the lower florets, longer than the lemma in the upper florets, almost smooth on the nerves; apex bisetulate; lodicules about 0.8 mm long, trilobulate at the apex; anthers 2–2.5 mm long; ovary glabrous. Caryopses not seen.

Chromosome number.—$2n = 14$ (Tateoka 1967, 1978; Frey 1992, 1993).

Anatomy and micromorphology.—Ligule apices composed of hairs and papillate cells; ligule epidermis composed of long cells with straight lateral walls; prickle hairs, macrohairs and stomata not observed; blades in transverse section expanded, V-shaped, with low and rounded ribs; furrows less than one half of the leaf thickness; abaxial surface without ribs; median bundle with a sclerenchymatic strand at the keel; first order vascular bundles with sclerenchymatic I-shaped girders; second order bundles free, alternating between the first order bundles; marginal sclerenchyma very small; bulliform cells not forming well defined fan-shaped groups; abaxial epidermis composed of fusiform long cells with straight side walls; short intercostal cells absent; stomata present; prickle hairs and macrohairs not observed.

Distribution.—*Trisetum sibiricum* is found in Alaska (U.S.A.) and Yukon (Canada) between 68° and 63° N and from the Bering Strait to Yukon. It is also widely distributed in Asia (Central Asia, Siberia, Mongolia, China), and Occidental Europe (Frey 1992).

Comments.—*Trisetum sibiricum* has been treated by some authors as a variety of *T. flavescens.* The characters that separate both species were clearly established by Frey (1992) who mentioned the lower sheaths pubescence, leaf blade width, prominent venation of the blades, awn geniculation, and color of the panicle to differentiate this species from *T. flavescens.* In addition, *T. sibiricum* has lemmas that are scabrous only along the midnerve in contrast to the uniformly scabrous lemmas of *T. flavescens.*

Specimens examined. **U.S.A. Alaska:** Brooks Range, Lake Peters, 24–26 Aug 1960, *Hultén s.n.* (S); Port Clarence, 65°05'N, 18 Jul 1879, *Kjellman s.n.* (S); NW Coast, Ogotoruk Creek, 30–31 Jul 1960, *Hultén s.n.* (S); Bering Strait District, Cape Thompson, 68°08'N, 165°57-59'W, sea level to 800 ft, top of bird cliffs, 27 Jul 1959, *Johnson, Viereck & Melchior 534* (US); vicinity of Ogotoruk Creek, 68°05-12'N, 165°30-48'W, sea level to 1000 ft, 20 Aug 1960, *H.R. & H.P. Melchior 286a* (US); Ogotoruk Creek Drainage, 68°05-12'N, 165°32-47'W, sea level to 1000 ft, solifluction slope, 5 Aug 1960, *Johnson RJ-130* (US); Teller, Port Clarence, Bering Strait, 6–20 Aug 1949, *Scamman 5410* (S); Port Clarence, 22–26 Jul 1879, *Kjellman s.n.* (S); Seward Peninsula, 65°16'N, 166°20'W, 24 Aug 1926, *A.E. & R.T. Porsild s.n.* (S); Norton Sound, Volcanic hills behind Pastolik, 63°08'N, 163°W, 1000 ft, 21 Jul 1926, *A.E. & R.T. Porsild 893* (S); White Mts., 900 m, 1 Jul 1953, *Gjaerevoll 294* (S); Ukinyik Creek, 68°43'N, 165°45'W, 1 Aug 1960, *Viereck & Bucknell s.n.* (S), 68°43-47'N, 165°45'-166°12'W, sea level - 2000 ft, 1 Aug 1960, *Viereck & Bucknell 4436* (US).

10a. Trisetum spicatum (L.) K. Richt. var. **spicatum**, Pl. Eur. 1:59. 1890. *Aira spicata* L. Sp. Pl. 1:64. 1753. *Aira subspicata* L., Syst. Nat. ed. 10. 2:873. 1759, nom. illeg. superfl. *Avena airoides* Koeler, Descr. Gram. 298, 1802, nom. illeg. superfl. *Trisetum subspicatum* (L.) P. Beauv., Ess. Agrost. 88, 149. 1812, nom. illeg. superfl. *Trisetaria airoides* (Koeler) Baumg., Enum. Stirp. Transsilv. 3:265. 1816, nom. illeg. superfl. *Trisetum airoides* (Koeler) P. Beauv. ex Roem. & Schult., Syst. Veg. 2:666. 1817, nom. illeg. superfl. *Koeleria subspicata* (L.) Reichb., Fl. Germ. Excurs. 49.

1830, nom. illeg. superfl. *Koeleria spicata* Reichb. ex Willk. & Lange, Prodr. Fl. Hispan. 1:72. 1861, nom. inval. *Trisetaria spicata* (L.) Paunero, Anales Jard. Bot. Madrid 9:516. 1959. Type: SWEDEN. Lapland: 1732, *Linnaeus s.n.* [lectotype: designated by Edgar & Conner, in Edgar p. 556 (1998), LINN-85.7!; isotype: S!].

Trisetum molle Kunth, Rev. Gram. 1:101. 1829, nom. nov., as comb., but basionym hom. illeg. *Avena mollis* Michx., Fl. Bor. Amer. 1:72, 1803, nom. illeg. hom. *Trisetum subspicatum* var. *molle* (Kunth) A. Gray, Manual (ed. 2) 572. 1856. *Rupestrina pubescens* Prov., Fl. Canada 689. 1862. *Trisetum spicatum* var. *molle* (Kunth) Beal, Grass. N. Amer. 2:377. 1896. *Trisetum spicatum* subsp. *molle* (Kunth) Piper, Contr. U.S. Natl. Herb. 11:125. 1906. *Trisetum spicatum* var. *michauxii* St. John, Fl. S.E. Washington 62. 1937, nom. superfl. *Koeleria canescens* Torr. ex Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4,2(1):13 1836, nom. inval. *Trisetum spicatum* subsp. *molle* (Michx.) Hultén, Svensk Bot. Tidskr. 53:216. 1959, isonym. Type: CANADA. Am. Bor., *herb. Sprengel* (syntype: LE-TRIN-1927.02!); *anonymous s.n.* (syntype: US-865596 fragm.!); Montreal, *Michaux s.n.* (syntype: P!; US-photo ex P!).

Melica triflora Bigelow, New England J. Med. Surg. 5:334. 1816. *Trisetum triflorum* (Bigelow) Á. Löve & D. Löve, Univ. Colorado Stud., Ser. Biol. 17:7. 1965. Type: U.S.A. New Hampshire: Mt. Washington, Aug, *F. Boott s.n.*

Trisetum groenlandicum Steud., Syn. Pl. Glumac. 1:228. 1854. Type: GREENLAND: prope Friedrichstal, *Ed Hohenacher s.n.* (holotype: P; isotypes: US-fragm. ex P-STEUD-435!, US-867624 fragm. ex LE!).

Trisetum labradoricum Steud., Syn. Pl. Gumac. 1.228. 1854. Type: CANADA: Labrador Hopedale, 1846–1848, *Albrecht s.n.* (holotype: P; isotype: US-fragm. ex P-STEUD-438!).

Trisetum subspicatum var. *laxius* Lange, Consp. Fl. Groenland. 164. 1880. *Trisetum spicatum* var. *laxius* (Lange) Lindm., Skand. Fl. 2:175. 1926. *Trisetum spicatum* var. *laxius* (Lange) Louis-Marie, Rhodora 30.239. 1929. Type: GREENLAND: Holstensborg.

Trisetum subspicatum var. *villosissimum* Lange, Consp. Fl. Groenland. 164. 1880. *Trisetum spicatum* var. *villosissimum* (Lange) Louis-Marie, Rhodora 30:239. 1929. Type: GREENLAND: Sermilik, *Bredefjord s.n.* (syntype: ?); Julianehaabs Distr., *Kornerup s.n.* (syntype: ?); Gl. Egedesminde, *Jensen s.n.* (syntype: C).

Trisetum brittonii Nash, Bull. New York Bot. Gard. 1(5):437. 1900. *Trisetum spicatum* var. *brittonii* (Nash) Louis Marie, Rhodora 30:239. 1939. Type: U.S.A. Michigan: Marquette, Picnic Island, 19 Jul 1883, *N. L. Britton s.n.* (holotype: NY-431708!; isotype: US-fragm. ex NY!).

Trisetum alaskanum Nash, Bull. New York Bot. Gard. 2(6):155–156. 1901. *Trisetum spicatum* var. *alaskanum* Malte ex Louis-Marie, Rhodora 30:239. 1929. *Trisetum spicatum* subsp. *alaskanum* (Nash) Hultén, Svensk Bot. Tidskr. 53:210. 1959. Type: CANADA. Yukon: Skagway, 28 Aug 1899, *R.S. Williams s.n.* (holotype: NY-431709!; isotypes: S-fragm. & photo ex NY!, US-377013!).

Trisetum americanum Gand., Bull. Soc. Bot. France 49:182. 1902. Type: U.S.A. Colorado and Idaho (syntypes: ?).

Trisetum congdonii Scribn. & Merr., Bull. Torrey Bot. Club 29:470. 1902. *Trisetum spicatum* unranked *congdonii* (Scribn. & Merr.) Hitchc., Proc. Biol. Soc. Wash. 41:160. 1928. *Trisetum spicatum* subsp. *congdonii* (Scribn. & Merr.) Hultén, Svensk. Bot. Tidskr 53:218. 1959. Type: U.S.A. California: Mariposa Co.: Shadow Lake Trail, 1899, *J.W. Congdon s.n.* (holotype, US-81772!; isotype: GH).

Trisetum majus (Vasey) Rydb., Bull. Colorado State Univ. Exp. Sta. 100:34. 1906. *Trisetum subspicatum* unranked *major* Vasey ex Rydb., Bull. Colorado State Univ. Exp. Sta. 100: 34. 1906, *nom. inval.* *Trisetum subspicatum* var. *major* Vasey, Bull. Colorado State Univ. Exp. Sta. 100:34. 1906, como sinónimo. *Trisetum spicatum* subsp. *majus* (Vasey) Hultén, Svensk Bot. Tidskr. 53:218. 1959. Type: U.S.A. Colorado: Pen Gulch, 1884, *G.R. Vasey s.n.* (holotype: US-868199!; isotype: NY-431706!).

Caespitose perennials, sometimes with short rhizomes. Culms 9–60 cm tall, erect, tomentose to densely hairy below the panicle, with hairs antrorse below the panicle, then retrorse below; nodes 1 or 2. Leaf sheaths 1–3(–6) cm long, glabrous; ligules ca. 1 mm long, finely denticulate; blades 1–5 cm × 1–1.5 mm, flat or conduplicate towards the apex, glabrous or rarely hairy or scabrous, sometimes ciliate on margins. Panicles 2.5–7(–10) × 0.5–1.5(–2) cm, spiciform, gold-purplish to brown-purple, bright, usually interrupted at the base; rachis hairy. Spikelets 4.5–6 mm long, (1–)2-flowered; pedicels hairy; rachilla 0.8–1 mm long, hairy, the hairs 0.5–1 mm long; glumes shorter than the florets, as long as 3/4 to 4/5 of the spikelet, subequal or the first a little shorter and narrower than the second glume; sometimes, the second glumes equal or a little longer than the spikelet, scabrous or less frequently ciliate on the keel; first glumes 3.7–5 × 0.5–1 mm, lanceolate, 1–3-nerved; second glumes 4.5–6 × 0.5–1.3 mm, 3-nerved; florets 3.8–5 × 0.7–0.8 mm, the second floret 4–4.5 mm long; lemmas dorsally awned, glabrous, scabrous, purplish towards the base, stramineous towards the apex; margin hyaline; apex with two setae; awn 3.5–5 mm long, borne dorsally on the upper 1/3 or 1/4, geniculate or merely curved, sometimes twisted, scabrous, purple; callus obtuse, with hairs 0.3–0.5 mm long; paleas 3–4 mm long, shorter or a little longer than the lemma, hyaline, 2-nerved, the nerves scabrous; anthers 0.5–1 mm long; lodicules ca. 0.6 mm long, hyaline; apex 2-lobed; ovary glabrous. Caryopses 2–2.8 × ca. 0.6 mm, glabrous; endosperm liquid.

Chromosome number.—$2n = 14, 28, 42$ (Holmgren & Holmgren 1977).

Distribution.—A cosmopolitan species widely distributed in Asia, America (North, Central and South America), Europe, Australia, and New Zealand (Hultén 1959; Clebsch 1960; Nicora 1978; Tovar 1993; Pohl & Davidse 1994; Zuloaga et al. 1994; Edgar 1998; Barkworth 1999; Finot 2003a, 2004; Finot et al. 2004). In North America, *T. spicatum* is found in Canada, United States, and Greenland.

Comments.—*Trisetum spicatum* is an extremely variable species, and several subspecific taxa have been described. Louis-Marie (1928-29) recognized 14 varieties for the Americas and Hultén (1959), recognized 22 infraspecific taxa, including 14 subspecies and 8 varieties. Six of the fourteen subspecies recognized by Hultén (1959) are described for North America: subsp. *alaskanum* (Nash) Hultén, subsp. *pilosiglume* (Fernald) Hultén, subsp. *molle* (Michx.) Hultén, subsp. *majus* (Vasey) Hultén and subsp. *congdonii* (Scribn. & Merr.) Hultén. However, the lack of morphological discontinuities hinders the recognition of most of the infraspecific taxa (Randall & Hilu 1986).

Specimens examined. **CANADA. Alberta:** Jasper National Park, NE slope of Mount Edith Cavell, 5800 ft, 28 Aug 1956, *Hermann 13510* (US); Jasper National Park, 7000 ft, 17 Jul 1918, *Macoun s.n.* (US); Jasper National Perk, 9 mi NW of Bubbling Springs on Hwy 93 along Sunwapta River, 52°34'59.3"N, 117°44'18.1"W,1260 m, 5 Jul 2004, *Peterson, Saarela & Smith 18427* (US); Banff National Park, 11 mi NW of Mosquito Creek at Bow Summit, 51°43'16.9"N, 116°29'37.1"W, 2072 m, 4 Jul 2004, *Peterson, Saarela & Smith 18402* (US). **British Columbia:** SSW of Fort Nelson, 57°20'N, 123°56'W, 18 Jul 1960, *Calder & Kulckonen 27145* (SI); 13 mi NW of Pink Mountain on Hwy 97 towards ft. Nelson, 58°39'13.4"N, 124°15'14.0"W, 880 m, 7 Jul 2004, *Peterson, Saarela & Smith 18457* (US); 1 mi S of Iskut on Hwy 37 towards Meziadin Junction along Coyote Creek, 57°43'05.5"N, 129°59'15.9"W, 847 m, 20 Jul 2004, *Peterson, Saarela & Smith 18676* (US). **Newfoundland & Labrador:** base Américaine de la Péninsule d'Ongava, rève gauche Riv. Koksoak, 8–13 Jul 1948, *de la Rüe s.n.* (P). **Northwest Territories:** Arctic Coast, Cape Dalhousie, 70°20'N, 129°55'W, 7-14 Aug 1927, *Porsild 2697* (S); 62 mi NE of Eagle Plains on Dempster Hwy 5 towards Inuvik, 67°03'47.7"N, 136°10'46.0"W, 888 m, 12 Jul 2004, *Peterson, Saarela & Smith 18557* (US); 152 mi S of Inuvik on Dempster Hwy 5 towards Eagle Plains, 67°10'53.3"N, 135°48'35.7"W, 720 m, 14 Jul 2004, *Peterson, Saarela & Smith 18590* (US). **Nunavut:** Frobisher Bay, 63°45'N, 67°15'W, 15 Aug. 1964, *Swales 172* (S); Ellesmere Island, Lake Hazen, 81°49'N, 71°18'W, 27 Jul 1967, *Kevan s.n.* (S); Southampton Island, Coral Harbor, 64°08'N, 83°17'W, 1 Aug 1948, *Cody 1716* (S); West side of Bathurst Inlet, 15 Aug 1950, *Kelsall & McEwen 255* (S). **Yukon:** alpine meadows between 3000–4000 ft, Mt. Caribou, 5 mi N of Carcross, 60°14'N, 134°42'W, 17 Aug 1949, *Mitchell 4565* (SI), 12 mi S of Beaver Creek and 7 mi NE on Snag Creek Road, 62°17'42.9"N, 140°33'38.1"W, 670 m, 9 Jul 2004, *Peterson, Saarela & Smith 18489* (US); 0.5 mi E of Alska/Yukon boundary on road towards Dawson, 64°05'01.5"N, 140°58'59.8"W, 225 m, 10 Jul 2004, *Peterson, Saarela & Smith 18513* (US); 86 mi NE of Ross River on Canol Road Hwy 6 just W of MacMillan Pass, 62°46'00.4"N, 131°02'20.8"W, 1010 m, 17 Jul 2004, *Peterson, Saarela & Smith 18620* (US); 143 mi NE of Ross River on Canol Road Hwy 6 at MacMillan Pass, 63 14 46.2 N, 130 01 45.2 W, 1382 m, 17 Jul 2004, *Peterson, Saarela & Smith 18631* (US). **GREENLAND:** 69°45'N, 13 Aug 11 Jul 1949, *de Lesse s.n.* (P); Kangâtsiak 68°18'N, 29 Jul 1997, collector illegible (P); Godthabsfjord, Ivnajaugtoq, 64°46'N, 50°40'W, 100 m, 20 Jul 1976, *Hansen & Fredskild 1079* (S); Ivnajaugtoq, 64°44'N, 50°44'W, 250 m, 2 Aug 1976, *Fredskild s.n.* (S); Isortuarssûptasia, N of Semilik, 63°45'N, 50°19'W, 480–500 m, 17 Aug 1976, *Fredskild 5924* (S); Skjoldungen distr., Eqalungmiut (Dronning Maries Dal) 63°28'N, 41°55'W, 14 Aug 1970, *Astrup & Nielsen 842* (CTES). **U.S.A. Alaska:** Juneau, 25 Jun 1909, *Hitchcock 1442* (P); Lake Iliamna Region, 1902, *Gorman 67* (P). **California:** Sierra Nevada, just S of Red Mountain, 21 Aug 1991, *Peterson, Annable & Weinpahl 10438* (US); White Mts., 30 Jul 1930, *Duran 505* (P). **Inyo Co.:** Mount Whitney region, 12200 ft, 20 Aug 1937, *Sharsmith 3302* (S); Inconsolable Range above Thunder & Lightning Lake, ca. 12000 ft, 14 Aug 1927, *Howell 24113* (S). **Colorado:** Rocky Mt., 39°41'N, 1862, *Hall & Harbour 625* (P). **Hinsdale Co.:** 16.6 mi W of Lake City on Henson Creek road to Ouray, 38°57'N, 107°34'W, 3750 m, 23 Sep 1992, *Peterson & Annable 12128* (US); Clear Creek Co. 17.7 km from Echo Lake Lodge on road to Mt. Evans, 29 Aug 1989, *Peterson & Annable 7783, 7784* (US), meadow just E of Summit Lake, 14.5 Km from Echo Lake Lodge on Mt. Evans Road, 4230 m, 29 Aug 1989, *Peterson & Annable 7786* (US); vicinity of Mount Carbon, 3400 m, 6 Aug 1910, *Tidestrom 3971* (S); Bottomless Pit, Pikes Peak, 31 Aug 1913, *Hitchcock 1443* (P), Independence Pass, 6 Aug 1955, *Gentry 2393* (S); Trail Ridge, Rocky Mountain National Park, 12000 ft, 20 Jul 1963, *Jones 36964* (S). **Idaho: Custer Co.:** Sawtooth Wilderness Area, along Baron Creek, 2000–2400 m, 11–12 Aug 1955, *Morton 8326* (P). **Elmore Co.:** River Lake, 8000 ft, 23 Aug 1947, *F. & L. Meyer 2283* (S). **Montana: Park Co.:** Henderson Mt., vicinity of Cooke City, 5 Sep 1948, *Witt 1410* (S). **Nevada:** Ely, along stream, upper part of Timber Creek, 13 Aug 1913, *Hitchcock 1444* (P). **New Mexico:** Pen Gulch Col., 8000 ft, 1884, *Vasey* (US 868199, possible type of *Trisetum majus* Vasey); vicinity of Las Vegas, Solitario, 7 Sep 1926, *Arsène 17891* (P); vicinity of Santa Fe, 3600 m, 12 Aug 1926, *Arsene & Benedict 16238* (P). **Utah: Grand Co.:** La Sal Mts., 2000 ft, 29 Jul 1924, *E. & L. Payson 4045* (S). **Washington: Clallam Co.:** Olympic Mts., Aug 1900, *Elmer 1947* (P); Pierce **Co.:** Mount Rainier National Park, 5000 ft, 16 Aug 1947, *Rose 47174* (S).

KEY TO THE VARIETIES OF *TRISETUM SPICATUM*

1. Glumes glabrous ______ **10a. T. spicatum** var. **spicatum**
1. Glumes hairy ______ **10b. T. spicatum** var. **pilosiglume**

10b. Trisetum spicatum var. **pilosiglume** Fernald, Rhodora 18:195. 1916. *Trisetum spicatum* subsp. *pilosiglume* (Fernald) Hultén, Svensk Bot. Tidskr. 53:215. 1959. TYPE: CANADA

NEWFOUNDLAND: Island off Pike's Arm, 19 Jul 1911, *M.L. Fernald, Wiegand & Bartram 4593* (HOLOTYPE: GH; ISOTYPES: CAN-33298, S-fragm. ex GH!, US-1024249!).

Perennials. Culms about 20 cm tall, densely hairy below the panicle, the hairs antrorse near the panicle, retrorse below. Leaf sheaths densely hairy; blades 40–60 × 2–3 mm, flat, densely hairy. Panicles 2.5–5 × 0.8–1.2 cm, spiciform, dense, tinged with green and purple; rachis densely hairy. Spikelets about 5 mm long, 2- or 3-flowered; pedicels hairy; rachilla about 0.8 mm long, the hairs about 0.5 mm long; glumes shorter than the spikelet, hairy, ciliate on the keel, acute, green on the back, the margins and apex purplish; first glumes 3.5–3.8 × 0.5 mm, 1-nerved; second glumes about 5 × 1 mm, longer and wider than the first glume, 3-nerved; lemma glabrous or shortly pilose towards the apex, dorsally awned on the upper third; apex with two setae; callus obtuse with hairs; paleas about 4 mm long, shorter or as long as the lemma; lodicules about 0.8 mm long; apex bilobulate, one of the lobes larger than the other; anthers about 0.8 mm long; ovary glabrous.

Chromosome number.—$2n = 14$ (Frey 1992).

Distribution.—This subspecies constitutes the boreal form of the species. It occupies the northeastern region of North America, south of Greenland, East of Canada (Newfoundland, Nova Scotia, Quebec, Manitoba, Ontario, and Saskatchewan), and northeastern United States (Maine, Michigan, Minnesota, New Hampshire, Vermont). Its northern limits are found at 61°N in southern Greenland (Neria), from where it extends to Newfoundland and Quebec, and northeast to the United States.

Specimens examined. **CANADA. Manitoba:** Hudson Bay, 14 Aug 1939, *E.C. Abbe & L.B. Abbe 3885* (S); Great Whale River, 8 Aug 1959, *E. Hultén s.n.* (S). **Nova Scotia: Victoria Co.:** rock crevices along river Salmon River, 5 Jul 1949, *Smith, Collins, Bruce & Sampson 2647* (US). **Ontario:** shore of Lake Superior at Heron Bay South, ca. 6 mi southeast of Marathon, 31 Jul 1961, *E.G. Voss 10448* (S). **Quebec:** Lac Mistassini, Ile Manitounouk (rive sud-est), 365–415 m, 12 Jul 1944, *Rousseau & Rouleau 99* (US) ; East Coast of Hudson Bay, sedimentary slopes near sea level at Boat Opening, Manitounuck Sound, 14 Aug 1939, *E.C. & L.B. Abbe 3863* (US); Lac Mistassini, Pointe Dutilly (Ile Manitounouk), 365–415 m, 23–25 Jul 1945, *Rousseau 1867* (US); Ile D'Anticosti, rivière La Loutre, eboulis argilo-calcaires, 6 Aug 1926, *F. Marie-Victorin & Rolland-Germain 25883* (US); calcareous cliffs and taus, Gros Morne, 7 Jul 1931, *Fernald & Weatherby 2424* (US); E coast of Hudson Bay, Great Whale River, 16 Aug. 1939, *E.C. & L.B. Abbe 4259* (US); Canadian Sub-Arctic Flora, Lac Mistassini et iles du centre, Quebec, 10–17 Aug 1943, *Dutilly & Lepage 11522*, 11483 (US); Ile d'Anticosti, Rivière Vaureal, 27 Jul 1925, *M. Victorin & R. Germain 20550* (P); Falaises de la Montagne St. Alban, pres du Cap-Rosier, 19 Jul 1923, *Marie-Victorin, Brunel, Rolland-Germain & Rousseau 17770* (US); rock crevices near Mt. St. Pierre, 27 Aug 1947, *Swallen 9778* (US); Bill of Portland Island, 13 Sep 1939, *Dutilly, O'Neill & Duman 87875* (US); Cape Jones Island, 54°27'N, 80°04'W, 17 Sep 1939, *Dutilly, O'Neill & Duman 97124* (US); Port Harrison, 58°24'N, 78°20'W, 7–8 Sep 1939, *Dutilly, O'Neill & Duman 87650* (US); Fort George, 53°50'N, 79°06'W, 21–27 Sep 1939, *Dutilly, O'Neill & Duman 97209* (US). **Newfoundland:** recuellis en 1816–1819, 1820, collector not indicated, no date (P); Northern shores of Notre Dame Bay, 20 Aug 1911, *Fernald & Wiegand 4495* (P); Labrador, 27 Jul 1923, *Sablou? 16* (US); Region of St. John Bay, 19 Jul 1929, *Fernald, Long & Fogg, Jr. 1289* (S); Roma Bay, 27 Jul 1930, *Janssan 248* (S); Labrador, 10 Jul 1937, *Potter 7867* (S); Labrador, Hopedale, 10 Jul 1937, *Potter 7865* (US); Western Newfoundland, St. John Bay, dry gravelly or shingly limestone barrens, Old Port Au Choix, 19 Jul 1929, *Fernald, Long & Fogg Jr. 1289* (US); Silurian area of Northwest coast, dry limestone barrens, Brig Bay, 6 Aug 1924, *Fernald, Long & Dunbar 26276* (US); Labrador, rocky hill, Battle Harbor, 13 Aug 1928, *Hitchcock 23871* (US); Labrador, Central Range of the Torngat, Scree slide from top of Precipice Ridge to Komaktorvil Lake, 59°12'N, 64°20'W, 29 Jul 1931, *Abbe 75* (US); Western Newfoundland, Lower Humber Valley, Hannah's Head, 12 Jul 1929, *Fernald, Long & Fogg, Jr. 1288* (US); Labrador, *Sornburger 240* (US); Labrador Peninsula, Battle Harbor, Aug 1912, *Birdseye s.n.* (US); Newfoundland, Western Newfoundland, St. John Bay, Doctor Brook, 24 Aug 1925, *Wiegand & Gilbert, Jr. 27454* (US); Newfoundland, Straits of Belle Isle, dry horizontal limestone, Rock Marsh, Flower Cove, 30 Jul 1924, *Fernald, Long, Dunbar 26275* (US); Western Newfoundland, Bonne Bay, limestone ledges and talus, Shag Cliff, 9 Aug 1929, *Fernald, Long & Fogg, Jr. 1291* (US); Labrador, Hopedale Region, Near the beach by the old Eskimo village, Hopedale, in *Salix-Empetrum* mat, 55°27'N, 60°10'W, *Abbe & Hogg 74* (US); Labrador, West Blanc Sables, 27 Jul 1893, *Waghorne 16* (US); Western Newfoundland, Bonne Bay, turfy limestone crest, 650 m, Killdevil, 23 Aug 1929, *Fernald, Long & Fogg, Jr. 1293* (US). **Saskatchewan**: Lake Athabaska, small island near base of Cornwall Bay, 59°27'N, 108°27'W, *Raup 6545* (US). **GREENLAND:** 62°30'N, 12 Jul 1878, *Kornerup 17* (S); Neria, 61°33'N, 24 Jul 1928, *Eugenius s.n.* (S). Sermilik Fjord, 60°37'N, 44°42'W, 30 m, 8 Aug 1962, *C. Hansen, K. Hansen & Petersen 191* (S); Kangerdluk, 60°13'N, 44°19'W, 10 Jul 1966, *Gravesen & C. Hansen s.n.* (S); Disko, Igdlorssuit, Prins Christians Sund, 60°10'N, 21 Jul 1925, *AE & MP Porsild s.n.* (US); Disko, ca. Neria 61°33'N, 24 Jul 1928, *Eugenius s.n.* (US); East Greenland, Grant Fjord (Clavering Fjord), Payer Land, 12 Aug 1939, *Bartlett 415* (US), Disko, ca. Neria 61°33'N, 19 Jul 1926, *Eugenius s.n.* (US); Angmagssalik, 65°N, 21 Aug 1939, *Bartlett 429* (US). **U.S.A. Maine:** Maine, Mt. Katahdin, North Basin, 13 Jul 1900, *Fernald s.n.* (US). **Michigan:** Isle Royal, 7 Aug 1901, *Stuntz & Allen 48* (US). **Minnesota: Lake Co.:** exposed rocks, Beaver Bay Is., 11 Jul 1938, *Fasset & Curtis 19562* (US). **New Hampshire:** Mt Washington, 1882, *Faxon s.n.* (US). **Vermont:** Smugglers Notch, Mt Mansfield, in turf of *Saxifraga*, etc., 24 Jun 1935, *Torrey et al. 2361* (US).

APPENDIX 1

Subgeneric treatment of *Trisetum* in North America.

Trisetum

Trisetum subgen. **Trisetum**

Trisetum subgen. **Trisetum** sect. **Trisetum**, Type: *Trisetum flavescens* (L.) P. Beauv.

Species included: *T. cernuum* var. *cernuum*, *T. cernuum* var. *canescens*, *T. montanum*, *T. orthochaetum*, *T. flavescens*, *T. sibiricum*.

Trisetum subgen. **Trisetum** sect. **Trisetaera** Asch. & Graebn., Type: *Trisetum spicatum* (L.) K. Richt.

Species included: *Trisetum projectum*, *T. spicatum* var. *spicatum*, *T. spicatum* var. *pilosiglume*.

APPENDIX 2

Numerical index of the species.

1. *Graphephorum melicoides*
2. *G. wolfii*
3. *Trisetum aureum*

4a. *Trisetum cernuum* var. *cernuum*,
4b. *T. cernuum* var. *canescens*

5. *T. flavescens*
6. *T. montanum*
7. *T. orthochaetum*
8. *T. projectum*
9. *T. sibiricum*

10a. *T. spicatum* var. *spicatum*,
10b. *T. spicatum* var. *pilosiglume*

APPENDIX 3

Index of exsiccatae.

Abbe 75 (10b); Abbe E.C. & L.B. 3863 (10b), 3885 (10b), 4259 (10b); Abbe & Hogg 74 (10b); Abrams 2772 (4b); Allen 42 (4a); Anderson s.n. (4b); Applegate 3151 (4b); Arsène 17891 (10a); Arsène & Benedict 16238 (10a), 16376 (6); Astrup & Nielsen 842 (10a); Austin s.n. (4b).

Bacigalupi s.n. (6); Bailey 2924b (8); Baker 27 (6), 95C (6), 223 (6); Barrell 10260 (6); Barrel & Spongberg 270a-65 (6); Bartholomew s.n. (2); Bartlett 415 (10b), 429 (10b); Beattie 3319 (4b), 3334 (4b); Beetle & Stebbins Jr. 3450 (4a), s.n. (4a); Birdseye s.n. (10b); Bolander 4 (4a), 29 (4a), 5019 (2), 6077 (4b), s.n. (4b); Boott s.n. (10a); Breitung 13955 (6), 14039 (6), 16778 (4a); Britton s.n. (10a); Brown 764 (4a); Bush s.n. (5).

Calder & Kulckonen 27145 (10a); Calder, Saville & Ferguson 13166 (4a); Chandler 1176 (4a); Chase 4840 (4b), 4904 (4a), 4920 (4a), 4947 (4b), 5003 (4a), 5062 (4a), 5080 (4a), 5129 (7), 5163 (4a), 5196 (4b), 5208 (4b), 5320 (6); Clements 200 (2); Clements, F.E. & E.S. 261 (6); Cliff 106 (4b); Cloud s.n. (4b); Cody 1716 (10a); Cooper 16 (4a); Copeland s.n. (4b); Coville & Kearney 2512 (4a); Cusick 6 (4a), 2426 (4a), 2976 (4b).

Dachkowski-Stokes s.n. (6); Davy 139 (4b), 6779 (4b), 6899 (4b), s.n. (4b); de la Rûe s.n. (10a); de Lesse s.n. (10a); Dore 12479 (4a); Duran 505 (10a), 3333 (4b); Dutilly & Lepage 11522, 11483 (10b), 87650 (10b), 87875 (10b), 97124 (10b), 97209 (10b), 98124 (10b).

Eastham 39 (4a); Eggleston 3136 (1), 11636 (4b), 19051 (6); Ehlers, J.H. & L.S. 8297 (6); Ellis 40 (6); Elmer 1143 (4b), 1944 (4b), 1945 (4b), 1946 (4a), 1947 (10a); Eugenius s.n. 19 Jul 1926 (10b), s.n. 24 Jul 1928 (10b); Eyerdam 1524 (4b).

Fasset & Curtis 19562 (10b); Faxon s.n. (10b); Fernald 187 (1), s.n. (10b); Fernald & Weatherby 2424 (10b); Fernald & Wiegand 4495 (10b), 4591 (1); Fernald, Long & Dunbar 26276 (10b), 26275 (10b); Fernald, Long & Fogg Jr. 1289 (10b), 1288 (10b), 1289 (10b), 1291 (10b), 1293 (10b); Fernald, Wiegand & Bartram 4593 (10b); Fredskild 5924 (10a), s.n. (10a).

Gentry 2393 (10a); Gjaerevoll 294 (9); Gorman 67 (10a); Gravesen & Hansen s.n. (10b); Griffiths & Cotton 238 (4b); Griffiths & Hunter 52 (4b), 53 (4a), 128 (4a).

Haenke s.n. (4a); Hall s.n. (6); Hall & Chandler 359 (8); Hall & Harbour 625 (10a); Hansen 1748 (4b), 1763 (4b), 2088 (4b); Hansen & Fredskild 1079 (10a); Hansen, Hansen & Petersen 191 (10b); Heller 3931 (4b), 3931b (4b), 3904 (4a); Hermann 119779 (4b), 12460 (4b), 12914 (4a), 13048 (4a), 13080 (6), 13510 (10a); Hitchcock 1441 (6), 1442 (10a), 1443 (10a), 1444 (10a), 1445 (6), 1446 (4b), 1447 (4a), 2229 (6), 2330 (6), 2645 (4b), 2757 (4b), 2807 (4a), 2859 (4b), 2925 (4b), 3005 (4b), 3082 (8), 3161 (4a), 3184 (8), 3307 (8), 3347 (4b), 3359 (4a), 4042 (4a), 4065 (4a), 4121 (4a), 4946 (4b), 10500 (8), 11222 (4b), 11264 (4b), 11633 (4b), 12274 (4a), 13078 (4b), 13287 (6), 23871 (10b), s.n. (4a), s.n. Jul 1901 (8); Holm s.n. (6); Holmgren & Tillet 9561 (6); Horner 540 (4b), 654 (4b); Hosford s.n. (5); Howell 79 (4a), 869 (4a), 1716 (4a), 24113 (10a), s.n. 31 May 1881, (4b), s.n. 1880 (4a); Hultén 542 (4a), s.n. 8 Aug 1959 (10b), s.n. 30–31 Jul 1960 (9), s.n. 24–26 Aug 1960 (9).

Janssan 248 (10b); Jensen s.n. (10a); Jepson 3136 (8); Johnson RJ-130 (9); Johnson, Viereck & Melchior 534 (9); Jones 36964 (10a), s.n. (6).

Kearney & Peebles 9970 (6); Kelsall & McEwen 255 (10a); Kennedy & Doten 264, 265 (8); Kevan s.n. (10a); Kjellman s.n. 18 Jul 1879 (9), s.n. 22–26 Jul 1879 (9); Kornerup 17 (10b); Krapovickas 8102 (2); Kraus s.n. (6).

Leckenby 19a (5); Leiberg 1132 (4b); 5124 (4b); Linnaeus s.n. (10a).

Macoun 28 (4a), 42 (4b), 50 (4b), 107 (4a), 141 (4b), 80985 (4b), s.n 18 Jun 1908 (4b), s.n. 23 Jun 1908 (4a), s.n. 13 Jul 1909 (4a), s.n. 17 Jul 1918 (10a).

Marie-Victorin & Rolland-Germain 20550 (10b), 25883 (10b); Marie-Victorin, Brunel, Rolland-Germain & Rousseau 17770 (10b); Martindale s.n. (3); McHenry 9130 (4b); McLake 4329 (4a); Melchior 286a (9); Merril & Wilcox 348 (2); Meyer 2283 (10a); Michaux s.n. (1); Mitchell 4565 (10a); Morton 11449 (1), 8326 (10a); Mosg 555 (4a).

Norberg 211 (4a); Nuttall s.n. (4b).

Parker 7533 & McClintock (6); Parks H.E. & S.T. 7551 (4a); Patterson 26 (6), s.n. 1892 (6); Payson 4045 (10a); Pendleton & Reed 1247 (8); Peterson 4794 (4a), 7783 (10a); Peterson & Annable 12128 (10a), 7784 (10a), 7786 (10a); Peterson, Annable & Weinpahl 10438 (10a); Peterson & Saarela 18754 (4a); Peterson, Saarela & Smith 18397 (6), 18402 (10a), 18427 (10a), 18457 (10a), 18489 (10a), 18513 (10a), 18557 (10a), 18590 (10a), 18620 (10a), 18631 (10a), 18676 (10a), 18723 (4a); Piper 845 (4b), 846 (4a), 1906 (4b), 1924 (4b), 4649 (4a), 4650 (4a), s.n. May 1890 (4a), s.n. Jun 1890 (4b), s.n. 12 Jun 1891 (4b); Porsild 893 (9), 2697 (10a), 7122 (5), s.n. 21 Jul 1925 (10b), s.n.. 24 Aug 1926 (9); Porsild & Breitung 10468 (6); Potter 7865 (10b), 7867 (10b); Pringle 130 (4a), 242 (5), 509 (4a), s.n. (4b); Purpus 5264 (8).

Raup 6545 (10b); Raven & Solbrig 1340 (2); Rogers 573 (4b); Rollins 1522 (6); Rose 47174 (10a); Rosendahl & Brand 129 (4a); Rousseau 1867 (10b); Rousseau & Rouleau 99 (10b); Ruprecht s.n. (9); Rydberg 2394 × (6), 2481 (6), 2481 (6), 2491 (6), s.n. Jun 1880 (4a), s.n. May 1886 (4b); Rydberg & Garrett 9825 (6).

Sablou? 16 (10b); Sandberg 369 (4a); Sandberg & Leiberg 823 (4a); Scamman 5410 (9); Sharsmith 3302 (10a); Shear & Bessey 1482 (2); Shear 1001 (6), 1214 (6)., 1218 (6), 1600 (4b), 1612 (4b), 1785 (4a), 718 (6), 720 (6), 71 (6); Shear & Scribner 1705 (4a); Sheldon 9.10811 (4b); Shelley & King 1229 (4b), 1230 (7); Smith, A.H. & C.E. Smith s.n. 1 Sep 1868 (1); Smith, Collins, Bruce & Sampson 2647 (10b); Sornburger 240 (10b); Spreadborough s.n. (4a); Standley 4536 (6), 4576 (6); Stebbins Jr. 3827 (8); Stebbins Jr.& Church 3107 (4a); Stuntz & Allen 48 (10b); Suksdorf 57 (4b), 58 (4b), 611 or 967 (4b), 949 (2), 1104 (4b), 2665 (4b), 10221 (4b), 10226 (4a), s.n. 17 Jun 1883 (4b), s.n. Jun 1885 (4a), s.n. 21 Jun 1889 (2); Swales 172 (10a); Swallen 1296 (6), 1937 (2), 6242 (4b), 6242c (4b), 6466 (4a), 6509 (6), 727 (4b), 790 (8), 797 (8), 853 (8), 9778 (10b), 6016 (4b).

Talcott s.n. 20 May 1890 (4b); Taylor T-119 (4a); Thompson 10785 (4b), 6752 (4b), 8582 (4a); Tidestrom 3971 (10a), 482-a (6); Torrey 584 (8); Torrey et al. 2361 (10b); Tracy 3527 (5), 4546 (4a), 5335 (4a), 800 (4a).

Vasey 19 (4b), 21 (6), 30 (4b), 636 (6), s.n. Jul 1881 (6), s.n. 1884 (10a), s.n. 1884 (6), s.n. 1889 (4b), s.n. 1889 (4a), s.n. Jul 1881 (6); von Eschscholtz s.n. (4a); Voss 10448 (10b); Viereck & Bucknell 4436 (9), s.n. 1 Aug 1960, (9).

Waghorne 16 (10b); Wiegand & Gilbert, Jr. 27454 (10b); Wilkens 10084a (6); Williams 2060 (8), 2177 (6), 2223 (6), 958 (4b), s.n. 28 Aug 1899, (10a); Witt 1410 (10a); Wolf & Rothrock s.n. 1873 (6); Wolfe 669 (6), s.n. 1873 (2); Wooton s.n. 4 Sep 1913 (2), s.n. 11 Aug 1910 (6).

Yates 522 (4b), 536 (4b).

APPENDIX 4

List of names and synonyms. **Accepted names** are present in bold, *synonyms* are italicized.

Acrospelion Besser ex Schult. & Schult.f. = **Trisetum**

Agrostis airoides (Poir.) Raspail= **Graphephorum melicoides**

Aira melicoides Michx. = **Graphephorum melicoides**

Aira spicata L = **Trisetum spicatum** var. **spicatum**

Aira subspicata L. = **Trisetum spicatum** var. **spicatum**

Arundo airoides Poir = **Graphephorum melicoides**

Avena airoides Koel. = **Trisetum spicatum** var. **spicatum**

Avena cernua (Trin.) Kunth = **Trisetum cernuum** subsp. **cernuum**

Avena distichophylla Vill. = **Trisetum distichophyllum**

Avena flavescens L. = **Trisetum flavescens**

Avena mollis Michx. = **Trisetum spicatum** var. **spicatum**

Avena nutkaensis J. Presl = **Trisetum cernuum** subsp. **cernuum**

Avena ruprechtii Griseb. = **Trisetum sibiricum**

Bromus berteroanus Colla

Calamagrostis airoides (Poir.) Steud. = **Graphephorum melicoides**

Calamagrostis sesquiflora (Trin.) Tzvelev
Danthonia intermedia Vasey
Deschampsia danthonioides (Trin.) Munro
Deyeuxia airoiodes (Poir.) P. Beauv. = **Graphephorum melicoides**
Dielsiochloa floribunda (Pilg.) Pilg.
Dupontia cooleyi A. Gray = **Graphephorum melicoides**
Graphephorum Desv.
Graphephorum altijugum E.Fourn.= **Peyritschia koelerioides**
Graphephorum cooleyi (A. Gray) Farw. = **Graphephorum melicoides**
Graphephorum melicoides (Michx.) Desv.
Graphephorum melicoides var. *cooleyi* (A. Gray) Scribn.= **Graphephorum melicoides**
Graphephorum melicoides var. *majus* A. Gray = **Graphephorum melicoides**
Graphephorum pringlei Scrib.ex Beal = **Trisetum pringlei**
Graphephorum shearii(Scribn.) Rydb. = **Trisetum montanum**
Graphephorum wolfii (Vasey) Vasey ex Coult.
Helictotrichon Besser ex Schult. & Schult. f.
Helictotrichon canescens (Buckley) Clayton = **Trisetum cernuum** subsp. **canescens**
Koeleria aurea Ten. = **Trisetum aureum**
Koeleria canescens Torr. ex Trin. = **Trisetum spicatum** var. **spicatum**
Koeleria spicata Reichb. ex Willk. & Lange = **Trisetum spicatum** var. **spicatum**
Koeleria subspicata (L.) Reichb. = **Trisetum spicatum** var. **spicatum**
Melica triflora Bigelow = **Trisetum spicatum** var. **spicatum**
Peyritschia E. Fourn.
Peyritschia deyeuxioides (Kunth) Finot
Peyritschia koelerioides (Peyr.) E. Fourn.
Poa melicoides (Michx.) Nutt. = **Graphephorum melicoides**
Rebentischia Opiz = **Trisetum**
Rebentischia flavescens (L.) Opiz = **Trisetum flavescens**
Rupestrina Prov. = **Trisetum**
Rupestrina pubescens Prov. = **Trisetum spicatum** var. **spicatum**
Sphenopholis Scribn.
Sphenopholis interrupta (Buckley) Scribn.
Sphenopholis pensylvanica (L.) Hitchc.
Triodia melicoides (Michx.) Spreng. = **Graphephorum melicoides**
Trisetaria Forssk.
Trisetaria airoides Baumg. = **Trisetum spicatum** var. **spicatum**
Trisetaria aurea (Ten.) Pignatti = **Trisetum aureum**
Trisetaria flavescens (L.) Baumg. = **Trisetum flavescens**
Trisetaria spicata (L) Paunero= **Trisetum spicatum** var. **spicatum**
Trisetarium Poir. = **Trisetum**
Trisetum Pers.
Trisetum airoides (Koel.) P.Beauv. ex Roem. & Schult. = **Trisetum spicatum** var. **spicatum**
Trisetum alaskanum Nash = **Trisetum spicatum** var. **spicatum**
Trisetum ambiguum Rúgolo & Nicora
Trisetum americanum Gand. = **Trisetum spicatum** var. **spicatum**
Trisetum sect. *Anaulacoa* Louis-Marie = **Trisetum** subg. **Trisetum** sect. **Trisetum**
Trisetum argenteum Scribn. = **Trisetum montanum**
Trisetum angustum Swallen
Trisetum sect. *Aulacoa* Louis-Marie = **Dielsiochloa** Pilg.
Trisetum aureum (Ten.) Ten.
Trisetum barbatipalelum (Hultén ex Veldkamp) Finot
Trisetum bifidum subsp. *sibiricum* (Rupr.) Trisetum Koyama = **Trisetum sibiricum**
Trisetum bongardii Louis-Marie = **Calamagrostis sesquiflora**
Trisetum brittonii Nash = **Trisetum spicatum** var. **spicatum**
Trisetum canescens Buckley = **Trisetum cernuum** subsp. **canescens**
Trisetum canescens Buckley fo. *tonsum* Louis-Marie = **Trisetum cernuum** subsp. **canescens**
Trisetum canescens Buckley fo. *velutinum* Louis-Marie = **Trisetum cernuum** subsp. **canescens**
Trisetum canescens montanum (Vasey) Hitchc. = **Trisetum montanum**
Trisetum caudulatum var. **correae** Nicora
Trisetum cernuum Trin.
Trisetum cernuum var. *canescens* (Buckley) Beal = **Trisetum cernuum** subsp. **canescens**
Trisetum cernuum subsp. **canescens** (Buckley) Calder & R.L.Taylor

Trisetum cernuum Trin. subsp. **cernuum**

Trisetum cernuum Trin. var. *luxurians* Louis-Marie = **Trisetum cernuum** subsp. **cernuum**

Trisetum cernuum Trin. var. *luxurians* fo. *pubescens* Louis-Marie = **Trisetum cernuum** subsp. **cernuum**

Trisetum cernuum Trin. var. *projectum* (Louis-Marie) Beetle = **Trisetum projectum**

Trisetum cernuum fo. *pubescens* G. Jones = **Trisetum cernuum** subsp. **cernuum**

Trisetum cernuum fo. *pubescens* Louis-Marie = **Trisetum cernuum** subsp. **cernuum**

Trisetum cernuum var. *sandbergii* (Beal) Louis-Marie = **Trisetum cernuum** subsp. **cernuum**

Trisetum congdonii Scribn. & Merr. = **Trisetum spicatum** var. **spicatum**

Trisetum curvisetum Morden & Valdes-Reyna

Trisetum deyeuxioides (Kunth) Kunth = **Peyritschia deyeuxioides**

Trisetum distichophyllum (Vill.) P. Beauv.

Trisetum durangense Finot & P.M. Peterson

Trisetum elatum Nutt. ex A. Gray = **Trisetum cernuum** subsp. **canescens**

Trisetum elongatum (Kunth) Kunth = **Sphenopholis interrupta**

Trisetum subsect. *Eutriseta* Louis-Marie = **Trisetum** subg. **Trisetum** sect. **Trisetum**

Trisetum filifolium Scribn. ex Beal

Trisetum flavescens (L.) P. Beauv.

Trisetum flavescens subsp. *pratense* (Pers.) Asch. & Graebn. = **Trisetum flavescens**

Trisetum flavescens var. *sibiricum* (Rupr.) Ohwi = **Trisetum sibiricum**

Trisetum floribundum Pilg. = **Dielsiochloa floribunda**

Trisetum glabrum Buckley = **Deschampsia danthonioides**

Trisetum subsect. *Graphephorum* (Desv.) Louis-Marie = **Graphephorum**

Trisetum groenlandicum Steud. = **Trisetum spicatum** var. **spicatum**

Trisetum hallii Scribn. = **Sphenopholis interrupta**

Trisetum subgen. *Heterolytrum* Louis-Marie = **Trisetum** subg. **Trisetum** sect. **Trisetum**

Trisetum interruptum Buckley = **Sphenopholis interrupta**

Trisetum irazuense (Kuntze) Hitchc.

Trisetum labradoricum Steud. = **Trisetum spicatum** var. **spicatum**

Trisetum ligulatum Finot & Zuloaga

Trisetum litorale (Rupr. ex Roshev.) Czer. = **Trisetum sibiricum**

Trisetum longiglume Hack. var. ***longiglume***

Trisetum ludovicianum = **Sphenopholis pensylvanica**

Trisetum majus (Vasey) Rydb. = **Trisetum spicatum** var. **spicatum**

Trisetum martha-gonzaleziae P.M. Peterson & Finot

Trisetum melicoides (Michx.) Scribn. = **Graphephorum melicoides**

Trisetum melicoides subsp. *cooleyi* (A. Gray) Scribn. = **Graphephorum melicoides**

Trisetum melicoides var. *majus* (A. Gray) Hitchc. = **Graphephorum melicoides**

Trisetum molle Kunth = **Trisetum spicatum** var. **spicatum**

Trisetum montanum Vasey

Trisetum montanum Vasey var. *pilosum* Louis-Marie = **Trisetum montanum**

Trisetum montanum Vasey var. *shearii* (Scribn.) Louis-Marie = **Trisetum montanum**

Trisetum nutkaensis (J.Presl) Scribner & Merr. ex Davy = **Trisetum cernuum** subsp. **cernuum**

Trisetum orthochaetum Hitchc.

Trisetum palmeri Hitchc.

Trisetum palustre (Michx.) Torr. = **Sphenopholis pensylvanica**

Trisetum paniculatum E. Fourn. = **Trisetum viride**

Trisetum pennsylvanicum (L.) P. Beauv. ex Roem. & Schult. = **Sphenopholis pensylvanica**

Trisetum pinetorum Swallen

Trisetum pratense Pers. = **Trisetum flavescens**

Trisetum pringlei (Scribn. ex Beal) Hitchc.

Trisetum projectum Louis-Marie

Trisetum rosei Scribn. & Merr.

Trisetum ruprechtii (Griseb.) Steud. = **Trisetum sibiricum**

Trisetum sandbergii Beal = **Trisetum cernuum** subsp. **cernuum**

Trisetum sesquiflorum Trin. = **Calamagrostis sesquiflora**

Trisetum shearii Scribn = **Trisetum montanum**

Trisetum sibiricum Rupr.

Trisetum sibiricum subsp. *litorale* Rupr. ex Roshev. = **Trisetum sibiricum**

Trisetum sibiricum var. *litorale* (Rupr. ex Roshev.) Rupr. ex Roshev. = **Trisetum sibiricum**

Trisetum spellenbergii Soreng, Finot & P.M. Peterson

Trisetum sect. *Sphenophoidea* Louis-Marie = **Sphenopholis**

Trisetum spicatum (L.) K. Richt.

Trisetum spicatum subsp. *alaskanum* (Nash) Hultén = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. *alaskanum* (Nash) Malte ex Louis-Marie = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. *brittonii* (Nash) Louis Marie = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum (unranked) *congdonii* (Scribn. & Merr.) Hitchc. = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum subsp. *congdonii* (Scribn. & Merr.) Hitchc. = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum subsp. *congdonii* (Scribn. & Merr.) Hultén = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. *laxius* (Lange) Lindm. = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. *laxius* (Lange) Louis-Marie = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum subsp. *majus* (Vasey ex Rydb.) Hultén = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. *michauxii* St. John = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. *molle* (Kunth) Beal = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum subsp. *molle* (Michx.) Hultén = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum subsp. *molle* (Kunth) Piper = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. *molle* (Michx.) Piper = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum subsp. *montanum* (Vasey) W.A. Weber = **Trisetum montanum**

Trisetum spicatum subsp. *pilosiglume* (Fernald) Hultén = **Trisetum spicatum** var. **pilosiglume** Fernald

Trisetum spicatum var. **pilosiglume** Fernald

Trisetum spicatum var. *projectum* (Louis-Marie) J. Howell = **Trisetum projectum**

Trisetum spicatum var. *spicatiforme* Hultén = **Trisetum spicatum** var. **spicatum**

Trisetum spicatum var. **spicatum**

Trisetum spicatum var. *villosissimum* (Lange) Louis-Marie = **Trisetum spicatum** var. **spicatum**

Trisetum subspicatum (L.) P. Beauv. = **Trisetum spicatum** var. **spicatum**

Trisetum subspicatum P. Beauv. = **Trisetum spicatum** var. **spicatum**

Trisetum subspicatum var. *laxius* Lange = **Trisetum spicatum** var. **spicatum**

Trisetum subspicatum fo. *maidenii* Gand. = **Trisetum spicatum** var. **spicatum**

Trisetum subspicatum var. *major* Vasey = **Trisetum spicatum** var. **spicatum**

Trisetum subspicatum var. *molle* (Kunth) A. Gray = **Trisetum spicatum** var. **spicatum**

Trisetum subspicatum var. *muticum* Bol. = **Graphephorum wolfii**

Trisetum subspicatum var. *villosissimum* Lange = **Trisetum spicatum** var. **spicatum**

Trisetum tolucense (Kunth) Kunth = **Trisetum spicatum** var. **spicatum**

Trisetum tonduzii Hitch.

Trisetum triflorum (Bigelow) Á. Löve & D. Löve = **Trisetum spicatum** var. **spicatum**

Trisetum trinii (Trin.) Louis-Marie = **Bromus berteroanus**

Trisetum subgen. **Trisetum**

Trisetum subgen. **Trisetum** sect. **Trisetaera** Asch. & Graebn.

Trisetum subgen. **Trisetum** sect. **Trisetum**

Trisetum viride (Kunth) Kunth

Trisetum virletii E. Fourn.

Trisetum williamsii Louis-Marie = **Danthonia intermedia**

Trisetum wolfii var. *brandegei* (Scribn.) Louis-Marie = **Graphephorum wolfii**

Trisetum wolfii fo. *muticum* (Bol.) Louis-Marie = **Graphephorum wolfii**

Trisetum wolfii subsp. *muticum* (Bol.) Scribn. = **Graphephorum wolfii**

Trisetum wolfii Vasey = **Graphephorum wolfii**

ACKNOWLEDGMENTS

This paper is part of the doctoral thesis of VLF in the Dpto. Botánica, Universidad de Concepción, Concepción, Chile. We Thank the Directors and Curators of the following herbaria: BA, BAA, BAF, C, CR, CONC, F, LP, MERL, P, PR, QCA, SGO, S, SI, US. We thank John H. Rumely, an anonymous reviewer, and Barney Lipscomb for suggesting improvements to the manuscript. VLF gratefully acknowledges the Myndel Botanica Foundation for a fellowship to study types of *Trisetum* at Paris (P) and Stokholm (S); Project DIUC 204.121.009-1-0 at the University of Concepción for financial support; the MECESUP-Universidad de Concepción UCO 9906/01 for a fellowship to study the genus at Smithsonian Institution, Washington, DC and Instituto de Botánica Darwinion, Buenos Aires; and Oscar Matthei and Clodomiro Marticorena for directing VLF's PhD.

REFERENCES

Barkworth, M.E. 1999. Manual of grasses for North America and Flora North America North of México, web manual. http://www.herbarium.usu.edu/webmanual/

Beal, W.J. 1896. Grasses of North America Vol. II. H. Holt & Co., New York.

Beetle, A.A. 1946. Notes on the distribution of California Grasses. II. Leafl. West. Bot. 4: 285–289.

Buckley, S.B. 1862. Descriptions of plants. N° 3. Gramineae. Proc. Natl. Sci. Philadelphia 1862:88–100.

Chaffey, N.J. 1983. Epidermal structure in the ligule of rice (*Oryza sativa* L.). Ann. Bot. 52: 13–21.

Chaffey, N.J. 1984. Epidermal structure in the ligules of four species of the genus *Poa* L. (Poaceae). Bot. J. Linn. Soc. 89:341–354.

Chaffey, N.J. 1994. Structure and function of the membranous grass ligule: a comparative study. Bot. J. Linn. Soc. 116:53–69.

Clayton, W.D. 1985. Miscellaneous notes on Pooid grasses. Kew Bull. 40:727–729.

Clayton, W.D. and S.A. Renvoize. 1986. Genera graminum. Grasses of the World. Kew Bull. Add. Ser. 13:1–389.

Clebsch, E.C. 1960. Comparative morphological and physiological variation in arctic and alpine populations of *Trisetum spicatum*. PhD Dissertation, Duke University.

Doğan, M. 1985. 31. *Trisetaria* Forsskal. In: Davis, P.H., ed. Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh. Pp 323–324.

Edgar, E. 1998. *Trisetum* Pers. (Gramineae:Aveneae) in New Zealand. New Zealand J. Bot. 36:539–564.

Ellis, R.P. 1976. A procedure for standardizing comparative leaf anatomy in the Poaceae. I. The leaf blade as viewed in transverse section. Bothalia 12:65–109.

Ellis, R.P. 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. Bothalia 12:641–671.

Erdman, K.S. 1965. Taxonomy of the genus *Sphenopholis* (Gramineae). Iowa State J. Sci. 39:289–336.

Finot, V.L. 2003a. *Trisetum*. In: Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone. 2003. Catalogue of New World grasses (Poaceae): IV. subfamily Pooideae. Contr. U.S. Natl. Herb. 48:659–676.

Finot, V.L. 2003b. *Peyritschia*. In: Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone. Catalogue of New World grasses (Poaceae): IV. subfamily Pooideae. Contr. U.S. Natl. Herb. 48:478.

Finot, V.L. 2004. Sistemática del género *Trisetum* Pers. (Poaceae: Aveneae) en América. Una aproximación filogenética basada en datos moleculares. Universidad de Concepción, Tesis Doctoral.

Finot, V.L., P.M. Peterson, R.J. Soreng, and F.O. Zuloaga. 2004. A Revision of *Trisetum*, *Peyritschia*, and *Sphenopholis* (Poaceae: Pooideae: Aveninae) in México and Central America. Ann. Missouri Bot. Gard. 91:1–30.

Finot, V.L., P.M. Peterson, F.O. Zuloaga, R.J. Soreng, and O. Matthei. 2005. A revision of *Trisetum* (Poaceae: Pooideae: Aveninae) in South America. Ann. Missouri Bot. Gard. In Press.

Finot, V.L. and R.J. Soreng. 2003. *Graphephorum*. In: Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone. 2003. Catalogue of New World grasses (Poaceae): IV. subfamily Pooideae. Contr. U.S. Natl. Herb. 48:380–381.

Frey, L. 1992. Taxonomy, karyology and distribution of the selected genera of tribe Aveneae (Poaceae) in Poland: II. *Trisetum*. Fragm. Flor. Geobot. 37:443–475.

Frey, L. 1993. Taxonomy, karyology and distribution of selected genera of tribe Aveneae (Poaceae) in Poland. IV. Conclusions Fragmenta Floristica et Geobotanica Suppl. 2(1):279–2 88.

Hitchcock, A.S. 1927. New species of grasses from Central America. Proc. Biol. Soc. Wash. 40:79–88.

Hitchcock, A.S. 1928. New species of grasses from the United States. Proc. Biol. Soc. Wash. 41:157–164.

Hitchcock, A.S. 1934. New species and changes in nomenclature of grasses of the United States. Amer. J. Bot. 21(3):127–139.

Hitchcock, A.S. 1939. *Trisetum* Pers. In: Howe, M.A., H.A. Gleason, and J.H. Barnhart, eds. North American flora 17(8):551–561. New York Botanical Garden, Bronx.

Hitchcock, A.S. 1950. Manual of the the grasses of the United States. U.S. Department of Agriculture, Misc. Publ. No. 200, Washington.

Holmgren, A.H. and N.H. Holmgren. 1977. Family Poaceae, the grass family. In: Cronquist, A., A.H. Holmgren, H.H. Holmgren, J.L. Reveal, and P.K. Holmgren, eds. Intermountain flora, vascular plants of the Intermountain West, U.S.A. Columbia University Press, New York.

Howell, J.T. 1979. A reconsideration of *Trisetum projectum* (Gramineae). Wasmann J. Biol. 37:21–23.

Hubbard, C. E. 1936. The species of *Helictotrichon* in tropical Africa. Kew Bull. 1936(5): 330–335.

Hultén, E. 1959. The *Trisetum spicatum* complex. Svensk Bot. Tidskr. 53:203–228.

Jonsell, B. 1980. *Trisetum* Pers. Fl. Europaea 5:220–224.

Kartesz, J.T. 1998. Biota of North America Program (BONAP). http://www.csdl.tamu.edu/FLORA/b98/check98.htm

Kerguélen, M. 1999. Index synonymique de la flora de France. http://www.dijon.inra.fr/flore-france/consult.htm

LOUIS-MARIE, P. 1928-29. The genus *Trisetum* in America. Rhodora 30(359):209–223. Rhodora 30(360):237–245.

METCALFE, C.R. 1960. Anatomy of the Monocotyledons. I. Gramineae. Oxford University Press, London.

NICORA, E.G. 1978. Gramineae. In, M.N. Correa, Flora Patagónica 3: 1–563. Coleccion Cientifica del INTA, Buenos Aires.

O'CONNER, P.J. 1990. 138. Poaceae Grass Family. In: W.L. Wagner, D.R. Herbst, and S.H. Sohmer, eds. Manual of the flowering plants of Hawai'i, vol. 2. University of Hawaii Press and Bishop Museum Press, Honolulu.

POHL, R.W. and G. DAVIDSE. 1994. *Trisetum* Pers. In: G. Davidse, M. Sousa & A.O. Chater, eds. Flora Mesoamericana Vol. 6. Alismataceae a Cyperaceae. Universidad Nacional Autónoma de México, México, D.F.; Missouri Botanical Garden, St. Louis; The Natural History Museum, London. Pp. 233–235.

RANDALL, J.H. and K.W. HILU. 1986. Biosystematic studies of North American *Trisetum spicatum* (Poaceae). Syst. Bot. 11:567–578.

RICHTER, K. 1890. Plantae Europaea, vol. 2. Verlag von Wilhelm Engelmann, Leipzig.

ROZHEVITS, R.Y. 1962. *Trisetum* Pers. In: Komarov, V. L. (ed.), Flora of the U.S.S.R. vol. II. Gramineae. National Science Foundation and Smithsonian Institution, Israel Program for Scientific Translations, Jerusalem. Pp. 201–206.

RYDBERG, P.A. 1906. Flora of Colorado. Agric. Exp. Sta. Bull. 100:33–34.

SCHWEICKERDT, H.G. 1939. A revision of the South African species of *Helictotrichon* Bess. ex Schultes. Bothalia 1:185–203.

SCRIBNER, F.L. 1884. New North American grasses. Bull. Torrey Bot. Club 11:5–7.

SCRIBNER, F.L. 1906. The genus *Sphenopholis*. Rhodora 8:137–146.

SCRIBNER, F.L. and E.D. Merril. 1902. Noteworthy North American grasses. Bull. Torrey Bot. Club 29:470.

SORENG, R.J. and C.W. GREENE. 2003. *Calamagrostis*. In: Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone, eds. Catalogue of New World grasses (Poaceae): IV. subfamily Pooideae. Contr. U.S. Natl. Herb. 48:191–227.

SORENG, R.J., P.M. PETERSON, G. DAVIDSE, E.J. JUDZIEWICZ, F.O. ZULOAGA, T.S. FILGUEIRAS, and O. MORRONE. 2003. Catalogue of New World grasses (Poaceae): IV. Subfamily Pooideae. Contr. U.S. Natl. Herb. 48:1–730.

STEUDEL, E.G. 1854. Synopsis plantarum glumacearum. Pars I. Gramineae. Synopsis plantarum graminearum, Stuttgart.

TATEOKA, T. 1967. *Trisetum sibiricum*. In: Löve, A., ed. IOPB Chromosome number reports 14. Taxon 16:564.

TATEOKA, T. 1978. Cytotaxonomic conspectus of Japanese *Trisetum* (Poaceae). Bull. Natl. Sci. Mus., Tokyo, B 4:1–3.

TOVAR, O. 1993. Las gramíneas (Poaceae) del Perú. Ruizia 13:1–480.

TSVELEV, N. N. 1983. Grasses of the Soviet Union [Zlaki SSSR]. Botanicheskii Institu im. V.L. Komarova and Smithsonian Institution, Amerind Publishing Co., New Delhi.

Tucker, G.C. 1996. The genera of Pooideae (Gramineae) in the southeastern United States. Harvard Pap. Bot. 9:11–90.

Weber, W.A. 1976. New combinations in the Rocky Mountain Flora. Phytologia 33: 105–106.

Zuloaga, F., E. Nicora, Z.E. Rúgolo de Agrasar, O. Morrone, J. Pensiero, and A. Cialdella. 1994. Catálogo de la familia Poaceae en la República Argentina. Monogr. Syst. Bot. Missouri Bot. Gard. 47:i–xi, 1–178.

BOOK REVIEW

Tony Prato and Dan Fagre. 2005. **National Parks and Protected Areas: Approaches for Balancing Social, Economic, and Ecological Values.** (ISBN 0-8138-1248-8, hbk.). Blackwell Publishing Professional, 2121 State Avenue, Ames, IA, 50014, U.S.A. (**Orders:** 800-862-6657; 1-515-292-3348; www.blackwellprofessional.com). $124.99, 446 pp., b/w figures, graphs, tables, index, 7" × 10".

"This book is designed as a primary or supplemental text for upper division undergraduate courses and introductory graduate courses in conservation and management of national parks and protected areas, natural resource planning and management, natural resource economics, conservation biology, public land management, and related subjects."

Features of the book include (from the publisher's notes):

* a multidisciplinary, systems perspective;
* focus on science- and knowledge-based natural resource management; concentration on North American national parks and protected areas with information and examples from other parts of the world;
* clarification of methods for dealing with social, economic, and ecological uncertainty;
* explanations of biophysical and economic simulation models and information management technologies: GIS, remote sensing, decision support systems, computer animation, etc.;
* discussion of the role of local communities and joint decision making for designing and implementing management strategies;
* case studies that show multi-dimensional decision making for specific management problems and issues.

Chapters are these:

1. Contemporary issues in protected area management
2. Role and status of protected area
3. Cultural values
4. Social, economic, and ecological values
5. Institutional environment
6. Selection and delineation
7. Concepts for ecosystem management
8. Approaches to ecosystem management
9. Case studies in protected area management--I
10. Case studies in protected area management--II
11. Future planning and management
12. Synthesis

The brief and dry-sounding chapter titles belie the remarkable information and perspectives laid out in this book, hopefully to be read and absorbed by those who will help all of us preserve and maintain natural areas.—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

NEW COMBINATIONS IN *FESTUCA CALIFORNICA* (POACEAE)

Stephen J. Darbyshire

Agriculture and Agri-Food Canada
Central Experimental Farm, Building #49
Ottawa, Ontario, K1A 0C6, CANADA

ABSTRACT

The *Festuca californica* Vasey complex is examined. Considerable morphological variation exists within and between populations which range from western Oregon to southern California. The characters of sheath pubescence, sclerenchyma distribution in the blades of vegetative shoots and ligule length are of use in distinguishing three taxa in the complex. Analysis of character variation and geographic distribution suggests that these taxa are best treated at the rank of subspecies; the new combinations *Festuca californica* subsp. *hitchcockiana* and *F. californica* subsp. *parishii* are provided.

RESUMEN

Se examina el complejo *Festuca californica* Vasey. Existe una variación morfológica considerable en y entre poblaciones que van desde el Oeste de Oregón hasta el Sur de California. Los caracteres pubescencia de la vaina, distribución de esclerénquima en las láminas de los tallos vegetativos y longitud de la lígula se usan para diferenciar los tres taxa del complejo. El análisis de la variación del carácter y distribución geográfica sugieren que estos taxa deben tratarse en el rango de subespecies; Se hacen las nuevas combinaciones *Festuca californica* subsp. *hitchcockiana* y *F. californica* subsp. *parishii*.

California fescue, *Festuca californica* Vasey, is the largest North American species of the genus and shows considerable variation in many morphological characters. It is usually readily distinguished from other North American species of *Festuca* by its large size and the presence of stiff hairs on the leaf collar region. These hairs may be absent over the back of the sheath apex and restricted to the margins (auricular region). Occasionally collar hairs are absent altogether on some sheaths, but examination of a number of leaves on the same plant will usually reveal hairs on the collar margins of at least some leaves.

Morphological variation was examined on 113 specimens of *Festuca californica* sensu lato, including three taxa that are sometimes recognized as separate species (e.g., Alexeev 1982; Aiken et al. 1997). Variation in characters used to distinguish taxa did not consistently correlate to allow the unambiguous recognition of separate species, although three infraspecific taxa may be recognized with some confidence. In addition to their morphological differences, they have largely separate distributions, hence are best treated as subspecies.

Unless otherwise stated, the descriptions of leaves refer to those of the sterile vegetative shoots or innovations which form a large proportion of the densely caespitose clumps of these bunch-grasses. The width of convolute, involute or conduplicate leaf blades is given as the widest diameter.

SIDA 21(3): 1455–1463. 2005

Festuca californica Vasey, Contr. U.S. Natl. Herb. 1(8):277. 1893. Type: U.S.A. California. Oakland hills, 1862, *H.N. Bolander 1505* (holotype: US-556212!).

Bromus kalmii var. *aristulatus* Torr., Pacific Railr. Rep. 4(5):157. 1857. *Festuca aristulata* (Torr.) Shear *ex* Piper, Contr. U.S. Natl. Herb. 10(1):32. 1906. *Festuca altaica* subsp. *eualtaica* var. *aristulata* (Torr.) St.-Yves, Candollea 2:273. 1925. Type: U.S.A. California. Mark West's Creek, 30 Apr 1854, *J.M. Bigelow s.n.* (lectotype, designated by Piper 1906:33: US-556211!; isolectotype: GH).

Plants densely caespitose, without rhizomes. **Culms** (30–)60–150(–275) cm tall; internodes glabrous to pubescent (often pubescent for up to 20 mm below the nodes). **Prophylls** 2–9 cm long, scabrous to pubescent (at least apically) and usually scabrous or ciliate on the veins. **Sheaths** open to the base, margins overlapping, glabrous or scabrous to pilose (sometimes only at the apex or on upper margins), persistent; **collars** usually densely pubescent, sometimes inconspicuously pubescent, with a few hairs at the margins, or glabrous; **ligules** (0.2–)0.8–1.5(–6) mm (ligules of the cauline leaves tend to be somewhat longer than those of the vegetative shoots), usually ciliate at apex, abaxial surface glabrous to pubescent; **blades** (0.5–)0.8–2(–2.5) mm wide (3–6.5 mm wide when flat), convolute, involute, conduplicate or flat, abaxial surface glabrous, scabrous or basally pubescent or pilose, adaxial surface puberulent to densely pubescent-pilose or more or less tomentose, 9–17(–19) veins, (3–)5–17(–19) adaxial ribs; **sclerenchyma** in a more or less continuous abaxial band or ring, usually with pillars or girders present at most veins, sometimes reduced to small strands at abaxial and adaxial surfaces (Fig. 1). **Inflorescences** (10–)15–25(–30) cm long, open; **branches** terete or angular, glabrous to scabrous-pubescent (especially on angles) and sometimes pubescent at the base in the axils of lower branches, spreading and lax, (1–)2(–3) per node, lower branches with a distinct pulvinus. **Spikelets** (8–)10–18(–20) mm long, borne toward the ends of the branches, usually green or sometimes reddish-purple, with (3–)4–6(–8) florets. **Glumes** lanceolate, glabrous or sparsely scabrous at apex. **Lower glumes** (3.5–)4.5–6.7(–8) mm long, 1 vein; **upper glumes** (4.5–)6–10 mm long, 3 veins; **lemma callus** indurate, wider than long, scabrous laterally; **lemmas** (5–)7.5–11(–11.5) mm long, lanceolate, scabrous, or puberulent (rarely pubescent), sometimes minutely bidentate, acute, usually with an awn (0.5–)1–3(–4) mm long; **paleas** slightly shorter than to slightly longer than lemma body, emarginate or bidentate, glabrous or pubescent on the margins, scabrous or pubescent between the veins apically or throughout, the veins scabrous to about the middle or sometimes right to the base; **rachillas** scabrous to pubescent (sometimes sparsely) at least on abaxial side (away from palea), usually glabrous on the adaxial side; **anthers** 3, (3–)4–7.5(–8.5) mm; **ovary apex** pubescent.

Distribution and habitat.—Dry open slopes and moist streambanks in chaparral, thickets, open forests and forest openings (coniferous, oak or mixed forests). Often on ultramafic substrates. Sea level to about 1500 m elevation. From

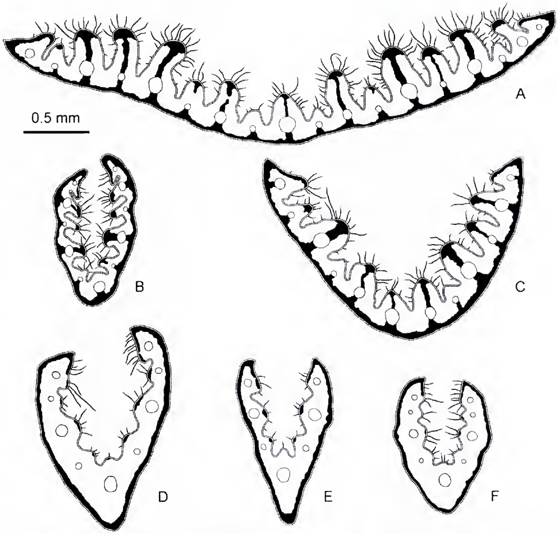


Fig. 1. Cross sections of leaf blades from vegetative shoots of *Festuca californica* (A, *Hawell & True 42564, RSA 300178*; B, *Crampton 4882, AHUC 25001*; C, *Hoover 8864, RSA 201564*; D, *Roos 92, RSA-POM 261420*; E, *Banks & Boyd 0509, DAO 796417*; F, *Banks & Boyd 0429, DAO 796414*). A–B. Subsp. *californica*. C. Subsp. *hitchcockiana*. D–F. Subsp. *parishii*. Sclerenchyma tissue distribution indicated in black.

western Oregon to the Palomar Mountains in southern California (Fig. 2). It is reported as far north as Washington County, Oregon in the online specimen database of OSU (oregonstate.edu/dept/botany/herbarium/db.php).

KEY TO THE INFRASPECIFIC TAXA OF *FESTUCA CALIFORNICA*

1. Culms 30–80(–100) cm tall; internodes usually pubescent for 5–20 mm below the nodes; lower sheaths usually densely retrorse pubescent, sometimes sparsely pubescent or glabrous; blades 0.5–1.2(–1.5) mm wide, conduplicate (sometimes loosely), with (3–)5–9 shallow adaxial ribs (to about half as deep as blade thickness); sclerenchyma in small abaxial strands to a continuous band and adaxial strands present or absent, pillars rarely formed, girders absent; spikelets with 3–4 florets; plants of the San Gabriel and San Bernardino Mountains and southward ________ subsp. **parishii**

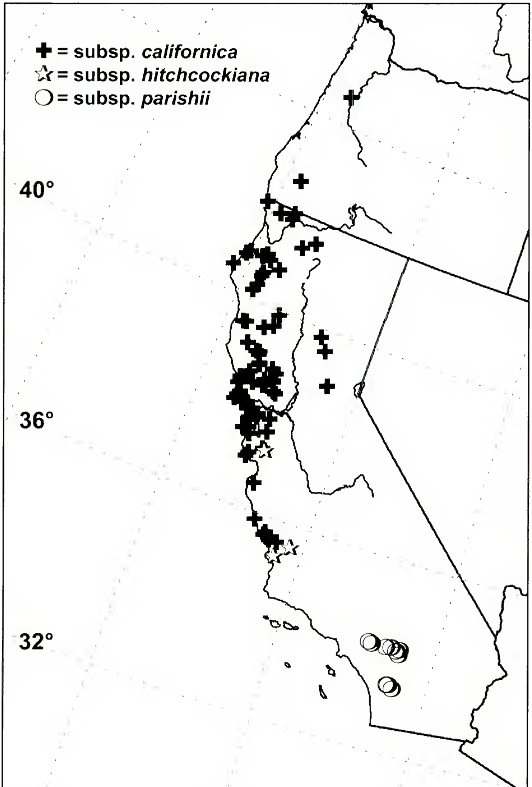


Fig. 2. Distribution of specimens of *Festuca californica* examined in this study. ✚ = subsp. *californica*. ☆ = subsp. *hitchcockiana*. ○= subsp. *parishii*.

1. Culms 60–180(–275) cm tall; internodes glabrous or pubescent for less than 5 mm below the nodes; lower sheaths usually glabrous or sometimes pubescent (the hairs spreading or sometimes retrorse); blades 0.8–2.5 mm wide (3–6.5 mm wide when flat), convolute, involute, conduplicate or often flat, with 7–15(–19) deep adaxial ribs (usually more than half as deep as blade thickness); sclerenchyma in a continuous abaxial band and with adaxial strands, forming pillars or girders at most of the veins; spikelets with (3–)4–6(–8) florets; plants more northerly in distribution.
   2. Ligules a short ciliate membrane 0.2–1(–1.2) mm long; spikelets (8–)12–18(–20) mm long; lemmas (5–)7.5–11 mm long ________________ subsp. **californica**
   2. Ligules a longer membrane (usually 1–6 mm long), ciliate or not; spikelets 8–12 (–17) mm long; lemmas 7–8(–8.5) mm long ________________ subsp. **hitchcockiana**

Festuca californica subsp. californica

Culms 60–180(–275) cm tall; internodes glabrous or often pubescent up to about 5 mm below the nodes. **Sheaths** glabrous to pubescent; **collars** usually densely pubescent (at least at the margins), sometimes inconspicuously pubescent or glabrous; **ligules** 0.2–1(–1.2) mm long, a ciliate membrane; **blades** 0.8–2 mm wide (3–5 mm wide when flat), convolute, involute, conduplicate or flat, with 7–15 (–19) deep ribs (usually more than half as deep as blade thickness); **sclerenchyma** a continuous abaxial band, with adaxial strands, usually forming girders at most veins (Fig. 1a, b). **Inflorescences** 15–25(–30) cm long. **Spikelets** (8–)12–18(–20) mm, with (3–)4–6(–8) florets. **Lemmas** (5–)7.5–11 mm long, usually entire, or sometimes minutely bidentate. Chromosome number: $2n = 56$ (Stebbins & Love 1941).

This is the most widespread subspecies, occurring from northwestern Oregon south to southwestern California. The leaf sheaths of the vegetative shoots are typically glabrous or scabrous, although plants with a few pubescent sheaths are not uncommon. The hairs are, however, usually not strongly retrorse and are often restricted toward the top of the sheaths. Plants with pubescent leaf sheaths differ from subsp. *parishii* in possessing sclerenchyma girders at the major veins in the leaf blades. Ligules are a ciliate membrane, usually about 0.5 mm long or less.

Selected specimens: **U.S.A. CALIFORNIA: Alameda Co.:** West Berkeley, 1916, *P.B. Kennedy*, (AHUC 5715); Berkeley, Shasta Road, N facing grassy slope, 1 Jun 1939, *G.L. Stebbins Jr. 2743* (AHUC 6265); Niles Canyon, 3.5 mi W of Sunol, rubbly shale slopes, coastal sage assoc., 4 Jun 1958, *B. Crampton 4882* (AHUC 25001). **Butte Co.:** NW side of Feather River Canyon near Pulga Bridge, serpentine canyonside, elev. 1400 ft, 11 Jun 1967, *J.T. Howell & G.H. True 42564* (RSA 300178); about 2 mi SW of Forbestown Diversion Dam, NE of Forbestown, yellow pine forest, on damp red soil on steep roadcut near small stream, 10 Jun 1984, *L. Ahart & P. Ahart 4701* (RSA-POM 365944). **Contra Costa Co.:** Mount Diablo, near junction of south and west roads, dry bank and roadside, 25 Apr 1931, *M.L. Bowerman 757* (RSA-POM 300669). **Del Norte Co.:** along Smith River at 18-mile Creek, 3 mi E of Gasquet, in chapparral, alt. 500 ft, 24 May 1933, *J.P. Tracy 12292* (RSA 10111); T17N R3E Sec. 32, at junction of roads to Bear Basin Butte and Big Flat, Douglas-fir woodland, elev. 3500 ft, 27 Jun 1976, *J.P. Smith 8848* (RSA-POM 365942). **El Dorado Co.:** 1 mi E of Georgetown, mixed evergreen forest with shrub understory, serpentine soil, 20 Aug 1959, *B. Crampton 5445* (AHUC 26540). **Glenn Co.:** Mendocino Natl.

For., Camp Ellendale area, ca. 3.5 mi E Alder Springs Ranger Station, elev. ca. 3000 ft, 11 Jun 1963, *B. Crampton 6831* (AHUC 29917). **Humboldt Co.:** Eureka, alt. 0–200 ft, 23 Jun 1900, *J.P. Tracy 1175* (DAO 64999); Eureka, alt. 0–500 ft, 23 Jun 1901, *J.P. Tracy 1175* (RSA-POM 206180); Willow Creek Canyon, alt. 2000 ft, 30 May 1926, *J.P. Tracy 7518* (RSA 10106); T2S R5E Sec. 12, W of Alder Springs along 2S07, growing on serpentine, Jeffrey Pine woodland, 16 Jun 1976, *T. Nelson & J. Nelson 2740* (RSA 273307). **Lake Co.:** near Clear Lake, western shore of lake, in *Rhus-Pinus-Quercus* assoc., 27 Apr 1927, *A.A. Beetle 1736* (AHUC 5948; DAV 4049); 1/4 mi S Whispering Pines, State Hwy. 29, roadcut, yellow pine-Douglas fir-maple, some chaparral, 13 Jun 1955, *B. Crampton 2832* (AHUC 21080). **Marin Co.:** near Olema, Aug 1898, *J.B. Davy s.n.* (RSA-POM 205834); Lagunitas, 7 May 1916, *L.S. Smith s.n.* (AHUC 2694); Mt. Tamalpais, Bootjack, on serpentine, 19 Jun 1938, *J.T. Howell 13920* (RSA 221132); Point Reyes, scattered clumps in densely vegetated flats on N side behind dunes, 12 Jun 1945, *A.A. Beetle 3998* (AHUC 10940); Angel Island, border between grassland and brush, 16 May 1946, *J.T. Howell 21888* (DAO 65002). **Mendocino Co.:** Ukiah, 24 May 1899, *W.C. Blasdale & J.B. Davy 5030* (RSA-POM 206181); Sherwood, open woods on dry slope, 15 Jun 1915, *A.S. Hitchcock s.n.*, Amer. Gr. Nat. Herb. no. 487, (DAO 65000); T20N R10W Sec. 33, Mendocino Natl. For., along forest service road 1N02 just north of Monkey Rock mixed evergreen forest, elev. 5800 ft, 14 Jul 1977, *J.P. Smith, J.O. Sawyer & T.W. Nelson 9412* (RSA 275370). **Monterey Co.:** coastal hills between Del Monte and Salinas, 2–3 mi on rd. to Johannesburg off rd. between Del Monte and Salinas, chaparral belt, 5 Jun 1946, *A.A. Beetle 4283* (AHUC 12343); Sargent Cypress Forest, Alder Creek, serpentine, 2000 ft, 7 May 1960, *C.B. Hardham 5666* (RSA 180213). **Napa Co.:** Monticello, Napa Road, 4 May 1927, *M. Wiesendanger 700* (DAV 4059); 4 mi E of Rutherford, 25 Apr 1950, *J. Street s.n.* (AHUC 13901); Knoxville Quad., T11N R5W NW1/4 Sec. 25, Cedar Creek, 3.5 mi SW of Knoxville & ca. 1/2 mi W of Devilhead Road at junction of the creek and a dirt road, grassy meadow and streamside, alt. 1800 ft, 6 May 1986, *L. LaPre s.n.* (RSA 371706). **San Francisco Co.:** Daly City, Colma Canyon, Apr 1916, *P.B. Kennedy s.n.* (AHUC 2691); Mt. Davidson, summit, large clumps among brush, 22 Apr 1956, *P.H. Raven 9004* (DAV 56413). **San Luis Obispo Co.:** Steiner Creek ("Serrano Canyon"), on brushy slopes in area of serpentine, 14 May 1947, *R.F. Hoover 7168* (DAO 636020); Santa Lucia Mts., between Rocky Butte and Pine Mt., 21 Jun 1950, *R.F. Hoover 7999* (DAO 635967). **San Mateo Co.:** Crystal Springs, 11 May 1902, *Le Roy Abrams 2461* (RSA-POM 87695); on eastern flank of first ridge W of San Andreas Lake on road to Pilarcitos Lake, elev. 650 ft, 15 May 1956, *R. Bacigalupi et al. 5645* (AHUC 32293). **Santa Cruz Co.:** 1 mi NW of Davenport, T10S R3W, 15 May 1935, *N.K. Carleson 3* (AHUC 25862). **Siskiyou Co.:** near Happy Camp, *Pseudotsuga* woods on slope above the Klamath River, 31 May 1942, *A.A. Beetle & G.L. Stebbins Jr. 3441* (AHUC 7646); T40N R9W Sec. 21, 2.0 mi S of Sugar Creek on Parrott Mill road, roadside in mixed conifer forest on metamorphic rock, 4400 ft, 4 Jul 1972, *J.P. Smith, J.O. Sawyer & M. O'Meara 5735* (RSA 273423). **Solano Co.:** Vaca Mts. facing Sacramento Valley, Gates Canyon, slopes wooded with live oak, bay and chaparral, 12 May 1958, *B. Crampton 4784* (AHUC 24872). **Sonoma Co.:** Duncan Mills Quadrangle, T6N R11W, near Bodega Port, elev. 25, 21 Apr 1934, *H.S. Yates s.n.* (RSA 123473, 123478), and *H.S. Yates 3806* (AHUC 25861); NE slopes of Fitch Mt. near Healdsburg, 10 Jun 1952, *P. Rubtzoff 1236* (DAO 291944). **Tehama Co.:** Mendocino Natl. For., Paskenta Dist., Crane Mills logging road, Whiskey Saddle, under conifers, elev. 4720 ft, 16 Jun 1954, *B. Crampton 1965* (AHUC 20661). **Trinity Co.:** New River trail from Grays Falls Campground on N side of Trinity River and W side of New River, rock outcroppings in California mixed evergreen with Douglas fir and digger line, elev. 1000 ft, 7 Apr 1973, *J.P. Smith 5962* (RSA 244973); T31N R10W Sec. 13, County Line Road along Brown's Creek, Garry oak woodland, elev. 2200 ft, 7 May 1978, *J.P. Smith, J.O. Sawyer & T.W. Nelson 9879* (RSA 296765); Bonanza King Quadrangle, T39N R7W Sec. 34, Shasta-Trinity Natl. For., Bear Creek at its junction with Trinity River, mixed conifer forest, elev. 3000 ft, 15 Jun 1979, *J.P. Smith & T.W. Nelson 10103* (RSA 293182). **Oregon: Benton Co.:** T11S R5W Sec. 18 NW 1/4 of NW 1/4, MacDonald State Forest N of Corvallis, trail to Butterfly Meadows, edge of opening in Douglas-fir forest on slope, mostly sunny spot, 15 Jun 1994, *B.L. Wilson & F. Camacho 7014* (DAO 786419). **Josephine Co.:** Galice Creek road 3.0 mi from junction with Rogue River road at Galice, steep serpentine hillside on N side of creek, common in partial shade at edge of oak-pine woods by the slope, elev. 1250 ft, 10 May 1974, *K.L. Chambers 3915* (DAO 540761).

Festuca californica subsp. **hitchcockiana** (E.B. Alexeev) S.J. Darbyshire, comb. et stat. nov. BASIONYM: *Festuca hitchcockiana* E.B. Alexeev, Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol., n.s., 87(2):111. 1982. TYPE: U.S.A. CALIFORNIA. Santa Clara Co.: 6 May 1921, *A.H. Wolley-Dod 207* (HOLOTYPE: K).

Culms 60–120 cm tall; internodes glabrous or pubescent for up to 5 mm below the nodes. **Sheaths** glabrous, scabrous or sometimes retrorse pubescent; **collars** densely to sparsely pubescent or sometimes glabrous; **ligules** (1–)1.5–6 mm long, with or without apical cilia; **blades** 0.8–2 mm wide (3–5 mm wide when flat), convolute, involute, conduplicate or flat, with 7–15(–17) deep adaxial ribs (usually more than half as deep as blade thickness); **sclerenchyma** as in subsp. *californica* (Fig. 1c). **Inflorescences** 15–25 cm long. **Spikelets** 8–12(–17) mm long, with (4–)5–6(–8) florets. **Lemmas** 7–8(–8.5) mm long, entire or minutely bidentate. Chromosome number unknown.

This subspecies is distinguished by its longer ligules which are usually not ciliate, but often lacerate. Ligules of leaves of the vegetative shoots are usually (1–)1.5–2 mm long while those of the culm leaves may be even longer. The collars may be glabrous or pubescent. Sclerenchyma in the leaf blades on the vegetative shoots is well developed with girders present at the major veins (Fig. 1c). The spikelets and lemmas tend to be somewhat smaller in this taxon than the other subspecies. Although the range overlaps with that of subsp. *californica*, it occurs only in central California (Santa Clara and San Luis Obispo counties) near the southern part of the range of the typical subspecies. It is less commonly collected than the other two subspecies and appears to have a more restricted distribution. The form of the ligule and somewhat smaller spikelets and floral bracts so clearly distinguish these populations that subspecific rank seems warranted.

Specimens seen: **U.S.A. CALIFORNIA: San Luis Obispo Co.:** See Canyon, 3 May 1948, *R.F. Hoover 7512* (DAO 635974); See Canyon, 14 May 1964, *R.F. Hoover 8864* (DAO 635612, 635951; RSA 201564); See Canyon, lower part of Perfumo Canyon, clay soil from serpentine, 14 May 1964, *R.F. Hoover 8878* (DAO 635956).

Festuca californica subsp. **parishii** (Piper) S.J. Darbyshire, comb. nov. BASIONYM: *Festuca aristulata* subsp. *parishii* Piper, Contr. U.S. Natl. Herb. 10(1):33. 1906. *Festuca parishii* (Piper) Hitchc. in Jepson, Fl. Calif. 1:169. 1912. *Festuca californica* var. *parishii* (Piper) Hitchc. in Abrams, Ill. fl. Pacific States 1:222. 1923. TYPE: U.S.A. CALIFORNIA: San Bernardino Mountains, Mill Creek Falls, alt. 5500 ft, 20 Jun 1901, *S.B. Parish 5036* (LECTOTYPE, designated by Hitchcock in Jepson 1912: 169: US-556210!).

Culms 30–80(–100) cm tall; internodes usually densely pubescent up to 20 mm below the nodes. **Sheaths** usually densely retrorse pubescent, rarely glabrous or sparsely pubescent; **collars** usually densely pubescent, at least at margins (rarely glabrous); **ligules** (0.2–)0.5–1.5(–2) mm, a ciliate membrane; **blades** 0.5–1.2(–1.5) mm wide, conduplicate (or loosely folded), with (3–)5–9 shallow adaxial ribs (up to about half as deep as blade thickness); **sclerenchyma** in small abaxial strands to a continuous band, with or without adaxial strands at the major veins, rarely forming pillars (girders absent) (Fig. 1d–f). **Inflorescences** 10–20 cm long. **Spikelets** 11–16 mm long, with 3–4 florets. **Lemmas** (8)9–11.5 mm long, usually minutely bidentate, sometimes entire. Chromosome number unknown.

This subspecies occurs in dry chaparral or open forests of southern California in the San Gabriel, San Bernardino and Palomar Mountains (Fig. 2). Although the lemmas tend to be somewhat larger than the other two subspecies, overall plants tend to be smaller. Leaf blades tend to be narrower and shorter (10–30 cm long, versus usually more than 30 cm long) and the sclerenchyma is less developed with the abaxial band often discontinuous or reduced to small fascicles opposite the veins, pillars only sometimes present and girders absent (Fig. 1d–f). Leaf sheaths of the vegetative shoots are usually densely retrorse pubescent, but are sometimes sparsely pubescent to glabrous.

Selected specimens: **U.S.A. CALIFORNIA: Los Angeles Co.:** San Dimas Expt. For., San Gabriel Mts., Wolfskill firebreak near Brown's Flat, 28 May 1942, *KHB (624) 631*, (RSA-POM 308944). **San Bernardino Co.:** San Bernardino Mts., 7 Oaks, Jul 1901, *A. Davidson 2245* (RSA 415966); San Antonio Mts., Cucamonga Cañon at Charcoal Camp, abundant under oaks on a north slope, upper Sonoran Zone, alt. 4700 ft, 7 Jun 1919, *I.M Johnson 2166* (RSA-POM 1271, 6414, 6415); San Bernardino Mts., near Glen Martin, near falls on road below, 1 Jun 1941, *J. Roos 92* (RSA-POM 261420); San Bernardino Mts., Waterman Canyon, shady hillside, 21 Apr 1943, *J. Roos 2633* (RSA-POM 302531); San Bernardino Mts., Fredalba, open places in forest with *Pinus ponderosa*, *Quercus kellogii*, etc., alt 5800 ft, 9 Jun 1951, *J. Roos & L. Roos 5061 (RSA 78227)*. **San Diego Co.:** Palomar Range, Agua Tibia Wilderness Area, western crest of Agua Tibia Mt. at head of a steep draw in the Pechanga Creek watershed, just NW of the large *Quercus agrifolia* woodland about the junction of the Palomar Divide and Dripping Springs trails, T9S R1W SW 1/4 NW1/4 Sec. 4, near 33°25'10"N 116°59'38"W, elev. ca. 4500 ft, extremely steep slopes with woodland of *Pseudotsuga macrocarpa* and *Quercus chrysolepis* and understory of *Ribes amarum*, *Polystichum*, *Monardella macrantha* ssp. *hallii*, *Carex triquetra*, locally common on more mesic exposures with some afternoon sun, 25 Apr 1995, *S. Boyd 8508* (DAO 796415; RSA); NW Palomar Mts., Cleveland Natl. For., Agua Tibia Wilderness Area, E face of Eagle Crag, S of upper Arroyo Seco, W of Cutca Valley, along Palomar-Magee Trail, T9S R1W NE 1/4 SW1/4 Sec. 14, elev. 4600 ft, big cone spruce woodland of *Pseudotsuga macrocarpa*, *Quercus chrysolepis*, *Linanthus floribundus*, *Keckiella ternata*, *Phacelia imbricata*, etc., granitic substrate with decomposed granite soil, aspect NE, slope 70%, 10 May 1995, *D.L. Banks & S. Boyd 0429* (DAO 796414, RSA). NW Palomar Mts., Cleveland Natl. For., Agua Tibia Wilderness Area, N peak of Agua Tibia Mt. on NE corner of peak, just S of the Riverside Co. boundary, in a very steep bowl-shaped depression on the N flank of Agua Tibia Mt., T9S R1W SE 1/4 NW 1/4 Sec. 4, 33°25'18"N 116°57'24"W, big cone spruce woodland of *Pseudotsuga macrocarpa*, *Quercus chrysolepis*, *Rubus leucodermis*, *Ribes amarum Polystichum imbricans* ssp. *curtum*, etc., granitic substrate and sandy humus-rich soil, aspect NW, slope 170% [sic], 1 Jun 1995, *D.L. Banks & S. Boyd 0509* (DAO 796417; RSA); NW Palomar Mts., Cleveland Natl. For., Agua Tibia Wilderness Area, NE face of Eagle Crag, SE of the Crosley Saddle, S of Cutca Trail along drainage that parallels trail, E of upper Arroyo Seco, T9S R1W SE 1/4 Sec. 14, elev. 4520 ft, big cone spruce woodland of *Pseudotsuga macrocarpa*, *Quercus chrysolepis*, *Q. berberidifolia*, *Arctostaphylos glandulosa*, *Carex triquetra*, etc., granitic substrate with decomposed granite humus-rich soil, aspect S, slope 50%, 15 Jun 1995, *D.L. Banks & S. Boyd 0684* (DAO 796416; RSA).

ACKNOWLEDGMENTS

The curators of the herbaria AHUC, DAO, DAV, RSA and US are thanked for kindly providing specimens, including types, for study. Jochen Müller is thanked for his many helpful suggestions. Jacques Cayouette, W.J. Cody, and an anonymous reviewer commented on earlier drafts.

REFERENCES

Aiken, S.G., M.J. Dallwitz, C.L. McJannet, and L.L. Consaul. 1997. Biodiversity among *Festuca* Poaceae) in North America: diagnostic evidence from DELTA and clustering programs, and an INTKEY package for interactive, illustrated identification and information retrieval. Canad. J. Bot. 75:1527–1555.

Alexeev, E.B. 1982. New and little-known fescues (*Festuca* L.) of North America. Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol., n.s., 87(2):109–118. [In Russian].

Stebbins, G.L., Jr. and R.M. Love. 1941. A cytological study of California forage grasses. Amer. J. Bot. 28:371–382.

BOOK REVIEWS

Tracy Irwin Storer, Robert L. Usinger, and David Lukas. 2004. **Sierra Nevada Natural History. Revised Edition.** (ISBN 0-520-23277-1, hbk.; ISBN 0-520-24096-0, pbk.). University of California Press, Berkeley, CA 94704, U.S.A (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax; www.ucpress.edu). $24.95 pbk., 439pp., color photos, b/w drawings, 5" × 8".

The original edition by Storer and Usinger was published in 1965. Lukas has extensively revised this popular guide to the topology, geography, fauna, and flora of the area, incorporating field and laboratory investigations and taxonomic changes. In the concise but thorough introduction he explains the region and its diversity. Very important is the relatively brief section, "The Changing Landscape," in which he discusses the effects of global warming, clear cutting of forests, the use of prescribed fire, introduced non-native species, and also human impact.

The book is not definitive in species of the area but rather those that are most likely to be encountered. Following each species description, distribution is noted, that is, the habitat, terrain, elevation. "Remarks" include interesting facts, such as, in the case of flowering plants, the use of them by man and other creatures. As in the earlier edition, drawings accompany many species in the text, and over 500 small but brilliant color photographs enhance the book, serving as both aid to identification and stimulus for the user.

The book is well bound and a comfortable-to-hold field-guide size.—*Joann Karges, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

Phyllis M. Faber (Ed.). 1997. **California's Wild Gardens: A Guide to Favorite Botanical Sites.** (ISBN 0-520-24031-6, pbk.). University of California Press, Berkeley, CA 94704, U.S.A (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax; www.ucpress.edu). $34.95 pbk., 236pp., color photos, 9" × 12".

This is a 2005 printing of a 1997 title, *California's Wild Gardens. A Living Legacy.* Quoting from the preface, "California is blessed with a wealth of plant life that reflects the diversity of its natural landscape. Showcasing some of the state's rare and unique plants and their distinctive habitats along with some of the more common treasures, this book attempts to provide an introduction to California's priceless botanical heritage." Both the California Native Plant Society and the California Department of Fish and Game are to be congratulated in producing this beautiful book.

EUGENIA INVERSA (MYRTACEAE), A NEW SPECIES FROM ESPÍRITO SANTO, BRAZIL

Marcos Sobral

Departamento de Botânica UFMG
Caixa Postal 486, 31270-901
Belo Horizonte, MG, BRASIL
sobral@ufmg.br

ABSTRACT

Eugenia inversa, a new species from coastal rainforests of the Brazilian state of Espírito Santo, is described and illustrated. The new species is apparently related to the central Brazilian *Eugenia mikanioides*, from which it is distinguished by pilose leaves and flowers, shorter pedicels and triangular, acute calyx lobes.

RESUMO

Eugenia inversa, uma nova espécie da floresta pluvial costeira do estado do Espírito Santo, Brasil, é descrita e ilustrada. Esta espécie é aparentemente próxima a *Eugenia mikanioides*, coletada no Brasil central, da qual se distingue pelas folhas e flores pilosas, pedicelos curtos e lobos do cálice triangulares.

Eugenia is one of the largest genera of the Myrtaceae in Brazil with about 350 native species (Landrum & Kawasaki 1997). The family as a whole comprises about 1000 species in Brazil (Landrum & Kawasaki 1997), and is especially well-represented in the southeastern Brazilian coastal forests, where it is frequently among the most sampled families in floristic inventories (e.g. Mori et al. 1983; Peixoto & Gentry 1990; Thomaz & Monteiro 1997). Among specimens examined from northern Espírito Santo, I have found an unidentified *Eugenia* that I consider as new and describe herein.

Eugenia inversa Sobral, sp. nov. (**Figs. 1, 2**). TYPE: BRAZIL. ESPÍRITO SANTO: mun. Conceição da Barra, Itaúnas, 15 Jan 2005, *M. Sobral 9666* (HOLOTYPE: BHCB; ISOTYPES: BRIT, CEPEC, M, MBM, K, MBML, RB, VIES).

Species haec a *Eugenia mikanioides* proxima, a qua foliis et floribus pilosis, pedicellis parvis et lobis calycinis exterioribus triangularibus quam interioribus valde majoribus recedit.

Small tree 3–4 m high. Bark reddish, peeling. Twigs, petioles and abaxial side of blades with indumentum of erect, brownish or grayish trichomes 0.4–0.8 mm long; pedicels and flowers with trichomes to 0.4 mm long. Petioles 1.5–2.5 × 1 mm long. Blades ovate, elliptic or oblong-elliptic, 60–100 × 30–50 mm, deflexed in living plants, discolored when dry, darker adaxially; glandular dots visible abaxially, to 0.1 mm in diameter and about 10 per square mm; apex acuminate to 20 mm; base cordiform, sometimes obtuse; midvein sulcate and occasionally

Fig. 1. *Eugenia inversa*. Scanned image of holotype (BHCB).

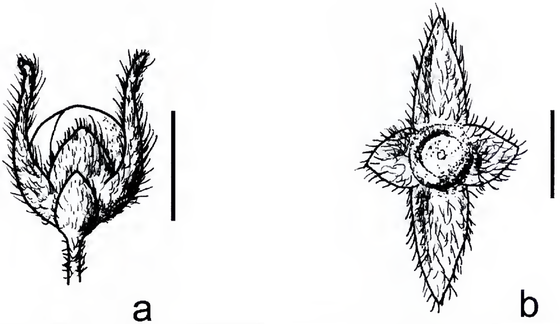


FIG. 2. *Eugenia inversa*. Schematic drawings of flowers: **a)** flower bud; **b)** calyx in an open flower viewed from above. Scales: 2 mm. Both from *Sobral 9666* (BHCB).

with trichomes to 0.3 mm long adaxially, salient abaxially; secondary veins 7–9 pairs, faintly visible adaxially, evident and sometimes weakly salient abaxially, leaving the midvein at angles about 70 degrees; paramarginal vein (sensu Carr et al. 1986) 3.5–5 mm from the revolute margin, sometimes a submarginal vein (sensu Carr et al. 1986) 0.8–1 mm from margin. Inflorescences glomeruliform to shortly racemiform (bracteate shoots sensu Landrum & Kawasaki 1997), axillary or terminal, sometimes ramiflorous, the axis 6–10 × 0.5–0.8 mm, with up to 6 flowers (or the flowers occasionally solitary), when axillary sometimes concealed by the leaves when observed from above; bracts triangular, 0.8–1.7 × 0.5–0.8 mm, persisting; pedicels 3–10 × 0.3–0.5 mm; bracteoles triangular, to 1 × 0.8–1 mm, densely covered with trichomes to 0.4 mm long and with 4–6 glandular setae to 0.2 mm long at the adaxial side, below the insertion of the flower; flower buds globose, to 3 × 2 mm, densely pilose; calyx lobes four, pilose on both sides, markedly unequal, the external ones lanceolate-triangular, 2–3 × 0.9–1.3 mm, visibly projected beyond the globe of the petals and sometimes slightly curved outwards in bud, the internal ones triangular, 0.7–1.3 × 1–1.8 mm; petals rounded, 1–1.3 × 1 mm, glabrous or with cilia to 0.1 mm long; stamens 30–40, 1–1.5 mm, the anthers globose, 0.2 × 0.2 mm, without evident glands; staminal ring 1 mm in diameter; style 1.8–2 mm, the stigma punctiform and finely papillose; ovary bilocular, with 1–4 central-basally attached ovules per locule. Fruits elliptic, vinose or black when ripe, sparsely pilose, 10–15 × 8–10 mm, 1-seeded; seed elliptic, with grayish testa; embryo with fused cotyledons and no evident hypocotyl.

Habitat, distribution and phenology.—*Eugenia inversa* is a small tree from restingas, that is, scrubby forests to 10 m high on sandy soils that exist along southeastern Brazilian coast line; presently it is known only for the municipality of Conceição da Barra, in northern Espírito Santo (about 18°30'S, 39°45'W); flowers were collected in January, February and June, and fruits in January, February, June and December.

Conservation status.—According to the criteria proposed by IUCN (2001) for evaluation of conservation status, this species could be considered as an endangered one (EN), since it fits criteria B1 ab(iii), that is, has an estimated range of less than 5000 km^2 (B1), grows in a severely fragmented habitat and is known from less than five localities (a), and its habitat presents a continuing decline in its extension (b(iii)), since restinga habitats in northern Espírito Santo have been suffering severe damage by anthropic activities such as urban expansion and extensive artificial *Eucalyptus* forestation.

Taxonomic affinities.—This species is apparently related to *Eugenia mikanioides* O. Berg (for description see Berg 1857–1859: 298), from which it can be set apart by the characters in the following key:

1. Leaves and flowers glabrous; pedicels more than 20 mm long; calyx lobes rounded, the internal ones larger than the external ones; plants from savanna formations of Goiás (central Brazil) ____ **Eugenia mikanioides**
1. Leaves and flowers evidently pilose; pedicels to 10 mm long; calyx lobes triangular, the external ones much larger than the internal ones; plants from coastal rainforests of Espírito Santo ____ **Eugenia inversa**

Etymology.—The epithet, derived from the Latin word for inverted, is allusive to the different sizes of the calyx lobes of the flowers; in most species of *Eugenia* with unequal calyx lobes, the external lobes are smaller than the internal ones. In *Eugenia inversa* the external lobes are markedly longer than the internal ones.

PARATYPES. **BRAZIL. Espírito Santo:** Conceição da Barra, 26 Feb 1992, *O. Pereira 2861* (RB, VIES); 9 Jun 1992, *O. Pereira 3461* (RB, VIES); 9 Dec 1992, *O. Pereira 4357* (RB, VIES); 15 Jan 2005, *M. Sobral 9670* (BHCB, MBM).

ACKNOWLEDGMENTS

To Oberdan Pereira and Luciana Thomaz, from the herbarium VIES (Universidade Federal do Espírito Santo) at Vitória, for their kind collaboration; to Leslie Landrum (ASU) and Lyn Craven (CAN) for their valuable suggestions for improving this paper; to the curators of herbarium RB (Jardim Botânico do Rio de Janeiro), for loaning the specimens cited here and to Barney Lipscomb (BRIT) for his kind and ready help along the editorial process of this paper.

REFERENCES

BERG, O.C. 1857–1859. Myrtaceae. In: Martius, K.F.P. von (org.) Flora Brasiliensis 14(1):1–656.

CARR, D.J., S.G.M. CARR, and J.R. LENZ. 1986. Leaf venation in Eucalyptus and other genera of

Myrtaceae: implications for systems of classification of venation. Australian J. Bot. 34: 53–62.

IUCN (International Union for the Conservation of Nature) 2001. The IUCN red list of threatened species: 2001 categories and criteria (v. 3.1). www.iucnredlist.org/info/categories_criteria2001.html

Landrum, L.R. and M.L. Kawasaki. 1997. The genera of Myrtaceae in Brazil: an illustrated synoptic treatment and identification keys. Brittonia 49:508–536.

Mori, S.A., B.M. Boom, A.M. Carvalho, and T.S. Santos. 1983. Ecological importance of Myrtaceae in an eastern Brazilian wet forest. Biotropica 15:68–70.

Peixoto, A.L. and A.L. Gentry. 1990. Diversidade e composição florística da mata de taubleiro na reserva florestal de Linhares (Espírito Santo, Brasil). Revista Brasil. Bot. 13:19–25.

Thomaz, L.D. and R. Monteiro. 1997. Composição florística da mata atlântica de encosta da Estação Biológica de Santa Lúcia, município de Santa Teresa, ES. Bol. Mus. Biol. Mello Leitão (n.s.) 7:3–48.

BOOK REVIEW

ELISEO TORRES and TIMOTHY L. SAWYER, JR. 2005. **Curandero: A Life in Mexican Folk Healing.** (ISBN 0 8263 3640 X, pbk.). University of New Mexico Press, 1601 Randolph Rd SE, Suite 200S, Albuquerque, NM 87106, U.S.A. (**Orders:** www.unmpress.com/Ordering.html, 1-800-249-7737). $14.95, 170 pp., b/w drawings, b/w photographs, 5 1/2" × 8".

In this hybrid between a memoir and an anthropological text, *Curandero: A Life in Mexican Folk Healing* recounts Eliseo "Cheo" Torres's experiences with curanderos, or traditional Mexican folk healers. The curandero tradition is strong in South Texas, where Dr. Torres was born and raised. This book covers the spiritual and historical aspects of the tradition, while making room to discuss the tradition as it is practiced today. Curanderos or curanderas heal their patients using herbs and techniques including massage and rituals. In this book, the reader is introduced to several famous curanderos including El Nino Fidencio and Don Pedrito Jaramillo, as well as fictional characters amalgamated from people Dr Torres knows. Herbal remedies used by curanderos, such as nopal cactus and the ubiquitous chamomile tea and "yerba Buena," or mint are discussed. The authors also lead the reader through magical remedies for spiritual illnesses including mal de ojo and susto. The text together with the black and white illustrations and photographs come together to provide an insider's view of a folk healing tradition that stretches across the Southwest and Mexico.—*Marissa Oppel, Museum Assistant, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., moppel@brit.org*

BOOK NOTICE

Interactive DVD

MICHAEL A. DIRR. 2005. **The Interactive Manual and Photo-Library of Woody Landscape Plants. DVD Version.** (ISBN 0-942375-03-3, hbk.). Varsity Press, 337 S. Milledge Ave., Suite 125, Athens, GA 30605, U.S.A. (**Orders:** www.nobleplants.com, hillary@nobleplants.com, 706-613-0046 phone/fax). $99.95, DVD, 7,600 high quality images; System requirements: Windows 98 or better, 22 MB free disk space, DVD player.

This interactive DVD manual provides "text covering 1,670 species and 7,800 cultivars; 1,100 line drawings of leaf and bud characteristics; 7,600 high quality plant images; and a searchable plant database with information about hardiness zones, water and light requirements, growth characteristics, flowers, fruits, and fall color—72 search criteria in all."

A MULTIVARIATE MORPHOMETRIC STUDY OF THE ASTER GENUS *SERICOCARPUS* (ASTERACEAE: ASTEREAE)

Michelle R. Leonard[1], Rachel E. Cook[2], John C. Semple[3]

Department of Biology
University of Waterloo
Waterloo, Ontario, CANADA N2L 3G1
jcsemple@sciborg.uwaterloo.ca

ABSTRACT

Sericocarpus is a genus of five species of white-rayed asters native to North America. Three species are found in eastern North America (*S. asteroides, S. tortifolius, S. linifolius*) and two are found in western North America (*S. oregonensis, S. rigidus*). *Sericocarpus oregonensis* has been divided into two subspecies based on pubescence and geography (subsp. *californicus* and subsp. *oregonensis*). Over 2300 herbarium specimens were examined to determine the distribution and morphological ranges of variation in traits of each species. Multivariate morphometric analyses of 111 specimens were undertaken to determine which of the 44 vegetative and 19 floral characteristics examined were diagnostic for the species and which species were most similar. The results of cluster and discriminant analyses indicated that all five species were distinct. The species were distinguished on the basis of stem, leaf and floral traits and to a lesser degree on geographic distribution and habitat data. In order to explore the validity of the division of *S. oregonensis* into two infraspecific taxa, stem and leaf pubescence traits were examined on 125 specimens of *S. oregonensis*. The results indicated that *S. oregonensis* can be divided into two subspecies based on pubescence and geography. The statistical results and morphometric measurements were used to construct comprehensive descriptions and an identification key to all taxa of *Sericocarpus*. The pappus was found to be triple or rarely quadruple in all species.

RESUMEN

Sericocarpus es un género norteamericano con cinco especies que tienen los radios blancos. Tres especies se encuentran en el Este (*S. asteroides, S. tortifolius, S. linifolius*) y dos en el Oeste (*S. oregonensis, S. rigidus*). *Sericocarpus oregonensis* ha sido dividido en dos subespecies basadas en la pubescencia y la geografía (subsp. *californicus* y subsp. *oregonensis*). Se han examinado más de 2300 especímenes de herbario para determinar la distribución y los rangos morfológicos de variación en caracteres de todas las especies. Se realizó un análisis morfométrico multivariante de 111 especimenes para determinar cuales de los 44 caracteres vegetativos y 19 florales examinados eran diagnósticos para las especies y que especies eran las más semejantes. Los resultados de los análisis discriminantes y de agrupamiento indican que las cinco especies son diferentes. Las especies se diferencian por caracteres de tallos, hojas y flores, y en menor medida por su distribución geográfica y datos del hábitat. Para comprobar la validez de la división de *S. oregonensis* en dos taxa infraspecíficos, se examinó la pubescencia de tallos y hojas en 125 especimenes de *S. oregonensis*. Los resultados indican que *S. oregonensis* puede dividirse en dos subespecies basadas en la pubescencia y la geografía. Los resultados estadísticos y las medidas morfométricas se usaron para realizar descripciones

---

[1] Current Address: 138 McNaughton Street, Sudbury, Ontario, P3E 1V3 CANADA

[2] Current Address: Chicago Botanical Garden, Conservation Science, 1000 Lake Cook Rd., Glencoe, Illinois U.S.A.

[3] Author of correspondence

SIDA 21(3): 1471–1505. 2005

detalladas y una clave de identificación de todos los taxa de *Sericocarpus*. Se encontró que el vilano era triple o raramente cuádruple en todas las especies.

INTRODUCTION

The genus *Sericocarpus* Nees (Asteraceae: Astereae) includes five species found only in North America according to the most recent reviews of the genus (Nesom 1993, 1994, 2000; Semple & Leonard 2005). Three of the species occur in the eastern United States (*S. asteroides*, *S. tortifolius* and *S. linifolius*) and two occur in the Pacific States of the United States and on southern Vancouver Island in British Columbia, Canada (*S. oregonensis* and *S. rigidus*). The first of these two western species has been subdivided into two subspecies subsp. *oregonensis* and subsp. *californicus*. Nees (1832) first recognized *Sericocarpus* as a genus distinct from *Aster* L. Others such as Gray (1884), Small (1903), Fernald (1950), and Nesom (1993, 1994, 2000) also treated *Sericocarpus* as a distinct genus. However, in the last fifty years, most botanists have followed Cronquist (1955, 1968, 1980; Gleason & Cronquist 1991) in treating *Sericocarpus* as part of the genus *Aster* in the broad traditional sense, including Jones (1980) and Semple and Brouillet (1980a). Semple et al. (1996) retained *Sericocarpus* within *Aster* subg. *Aster* on the basis of similarities in phyllary traits and the results of a restriction fragment length polymophism analysis of chloroplast DNA (Xiang & Semple 1996), but Semple et al. (2002) treated it as a separate genus based on ITS sequence data, which they summarized and on morphological traits. *Sericocarpus* is more closely related to the goldenrod genus *Solidago* than to other North American species of asters, which themselves can no longer be placed in a large traditionally defined genus *Aster*. DNA studies have shown *Aster* in the new sense is restricted to Europe and Asia with one arctic-alpine exception (Noyes & Rieseberg 1999; Brouillet et al. 2001; Semple et al. 2002). Nesom (2000) included *Sericocarpus* in a narrowly defined subtribe Solidagininae O. Hoffmann; this is one branch of the "North American Clade" of the tribe Astereae (Semple at al. 2002).

Sericocarpus linifolius (L.) B.S.P. is the nomenclatural type of the genus. It has been treated as *Conyza linifolia* L., *Aster linifolius* L. and *Aster solidagineus* Michx., the latter name reflecting similarities to the grass-leaved goldenrods of the genus *Euthamia*, which at the time was erroneously included in *Solidago*. *Sericocarpus linifolius* lacks the prominent basal leaves and dentate leaf margins of *S. asteroides*. Its leaves are linear-oblong to linear-oblanceolate all along the length of the stem. *Sericocarpus linifolius* has the smallest heads in the genus.

Sericocarpus asteroides (L.) B.S.P. has been treated in the past as *Conyza asteroides* L., *Aster asteroides* (L.) MacMillan, *Aster conyzoides* Willd., and *Aster paternus* Cronq. Although other species may exhibit basal leaves, *S. asteroides* has distinctive, serrate, spatulate basal leaves and is the only species to have basal leaves usually present at the time of flowering. The lower stem leaves, also dentate, become progressively more narrowly ovate near the top of the stem.

Sericocarpus tortifolius (Michx.) Nees also has been known, at one time or another, as *Aster tortifolius* Michx., *Aster bifoliatus* (Walt.) Ahles, *Conyza bifoliatus* Walt., and *Sericocarpus bifoliatus* (Walt.) Porter. Its non-dentate leaves are smaller and more oblanceolate than the other four species. Its leaves and stem are the most densely pubescent in the genus. Of the three eastern species, *S. tortifolius* has the smallest range, which extends from southern Florida northeast to North Carolina and west to southern Mississippi.

Sericocarpus linifolius and *S. asteroides* have similar ranges. Both are found along most of the eastern seaboard from New Hampshire down to South Carolina, but they never extend down to southern Georgia or Florida. *Sericocarpus linifolius* occurs a little further west than *S. asteroides* generally does, occurring in western Tennessee and Kentucky. *Sericocarpus linifolius* can also be found in a small area in southeastern Indiana, while *S. asteroides* generally does not extend beyond central Ohio in the north except for a few isolated collections in southern Wisconsin, southwestern Michigan and northwestern Indiana. These latter may be chance adventives.

Sericocarpus oregonensis Nutt. has been treated in the past as *Aster oregonensis* (Nutt.) Cronq., *Sericocarpus californicus* Durand, and *Sericocarpus rigidus* Lindl. in Hook. var. *californicus* (Durand) Blake. The lower leaves of *S. oregonensis* are distinctly reticulate-veined and the heads are usually found in several to many separate clusters. Ferris (1958) divided *Sericocarpus oregonensis* into two taxa: subsp. *californicus* (Durand) Ferris and subsp. *oregonensis*. In the same year, Keck (1958) also recognized two subspecies but treated them in *Aster oregonensis*, as did Allen (1993). In contrast, Nesom (1993) recognized two varieties in the species: *Sericocarpus oregonensis* Nutt. var. *oregonensis* and *Sericocarpus oregonensis* Nutt. var. *californicus* (Durand) Nesom. Nesom (1993) described var. *oregonensis* as having scabrous-puberulent leaves, while var. *californicus* had densely hirsute or pilose leaves (Nesom 1993). *Sericocarpus oregonensis* subsp. *californicus* can be found in the Sierra Nevada range area of eastern California, while subsp. *oregonensis* extends from northern California to western Washington along the Coastal/Cascade ranges.

Sericocarpus rigidus Lindl.in Hook. has a number of nomenclatural synonyms, including *Aster curtus* Cronq. and *Sericocarpus rigidus* Lindley in Hook. var. *laevicaulis* Nutt. It is by far the rarest of the five species of genus. *Sericocarpus rigidus* is similar in appearance to *S. oregonensis* but is smaller in stature, being 1–3 dm tall as opposed to 4–12 dm tall. Furthermore, *S. rigidus* lacks the reticulate-veined lower leaf surfaces of *S. oregonensis*. The heads are usually found in a single cluster with typically 1–3 ray florets as compared to 4–7 in the case of *S. oregonensis*. *Sericocapus rigidus* is found in two isolated pockets, one in western Oregon and the second extending from western Washington at the south end of Puget Sound to the southern tip of Vancouver Island.

In 1990, *Sericocarpus rigidus* was included on the United States Fish and

Wildlife Service's "Endangered and Threatened Wildlife and Plants List" in the Federal Register (Clampitt 1993). In 1996, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assigned to *Aster curtus* (Cronq.) the status of "threatened" and revised the listing to *Sericocarpus rigidus* in 2000. COSEWIC describes threatened species as those "likely to become endangered if limiting factors are not reversed" (Douglas & Illingworth 1996). In the case of *S. rigidus*, the principal "limiting factor" is habitat destruction. Most populations are also threatened by competition from aggressive exotic species, such as *Cytisus scoparius*. Fire suppression has also favored the expansion of native species, such as *Symphoricarpos albus*. The proliferation of this shrub is crowding out *S. rigidus* from its natural habitat (Douglas & Illingworth 1996).

All chromosome number reports in *Sericocarpus* are diploid. In total, 44 chromosome count reports of $2n = 9_{II}$ or $2n = 18$ have been published: 14 for *S. asteroides*, five for *S. linifolius*, 14 for *S. oregonensis*, and 11 for *S. tortifolius*. (Huziwara 1965; Anderson et al. 1974; Pinkava & Keil 1977; Semple & Brouillet 1980b; Hill 1983; Semple et al. 1983; Jones & Smogor 1984; Semple 1985; Semple et al. 1989, 1992, 1993; 2001; Semple & Cook 2004). No count is known for *S. rigidus*. Polyploidy is unknown in the genus and thus is not a factor influencing morphology.

The goal of this study was twofold. First, a multivariate morphometric analysis of the genus had never been undertaken before. Second, detailed descriptions were needed to be prepare the treatment of the genus for Flora North America Project (Semple & Leonard 2005). The names of taxa used in this paper are those accepted at the conclusion of this study.

MATERIAL AND METHODS

Over 2300 herbarium specimens of *Sericocarpus* were examined; These were borrowed from or examined at BRIT, CAS, DAO, GH, LINN, MO, NY, ORE, OSC, UC, UVIC, WAT, WILLU and WTU (Holmgren et al. 1990). Of these, 111 specimens were selected for multivariate analyses based on their completeness and developmental stage. Forty-four vegetative and 19 floral characteristics were measured for each of the selected specimens. Some traits such as lower stem leaf features were not available for scoring on all specimens (Table 1). When possible, all traits were measured in replicates of five. Character measurements were then averaged and these averages were used in subsequent statistical analyses. Ray and disk achene pubescence was scored on a scale of 1–5 with 5 representing the highest degree of pubescence. Shape of the leaf apex and base were scored on a scale of 1–10 using a reference card developed in the laboratory.

Each specimen was assigned to an *a priori* group based on geography and morphological characteristics, which were determined through observations and a review of the literature (Nesom 1993). The exclusion of *a priori* traits from discriminant analyses avoided the introduction of circular logic and bias into the statistical analyses. When a pair of traits highly correlated with one another (Pearson's correlation coefficient (R = | 0.7 |) one of the pair was excluded from further analyses. Highly correlated traits were excluded because two traits showing high correlation could indicate that the phenotype of those two traits resulted from the regulation of a single gene, in which cases, including both traits would be redundant.

Analysis of pubescence variation in the two subspecies of *Sericocarpus oregonensis* (subsp. *oregonensis* and subsp. *californicus*) was assessed by measuring the number of hairs per mm^2 for each of the traits listed in Table 2.

All clustering and discriminant analyses were performed using either SYSTAT 10.0 (SPSS Inc. 2000) or SAS ver. 8.0 (SAS Institute Inc. 1999) software packages. UPGMA cluster analyses using average linkage on squared Euclidian distances were performed in order to determine the relative similarities among the 111 specimens. The cluster analysis used standardized data and all measured traits, with the exception of basal leaf traits, which were only present on *Sericocarpus asteroides* at the time of flowering.

For the canonical analyses, characters not used to define *a priori* group were selected based on the results of a stepwise discriminant analysis, which determines which traits best separate the *a priori* groups. Only nine traits with the highest F-values were then used in a classificatory discriminant analysis because only nine specimens of *Sericocarpus rigidus* were included.

A classificatory discriminant analysis assigns specimens *a posteriori* to groups using the set of characteristics chosen in the stepwise discriminant analysis. The classificatory analysis also includes a test for equality between group centroids (Wilk's lambda, Pillai's Trace and Lawley-Hotelling trace). Geisser assignment probabilities and correct classification rates were also determined. These assess the reliability of the *a posteriori* classification of the specimens relative to the *a priori* groupings and the strengths of alternative placements of the specimens.

Canonical discriminant analysis is a dimensional-reduction technique used to help visualize the results of the discriminant analyses. The number of canonical scores that can be used is one less then the number of *a priori* groups up to three. Canonical score plots were rotated to determine if a single perspective would suffice to illustrate group separation. Two dimensional plots of combinations of canonical scores were also plotted and those that best revealed group separation were selected.

Digital photomicrographs of cyselae were taken using a Nikon CoolPix 990 camera manually held against the ocular lens of either the dissecting or compound microscope. Pictures were taken of specimens under the compound light microscope with either below stage or above stage lighting. Final digital illustrations were made using CorelDraw 12® from digital images edited with Corel PhotoPaint12® (Corel Corp.). In some illustrations the contrast was manipulated

Table 1. Traits measured for the morphometric analysis of *Sericocarpus*.

STLNG	Stem length (mm)
STHRLO	Number of hairs on the lower stem per mm^2
STHRMD	Number of hairs on the mid stem per mm^2
STHRUP	Number of hairs on the upper stem per mm^2
BLHRSU	Number of hairs on the basal leaf surface per mm^2
BLHRMR	Number of hairs on the basal leaf margins per mm^2
BLHRVN	Number of hairs on the basal leaf vein per mm^2
BLLENG	Basal leaf length (mm)
BLWID	Basal leaf width (mm)
BLWTIP	Basal leaf measured from the widest point to the tip (mm)
BLAPX	Basal leaf shape at its apex (1–10)
BLBASE	Basal leaf shape at its base (1–10)
BLDENT	Basal leaf dentation—number of serration on the leaf margin
BLBEAD	Number of resin beads on the basal leaf per mm^2
LLHRSU	Number of hairs on the lower leaf surface per mm^2
LLHRMG	Number of hairs on the lower leaf margin per mm^2
LLHRVN	Number of hairs on the lower leaf vein per mm^2
LLLENG	Lower leaf length (mm)
LLWIDE	Lower leaf width (mm)
LLWTIP	Lower leaf measured from the widest point to the tip (mm)
LLAPX	Lower leaf shape at its apex (1–10)
LLBASE	Lower leaf shape at its base (1–10)
LLDENT	Lower leaf dentation—number of serration on the leaf margin
LLBEAD	Number of resin beads on the lower leaf per mm^2
MLHRSU	Number of hairs on the mid leaf surface per mm^2
MLHRMG	Number of hairs on the mid leaf margin per mm^2
MLHRVN	Number of hairs on the mid leaf vein per mm^2
MLLENG	Mid leaf length (mm)
MLWIDE	Mid leaf width (mm)
MLWTIP	Mid leaf measured from the widest point to the tip (mm)
MLAPX	Mid leaf shape at its apex (1–10)
MLBASE	Mid leaf shape at its base (1–10)
MLDENT	Mid leaf dentation—number of serrations on the leaf margin
MLBEAD	Number of resin beads on the mid leaf surface per mm^2
ULHRSU	Number of hairs on the upper leaf surface per mm^2
ULHRMG	Number of hairs on the upper leaf margin per mm^2
ULHRVN	Number of hairs on the upper leaf vein per mm^2
ULLENG	Upper leaf length (mm)
ULWIDE	Upper leaf width (mm)
ULWTIP	Upper leaf measured from the widest point to the tip (mm)
ULAPX	Upper leaf shape at its apex (1–10)
ULBASE	Upper leaf shape at its base (1–10)
ULDENT	Upper leaf dentation—number of serrations on the leaf margin
ULBEAD	Number of resin beads on the upper leaf surface per mm^2
NOINFL	Number of heads on lateral branch
HDHGT	Head height (mm)
HDWIDE	Head width (mm)
OUTPHY	Outer phyllary length (mm)
TWOPHY	Second layer phyllary length (mm)
THRPHY	Third layer phyllary length (mm)
INPHY	Inner phyllary length (mm)
RAYFLR	Number of ray florets per head
RSTRLNG	Ray strap length (mm)
RCORTB	Ray corolla tube length—measured from base to beginning of strap (mm)
RACHLNG	Ray cypsela body length (mm)
RPAPLNG	Ray cypsela pappus length (mm)
RPBSC	Ray cypsela pubescence (0–5)
DISFLOR	Number of disc florets per head
DCORTB	Disc corolla tube length (mm)
DACHLNG	Disc cypsela body length (mm)
DPAPLNG	Disc cypsela pappus length (mm)
DPBSC	Disc cypsela pubescence (0–5)
DCORLB	Disc corolla lobe length (mm)

TABLE 2. Traits measured for the pubescence analysis of *Sericocarpus oregonensis*; all counts are given in numbers of hairs/mm^2.

STHRLO	Number of hairs on lower stem.	MLHRSU	Number of hairs on mid leaf surface.
STHRMD	Number of hairs on mid stem.	MLHRVN	Number of hairs on mid leaf vein.
STHRUP	Number of hairs on upper stem.	MLHRMG	Number of hairs on mid margin.
LLHRSU	Number of hairs on lower leaf surface.	ULHRSU	Number of hairs on upper leaf surface.
LLHRVN	Number of hairs on lower leaf vein.	ULHRVN	Number of hairs on upper leaf vein.
LLHRMG	Number of hairs on lower leaf margin.	ULHRMG	Number of hairs on upper leaf margin.

to increase the difference between pappus bristles and background for illustrative purposes.

RESULTS

Cluster analyses

Standardized data for 53 characters (Table 1) were included in an UPGMA cluster analysis. Traits not included were those for which data was not available for all specimens, e.g. stem height and lower leaf traits. Results indicate separation into four main branches (Fig. 1; A–D) and two small basal clusters. The three eastern species clustered into three groups corresponding to the species with only three exceptions. Branch A included all the specimens of *Sericocarpus tortifolius* and no other taxa. Branch B included all but one of the *S. linifolius* specimens, with no inclusion of specimens of any other taxa. The single exception was a *S. linifolius* specimen (lin32), which occurred on a more basal branch along with one *S. asteroides* specimen (ast26). Branch C included all but two of the measured *S. asteroides* specimens, as well as two small *S. oregonensis* specimens (cal23 & cal19). Of the two *S. asteroides* specimens not clustered within Branch C, one specimen clustered with one *S. linifolius* specimen. The other *S. asteroides* specimen (ast92) occurred by itself on the basal branch of the dendrogram; it was a robust individual.

Branch D consisted of only members of the two western species *Sericocarpus oregonensis* and *S. rigidus*. The branch was subdivided into three clusters (a, b and c). Branch c included all nine *S. rigidus* specimens as well as two smaller *S. oregonensis* subsp. *oregonensis* specimens (oreg101 & oreg107). Branches a and b were composed entirely of *S. oregonensis* specimens with both clusters including specimens from the Sierras (subsp. *californicus*) and from the Coastal and Cascade Mts. (subsp. *oregonensis*). Six of the eight specimens in cluster a belonged to subsp. *californicus*. Four of the six specimens in cluster b belonged to subsp. *oregonensis*. The two specimens of subsp. *californicus* in cluster b had pubescence values at the lower end of the ranges of the traits for the subspecies.

A cluster analysis was performed on a matrix of 12 stem and leaf pubescence traits scored on 107 specimens of *S. oregonensis*. Specimens of the two subspecies were intermixed and did not form two distinct cluster groups corresponding to the geographically based subspecies.

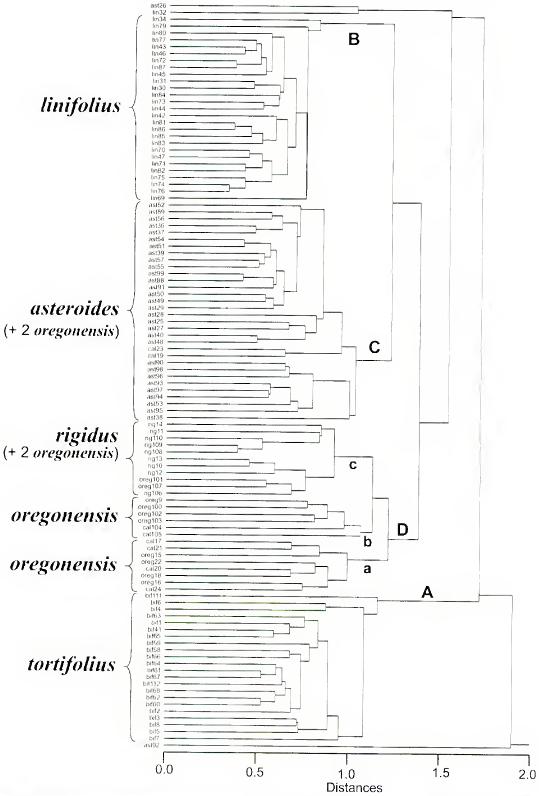


FIG. 1. UPGMA cluster analysis based on all characters. Branches indicated by letters are discussed in the text.

Discriminant Analyses

A canonical discriminant analysis was carried out on 107 specimens of *Sericocarpus*. *A priori* group membership was determined using the characteristics listed in Table 3. Leaf length, width and pubescence, as well as stem pubescence were diagnostic traits used in the assignment of all specimens into *a priori* groups. Specimens were assigned to groups in part on the basis of geographic distribution. In the literature, five species level groups have been widely accepted (e.g., Nesom 1993). Examination of more than 2300 specimens indicated that five species groups were recognizable using key characters from the literature. Three *a priori* groups included only specimens from the eastern United States. Specimens assigned *a priori* to the *S. tortifolius* group were the most pubescent, had obovate upper stem leaves and all came from the southeastern United States. Specimens assigned *a priori* to the *S. linifolius* group were glabrous for all traits listed in Table 3, had narrowly elliptic, lanceolate or linear leaves, and all came from the eastern United States. Specimens of the *S. linifolius* group also had the longest mid and upper stem leaves. Specimens assigned *a priori* to the *S. asteroides* group were from the eastern United States and had basal rosette and lower stem leaves that were petiolate and obovate to oblanceolate and usually serrate; upper stem leaves were reduced, becoming sessile and ovate to lanceolate. The widest lower and mid stem leaves were observed on specimens of *S. asteroides*.

Western North American specimens were assigned *a priori* to *S. oregonensis* and *S. rigidus*. Specimens with one or two ray florets with short straps were assigned *a priori* to the *S. rigidus* group; these came from the south end of Vancouver Island in British Columbia and western Washington and Oregon. Western specimens with at least three ray florets with longer, broader straps were assigned *a priori* to the *S. oregonensis* group, which was not subdivided into subspecies groups for the species level analysis. On average, *S. oregonensis* specimens tended to have the widest upper stem leaves.

A stepwise discriminant analysis was used to select traits to be included in the discriminant functions used in further analyses. The means, standard deviations, ranges, and minimum and maximum values of all characters analyzed are presented in Table 4. The nine characters selected and used in further analyses are indicated by asterisks. The stepwise discriminant analysis selected twelve traits as having some value in discriminating groups. Of these, the three with the lowest F-values (HDHGT, RCORTB, DISFLOR) were discarded in order that the number of traits used in the classificatory discriminant analysis not exceed the number of specimens in the smallest *a priori* group; nine suitable specimens of *S. rigidus* were included. Other traits scored were rejected from further analysis because they correlated highly with traits included in the stepwise discriminant analysis.

Table 3. Characteristics used to make *a priori* group assignments to five species level groups in *Sericocarpus*; means, ± standard deviations, (ranges) and minimum / maximum; all lengths and widths are given in mm and all pubescence counts are given in numbers of hairs/mm^2.

Character	*S. asteroides*	*S. tortifolius*	*S. linifolius*	*S. oregonensis*	*S. rigidus*
STHRLO	2.63 ± 2.37 (0.26–4.99) 0 / 9	34.45 ± 12.85 (21.61–47.30) 0 / 55	0.00 ± 0.00 (0.00–0.00) 0 / 0	8.44 ± 6.46 (1.99–14.90) 0 / 23	1.78 ± 2.39 (0.00–4.16) 0 / 6
STHRMD	6.00 ± 3.45 (2.55–9.45) 0 / 15	39.73 ± 6.85 (32.88–46.57) 30 / 55	0.00 ± 0.00 (0.00–0.00)	11.22 ± 4.76 (6.46–15.98) 3 / 18	2.37 ± 4.39 (0.00–7.05) 0 / 13
STHRUP	10.94 ± 5.48 (5.45–16.42) 0 / 25	42.41 ± 9.40 (33.01–51.81) 25 / 59	0.00 ± 0.00 (0.00–0.00) 0 / 0	11.28 ± 5.14 (6.14–16.42) 2 / 20	8.11 ± 8.74 (0.00–16.85) 0 / 25
LLHRSU	2.48 ± 2.10 (0.37–4.58) 0 / 7	22.43 ± 5.56 (16.88–27.99) 14 / 36.67	0.00 ± 0.00 (0.00–0.00) 0 / 0	8.36 ± 3.76 (4.59–12.12) 0 / 13	1.10 ± 1.93 (0.00–3.03) 0 / 4.67
LLLENG	60.03 ± 22.08 (37.95–82.10) 29.70 / 106.25	26.22 ± 5.71 (20.51–31.93) 15 / 38	50.39 ± 12.26 (38.13–62.64) 25.13 / 75.67	57.60 ± 16.82 (40.78–74.42) 39.60 / 97.75	38.95 ± 11.19 (27.77–50.14) 24.83 / 56.50
LLWIDE	16.26 ± 5.55 (10.71–21.81) 7 / 28.25	9.33 ± 2.52 (6.81–11.85) 5.25 / 14.00	5.86 ± 1.52 (4.34–7.38) 3 / 9.50	10.40 ± 2.76 (7.63–13.16) 7 / 16.13	6.91 ± 1.04 (5.86–7.95) 5.50 / 8.92
MLHRSU	2.37 ± 2.36 (0.01–4.73) 0 / 7.00	26.85 ± 4.93 (21.92–31.78) 18 / 41.33	0.00 ± 0.00 (0.00–0.00) 0 / 0	11.52 ± 6.01 (5.51–17.52) 0 / 21.67	2.11 ± 3.06 (0.00–5.18) 0 / 8.80
MLLENG	37.22 ± 11.80 (25.42–49.02) 16.17 / 57.90	21.90 ± 5.69 (16.21–27.59) 12.75 / 34.60	41.53 ± 6.60 (34.93–48.14) 27.10 / 52.40	43.61 ± 12.42 (31.19–56.03) 29.50 / 80.25	33.50 ± 9.53 (23.97–43.02) 20.88 / 46.50
MLWIDE	11.15 ± 3.52 (7.63–14.67) 6.50 / 20.75	8.52 ± 2.27 (6.25–10.79) 5.20 / 14.00	3.87 ± 0.74 (3.13–4.61) 2.40 / 6.10	10.33 ± 2.78 (7.55–13.11) 6.44 / 16.27	6.91 ± 1.43 (5.48–8.34) 4.97 / 9.25
ULHRSU	1.94 ± 2.13 (0.00 ± 4.07) 0 / 9.00	30.74 ± 7.97 (22.77–38.72) 18.20 / 54.33	0.00 ± 0.00 (0.00–0.00) 0 / 0	14.96 ± 9.37 (5.60–24.33) 3 / 34	1.98 ± 2.55 (0.00–4.53) 0 / 6.60
ULLENG	21.27 ± 6.50 (14.78–27.77) 11.00 / 44.83	14.37 ± 2.89 (11.49–17.26) 9.70 / 21.60	24.73 ± 5.42 (19.31–30.16) 13.67 / 36.90	22.97 ± 7.50 (15.48–30.47) 12.25 / 42.75	22.00 ± 6.71 (15.29–28.72) 12.67 / 33.50
ULWIDE	6.16 ± 1.92 (4.24–8.07) 3.75 / 11.00	5.93 ± 1.32 (4.61–7.25) 3.45 / 8.20	2.81 ± 0.61 (2.20–3.42) 1.85 / 4.10	6.41 ± 1.63 (4.78–8.04) 3.50 / 10.00	4.98 ± 1.16 (3.82–6.14) 3.70 / 7.38
RSTRLNG	4.30 ± 0.84 (3.46–5.15) 2.48 / 6.03	4.80 ± 0.92 (3.88–5.72) 3.38 / 6.35	6.00 ± 1.47 (4.53–7.47) 4.19 / 10.50	4.46 ± 0.76 (3.70–5.23) 3.10 / 5.59	2.10 ± 0.55 (1.55–2.64) 1.56 / 3.00
RAYFLR	5.06 ± 0.99 (4.07–6.05) 3.20 / 7.60	3.90 ± 0.85 (3.05–4.76) 2.00 / 5.40	3.80 ± 0.98 (2.82–4.79) 2.80 / 6.40	4.08 ± 1.22 (2.86–5.29) 2.00 / 5.80	1.45 ± 0.54 (0.91–1.99) 0.75 / 2.33

Table 4. Characteristics included in a stepwise discriminant analysis of five *a priori* species groups of *Sericocarpus*; means ± standard deviations, (ranges), and minimum and maximum values; all lengths are given in mm and all pubescence counts are given in numbers of hairs/mm^2; characteristics are shown in order of decreasing F-values; traits selected by the analysis are indicated by and asterisk*.

Character	*S. asteroides*	*S. tortifolius*	*S. linifolius*	*S. oregonensis*	*S. rigidus*
THRPHY*	5.70 ± 0.72 (4.98–6.43) 4.17 / 7.14	4.43 ± 0.59 (3.85–5.02) 3.61 / 6.07	4.62 ± 0.41 (4.21–5.04) 3.84 / 5.45	6.38 ± 0.64 (5.74–7.01) 4.69 / 7.15	7.26 ± 0.87 (6.39–8.13) 6.13 / 8.57
MLHRVN*	6.63 ± 3.12 (3.52–9.75) 0 / 12.00	14.29 ± 3.42 (10.87–17.71) 10.20 / 22.00	0.00 ± 0.00 (0.00–0.00) 0 / 0	7.67 ± 3.51 (4.16–11.17) 2.00 / 15.00	3.37 ± 2.56 (0.81–5.93) 0 / 6.80
DCORLB*	0.94 ± 0.18 (0.76–1.12) 0.6 / 1.5	1.37 ± 0.23 (1.15–1.60) 1.05 / 1.78	1.45 ± 0.23 (1.22–1.68) 1.05 / 1.94	1.21 ± 0.16 (1.05–1.38) 1.00 / 1.66	0.83 ± 0.10 (0.73–0.93) 0.63 / 0.96
ULHRMG*	5.68 ± 1.76 (3.92–7.44) 2.67 / 8.60	13.20 ± 3.08 (10.12–16.29) 8.80 / 22.00	3.85 ± 1.28 (2.57–5.13) 1.33 / 7.20	4.57 ± 5.32 (0.00–9.88) 0 / 12.40	8.77 ± 1.39 (7.37–10.16) 7.20 / 11.50
DCORTB*	3.70 ± 0.33 (3.37–4.04) 3.22 / 4.35	4.82 ± 0.63 (4.19–5.46) 3.84 / 5.95	3.10 ± 0.38 (2.72–3.47) 2.25 / 3.75	4.59 ± 0.46 (4.12–5.05) 3.39 / 5.15	5.09 ± 0.52 (4.58–5.61) 4.44 / 6.23
RACHLNG*	1.19 ± 0.22 (0.98–1.41) 0.80 / 1.84	1.48 ± 0.29 (1.20–1.77) 1.14 / 2.35	0.97 ± 0.11 (0.86–1.08) 0.73 / 1.22	2.06 ± 0.56 (1.5–2.62) 1.27 / 3.32	1.58 ± 0.36 (1.23–1.94) 1.25 / 2.19
MLWTIP*	17.13 ± 6.29 (10.84–23.41) 7.38 / 30.25	8.46 ± 4.23 (4.23–12.69) 4.40 / 24.50	18.59 ± 3.62 (14.96–22.21) 13.30 / 27.00	20.02 ± 6.73 (13.29–26.75) 11.50 / 33.30	12.40 ± 3.35 (9.05–15.75) 8.06 / 18.50
HEWIDE*	4.44 ± 0.70 (3.75–5.14) 3.08 / 6.00	5.24 ± 1.49 (3.76–6.73) 3.50 / 10.53	3.19 ± 0.67 (2.51–3.86) 2.26 / 4.82	5.79 ± 0.84 (4.95–6.63) 4.44 / 7.19	5.55 ± 0.86 (4.68–6.41) 4.10 / 6.54
ULHRVN*	6.03 ± 2.70 (3.34 8.73) 0 / 12.33	12.62 ± 7.33 (5.29–19.96) 0 / 20.80	0.00 ± 0.00 (0.00–0.00) 0 / 0	8.63 ± 3.18 (5.45–11.81) 3.00 / 16.50	3.53 ± 2.72 (0.81–6.25) 0.20 / 7.40
RCORTB	3.08 ± 0.45 (2.63–3.53) 2.36 / 4.23	3.40 ± 0.39 (3.01–3.80) 2.67 / 4.19	3.08 ± 0.42 (2.66–3.51) 2.35 / 3.96	3.15 ± 0.33 (2.82–3.49) 2.55 / 3.71	3.07 ± 0.46 (2.61–3.53) 2.50 / 3.88
HEHGT	8.24 ± 0.84 (7.4–9.09) 7.03 / 10.44	10.63 ± 0.96 (9.67–11.58) 9.25 / 13.78	6.92 ± 0.72 (6.20–7.65) 5.63 / 8.38	10.17 ± 1.16 (9.02 ± 11.33) 7.89 / 12.13	10.53 ± 1.01 (9.52–11.54) 9.35 / 12.37
DISFLOR	13.51 ± 2.59 (10.92–16.10) 9.60 / 19.20	8.65 ± 1.21 (7.45–9.86) 6.40 / 10.80	8.61 ± 2.32 (6.28–10.93) 5.20 / 14.60	13.41 ± 3.08 (10.32–16.49) 9.00 / 19.25	13.03 ± 2.43 (10.60–15.46) 9.5 / 16.8
OUTPHY	3.28 ± 0.44 (2.84–3.72) 2.36 / 4.20	2.24 ± 0.34 (1.9–2.58) 1.76 / 3.12	2.96 ± 0.27 (2.69–3.23) 2.40 / 3.49	3.92 ± 0.49 (3.43–4.42) 2.76 / 4.57	4.21 ± 0.73 (3.48–4.93) 3.14 / 5.29
ULWTIP	10.75 ± 3.64 (7.10–14.39) 5.19 / 19.50	5.35 ± 1.14 (4.22–6.49) 2.42 / 7.50	13.76 ± 2.95 (10.81–16.72) 8.83 / 19.00	11.56 ± 3.85 (7.70–15.41) 5.88 / 20.75	9.23 ± 2.10 (7.13–11.33) 6.95 / 12.30

Table 4 continued

Character	*S. asteroides*	*S. tortifolius*	*S. linifolius*	*S. oregonensis*	*S. rigidus*
MLHRMG	5.62 ± 1.72 (3.90–7.34) 3.00 / 8.25	11.93 ± 1.99 (9.94–13.92) 8.67 / 17.33	3.91 ± 1.42 (2.49–5.33) 1.00 / 6.60	4.71 ± 5.88 (0.00–10.59) 0 / 18.50	8.31 ± 1.97 (6.34–10.28) 7.00 / 13.00
NOINFL	3.50 ± 1.28 (2.22–4.78) 2.60 / 5.60	2.98 ± 0.41 (2.57–3.40) 2.40 / 4.00	3.18 ± 1.08 (2.10–4.26) 2.40 / 8.40	3.33 ± 0.36 (2.98–3.69) 2.60 / 4.20	2.87 ± 0.45 (2.42–3.32) 2.20 / 3.40

The Mahalanobis distances between group centroids and the associated F-statistics and their probabilities generated by the classificatory discriminant analysis (Table 5) indicated that all five *a priori* species level groups were strongly supported ($p<0.001$ in all cases). Other tests, i.e. the probabilities for the Wilk's lambda, Pillai's trace, and Lawley-Hotelling trace indicated there were significant differences between group centroids ($p < 0.0001$).

In the classificatory discriminant analysis, specimens was assigned *a posteriori* to five species level groups using the discriminant functions. In the *a posteriori* classification analysis (Table 6), 100% correct classification was made *a posteriori* for specimens assigned *a priori* to *Sericocarpus asteroides*, *S. tortifolius*, and *S. rigidus*. For *S. linifolius*, 96% of the specimens were correctly classified *a posteriori*; one of 28 specimens was assigned to *S. asteroides*. For *S. oregonensis*, 83% were correctly classified; three of 18 specimens were assigned to *S. asteroides*. Overall, 96% of specimens were correctly assigned *a posteriori* to their respective *a priori* groups. In the Jackknifed classification analysis (Table 7), the overall correct *a posteriori* assignment rate was 91%. Again, all specimens were assigned correctly to *S. tortifolius*. The correct classification rates for the other four groups were 90% for *S. asteroides*, 96% for *S. linifolius*, 72% for *S. oregonensis* and 89% for *S. rigidus*.

Plots of the canonical variate scores on the first and second and first and third canonical axes are shown in Fig. 2. Specimens of *S. linifolius* and *S. tortifolius* are separated from the other taxon on the first two axis, while the other three species separate on the first and third axes although with slight overlap toward the center of the distribution of symbols.

Univariate analyses of S. *oregonensis*: subsp. *oregonensis* and subsp. *californicus*
Pubescence traits of 107 specimens of *Sericocarpus oregonensis* were analyzed. The means, standard deviations, ranges (as well as, minimum and maximum values) for stem and leaf pubescence traits measured for subsp. *oregonensis* and subsp. *californicus* are presented in Table 8. Results indicate that subsp. *oregonensis*, which grows in the Coastal/Cascade Mountains region, was less pubescent than subsp. *californicus* found in the Sierra Nevada region of California. Two-sample t tests were run comparing each trait listed in Table 8 by subspecies. Even though the ranges of values of the subspecies overlapped, there

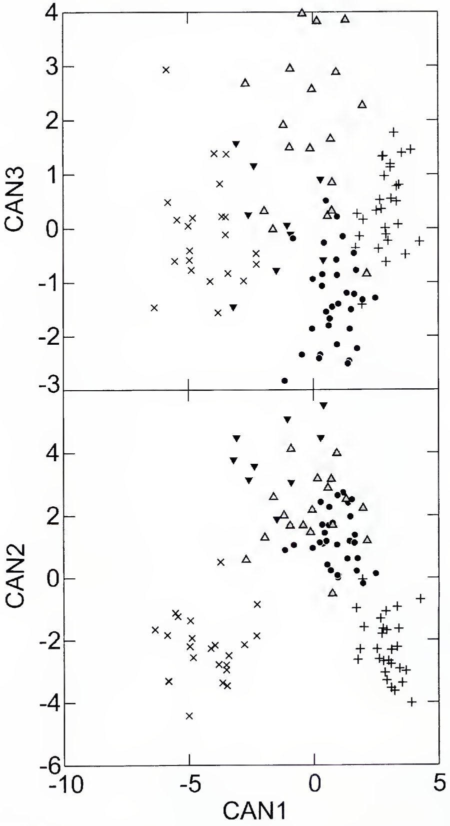


Fig. 2. Plots of the first and second and first and third canonical variates of 107 specimens included in the five taxon canonical analysis of *Sericocarpus*. Key to symbols: *S. asteroides*, solid dots; *S. linifolius*, +; *S. oregonensis*, light shaded triangles; *S. rigidus*, inverted black triangles; and *S. tortifolius*, ×.

TABLE 5. Mahalanobis distances (squared) between group centroids and associated, F-statistics for the five species level groups analysis of *Sericocarpus*; probabilities between groups in all comparisons were < 0.0001.

	a posterori group			
a priori group	asteroides	tortifolius	linifolius	oregonensis
S. tortifolius	70.173 91.201			
S. linifolius	20.281 30.077	97.071 122.457		
S. oregonensis	11.865 13.668	59.249 60.062	38.146 42.796	
S. rigidus	18.499 13.114	81.725 53.450	53.885 37.579	20.152 12.381

TABLE 6. Results of an *a posteriori* classificatory discriminant analysis of 107 specimens of *Sericocarpus* using a linear discriminant function.

Group	*a posterori* group					
a priori group	asteroides	tortifolius	linifolius	oregonensis	rigidus	N
asteroides	30 100%	0	0	3 10%	0	30
tortifolius	0	22 100%	0	0	0	22
linifolius	1 4%	0	27 96%	0	0	28
oregonensis	3 17%	0	0	15 83%	0	18
rigidus	1 11%	0	0	0	9 100%	9
TOTALS	34	22	27	16	8	107

was a statistically significant difference (p=0.00, ± = 0.05) between the means for every trait.

DISCUSSION

Cluster and discriminant analyses support the division of *Sericocarpus* into five species. *Sericocarpus linifolius* and *S. tortifolius* are the two most distinct species within the genus. *Sericocarpus asteroides*, *S. oregonensis*, and *S. rigidus* are generally more similar to one another with the greatest similarity being between the latter two, which are the western North America species. The similarity between these three latter species is reflected in the inclusion of a few of the *S. oregonensis* specimens within the *S. asteroides* and *S. rigidus* branches in

TABLE 7. Results of an *a posteriori* jackknifed classificatory discriminant analysis of 107 specimens of *Sericocarpus* using a linear discriminant function.

Group	*a posterori* group					
a priori group	asteroides	tortifolius	linifolius	oregonensis	rigidus	N
asteroides	27 90%	0	0	3 10%	0	30
tortifolius	0	22 100%	0	0	0	22
linifolius	1 4%	0	27 96%	0	0	28
oregonensis	5 28%	0	0	13 72%	0	18
rigidus	1 11%	0	0	0	8 89%	9
TOTALS	34	22	27	16	8	107

the cluster analysis, even if such confusion of identity is unlikely due to very different general appearances and provenances. Regardless of the similarity on technical traits as seen in the cluster analysis between *S. asteroides* and the two western species, the 100% correct *a posteriori* classification rate for *S. asteroides* in the classificatory discriminant analysis establishes that it is indeed a distinct species, especially considering the obvious basal rosette trait was not included in the analyses. The technical similarities in traits scored is not reflected in the ease with which *S. asteroides* can be identified in the field.

All of the specimens placed *a posteriori* by the classificatory discriminant analysis into a different group than their *a priori* placements were examined and found to have been correctly placed *a priori* on the basis of the diagnostic traits not included in the analyses. While readily identified as belonging to one of the *a priori* groups, the specimens generally were either stunted or robust compared to other members of the group. Thus, either favorable or unfavorable growing conditions likely influenced others traits that were included in the analyses. The *S. linifolius* specimen not included in Branch B of the cluster diagram (Fig. 1) was also the one misclassified specimen in the classification matrix generated by the classificatory discriminant analysis. This specimen was found to be a very robust plant for the species, therefore explaining its *a posteriori* inclusion into the *S. asteroides* group. There is no doubt that it is specimen of *S. linifolius* based on the *a priori* characteristics excluded from the analyses.

The three misclassified *Sericocarpus oregonensis* specimens were examined, and though some did not always conform to the norm for one trait or another, the initial *a priori* assignments were correct. One of the misclassified *S. oregonensis* specimens (cal23), clustered, along with a second *S. oregonensis*

TABLE 8. Pubescence characteristics measured for the two subspecies of *S. oregonensis*; means " standard deviations, (ranges), and minimum / maximum values; all pubescence counts are given in numbers of hairs/mm^2.

Character	**subsp. oregonensis** ***n* = 63**	**subsp. californicus** ***n* = 62**
STHRLO	9.54 ± 3.88 (5.65–13.42) 1.00 / 18.00	14.07 ± 3.52 (10.55–17.59) 4.00 / 23.00
STHRMD	10.89 ± 4.36 (6.53–15.25) 2.00 / 24.00	14.27 ± 3.20 (11.07–17.47) 7.00 / 22.00
STHRUP	12.03 ± 4.19 (7.84–16.22) 4.00 / 26.00	18.26 ± 4.96 (13.30–23.21) 11.00 / 33.00
LLHRSU	8.57 ± 3.41 (5.16–11.98) 2.00 / 19.33	14.75 ± 4.57 (10.18–19.32) 7.00 / 25.20
LLHRVN	5.16 ± 1.60 (3.56–6.76) 2.00 / 8.60	7.84 ± 1.70 (6.15–9.54) 3.00 / 11.40
LLHRMG	7.57 ± 1.63 (5.94–9.20) 4.67 / 13.40	9.38 ± 1.75 (7.64–11.13) 6.00 / 13.20
MLHRSU	10.00 ± 3.83 (6.17–13.83) 2.00 / 19.00	16.72 ± 4.12 (12.61–20.84) 6.67 / 27.00
MLHRVN	5.52 ± 1.48 (4.04–7.00) 2.75 / 9.60	8.48 ± 2.04 (6.44–10.52) 4.00 / 13.80
MLHRMG	7.54 ± 1.58 (5.96–9.11) 4.75 / 11.40	9.38 ± 1.92 (7.46–11.30) 5.80 / 14.80
ULHRSU	12.32 ± 4.65 (7.67–16.97) 3.67 / 23.80	20.49 ± 4.56 (15.93–25.04) 8.33 / 29.60
ULHRVN	5.90 ± 1.54 (4.36–7.44) 2.67 / 11.00	8.88 ± 1.75 (7.13–10.63) 5.33 / 13.40
ULHRMG	8.00 ± 1.75 (6.24–9.75) 4.00 / 13.60	10.22 ± 1.79 (8.43–12.01) 6.60 / 14.20

specimen, within the *S. asteroides* group. Both of these were smaller, less robust plants. Two *S. oregonensis* specimens clustered within the *S. rigidus*. These specimens were dwarf plants with stem lengths corresponding to the lower end of the range for the species (STLNG = 24 cm and 46.5 cm, respectively, Mean = 62.4 mm). The remaining *S. oregonensis* specimens clustered into two groups. The branch b cluster in Fig. 1 is composed of four individuals of *S. oregonensis* subsp. *oregonensis* and two of *S. oregonensis* subsp. *californicus*. The latter two specimens have low hair counts for the subspecies (ULHRSU = 16.6 hairs/mm^2 and 18.8 hairs/mm^2, respectively; mean = 20.5 hairs/mm^2). The branch a cluster in Fig. 1 is composed of six *S. oregonensis* subsp. *californicus* and two *S. oregonensis* subsp. *oregonensis* specimens. Upon close re-examination of the two *S. oregonensis* subsp. *oregonensis* specimens, no obvious morphological traits which could account for its clustering within branch a were observed.

Of the five *Sericocarpus* species, *S. tortifolius* is the most distinct on scored technical traits. All cases clustered together with no inclusion of specimens from any other species. *Sericocarpus tortifolius* is also the only species to show 100% correct classification rates in both the Classification and Jacknifed matrices. The highest F-value (F = 122.457) and Mahalanobis distance (D = 97.071) occurred between the *S. linifolius* and the *S. tortifolius* group centroids. These results confirm the cluster analysis and canonical analysis results which indicate that of the five species, *S. linifolius* and *S. tortifolius* are the most distinct.

Of the one-hundred and seven specimens assigned *a posteriori* during a classificatory discriminant analysis, only four specimens were misclassified. The average Geiser assignment probabilities were: 0.94 for *S. asteroides*, 1.00 for *S. tortifolius*, 0.97 for *S. linifolius*, 0.82 for *S. oregonensis*, and 0.97 for *S. rigidus*. These high Geiser assignment probabilities indicate that the within-group variances are small in comparison to the between-group variances.

The strong F-values and low probabilities of the Wilk's lambda (F = 34.863, $p < 0.001$), Pillai's Trace (F = 22.640, $p < 0.001$) and Lawley-Hotelling trace (F = 48.065, $p < 0.001$) generated during the classificatory discriminant analysis, all indicate that the probability that all specimens tested are representative of one single group rather than five species groups is extremely small.

Scoring of canonical traits on the first and second axes show strong group separation by *S. tortifolius* and *S. linifolius*. The overlapping of the three remaining species on the first and second axes is resolved when the canonical scores are plotted on the second and third canonical axes. The separation visualized in the canonical analysis is supported by the aforementioned cluster and discriminant analyses.

The division of *S. oregonensis* into two subspecies, subsp. *oregonensis* and subsp. *californicus*, is based on both geographic and morphological traits. Those plants growing in the Coastal/Cascade Mountain ranges of Washington, Oregon and California (subsp. *oregonensis*) are more sparsely pubescent than those plants growing in the Sierra Nevada region of eastern California (subsp. *californicus*). The ranges for both subspecies overlap in far northern California; however, the means for all measured pubescence traits is consistently smaller in the case of *S. oregonensis* subsp. *oregonensis* specimens. Two-sample t test results indicate that the difference between the means of both subspecies is statistically significant (prob = 0.00, C.I. = 95%). *Sericocarpus oregonensis* is also found in an intermediate geographical region, namely Butte and Shasta counties in California, where both subspecies are found, but can easily be assigned to appropriate subspecies by examining pubescence traits.

In conclusion, based on the results of the multivariate morphometric analyses, and to a lesser extent on geographical data, the aster genus *Sericocarpus* should be divided into five species: *S. asteroides*, *S. tortifolius*, *S. linifolius*, *S. oregonensis*, and *S. rigidus*. Differences in the degree of pubescence and in geographical location within *S. oregonensis*, support the separation of this species into two infraspecific taxa: *Sericocarpus oregonensis* subsp. *oregonensis*, found in the coastal/cascade region of Washington, Oregon, and California is more sparsely pubescent than *S. oregonensis* subsp. *californicus*, which grows in the Sierra Nevada region of California. Subspecies ranks is adopted following Semple (1974) because the two infraspecific taxa have essentially allopatric distributions. For an alternative usage of infraspecific ranks see Turner and Nesom (2000) who presented the argument that subspecies rank should be used as a grouping category only like subgenus, subtribe, etc. We find it useful to continue to use two infraspecific ranks (subspecies and variety) to emphasize geographic features of the taxa.

TAXONOMIC TREATMENT[4]

Sericocarpus Nees, Gen. et sp. Aster. 10, 148. 1832. *Aster* subg. *Sericocarpus* (Nees) A.G. Jones. Brittonia 32: 238. 1980. *Aster* sect. *Sericocarpus* (Nees) Semple, Phytologia 58:429. 1985. LECTOTYPE [Britt. in Britt. & Brown 1913]: *Sericocarpus solidagineus* (Michx.) Nees = *Sericocarpus linifolius* (L.) B.S.P.

Aster sect. *Serratifolii* Loudon, Hort Brit. 347. 1830. "Leaves lanceolate and ovate, lower ones serrate" LECTOTYPE [Sundberg & Jones 1987]: *Aster conyzoides* Willd. = *Sericocarpus linifolius* (L.) B.S.P.

Perennial herbs from rhizomatous to stout, branching, woody caudex. Stem erect, glabrate to pubescent, (15–)32–48–62(–117) cm. Basal leaves usually absent at time of flowering, puberulent, (2–)4–8–11(–15) cm long, serrate near apex, spatulate to petiolate, reticulate veined. Stem leaves linear to (ob)ovate, sessile, acuminate to acute, sometime slightly cuspidate (1–)2–3–5(–11) cm long, (0.1–)0.4–0.8–1(–3) cm wide, reticulate veined, glabrate to moderately hispidulous or hispidulous-pilose, hairs 0.05–0.5 mm long, longest hairs sometimes twisted,

---

[4] All measurements in the taxonomic treatment are given in the following format: (minimum)–minus the standard deviation–**mean**–plus the standard deviation–(maximum).

usually sparsely to moderately finely glandular punctuate, the stipitate-glands recessed, sometimes resinous, margins ciliate, serrate becoming entire or entire, upper leaves decreasing in size upward. Capitulescence corymbiform to broadly corymbiform, sometimes compact; heads 2–5 per branch; bracts, ciliate, glabrate to pubescent, broadly lanceolate to narrowly ovate. Involucre (3.8–)5.0–6.0–7.0(–8.6) mm high at anthesis, (2.3–)3.8–4.8–5.9(–10.5) mm wide; phyllaries in 3–5 imbricate series, ciliate, glabrate to pubescent, base narrowly to widely oblong, tip narrowly to broadly acute, outer series (1.8–)2.5–3.3–4.1(–5.3) mm long, mid series (2.7–)3.5–4.4–5.2(–6.5) mm long, inner series more linear and less chlorophyllous, margins ciliate, dark green zone at the apex, thumb-nail shaped. Ray florets 1–6, strap (1.6–)2.9–4.3–5.8(–10.5) mm long, corolla tube (2.4–)3.0–3.2–3.3(–4.2) mm long, cypselae strigose to densely strigose, (0.7–)1.0–1.5–1.9(–3.3) mm long at anthesis, increasing twofold by maturity,pappus, triple or rarely quadruple: secondary outer series of very few linear scales, 0.1–1mm long; middle and inner series of barbellate bristles, secondary inner series of mid length tapering bristles, 35–70% the length of the primary inner series; primary outer series of tapering bristles 80–95% the length of the primary inner bristles; primary inner series bristles strongly clavate, (3.5–)4.3–5.2–6.1(–7.8) mm long. Disc florets, 5–19, corolla lobe (0.6–)0.89–1.2–1.4(–1.9) mm long, corolla tube (2.3–)3.4–4.3–5.1(–6.2) mm long; cypselae strigose to densely strigose, (0.8–)1.1–1.6–2.0(–3.3) mm long at anthesis, increasing 2–3 times by maturity, pappus, triple or rarely quadruple: secondary outer series of very few linear scales, 0.1–1mm long; middle and inner series of barbellate bristles, secondary inner series of mid length tapering bristles, 40–75% the length of the primary inner series; primary outer series of tapering bristles 80–95% the length of the primary inner bristles; primary inner series bristles strongly clavate, (3.3–)4.7–5.8–6.8(–8.3) mm long. Chromosomal base number: $x = 9$; all reports diploid ($2n = 18$). Flowering midsummer to early fall.

The pappus has been reported as double in the past (e.g., Cronquist 1980). Hood and Semple (2003) noted that the pappus was biseriate with the outer whorl slightly shorter than the strongly clavate inner whorl with some overlapping of the bases of the bristles. Semple and Hood (submitted) noted that a quadruple pappus was the likely plesiomorphic state in the North American clade; their labels for the four whorls are used here. Further examination of the pappus of *Sericocarpus* species revealed that it is usually triple (Fig. 3). What had been interpreted as a outer whorl of variable length non-clavate bristles is reinterpreted here to be two whorls that sometime grade from the few mid length secondary inner bristles into the primary outer bristles. The secondary inner series bristles tend to be slightly shorter, and thus more distinct, in ray fruit than disc fruit. The primary inner whorl bristles are very obviously clavate and are the longest. Very rarely, a few very short linear scales forming a secondary outer pappus series were present on some fruits; these were not easily

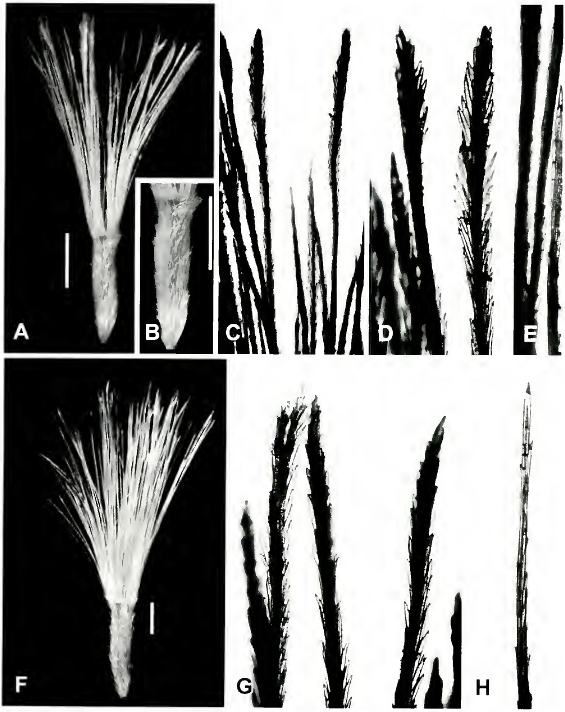


Fig. 3. Fruit traits in *Sericocarpus*, disc fruits; scale bars = 1 mm. **A–F.** *S. asteroides* (*Semple 9566 WAT*). **A.** mature fruit. **B.** Fruit body detail. **C.** Silhouette of upper portion of primary whorls of pappus. **D.** Tips of primary inner whorl bristles. **E.** Tip of secondary inner whorl bristle. **F–H.** *S. tortifolius* (*Semple, Brouillet & Canne 3931* WAT). **F.** Mature fruit. **G.** Tips of primary whorl bristles. **K.** Tips of primary inner whorl bristles. **H.** Tip of secondary outer whorl bristle.

detected and can be obscured by the long hairs of the fruit body. The same rarity occurs in the related genus *Solidago* (Hood and Semple 2003).

KEY TO THE SPECIES OF *SERICOCARPUS*

1. Lower stem leaves dentate, upper leaves becoming entire ______ **2. S. asteroides**
1. All leaves entire
   2. Stems and leaves moderately to densely hispidulous or finely pilose-villous.
      3. Stems hispidulous, hairs 0.1–0.5 mm long; leaves obovate, acuminate to slightly cuspidate, lower leaves < 3 cm in length; phyllaries in 4–5 strongly graduate series ______ **3. S. tortifolius**
      3. Stems hispid-pilose-villous, hairs 0.1–1.5 mm long; leaves elliptical with acute tips, lower leaves > 5 cm in length; phyllaries in 3 series outer half or more the length of the inner ______ **4. S. oregonensis** subsp. **californicus**
   2. Stems and leaves glabrous to sparsely minutely hispidulous.
      4. Leaves linear, involucres 4–6 mm high at anthesis, erect ray florets extending beyond pappus; eastern United States ______ **1. S. linifolius**
      4. Leaves elliptical to (ob)lanceolate, involucres (5–)6–8 mm high at anthesis; erect rays shorter than pappus; California to British Columbia.
         5. Rays 2–5 per head, ray strap >2 mm long ______ **4. S. oregonensis** subsp. **oregonensis**
         5. Rays 1 per head, ray strap <2 mm long ______ **5. S. rigidus**

1. Sericocarpus linifolius (L.) B.S.P., Prel. Cat. N.Y. 26. 1888. non Britt. (1888). (**Fig. 4F**). *Conyza linifolia* L., Sp. Pl. 861. 1753. non *Aster linifolius* L. TYPE: *Kalm s.n.*, Herb. Linn. 993.10, right hand specimen (LINN!; LECTOTYPE ([Reveal in Jarvis & Turland (ed.), Taxon 47:359. 1998]). Plukenet, Phytographia t. 79, f. 2. 1691 cited in protologue.

Aster solidagineus Michx., Fl. Bor. Amer. 2:108. 1803. *Sericocarpus solidagineus* (Michx.) Nees, Gen. et Sp. Aster. 149. 1832. TYPE: "Hab. in sylvis Carolinae septentrionalis comitatus," *Burke s.n.* (HOLOTYPE: P!). Renaming of *Conyza linifolia* L. Authentic specimens: "Hab. Virginia et Carolina," *Michaux s.n.* (HOLOTYPE: P) *Michaux s.n.* (P!)

Aster solidaginoides Pers., Syn. 2:443. 1807. Orthographic variant of *A. solidagineus* Michx. *Aster solidaginoides* Willd., Sp. Pl. 3:2024. 1803. Orthographic variant of *A. solidagineus* Michx. *Aster solidaginoides* Nees, Syn. Ast. 18. 1818. Orthographic variant of *A. solidagineus* Michx.

Perennial herb from stout, branching, woody caudex. Stem erect, glabrate, (22–)34–47–60(–75) cm, striate, the narrow membranous ridges often reddish. Basal leaves absent at time of flowering. Stem leaves, linear, sessile, acuminate, (1–)2–4–5(–8) cm long, (0.1–)0.2–0.4–0.6(–1) cm wide, reticulate veined, glabrate, glandular punctuate, margins ciliate, entire, upper leaves decreasing in size upward. Capitulescence broadly corymbiform; heads 2–4 per branch; bracts, ciliate, glabrate, broadly lanceolate to narrowly ovate. Involucre (3.8–)4.2–4.6–5.0(–5.5) mm high at anthesis, (2.3–)2.5–3.2–3.9(–4.8) mm wide; phyllaries in 3–4 imbricate series, glabrate, base widely oblong, tip broadly acute, outer series (2.4–)2.7–3.0–3.2(–3.5) mm long, mid series (3.0–)3.3–3.6–4.0(–4.4) mm long, inner series more linear and less chlorophyllous, margins ciliate, dark chlorophyll zone at the apex, thumb-nail shaped. Ray florets, 2–6, strap (4.2–)4.5–6.0–7.5(–10.5) mm long, corolla tube (2.4–)2.7–3.1–3.5(–4.0) mm long, cypselae densely strigose, (0.7–)0.8–1.0–1.1(–1.2) mm long at anthesis, increasing twofold by maturity,

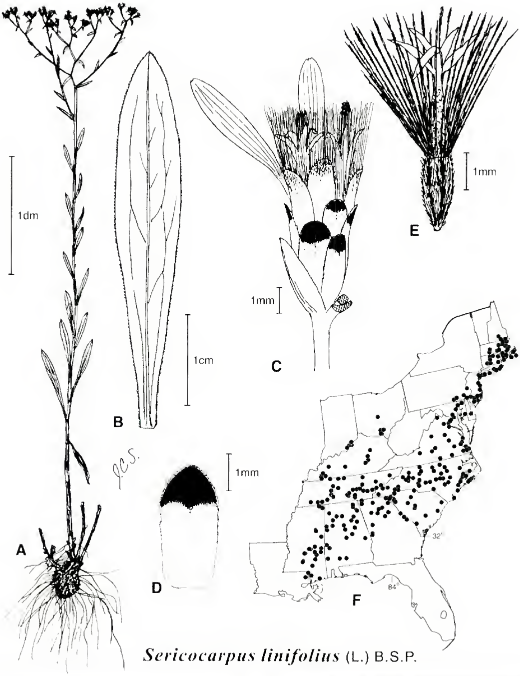


Fig. 4. Morphology and distribution of *Sericocarpus linifolius*. **A.** Habit. **B.** Lower mid stem leaf. **C.** Head, on only some florets shown; hatch marks indicated location of bract and second head (not shown). **D.** Mid series phyllary with chlorophyllous zone dark. **E.** Mature disc floret achene with floret still attached. **F.** Distribution in the eastern United States based on all collections seen.

pappus double or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–60% of primary inner series; primary outer bristles 70–90% of inner bristles; primary inner bristles moderately strongly clavate, (3.5–)3.9–4.3–4.7(–5.1) mm long. Disc florets, 5–15, corolla lobe (1.1–)1.2–1.5–1.7(–1.9) mm long, corolla tube (2.3–)2.7–3.1–3.5(–3.8) mm long; cypselae densely strigose, (0.8–)0.9–1.0–1.1(–1.3) mm long at anthesis, increasing 2 fold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–60% of primary inner series; primary outer bristles 70–90% of inner bristles; primary inner bristles strongly clavate, (3.3–)4.1–4.5–5.0(–5.5) mm long. Chromosome number: $2n = 18$.

Flowering midsummer–early fall. Dry to moist sandy, clay and gravelly open soils of open deciduous and pine woods, oak and pine barrens, roadsides, fields; 5–850 m; southern New Hampshire, Massachusetts, Rhode Island, Connecticut, New Jersey, Long Island and adjacent New York, southeastern Pennsylvania, eastern Maryland, Delaware, D.C., Virginia, West Virginia, Kentucky, into southern Ohio and extreme southeastern Indiana, North Carolina, Tennessee, South Carolina, northern Georgia, Alabama, Mississippi, and extreme eastern Louisiana.

2. Sericocarpus asteroides (L.) Nees, Gen. et Sp. Aster. 150. 1832. (**Figs. 3A–E, 5**)

Conyza asteroides L., Sp. Pl. 2:861. 1753. *Sericocarpus asteroides* (L.) B.S.P., Prel. Cat. N.Y. 26. 1888 *Aster asteroides* (L.) MacMillan, Meta. Minn. 524. 1892. TYPE: Herb. Linn. 993.10, the two left-hand specimens (LINN!; LECTOTYPE [Reveal et al., Huntia 7:214. 1987]).

Aster conyzoides Willd., Sp. Pl. 3:2043. 1803. non Desf. (1829). Substitute name for and typified by *Conyza asteroides* L.

Aster marylandicus Michx., Fl. Bor. Amer. 2:108. 1803. Based illegitimately on *Conyza asteroides* L. (see Cronquist (1947) for discussion).

Sericocarpus conyzoides (L.) Nees _*plantaginifolius* Nees, Gen. et Sp. Aster. 150. 1832. TYPE: U.S.A. NEW JERSEY: *Nuttall s.n.* (HOLOTYPE: not seen).

Sericocarpus asteroides (L.) B.S.P. f. *albopapposus* Farwell, Pap. Michigan Acad. Sci. 1:100. 1923. TYPE: U.S.A. MICHIGAN: Galesburg, 31 Aug 1818, *Farwell 5097a* (HOLOTYPE: not seen).

Sericocarpus asteroides (L.) B.S.P. f. *roseus* H.K. Svenson, Rhodora 30:136. 1928. TYPE: U.S.A. MASSACHUSETTS: Falmouth, "in sandy soil," 1 Sep 1926, *Svenson s.n.* (HOLOTYPE: GH!)

Aster paternus Cronq., Bull. Torrey Bot. Club 74:149. 1947. Based on *Conyza asteroides* L.

Perennial herb from short-branching woody caudex. Stem very sparsely to moderately hispidulous-puberulent, erect, (14–)26–39–52(–65) cm. Basal leaves present at time of flowering, (2–)4–8–11(–15) cm long, serrate near apex, spatulate to petiolate, reticulate veined, puberulent. Stem leaves, narrowly to broadly ovate, sessile, (1–)2–4.0–6(–11) cm long, (0.4–)0.6–1–2(–3) cm wide, cuneate, acuminate to acute, reticulate veined, glabrate to sparsely hispidulous, sparsely to moderately glandular punctuate, margins ciliate, serrate, upper leaves decreasing in size upward, becoming entire. Capitulescence corymbiform; heads 2–5 per branch. Involucre (4.2–)5.0–5.7–6.4(–7.1) mm high at anthesis, (3.1–)3.8–4.4–5.1(–6.0) mm wide; phyllaries in 3–4 imbricate series, broadly lanceolate to narrowly ovate, outer series (2.4–)2.8–3.3–3.7(–4.2) mm long, mid series (3.3–)3.9–4.4–5.0(–5.4) mm long, inner more linear and less chlorophyllous, margins ciliate, dark chlorophyll zone at the apex, thumb-nail shaped. Ray florets, 3–7,

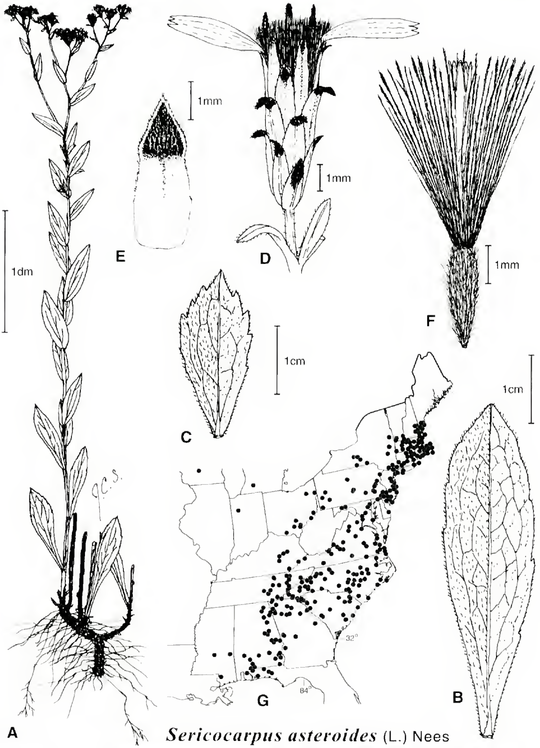


Fig. 5. Morphology and distribution of *Sericocarpus asteroides*. **A.** Habit. **B.** Lower mid stem leaf. **C.** Small serrate leaf. **D.** Head, on only some florets shown. **E.** Mid series phyllary with chlorophyllous zone dark. **F.** Mature disc floret achene with floret still attached. **G.** Distribution in the eastern United States based on all collections seen; the collections from Michigan is based on a literature report and was not seen.

strap (2.5–)3.5–4.3–5.2(–6.0) mm long, corolla tube (2.4–)2.6–3.1–3.5(–4.2) long, cypselae, densely strigose, (0.8–)1.0–1.2–1.4(–1.8) mm long at anthesis, increasing twofold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–75% of primary inner series; primary outer bristles 70–90% of inner bristles; primary inner bristles moderately strongly clavate, (3.6–)4.0–4.4–4.8(–5.2) mm long. Disc florets, 9–20, corolla lobe (0.6–)0.8–0.9–1.1(–1.5) mm long, corolla tube (3.2–)3.4–3.7–4.0(–4.4) mm long; cypselae densely strigose, (0.8–)1.1–1.3–1.5(–1.7) mm long at anthesis, increasing twofold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 50–70% of primary inner series; primary outer bristles 70–90% of inner bristles; primary inner bristles strongly clavate, (3.7–)4.3–4.7–5.0(–5.4) mm long. $2n = 18$.

Flowering mid summer to early fall. Dry sandy, clay, and shaly open soils in fields and open mixed and pine woods, road margins; 3–1550 m; extreme southern Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, New York, Pennsylvania, Ohio, Maryland, Delaware, D.C., Virginia, West Virginia, eastern Kentucky, North Carolina, eastern Tennessee, South Carolina, northern and central Georgia, Alabama, and southern Mississippi (Fig. 5G). The species has not been reported from Louisiana (Gandhi and Thomas 1989; USDA, plants.usda.gov web site). Single collections of *S. asteroides* labeled as being from northwestern Indiana and south central Wisconsin are of questionable provenance or are likely chance introductions. A single collection reported from southwestern Michigan was not seen; this also is most likely an introduction or of "dubious status" (Voss 1996).

3. Sericocarpus tortifolius (Michx.) Nees, Gen. et Sp. Aster. 151. 1832. (**Figs. 3F–H, 6**) *Aster tortifolius* Michx., Fl. Bor. Amer. 2:109. 1803. non (Torr. & A. Gray) A. Gray (1868). TYPE: U.S.A. "Hab. in Carolina inferiore," *Michaux s.n.* (HOLOTYPE: P-MICHX!; ISOTYPE: P, several pieces on one sheet).

Conyza bifoliata Walt., Fl. Car. 204. 1788. non L. (1753), non Cham. & Less. (1831). *Sericocarpus bifoliatus* (Walt.) Porter, Mem. Torrey Bot. Club 5:322. 1894. *Aster bifoliatus* (Walt.) Ahles, J. Elisha Mitchell Sci. Soc. 80:173. 1964. TYPE: U.S.A. Carolinas? (HOLOTYPE/LECTOTYPE: BM?, not seen, not on p.36 of Schubert's photographs of Walter Herbarium)

Sericocarpus collinsii Nutt., Trans. Am. Phil. Soc. 2, 7:302. 1841. *Sericocarpus bifoliatus* (Walt.) Porter var. *collinsii* (Nutt.) Blake, Proc. Amer. Acad. Arts 51:515. 1916. TYPE: U.S.A. EAST FLORIDA: Mr. Ware (HOLOTYPE: BM, not seen; simple sketch seen);

Sericocarpus acutisquamus Small, Fl. S.E.U.S. 1206, 1339. 1903. TYPE: U.S.A. FLORIDA. Columbia Co.: Lake City, 29–31 Aug 1895, *G.V. Nash 2486* (HOLOTYPE: NY ex Columbia College!). Small lists *Sericocarpus bifoliatus* (Walt.) Porter var. *acutisquamus* Nash but this name does not appear to have been published.

Perennial herb from short-branching woody caudex. Stem erect, (33–)39–61–83(–117) cm, puberulent, hispidulous-pilose-villous hairs 0.1–0.5 mm long, sparsely stipitate-glandular. Basal leaves absent at time of flowering. Stem leaves sessile, obovate, acuminate to slightly cuspidate, (0.9–)1–2–3(–4) cm long, (0.3–)

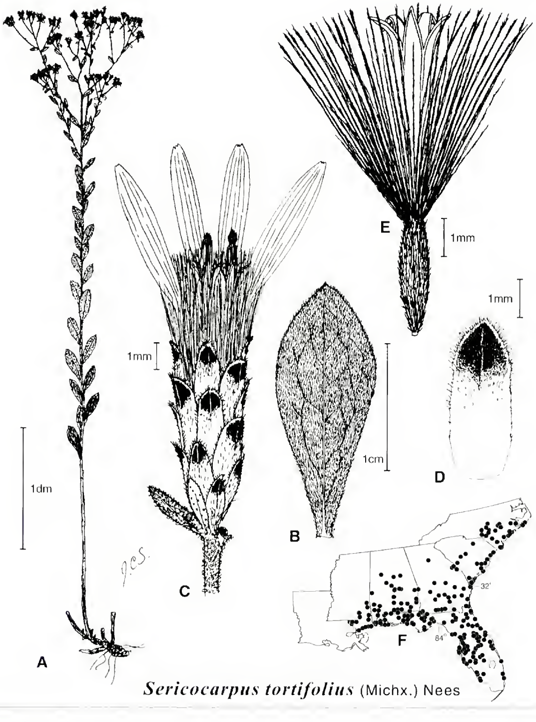


Fig. 6. Morphology and distribution of *Sericocarpus tortifolius*. A. Habit. **B.** Lower mid stem leaf. **C.** Head, only some florets shown. **D.** Mid series phyllary with chlorophyllous zone dark. **E.** Mature disc floret achene with floret still attached. **F.** Distribution in the eastern United States based on all collections seen.

0.6–0.8–1(–1) cm wide, reticulate veined, sparsely to moderately finely pilose-scabrous, hairs 0.05–0.1 mm long, finely glandular punctuate, the stipitate glands minute, margins ciliate, entire, upper leaves decreasing in size upward. Capitulescence corymbiform; heads 2–4 per branch; bracts, ciliate, pubescent, broadly lanceolate to narrowly ovate. Involucre (4.8–)5.2–6.0–6.7(–8.0) mm high at anthesis, (3.1–)3.8–4.4–5.1(–6.0) mm wide; phyllaries in 4–5 imbricate series, ciliate, puberulent base widely oblong, tip acute, outer series (1.8–)1.9–2.2–2.6(–3.1) mm long, first mid series (2.7–)2.8–3.2–3.7(–4.4) mm long, second mid series (3.6–)3.9–4.4–5.0(–6.1), inner series more linear and less chlorophyllous, margins ciliate, dark chlorophyll zone at the apex, thumb-nail shaped. Ray florets, 2–5, strap (3.4–)3.9–4.8–5.7(–6.4) mm long, corolla tube (2.7–)3.0–3.4–3.8(–4.2) long, cypselae densely strigose, (1.1–)1.2–1.5–1.8(–2.4) mm long at anthesis, increasing twofold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–70% of primary inner series; primary outer bristles 80–90% of inner bristles; primary inner bristles moderately strongly clavate, (5.4–)5.9–6.5–7.1(–7.8) mm long. Disc florets, 6–11, corolla lobe (1.1–)1.2–1.4–1.6(–1.8) mm long, corolla tube (3.8–)4.19–4.82–5.5(–5.6) mm long; cypselae densely strigose, (1.2–)1.2–1.5–1.9(–2.6) mm long at anthesis, increasing twofold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 50–70% of primary inner series; primary outer bristles 80–90% of inner bristles; primary inner bristles moderately strongly clavate, (5.7–)6.2–6.8–7.4(–8.3) mm long. $2n = 18$.

Flowering midsummer–early fall. Dry to moist clay, sandy and gravelly open soils in oak and pine barrens, oak scrub, pastures, roadsides, mostly coastal plain; ca. 5–200 m; eastern North Carolina, South Carolina, Georgia, Florida, Alabama, southeastern Mississippi and adjacent Louisiana.

4. Sericocarpus oregonensis Nutt., Trans. Amer. Phil. Soc. 2, 7:302. 1840. (**Fig. 7**)

Aster oregonensis (Nutt.) Cronq., Vasc. Fl. Pacif. Northw. 5:91. 1955. "Round Ft. Vancouver" [protologue]. "Margins of Wahlament & Wappatoo Island" [Nuttall's handwritten label], 1835?, *Nuttall s.n.* (HOLOTYPE: BM, photo!).

Perennial herb from stout, branching, woody caudex. Stem erect, (24–)40–62–85(–102) cm, glabrous to very sparsely hispidulous-scabrous, hairs 0.05 mm long, or moderately to densely hispidulous-pilose-villous, hairs 0.1–1.5 mm long, sometimes resinous-glandular. Basal leaves absent at time of flowering. Stem leaves broadly lanceolate to narrowly ovate, sessile, acuminate to acute, (1–)2–4–6(–10) cm long, (0.3–)0.6–0.9–1(–2) cm wide, reticulate veined, finely scabrous or hispidulous-scabrous, more densely so on the abaxial veins, the hairs 0.1–0.5(–2) mm long, glandular punctuate to very resinous, margins ciliate, entire, upper leaves decreasing in size upward. Capitulescence corymbiform; heads 2–4 per branch; bracts, ciliate, pubescent, broadly lanceolate to narrowly ovate. Involucre (4.7–)5.7–6.4–7.0(–7.2) mm high at anthesis, (4.4–)5.0–5.8–6.6(–7.2) mm wide; phyllaries in 3–4 imbricate series, ciliate, puberulent, base narrowly oblong, acuminate, outer series (2.8–)3.4–3.9–4.4(–4.6) mm long, mid series (3.8–)4.5–5.0–5.4(–5.6) mm long, inner series more linear and less chlorophyllous, margins ciliate, dark chlorophyll zone at the apex, thumb-nail shaped. Ray florets,

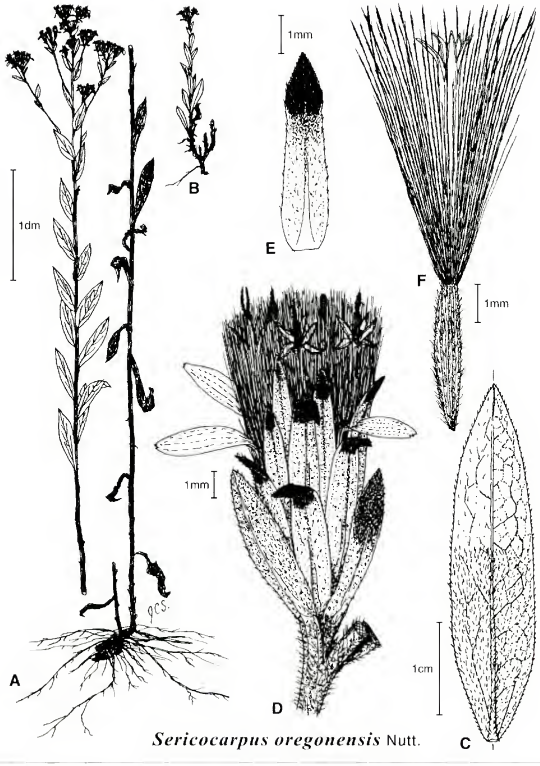


FIG. 7. Morphology of *Sericocarpus oregonensis*. **A–B.** Habits of large and small plants, respectively. **C.** Lower mid stem leaf; upper half subsp. *oregonensis,* lower half subsp. *californicus*. **D.** Head, on some florets shown; hatch marks indicated location of bract and second head (not shown). **E.** Mid series phyllary with chlorophyllous zone dark. **F.** Mature disc floret achene with floret still attached.

2–6, strap (3.1–)3.7–4.5–5.2(–5.6) mm long, corolla tube (2.6–)2.8–3.2–3.5(–3.8) mm long, cypselae strigose, (1.3–)1.5–2.1–2.6(–3.3) mm long at anthesis, increasing two-threefold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–75% of primary inner series; primary outer bristles 80–95% of inner bristles; primary inner bristles moderately strongly clavate, (4.1–)4.7–5.3–5.9(–6.6) mm long. Disc florets, 9–20, corolla lobe (1.0–)1.1–1.2–1.4(–1.7) mm long, corolla tube (3.4–)4.1–4.6–5.1(–5.2) mm long; cypselae strigose, (1.4–)1.7–2.2–2.7(–3.3) mm long at anthesis, increasing twofold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–75% of primary inner series; primary outer bristles 80–95% of inner bristles; primary inner bristles moderately strongly clavate, (4.8–)5.5–6.1–6.7(–7.2) mm long. $2n = 18$.

4a. Sericocarpus oregonensis subsp. **oregonensis (Figs. 7c, 8).** *Sericocarpus oregonensis* var. *oregonensis. Aster oregonensis* subsp. *oregonensis.*

Flowering midsummer to early fall. Stems glabrous-glabrate, the hairs minutely scabrous; leaves glabrous to very sparsely and minutely hispidulous-pilose, hairs 0.05 mm long, obviously resinous especially along the veins. Dry to moist sandy to rocky soils in open areas in oak and pine woods, brushlands, roadsides, disturbed habitats; 100–1800 m; Coast and Cascade ranges, Washington where it is rare, western Oregon, and northern California south to Mendocino County.

4b. Sericocarpus oregonensis Nutt. subsp. **californicus** (Durand) Ferris, Contr. Dudley Herb. 5:100. 1958. (**Figs. 7c, 8**). *Sericocarpus californicus* Durand, J. Acad. Nat. Sci. Phil. 2, 3:90. 1855. non *Aster californicus* Less. in Schldl. & Cham. (1831), nec Kuntze (1891). *Sericocarpus rigidus* Lindl. in Hook. var. *californicus* (Durand) Blake, Proc. Amer. Acad. Arts 51:515. 1916. *Aster oregonensis* (Nutt.) Cronq. subsp. *californicus* (Durand) Keck., Aliso 4:105. 1958. TYPE: U.S.A. CALIFORNIA. Nevada Co.: Nevada City, *Rattan s.n* (HOLOTYPE: P, fragment NY)

Flowering midsummer–early fall. Stems moderately to densely hispidulous-pilose, the longest hairs villous twisted, hairs 0.1–1.5 mm long; leaves moderately hispidulous-scabrous, more densely so along the abaxial veins, the hairs on the surface 0.1–0.5 mm long, those on the veins to 1–2 mm long, finely glandular punctate. Dry to moist sandy soils in open areas in oak and pine woods, along dry streams, granitic and serpentine barrens; 800–2200 m; Sierra Nevada Range of eastern California.

5. Sericocarpus rigidus Lindl. in Hook., Fl. Bor.-Amer. 2:14. 1834. (**Fig. 9**). SYNTYPES: U.S.A. OREGON or WASHINGTON: Columbia River, *Scouler s.n.* (LECTOTYPE [Cronquist 1955]: CGE?, not found in search of types; ISOLECTOTYPE: NY ex Torrey!).

Sericocarpus rigidus Lindl. in Hook. var. *laevicaulus* Nutt., Trans. Amer. Phil. Soc. 2, 7:302. 1840. TYPE: U.S.A. WASHINGTON: Fort Vancouver, *Nuttall s.n.* (HOLOTYPE: not seen)

Aster curtus Cronquist, Vasc. Fl. Pacif. Northw. 5:80. 1955. New name for *Sericocarpus rigidus* Lindl. in Hook. (1834).

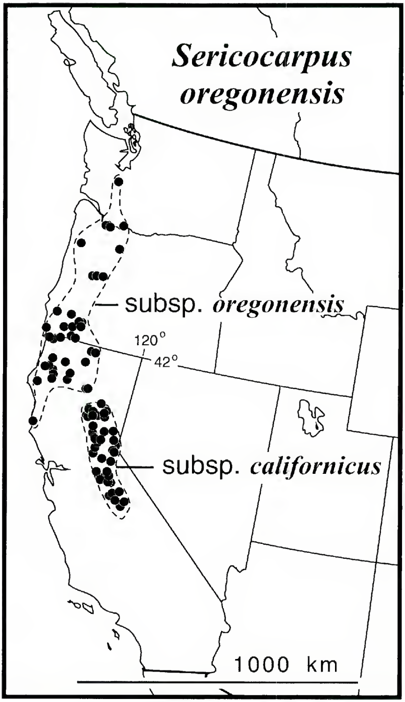


Fig. 8. Distribution of *Sericocarpus oregonensis* in the western United States based on all collections seen.

Perennial herb from short, branching, rhizomatous, woody caudex. Stem erect, puberulent, (19-)21-28-34(-37) cm. Basal leaves absent at time of flowering. Stem leaves, puberulent, obovate, sessile, acute, upper leaves becoming acuminate, (1-)2-3-4(-6) cm long, (0.3-)0.5-0.6-0.8(-0.9) cm wide, reticulate veined, margins ciliate, entire, upper leaves decreasing in size upward. Capitulescence broadly corymbiform, compact; heads 2-3 per branch; bracts ovate, ciliate,

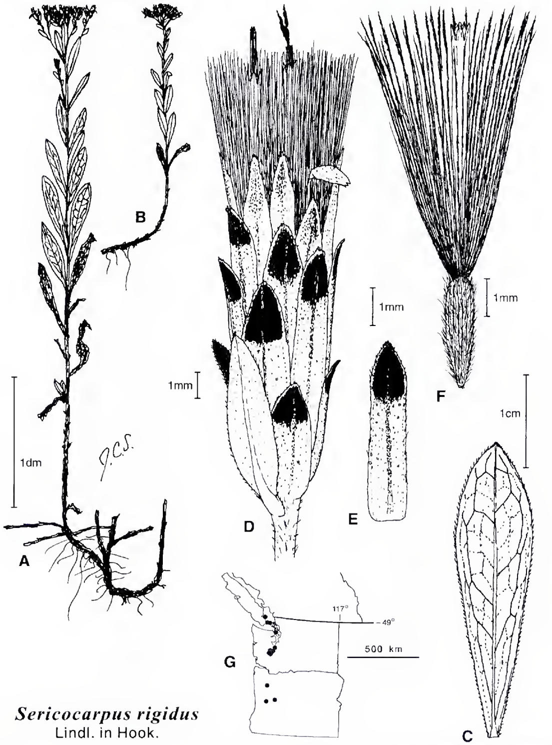


Fig. 9. Morphology and distribution of *Sericocarpus rigidus*. **A–B.** Habits or large and small plants, respectively. **C.** Mid stem leaf. **D.** Head, only some florets shown. **E.** Mid series phyllary with chlorophyllous zone dark. **F.** Mature disc floret achene with floret still attached. **G.** Distribution in the Oregon, Washington and British Columbia based on all collections seen.

puberulent. Involucre (6.1–)6.4–7.3–8.1(–8.6) mm high at anthesis, (4.1–)4.7–5.6–6.4(–6.5) mm wide; phyllaries in 3–4 imbricate series, slightly ciliate, puberulent, base narrowly oblong, tip acuminate to acute, outer series (3.1–)3.5–4.2–4.9(–5.3) mm long, mid series (4.6–)4.7–5.5–6.2(–6.5) mm long, inner series more linear and less chlorophyllous, margins ciliate, dark chlorophyll zone at the apex, thumb-nail shaped. Ray florets, 1–2, strap, ligulate, (1.6–)1.6–2.1–2.6(–3.0) mm long, corolla tube (2.5–)2.6–3.1–3.5(–3.9) mm long, cypselae strigose, (1.3–) 1.2–1.6–1.9(–2.2) mm long at anthesis, increasing twofold by maturity pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–75% of primary inner series; primary outer bristles 80–95% of inner bristles; primary inner bristles moderately strongly clavate, (4.6–)5.1–5.7–6.2(–6.5) mm long. Disc florets, 9–17, corolla lobe (0.6–)0.7–0.8–0.9(–1.0) mm long, corolla tube (4.4–)4.6–5.1–5.6(–6.2) mm long; cypselae strigose, (1.4–)1.5–1.8–2.1(–2.3) mm long at anthesis, increasing twofold by maturity, pappus triple or rarely quadruple: secondary outer linear scales 0–very few, 0.1–1mm long; secondary inner bristles few, 40–75% of primary inner series; primary outer bristles 85–95% of inner bristles; primary inner bristles moderately strongly clavate, (5.7–)6.2–6.6–7.1(–7.4) mm long. $2n = 18$.

Flowering midsummer to early fall. Prairie habitats, dry pastures, dry grassy Garry oak forests with rocky outcrops; 10–120 m; extreme southern British Columbia, western Washington, and scattered disjunct locations in western Oregon (Fig. 6G). *Sericocarpus rigidus* grows on the southern part of Vancouver Island, B.C. and in scattered locations to the south end of the Puget Sound area in Washington. The species is rare throughout its range and is listed by COSEWIC in Canada as Threatened, by USFWS as Species of Concern, as Sensitive in Washington, and as Threatened in Oregon.

ACKNOWLEDGMENTS

This research was supported by Natural Sciences and Engineering Research Council of Canada Operating and Discovery Grants to J.C.S., a Natural Sciences and Engineering Research Council of Canada Post Graduate Scholarship and an Ontario Graduate Scholarship to R.E.C. This work was initiated as a Biol499 Senior Research Project at University of Waterloo by M.R.L. Gina Murrell (CGE) is thanked for assistance in attempts to locate type material of *S. rigidus* in 2004. Guy Nesom and David Keil are thanked for their helpful suggestions in their reviews of the manuscript.

REFERENCES

Allen, G.A. 1993. Aster. In: J.C. Hickman, ed. The Jepson manual: higher plants of California. University of California Press. Berkeley. Pp. 205–209.

Anderson, L.C., D.W. Kyhos, T. Mosquin, A.M. Powell, and P.H. Raven. 1974. Chromosome numbers in Compositae. IX. *Haplopappus* and other Astereae. Amer. J. Bot. 61:665–671.

Brouillet, L.*, G.A. Allen, J.C. Semple, and M. Ito. 2001. ITS phylogeny of North American asters (Asteraceae: Astereae). Botany 2001 [ASPT/BSA/IOPB joint meeting] Albuquerque, New Mexico 12–16 August 2001. http://www.botany2001.org/section12/abstracts/63.shtml

Clampitt, C.A.. 1993. Effects of human disturbances on prairies and the regional endemic Aster curtus in western Washington. Northwest Sci. 67:163–169.

Cronquist, A. 1955. Vascular plants of the Pacific Northwest. Part 5: Compositae. University of Washington Press. Seattle.

Cronquist, A. 1968. *Aster* L. In: H. A. Gleason, ed. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. Hafner Pub. Co., New York.

Cronquist, A. 1980. Vascular flora of the southeastern United States. I. Asteraceae. Univ. North Carolina Press, Chapel Hill.

Douglas, G.W. and J.M. Illingworth. 1996. Status of the white-top aster *Aster curtus* in Canada. 20 pp. Report. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

Fernald, M.L. 1950. Gray's manual of Botany, 8th ed. Van Nostrand, New York.

Ferris, R. S. 1958. Taxonomic notes on western Plants. Contrib. Dudley Herbarium 5:99–108.

Gandhi, K.N. and R.D. Thomas. 1989. Asteraceae of Louisiana. Sida, Bot. Misc. No. 4. Dallas, Texas.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd edition. New York Botanical Garden. Bronx, New York.

Gray, A. 1884. Synoptical flora of North America. Vol. 1, part. 2. Ivison, Blakemean, Taylor & Co., New York.

Hill, L.M. 1983. Chromosome numbers of twelve species of *Aster* (Asteraceae) from Virginia. Castanea 48:212–217.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett. 1990. Index herbariorum. Part I. The herbaria of the world, ed. 8. Regnum Vegetabile 120:1–693.

Hood, J.L.A. and J.C. Semple. 2003. Pappus variation in *Solidago* (Asteraceae: Astereae). Sida 20:1617–1630.

Huziwara, Y. 1965. Chromosome analysis in the tribe Astereae. Jap. J. Genet. 40:63–72.

Jones, A.G. 1980. A classification of the new world species of Aster (Asteraceae). Brittonia 32:230–239.

Jones, A.G. and R.A. Smogor. 1984. In Chromosome number reports LXXXII. Taxon 33: 126–127.

Keck, D. 1958. Taxonomic notes on the California flora. Aliso 4:101–105.

Nees, C.G. von Esenbeck. 1832. Genera et species Asterearum. Grüson, Breslau. [Reprinted 1833. Leonard Schrag., Nuremburg.]

Nesom, G.L. 1993. Taxonomy of *Sericocarpus* (Asteraceae: Astereae). Phytologia 75:45–54.

Nesom, G.L. 1994. Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. Phytologia 77:141–297.

Nesom, G.L. 2000. Generic conspectus of the tribe Astereae (Asteraceae) in North America, Central America, the Antilles and Hawaii. Sida, Bot. Misc. 20. Botanical Research Institute of Texas. Ft. Worth.

Noyes, R.D. and L.H. Rieseberg. 1999. ITS sequence data support a single origin for North American Astereae (Asteraceae) and reflect deep geographic divisions in *Aster* S.L. Amer. J. Bot. 86:398–412.

Pinkava, D. and D. Keil. 1977. Chromosome counts of Compositae from the United States and Mexico. Amer. J. Bot. 64:680–686.

Semple, J.C. 1985. Chromosome number determinations in Fam. Compositae tribe Astereae. Rhodora 87:517–527.

Semple, J.C. and L. Brouillet. 1980a. Chromosome numbers and satellite chromosome morphology in Aster and Lasallea. Amer. J.Bot. 67:1027–1039.

Semple, J.C. and L. Brouillet. 1980b. A synopsis of North American asters: the subgenera, sections and subsections of *Aster* and *Lasallea*. Amer. J. Bot. 67:1010–1026.

Semple, J.C. and J.L.A. Hood. Submitted. Pappus variation in North American Asters. I. Double, triple and quadruple pappus in *Symphyotrichum* and related aster genera (Asteraceae: Astereae). Sida.

Semple, J.C. and M.R. Leonard. 2005. *Sericocarpus* Nees. In: Flora North America Editorial Committee, eds. Flora of North America. Vol. 20. Asteraceae. Oxford University Press.

Semple, J.C., J.G. Chmielewski, and C.C. Chinnappa. 1983. Chromosome number determinations in *Aster* L. (Compositae) with comments on cytogeography, phylogeny and chromosome morphology. Amer. J. Bot. 70:1432–1443.

Semple, J.C., J.G. Chmielewski, and M. Lane. 1989. Chromosome numbers in Fam. Compositae, Tribe Astereae. III. Additional counts and comments on some generic limits and ancestral base numbers. Rhodora 91:296–314.

Semple, J.C., J.G. Chmielewski, and Chunsheng Xiang. 1992. Chromosome numbers in Fam. Compositae, Tribe Astereae. IV. Additional reports and comments on the cytogeography and status of some species of *Aster* and *Solidago*. Rhodora 94:48–62.

Semple, J.C. and R.E. Cook. 2004. Chromosome number determinations in fam. Compositae, Tribe Astereae. VII. Some eastern North American and Eurasian taxa. Rhodora 106: 253–272.

Semple, J.C., S. Heard, and Chunsheng Xiang. 1996. The Asters of Ontario (Compositae: Astereae): *Diplactis* Raf., *Oclemena* Greene, *Doellingeria* Nees and *Aster* L. (including *Canadanthus* Nesom, *Symphyotrichum* Nees and *Virgulus* Raf.). Univ. Waterloo Biol. Series 38:1–94.

Semple, J.C., S.B. Heard, and L. Brouillet. 2002. Cultivated and native asters of Ontario (Compositae: Astereae): *Aster* L. (including *Asteromoea* Blume, *Diplactis* Raf. and *Kalimeris* (Cass.) Cass.), *Callistephus* Cass., *Galatella* Cass., *Doellingeria* Nees, *Oclemena* E.L. Greene, *Eurybia* (Cass.) S.F. Gray, *Canadanthus* Nesom, and *Symphyotrichum* Nees (including *Virgulus* Raf.). Univ. Waterloo Biol. Series 41:1–134.

Semple, J.C., Chunsheng Xiang, Jie Zhang, M. Horsburgh, and R. Cook. 2001. Chromosome number determinations in Fam. Compositae, Tribe Astereae. VI. Western North American taxa and comments on generic treatments of North American asters. Rhodora 95:234–253.

Semple, J.C., Jie Zhang, and Chunsheng Xiang. 1993. Chromosome numbers in Fam. Compositae, Tribe Astereae. V. Eastern North American taxa. Rhodora 95:234–253.

Small, J.K. 1903. Flora of the southeastern United States. Published by the author. New York, New York.

Voss, E.G. 1996. Michigan flora. Part III. Dicots (Pyrolaceae-Compositae). Cranbrook Institute of Science Bull. 61.

Xiang, Chunsheng and J.C. Semple. 1996. Molecular systematic study of *Aster* sensu lato and related genera (Asteraceae: Astereae) based on chloroplast DNA restriction site analyses and mainly North American taxa. In D.J.N. Hind and H. Beentje, vol. eds. Compositae: Systematics. Proceedings of the International Compositae Conference, Kew, 1994. Vol. 1. Systematics (D.J.N. Hind, Editor-in-Chief). Royal Botanic Gardens, Kew. Pp. 393–423.

Turner, B.L. and G.L. Nesom. 2000. Use of variety and subspecies and new varietal combinations for *Styrax platanifolius* (Styraceae). Sida 19:257–262.

BOOK REVIEW

Judith Sumner. 2004. **American Household Botany: a History of Useful Plants 1620-1900.** (ISBN 0-88192-652-3, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $27.95, 396 pp., b/w illus., 16 color plates, 6 1/2" × 9 1/4".

A history of plants in the domestic scene it is, but this book is much more, indeed an encyclopedic reference to the "useful" plants of North America from colonial times. It is also a compendium of the continent's cultural diversity and consequently its culinary as well as horticultural diversity. The author details what plants the early colonists brought from Europe both for comestible and medicinal purposes and how they adapted to the plants that native American tribes used for these and for other uses. Not least in importance was the knowledge of preparing food; for this the author quotes from the notable cookbooks dating from 1672, many of which listed the salutary effects of correct preparation. In order to have food through the long winters the colonists had to learn the best ways for preserving food by correct storage and through cooking methods such as pickling. Imported and native herbs and spices played a large role in both. The passages on the "botanical pantry," detailing the means of curbing growth of bacteria and fungi in fresh and preserved foods, the usages of spices for flavoring (how, for instance, sassafras became an important herb for Creole cuisine), the experiments using native plants as substitutes for oriental teas, are engrossing. One of the most important chapters, not surprisingly, as the author teaches medicinal botany in the Arnold Arboretum at Harvard University, is that on herbal medicines, in which she gives insights to the very chemicals that make the plants effective in healing—or dangerous in excess.

While food and medicine are the major portions of the book, the growing and use of plants through these two centuries is extremely valuable. The author tells us such facts as that cotton had become an economic crop by 1607 in Virginia and by the early 1700's was beginning to replace linen (homespun) as an affordable fabric, that American women were testing native plants for dyes and tannin from native plants, and a number of native plants were being used for inks, that public kitchens for the indigent were started in 1890.

Landscape plants are featured as well as the horticultural contributions of William Bartram and Thomas Jefferson. The author delves into the teaching of botany in schools beginning with the first textbook by Almira Phelps in 1829. Soon the discipline was not limited to the classroom but expanded into the garden and eventually to the wild. She also recounts Asa Gray's interest in teaching botany to youngsters, attested by his textbook of 1836 and his numerous contributions to botany, not least his influential *Manual of the Botany of the Northeastern United States* (1848).

This book is comprehensive—from the basic uses of plants for food to the ornamental uses of flowers in the parlor. It is well documented, authoritative, eminently readable, and a good resource for several disciplines.—*Joann Karges, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

NEOTYPIFICATION OF *CEROPEGIA PALUSTRIS* AND *LYONIA MARITIMA* (APOCYNACEAE: ASCLEPIADOIDEAE)

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, NC 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

Ceropegia palustris Pursh and *Lyonia maritima* Elliott (Apocynaceae: Asclepiadoideae) are currently recognized as synonyms of *Funastrum angustifolium* (Pers.) Liede & Meve. The diminutive vine, one of the most readily recognizable taxa among a number of taxonomically difficult climbing milkweeds in the southeastern United States, occurs primarily in swamps, hammocks, and salt marshes. A neotype is proposed here for *C. palustris*, which will automatically also serve as the type of *L. maritima*, as Elliot was well-aware that the two were synonymous. Additional relevant historical specimens of interest housed at BM, CHARL, and PH are also discussed.

RESUMEN

Ceropegia palustris Pursh y *Lyonia maritima* Elliott (Apocynaceae: Asclepiadoideae) se reconocen usualmente como sinónimos de *Funastrum angustifolium* (Pers.) Liede & Meve. Esta pequeña trepadora, que es uno de los taxa más fácilmente reconocibles entre un grupo taxonómicamente difícil de trepadoras del Sureste de los Estados Unidos, aparece primariamente en pantanos y lagunas saladas. Se propone aquí un neotipo para *C. palustris*, que servirá también automáticamente como tipo de *L. maritima*, porque Elliot estaba muy convencido de que los dos eran sinónimos. Se discuten también especimenes adicionales de relevancia histórica que se encuentran en BM, CHARL, y PH.

Ceropegia palustris Pursh and *Lyonia maritima* Elliott (Apocynaceae: Asclepiadoideae) are currently recognized as synonyms of *Funastrum angustifolium* (Pers.) Liede & Meve (= *Cynanchum angustifolium* Pers.; Liede & Meve 2003). The diminutive vine, one of the most readily recognizable taxa among a number of taxonomically difficult climbing milkweeds in the southeastern United States (Drapalik 1969; Sundell 1981; Rosatti 1989; Liede 1997), is known from the Atlantic and Gulf Coasts of the United States, Mexico, and Belize, as well as the Bahamas and West Indies (Radford et al. 1968; Correll & Correll 1982; Balick et al. 1999). It occurs primarily in swamps, hammocks, and salt marshes, where it constitutes a quite inconspicuous component of the flora. The taxon was first described as *Cynanchum angustifolium* by Christiaan Persoon (Syn. Pl. 1:274. 1805). In 1814, Frederick Pursh independently described the species as *Ceropegia palustris* (Fl. Amer. Sept. 1:184). Pursh's name was the basionym for at least five combinations published over the next century (see below). In 1817, Stephen Elliott published the name *Lyonia maritima* for the

SIDA 21(3): 1507– 1513. 2005

taxon (Sketch Bot. S. Carolina 1:316), honoring John Lyon with a new genus, well-aware that Pursh had already described the taxon in *Ceropegia*. However, the conservation of *Lyonia* Nutt. (Ericaceae; 1818) against *Lyonia* Raf. (Polygonaceae; 1808) is automatically extended to *Lyonia* Elliott (ICBN, Art. 14.10; Greuter et al. 2000). Although the nomenclatural availability of *Lyonia* Elliott is moot, the issue of typification of Elliott's and Pursh's names remains of interest from an historical perspective as both men made important contributions to North American botany (Pursh 1814; Elliott 1817).

In his description of *Ceropegia palustris*, Pursh (1814) notes having seen a specimen in the Lyon herbarium. Liede and Meve (2003) list this specimen as the type, although without tracing it. Ewan & Ewan (1963) note that although John Lyon's journal has been saved, his herbarium, which apparently at one point had been left in Asheville, North Carolina (Gray 1842), has unfortunately been lost or destroyed. Additionally, no relevant specimen was found in BM, C, LIV, MANCH, PH, K, or OXF, herbaria known to house Pursh collections. In the absence of any specimens of *Funastrum angustifolium* known to have been seen by Pursh, a neotype must be designated. Unfortunately, the exact locality of Lyon's collection of the taxon cannot be ascertained. Lyon does not mention the taxon in his journal (Ewan & Ewan 1963). Further complicating matters is the fact that during Lyon's exploration of coastal Carolina, in 1803–1804 and later again in 1808, he collected from the southern border of South Carolina, northward to Wilmington, North Carolina (Ewan & Ewan 1963)—a rather expansive coastal strip of marshes. In the absence of a more narrowly definable locality, a neotype is thus chosen from the marshes of Charleston County (*S.W. Leonard 2715 with A.E. Radford*, NCU).

As indicated in the protologue of *Lyonia maritima*, Elliot was well-aware that *Ceropegia palustris* Pursh was a synonym (Elliott 1817). Thus, *L. maritima* Elliott is superfluous and illegitimate and the neotype chosen for *C. palustris* is automatically the type of *L. maritima*. However, from an historical perspective it remains of interest what specimens Elliott actually studied. His collections are known to be housed in the herbaria of CHARL and NY (Weatherby 1942; TLII). However, Weatherby (1942) makes no mention of a matching type for *Lyonia maritima* or its synonyms at CHARL. A search of the NY online type register has also proved unsuccessful. However, during a visit to CHARL to study Elliott's handwriting, an intriguing specimen was discovered—filed under *Asclepias* and mounted with material of *Asclepias pedicellata* (Fig. 1A). The specimen is clearly *Funastrum angustifolium* and is labelled "*Asclepias*" in Elliott's hand (Fig. 1B). Judging from the large script, CHARL curator Albert Sanders believes the specimen to stem from Elliott's early collecting days (pers. comm.). Apparently, Elliott's style of labelling, including the size of his script, changed noticeably over the years (Sanders, pers. comm.). Elliott was punctilious about

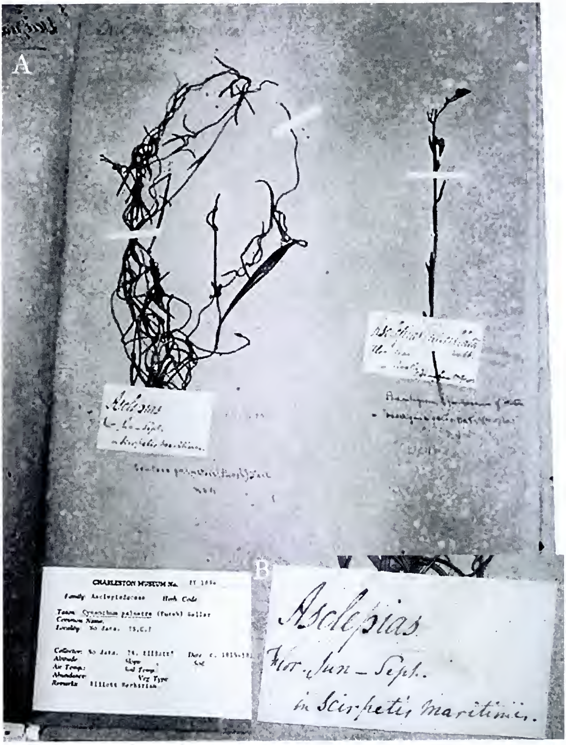


Fig. 1. **A.** Type of *Lyonia maritima* Elliott (specimen at left; CHARL). The specimen on the right is referred to *Asclepias pedicellata* Walter. **B.** (inset) Label detail of type of *Lyonia maritima* Elliott (CHARL).

noting the original collectors on labels associated with the plants given to him. No collector name appears on the label in question. Therefore, although no mention of *Lyonia* is made on the sheet, it is clear that this is a personal collection of the plant Elliott would later describe as *Lyonia maritima*. Weatherby (1942) and others likely missed the specimen as it would not be expected under *Asclepias*.

A search of PH by James Macklin resulted in an additional intriguing specimen. The specimen is clearly the taxon in question and bears (1) the name "*Vincetoxicum palustris* A. Gr." on the PH label, (2) a cut-out from an older sheet bearing Elliott's name ("S. Carol Elliott"), (3) another cut-out from an older sheet bearing the name "*Ceropegia palustris*," and "*Lyonia*," (4) a cut-out bearing the handwritten "Baldw Geo," and (5) a cut-out bearing the handwritten "pub. nom. Ceropegia pal. Bald. Geo." This latter annotation appears to be in the characteristic small, dense hand of Muhlenberg. Although only one taxon is present, the sheet appears to bear material of mixed origin. The abbreviations *Geo* and *S. Carol* likely refer to the states of origin: Georgia and South Carolina, respectively. The presence of Elliott's name, along with the geographical origin South Carolina, indicates the material to have been Elliott's that was at some point sent to PH. Elliott corresponded with numerous botanists, including Muhlenberg and Baldwin. The other labels on the sheet indicate origin of respective material from Baldwin, who was in Georgia 1812–1813. Unfortunately, it is difficult to date this specimen. The taxon is not mentioned in the correspondence between Baldwin and Muhlenberg, reproduced in *Reliquiae Baldwinianae* (Darlington 1843). The presence of an annotation bearing the name *Lyonia*, could indicate that the specimen was either received following publication of Elliott's *Sketch* or prior to and subsequently annotated. In either case, Elliott appears to have been the sender of some of the material.

Another interesting specimen is the Elliott sheet housed in deCandolle's *Prodromus* herbarium (G-DC). Decaisne (1844) notes seeing this specimen in his *Prodromus* treatment. Fortunately, the *Prodromus* herbarium is available on microfiche. The specimen in question can be found on IDC microfiche no. 1541. V.8: 588.41–595.32 [top row, 2nd specimen from right]. Two labels are found on the sheet. One label indicates the name used by Decaisne (i.e., *Seutera maritima*) and the other records the name as received by de Candolle from Elliott (i.e., *Lyonia maritima*).

As a final note, it appears that Thomas Walter collected this taxon in the course of his work on the *Flora Caroliniana* (Walter 1788)! Although the flowers (as well as the subtending sheet) have been eaten, it appears that the specimen found on Sheet 11 of his herbarium at BM and marked with a slashed 600 is indeed *Funastrum angustifolium* (Fig. 2). The glabrous specimen bears linear, sessile leaves and umbellate, 6–9-flowered inflorescences (based on the

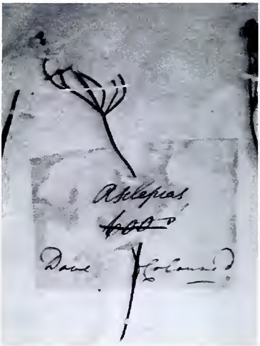


Fig. 2. Collection of *Funastrum angustifolium* on Sheet 11 of the Thomas Walter Herbarium (BM).

number of pedicel stubs). The stems are flexuous and 'caved in' in a manner consistent with recent collections of the vine versus erect asclepiads. Had he described the taxon in his flora, his name would have priority over Persoon's. As it is, Walter's collection will remain one of the earliest known collections of the taxon, if not the earliest.

Funastrum angustifolium (Pers.) Liede & Meve, Nordic J. Bot. 22:587. 2003. *Cynanchum angustifolium* Pers., Syn. Pl. 1:274. 1805. Type: "Hab. ad littora maris in Carolina," *Michaux, fil. s.n.* (HOLOTYPE: P)

Ceropegia palustris Pursh, Fl. Amer. Sept. 1:184. 1814. *Vincetoxicum palustre* (Pursh) A. Gray, Syn. Fl. N. Amer. 2 (1):102. 1878. *Cynanchum palustre* (Pursh) Heller, Cat. N. Amer. Pl. 6. 1898. *Metastelma palustre* (Pursh) Schltr., Symb. Antill. 1(2):258. 1899. *Seutera palustris* (Pursh) Vail, Fl. South. U.S. 952. 1903. *Lyonia palustris* (Pursh) Small, Fl. Miami: 149. 1913. Type: U.S.A. South Carolina: Charleston Co.: "Edge of salt marsh near the northern end of Folly Beach," *S.W. Leonard* 2715 *with A.E. Radford* (NEOTYPE: NCU!, designated here).

Lyonia maritima Elliott, Sketch Bot. S. Carolina 1:316. 1817; nom. illeg. *Seutera maritima* (Elliott) Decne., in DC. Prodr. 8:590. 1844.

Amphistelma salinarum C. Wright ex Griseb., Cat. Pl. Cub. 175. 1866. *Metastelma salinarum* (C. Wright ex Griseb.) C. Wright in Sauvalle, Anal. Acad. Ci. Habana 7:105. 1870. *Vincetoxicum salinarum* (C. Wright ex Griseb.) Benth. & Hook.f., Gen. pl. 2:762. 1876. *Cynanchum salinarum* (C. Wright ex Griseb.) Alain, Mem. Soc. Cubana Hist. Nat. 22:20. 1955. Type: CUBA: *Wright* 2958 (ISOTYPES: GH, NY!).

ACKNOWLEDGMENTS

I thank the curators and staff of C, CHARL, BM, G-DC, K, LIV, MANCH, OXF, PH for their kind assistance in trying to locate specimens in their respective herbaria. Additionally, I thank James Macklin (PH) and Vicki Noble (BM) for supplying digital images and Albert Sanders (CHARL) for access to CHARL and thoughtful conversation. Also, I thank the Interlibrary Loan department of NC State University for timely assistance in obtaining works not held locally, Fred Barrie for a thoughtful review, and Wendy Worley for logistical support.

REFERENCES

Balick, M.J., M.H. Nee, and D.E. Atha. 1999. Checklist of the vascular plants of Belize, with common names and uses. New York Botanical Garden Press, New York.

Correll, D.S. and H.B. Correll. 1982. Flora of the Bahama Archipelago (Including the Turks and Caicos Islands). Gantner Verlag, Vaduz.

Darlington, W. 1843. Reliquiae Baldwinianae: selections from the correspondence of the late William Baldwin, M.D. Kimber & Sharpless, Philadelphia.

Drapalik, D.J. 1969. A biosystematic study of the genus *Matelea* in the southeastern United States. Ph.D. Dissertation, University of North Carolina, Chapel Hill.

Elliott, S. 1817. A sketch of the botany of South-Carolina and Georgia: Vol.1, pt. 4. J.R. Schenck, Charleston.

Ewan, J. and N. Ewan. 1963. John Lyon, nurseryman and plant hunter and his journal, 1799–1814. Trans. Amer. Philos. Soc. 53:1–69.

Gray, A. 1842. Notes of a botanical excursion to the mountains of North Carolina, etc. Amer. J. Sci. 42:1–49.

Greuter, W., J. McNeill, F.R. Barrie, H.-M. Burdet, V. Demoulin, T.S. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth. 2000. International Code of Botanical Nomenclature. Regnum Veg. 131. Koeltz Scientific Books, Königstein.

Heller, A.A. 1898. Catalogue of North American plants north of Mexico.

Liede, S. 1997. American *Cynanchum* (Asclepiadaceae)—a preliminary infrageneric classification. Novon 7:172–181.

Liede, S. and U. Meve. 2003. Dissolution of *Cynanchum* sect. *Macbridea* (Apocynaceae – Asclepiadoideae). Nordic J. Bot. 22:587.

Merrill, E.D. 1949. Adventures in locating validly published, but unlisted binomials. Amer. J. Bot. 36:14–19.

Pursh, F.T. 1814. Flora Americae septentrionalis. White, Cochrane, and Co., London.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of Chapel Hill Press, Chapel Hill.

Rosatti, T.J. 1989. The genera of suborder Apocynineae (*Apocynaceae* and *Asclepiadaceae*) in the southeastern United States. J. Arnold Arbor. 70:443–514.

Schlechter, R. 1899. Asclepiadaceae. In: Symbolae antillanae, Urban, I., ed. Kraus Reprint, Ltd., Vaduz, Lichtenstein. Pp. 236–290.

Small, J.K. 1896. Studies in the botany of the southeastern United States. V. Bull. Torrey Bot. Club 23:125–130.

Sundell, E. 1981. The New World species of *Cynanchum* L. subgenus *Mellichampia* (A. Gray ex S. Wats.) Woods. (Asclepiadaceae). Evol. Monogr. 5:1–62.

Walter, T. 1788. Flora Caroliniana. Murray Printing Co. (Photolithographers), Cambridge.

Weatherby, C.A. 1942. A list of type specimens in Elliott.s herbarium. Rhodora 44:249–262.

BOOK REVIEW

ALTON BOWMAN. 2004. **The Flower Mound, Flower Mound, Texas: A History and Field Guide to the Flowers and Grasses.** (ISBN 1-57864-290-6, pbk.). The Donning Company Publishers, 184 Business Park Drive, Suite 206, Virginia Beach, VA 23462, U.S.A. (**Orders/Availability:** Contact Alton Bowman, 817-430-1976). Price not given, 112 pp., color and b/w photos, b/w maps, bibliography, index, 8 1/2" × 11".

The book, *The Flower Mound, Flower Mound, Texas: A History and Field Guide to the Flowers and Grasses* is a wonderful resource for anyone interested in learning more about the history and flora of the Flower Mound, the namesake of the small town just north of Dallas. The opening chapters introduce readers to the location, geology and wildlife of the Flower mound, as well as a brief history of the mound including Native American archeology and first settlers. The author devotes a chapter to the history of ownership of the mound and how historic owners had the forethought to preserve the flora of the mound.

The majority of the book is written as a field guide. It is rich with color photographs of flora making identification easy for the user. The guide is arranged by which species blooms during specific seasons (~2 month periods), beginning with early bloomers such as ten-petal anemone to brown eyed Susan's in the early summer and ending with species of the later seasons such as gayfeather and saw-leaf daisies. At the end of each "season" is an incredibly handy quick-glance color guide to those species blooming during that period of time. Each plant description includes the plant's common name, Latin name, family name, expected blooming period, a description of the plant (height, fruits etc.), location on the mound, and seasonality. The description also includes other comments for each species, where the author has added interesting tidbits such as the history of the plant's name, historic uses, and other valuable information.

The Flower Mound, Flower Mound, Texas: A history and Field Guide to the Flowers and Grasses is a highly recommended book for any person with an interest in the Flower Mound—especially the flora of the Flower Mound. This is an incredibly easy to use guide; little to no previous botanical knowledge is needed to use it. The greatest thing about the book is the many historic images and color photos of the flowers and plants of the mound. All proceeds (100%) from the sale of this book are used for the perpetual care of the Flower Mound.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

BOOK NOTICE

Timber Press

BEVERLEY NICHOLS. 2002. **Down the Garden Path.** (ISBN 0-88192-710-4, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 296 pp., b/w figs., 5 1/2" × 8".

This book was originally published in 1932 by Jonathan Cape. The new Timber Press printing comes with a Foreword and Index copyrighted by Timber Press, Inc.

A NEW COMBINATION IN *MATELEA* (APOCYNACEAE: ASCLEPIADOIDEAE) FOR AN ENDEMIC JAMAICAN VINE

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

A new combination in *Matelea* (Apocynaceae: Asclepiadoideae) for an endemic Jamaican vine is proposed.

RESUMEN

Se propone una combinación nueva en *Matelea* (Apocynaceae: Asclepiadoideae) para una trepadora endémica de Jamaica.

Critical study of West Indian specimens of subtribe Gonolobinae (Apocynaceae: Asclepiadoideae) has resulted in the need for a new combination for an endemic Jamaican vine:

Matelea rhamnifolia (Griseb.) Krings, comb. nov. *Gonolobus rhamnifolius* Griseb., Fl. Brit. W.I. 420. 1862. Protologue: 'Jamaica!, *Al.*, S. Anns, near Moneague.' TYPE: JAMAICA: *R.C. Alexander s.n.* (HOLOTYPE: GOET!)

The critical character defining placement in *Gonolobus* Michx.—dorsal anther appendages (Woodson 1941; Rosatti 1989; Stevens 2001)—is lacking, although mistakenly attributed to the species by Adams (1972). Other characters that have been used to refer taxa to *Gonolobus* include winged follicles and the absence of glandular hairs (see Woodson 1941). Follicles are unknown for *Matelea rhamnifolia*, although suspected to be winged, not muricate, based on its affinities to *M. correllii* Spellman. The follicle character is moot, however, as few fruit collections were apparently available to Woodson (1941) and more recent analysis has shown the character not to be useful in generic delimitation (Krings, unpubl.). Glandular hairs, although thought characteristic of *Matelea* Aubl. by Woodson (1941), are also without circumscriptional value in the *Gonolobus*-*Matelea* question, being present in both the type of *Gonolobus* Michx. (i.e., *G. suberosus* (L.) R. Br.) and numerous species lacking dorsal anther appendages (Rosatti 1989), including *M. rhamnifolia*.

The Jamaican endemic *Matelea rhamnifolia* appears most closely related to the Cuban endemic *M. nipensis* (Urb.) Woodson (at least among West Indian taxa); both likely belonging to a complex also including the Cuban endemics

SIDA 21(3): 1515–1517. 2005

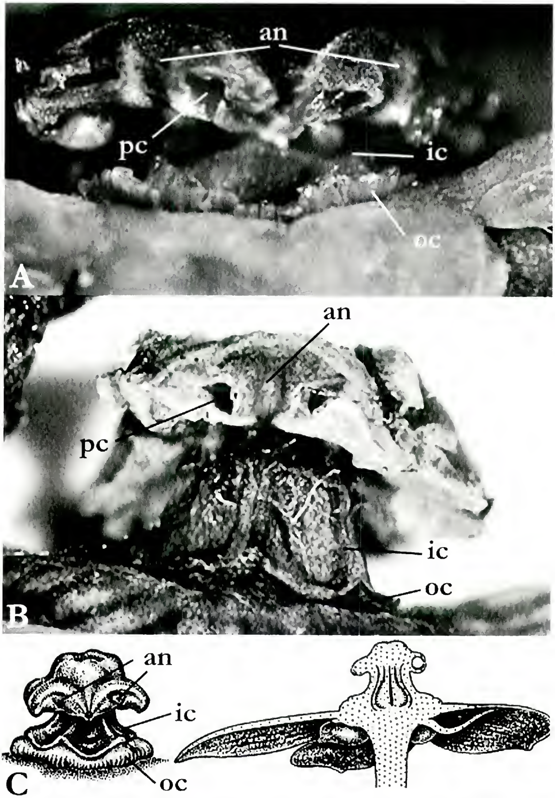


Fig. 1. Corona and gynostegium morphology of: **(A)** the Jamaican endemic *Matelea rhamnifolia* (from *Proctor 11825*, GH) and the related **(B)** Cuban endemic *M. nipensis* (from *Webster 3813*, GH) and *(C)* Bahaman endemic *M. correllii* (from Spellman 1978). Note absence of dorsal anther appendages in all three species. **an**=anther; **ic**=inner corona; **oc**=outer corona; **pe**=pollinium cavity.

M. bayatensis (Urb.) Woodson and *M. tigrina* (Griseb.) Woodson and the Bahaman endemic *M. correllii*. *Matelea rhamnifolia* and *M. nipensis* share oblong leaves that are basally truncate or rounded, reduced peduncles, short corolla lobes, and gynostegial coronas of similar morphology. Both species exhibit a low, somewhat undulating outer corona which subtends an inner corona and the associated staminal tube (Fig. 1A, B). The same morphology is present in *M. correllii* and was well-illustrated in the protologue of this latter species (Fig. 1C). The corolla lobes of both *M. rhamnfolia* and *M. nipensis* are also reticulate (at least when dry) and bear a white spot at each of the apices – both characters shared by the larger-flowered members of the complex mentioned above and the continental *M. pusilliflora* L.O. Williams. *Matelea rhamnifolia* is distinguished from *M. nipensis* by its larger leaves, a longer and more well-developed floral tube (ca. 1.3 mm vs. ≤ 0.5 mm), and a shorter filament tube (0.5 mm vs. 0.7 mm).

Representative specimens examined: *Matelea nipensis* (Urb.) Woodson: **CUBA:** *Ekman 9710* (ISOTYPES: NY, S); *Berazain & Alvarez 24357* (HAJB); *Clemente 4342* (NY); *Webster 3813* (GH).

Matelea rhamnifolia (Griseb.) Krings: **JAMAICA:** *Alexander s.n.* (HOLOTYPE: GOET); *Proctor 11825* (GH, IJ).

ACKNOWLEDGMENTS

I thank the curators and staff of the following herbaria for access to their collections or loans of specimens: BH, BM, BOLO, BREM, BRIT, C, CGE, DUKE, E, F, FI, FLAS, FR, FTG, G, GA, GH, GOET, H, HAC, HAJB, HBG, IJ, JE, K, KY, LL, M, MICH, MIN, MISS, MO, NCU, NO, NY, O, OK, OXF, P, PH, RSA, S, TENN, TEX, U, UC, UNA, US, USCH, USF, WILLI, WU, Z. I also thank the curators and staff of the following herbaria for searching their collections for West Indian Gonolobinae material, although finding no representation: BG, BKL, BR, BUF, COLO, CR, FLAS, IA, ISC, LD, MSU, NEU, NSW, UPS, TUR. Guy Nesom and an anonymous reviewer provided helpful comments on an earlier version of this paper.

REFERENCES

Adams, C.D. 1972. Flowering plants of Jamaica. University of the West Indies, Mona.

Rosatti, T.J. 1989. The genera of suborder Apocynineae (*Apocynaceae* and *Asclepiadaceae*) in the southeastern United States. J. Arnold Arbor. 70:443–514.

Spellman, D.L. 1978. A new *Matelea* (Asclepiadaceae) from the Bahamas. Ann. Missouri Bot. Gard. 65:1255–1257.

Stevens, W.D. 2001. Flora de Nicaragua: Asclepiadaceae. Monogr. Syst. Bot. Missouri Bot. Gard. 85:234–270.

Woodson, R.E. 1941. The North American Asclepiadaceae. Ann. Missouri Bot. Gard. 28: 193–244.

BOOK REVIEW

Chuck R. Coffee and Russell L. Stevens. 2004. **Grasses of Southern Oklahoma and North Texas: A Pictorial Guide.** (ISBN 0-9754303-0-0, pbk.). Samuel Roberts Noble Foundation, Inc., Agricultural Division, 2510 Sam Noble Parkway, Ardmore, OK 73401, U.S.A. (**Orders:** Noble Foundation, Attn: Ag Publications Distribution, 2510 Sam Noble Pky., Ardmore, OK 73401; http://www.noble.org/Storefront/AgStore/Product.asp?ProductID=NF-FO-04-01). $25.00 + $4.00 shipping, 120 pp., color images, b/w drawings, glossary, index, 8 1/2" × 11".

Have you always wanted an easy to use pictorial reference for local north Texas or southern Oklahoma grasses? *The Grasses of Southern Oklahoma and North Texas: A Pictorial Guide* is that perfect reference. This guide includes color photographs of 116 common grasses of the north Texas and southern Oklahoma region. Each species is devoted one page with photographs showing the entire plant and up-close images of key features such as spikelets, inflorescence, and the sheath wrapping around the stem. Key features of the plant; including uses by wildlife and livestock, are included for each species. In small boxes that accompany the photographs, the authors have also included additional species information including family, tribe, synonymous names, longevity, seasonality, origin, height, and flowering period.

This book can easily be used by farmers, ranchers, students, gardeners, nature enthusiasts, and seasoned professionals alike. Familiarity with botanical terminology is not required; authors provide a figure with all key parts labeled, as well as a glossary of key terms. The plants included in the books are listed in multiple ways: by tribe, by indexes of common names, and by scientific names. Authors have also included a list of useful references for finding additional information.

This guide is highly recommended for anyone with an interest in learning about north Texas and southern Oklahoma grasses. Ranchers, land managers, and gardeners will find useful information regarding habitat, environmental value, and wildlife/livestock usage. The many color photographs are an asset for anyone wanting to identify these species in the field. It is often said that a picture is worth a thousand words, and this guide includes a number of carefully selected images showing the growth form and key features for each species. This guide will be a wonderful and useful addition to your library.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

A NEW SPECIES OF *MATELEA* (APOCYNACEAE: ASCLEPIADOIDEAE) FROM HISPANIOLA

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

A new species of *Matelea* is described from Hispaniola, resulting from study of subtribe Gonolobinae (Apocynaceae: Asclepiadoideae) in the West Indies.

RESUMEN

Se describe una especie nueva de *Matelea* de la Española como resultado del estudio de la subtribu Gonolobinae (Apocynaceae: Asclepiaoideae) en las Indias Occidentales.

In the course of on-going systematic study of subtribe Gonolobinae (Apocynaceae: Asclepiadoideae) in the West Indies, a new species of *Matelea* Aubl. was discovered from Hispaniola:

Matelea pentactina Krings, sp. nov. (**Fig. 1, A–B, E**). TYPE: HAITI: Les Roseaux, Massif de la Hotte western group, rocky ledge, ca. 1300 m, 16 Sep 1928, *Ekman H 10685* (HOLOTYPE: S!).

Species nova distinguibili a *Matelea tamnifolia* (Griseb.) Woodson folio basi rotundata, non cordata vel auriculata, *a* Matelea constanzana*Jiménez corolla viridis vel flava, lobis utrinque reticulato-venosis, superne puberulis,* et a *Matelea ovatifolia* (Griseb.) Woodson corolla trichomata 0.11 mm longa, corona segmentis erectis ovatis, (1.5–)1.7–1.9 mm, via antheram 0.5–0.6 mm.

Twining vine; stems herbaceous when young, becoming woody with age, the bark cream-colored, somewhat corky; stems pubescent in lines, the trichomes white, multi-cellular, retrorsely curved or sometimes straight, to 0.2 mm long; leaves opposite, simple, the blades ovate to elliptic, (6.5–)12.7–21 mm × (2.6–)6.8–13.6 mm, both surfaces glabrous or glabrate, the apices obtuse to narrowly rounded, apiculate, the apiculum to 1.2 mm long, the bases rounded the margins entire, glabrous or ciliolate, the cilia ca. 0.08 mm long, colleters 2, yellow to orange, borne adaxially on the midvein at the base of the blade, to 0.2 mm long, petioles 2.9–9.4 mm long, grooved adaxially, glabrous except for the groove, trichomes mostly antrorse, to 0.18 mm long; inflorescence axillary, umbelliform, the peduncles severely reduced to obsolete, pedicels 5–12 mm long, puberulous with trichomes to 0.12 mm long or glabrate; sepals 5, ovate to lanceolate, ca. 1 mm long, the apices rounded to obtuse, both surfaces glabrous, the margins glabrous or very sparsely ciliolate; corolla rotate, pale green or yellow with dark green reticulations, 5-lobed, the lobes ovate, to 4.2 mm long, the adaxial surface

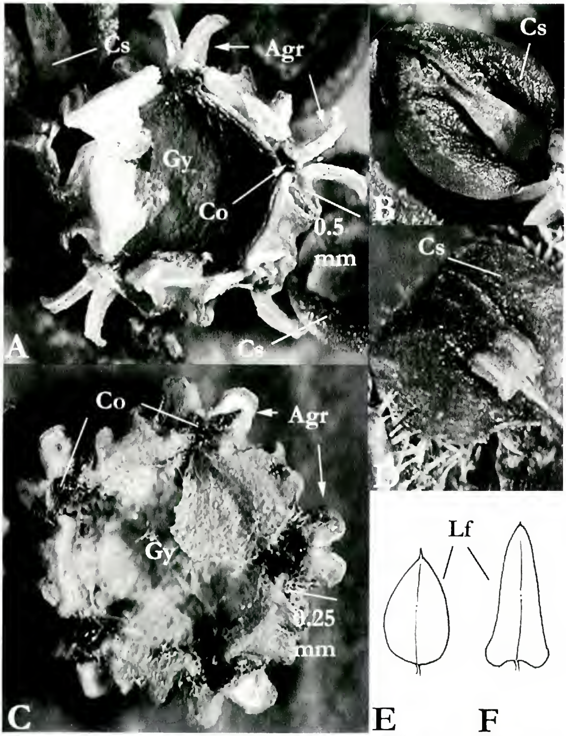


Fig. 1. *Matelea* subgenus *Poicilla*: **A–B & E,** *Matelea pentactina* Krings (*Ekman H 10685*, S); **C–E,** *Matelea ovatifolia* (Griseb.) Woodson (*Wright 2965*, GH); **F,** *Matelea tamnifolia* (Griseb.) Woodson (*Wright s.n.*, GH). **Agr** = Anther guide rail; **Co** = Corpusculum; **Cs** = erect staminal corona segment; **Gy** = Gynostegium; **Lf** = leaf.

pubescent near the base of the lobes, the trichomes whitish to 0.11 mm long, the abaxial surface glabrous; faucal annulus [Ca] pubescent; corona of fused staminal and interstaminal parts [C(is)], glabrous, the staminal segments [Cs] erect, foliate, ovate (1.5–)1.7–1.9 mm long, the apices obtuse, deeply notched, higher than the apex of the gynostegium; gynostegium stipitate, the stipe ca. 0.2 mm long; dorsal anther appendages [Cd] lacking; anther guide rails outwardly pronounced, 0.5–0.6 mm long; pollinaria descending; follicles unknown.

Etymology.—The epithet *pentactina* refers to the five, elongate, outwardly projecting anther guide rails, reminiscent of rays.

Additional specimens examined: **Haiti:** Massif de la Selle, gr. Crete-a-Piquants, Port-au-Prince, between Carrefour-Martin and Bois d'Orme, c. 800 m, limestone, 17 Dec 1926, *Ekman H 7402* (S!).

Matelea pentactina is most closely related to *Matelea ovatifolia* (Griseb.) Woodson (Fig. 1, C–E) and both its holotype and paratype have previously been referred to the latter (see Liogier 1981). Vegetatively the two species are exceedingly similar and may not be conclusively distinguished. However, a number of floral character states distinctly separate them (see Table 1 and key below). *Matelea ovatifolia* appears endemic to Cuba and *M. pentactina* to Hispaniola, although the single specimen seen from the Dominican Republic (*Fuertes 991*, GH) is sterile and thus cannot be conclusively referred to either based on morphology. A handwritten note with the holotype of *M. pentactina*, presumably by Ekman, indicates it was "seen occassionaly throughout southern Haiti (at least), although seldom with flrs!" A similar note on the paratype reads: "Rare, although I think I have seen it sterile before and taken it for some Metastelma [sic]." *Matelea pentactina* also appears closely related to the Hispaniolan *Matelea constanzana* Jiménez (nom. nov. for *Poicillopsis tuerckheimii* Schltr. as the epithet is not available in *Matelea*). This latter species was apparently known only from the type (Sto. Domingo prope Constanza, *Tuerckheim 3466*, Jul 1910; see also Liogier 1981) and appears to no longer be extant. The protologue indicated that *M. constanzana* also bears obtuse staminal corona segments, but exhibits glabrous white flowers. The striking reticulations evident in the pubescent, green or yellow-flowered *M. pentactina* were not described for *M. constanzana*.

According to the subgeneric classification erected by Woodson (1941), *Matelea pentactina* and *M. ovatifolia*, as well as *M. tamnifolia* (Griseb.) Woodson (endemic to Cuba; Fig. 1, F), belong to the entirely Antillean subgenus *Poicilla*. Woodson (1941) did not include the entity now known as *M. constanzana* in his treatment, but its affinities would seem to place it in his subg. *Poicilla* as well. Although many of Woodson's (1941) subgenera are likely ill-conceived (Stevens 1988), subgenus *Poicilla* is maintained here in the absence of a rigorous test of Woodson's (1941) concept. A key to the subgenus is provided below. On-going systematic study of West Indian Gonolobinae aims to improve generic and subgeneric circumscriptions.

TABLE 1. Floral morphological characters distinguishing *Matelea pentactina* from the related *M. ovatifolia* (Apocynaceae: Asclepiadoideae).

Character	Matelea pentactina	Matelea ovatifolia
Adaxial corolla surface trichomes	to 0.11 mm long	0.13–0.20 mm long
Erect staminal corona segments [C(s)]	(1.5–)1.7–1.9 mm long, ovate, the apices obtuse	0.99–1.28 mm long, obovate to suborbicular, the apices rounded to emarginated
Anther guide rails	0.5–0.6 mm long	to 0.26 mm long

KEY TO *MATELEA* SUBGENUS *POICILLA*

1. Leaf blades lanceolate, the bases cordate to auriculate ________ **Matelea tamnifolia**
1. Leaf blades ovate, the bases rounded to truncate (very rarely shallowly cordate).
   2. Vine exhibiting the combination of corolla lobes white, glabrous on both surfaces, not reticulate, and staminal corona segments rhombic, obtuse ________ **Matelea constanzana**
   2. Vine not exhibiting the above combination of characters (i.e., if corolla lobes white, then corona segments obovate to suborbicular, the apices rounded to emarginate OR if corona segments obtuse, then corollas green to yellow, reticulate)
      3. Adaxial corolla pubescence 0.13–0.2 mm long; erect staminal corona segments 0.99–1.28 mm long, obovate to suborbicular, the apices rounded to emarginate; anther guide rails to 0.26 mm long ________ **Matelea ovatifolia**
      3. Adaxial corolla pubescence to 0.11 mm long; erect staminal corona segments (1.5–)1.7–1.9 mm long, ovate, the apices obtuse; anther guide rails 0.5–0.6 mm long ________ **Matelea pentactina**

ACKNOWLEDGMENTS

I thank the curators and staff of the following herbaria for access to their collections or loans of specimens: BH, BM, BOLO, BREM, C, CGE, DUKE, E, F, FI, FR, FTG, G, GH, GOET, H, HAC, HAJB, HBG, IJ, JE, K, M, MICH, MIN, MO, NY, O, OXF, P, PH, RSA, S, U, UC, US, USF, WU, Z. I also thank the curators and staff of the following herbaria for searching their collections for West Indian Gonolobinae material, although finding no representation: BG, BKL, BR, BUF, COLO, CR, FLAS, IA, ISC, LD, MSU, NEU, NSW, UPS, TUR. The thoughtful review of a previous version of the manuscript by Mary E. Endress, Alain Liogier, and Paul Fantz is gratefully acknowledged.

REFERENCES

KUNZE, H. 1995. Floral morphology of some Gonolobeae (Asclepiadaceae). Bot. Jahrb. Syst. 117:211–238.

LEON, J.S. and A.H. LIOGIER. 1974. Flora de Cuba. Habana & Rio Piedras, reprint by Otto Koeltz Science Publishers, Koenigstein.

Liede, S. and H. Kunze. 1993. A descriptive system for corona analysis in Asclepiadaceae and Periplocaceae. Pl. Syst. Evol. 185:275–284.

Liogier, A.H. 1981. La flora de la Española: *Matelea*. Phytologia Memoirs 6:28–36.

Schlechter, R. 1899. Asclepiadaceae. In: Symbolae Antillanae, I. Urban, ed. Gebrüder Borntraeger, Berlin. Pp. 236–290.

Stevens, W.D. 1988. A synopsis of *Matelea* subg. *Dictyanthus* (Apocynaceae – Asclepiadoideae). Ann. Missouri Bot. Gard. 75:1533–1564.

Woodson, R.E. 1941. The North American Asclepiadaceae. Ann. Missouri Bot. Gard. 28: 193–244.

BOOK REVIEW

Marianna Appel Kunow. 2003. **Maya Medicine: Traditional Healing in the Yucatan.** (ISBN 0-8263-2864-4, hbk.). University of New Mexico Press, 1601 Randolph Rd SE, Suite 200S, Albuquerque, NM 87106, U.S.A. (**Orders:** www.unmpress.com/Ordering.html, 1-800-249-7737). $29.95, 152 pp., tables, b/w figures, appendices, glossary, index, 6" × 9".

Marianna Appel Kunow wrote her new book, *Maya Medicine*, in a refreshingly conversational and easy to read style. It was the culmination of her graduate research into healing plants and the people of the Yucatan that use them. The text presents information about the author's field plant collection and also showcases the lives and practices of the healers with whom she worked.

Some of the studies into the Yucatan healers include discussions of how they became curers; some were trained through "dreams," while others learned from family members or extended education in addition to traditional western training. The author shares some information about the healer's family as well. Additional information includes the types of medicine practiced by the curers—medicinal plants, massage, ceremonial rituals and midwifery. Kunow also includes a chapter to discuss the common techniques used for treatment such as prayer, plant medicine, massage, plant magic, crystals, dream interpretation, and western medicine.

One of the more informative discussions is on the perceived causes of various diseases. Kunow introduces the concept of hot and cold types of conditions and various "magical" diseases such as the evil eye. Common ailments such as colds and skin complaints are also covered. Various plants used for these treatments are listed in table form

With respect to the actually layout of the book, approximately half of it focuses on Kunow's plant lists, illustrations and field notes. The author created multiple tables to relate both scientific and common names to two previous texts on ethno-botany: Roy's 1931 *Ethno-Botany of the Maya* and the *Book of Chilam Balam of Kaua* (Bricker). Common names in the various tables are given and compared in Spanish, Mayan and Kaua. The comparison tables are followed by black and white illustrations of thirty-six of the plants discussed as well as the valuable plant catalog of names and field notes for plant species collected. Other useful items such as a list of plant names by family, glossary of terms and index are also included.

In her book *Mayan Medicine*, author Marianna Appel Kunow shares her personal experience of working with various curers in the Yucatan during her graduate research. There are two foci for the content of this book: the healers and the plants they use. The author spends half of the book describing the healers' backgrounds, preferred practices, techniques and personalities. The remaining half is primarily tabular information about the names and uses of the plants collected and discussed during research activities by the author. The conversational style makes the text easy enough for most high school students and beyond to read and enjoy. Anyone with an interest in ethno-botany or traditional healing will likely enjoy reading *Mayan Medicine*.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NOTES ON THE *MATELEA BAYATENSIS-CORRELLII-TIGRINA* COMPLEX (APOCYNACEAE: ASCLEPIADOIDEAE: GONOLOBINAE) IN THE GREATER ANTILLES AND BAHAMAS

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

As a component of a larger study of the West Indian *Matelea* subgenus *Ptycanthera*, this study sought to critically examine patterns of morphological variation within the embedded *M. bayatensis-correllii-tigrina* complex. Resolution of species-level circumscriptions are necessary before larger issues of subgeneric and generic circumscription can be adequately addressed. Morphological characters were analyzed using parsimony analysis, neighbor-joining, and ANOVA. Results show that *Matelea bayatensis*, *M. correllii*, and *M. tigrina* are very closely related morphologically. The three species appear to differ only in pubescence and relatively minor floral character states, some of which overlap. At present, none of the observed variation appears important enough to warrant the continued recognition of three distinct species.

RESUMEN

Este estudio es un componente de otro más amplio de *Matelea* subgenus *Ptycanthera* delas Indias Occidentales, y está dedicado a examinar críticamente los patrones de variación morfológica en el complejo *M. bayatensis-correllii-tigrina*. Se necesita la resolución de las circunscripciones a nivel específico antes de abordar las circunscripciones de los géneros y subgéneros adecuadamente. Los caracteres morfológicos se analizaron usando análisis de parsimonia, del vecino más próximo, y ANOVA. Los resultados muestran que *Matelea bayatensis*, *M. correllii*, y *M. tigrina* están muy relacionados morfológicamente. Las tres especies parecen diferir sólo en la pubescencia y estados de carácter florales relativamente menores, algunos de los cuales se solapan. Actualmente, ninguna de las variaciones observadas parece lo suficiente importante como para justificar el reconocimiento de tres especies diferentes.

The Metastelmatinae-Oxypetalinae-Gonolobinae clade sensu Rapini et al. (2003) is the most morphologically diverse of the New World Asclepiadeae and most members have never been monographed. The circumscription of two Gonolobinae genera—*Gonolobus* Michx. and *Matelea* Aubl.—has been particularly complicated by the swelling of the latter by Woodson (1941). Unable to come to terms with the large variation in corona morphology, Woodson (1941) submerged numerous genera within *Matelea*, increasing its size from four to over 100 species. Estimates of species numbers of *Gonolobus* vary from 100 to 150 (Rosatti 1989; Mabberly 1997; Stevens 2001). The degree of variation is largely the result of differences regarding generic limits, as well as still poorly known tropical taxa. Woodson (1941) considered the entirely Antillean subgenus *Ptycanthera* to be "largely the deciding factor" for his inclusive treatment of *Matelea*, noting that "were it not for the Antillean species, one might compose a fairly respectable key to several genera upon the continent." As a component of a larger study of *M.* subg. *Ptycanthera*, that ultimately seeks to bear on issues of generic circumscription, this study sought to critically examine patterns of morphological variation within the embedded *M. bayatensis-correllii-tigrina* complex. Resolution of species-level circumscriptions are necessary before larger issues of subgeneric and generic circumscription can be adequately addressed.

METHODS

Based on study of available specimens (Table 1), a matrix of morphological character states (Tables 2 & 3) was developed for seven species and subjected to parsimony analysis using PAUP* (Swofford 2003). Besides *Matelea bayatensis* (Urb.) Woodson, *M. correllii* Spellman, and *M. tigrina* (Griseb.) Woodson (all members of subg. *Ptycanthera* sensu Woodson 1941), the matrix also included three additional West Indian taxa, representing other members of subg. *Ptycanthera*, as well as subg. *Poicilla* sensu Woodson (1941). Closely allied to *Matelea* (Rapini et al. 2003), the type for the genus *Gonolobus* Michx. (i.e., *Gonolobus suberosus* (L.) R.Br.) was chosen as the outgroup (see also Krings & Xiang 2004). The morphological data matrix (Table 2) was comprised of sixteen qualitative characters. Multistate characters were treated as polymorphisms. Bootstrap support values were determined using the branch-and-bound algorithm with 10,000 replicates. To examine phenetic similarity, the morphological character matrix was also subjected to Neighbor-joining (NJ) analysis using PAUP* (Swofford 2003). Continuous data represented by pedicel and corolla lobe length, both characters historically used by authors to delimit taxa in the complex (see Grisebach 1863; Urban 1925), were critically analyzed using ANOVA. In all, thirteen herbarium sheets of *Matelea bayatensis*, *M. correllii*, and *M. tigrina* were examined, although only four individual collections exhibited flowers (Table 1). These specimens essentially represent the sum total of available herbarium specimens of the group, as material was requested from eighty-three institutions known or likely to house material of subtribe Gonolobinae in the West Indies. Only the holotype of *M. correllii* (MO), the lectotype of *M. tigrina* (GOET fide Howard 1988), and a syntype of *M. tigrina* (MO), were not studied as they could not be obtained on loan.

RESULTS

Parsimony.—An exhaustive search using PAUP* (Swofford 2003) evaluated 945 trees and yielded two of shortest length (Length=29; CI=0.862; RI=0.692; Fig. 1). Nine of the sixteen morphological characters (56%) were parsimony informative. The two trees are identical except for resolution of the *Matelea bayatensis*-

TABLE 1. Specimens examined and chosen for analysis.

Subgenus of Matelea sensu Woodson (1941)	Species	Locality	Source
–	*Gonolobus suberosus* (L.) R.Br.	Southeastern U.S.A.	Krings & Xiang (2004)
Poicilla	*Matelea ovatifolia* (Griseb.) Woodson	Cuba, Oriente	*Wright 2965* (ST: G, GH, BREM, UC)
Ptycanthera	*Matelea bayatensis* (Urb.) Woodson	Cuba, Oriente	*Engström 3056* (ST: NY, S)
Ptycanthera	*Matelea correllii* Spellman	Bahamas, Long Island	Spellman (1978), *Correll 49112* (IT: F, FTG, GH, NY, US), *Correll 48157* (topotype: FTG, MO, NY); *Correll 44937* (FTG)
Ptycanthera	*Matelea oblongata* (Griseb.) Woodson	Cuba, Occidente	*Britton & Wilson 14867* (NY), *Britton et al. 7379* (NY), *Ekman 17625* (S), *Leon 17423* (NY), *Shafer 13508* (NY)
Ptycanthera	*Matelea pauciflora* (Spreng.) Woodson	Hispaniola	*Ekman H14296* (S), *Garcia & Pimentel 2531* (MO)
Ptycanthera	*Matelea tigrina* (Griseb.) Woodson	Cuba, Oriente	*Wright 1667* (ST: G, GH)

correllii-tigrina clade. The clade itself appears well-supported by bootstrap values, as is the *Matelea ovatifolia-oblongata* clade. The two Cuban taxa, *Matelea bayatensis* and *M. tigrina* emerged nearer one another than either to *M. correlli* in one of the trees, although with very weak bootstrap support.

NJ and ANOVA.—The neighbor-joining (NJ) analysis showed the Cuban taxa—*M. bayatensis* and *M. tigrina*—to be more similar to each other than either is to the Bahaman taxon *M. correllii* (Fig. 2). The NJ tree is identical to the second of the shortest trees identified by parsimony analysis (Fig. 1, B). *Matelea tigrina* bears sepals that are densely pubescent with both glandular and eglandular hairs and corolla lobes that are pubescent (though not densely so) on the abaxial surface. In contrast, *Matelea correllii* bears glabrous calyces and corollas. *Matelea bayatensis* is intermediate. Its sepals are scattered (not densely) pubescent, with glandular and eglandular hairs, and the abaxial corolla lobes are glabrous. Sepals are lanceolate in *Matelea bayatensis* and *M. tigrina*, and ovate in *M. correllii*. All three taxa in the complex show strong reticulations of their corolla lobes, white dots at the corolla lobe apices, and similar corona and gynostegial morphology. Although pedicel length and corolla lobe length have been used to delimit taxa in the complex (see Grisebach 1863; Urban 1925), an analysis of variance showed no statistically significant difference in mean

TABLE 2. Characters and states scored for the parsimony and neighbor-joining analyses.

Character	State
1. Adaxial leaf blade vestiture	0 = glabrous/glabrate; 1 = pubescent
2. Abaxial leaf blade vestiture	0 = glabrous/glabrate; 1 = pubescent
3. Leaf blade apex	0 = acuminate, 1 = acute or obtuse; 2 = rounded or emarginate
4. Leaf blade bases	0 = cordate; 1 = rounded/truncate; 2 = cuneate
5. Adaxial sepal vestiture	0 = glabrous; 1 = pubescent
6. Abaxial sepal vestiture	0 = glabrous; 1 = pubescent
7. Corolla coloration	0 = uniformly colored; 1 = reticulate; 2 = center differently colored
8. Corolla adornment	0 = absent; 1 = each lobe bearing a white spot apically
9. Corolla lobe shape	0 = broadly ovate to suborbicular; 1 = oblong, triangular-deltate, or lanceolate
10. Adaxial corolla lobe vestiture	0 = glabrous; 1 = pubescent
11. Abaxial corolla lobe vestiture	0 = glabrous; 1 = pubescent
12. Cs (staminal corona, see Kunze 1995)	0 = absent or shallow; 1 = well-developed, and/or foliate
13. Stylar head shape	0 = flat or depressed, 1 = conical
14. Stylar head appendage	0 = absent; 1 = present
15. Cd (dorsal anther appendages, see Kunze 1995)	0 = absent; 1 = present
16. Orientation of pollinium cavity in the gynostegial head	0 = +/- horizontal; 1 = descending

pedicel or corolla lobe length at the 95% confidence level between the three species (pedicel length: $F = 1.98 < F_{crit} = 3.49$; corolla lobe length: $F = 3.65 < F_{crit} = 3.86$). A graphical representation of these data shows evident overlap (Fig. 3).

DISCUSSION

The oldest name in the *Matelea bayatensis-correllii-tigrina* complex was provided by Grisebach (1863) for a Cuban taxon then referred to the genus *Gonolobus*: *G. tigrinus* Griseb. Urban (1925) later added *G. bayatensis* Urb. to the complex, distinguishing it from *G. tigrinus* by shorter pedicels, lanceolate sepals (vs. elliptic-oblong) which are scarcely pilose abaxially (vs. pilose), and longer corolla lobes, these ovate to ovate-rotund (vs. orbicular). A study of the types of both taxa quickly shows these characters to be problematic (*M. tigrina*: *Wright 1667*, G!, GH!; *M. bayatensis*: *Arth. Engström* in herb. Ekman 3056, NY!, S!). Urban's interpretation of sepal and corolla lobe shapes is subjective and these features appear to intergrade. Perhaps his pedicel measurements were not made on extant material, as pedicels on the remaining types are 2.71–3.96 mm long and thus well within the range of *G. tigrinus* (i.e., 2.6–3.69 mm). Furthermore, corollas of *G. tigrinus* were described in Grisebach's protologue as 5–6 mm long,

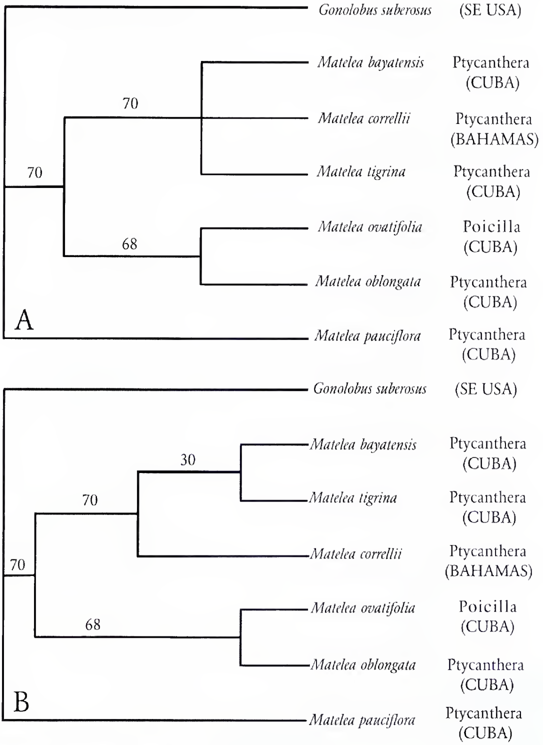


Fig. 1. The two shortest trees (A–B) resulting from a parsimony analysis of morphological characters (exhaustive search) in study of the Antillean *Matelea bayatensis-correllii-tigrina* complex (each tree: length = 29; CI = 0.862; RI = 0.692). Bootstrap support values appear above branches. Marginal annotations indicate subgenus of *Matelea* sensu Woodson (1941) (if applicable), followed by geographic distribution of the species.

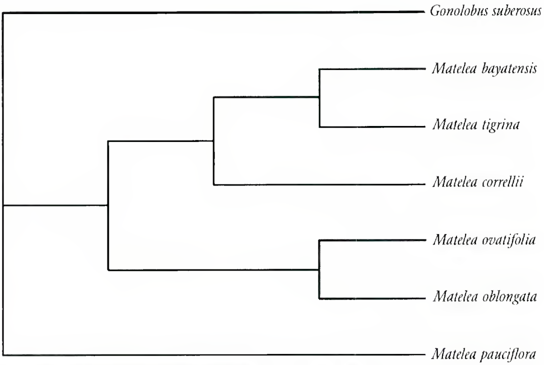


Fig. 2. Neighbor-joining tree showing phenetic similarity in the Antillean *Matelea bayatensis-correllii-tigrina* complex based on sixteen morphological character states.

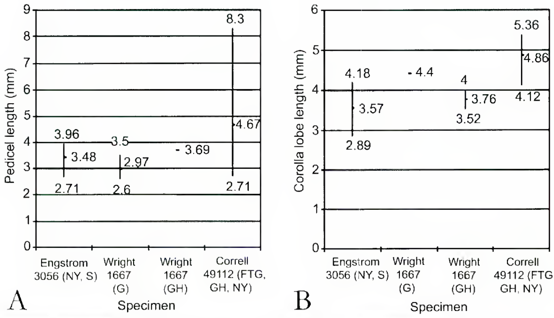


Fig. 3. Continuous floral characters historically used to delimit *Matelea bayatensis*, *M. correllii*, and *M. tigrina*: A, pedicel length; B, corolla lobe length. Measurements indicate maximum, mean, and minimum from top to bottom (in mm), unless only a single measurement was available. *Engström 3056* = *M. bayatensis*; *Wright 1667* = *M. tigrina*; *Correll 49112* = *M. correllii*. The two Wright specimens likely represent two different individuals collected at different times and localities (see Howard 1988).

Table 3. Morphological character matrix used in the parsimony and neighbor-joining analyses of the *Matelea bayatensis-correllii-tigrina* complex.

Taxon	**Character states**
Gonolobus suberosus	{01}10001{02}01{01}110010
Matelea bayatensis	001{01}011100001000
Matelea correllii	0011001100001000
Matelea oblongata	00{01}{12}000010021001
Matelea ovatifolia	001{01}000001020001
Matelea pauciflora	{01}1{12}1010010001100
Matelea tigrina	001{01}011100101000

just a millimeter shorter than *G. bayatensis*. When dried both taxa have similar corolla lobe lengths (to 4.18 mm in *G. bayatensis*; to 4.4 mm in *G. tigrinus*)—although differential shrinkage has been shown in other *Matelea* species (see Drapalik 1969). The sepal vestiture trait remains true. However, this seems insufficient basis for recognizing two separate species.

Without publishing a critical study of the complex, Woodson (1941) later provided new combinations for both taxa in *Matelea*, applying his concept that *Gonolobus* should be characterized primarily by dorsal anther appendages and smooth, winged follicles. Dorsal anther appendages appear to be lacking in both *M. tigrina* and *M. bayatensis*. Follicles of the two were unknown to Woodson (1941), as they are today, as both species are known only from the type specimens, none of which bear fruit. However, the interpretation of the presence of dorsal anther appendages can be difficult from herbarium specimens. At least six species transferred from *Gonolobus* to *Matelea* by Woodson (1941) were considered by Schlechter (1899) and Urban (1925) to bear dorsal anther appendages to some degree. The controversial taxa fall into two *Matelea* subgenera sensu Woodson (1941)—*Pachystelma* and the Antillean *Ptycanthera*—and include *M. bayatensis* and *M. tigrina*. The utility of the follicle character (primarily winged in *Gonolobus* vs. primarily muricate in *Matelea*) is also problematic. With greater collections since Woodson (1941), it has become clear that several taxa apparently lacking dorsal anther appendages bear winged instead of muricate follicles. These taxa include the more recently described *Matelea correllii* Spellman (1978) from the Bahamas, which bears extreme resemblance in habit, foliar, and floral characters to *M. bayatensis* and *M. tigrina*.

Matelea bayatensis, *M. correllii*, and *M. tigrina* are clearly closely related morphologically (Figs. 1–3). The three taxa appear to differ only in pubescence and relatively minor floral character states, some of which overlap (Fig. 3). This minor variation may be due to the very limited number of collections and might be completely indistinct if more collections were available. Flower sizes (including pedicel lengths) can likely be influenced by growing conditions, as can pubescence. At present, none of the observed variation appears important enough to warrant the continued recognition of three distinct species. At the least, based on current evidence (albeit limited), the two Cuban species—*Matelea bayatensis* and *Matelea tigrina*—can be considered synonymous. Considering geographic distribution, that the Cuban taxa appear more closely related to each other than each is to the Bahaman taxon, and that *Gonolobus tigrinus* is the oldest basionym, it also seems appropriate to treat the Bahaman taxon as a subspecies within *Matelea tigrina*. The question of whether the species should be referred to *Gonolobus* cannot yet be answered based on the material at hand. On-going work toward a robust phylogeny based on molecular data aims to address this question. Until then, new combinations are avoided to limit unnecessary names.

TAXONOMIC TREATMENT

Matelea tigrina (Griseb.) Woodson, Ann. Missouri Bot. Gard. 28:226. 1941. *Gonolobus tigrinus* Griseb., Mem. Amer. Acad. Arts ser. 2, 8:520. 1863. TYPE: CUBA: *Wright 1667*, 1860 (LECTOTYPE: GOET (fide Howard 1988); SYNTYPES: MO [image online!], G!, GH!).

Gonolobus bayatensis Urb., Symb. Antill. 9(3).420–421. 1925. [synon. nov.] *Matelea bayatensis* (Urb.) Woodson, Ann. Missouri Bot. Gard. 28:226. 1941. TYPE: CUBA: *Arth. Engström* in herb, *Ekman n. 3056* (SYNTYPES: NY!, S!).

Matelea correllii Spellman, Ann. Missouri Bot. Gard. 65:1255–1257. 1978. [synon. nov.] TYPE: BAHAMAS. LONG ISLAND: *D.S. Correll 49112* (HOLOTYPE: MO; ISOTYPES: F!, FTG!, GH!, NY!, US!)

Distribution.—The putative subspecific entity comprised by *M. tigrina* and *M. bayatensis* is apparently restricted to Cuba. The putative subspecific entity comprised by *M. correllii* is apparently endemic to the Bahamas.

Notes.—Spellman's (1978) note of a resemblance between *M. correllii* and *M. grisebachiana* (Schltr.) Alain is puzzling as the latter was described with leaves only to 0.7 cm wide (initially described as *Gonolobus tigrinus* var. *angustifolius* Griseb.) and oblong corolla lobes. Leaves of *M. correllii* average 1.5–2.5 cm diam. Schlechter (1899) also noted differences between *M. tigrina* and *M. grisebachiana* in the outer corona and in the presence of conspicuous dorsal anther appendages ('Cd' sensu Kunze 1995) in the latter. Unfortunately, the type of *M. grisebachiana* (Cuba, *Wright s.n.*) has not yet been located and may have been destroyed. Additional specimens of *M. grisebachiana* have also not been located and could thus not be analyzed.

ACKNOWLEDGMENTS

I thank the curators and staff of the following herbaria for access to their collections or loans of specimens: BH, BM, BOLO, BREM, C, CGE, DUKE, E, F, FI, FR, FTG, G, GH, GOET, H, HAC, HAJB, HBG, IJ, JE, K, M, MICH, MIN, MO, NY, O, OXF, P, PH, RSA, S, U, UC, US, USF, WU, Z. I also thank the curators and staff of the following herbaria for searching their collections for West Indian

Gonolobinae material, although finding no representation: BG, BKL, BR, BUF, COLO, CR, FLAS, IA, ISC, LD, MSU, NEU, NSW, UPS, TUR. The assistance of the North Carolina State University Libraries Inter-Library Loan Service is also gratefully acknowledged, as are the manuscript reviews by Bruce Hansen and Justin Williams.

REFERENCES

Drapalik, D.J. 1969. A biosystematic study of the genus *Matelea* in the southeastern United States. Ph.D. Dissertation, University of North Carolina, Chapel Hill.

Grisebach, A.H.R. 1863. Plantae Wrightianae Cubenses: Asclepiadeae. Mem. Amer. Acad. Arts ser. 2, 8:520–521.

Howard, R.A. 1988. Charles Wright in Cuba, 1856–1867. Chadwick-Healy, Alexandria.

Krings, A. and Q.-Y. Xiang. 2004. The *Gonolobus* complex (Apocynaceae - Asclepiadoideae) in the southeastern United States. *Sida* 21:103–116.

Kunze, H. 1995. Floral morphology of some Gonolobeae (Asclepiadaceae). Bot. Jahrb. Syst. 117:211–238.

Mabberley, D.J. 1997. The plant-book : A portable dictionary of the vascular plants. Cambridge University Press, Cambridge.

Rapini, A., M.W. Chase, D.J. Goyder, and J. Griffiths. 2003. Asclepiadeae classification: evaluating the phylogenetic relationships of New World Asclepiadoideae (Apocynaceae). Taxon 52:33–50.

Rosatti, T.J. 1989. The genera of suborder Apocynineae (Apocynaceae and Asclepiadaceae) in the southeastern United States. J. Arnold Arbor. 70:443–514.

Schlechter, R. 1899. Asclepiadaceae. In: Symbolae Antillanae, I. Urban, ed. Gebrüder Borntraeger, Berlin. Pp. 236–290.

Spellman, D.L. 1978. A new *Matelea* (Asclepiadaceae) from the Bahamas. Ann. Missouri Bot. Gard. 65:1255–1257.

Stevens, W.D. 2001. Flora de Nicaragura: Asclepiadaceae. Monogr. Syst. Bot. Missouri Bot. Gard. 85:234–270.

Swofford, D. L. 2003. *PAUP 4.0**. Sinauer Associates, Sunderland.

Urban, I. 1925. Symbolae Antillanae. Gebrüder Borntraeger, Berlin.

Woodson, R.E. 1941. The North American Asclepiadaceae. Ann. Missouri Bot. Gard. 28: 193–244.

BOOK REVIEW

Arturo Gómez-Pompa, Michael F. Allen, Scott L. Fedick, Juan J. Jiménez-Osornio (Eds.). 2003. **The Lowland Maya Area: Three Millennia at the Human-Wildland Interface**. (ISBN 1 56022 971 3, pbk.). Food Products Press, An Imprint of the Haworth Press, Inc, 10 Alice Street, Binghamton, NY 13904-1580, U.S.A. (**Orders:** www.haworthpress.com, 1-800-429-6784). $79.95, 659 pp., b/w illustrations, b/w photographs, 6" × 8".

The Lowland Maya have lived in the Yucatan Peninsula for over 3,000 years. This book takes an integrative approach in seeking to understand how the Lowland Maya have interacted with their environment so successfully without destroying its biodiversity. A total of 36 chapters, this book is a compendium of scientific and anthropological information from specialists in a wide range of fields including ethnobotany, ecology, geology, biodiversity, archaeology, horticulture, botany, anthropology, and history.

Areas of focus include the physical nature of the lowland environment, biodiversity, agriculture, interactions between plants and people, and a section on the future of the region. Included is a discussion of the impact of climate change on the area. The agriculture section includes an interesting chapter on the cultivation and distribution of the chocolate tree (*Theobroma cacao* L.), the possible use of periphyton as a fertilizer, and a chapter on bioprospecting plants and fungi in El Eden Ecological Reserve in Mexico.

The El Eden Ecological Reserve is discussed extensively with several chapters on its biodiversity including butterfly fauna, fungi, periphyton in wetlands, and ants. Chapters on the Maya view of fields and forests, traditional plant use, and anthropogenic plants document the Lowland Mayan concept of their environment, providing clues for their successful interaction with their world.

This is a "big picture" book filled with detailed chapters intended to help the reader understand that picture. The helpful "Summary of Recommendations" at the end of the book reviews this wealth of information and includes recommendations for the future.—*Marissa Oppel, Museum Assistant, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., moppel@brit.org.*

BOOK NOTICE

Carmen Ulloa Ulloa, James L. Zarucchi, and Blanca León. 2004. **Diez años de adiciones a la flora del Perú, 1993–2003.** Arnaldoa. Edición Especial. Noviembre 2004. Museo de Historia Natural, Universidad Privada Antenor Orrego, Apartado 1001, Trujillo, PERÚ. (**Contact:** asagasteguia@upao.edu.pe). Price not given, 242 pp., 6 1/2" × 9 1/8".

Summary.—"Of the 1845 new additions to the Peruvian flora, 840 are new taxa described from Peruvian material, 669 names are new records for Peru, and 336 are taxonomic changes. The new total for the flora is 18,652 species of seed plants. Some 480 new bibliographic records are listed."

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES X: DEFINICIÓN DE LA VERDADERA IDENTIDAD DE MANDEVILLA *LEPTOPHYLLA*, CON LA DESCRIPCIÓN DE DOS NUEVAS ESPECIES Y UNA NUEVA COMBINACIÓN DE *MANDEVILLA* (APOCYNOIDEAE: MESECHITEAE) PARA SUR AMÉRICA

J. Francisco Morales

Instituto Nacional de Biodiversidad
Apartado 22-3100
Santo Domingo, Heredia, COSTA RICA

RESUMEN

El estudio del tipo de *Mandevilla leptophylla* (A. DC.) K. Schum. ha revelado que el concepto de esa especie ha sido mal interpretado desde la última monografía del género. Por otro lado, el tipo de *Echites gracilis* Kunth, taxón incorrectamente tratado como un sinónimo de *M. subsagittata* (Ruiz & Pav.) Woodson, es coespecífico con el material referido hasta ahora como *M. leptophylla*. Por lo tanto, una nueva combinación, *M. gracilis* (Kunth) J.F. Morales es establecida, comentándose las relaciones entre este taxón y el verdadero concepto de *M. leptophylla*, incluyendose descripciones, ilustraciones y especímenes examinados de ambos taxones. *Mandevilla linearis* N.E. Br. es a su vez lectotipificado y reducido a la sinonimia de *M. gracilis*. Adicionalmente, dos nuevas especies de *Mandevilla* subgénero *Exothostemon*, *M. amazonica* y *M. colombiana*, ambas relacionadas con *M. gracilis*, son descritas e ilustradas, discutiendose sus afinidades taxonómicas

ABSTRACT

A study of the type collection of *Mandevilla leptophylla* (A. DC.) K. Schum. has revealed that the concept of this species has been misinterpreted since the last monograph of the genus. However, *Echites gracilis* Kunth, erroneously placed in synonymy of *M. subsagittata* (Ruiz & Pav.) Woodson, is conspecific with the material traditionally treated as *M. leptophylla*. Therefore, the new combination *M. gracilis* (Kunth) J.F. Morales is here proposed and the relationship with *M. leptophylla* is discussed. Clarifying descriptions, illustrations and specimen citations are included for both taxa. *Mandevilla linearis* N.E. Br. is lectotypified and relegated to the synonymy of *M. gracilis*. Two new species of *Mandevilla* subgenus *Exothostemon* (*M. amazonica* and *M. colombiana*) are also described and illustrated; their taxonomic affinities with *M. gracilis* are discussed.

El estudio de la colección tipo de *Mandevilla leptophylla* (A. DC.) K. Schum. ha permitido determinar que el concepto de esa especie manejado desde la última monografía del género (Woodson 1933) es incorrecto, dado que el tipo es totalmente discordante con la descripción y los especímenes examinados citados por Woodson (1933), perteneciendo incluso a un subgénero diferente. El tipo de *M. leptophylla*, el cual tiene corolas hipocrateriformes, proviene del estado de Bahia en Brasil y pertenece al subgénero *Mandevilla*, debido a sus láminas foliares con los coléteres agrupados en la base de la superficie adaxial del nervio central y tubo de la corola recto. Los especímenes citados por Woodson (1933), así como la descripción provista en su monografía, caracterizan a un taxón perteneciente al subgénero *Exothostemon*, debido a sus láminas foliares con coléteres distribuidos a lo largo de la superficie adaxial del nervio central y corolas infundibuliformes, con el tubo algo giboso basalmente. De esta manera, el concepto de *M. leptophylla* manejado desde la monografía de Woodson (1933), carece de un nombre disponible. Sin embargo, el estudio de especímenes tipo en el herbario de París (P), ha revelado que el tipo de *Echites gracilis* Kunth, incorrectamente reducido a la sinonimia de *Mandevilla subsagittata* (Ruiz & Pav.) Woodson por Woodson (1933), es concordante con el mal aplicado concepto de *M. leptophylla* manejado hasta ahora. Por lo tanto, la nueva combinación *M. gracilis* (Kunth) J. F. Morales es establecida, brindandose una descripción completa de ese taxón y de *M. leptophylla*, incluyendo ilustraciones, especímenes examinados y discusión de sus afinidades taxonómicas. Finalmente, se describen dos nuevas especies pertenecientes al subgénero *Exothostemon* (Woodson 1933), ambas relacionadas con *M. gracilis* y con hojas muy angostamente elípticas hasta casi lineares. A través de las descripciones, las partes de las corolas infundibuliformes siguen lo propuesto por Morales & Fuentes (2004).

Mandevilla amazonica J.F. Morales, sp. nov. (**Fig. 1**). Tipo. VENEZUELA. Amazonas: O de San Carlos de Rio Negro, 28 Nov 1977 (fl), *Liesner* 3968 (holotipo: INB; isotipo: MO).

A *Mandevilla colombiana* J.F Morales, cui similis, pedicellis minoribus 2–3 mm longis (vs. 8–12 mm), et corollae 1.8–2.2 mm diametro (vs. 3–3.5 mm), differt.

Liana; ramitas teretes a subteretes, sólidas, no huecas, muy diminuta y esparcidamente puberulentas cuando jóvenes, glabrescentes con la edad; coléteres interpeciolares inconspicuos, menos de 0.5 mm de largo. Hojas opuestas; pecíolos 1–2.5 mm de largo; láminas foliares 1.8–5.3 × 0.3–0.7 cm, angostamente linear-elípticas a angostamente linear-ovadas, el ápice agudo-mucronulado, la base auriculada y cordada, membranáceas, glabras a glabrescentes, con varios coléteres dispuestos en forma irregular a lo largo del nervio central adaxialmente, usualmente no revolutas marginalmente, la venación secundaria levemente impresa en ambas caras, la venación terciaria no evidente. Inflorescencia conspicuamente más larga que las hojas subyacentes, axilar, muy diminutamente y esparcidamente puberulenta, con 9 a 12 flores, pedúnculo 12–27 mm de largo, pedicelos 2–3 mm de largo, brácteas 1.5–2 × 0.5–1 mm, angostamente ovadas, escariosas; sépalos 2–2.2 × 0.9–1.2 mm, muy angostamente ovados, acuminados, el ápice usualmente no reflexo, algunas veces levemente reflexos distalmente, escariosos, glabrescentes, muy diminuta e inconspicuamente puberulentos, raramente inconspicua y esparcidamente puberulentos, el coléter solitario, entero, subentero a diminutamente lacerado;

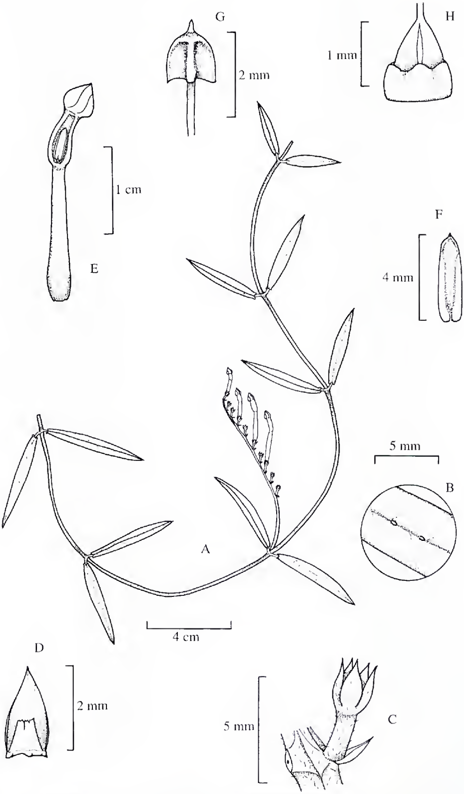


Fig. 1. *Mandevilla amazonica* (*Liesner 3968*, INB). **A.** Ramita con inflorescencias. **B.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. **C.** Cáliz, pedicelo y bráctea. **D.** Sépalo y coléter, vista adaxial. **E.** Tubo de un botón parcialmente abierto, mostrando la posición de las anteras y el tubo giboso. **F.** Antera, vista dorsal. **G.** Cabeza estigmática. **H.** Nectario y ovario.

corola hipocrateriforme, amarillo-anaranjada o amarillo-verdosa, la garganta rojiza interiormente, glabra externamente, el tubo 22–26 mm de largo, 1.8–2.2 mm de ancho, conspicuamente giboso, abultado en la posición de los estambres, el ápice del botón floral agudo; lóbulos 9–10 × 6–8 mm, obovados, extendidos, pero aparentemente crispados marginalmente; estambres insertos en la mitad distad del tubo de la corola, anteras 4–4.3 mm de largo, glabras dorsalmente, auriculadas basalmente, con las aurículas redondeadas, cabeza estigmática 1.4–1.6 mm de largo; ovario 1.2–1.5 mm de largo, glabro; nectario anular, ca. la mitad de la longitud del ovario, levemente pentalobulado. Folículos desconocidos.

Distribución, hábitad y ecología.—Endémica al estado de Amazonas en Venezuela, donde se encuentra creciendo en bosques alterados y áreas abiertas en elevaciones de 50–150 m. Especímenes con flores han sido recolectados en Noviembre y Diciembre.

Mandevilla amazonica es una especie bastante distintiva que se reconoce al instante por sus hojas muy angostas, 3–6 mm de ancho, con las láminas lineares o linear-elípticas, usualmente muy delgadas y frágiles al secar. Se encuentra cercanamente relacionada con *M. colombiana*, de la que se separa con facilidad por sus pedicelos más pequeños (2–3 mm vs. 8–12 mm), hojas con la venación secundaria impresa en ambas caras (vs. no impresa) y corola con el tubo mucho más angosto (1.8–2.2 mm vs. 3–3.5 mm). Adicionalmente y como consecuencia de sus láminas foliares angostamente linear-elípticas a angostamente linear-ovadas puede confundirse con *M. gracilis*, pero *M. amazonica* se separa al instante por su corola hipocrateriforme.

Especímenes examinados. **VENEZUELA. Amazonas:** S del aeropuerto de San Carlos de Río Negro, 3 Dic 1977 (fl), *Liesner 4153* (INB, MO).

Mandevilla colombiana J.F. Morales, sp. nov. (**Fig. 2**). Tipo: COLOMBIA. Caquetá: Solano, Paujil, río Caquetá, NO de Araracuara, 3 Dic 1993 (fl, fr), *Arbeláez & Sueroque 505* (holotipo: COL; isotipos: COAH, HUA, INB, U).

A *Mandevilla amazonica* J.F. Morales, cui affinis, pedicellis longiribus 8–12 mm longis (vs. 2–3 mm) et corollae 3–3.5 mm diametro (vs. 1.8–2.2 mm), differt.

Liana; ramitas teretes a subteretes, sólidas, no huecas, muy diminuta y esparcidamente papilado-puberulentas; coléteres intrapeciolares inconspicuos, menos de 0.5 mm de largo. Hojas opuestas; pecíolos 1–1.5 mm de largo; láminas foliares 4.5–5.5 cm × 2.5–4(–5) mm, lineares a linear-elípticas, agudas a agudo-mucronuladas apicalmente, la base cordado-auriculada, membranáceas, glabras, con los coléteres dispuestos en forma irregular a lo largo del nervio central adaxialmente, usualmente no revolutas marginalmente, raramente algunas hojas inconspicuamente revolutas, la venación secundaria y terciaria usualmente no impresa, algunas veces las venas secundarias inconspicuamente impresas abaxialmente. Inflorescencia más larga que las hojas subyacentes, axilar, glabra a glabrescente, usualmente con muchas flores, pedúnculo 16–18

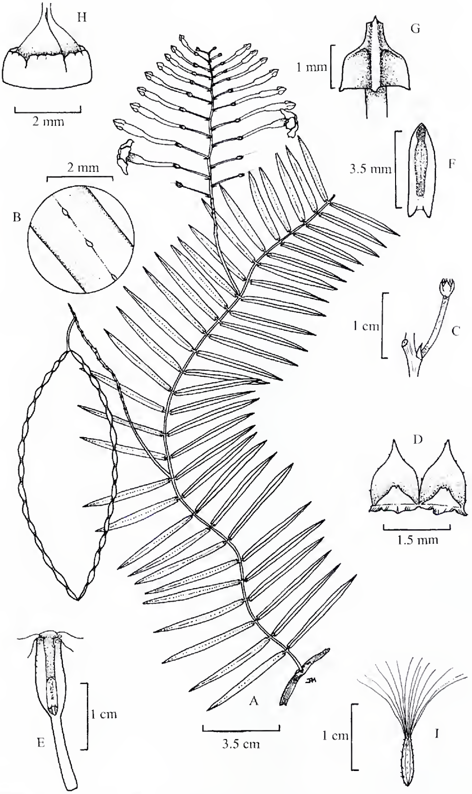


Fig. 2. *Mandevilla colombiana* (*Arbeláez & Sueraque 505*, HUA). **A.** Ramita con inflorescencia y frutos. **B.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. **C.** Cáliz, pedicelo y bráctea. **D.** Sépalos y coléteres, vista adaxial. **E.** Tubo de un botón parcialmente abierto, mostrando la posición de las anteras y el tubo basalmente giboso. **F.** Antera, vista dorsal. **G.** Cabeza estigmática. **H.** Nectario y ovario. **I.** Semilla.

mm de largo, pedicelos 8–14 mm de largo, brácteas 1.5–2 × 0.5–1 mm, ovadas, escariosas; sépalos 1.3–1.6 × 1–1.2 mm, muy angostamente ovados, acuminados, el ápice no reflexo, escariosos, glabros, glabrescentes o inconspicuamente puberulentos, inconspicuamente ciliolados marginalmente, coléter solitario subentero a variadamente lacerado apicalmente; corola hipocrateriforme, el tubo verde-rojizo, la garganta interiormente roja, los lóbulos amarillos, glabra externamente, el tubo 23–26 mm de largo, 3–3.5 mm de ancho, levemente giboso basalmente, el ápice del botón floral agudo; lóbulos 15–17 × 5–7 mm, obovados, extendidos y levemente reflexos y crispados marginalmente; estambres insertos en el extremo distal del tubo, anteras 4–4.5 mm de largo, glabras dorsalmente, auriculadas basalmente, con las aurículas obtusas, cabeza estigmática 1.7–2.1 mm de largo; ovario 1.5–2 mm de largo, glabro; nectario ca. la mitad de la longitud del ovario, levemente pentalobulado, el borde superior inconspicuamente eroso. Folículos 10.5–19 cm × 1.8–3 mm, muy esparcida e inconspicuamente puberulentos a glabrescentes, monilifomes; semillas 7–8 mm de largo, inconspicuamente puberulentas a glabrescentes, la coma 0.9–1.8 cm de largo, canela.

Distribución, hábitad y ecología.—Endémica al S de Colombia, en los departamentos de Amazonas y Caquetá, donde crece en vegetación asociada a afloramientos rocosos, así como vegetación secundaria en márgenes de quebradas y ríos, en elevaciones de 50–350 m. Especímenes con flores han sido recolectados en Noviembre, Diciembre y Marzo. Material con frutos ha sido recolectado a principios de Diciembre.

Mandevilla colombiana se encuentra relacionada con *M. amazonica*, otra especie de hojas lineares endémica al estado de Amazonas, en Venezuela. Aunque ambos taxones comparten algunos caracteres morfológicos, tales como la forma y el tamaño de las hojas, *M. colombiana* se reconoce por sus pedicelos más largos (8–14 mm vs. 2–3 mm) y flores con el tubo de la corola más angosto. Aunque también se puede confundir con *M. gracilis*, este último taxón tiene corolas infundibuliformes. *Mandevilla colombiana* también puede confundirse con *M. annulariifolia* Woodson y especies afines (e.g., *M. benthamii* (A. DC.) K. Schum.), pero este grupo de taxones se puede separar al instante por sus hojas verticiladas. El epiteto está dedicado a Colombia, país de belleza y diversidad florística incomparable, cuyo estudio de la flora me ha reportado una serie de novedades taxonómicas muy peculiares en los últimos años.

Especímenes examinados. **COLOMBIA. Amazonas:** Puerto Santander, trocha a La Chorrera, SO de Araracuara, 24 Nov 1993 (fl), *Cárdenas et al. 4206* (COAH, COL, INB); río Caquetá, Araracuara, Nov 1982 (fl), *Idrobo et al. 11265* (COL). **Caqueta:** Solano, Araracuara, río Caquetá, 3 Mar 1992 (fl), *Arbeláez & Restrepo 60* (COAH, HUA, INB, MO); Solano, Paujil, río Caquetá, NO de Araracuara, 27 Oct 1992 (fl), *Arbeláez et al. 273* (COAH); Solano, Araracuara, 25 Feb 1997 (fl, fr), *Arbeláez & Sueroque 743* (COAH), Araracuara, camino al Balcón del Diablo, 5 Mar 1986 (fl), *Palacios & Plazas 1204* (COAH); sierra de Chiribiquete, 24 Ago 1992 (fl), *Palacios et al. 2506* (COL).

Mandevilla gracilis (Kunth) J.F. Morales, comb. nov. (**Fig. 3**). Basiónimo. *Echites gracilis* Kunth, Nov. Gen. Sp. 3:219. 1818 [1819]. *Exothostemon gracile* (Kunth) G. Don, Gent. Syst. 4:82. 1838. Tipo: VENEZUELA. Amazonas: inter Cataractas Ature et Maypure, May (fl, fr), *Humboldt s.n.* (holotipo: P-HB; fotografías, INB).

Mandevilla linearis N.E. Br., Trans. Linn. Soc. London, Bot. 6:48. 1901, syn. nov. Tipo: GUYANA: Valle Kotinga, 1894 (fl), *McConnel & Quelch 194* (lectotipo: K, seleccionado aquí, fotografía en INB).

Lianas; ramitas teretes a subteretes, sólidas, no huecas, diminuta y esparcidamente puberulentas cuando jóvenes, glabrescentes con la edad; coléteres interpeciolares inconspicuos, hasta 0.3 mm de largo. Hojas opuestas; pecíolos 1-3 mm de largo; láminas foliares 2.5-7.5 × 0.2-0.8(-1.2) cm, lineares a linear-elípticas, angostamente agudas a angostamente acuminadas o mucronuladas apicalmente, la base levemente auriculado-cordada a angostamente cordada, firmemente membranáceas o subcoriáceas, glabras a glabrescentes adaxialmente, diminuta y densamente puberulentas a diminutamente tomentulosas abaxialmente, los coléteres irregularmente distribuidos a lo largo del nervio central adaxialmente, usualmente revolutas marginalmente, la venación secundaria y terciaria moderadamente impresa en ambas superficies, pero algunas veces las venas terciarias inconspicuas abaxialmente. Inflorescencia más corta o igualando las hojas subyacentes, axilar, diminutamente puberulenta a glabrescente, con 2 a 14 flores, pedúnculo 2-15(-20) mm de largo, pedicelos 1-2 mm de largo, brácteas 1.5-3.5(-5) × 0.5-1 mm, angostamente ovadas, escariosas; sépalos 1.7—2.3 × 1.1-1.6 mm, muy angostamente ovados, cortamente-acuminados apicalmente, el ápice no reflexo, escariosos, diminuta y esparcidamente puberulentos en la base a glabrescentes, el coléter solitario, subentero o irregularmente lacerado apicalmente; corola infundibuliforme, el tubo amarillo-anaranjado o matizado con rojizo, los lóbulos y la garganta amarilla, esparcida e inconspicuamente pilosulosa a glabra o glabrescente externamente, el tubo basalmente giboso, la parte inferior 23-29 mm de largo, 1.5-3 mm de diámetro, la parte superior 11-14 mm de largo, cónica, 10-16(-20) mm de diámetro en el orificio, el ápice del botón floral agudo-mucronulado o agudo-mucronado; lóbulos 8-20 × 6-18 mm, obovados, extendidos y algo reflexos marginalmente; estambres insertos en base de la parte superior del tubo; anteras 4.8-5.1 mm de largo, glabras dorsalmente, auriculadas basalmente, las aurículas obtusas a redondeadas, cabeza estigmática 1.2-1.4 mm de largo; ovario 1.5-1.9 mm de largo, glabro; nectario leve a moderadamente pentalobado, 1-1.3 mm de largo. Folículos 9-14 × 0.2-0.3 cm, glabros a glabrescentes, levemente moniliformes; semillas 6.3-8 mm de largo, glabras, coma 0.7-1.5 cm de largo, amarillo-café.

Distribución, hábitad y ecología.—Restringida al S de Venezuela (estados de Amazonas y Bolívar) y al O de Guyana, donde crece en sabanas y vegetación arbustiva asociada a afloramientos rocosas, así como en bosques de galería y

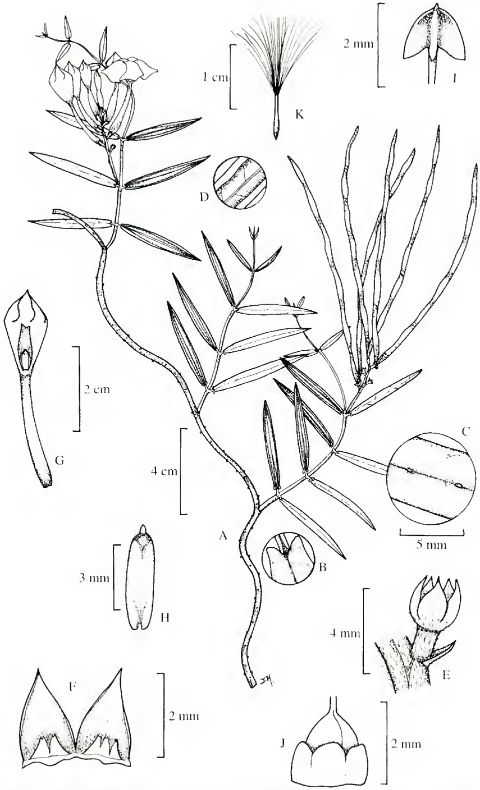


Fig. 3. *Mandevilla gracilis* (*Henkel et al. 5579*, INB). **A.** Ramita con inflorescencia y frutos. **B.** Detalle de la base auriculada de la lámina foliar. **C.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. **D.** Detalle de la superficie abaxial de la hoja, mostrando los bordes involutos. **E.** Cáliz, pedicelo y bráctea. **F.** Vista de la cara adaxial de dos sépalos, mostrando los coléteres. **G.** Tubo de un botón parcialmente abierto, mostrando la posición de las anteras y el tubo basalmente giboso. **H.** Antera, vista dorsal. **I.** Cabeza estigmática. J. Nectario y ovario. K. Semilla.

márgenes de bosques, en elevaciones de 750–1400 m. Especímenes con flores han sido recolectados de Marzo a Diciembre. Material con frutos se conoce en Marzo y de Septiembre a Diciembre.

Mandevilla gracilis pertenece al subgénero *Exothostemon*, donde se encuentra algo relacionada con *M. amazonica* y *M. colombiana*, pero se puede separar con facilidad por sus corolas infundibuliformes (vs. hipocrateriformes). Otras especies dentro del mismo subgénero con corolas infundibuliformes que ocasionalmente pueden presentar hojas con láminas lineares a linear-elípticas, incluyen a *M. lancifolia* Woodson y *M. nerioides* Woodson, pero estos dos taxones se distinguen de *M. gracilis* por sus hojas con los nervios secundarios dispuestos ca. en forma perpendicular en relación al nervio central (vs. arcuados), así como por sus ramitas jóvenes irregularmente acostilladas o aladas (vs. teretes a subteretes).

Echites gracilis fue incluido en la sinonimia de *Mandevilla subsagittata* (Ruiz & Pavon) Woodson por Woodson (1933, 1936), pero el tipo de *E. gracilis* tiene corolas claramente infundibuliformes, no hipocrateriformes como en *M. subsagittata*, por lo que debe ser removido de la sinonimia de este último taxón. Ahora bien, luego del análisis de los ejemplares tipo de *M. linearis* N. E. Brown y de *E. gracilis* es claro que ambos son coespecíficos. Ambos taxones comparten el mismo tipo de caracteres morfológicos en relación a la forma, dimensiones e indumento de las hojas, inflorescencias con brácteas escariosas, flores cortamente pediceladas, con los pedicelos usualmente inferiores a 5 mm de largo y corolas infundibuliformes, con la parte superior del tubo cónica. *Mandevilla linearis* fue considerado erróneamente como un sinónimo de *M. leptophylla* por Woodson (1933). Por lo tanto, debido a que *E. gracilis* tiene prioridad sobre *M. linearis* por ser un nombre más viejo, una nueva combinación se establece y el último taxón es relegado nuevamente a la sinonimia.

Mandevilla linearis es lectotipificado aquí. Dos sintipos fueron citados en la descripción original (Brown 1901), ambos colectados por McConnell y Quelch en las Guyanas. Estas dos colecciones se hayan montadas en una misma lámina y se encuentran depositadas en el herbario del Kew Botanical Garden (K). A pesar de que ambos sintipos se encuentran en buen estado de conservación, se designa la colección *McConnell & Quelch 194*, montada en la sección derecha, como el lectotipo, debido a que posee una inflorescencia completa, mientras que el otro sintipo (*McConnell & Quelch 132*) montado en la sección izquierda, carece de una inflorescencia completa.

Especímenes examinados. **VENEZUELA. Bolivar:** Sifontes, La Hoyada, O de Santa Elena de Uairén, Oct 1986 (fl), *Aymard 4654* (MO, PORT); Gran Sabana, S de La Ciudadela, 3 Dic 1973 (fl), *Davidse 4722* (MO), La Gran Sabana, entre El Dorado y Santa Elena, 4 Dic 1973 (fl), *Davidse et al. 4891* (MO); Gran Sabana, Maremán-Parú, N de Kama-Meru, 5 Abr 1985 (fl), *Holst et al. 2234* (INB, MO); alrededor de Santa Elena de Uairén, 25 Abr 1946 (fl, fr), *Lasser 1440* (NY, VEN); Gran Sabana, San Ignacio de Yuruaní, 7 May 1988 (fl, fr), *Liesner 24319* (MO); Gran Sabana, río Kukenán, base de monte Roraima, 24 Sep

1944 (fl), *Steyermark 58580* (F, MO); Gran Sabana, entre Kun y catarata de Rué-Merú, 2 Oct 1944 (fl), *Steyermark 59134* (F, MO); Gran Sabana, entre Divina Pastora y Santa Elena, 3 Oct 1944 (fl, fr), *Steyermark 59288* (F, MO); Gran Sabana, río Aponguao, S de El Dorado, 21 Dic 1970 (fl, fr), *Steyermark et al. 104181* (MO, VEN); Roscio, a lo largo del río Uairen, 1 Dic 1982 (fl), *Steyermark & Liesner 127413* (MO, VEN). **GUYANA.** Potaro-Siparuni, montañas Pakaraima, region superior del río Ireng, 4 Jul 1994 (fl), *Henkel 5450* (INB, P, US); región Potaro-Siparuni, montañas Pakaraima, cima Malakwalai-Tipu, 13 Jul 1994 (fl), *Henkel et al. 5579* (INB, P, US); región superior del río Mazaruni, sabana Haieka, cerca de villa Chinowieng, 21 Ago 1960 (fl), *Tillet & Tillet 45225* (NY).

Mandevilla leptophylla (A. DC.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. (**Fig. 4**). *Echites linearifolia* Stadelm., Flora 24(1 Beibl.):18. 1841, nom. illeg., no Desv. ex Ham., 1825. *Echites leptophylla* A. DC, Prodr. 8:455. 1844. *Amblyanthera leptophylla* (A. DC.) Müll. Arg., Fl. Bras. 6(1):142. 1860. *Mitozus leptophyllus* (A. DC.) Miers, Apocyn. S. Am. 220. 1878. TIPO: BRASIL. BAHIA: Catingas entre Villa Novam y Rainha, fecha perdida (fl) *Martius 2271* (HOLOTIPO: M, foto F neg. 20147, dibujo en F).

Liana; ramitas teretes a subteretes, sólidas, no huecas, diminutamente hispídulas, glabrescentes cuando viejas, coléteres interpeciolares conspicuos, 1.5–3 mm de largo, usualmente muy desarrollados en tallos maduros. Hojas opuestas; pecíolos (1–)2–3 mm de largo; láminas foliares 3.5–8 3 0.5–1.6(–2.2) cm, muy angostamente elípticas, muy angostamente ovado-elípticas a linear-elípticas, el ápice agudo, algunas veces cortamente mucronulado, la base obtusa a redondeada, algunas veces dispuestos sobre la costa del pecíolo, membranáceas, muy esparcidamente hispídulas adaxialmente, densamente hispídulas abaxialmente, con 2 ó 3 coléteres agrupados en la base del nervio central adaxialmente, el margen algunas veces levemente revoluto y ondulado, la venación secundaria y terciaria levemente impresa abaxialmente, usualmente inconspicua adaxialmente. Inflorescencia usualmente más larga que las hojas subyacentes, axilar a terminal, diminutamente hispídula, con 1 a 5 flores, pedúnculo 14–42 mm de largo, pedicelos 6–13(–17) mm de largo, brácteas ca. 1 mm de largo, angostamente ovadas, escariosas; sépalos 4–7 3 1–2 mm, angostamente ovados, largamente acuminados, el ápice usualmente reflexo, escariosos, diminutamente hispídulos, coléteres usualmente en pares, ubicados cerca de los márgenes, enteros a subenteros; corola hipocrateriforme, el tubo verde, los lóbulos púrpura intenso o rojizo-púrpura, la garganta verdosa, glabra a glabrescente externamente, el tubo 22–29 mm, 2.5–3.5 mm de ancho, no giboso, el ápice del botón floral angostamente agudo; lóbulos 11–18 3 8–13 mm, obovados, extendidos y reflexos; estambres insertos en la mitad distal del tubo, cerca de la boca, anteras 5.3–6 mm de largo, dorsalmente glabras, la base auriculada, con las aurículas redondeadas, cabeza estigmática 1.9–2.1 mm de largo; ovario 1.3–1.5 mm de largo, glabro; nectario anular, 0.4–0.5 mm de largo, irregularmente lobulado. Folículos desconocidos.

Distribución, hábitad y ecología.—Esta especie está restringida al E de Brasil, en los estados de Bahia y Minas Gerais, donde crece en formaciones de Caatingas,

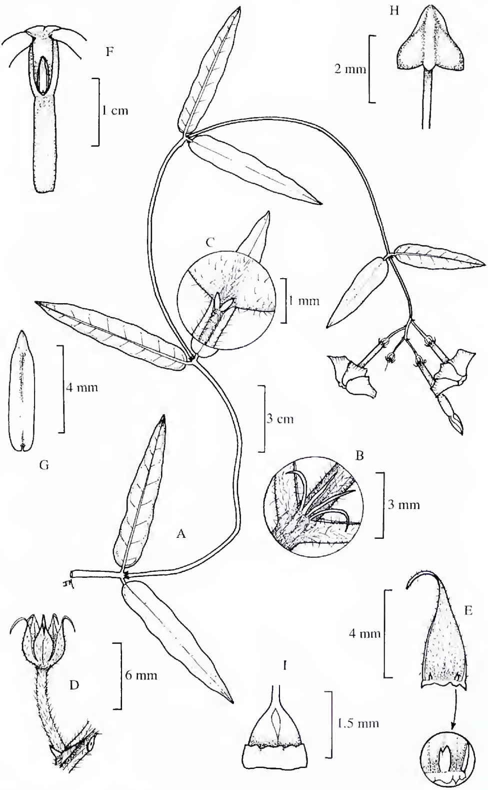


Fig. 4. *Mandevilla leptophylla* (*Taylor et al. 1481*, INB). **A.** Ramita con flores. **B.** Detalle de los coléteres interpeciolares. **C.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres agrupados en la base del nervio central. **D.** Cáliz, pedicelo y bráctea. **E.** Sépalo y coléteres, vista adaxial, mostrando el detalle de un coléter. **F.** Tubo de la corola parcialmente abierto, mostrando la posición de las anteras y el tubo no giboso. **G.** Antera, vista dorsal. **H.** Cabeza estigmática. **I.** Nectario y ovario.

en suelos rocosos graníticos y de arenisca, en elevaciones 400–700 m. Especímenes con flores han sido recolectados de diciembre a marzo.

En la última monografía del género, Woodson (1933) citó cinco colecciones examinadas bajo su concepto de *Mandevilla leptophylla*, dos ellas sintipos de *Mandevilla linearis* (*McConnell 132* y *194*, ambas de Guyana) y las otras tres pertenecientes a colecciones hechas en las Guyanas (*Tate 228*, *Schomburgk 383*) y Brasil (*Ule 8450*). Tal y como se infiere de los especímenes examinados, él no examinó el tipo de *M. leptophylla*, colectado por Martius en el estado de Bahia, Brasil. De esta manera, a través del estudio de todas las colecciones tipos de los nombres sinonimizados por Woodson, así como de los especímenes anteriormente citados (excepto la colección de Schomburgk destruida en 1943 y de la cual no se encontraron duplicados en los herbarios BM y K ni en otros herbarios europeos), se ha logrado determinar que en realidad ninguno de estos especímenes corresponden en realidad a *M. leptophylla* y todos ellos deben ser tratados como *M. gracilis*.

Mandevilla leptophylla fue erróneamente incluida en el subgénero *Exothostemon* por Woodson (1933), basado principalmente en la incapacidad de examinar la colección tipo. Esta especie debe ser transferida al subgénero *Mandevilla* por sus flores con el tubo de la corola recto, no giboso basalmente, así como por sus láminas foliares con los coléteres agrupados en la base del nervio central adaxialmente y sépalos con los coléteres dispuestos en forma alterna de acuerdo al arreglo quincuncial del sépalo y no en forma epicéntrica. Dentro del subgénero *Mandevilla*, *M. leptophylla* se puede confundir con *M. angustifolia* (Malme) Woodson, otro taxón con hojas linear-elípticas, pero *M. leptophylla* se puede reconocer por sus láminas foliares densamente hispídulas abaxialmente (vs. glabras), corolas hipocrateriformes (vs. infundibuliformes), con los lóbulos púrpura intenso a rojizo-púrpura (vs. rosado intenso o púrpura-rosado) y anteras más pequeñas (5.3–6 mm vs. 6.5–7.5 mm).

Especímenes examinados. **BRASIL. Bahia:** Bahia, Machado Portella, 30 Dic 1912 (fl), *Lützelburg 5035* (M); Rio de Contas, cerca de Livramento do Brumado, 6 Mar 1994 (fl), *Souza et al. 5279* (ESA, INB, K, SP). **Minas Gerais:** Monte Azul, cerca de Vila Angical, 29 Ene 1991 (fl), *Taylor et al. 1481* (BHCB, INB, K, Z).

AGRADECIMIENTOS

Se agradece a los siguientes herbarios por el préstamo y uso de sus colecciones: BHCB, COAH, ESA, F, HUA, K, M, MO, NY, P, PORT, VEN, SP, US, Z. Quiero agradecer al Kew Botanical Garden (K) y a David Goyder por facilitar una fotografía del especimen tipo de *Mandevilla linearis*. También quiero agradecer a las siguientes personas por facilitar el acceso a diferentes herbarios o brindar facilidades logísticas para la visita de los mismos: Lucille Allorge (P), Julio Betancur (COL), Ricardo Callejas (HUA), Asunción Cano (USM), Dairon Cárdenas (COAH), Álvaro Cogollo (JAUM), Wilson Devia (TULV), José Luis Fernández-Alonso (COL), Ramiro Fonnegra (HUA), Paul e Hiltje Maas (U), Francisco Javier

Roldán (HUA), Philip Silverstone-Sopkin (CUVC), Bruno Wallnöfer (W) y Homero Vargas (QCNE).

REFERENCIAS

BROWN, N.E. 1901. Report on two botanical collections made by Messrs. F. V. McConnell and J.J. Quelch at Mount Roraima in British Guiana. Trans. Linn. Soc. London, Bot. 2, 6: 1–108.

MORALES, J.F. y A. FUENTES. 2004. Estudios en las Apocynaceae Neotropicales VIII: nuevas especies de *Mandevilla* para Perú y Bolivia, con notas sobre la morfología floral en corolas infundibuliformes. Candollea 59:167–174.

WOODSON, R.E. 1933. Studies en the Apocynaceae IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 20:605–790.

WOODSON, R.E. 1936. Studies in the Apocynaceae. IV. The American genera of Echitoideae. Ann. Missouri Bot. Gard. 23:276—436.

BOOK REVIEW

JAMES L. CASTNER. 2004. **Photographic Atlas of Botany and Guide to Plant Identification.** (ISBN 0-9625150-0-0, spiral pbk.). Feline Press, P.O. Box 357219, Gainesville, FL 32635, U.S.A. (**Orders:** Feline Press, P.O. Box 357219, Gainesville, FL 32635, U.S.A.; jlcastner@aol.com). $40.00, 310 pp., color photographs, glossary, index, 8 1/2" × 11".

It has been said that a picture is worth a thousand words—this is very true for Castner's Photographic Atlas of Botany. Castner's book is a great resource for both beginners and professionals in the plant sciences field. The author presents the reader with plant anatomy and taxonomic traits in hundreds of precise color photographs. This is the book I wish I had had on my shelf when I started taking lab-based plant courses.

The author begins with an approximately 50 page pictorial guide to plant anatomy, roots, stems, leaves, flower structures, and fruit types. Castner includes photographs of live plants and microscopic anatomy of items such as roots stems and leaves. Included in the plant anatomy sections are images of leaf scars, specialized root/stem structures, leaf arrangement, leaf apices, leaf margins, flower structures, and flower anatomy as well as images of the different types of simple, multiple and aggregate fruits. The photographs presented include many cross and longitudinal sections among the various examples of each area of anatomy. For example, placentation types are shown in cross sections and multiple images of flower nectaries are provided. These perfectly composed photographs are unmistakable as to what they are depicting, thus providing a valuable resource to those learning plant anatomies or learning to use a flora key.

The majority of the book is devoted to plant taxonomy and shows photographs of the various plant families within the seedless vascular plants through the angiosperms. Each family section begins with traits given for each distinct family, as well as terminology that may be necessary to know while looking at the photographs associated with that family. The color photographs and labels within the photographs are crisp and clear, making traits easy to spot. Castner has collected a good diversity of photographs for the different families and subfamilies for the reader to view. The book finishes with a comprehensive glossary and helpful references.

James Castner's book *A Photographic Atlas of Botany and Guide to Plant Identification* is strongly recommended for those learning plant anatomy and taxonomy. This would make a wonderful reference text for botanical-based college courses. The book is organized by cladistic relationships between families which may frustrate some users, a "by family" index is included for those unfamiliar with such organization. This book is also a very reasonably priced, given the number and quality of the color photographs. These images make the task of learning plant anatomy and taxonomy easier because the photographs show the reader exactly what is being described. It can't be said enough that this photographic atlas is a fantastic resource for both beginners and professionals in the plant sciences. In fact, I recently purchased my own copy!—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES XI: UNA NUEVA ESPECIE DE *MANDEVILLA* (APOCYNOIDEAE: MESECHITEAE) PARA SUR AMÉRICA, CON UN NUEVO REPORTE PARA LAS APOCYNACEAE DE PARAGUAY

J. Francisco Morales

Instituto Nacional de Biodiversidad
Apartado 22-3100
Santo Domingo, Heredia, COSTA RICA

RESUMEN

El estudio de los tipos de *Mandevilla lasiocarpa* y de los nombres asociados a este taxón como sinónimos, revela que todos son sinónimos de *M. hirsuta* y que el taxón para el que Woodson empleó este nombre en su monografía necesita un nombre nuevo. Por lo tanto, se propone *Mandevilla matogrossana*, se describe e ilustra detalladamente, discutiéndose su relación con *M. hirsuta*. Adicionalmente, se propone una nueva lectotipificación para *Echites hirsuta* var. *angustifolia* Stadelm. y se cita por primera vez la presencia de *M. hirsuta* en Paraguay.

ABSTRACT

The study of the types of *Mandevilla lasiocarpa* and related synonymy has revealed that all of them are synonyms of *M. hirsuta* and the concept of the species *M. lasiocarpa* used by Woodson in his monograph don't has a name. Therefore, a new name is proposed and this taxon is described and illustrated. The relations with *M. hirsuta* are discussed. *Echites hirsuta* var. *angustifolia* Stadelm. is lectotypified and *M. hirsuta* is reported for first time from Paraguay.

Durante la preparación de una nueva monografía de *Mandevilla* (Apocynoideae, Mesechiteae), casi la totalidad de colecciones originales de las especies descritas hasta el día de hoy han sido examinadas, con el fin de comprobar la correcta aplicación de nombres y sinónimos. Como resultado, se han producido tratamientos regionales que han propuesto la sinonimización de varios nombres (Morales 1998), así como la descripción de varios taxones (e.g., Morales & Fuentes 2004). En este proceso, he determinado que el concepto de *M. lasiocarpa* (A. DC.) Malme, utilizado desde la monografía de Woodson (1933), carece de un nombre, pues tanto la colección tipo, como el resto de nombres sinonimizados bajo esa especie, representan especímenes de la común *M. hirsuta* (Rich.) K. Schum. Por lo tanto, se procede a una discusión de los nombres involucrados en este complejo y a la descripción de una nueva especie.

Echites lasiocarpa A. DC. fue descrito por Alphonse de Candolle (1844), basado en un especimen colectado por Manso en Cuiabá, en el estado de Bahia, Brasil y en el concepto de *Echites hirsuta* Ruiz & Pav. var. *latifolia* Stadelm., cuyo tipo es una colección de Martius, hecha en el estado de Bahia, Brasil, y que corresponde a *M. hirsuta*. Ahora bien, el mismo De Candolle no estaba seguro de la identidad del especimen en Ginebra (G), pues dicha colección solo tiene frutos y él mismo indicó en su tratamiento "specim. fructif. non certo." Este especimen, a pesar de poseer solo frutos, es concordante en el resto de caracteres morfológicos con *M. hirsuta*. El estudio de un duplicado de la colección de Manso, en el herbario de la Universidad Martín Luther (HAL), en Halle, Alemania, ha demostrado que definitivamente se trata de un típico especimen de *Mandevilla hirsuta*, ya que este especimen tiene flores, de las que fácilmente, basado en la forma cónica de la parte superior de la corola, se infiere que pertenece a *M. hirsuta*.

Ahora bien, en forma posterior Woodson (1933) redujo *Echites hirsuta* var. *angustifolia* Stadelm. a la sinonimia de *Mandevilla lasiocarpa*, así como *E. lasiocarpa* var *lobbiana* A. DC. El material tipo de *E. hirsuta* var. *angustifolia*, fue colectado por Martius en Porto D'Estrella, en el estado de Rio de Janeiro, Brasil, mientras que *E. lasiocarpa* var *lobbiana* fue descrita a partir una colección hecha por Lobb en el mismo estado. El estudio de ambas colecciones ha demostrado que a la vez, ambos especímenes pertenecen a *M. hirsuta*, dado la forma de la corola entre ambas es idéntica (infundibuliforme, con la parte superior del tubo cónica). Basado en la lista de especímenes examinados por Woodson en su monografía, es fácil inferir que él no examinó las colecciones originales de ninguno de estos taxones, pues no fueron citados entre los materiales estudiados y que probablemente, basó su descripción en las colecciones citadas en dicho trabajo, que en su mayoría, correspondían a especímenes colectados por Malme en Mato Grosso, con una colección adicional hecha por Ducke en el estado de Pará, Brasil. Así, aunque su concepto de *Mandevilla lasiocarpa* es correcto y de hecho las colecciones de Malme pertenecen a un taxón distinto a *M. hirsuta*, los tipos de todos los nombres que él incluye cono sinónimos, pertenecen a *M. hirsuta*. En todo caso, la preparación de una nueva monografía de *Mandevilla* ha demostrado que *M. hirsuta* tiene corolas infundibuliformes, con la parte superior del tubo de la corola cónico, y se encuentra ampliamente distribuida desde México hasta Brasil, Bolivia, Paraguay y las Antillas, mientras que el concepto de *M. lasiocarpa* usado desde la monografía de Woodson (1933), representa un taxón raro conocido por pocas colecciones, caracterizado por sus corolas angostamente subinfundibuliformes, pero pareciendo hipocrateriformes, distribuido principalmente en el estado de Mato Grosso, en Brasil, con un par de colecciones disyuntas del estado de Bolivar, Venezuela y del departamento de Santa Cruz, Bolivia y que hasta el momento, no se ha examinado ningún especimen que demuestre su presencia en las estados costeros de Brasil. Por todos los datos expuestos, se hace necesario sinonimizar adecuadamente los nombres y proponer una nueva especie para el concepto de *M. lasiocarpa* utilizado por Woodson (1933). Las descripciones de las partes de la corola siguen el concepto usado por Morales & Fuentes (2004).

Mandevilla matogrossana J.F. Morales, sp. nov. (**Fig. 1**). TIPO. BRASIL. MATO GROSSO: Peixoto de Azevedo, cerca de Matupá, en camino a río Xingu, 24 Abr 1997 (fl, fr), *Souza et al. 15671* (HOLOTIPO: INB; ISOTIPOS: ESA, MT).

A *M. hirsuta* (Rich.) K. Schum., cui affinis, corollae augusta subinfudibuliformis, faucibus 9–11 mm longis (vs. 14–24 mm longis) et 4–7 mm diametro (vs. 12–20 mm) differt.

Liana; ramitas cilíndricas a subcilíndricas, usualmente sólidas, algunas veces huecas, esparcidamente híspidas, híspidulas, pilosas a pilosulosas; coléteres interpeciolares inconspicuos, 0.5 mm de largo o menos. Hojas opuestas; pecíolos 12–37 mm de largo; láminas foliares 5–12(–13.5) × 2–6.5 cm, elípticas, obovado-elípticas a angostamente obovadas, abruptamente caudado-acuminadas apicalmente, la base cordada, con los coléteres dispuestos en forma irregular a lo largo del nervio central adaxialmente, membranáceas, esparcida a moderadamente estrigillo-seríceas adaxialmente, densamente a moderadamente seríceas abaxialmente, no revolutas marginalmente, la venación secundaria conspicua en ambas caras, la venación terciaria usualmente inconspicua e impresa adaxialmente, levemente impresa abaxialmente. Inflorescencia usualmente más larga o al menos igualando las hojas subyacentes, axilar, densamente a moderadamente tomentulosa o seríceo-tomentulosa, con muchas flores pequeñas, pedúnculo 18–58 mm de largo, pedicelos 5–8 mm de largo, brácteas 4–11 × 1–1.5(–2) mm, angostamente ovado-elípticas a angostamente elípticas, escariosas a algo subfoliáceas; sépalos 4–7 × 1–1.5 mm, muy angostamente ovados a angostamente linear-ovados, acuminados, el ápice no reflexo, subfoliáceos, esparcidamente a densamente seríceos, el coléter solitario, entero, subentero a inconspicuamente eroso apicalmente; corola angostamente subinfundibuliforme, pero pareciendo hipocrateriforme, el tubo verde o crema-verdoso, los lóbulos crema, la garganta púrpura interiormente, velutino-híspida a densamente híspida externamente, el tubo giboso, abultado en la posición de los estambres, la parte inferior 11–20 mm de largo, 2–2.5 mm de ancho, la parte superior 9–11 mm de largo, angostamente cilíndrica, 4–7 mm de diámetro en el orificio, el ápice del botón floral acuminado; lóbulos 14–22 × 11–14 mm, obovados, extendidos y algo reflexos distalmente; estambres insertos en la base de la parte superior del tubo, anteras 4–4.5 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas redondeadas, cabeza estigmática 1.1–1.3 mm de largo; ovario 1–1.3 mm de largo, glabro; nectario casi tan largo como el ovario, penta-lobulado, a veces casi totalmente dividido en cinco nectarios individuales. Folículos 10–14 × 0.2–0.3 cm, densa a moderademente villosos o hispidulosos, moniliformes; semillas 7–8.5 mm de largo, glabras, coma 1.5–2.3 cm de largo, café-canela.

Distribución, hábitat y ecología.—Conocida en el SE de Venezuela, Brasil (estado de Mato Grosso) y el NE de Bolivia, donde crece márgenes de carreteras y quebradas, así como en vegetación de sabanas y cerrados, en elevaciones de

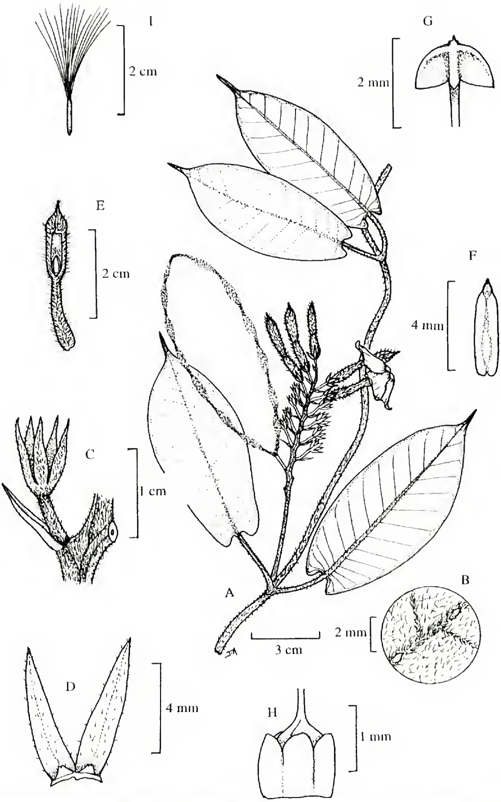


Fig. 1. *Mandevilla matogrossana* (*Souza et al. 15671*, INB). **A.** Ramita con inflorescencias y folículos. **B.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. **C.** Cáliz, pedicelo y bráctea. **D.** Sépalos y coléteres, vista adaxial. **E.** Botón floral parcialmente abierto, mostrando la posición de las anteras y el tubo basalmente giboso. **F.** Antera, vista dorsal. **G.** Cabeza estigmática. **H.** Nectario y ovario. **I.** Semilla.

50–350 m. Especímenes con flores y frutos han sido recolectados en febrero y de abril a julio.

En forma general, *Mandevilla matogrossana* ha sido tradicionalmente confundida con la común *M. hirsuta*, ya que en ausencia de flores, ambas especies son prácticamente idénticas, compartiendo forma y tamaño de hojas, inflorescencias, indumento y folículos similares. Sin embargo, la forma de la corola es determinante para separar ambas especies. De esta forma en *M. hirsuta* la parte superior de la corola es anchamente cónica (Fig. 2), mientras que en *M. matogrossana* en angostamente subinfundibuliforme y relativamente cilíndrica, dando la apariencia de una corola hipocrateriforme (Fig. 1 E). Asimismo, *M. matogrossana* puede ser confundida con *M. pavonii* (A. DC.) Woodson pero esta última especie tiene corolas hipocrateriformes (vs. angostamente subinfundibuliformes), sépalos más cortos (2.5–3 mm vs. 4–7 mm) y corolas con los tubos más largos.

El nombre de esta especie hace referencia al estado de Mato Grosso, Brasil, dado que la mayoría de colecciones conocidas provienen de esa zona geográfica.

Especímenes examinados. **VENEZUELA. Bolivar:** SO de Monteco, camino a San Pedro de las Dos Bocas, 1 Ago 1978 (fl, fr), *Liesner & González 5966* (MO). **BRASIL. Mato Grosso:** Alto Paraguai, carretera Currupira-Arenápolis, 27 Ene 1995 (fl), *Dubs 1793* (K, MBM, Z); Cuiabá, 5 Dic 1893 (fl), *Malme 1196* (BM, S, US); São Félix do Araguaia, 22 Mar 1997 (fl), *Souza et al. 14887* (ESA, MT); Alta Floresta, Fazenda Pontal, 19 Abr 1997 (fl), *Souza et al. 15097* (ESA, MT, UEC); Guarantã do Norte, Serra do Cachimbo, 26 Abr 1997 (fl), *Souza et al. 15873* (ESA, MT); Parecis, Diamantino, Fazenda Camargo, 22 May 1997 (fl, fr), *Souza et al. 16922* (ESA, INB); Aripuanã, carretera Juruena–Aripuanã, 9 Jul 1997 (fl, fr), *Souza et al. 18518* (ESA, INB, MT). **Pernambuco:** Catucá, fecha perdida (fl, fr), *Gardner 1061* (K); Caruaru, Murici, Brejo dos Cavalos, 22 Jul 1994 (fl), *Sales & Rodal 221* (PEUFR, US). **BOLIVIA. Santa Cruz:** Ñuflo de Chavez, S de Concepción, 26 Feb 1998 (fl, fr), *Wood et al. 13118* (K [2 láminas]).

TRATAMIENTO TAXONÓMICO

Mandevilla hirsuta (Rich.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. *Echites hirsuta* Rich., Actes Soc. Hist. Nat. Paris 1:107 1792. *Mandevilla tomentosa* var. *hirsuta* (Rich.) Kuntze, Revis. Gen. Pl. 2:416. 1891. Tipo. GUYANA FRANCESA: Cayenne, 1792 (fl), *Leblond 387* (lectotipo, designado por Allorge-Boiteau (1998), P-LA; isolectotipos: G-DC (foto F neg. 26863), P [2 láminas]).

Echites lasiocarpa A. DC. Prodr. 8:463. 1844. *Temnadenia lasiocarpa* (A. DC.) Miers, Apoc. S. Am. 210. 1878. *Mandevilla lasiocarpa* (A. DC.) Malme, Bih. Kongl. Svenska Vetensk.-Akad. Handl. 24 (3/10):25. 1899, syn. nov. Tipo. BRASIL. Bahia: Cuiabá (citado como Cuyabá), fecha perdida (fl, fr), *Manso 29* (holotipo: G-DC; isotipo: HAL).

Echites hirsuta Ruiz & Pav. var. *angustifolia* Stadelm., Flora 24(1):Beibl. 28. 1841. *Echites lasiocarpa* A. DC. var. *angustifolia* (Stadelm.) A. DC., Prodr. 8:463. 1844, syn. nov. Tipo. BRASIL. Rio de Janeiro: Porto d'Estrella, fecha perdida (fl), *Martius 162* (lectotipo: M, designado aquí, fotocopia, INB).

Echites hirsuta Ruiz & Pav. var. *latifolia* Stadelm., Flora 24(1):Beibl. 27. 1841. Tipo. BRASIL. Bahia: Datos perdidos (fl), *Martius s.n.* (holotipo: M, fotocopia, INB).

Echites lasiocarpa A. DC. var. *lobbiana* A. DC., Prodr. 8:464. 1844. *Temnadenia lobbiana* (A. DC.) Miers, Apocyn. S. Amer. 209. 1878, syn. nov. Tipo. BRASIL. Rio de Janeiro: montaña de Orgaos, fecha perdida (fl), *Lobb s.n.* (holotipo: G-DC; isotipo: K).

Fig. 2. Detalle de un corte longitudinal de *M. hirsuta*, mostrando la forma cónica de la parte superior del tubo de la corola.

Echites hirsuta Ruiz & Pav. var. *angustifolia* Stadelm. es lectotipificado y la colección de *Martius 162* designado como el lectotipo, dado que el otro sintipo citado en la descripción original (*Pohl s.n.*) no pudo ser localizado entre las colecciones originales depositadas en los principales herbarios europeos ni norteamericanos.

El tratamiento más reciente de las Apocynaceae de Paraguay (Escurra et al. 1992), reportó un total de 16 géneros nativos y 49 taxones, de las cuales siete corresponden a especies de *Mandevilla*. Mientras revisaba material en el herbario de Ginebra (G), un especimen colectado por Bernardi en el departamento de Canendiyú, representa la primera colección conocida de *M. hirsuta* para Paraguay, lo que convierte a esta especie en el taxón con la más amplia distribución del género, conocido ahora desde el S de México hasta el S de Brasil, Paraguay, Bolivia, y las Antillas.

Especímenes examinados. **PARAGUAY. Canendiyú:** Salto del Guairá, 25 Oct 1978 (fl), *Bernardi 18173* (G).

AGRADECIMIENTOS

Se agradece a los siguientes herbarios por el envío de material en préstamo, BM, ESA, G, HAL, K, M, MO, MT, S, US, Z y en forma especial a ESA y MO, por el numeroso envío de material como regalo por identificación.

REFERENCIAS

Allorge-Boiteau, L. 1998. New combinations in *Odontadenia* and *Mandevilla* (Apocynaceae). Phytologia 84:304–306.

De Candolle, A. 1844. Apocynaceae, en, A de Candolle, ed. Prodromus systematis naturalis regni vegetabilis. Treuttel & Würtz, Paris. Paris. 8:317–489.

Ezcurra, C., M.E. Endress y A.J.M. Leeuwenberg. 1992. Fl. Paraguay. Conservatoire et Jardin botaniques de la Ville de Genève, Switzerland, Missouri Botanical Garden, St. Louis, U.S.A. 17:1–121.

Morales, J.F. 1998. A synopsis of the genus *Mandevilla* (Apocynaceae) in Mexico and Central America. Brittonia 50:214–233.

Morales, J.F. y A. Fuentes. 2004. Estudios en las Apocynaceae Neotropicales VIII: nuevas especies de *Mandevilla* (Apocynoideae, Mesechiteae) para Perú y Bolivia, con notas sobre la morfología floral en corolas infundibuliformes. Candollea 59:167–174.

Woodson, R.E. 1933. Studies en the Apocynaceae IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 20:605–790.

BOOK REVIEW

Peter Loewer. 2005. **Seeds: The Definitive Guide to Growing, History & Lore.** (ISBN 0-88192-682-5, pbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $17.95, 229 pp., approx. 48 b/w illus., tables, index, 6 1/8" × 9 1/4".

Seeds: The Definitive Guide to Growing, History & Lore by Peter Loewer is an informative, easy to read, and entertaining book covering many topics relating to plant seeds. This book is especially useful because no botanical background is required to understand the text. Any necessary information on seed anatomy, ecological and botanical aspects is described by the author and often illustrated with black and white drawings. Mr. Loewer left no seed related topic out, including chapters on seed chemistry, plant families, flower pollination, seed longevity, dispersal, germination, the buying and selling of seeds, seed companies, seed collectors, collecting your own seed, seed diversity, and seed references galore. All topics are accompanied by a treasure trove of plant and interesting story examples.

The first few chapters cover the basics of plant families, flower pollination, seed chemistry, genetics, seed dispersal, and seed germination. The basic process of germination is described thoroughly with both text and pictures. Loewer goes into more detail in another chapter on specifics for germination such as storage, temperature, moisture, light, and a "paper towel" method of efficiently germinating seeds. A number of intriguing experiments on seed longevity are discussed including historical lore and storage recommendations for enthusiasts.

A number of chapters are devoted to the business of seeds because, after all, the business of seeds is big business. The chapter on buying and selling seed is truly eye-opening. The chapter includes a history of seed sales from Christopher Columbus and the Jamestown settlers buying staple crops to the first flower seed mail-order catalogs. In addition to the historical review of seed sales, a few seed company owners and their companies are profiled. The author also includes a chapter that introduces the reader to the many other businesses built on and around seeds; for instance businesses that make seed germinating equipment, special fungicidal seed coatings, and seed development companies.

There are a couple of chapters for the seed collector. They contain such useful information as how to collect, seed company contact information, and seed exchange information. To aid in your collection ventures, a variety of seed starting guides and informational handbooks are also recommended. A couple of extraordinary seed collectors are profiled in this chapter, Chris Chadwell of the Sino-Himalayan Plant Association for example.

The closing chapters offer guidance and suggestions to increase your success with starting seeds. The reader is taken through the process from choosing seed, seed starting medium, soil sterilization, labeling, propagation frames, seed starting conditions, seed sowing containers, lighting, emergence, hardening off and into the garden bed. The author stresses the importance of record keeping and proper labeling to help increase chances of success year after year. Also included are suggestions for starting ferns from spores.

Seeds: The Definitive Guide to Growing, History & Lore is a joy to read. This book is full of interesting stories, histories, examples, and useful information on learning about seeds and success with seed gardening. One of the most valuable reasons for buying this book is the large list of reference information including contact information for seed companies, exchange groups, literary resources, plant societies, and supplies. The book is recommended for anyone with an interest in seed history, lore, gardening, or how little things like seeds grow to become big business.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NEW SPECIES AND NEW COMBINATIONS IN *ERICAMERIA* (ASTERACEAE: ASTEREAE)

Roland P. Roberts[1]

Department of Biological Science
Towson University
Towson, Maryland 21252, U.S.A.
rroberts@towson.edu

Lowell E. Urbatsch

Department of Biological Science
Louisiana State University
Baton Rouge, Louisiana 70803, U.S.A.
leu@lsu.edu

John Anderson

Bureau of Land Management
Phoenix Field Office
21605 North Seventh Avenue
Phoenix, Arizona 85207
John_Anderson@blm.gov

ABSTRACT

One new species of *Ericameria* is described and two new combinations are proposed. Using morphological and molecular evidence we describe ***Ericameria arizonica*** Roberts, Urbatsch, & Anderson, presently known only from the Grand Canyon, Arizona, and propose the elevation of *E. discoidea* var. *linearis* and *E. discoidea* var. *winwardii* to species rank as ***E. linearis*** (Rydb.) Roberts & Urbatsch and ***E. winwardii*** (Dorn & Delmatier) Roberts & Urbatsch, respectively.

RESUMEN

Se describe una nueva especie de *Ericameria* y se proponen dos nuevas combinaciones. Usando datos morfológicos y moleculares, describimos **Ericameria arizonica** Roberts, Urbatsch, y Anderson, conocida solamente de El Gran Cañón, Arizona, y proponemos la elevación de *E. discoidea* var. *linearis* y *E. discoidea* var. *winwardii* a nivel de especie como **E. linearis** y **E. winwardii**, respectivamente.

Sequence-based phylogenetic investigations and taxomomic studies of *Ericameria* done, in part, for preparing the treatment to appear in Flora North America (Asteraceae: Astereae) have revealed one previously undescribed species and indicate that two known varieties would be more appropriately treated at specific rank. *Ericameria arizonica* from Arizona is herein described as new and *E. discoidea* (Nutt.) G.L. Nesom var. *linearis* (Rydb.) G.L. Nesom and *E. discoidea* (Nutt.) G.L. Nesom var. *winwardii* Dorn & Delmat. are raised to the rank of species as *E. linearis* and *E. winwardii*. ETS/ITS sequence data (Roberts & Urbatsch 2003, 2004; Urbatsch et al. 2003) were invaluable in circumscribing the genus that in recent decades had been the subject of numerous investigations (Urbatsch 1978; Urbatsch & Wussow 1979; Nesom 1990; Nesom et al. 1990; Nesom & Baird 1993; Anderson 1995; Urbatsch & Roberts 2004). Although low levels of interspecific sequence variation disallowed an assessment of detailed

---

[1] Author for correspondence.

SIDA 21(3): 1557–1564. 2005

relationships among species, such data were not inconsequential either and offered some support for our present taxonomic decisions. *Ericameria*, in its most recent rendition, consists of 36 species that occupy arid habitats of western North America ranging from northern Mexico northward into Canada. Two species are restricted to Baja California, *E. juarezensis* (Moran) Urbatsch and *E. martirensis* Wiggins, while the other 34 grow in part or wholly north of Mexico.

NOMENCLATURAL TREATMENT

Ericameria arizonica R.P. Roberts, Urbatsch & J. Anderson, sp. nov. (**Fig. 1**). TYPE: U.S.A. ARIZONA. Coconino Co.: Grand Canyon National Park, South Rim, Mather Point, eastern edge of view point E of paved walkways, north-facing Kaibab Limestone cliff edges shaded by pinyon pine, 1 Oct 1998, *N. Brian 98-291* (HOLOTYPE: ASC!).

Frutices ad 0.5 m alti; caules ramosi resinosi glandibus stipitatis; folia ascendentia vel effusa elliptica vel anguste oblanceolata 10–35 mm longa 2–5 mm lata glandulosa typice resinosi-punctata; involucra obconica 5.5–7.5 mm longa 2.5–4 mm lata; phyllaria 4–5-seriata valde gradata lanceolata ad elliptica 2–7 mm longa 0.5–1.2 mm lata, apicibus acutis ad cuspidatis aliquando acuminatis; capitula radiata, flosculis 12–20; flosculi radii 1–8; flosculi disci 5–15, corollis 5–7 mm longis, ramis stylorum 2–2.7 mm longis, appendicibus stylorum 1.3–1.7 mm longis, cypselae 4–5.5 mm longae glabrae vel dense sericeae; pappi albidi 4–5.5 mm longi.

Shrubs to 0.5 m. Stems branched, bark reddish tan becoming darker when older, stipitate glandular, usually resin coated. Leaves ascending to spreading, elliptic to narrowly oblanceolate, 10–35 × 2–5 mm, flat to somewhat concave adaxially, margins entire, glandular, typically resin-dotted, apices acute, apiculate, midvein evident and 1–2 fainter collateral veins often present; axillary fascicles of leaves absent. Capitulescences of cymose clusters to 4 cm wide. Involucres obconic, 5.5–7.5 × 2.5–4 mm. Phyllaries in 4–5 series, strongly graduated, tan, lanceolate to elliptic, 2–7 × 0.5–1.2 mm, mostly chartaceous, margins abruptly constricted at base of appendage, apices acute to cuspidate, sometimes long acuminate, usually recurved, midvein faintly evident, often resin dotted. Capitula radiate, flowers 12–20. Ray flowers 1–8, laminae elliptic, 3–4 × 0.8–1.3 mm. Disc flowers 5–15, corollas 5–7 mm, tubes glabrous, lobes 0.5–1 mm. Style-branches 2–2.7 mm, appendages attenuate, 1.3–1.7. Cypselae 4–5.5 mm, glabrous to densely sericeous. Pappi whitish-tan, 4–5.5 mm.

Etymology.—*Ericameria arizonica* is named for Arizona, the only state from which this species is presently known.

Distribution, ecology, and phenology.—The species has been collected from several sites along the south rim of the Grand Canyon where it grows on steep limestone cliffs, ca. 2100–2300 m. Flowering occurs in September and October. Chromosome number unknown.

Discussion.—*Ericameria arizonica* is allied to *E. cervina* (S. Watson) Rydb., a species that typically occurs on granitic and other non calcareous substrates. *Ericameria arizonica* is distinguished from *E. cervina* by having stipitate glandular hairs especially on its inflorescence branches, much narrower, elliptic to

NATIONAL PARK SERVICE NPS FORM 10-512 (JUNE 1982)
Park Code
Technical Name Haplopappus cervinus Wats.
(=Ericameria cervina (Wats.) Rydb.)
Cat No
Common Name Antelope goldenbush
Acc No
Compositae
Locality Mather Point, eastern edge of view point, east of the paved walkways, north facing Kaibab Limestone cliff edges shaded by pinyon pine, South Rim, Grand Canyon National Park, Coconino Co., AZ
Elevation ca. 7,100 ft
Habitat Broken cliff edge of Kaibab Limestone, uncommon at this site
Det. & Collected By Nancy Brian 98-291
Date Oct. 1, 1998
HERBARIUM COLLECTION

Fig. 1. Holotype for *Ericameria arizonica*, *N. Brian 98-291* (ASC). Size marker in lower left corner equals 1 cm.

narrowly obovate leaves, more acute phyllary apices, and its occurrence on limestone substrates (Figs. 1, 2). It is distinguished from *E. nana* Nutt., another species in this complex, by its taller stature, more widely spaced leaves, acute phyllaries, lack or reduction of axillary leaf fascicles, and the presence of stipitate glandular pubescence. Certain specimens, mostly from Nevada, such as *Train 2494* (WTU), 20 mi W of Panaca in Lincoln County, are similar to *E. arizonica* in leaf form but lack the stipitate glands and possess axillary fascicles of leaves. Relationships among such populations are not presently known.

Samples of all three taxa were included in the macromolecular-based investigations of *Ericameria* (Roberts & Urbatsch 2003), where less than 1% divergence was detected among their ETS/ITS sequences. Similar sequence differences for this region of DNA were observed among more distantly related species of *Ericameria*. *Ericameria arizonica* and *E. cervina* consistently occurred in a clade with *E. lignumviridis* (S.L. Welsh) G.L. Nesom, *E. nana*, *E. obovata* (Rydberg) G.L. Nesom, and *E. watsonii* (A. Gray) G.L. Nesom. Relationships of *E. arizonica*, designated "*E. cervina* 1" in our above cited molecular study, within this lineage were usually unresolved. The relationship of *E. cervina*, designated "*E. cervina* 2" in the molecular study, was sometimes weakly associated with *E. nana*. Despite the lack of sequence divergence among these species, they are clearly distinguished by morphological traits and substrate preferences.

PARATYPES. **U.S.A. Arizona: Coconino Co.:** Grand Canyon, hotel to Hopi Point, near rim, 6900 ft, 5 Jun 1927, *Blake 9818* (US); top of Lookout Trail near rim, 6900 ft, 5 Jun 1927, *Blake 9815* (US); South Rim, Maricopa Point, NE edge of the fenced enclosure E of Lost Orphan Mine, vertical edges and cliff breaks in north-facing Kaibab Limestone, ca. 7000 ft, 8 Sep 1998, *Brian 98-279* (ASC); trail from Grand View, 26–28 Sep 1913, *Eastwood 3580* (CAS); Bright Angel Trail, 22 Oct 1905, *Eastwood 16* (US); same locality, *Eastwood 18* (US); head of Bright Angel Trail, common on limestone only along the rim, 6800 ft, 26 Sep 1920, *Hall 11191* (DH); Grand View, 7400 ft, growing from cleft in rock, 26 Sep 1920 (DH); Grand View Trail, 22 Aug 1907, *Thornber & Hockdoerffer 2931* (CAS).

Ericameria linearis (Rydberg) R.P. Roberts & Urbatsch, comb. nov. BASIONYM *Macronema lineare* Rydberg, Mem. New York Bot. Gard. 1:384. 1900. *Haplopappus macronema* A. Gray subsp. *linearis* (Rydberg) H.M. Hall, Carnegie Inst. Wash. Publ. 389:206. 1928. *Haplopappus macronema* var. *linearis* (Rydberg) R.D. Dorn. Vasc. Pl. Wyoming 295. 1988. *Ericameria discoidea* (Nutt.) G.L. Nesom var. *linearis* (Rydberg) G.L. Nesom. Phytologia 68:153. 1990. TYPE: U.S.A. WYOMING: Teton Forest Reserve, N.W. Wyoming, Gros Ventre River. *Tweedy 557* (HOLOTYPE: NY).

Distribution, ecology, and phenology.—*Ericameria linearis* grows on dry, stony slopes at elevations around 2300 m and flowers from late summer into fall. It has been documented for Beaverhead County in southwestern Montana and in Fremont, Park, Sublette, and Teton counties in northwestern Wyoming.

Discussion.—Leaves linear in shape, 1–2.5(3) mm wide, pubescence glandular or rarely glabrous, sometimes floccose-tomentose but still glandular; and involucres less than 11 mm tall characterize *Ericameria linearis*. Its probable sister taxon, *E. discoidea*, differs in having glandular but otherwise glabrous,

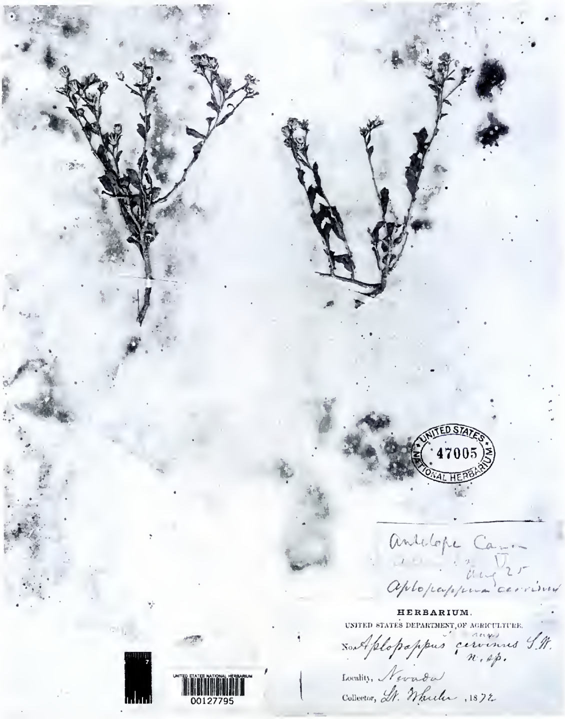


Fig. 2. Portion of probable isotype for *Ericameria cervina* based on *Haplopappus cervinus* Wats., Utah, Antelope Canyon, 1872, *Wheeler* (US). Size marker in lower left corner equals 1 cm.

oblong to oblanceolate leaves, mostly wider than 3 mm often with crisped margins and a darker green color, and involucres 10–13 mm tall. *Ericameria linearis* grows in southwestern Montana and northwestern Wyoming. Except for the possibility of its being sympatric with *E. discoidea* in southwestern Montana, the geographic ranges for the two species do not overlap. The latter is widespread in mountainous areas of southeastern Oregon, east-central California, Nevada, Utah, and Colorado; and it is not known from Wyoming. *Ericameria linearis* grows at lower altitudes than *E. discoidea* and for the most part at higher latitudes. Rydberg (1900) originally described *E. linearis* as a distinct species in the genus *Macronema* that, for the most part, is now included within the concept of *Ericameria*. Hall (1928) reduced the species to subspecific rank in *Haplopappus macronema* A. Gray, and others have likewise retained its infraspecific status. We restore the taxon to specific rank based on its morphological differences and its restricted, putatively allopatric distribution.

Ericameria winwardii (R.D. Dorn & C.H. Delmatier) R.P. Roberts & Urbatsch, stat. nov. *Ericameria discoidea* var. *winwardii* Dorn & Delmatier, Madroño 52:63. 2005. TYPE. U.S.A. WYOMING. Lincoln Co.: ca. 11 mi SW of Kemmerer, 41° 42 471' N, 110 43.381 W, 2135 m, 26 Jul 2002, *Dorn 9393* (HOLOTYPE: RM, ISOTYPES: BRY, COLO, IDS, MO, NY).

Distribution, ecology, and phenology.—*Ericameria winwardii* is known from Bear Lake County, Idaho, and Lincoln County, Wyoming. It grows on silty-clay and clay-shale slopes between 2050 and 2150 m (Dorn & Delmatier 2005). Flowering occurs late summer to fall.

Discussion.—Dorn and Delmatier (2005) observed a greater similarity of *Ericameria winwardii* to *E. linearis* than to *E. discoidea* on the basis of leaf form and pubescence. *Ericameria winwardii* is readily distinguished from *E. linearis* and *E. discoidea* by its smaller stature, floccose-tomentose pubescence throughout, absence of glandular hairs, and 10 or fewer florets per capitulum. Its stems lack the white, felt-like tomentum characteristic of *E. discoidea*. *Ericameria winwardii* appears to grow in finer, moister, less sloping soils than the other two species which are adapted to dry, well-drained, stony slopes and alpine fellfields (Hall 1928). We initially thought specimens of *E. winwardii* represented *E. linearis* but soon learned of their differences. Dorn and Delmatier (2005) independently concluded that *E. winwardii* represented an undescribed taxon, which they elected to treat as a variety within the *E. discoidea* complex. We conclude that it deserves specific rank due to its unique morphology, restricted, allopatric distribution, and adaptation to different edaphic conditions.

The sequence-based investigations of Roberts and Urbatsch (2003) included *Ericameria winwardii* (identified as *E. discoidea* var. *linearis* in that study) and typical *E. discoidea* (Nutt.) G.L. Nesom. In the combined analyses of the ETS/ITS data both taxa were placed in a lineage with *E. nauseosa* (Pall. ex Pursh) G.L. Nesom & G.I. Baird and *E. parryi* (A. Gray) G.L. Nesom & G.I. Baird. The former and latter pairs of taxa were sister in the Bayesian analysis of the ETS data, whereas, the combined ETS/ITS resulted in a trichotomy consisting of *E. discoidea* and *E. winwardii* with the third branch supporting *E. nauseosa* and *E. parryi*. Relationships among these taxa were unresolved within *Ericameria* when the ITS data were analyzed independently. As with *E. arizonica*, the percent sequence divergence among these taxa was comparable to that of other species in the genus (Roberts & Urbatsch 2003). Such low levels of divergence might indicate a relatively recent radiation of taxa or some measure of long generation time such that mutations in ETS and ITS regions accumulate slowly. Taxa in the *E. discoidea/nauseosa* lineage are characterized by a dense felty to floccose tomentum on some or all of their organs. Another measure of similarity among species in this clade is their ability to hybridize. Anderson and Reveal (1966) demonstrated the intermediacy of *E.* ×*bolanderi* (A. Gray) G.L. Nesom & G.I. Baird between *E. discoidea* and *E. nauseosa* in several morphological and anatomical characters providing abundant, circumstantial evidence for its hybrid origin. At the time of their study the putative parental taxa were regarded as belonging to different genera, *Halopappus* section *Macronema* and *Chrysothamnus*. Subsequently, Anderson (1984) provided evidence for hybrids forming between *E. nauseosa* and *E. parryi* resulting in a stabilized derivative taxon regarded by Nesom and Baird (1993) as *E.* × *uintahensis* (L.C. Anderson.) G.L. Nesom & G.I. Baird.

Despite the low level of resolution based on sequence data, *Ericameria discoidea*, *E. linearis*, and *E. winwardii* are morphologically distinct and apparently geographically allopatric. Observations of populations in nature suggest divergence in edaphic adaptations for *E. winwardii* compared to *E. discoidea* and *E. linearis* (Dorn & Delmatier 2005). Features of the leaves including shape, pubescence and margin characteristics can be used to distinguish among them. Distributional data indicate that the geographical ranges for the three taxa are distinct (Dorn & Delmatier 2005).

ACKNOWLEDGMENTS

The authors thank the curators and staff personnel of ASC, ASU, BRY, CAS, DH, RM, UNLV, US, UT, and WTU for specimen loans on which this and related research was based. We also thank Kurt Neubig for preparing the Latin diagnosis for *E. arizonica*, Yalma L. Vargas-Rodriguez, and reviewers (Guy Nesom) for their comments on this manuscript.

REFERENCES

Anderson, L.C. 1984. *Chrysothamnus nauseosus* ssp *uintahensis*: a stabilized hybrid. Great Basin Naturalist 44:416–420.

Anderson, L.C. 1995. The *Chrysothamnus-Ericameria* connection (Asteraceae). Great Basin Naturalist 55:84–88.

Anderson, L.C. and J.L. Reveal. 1966. *Chrysothamnus bolanderi*, an intergeneric hybrid. Madroño 18:225–256.

Dorn, R.D. and C.H. Delmatier. 2005. A new variety of *Ericameria discoidea* (Asteraceae) from Idaho and Wyoming. Madroño 52:63–65.

Hall, H.M. 1928. The genus *Haplopappus* – a phylogenetic study in the Compositae. Carnegie Institute of Washington Publication No. 389.

Nesom, G.L. 1989. New combinations in *Ericameria* (Compositae: Astereae). Phytologia 67:104–106.

Nesom, G.L. 1990. Taxonomic summary of *Ericameria* (Asteraceae: Astereae), with the inclusion of *Haplopappus* sects. *Macronema* and *Asiris*. Phytologia 68:144–155.

Nesom, G.L. and G.I. Baird. 1993. Completion of *Ericameria* (Asteraceae: Astereae), diminution of *Chrysothamnus*. Phytologia 75:74–93.

Nesom, G.L. and G.I. Baird. 1995. Comments on "the *Chrysothamnus* - *Ericameria* connection." Phytologia 78:61–65.

Nesom, G.L., Y. Suh, D.R. Morgan, and B.B. Simpson. 1990. *Xylothamia* (Asteraceae: Astereae), a new genus related to *Euthamia*. Sida 14:101–116.

Roberts, R.P. and L.E. Urbatsch. 2003. Molecular phylogeny of *Ericameria* (Asteraceae, Astereae) based on nuclear ribosomal 3 ETS and ITS sequence data. Taxon 52:209–228.

Roberts, R.P. and L.E. Urbatsch. 2004. Molecular phylogeny of *Chrysothamnus* and related genera (Asteraceae, Astereae) based on nuclear ribosomal 3'ETS and ITS sequence data. Syst. Bot. 29:199–215.

Urbatsch, L.E. 1978. The Chihuahuan Desert species of *Ericameria* (Compositae: Astereae). Sida 7:298–303.

Urbatsch, L.E. and J.R. Wussow. 1979. The taxonomic affinities of *Haplopappus linearifolius* (Asteraceae - Astereae). Brittonia 31:265–275.

Urbatsch, L.E., R.P. Roberts, and V. Karaman. 2003. Phylogenetic evaluation of *Xylothamia*, *Gundlachia*, and related genera (Asteraceae, Astereae) based on ETS and ITS nrDNA sequence data. Amer. J. Bot. 90:634–649.

Urbatsch, L.E. and R.P. Roberts. 2004. New combinations in the genus *Gundlachia* and four new genera of Astereae (Asteraceae) from northern Mexico and the southern United States. Sida 21:243–257.

TAXONOMIC REVISION OF THE NEOTROPICAL GENUS: *ERITHALIS* (RUBIACEAE: CHIOCOCCEAE)

Vivian Negrón-Ortiz

Botany Department
Miami University
Oxford, Ohio 45056, U.S.A.

ABSTRACT

A taxonomic revision of *Erithalis*, genus of perennial trees and shrubs, is presented utilizing morphological data. Principal Component Analysis involving 14 vegetative and floral characters provided support for four morphologically distinct taxa (*E. angustifolia, E. harrisii, E. odorifera*, and *E. quadrangularis*) and a fifth poorly defined complex (*E. diffusa, E. fruticosa, E. salmeoides and E. vacciniifolia*). A few qualitative characters, as well as geographic distributions of the taxa, however, can distinguish the latter group. *Erithalis insularis* grouped within the fifth group, and is here placed in synonymy with *E. fruticosa*. Thus, in this study are recognized *E. angustifolia, E. diffusa, E. fruticosa, E. harrisii, E. odorifera, E. quadrangularis, E. salmeoides*, and *E. vacciniifolia* based on differences in inflorescence, flower, leaf, and growth habit characteristics. Phylogenetic relationships among the species, morphological description of their inflorescences and flowers, and the breeding system of *E. fruticosa* are presented. A key to the species, synonymies, typifications, descriptions, uses, and list of representative specimens is provided.

RESUMEN

Se presenta una revisión taxonómica de *Erithalis*, un género de árboles y arbustos de hoja perenne, utilizando análisis morfológicos. Análisis de Componentes Principales basados en 14 características vegetativas y florales confirman cuatro taxones (*E. angustifolia, E. harrisii, E. odorifera*, y *E. quadrangularis*) y un quinto complejo (*E. diffusa, E. fruticosa, E. salmeoides* y *E. vacciniifolia*). Este último grupo, sin embargo, puede distinguirse por varios caracteres cualitativos, además de la distribución geográfica de estos taxones. *Erithalis insularis* se agrupó con éste último grupo, y se coloca aquí como sinónimo de *E. fruticosa*. Por lo tanto, en este estudio son reconocidos *E. angustifolia, E. diffusa, E. fruticosa, E. harrisii, E. odorifera, E. quadrangularis, E. salmeoides*, y *E. vacciniifolia*, basándonos en diferencias de la inflorescencia, flor, hoja, y hábito de crecimiento. Se presentan las relaciones de filogenia entre las especies, descripción morfológica de sus inflorescencias y flores, y el sistema reproductor de *E. fruticosa*. Se provee una clave para las especies, sinónimos, tipificación, descripciones, usos y especímenes representativos.

INTRODUCTION TO *ERITHALIS*

Taxonomic History

Erithalis P. Browne (Rubiaceae: Chiococceae) is comprised of perennial trees or shrubs. It is distributed throughout the Caribbean Basin, Venezuela, and in the island of Fernando de Noronha, Brazil (Fig. 1). Twenty-six species, subspecies and varieties have been described in the genus (Andersson 1992; Candolle 1830; Correll & Correll 1982; Engler 1897; Lioger 1962, Lioger & Martorell 1982;

SIDA 21(3): 1565–1598. 2005

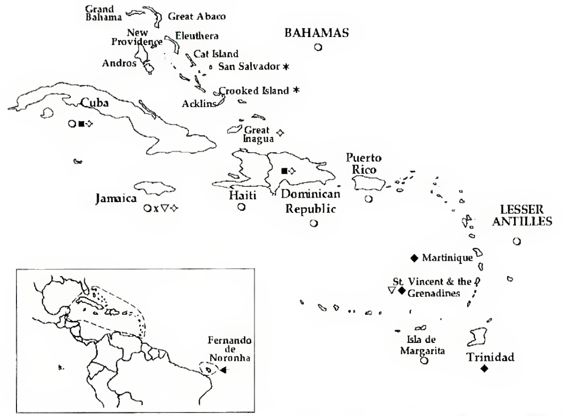


Fig. 1. Distribution of *Erithalis*. Symbols represent: ♦ = *E. angustifolia*, ✶ = *E. diffusa*, x = *E. harrisii*, ○ = *E. dorifera*, ∇ = *E. quadrangularis*, ✧ = *E. salmeoides*, ■ *E. vacciniifolia*. Inset: disjunct distribution of *E. fruticosa*.

Grisebach 1864, 1866; Moore & Rendle 1936; Rafinesque 1838; Sauvalle 1869; Standley 1934; Steyermark 1974; Urban 1903, 1908; Zappi & Nunes 2000). In particular, the two widely distributed species—*E. fruticosa* L. and *E. odorifera* Jacq.—have been described under different names (Candolle 1830; Grisebach 1866; Rafinesque 1838; Urban 1903). For example, *E. odorifera* has been ranked as synonym, variety, or subspecies of *E. fruticosa* by many specialists on the Caribbean flora (Correll & Correll 1982; Grisebach 1864, 1866; Howard 1989; Lioger 1962) and on the neotropical Rubiaceae (Standley 1934; Steyermark 1974).

There has been little or no comprehensive examination of this genus across its entire range, and many species have been described on the basis of extremely limited material. Previous studies include the original species descriptions, which are mostly brief (Hooker 1873; Correll 1977; Candolle 1830; Engler 1897; Rafinesque 1838; Urban 1903, 1908; Zappi & Nunes 2000), taxonomic keys and/or species lists for particular regions (Adams 1972; Andersson 1992; Correll & Correll 1981; Lioger 1962; Lioger and Martorell 1982; Grisebach 1864, 1866; Moore and Rendle 1936; Sauvalle 1869; Steyermark 1974), and phylogenetic and biogeographical studies based on molecular data (Negrón-Ortiz & Watson 2002, 2003).

Among the regional floras, i.e., taxonomic keys and/or species lists for particular regions, the work done in Cuba (Grisebach 1866; Lioger 1962; Sauvalle 1869) is notable. In *Catalogus Plantarum Cubensium*, Grisebach (1866) lists for Cuba (without descriptions except when noted) four species of *Erithalis* and one variety: *E. angustifolia* DC., *E. fruticosa*, *E. fruticosa* var. *odorifera* Jacq., *E. parviflora* Griseb., and *E. rotundata* Griseb. He transferred *E. angustifolia* Rich. to *E. parviflora*, briefly describing it as follows: "corolla quam in ceteris minor, calycis limbo minutissime 5 dentato, antheris filamento brevioribus." Shortly thereafter, Sauvalle (1869) revised Grisebach's list, and reached similar conclusions. However, he treated *E. fruticosa* var. *odorifera* as a synonym of *E. rotundata*. In addition, he included *Chione* Griseb. in *E. vacciniifolia* (Griseb.) Wr., without any description except by listing the collection number, *2719*. By the mid-20th century, Liogier (1962) recognized only two species for this island, *E. fruticosa* and *E. vacciniifolia*, perhaps following Standley's treatment (see below for details).

The most complete treatment, but limited to species descriptions, is by Standley (1934), who recognized six species of *Erithalis*. He ranked *E. angustifolia* sensu Griseb. as synonym of *E. acuminata* Krug & Urb., and recognized the Puerto-Rican endemic *E. revoluta* Urb. as a distinct taxon. Liogier and Martorell (1982) then placed the latter species in synonymy with *E. fruticosa*. Standley (1934) was the first to proposed a broad delimitation for *E. fruticosa*: he considered *E. odorifera*, *E. inodora* Jacq., *E. elliptica* Raf., *E. odorata* Raf., *E. rotundata*, *E. parviflora*, *E. fruticosa* var. *inodora* DC. and *E. fruticosa* var. *odorifera* to be synonymous. In addition, Standley treated *E. angustifolia* DC., *E. pentagonia* DC., and *E. uniflora* Gaertn.f. as doubtful species. Subsequently, Liogier (1962) determined that *E. angustifolia* DC. is a synonym of *E. fruticosa*.

Moore and Rendle (1938) followed Standley's classification for their treatment in *Flora of Jamaica*, but with several modifications. In their classification, they maintained *E. fruticosa*, *E. harrisii* Urb. and *E. quadrangularis* Krug & Urb., which were also later sustained by Adams (1972). They ranked *E. odorifera* at the species level indicating that "this and *E. fruticosa* are very distinct," and that the leaves and calyx-tube are "much larger." They also added a new variety, *E. harrisii* var. *angusta* S. Moore ex Rendle. Adams (1972) placed the later two taxa in synonymy with *E. fruticosa*.

In his checklist of Neotropical Rubiaceae, Andersson (1992) listed 21 *Erithalis* taxa, including synonyms, varieties and subspecies. Of those, he tentatively accepted nine species, which represent merely Standley's six species with the addition of *E. salmeoides* Correll and *E. diffusa* Correll (Correll 1977), and *E. odorifera*, which he elevated to species rank separating it from *E. fruticosa* following Howard (1989). *Erithalis revoluta*, synonymized with *E. fruticosa* by Liogier and Martorell (1982), was maintained as a separate species by Andersson, who was perhaps not aware of Liogier and Martorell's work. Clearly, throughout these local floras and treatments, *E. fruticosa* ranked as a distinct species.

Species Concept

Various morphological characters have been used to delimit the species of *Erithalis*. I use the basic framework of Andersson who recognized nine species, and the recently transferred species, *E. insularis* (Ridl.) Zappi & T.S. Nunes (Zappi & Nunes 2000). Many of the morphological characters used historically display continuous variation among species, especially among taxa with overlapping distributions. *Erithalis fruticosa*, as traditionally recognized, exhibits considerable morphological diversity and a pan-Caribbean geographical distribution, and overlaps in distribution with many of the recognized taxa in the genus. *Erithalis odorifera* shares a similar distribution and habitat as *E. fruticosa*, occurring sympatrically on several islands, and intermediate forms between these two taxa appear to bridge the main differences between them (Moore & Rendle 1938; Negrón-Ortiz, pers. obs.; Steyermark 1974). Howard (1989) used characters such as size of the corolla tube, floral fragrance intensity, and leaf size to separate these two species.

Erithalis harrisii, *E. quadrangularis*, *E. revoluta*, and *E. vacciniifolia* are each considered endemic to one or several islands of the Greater Antilles (Fig. 1). Characters such as stipule length, the ratio of leaf length to width, petiole length and robustness, leaf apex, and calyx lobes shape have been used to separate these endemic species from *E. fruticosa* (Urban 1903). *Erithalis acuminata*, the only species reported endemic to the Lesser Antilles, is separated from *E. fruticosa* by the size of the corolla tube and height of the plant. *Erithalis diffusa* and *E. salmeoides*, currently considered endemic species to the Bahamian Archipelago (Correll & Correll 1982), differ from each other and *E. fruticosa* in growth habit, corolla, and anther length.

Erithalis insularis, a species collected from the island of Fernando de Noronha, Brazil, was recently transferred by Zappi and Nunes (2000) based on a type specimen originally described as *Palicourea insularis* Ridl. They claim it differs from the other *Erithalis* by "its poorly branched, few-flowered inflorescences, and leaves distributed along the new branches."

PHYLOGENY AND EVOLUTION

Morphometrics

Taxonomy of island genera is often regarded as difficult because of their complexity, including widespread and variable species that contain several more or less distinct forms, joined to one another by intermediates, and by the lack of discrete characters to separate these forms (Henderson & Ferreira 2002). Infra- and inter-specific variability of island species and other groups of taxa have frequently been examined by multivariate statistical techniques (e.g., Fritsch & Lucas 2000; Henderson & Ferreira 2002; Janovec & Harrison 2002; Negrón-Ortiz & Hickey 1996; Thompson & Lammers 1997), thus, I used multivariate techniques to investigate morphological variation within *Erithalis*. This was done as a precursor to determine the best characters for use in the phylogenetic analyses, and in the taxonomic treatment.

Morphological studies were based on specimens examined from herbaria BM, FTG, GH, LL, MO, MU, NY, Tex and US, and from field collections made in Jamaica, St. Vincent and the Grenadines (Lesser Antilles), Puerto Rico, Florida (USA), and Andros Island (Bahamas). Over 278 specimens were examined over the course of the study, representing the entire range of morphological and geographical variation within this genus. A total of 14 characters (leaf length, leaf width, corolla length, number of corolla lobes, style length, calyx length, anther length, filament length, inflorescence length, growth habit, petal type, stigma type, inflorescence type, position of anther relative to the stigma) were measured on 133 specimens. Specimens with complete data sets were selected for combined analyses of floral and vegetative data; these totaled 70 collections and represented ten species. The holotypes of *E. acuminata* (here after: *E. angustifolia*, see taxonomic treatment), *E. quadrangularis*, *E. salmeoides*, and *E. vacciniifolia*, isotypes of *E. angustifolia*, *E. diffusa*, *E. insularis*, *E. parviflora* and *E. salmeoides*, and syntypes of *E. angustifolia*, *E. harrisii* and *E. rotundata* were included in the study. The data matrix was subjected to standarized Principal Component Analyses (PCA) using JMP 3.1 (Statistical Discovery Software, SAS Institute Inc. 1995); scatter plots were generated using CA-Cricket Graph III 1.5.3 (Computer Assoc. International, Inc. 1992).

The results of the PCA indicate that the first three principal components for vegetative and floral characters accounted for 72% of the standardized variance. The first component explained 50% of the total variance, with the highest loading for the following characters: leaf length, leaf width, corolla length, style length, anther length, and filament length. The second component explained a further 12% of the variance, with the highest loading for calyx length and inflorescence type.

Five clusters were evident in the two dimensional PCA (Fig. 2). The type specimen of *E. angustifolia* is located in the upper part of the figure, separated from the other species by its narrow paniculate and racemose inflorescence-types, and larger acuminate leaf. *Erithalis harrisii* forms a single cluster, separated from the other clusters by its densely branched panicle inflorescence-type (sensu Delprete 1996) and recurved corolla lobes. A third cluster, separated from the rest by larger leaves, longer corolla and anthers, is comprised of *E. quadrangularis* and two specimens of *E. odorifera* from Dominica and St. Vincent, Lesser Antilles. In addition, these two *E. odorifera* specimens are small trees, similar in height and habit to *E. quadrangularis*. A fourth cluster grouped *E. odorifera* specimens, except for four individuals (Fig. 2), by characters of intermediate size between *E. quadrangularis* and *E. fruticosa* (Figs. 2, 3).

Erithalis diffusa, *E. fruticosa*, *E. salmeoides* and *E. vacciniifolia* formed a single cluster (Fig. 2), which also includes four individuals of *E. odorifera*. The

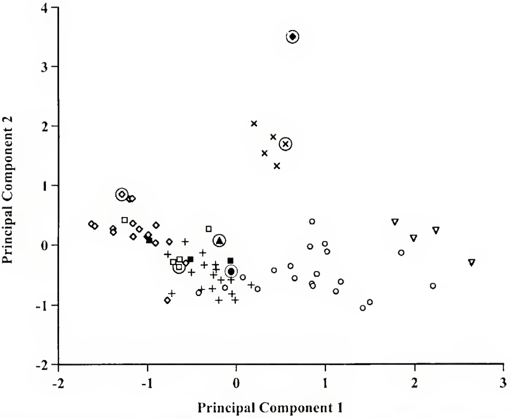


Fig. 2. Two dimensional PCA for floral and vegetative characters. The analyses involved 70 specimens. Symbols represent: ♦ = *E. angustifolia*, □ = *E. diffusa*, + = *E. fruticosa*, x = *E. harrisii*, ▲ = *E. insularis*, ❍ = *E. odorifera*, ∇ = *E. quadrangularis*, ● = *E. rotundata*, ◇ = *E. salmeoides*, ■ = *E. vacciniifolia*. Circled symbols represent holotypes, isotypes or syntypes.

types of *E. insularis* and *E. rotundata* group within this cluster. Although overlap between *E. diffusa*, *E. fruticosa*, *E. salmeoides* and *E. vacciniifolia* was evident in this cluster (Fig. 2), the geographic distributions of *E. diffusa*, *E. salmeoides* and *E. vacciniifolia* are not continuous. Typical *E. salmeoides* is found on Great Inagua, Bahamas, northern Dominican Republic, Jamaica and Cuba, *E. diffusa* is found in San Salvador & Crooked Island, Bahamas, and *E. vacciniifolia* is found in Cuba and southern Dominican Republic. In addition to their geographic distribution, they differ in growth habit and stigma type. *Erithalis vacciniifolia* and *E. diffusa* are prostrate or sprawling shrubs, whereas *E. salmeoides* is an erect shrub. *Erithalis diffusa* and *E. salmeoides* possess a bilobed stigma (Fig. 4 A, B, E), whereas the stigma of *E. vacciniifolia* consists of 5–8 minute lobes, with papillae spreading along the style (Fig. 4, C, D, F). Also, the placement of the anthers above the stigma is distinctive in *E. salmeoides*.

Erithalis fruticosa overlaps in distribution with many of the species, and in these areas of sympatry there are individuals with intermediate characters, masking species delimitations. For instance, *E. fruticosa* and *E. odorifera* co-occur in the SW coast of Puerto Rico intergrading continuously in vegetative and

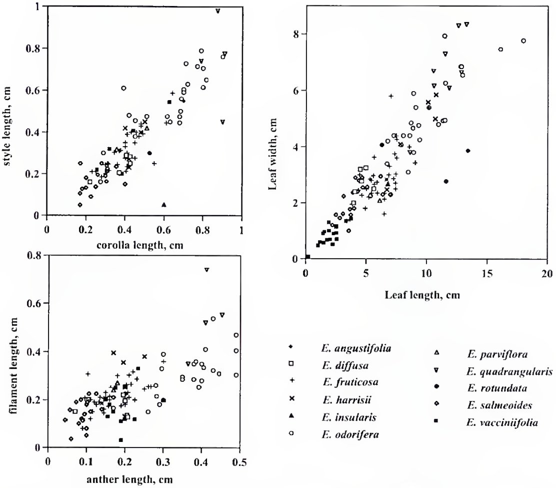


Fig. 3. Scattergrams of floral (A, B) and vegetative (C) characters. Symbols represent species, and each point represents an individual plant.

floral characters. Similarly, in Dominican Republic *E. vacciniifolia* and *E. fruticosa* occur together along the SE coast and intergrade continuously in stature and leaf size (McDowell, pers. obs.). In the Bahamas, *E. fruticosa* and *E. salmeoides* intergrade in their vegetative characters, but their floral traits are distinct. The presence of intermediates suggests hybridization. However, no experimental work has been done to investigate the potential for hybridization between the recognized species of *Erithalis*.

Most of the quantitative characters are not good discriminatory characters (Fig. 3). Nevertheless, it is obvious that specimens of *E. harrisii*, *E. quadrangularis*, and *E. odorifera* have distinctly larger flowers and leaves, compared to the other species of the genus (Fig. 3). *Erithalis vacciniifolia* has smaller and narrower leaves (Fig. 3C), whereas *E. salmeoides* has smaller flowers (Fig. 3A, B).

In summary, the PCA presented here provides support for recognition of four morphologically distinct groups, and a fifth poorly defined group. The distribution of individuals in the PCA ordination indicated the specimens of *E.*

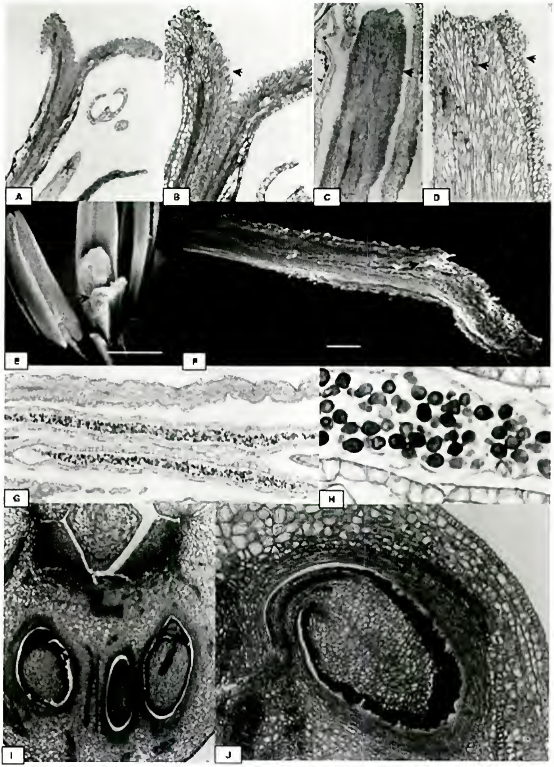


Fig. 4. Stigmas, anther, and ovules of *Erithalis*. **A–D, G–J.** Light micrographs of longitudinal sections. **E–F.** Scanning electron micrographs (SEM). A, B, E. Receptive bi-lobed stigma of *E. diffusa* (*Strittmatter s.n.*); Bar = 500µm. **C–D.** Stigma of *E. odorifera* (*Negrón-Ortiz 806*) from a flower bud showing the position of the stigmatic papillae (C), and detail of longitudinal slits of the middle lobes (D). F. Style of *E. vacciniifolia* (*Delprete 7551*) showing a minute and agglutinated lobe, and stigmatic papillae (arrow); Bar = 250µm. **G–H.** Basifixed anther (G, arrow) of *E. odorifera* (*Negrón-Ortiz 806*), and a close view of binucleated pollen grains (H). **I–J.** Pendulous ovules of *E. diffusa* (*Strittmatter s.n.*).

angustifolia, *E. harrisii*, *E. quadrangularis*, and *E. odorifera* were readily distinguishable from each other and from specimens of the other species. The remaining taxa, *E. diffusa*, *E. fruticosa*, *E. salmeoides* and *E. vacciniifolia*, do not show clear-cut taxonomic distinctions based on the two dimensional PCA. Although characters such as stigma type, placement of the anthers relative to the stigma, growth habit, as well as their geographic distribution (to some extent) can distinguish these four species, the lack of distinct groupings in the PCA could be a consequence of introgression between *E. fruticosa* and any of the other species.

Phylogeny

Monophyly, phylogenetic relationships, and biogeography of *Erithalis* have been investigated by Negrón-Ortiz and Watson (2002, 2003) using DNA sequence data of the Internal and External Transcribed Spacers (ITS and ETS) of nuclear ribosomal DNA, and the chloroplast *trn*L-*trn*F intergenic spacer. These analyses involved seven species of *Erithalis*, including multiple populations of the widespread *E. fruticosa* and *E. odorifera*, but excluded *E. angustifolia* and *E. insularis*. I was unable to relocate *E. angustifolia*, and *E. insularis* is only known from the type specimen (Zappi & Nunes 2000). Negrón-Ortiz and Watson (2002) concluded that *Erithalis* is a well-supported monophyletic genus (Fig. 5); the evidence includes an eight base-pair indel in the *trn*L-*trn*F intergenic spacer, present in all species of this genus but in neither of the outgroup taxa. In addition, both molecular and morphological data support a close relationship of *Erithalis* to *Chiococca* P. Browne ex L. (Bremer & Jansen 1991; Delprete 1996; Negrón-Ortiz & Watson 2002). Biogeographic analyses suggest that a combination of vicariance and dispersal events appears to be involved in the historical and present distributions of *Erithalis*, and support a Greater Antillean origin for *Erithalis* (Negrón-Ortiz & Watson 2003).

To provide a more robust resolution of phylogenetic relationships within *Erithalis*, I carried out parsimony analyses of a combined data set of molecular characters (ITS, ETS & *trn*L-*trn*F sequences) and five morphological characters (corolla lobe: recurved, straight; growth habit: prostrate, erect; inflorescence type: corymbose, paniculate, racemose, others; position of anther relative to the stigma: above, below; stigma lobes: bi-lobed, 5–8) using PAUP* 4.0b8 (Swofford 2001), with gaps treated as missing data and polymorphic states as uncertain. The Branch and Bound Search Option was employed with MULTREES in effect and Furthest Addition Sequence. Bootstrap analysis was conducted for 500 replicates, with tree-bisection-reconnection (TBR) and STEEPEST DESCENT in effect (Felsenstein 1985), and branch support analyses (Bremer 1998) were performed using Autodecay 4.02 (Eriksson 1999). In addition, the molecular data set was analyzed using hierarchical likelihood ratio tests to estimate the best-fit model for the data set (MODELTEST v3.06; Posada & Crandall 1998). This procedure showed that the K80+G model best fit the data, then the heuristic

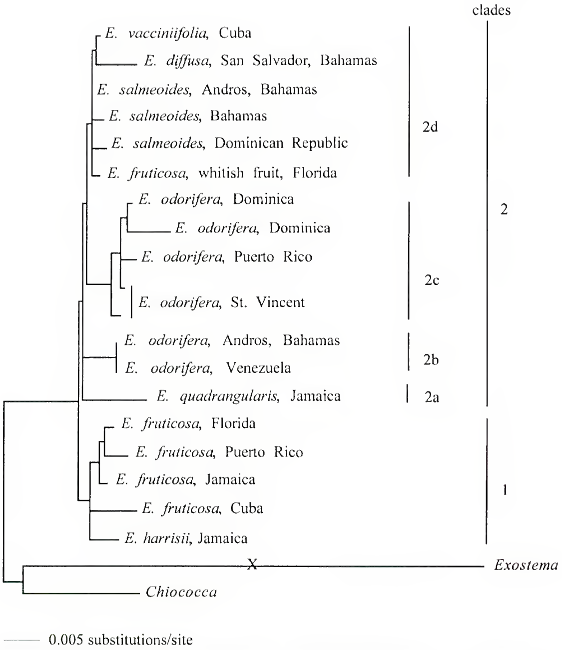


Fig. 5. The best maximum likelihood tree (–Ln = 4211.63789) inferred from analyses of molecular data. X = reduced 2.50 cm. Numbers represent clades.

ML analysis was done with random sequence addition for 100 replicates, MULTREES on and TBR branch swapping.

Analyses of the combined morphological and molecular data generated 13 most parsimonious trees of 101 steps (CI=0.561, RI=0.538, excluding constant and uninformative characters). Eight ML trees with a score of -Ln = 4211.63789 were recovered using the K80+G model of evolution (Fig. 5). The topology of the best ML tree is congruent with the 13 equally most parsimonious trees of combined morphological and molecular data set, and to those obtained via the analysis of ITS, ETS, and *trn*L-*trn*F spacer (Negrón-Ortiz & Watson 2000). Therefore, a cladogram with the results of heuristic ML analysis is shown in Fig. 5.

The phylogenetic analyses consistently identified two weakly supported major clades (Fig. 5). Clade 1 weakly supports a sister group relationship of *E. harrisii* to multiple populations of *E. fruticosa* that occur in the Greater Antilles and Florida. These two shrubby species share corolla size (mean = 4.4 vs. 4.0 mm, respectively), a stigma of 5–8 minute lobes, but differ in leaf length (mean = 9.21 vs. 6.12 cm, respectively; Fig. 3C) and leaf width (mean = 4.61 vs. 2.83 cm, respectively; Fig. 3C), inflorescence type, corolla lobe curvature, and leaf texture. In *E. harrisii* the inflorescence is a densely branched panicle, the corolla lobes are strongly recurved, and the leaves are thick, glossy above and scabrous below. In *E. fruticosa*, the inflorescence is commonly cymose [some individuals have a sparsely branched panicle (sensu Delprete 1996), others a corymb inflorescence type], corolla lobes vary from somewhat reflexed to straight, and the leaves are usually leathery. *Erithalis harrisii* occurs in mid- to high elevations (˜500–800 m) in the mountains of Jamaica, whereas *E. fruticosa* is mostly found at sea level throughout the Caribbean.

Clade 2 contains four subclades of five remaining species, but also includes one sample of the white-pinkish fruited *E. fruticosa* from Florida, suggesting that *E. fruticosa* is not monophyletic and/or that sample is of hybrid origin. Within clade 2, *E. odorifera* is largely monophyletic, with the exception of two samples from the Bahamas and Venezuela (subclade 2b), which fall outside the main *E. odorifera* subclade (2c). Perhaps, these populations lack sufficient molecular characters for supporting monophyly, or represent two cryptic lineages.

The Jamaican endemic *E. quadrangularis* is placed sister to the second major clade (2). *Erithalis odorifera* populations, morphologically resemble *E. quadrangularis,* sharing character states of floral morphology [linear anther shape and size (Fig. 3B), calyx length (mean = 0.13 cm), corolla length (Fig. 3A), stigma of 5–8 minute lobes (Fig. 4C, D, F), and upright growth habit]. *Erithalis quadrangularis* occurs at high elevations (600 - 800 m) in the mountains of Jamaica, at sea-level in the coast of St. Vincent (Lesser Antilles), and exhibits relatively larger (range = 8–21.7 vs. 6–13 cm in *E. odorifera*) and wider leaves (range = 3.5–10.1 vs. 3–7.7 cm in *E. odorifera*), axillary or terminal cymose-corymbose inflorescences (Fig. 6A), and recurved corolla lobes. *Erithalis odorifera* can be found from sea level to 300–500 m of elevation, exhibits axillary, cymose inflorescences (Fig. 6D), and straight corolla lobes.

The data weakly support a sister relationship of *E. odorifera* populations from the Lesser Antilles and Puerto Rico (subclade 2c) to subclade 2d which is composed of multiple species from the Bahamas, Florida, and the Greater Antilles. These two subclades exhibit more morphological differences than similarities. The *E. odorifera* subclade (2c) is comprised of shrubs or small trees with cymose

Fig. 6. Inflorescences of *Erithalis*. **A.** *E. quadrangularis* (*Harris* 12013). **B.** Solitary flower of *E. vacciniifalia* (*Pollard, Palmer & Palmer* 212). **C–D.** Axillary-cymose inflorescences of *E. fruticosa* (C, *Negrón-Ortiz* 795), and *E. odarifera* (D, *Negrón-Ortiz* 800). Bar = 1 cm.

inflorescences, larger corollas of 5–7 lobes, and long and wider leaves. The species of the Bahamas, Florida and Greater Antilles subclade (2d) are erect or prostrate shrubs, with corymbose inflorescences and/or solitary flowers or reduced cyme (sensu Delprete 1996), and small corollas (1.8–6.0 mm long; Figs. 3A, 6B).

The species of subclade 2d are morphologically distinct from each other, distinguished by differences in growth habit, leaf length and width, anther length, stigma type, and the placement of the anthers relative to the stigma. The taxa comprising this subclade vary from erect shrubs, such as *E. salmeoides*, to sprawling shrubs with prostrate branches, such as *E. diffusa* and *E. vacciniifolia*. *Erithalis vacciniifolia* displays smaller and narrower leaves, stigma of 5–8 minute lobes (Fig. 4F), and longer anthers (Fig. 3B). *Erithalis salmeoides* exhibits smaller anthers and styles (Fig. 3A, B), and the anthers extend above the stigma. *Erithalis salmeoides* and *E. diffusa* have a bi-lobed stigma (Fig. 4A, B, E).

In summary, the phylogenetic analyses presented here are in agreement with previous studies (Negrón-Ortiz & Watson 2002, 2003). The data confirm the monophyly of *Erithalis*, provide good resolution at the interspecific level, but do not support monophyly where more than one plant per species was sampled.

Geographic distribution and ecology

Erithalis is distributed from southern Florida throughout the West Indies, to Margarita and other Venezuelan islands, Quintana Roo (Mexico), the coast of Honduras, Colombia and the island of Fernando de Noronha, Brazil. The species occur in a wide variety of habitats, including coastal areas, open disturbed locales, rocky areas, montane areas, coppices, pinelands, sand dunes, limestone soils, and near coastal mangrove communities.

The species have bird-dispersed fruits (Bancroft & Bowman 1994; Negrón-Ortiz & Watson 2002, 2003), which helps explain the distribution of the genus across so many islands in the Caribbean, and the disjunct geographical distribution of *E. fruticosa* (Fig. 1).

FLORAL BIOLOGY

Inflorescence

The most common type of inflorescence is an axillary, many flowered compound cyme (Fig. 6); this varies greatly in length and number of flowers, and occurs either one or two per node. By various reductions or amplifications of development, these cymose inflorescences may appear paniculate, corymbose, or racemose. In other cases the inflorescence is reduced to a solitary, axillary flower (Fig. 6). In addition to these axillary inflorescence types, rarely terminal cymose-like inflorescences also occur in *Erithalis*.

The proximal portions of the inflorescences typically bear leaf-like bracts (pherophylls) of variable size and shape. In some cases the leaf-like bracts are similar in size and shape to leaves in the vegetative portion of the plant. The bracts decrease in size towards the distal parts, becoming small to minute.

Flowers

The flowers are bisexual, mainly white, but pinkish-white (Delprete, pers. obs.) and creamy-white corollas are also reported. The latter color, however, could be indicative of flower senescence (pers. obs.). Pentamerous corollas are typical in most species, but plants with 4–8-merous corollas do occur, and the number can vary even within a single inflorescence. Corolla lobes are mostly straight, but recurved corolla lobes are also present and characteristic of the Jamaican species *E. harrisii*. Rarely, both straight and recurved lobes occur within the same plant of certain species. Generally, the outside and inside of the corolla are entirely glabrous. In *E. harrisii* and some plants of *E. quadrangularis* an external indumentum is present, comprised of short hairs.

Stamens are present in the same number as the corolla lobes and alternate with the latter. The anthers are yellow, basifixed (Fig. 4E, G), and can be situated above, below or at the same level as the stigma. The latter character can be useful for species delineation, i.e., *E. salmeoides*. The pollen grains are binucleate (Fig. 4H). The bases of the filaments are either glabrous, with scattered hairs, or densely pubescent, and are connate forming a minute tube.

Erithalis exhibits two types of stigmas, which are of taxonomic importance (Fig. 4A-F). In almost all species the stigma consists of 5–8 minute lobes (usually 5), with papillae spreading along the style forming grooves (Fig. 4C, D, F). In only two species, *E. salmeoides* and *E. diffusa*, a bi-lobed stigma is present with papillae confined to the inside of the lobes (Fig. 4A, B, E). In the field, the papillae consisting of the first type of stigma change color from white to purple, indicative of loss of receptivity and senescence.

Erithalis displays two ripe fruit colors, dark-purple and whitish-pink. Whitish-pink fruit color has been reported in the Bahamas (Andros, Great Abaco, Great Inagua and Cat Islands), Florida (Miami), Virgin Islands (St. John), Cuba, and Mexico. Unique to *Erithalis* is the presence of a multi-locular ovary, whereas a single pendulous ovule per locule occurs in all genera of the Chiococceae (Fig. 4I, J).

Breeding systems

All species of *Erithalis* are monomorphic and homostylous. The flowers are fragrant, and produce abundant nectar. Neither secondary pollen presentation nor heterostyly occurs in any of the species. In addition, neither protandry nor protogyny was observed in the field (pers. obs.), so stigma receptivity appears simultaneous with anthesis.

The breeding system of dark-purple and whitish-pink fruited morphs *E. fruticosa* was examined at Fairchild Tropical Garden (FTG), Coral Gables, FL. The garden hosts small, wild populations of *Erithalis* where both fruit color morphs grow sympatrically. Eleven plants (7 dark-purple, and 3 whitish-pink fruited *E. fruticosa*) were marked, and five pollination treatments were designed to test the type of mating system (Negrón-Ortiz 1996). Emasculated and bagged flowers were tested for apomixis. Unpollinated and bagged flowers provided a test for autogamy, hand pollinated and bagged flowers tested for selfing, and emasculated, bagged and hand-pollinated flowers tested for outcrossing. Control flowers were neither bagged, emasculated, nor hand pollinated. Abscised corollas with their styles attached were examined for pollen tube growth (for details of methods see Negrón-Ortiz 1996), and at the end of field season, fruits from monitored flowers were collected and inspected for seeds.

A total of 350 flowers were monitored (subjected to pollination treatments and controls). Germinated pollen tubes were observed on the stigma of virtually every replicate for each pollination treatment, i.e., self, outcross, autogamy and control (Fig. 7A–C). Additionally, a greater number of pollen tubes reached the middle of the style than the base (Fig. 8A), suggesting intraspecific pollen tube competition. In 97% of outcrossed flowers (63 of 65 monitored flowers) the tubes successfully reached the base of the style (Fig. 7A), and seeds were produced (Fig. 8B). In the self- and unpollinated-bagged (autogamy) treatments, however, approximately 90% of the tubes were arrested in the stigma (Fig. 7B), and only a few reached the base of the style producing fruits (Fig. 8).

The results indicate that allogamy, i.e., outcrossing, is the main mating system occurring in *E. fruticosa*. However, self-sterility is incomplete because a few mature fruits were produced after self- (3%) and unpollinated-bagged (autogamy, 6%) treatments (Fig. 8B). There is no evidence for asexual seed production (Fig. 8B).

Fruit set was significantly greater for cross-pollinated flowers than for controls (97% vs. 26 %), suggesting that most fruits from the control treatment resulted from selfing and/or self-pollen deposition. In addition, comparisons between fruit set of manual cross-pollinated flowers and the control treatment of open-pollinated flowers reveals whether floral visitors are effective as pollinators. The results are consistent with an explanation of insufficient pollinator visits or limited pollination efficiency (e.g., if most visitors are acting as nectar robbers). Nectar was abundant at noon, and the only visitors observed at this site were bees and butterflies. Thus, it is possible that the study site at FTG lacks the natural pollinators.

USES

Erithalis, specifically *E. fruticosa*, has various economic and medicinal uses. The wood has been used for posts and torches (Kimber 1988; Little et al. 1974). The bark, fruits, and the resin have diuretic and astringent properties and are used to treat inflammation of the kidney and bladder, and blennorrhoea (any mucous discharge from the urethra or vagina; Liogier 1990). The leaves are used to treat skin sores (University of the Virgin Islands 2002). Other uses include treatment of hemorrhoids and measles, use as a styptic, drink ('spirit'), and as charms against spirits/witches.

The leaves and fruits of *E. fruticosa* are used as a source of food by the rock iguanas of British Virgin Islands, the Florida Key Deer and by the threatened white-crowned pigeon. The plant is used as a larval host by the coleoptera *Plocetes bahamensis* Casey (Anderson 1991).

SYSTEMATIC TREATMENT

Erithalis

Erithalis P. Browne, Civ. Nat. Hist. Jamaica. 165, t. 17, fig. 3. 1756. TYPE SPECIES: *Erithalis fruticosa* L.

Herrera Adanson, Fam. des plantes. 2:158. 1763. TYPE: based on P. Browne, Civ. Nat. Hist. Jamaica. 165, t. 17, fig. 3. 1756.

Fig. 7. Pollen grains and pollen tubes of ***Erithalis*.** **A–B.** Epifluorescent micrographs of *E. fruticosa* (*Negrón-Ortiz* 795). Pollen tubes following outcross (A) and self (B) pollinations. **C.** SEM pollen grain and tube of *E. vacciniifolia* (*Delprete* 7551), Bar = 10μm.

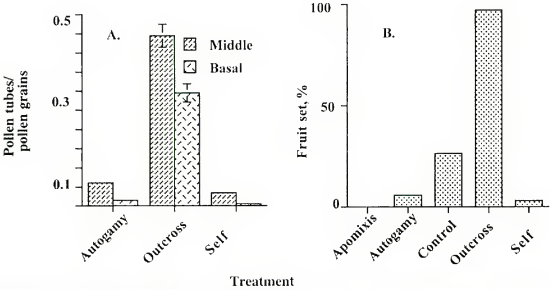


Fig. 8. Pollen tubes and fruit set per treatment. **A.** Ratio of pollen tubes in the style to pollen grains on the stigma; bars represent SE. **B.** Percent of fruit set per treatment.

Shrubs or **small trees**; raphides absent. Stipules interpetiolar, connate at base into cup-shaped sheath, truncate, deltoid to broadly triangular, apiculate, rarely acuminate, persistent. **Leaves** opposite, entire, long- to short-petiolate or sessile; blades acuminate, ovate, broadly ovate, broadly elliptic, narrowly obovate, obovate, oblong or oblanceolate, thinly to thickly coriaceous; domatia absent. **Inflorescence** axillary, paniculate and sparsely branched, corymbose, racemose, uniflorous, cymose-paniculate, cymose-corymbose, glabrous or puberulent; middle bracts long or minute. **Flowers** bisexual, fragrant, pedicellate. **Hypanthium** ovoid, obovoid or globose. **Calyx** cup-shaped, lobes small, 5 to 10, broadly triangular, broadly ovate or rounded, absent or minute, persistent. **Corolla** hypocrateriform or narrowly infundibuliform or rotate, actinomorphic, white to cream-white, rarely pinkish-white; tube internally glabrous, some with an external indumentum of short hairs; lobes 4–8, slightly imbricate, oblong or linear, margin entire, rounded at apex, recurved or somewhat straight. **Stamens** alternate to the corolla lobes, 4–8; **filaments** attached at base of the corolla tube, basally connate, filiform, smaller, equal or longer than corolla tube, puberulent or pubescent at basal portion (glabrous above) or with a tuft of hairs at base; **anthers** situated above, below or at the same level of the stigma; narrowly elliptic, narrowly oblong, or linear, round at base, round or acute at apex, dehiscing by longitudinal slits, basifixed. **Pollen** tricolpate, exine surface echinate-perforate, released as monads, binucleate. **Style** exserted just beyond the corolla, terete, glabrous. **Stigma** bilobed or 5–8 lobed, minute and agglutinated, ovate or oblong. **Ovary** inferior, 2–5 locules, 5–20 celled; placentation axile, placenta reduced, ovules pendulous. **Fruit** drupaceous, with woody pyrenes; pericarp fleshy, dark purple or whitish-pink. **Seeds** laterally compressed; **embryo** small.

KEY TO THE SPECIES

1. Prostrate or sprawling shrubs, with decumbent branches.
    2. Leaves sub-orbicular, rounded at the apex, 3.8–5.9 cm × 1.8–3.4 cm, pedunculate; stigma bi-lobed, anthers 1.9–2.1 mm long, longer than the filament; inflorescence a cyme, or cymose-paniculate (Bahamas) ______ **E. diffusa**
    2. Leaves ovate, elliptic, obovate, rounded to obtuse at the apex, 1.3–4.7 cm × 0.8–1.9 cm; sessile or short pedunculate; stigma with 5–8 small lobes; anthers approximately 1.2–2.8 mm long, shorter than the filament; inflorescence either a cyme, a solitary flower, a raceme, or found in any combination within the same plant (Cuba and Dominican Republic) ______ **E. vacciniifolia**
1. Erect shrubs or trees, with upright branches.
    3. Leaves narrowly elliptic with blade tip acuminate; inflorescence narrowly paniculate with long stalks and/or racemose (Martinique, St. Vincent and Trinidad) ______ **E. angustifolia**
    3. Leaf blades ovate, elliptic, or obovate.
        4. Leaf leathery, glossy above and scabrous beneath; inflorescence densely paniculate; corolla lobes recurved (Jamaica) ______ **E. harrisii**
        4. Leaves leathery or papery, glabrous above and predominantly smooth beneath; inflorescences primarily cymose, some racemose, narrowly paniculate, or found in any combination within the same plant; corolla lobes typically straight, or somewhat recurved.
            5. Anthers positioned above the style; stigma bi-lobed; inflorescence usually less than 4 cm long, rarely longer (Bahamas, Dominican Republic, Cuba and Jamaica) ______ **E. salmeoides**
            5. Anthers positioned below or equal to the style, rarely above the style or in any combination; stigma with 5–8 small lobes; inflorescences 5–9.7 cm long.

6. Anthers linear, 1.4–5.0 mm long; inflorescence 8 cm long or longer; middle bracts large; leaf papery or coriaceous, 7.7–21.6 cm long; corolla lobes straight or recurved.
    7. Inflorescences axillary or terminal, cymose-corymbose; middle bracts 3.4–10.4 cm long; corolla lobes recurved in anthesis; leaf coriaceous, 8–21.6 × 3.6–10.1 cm (mountains of Jamaica and St Vincent) **E. quadrangularis**
    7. Inflorescence axillary, mainly cymose; middle bracts minute to 2.4 cm long; corolla lobes straight in anthesis, rarely recurved; leaf papery or coriaceous, 6–12.9 × 3–7.7 cm (Bahamas, Greater and Lesser Antilles, Venezuelan islands) **E. odorifera**
6. Anthers ellipsoid, oblong, subglobose, in some cases somewhat linear, 0.7–3.5 mm long; inflorescence less than 8 cm long; middle bracts primarily minute; leaf coriaceous, 3.4–10.7 × 1.4–5.7 cm; corolla straight 4–6 lobes (throughout the Caribbean, Fernando de Noronha Island) **E. fruticosa**

Erithalis angustifolia DC., Prodr. 4:465. 1830. Type: CUBA: without locality, 1825, *de la Ossa* (holotype: G; IDC herbarium geneovense, microfiche!).

Erithalis acuminata Krug & Urb., Notizbl. Königl. Bot. Gart. Berlin. 1:319–320. 1897. Type: Lesser Antilles: Martinique, Guilding, 1877, *Duss 206* (holotype: B, destroyed; Lectotype: NY!, here designated).

Chiococca pulcherrima Wernh., J. Bot. 51:322. 1913. Type: Lesser Antilles: St Vincent, without date, *Anderson 308* (holotype: BM, isotype: K!).

Shrub 1–2 m high, the branches glabrous. **Leaves** coriaceaous; blades acuminate, gradually narrowed to the base, 6.2–13.8, 2.6–4.1; petioles 1.9–2.3 cm long. **Inflorescences** axillary, narrowly paniculate with long stalks and a few flowers, racemose, 9–10.5 cm long; glabrous; bracts minute. **Flower** pedicels 1–1.5 cm long. **Calyx** and hypanthium glabrate, calyx 0.9 mm long, denticulate. **Corolla** white, 1.7 cm long; **lobes** 5; **style** 5.5 mm long; stigmatic papillae 5 small lobes. **Stamens** 5; filaments white, 2 mm long, placed below the style; anther 3 mm long. **Fruit** a drupe, globose.

The name *E. angustifolia* is based on Candolle's description. The type is probably at G, while the photo is in the IDC microfiche, without number.

Distribution and ecology.—Found between 900–1100 m height in Montagne Pelée, Martinique, and St. Vincent and the Grenadines (Lesser Antilles). In addition, it was documented in the mountains of Trinidad.

Anderson collected *E. angustifolia* (as '*Chiococca pulcherrima*,' Fig. 9) in Trinidad, and described it as a scarce "beautiful shrub that grows on the summits of the highest mountains" (Wernham 1913). However, personal communication with Mr. Winston Johnson from the National Herbarium of Trinidad & Tobago indicates that *E. angustifolia* no longer occurs on the island.

Kimber (1988) listed this species (among others), and mentioned that all the species in the list were collected in 1962, 1963 and 1975. However, the species is not listed for the island in the document "Arbres de la Martinique–Les arbres

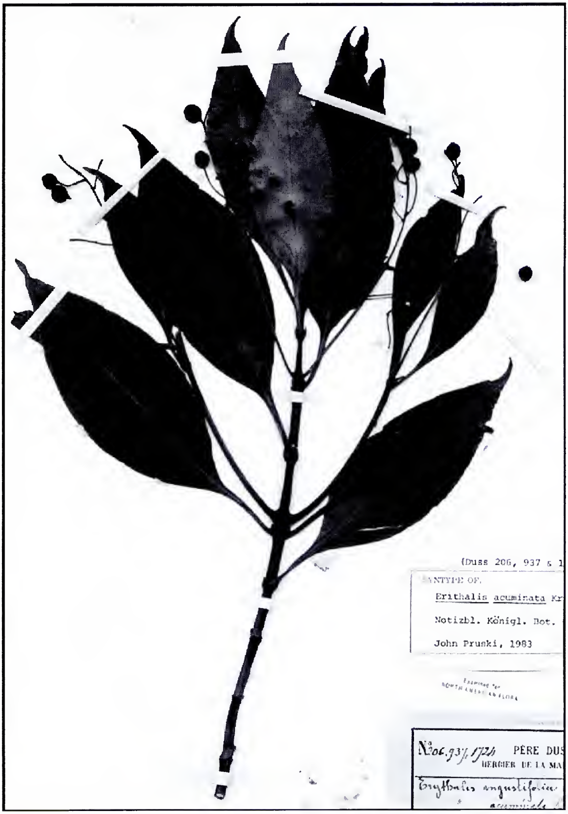


Fig. 9. *Erithalis angustifolia* (*Duss* 206) from Martinique, Lesser Antilles.

de la forêt martiniquaise-répertoire complet" written by F. Palli (www.palli.ch/~kapeskreyol/divers/arbres.html); only *E. odorifera* is documented.

Specimens examined. **TRINIDAD:** without locality, s.d., *Anderson 308* (Type of *Chiococca pulcherrima*, BM). **LESSER ANTILLES:** Martinique, Montagne Pelée, 1877, *Duss 206* (NY); Montagne Pelée, 1877, 1879, 1883, *Duss 206, 937, 1724* (SYNTYPE: NY; all numbers and dates on one label).

Common name.—Bois flambeau montagne.

Conservation status.—I was unable to locate *E. angustifolia* in St. Vincent and the Grenadines. According to Howard (1989), the Guilding collection cited by Urban may have been from St. Vincent Botanical Garden. However, I searched the collection at this institution, and found neither the plant nor records of its existence. I recommend searching for this species in Martinique and Trinidad to determine whether this taxon, is extinct. Certainly, it should be among the taxa in highly endangered of extinction.

Erithalis diffusa Correll., J. Arnold Arbor. 58:47. 1977. TYPE: BAHAMAS: San Salvador, N of airport, 21 Nov 1974, *Correll 43840* (HOLOTYPE: A!; ISOTYPES: FTG!, NY!)

Sprawling shrubs to 1 m high, the branches prostrate on ground to low-arching. **Leaves** glossy above; the blades leathery and thick, sub-orbicular to broadly oval, rounded at apex, 3.8–5.9, 1.8–3.4 cm; the petioles 0.8–1.0 mm long; young leaves slightly sticky. **Inflorescences** axillary, cymose, cymose-paniculate, 4.7–7 cm long; middle bracts minute; or solitary flowers. **Flowers** fragrant, pedicellate. Calyx and hypanthium glabrate, calyx 5-denticulate, 0.4–0.5 mm long; hypanthium about 1.5 mm long. **Corolla** white, 2.2–4.5 mm long; tube 1.5 mm long; lobes 4 or 5, somewhat straight. **Stamens** 5; filaments white, 1–2.5 mm long; **anther** yellow, linear, 0.19–0.21 cm long; situated below or at the same level with the stigma; longer or as long as the filaments. **Style** 1.6–3.3 mm long; stigma bilobed. **Fruit** a drupe, orbicular, about 5 mm in dm, dark purple when ripe.

Distribution and ecology.—*Erithalis diffusa* (Fig. 10) is endemic to the Bahamas: San Salvador and Crooked Islands. It grows in rocky shore locations; common in beach strand, scrub-land, coppices and coastal thickets. This species is a component of the coastal vegetation of San Salvador, which is defined as the sea strand/sea oats community, consisting of sea oats (*Uniola paniculata* L.), sea grapes (*Coccoloba uvifera* L.), and railroad vine (*Ipomea pes-caprae* (L.) R. Br.), all of which assist in stabilization of the dunes.

Specimens examined. **BAHAMAS. Crooked Island:** 20 Feb 1975, *Correll* (FTG); 18 Feb 1975, *Correll* 44380 (FTG). **SAN SALVADOR:** N of airport, 21 Nov 1974, *Correll* 43840 (Type FTG, NY); *Strittmatter* s.n. 2000 (MU); along Snow Bay, 2 May 2000, *Vincent et al* 8955 (MU); N of Polaris, 7 Feb 1973, *Van Eenwyk et al.* 4-2 (FTG); E of Field Station, 28 Dec 1980, *Thieret* 52532 (MU).

Erithalis fruticosa L., Syst. Nat., ed. 10, 930. 1759. TYPE: JAMAICA: without locality, s.d., (HOLOTYPE: P. Browne, Civ. Nat. Hist. Jamaica 1, t. 17, fig. 3. 1756).

Erithalis odorata Pers, Syn. Pl. 1:200. 1805, nom. Alt.

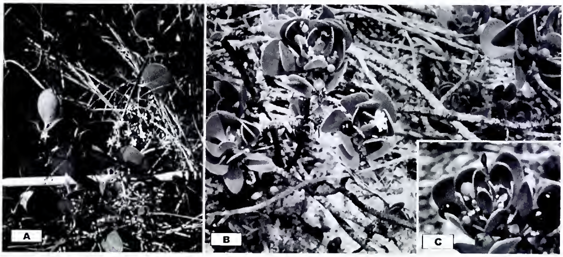


Fig. 10. ***Erithalis diffusa*** **from San Salvador, Bahamas. A. Growth habit. B. Detail of the globose, dark-purple drupaceous fruit (Photographs by Eric J. Tepe and Michael Vincent).**

Erithalis elliptica Raf., Sylva Tellur. 123. 1838. TYPE: JAMAICA: based on Swartz' description of *E. fruticosa*.

Erithalis harrisii Urb. var. *angusta* S. Moore ex Rendle, Fl. Jam. J. Bot. 73:279. 1935. TYPE: JAMAICA. Luana Point, Harris 9821 (HOLOTYPE: BM!).

Erithalis inodora Jacq., Select. Stirp. Amer. 73. 1763. *Erithalis fruticosa* var. *inodora* (Jacq.) Persoon, Syn. Pl. 1:200. 1805. TYPE: CURAÇAO: (no Jacq. specimen located).

Erithalis parviflora Griseb., Cat. Pl. Cub. 134. 1866. TYPE: CUBA: 1860–64, *Wright 2721* (HOLOTYPE: GOET!; ISOTYPES: K!, MO!, NY!, US!).

Erithalis revoluta Urb., Symb. Ant. 3:379. 1903. TYPE: PUERTO RICO: Guánica, Caña Gorda, *Sintenis 3796* (no type located). One set of Sintenis' West Indian collection was placed at B (now destroyed).

Erithalis insularis (Ridl.) Zappi & T.S. Nunes, Kew Bull. 55:655–656. 2000. Syn. nov. *Palicourea insularis* Ridl., J. Linn. Soc. Bot. 27:41. 1890. TYPE: BRAZIL: Pernambuco, Fernando de Noronha Island, 1887, *Ridley, Lea & Ramage 86* (HOLOTYPE: BM-n.v., not at BM per BM staff, LECTOTYPE: K!, here designated; ISOTYPE: B-destroyed, photo NY!).

Shrubs or **small trees** 0.6–8 m high, the branches mainly glabrous, some puberulent. **Leaves** glossy, leathery and thick; the blades dark-green above, obovate, oblong, elliptic-oblong, orbicular, oblanceolate, rounded or obtuse at the apex, 3.4–10.7, 1.4–5.7 cm; the petioles 0.4–5 mm long. **Inflorescences** cymose, cymose-paniculate, axillary or terminal, 5.8–6.8 cm long, the branches glabrous; bracts variable in length to minute. **Flowers** white, fragrant, pedicellate. Calyx and hypanthium glabrate, green, calyx 0.2–01.5 mm long. **Corolla** white, 2–6.5 mm long; **lobes** 4–6, straight. **Stamens** 4–6; **filaments** white, 0.8–3.8 mm long, the base with scattered hairs; **anther** yellow, 0.7–3.5 mm long, situated below or above the stigma. **Style** 1.1–6.0 mm long. **Stigma** with 5–8 minute lobes. **Fruit** a drupe, 3 to 5 mm in diameter, globose, dark-purple or whitish-pink; five to 14 celled.

Erithalis was established in 1756 (Browne 1756) based on *E. fruticosa* L. from Jamaica. In 1786, Forster, not aware of P. Browne's description, illegitimately used the name *Erithalis* for a description of an entirely different genus, *Timonius* DC. (= *Timonius* Rumph., originally described in 1743).

Erithalis fruticosa (Fig. 11) is morphologically a highly variable species (Long & Lakela 1976). It is a slow growing, evergreen shrub that typically is 1 to 2 m in height, and can occasionally reach 8 m in height. Commonly, the species has multiple stems arising near the ground. The branches root when they come in contact with the ground. The bark is gray, and smooth to warty. The resinous wood is brown, hard, fine-textured, and heavy. The foliage may be dense or sparse depending on whether the shrubs grow in full sun or partial shade (pers. obs.).

The species flowers and fruits throughout the year (Little et al. 1974; Nelson 1996) with peaks during the dry months of January, February and March. The fruits can be either dark- purple or whitish-pink, and both color fruits occur sympatrically in populations of Andros Island (Bahamas) and Coral Gables, Florida. Acevedo-Rodríguez (1996) observed the whitish-pink fruited form in St. John, U.S. Virgin Islands, Correll reported it in Cat Island (FTG # 46194) and Great Abaco (NY # 45561), and Shafer in Cuba (NY # 2803). The dark-purple fruits have a bittersweet flavor and are dispersed by birds (Bancroft & Bowman 1994; Howard 1989; Liogier 1997; Little et al. 1974; Nelson 1996). Fruits collected in Puerto Rico averaged 0.1087 + 0.0071 g/fruit, and air-dried seeds separated from them averaged 0.00092 g/seed or 1,080,000 seeds/kg (Francis, JK).

Distribution and ecology.—Erithalis fruticosa occurs in Florida, the Bahamas, the Greater and Lesser Antilles, Trinidad, Quintana Roo (Mexico), Belize (Howard 1989; Little et al. 1974), Parque Nacional Moroccoy and Venezuelan Caribbean islands (Liogier 1962), San Andrés, Providencia and Santa Catalina (Colombia; Jiménez-B. 2002), and the island of Fernando de Noronha (Brazil, Pernambuco). Although the species is reported for the Lesser Antilles, I did not see evidence of E. fruticosa during two recent collecting trips to St. Vincent and the Grenadines (Lesser Antilles).

Erithalis insularis is here placed as synonym of *E. fruticosa*, thus extending the range of *Erithalis*' distribution to the Atlantic Ocean. The fruits of *E. fruticosa* are dispersed by the threatened white-crowned pigeon in the Florida Keys and the Bahamas (Bancroft & Bowman 1994). Therefore, it is plausible that the disjunct geographical distribution exhibited by this species (Fig. 1) is a consequence of avian dispersal.

Erithalis fruticosa grows from near sea level to 120 m in elevation in Puerto Rico in areas that receive from 750 mm to about 1800 mm of annual precipitation (Little et al. 1974). The species is drought tolerant, and can grow in open areas and under the canopy of low-density forest. It is most common near beaches, on rock outcroppings and bluffs near the shoreline, especially in moist limestone areas, and on limestone hills in the interior. In Florida, it is found in beach strand vegetation, on sand dunes, and coastal hammocks (Nelson 1996).

Fig. 11. ***Erithalis fruticosa*. A.** Growth habit. **B.** Detail of the flower. **C–D.** White-pinkish (C; *Negrón-Ortiz* 794) and dark-purple (D; *Negrón-Ortiz* 795) fruits. (Photos A, B taken at Discovery Bay, Jamaica, and C, D at Fairchild Tropical Garden, Coral Gable, Florida).

In Martinique, it is reported as a component of the community of the littoral hedge, "a dense thicket at the seaward margin of the littoral woodland" (Kimber 1988).

Representative specimens examined. **U.S.A. FLORIDA. Dade Co.:** Coral Gables, Fairchild Tropical Garden, 1 Jan 1999, *Negrón-Ortiz* 794, 795, 798, (MU); Key Biscayne, Cape Florida State Park, 19 Jun 1970, *Gillis* 9439 (FTG). **Monroe Co.:** Big Pine Cay, 30 Apr 1958, *Travers* 710 (LL); 17 Feb 1991, *Orzell & Bridges* 15996 (LL). **Cuba:** without locality, 1860-1864, *Wright* 2722 (MO). **Camaguey:** 28 Oct 1909, *Shafer* 2803 (NY); **Matanzas:** Puerto Escondido, 16 Apr 1994, *Acevedo et al.* 6525 (NY). **Santiago:** rd. to El Morro, Jun 1943, *Bro. Clemente* 2830 (NY); without locality, Sep 1859-Jan 1860, *Wright* (*s.n.* MO); 17 Nov 1915, *Ekman* 6611 (MO). **Dominican Republic:** about 20 m W of Santiago, 19 May 1969, *Liogier* 15251 (NY). **Laguna Oviedo:** 18 Sep 1981, *Zanoni & Mejía* 16786 (MO). **La Altagracia:** 21 km SE Playa El Macao, 13 May 1980, *Mejía & Zanoni* 6527 (FTG). **Isla Catalinita:** 8 Oct 1981, *Zanoni & Mejía* 17126

(FTG, NY). **Haiti:** vicinity of Jean Rabel, 27 Jan–9 Feb 1929, *Leonard & Leonard* 12856 (MO). **JAMAICA. St. Mary Parish:** 5 m [mi] from Port Maria, 10 Jan 1960, *Adams* 6132 (MO); around Green Castle, 5 Jul 1963, *Crosby et al.* 509 (NY). **Puerto Rico. Cabo Rojo:** Faro, 24 Dec 1998, *Negrón-Ortiz* 725, 726 (MU). **Guanica:** Dry Forest, 1 Jan 1998, *Negrón-Ortiz* 569 (MU). **Isla de Mona:** camino de Sardinera a Uvero, 28 May 1991, *Acevedo & Siaca* 4359 (FTG). **Virgin Islands. St. John:** 21 Jun 1989, *Acevedo Rodriguez* 002731 (NY). **LESSER ANTILLES. Anguilla:** near beach, W end of the island, 5 Feb 1985, *Howard & Kellog* 19004 (NY). **BAHAMAS. Ackling Island:** about 4 m N of Pinefield, 21 Feb 1975, *Correll* 44462 (NY). **Andros:** May 1998, *Negrón-Ortiz* 655 (MU). **Anegada:** NW part of the island, 8 Jul 1990, *Smith* s.n. (FTG). **Cat Island:** between Dolphin Head and Zonicle Hill, 22 Nov 1975, *Correll* 46194 (FTG). **Crooked Island:** W of Colonel Hill, 20 Apr 1971, *Willis* 10609 (FTG). **Bimini Island:** about 0.5 m S of Ferry landing, 12 Jun 1964, *Stimson* 709 (LL); near middle of Cat Cay, 10 Jul 1975, *Correll & Correll* 45583 (FTG). **Great Abaco:** E end of Well's Cay, 25 Jun 1975, *Correll* 45561 (NY). **Grand Bahama:** 9 m ESE of W end, 23 Dec 1968, *Lewis* 7153 (FTG). **Grand Cayman:** 11 Nov 1979, *Correll & Correll* 51034 (FTG); 16 Aug 1938, *Kings* G.C. 335 (NY). **Great Exuma:** in marshland near Steventone, 7 Dec 1973, *Correll* 40770 (FTG); E of Stuart Manor, 9 Dec 1973, *Correll* 40862 (FTG), in coppice near George Town airport, 9 Jul 1978, *Correll* 49996 (FTG); Far Bay, 16 May 1989, *Houghton* 1098 (MO); Fartz 4003 (FTG). **Great Inagua:** 18 Oct 1904, *Nash & Taylor* 1149 (NY); Union Creek, 7 May 1970, *Hill* 479 (FTG). **SAN SALVADOR:** SE end, 27–28 Nov 1907, *Wilson* 7280 (NY). **Belize: Cayo Caulker**, 25 Jun 1981, *Whitefoord* 3320 (MO). **Turneffe Island:** 28 Feb 1942, *Egler* 42-6 (LL). **Gallows Point:** N end, 13 Oct 1977, *Janzen & Ives* 1117 (MO). **Water Cay:** 25 Mar 1967, *Dwyer et al.* 678 (MO). **Mexico. Quintana Roo:** W of Puerto Morelos, 4 May 1982, *Davidse et al* 20049 (LL); Playa Puerto Morelos, *Téllez & Cabrera* 10794 (MO). **Venezuela. Parque Nacional Morrocoy:** ca. 5 km NE of Chichiriviche, 19 May 1984, *Ramirez* 925 (MO). **BRAZIL. Pernambuco:** Fernando de Noronha, 1887, *Ridley, Lea & Ramage* 86 (K).

Common names and uses.—'Black torch' (Bahamas, Belize, Florida, Puerto Rico & Virgin Islands); 'Black candlewood' (Cayman Islands); 'Cubra prieta' or 'Rompe machete' or 'Víbona' or Jayajabico' or 'Yayajabico' (Cuba); 'Candlewood' (Lesser Antilles); 'Tea' or 'Manglillo' (Puerto Rico & Virgin Islands).

The wood is resistant to rot and has been used for posts and torches (Kimber 1988; Little et al. 1974; University of the Virgin Islands 2002). Native people from Martinique used boughs of *E. fruticosa* for torches during late 1600s, and by 1930s the natives were still using it, thus contributing to the species decline in that island (Kimber 1988). The bark, fruits, and the resin have diuretic and astringent properties and are used to treat inflammation of the kidney and bladder, and blennorrhoea (Liogier 1990). The leaves are parched and ground for treating skin sores (University of the Virgin Islands 2002). Other uses include treatment of hemorrhoids and measles, and use as a styptic.

The leaves and fruits of *E. fruticosa* are used as a source of food by a few animals. The leaves represent 3.5% of the rock iguanas' diet on Anegada, British Virgin Islands (Mitchell 1999). The fruits are consumed by the Florida Key Deer (Dooley 1975), a Federal Endangered mammal, and by the threatened white-crowned pigeon during nestling (Bancroft & Bowman 1994).

Conservation status.—Threatened in Florida (www.plantatlas.usf.edu/browse2.asp?family=RUBIACEAE).

Erithalis harrisii Urban, Symb. Ant. 5:514. 1908. TYPE. JAMAICA: near Troy, 30 June 1904 (fl), *Harris* 8743 (LECTOTYPE: NY 00115115, here designated).

Shrubs or **small tree** to 3–7.5 m tall, the branches puberulent. **Leaves** glossy above, scabrous below, thick; the blades obovate-oblong to elliptic-oblong, 4–10.9, 1.7–6 cm; the petioles 1–1.9 cm long. **Inflorescences** panicle, axillary or terminal, the branches puberulent; bracts 1–2, 0.9–2.8 mm. **Flowers** fragrant, pedicellate. **Hypanthium** globose. Calyx and hypanthium glabrate, calyx 5-denticulate, 0.5 mm long. **Corolla** white, 4–4.8 mm long; lobes 5, recurved. **Stamens** 5; filaments white, the base densely puberulent, 1.3–4 mm long, as long as or 3/4 as high as the style; **anther** yellow, linear, 1.5–2.5 mm long. **Style** 2.3 –4.5 mm long. **Stigma** of 5–8minute lobes. **Fruit** globose, green when immature, turning red to dark-red when mature or pink.

Distribution and ecology.—This species (Fig. 12) is endemic to the mountains of Jamaica. It is found in a few localities of woodland margins on rough limestone. It grows on rocky banks, at 500–800 m elevations.

Conservation status.—This taxon is listed under the 2003 IUCN Red List of Threatened Species and considered a low risk species, subcategory: nt (WCMC 1997).

Specimens examined. **JAMAICA:** near Troy, 30 Jun 1904 (fl), *Harris* 8743 (NY); syntypes: [NY (00115114), US]. **Trelawny Parish:** 1 Jan 1999 (fl), *Negrón-Ortiz* 789 (MU); 791 (MU); 14 Aug 1963, *Crosby & Anderson* 1196 (LL); Ramgoat cave, N of Albert Town, 29 Jul 1962, *Fosberg* 42935 (NY). **St. Ann Parish:** Mount Diablo, 12 Jul 1989, *Nesbeth & Scott* 078 (MO); road to Hollymount, 21 Sep 1962, *Adams* 11680 (MO). **Clarendon:** 30 Sep 1912, *Harris* 11227 (MO).

Erithalis odorifera Jacq., Select. Stirp. Amer. Hist. 72, pl. 173 (fig. 23: flower & fruit). 1763. *Erithalis fruticosa* L. var. *odorifera* (Jacq.) Grisebach, Fl. Brit. WI. 336. 1861. *Erithalis fruticosa* L. subsp. odorifera (Jacq) Steyermark, Fl. Venez. 9:869. 1974. *Erithalis odorata* Raf., Sylva Tellur. 123. 1838. (LECTOTYPE: Jacquin, Martinique. Plum. ic. 249, f.2., here selected).

Erithalis rotundata Griseb., Mem. Amer. Acad. Arts 2, 8:507. 1862. TYPE: CUBA: Monte Verde, Jan–Jul 1859, *Wright 1268* (LECTOTYPE: GOET!, here designated), ibid, *Wright 1267* (SYNTYPES: GOET!, MO!); ibid, *Wright 1268* [SYNTYPES: MO! (2 copies), NY! (2 copies)].

Large shrubs or **small trees** to 1–8 m tall, the branches glabrous. **Leaves** glossy, leathery and thick or papery; the blades obovate-oblong to elliptic-oblong, 6–13. 3–7.7 cm; the petioles 0.05–3.2 cm long. **Inflorescences** cymose, axillary, 9–9.7 cm long, the branches glabrous; bracts minute to 2.2 cm long. **Flowers** sweet fragrant, pedicellate. Calyx and hypanthium glabrate, calyx 0.5–1.1 mm long. **Corolla** white, 3.9–9 mm long; lobes 5–7, straight, rarely recurved. **Stamens** 5–7; filaments white, the base glabrous or with scattered hairs, 1.5–5 mm long; **anther** yellow, linear, 2–5 mm long. **Style** 1.2–8 mm long. **Stigma** of 5–8 minute lobes, rarely bi-lobed. **Fruit** a drupe, globose, dark-purple when mature.

Distribution and ecology.—The Bahamas, Greater and Lesser Antilles, and Caribbean coast of Venezuela.

Erithalis odorifera (Fig. 13) grows near the beach, on sandy coastal thickets, coppice, along the road, and from sea level to ~300 m in elevation; occurring solitary to abundant. This species is very distinctive in the Lesser Antilles, and according to Sandwith (1938), "it appears to replace *E. fruticosa*" in most of these

Fig. 12. *Erithalis harrisii*. **A.** Portion of a small tree with glossy leaves (arrows). **B.** SEM of the style and stamens. Bar = 1000μm. **C.** Inflorescences with immature fruits, flowers in anthesis, and flower buds; note the recurved corolla lobes. (Photos A & C taken in Trelawny Parish, Jamaica).

islands. When it overlaps in distribution with *E. fruticosa*, individuals with intermediate characters are formed, bridging the taxonomic-diagnostic character between these two species.

Specimens examined. **BAHAMAS. Andros:** S of Maidenhair Coppice, 24 May 1997, *Vincent* et al. 7784 (MU); May 1998, *Negrón-Ortiz* 654 (MU). **Great Abaco:** Lubbers Quarters Cay, 4 Jul 74, *Correll et al.* 42568 (FTG). **New Providence:** Lake Cunningham, 25 Sep 1963, *Popenoe* (bar code 000162, FTG). **St. Kitts:** 18 Jun 1944, *Beard* 289 (MO). **CUBA:** 1865, *Wright* 1869 (NY), 26 Aug 1893, *Combs* 538 (NY). **DOMINICAN REPUBLIC. Barahona:** Boca de Maniel, 20 May 1981, *Zanoni et al.* 13514 (MO, NY). **El Seibo:** Los Haitises, 29 Jun 1982, *Zanoni* et al. 21105 (NY). **La Altagracia:** Laguna Bavaro, 29 Apr 1981, *Zanoni et al.* (FTG). **HAITI:** without locality, 14 Aug 1903, *Nash* 431 (NY); W of Jeremie, 28 Dec 1941, *Holdridge* 923 (NY); vicinity of St. Louis du Nord, 7 Apr 1929, *Leonard & Leonard* 14398 (NY). **Puerto Rico. Arecibo:** Barrio Río Arriba, Río Abajo Forest Reserve, 6 Jul 1994, *Axelrod* et al. 7928. **Cabo Rojo:** Guaniquilla, La Mela, near the ocean, Jan 1999, *Negrón-Ortiz* 700 (MU). **Rio Grande:** Barrio Zarzal, Punta Picúa, 2 Jun 1992, *Proctor & Rivera* 47972 (FTG). **Isla Vieques:** Sun Bat, Half Moon Beach, 26 Nov 1981, *Hansen et al.* 9461 (FTG). **US VIRGIN ISLANDS. St. John:** 21 Jan 1991, *Acevedo* et al. 3988 (NY); Jumbie Beach, 17 Jun 1984, *Mori* et al. 16594 (NY). **LESSER ANTILLES. Dominica:** Bataka area, 10 Jan 1994, *Higgins* 102 (NY), Grand Bay, near point Carib, 27 Jul 1964, *Wilbur et al.* 8020 (MO); near

Fig. 13. *Erithalis odorifera*. **A.** Habit of an immature shrub. **B.** Flowers in anthesis; note the variation of corolla lobe number. **C.** SEM of the style and stamens. Bar = 1000μm. (Photos A & B taken on Bequia island, St. Vincent and the Grenadines, Lesser Antilles).

Ansedume on the northern coast, 11 Aug 1964, *Wilbur* et al. 8304 (MO, LL); Bluffs leading down to L'Anse Noire, 16 Jul 1964, *Wilbur et al.* 7517 (LL, MO); St. Andrew Parish, 28 Aug 1992, *Lee* 57 (NY); St. David Parish, 12 Mar 24751, *Hill* 24751 (NY). **Guadaloupe:** without locality, 1894, *Lee* 2557 (NY); 6 Aug 1973, *Sastre & Jeremie* 1861 (MO). **Martinique:** without locality, 1879, *Duss* 945 (NY). **St. Vincent and the Grenadines:** along the road, Jan 2000, *Negrón-Ortiz* 800 (MU); *Negrón-Ortiz* 807 (MU).

Common names and uses.—'Scented blacktorch' (Bahamas, Puerto Rico); 'Bwa flanbo' or 'Bwa chandèl' or 'Flambeau noir' or 'Bois chandelle' or 'Bois flambeau' (Dominica, Martinique); 'Parrot apple' (Tobago). In Dominica, the plant (part not specified) is used as a drink ('spirits'), and the twigs as charms against spirits/witches [label data, *Higgins* 102 (NY)].

Erithalis quadrangularis Krug & Urb., Notizbl. Königl. Bot. Gart. Berlin. 1:320. 1897. Type: JAMAICA: Manchester, 29 Apr 1896, *Harris 6318* (holotype: B-destroyed; lectotype: NY!, here designated).

Large shrub or **small tree** to 3.5–9 m tall, the branches glabrous. **Leaves** leathery and thick; the blades oval, ovate-elliptic, 8–21.6, 3.5–9.2 cm; the petioles 1–1.9 cm long. **Inflorescences** cymose-corymbose, axillary or terminal, 5.25–11.5 cm long; bracts 3.5–10.4 cm long. **Flowers** fragrant, pedicellate. Calyx and hypanthium glabrate or puberulent, calyx denticulate, 1–2.1 mm long. **Corolla** white, turning yellow, 6.8–12 mm long; lobes 6–8, recurved. **Stamens** 6–8; filaments white, 3–7.8 mm long, the base with scattered hairs; **anther** yellow, linear, 3.5–4.8 mm long. **Style** 4.5–10 mm long. **Stigma** of 5–8 minute lobes. **Fruit** subglobose.

Distribution and ecology.—*Erithalis quadrangularis* (Fig. 14) is endemic to Jamaica and to St. Vincent and the Grenadines. Known from a few Jamaican parishes: St. Ann, Clarendon, Manchester, and from Unity Valley district. It grows in woodlands on limestone, on rocky slopes, along roads, from sea level to 457 m elevation, and is not common. Although in many cases morphologically similar to *E. odorifera*, *E. quadrangularis* could be distinguished by longer, wider and thicker leaves, longer inflorescences, and recurved corolla lobes.

Conservation status.—This taxon is listed under the 2003 IUCN Red List of Threatened Species and represents a vulnerable species, criteria: B1, 2c (WCMC 1997).

Specimens examined. **JAMAICA. Unity Valley District:** between Moneague and Mt. Diablo, 2 Jul 1965, *Proctor* (I.L). **St. Ann Parish:** 23 May 1965, *Proctor* 26422 (I.L); Douglas Castle District, 11 Jun 1976, *Thorne & Proctor* 48167 (NY); Albion Pen, 12 May 1915, *Harris* 12013 (NY). **Clarendon Parish:** 22 May 1912, *Harris* (NY); Peckham Woods, May 1955, *Robertson* 2005 (NY)**: Manchester Parish:** Maudeville, 21–23 Sep 1908, *Britton* 3748 (NY); New Yveeu, 21–23 Sep 1908, *Britton* 3756 (NY); Marshall's Penn, 30 May 1959, *Proctor* 19678 (NY); vicinity of Marshall's Penn Est., 23 Apr 1961, *Kramer & Proctor* 1682 (NY); 25 Jul 1997, *Barcelona et al.* 1196 (MU). **Near Manchester:** New Greon, 29 Apr 1896, *Harris* 6318 (NY). **LESSER ANTILLES. St. Vincent and the Grenadines:** along the road, Jan 2000, *Negrón-Ortiz* 806 (MU).

Erithalis salmeoides Correll, J. Arnold Arbor. 58:49. 1977. TYPE: BAHAMAS. GREAT INAGUA: between Conch Shell Point and Lanter Head, 3 Aug 1975, *Correll* 45897 (HOLOTYPE: A!, ISOTYPE: FTG!).

Shrubs 3–7.5 m tall, the branches glabrous. **Leaves** leathery and thick; the blades obovate to broadly oval, rounded at the apex, 1.9–4.7, 1.2–3.8 cm; the petioles 0.4–0.9 cm long. **Inflorescences** cymose, cymose-paniculate, axillary, 4.5–5.4 cm long, glabrous; bracts variable to minute. **Flowers** fragrant, pedicellate. **Calyx** and hypanthium glabrate, calyx denticulate, 0.1–0.6 mm long. **Corolla** white, 1.7–4 mm long; lobes 4–5, straight. **Stamens** 4–5, longer than the style; filaments white, 0.3–2.5 mm long, the base with scattered hairs; **anthers** ellipsoid, 0.2–1.9 mm long. **Style** 0.5–2 mm long. **Stigma** bi-lobed. **Fruit** orbicular, dark-purple or whitish-pink.

Distribution and ecology.—Bahamas (Fig. 15): Great Inagua, Little Inagua, Mayaguana; Turks & Caicos; Dominican Republic, Jamaica, and Cuba.

This species is morphologically variable. In the southern Bahamian islands,

Fig. 14. *Erithalis quadrangularis* (*Proctor* 26422) from St. Ann Parish, Jamaica.

the species is reported as a low shrub, but in other areas it is taller in habit and morphologically (e.g., leaf size and shape, inflorescence length) indistinguishable from *E. fruticosa*, except for the position of the anthers with respect to the stigma height and the bi-lobed stigma (vs. stigma of 5–8 minute lobes, stamens positioned ≤ than the style, in *E. fruticosa*). In the molecular data phylogeny several specimens of *E. salmeoides* are placed in a polytomy with *E. fruticosa*, suggesting a close relationship or hybridization between these species.

Representative specimens examined. **BAHAMAS. Great Inagua:** Nov 1890, *Hitchcock s.n.* (MO), Salt Point Hill, 15 Dec 1997, *Freid* 97-093 (MU); 12 Oct 1904, *Nash & Taylor* 949 (NY); between Conch Shell Point and Lanter Head, 3 Aug 1975, *Correll* 45897 (Isotype FTG); near Smith's Thach Pond, between Conch Shell Point and Lanter Head, 23 Jul 1976, *Correll* 47475 (FTG, MO); near entrance to Flamigo Reserve, 27 Jul 1976, *Correll* 47565 (FTG). **Little Inagua:** Moujean Harbor, 17 Jul 1976, *Correll* 47351 (FTG). **Mayaguana:** S of Low Point Bay, 8 Feb 1973, *Proctor & Gillis* 33173 (MO). **Turks & Caicos:** Pine Cay, 24 Jan 1993, *Raven* 28205 (FTG, MO, NY); Salt Cay, Long Bay Point, 13 Jun 1979, *Buden* 23 (FTG); Providenciales, 16 Dec 1975, *Correll* 46406 (FTG, NY); 17 Dec 1975, *Correll* 46445 (FTG, NY). **Grand Turk:** Mount Wisdom, 20 Dec 1975, *Correll* 46558-A (FTG, NY). **CUBA. Southern Baracoa:** 17 Jul–4 Aug 1924, *Fre. Leon* 12413 (NY). **DOMINICAN REPUBLIC. Monte Cristo Prov.:** El Morro de Monte Cristo, 19 Jul 1981, *Judd et al.* 2992 (FTG, NY). **Jamaica. Pedro Bluff:** honey-combed limestone, 9 Jul 1907, *Harris* 9718 (NY).

Erithalis vacciniifolia (Griseb.) Wright, Anal. Acad. Ci. Habana 6:126. 1869. *Chione vacciniifolia* Griseb., Cat. Pl. Cub. 133. 1866. *Erithalis fruticosa* L. subsp. *vacciniifolia* (Griseb.) Borhidi, Bot. Közlem. 58:177. 1971. TYPE: CUBA: Baracoa, 1860–64, *Wright 2719* (HOLOTYPE: GOET!; SYNTYPE: K!).

Fig. 15. *Erithalis salmeoides* (*Raven* 28205) from Pine Cay, Bahamas.

Prostrate or **creeping shrub** to 2 m tall, the branches glabrous or puberulent. **Leaves** glossy, leathery and thick; the blades obovate or broadly oval, 1.1–4.7, 0.8–1.9 cm; sessile or short-petiolate, the petioles to 0.3 cm long. **Inflorescences** cymose, or cymose-paniculate or solitary flowers, axillary; bracts minute up to 2 mm long. **Flowers** fragrant, pedicellate. Calyx and hypanthium glabrate, calyx denticulate, 0.5–0.8 mm long. **Corolla** white, 2.5–6.5 mm long; lobes 4–6, straight. **Stamens** 4–6; filaments white, 0.3–3.6 mm long, the base with scattered hairs; **anther** yellow, linear to ellipsoid or oblong, 1.2–2.8 mm long. **Style** 1.2–5.2 mm long. **Stigma** of 5–8 minute lobes. **Fruit** globose, dark purple to blackish.

Distribution and ecology.—Cuba and Dominican Republic (Fig. 16) (Isla Beata, collected in 1950, but not re-collected since then). Found growing on

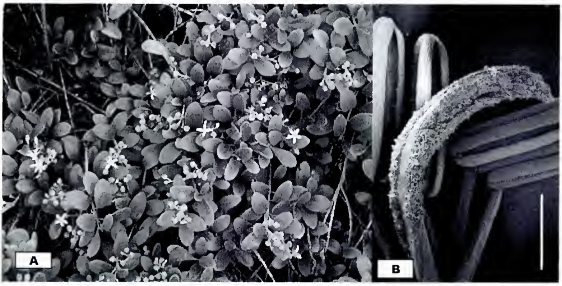


Fig. 16. *Erithalis vacciniifolia* from Dominican Republic, Greater Antilles. **A.** Habit. **B.** SEM of the style and stamens (*Delprete* 7551 NY). Bar = 1000μm. (Photo A was taken by Piero Delprete).

coastal thickets, on limestone hills or coastal cliffs, sandy beach, and in depressions in limestone rock. Common.

Specimens examined. **BAHAMAS. Andros:** 18 Aug – 10 Sep 1906, *Brace* 5152 (NY). **CUBA. Santiago:** 10 Mar 1938, *Bro. Clemente* 2352 (GH): oeste de la playa de Zuragúa, Oct 1950, *Hno. Clemente & Chrysogone* 7434 (GH); 7 Nov 1917, *Ekman* 8711 (GH); El Morro, 10 Mar 1938, *Bro. Clemente* 2351 (GH); Siboney, 18 Jul 1953, *Bro. Alain & López Figueira* 3056 (GH); near Siboney, Apr 1949, *Bro Clemente* 6557 (GH, NY); El Dudosa, Pilón, Jul 1949, *Bro. Alain* 1099 (GH); May 1947, *Bro. León* 22794 (GH); vicinity of Baracoa, 1–7 Feb 1902, *Pollard* et al. 212 (GH); near Santiago, 13 Apr 1902, *Hamilton* 233 (NY). **DOMINICAN REPUBLIC:** E of ciudad Trujillo, on road to Boca Chica, Cancedo beach, Dec 1962, *Bro. Augusto* 455 (NY); 1 Apr 1958, *Moore* 7578 (GH). **Barahona:** N end of Beatu Island, 9 Aug 1950, *Howard* 12416 (GH); Caucedo, 15 Feb 1964, *Bro. Augusto* 1362 (NY).

EXCLUDED TAXA

Illegitimate names include: *Erithalis obovata* Forst., *Erithalis timon* Spreng., and *Erithalis polygama* Forst. var. *timonius* Willd., all of which are synonyms of *Timonius timon* (Spreng.) Merr. var. *timon* (Darwin 1993). *Erithalis uniflora* Gaertn. is *Polyphragmon minus* A. Rich. ex DC., a description based upon a fruit of unknown origin (Standley 1934), and *Erithalis cymosa* Forst. is *Timonius forsteri* DC (Candolle 1830; Lioger 1962). *Erithalis pentagonia* DC is synonym of *Dendropanax arboreous* (L.) Dec. & Planch; Araliaceae), described from Cuba (Liogier 1962; Standley 1934).

ACKNOWLEDGMENTS

This research was made possible by grants from the National Science Foundation (DEB-9807089) and Willard Sherman Turrell Herbarium (#174) to V. Negrón-Ortiz. Special thanks go to the directors and curators of BM, FTG, GOET, GH, LL, MO, MU, NY, TEX and US for loaning specimens and/or sending images of type specimens; to David L. Gorchov for assistance in the field and constructive comments on earlier drafts; to Piero Delprete and Tim McDowell for helpful comments and greatly improving this manuscript; to Michael Vincent for providing assistance with nomenclature and constructive suggestions on previous drafts; to Piero Delprete, Ethan Freid, Tim McDowell and Lara I. Strittmatter provided leaf material used for molecular studies.

REFERENCES

Acevedo-Rodríguez, P. 1996. Flora of St. John, U.S. Virgin Islands. Mem. N.Y. Bot. Gard. 78:374.

Adams, C.D. 1972. Flowering plants of Jamaica. Univ. of Jamaica, Mona, Jamaica.

Adanson, M. 1763. Familles des plantes. 2:158. Paris.

Anderson, R.S. 1991. A new species of *Plocetes* from the Florida Keys with notes on other species occurring in the United States (Coleoptera, Curculionidae, Curculioninae, Tychiini). Fl. Entomol. 74:105–110.

Andersson, L. 1992. A provisional checklist of neotropical Rubiaceae. Meise: National Botanic Garden, Belgium.

Bancroft, G.T. and R. Bowman. 1994. Temporal patterns in diet of nestling white-crowned pigeons: implications for conservation of frugivorous columbids. Auk. 111:844–852.

Borhidi, A. 1971. *Erithalis*. Bot. Közlem. 58:177.

Bremer, B. and R.K. Jansen. 1991. Comparative restriction site mapping of chloroplast DNA implies new phylogenetic relationships within the Rubiaceae. Amer. J. Bot. 78:198–213.

Browne, P. 1756. *Erithalis*. The civil and natural history of Jamaica. London. P. 165.

Candolle, A.P. de. 1830. Rubiaceae. Prodromus. 4:341–622. Treuttel & Würtz, Paris.

Correll, D.S. 1977. New species and a new combination from the Bahamas, Caicos and Turk islands. J. Arnold Arbor. 58:48–51.

Correll, D.S. and H.B. Correll. 1982. Flora of the Bahama Archipelago (including the Turk and Caicos islands). Vaduz: J. Cram. Publisher.

Darwin, S.P. 1993. A revision of *Timonius* subgenus *Timonius* (Rubiaceae: Guettardeae). Allertonia. 7:1–39.

Delprete, P.G. 1996. Evaluation of the tribes Chiococceae, Condamineeae and Catesbaeeae (Rubiaceae) based on morphological characters. Opera Bot. Belg. 7:165–192.

Dooley, A.L. 1975. Foods of the Key deer (*Odocoileus virginianus clavium*). M.A. Thesis, Southern Illinois Univ., Carbondale.

Engler, A. 1897. III. Giagnosen neuer Arten. Notizbl. Königl. Bot. Gart. Berlin. 1:319–321.

Eriksson, T. 1999. Autodecay 4.0 (program distributed by the author). Bergius Foundation, Royal Swedish Academy of Sciences, Stockholm.

Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. Evolution 39:783–791.

Forster, J. G. A. 1786. Fl. Ins. Austral. Prodr. 17.

Francis, J.K. (without date). U.S. Department of Agriculture, Forest Service, International

Institute of Tropical Forestry, Río Piedras, PR. www.fs.fed.us/global/iitf/pdf/shrubs/Erithalis%20fruticosa.pdf.

Fritsch, P. and S. Lucas. 2000. Clinal variation in the *Halesia carolina* complex (Styracaceae). Syst. Bot. 25:197–210.

Grisebach, A. 1859–1864. Flora of the British W Indian Islands. Lovell Reeve & Co., London. Weinheim.

Grisebach, A. 1862. Plantae Wrightianae e Cuba orientali lectae. Mem. Am. Acad. Arts, ser. 2. 8:507.

Grisebach, A. 1866. Catalogus plantarum Cubensium. Engelmann, Leipzig. Pp. 133–134.

Henderson, A. and E. Ferreira. 2002. A morphometric study of *Synechanthus* (Palmae). Syst. Bot. 27:693–702.

Hooker, J.D. 1873. Rubiaceae. In: G. Bentham & J.D. Hooker, Genera plantarum. 8:105.

Howard, R.A. 1989. Flora of the Lesser Antilles, Leeward and Windward Islands. Vol. 6. Arnold Arboretum, Harvard University, Jamaica Plain, MA.

Jacquin, N.J. 1763. *Erithalis*. Selectarum stirpium Americanarum historia [microform]. Pp. 72–73.

Janovec, J.P. and J.S. Harrison. 2002. A morphological analysis of the *Compsoneura sprucei* complex (Myristicaceae), with a new combination for the Central American species *Compsoneura mexicana*. Syst. Bot. 27:662–673.

Jiménez-B., L.C. 2002. Lista de las colecciones colombianas de Rubiaceae depositadas en el Herbario Nacional Colombiano (COL). Caldasia. 24:41–64.

Kimber, C.T. 1988. Martinique revisited: the changing plant geographies of a West Indian island. College Station: Texas A&M University Press.

Linné, C. 1759. *Erithalis*. Systema naturae. Ed. 10:930.

Liogier, E.E. (= H.A.). 1962. *Erithalis*. Flora de Cuba. 5:89–90.

Liogier, H.A. 1990. Plantas medicinales de Puerto Rico y del Caribe. Iberoamericana de Ediciones, Inc. San Juan, PR.

Liogier, H.A. 1997. Descriptive flora of Puerto Rico and adjacent islands. 5:436. Editorial de la Universidad de Puerto Rico (EDUPR), San Juan, PR.

Liogier, H.A. and L.F. Martorell. 1982. Flora of Puerto Rico and adjacent islands: a systematic synopsis. EDUPR, Río Piedras, Puerto Rico.

Little, E.L., Jr., R.O. Woodbury, and F.H. Wadsworth. 1974. Trees of Puerto Rico and the Virgin Islands. Agric. Handb. 449. 2:1024 p. U.S. Department of Agriculture, Washington, DC.

Long, R.W. and O. Lakela. 1976. A flora of Tropical Florida. Banyan Books, Miami, FL.

Mitchell, N.C. 1999. Effect of introduced Ungulates on density, dietary preferences, home range, and physical condition of the iguana (*Cyclura pinguis*) on Anegada. Herpetologica 55:7–17.

Moore, S. and A.B. Rendle. 1936. Rubiaceae. Flora of Jamaica, containing descriptions of the flowering plants known from the island. 7:65–68. British Museum, London.

Negrón-Ortiz, V. 1996. Reproductive biology of *Ernodea* (Rubiaceae) in Puerto Rico and the Bahamas. Opera Bot. Belgica 7:403–412.

Negrón-Ortiz, V. and L.E. Watson. 2003. Hypotheses for the colonization of the Caribbean Basin by two genera of the Rubiaceae: *Erithalis* and *Ernodea*. Syst. Bot. 28:442–451.

Negrón-Ortiz, V. and L.E. Watson. 2002. Molecular phylogeny and biogeography of *Erithalis* (Rubiaceae), an endemic of the Caribbean Basin. Plant Syst. Evol. 234:71–83.

Negrón-Ortiz, V. and R.J. Hickey 1996. The genus *Ernodea* (Rubiaceae) in the Caribbean Basin. II. Morphological analyses and systematics. Syst. Bot. 21:445–458

Nelson, G. 1996. The shrubs and woody vines of Florida. Pineapple Press, Inc., Sarasota, FL.

Persoon, C.H. 1805. Synopsis plantarum [microform]. 1:200. Parisiis Lutetiorum, France.

Posada, D. and K.A. Crandall. 1998. Modeltest: testing the model of DNA substitution. Bioinformatics 14:817–818.

Rafinesque, C.S. 1838. Sylva Telluriana. Mantis synopt. New genera and species of trees and shrubs of North America, and other regions of the earth. Philadelphia. P. 123.

Sandwith, N.Y. 1938. Notes on the flora of Tobago. Contributions to the flora of Tropical America: 37. Bull. Misc. Infor. Kew. 294:364.

Sauvalle, F.A. 1869. Revisio catalogi Grisebachiani vel index plantarum cubensium. Anal. Acad. Ci. Habana. 6:126.

Standley, P.C. 1934. Rubiaceae. North Amer. Fl. 32:279–281.

Steyermark, J.A. 1974. Flora de Venezuela. 9:867–870. Instituto Botanico, Caracas.

Swofford, D.L. 2001. PAUP*: Phylogenetic analysis using parsimonious version 4.0b8. Sunderland, Massachusetts, Sinauer Associates.

Thompson, S. and T. Lammers. 1997. Phenetic analysis of morphological variation in the *Lobelia cardinalis* complex (Campanulaceae: Lobelioideae). Syst. Bot. 22:315–331.

University of the Virgin Islands. 2002. *Erithalis fruticosa* (blacktorch). rps.uvi.edu/ VIMAS/ blacktorch.htm.

Urban, I. 1903. Symbolae Antillanae 3:379–380, Berlin, Leipzig, Paris, London.

Urban, I. 1908. Symbolae Antillanae 5:514. Berlin, Leipzig, Paris, London.

WCMC (World Conservation Monitoring Centre). 1997. *Erithalis harrisii, Erithalis quadrangularis*. In: IUCN 2003. 2003 IUCN Red List of Threatened Species. www.redlist.org.

Wernham, H.F. 1913. New Rubiaceae from tropical America.-III. J. Bot. 51:322–323.

Zappi D. and T.S. Nunes. 2000. Notes on the Rubiaceae of northern Brazil. I. *Erithalis, Psychotria* and *Rudgea*. Kew Bull. 55:655–668.

UNA NUEVA ESPECIE DE *AIPHANES* (ARECACEAE) DE LA CORDILLERA DE MÉRIDA, VENEZUELA

Santos Miguel Niño

Universidad Nacional Experimental de los
Llanos Occidentales "Ezequiel Zamora" (UNELLEZ)
Mesa de Cavacas
Guanare, estado Portuguesa 3323
VENEZUELA
smiguel@cantv.net

L.J. Dorr

National Museum of Natural History
Dept. of Botany, MRC-166
Smithsonian Institution
P.O. Box 37012
Washington, DC 20013-7012, U.S.A.
dorrl@ si.edu

Fred W. Stauffer

Conservatoire et Jardin botaniques de la Ville de Genève
Case postale 60 CH-1292
Chambésy/ Genève, SWITZERLAND
fred.stauffer@cjb.ville-ge.ch

RESUMEN

Se describe e ilustra una nueva especie de Arecaceae (**Aiphanes stergiosii** M. Niño, Dorr, & F.W. Stauffer), y se presenta una clave para distinguir entre la nueva especie con especies relacionadas. Así mismo, se mencionan aspectos ecológicos y geográficos de su distribución.

ABSTRACT

A new species of palm (**Aiphanes stergiosii** M. Niño, Dorr, & F.W. Stauffer) is described and illustrated, and a key is given to distinguish this new species from related ones. In addition, information is provided on the ecology and geographical distribution of this new species.

INTRODUCCIÓN

El género *Aiphanes* Willd. (Arecaceae) tiene amplia distribución en el neotrópico con su centro principal de diversidad en el oeste de Colombia y Ecuador (Borchsenius y Bernal 1996). Hasta los momentos se conocen 23 especies de este género (Borchsenius y Bernal 1996; Bernal 2001). En la revisión de Borchsenius y Bernal (1996) solamente *A. aculeata* Willd. fue reportada en Venezuela y localizada en los estados Barinas, Delta Amacuro (localidad tipo del sinónimo *A. orinocensis* Burret), Miranda (localidad tipo de la especie) y Sucre. En el neotrópico, *A. aculeata* se distribuye desde Trinidad y Venezuela hasta Bolivia y Brasil (Henderson et al. 1995).

Recientes exploraciones botánicas por los Andes de Venezuela, llevadas a cabo por la Universidad de Los Llanos Occidentales "Ezequiel Zamora" (UNELLEZ) y el Smithsonian Institution de Washington, DC (U.S.A.) en el Parque Nacional Guaramacal, han dado como resultado el hallazgo de una nueva especie de *Aiphanes* para la ciencia, así como nuevos registros de distribución de palmas para la región andina venezolana (Dorr et al. 2000). El Parque Nacional Guaramacal está ubicado, entre los estados Portuguesa y Trujillo, coordenadas 9°21'-9°02' latitud Norte y 70° 00-70°15'30" longitud Oeste (Cuello y Romero 1999; Dorr et al. 2000).

Aiphanes stergiosii M. Niño, Dorr, & F.W. Stauffer, sp. nov. (**Fig. 1**). TIPO: VENEZUELA. PORTUGUESA. Municipio Sucre: Parque Nacional Guaramacal, "La Concepción" (Coord UTM 19-382.173 E y 1.033.526 N), 1700 m, Dic 2000, *M. Niño & B. Stergios 1431* (HOLOTIPO: PORT; ISOTIPOS: K, US, VEN, Z-ZT).

Differt a *A. lindeniana* habitu solitaro, foliis glabris, costa prominente in superficiebus ambabus folii, pedunculo magis angustiore (3-5 vs. 7-8 mm lato basi), sepalis floris pistillatae brevioribus (1-2.5 mm vs. 3.5-7 mm longis) et marginibus semper fimbriatis-adpressis.

Palma solitaria de hasta 6 m de altura. Tallo densamente espinoso, 2-4 m de altura, 3-4.5 cm de diámetro; espinas pardo-negruzcas, agrupadas en el centro del entrenudo, con espinas aplanadas, grandes y pequeñas de 1-9 cm de largo, base estrecha de 0.5-2 mm que se reduce a una acícula a partir de la parte media, generalmente descendentes. Hojas 4-8 por planta, ligeramente arqueadas; vaina foliar de 18-20 × 3-3.5 cm, con indumento blanquecino, espinas similares a las del tallo, 0.2-8 cm de longitud, la base ligeramente cubierta con indumento de la vaina o completamente lisa y brillante. Pecíolo de 20-30 cm de longitud, glabro, espinas largas en la base, hasta 9 cm de longitud, muy pocas y pequeñas en el ápice. Raquis de 85-95 cm de longitud, dorsalmente costado, de 4-6 mm de ancho en su parte media, cara adaxial con ninguna o muy pocas espinas, cara abaxial siempre con espinas, progresivamente de menor tamaño y cantidad hacia el ápice; espinas aceriformes, negras, dispersas, algunas con indumento blanquecino en la base, hasta 3.5 cm de longitud. Pinnas 18-24 por lado, insertas en grupos de 3-6. Pinnas mediales de 10-25 cm de largo y 5-8.5 de ancho, el ápice glabro por ambas caras, casi siempre con 0-4 espinas dispersas en el nervio central de la haz, bordes laterales lisos, glabros o con espinas dispersas de 1-5 mm de largo; ápice truncado, proyección distal sobresaliendo en una cauda de 5-25 mm de largo, con algunas espinas presentes muy delgadas de 1-4 mm de longitud; nervio medio amarillento y prominente en la haz y el envés, con 0-15 espinas en las nervaduras de la haz de 5-15 mm de largo, el envés sin espinas. Pinna apical casi siempre partida en dos (producto de la acción del viento fuerte) o entera, con borde apical praemorso, 15-25 cm de longitud y 15-24 cm de ancho, glabra, con 10-12 nervios prominentes por ambas caras, y 0-3 espinas de 5-15 mm de longitud. Inflorescencia interfoliar, péndula, 1-ramificada; prófilo inserto desde la base del pedúnculo, aplanado, glabro, hasta 45 cm de longitud y 1.4 cm de ancho; bráctea del pedúnculo ligeramente tomentosa, con algunas espinas negras dispersas, 90-120 cm de largo y 4-5 cm de ancho; pedúnculo terete, de 100-120 cm de largo y 3-5 mm de diámetro en la base, cubierto con espinas pardo-negruzcas pequeñas y cilíndricas de 5-20 mm de largo, con indumento

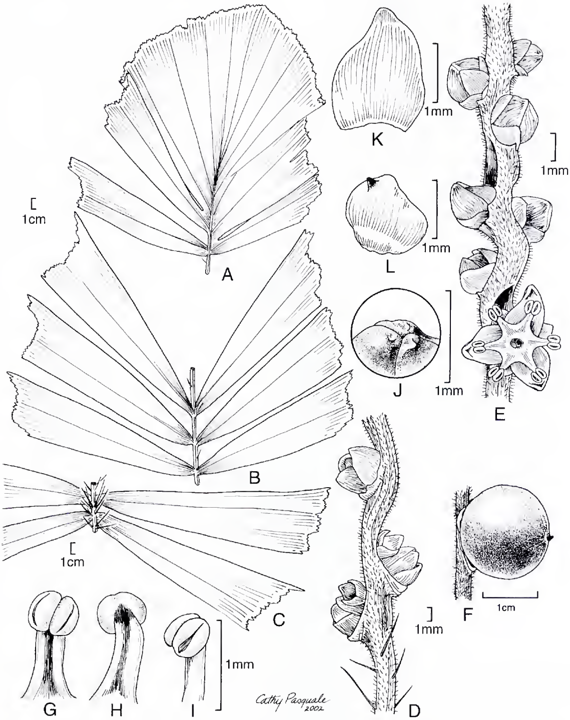


Fig. 1. *Aiphanes stergiosii* M. Niño et al. **A.** Apice de una hoja (la mayoría de los ápices eventualmente se presentan divididos, probablemente por factores ambientales). **B.** Parte media de una hoja. **C.** Base de una hoja. **D.** Flores estaminadas y pistiladas. **E.** Flores estaminadas. **F.** Fruto. **G–I.** Anteras. **J.** Pistilodio. **K–L.** Sépalos de una flor estaminada (todo basado en *Niño & Stergios 1431*, US).

ferrugíneo disperso; raquis hasta 35 cm de longitud, densamente ferrugineo-tomentoso, decreciendo en grosor desde 4 mm en la base a 1 mm en el ápice, con espinas de 5–12 mm de longitud decreciendo en tamaño y cantidad hacia el ápice del raquis; raquillas con espínulas pardo-negruzcas, densamente tomentosas, presenta una bráctea muy delicadas y caedizas en su base; raquillas basales de 20–45 cm de largo y 0.7–1 mm de grosor en su parte media, espinas en la base, con tríadas insertas cercanas a la base hasta 2/5 de la raquilla, luego flores estaminadas hacia el ápice; raquillas apicales de 5–12 cm de largo, sin espinas, con flores estaminadas en díadas, estrechamente cercanas o formando pares. Flores estaminadas blancas a violeta claro, superficiales, ligeramente sumergida dejando una pequeña concavidad; sépalos imbricados, 0.1–0.2 mm connados en la base, luego libres, 0.5–1 mm de largo; pétalos libres de 1.2–1.9 mm de largo; estambres 6, filamentos de 0.8–1.2 mm de longitud; anteras con 0.5–0.6 mm de longitud y 0.4–0.6 mm de ancho, dorsifijas, blancas, dehiscentes longitudinalmente y a los lados de cada teca, conectivo claro; pistilodio rugoso, piramidal, de 0.3–0.4 mm de altura; polen ovoideo, monosulcado. Flores pistiladas púrpura en la antesis; sépalos 1–2.5 mm de longitud, libres, imbricados, glabros, fimbriado-adpreso por los bordes; pétalos 3–4.5 mm de largo, connados ca. hasta la mitad de su longitud, o ligeramente más arriba, valvados, lóbulos triangulares; pistilo glabro, liso, piramidal, unicuspidado, de 2–3 mm de longitud; anillo estaminodial 2–3 mm de alto. Fruto globoso rojo o naranja, epicarpo liso y brillante, caedizos, con 10–15 mm de diámetro.

Distribución y ecología.—*Aiphanes stergiosii* es únicamente conocida del lugar tipo, en la vertiente sur del Parque Nacional Guaramacal entre 1600 y 2000 m. La comunidad de palmas posee mayor densidad a 2000 m, donde el suelo es poco profundo, arenoso y el bosque es más abierto por los fuertes vientos que dominan en la zona. El bosque donde habita es de montaña, húmedo, siempre verde, pluriestratificado, con abundantes epifitas y árboles de hasta 25 m de altura. La intervención humana es muy escasa dado lo inaccesible del sitio, solo hay evidencia de cazadores esporádicos.

El fruto de *Aiphanes stergiosii* es consumido por animales silvestres del bosque, seguramente por pequeños y medianos mamíferos, dadas las características de las mordidas en restos de frutos encontrados en el suelo, además de algunas huellas. Como es de suponer, la dispersión de las semillas la realizan estos animales y algunas aves de gran porte, como tucanes. Al observar el sitio donde deberían caer los frutos, se aprecia que incluso las semillas son consumidas totalmente y/o transportadas. Como indica Utrera (1999), la mastofauna del Parque Nacional Guaramacal, asociada a los bosques montanos, se caracteriza por el predominio de especies de hábitos alimentarios primordialmente frugívoros. Sin embargo se puede apreciar buena regeneración de la especie, dado que se observan pequeñas plantas dispersas en el área.

Nombre vulgar.—macanilla.

Relaciones taxonómicas.—Hasta los momentos la única especie reportada para el género en Venezuela es *Aiphanes aculeata*, la cual se puede distinguir de *A. stergiosii* por formar colonias en tierras bajas entre 100–500 m, además de poseer, hojas grandes con más de 2 m, foliolos tricuspidados y flores amarillentas. Las especies más relacionadas se encuentran en la región de los Andes Occidentales de Colombia, entre ellas están: *A. lindeniana* (H. Wendl.) H. Wendl., *A. hirsuta* Burret, y *A. erinacea* (H. Karst.) H. Wendl.

Aiphanes lindeniana es probablemente la especie que mayor afinidad tiene con *A. stergiosii*, además de compartir hábitats similares, poseen caracteres comunes como la inflorescencia 1-ramificada, espinulosa, con flores violeta o blancas y fruto globoso, naranja o rojizo. Se pueden distinguir principalmente por el aspecto que tiene *A. lindeniana* de ser más robusta y tener abundantes y densas espinas, con tendencia a formar colonias cespitosas, aunque se puede presentar solitaria. Las características más resaltantes que la separan de *A. stergiosii* son el indumento ferrugíneo en el pecíolo y raquis de la hoja; los foliolos con indumento y finamente espinuloso por el envés; las espinas pequeñas y abundantes en los bordes; los nervios principales espinosos, prominentes solo por la haz; y el envés pubescente a espinoso. El pedúnculo de la inflorescencia de *A. lindeniana* es grueso (7–10 mm de diámetro) y con gran densidad de espinas grandes (2–4.6 cm de largo); las flores pistiladas son evidentemente de mayor tamaño (hasta 7 mm de longitud), los sépalos en sus bordes son ligeramente fimbriado-adpresos (no muy evidente); el ovario ovoide a subgloboso; el polen es casi siempre globoso, con la exina finamente reticulada. No logramos ver el holotipo de *A. lindeniana*, pero si examinamos algunos especimenes referidos por Borschenius y Bernal (1996) (ver el Apéndice I).

Aiphanes stergiosii, en todas las colecciones realizadas en Venezuela, se le ha observado solitario; el raquis de la hoja sin indumento, liso con algunas espinas dispersas; los foliolos en sus bordes no tienen espinas o se presentan algunas dispersas, son glabros por ambas caras; los nervios principales son prominentes por ambas caras, los del envés no tienen espinas y algunas espinas están presentes en la haz; el pedúnculo de la inflorescencia es delicado hasta con 5 mm de diámetro, las espinas son ralas o escasas y pequeñas (0.3–1 cm de largo); las flores pistiladas son pequeñas, no mayores de 5 mm de longitud, los sépalos poseen una línea amarillenta, evidentemente fimbriado-adpresa de 1–2 mm de longitud; el ovario es piramidal; el polen es ovoide, ligeramente perforado y verrucoso (Fig. 2).

Otra especie similar es *Aiphanes erinacea*, hasta ahora sólo colectada en Colombia y Ecuador. Se puede diferenciar básicamente por poseer un hábito cespitoso, además de ser una planta de menor tamaño (hasta 5 m de tallo), conspicuamente prostrada, las hojas poseen espinas amarillas, y las pinnas están

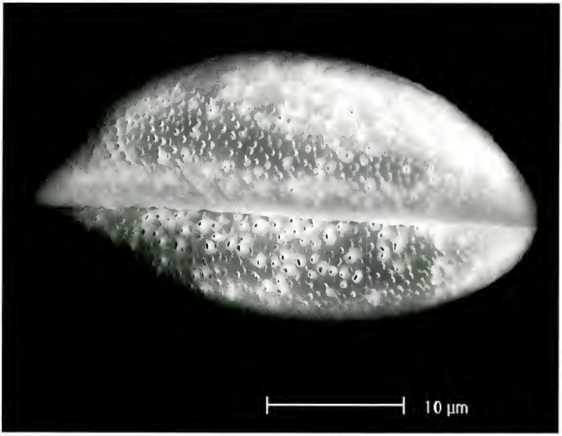


Fig. 2. Grano de polen de *Aiphanes stergiosii* M. Niño et al. en MEB (*Niño & Stergios 1431*, US).

en grupos de 2–3 (–4), el fruto es rojo oscuro, el polen es ovoideo con evidentes verrugas o espinas supratectales (Borchsenius y Bernal 1996).

Aiphanes hirsuta tiene un amplio rango de distribución geográfica y altitudinal (100–2200 m), aparece una forma en Centro América (Costa Rica y Panamá), así como en Colombia y Ecuador, con gran variabilidad. Sin embargo, difiere ampliamente de *A. stergiosii*, por ser cespitosa los foliolos en su cara abaxial poseen espínulas amarillentas, el pedúnculo de la inflorescencia es densamente armado con espinas de 3–5 cm de longitud, el fruto (casi siempre espinuloso) es rojo oscuro hasta púrpura, ocasionalmente blancuzco.

Existe una separación geográfica entre *Aiphanes stergiosii* y las especies relacionadas más cercanas, ca. 600 km con *A. lindeniana*, existiendo además barreras ambientales muy amplias, como el valle del Río Uribante (en Venezuela), que baja a tan solo 300 m, y los altos andes de la Sierra Nevada de Mérida, donde hasta ahora no se ha reportado otra especie de *Aiphanes*. Por este motivo también descartamos la posibilidad de una forma geográfica. La comparación entre especimenes colombianos nos evidencia la similitud entre ellos, pero también una notoria diferencia con la de Venezuela. Pensamos que se trata de una nueva especie que puede ayudar a dilucidar la especiación de este grupo de palmas en los andes.

CLAVE PARA DISTINGUIR LAS ESPECIES DE *AIPHANES* DE VENEZUELA DE ALGUNAS RELACIONADAS DE CENTRO AMÉRICA Y LA CORDILLERA NOROCCIDENTAL DE COLOMBIA

1. Tallos de 3–10 m × 6–10 cm; raquillas con indumento peltado, raramente espinoso; pistilodio de 0.5–1 mm de longitud (Venezuela, Colombia, Trinidad y Tobago, Brasil, Perú) ________ **A. aculeata** Willd.
1. Tallos de 3–6 m × 3–5 cm; raquillas pubescentes, glabras o espinosas; pistilodio diminuto hasta 0.5 mm de longitud (Costa Rica, Panamá, Venezuela, Colombia, Ecuador).
    2. Planta generalmente multicaule, alguna monocaule.
        3. Tallos y/o hojas armados con espinas amarillas.
            4. Inflorescencia sin ramificaciones; tallos hasta con 2 cm de diámetro (Oeste de Colombia) ________ **A. simplex** Burret
            4. Inflorescencia ramificada; tallos de 2.5–5 cm de diámetro (Colombia y Ecuador) ________ **A. erinacea** (H. Karst.) H. Wendl.
        3. Tallos y hojas armados con espinas negras o pardo oscuro.
            5. Ramas de la inflorescencia densamente cubierta de espínulas.
                6. Pinnas basales de 17–45 × 1–13 cm; fruto espinuloso, rojo oscuro a violeta (Costa Rica, Panamá, Colombia, Ecuador) ________ **A. hirsuta** Burret
                6. Pinnas basales de 7–20 × 0.5–1.5 cm; fruto completamente glabro, rojo claro a naranja (NO de Colombia) ________ **A. lindeniana** (H. Wendl.) H. Wendl.
            5. Ramas de la inflorescencia sin espínulas ________ **A. leiostachys** Burret
    2. Planta monocaule.
        7. Raquis de la hoja con indumento y finamente espinuloso; foliolos con borde densamente espinosos, envés con indumento y espinuloso, nervios principales del envés pubescentes a espinosos y la haz con hilera de espinas; base del pedúnculo de inflorescencia de 5–10 mm de diámetro (NO de Colombia) ________ **A. lindeniana** (H. Wendl.) H. Wendl.
        7. Raquis de la hoja casi siempre sin indumento, liso con algunas espinas dispersas; foliolos con bordes sin espinas o con algunas espinas dispersas, glabros por ambas caras; nervios principales del envés sin espinas, algunas espinas presentes en la haz pero sin formar una hilera continua; base del pedúnculo de inflorescencia de 3–5 mm de diámetro (Venezuela) ________ **A. stergiosii** M. Niño et al.

APÉNDICE I. MATERIAL EXAMINADO DE *AIPHANES*

Aiphanes aculeata Willd.

VENEZUELA. Miranda: Cárdenas, Valle de Siquire; 400–800 m, 6 Apr 1917, *H. Pittier 7676* (US). **COLOMBIA. Valle:** Puerto Caldas, Cauca Valley, 860–900 m, 31 Aug 1922, *E.P. Killip y T.E. Hazen 11039* (US).

Aiphanes lindeniana (H. Wendl.) H. Wendl.

COLOMBIA. Cundinamarca: Near Fusagasuga, 9000 ft, 12 Oct 1946, *M.B. Foster & R. Foster 1870* (holotipo de *Aiphanes concinna* H.E. Moore: BH). **Huila:** Finca Merenberg, Cauca border E of Leticia (2°16'N, 76°12'W), 2275–2300 m, 7 Jul 1984, *A. Gentry et al. 47724* (MO); Ibid., 2300 m, 8 Jul 1984, *A. Gentry et al. 47756* (MO).

Aiphanes stergiosii M. Niño et al.

VENEZUELA. Portuguesa: Municipio Sucre: Divisoría de La Concepción, 1900 m, Enero 2000, *N. Cuello et al. 1868* (PARATIPOS: PORT, US); Parque Nacional Guaramacal, "La Concepción" (Coord. UTM 19–382.173 E y 1.033.526 N), 1700 m, Dic 2000, *M. Niño & B. Stergios 1431* (HOLOTIPO: PORT; ISOTIPOS: K, US, VEN, Z-ZT).

AGRADECIMIENTOS

Los autores expresan su agradecimiento a la Andrew W. Mellon Foundation y el Smithsonian Institution por el apoyo brindado al Proyecto Flora de Guaramacal; a Cathy Pasquale por el dibujo; al Dr. Jing-Ping Liao (IBSC) por su ayuda en la toma de microfotografías en MEB del polen de la nueva especie; y a Finn Borschenius (AAU) y Scott Zona (FTG) por la revisión y los cambios sugeridos al manuscrito. También a Jim Solomon (MO) y Kevin Nixon (BH) quienes gentilmente nos facilitaron unos préstamos de *Aiphanes lindeniana*.

REFERENCIAS

BERNAL, R. 2001. Una nueva especie de *Aiphanes* (Palmae) de los Andes de Colombia. Caldasia 23:163–167.

BORCHSENIUS, F. y R. BERNAL. 1996. *Aiphanes* (Palmae). Fl. Neotrop. Monogr. 70:1–95.

CUELLO, N.L. y F. ROMERO. 1999. Introducción. En: N.L. Cuello A., editora, Parque Nacional Guaramacal. UNELLEZ–Fundación Polar, Caracas. Pp. 1–6.

DORR, L.J., B. STERGIOS, A.R. SMITH, y N.L. CUELLO A. 2000 [2001]. Catalogue of the vascular plants of Guaramacal National Park, Portuguesa and Trujillo states, Venezuela. Contr. U.S. Natl. Herb. 40:1–155.

HENDERSON, A., G. GALEANO, y R. BERNAL. 1995. Field guide to the palms of the Americas. Princeton, New Jersey.

UTRERA, A. 1999. Mastofauna del Parque Nacional Guaramacal. En: N.L. Cuello A., ed., Parque Nacional Guaramacal. UNELLEZ–Fundación Polar, Caracas. Pp.153–159.

THREE PREVIOUSLY UNDESCRIBED SPECIES OF *VACCINIUM* (ERICACEAE) FROM COSTA RICA AND PANAMA

Robert L. Wilbur

Department of Biology
Duke University
Durham, North Carolina 27708, U.S.A.
rwilbur@duke.edu

James L. Luteyn

New York Botanical Garden
Bronx, New York 10458-5126, U.S.A.
jluteyn@nybg.org

ABSTRACT

Three new species of *Vaccinium* (Ericaceae) are described from Costa Rica and Panama: ***Vaccinium almedae*** Wilbur & Luteyn, ***V. furfuraceum*** Wilbur & Luteyn , and ***V. luteynii*** Wilbur.

Key Words: Ericaceae, *Vaccinium*, Costa Rica, Panama

RESUMEN

Se describen tres nuevas especies de *Vaccinium* (Ericaceae) de Costa Rica y Panamá: ***Vaccinium almedae*** Wilbur & Luteyn, ***V. furfuraceum*** Wilbur & Luteyn, y ***V. luteynii*** Wilbur.

Palabras Claves: Ericaceae, *Vaccinium*, Costa Rica, Panama

INTRODUCTION

In order to validate the names of three new species of *Vaccinium* (Ericaceae) prior to their appearance in William Burger's *Flora Costaricensis*, which frowns on such distractions appearing therein, their descriptions are presented here. A discussion of the presumed relationships of each of these species will appear in a later paper treating systematically all the species of *Vaccinium* known from Mexico and Central America.

Vaccinium almedae Wilbur & Luteyn, sp. nov. (**Fig. 1**). Type: PANAMA. Chiriquí: Edwin Fabrega Dam and Reserve in Fortuna, along trail to hydrological station, along Río Hornito, below forestry house along the road in wet forest, 8°45'N, 82°05'W, 1200 m, 20 Jan 1989 (fl), *Almeda,de Nevers & McPherson* 6369 (holotype: PMA!; isotypes: CAS!, DUKE!, MO, NY!).

Frutex epiphyticus 1–2 m altus. Folia coriacea, integra, glabra; nervatioa camptrodroma. Petioli 7–15 × 2–3.5 mm, glabri. Inflorescentiae ramiflorae fasciculatae; pedicelli 5–10 mm longi, gracili; bracteolae 2, deltatae, 0.5–0.8 mm longi; margo fimbriato. Calyx pedicellis articulatus, 3–4 mm longus, glabrus; lobi calycis triangulari acuti, 0.2–0.4 mm alti. Corolla cylindrica glabra, 5–9 mm longa; lobi corollaei 5, ca. 2.5 mm longi. Stamina 10, filamenta 1–2.5 mm longa, glabra; thecae 1.4–2.2 mm longae, laevigatae, tubuli separati, gracili 3–4.8 mm longi, truncati.

Coarse, rigid, epiphytic **shrubs** 1–2 m tall; branchlets and branches ± terete, glabrous or nearly so but current season growth not present, thin, brownish or

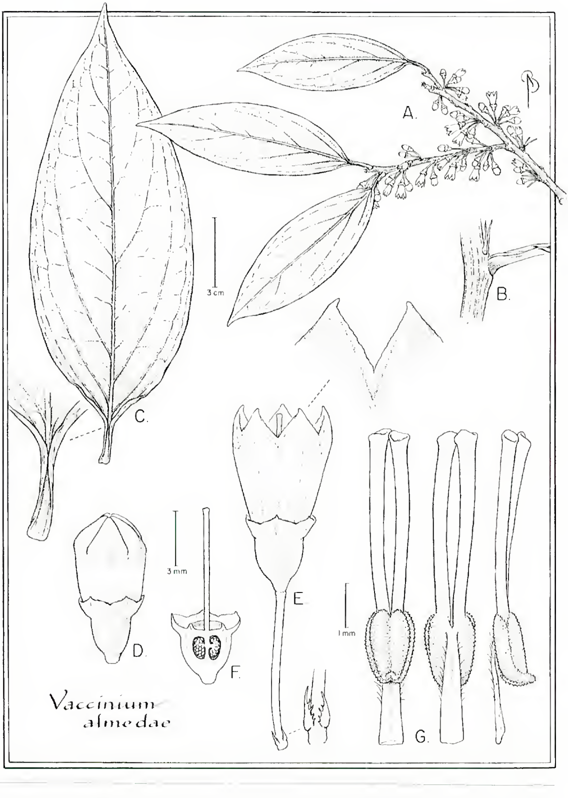


Fig. 1. *Vaccinium almedae*. **A.** Habit. **B.** Detail of leaf axil showing pseudostipular axillary bud scales. **C.** Leaf with detail of adaxial portion of blade-petiole junction. **D.** Flower in bud. **E.** Flower at anthesis with detail of basal pedicellary bracteoles and the thinner sinus tissue between the corolla lobes. **F.** Longitudinal section of gynoecium through calyx. **G.** Stamens showing ventral, dorsal, and lateral views (all drawn from the holotype, *Almeda et al. 6369)*.

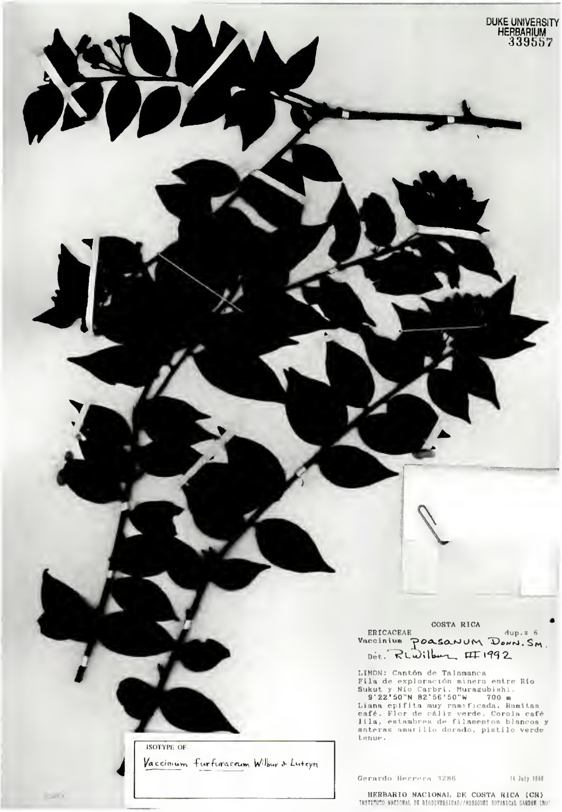
grayish. **Leaf-blades** coriaceous, elliptic, mostly 6–18 cm long, 3–7.5(–9) cm broad, apically acute to acuminate, basally rounded to shortly tapering and sometimes curling or somewhat conduplicate around the petiole at the junction, marginally entire, glabrous on both surfaces, the venation 3-5-plinerved, the veins ± depressed above except the midrib elevated for the proximal third to half while elevated beneath through the 3–4 order and forming an indistinct reticulum; petioles mostly 7–15 mm long, 2–3.5 mm diam., somewhat flattened above and there rather broadly and shallowly grooved, glabrous. **Inflorescences** mostly ramiflorus, of several to numerous, sessile fascicles (2–10-flowered) emerging from small, depressed mounds 1–2 mm diam., 1–2 mm long; floral bracts ciliate, scale-like, 0.6–1.5 mm long; pedicels slender, glabrous, 5–10 mm long, 0.2–0.3 mm diam.; bracteoles 2, ciliate, deltoid, 0.5–0.8 mm long. **Flowers** 5-merous; calyx ca. 3–4 mm long, clearly articulate with the pedicels, the hypanthium cylindric-obconic, ca. 1.5–2.2 mm long, 1.6–2 mm diam., glabrous, the lobes broadly based, minute, varying from barely detectable to perhaps as much as 0.2–0.4 mm long, glabrous; corolla cylindric to more typically gradually funnelform, glabrous both externally and internally, greenish-white, 5–9 mm long, flaring to ca. 5–6 mm diam. from a 2–2.5 mm diam. base, the lobes narrowly triangular to deltoid, acute, ca. 2.5 mm long; stamens 10, included, 7–8 mm long, the filaments 1–2.5 mm long, united in the basal 0.5 mm, glabrous, flattened, the anthers attached medially, lacking spurs, 6–7 mm long, the thecae very finely pebbled, ca. 1.4–2.2 mm long, basally incurved and apiculate, the tubules ca. 3–4.8 mm long, dehiscing by truncate to slightly flaring, terminal pores; styles slightly exserted, glabrous. **Berry** immature, 3–4 mm diam., glabrous.

Distribution.—Presently known only from five collections; three made near the Fabrega Dam site at Fortuna (Chiriquí Province), one from Cerro Colorado (Bocas del Toro Province), Panama in wet forest, at 1150–1500 m, and one from Cerro Arizona near Santa Fe, Veraguas Province. Flowering: Jan.; immature fruits: Apr.

Additional collections examined: **PANAMA. Bocas del Toro:** region of Cerro Colorado 7 mi from Chami Camp, ca. 8°35'N, 81°45'W, ca. 1500 m, 12 Apr 1986, *McPherson 8825* (MO!). **Chiriquí:** Fortuna Dam region, along trail to hydrological station on Río Hornito, below forestry house on hwy, 8°45'N, 82°15'W, 1150–1200 m, 20 Jan 1989, *McPherson 13612* (DUKE!, MO!); Fortuna dam site, along stream on white sandy soil, 1200 m, 7 Feb 1985, *van der Werff & van Hardeveld 6609* (MO, photo NY neg. 13043). **Veraguas:** in forest below summit of Cerro Arizona, above Santa Fe, elev. 4400 ft, *Hammel & Kress 8568* (DUKE!)

Vaccinium furfuraceum Wilbur & Luteyn, sp. nov. (**Fig. 2**). TYPE: COSTA RICA. LIMÓN: Cantón de Talamanca, fila de exploración minera entre Río Sukut y Río Carbri, Muragubishi, 9°22'50"N, 82°56'50"W, 700 m, 14 Jul 1989 (fl), *Herrera 3286* (HOLOTYPE: INB!; ISOTYPES: DUKE!, F!, NY! and 4 duplicates to be distributed).

Frutex epiphyticus; ramuli teretes pubescentes vel pilosi. Petioli 2–3(–4) mm longi, pilosi. Lamina ovata vel ovato-elliptica, (2.5–)4–6 × (1.2–)1.8–2.5 cm, basi rotundata, apice acuminata. Inflorescentiae axillares, racemosae vel corymbosae, 3–10(–12) florae. Calyx pedicellis articulatus. Hypanthium squamatum obconicum, 1.5 × 5–6 mm. Corolla extus squamata; tubus 8–12 mm longus.



DUKE UNIVERSITY
HERBARIUM
339557

COSTA RICA
ERICACEAE dup.= 6
Vaccinium poasanum Donn. Sm.
Dét. RLWilbur III 1992

LIMON: Cantón de Talamanca
Fila de exploración minera entre Río Sukut y Río Carbri. Muragubishi.
9°22'50"N 82°56'50"W 700 m
Liana epífita muy ramificada. Ramitas café. Flor de cáliz verde. Corola café lila, estambres de filamentos blancos y anteras amarillo dorado, pistilo verde tenue.

Gerardo Herrera 3286 14 July 1989

HERBARIO NACIONAL DE COSTA RICA (CR)
INSTITUTO NACIONAL DE BIODIVERSIDAD//MISSOURI BOTANICAL GARDEN INO'

ISOTYPE OF
Vaccinium furfuraceum Wilbur & Luteyn

Fig. 2. *Vaccinium furfuraceum*. Isotype (*Herrera 3286*, DUKE)

Much-branched, epiphytic, lianoid **shrubs** with branchlets brownish, ± terete, finely ridged and grooved, densely spreading hirsutulous, 1.5–4 mm diam. **Leaf-blades** somewhat coriaceous, ovate to ovate-elliptic, (2.5–)4–6 cm long, (1.2–)1.8–2.5 cm broad, basally rounded, apically acuminate and ± tapering abruptly to the narrowly rounded tip, marginally entire, glabrous above or nearly so except moderately pilose along the principal veins, moderately to densely spreading pilose beneath along the principal, secondary and even tertiary veins with hyaline trichomes up to 0.7 mm long and also densely beset especially when young with short, thick, glandular, scale-like trichomes ca. 0.1–0.2 mm long on both the veins and the surface, the venation weakly 5-plinerved, the secondary nerves joining together in a series of prominent arches, the lamina ± bullate, the midrib and secondary veins impressed above and elevated beneath and the tertiary veins slightly elevated on both surfaces; petioles 2–3(–4) mm long, densely spreading pilose. **Inflorescences** axillary, congregated distally, sometimes appearing terminal, racemes but with the rachis often contracted and the flowers hence appearing somewhat corymbose, 3–10(–12) flowered, 2.5–5 cm long overall; rachises (2–)4–8 mm long, densely glandular-strigillose with thickened trichomes 0.1–0.3 mm long and sparingly to moderately pilosulous with hyaline spreading trichomes, 0.3–0.6 mm long; floral bracts narrowly lanceolate to linear-lanceolate, marginally glandular ciliate, 2.5–2.6 mm long; pedicels (0.6–)1–2(–2.4) cm long, moderately to densely glandularly strigillose and also sparingly pilosulous with hyaline trichomes; bracteoles 2, appressed, linear-lanceolate, glandular-ciliate, located in about proximal third, ca. 2.8 mm long. **Flowers** 5-merous; calyx 3–4.5 mm long, strongly articulate with pedicels, the hypanthium shallowly obconic, ca. 1.5 mm long, ca. 5–6 mm diam. distally, prominently flaring from the approximately 3 mm diam. basal portion, densely and scurfily glandular-squamate throughout, the limb ca. 3 mm long including the lobes, the lobes deltoid-triangular to broadly oblongish with an abrupt distal tip, ca. 1–1.2 mm long, ca. 2.3 mm broad at base; corolla broadly cylindrical, relatively thin in texture, densely scurfily glandular-squamate externally, glabrous internally, the tube 8–12 mm long, ca. 8 mm in diam. distally, the lobes triangular, 2.5–3 mm long, ca. 3 mm broad basally, acute; stamens 10, included, ca. 7–9.5 mm long, the filaments conspicuously hyaline ciliate, flattened, 2–3 mm long, the anthers lacking spurs, ca. 7 mm long, the thecae granular, 2–2.2 mm long, basally incurved, the tubules ca. 3–5 mm long, dehiscing by latrorse, elongate clefts ca. 1–2 mm long; styles about as long as the corolla, straight, glabrous. **Berry** not seen.

Distribution.—Known only from the type collection made in Costa Rica in the Talamanca foothills of Limón Province at ca. 700 m.

Vaccinium luteynii Wilbur, sp. nov. (**Fig. 3**). TYPE: PANAMA. BOCAS DEL TORO: Fortuna Dam-Chiriquí Grande Road, 2–3 km N of the Continental Divide, ca. 8°48'N, 82°12'W, 700–

760 m, disturbed, steep roadside slopes, 15 Oct 1998 (fl), *Luteyn, Riggs,Guerra, and Sylva 15322* (HOLOTYPE: PMA!, ISOTYPES: AAU!, CAS!, DUKE!, E!, G!, K!, MO!, NY!, TEX!, US!).

Frutex epiphyticus; ramuli teretes glabri. Folia coriacea glabra, ovata vel ovato-elliptica vel oblongo-ovata, basi rotundata, apice acuta vel acuminata, lamina 5–15 × 3–6 cm; petioli glabri, 1–5 mm longi. Calyx pedicellis articulatus; hypanthium subglobosum, succulentum, glabratum, ca. 1 mm altum y 4–4.5 mm diam.; limbus calycis 3 mm longus, 10-lobata, lobi calycis 5, 0.6–1 mm longi acuti glabri; corolla succulenta, urceolata ad campanulata ca. 5–10 mm alta, ca. 6 mm diam.; extus glabra, intus pilosi, lobi corollae ca. 3 mm longi acuti.

Terrestrial or epiphytic **shrubs** to 4 m tall, with tan to dull reddish-brown, glabrous, terete branches. **Leaves** subopposite, the blades coriaceous, ovate to oblong-ovate or ovate-elliptic, ca. 5–15 cm long, 3–6 cm broad, apically acute to somewhat acuminate, basally rounded to almost subclasping, marginally entire and slightly thickened and revolute, glabrous or very nearly so on both surfaces, the venation 3–5(–7)-plinerved with lateral nerves arising from proximal 1/4–1/3 of midrib, midrib proximally much thickened and weakly elevated in basal 1/4 above, then thinner and weakly impressed becoming flush to slightly elevated near apex, lateral nerves weakly impressed to flush proximally above but soon slightly elevated distally, reticulate veinlets elevated above, all venation somewhat elevated beneath throughout; petioles stout, glabrous, 1–5 mm long. **Inflorescences** axillary (often appearing terminal), corymbose racemes mostly 5–8 cm long overall, 10–13-flowered, with glabrous to very sparingly and minutely puberulent peduncles; rachises 1.5–4.5 cm long; floral bracts persistent, triangular or lanceolate, scale-like, glabrous but often marginally, minutely ciliate, 2–2.5 mm long; pedicels glabrous, irregularly angulate or ridged, 20–40 mm long, ca. 0.6–1 mm in diam.; bracteoles 2, at or very near the base, subopposite, glabrous or minutely ciliate, lanceolate to narrowly triangular, persistent, 1.2–2 mm long. **Flowers** 5-merous; calyx 4–4.2 mm long, articulate with pedicels, the hypanthium subcylindric, deeply and bluntly rugose, glabrous, ca. 1 mm long, 4–4.5 mm in diam., the limb ca. 3 mm long, smooth above but broadly and saccately spurred opposite and below each lobe, the spurs solid (not hollow) and sometimes slightly and broadly bilobed, the lobes triangular, 0.6–1 mm long, acute, glabrous; corolla thick and somewhat fleshy, broadly urceolate to urceolate-campanulate, ca. 10 mm long, ca. 8 mm broadest diam. when fresh, but drying 5–8 mm long and ca. 6 mm in diam. just beneath the throat and 3.5–4 mm in diam. just above the calyx, green, externally glabrous and internally densely pilose with sordid, white trichomes especially in the throat and lobes, the lobes ca. 3 mm long, acute; stamens 10, included, ca. 6.5 mm long, the filaments 3.5–4 mm long, long-pilose in distal half, attached to the anther dorsally slightly above its middle, the anthers golden, lacking spurs, ca. 3.5 mm long, the thecae ca. 2–2.5 mm long, densely and finely papillate, the lower third strongly incurved, the tubules ca. 1 mm long, dehiscing by introrse, strikingly oblique pores. **Berry** not seen.

Distribution.—Montane rainforests in Panama, along the continental divide, between Bocas del Toro and Chiriquí, at 700–950 m.

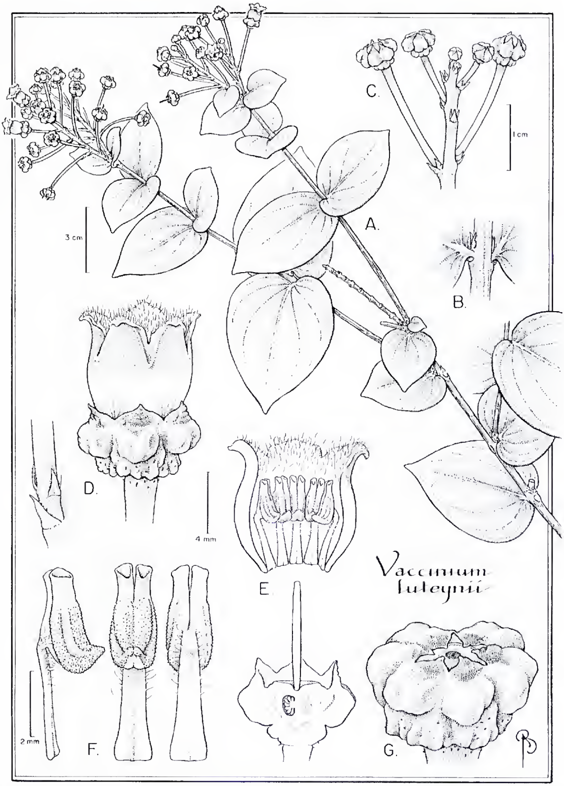


Fig. 3. *Vaccinium luteynii*. **A.** Habit showing subopposite leaves. **B.** Details of leaf insertion on stem. **C.** Details of inflorescence post-anthesis. **D.** flower showing saccate spurs below each calyx lobe and detail of pedicellary basal bracteoles and floral bract. **E.** Longitudinal section of corolla showing position of stamens and calyx (the sketch immediately beneath) **F.** Stamens showing lateral, ventral, and dorsal views. **G.** Calyx post-anthesis (all drawn from the holotype, *Luteyn et al. 15322*).

Additional collections examined: **PANAMA. Bocas del Toro:** along road between Florida and Chiriquí Grande, 1.2 mi N of Continental Divide, 5.3 mi N of bridge over Fortuna Dam, 8°44'N, 82°17'W, 910 m, 12 Mar 1985, *Croat & Grayum 60459* (DUKE!, MO!, NY!, WIS!); forest along the Gualaca-Chiriquí Grande road, 31.7 km S of Chiriquí Grande and 15.7 km N of Sitio de Presa, ca. 8°49'N, 82°12'W, 1070 m, *Luteyn 14831* (DUKE!, MO!, NY!, P!, PMA!, SCZ!, W!); Fortuna Dam-Chiriquí Grande road, 2–3 km N of the Continental Divide, ca. 8°48'N, 82°12'W, 700–760 m, 15 Oct 1998 (fl), *Luteyn, Riggs, Guerra & Sylva 15325* (DUKE!, MO!, NY!, PMA!, U!) **Chiriqui:** Fortuna Dam area, Km 63 N of dam along road to Chiriquí Grande, ca. 8°48'N, 82°12'W, 890 m, 16 Jan 2003 (bud), *Luteyn & Pedraza 15545* (NY!, PMA!); Campamento de Bijao-Fortuna, 19 Mar 1976, *Mendoza, Mendieta & Mayo 260* (DUKE); road from Fortuna Lake to Chiriquí Grande, 5 km along track just S of continental divide wet forest, 8°49'N, 82°12'W, 700 m, *Hampshire & Whiteford 441* (NY).

ACKNOWLEDGMENTS

We both thank Bobbi Angell for the clear and precise illustrations that surely make up for our failure in verbal descriptions. The NSF is to be thanked for financial support to JLL and others for fieldwork expenses without which these species and many others would not have been found before the forest in which they have flourished for centuries were leveled. We also are most appreciative for Guy Nesom (BRIT) checking the faulty Latin of one of us. And without Sherri Herndon's devoted attention to detail little would be accomplished. We also are most grateful for the two reviewers, Laurence J. Dorr and Lucia Kawasaki and the editor for their helpful criticisms, suggestions and agreeing to evaluate the manuscript on very short notice.

CUNICULOTINUS AND *LORANDERSONIA*, TWO NEW GENERA OF ASTERACEAE: ASTEREAE AND NEW COMBINATIONS IN *CHRYSOTHAMNUS*

Lowell E. Urbatsch

Department of Biological Sciences
Louisiana State University
Baton Rouge, Louisiana 70803, U.S.A.

Roland P. Roberts

Department of Biological Sciences
Towson University
Towson, Maryland 21252-0001, U.S.A.

Kurt M. Neubig

Department of Botany
University of Florida, PO Box 111526
Gainesville, Florida 32611, U.S.A.

ABSTRACT

Cuniculotinus is described as a new monotypic genus from California and Nevada to accommodate *Chrysothamnus gramineus*, resulting in the new combination ***Cuniculotinus gramineus***. Sequence-based phylogenetic investigations clearly demonstrate its remoteness from *Chrysothamnus* and place it nearer *Sericocarpus*. Four additional species regarded as *Chrysothamnus* are likewise shown to be phyletically distinct and are accomodated in the proposed new genus ***Lorandersonia***. *Lorandersonia* also includes one species previously recognized in *Hesperodoria*, *H. salicina*, and two species previously treated as *Tonestus*, *T. microcephalus* and *T. peirsonii*. New combinations in *Lorandersonia* are ***L. baileyi***, ***L. linifolia***, ***L. microcephala***, ***L. peirsonii***, ***L. pulchella***, ***L. salicina***, and ***L. spathulata***. *Chrysothamnus* is further modified by the inclusion of *Hesperodoria scopulorum* and *Vanclevea stylosa*, necessitating the new specific combinations ***C. scopulorum*** and ***C. stylosus*** and the varietal combination ***C. scopulorum*** var. ***canonis***.

RESUMEN

Se describe el género ***Cuniculotinus***, como un género nuevo monotípico de California y Nevada para ubicar a *Chrysothamnus gramineus* H.M. Hall. Por lo tanto se realiza una nueva combinación, ***C. gramineus***. Investigaciones filogenéticas basadas en secuenciación de ADN demuestran claramente su lejanía con *Chrysothamnus* y la ubica cerca de *Sericocarpus*. Del mismo modo, cuatro especies adicionales consideradas como *Chrysothamnus* muestran ser filogenéticamente distintas, por lo cual se propone el género nuevo ***Lorandersonia.*** Este nuevo género también incluye especies reconocidas previamente en *Hesperodoria*, *H. salicina*, y dos especies tratadas generalmente como *Tonestus*, *T. microcephalus* (Cronquist) G.L. Nesom & D.R. Morgan y *T. peirsonii* (D.D. Keck) G.L. Nesom & D.R. Morgan. Las combinaciones nuevas en *Lorandersonia* son: ***L. baileyi***, ***L. linifolia***, ***L. microcephala***, ***L. peirsonii***, ***L. pulchella***, ***L. salicina***, ***L. spathulata***. Además, se modifica *Chrysothamnus* con la inclusión de *Hesperodoria scopulorum* (M.E. Jones) Greene y *Vanclevea stylosa* (Eastwood) Greene lo cual hace necesarias las nuevas combinaciones específicas, ***C. scopulorum*** y ***C. stylosa,*** y la combinación de variedad *C. scopulorum* var. ***canonis.***

SIDA 21(3): 1615–1632. 2005

INTRODUCTION

Phylogenetic investigations based on sequence data of the nuclear ribosomal DNA spacer region, the ITS 1 and 2, plus the 5.8S, and a portion of 3' ETS, used to test decades-old hypotheses of relationships for species of *Chrysothamnus*, readily demonstrate its non-monophyly (Roberts & Urbatsch 2004). Hall and Clements (1923) comprehensively monographed *Chrysothamnus*, and Anderson (1986a) provided an updated and inclusive synopsis, nomenclatural information, keys, and distribution maps. During the intervening years, five species unknown to earlier monographers were published or elevated to specific rank; *Chrysothamnus pyramidatus* Hall & Clements was transferred to *Baccharis* (Rzedowski 1972) and subsequently placed in *Aztecaster* (Nesom 1993). The treatments by Hall and Clements and Anderson also differed in species alignments at infrageneric levels.

The sixteen species accounted for by Anderson (1986a) are placed in four distantly related clades in our sequence-based gene tree shown in Figure 1 (Roberts & Urbatsch 2004). Except for *Chrysothamnus* sect. *Punctati*, infrasectional gene tree relationships compared to the five sections recognized by Anderson (1986a) are largely incongruous. *Chrysothamnus albidus* (M.E. Jones ex A. Gray) Greene (sect. *Chrysothamnus*), *C. paniculatus* (A. Gray) H.M. Hall and *C. teretifolius* (Durand & Hilgard) H.M. Hall (sect. *Punctati*), and *C. nauseosus* Pallas ex Pursh) G.L. Nesom & G.I. Baird and *C. parryi* (A. Gray) G.L. Nesom & G.I. Baird (sect. *Nauseosi*) were resolved within *Ericameria*, supporting the conclusions of Nesom and Baird (1993), whose decisions were partially influenced by cpDNA restriction enzyme investigations of Suh (1989) and Morgan (1990). Thus, two independent molecular data sets, one chloroplast and one nuclear, corroborate the generic disposition of sect. *Punctati* and sect. *Nauseosi*. *Chrysothamnus gramineus* (sect. *Gramini*), the next most divergent taxon, is positioned outside of *Sericocarpus* and is here segregated as the monospecific genus *Cuniculotinus*.

Lorandersonia is proposed to accommodate four other species of *Chrysothamnus*, resulting in the following new combinations: *L. baileyi* and *L. pulchella* (*Chrysothamnus* sect. *Pulchelli* sensu Anderson 1986a) and *L. linifolia* and *L. spathulata* (sect. *Chrysothamnus*). Three additional species are robustly supported within the *Lorandersonia* clade and new combinations are made for these: *L. microcephala* and *L. peirsonii*, formerly regarded as *Tonestus*, and *L. salicina*, traditionally treated within *Hesperodoria*.

Chrysothamnus in the sense of Anderson (1986a) is left with seven species. Two additional taxa regarded as other genera are resolved within the *Chrysothamnus* clade and new combinations are proposed for them: *C. scopulorum* and *C. stylosus*, previously treated as *Hesperodoria scopulorum* and *Vanclevea stylosa*, respectively. *Chrysothamnus* as newly constituted comprises 9 species (Fig. 1).

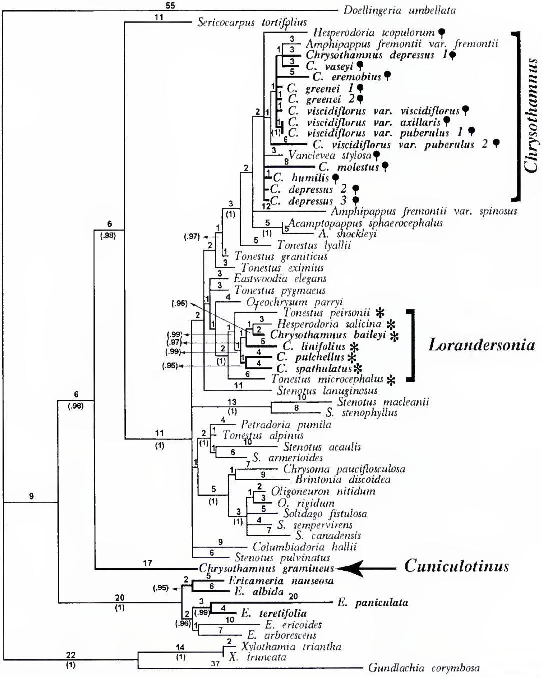


FIG. 1. Fifty percent majority rule consensus tree resulting from Bayesian analysis of combined ETS and ITS data sets is shown. This figure is modified from one published in Roberts & Urbatsch (2004). More details and a discussion of results from this and other analyses based on these sequence data are given. Bolded taxon names and wider branches highlight taxa treated as *Chrysothamnus* (Anderson 1986a). A large arrow indicates taxa treated herein as *Cuniculotinus*, the asterisk symbol * those considered *Lorondersonia*, and the 📍 symbol those taxa regarded as *Chrysothamnus*.

The primary purpose of the present paper is to provide formal nomenclatural changes reflecting the relationships discovered in our sequence-based phylogenetic studies. Taxa are also characterized and their relationships are discussed. A key to the taxa considered in this study is provided.

NOMENCLATURAL TREATMENT

Cuniculotinus Urbatsch, R.P. Roberts, & Neubig, gen. nov. TYPE: *Chrysothamnus gramineus* H.M. Hall, Muhlenbergia 2:342. 1916. *Cuniculotinus gramineus* (H.M. Hall) Urbatsch, R.P. Roberts, & Neubig, combination made herein. *Chrysothamnus* sect. *Gramini* L.C. Anderson, in part, Proc. Symp. Biol. *Artemisia* and *Chrysothamnus*, 29. 1986. *Ericameria* sect. *Gramini* L.C. Anderson, Great Basin Naturalist 55:87. 1995, in part.

E radice perenne multicaulis; caules erecti ca. 1 dm alti glabri striati, basi frutescentes usque ad apices foliosi; folia alterna sessilia lanceolata acuminata 30–85 mm longa 3–9 mm lata e basi 3–5-nervia glabria, marginibus integris scabris; capitula pauca, laxe racemosa 1–2 bracteata; bracteae angustae acutae quam involucro brevioribus; pedunculi 0.5–8 cm longi ad axillas foliorum oriundis; involucra cylindracea 11–15 mm longa 3–4 mm lata; phyllaria valde imbricata ca. 3-seriata oblonga obtusissima chartacea, exterioribus mucronatis ciliatis apice viridescentibus; flosculi disci 4–7 consimiles, corollis glabris tenuibus infundibuliformibus 9–12 mm longis, dentibus 5 ovatis acutis, antheris basi minute auriculatis apice attenuatis, ramis stylorum acutis longe exsertis; cypselae fere exacte cylindraceis 5–6-striatae glabrae; pappi setae argentei corollae aequilongi.

Subshrubs from a branching, woody caudex to 1 dm. Stems annual, several, to 6 dm, green with tan ridges descending from leaf bases, glabrous. Leaves cauline, alternate, ascending, sessile, linear to lanceolate or oblong-oblanceolate, 30–85 × 3–9 mm, coriaceous, margins entire or edged with conic trichomes, glabrous to sparsely pubescent, often resin dotted, midvein and 2–4 collateral veins prominent; basal leaves ± persistent; cauline leaves reduced in size distally and becoming bract-like in the capitulescence. Capitulescences solitary to cymose at branch tips, branches racemose. Involucres tubinate to cylindric, 11–15(–17.5) × 3–4 mm. Phyllaries in 4–6 series, graduated, silvery to pale yellow, generally marked with green to brownish distal patch, not keeled, ±imbricate, ovate or oblong to obovate, 2–14 × 0.7–3 mm, mostly chartaceous, midvein and 2 collaterals evident, apices truncate, mucronate to caudate tipped. Capitula discoid, receptacles flat, finely alveolate. Disk flowers 4–7, yellow, corollas 9–12 mm, lobes acute, 1–1.3 mm; anthers 3.1–4.1 mm, appendages attenuate, 0.5–1.1 mm. Style branches 3.5–4.2 mm, appendages linear, 1.4–1.7 mm, apices acute. Cypselae tan-brownish, oblong, 7–9 mm, glabrous, 5-6 nerved. Pappi silvery-tan, ±80 minutely-setose bristles, 8–10 mm. $x = 9$.

Etymology.—The generic name is based on the Latin word *cuniculus*, a rabbit, + "tinus" as applied to laurustinus (*Viburnum tinus* L.), a shrubby plant," thus "rabbit brush" a commonly used name for species of *Chrysothamnus* in the traditional sense.

Prominent features, distribution, and relationships.—*Cuniculotinus* is distinguished by its herbaceous annual stems arising from a woody caudex; leaves relatively broad, nearly glabrous, with a prominent midvein and 1–2 pairs of collateral veins; capitula discoid, racemosely disposed; phyllaries multiseriate, imbricate, mostly chartaceous, often truncate to emarginate and mucronately-tipped that when fresh are marked with a conspicuous, green, apical patch. Its only known species, *C. gramineus*, occurs in Clark and Nye counties, Nevada, and adjacent Inyo County, California, where it grows as an uncommon, understory element in yellow pine savanna communities at relatively high elevations. Sequence-based phylogenies show it in a relatively isolated position, with *Sericocarpus* as its closest kin; alternatively, it occupies a position between *Sericocarpus* and *Ericameria* (Roberts & Urbatsch 2004; Beck et al. 2004). *Sericocarpus*, with two species in the western United States and three in the east, also exhibits an herbaceous perennial life form and has coriaceous, green-tipped, multiseriate, phyllaries.

Cuniculotinus gramineus (H.M. Hall) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Chrysothamnus gramineus* H.M. Hall, Muhlenbergia 2:342. 1916. *Ericameria graminea* (H.M. Hall) L.C. Anderson, Great Basin Naturalist 55:86. 1995. *Petradoria discoidea* L.C. Anderson, nom. nov., Trans. Kans. Acad. Sci. 65:676. 1964. [*non Petradoria graminea* Wooton & Standley, Contr. U.S. Natl. Herb. 16:183. 1913. *Petradoria pumila* Greene var. *graminea* (Wooton & Standley) S.L. Welsh, Great Basin Naturalist 43:324. 1983]. TYPE: U.S.A. NEVADA. Clark Co.: Charleston Mountains, head of Lee Canyon, alt. 2450 m, 4 Aug 1913, *A.A. Heller 11075* (HOLOTYPE: UC 175597).

Discussion.—The relationship of *Chrysothamnus gramineus* has puzzled systematists since its discovery and publication by Hall (1916). Hall and Clements (1923) noted the anomalous nature of the species relative to other *Chrysothamnus* but justified their placement of it by reference to its striate achenes, which are similarly seen in members of *Chrysothamnus* sect. *Pulchelli* and in *C. vaseyi*. Potential kinship with the monotypic *Petradoria* and with *Hesperodoria scopulorum* were also suggested but dismissed due to morphological discordance (Hall & Clements 1923). Anderson (1964a) concluded that anatomical and morphological evidence supported the placement of *C. gramineus* in *Petradoria*, a genus previously containing but one species, *P. pumila* (Nutt.) Greene. The published name *Petradoria graminea* Wooton & Standley for a different taxon necessitated creating the epithet *P. discoidea* L.C. Anderson for *C. gramineus*. Anderson (1983) noted similarities in habit and other features of *P. discoidea* to *C. eremobius* L.C. Anderson, also from Nevada, subsequent to the discovery and publication of the latter. Shortly thereafter, he reevaluated the status of these species and reinstated *P. discoidea* within *Chrysothamnus*, accommodating both it and *C. eremobius* in his newly proposed *Chrysothamnus* sect. *Gramini* (Anderson 1986a). Molecular-based studies have shown *Cuniculotinus* to be distant from its earlier hypothesized congeners and its treatment as a distinct genus is warranted (Roberts & Urbatsch 2004).

Lorandersonia Urbatsch, R.P. Roberts, & Neubig, gen. nov. TYPE: *Linosyris pulchella* A. Gray, Pl. Wright. 1:96. 1852. *Lorandersonia pulchella* (A. Gray) Urbatsch, R.P. Roberts, & Neubig, combination made herein. *Chrysothamnus* Nutt., Trans. Amer. Philos. Soc. ser. 2, 7:323. 1840, in part. *Hesperodoria* Greene, Leafl. Bot. Observ. Crit. 1:173. 1906, in part. *Tonestus* A. Nelson, Bot. Gaz. 37:262. 1904, in part.

Plantae frutices vel suffrutices; caules erecti ad ascendentes; folia plerumque sempervirentia linearia ad oblonga vel lanceolata ad anguste oblanceolata, costis prominentibus aliquando cum 1–2 nervae collaterales; involucri valde gradati vel subaequales 3–6-seriati; phyllaria imbricatia vel verticalia ordinata; capitula discoidea vel radiata, flosculi radii (1–)6–8 pistillati fertiles, corollis flavis; flosculi disci 4–15, corollis coloratis similibus flosculis radiis; pappi setae albidi 10–80+ subaequalis similes in flosculi radii et disci.

Plants suffrutescent or shrubs to 3.5 m. Stems erect to ascending, often fastigiately or intricately branched; bark typically tan, becoming white to gray when older; twigs usually greenish, glabrous to scabrous, often resinous, punctate in one species. Leaves mostly evergreen, cauline, often crowded, appressed or ascending to spreading, becoming deflexed in one species, laminar, linear to oblong or lanceolate to narrowly oblanceolate, 4–75 × 0.5–8 mm, sessile or short-petiolate, blades planar to concave, margins entire or edged with trichomes, apices acute, glabrous to scabrous, sometimes punctate, often ± resin-coated, sometimes resin-dotted; midvein prominent, 1–2 pairs of collateral veins sometimes present. Capitulescences usually congested, rounded compound cymes to corymbose, occasionally racemose. Involucres cylindric to obconic or hemispheric, 4–15 × 1.5–6 mm. Phyllaries in 3–6 series, imbricate to vertically aligned, strongly graduated or subequal, green to tan, ovate to oblong or lanceolate, to oblanceolate, 0.5–7 × 0.5–1.3 mm, apices acute, acuminate, cuspidate, obtuse, erect or slightly spreading, often resinous; midvein obscure to evident, sometimes enlarged subapically and glandular; lowermost sometimes herbaceous or herbaceous-tipped, otherwise mostly chartaceous. Capitula discoid or radiate in *L. microcephala* (rays have also been observed in *L. spathulata*), flowers 4–22. Ray flowers (1–)6–8, pistillate, fertile, ranging from pale to darker yellow; laminae elliptic to obovate, 3.5–5 × ±1 mm. Disc flowers 4–15, bisexual, corollas same color as ray corollas, 3.5–14 mm, lobes erect to spreading or reflexed, 0.5–2.2 mm. Style branches 1.7–4.6 mm, appendages lanceolate or attenuate to subulate, 0.7–2.2 mm. Cypselae mostly tan to brownish, usually prismatic, oblong to obconic, 1.5–7 mm, glabrous to densely pubescent. Pappi similar in ray and disk flowers, whitish-tan, 20–80+, subequal, setose bristles, 3–12 mm. $x = 9$.

Etymology.—*Lorandersonia* is named for Loran C. Anderson, Professor of Biological Sciences, Florida State University, Tallahassee, Florida, who has dedicated much of his professional career to the study of *Chrysothamnus* and related Astereae and has significantly increased our knowledge of these taxa.

Prominent features, distribution, and relationships.—Features diagnostic for the genus include the following: shrubs with leafy stems; stems annual in *L. microcephala* and *L. peirsonii* from a woody caudex; leaves ascending, often parallel to the stem but not appressed, sessile to subsessile, laminar, oblanceolate to narrowly so, margins entire to ciliate, remotely serrate in *L. peirsonii*, apices attenuate, obtuse in *L. peirsonii*, and blades relatively thin, midvein conspicuous, collateral veins arising proximally often evident; capitula usually numerous, small, congested, organized into rounded cymes, forming corymboid capitulescences, monocephalous in *L. peirsonii*; phyllaries in 3–6 series, typically strongly graduated, chartaceous except for an apical or subapical, often narrow, diamond-shaped green patch, median vein mostly evident, sometimes somewhat thickened distally, phyllaries subequal in *L. peirsonii*; ray flowers absent except in *L. microcephala* and *L. peirsonii*, rarely present in *L. spathulata*. Evenly spaced gland-tipped hairs occur at least on young stems and emergent leaves, especially those transitional from leaves to phyllaries. The glandular portion is soon deciduous in most species but is persistent in *L. peirsonii*.

The southern Rocky Mountains is the center of diversity for this genus, but its entire range includes central Coahuila and northern Chihuahua, Mexico, northward to southwestern Kansas, southern Montana, and central Utah, with one outlyer in Inyo and Mono counties, California. Species in this genus occupy a considerable altitudinal range, 300–3600 meters, and are adapted to various arid habitats ranging from sand dunes to stony soils and rock crevices.

Basal to *Lorandersonia* in our gene trees are *Oreochrysum parryi* (A. Gray) Rydberg, *Tonestus pygmaeus* (Torrey & A. Gray) A. Nelson, and *Eastwoodia elegans* Brandegee. Sister to the just named taxa is a grade, although not always fully resolved, consisting of three species of *Tonestus*, *Acamptopappus*, and *Amphipappus fremontii* Torrey & A. Gray var. *spinosus* A. Nelson, crowned with *Chrysothamnus* sensu stricto. See Fig. 1 for more details and Roberts and Urbatsch (2004) for additional discussion.

Lorandersonia baileyi (Wooton & Standley) Urbatsch, R.P. Roberts, & Neubig, comb. nov. Basionym: *Chrysothamnus baileyi* Wooton & Standley, Contr. U.S. Natl. Herb. 16:181. 1913. *C. pulchellus* (A. Gray) Greene subsp. *baileyi* (Wooton & Standley) Hall & Clements. Phylog. Method Taxon., 194. 1923. *Chrysothamnus pulchellus* Greene var. *baileyi* (Wooton & Standley) S.F. Blake, J. Washington Acad. Sci. 30:467. 1940. *Ericameria pulchella* subsp. *baileyi* (Wooton & Standley) L.C. Anderson, Great Basin Naturalist 55:86. 1995. Type: U.S.A. New Mexico: N end of Guadalupe Mountains, 4 Sep 1902, *V.O. Bailey 490* "number provided in protologue is *498* compared to *490* on specimen" (holotype: US 00443565).

Distribution, ecology, and relationships.—This taxon has been documented for the states of Chihuahua and Coahuila, Mexico and for Arizona, Colorado, Kansas, New Mexico, Oklahoma, Texas, and Utah. It grows in open prairies typically in deep, sandy soils at elevations 1350–2350 m and flowers from late summer to fall. *Lorandersonia baileyi* is often treated as a subspecies of *L. pulchella*, and the two are very similar in habit, leaf form and in having involucres composed of relatively long, vertically aligned phyllaries. Ciliate leaf margins and young stems with evenly spaced trichomes distinguish *L. baileyi* from the glabrous *L. pulchella*. In our best resolved phylogenies, *L. bailey* and *L. salicina* are sister taxa, with *L. linifolia* basal (Roberts & Urbatsch 2004). Presence of gland-tipped hairs on young stems and young leaves transitional to phyllaries is a feature seen in *L. baileyi* and to a lesser extent in other taxa with the exception of *L. peirsonii*, which is covered throughout with similar appearing indumentum.

Lorandersonia linifolia (Greene) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Chrysothamnus linifolius* Greene, Pittonia 3:24. 1896. *Bigelowia linifolia* A. Nelson, Wyoming Agric. Exp. Sta. Bull. 28:123. 1896. *Chrysothamnus viscidiflorus* (Hook.) Nutt. subsp. *linifolius* (Greene) Hall & Clements, Phylog. Method Taxon. 184. 1923. *Chrysothamnus viscidiflorus* var. *linifolius* (Greene) Kittell in Tidestrom & Kittell, Fl. Arizona and New Mexico, 395. 1941. *Ericameria linifolia* (Greene) L.C. Anderson, Great Basin Naturalist 55:86. 1995. TYPE: U.S.A. WYOMING: in moist, alkaline soil, plentiful along a streamlet near Rock Springs, 9 Aug 1895, *E.L. Greene s.n.* (HOLOTYPE: NDG).

Distribution, ecology, and relationships.—This species is often locally abundant and widespread, ranging from Arizona and New Mexico northward to Utah, Montana, and Wyoming. It occupies alkaline moist sites along rivers, stream banks, and drainage areas at elevations from 1200 to 2400 meters and flowers late summer and fall. Growing to over 3 meters tall, it is the largest member of the genus. It superficially resembles *L. spathulata* but may be distinguished from that species by its leaf shape, glabrous to glabrate shoots, and densely pubescent achenes. A population sampled in Mesa County, Colorado, differed from the norm in having numerous spreading trichomes on its young twigs and capitulescence branches, and trichome-edged leaves with more noticeable resin dots. *Lorandersonia linifolia* is basal to *L. baileyi* and *L. salicina* in our gene-based trees (Roberts & Urbatsch 2004) and combines some features of both species. This is especially true for the Mesa County population, whose foliage is conspicuously resin-dotted and which has pubescent achenes typical of *L. salicina*. Its pubescent stems and trichome-edged leaves, however, are characteristic of *L. baileyi*.

Lorandersonia microcephala (Cronquist) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Haplopappus microcephalus* Cronquist, Madroño 11:186. 1951. *Tonestus microcephalus* (Cronquist) G.L. Nesom & D.R. Morgan, Phytologia 68:178. 1990. TYPE: U.S.A. NEW MEXICO. Taos Co.: Tres Piedras, crevices of granitic rocks in open yellow pine forest, altitude 8200 ft., 8 Jul 1950, *Ripley & Barneby 10316* (HOLOTYPE: WS; ISOTYPE: CAS).

Distribution, ecology, and relationships.—*Lorandersonia microcephala* grows on thin soils and cracks in granite outcrops at elevations from 2400 to 2700 meters and flowers from July to September. Its distribution is restricted to a few sites in northern New Mexico and southern Colorado where it is uncommon and of special conservation concern. Cronquist (1951) discussed this species obscure affinities and regarded it as *Haplopappus* after considering *Petradoria* and *Hesperodoria* as possible congeners. The species was transferred to *Tonestus* by Nesom and Morgan (1990). Lane et al. (1996) based on limited sampling noted that *L. microcephalus* shared more DNA characters with their cpDNA constituted

Petradoria group than with *Tonestus*. In our ETS/ITS based trees this species is basal in *Lorandersonia* and quite remote from *Petradoria*. *Tonestus* as constituted by Nesom and Morgan (1990) is highly polyphyletic with *L. peirsonii* the only *Tonestus* placed in the *Lorandersonia* clade. As with *L. baileyi*, *L. microcephala* has glandular trichomes on its young stems and leaves, especially those transitional to phyllaries, as abundantly seen in on all aerial parts of *L. peirsonii*. Besides sharing similar trichomes types, the latter two taxa have herbaceous stems from woody caudices with persistent leaves and especially leaf bases, congested internodes, radiate capitula, and both grow on granite outcrops and at high elevations. *Lorandersonia microcephala* closely resembles other species in the genus in leaf form and capitulum size, shape, number, and arrangement.

Lorandersonia peirsonii (D.D. Keck) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Haplopappus eximius* H.M. Hall subsp. *peirsonii* D.D. Keck, Madroño 5:169. 1940. *Haplopappus* (*Aplopappus*) *peirsonii* (D.D. Keck) J.T. Howell, Leafl. Western Bot. 6:86. 1950. *Tonestus peirsonii* (D.D Keck) G.L. Nesom & D.R. Morgan, Phytologia 68:178. 1990. TYPE: U.S.A. CALIFORNIA. Inyo Co.: Transverse Ridge, Upper Rock Creek Lake Basin, NW corner of Inyo County, 3380 m, 5 Aug 1933, *F.W. Peirson* (HOLOTYPE: UC, ISOTYPE: JEPS).

Distribution, ecology, and relationships.—*Lorandersonia peirsonii* is a morphologically divergent species in an otherwise relatively uniform genus. It grows in the High Sierra Province in California rather than the Rocky Mountains and nearby plains. Its shoots are densely and uniformly covered with glandular trichomes, leaf margins are remotely and conspicuously serrate, and its capitulescence monocephalous. Nevertheless, as noted in the discussion of *L. baileyi* and *L. microcephala*, there are some similarities to other *Lorandersonia* species. That this species is convergent in DNA sequence for the ETS/ITS region is yet untested. All sequences for *L. peirsonii* taken from different specimens at different times with different stock reagents yielded identical results, except for one or two base pairs, but all samples were taken from herbarium specimens and the possibility of contamination needs to be unequivocally eliminated.

Even more puzzling than *Lorandersonia peirsonii*'s overall dissimilarity to other *Lorandersonia* is its great similarity to *Tonestus eximius* (H.M. Hall) A. Nelson & J.F. Macbride. Keck (1940) treated *L. peirsonii* as a subspecies of the latter in its original publication. Howell (1950) raised it to specific rank. In their reinstatement of *Tonestus*, Nesom & Morgan (1990) grouped the two species together, along with *T. alpinus* (L.C. Anderson & Goodrich) G.L.Nesom & D.R. Morgan, based on morphological similarities. The technical features that distinguish *T. eximius* include its narrower capitula, fewer phyllaries with more obtuse apices, fewer ray flowers, and shorter disk corollas. Yet the two species differ by several basepairs in their ETS/ITS sequences. *Tonestus eximius* is associated with a grade of taxa just below *Chrysothamnus* sensu stricto, several nodes removed from *Lorandersonia* (Fig. 1). DNA sequences obtained from freshly collected leaves of *T. eximius* were virtually identical to samples obtained from herbarium specimens and reported by Roberts and Urbatsch (2004). Here, too, molecular variation unrelated to phylogeny is suspected. These two species and *Tonestus*, in general poses many questions for further investigation. Most species of *Tonestus* sensu Nesom and Morgan (1990) are generally restricted rocky outcrops at high elevations. Perhaps the genetic potential to converge into high elevation life forms exists in several lineages of Astereae. Brouillet et al. (2004) provided such evidence by demonstrating, based on ETS/ITS sequence data, that *T. kingii* and *T. aberrans* are allied to the phyletically distant Eurybioid/Machaerantherinae clade and that their similarity to other *Tonestus* is superficial.

Lorandersonia pulchella (A. Gray) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Linosyris pulchella* A. Gray, Pl. Wright. 1:96. 1852. *Chrysothamnus pulchellus* Greene, Erythea 3:93. 1895. *Chrysothamnus pulchellus* Greene subsp. *typicus* Hall & Clements, Phylog. Method Taxon. 194. 1923. *Ericameria pulchella* (A. Gray) L.C. Anderson, Great Basin Naturalist 55:86. 1995. TYPE: U.S.A. TEXAS: prairies below El Paso, Oct 1849, *Wright 287* (HOLOTYPE: GH; ISOTYPE: US).

Chrysothamnus elatior Standley, Proc. Biol. Soc. Washington 26:118. 1913. *Chrysothamnus pulchellus* (A. Gray) Greene subsp. *elatior* (Standley) H.M. Hall & Clements, Phylog. Method Taxon. 194. 1923. TYPE: U.S.A. NEW MEXICO: Dona Ana Co.: San Andreas Mountains, sandhills N of Goldenbergs Ranch, 12 Oct 1912, *E.O. Wooton s.n.* (HOLOTYPE: US).

Distribution, ecology, and relationships.—This species occurs in Chihuahua, Mexico, and in New Mexico and Texas, where it grows on dry hills and plains, often in sandy soils, at elevations from 1500–2000 meters. Its similarities and differences to *L. baileyi* are noted in the discussion of that species. In our sequence-based trees, *L. pulchellus* is sister to *L. spathulatus* (Roberts & Urbatsch 2004), from which it differs in several morphological characters, involucral features being the most notable.

Lorandersonia salicina (S.F. Blake) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Haplopappus salicinus* S.F. Blake, Proc. Biol. Soc. Washington 48:171. 1935. *Hesperodoria salicina* (S.F. Blake) G.L. Nesom, Phytologia 71:245. 1991. TYPE: U.S.A. ARIZONA: Coconino Co.: Grand Canyon, Bright Angel Trail, 22 Oct 1905, *A. Eastwood 10* (HOLOTYPE: US 00619950).

Distribution, ecology, and relationships.—This species is restricted to a few sites in northern Arizona and is of conservation concern. Its habitat consists of rocky cliff faces and stony soils from 300 to 950 meters. What became the type specimen for *Haplopappus salicinus* (*Eastwood 10*) was earlier considered by Hall (1928) to be *Haplopappus scopulorum* in sect. *Hesperodoria*. Blake (1935) noted its distinctive nature when describing it as a new species but still allied it to *H. scopulorum*. So did Nesom (1991), who further noted numerous similarities and differences between the two species. Combining *Hesperodoria*, *Vanclevea*, and *Petradoria* into a single genus or broadening *Chrysothamnus* to encompass these species were also proposed (Nesom 2000). In our gene-trees *L. salicina* is sister to *L. baileyi*, with *L. linifolia* basal (Roberts & Urbatsch 2004). Among the lorandersonias, *L. salicina* is most like *L. linifolia* in often having resin-dotted leaves that are similar in size and form, relatively short involucres, and achenes pubescent with long ascending hairs. The adaxial, often copious resin coating of the emerging leaves of *L. salicina* is characteristic of *L. baileyi*, *L. linifolia*, and perhaps some of its other congeners as well. *Lorandersonia salicina* is differentiated from *L. linfolia* by its much smaller stature, resin-coated to resin-dotted stems, absence of the uniformly spaced, spreading trichomes, and its few-headed, loosely corymboid capitulescences.

Lorandersonia spathulata (L.C. Anderson) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Chrysothamnus spathulatus* L.C. Anderson, Madroño 17:226. 1964. *Ericameria spathulata* (L.C. Anderson) L.C. Anderson, Great Basin Naturalist 55:86. 1995. TYPE: U.S.A. NEW MEXICO. Otero Co.: Upper Burro Flats, 6000 ft, between LaLuz and LaBorcita canyons, 7 mi NE by road from town of LaLuz, T15S, R19E, sec 14 & 15, 14 Oct 1961, *L.C. Anderson 2052* (HOLOTYPE: UC; ISOTYPES: KSC, MSC, NMC, US, UTC).

Distribution, ecology, and relationships.—*Lorandersonia spathulata* is known from south-central New Mexico and nearby areas in Texas, where it grows on loamy soils associated with piñon, juniper, and oak woodlands from around 1700 to 2200 meters. Anderson (1964b) noted its similarity to *C. viscidiflorus* (Hook.) Nutt. subsp. *lanceolatus* (Nutt.) Hall & Clements in corolla shape and style branch size, apparently regarding this as some measure of relatedness. He maintained *L. spathulata* in sect. *Chrysothamnus* in his (1986a) synopsis. This species is robustly supported within the *Lorandersonia* clade, and as noted previously, is sister to *L. pulchella*.

Chrysothamnus Nutt., Trans. Amer. Philos. Soc. ser. 2, 7:323. 1840. TYPE: *Chrysothamnus pumilus* Nutt. (typ. cons.). = *Chrysothamnus viscidiflorus* (Hook.) Nutt. *Chrysothamnus* sect. *Gramini* L.C. Anderson, Proc. Symp. Biol. *Artemisia* and *Chrysothamnus*. 29. 1986, in part. *Chrysothamnus* sect. *Pulchelli* Hall & Clements, Publ. Carnegie Inst. Washington 326:175. 1923. in part. *Hesperodoria* Greene, Leafl. Bot. Observ. Crit. 1:173. 1906, in part.

Vanclevea Greene, Pittonia 4:50. 1899.

Discussion.—*Chrysothamnus* in the traditional sense has long been considered a difficult genus due to complex infraspecific variation in *Chrysothamnus nauseosa*, *C. parryi*, and *C. viscidiflorus* (Hook.) Nutt. and also because of uncertainty concerning its monophyly (Hall & Clements 1923; Anderson 1986b). Species in sect. *Punctati* and *C. albidus*, in particular, have been noted for their anomalies relative to others in the genus and for their similarities to species elsewhere in tribe Astereae (Hall & Clements 1923). Sequence-based phylogenetic investigations have been invaluable in addressing questions concerning generic circumscription and interspecific species relationships, as discussed in the present paper and elsewhere (Roberts & Urbatsch 2004; Suh 1989; Morgan 1990). Such data also have added a new level of complexity and have posed new hypotheses concerning the circumscription of *Chrysothamnus*.

Acamptopappus, *Amphipappus*, and *Vanclevea* are closely associated with or are included in *Chrysothamnus* in our sequence-based clade (Fig. 1). *Acamptopappus* is supported as part of a polytomy that also includes *Amphipappus fremontii* var. *spinosus* and *Chrysothamnus* (Fig. 1). Three taxa traditionally regarded as other genera are supported within *Chrysothamnus* (Fig. 1). Among these, *Hesporodoria scopulorum* and *Vanclevea stylosa* can readily be placed in *Chrysothamnus* because they exhibit no morphologically incongruous characteristics. Their affinities to one another (Anderson & Weberg 1974) and to *Chrysothamnus* had been noted (Nesom 1997, 2000) and sequence data support these hypotheses (Roberts & Urbatsch 2004). The presence of *Amphipappus fremontii* within the *Chrysothamnus* clade is perplexing because *A. fremontii* var. *spinosus* is placed several nodes below. Functionally staminate disk florets and 1–2 pistillate ray florets, features unknown for other taxa in this investigation except in *Petradoria*, characterize *Amphipappus*. There is some evidence for intergradation between the two varieties of *A. fremontii* (Nesom 2005), and the pubescence characters, their major distinguishing feature, are regarded as technical and perhaps trivial. Although Nelson (1934) recognized *A. spinosus* as a distinct species, he noted its strong similarity to the typical taxon. Furthermore, some years earlier (Nelson 1909), he described the same variant as a variety of *A. fremontii* based on a different type.

Lane (1988) hypothesized that *Acamptopappus*, *Amphipappus*, *Chrysothamnus*, *Vanclevea*, *Ericameria*, and others share a common ancestral stock. Sequence data support certain aspects of her hypothesis and her generalized statement is brought to a finer focus. *Chrysothamnus* is paraphyletic since it includes typical *Amphipappus fremontii*. Because of its distinctive floret morphology, the possibility of convergence among ETS/ITS sequences, and possible analytic problems such as long branch attraction or sample contamination, incorporation of *Amphipappus* into *Chrysothamnus* should be delayed until hypotheses posed herein are tested further. *Acamptopappus* is also maintained as a distinct genus because of its morphological cohesiveness and monophyly robustly supported by sequence data (Roberts & Urbatsch 2004).

Chrysothamnus scopulorum (M.E. Jones) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Bigelowia menziesii* var. *scopulorum* M.E. Jones, Proc. Calif. Acad. Sci. ser. 2, 5:692. 1895. *Haplopappus scopulorum* (M.E. Jones) S.F. Blake, Contr. U.S. Natl. Herb. 25:542, 546. 1925. *Hesperodoria scopulorum* (M.E. Jones) Greene, Leafl. Bot. Observ. Crit. 1:173. 1906. TYPE: U.S.A. UTAH: Canyon of the upper Virgin River above Springdale, 1219 m, 23 Sep 1894, *M.E. Jones 6074* (LECTOTYPE: US 00236810).

Haplopappus scopulorum var. *hirtellus* S.F. Blake, Proc. Biol. Soc. Washington 48:170. 1935. TYPE: U.S.A. UTAH. Iron Co.: Cedar Canyon, 2 Sep 1931. *A.O. Garrett 6051* (HOLOTYPE: US 01623835)

Chrysothamnus scopulorum var. **canonis** (S.L. Welch) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Haplopappus scopulorum* (M.E. Jones) S.F. Blake var. *canonis* S.L. Welsh, Utah Flora (ed. 3), 200. 2003. TYPE: U.S.A. UTAH. Naturalist Cove, base of N facing cliffs, east of The Neck, Canyonlands National Park, n.d., *S.L. Welsh 8813* (HOLOTYPE: BRY).

Distribution, ecology, and relationships.—Chrysothamnus scopulorum grows on brushy mountain slopes and in the understory of ponderosa pine in Arizona and Utah between 1200 and 2200 m. Features diagnostic for this species include its compact clusters of 20± capitula on long peduncular branches bearing widely spaced, distally reduced leaves/bracts, 5–6 seriate involucres, imbricate phyllaries, relatively large capitula of 10–16(–20) florets, and pubescent achenes. In our gene tree (Fig. 1), it is one of seven basal polytomic branches, its sister relationships unresolved. Within *Chrysothamnus* it closely resembles *C. stylosus* but is readily differentiated from that taxon by its non-glutinous involucres, smaller capitula, and terete pappus bristles. It is the type for the ditypic *Hesperodoria*, earlier regarded as a section within *Haplopappus* (sensu Hall 1928). As noted in the discussion of *Lorandersonia*, similarities between *C. scopulorum* and *L. salicina* (*H. salicina*) are convergent.

Chrysothamnus stylosus (Eastwood) Urbatsch, R.P. Roberts, & Neubig, comb. nov. BASIONYM: *Grindelia stylosa* Eastwood, Proc. Calif. Acad. Sci. ser. 2, 6:293. 1896. *Vanclevea stylosa* (Eastwood) Greene, Pittonia 4. 51. 1899. TYPE: U.S.A. UTAH: 13 Jul 1895, *A. Eastwood 36* (HOLOTYPE: CAS).

Distribution, ecology, and relationships.—Chrysothamnus stylosus is endemic to the Colorado Plateau and has been documented for at least six counties in southern Utah and in adjacent Arizona, where it inhabits dunes and sandy soil at elevations from 1100–1700 meters. It is readily diagnosed by its glutinous shoots and involucres, relatively broad, spreading to deflexed, falcate leaves with acute apices, 3–5-seriate involucres, graduated, acuminate-tipped phyllaries, 20 or more flowers per head, and numerous, flattened pappus bristles. Previously treated in the monotypic genus *Vanclevea*, its similarity to *Hesperodoria* (as suggested by Anderson and Weberg 1974) and to *Chrysothamnus* (Nesom 1997, 2000) is supported in part by ETS/ITS sequence data (Roberts & Urbatsch 2004). Within *Chrysothamnus*, it and five other taxa, plus a branch bearing several other species, form a basal polytomy (Fig. 1). As in other studies of this nature (Roberts & Urbatsch 2003, 2004), low levels of sequence variation provide little resolution within genera.

The following is key to taxa within and related to Cuniculotinus, *Chrysothamnus*, and *Lorandersonia* based ETS/ITS sequence data (Fig. 1). A key to the genera *Chrysothamnus*, and *Lorandersonia* is not possible due to apparent convergence among various species. Therefore, taxa in these two genera appear at various places in the key.

KEY TO TAXA IN THE *CHRYSOTHAMNUS* AND *LORANDERSONIA* CLADES

1. Disk flowers 3–7, functionally staminate; ray flowers 1–2, pistillate, ligule apices distinctly 2–3 lobed; pappus of crinkly bristles, 2 to several fused at base **Amphipappus**

1. Disk flowers hermaphroditic, often many more than 7 per capitulum; rays 0 to numerous; ligule apices rounded or irregularly notched or toothed; pappus of separate bristles or scales, not conspicuously contorted.

  2. Rays 0; florets, at least the outer several series, associated with readily deciduous paleae, much longer than achenes; pappus of 5–8 narrowly deltate scales; capitula with 30 or more florets **Eastwoodia**

  2. Rays 0–several; palea lacking, relatively short, conic projections present in certain taxa; pappus of 10 or more bristles; capitula may contain fewer or more than 30 florets.

    3. Phyllaries graduated, mid-level ones obovate, more than 2 mm wide distally, apices retuse to emarginate, notch conspicuously cuspiate, lower or outermost chartaceous **Cuniculotinus**

    3. Phyllaries graduated or subequal, rarely more than 2 mm wide distally, but if so, apices obtuse to rounded, never notched, lower or outermost often herbaceous.

      4. Receptacles with persistent, sharp, conic projections; phyllaries 2–3 seriate; involucres hemispheric to nearly spheric; desert shrubs of the southwestern U.S. with disk flowers 14 or more; rays present in one species, absent in another **Acamptopappus**

      4. Receptacles without sharp, conic; phyllaries (2–)3–6+ seriate; involucres cylindric, turbinate, or campanulate; disk flowers 15 or fewer in most species except for certain low growing, montane, herbaceous-stemmed taxa with 15 or more ray florets per capitulum.

        5. Ray flowers 5 or more per capitulum.

          6. Capitula in compact corymbiform clusters; disk flowers 15 or fewer **Lorandersonia microcephala**

          6. Capitula solitary; disk flowers 40 or more.

            7. Leaf margins entire rarely with a few apical teeth; shoots and phyllaries pubescent with spreading and mostly gland-tipped hairs **Tonestus lyallii**

            7. Leaf margins saliently toothed; shoots and phyllaries pubescent with shaggy, crisped hairs, or with gland-tipped hairs.

              8. Many-stemmed, tap-rooted perennial herbs from an underground, branching caudex; stems and involucres pubescence of eglandular, shaggy, crisped hairs; Rocky Mountain alpine meadows **Tonestus pygmaeus**

              8. Mat-forming herbaceous perennials from underground, branching caudices and deep-seated rhizomes; stems and involucres with abundant, gland-tipped hairs; mountains of east-central California and adjacent Nevada **Lorandersonia eximius**

        5. Ray flowers 0; reported for *L. spathulata* but rare.

          9. Disk flowers 8 or more per capitulum.

            10. Disk flowers 30 or more; involucres and often stems distally glutinous **Chrysothamnus stylosa**

10. Disk flowers 20 or fewer; involucres and stems may be resin dotted but not glutinous.
    11. Basal leaves and lower cauline leaves bearing 1–3 pairs of salient teeth; shoots and involucres pubescent with relatively long gland-tipped hairs ________ **Tonestus graniticus**
    11. Leaf margins entire; shoots resin-dotted or pubescent with short, conic, eglandular hairs.
        12. Stems and leaves resin-dotted; involucres 3–6 seriate ________ **Lorandersonia salicina**
        12. Stems and leaves pubescent with spreading, eglandular hairs; involucres 6+–seriate ________ **Chrysothamnus scopulorum**

9. Disk flowers fewer than 8 per capitulum (the highly variable *C. viscidiflorus* subsp. *viscidiflorus* is known to have up to 14 flowers per head, but it may be distinguished by its leaves twisted on their long axes).
    13. Leaves 10 or more mm wide, strongly veined; stems annual ________ **Chrysothamnus eremobius**
    13. Leaves less than 10 mm wide, midvein often evident, collateral veins 0 or inconspicuous; stems perennial.
        14. Leaves twisted about long axis ________ **Chrysothamnus viscidiflorus**
        14. Leaves flat, not twisted.
            15. Achenes glabrous to sparsely pubescent throughout or distally only, sometimes with glistening atomiferous trichomes.
                16. Stems and leaves glabrous or uniformly pubescent with short, spreading conic trichomes; distal portion of achenes usually with glistening atomiferous trichomes and sometimes a few elongated hairs or glabrous throughout.
                    17. Stems and leaves uniformly and abundantly pubescent with short, spreading, conic trichomes; distal portion of achenes usually with glistening atomiferous trichomes and sometimes a few elongated hairs or glabrous throughout; disk corollas 7–11 mm long ________ **Chrysothamnus depressus**
                    17. Stems uniformly and abundantly pubescent with short, spreading, conic trichomes or glabrous; leaves glabrous or ciliolate margined; achenes glabrous; disk corollas 9 mm or more long.
                        18. Margins of leaves ciliolate; widespread in New Mexico and adjacent states ________ **Lorandersonia baileyi**
                        18. Margins of leaves glabrous; central New Mexico and adjacent Texas ________ **Lorandersonia pulchella**
                16. Stems and leaves uniformly predominantly pubescent with gland-tipped trichomes, short, spreading conic trichomes if present sparsely so;

achenes glabrous or distal portion with a few elongated hairs; disk corollas 7 or more mm long.
    19. Stems and leaves mainly pubescent with gland-tipped trichomes, eglandular ones may also be present _______ **Chrysothamnus molesta**
    19. Achene apices with a few elongated hairs or glabrous throughout; leaves resin dotted _______ **Chrysothamnus vaseyi**
15. Achenes pubescent to densely so with elongated trichomes; atomiferous spheres typically lacking.
  20. Leaves or capitulescence bracts extending to apices of the involucres or far beyond; leaves often resin dotted _______ **Chrysothamnus humilis**
  20. Leaves or capitulescence bracts not extending to the level of the involucres.
    21. Leaves 1–2 mm wide or narrower, glabrous or remotely scaberulous; phyllary apices acuminate or cuspidate with a slender tip.
      22. Leaves 1(–2) mm wide or narrower, glabrous or remotely scaberulous; phyllary apices acuminate or cuspidate with a slender tip _______ **Chrysothamnus greenei**
      22. Leaves 1–2 mm wide, glabrous; phyllary apices acute to rounded, somewhat thickened apically _______ **Chrysothamnus viscidiflorus** subsp. **planifolius**
    21. Leaves (2–)3 mm or more wide; phyllary apices acuminate, acute, or rounded.
      23. Cypselae densely pubescent; twigs glabrous or nearly so; leaves lanceolate, widest point nearer the leaf base, glabrous, often resin dotted; northeastern New Mexico and northward _______ **Lorandersonia linifolia**
      23. Cypselae sparsely pubescent; twigs scabrous; leaves oblanceolate to spatulate, widest point nearer the leaf apex, scabrous, lacking resin dots; southern New Mexico and adjacent Texas _______ **Lorandersonia spathulata**

ACKNOWLEDGMENTS

The authors thank the curators and staff personnel of ASC, ASU, BRY, CAS, DH, RM, UNLV, US, UT, and WTU for specimen loans on which this and related research was based. We thank Yalma L. Vargas-Rodriguez for preparing the Spanish abstract and Guy Nesom for a thorough and most helpful review on a very short notice.

REFERENCES

Anderson, L.C. 1964a. Studies on *Petradoria* (Compositae): anatomy, cytology, taxonomy. Trans. Kans. Acad. Sci. 66:632–684.

Anderson, L.C. 1964b. Taxonomic notes on the *Chrysothamnus viscidiflorus* complex (Astereae, Compositae). Madroño 17:222–227.

Anderson, L.C. 1983. *Chrysothamnus eremobius* (Asteraceae): a new species from Nevada. Brittonia 35:23–27.

Anderson, L.C. 1986a. An overview of the genus *Chrysothamnus* (Asteraceae). In: Proceedings – Symposium on the biology of *Artemisia* and *Chrysothamnus*. E.D. McArthur and B.L. Welch (compilers). General Technical Report INT-200. U.S.D.A. Forest Service, Ogden, Utah. Pp. 26–45.

Anderson, L.C. 1986b. Sympatric subspecies in *Chrysothamnus nauseosus*. In: Proceedings – Symposium on the biology of *Artemisia* and *Chrysothamnus*. E.D. McArthur and B.L. Welch (compilers). General Technical Report INT-200. U.S.D.A. Forest Service, Ogden, Utah. Pp. 93–103.

Anderson, L.C. and P.S. Weberg. 1974. The anatomy and taxonomy of *Vanclevea* (Asteraceae). Great Basin Naturalist 34:151–160.

Beck, J.B., G.L. Nesom, P.J. Calie, G.I. Baird, R.L. Small, and E.E. Schilling. 2004. Is subtribe Solidagininae (Asteraceae) monophyletic? Taxon 53(3):691–698.

Blake, S.F. 1935. Five new plants of the genus *Aplopappus*. Proc. Biol. Soc. Washington 48:169–174.

Brouillet, L., L.E. Urbatsch, and R.P. Roberts. 2004. *Tonestus kingii* and *T. abberrans* are related to *Eurybia* and the Machaerantherinae (Asteraceae: Astereae) based on nrDNA (ITS and ETS) data: reinstatement of *Herrickia* and a new genus, *Triniteurybia*. Sida 21:889–900.

Cronquist, A. 1951. A new *Haplopappus* from New Mexico. Madroño 51:186–187.

Hall, H.M. 1916. Two new Compositae from Nevada. Muhlenbergia 2:342–344.

Hall, H.M. 1928. The genus *Haplopappus*—a phylogenetic study in the Compositae. Carnegie Inst. Washington Publ. No. 389.

Hall, H.M and F.E. Clements. 1923. The phylogenetic method in taxonomy: The North American species of *Artemisia*, *Chrysothamnus*, and *Atriplex*. Carnegie Inst. Washington Publ. No. 326.

Howell, J.T. 1950. Studies in California *Aplopappus*. Leafl. Western Bot. 6:84–88.

Keck, D.D. 1940. New species in *Haplopappus*. Madroño 5:166–169.

Lane, M.A. 1988. Generic relationships and taxonomy of *Acamptopappus* (Compositae: Astereae). Madroño 35:247-265.

Lane, M.A., D.R. Morgan, Y. Suh, B.B. Simpson, and R.K. Jansen. 1996. Relationships of North American genera of Astereae, based on chloroplast DNA restriction site data. In: Proceedings of the International Compositae Conference, Kew, 1994, eds. D.J.N. Hind and H.J. Beentje. Royal Botanic Gardens, Kew. Pp. 49–77.

Morgan, D.R. 1989. A systematic study of *Machaeranthera* (Asteraceae) and related groups using restriction site analysis of chloroplast DNA and a taxonomic revision of *Machaeranthera* section *Psilactis*. Ph.D. dissertation, Univ. of Texas, Austin.

Nelson, A. 1909. Contributions from the Rocky Mountain Herbarium. VIII. Bot. Gaz. 21:425–437.

Nelson, A. 1934. Rocky Mountain herbarium studies. II. Amer. J. Bot. 21:573–582.

Nesom, G.L. 1991. Redefinition of *Hesperodoria* (Asteraceae: Astereae) and the segregation of *Columbiadoria*, a new monotypic genus from the western United States. Phytologia 71:244-251.

Nesom, G.L. 1993. *Aztecaster* (Asteraceae: Astereae), a new ditypic genus of dioecious shrubs from Mexico with redefinitions to the subtribes Hinterhuberinae and Baccharidinae. Phytologia 75:68. 1993

Nesom, G.L. 1997. *Vanclevea* (Asteraceae: Astereae): $n=9$ confirmed. Phytologia 82:130–133.

Nesom, G.L. 2000. Generic conspectus of the tribe Astereae (Asteraceae) in North America, Central America, the Antilles, and Hawaii. Sida, Bot. Misc. 20:1–100.

Nesom, G.L. 2005. *Amphipappus*. In: Flora of North America Editorial Committee, eds. Fl. North America North of Mexico; 12 + vols. Oxford Univ. Press, New York and Oxford. Vol. 20.

Nesom, G.L. and G.I. Baird. 1993. Completion of *Ericameria* (Asteraceae: Astereae), diminution of *Chrysothamnus*. Phytologia 75:74–93.

Nesom, G.L. and D.R. Morgan. 1990. Reinstatement of *Tonestus* (Asteraceae: Astereae). Phytologia 68:174–180.

Roberts, R.P. and L.E. Urbatsch. 2003. Molecular phylogeny of *Ericameria* (Asteraceae, Astereae) based on nuclear ribosomal 3'ETS and ITS sequence data. Taxon 52:209–228.

Roberts, R.P. and L.E. Urbatsch. 2004. Molecular phylogeny of *Chrysothamnus* and related genera (Asteraceae, Astereae) based on nuclear ribosomal 3'ETS and ITS sequence data. Syst. Bot. 29:199–215.

Rzedowski, J. 1972. Tres adiciones al genero *Baccharis* (Compositae) en Mexico. Brittonia 24:398–402.

Suh, Y. 1989. Phylogenetic analysis of chloroplast DNA in North American Astereae (Asteraceae) based on chloroplast DNA. Ph.D. dissertation, Univ. of Texas, Austin.

SYMPHYOTRICHUM PYGMAEUM: TRANSFER OF *EURYBIA PYGMAEA* FROM THE EURYBIOID GRADE TO THE SUBTRIBE SYMPHYOTRICHINAE (ASTERACEAE: ASTEREAE)

Luc Brouillet and Sugirthini Selliah

Herbier Marie-Victorin
Institut de recherche en biologie végétale
Université de Montréal
4101 sherbrooke St. E
Montreal, Quebec, CANADA, H1X 2B2
email: luc.brouillet@umontreal.ca

ABSTRACT

Morphology and molecular phylogenetic data show that *Eurybia pygmaea* is not a member of *Eurybia* but belongs in *Symphyotrichum*, close to *S. yukonense* of subg. *Virgulus* section *Grandiflori*. Therefore, we transfer the species to that genus, as *Symphyotrichum pygmaeum* (Lindl.) Brouillet & S. Selliah.

RESUMEN

Los datos filogenéticos morfológicos y moleculares muestran que *Eurybia pygmaea* no es un miembro de *Eurybia* sino que pertenece a *Symphyotrichum*, próximo a *S. yukonense* del subg. *Virgulus* section *Grandiflori*. Por ello, transferimos la especie a ese género como *Symphyotrichum pygmaeum* (Lindl.) Brouillet & S. Selliah.

Eurybia pygmaea (Lindl.) G.L. Nesom, the pygmy aster, is endemic to the western Canadian Arctic and northeastern arctic Alaska. Described initially as *Aster pygmaeus* Lindley, it was later placed in synonymy of the morphologically similar *Eurybia sibirica* (L.) G.L. Nesom (*A. sibiricus* L. subsp. *pygmaeus* (Lindl.) Löve & Löve or *A. sibiricus* var. *pygmaeus* (Lindl.) Cody). *Eurybia sibirica* is a primarily western, boreal montane species that reaches the western North American Arctic and crosses into Eurasia, the only species of genus *Eurybia* to do so. This species clearly belongs to the eurybioid grade (Brouillet et al. 2004).

In his work on the North American species of asters, Nesom (1994) accepted the hypothesis of a close relationship between *A. pygmaeus* and *A. sibiricus*, and therefore transferred the former to *Eurybia* at the rank of species, *E. pygmaea* (Lindl.) G.L. Nesom. Hultén (1968) and Porsild and Cody (1980), however, had drawn attention to the similarity of *E. pygmaea* (as *A. pygmaeus*) to another species, *Aster yukonense* Cronquist, an endemic of interior Yukon and Alaska, and of the Mackenzie drainage of the Northwest Territories. Nesom (1994) transferred *A. yukonense* to another North American segregate of *Aster*, *Symphyotrichum*, as *S. yukonense* (Cronquist) G.L. Nesom, as a member of subgenus *Virgulus*. He did not discuss the possible relationships of *E. pygmaea* to *S. yukonense*. Scoggan (1978–1979) underlined the similarity of *S. yukonense* to *S. campestre*. Subgenus *Virgulus* is characterized by its chromosome base number of x = 5, while *Eurybia* has x = 9. The chromosome number of *E. pygmaea* is yet unknown.

In a molecular-based (nr DNA ITS and ETS) phylogenetic analysis of the eurybioid grade with respect to other North American Astereae (subsequent to Brouillet et al. 2004), *Eurybia pygmaea* did not group with other species of the genus, but was found embedded within the Symphyotrichinae with members of *Symphyotrichum* subg. *Virgulus*, in a clade comprising *S. novae-angliae* (ITS dataset, which did not include *S. yukonense*) or *S. novae-angliae*, *S. fendleri* and *S. yukonense* (ETS dataset) (S. Selliah and L. Brouillet, unpublished). In the latter, *E. pygmaea* is sister to *S. yukonense*. Forcing *E. pygmaea* to *Eurybia* results in much longer trees and is therefore less parsimonious. Furthermore, genus *Eurybia* is characterized by a synapomorphic deletion of 9 bp in the *trnL* intron (cpDNA), a deletion not found in the closely related *Oreostemma*, *Herrickia*, *Triniteurybia* or Machaerantherinae, nor in any other North American Astereae investigated so far, including members of the Symphyotrichinae (M. Lauzé, pers. comm.). These data indicate that *E. pygmaea* is not a member of *Eurybia*, but instead belongs to *Symphyotrichum* subenus *Virgulus*, section *Grandiflori*. This hypothesis would be easily tested by counting the chromosome number of *E. pygmaea*: a count based on x = 5 (with a distinctive karyotype, Semple & Brouillet 1980) would confirm membership in the *Virgulus* group of *Symphyotrichum*.

Morphologic examination of herbarium specimens reveals the striking similarity of *Eurybia pygmaea* to *Symphyotrichum yukonense*, to the point that a problem of a transition between the two species may be perceived (D. Murray, pers. comm.). Indeed, smaller, single-headed individuals of *S. yukonense* could be easily mistaken for the former. Both species have wiry caudices, stems short, branched, purplish, simple, brittle, villous, leaves yellowish-green, narrow, more or less clasping, entire (occasionally subserrate in *E. pygmaea*), sparsely villous or strigose to glabrate, marginally ciliate or villous-ciliate, capitulescences few-headed and paniculiform or single-headed, and campanulate heads with phyllaries subequal, often purplish, not or little basally scarious, leafy, lanceolate to linear-lanceolate, more or less villous, rays 8 to 30, purple, 5–11 mm long, disc corollas weakly ampliate or funnelform, nerved cypselae with sordid or purplish, acute, barbellate bristles. Observation of the phyllary tips of *E. pygmaea* further revealed the presence of a few short-glandular hairs, which are absent from *E. sibirica* but typical of the *Grandiflori* and of *S. yukonense*. This needs to be confirmed by examination of live material to ensure that the small hairs observed are indeed glandular and similar to those of *S. yukonense*. Overall, similarities between *E. pygmaea* and *S. yukonense* are greater than those perceived between the former and *E. sibirica*.

Within the framework of preparing treatments for *Eurybia* and *Symphyotrichum* for the Flora of North America project, we are therefore proposing the transfer of *Eubyria pygmaea* to *Symphyotrichum*.

Symphyotrichum pygmaeum (Lindl.) Brouillet & S. Selliah, comb. nov. Basionym: *Aster pygmaeus* Lindley in W.J. Hooker, Fl. Bor.-Amer. 2:6. 1834. *Aster sibiricus* L. subsp. *pygmaeus* (Lindley) Löve & Löve, Bot. Not. 128:521. 1975 (1976). *Aster sibiricus* L. var. *pygmaeus* (Lindley) W. J. Cody, Canad. Field-Naturalist 68: 117. 1954. *Eurybia pygmaea* (Lindl.) G.L. Nesom, Phytologia 77:261. 1994 (1995).

ACKNOWLEDGMENTS

The authors wish to thank D. Murray (University of Alaska Fairbanks) for information concerning this problem and for constructive comments on the manuscript, Guy Nesom (Botanical Research Institute of Texas) for comments on the manuscript, the curators of ALA and MT for the loan of specimens, and M. Lauzé (Université de Montréal) for the chloroplast DNA data.

REFERENCES

Brouillet, L., L. Urbatsch, and R.P. Roberts. 2004. *Tonestus kingii* and *T. aberrans* are related to *Eurybia* and the *Machaerantherinae* (Asteraceae: Astereae) based on nrDNA (ITS and ETS) data: reinstatement of *Herrickia* and a new genus, *Triniteurybia*. Sida 21:889–900.

Hultén, E. 1968. Flora of Alaska and neighboring territories. Stanford Univ. Press, Stanford, CA.

Nesom, G.L. 1994. Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. Phytologia 77:141–297.

Porsild, A.E. and W.J. Cody. 1980. Vascular plants of Continental Northwest Territories, Canada. Nat'l Mus. Canada, Ottawa.

Scoggan, H.J. 1979. The flora of Canada. Part 4 - dicotyledonae (Loasaceae to Compositae). Nat'l Mus. Nat. Sci. Publ. Bot. 7(4).

Semple, J.C. and L. Brouillet. 1980b. Chromosome numbers and satellite chromosome morphology in *Aster* and *Lasallea*. Amer. J. Bot. 67:1027–1039.

BOOK REVIEW

Ricard Solé and Brian Goodwin. 2000. **Signs of Life: How Complexity Pervades Biology.** (ISBN 0-465-01928-5, pbk.). Basic Books, 387 Park Avenue South, New York, NY 10016, U.S.A. (**Orders:** 212-340-8100, 212-340-8115 fax; www.basicbooks.com). $17.50, 322 pp., b/w figures, charts, notes, index, 6" × 9 1/4".

The book *Signs of Life* addresses the concept of complexity in biology. To completely appreciate this text, readers should have a strong background in mathematics, physics, biology and if possible systems modeling. Such a foundation is helpful in understanding the many mathematical equations that the reader is presented with during the authors' discussions. The vocabulary of this book is advanced; I found it necessary to look up words and theory references either in a dictionary or online. The language and terminology choices in the text are much more involved than the back cover description would lead you to believe In fact, the writing style and vocabulary choices used in this book will likely discourage, if not exasperate, most readers.

The first chapter serves as an overview of the book, which this reader found too mathematically/physics intensive (i.e. technically term laden) to get a good foothold on the examples and messages the authors were attempting to convey. A number of topics relating to nonlinearity, chaos and emergence were discussed in chapter one; some explained and some not, including: Lorenz attractors, Navier-Stokes equations, excitable media, slime mold life cycle, Bernard cells, bifurcation, and convection.

The second chapter focused on order, complexity and disorder. Although heavy on the physics and math, this chapter was understandable The chapter discusses the Ising model, which was initially explained with magnetic attractor changes at extreme temperatures. The Ising model was carried into examples of fire spread, sandpile shape, and discussion of critical limits in various biological and physical systems.

Chapter three centered on the topics of genetic networks and what processes control cell differentiation and genetic development. Items discussed included the ideas of rate limiting steps, isologous diversification and gene regulation of metabolic activities

My initial interest and excitement about this book arose from both the title and description on the back. That interest was quickly replaced with frustration after the continual exposure to advanced mathematics, physics terminology and equations, and I stopped reading after chapter three. Additional chapter titles include: Brain Dynamics, Ants, Brains & Chaos, Baroque of Nature, Life on the Edge of Catastrophe, Evolution & Extinction, Fractal Cities, and Market Crashes. I am sure that readers more familiar or comfortable with the many theories and equations referenced in this book will be able to glean a wealth of knowledge and interesting relationships included by the authors.

The book *Signs of Life* covers the topic of complexity in biology. The authors have included many "boxes" within the text that offer readers an in-depth mathematical equation, chart, graph or mathematical analysis related to the topics discussed. Each chapter also has a references area for those readers who wish to learn more or read specific source material. Unfortunately the authors' use of extremely technical terminology and verbose writing style, make understanding complexity in biology very complex itself.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NEW COMBINATIONS IN *ARTEMISIA* (ASTERACEAE: ANTHEMIDEAE)

Leila M. Shultz

Utah State University
Logan, Utah, 84322-5230, U.S.A.
shultz@cc.usu.edu

ABSTRACT

Two combinations are proposed: *Artemisia arbuscula* subsp. *longiloba* (Osterhout) Shultz and *Artemisia globularia* subsp. *lutea* (Hultén) Shultz. *Artemisia globularia* subsp. *lutea* is lectotypified.

RESUMEN

Se proponen dos combinaciones (*Artemisia arbuscula* subsp. *longiloba* y *Artemisia globularia* subsp. *lutea*) y se lectotipifica *Artemisia globularia* subsp. *lutea*.

Taxa for which new combinations are here proposed are included in the forthcoming treatment of *Artemisia* in the Flora of North America North of Mexico (Shultz 2005). Both combinations already exist at varietal rank but they are made here at subspecific rank for better consistency with traditional usage in the genus (e.g., Shultz 1983, 1987) and with the FNA treatment.

Artemisia arbuscula Nutt. subsp. **longiloba** (Osterhout) Shultz, comb. nov. BASIONYM: *Artemisia spiciformis* Osterhout var. *longiloba* Osterhout, Muhlenbergia 4:69. 1908. *Artemisia longiloba* (Osterhout) Beetle, Rhodora 61:84. 1959. *Artemisia arbuscula* var. *longiloba* (Osterhout) Dorn, Vasc. Pl. Wyoming 295. 1988. *Seriphidium arbusculum* (Nutt.) W.A. Weber subsp. *longilobum* (Osterhout) W.A. Weber, Phytologia 55:7. 1984. TYPE: U.S.A. COLORADO. Grand Co.: Sulphur Springs, *Osterhout 3592* (HOLOTYPE: GH!).

Artemisia arbuscula is one of the more perplexing species in *Artemisia* subg. *Tridentatae*. Anatomic and morphologic characteristics (leaf phenology and size of heads) suggest multiple hybrid origins and different parental taxa for the subspecies (Shultz 1987). The phenology of leaves on flowering plants in an otherwise evergreen species suggests a hybrid origin involving species of the *A. tridentata* and *A. cana* lineages. In most instances, populations of *A. arbuscula* appear to be stable and self-reproducing from fully fertile seeds.

Artemisia arbuscula occurs throughout western North America, primarily as isolated populations in California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming. *Artemisia arbuscula* subsp. *longiloba* differs from other subspecies of *A. arbuscula* by its distinctive leaf lobing and early blooming time. It is the only member of the Tridentatae complex to begin flowering as soon as snow melts in early spring and it is ecologically distinguished from other subspecies by its occurrence at lower elevations, in finegrained clay soils. Morphological characteristics that separate subsp. *longiloba* from subsp. *arbuscula* are its smaller heads (2–3 mm diam. as opposed to 3–4.5 mm); subsp. *longiloba* is separated from subsp. *thermopola* by its shallowly lobed leaves (less than 1/2 their lengths) as opposed to deeply cleft leaves (more than 1/2 their lengths).

I proposed the taxonomic status adopted here in my doctoral dissertation (Shultz 1983). Osterhout first recognized the 'longiloba' morphological form; he considered it a variant of *Artemisia spiciformis*, a species that also appears to be of hybrid origin. Because *A. arbuscula* subsp. *longiloba* occurs sporadically in the Intermountain west and exhibits a broad range of morphological variation, I have hesitated to formalize its status. Twenty years of additional field work have helped to confirm my belief that this taxon should be recognized but with the *caveat* that it may be derived from different taxonomic lineages (at subspecific rank) in different parts of its range. The taxon described as *A. arbuscula* subsp. *longicaulis* A.H. Winward & E.D. McArthur (1995) may be a polyploid derivative of the *Artemisia arbuscula* complex. This complex continues to present an interesting puzzle that in all likelihood represents a pattern of reticulate evolution.

Artemisia globularia Chamisso ex Besser subsp. **lutea** (Hultén) Shultz, comb. nov. BASIONYM: *Artemisia globularia* var *lutea* Hultén, Acta Univ. Lund 2, 46.1567 1950. *Artemisia globularia* f. *lutea* (Hulten) B. Boivin, Naturaliste Canad. 94:632. 1967. TYPE: U.S.A. ALASKA: St. Matthew Island, 16 Jul 1938, *J.P. Anderson 4007* (LECTOTYPE: S, here formally designated). Selected by D.F. Murray in 1981, who studied all the material available to Hultén at S. The Anderson collection is the only one of the syntypes in Hultén's herbarium and thus the only one he could have had before him at the time of writing the description.

As currently circumscribed, *Artemisia globularia* subsp. *lutea* is known only from Alaska. It is common on St. Mathew Island, infrequent on surrounding islands, and of conservation concern. The bright yellow corollas with orange glands distinguish it from subsp. *globularia*, which has reddish-black, eglandular corollas. It is unusual to have such distinguishing characteristics at the subspecies level. Elven et al. (2004) documented multiple chromosome races within *A. globularia*, suggesting need for further study to determine relationships of this taxon.

ACKNOWLEDGMENTS

This research has been supported, in part, by a grant to the author from the USDA Forest Service. Special thanks are extended to David F. Murray, Kanchi Gandhi, and two journal reviewers for comments on this manuscript, and to Luc Brouillet for his comments on the draft manuscript for Flora of North America North of Mexico. Curators of the Gray Herbarium (GH) of Harvard University, the Intermountain Herbarium (UTC) of Utah State University, the

Swedish Museum of Natural History (S), and the Rocky Mountain Herbarium (RM) of the University of Wyoming provided access to collections and databases.

REFERENCES

ELVEN, R., D.F. MURRAY, V. YU. RAZZHIVIN, and B.A. YURTSEV (eds.). 2004. Checklist of the Panarctic flora (PAF). Vascular plants. Final draft version. National Centre of Biosystematics, Natural History Museums and Botanic Garden. University of Oslo, Oslo, Norway.

SHULTZ, L.M. 1983. Systematics and anatomical studies of *Artemisia* subgenus *Tridentatae*. Ph.D. dissertation. Claremont Graduate School, Claremont, California.

SHULTZ, L.M. 1987. Comparative leaf anatomy of sagebrush. In: E.D. McArthur and B.L. Welch, eds. 1987. Proc. Symp. Biol. of *Artemisia* and *Chrysothamnus*. Provo, Utah. Pp. 253–264.

SHULTZ, L.M. 2005. *Artemisia*, pp. xxx-xxx. In Flora North America Editorial Committee, eds. Flora of North America. Vol. 21. Asteraceae. Oxford University Press, Oxford and New York.

WINWARD, A.H. and E.D. MCARTHUR. 1995. Lahontan sagebrush (*Artemsisia arbuscula* ssp. *longicaulis*): A new taxon. Great Basin Naturalist 55:152.

BOOK REVIEW

MARK FLANAGAN and TONY KIRKHAM. 2005. **Plants From the Edge of the World: New Explorations in the Far East.** (ISBN 0-88192-676-0, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and Timber Press, 2 Station Rd, Swavsey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 312 pp., color maps, numerous color photos, 7 1/4" × 9 /14".

This engaging book chronicles the authors' plant-collecting expeditions in the Far East in the aftermath of the Great Storm (Hurricane Hugo) of October 1987, which devastated Royal Botanic Gardens, Kew, London and Wakehurst Place in West Sussex. During the subsequent assessment of damage and inventory of the collections, it became clear that there were large gaps in both the taxonomic and geographic representation of the world's temperate woodlands, especially those from the edge of eastern Asia. A plant collecting program was developed targeting areas of the world that were underrepresented in Kew's collections. Joint expeditions to Sichuan, China were mounted by others; the authors found themselves in charge of expeditions to some very remote areas in Korea, Taiwan, eastern Russia and Japan.

Plants and hunting them form the heart of the book, but the story is as much an adventure tale as one about botany. Well written, never dry, often exciting, sometimes hilarious, the book allows the reader to experience events in an immediate way through the use of first-person narrative. From their eight-hour climb to a Korean mountain top to crossing a storm-swollen river in Russia hand-in-hand, the authors keep the reader's attention. They eat sandpiper stew, but pass on pigs' ears. They savor beer in several memorable places. They look more kindly on Spam after days in Todong where the smell of drying squid permeates the air. And on every page they describe the plants they are hunting and the way they are hunting them. They pursue their goals though rain, hail, heat, cold and dark of night, always with a sense of humor. Think of Michael Palin crossed with a postman-botanist and you get the idea.

The final chapter details what has happened at Kew and Wakehurst Place as the collections have been planted and grown. The book also includes homage to those who went before them at Kew, notably E.H. Wilson, in whose footsteps the authors found themselves walking as they gathered seed in the species-rich temperate forests on the "edge of the world."

Mark Flanagan is currently Keeper of the Gardens in Windsor Great Park, with responsibilities for the world-renowned Savill and Valley Gardens and the gardens at Frogmore. Tony Kirkham is Head of the Arboretum and Horticultural Services at the Royal Botanic Garden, Kew, where he cares for the existing heritage landscape and woody plant collections and maintains the integrity and development of the living scientific plant collections. Both travel extensively for plant collecting trips, lecture and publish.—*Penny McCook, volunteer, Botanical Research institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

NEW COMBINATION IN *CONOCLINIUM* (ASTERACEAE: EUPATORIEAE)

Thomas F. Patterson

South Texas College
142 FM 3167
Rio Grande City, Texas 78582, U.S.A.
tfpatt@southtexascollege.edu

ABSTRACT

Conoclinium betonicifolium (P. Miller) King & H. Robinson var. **integrifolium** (A. Gray) T.F. Patterson is an inland taxon that has mostly oblanceolate to ovate leaf blades.

RESUMEN

Conoclinium betonicifolium (P. Miller) King & H. Robinson var. **integrifolium** (A. Gray) T.F. Patterson es un taxon del interior que usualmente tiene limbos foliares de oblanceolados a ovados.

A study of the genus *Conoclinium* DC. (Patterson 1994) reaffirmed an earlier observation by Asa Gray that a bimodal pattern of variation exists within *Conoclinium betonicifolium* (Miller) King & H. Robinson. The inland taxon, which has distinctive leaf morphology, is formally treated here at varietal rank. The distributions of the two varieties in Texas were mapped by Turner et al. (2003).

Conoclinium betonicifolium (Miller) King & H. Robinson, Phytologia 19:300. 1970. *Eupatorium betonicifolium* Miller, Gard. Dict. ed. 8, *Eupatorium* no. 9. 1768.

1. Leaf blades mostly oblong to oblong-lanceolate (commonly subauriculate), bases truncate to cordate, margins crenate; coastal habitats ______________ **a.** var. **betonicifolium**
1. Leaf blades mostly oblanceolate to ovate (commonly attenuate), bases obtuse, truncate, or cordate, margins crenate or entire; inland habitats along streams and around lakes ____ **b.** var. **integrifolium**

a. Conoclinium betonicifolium (P. Miller) King & H. Robinson var. **betonicifolium**

Conoclinium betonicum DC., Prodr. 5:135. 1836. *Eupatorium betonicum* (DC.) Hemsley, Biol. Cent.-Amer., Bot. 2(7):93. 1881.

Flowering Apr–Jun, Sep–Oct. Gulf coast, dunes, beaches, sandy loam, roadside ditches, edge of woods, salt marshes; 0–10 m; Texas; Mexico (Tamaulipas, Veracruz, southward along Gulf coast).

b. Conoclinium betonicifolium (P. Miller) King & H. Robinson var. **integrifolium** (A. Gray) T.F. Patterson, comb. nov. BASIONYM: *Conoclinium betonicum* DC. var. *integrifolium* A. Gray, Smithsonian Contr. Knowl. 3(5):88. 1852. *Conoclinium integrifolium* (A. Gray) Small, Fl. S.E. U.S. 1170. 1903. TYPE: U.S.A. TEXAS. MAVERICK CO.: Rio Grande and Escondida Creek, 1848, *C. Wright s.n.* (HOLOTYPE: GH!; ISOTYPES: GH!, US!).

Flowering Jun–Sep. Inland along streams, around lakes, marsh edges, saline soil near irrigation, old fields; 50–1000 m; Texas; Mexico (Chihuahua, Coahuila, Jalisco, Nuevo León, Puebla, San Luis Potosí, Tamaulipas).

ACKNOWLEDGMENTS

I thank Guy Nesom (BRIT) and John Strother (UC) for their assistance with this paper.

REFERENCES

Patterson, T.F. 1994. A taxonomic revision of *Conoclinium* DC. (Asteraceae, Eupatorieae). M.S. thesis. University of Texas.

Turner, B.L., H. Nichols, G.C. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Sida, Bot. Misc. 24 (Vol. 1, Dicots):1–648.

A NEW COMBINATION IN THE GENUS *PACKERA* (ASTERACEAE: SENECIONEAE)

Debra K. Trock

Herbarium, Botany Department
California Academy of Sciences
875 Howard Street
San Francisco, California 94103-3009, U.S.A.

ABSTRACT

The following new combination in *Packera* is made: *Packera musiniensis* (S.L. Welsh) Trock.

RESUMEN

Se hace la siguiente nueva combinación en *Packera*: *Packera musiniensis* (S.L. Welsh) Trock.

Packera (Asteraceae: Senecioneae) is represented in North America north of Mexico by fifty-four species. During preparation of the treatment of *Packera* for the Flora of North America, the need for the following new combination was recognized.

Packera musiniensis (S.L. Welsh) Trock, comb. nov. BASIONYM: *Senecio musiniensis* S.L. Welsh, Rhodora 95:400. 1993 (HOLOTYPE: BRY).

Packera musiniensis is a distinctive high elevation dwarf species known only from Musinea Peak and from the Wasatch Plateau (Welsh 1993) in Sanpete County, Utah. Its affinities within *Packera* are uncertain, but Welsh believes it to be closely related to either *P. cana* (Hook.) W.A. Weber & Á. Löve, *P. multilobata* (Torr. & A. Gray) W.A. Weber & Á. Löve, or both.

ACKNOWLEDGMENTS

I would like to thank Kanchi Gandhi for his assistance with the nomenclature and Alan Prather for providing valuable comments.

REFERENCES

WELSH, S.L. 1993. New taxa and new nomenclatural combinations in the Utah flora. Rhodora 95:392–421.

BOOK NOTICES

Timber Press

D.J. Callaway and M.B. Callaway (Eds.). 2000. **Breeding Ornamental Plants.** (ISBN 0-88192-482-2, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 359 pp., 88 color photos, 10 b/w photo, 26 line drawings, 26 tables, 6" × 9".

The authors have succeeded in their goal of producing a book "useful to gardeners interested in plant breeding, .. presented in an interesting and easily understandable format." It is remarkably condensed, but plenty of references are at hand for whoever might want to dig more deeply. The first two chapters are by the Calloways: "Genetics and its applications," a brief and gentle introduction to Mendelian genetics, quantitative genetics, and polyploidy, and "Plant breeding—practical matters," an overview of how one might approach a 'back-yard' breeding program Short sections on "naming selections" and "plant protection and trademarks" are especially interesting (to me). Then, from various authors, a series of chapters follows on particular plant genera and groups. daylilies, daffodils, Siberian *Iris*, hostas, ornamental aroids, African violets, gesneriads, *Amaryllis*, *Penstemon*, rhododendrons and azaleas, *Kalmia* and relatives, camellias, lilacs, magnolias, and oaks. These are nicely edited for consistency of format and all include sections on "important traits and breeding objectives," "hybridization mechanics," and "propagation," in addition to topics particular to the plant group.

Even if not interested in breeding, many gardeners and botanical enthusiasts will enjoy reading sections of this book related to plants of their special interest. For example, find important mutations in African violets and the date on which each was first recorded, and read about the history of daylily hybridizing, vegetative propagation in camellias by cuttings and grafting, and key groups and breeding lines in daffodils.—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

Paul Cappiello and Don Shadow. 2005. **Dogwoods: the Genus *Cornus*.** (ISBN 0-88192-679-5, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 224 pp., color photos, b/w drawings, 7 1/2" × 11".

This is primarily an overview of all dogwoods of horticultural merit. Obviously some species are left out. About 31 species are included out of a possible 45–65 reported for the genus by the author. A key to species treated would have been a nice addition. In spite of having no key, this book is filled with an enormous amount of horticultural information on choice selections and hybrids available to the dogwood lover. The author provides in excess of 200 excellent photos.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

CORRECT AUTHOR CITATION FOR *CIRSIUM EATONII* VAR. *ERIOCEPHALUM* (ASTERACEAE: CARDUEAE): ERRATUM FOR SIDA 21:212. 2004

David J. Keil

Biological Sciences Department
California Polytechnic State University
San Luis Obispo, California 93407, U.S.A.
dkeil@calpoly.edu

In a recent paper (Keil 2004) I proposed the new combination *Cirsium eatonii* (A. Gray) B.L. Rob. var. *eriocephalum* (A. Nelson) D.J. Keil. I attributed the authorship of the varietal epithet *eriocephalum* to Nelson (Coulter and Nelson 1909) because *Cirsium eriocephalum* A. Gray, Proc. Acad. Nat. Sci. Philad. 1863:69, 1864, was a later homonym. However, a colleague pointed out to me that Gray (1874) had validly published the epithet as *Cnicus eriocephalus* A. Gray, and that Nelson (Coulter and Nelson 1909) had cited Gray's *Cnicus eriocephalus* when he published *Cnicus hookerianus* Nutt. [var.] *eriocephalus*. My attribution of the epithet to Nelson was therefore incorrect. The combination is republished here with the corrected authorship and basionym.

Cirsium eatonii (A. Gray) B.L. Rob. var. **eriocephalum** (A. Gray) D.J. Keil, comb. nov. BASIONYM: *Cnicus eriocephalus* A. Gray, Proc. Amer. Acad. Arts 10:46. 1874.

REFERENCES

COULTER, J.M. and A. NELSON. 1909. New manual of the botany of the central Rocky Mountains (vascular plants). American Book Company, New York, Cincinnati, and Chicago.

GRAY, A. 1874. A synopsis of North American thistles. Proc. Amer. Acad Arts 10:39–49.

KEIL, D.J. 2004. New taxa and new combinations in North American *Cirsium* (Asteraceae: Cardueae). Sida 21:207–219.

BOOK NOTICES

Timber Press

PETER GOLDBLATT, JOHN MANNING, and GARY DUNLOP. Illustrations by AURIOL BATTEN. 2005. ***Crocosmia* and *Chasmanthe*.** (ISBN 0-88192-651-5, hbk.). Royal Horticultural Society Plant Collector Guide. Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 219 pp., 15 watercolor plates, b/w drawings, 7 1/4" × 9 1/4".

Crocosmia and *Chasmanthe* are in the Iridaceae family. A key to species for both genera is a nice addition as are the beautiful watercolor plates.

T.M.E. BRANNEY. 2005. **Hardy Gingers: Including *Hedychium*, *Roscoea*, and *Zingiber*.** (ISBN 0-88192-677-9, hbk.). Royal Horticultural Society Plant Collector Guide. Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 267 pp., color photos, 7" × 9".

This book is specifically about gingers that are perfectly at home in the temperate garden. The eight chapters in the book are: **1)** Botany, **2)** Ecology, **3)** Cultivation, **4)** Propagation, **5)** Culinary and Medicinal Uses, **6)** Cut Flower Uses, **7)** Landscaping Uses, and **8)** A–Z of Hardy Gingers.

TORSTEN ULMER and JOHN M. MACDOUGAL. Drawings by BETTINA ULMER. 2004. ***Passiflora*: Passion Flowers of the World.** (ISBN 0-88192-648-5, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $44.95, 430 pp., 343 color photos, 258 b/w line drawings, 7 1/2" × 10 1/2".

Ulmer and MacDougal with the help of artist Bettina Ulmer have made a significant contribution to botany and horticulture with their *Passiflora* book. It is full of good descriptive information and is beautifully illustrated with excellent line drawings and color photos. There are 19 chapters that discuss everything from history, systematics, morphology, and cultivation to butterflies and diseases.

NESTOTUS AND *TOIYABEA*, TWO NEW GENERA OF ASTERACEAE: ASTEREAE FROM THE WESTERN UNITED STATES AND CANADA

Roland P. Roberts

Department of Biological Sciences
Towson University
Towson, Maryland 21252-0001, U.S.A.

Lowell E. Urbatsch

Department of Biological Sciences
Louisiana State University
Baton Rouge, Louisiana 70803, U.S.A.

Kurt M. Neubig

Department of Botany
University of Florida, PO Box 111526
Gainesville, Florida 32611, U.S.A.

ABSTRACT

Nestotus is described as a new ditypic genus from the western United States and the Yukon Territory, Canada, to accommodate *Stenotus macleanii* (Brandegee) A. Heller and *Stenotus stenophyllus* (A. Gray) Greene, resulting in two new combinations ***N. macleanii*** and ***N. stenophyllus***. Sequence-based phylogenetic investigations consistently demonstrate and robustly support the relatedness of these two taxa and their distinctiveness from the type species, *S. acaulis* (Nutt.) Nutt., and other taxa placed in *Stenotus*. ***Toiyabea*** is described as a monotypic genus from Nevada to accommodate *Tonestus alpinus* (L.C. Anderson & S. Goodrich) G.L. Nesom & D.R. Morgan, resulting in the new combination ***Toiyabea alpina***. This species, *Petradoria*, plus *S. acaulis* and *S. armerioides* Nutt. constitute a well-supported polytomy sister to *Solidago* and related taxa in our molecular-based phylogeny.

RESUMEN

Se describe ***Nestotus*** como un género ditípico nuevo del oeste de los Estados Unidos y del territorio de Yukón en Canadá para ubicar a *Stenotus macleanii* (Brandegee) A. Heller y a *Stenotus stenophyllus* (A.Gray) Greene con las consecuentes combinaciones nuevas ***N. macleanii*** y ***N. stenophyllus.*** La relación entre estas dos especies y las diferencias entre ellas, y la especie tipo, *S. acaulis* (Nutt.) Nutt., y otras especies de *Stenotus* es demostrada consistentemente con un alto apoyo en las investigaciones basadas en secuencias de ADN. Adicionalmente se describe ***Taiyabea*** como un género monotípico de Nevada para ubicar a *Tonestus alpinus* (L.C. Anderson & S. Goodrich) G.L. Nesom & D.R. Morgan con la consecuente nueva combination ***Toiyabea alpina.*** Esta especie, *Petradoria*, junto con *S. acaulis* y *S. armeroides* Nutt. constituyen en nuestra filogenia molecular una politomía con alto apoyo, la cual es hermana de *Solidago* y los táxones emparentados.

INTRODUCTION

The sequence-based investigations of Roberts (2002) and Roberts and Urbatsch (2004) focused on sorting out relationships among several genera of the tribe Astereae. The patterns of relationship unveiled by the sequence-based investigations are in many cases incongruent with those inferred from morphology. Among the taxa included in those investigations were the six species of *Stenotus*

Nutt. and the eight known species of *Tonestus* A. Nelson. Those investigations (Roberts 2002; Roberts & Urbatsch 2004) revealed that *Stenotus* as defined by Morse (1998) and *Tonestus* as defined by Nesom and Morgan (1990) are not monophyletic. A single species, *S. armerioides*, clustered with *S. acaulis*, the type of the genus (Fig. 1), while the other species of *Stenotus* either were more closely aligned with other genera rather than with their congeners or their relationships were not fully resolved. Species of *Tonestus* included in the sequence-based investigations were also not closely aligned with each other. Three species including the type, *T. lyallii* (A. Gray) A. Nelson, were part of a grade under the *Chrysothamnus/Acamptopappus* lineage, whereas the other five species were associated with other lineages (Fig. 1). Here we address the cladistic relationship of three taxa: *Stenotus macleanii* (Brandegee) A. Heller, *S. stenophyllus* (A. Gray) Greene, and *Tonestus alpinus* (L.C. Anderson & S. Goodrich) G.L. Nesom & D.R. Morgan. The specifics of other species previously treated in *Stenotus* and *Tonestus* are addressed elsewhere (Brouilet et al. 2004; Urbatsch et al. 2005) or will be the subject of further investigation. In the sequence-based investigation summarized in Figure 1, *S. macleanii* and *S. stenophyllus* were consistently resolved with robust bootstrap and Bayesian support as sister taxa in all trees, though their relationship to other taxa included in the study was not fully resolved (Roberts 2002; Roberts & Urbatsch 2004). These taxa were also sister in the morphological study of the genus *Stenotus* by Morse (1998). Morse (1998) proposed that these taxa were closely related to *S. lanuginosus* (A. Gray) Greene and indicated that they are united by characteristics that include thin, stipitate-glandular leaves and herbaceous, stipitate-glandular phyllaries of equal lengths in two series. The sequence-based investigations of Roberts (2002) and Roberts and Urbatsch (2004) were inconclusive in reference to this proposition because the relationship of the *S. macleanii* /*S. stenophyllus* clade to *S. lanuginosus* was not fully resolved on all phylograms. Both clades typically were part of a large polytomy (Fig. 1). As a result of the consistent, strong, sequence-based support of *S. macleanii* and *S. stenophyllus* and their morphological distinctness from other *Stenotus* (sensu Morse 1998) and all other taxa included in the molecular investigation, we describe the genus ***Nestotus*** to accommodate these two species.

Toiyabea is proposed to accommodate one species, *Tonestus alpinus*, which was previously placed in *Haplopappus* by Anderson (1980) and subsequently transferred to *Tonestus* by Nesom and Morgan (1990) in their reinstatement of that genus. The proposition of this new genus necessitates the combination *Toiyabea alpina*. In the sequence-based investigations (Roberts 2002; Roberts & Urbatsch 2004), *Tonestus alpinus* was most often placed in a lineage with *Petradoria pumila* (Nutt.) Greene, *Stenotus acaulis*, and *S. armerioides*. The position and relationships among the four taxa in that lineage were not congruent across analytical methods or data sets. Bayesian analysis of the ITS and combined

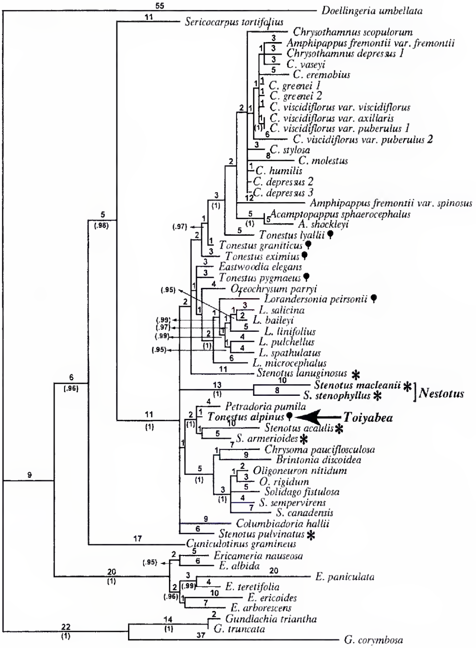


Fig. 1. Fifty percent majority rule consensus tree resulting from Bayesian analysis of combined ETS and ITS data sets is shown. Taxa regarded as *Stenotus* (sensu Morse 1998) are marked with the asterisk "*" symbol. The ⚲ symbol indicates species of *Tonestus* (sensu Nesom & Morgan 1990). Not included in the figure but part of our investigations were *T. aberrans* and *T. kingii* which proved to be aligned with subtribe Machaerantherinae (Brouillet et al. 2004). The large arrow indicates taxa treated herein as *Toiyabea;* the bracket marks those considered *Nestotus*. This figure is modified from one published in Roberts and Urbatsch (2004). More details and a discussion of results from this and other analyses based on these sequence data are also given in that publication.

data sets supported a trichotomy composed of *Petradoria*, *Tonestus alpinus*, plus a weakly supported clade consisting of *Stenotus acaulis* and *S. armerioides* as shown in Fig. 1 (Roberts & Urbatsch 2004). In both analyses this lineage was sister to a clade containing *Solidago* and taxa representing three other genera. In the Bayesian analysis of the ETS data, *Petradoria* was sister to the *Solidago* lineage whereas *Tonestus alpinus*, *Stenotus acaulis* and *S. armerioides* were part of a polytomy basal to *Petradoria*. Unlike the previous two situations, analyses employing parsimony and maximum likelihood of the combined ETS/ITS data matrices resulted in phylograms in which the four taxa under consideration formed an unresolved lineage with weak to moderate bootstrap support (Roberts & Urbatsch 2004). This clade was a weakly supported sister to the *Solidago* lineage in the maximum likelihood analysis, but part of a large polytomy above *Sericocarpus* in the parsimony analysis.

The proposed close relationship of *Tonestus alpinus* to *T. eximius* (Anderson 1980) is not supported by the nrDNA data. Instead, this taxon is apparently closely aligned to *Petradoria* and the two species of *Stenotus*. The two species of *Stenotus* are morphologically distinctive from *Petradoria* and merit continued recognition at generic rank. We propose *Toiyabea* to accommodate *Tonestus alpinus* because of its distinctiveness from *Petradoria* and *Stenotus* and its failure to aggregate with any specific taxon in the sequence-based analyses.

NOMENCLATURAL TREATMENT

Nestotus R.P. Roberts, Urbatsch & Neubig, gen. nov. TYPE: *Haplopappus stenophyllus* A. Gray in Torrey, Wilkes, U.S. Expl. Exped. 17:347. 1874 = *Nestotus stenophyllus* (A. Gray in Torrey) R.P. Roberts, Urbatsch & Neubig, combination made herein. *Stenotus* Nutt., in part, Trans. Amer. Philos. Soc. ser. 2. 7:334. 1840. *Stenotus stenophyllus* (A. Gray in Torrey) Greene, Erythea 2:72. 1894.

Plantae suffrutices tegetes formantes; caules ad 12 cm plures e caudice lignoso ramoso; folia caulina ut videtur fasciculata marcescentia; pedunculi 1–5 cm; involucri 2-seriati vel raro 3-seriati; flosculi disci 9–27, rami stylorum lanceolati; pappi setae albidae 30–50.

Mat-forming subshrubs. Stems to 12 cm, several arising from a branching, woody caudex, prostrate to upright, bark becoming dark brown to gray, flaky to fibrous when older; twigs, mostly ascending, whitish tan to purplish, mostly 1–4 cm, generally pubescent and often stipitate glandular. Leaves cauline, crowded, appearing fascicular, ascending to spreading, often marcescent, linear to narrowly spatulate, 3–21 × 0.3–2.0 mm, ± clasping, often whitish basally, glabrous to scabrous or villous, often stipitate-glandular, margins scabrous with short, spreading-ascendant cilia, apices, acute to obtuse, often minutely mucronate, generally 1-nerved. Capitulescences solitary, peduncles 1–5 cm, usually pubescent, often stipitate glandular. Involucres campanulate to hemispherical 5–10. Phyllaries ±imbricate, 2 or rarely 3 seriate, outer linear or narrowly oblong to oblanceolate, inner narrowly oblanceolate, stipitate-glandular abaxially, chartaceous proximally, herbaceous and pliable distally, sometimes weakly keeled, margins scarious, 1-nerved (rarely weakly 3-nerved). Capitula radiate, florets 20–30. Ray florets 5–11, pistillate, fertile, corollas yellow, laminae elliptical to oblong, 4.5–12 × 1.3–5.5 mm. Disk florets 9–27, bisexual, fertile, corollas narrowly or broadly vase-shaped, 4.5–7.3 mm, lobes 0.8–2 mm, tubes glabrous to pubescent. Style-branches lanceolcate, 1.2–2.5 mm, appendages 0.6–1.3 mm. Cypselae, 3.7–5 mm, pubescent. Pappi whitish, ±30–50, setose bristles, to 6.0 mm, same on ray and disk florets. $x = 9$.

Etymology.—*Nestotus* is an anagram derived from the generic name *Stenotus*, in which the two species in this genus have previously resided.

Prominent features, distribution, and relationships.—Phylogenetic studies (Roberts 2002; Roberts & Urbatsch 2003, 2004; Urbatsch et al. 2004) indicate that the two species placed together in this genus deserve taxonomic distinction. They are both mat-forming subshrubs from the northwestern United States and Yukon Territory, Canada, characterized by crowded, linear, prominently uninervate leaves. The two can be distinguished from each other by leaf pubescence features and geographic distribution (Morse 1998). Morse (1998) also indicated a close relationship with *S. lanuginosus*, which is not supported by the nuclear ribosomal data of Roberts and Urbatsch (2004). The relationship of this genus to others investigated is not fully resolved and is in need of further study.

Morse (1998) observed that *Stenotus acaulis* and *S. armerioides* intergrade in regions of sympatry and he suggested this might be due to interspecific hybridization. On the other hand, *S. stenophyllus* (*Nestotus stenophyllus*) and *S. acaulis* do not appear to intergrade or hybridize where they are sympatric. These observations are consistent with the relationships shown by sequence data that support a close relationship between *S. acaulis* and *S. armerioides* and a more distant affinity of these species with *Nestotus* (Fig. 1).

Nestotus macleanii (Brandegee) R.P. Roberts, Urbatsch & Neubig, comb. nov. BASIONYM: *Haplopappus macleanii* Brandegee, Bot. Gaz. 27:448. 1899. *Stenotus macleanii* (Brandegee) A. Heller, Muhlenbergia 1:7. 1900. *Stenotopsis macleanii* (Brandegee) A. Nelson, Bot. Gaz. 37:261. 1904. TYPE: CANADA. YUKON TERRITORY: near Dawson, 1848, *J. MacLean s.n.* (HOLOTYPE: US, fragment UC).

Stenotus borealis Rydb., Bull. N.Y. Bot. Gard. 2:184. 1901. TYPE: CANADA. YUKON TERRITORY: foot of Lake Lebarge, 23 Jun 1899, *J.B. Tarleton 51* (HOLOTYPE: US, fragment UC).

Distribution, ecology, and relationships.—This taxon has been reported only from the Yukon River drainage in southwestern Yukon Territory, Canada (Morse 1998). It inhabits rocky slopes, grasslands, and river bluffs. *Nestotus macleanii* is the more northern of the two species in the genus. It is found at elevations ranging from 450–850 meters and flowers in late spring. The close relationship of *N. macleanii* to *N. stenophyllus* was highlighted by Hall (1928) and Morse (1998) and is confirmed by the sequence-based investigations. The two taxa are very similar morphologically but can be distinguished by differences in pubescence and geographic distribution, as highlighted in the key to species at the end of this treatment.

Nestotus stenophyllus (A. Gray in Torrey) R.P. Roberts, Urbatsch & Neubig, comb. nov. BASIONYM: *Haplopappus stenophyllus* A. Gray in Torrey, Wilkes, U.S. Expl. Exped. 17:347. 1874. *Aster stenophyllus* (A. Gray in Torrey) Kuntze, Revis. Gen. Pl. 1:318. 1891. *Stenotus stenophyllus* (A. Gray in Torrey) Greene, Erythea 2:72. 1894. *Hoorebekia stenophylla* (A. Gray in Torrey) Piper, Contr. U.S. Natl. Herb. 11:561. 1906. TYPE: UNITED STATES. [Washington] "WASHINGTON TERRITORY." [Yakima or Kittitas Co.]. Spipen (Naches) River to the north fork of the Columbia River, 1838–1842, *Pickering & Brackenridge s.n.* (HOLOTYPE: GH).

Distribution, ecology, and relationships.—*Nestotus stenophyllus* is found in California, Idaho, Nevada, Oregon, and Washington. It inhabits sagebrush steppe on basaltic, rhyolitic, or granitic soils at elevations of 900–2300 meters. Flowering occurs mid to late spring. Its close relationship to *N. macleanii* has been previously discussed and affinities to other taxa are uncertain at this time.

Toiyabea R.P. Roberts, Urbatsch & Neubig, gen. nov. TYPE: *Haplopappus alpinus* L.C. Anderson & S. Goodrich, Great Basin Naturalist 40:73. 1980 = *Toiyabea alpina* (L.C. Anderson & S. Goodrich) R.P. Roberts, Urbatsch & Neubig, combination made herein. *Tonestus alpinus* (L.C. Anderson & S. Goodrich) G.L. Nesom & D.R. Morgan, Phytologia 68:177. 1990.

Herbae perennes et lignosae 0.5–2.0 dm altae; caules valde glandulosi; folia in basi obovata vel oblanceolata serrata vel dentata 3–7 cm longa 10–36 mm lata, folia caulina angustiora et serrata 3–5.5 cm longa 8–18 mm lata; capitula discoidea solitaria vel in cymis; involucra 10–12 mm longa circa 7 mm lata; phyllaria 21–28, exterioribus ovatis et folio similibus et glandulosis, interioribus angustis; flosculi 29–55 flavi, corollis 5.8–7.1 mm longis, lobis circa 1.3 mm longis; cypselae 4–5 mm longae et pubescentiae.

Perennial herbs, short rhizomatous, woody only at base, to 1.0(–2.0) dm tall. Stems several arising from caudex, typically unbranched, green, densely pubescent, hairs stipitate glandular. Leaves basal and cauline; ascending to spreading, both types similar, the latter somewhat reduced distally and sessile, spatulate to obovate or oblanceolate, 30–70 × 8–36 mm, herbaceous; bases attenuate to cuneate, clasping, more so distally; margins of distal half of blades coarsely dentate to serrate, apices acute to attenuate; midvein prominent, 1–2 pairs of smaller, ± parallel collateral veins often evident, both surfaces densely stipitate glandular, also often bearing resinous globules. Capitulescences usually monocephalous or with up to 5 capitula in an elongate or flat-topped cyme. Capitula discoid. Involucres campanulate to hemispheric, 10–12 × 7–10 mm. Phyllaries 2–3 seriate, 21–28, subequal, imbricate, outermost leaflike, broadly ovate, 3-nerved, stipitate glandular, slightly spreading, apices obtuse with small mucro, inner bracts narrower, lanceolate-spatulate, margins finely ciliate, apices acuminate-cuspidate. Receptacles convex, alveolate. Ray florets 0. Disk florets (29–)35–50(55), bisexual, corollas golden-yellow, (5.8–)6.4–7.1(–7.6) mm, lobes (1–)1.3(–1.6) mm, lanceolate, slightly spreading to recurved. Anthers yellow, about 2.6 mm. Style branches 1.8–2.5 mm, appendages narrowly lanceolate, 1.2–1.7 mm.

Cypselae cylindric to fusiform, 4–5 mm, pubescent. Pappi tannish, ca. 25 setose bristles, 6–7 mm. $x = 9$.

Etymology.—Named for the Toiyabe Mountain Range, Nevada. Toiyabe is said to be a Shoshone Indian word meaning "Black Mountains."

Prominent features, distribution, and relationships.—*Toiyabea* is monotypic and is known from the Toiyabe and Toquima mountains of southern Nevada. This species was originally described as *Haplopappus* (Anderson 1980) and later transferred to *Tonestus* (Nesom & Morgan 1990). Analyses based on DNA sequence data fail to support the monophyly of *Tonestus* sensu Nesom & Morgan (Roberts 2002; Roberts & Urbatsch 2004; Brouillet et al. 2004). Close affinity of *Toiyabea alpina* to *Tonestus eximius* (H.M. Hall) A. Nelson & Macbride and to *Tonestus peirsonii* (Keck) Nesom & Morgan suggested by morphological similarity is likewise not supported by sequence data (Roberts & Urbatsch 2004). Evolutionary affinities of *Toiyabea* appear to be with *Petradoria* and the clade composed of *Stenotus acaulis* and *S. armerioides* (Fig. 1).

Toiyabea alpina (L.C. Anderson & S. Goodrich) R.P. Roberts, Urbatsch & Neubig, comb. nov. BASIONYM: *Haplopappus alpinus* L.C. Anderson & S. Goodrich, Great Basin Naturalist 40:73. 1980. *Tonestus alpinus* (L.C. Anderson & S. Goodrich) G.L. Nesom & D.R. Morgan, Phytologia 68:177. 1990. TYPE: UNITED STATES. NEVADA. [Nye Co.]: granitic rocks at 10,600 ft on 11,077 ft peak on Toiyabe Crest between Washington Creek and Aiken Creek, 24 air mi SSW of Austin, 1979, *L.C. Anderson 4885* (HOLOTYPE: BRY).

Distribution, ecology, and relationships.—*Toiyabea alpina* inhabits rocky terrain near and above the tree line on the Toiyabe and Toquima mountains of southern Lander and Nye counties, Nevada (Anderson 1980). This taxon occurs infrequently on various substrates and might be of conservation concern. It is found in association with several other species of Asteraceae and other alpine endemics of Nevada, including *Draba arida* C.L. Hitchc. and *Geranium toquimense* N.H. Holmgren & A.H. Holmgren (Anderson 1980). Plants of this species flower from mid-summer into the fall. In his description of the species, Anderson (1980) highlighted vegetative and reproductive features that suggested a close relationship with *Tonestus* (*Haplopappus*) *aberrans* (A. Nelson) G.L. Nesom & D.R. Morgan and *T.* (*Haplopappus*) *eximius* A. Nelson & J.F. Macbr. The sequence-based investigations did not confirm these relationships. Instead, *Tonestus aberrans* was assessed to be more closely aligned with the *Machaerantherinae*, resulting in the description of the genus *Triniteurybia* to accommodate that taxon (Brouillet et al. 2004). In addition, the position of *Tonestus eximius* was either not fully resolved or else weakly aligned in a grade below *Chrysothamnus* sensu Urbatsch et al. (2005). *Toiyabea alpina*, for the most part, received moderate to strong support in a clade in which it was unresolved with *Petradoria pumila* and *Stenotus acaulis*/*S. armerioides* (Roberts 2002; Roberts & Urbatsch 2004). *Toiyabea alpina* can be distinguished from the two species of *Stenotus* by its similar basal and cauline leaves, leaf-like outer phyllaries, and discoid capitula. Its closest evolutionary affinities appear to be with *Petradoria*, from which it is distinguished by its densely stipitate-glandular pubescent, spatulate, ovate or oblanceolate leaves with coarsely toothed margins, foliaceous phyllaries, and eradiate capitula producing 35 or more bisexual disc florets.

KEY TO *NESTOTUS*, *PETRADORIA*, *STENOTUS*, *TOIYABEA*, AND RELATED TAXA

1. Capitula in a densely corymbiform capitulescence, 5 or more per cluster; involucres cylindric to turbinate, up to 3 mm broad, phyllaries strongly graduated; disk flowers 2–4 per capitulum, functionally staminate, ray flowers 1–3 ____ **Petradoria**
1. Capitula solitary or capitulescence at most with 4 per cluster, scapose; involucres campanulate to hemispheric, more than 3 mm broad, phyllaries subequal to graduated; disk flowers 12+ per capitulum, bisexual, ray flowers 0 or 5–17.
    2. Leaf margins coarsely toothed, cauline (peduncular) leaves well-developed and similar to basal leaves; phyllaries wholly foliaceous; Lander and Nye counties, Nevada ____ **Toiyabea**
    2. Leaf margins entire, cauline (peduncular) leaves much reduced or absent; phyllaries chartaceous at least proximally; not known from Lander and Nye counties (except for *S. acaulis*).
        3. Capitula discoid; Sierra de San Pedro Mártir, Baja California ____ **Stenotus pulvinatus**
        3. Capitula radiate; western U.S.A. and Canada.
            4. Shoots villous to lanate with long, crinkly hairs and stipitate, glandular trichomes; taproots poorly developed ____ **Stenotus lanuginosus**
            4. Shoots with short, straight or arching conic hairs, glandular hairs sometimes also present; taproots usually well-developed,
                5. Phyllaries weakly imbricate, phyllary apices acute, green portion much longer than broad often extending full length of phyllaries; leaves generally bearing short, gland-tipped hairs; intergrades with *S. armerioides* occur in Colorado and eastern Wyoming ____ **Stenotus acaulis**
                5. Phyllaries regularly imbricate, phyllary apices obtuse to rounded, green portion about as long as broad and generally restricted to the distal one-third; leaves viscid or viscid dotted, stalked hairs not evident ____ **Stenotus armerioides**

KEY TO SPECIES OF *NESTOTUS*

1. Leaf surfaces glabrous, margins often ciliate; Yukon River drainage, Yukon Territory, Canada ____ **N. macleanii**
1. Leaf surfaces and margins abundantly pubescent with gland-tipped trichomes; northwestern U.S.A. ____ **N. stenophyllus**

ACKNOWLEDGMENTS

The authors thank the curators and staff personnel of ASC, ASU, BRY, CAS, DH, RM, UNLV, US, UT, and WTU for specimen loans on which this and related research is based. We thank Mario Blanco and Lorena Endara for preparing the Spanish abstract and Guy Nesom and others for their helpful comments.

REFERENCES

Anderson, L.C. 1980. *Haplopappus alpinus* (Asteraceae): a new species from Nevada. Great Basin Naturalist 40:73–77.

Brouillet, L., L.E. Urbatsch, and R.P. Roberts. 2004. *Tonestus kingii* and *T. abberrans* are related to *Eurybia* and the Machaerantherinae (Asteraceae: Astereae) based on nrDNA (ITS and ETS) data: reinstatement of *Herrickia* and a new genus, *Triniteurybia*. Sida 21:889–900.

Greene, E.L. 1895. Observations on the Compositae. VIII. Erythea 3:6–15.

Hall, H.M. 1928. The genus *Haplopappus* – a phylogenetic study in the Compositae. Carnegie Inst. Washington Publ. No. 389.

Morse, C.A. 1998. Systematics and taxonomy of *Stenotus* Nutt. (Asteraceae: Astereae). M.A. thesis. Univ. Kansas, Lawrence.

Nesom, G.L. and D.R. Morgan. 1990. Reinstatement of *Tonestus* (Asteraceae: Astereae). Phytologia 71:122–127.

Roberts, R.P. 2002. Phylogeny of *Ericameria*, *Chrysothamnus* and related genera (Asteraceae: Astereae) based on nuclear ribosomal DNA sequence data. Ph.D. diss., Louisiana State Univ., Baton Rouge.

Roberts, R.P. and L.E. Urbatsch. 2003. Molecular phylogeny of *Ericameria* (Asteraceae, Astereae) based on nuclear ribosomal 3' ETS and ITS sequence data. Taxon 52:209–228.

Roberts, R.P. and L.E. Urbatsch. 2004. Molecular phylogeny of *Chrysothamnus* (Asteraceae, Astereae) based on nuclear ribosomal 3' ETS and ITS sequence data. Syst. Bot. 29: 199–215.

Urbatsch, L.E., R.P. Roberts, and K.M. Neubig. 2005. *Cuniculotinus* and *Lorandersonia*, two new genera of Asteraceae: Astereae and new combinations in *Chrysothamnus*. Sida 21: 1615–1632.

BOOK NOTICES

Timber Press

ROBBIN C. MORAN. 2004. **A Natural History of Ferns.** (ISBN 0-88192-667-1, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 301 pp., 26 color plates, 145 b/w line drawings, 6 1/4" × 9 1/4".

Robbin Moran's new book, *A Natural History of Ferns*, is a delight. This book is not a field guide to the identification of ferns. The author is quick to point out, "...—there are plenty of those [field guides] available. Instead, it picks up where field guides leave off, examining the biology of these plants—how they grow and develop, reproduce and disperse, adapt and evolve." If you are into ferns then you will delight in this book.

BILL MCCLAREN. 2004. **Encyclopedia of Dahlias.** (ISBN 0-88192-658-2, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 211 pp., 800+ color photos, 8 1/2" × 11".

Dahlias are beautiful and if nothing else you would enjoy this as a 'coffee table' book. About 700 selections are included with notes on their history, awards and cultural peculiarities. Thirteen chapters cover about every aspect of *Dahlia* including dahlia care and propagation, wild species of dahlia, hybridizing, and classification

TONI LAWSON-HALL and BRIAN ROTHERA. 2004. **Hydrangeas: A Gardener's Guide. Revised Edition.** (ISBN 0-88192-669-8, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 176 pp., color photos, b/w drawings, 7 1/2" × 10 3/4".

From the Dustjacket.—This book is in two sections. In the first chapter, The Genus *Hydrangea*, the history and natural distribution of hydrangeas are outlined, and the general characteristics explained. The 14 speices mostly commonly grown in cultivation are described in detail, with special reference to the naming problems of *H. macrophylla*. The second section describes 100 cultivars in detail.

CHROMOSOME NUMBERS OF *GLANDULARIA* (VERBENACEAE) FROM CENTRAL AND TRANS-PECOS, TEXAS

B.L. Turner

Plant Resources Center
The University of Texas
Austin, Texas 78712-0471, U.S.A.

A. Michael Powell

Herbarium (SRSC)
Sul Ross State University
Alpine, Texas 79831, U.S.A.

ABSTRACT

Meiotic chromosome counts for 66 populations of the genus *Glandularia* (sensu Umber 1979) are reported, all from the state of Texas. These include counts for the following taxa: *G. bipinnatifida* var. *bipinnatifida* ($n = 15$ pairs); *G. bipinnatifida* var. *brevispicata* ($n = 15$ pairs); *G. pumila* ($n = 10$ pairs); *G. quadrangulata* ($n = 10$ pairs); *G. racemosa* ($n = 10$ pairs); *G verecunda* ($n = 10$ pairs); and *G. wrightii* ($n = 10$ pairs). The taxonomic import of these data is discussed.

RESUMEN

Se publican los recuentos cromosomáticos en meiosis de 66 poblaciones del género *Glandularia* (sensu Umber 1979), todos del estado de Texas. Se incluyen recuentos de los siguientes taxa: *G. bipinnatifida* var. *bipinnatifida* ($n = 15$); *G. bipinnatifida* var. *brevispicata* ($n = 15$); *G. pumila* ($n = 10$); *G. quadrangulata* ($n = 10$); *G. racemosa* ($n = 10$); *G verecunda* ($n = 10$); y *G. wrightii* ($n = 10$). Se discute la importancia taxonómica de estos datos.

Glandularia is a difficult genus, as well noted by Umber (1979) in his systematic treatment of the group, and by both Henrickson (2003) and Turner (2003) in their running accounts of several taxa. In his efforts to utilize cytological data in evaluating taxonomic groupings, Umber summarized previous counts for the genus, this amounting to 47 reports for 20 species, including 10 of his own. Subsequently, few additionally counts have been forthcoming, although Poggio et al. (1993), without reference to Umber's work, noted that the genus is amphitropical in distribution, those of South America possessing mostly diploid taxa ($2n = 10$ or $2x = 5$), those of North America mostly hexaploid ($2n = 30$ or $6x = 30$). Actually, of the North American taxa of *Glandularia* counted to date (ca. 20 species), half are tetraploids ($4x = 20$), and half are hexaploids ($6x = 30$); no diploids have been reported, suggesting a South American origin for the group, as first noted by Schnack (1964).

In the present account we provide chromosome counts for an additional 66 populations from six species, all of these from Texas, as summarized in Table 1. We subsequently discuss the import of these data according to the treatment of Umber.

TABLE 1. Chromosome counts of *Glandularia* (sensu Umber 1979).

Glandularia bipinnatifida (Nutt.) Nutt. var. **bipinnatifida**: all counts $n = 15$ pairs.
Brewster Co.: 0.5 mi S of Alpine, *Powell 6415* (SRSC).
Brewster Co.: 1 mi S of Alpine, *Powell 6416* (SRSC).
Brewster Co.: 1.4 mi S of Alpine, *Powell 6417* (SRSC).
Brewster Co.: 9 mi SE of Alpine, *Powell & Powell 6429* (SRSC).
Brewster Co.: 6 mi N of Alpine, *Powell & Powell 6431* (SRSC).
Brewster Co.: 3 mi W of Alpine, *Turner 24-157* (SRSC, TEX).
Brewster Co.: 14 mi NE of Marathon, *Turner 24-168* (SRSC, TEX).
Crockett Co.: ca. 15 mi W of Ozona, *Turner 24-532* (SRSC, TEX).
Culberson Co.: ca. 18 mi W of Orla, *Turner 24-370* (SRSC, TEX).
Hudspeth Co.: 6.1 mi W of Sierra Blanca, *Turner 24-184* (SRSC, TEX).
Hudspeth Co.: Allamoore exit, IH 10, ca. 20 mi E of Sierra Blanca, *Turner 24-318* (SRSC).
Jeff Davis Co.: 0.1 mi along Farm Rd 2017 from Hwy. 90, *Turner 24-554* (SRSC, TEX).
Kimble Co.: ca. 3.6 mi along old Segovia Road from IH-10, *Turner 24-221* (SRSC, TEX).
Pecos Co.: ca. 3 mi W of Longfellow, *Rodriguez & Turner 24-201* (SRSC, TEX).
Pecos Co.: ca. 4 mi NW of Longfellow, *Rodriguez & Turner 24-202B* (SRSC, TEX).
Pecos Co.: ca. 27 mi S of Fort Stockton, *Turner 24-169* (SRSC, TEX).
Pecos Co.: 23 mi S of Fort Stockton, *Turner 24-179* (SRSC, TEX).
Pecos Co.: 2.1 mi N of Fort Stockton, *Powell & Powell 6436* (SRSC).
Pecos Co.: 2 mi SE of Fort Stockton, *Powell & Powell 6438* (SRSC).
Pecos Co.: 1.5 mi S of Fort Stockton, *Powell & Powell 6440* (SRSC).
Pecos Co.: N part of Fort Stockton, *Powell & Powell 6443* (SRSC).
Pecos Co.: ca. 15 mi E of Bakersfield, *Turner 24-444* (SRSC, TEX).
Presidio Co.: ca. 22 mi W of Marfa, *Turner 24-183* (SRSC, TEX).
Presidio Co.: ca. 20 mi S of Marfa, *Turner 24-277* (SRSC, TEX).
Reeves Co.: 2 mi E of Balmorhea, *Turner 24-226* (SRSC, TEX).
Sutton Co.: 6 mi W of Sonora, *Turner 24-223* (SRSC, TEX).

Glandularia bipinnatifida var. **brevispicata** Umber: all counts $n = 15$ pairs.
Culberson Co.: ca. 2 mi W of Guadalupe Mts. Natl. Park, *Turner 24-228* (SRSC, TEX).
Culberson Co.: 3 mi along Hwy. 652 from its juncture with US 180, *Turner 24-242* (SRSC, TEX).
Culberson Co.: roadside park just W of Guadalupe Mts. Natl. Park, *Turner 24-254* (SRSC, TEX).

Glandularia pumila (Rydb.) Umber: all counts $n = 10$ pairs.
Brewster Co.: ca. 5 mi W of Alpine, *Turner 24-141* (SRSC).
Crockett Co.: above Fort Lancaster, *Turner 24-32* (TEX).

Glandularia quadrangulata (Heller) Umber: all counts $n = 10$ pairs.
Crockett Co.: ca. 5 mi due N of Sheffield, *Turner 24-72* (SRSC, TEX).
Crockett Co.: where Hwy. 1973 crosses into Val Verde Co, *Turner 24-145* (SRSC, TEX).

Glandularia racemosa (Eggert) Umber: all counts $n = 10$ pairs.
Brewster Co.: Dog Flats, Big Bend Natl. Park, *Powell et al. 6406* (SRSC).
Brewster Co.: 5.6 mi S along Hwy. 385 from intersection with Hwy. 2627, *Turner 24-51* (SRSC, TEX).
Brewster Co.: 6 mi E of Marathon, *Turner 24-142* (SRSC, TEX).
Pecos Co.: 9 mi W of Fort Stockton, *Turner 24-29* (SRSC, TEX).
Pecos Co.: 3.5 mi E of Fort Stockton, *Turner 24-30* (SRSC, TEX).
Pecos Co.: 2.2 mi along Hwy. 67 from IH-10, *Turner 24-43* (SRSC, TEX).
Pecos Co. 11.5 mi SE of Imperial, *Turner 24-59* (SRSC, TEX).
Pecos Co.: 6 mi S of Fort Stockton, *Turner 24-180* (SRSC, TEX).

Table 1. continued

Glandularia verecunda Umber: all counts $n = 10$ pairs.

- Brewster Co.: Dog Flats, Big Bend Natl. Park, *Powell et al. 6405* (SRSC).
- Brewster Co.: 10 mi N of Panther Junction, Big Bend Natl. Park, *Powell et al. 6412* (SRSC).
- Brewster Co.: 5.6 mi S along Hwy. 385 from intersection with Hwy. 2627, *Turner 24-50* (SRSC, TEX).
- Pecos Co.: 9 mi W of Fort Stockton along IH-10, *Turner 24-28* (SRSC, TEX).
- Pecos Co.: 3.5 mi E of Fort Stockton, *Turner 24-30* (SRSC, TEX).
- Pecos Co.: 2.2 mi along Hwy. 67 from IH-10, *Turner 24-44* (SRSC, TEX).
- Pecos Co.: 0.3 mi from Pecos River along Hwy. 67, *Turner 24-66A* (SRSC, TEX).
- Pecos Co.: 2 mi S along Hovey road from IH-10, *Turner 24-121* (SRSC, TEX).

Glandularia wrightii (A. Gray) Umber: all counts $n = 10$ pairs.

- El Paso Co.: Franklin Mts., ca. 8 mi N of El Paso, Loop Road, Fusselman Mt. Canyon trailhead, *M. Turner 107* (SRSC).
- Brewster Co.: Panther Junction, Big Bend Natl. Park, *Fenstermacher s.n.* (SRSC).
- Brewster Co.: Panther Pass, Big Bend Natl. Park, *Fenstermacher s.n.* (SRSC).
- Brewster Co.: 9 mi SE of Alpine, *Powell 6414* (SRSC).
- Brewster Co.: ca. 5 mi S of Alpine, *Powell 6418* (SRSC, TEX).
- Brewster Co.: 9 mi SE Alpine, *Powell & Powell 6430* (SRSC).
- Brewster Co.: 6 mi N of Alpine, *Powell & Powell 5432* (SRSC).
- Brewster Co.: ca. 5 mi W of Alpine, *Turner 24-156* (SRSC, TEX).
- Brewster Co.: Turner Canyon, 5 mi W Alpine, *Turner 24-429* (SRSC).
- Brewster Co.: 32 mi S of Alpine, *Turner 24-159* (SRSC, TEX).
- Jeff Davis Co.: ca. 8 mi NW of Fort Davis, *Hedges 75* (SRSC).
- Jeff Davis Co: 4 mi S of Fort Davis, *Powell et al. 6433* (SRSC).
- Jeff Davis Co.: Davis Mts. State Park, *Turner 24-200* (SRSC, TEX).
- Jeff Davis Co.: ca. 20 mi E of Fort Davis, *Turner 24-227* (SRSC, TEX).
- Presidio Co.: ca. 20 mi S of Marfa, *S. Powell 22* (SRSC).
- Presidio Co.: ca. 14 mi S of Marfa, *Turner 24-288* (SRSC, TEX).
- Presidio Co.: ca. 23 mi S of Marfa, *Turner 24-289* (SRSC, TEX).

Glandularia bipinnatifida var. bipinnatifida

Umber reported chromosome counts for 18 collections of this taxon from over a broad range. Fifteen of these were listed as $n = 15$ pairs; three with $n = 10$ pairs. The latter counts, as noted below, perhaps relate to *G. wrightii*. We report herein counts for an additional 26 collections of *G. b.* var. *bipinnatifida*, all with $n = 15$ pairs.

Glandularia bipinnatifida var. breviscapa

Umber reported a single collection (the Type) of this taxon as $n = 15$ pairs. We have added three additional counts from the Guadalupe Mts. of Culberson Co., Texas, all with $n = 15$ pairs.

Glandularia pumila

Umber reported only two counts for this taxon, both by Lewis and Oliver (1961) from Central Texas, and both with $n = 10$ pairs. We report here two additional counts from western Texas, both having the same number.

Glandularia quadrangulata

Umber listed a single count of $n = 10$ pairs for this taxon, as first reported by Lewis and Oliver (1961) from a population in southern Texas. We report two additional collections, both with $n = 10$ pairs.

Glandularia racemosa

Umber reported counts of only two collections of this taxon, an unvouchered count of $n = 15$ pairs by Derman (1936), and a count of $n = 15$ pairs by Umber himself, the latter from Pecos Co., Texas. On the basis of these two reports Umber reckoned the taxon to be a hexaploid ($6x = 30$). We present here counts from eight Texas populations, including the populational site from which Umber obtained his count of $n = 15$ pairs. All proved to be tetraploids ($4x = 40$).

It would appear that *G. racemosa* is not a hexaploid as previously reported; both Umber (1979) and Henrickson (2003) used such data to bolster their acceptance of *G. racemosa* as a valid species, as opposed to its submergence under *G. quadrangulata* as originally proposed by Turner (1998). Actually, morphological characters alone will serve to distinguish *G. racemosa* from *G. quadrangulata* (Turner, in prep.).

Glandularia wrightii

Umber reported counts of three collections of this taxon, all with $n = 10$ pairs. He acknowledged its close relationship to *G. bipinnatifida* (so far as known a hexaploid) but noted its consistently tetraploid chromosome number, and seeming restriction to the higher portions of the Chisos, Davis, and Franklin mountains of Trans-Pecos, Texas. The only exceptional counts for *G. bipinnatifida* (i.e., $n = 10$ pairs) reported by Umber are three: two from Texas (El Paso and Pecos counties) and one from Arizona (Apache Co.). Interestingly, two of the latter were identified by their collectors as *G. wrightii*. Regardless, we present here counts for 17 collections of *G. wrightii*, all tetraploid with $n = 10$ pairs. The species often grows in close proximity to *G. bipinnatifida* without showing signs of hybridization, although putative first generation hybrids would be exceedingly difficult to detect without cytological data. Nevertheless, field observations and chromosomal data assembled by the present authors strongly suggest that *G. wrightii* is a good biological species, contrary to the views of Turner (1998) who treated it as synonymous with his concept of *G. bipinnatifida* var. *ciliata* (Benth.) B.L.Turner.

MATERIALS AND METHODS

All counts were obtained from meiotic material collected in the field; preservation and staining procedures follow the methods outlined by Powell and Weedin (2001).

ACKNOWLEDGMENTS

We are grateful to Joselyn Fenstermacher for the collection of buds from Big Bend National Park, and to Matt Turner for buds from El Paso Co. Ray Umber provided helpful review comments.

REFERENCES

DERMAN, H. 1936. Cytological study and hybridization in two sections of *Verbena*. Cytologia 7:160–175.

HENRICKSON, J. 2003. Studies in *Glandularia* (Verbenaceae): the *Glandularia quadrangulata* complex. Sida 20:953–967.

LEWIS, W.H, and R.C. OLIVER, 1961. Cytogeography and phylogeny of the North American species of *Verbena*. Amer. J. Bot. 48:638–643.

POGGIO, L., S.M. Botta, E.J. GREIZERSTEIN, and M.R. FERRARI. 1993. Natural hybridization in *Glandularia* (Verbenaceae) I. Evolutionary implications for chromosome pairing. Darwiniana 32:77--90.

POWELL, A.M. and J.F. WEEDIN. 2001. Chromosome numbers in Chihuanhuan Desert Cactaceae. III. Trans-Pecos Texas. Amer. J. Bot. 88:481–485.

SCHNACK, B. 1964. Bases naturales de la separacion generica de *Verbena* y *Glandularia* (Verbenaceae). Notas Comision Inv. Cient. de la Gobernacion Peia. 2:1–12.

TURNER, B.L. 1998. Texas species of *Glandularia* (Verbenaceae). Lundellia 1:3–16.

TURNER, B.L. 2003. *Glandularia verecunda* (Verbenaceae): species or fruit-form? Sida 20: 1647–1648.

UMBER, R.E. 1979. The genus *Glandularia* (Verbenaceae) in North America. Syst. Bot. 4: 72–102.

BOOK REVIEW

A. Michael Powell and James F. Weedin. 2004. **Cacti of the Trans-Pecos & Adjacent Areas.** (ISBN 0-89672-531-6, hbk). Texas Tech University Press, Box 41037, Lubbock, TX 79409-1037, U.S.A. (**Orders:** www.ttup.ttu.edu, 1-800-832-4042). $60.00, 509 pp, 313 color figs, b/w drawings and maps, 7" × 10".

A book written by two experts on the cacti in the Chihuahuan Desert Region (CDR) of North America. The focus of this book being the Cactaceae in the Trans-Pecos region of west Texas and the reconciliation of the nomenclatural/taxonomic confusion that has evolved in the literature over the years. The authors have meticulously put together a complete synopsis of the taxonomy, biology, ecology, evolution, and ethnobotanical history of this very complex and controversial family of plants.

Western Texas does have the unique claim of being the host to more species of cacti than any other state in the US. This fact has given the authors, Dr. A.M. Powell, professor emeritus at Sul Ross State University, and Dr. J.F. Weedin professor of biology at the Community College of Aurora, Colorado, the opportunity to spend a career studying these plants out in the field, and in the labs, test gardens and greenhouses at Sul Ross and the Chihuahuan Desert Research Institute. The authors have given the readers numerous paths to follow when it comes to identifying taxa.

The book includes very detailed Trans-Pecos distribution maps, as well as a continental distribution map for each taxon. The color photography that the authors have included shows the wide variety of habitat in the region. The readers are also given very detailed photographs of mature plants at anthesis as well as plants with mature fruits. Photographs combined with the several levels of keys given in the work, have made the daunting task of correctly identifying cacti much less of a challenge.

The detailed information that is given in the description and discussion of each taxon provides the readers, whether scientist or layperson, with information, and resources that leave no questions unanswered or unaddressed. This book covers the entire history of the study of CDR cacti and mentions numerous opportunities for future study. Apparently there are many taxa that need further study and this book will function as a solid foundation for that work, for many years to come. The authors also mention, to some degree, numerous other taxa that occur outside the Trans-Pecos region, giving the readers a well rounded piece of botanical literature for the Cactaceae in the southwestern US. With the selected glossary and extensive bibliography (literature cited) included, it is obvious this very fine book has been a long time in the making.

These authors have now provided the world with the much needed scientific clarification on this family of succulent plants that humans have loved and hated for thousands of years.—*Justin W. Allison, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

DOCUMENTED CHROMOSOME NUMBERS 2005: 1. MISCELLANEOUS COUNTS FROM WESTERN TEXAS, MOSTLY TRANS-PECOS

A. Michael Powell
Herbarium
Sul Ross State University
Alpine, Texas 79832, U.S.A.

B.L. Turner
Plant Resources Center
University of Texas
Austin, Texas 78712-0471, U.S.A.

ABSTRACT

Twenty-seven meiotic chromosome counts are reported for 20 species in nine families of plants from western Texas, mostly the Trans-Pecos region. The counts for *Packera texensis*, *Chamaesyce stictospora*, *Astragalus argillophilus*, *A. bigelovii*, and *A. marcidus* are first reports.

RESUMEN

Se publican veintisiete recuentos cromosomáticos en meiosis de 20 especies de nueve familias de plantas del Oeste de Texas, la mayoría de la región de Trans-Pecos. Los recuentos de *Packera texensis*, *Chamaesyce strictospora*, *Astragalus argillophilus*, *A. bigelovii*, y *A. marcidus* son los primeros realizados.

Bud collections were obtained and the following chromosome number determinations were made during the course of floristic fieldwork in Trans-Pecos, Texas, and nearby areas of the state. Meiotic chromosome counts were produced by the first author, or in some cases initiated by the collector cited and verified by AMP, using techniques described in Turner and Johnston (1961); the second author also verified many of the counts. We acknowledge the collections and chromosomal observations of E.F. McRae, W. Jacobs, D. Foster, and S.A. Powell. Vouchers are in SRSC and/or TEX.

Asteraceae

Bahia absinthifolia Benth. $2n = 24$ II. Brewster Co.: 11.2 km ENE of Lajitas along Hwy 170, *B.L. Turner 24-45.*

Packera texensis O'Kennon & Trock. $2n = 23$ II. Gillespie Co.: 2.4 km N of Keese-Sagebeil Road, ca. 1.3 km N of type locality, *B.L. Turner 24-75.*

Psathyrotopsis scaposa (A. Gray) H. Rob. $2n = 19$ II. Hudspeth Co.: ca. 5.1 km SE of intersect. of Hwy 192 (to Indian Hot Springs) with Quitman Pass road, *B.L. Turner 24-358.*

Solidago gigantea Aiton. $2n = 9$ II. Presidio Co.: ca. 3.5 km NNE of Ruidosa, *B.L. Turner 23-181.*

Brassicaceae

Streptanthus playtcarpus A. Gray. $2n = 14$ II. Crockett Co.: ca. 12.9 km E of Sheffield, roadside park along U.S. 90, where it drops off into Pecos River Valley, *B.L. Turner 21-202.*

Cactaceae

Opuntia macrocentra Engelm. $2n = 11$ II. Culberson Co.: 3.2 km N of Kent, *B.L. Turner s.n.*

SIDA 21(3): 1663–1664. 2005

Euphorbiaceae

Chamaesyce stictospora (Engelm.) Small. $2n = 6$ II. Pecos Co.: 40 km N of U.S. 67 and U.S. 90 junct., along U.S. 90, *E.F. McRae 14*.

Chamaesyce theriaca (L.C. Wheeler) Shinners. $2n = 14$ II. Presidio Co.: 1.9 km W of Redford, *E.F. McRae 37*.

Fabaceae

Astragalus argillophilus Cory. $2n = 11$ II. Reagan Co.: ca. 1.9 km S of Big Lake, *B.L. Turner 24-41*.

Astragalus bigelovii A. Gray. $2n = 11$ II. Hudspeth Co.: ca. 12.9 km W of Sierra Blanca, *B.L. Turner 24-12*.

Astragalus marcidus Greene ex Rydb. $2n = 11$ II. Presidio Co.: N of Marfa, 5.9 km S of Jeff Davis Co. line, *B.L. Turner 24-134*; near head of Pinto Canyon, 48 km SW of Marfa, *B.L. Turner 24-104*.

Astragalus mollissimus Torr. var. *earlei* (Greene ex Rydb.) Tidestr. $2n = 11$ II. Hudspeth Co.: ca. 3.2 km E of Sierra Blanca, *B.L. Turner 24-26*.

Hydrophyllaceae

Phacelia coerula Greene. $2n = 11$ II. Hudspeth Co.: ca. 12.9 km W of Sierra Blanca, *B.L. Turner 24-13*.

Phacelia integrifolia Torr. $2n = 11$ II. Crane Co.: 16.4 km W of Crane, *B.L. Turner 24-61*.

Phacelia popei Torr. & A. Gray. $2n = 11$ II. Brewster Co.: ca. 8 km along Agua Fria road from Hwy 118, *B.L. Turner 21-34*.

Phacelia robusta (J.F. Macbr.) I.M. Johnst. $2n = 11$ II. Brewster Co.: ca. 12 km along Agua Fria road from Hwy 118, *B.L. Turner 21-36*.

Liliaceae

Schoenocaulon texanum Scheele. $2n = 8$ II. Pecos Co.: Glass Mts., R. Warnock Park, ca. 43 km S of Fort Stockton, *B.L. Turner 24-170*.

Ranunculaceae

Delphinium wootonii Rydb. $2n = 8$ II. Brewster Co.: 4.2 km S of Alpine, *A.M. Powell 6427*.

Solanaceae

Chamaesaracha coniodes Britton. $2n = 24$ II. Brewster Co.: Alpine, above Kokernot Lodge, *A.M. Powell* and *S.A. Powell 6281, 6282, 6283* (counts from three individual plants).

Chamaesaracha sordida (Dunal) A. Gray. $2n = 12$ II. Brewster Co.: Sul Ross State University campus, *W. Jacobs* and *D. Foster 6*; sidewalk above Kokernot Springs, *B.L. Turner 99-95*; Alpine, near Kokernot Lodge, *A.M. Powell* and *S.A. Powell 6279, 6280* (counts from two individual plants); 14.5 km SE of Alpine, *A.M. Powell* and *S.A. Powell 5548*.

ACKNOWLEDGMENTS

We thank Dale E. Johnson for his review comments.

REFERENCES

Turner, B.L. and M.C. Johnston. 1961. Chromosome numbers in the Compositae. III. Certain Mexican species. Brittonia 13:64–69.

DOCUMENTED CHROMOSOME NUMBERS 2005: 2. COUNTS FROM WESTERN TEXAS, MOSTLY TRANS-PECOS CACTI

A. Michael Powell

Herbarium
Sul Ross State University
Alpine, Texas 79832, U.S.A.

James F. Weedin

Department of Science
Community College of Aurora
Aurora, Colorado 80011, U.S.A.

ABSTRACT

Sixty-four chromosome counts are reported for 27 taxa, mostly of western Texas, and most of them are opuntioid cacti (51 counts) of the Trans-Pecos region. Meiotic configurations suggest that Jeff Davis and Presidio county populations of *O. davisii* are triploid. Among the *Opuntia* reports are 11 diploid and two tetraploid counts attributed to *O. macrocentra*, and seven counts documenting a tetraploid taxon here referred to *O. mackensenii* var. *minor*. Three meiotic and two pollen stainability observations indicate that at least some plants of *O. schottii* var. *schottii* are partially or completely sterile.

RESUMEN

Se publican sesenta y cuatro recuentos cromosomáticos de 27 taxa, la mayoría del Oeste de Texas, y la mayoría de ellos son cactus opuntioides (51 recuentos) de la región de Trans-Pecos. Las configuraciones meioticas sugieren que las poblaciones de los condados de Jeff Davis y Presidio de *O. davisii* son triploides. Entre los recuentos de *Opuntia* 11 son diploides y dos tetraploides atribuidos a *O. macrocentra*, y siete recuentos que documentan un taxon tetraploide los referimos aquí a *O. mackensenii* var. *minor*. Tres observaciones meioticas y dos tinciones de polen indican que al menos algunas plantas de *O. schottii* var. *schottii* son parcial o completamente estériles.

Most of the chromosome counts presented below are the product of long-term investigations of Cactaceae in Trans-Pecos Texas and adjacent areas (cf. Weedin & Powell 1978; Powell & Weedin 2001; 2004). Two counts are from New Mexico, and one is from Colorado. Meiotic chromosome numbers were determined by the first author, following the techniques in Turner and Johnston (1961). The two pollen stainability tests with flowers of *O. schottii* were conducted after crushing anthers in Cotton Blue in lactophenol (Powell et al. 1991). For Cactaceae, buds were obtained from plants in the field, or buds were ultimately secured from cultivated stem cuttings. Miscellaneous counts of the non-cactus taxa were initiated by the respective collectors of voucher specimens, from field-collected buds, and verified by the first author. Amy Causey-Slover collected and contributed the buds of *Opuntia davisii* and *O. tunicata* (with M. Rodriguez). We thank G. Kliem-Pendley and S. Tripp for the non-cactus counts. We are grateful to L. Hedges, G. Raun, G. Kliem-Pendley, P. Griffith, B. L. Turner, S.A. Powell, J. Brady, D. Ferguson, and P. Manning for providing cactus plants, buds, or *Opuntia* stem cuttings; P. Manning also nurtured and helped to relocate living vouchers. Herbarium specimen vouchers are at SRSC. An asterisk (*) denotes chromosome counts also listed in Pendley (2001).

Asteraceae

Berlandiera lyrata Benth., $2n = 15$ II. Brewster Co.: Alpine, *G.M. Kliem 283*; *S. Tripp 12*.

Engelmannia peristenia (Raf.) Goodman & C. A. Lawson, $2n = 9$ II. Brewster Co.: Alpine, *S. Tripp 1*.

Xanthisma spinulosum (Pursh) D. R. Morgan & R. L. Hartm. var. *spinulosum*, $2n = 4$ II. Brewster Co.: Alpine, *S. Tripp 3*; Alpine, Old Mosley Lane main gate off hyw. 90, *G.M. Kliem 246*.

Psilostrophe tagetina (Nutt.) Greene, $2n = 16$ II. Brewster Co.: Alpine, *S. Tripp 8*.

Senecio flaccidus Less., $2n = 20$ II. Brewster Co.: Lizard Mt. Ranch, W of Alpine, *G.M. Kliem 313*.

Cactaceae

Ancistrocactus brevihamatus (Engelm.) Britton & Rose var. *pallidus* A.D. Zimmerman ex A.M. Powell, $2n = 11$ II. Brewster Co.: Marathon, *P.R. Manning 1016*.

Ancistrocatus brevihamatus var. *brevihamatus*, $2n = 11$ II. Val Verde Co.: Devils River State Natural Area, *L. Hedges s.n.*

Echinocereus dasyacanthus Engelm., $2n =$ ca. 44 (meiotic configurations show mostly II's, possibly some multivalents; also $2n =$ ca. 44, somatic count by J.F. Weedin). Brewster Co.: Big Bend Natl. Park, W slopes of the Chisos Mts., below the Window, *A.M. Powell* and *S.A. Powell 6307*; plants in this population morphologically approach *E. pectinatus* (Scheidw.) Engelm. var. *ctenoides* (Engelm.) Weniger ex G. Frank, or *E. ctenoides* (Engelm.) Rumpler. So far as known, *E. pectinatus* is always diploid ($2n = 11$ II; Powell & Weedin 2004).

Opuntia atrispina Griffiths, $2n = 11$ II. Val Verde Co.: Pecos River high bridge, *A.M. Powell* and *S.A. Powell 6246*.

Opuntia cf. *atrispina* Griffiths, $2n = 11$ II. Val Verde Co.: Pecos River high bridge, *A.M. Powell* and *S.A. Powell 6243*; buds collected from more than one plant; meiocytes from one bud showed $2n = 11$ II; meiocytes from a second bud showed $2n = 22$ II.

Opuntia azurea Rose var. *diplopurpurea* A.M. Powell & J.F. Weedin, $2n = 11$ II. Presidio Co.: 17.5 km SE of Ruidosa, *A.M. Powell* and *S.A. Powell 6295*. Brewster Co.: Lizard Mt., W of Alpine, *G. Kliem 385** (no voucher); Big Bend Natl. Park, Maxwell Road jct., *A.M. Powell* and *M.P. Griffith 6310*; Big Bend Natl. Park, Sotol Vista, *A.M. Powell* and *M.P. Griffith 6311*.

Opuntia azurea Rose var. *parva* A.M. Powell & J.F. Weedin, $2n = 11$ II. Brewster Co.: Big Bend Natl. Park, 6.5 km S on Maxwell Road, "Fins" of Fire Exhibit, *G. Kliem 131**, 21.6 km S on Maxwell Road, *G. Kliem 132** (no voucher); *136**; Black Gap, just inside N border, near paved road, *G. Kliem 133**; Big Bend Natl. Park, K-Bar camping area, *G. Kliem 143**.

Opuntia cf. *camanchica* Engelm. & J.M. Bigelow, $2n = 33$ II. Brewster Co.: Big Bend Natl. Park., Persimmon Gap, *A.M. Powell* and *S.A. Powell 6080*; $2n =$ ca. 66 (meiotic configurations suggest numerous multivalents), Big Bend Natl. Park, Rattlesnake Mts., *G.G. Raun 95-44*; $2n =$ ca. 66 (meiotic configurations indicate probable multivalents). Val Verde Co.: Pecos River high bridge, *A.M. Powell* and *S.A. Powell 6247*.

Opuntia camanchica Engelm. & J.M. Bigelow, $2n =$ ca. 33 II. Hudspeth Co.: N of Sierra Blanca, *A.M. Powell* and *S.A. Powell 6238*.

Opuntia cymochila Engelm. & J.M. Bigelow, $2n =$ ca. 66 (meiotic configurations suggest numerous multivalents). COLORADO. Arapahoe Co.: *J.F. Weedin 1706*; $2n =$ ca. 33 II. TEXAS. Moore Co.: Cactus, *J.F. Weedin 1671*.

Opuntia davisii Engelm. & J.M. Bigelow, $2n = 22$ II. NEW MEXICO. Chaves Co.: Roswell, *A. Causey 18*. *Opuntia davisii*, $2n =$ ca. 33 (meiotic configurations suggest II's, I's, and multivalents, as though $3x$; some tetrads with micronuclei). TEXAS. Jeff Davis Co.: just W of Fort Davis, *A.*

Causey 3. Presidio Co.: 4 km S of Marfa, *A. Causey 9*. Meiotic observations of *O. davisii* support a taxonomic distinction between populations in New Mexico and Trans-Pecos Texas (Powell & Weedin 2001, 2004). Amy Causey-Slover is studying the biology of *O. davisii*.

Opuntia engelmannii Salm-Dyck ex Engelm. var. *engelmannii* (cf. *O. valida* Griffiths, D.J. Ferguson, pers. comm.), $2n = 33$ II. Pecos Co.: 19.3 km WNW of Fort Stockton, *A.M. Powell* and *S.A. Powell 6009*.

Opuntia engelmannii var. *lindheimeri* (Engelm.) B.D. Parfitt & Pinkava, $2n = 33$ II. Uvalde Co.: ca. 1.6 km N of jct. of hwys 236 and 90, *J.F. Weedin 1670*.

Opuntia mackensenii Rose var. *mackensenii* (*O. gilvescens* Griffiths, D.J. Ferguson, pers. comm.), $2n = 22$ II. Terrell Co.: 6.5 km W of the Pecos River, along hwy 90, *S. Lee 29*.

Opuntia cf. *mackensenii* var. *mackensenii*, $2n =$ ca. 55 (meiotic configurations show possible II's, I's, and multivalents, 22-28 per pole in anaphase I; $5x$). Terrell Co.: 25.8 km W of Sanderson near Longfellow, *A.M. Powell* and *S.A. Powell 6220*.

Opuntia mackensenii Rose var. *minor* (M.S. Anthony) A.M. Powell & J.F. Weedin, $2n = 22$ II. Presidio Co.: 1.62 km E of Marfa, *A.M. Powell* and *S.A. Powell 6334*. Pecos Co.: 22.5 km E of Fort Stockton, *A.M. Powell* and *S.A. Powell 6318*. Brewster Co.: 21 km E of Marathon, *A.M. Powell* and *S.A. Powell 6326*. Terrell Co.: 22.5 km W of Dryden, *G.G. Raun 98-14b*. Val Verde Co.: Langtry, *A.M. Powell* and *S.A. Powell 6249*; $2n =$ ca. 22 II. Ward Co.: 21 km S of Monahans, *A.M. Powell* and *S.A. Powell 6316*. Brewster Co.: Alpine, *A.M. Powell* and *S.A. Powell 6050*.

Opuntia macrocentra Engelm., $2n = 11$ II. Hudspeth Co.: W of Sierra Blanca, Lasca Road, *J. Brady s.n.*; ca. 13 km W of Sierra Blanca, *M.P. Griffith 101; 102*. Culberson Co.: ca. 4.8 km N of Van Horn, along hwy 54, *P.R. Manning 2063; 2064*; between the Delaware and Apache mts, along FM 2185, ca. 48 km N of Van Horn, *G. Kliem 165**; *306**; *309**; *310**; 32 km N of Van Horn, along FM 2185, *G. Kliem 307**; *312**.

Opuntia macrocentra Engelm., $2n = 22$ II. El Paso Co.: Fabens cemetery, *J.F. Weedin 2177*. Culberson Co.: 37 km N of Van Horn, along hwy 54, *P.R. Manning 2069*. The diploid ($2n = 11$ II) and tetraploid ($2n = 22$ II) counts here attributed to the purple prickly pear *O. macrocentra* provide additional distributional information about the two morphologically similar cytotypes (Powell & Weedin 2001; 2004). It appears that the tetraploids occur from southeast Arizona across southern New Mexico (Pinkava et al. 1992; 1998), into the Trans-Pecos in El Paso County (Pinkava et al. 1985), and in the northern halves of Hudspeth and Culberson counties (Powell & Weedin 2001). The diploids that most resemble *O. macrocentra* tetraploids appear to be confined to southern Hudspeth and Culberson counties, but may extend farther southeast into Pecos, Jeff Davis, Presidio, and Brewster counties, and even farther northwest into El Paso County or beyond. For the most part, the purple or purplish prickly pears in the Big Bend Region of Trans-Pecos Texas, sometimes included with *O. violacea* Engelm. (Benson 1982) or *O. macrocentra*, have recently been aligned with *O. azurea* Rose (Powell & Weedin 2004). The type locality for *O. macrocentra* is near El Paso.

Opuntia phaeacantha Engelm. var. *phaeacantha*, $2n =$ ca. 66 (meiotic observations indicate possible multivalents and I's). NEW MEXICO. Santa Fe Co.: E Cochiti Reservation near Santa Fe, type locality, *D.J. Ferguson s.n.*

Opuntia polyacantha Haw. var. *trichophora* (Engelm. & J.M. Bigelow) J.M. Coult., $2n = 11$ II. Hudspeth Co.: S of Dell City, *S. Lee 11*.

Opuntia (= *Grusonia*) *schottii* Engelm. var. *schottii*, $2n =$ ca. 44 (mieotic observations show possible multivalents). Brewster Co.: Heath Canyon, *A.M. Powell* and *S.A. Powell 6152* (pollen stainability 47 %). Terrell Co.: Sanderson, *G.G. Raun 98-40*, no chromosome count possible, only abnormal meiocytes observed in anthers of flower buds. Val Verde Co.: Langtry, *A.M. Powell* and *S.A. Powell 6248*, no chromosome count possible, only abnormal meiocytes observed in poorly developed anthers (pollen stainability 0 %).

Opuntia strigil Engelm., $2n = 11$ II. Terrell Co.: 67 km E of Marathon, *P.R. Manning 1064*; W of Dryden, *G.G. Raun 98-14a*.

Opuntia tunicata (Lehm.) Pfeiff., $2n = 11$ II. Pecos Co.: Glass Mts., Gap Tank, *A. Causey 28*.

Opuntia sp., $2n = 11$ II. Brewster Co.: Big Bend Natl. Park, Boquillas overlook, *A.M. Powell* and *S.A. Powell 6276* [same morphotype as that reported in Powell and Weedin (2001), as *Opuntia* sp., *B.G. Hughes 800*], suspected hybrid between *O. rufida* Engelm. and *O. azurea* var. *parva*.

Loasaceae

Cevallia sinuata Lag., $2n = 13$ II. Brewster Co.: Lizard Mt. Ranch W of Alpine, *G.M. Kliem 249*.

Solanaceae

Solanum elaeagnifolium Cav., $2n = 12$ II. Brewster Co.: Alpine, *G.M. Kliem 245*.

Solanum rostratum Dunal, $2n = 12$ II. Gillespie Co.: 50 km E of intersect. I-10 and hwy 290 between Fredricksburg and Junction, *S. Tripp 5*.

ACKNOWLEDGMENTS

We appreciate the review comments of Peter Goldblatt.

REFERENCES

Benson, L. 1982. The cacti of the United States and Canada. Stanford University Press, Stanford, California.

Pendley, G.K. 2001. The pollination ecology of *Opuntia* cf. *macrocentra* (Cactaceae) in the Trans-Pecos region of Texas. M.S. Thesis, Sul Ross State University, Alpine, TX.

Pinkava, D.J., M.A. Baker, B.D. Parfitt, M.W. Mohlenbrock, and R.D. Worthington. 1985. Chromosome numbers in some cacti of western North America–V. Systematic Bot. 10:471–483.

Pinkava, D.J., B.D. Parfitt, M.A. Baker, and R.D. Worthington. 1992. Chromosome numbers in some cacti of western North America–VI, with nomenclatural changes. Madroño 39:98–113.

Pinkava, D.J., J.P. Rebman, and M.A. Baker. 1998. Chromosome numbers in some cacti of western North America–VII. Haseltonia 6:32–41.

Powell, A.M. and J.F. Weedin. 2001. Chromosome numbers in Chihuahuan Desert Cactaceae. III. Trans-Pecos Texas. Amer. J. Bot. 88:481–485.

Powell, A.M. and J.F. Weedin. 2004. Cacti of the Trans-Pecos and adjacent areas. Texas Tech University Press, Lubbock.

Powell, A.M., A.D. Zimmerman, and R.A. Hilsenbeck. 1991. Experimental documentation of natural hybridization in Cactaceae: origin of Lloyd's hedgehog cactus, *Echinocereus* × *lloydii*. Pl. Syst. Evol. 178:107–122.

Turner, B.L. and M.C. Johnston. 1961. Chromosome numbers in the Compositae III. Certain Mexican species. Brittonia 13:64–69.

Weedin, J.F. and A.M. Powell. 1978. Chromosome numbers in Chihuahuan Desert Cactaceae. Trans-Pecos Texas. Amer. J. Bot. 65:531–537.

DOCUMENTED CHROMOSOME NUMBERS 2005: 3. CHROMOSOME NUMBERS IN NORTH AMERICAN SPECIES OF *SILENE* AND *STELLARIA* (CARYOPHYLLACEAE)

J.K. Morton

Department of Biology
University of Waterloo
Waterloo, Ontario, CANADA N2L 3G1

ABSTRACT

Chromosome numbers are reported for 44 collections of *Silene* and 74 collections of *Stellaria* (Caryophyllaceae) from continental North America. First published reports include those for *Silene drummondii* Hook. subsp. *striata* (Rydberg) J.K. Morton $2n = 72$, *S. hitchguirei* Bocquet $2n = 24$, *S. uralensis* (Rupr.) Bocquet subsp. *ogilviensis* (A.E. Porsild) D.F. Brunton $2n = 48$, *Stellaria fontinalis* (Short & Peter) B.L. Robinson $2n = 26$, *S. nitens* Nuttall $2n = 20$ & 40 and *S. parva* Pederson $2n = 34$.

First published reports for material of North American origin include *Silene dichotoma* Ehrhart $2n = 24$, *S. dioica* (L.) Clairville $2n = 24$, *S. flos-cuculi* (L.) Clairville $2n = 24$, *Stellaria alsine* Grimm $2n = 24$, *S. cuspidata* Willd. ex Schltdl. subsp. *prostrata* J.K. Morton $2n = 26$, *S. neglecta* Weihe $2n = 20$ & 22 and *S. palustris* Retz. $2n =$ ca. 198.

RESUMEN

Se publican los números cromosomáticos de 44 colecciones de *Silene* y 74 colecciones de *Stellaria* (Caryophyllaceae) de Norte América continental. Entre los primeros recuentos publicados se encuentran los de *Silene drummondii* Hook. subsp. *striata* (Rydberg) J.K. Morton $2n = 72$, *S. hitchguirei* Bocquet $2n = 24$, *S. uralensis* (Rupr.) Bocquet subsp. *ogilviensis* (A.E. Porsild) D.F. Brunton $2n = 48$, *Stellaria fontinalis* (Short & Peter) B.L. Robinson $2n = 26$, *S. nitens* Nuttall $2n = 20$ & 40 y *S. parva* Pederson $2n = 34$.

Los primeros recuentos en material originario de Norte América son *Silene dichotoma* Ehrhart $2n = 24$, *S. dioica* (L.) Clairville $2n = 24$, *S. flos-cuculi* (L.) Clairville $2n = 24$, *Stellaria alsine* Grimm $2n = 24$, *S cuspidata* Willd. ex Schltdl. subsp. *prostrata* J.K. Morton $2n = 26$, *S. neglecta* Weihe $2n = 20$ & 22 y *S. palustris* Retz. $2n =$ ca. 198.

INTRODUCTION

The purpose of this paper is to put on record previously unpublished data on chromosome numbers in the species of *Silene* and *Stellaria*, both native and introduced, occurring in continental North America.

METHODS AND MATERIALS

The methods used in obtaining these chromosome counts are described in Morton 2002. Voucher specimens are retained in the author's research collections and partial sets of duplicates have been distributed to WAT, MICH, DAO and VDB. Collection numbers prefixed with NA are J.K. Morton or J.K. Morton and Joan M. Venn collections.

SIDA 21(3): 1669–1674. 2005

DISCUSSION

Many of these chromosome counts confirm those from previous workers. However, the following appear to be the first published accounts for their respective taxa:- *Silene drummondii* subsp. *striata* $2n = 72$, *S. hitchguirei* $2n = 24$, *S. uralensis* subsp. *ogiliviensis* $2n = 48$, *Stellaria fontinalis* $2n = 26$, *S. nitens* $2n = 20$ & 40 and *S. parva* $2n = 34$.

The following chromosome counts appear to be the first published counts for North American material of these taxa:- *Silene dichotoma* $2n = 24$, *S. dioica* $2n = 24$, *S. flos-cuculi* $2n = 24$, *Stellaria alsine* $2n = 24$, *S. cuspidata* subsp. *prostrata* $2n = 26$, *S. neglecta* $2n = 20$ & 22 and *S. palustris* $2n =$ ca. 198.

Polyploidy is prevalent in the genus *Silene*, both within single species and between closely related taxa. Examples from the current study include *Silene ostenfeldii* with $2n = 24$, 48 & 72; *S. drummondii* subsp. *drummondii* with $2n = 24$ (Cronquist 1991) & 48, and subsp. *striata* with $2n = 72$; *S. menziesii* with $2n = 24$ & 48 and the closely allied *S. williamsii* with $2n = 48$; *S. repens* with $2n = 24$ & 48; *S. uralensis* subsp. *uralensis* with $2n = 24$ (Packer & McPherson 1974), subsp. *ogilviensis* $2n = 48$ and subsp. *porsildii* $2n = 48$ (Knaben 1968).

Stellaria graminea has diploid ($2n = 26$) and tetraploid ($2n = 52$) cytotypes in Europe where it is a native species. All the populations that have been examined from North America, where it is an aggressive introduced rhizomatous weed, are tetraploid with the exception of a sterile triploid ($2n = 39$) colony in Newfoundland. Only the diploid cytotype is known to occur in the British Isles (Blackburn & Morton 1957; Stace 1997). Its absence from North America is surprising in view of the close links between Britain, Newfoundland and the New England states.

The chromosome counts for the broad-leaved form of *Stellaria borealis* are the first reports for this variant. These counts are for plants referable to subspecies *sitchana*. The name var. *latifolia* cannot correctly be applied to these plants because it was originally given to a similar broad-leaved form of *S. borealis* subsp. *borealis* as *S. calycantha* var. *latifolia* B. Boivin (1951). The broad-leaved forms of subsp. *sitchana* retain their characters under cultivation. It appears that this variant is associated with rivers and streams at mid elevations (1200–2100 m) on the forested slopes of the Sierra Nevada Mountains of California.

ACKNOWLEDGMENTS

I am indebted to Joan M. Venn for technical assistance during this study and for her help in preparing the manuscript for publication. I also want to thank Dale Johnson for reviewing an earlier draft of this paper.

TABLE 1. Chromosome numbers in *Silene*.

Taxon	Locality & collection number	Chromosome No. (2n)
S. acaulis (L.) Jacq.	**AB:** Kananaskis, Highwood Pass, *Morton s.n.*	24
S. antirrhina L.	**AZ:** Yavapai Co.: Rimrock, Phoenix to Flagstaff rd., *Morton s.n.*. **BC:** Okanagan, Hedley, *Morton s.n.*. **MB:** Whiteshell Prov. Pk., *NA3733*. **ON:** Essex Co.: Point Pelee, *Morton s.n.*	24
S. caroliniana Walter subsp. *wherryi* (Small) P.T. Clausen	**KY:** Anderson Co.: US-62, W of Lexington, nr. Tyrone Bridge, *NA6857*	48
S. coronaria (L.) Clairville	**BC:** Vancouver Is., Hwy 1, 10 km N of Duncan, *NA13582*. **ON:** Waterloo region-Waterloo, *McClintock s.n.*	24
S. cserii Baumg.	**ON:** Waterloo Region, Waterloo, *NA5579*. **SK:** Estevan *Alex s.n.*	24
S. dichotoma Ehrhart	**ON:** Lambton Co.: Pinery Prov. Pk. *Calvert s.n.*. **VA:** Floyd Co.: Blue Ridge Pkway., ml 168 at Saddle Overlook, *NA6551*	24
S. dioica (L.) Clairville	**BC:** Vancouver, Stanley Park, *NA13499*	24
S. douglasii Hook. var. *douglasii*	**OR:** Deschutes Co.: *Halse 4669*	48
S. drummondii Hook. subsp. *drummondii* For.	**SK:** Cypress Hills, *NA3870* & *NA13296*. **UT:** Summit Co.: Wasatch Natl. along Hayden Fork, *NA7282*	48
S. drummondii Hook. subsp. *striata* (Rydberg) J.K. Morton	**CO:** Larimer Co.: Hwy. 34 in Rocky Mnt. Natl. Pk., *Morton s.n.*	72
S. flos-cuculi (L.) Clairville	**NS:** Kings Co.: Annapolis Vall., Aylesford, *NA5447*. **NY:** I-81 between Binghampton & Syracuse, *NA3581*	24
S. gallica L.	**BC:** Vancouver Is., Victoria, Uplands Pk., *NA13551*. **TX:** Brazos Co.: Hensel Pk., *Fryxell 1270*	24
S. hitchguirei Bocquet	**CO:** Clear Creek Co.: Mnt. Evans, *NA7375*	24
S. involucrata (Cham. & Schlecht.) Bocquet subsp. *involucrata*	**NT:** Tuktoyaktuk *Gillett 18719*. **YT:** Dawson, *Morton s.n.*	48
S. involucrata (Cham. & Schlecht.) Bocquet subsp. *tenella* (Tolm.) Bocquet	**NT:** Dempster Hwy., Campbell L., S of Inuvik, *NA13830*. **YT:** Dempster Hwy., km 141, Ogilvie Mnts., *NA14010*	48
S. latifolia Poir.	**AB:** Fort Saskatchewan, *NA3893*	24
S. menziesii Hook.	**AB:** Coleman to Kananaskis rd., Livingstone Falls, *NA4656*. **BC:** Cache Creek, *NA3406*. Mannings Prov. Pk., *NA13511*. Princeton, *NA13506*	48
	YT: Alaska Hwy., NW of Haines Jnct., *NA2060*	24
S. noctiflora L.	**ON:** Wellington Co.: Luther Lake, *NA4950*	24
S. ostenfeldii (A.E. Porsild) J.K. Morton	**AK:** Taylor Hwy. near Chicken, *NA2131*	24
	NT: Heart Lake, nr. Hay River, *Packer 168*. **NT:** Banks Is. *Kuc, CAN 330826*.	48
	YT: Klondike Hwy. at Moose Creek, SE of Dawson, *NA2180*	72

TABLE 1. continued

Taxon	Locality & collection number	Chromosome No. (2n)
S. parryi (S.Watson) Hitchcock & Maguire	**WA:** Pierce Co.: Mnt. Rainier, *Morton s.n.*	48
S. repens Patron	**AK:** Taylor Hwy. near Chicken, *NA2128*. **YT:** Dawson, Dome Mnt., *NA13751*	24
	YT: Dempster Hwy. N of Engineer Creek, Ogilvie Mnts., *NA13936*	48
S. uralensis (Rupr.) Bocquet subsp. *ogilviensis* (A.E. Porsild) D.F. Brunton	**AK:** Kotzebue, *Packer 3473*	48
S. virginica L.	**NC:** Rutherford Co.: Lake Lure, *NA4431*	48
S. williamsii Britton	**AK:** Taylor Hwy. near Chicken, *NA2127*	24

TABLE 2. Chromosome numbers in *Stellaria*.

Taxon	Locality & collection number	Chromosome No. (2n)
S. alsine Grimm	**NF:** St. George's Dist.: St. Andrews, NW of Port aux Basques,, *NA12112*. **NS:** Cape Breton Co.: between Sydney & North Sydney, *NA5164*	24
S. borealis Bigelow subsp. *sitchana* (Steudel) Piper	**BC:** Vancouver Is.: Malahat Dist., Shawnigan Lake, *NA17204*	ca. 52
	BC: Vancouver Is.: Alberni Dist., Cameron R., W of Cathedral Grove, *NA8365*. **WA:** Pierce Co.: lower slopes Mt. Rainier, E side, *NA3325*	52
	BC: New Westminster Dist.: Garibaldi, N of Vancouver, *NA3355*	*n* = 26
broad-leaved form (var. "*latifolia*")	**CA:** Elderado Co.: W side Lake Tahoe, *NA17398*. Mariposa Co.: Yosemite Natl. Pk., *NA17405*. Plumas Co.: CA-89, between Clio & Sierra Co. line, *NA17395*. Sierra Co.: Tahoe Natl. For. at Sulphur Ck. crossing, *NA17396*	52
S. crassifolia Ehrhart	**AB:** Cypress Hills Prov. Pk., *NA3825*. Lac St. Anne, rte. 43, W of Edmonton, *NA1902*. **YT:** S end Dempster Hwy., nr. Dawson, *NA2166*	26
S. cuspidata Willd. ex Schltdl. subsp. *prostrata* (Baldwin) J.K. Morton	**TX:** Hidalgo Co.: S of Mission, *Morton s.n.*. Atascosa Co.: nr. Jourdanton, *NA19111*. Live Oak Co.: FM-99 at Atascosa R. crossing, *NA19124*	26
S. fontinalis (Short & Peter) B.L. Robinson	**TN:** Nashville *Morton s.n.*	26
S. graminea L.	**BC:** Vancouver - Pitt Meadows, *NA13504*. **NB:** York Co.: Fredericton, *NA4210*. **NF:** St. Barbe South Dist.: Bonne Bay, *NA5320*. St. John's, *NA5238*. White Bay North Dist.: St. Anthony (Northern Peninsula) *Morton s.n.*	52

TABLE 2. continued

Taxon	Locality & collection number	Chromosome No. (2n)
	NS: Halifax Co.: Halifax *Morton s.n.*.Victoria Co.: Cape Breton Is., Ingonish *Morton s.n.*. Cape Breton Co.: Cape Breton Is., Glace Bay, *NA4261*. **ON:** Bruce Co.: Dyer Bay to Cabot Head, *NA2770.* Sudbury Dist.: Massey *Morton s.n.* Muskoka Dist.: Gravenhurst *Morton s.n.* Manitoulin Dist.: Manitoulin Is. *Morton s.n.* **PE:** Kings Co.: Panmure Head Shchepanek & Dugal 382; *Shchepanek & Dugal 3664.* Kings Co.: Montague *Shchepanek & Dugal 3664.* **PQ:** Cté de Kamouraska: Saint- Denis, *NA2901.* Cté de Gatineau: Masham *Morton s.n.* Cté de Rouville: Rougemont *Morton s.n.* Cté de Charlevoix: Baie-Sainte-Catherine, *NA15254.* Cté de Verchères: Verchères (Montreal), *NA4982.* Cté de Gaspé-Ouest: Sainte-Anne-des-Monts, *NA2969.* Cté de Gaspé-Est: Douglastown, *NA3020.* Cté de Matane: slopes of Mont Logan, *NA4023.* **ME:** Acadia Natl. Pk.: Seal Cove, NA*5149.* Penobscot Co.: Newport, *NA5134* Somerset Co.: Mercer, *NA5132.* **MI:** St. Clair Co.: Port Huron *Morton s.n.* **NC:** Jackson Co.: Cherokee *Morton s.n.* **PA:** Chester Co.: Octoraro Ck. below Lees Bridge (Nottingham), *NA3568.*	
	NF: St. Barbe South Dist.: Hawke's Bay (Northern Peninsula), *NA12341*	39
S. humifusa Rattb.	**NF:** St. George's Dist.: St. George's nr. Stephenville, *NA5187.* St. Barbe North Dist.: New Ferolle (Northern Peninsula), *NA12329*	26
S. longipes Goldie subsp. *longipes*	**CA:** Shasta Co.: Lessen Volcanic Natl. Pk., *NA17378.* Plumas Co.: CA-89 at Sulphur Ck., *NA17392.* **UT:** Summit Co.: Wasatch Natl. For. Along Hayden Fork, *NA7277*	52
	CO: Clear Creek Co.: slopes of Mt. Evans, *NA7353.* Rocky Mnt. Natl. Pk.: US-36 above Estes Park, *NA7332*	104
	NT: Dempster Hwy. in Richardson Mnts. ca. 50 km S of Peel R. crossing, *NA13852*	ca. 104
	WY: Albany Co.: Laramie, Snowy Range Pass, *NA7294*	106
S. media (L.) Vill.	**CA:** Mendocino Co.: Fort Bragg, *NA15796.* **ON:** Essex Co.: Point Pelee, *NA3534.* Essex Co.: Pelee Is., Fish Pt., *NA3604*	40
	ON: Waterloo Reg. Mun.: Waterloo, *NA19383*	40–42
S. neglecta Weihe	**KY:** Boone Co.: US-42, SW of Hume, *NA7799*	22
	KY: Grant Co.: Corinth, *NA19612*	20
S. nitens Nutt.	**BC:** Vancouver Is.: Cowichan Lake Dist., Skutz Falls (W of Duncan), *Morton s.n.*	40
	AZ: Gila Co.: AZ-188 between Punkin Center & Roosevelt, *NA11379*	20

Table 2. continued

Taxon	Locality & collection number	Chromosome No. (2n)
S. pallida (Dum.) Crépin	**AZ:** Graham Co.: Aravaipa Canyon, *NA18504*. **KY:** Boone Co.: I-75, S of Cincinnati, *NA7797*. **NC:** Carteret Co.: Beaufort, *NA5646b*. **ON:** Elgin Co.: Hwy. 401 between Dutton & West Lorne, *NA19390a*	22
S. palustris Retz.	**PQ:** Cté de Verchères: Verchères (Montreal), *NA4981 &, NA5452*	ca. 198
S. parva Pederson	**LA:** Acadia Parish: Crowley, *NA18461*	34
S. porsildii Chinnappa	**AZ:** Greenlee Co.: Mt. Baldy, *NA7058*. **NM:** San Miguel Co.: slopes of Sante Fe Baldy, *NA7116*	26
S. umbellata Turcz.	**CO:** Clear Creek Co.: Mt. Evans, *NA7373*. **WY:** Park Co.: Beartooth Pass, *NA4808*. **YT:** Dawson, at start of Dempster Hwy., *NA2170*	26

REFERENCES

Blackburn, K.B. and J.K. Morton. 1957. The incidence of polyploidy in the Caryophyllaceae of Britain and Portugal. New Phytol. 56:344–351.

Boivin, B. 1951. Centurie de plantes Canadiennes. II. Canad. Field-Naturalist 65:7.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. ed. 2. New York.

Knaben, G. 1968. Chromosome numbers of flowering plants from central Alaska. Nytt Mag. Bot. 15:240–254.

Morton, J.K. 2002. Documented chromosome numbers 2002:2. Chromosome numbers in North American species of *Cerastium* (Caryophyllaceae). Sida 20,1:227–231.

Packer, J.G. and G.D. McPherson. 1974. Chromosome numbers in some vascular plants from northern Alaska. Canad. J. Bot. 52:1095–1099.

Stace, C. 1997. New flora of the British Isles. ed. 2. Cambridge Univ. Press.

MORFOLOGÍA DE TRICOMAS FOLIARES EN ESPECIES DE *SOLANUM* SECCIÓN *ACANTHOPHORA* (SOLANACEAE), PRESENTES EN VENEZUELA

William A. Granada-Chacón y Carmen E. Benítez de Rojas

Instituto de Botánica Agrícola, Facultad de Agronomía
Universidad Central de Venezuela
Apdo. 4579, Maracay, Estado Aragua, VENEZUELA
E-mail: williamgranada@latinmail.com, cbenitez@telcel.net.ve

RESUMEN

Se caracterizó la morfología cualitativa y cuantitativa de tricomas foliares en *S. acerifolium* Dun., *S. agrarium* Sendtn., *S. capsicoides* All. y *S. mammosum* L. (sección *Acanthophora* Dun.). Se seleccionaron 5–10 hojas frescas en máxima expansión foliar, procedentes de 3–5 individuos, que luego fueron preservadas en FAA 70%; también se utilizó a razón de 4–5 hojas rehidratas en lactofenol por cada espécimen de herbario. Se hicieron montajes microscópicos, utilizando la porción media de la lámina foliar y del pecíolo; además se hicieron montajes de lámina foliar aclarada. La diversidad morfológica de tricomas permitió separarlos en tres tipos básicos: simples, estrellados y glandulares, con varios subtipos. Se describen 11 subtipos en *S. agrarium* y 7 en la restantes especies. A cada subtipo se le determinó su ubicación en las distintas partes de la hoja. Se presenta una clave basada en rasgos tricomáticos y las ilustraciones de los tricomas descritos. La diversidad de los tricomas en las especies estudiadas, prueba ser un criterio taxonómico de alto valor para distinción de miembros del género *Solanum*.

ABSTRACT

The qualitative and quantitative morphology of foliar trichomes in *S. acerifolium* Dun., *S. agrarium* Sendtn., *S. capsicoides* All. and *S. mammosum* L. (section *Acanthophora* Dun.) where characterized. Five to ten fresh, fully expanded leaves from 3–5 individuals, were preserved in FAA 70%. Herbarium specimens were also used (4–5 leaves from each specimen). Fragments of fresh material (middle portion of leaf and petiole) and herbarium material for microscope examination. The diversity of the morphological trichomes studied separate into three basic types: simple, glandular, and estellate, with several subtypes. Eleven subtypes are described in *S. agrarium* and seven in the other species. A key fixed on trichomatic features and the illustrations of the described trichomes is presented. The diversity of trichome types and morphology of trichomes are useful characters in identifying species of the genus *Solanum*.

INTRODUCCIÓN

La sección *Acanthophora* Dun. conforma, con otras 26 secciones, al subgénero *Leptostemonum* (Dunal) Bitter del género *Solanum* (D'Arcy 1991). Comprende *ca.* 18 especies de América tropical y subtropical; algunas de las cuales, como *Solanum aculeatissimum* Jacq., *S. capsicoides* All., *S. mammosum* L., y *S. viarium* Dun., fueron introducidas en el viejo mundo (Nee 1991, 1999). Esta sección fue descrita por Dunal (1813), teniendo a *S. mammosum* L., como especie tipo. Posteriormente, en 1852, este mismo autor redefine el grupo e incluye las 53 especies hasta el momento conocidas, distribuidas en dos subgrupos denominados "*Psilocarpa*" y "*Lasiocarpa*." En 1962, Seithe estudió ampliamente la pubescencia en *Solanum* y señaló para la Sectio *Simplicipilum* Bitt. (section *Acanthophora* Dun.) tricomas estrellados, espinosos y porrectos; de una a varias células alargadas. Posteriormente la misma autora en 1979, reúne la pubescencia de *Solanum* en ocho tipos básicos de tricomas, describe sus variaciones y otros aspectos sobre el desarrollo ontogenético.

Dada la relevancia de las características asociadas al indumento en miembros solanáceos, identificamos y describimos los tricomas foliares en especies de *Solanum* secc. *Acanthophora*. Igualmente, se determinaron las dimensiones morfométricas de los tipos descritos y la ubicación de cada uno de ellos, en las distintas partes de la hoja.

MATERIALES Y MÉTODOS

En este estudio se usó material vegetal fresco y de herbario (Cuadro 1). El material fresco se preservó en FAA 70% y se seleccionaron de 5–10 hojas adultas, del tercio medio de la planta y procedentes de tres o más individuos. El material de herbario se re-hidrató en lactofenol durante 1–2 meses (Peña y Saralegui 1982), y se tomaron 3–4 hojas por espécimen. De las hojas se extrajeron la parte media de la lámina foliar (0.5 cm de ancho y 1cm de largo) y el pecíolo (0.5 cm de largo); y se seccionaron transversalmente a mano libre. Los cortes se tiñeron con azul de toluidina 0.5% o safranina acuosa 1%, e inmediatamente se montaron en agua-glicerina (v:v) para preparaciones semipermanentes.

Para obtener preparaciones permanentes (Roth 1964), las porciones vegetales incluidas en parafina se cortaron con un micrótomo de rotación con un espesor 15 µm. Los cortes se tiñeron con azul de toluidina acuosa 1% (Sakai 1973) y posteriormente se desparafinaron y montaron en Bálsamo de Canadá.

Para observar las epidermis de la hoja en vista frontal, se elaboraron aclarados de la lámina foliar, siguiendo las metodologías de Shobe y Lerten (1967) y Dizeo de Strittmatter (1973), con algunas modificaciones (Granada-Chacón y Benítez de Rojas 2005). Los materiales foliares frescos fijado en FAA 70% y el rehidratado en lactofenol, se cortaron en segmentos de 1 cm^2 y se colocaron en etanol al 96% durante 15 min a 60° C. Luego se transfirieron a una solución 1:1 de etanol 96% e hidróxido de sodio 5% en solución acuosa, durante 15 min a 60°C. Seguidamente, el material se lavó con agua destilada 3 veces y se colocó en una solución de hipoclorito de sodio al 5.25%, hasta que el tejido se tornó translúcido, lo que ocurrió en 3 min en *S. accrifolium* y *S. mammosum*, y en 3–5 min en las especies restantes. Después el material se lavó con agua destilada 5 veces durante 3 min. Finalmente las secciones se tiñeron con azul de toluidina

Cuadro 1. Especímenes estudiados.

Especie	Especímenes (MY)	Altitud (m snm)	Estado	Hábitat
S. acerifolium	*Granada, W.* 61	1500	Miranda	Selva nublada
	Granada, W. 62	1700		
	Granada, W. 63	1450		
	Granada, W. 69	1000	Mérida	Maleza en cafetal
S. agrarium	*Granada, W.* 58	50–100	Aragua	Espinar costanero, vegetación secundaria
	Fernández, Antonio 1481 (Material desecado)	-	Lara	Selva deciduas
	Trujillo, B. 5556 (Material desecado)	-	Lara	Selva deciduas
	Trujillo, B. 6783 (Material desecado)	-	Lara	Selva deciduas
S. capsicoides	*Granada, W.* 66	-	Mérida	Cultivada, ornamental
	Granada, W. 68	-	Mérida	Cultivada, ornamental
S. mammosum	*Granada, W.* 59	450	Aragua	Sabanas arboladas
	Granada, W. 72	-	Carabobo	Cultivada, ornamental
	Granada, W. 73	400	Carabobo	Maleza en potreros

al 0.5% o con safranina al 1%. En el primer caso el tejido se mantuvo inmerso en el colorante durante 1 min, y en el segundo durante 5-15 seg.

Para identificar y describir los tipos de tricomas, se observaron con un microscopio óptico (Biomed-Leiz) las preparaciones en sección transversal y aclarados de las porciones vegetales seleccionadas. Así, se identificaron los tipos básicos y las variantes en cada uno de ellos, seleccionándose como formas consistentes, aquellas que ocurrían regularmente en cada espécimen analizado por especie. Simultáneamente, se consideró la localización topográfica de cada uno de los tipos tricomáticos según: superficies adaxial y abaxial de la lámina foliar, nervadura principal y pecíolo. Las partes componentes en cada tipo tricomático, se midieron con ayuda de un ocular calibrado a una escala de referencia, determinándose la longitud del tricoma, largo y ancho de sus células componentes y diámetro de la base en aquellos tipos con base pluricelular.

La determinación de las dimensiones morfométricas en los tipos tricomáticos, se llevó a cabo por separado en cada material analizado por especie (Cuadro 1). En cada estructura se hicieron 20-30 mediciones, para establecer un intervalo de variación en cada caso. Las fotografías de los tricomas se tomaron con una cámara incorporada al microscopio; también se elaboraron dibujos a escala de los tipos tricomáticos. Los tipos básicos de tricomas son nombrados según Roe (1971) y la terminología de las descripciones está apoyada en Font Quer (1953), Stearn (1992) y Harris y Woolf Harris (1994).

Las características cualitativas del indumento, se observaron en los aclarados de lámina foliar y en especimenes de los herbarios CAR, MER, MERF, MY, MYF y VEN (Holmgren et al. 1990); el material desecado se examinó con un microscopio estereoscópico Leica MS5.

RESULTADOS Y DISCUSIÓN

A. Caracterización morfológica de los tricomas.—Los tricomas están constituidos por: (a) la base, una estructura unicelular o pluricelular dispuesta e inmersa en el tejido epidérmico y (b) el cuerpo, constituido por la célula o grupos de éstas dispuestas sobre la base. En tricomas simples, el cuerpo incluye las células dispuestas sobre la base; mientras que en tricomas simples glandulares, el cuerpo se diferenció en pie y cabeza. El primer término se aplica a la célula o grupo de células que sostienen una estructura apical (unicelular o pluricelular y generalmente globosa u ovoide) que representa la cabeza.

Tricomas en *Solanum acerifolium*

1. Simples:

- **A.** Base de 1–2 células, cuadrangulares o rectangulares. Cuerpo unicelular cónico, ancho en la base. (Figs. 1:1A y 2:D).
- **B.** Base de 1–2 células. Cuerpo acicular, de 1–3 células uniseriadas, de tamaño desigual y de paredes delgadas. A veces se observaron tricomas con el cuerpo de 2 células, con la apical corta, ligeramente triangular y obtusa. (Fig. 1:1B).
  Variaciones raras: ocasionalmente ocurren tricomas simples del subtipo 1B, con un radio lateral reducido originándose de la base.
- **C.** Base pluricelular de células cuadrangulares a redondeadas. Cuerpo en forma acicular, de 3–4 células uniseridas. (Figs. 1:1C, 2:E, 2:F y 2:G).

2. Estrellados:

- **A.** Base generalmente de 4 células pequeñas, cortas. Cuerpo mayormente de 4 radios laterales, ocasionalmente 3, equidistantes, unicelulares, aciculares, de tamaño ligeramente desigual, porrectos o levantados hacia el radio central en ángulo ligeramente menor a 45° Un radio central unicelular de longitud mayor a los laterales. (Figs. 1:2A, 2:A, 2:B y 2:C).

3. Glandulares:

Cortos

- **A.** Base unicelular redondeada, en ocasiones sobresale de la epidermis. Cuerpo: a) Pie de 1–2 células, en caso de 2 células la anterior a la cabeza es corta y ligeramente más ancha en la zona de conexión con la cabeza. b) Cabeza de 4 o más células, generalmente globosa a subglobosa u ovoidea, con la parte angosta conectada al pie. (Figs. 1:3A y 2:J).

Largos

- **A.** Base de 1–2 células, prolongándose aproximadamente unos 15 mμ sobre la epidermis. Cuerpo: a) Pie de 2 células, la primera ligeramente lageniforme, la segunda corta y pequeña. b) Cabeza de 3 células, globosas y con contenido denso. (Figs. 1:3B y 2:H).
- **B.** Base de 1–2 células, en ocasiones las células de la base presentan mayor grosor que las células epidérmicas típicas, por lo que se prolongan sobre la epidermis 7–15 mμ. Cuerpo: a) Pie de 3 células de tamaño desigual. b) Cabeza generalmente unicelular, ovoidea con contenido denso. (Figs. 1:3B y 2:I)

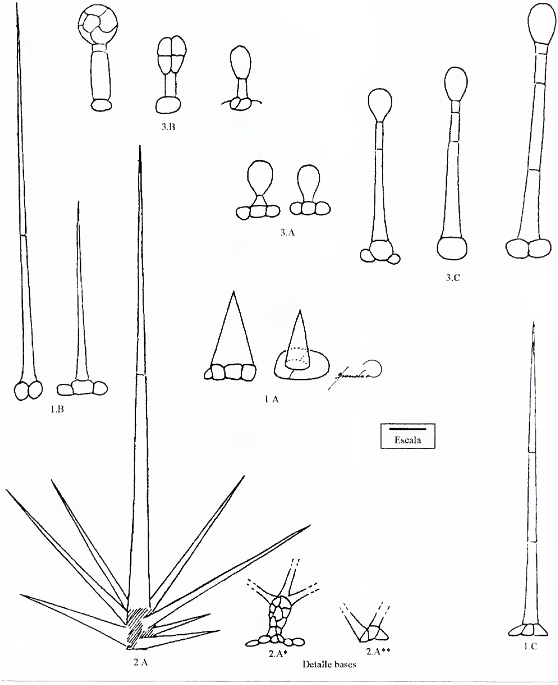


Fig. 1. Tipos de tricomas en *S. acerifolium*. **1)** Simples, subtipos: A, B y C. **2)** Estrellado, subtipo: A. **3)** Glandulares, subtipos: A, B y C. Escala: 1C: 30 µm. 1A, 1B, 3A, 3B, 3C: 50 µm. 2A: 100 µm.

Tricomas en *Solanum agrarium*

1. Simples:

- **A.** Base unicelular redondeada; cuerpo acicular o ligeramente cónico, de 1–2 células; cuando dos, éstas de diferente longitud, generalmente la primera más larga. (Figs. 3:1A y 4:J).
- **B.** Base unicelular obtusa piriforme (lageniforme), notablemente proyectada sobre la epidermis; cuerpo acicular, de 1–2 células. (Fig. 3:1B).

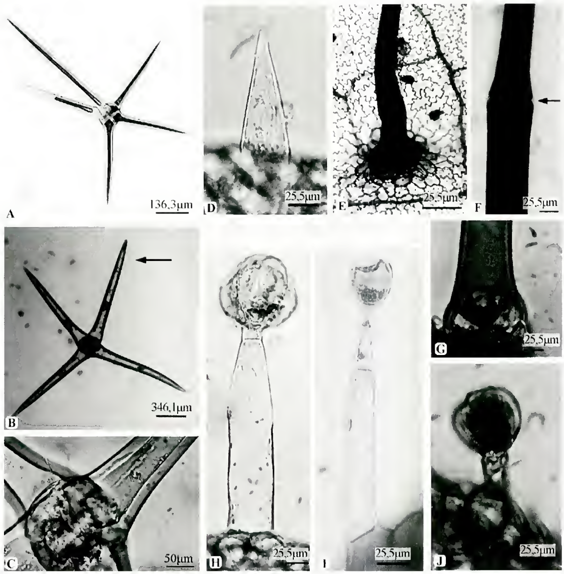


Fig. 2. Tricomas en *S. acerifolium*. Tricomas estrellados: A) De cuatro radios laterales. B) De tres radios laterales, el radio central señalado con la flecha. C) Detalle de la zona de origen de los radios laterales. Tricomas simples: D) Subtipo 1A. E) Detalle de la base pluricelular en tricoma subtipo 1C. F) Señalado con la flecha, se muestra en detalle la zona de unión de las células del cuerpo de un tricoma subtipo 1C. G) Detalle en sección transversal de la base pluricelular de tricoma subtipo 1C. Glandulares: H) Subtipo 3B. I) Subtipo 3C. J) Subtipo 3A.

C. Base unicelular cuadrangular; cuerpo alargado, grueso y formado por 4 células cortas, con paredes ligeramente gruesas. (Fig. 3:1C).

D. Base pluricelular, prolongándose ligeramente por encima de la epidermis; cuerpo acicular, de 2–4 células. (Figs. 3:1D, 4:G y 4:H).

2. Estrellados:

A. Cuerpo de 3 radios laterales, a veces 4 o 5, originándose de un punto común y colocados equidistantemente, unicelulares, aciculares, de tamaño desigual y porrectos. Un radio central unicelular ligeramente más largo que los laterales. (Figs. 3:2A, 4:A, 4:B y 4:C).

B. Cuerpo de 3 radios laterales, aciculares, unicelulares, de tamaño ligeramente desigual,

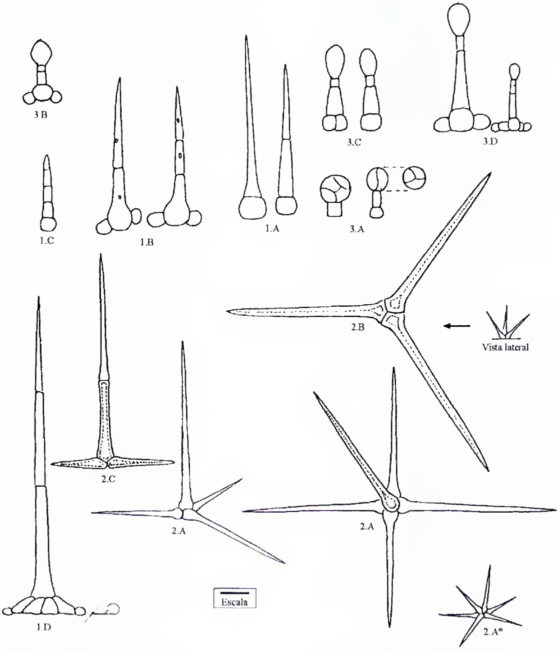


Fig. 3. Tipos de tricomas en *S. agrarium*. 1) Simples, subtipos A, B, C, y D. 2) Estrellados, subtipos A, B, y C. 3) Glandulares, Subtipos A, B, C, y D. Escala: 1A, 1B, 1C, 1D, 3A, 3B, 3C y 3D: 50 µm. 2A, 2B y 2C: 100 µm. 2A*: 200 µm.

originándose de un punto común y dispuestos en ángulo de unos 45° respecto al plano de la epidermis. (Figs. 3:2B y 4:D).

Muy raras veces se observó para el subtipo 2B, un pedícelo alargado de 1-2 células, que levanta notablemente los radios sobre la epidermis. Otra variación muy poco frecuente, es el subtipo 2B con numerosos radios laterales, finísimos y un radio central, ligeramente más grueso.

C. Cuerpo de 2 radios laterales unicelulares originándose de un punto común, aciculares, de tamaño ligeramente desigual, porrectos, rara vez ligeramente oblicuos; un radio central acicular, más largo que los radios laterales, de 1-2 células, cuando 2 la primera con paredes ligeramente gruesas. (Figs. 3:2C, 2:E y 2:I).

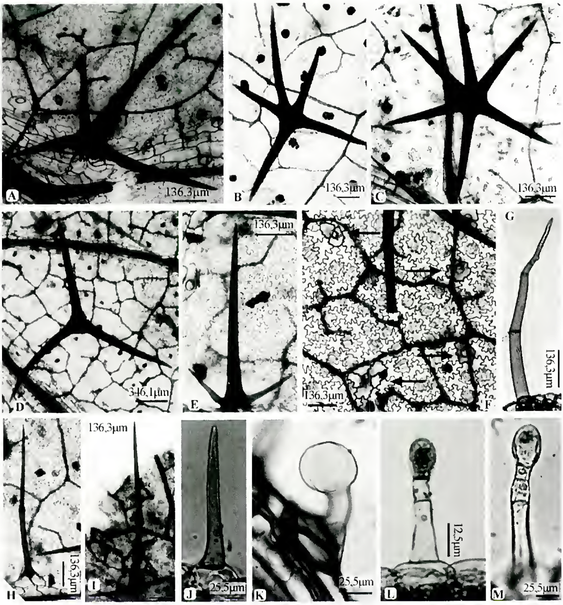


Fig. 4. Tricomas en *S. agrarium*. Tricomas estrellados: **A)** Subtipo 2A, con tres radios laterales. **B)** Subtipo 2A, con cuatro radios laterales. **C)** Subtipo 2A, con 5 radios laterales. **D)** Sub tipo 2B. **E)** Subtipo 2C, con el radio central unicelular. **I)** Subtipo 2C, con el radio central bicelular. Tricomas simples: **G)** Subtipo 1D. **H)** Subtipo 1A. **J)** Subtipo 1A. Tricomas glandulares: **K)** Subtipo 3A. **L)** Subtipo 3D. **M)** Subtipo 3D. **F)** Epidermis abaxial (VF) se muestra señalado con las flechas, bases de tricomas de 1,2 y 5 células.

3. Glandulares:

Cortos y medianos

A. Base unicelular. Cuerpo: a) Pie unicelular cilíndrico, corto a ligeramente alargado. b) Cabeza de 1–4 células. (Figs. 3.3A y 4 K)

B. Base unicelular. Cuerpo: a) Pie de 2 células, la primera célula alargada y ligeramente ancha hacia la base, luego una célula pequeña cuadrangular. b) Cabeza unicelular aovada a romboide ligeramente aguda hacia el ápice (Fig. 3.3B).

Largos

- **A.** Base de 1-2 células. Cuerpo: a) Pie de 2 células, la primera alargada, más ancha en la base, la segunda corta y ligeramente rectangular. b) Cabeza unicelular, aovada y alargada. (Fig. 3:3C).
- **B.** Base unicelular, a veces muy desarrollada y sobresale de la epidermis. Cuerpo: a) Pie de 2-3 células de tamaño diferente, la célula próxima a la cabeza, corta. b) Cabeza unicelular aovada y angosta hacia la parte inferior. (Figs. 3:3D. 4:L, 4:M).

Tricomas en *Solanum capsicoides*

1. Simples:

- **A.** Base unicelular grande, prolongándose ligeramente sobre la epidermis. Cuerpo unicelular de forma cónica-alargada, casi acicular hacia la parte superior. (Figs. 5:1A y 6:A).
- **B.** Base con 2-3 células, cuerpo cónico, de 3 células con paredes ligeramente gruesas y con un ligero engrosamiento de la pared celular, en las zonas de unión de las células. (Figs. 5:1B y 6:C).
- **C.** Base pluricelular. Cuerpo acicular de hasta 6 células, de longitud desigual; la primera algo ancha hacia la zona de unión con la base del tricoma. (Fig. 5:1C).
- **D.** Base pluricelular de 3 capas, prolongándose notablemente sobre la epidermis. Cuerpo delgado en forma de "látigo," de 4-5 células alargadas. (Figs. 5:1D y 6:A).

2. Glandulares:

Cortos y medianos

- **A.** Base unicelular redondeada. Cuerpo. a) Pie unicelular, alargado-rectangular o corto-cuadrangular. b) Cabeza de 1-2 células, aovada. (Figs. 5:2A y 7:B).
- **B.** Base de 1-2 células cuadrangulares. Cuerpo: a) Pie alargado-rectangular o ligeramente-ancho hacia la base, de 1-2 células; cuando 2 la anterior a la cabeza es más corta. B) Cabeza globosa, grande, de 4 o más células, a veces con un angostamiento en la zona de unión con el pie. (Figs. 5:2B. 7:A, 7:B y 7:C).

Largos

- **A.** Base de 1-2 células, prolongándose ligeramente sobre la epidermis. Cuerpo: a) Pie generalmente de 2 células o unicelular; cuando 2 células, la segunda corta y cuadrangular. b) Cabeza uni ó pluricelular. (Figs. 5:2C, 7:D y 7:E).

Tricomas en *Solanum mammosum*

1. Simples:

- **A.** Base de 1-3 ligeramente de la epidermis. Cuerpo acicular generalmente de 3-4 células. (Fig. 8:1C).

2. Estrellados:

- **A.** Base pluricelular corta o alargada, pedicelada, formando una estructura a modo de papila (Fig. 8:2A*), rara vez la base no pedicelada (Figs. 8:2A** y 9:C). Radios laterales hasta 8, unicelulares, de longitud desigual y originándose de diferentes puntos; rara vez radios laterales bicelulares. El radio central acicular generalmente de 2 células, la primera más larga y de paredes ligeramente engrosadas. (Figs. 8:2A, 9:A y 9:B).

3. Glandulares:

Cortos

- **A.** Base unicelular de células redondeadas. Cuerpo: a) Pie generalmente ausente; cuando presente, muy corto, unicelular, ancho en la zona de unión con la base y estrecho en la zona de unión con la cabeza. b) Cabeza unicelular, ovoide y grande. (Figs. 8:3A).

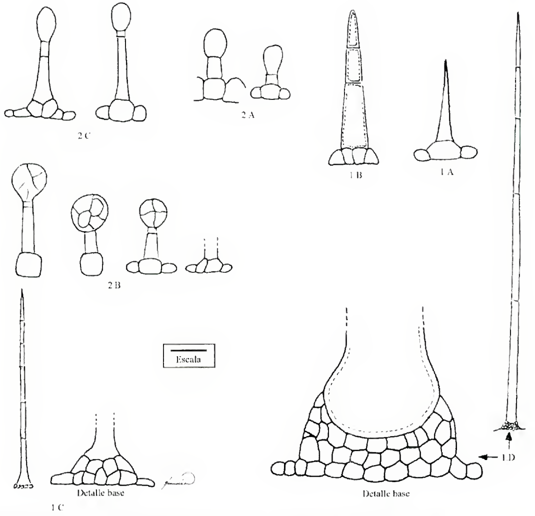


Fig. 5. Tipos de tricomas en *S. capsicoides*. 1) Simples, subtipos A, B, C y D. 2) Glandulares, subtipo: A, B y C. Escala: 1A, 1B, 2A, 2B, 2C y detalle base de 1D: 50 µm. 1C y 1D: 500 µm. Detalles base de 1C: 100 µm.

B. Base de 1-2 células. Cuerpo: a) Pie 1-2 células, ligeramente ancho. B) Cabeza de 1-5 células o más, ovoide a globosa. (Figs. 8:3B, 9.I y 9.F).

Largo

A. Base de 1-3 células redondeadas, a veces prolongándose sobre la epidermis. Cuerpo. a) Pie de 2-4 células; cuando 4 la última es estrecha en su parte inferior y ligeramente más ancha en la zona de unión con la cabeza. b) Cabeza de 1-varias células, ovoide a ligeramente alargada (Figs. 8.3C, 9:G y 9:H).

B. Caracterización cuantitativa de los tipos tricomáticos y su ubicación topográfica en la hoja.—Las dimensiones de los tricomas determinadas para cada una de las especies tratadas (Cuadros 2, 3, 4 y 5) están referidas a la longitud de los diferentes tipos de tricomas, grosor en sección transversal (ST) de la base, diámetro en vista frontal (VF) en bases pluricelulares, longitud del cuerpo del pie o de los radios y longitud de la cabeza en tricomas glandulares.

Igualmente para cada tipo tricomático se señala la ubicación topográfica,

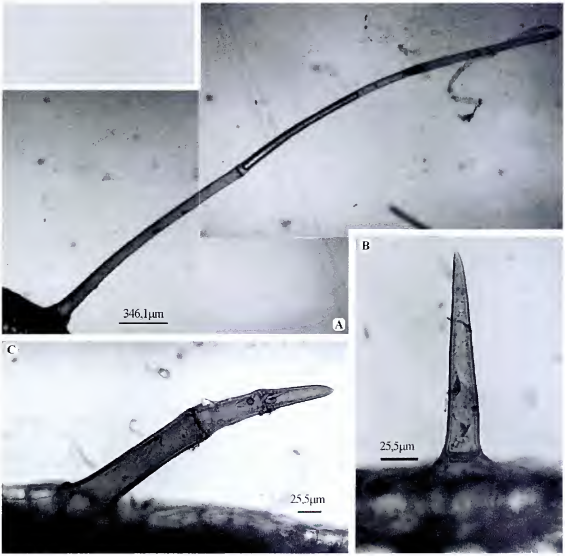


Fig. 6. **Tricomas en *S. capsicoides*. Tricomas simples: A) Subtipo 1D. B) Subtipo 1A. C) Subtipo 1B.**

según su ocurrencia en la lámina foliar: superficie adaxial y abaxial, nervadura media y pecíolo.

La familia Solanaceae y en especial el género *Solanum* exhiben una amplia riqueza de tricomas, rasgo importante en la sistemática de este grupo (Solereder 1908; Metcalfe y Chalk 1950; Seithe 1962). En correspondencia con ello, para cada una de las especies estudiadas se identificaron patrones consistentes de diferentes formas de tricomas.

Las especies estudiadas mostraron tricomas estrellados de pocos radios y ocurriendo sólo en la cara abaxial de la hoja (excepto en *S. capsicoides*); igualmente presentaron tricomas simples de pocas células, hialinos o translúcidos y a veces tricomas simples con radios vestigiales en la base, como se observó en *S. acerifolium*. Todos estos rasgos se han mencionados para el indumento en especies de la secc. *Acanthophora* (Nee 1991).

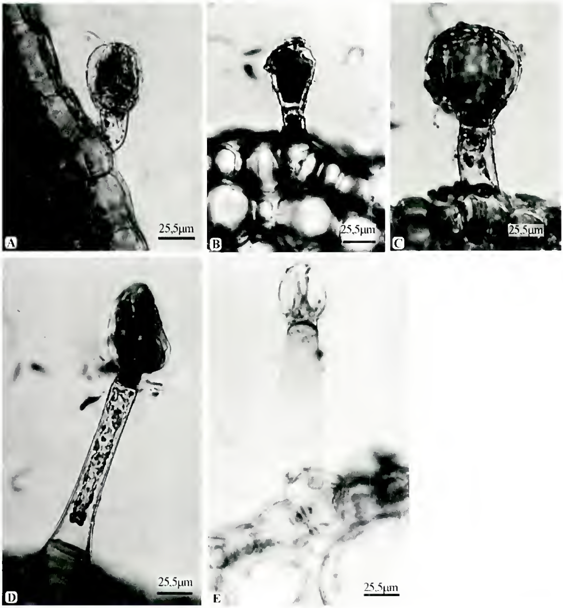


Fig. 7. Tricomas en *S. capsicoides*. Tricomas glandulares: A) y B) Subtipo 2A. C) Subtipo 2B. D) y E) Subtipo 2C.

De las especies aquí tratadas, *S. acerifolium* presenta menor variabilidad en el tipo de tricoma estrellado con respecto a *S. agrarium*, en la que ocurren 3 subtipos, de los cuales uno carece de radio central (Fig. 3:2B y Fig. 4:D). En esta última especie destaca igualmente, el tricoma simple de base lageniforme en la nervadura principal (Fig. 3:1B). *Solanum capsicoides* se diferencia del resto de las especies, porque carece de tricomas estrellados; siendo la única especie de la sección con esta característica (Nee 1991). Asimismo, en esta especie se encontró un tricoma simple en forma de látigo (Fig. 5:1D y Fig. 6:A), que resalta por sus dimensiones (5.9–6 mm de largo), por su base pluricelular y por ocurrir exclusivamente en la epidermis del pecíolo.

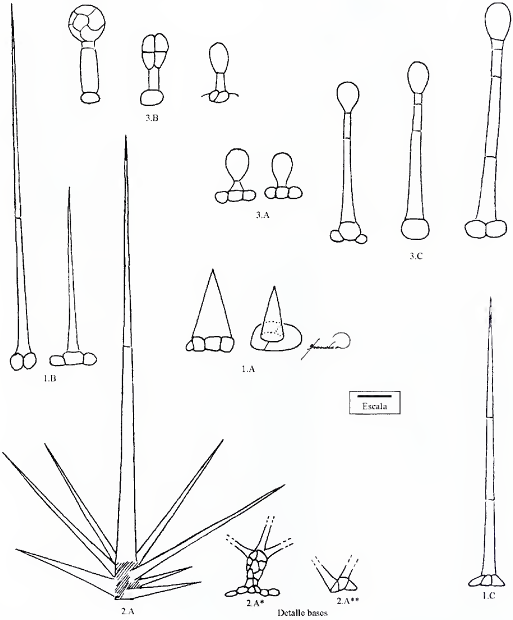


Fig. 8. Tipos de tricomas en *S. mammosum*. 1) Simples, subtipos. A, B, y C. **2)** Estrellado, subtipo: A, con dos variantes para la base según 2.A* y 2.A**. **3)** Glandulares, subtipos: A, B y C. Escala: 1A, 1B, 2A**, 3A, 3B, y 3C: 50µm. 1C y 2A*: 100 µm. 2A: 125µm.

D. Características generales del indumento foliar.—Los tricomas estrellados ocurren en 3 de las especies analizadas (*S. acerifolium*, *S. agrarium* y *S. mammosum*) exclusivamente en la superficie abaxial de la hoja, por su parte, *S. capsicoides*, que carece de este tipo de tricoma. Igualmente otro rasgo generalizado, es la presencia de tricomas simples y glandulares.

El indumento registrado cualitativamente para las especies es:
Solanum acerifolium: indumento velloso en hojas jóvenes, luego puberuloso hasta

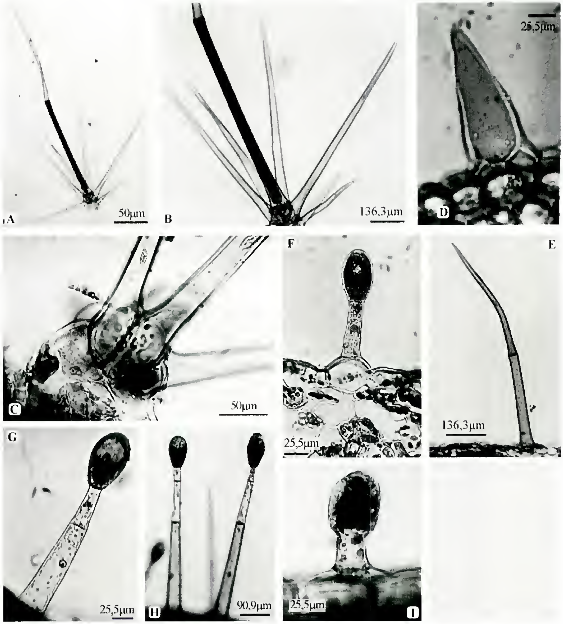


Fig. 9. Tricomas en *S. mammosum*. Tricomas Estrellados: A) Vista lateral del Subtipo 2A. B) Detalle de los radios laterales y la primera célula del radio central. C) Detalle en sección transversal de una base ancha y no pedicelada. Tricomas simples: D) Subtipo 1A. E) Subtipo 1C. Tricomas glandulares: F) G) y H) Subtipo 3C. I) Subtipo 3B.

pubescente, los tricomas simples con densidad más o menos constante en ambas caras; los estrellados dispersos con tendencia a concentrase en el tercio basal de la lámina.

Solanum agrarium: indumento pubéruloso hasta velloso, con mayor densidad sobre los nervios; tricomas estrellados de 3 y 4 radios laterales, menos común de 2 y 5 radios laterales. Los tricomas estrellados con tendencia a ubicarse con mayor densidad hacia los tercios basal y apical de la hoja.

Solanum capsicoides: indumento de tricomas simples, pubéruloso hasta velloso,

Cuadro 2. Morfometría y ubicación de tricomas en la hoja de *Solanum acerifolium*.

Base				Cuerpo				Ubicación topográfica
				Pie		Cabeza		
Tipo Básico	**Sub Tipo**	**N° de células**	**Grosor y/o diámetro Aproximado en Vista frontal (μm)**	**N° de células ó N° de radios**	**Longitud μm del cuerpo, pie ó radios**	**N° de células**	**Longitud (μm)**	
1. Simple	A	1–2	g: 17–25	1	c: 18–237	-	-	L: ad, ab; NP,
	B	1–3	g: 15–37	1–3	c: 08–422	-	-	L: ad, ab. NP, Pe.
	C	Pluricelular	g: 55–179. Ø: 125–520	3–4	c: 25–1100	-	-	L: ad, ab.
2. Estrellado	A	Pluricelular	g: 6.8	r: 5	r: 217 - 625	-	-	L: ab.
3. Glandular	A	1	g: 12–25	1–2	p: 17–38	4–6	17–38	L: ad, ab. NP, Pe.
	B	1–2	g: 27–40	2	p: 142–170	3	55–67	L: ad, ab. NP, Pe.
	C	1–2	g: 27– 42	3	p: 97–455	Pluricelular	25–68	L: ad, ab. NP, Pe.

g: grosor. Ø: diámetro en vista frontal. **c**: longitud del cuerpo. **p**: longitud del pie. **r**: longitud de radios **L**: lámina foliar. **ad**: superficie adaxial. **ab**: superficie abaxial. **NP**: nervadura principal. **Pe**: pecíolo.

Cuadro 3. Morfometría y ubicación de tricomas en la hoja de *Solanum agrarium*.

		Base		Cuerpo				Ubicación topográfica
				Pie		Cabeza		
Tipo Básico	Sub Tipo	N° de células	Grosor y/o diámetro Aproximado en Vista frontal (μm)	N° de células ó N° de radios	Longitud μm del cuerpo, pie ó radios	N° de células	Longitud (μm)	
1. Simple	A	1	g: 25–55	1–2	c: 132–330	-	-	L: ad, ab. NP, Pe.
	B	1	g: 82–113	1–2	c: 162–187	-	-	NP.
	C	1	g: 30–37	4	c: 110–125	-	-	NP.
	D	Pluricelular	g: 30–50. ∅: 120–273	3–4	c: 875–2125	-	-	L: ad, ab.
2. Estrellado	A	-	-	r: 4–6	r: 270–825	-	-	L: ab.
	B	-	-	r: 3	r: 500–700	-	-	L: ab.
	C	Pluricelular	-	r: 2–3	r: 200–790	-	-	L: ab.
3. Glandular	A	1	p: 12–25	1	p: 22–47	1–4	17–32	L: ad, ab. Pe
	B	1	p: 25–37	2	p: 35–65	1	30–55	L: ad, ab. NP, Pe.
	C	1–2	p: 12–37	2–3	p: 37–70	1	50–67	L: ad, ab. NP, Pe.
	D	1	p: 25–38	2–3	p: 50–115	1	31–52	L: ad, ab. NP, Pe.

g: grosor. **∅**: diámetro en vista frontal. **c**: longitud del cuerpo. **p**: longitud del pie. **r**: longitud de radios **L**: lámina foliar. **ad**: superficie adaxial. **ab**: superficie abaxial. **NP**: nervadura principal. **Pe**: pecíolo.

CUADRO 4. Morfometría y ubicación de tricomas en la hoja de *Solanum capsicoides*.

		Base		Cuerpo				Ubicación topográfica
				Pie		Cabeza		
Tipo Básico	Sub Tipo	N° de células	Grosor y/o diámetro Aproximado en Vista frontal (µm)	N° de células N° de radios	Longitud µm del cuerpo, pie ó radios	N° de células	Longitud (µm)	
1. Simple	A	1	47-52	1	c: 115–130			L: ad, ab. NP, Pe.
	B	2–3	g: 9–15 Ø: 30–35	3	c: 150–170	-	-	L: ad, ab.
	C	Pluricelular	g: 50–90 Ø: 125–250	3–7	c: 210–2925			L: ab, ad.
	D	Pluricelular	g: 62–95 Ø: 255–273	4–5	c: 5900–6000			Pe.
2. Glandular	A	1-2	g: 15–25	1	p: 22–37	5–6	22–100	L: ad, ab. NP, Pe.
	B	1	g: 15–22	1–2	p: 30–53	2–4	37–52	L: ad, ab. NP, Pe.
	C	1–2	g: 30–35	1–2	p: 77–97	1	20–42	L: ad, ab. NP, Pe.

g: grosor. **Ø**: diámetro en vista frontal. **c**: longitud del cuerpo. **p**: longitud del pie. **L**: lámina foliar. **ad**: superficie adaxial. **ab**: superficie abaxial. **NP**: nervadura principal. **Pe**: pecíolo.

CUADRO 5. Morfometría y ubicación de tricomas en la hoja de *Solanum mammosum*.

		Base		Cuerpo				Ubicación topográfica
				Pie		Cabeza		
Tipo Básico	Sub Tipo	N° de células	Grosor y/o diámetro Aproximado en Vista frontal (µm)	N° de células ó N° de radios	Longitud µm del cuerpo, pie ó radios	N° de células	Longitud (µm)	
1. Simple	A	1–3	g: 20–45	1	c: 45–107	-	-	L: ad, ab. Pe.
	B	1–2	g: 22–37	1–2	c: 250–500	-	-	L: ad, ab. NP. Pe.
	C	Pluricelular	g: 25–30. Ø: 75–112	2–5	c: 730–1360	-	-	L: ad, ab.
2. Estrellado	A	Pluricelular	g: 30–130. Ø:70–320	r: hasta 8	r laterales: 400–1250. r central: 1520–1730	-	-	L: ab.
3. Glandular	A	1	g: 15–20	0–1	p: 7–12	1	52–65	L: ad, ab. Pe.
	B	1–2	g: 17–25	1–2	p: 12–75	3–5	27–55	L: ad, ab. NP.
	C	1–3	g: 22–38	2–3	p: 70–220	1	40–87	L: ad, ab. NP, Pe.

g: grosor. **Ø**: diámetro en vista frontal. **c**: longitud del cuerpo. **p**: longitud del pie. **r**: radios **L**: lámina foliar. **ad**: superficie adaxial. **ab**: superficie abaxial. **NP**: nervadura principal. **Pe**: pecíolo.

con mayor densidad en la haz; tricomas escasos en el envés y con mayor densidad sobre los nervios.

Solanum mammosum: indumento pubescente, velutino, velloso o rara vez puberuloso, pelos simples y glandulares en ambas caras; tricomas estrellados de radios laterales más finos que el radio central.

D. Clave para las especies de *Solanum* sección *Acanthophora* de Venezuela, con base en tipos de tricomas.

1. Indumento con tricomas estrellados ausentes en ambas caras de la hoja ___ **S. capsicoides** All.
1. Indumento con tricomas estrellados en la cara abaxial de la hoja.
    2. Tricomas estrellados con pedicelo corto, radios laterales originándose de diferentes puntos ___ **S. mammosum** L.
    2. Tricomas estrellados sésiles, radios laterales originándose de un punto común.
        3. Tricomas con 4 radios laterales, en ocasiones con 3; radio central siempre presente y unicelular ___ **S. acerifolium** Dun.
        3. Tricomas estrellados con 2, 3, 4, o 5 radios laterales; radio central ausente en un tipo de tricoma con tres radios laterales y a veces bicelular en tricomas con dos radios laterales ___ **S. agrarium** Sendtn.

AGRADECIMIENTOS

Los autores desean expresar su gratitud a la Facultad de Agronomía, Vicerrectorado Académico y Concejo de Desarrollo Científico y Humanístico, todos de la Universidad Central de Venezuela, por la ayuda financiera. Igualmente a los herbarios CAR, MY, MYF, MER, MERF y VEN por el apoyo durante la consulta del material de herbario.

REFERENCIAS

Ahmad, K.J. 1964. Epidermal studies in *Solanum*. Lloydia 27:243–250.

D'Arcy, W.G. 1991. The Solanaceae since 1976, with a review of its biogeography. In: Solanaceae III. Taxonomy, chemistry and evolution. J.G. Hawkes, R.N. Lester, M. Nee and N. Estrada-R., eds. The Royal Botanic Gardens, Kew. Richmond, Surrey, UK. Pp. 75–137

Dizeo de Strittmatter, C. 1973. Nueva técnica de diafanización. Bol. Soc. Argent. Bot. 15: 127–129.

Dunal, F. 1813. Histoire naturelle, médicale et économique des *Solanum*, et des genres qui ont eté confondus avec eux. Paris. Pp. 131, 218.

Dunal, F. 1852. Solanaceae. En: DC. Prodr. 13(1):1–169.

Font Quer, P. 1953. Diccionario de botánica. Editorial Labor. Barcelona, España.

Granada-Chacón, W.A. y C.E. Benítez de Rojas. 2004. Anatomía foliar de cuatro especies de *Solanum* L. sección *Acanthophora* Dunal en Venezuela. Acta Ci. Venez. 55:13–26

Harris, J.G. and M. Woolf Harris. 1994. Plant identification terminology and illustrated glossary. Spring Lake Publishing. Utah, U.S.A.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett 1990. Index herbariorum. I part. Eigth edition. International Assocition for Plant Taxonomy. New York Botanical Garden. USA. Pp. 570, 607, 611, 644.

Metcalfe, C.R. and L. Chalk. 1950. Anatomy of the Dicotyledons. Vol. II. Clarendon Press, Oxford. Pp. 965–978.

Nee, M. 1991. Synopsis of *Solanum* Section *Acanthophora*: A group of interest for glycoalkaloids. In: Solanaceae III. Taxonomy, chemistry and evolution. J.G. Hawkes, R.N. Lester, M. Nee and N. Estrada-R., eds. The Royal Botanic Gardens and Linnean Society London. Pp. 257–266.

Nee, M. 1999. Synopsis of *Solanum* in the New World. In Solanaceae IV. M. Nee, D.E. Symon, R.N. Lester and J.P. Jessop, eds. Royal Botanic Gardens, Kew. Pp. 285–333.

Peña, E. y H. Saralegui. 1982. Técnicas de anatomía vegetal. Universidad de la Habana, Cuba. Pp. 97–97.

Roe, K.E. 1971. Terminology of hairs in the genus *Solanum*. Taxon 20:501–508.

Roth, I. 1964. Microtécnica vegetal. Universidad Central de Venezuela. Facultad de Ciencias, Escuela de Biología. Imprenta Universitaria. Caracas. Pp. 20–29.

Sakai, W. 1973. Simple method for differential staining of paraffin embedded plant material using toluidine blue O. Stain Technol. 48:247–249.

Seithe, A. 1962. Die Haararten der gattung *Solanum* L. Bot. Jahrb. Syst. 81:261–336.

Seithe, A. 1979. Hair types as taxonomic characters in *Solanum*. In: The Biology and Taxonomiy of Solanaceae. J.G. Hawkes, R.N. Lester and A.D. Skelding, eds.. Linnean Soc. Symp., Ser. 7. Academic Press, London. Pp 307–319.

Shobe, W.R. and N.R. Lersten. 1967. A technique for clearing and staining gymnosperm leaves. Bot. Gaz. 128:150–152.

Solereder, H. 1908. Systematic anatomy of the dicotyledons. Vol. I. Claredon Press, Oxford. Pp. 575–583.

Stearn, W. 1992. Botanical Latin. History, grammar, syntax. terminology and vocabulary. Fourth Ed. Timber Press. Portland, Oregon.

INTRODUCED SPECIES IN KANSAS: FLORISTIC CHANGES AND PATTERNS OF COLLECTION BASED ON AN HISTORICAL HERBARIUM

Teresa M. Woods

Herbarium and Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.

Suzanne C. Strakosh

Herbarium and Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.

Madhav P. Nepal

Herbarium and Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.

Seemanti Chakrabarti

Department of Entomology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.

Nicholas B. Simpson

Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.

Mark H. Mayfield

Herbarium and Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.

Carolyn J. Ferguson[1]

Herbarium and Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901, U.S.A.
ferg@ksu.edu

ABSTRACT

Herbaria with significant historical collections are critical to tracking floristic changes such as the introduction and spread of non-native plant species. To explore the importance of herbarium specimen data for understanding floristic changes in the central Great Plains, we utilized the Kansas State University Herbarium (KSC), known for its rich historical collections dating from the late 1800s. A list of all angiosperm plant taxa introduced to Kansas was obtained, and collection data (collector, number, year and county) were recorded for all in-state specimens (excluding cultivated material). A total of 6,565 specimens were recorded, comprising 314 species, 201 genera and 50 families, and dating from 1869. Of the recognized introduced species, 153 are represented by KSC collections made in Kansas prior to 1900, and 243 prior to 1940. All Kansas counties are well-represented by the early KSC material (1890s), bolstering our ability to infer floristic changes since that time. While 988 different collectors are represented, 14 collectors account for 52% of the specimens of introduced species. Peak collecting at KSC occurred in the 1890s and 1930s, and assessment of biases suggest that our data are a reasonably accurate representation of the presence and distribution of introduced species in Kansas at those times. Species not represented by pre-1900 KSC material were likely not established or even introduced in the state at the time; if a species was not documented prior to 1940 it was likely still not well established by then. This study demonstrates the utility of data housed at KSC, and by extension in other historical collections, for the study of regional floristic changes.

---

[1] Author for correspondence

SIDA 21(3): 1695–1725. 2005

RESUMEN

Los herbarios con colecciones históricas significativas son críticos para rastrear los cambios florísticos tales como la introducción y la extensión de las especies de plantas que no son nativas. Para explorar la importancia de datos de especímenes de herbario para entender los cambios florísticos en las llanuras centrales de Norteamérica, nosotros utilizamos el Herbario de Kansas State University (KSC), conocido por sus colecciones históricas ricas en datos desde el final de los 1800. Se obtuvo una lista de todas las angiospermas introducidas en Kansas, y los datos de la colección (el coleccionista, número, año y condado) fueron registrados para todos los especímenes del estado (excluyendo el material cultivado). Se registró un total de 6565 especímenes, que se incluyen en 314 especies, 201 géneros y 50 familias, que datan desde 1869. De las especies introducidas que se reconocieron, 153 son representadas por colecciones de KSC hechas en Kansas antes de 1900, y 243 antes de 1940. Todos los condados de Kansas están bien representados por el material inicial de KSC (1890s), reforzando nuestra habilidad de inferir los cambios florísticos desde ese tiempo. De los 988 colectores diferentes existentes, 14 de ellos son responsables del 52% de los especímenes de especies introducidas. Los puntos máximos de recolección en KSC ocurrieron en los 1890 y los 1930, y la evaluación de los sesgos sugiere que nuestros datos son una representación razonablemente precisa de la presencia y la distribución de las especies introducidas en Kansas en esos tiempos. Las especies no representadas en el material de KSC antes de 1900 probablemente no estaban establecidas ni habían sido introducidas aún en el estado en ese tiempo; si una especie no se documentó antes de 1940, es probable que todavía no estuviese bien establecida. Este estudio demuestra la utilidad de los datos de KSC, y por extensión de otras colecciones históricas, para el estudio de cambios florísticos regionales.

INTRODUCTION

Many non-native plants in North America were introduced decades and even centuries ago through agriculture, horticulture, shipping, and tainted seed imports, among other avenues (Mack & Lonsdale 2001; Reichard & White 2001; Costello & McAusland 2003; Cox 2004). After initial colonization, some introduced species became established and even spread in their new environments, at times altering the landscape profoundly (D'Antonio & Vitousek 1992; Gordon 1998; Callaway & Aschehoug 2000; Lavoie et al. 2003). The necessity of understanding the biological processes of establishment, spread, and invasion of introduced species has come into acute focus in recent decades as introduced species have caused immense economic and environmental damage (Pimentel et al. 2000; Naylor 2000; Zavaleta 2000). New associations with seed dispersers, pollinators, microorganisms, herbivores, pathogens, and other plants sometimes inhibit the spread of alien plant species, and sometimes foster their proliferation (Richardson et al. 2000a; Klironomos 2002; Siemann & Rogers 2003; Parker & Haubensak 2002; Callaway et al. 2004; Cox 2004; Kellogg & Bridgham 2004). As the number of introduced species has grown, so has the complexity of their ecological interactions in their adventive environments (Daehler 1994; Daehler & Strong 1997; Gordon 1998; Simberloff & Von Holle 1999; Callaway & Aschehoug 2000; Vilá et al. 2000; Daehler 2003; Brooks et al. 2004).

Given that many introductions into North America occurred well over a century ago, studies of the distributional history of non-native species can provide us with the knowledge of temporal and spatial data (e.g. earliest locations, patterns of colonization, rates of spread, etc.) to understand past introductions more completely (Mack 2000; Meekins et al. 2001; Novak & Mack 2001). A better understanding of the establishment, distributional changes, and community associations of introduced taxa over time is vital to making informed decisions in managing existing introductions and in predicting future invasions (Ricciardi et al. 2000; Kolar & Lodge 2001; Lambrinos 2001; Lavoie et al. 2003; Dybos 2004; Simpson 2004).

The most reliable resources for historical research of biological distributions are natural history collections (Soberón et al. 2000; Ter Steege et al. 2000; Prather et al. 2004a, 2004b). As repositories of well-preserved plant specimens complete with spatial and temporal data, herbaria provide indisputable documentation of plant species occurrence, and form the very basis of floristic and plant taxonomic science as well as biodiversity studies (Prather et al. 2004b; Suarez & Tsutsui 2004). Herbarium specimens have been used effectively to document plant distributional changes such as species declines (Laughlin 2003; Lavoie et al. 2003) and spread of introduced plant species (Sheeley & Raynal 1996; Pyšek et al. 1998; Weber 1998; Lambrinos 2001; Novak & Mack 2001; Mihulka & Pyšek 2001; Pyšek et al. 2001; Delisle et al. 2003; Lavoie et al. 2003). Given that natural history collections contain inherent temporal and spatial inconsistencies, floristic analyses based on herbarium data must take into account collection biases (Soberón et al. 1996; Mack 2000; Mihulka & Pyšek 2001; Delisle et al. 2003). For instance, the date of first record of a species in an herbarium may accurately represent its approximate time of arrival in the region; alternatively, the date of first record may occur long after a particular species first appeared in the flora due to sparse collecting prior to documentation.

The Kansas State University Herbarium (KSC), founded in 1877, holds an extensive collection of significant historical specimens from the Great Plains of central North America. Indeed, an estimated 40% of its ca. 180,000 specimens of vascular plants were collected prior to 1900 (Barnard 2003), largely in association with the efforts of the distinguished botanist, A. S. Hitchcock, an early KSC curator who directed the herbarium from 1890 to 1901. Hitchcock promoted extensive collecting among his students and colleagues, and as a result, he and his protégés deposited a rich record of Kansas plant specimens at KSC prior to 1900 (Barkley 1965). Since then, KSC has been maintained and enhanced by numerous dedicated and productive curators (e.g., F.C. Gates, who directed KSC from 1919–1955; L.C. Hulbert, 1955–1961; and T.M. Barkley, 1961–1998). The result is an outstanding resource for researching historical floristic changes.

To explore the importance of herbarium specimen data for understanding floristic changes in the central Great Plains as represented by Kansas, we inventoried all specimens of non-native flowering plants collected in the state that are housed at KSC, identifying first records and subsequent temporal data for each species. Earliest date of collection for each species was also cross-referenced with data at the R.L. McGregor Herbarium of the University of Kansas (KANU). To enable more robust floristic inferences, we determined collecting biases based on the KSC material, ascertaining collecting activity levels across time periods, spatial collecting patterns and effects of major collectors. These patterns demonstrate the utility of the historical component of the collections within the KSC herbarium and, moreover, the general importance of natural history collections as tools for understanding the dynamics of biological history.

METHODS

An initial list of introduced flowering plant species occurring in Kansas was obtained from the PLANTS Database (USDA National Resources Conservation Service; plants.usda.gov). *Introduced* or *non-native* species (also synonymous with *alien*, *exotic* and *nonindigenous* species) are here defined as those originating on other continents that are present in North America due to human activity. While there are certainly cases of native North American taxa that have been introduced into Kansas from other regions, our definition enabled us to analyze data for the vast majority of species not native to Kansas and it minimized ambiguity regarding geographic origins. We aimed to include in this analysis species recognized as *naturalized plants* (sensu Nesom 2000; Richardson et al. 2000b), and we also included species documented as *waifs* and *persisting* (Nesom 2000; the *casual alien plants* of Richardson et al. 2000b; when in doubt about persistence, we included material).

KSC was then inventoried for these species, and the following data were obtained for each specimen: species, year of collection, county, collector(s), and collection number. KSC material is generally filed following *Flora of the Great Plains* (FGP: Great Plains Flora Association 1986). Thus, when a PLANTS name was encountered that was updated or otherwise differentially recognized over FGP, the herbarium holdings were consulted for material potentially filed under the name recognized by PLANTS and the corresponding synonym(s) in FGP. Differences in taxonomy as represented by PLANTS relative to FGP were reconciled prior to analyses.

Because our goal was to count collections, we deleted duplicates when we knew of them (e.g., same collector with all other data present and matching). However, there may be early collection duplicates that are not deleted because they could not be identified as such (e.g., Hitchcock did not use collection numbers). Because of this ambiguity, we herein use the term *specimen* to refer to what was counted, i.e., each sheet representing—to the best of our knowledge—one collection. In addition, specimens were excluded if they lacked temporal data (year) or clearly represented cultivated material. The determination of whether or not a specimen represented cultivated material was occasionally difficult, particularly for historical collections with limited label data. With regard to taxon identification, we generally depended on the well-curated status of the collection, only checking identifications when the investigators had questions or when preliminary analysis pointed to potential problems.

Temporal patterns were determined by conducting searches of the database for material corresponding to each decade. We defined a decade as beginning with the year ending in "0" and ending with the year ending in "9"; for example, the 1890s corresponds to material collected from 1 January 1890 to 31 December 1899. We also used a KSC data set from a related study (Prather et al. 2004a; on general temporal trends in collecting in the United States) to analyze temporal collecting patterns for a sample of Kansas specimens of native species relative to our data for introduced species. Additionally, we compared our data on timing of first collection for each species to the earliest records housed at KANU based on the KANU specimen database.

Spatial collecting patterns were mapped to the county level (ArcGIS version 9.0, ESRI) to explore numbers of species and specimens documented by the KSC collection by the end of major collecting peaks. Specimens lacking clear county information were excluded from spatial analysis. To assess spatial biases, we compared the spatial collecting patterns to population centers (defined as counties that have or have had a population of 30,000 or greater at any time since 1900, based on data from the Kansas Census Bureau; www.census.gov/population/cencounts/ks190090.text; www.census.gov/popest/counties/tables/CO-EST2003-01-20.pdf), and present locations of four year colleges and universities (Kansas on the Net; www.kotn.org/colleges.html).

To study biases due to particular collectors, we identified major collectors for this study (defined as individuals who contributed 100 or more of the Kansas specimens in our sample), and examined their collecting time frames, numbers of collections, and numbers of counties covered.

RESULTS

Specimens of non-native taxa in the KSC collection.—A total of 6,565 specimens of introduced flowering plants were recorded from KSC, comprising 314 species, 201 genera and 50 families (App. 1). Of the 412 species on the initial list obtained from PLANTS, 80 were excluded from our study because 1) they are in fact native species contrary to their listing in PLANTS as introduced, 2) we considered them to occur only under cultivation and not to persist in the Kansas flora as defined above, or 3) we found no vouchers at KSC or KANU (some of these were cited in previous literature but do not actually occur in Kansas; others may in fact occur or have occurred but are not vouchered at KSC or KANU and warrant further investigation). Twenty-four introduced species were added to the list because 1) they are in fact introduced species contrary to their listing in PLANTS as native, 2) they were discussed as additional taxa for Kansas by Freeman et al. (1998), 3) taxon recognition at the species level is favored over recognition at the subspecific level in PLANTS, or 4) we were aware of their

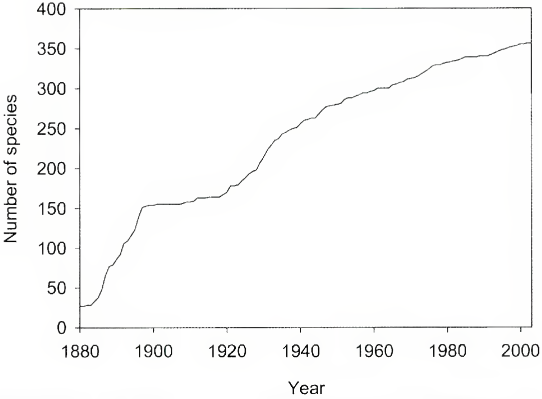


Fig. 1. Cumulative number of introduced species recorded at both KSC and KANU per year. The sharp rise shown in the number of species on record between 1880 and 1900 is what would be expected as a result of high collecting activity (Figs. 2, 4) and an initial documentation period during which time species that perhaps had long existed in the flora were initially collected. The low rate of increase from 1900 to 1930 corresponds with low collecting activity generally at both institutions (Prather et al., 2004a). The rate rose again in the early 1930s, only to slow later in the decade, despite it being a time of peak collecting activity at KSC, suggesting that most introduced species present in the flora at that time were, in fact, accounted for then. We expect that most introduced species present today are documented, because collecting activity in the latter half of the 20th century at KANU was relatively strong (Prather et al., 2004a).

presence in the Kansas flora. The changes made relative to the PLANTS list, with notes, are provided in Appendix 2.

Temporal collecting patterns.—A total of 1,994 Kansas KSC specimens representing 153 introduced species pre-date 1900. By 1940, 3,737 specimens and 243 species were represented (Figs. 1, 2a). Peaks in collection of introduced species in Kansas occurred in the 1890s and 1930s, with relatively reduced collecting activity in the 1900s, 1910s and 1970s (Fig. 2a). These results are highly congruent with collecting patterns for KSC inferred from a sample of native species (Fig. 2b; Prather et al. 2004a).

Of the 356 introduced species vouchered at KSC and/or KANU, the first or concurrent first records for 76% reside at KSC; for the time period prior to 1940 (251 species total), 94% of the earliest collections reside at KSC; and for the time period prior to 1900 (154 species), 95% of the earliest collections reside at KSC (App. 1). Based on both the KSC and KANU data of first records, 43% of the

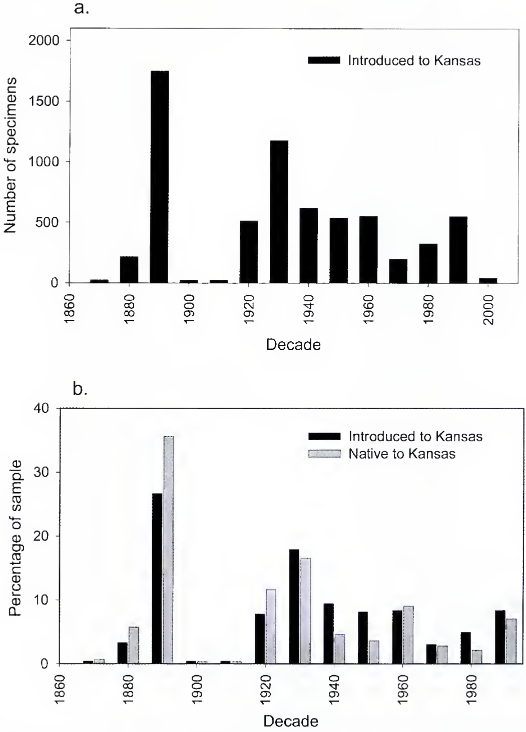


FIG. 2. Temporal patterns of plant collecting at KSC. **a)** The number of introduced specimens from Kansas collected in each decade of the herbarium's history. **b)** Comparison of collecting patterns based on introduced specimens at KSC (this study) and the overall KSC collecting pattern based on a sample of native taxa (Prather et al. 2004a); within each data set, we transformed numbers to percentages of each total sample (e.g., 27% of all Kansas KSC specimens of introduced plants were collected in the 1890s; 36% of the sample of KSC specimens studied by Prather et al. was collected in the 1890s). The results of both studies are highly congruent, suggesting they are generally representative of overall KSC collecting patterns. Minor differences suggest that the native collection was acquired prior to 1930 at a slightly higher rate than the introduced collection, whereas the trend was reversed after 1930.

currently recognized non-native species were collected in Kansas prior to 1900; and 71% were present by 1940. Moreover, examination of data for particular species shows that several problematic weeds and/or invasives (Stubbendieck et al. 1994; Division of Plant Health 2003) were established prior to 1900 (Fig. 3).

Spatial collecting patterns.—Kansas non-native flora prior to 1900 is well documented at KSC with representation from all 105 counties. Spatial mapping of species and specimens over time demonstrates a widely distributed collecting pattern at the level of counties prior to 1900 (Fig. 4a,b), with an increasing bias over time toward educational and population centers (Fig. 4c), although statewide collecting continued. The most thorough collecting over the course of the 20th century was from four counties in central and eastern Kansas: Cloud, Neosho, Riley and Saline. Not surprisingly, the county in which KSC resides, Riley County, is represented by the highest number of specimens of introduced plants: 1,025 (15.6% of the total).

Major collectors.—Fourteen collectors each contributed over 100 specimens of introduced plants to the KSC holdings, and together their activity accounts for 3,405 specimens (52% of the material studied). Figure 5a shows, for each major collector, the number of specimens deposited and the number of counties represented by those specimens; Figure 5b illustrates the time period in which each major collector actively contributed to KSC based on the material studied. Of the four major collectors who collected introduced species broadly (from over 33% of Kansas counties), Hitchcock and G.L. Clothier acquired most of their specimens prior to 1900, Gates in the early to mid 1900s, and Hulbert in the mid to late 1900s (Fig. 5). Of the ten most active collectors who collected from less than 10% of Kansas counties, only one of these collected prior to 1900, while four were active in the early to mid 1900s and five in the mid to late 1900s (Fig. 5). Three of the four counties best represented in this study correspond with the primary collecting area for particular major contributors: S.V. Fraser in Cloud County, J. Hancin in Saline County, and W.W. Holland in Neosho County.

DISCUSSION

The flora of the Great Plains has changed radically with the introduction of non-native species, and many of these floristic shifts are documented in the Kansas State University Herbarium. With 153 species of introduced flowering plants established in Kansas prior to 1900 based on KSC records (1,994 specimens), it is clear that the Great Plains had already undergone significant change by the turn of the last century. For example, Figure 3 shows many species currently considered noxious or agronomically important weeds and/or invasive species (Stubbendieck et al. 1994; Division of Plant Health, 2003) were well-established within the state by 1900: *Cirsium arvense* (Asteraceae); *Cardaria draba* (Brassicaceae); *Convolvulus arvensis* (Convolvulaceae); *Abutilon theophrasti*

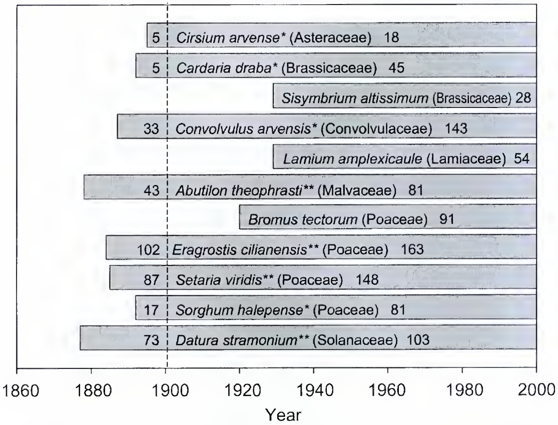


Fig. 3. Documentation of early arrival of some species of interest. Timelines begin with first records, whether housed at KSC or KANU (App. 1). Number of KSC specimens recorded prior to 1900 is shown just to the left of the vertical line, and total number of KSC specimens for each species is listed at the end of each line. Single asterisks indicate species included on the Kansas noxious weed list (Division of Plant Health 2003), and double asterisks denote Great Plains invasive species according to Stubbendieck et al. (1994). Other species are prevalent today yet not documented in Kansas until after the turn of the 20th century.

(Malvaceae); *Eragrostis cilianensis* (Poaceae); *Setaria viridis* (Poaceae); *Sorghum halepense* (Poaceae); *Datura stramonium* (Solanaceae). Equally intriguing is the fact that many notable introduced species prevalent in Kansas today are not documented until the 1920s or 1930s (Fig. 3), such as *Sisymbrium altissimum* (Brassicaceae), *Lamium amplexicaule* (Lamiaceae) and *Bromus tectorum* (Poaceae). Given that a lack of documentation via herbarium specimens does not necessarily indicate a species was absent from the flora at the time, inferences regarding the general timing of introduction of such species must be based on careful analysis of collecting patterns and biases for the herbaria examined, and eventually compared to introduction records for adjacent states.

In the case of KSC, we found the collecting of introduced species prior to 1900 and during the 1930s remarkably extensive (Figs. 1, 2, 4), and the congruence we found in overall collecting pattern between our study and that of Prather et al. (2004a) corroborates these collecting "peaks." The historical na-

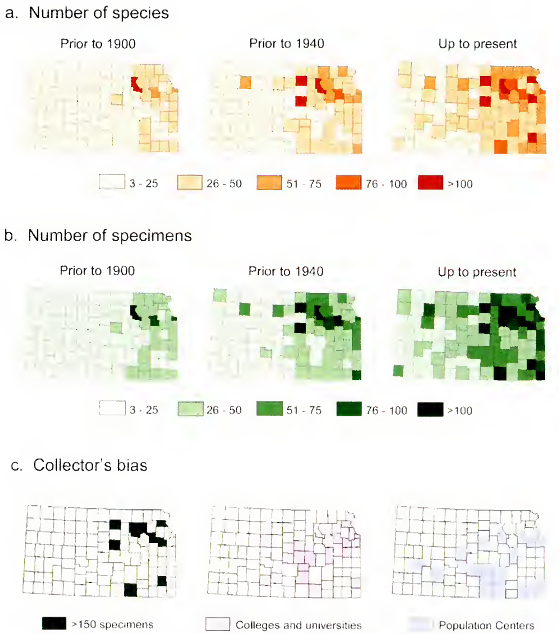


Fig. 4. Spatial patterns of collecting of introduced species at KSC. **a, b)** Number of species and specimens, respectively, collected in each county over time. The counties with higher numbers of species correspond closely with the counties from which higher numbers of specimens were recorded; thus, the greater number of species documented in these counties is likely a result of collecting bias rather than a demonstrated difference in actual species richness. **c)** Comparison of counties represented by over 150 specimens (left) to counties with four-year colleges or universities (middle) and to counties that have recorded a population greater than 30,000 at any census since 1900 (right). Six of the nine counties with large specimen counts correspond to educational or population centers, or both. Two of the others (Cloud and Neosho) had strong individual collectors sampling from those counties almost exclusively (see text), and the third (Pottawatomie) is adjacent to the home county of KSC.

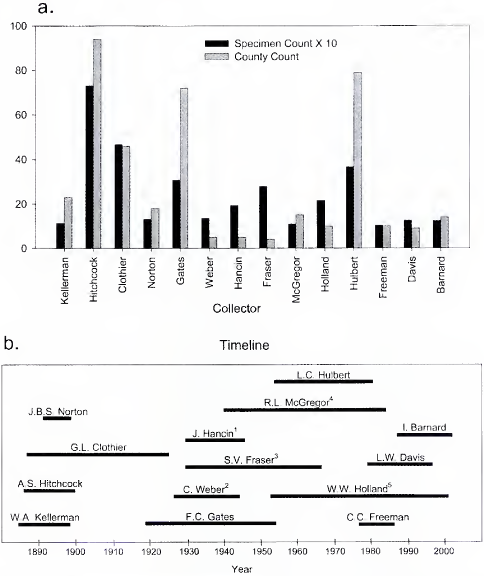


Fig. 5. Major collectors of introduced species at KSC. a) Specimen count and county count for each collector contributing more than 100 specimens of introduced plants. Collectors are in general chronological order, left to right, based on their activity at KSC. b) Timeline representing the active periods of collecting for each collector based on these data. Institutional affiliation for the time period indicated is KSC unless otherwise indicated in footnotes (note that some collectors have been and/or are active at other times elsewhere; e.g., Hitchcock moved to US; Freeman is currently at KANU). Hitchcock, Clothier, Gates and Hulbert stand out as the most prolific and even collectors based on species and county counts. While also prolific, Fraser and Hancin concentrated their activities in six and four counties, respectively. In total, the 14 major collectors contributed 52% of the material studied.

---

[1] A collector working in Saline County whose specimens were mainly deposited at Bethany College, Lindsborg, Kansas. The herbarium of Bethany College was incorporated into KSC in 1990.

[2] Affiliation presumed to be KSC (labels indicate Kansas State University, but we have little information about this collector).

[3] A reverend working in Cloud County whose collection was deposited at Marymount College, Salina, Kansas; the Marymount College Herbarium was incorporated into KCS in 1992.

[4] KANU Curator, 1954–present (1988–, Curator Emeritus).

[5] A doctor of veterinary medicine who works independently in Neosho County.

ture of the KSC collection in the region is underscored by the finding that KSC houses the overwhelming majority of earliest records of introduced species in relation to KANU.

Spatially, collecting at KSC was more evenly distributed across the state prior to 1900, and less so in more recent decades. Indeed, over time KSC shows an increasing bias (based on specimens of introduced plants) toward counties with four-year colleges and universities, and/or population centers (Fig. 4c), suggesting that many collectors focus their collecting efforts in areas that are easily accessed (e.g., near home and work). Other researchers have noted similar biases (in Mexico, Soberón 1996; in Texas, B. Lipscomb, Botanical Research Institute of Texas, pers. comm.), emphasizing a need for increased collecting in remote areas. Eastern and central Kansas, which include most of the population and educational centers, show far greater representation in our study than western Kansas, especially after 1940.

This study does not address the question of differences in species richness of introduced plants across Kansas, an interesting avenue for future research. The observed patterns in this study document collecting bias at the county level as indicated by the correlation of higher species numbers with higher numbers of collections (Fig. 2a, 2b). A demonstration that the number of species for particular unit areas is fairly stable regardless of increased collecting activity (over some moderate level) could enable exploration of geographical differences in species richness. We suggest that an intriguing investigation of species richness of native and introduced taxa could be accomplished within the region by drawing on the data housed within the network of Great Plains herbaria, provided that collecting biases were carefully taken into account.

The role of individual collectors is highlighted by this study. Those who collected widely provided KSC with a broad, spatially distributed collection. For example, the prolific and broad collecting in the 1890s suggests that Hitchcock and his protégés worked systematically to obtain, at a minimum, a specimen of each species present in each county. Collecting patterns during the 1930s also indicate relatively thorough and even collecting, accomplished largely through the efforts of Gates and numerous less prolific collectors (many cited as County Agricultural Extension Agents). Alternatively, those individuals who collected abundantly in limited regions (e.g., Fraser, Hancin, Holland) provided KSC with a very thorough sampling of particular counties. Although collecting continued throughout the state, the most active collecting after 1925 was concentrated in four counties: Cloud, Neosho, Riley and Saline, due in large part to specific individuals. This results in KSC having excellent documentation over an extended time within these areas.

It should be noted that the major collectors as determined by this study likely do not correspond entirely with major collectors overall for KSC, as many botanists and taxonomists focus on certain groups of plants and, in many cases, native species. Undoubtedly, some of the major collectors discussed here were generalists in their collecting (e.g., Hitchcock collected both native and introduced species widely). On the other hand, some workers, perhaps especially at agricultural universities such as Kansas State University, are particularly interested in weeds [e.g., L.W. Davis' collecting (Fig. 5) took place while she was researching weeds of the region, culminating in *Weed Seeds of the Great Plains* (1993)]. Broader comparisons of KSC collector data will be feasible once the entire herbarium holdings are databased.

Based on our analyses of the strengths and biases of the KSC material, we are confident that the records from the 1890s and the 1930s represent a reasonably accurate account of the presence and distribution in Kansas of introduced species at those times (although we acknowledge that some species and areas may have been missed by collectors). If an introduced species is not represented by pre-1900 KSC material, it most likely was not established in Kansas by then, and probably not even introduced to Kansas. If a species was not documented prior to 1940, it likely was still not well-established in Kansas by that time. Appropriate floristic inferences for Kansas made in reference to periods post-1940 must utilize complementary herbaria such as KANU.

We encourage researchers to utilize the KSC collection more extensively, incorporating the collection biases identified here to form accurate floristic inferences. Although the temporal data for particular plant species presented in Appendix 1 are a primary result of this study, we hope that others will improve the taxonomic and distributional data to a more refined level. Looking to the future, increased collecting activity is fundamental to the goal of better understanding and managing plant introductions.

This study underscores the critical importance of natural history collections as resources for investigations in distributional changes of species—in this case, of introduced plants. Given the understanding of collecting biases and strengths of a particular collection, floristic changes can be rigorously studied. The increased use of information technology such as databasing and georeferencing, as well as analytical techniques that account for biases (Weber 1998; Soberón et al. 2000; Ter Steege et al. 2000; Mihulka & Pyšek 2001; Delisle et al. 2003) will continue to highlight the value of herbaria in accurately tracking the establishment and spread of introduced plant species, and changes in community associations. Ironically, just at a point when natural history collections are becoming more widely recognized as critical research infrastructure, drastic funding cuts threaten the very existence and curation of some collections (Dalton 2003; Gropp 2003; Suarez & Tsutsui 2004). Despite these setbacks, the increasing accessibility of herbarium specimen data online and the linking of these databases (via Distributed Generic Information Retrieval, DiGIR, sourceforge.net/projects/digir; e.g., the National Biological Information Infrastructure of the Global Biodiversity Information Facility, gbif.nbii.gov/search/

search.html) are beginning to enable inter-collection data-mining with great opportunities for tracking floristic patterns on a large scale. As new technologies emerge, we expect to see the wealth of data in natural history collections yielding exciting new information for different geographical regions. Indeed, as the Natural Science Collections Alliance (2004) states, "... we are just embarking on the Golden Age of collections research."

APPENDIX 1

Species included in analyses, with general historical temporal information on specimens (see text). Taxonomy is alphabetical, with family recognition following the APG system (Angiosperm Phylogeny Group 2003) and taxa listed to species following the PLANTS Database (USDA NRCS, see text)[1,2,3]. Additional information is provided below the name only when necessary to reference the taxon in *Flora of the Great Plains* (FGP; Great Plains Flora Association 1986; i.e., when the species is treated under a different name there and the currently accepted name is not mentioned as a synonym or otherwise discussed, or, in some cases, where additional information is necessary to clarify treatment here relative to FGP). Note that some of the species here were mentioned but not described in FGP (usually because they were considered waifs, cultivated taxa not considered to escape or persist long, or uncommon species very similar to described taxa). A single asterisk denotes a species that was added to the FGP in the supplement accompanying the second printing (Brooks 1991), and is therefore not referenced in the regular index of that treatment. A double asterisk denotes a species that was not referenced at all in FGP.

Family/Species[1,4]	**KSC:**				**KANU:**	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Amaranthaceae						
Atriplex hortensis L.	1928	0	4	5		—
Atriplex rosea L.	1932	0	1	2		—
Atriplex prostrata Bouchér ex DC.	—	0	0	0	X	1971
Chenopodium album L.	1885	29	3	47		1952
Chenopodium ambrosioides L.	1890	16	16	38		1915
Chenopodium botrys L.	1888	3	1	5		—
Chenopodium glaucum L.	1897	1	1	3		1912
Chenopodium murale L.**	1897	1	0	3		—
Chenopodium pumilio R. Br.	—	0	0	0	X	1992
Kochia scoparia (L.) Schrad.	1912	0	43	83	same	1912
Salsola collina Pall.	1923	0	2	3		1972
Salsola tragus L. FGP: *S. iberica* Sennen & Pau	1894	21	21	51		1900

Family/Species[1, 4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Apiaceae						
Bupleurum rotundifolium L.	1890	1	0	8		1969
Conium maculatum L.	1927	0	11	38	same	1927
Daucus carota L.	1891	12	7	35		1929
Falcaria vulgaris Bernh. FGP: *F. sioides* (Wibel) Aschers.	1936	0	1	2	X	1932
Foeniculum vulgare Mill.	—	0	0	0	X	1965
Pastinaca sativa L.	1896	6	1	10		1930
Torilis arvensis (Huds.) Link	1926	0	1	21		1929
Apocynaceae						
Cynanchum louiseae Kartesz & Gandhi FGP: *C. nigrum* (L.) Pers.	1941	0	0	4		1979
Vinca minor L.	1925	0	1	1		1969
Asteraceae						
Achillea millefolium L. var. *millefolium*[1]	1876	64	25	131		1918
Acroptilon repens (L.) DC.	1921	0	16	31		1976
Anthemis cotula L.	1885	27	5	38	X	1880
Arctium minus Bernh.	1879	34	6	50		1913
Artemisia abrotanum L.	1931	0	1	2		—
Artemisia annua L.	1897	1	2	5		1995
Artemisia biennis Willd.	1886	8	8	19		1956
Carduus acanthoides L.	2001	0	0	1	X	1940
Carduus nutans L.	1932	0	1	24		1940
Centaurea biebersteinii DC. FGP: *C. maculosa* auct. non Lam.	1951	0	0	4	X	1940
Centaurea cyanus L.	1888	1	4	9		1952
Centaurea solstitialis L.	1919	0	5	10		1961
Cichorium intybus L.	1888	2	8	22		1929
Cirsium arvense (L.) Scop.	1895	5	2	18		1975
Cirsium vulgare (Savi) Ten.	1894	17	4	36		1929
Cosmos bipinnatus Cav.**	1929	0	1	3		1995
Crepis capillaris (L.) Wallr.	1947	0	0	1		—
Galinsoga parviflora Cav.	1921	0	1	3		1968
Galinsoga quadriradiata Cav.	1896	1	4	13		1932
Gnaphalium uliginosum L.	1892	1	0	1		—
Guizotia abyssinica (L. f.) Cass.**	—	0	0	0	X	1976
Lactuca saligna L.	1941	0	0	15		1949
Lactuca serriola L.	1895	25	17	72		1913
Leontodon hispidus L.	—	0	0	0	X	1952
Leucanthemum vulgare Lam.	1887	10	8	31		1929
Matricaria discoidea DC. FGP: *M. matricarioides* auct. non (Less.) Porter	1931	0	1	12		1964

Family/Species[1,4]	**KSC:**				**KANU:**	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Matricaria recutita L. FGP: *M. chamomilla* L. 1755 & 1763, non 1753	1929	0	3	5		—
Onopordum acanthium L.	1933	0	1	1		1975
Parthenium hysterophorus L.	1932	0	2	9		1950
Scorzonera laciniata L.	1976	0	0	2	same	1976
Senecio vulgaris L.	1992	0	0	1	X	1976
Sonchus arvensis L.	1984	0	0	1	X	1959
Sonchus asper (L.) Hill	1878	26	13	59		1915
Sonchus oleraceus L.	1896	1	3	7		1918
Tanacetum vulgare L.	1897	3	1	5		—
Taraxacum laevigatum (Willd.) DC.	1890	2	8	18		1929
Taraxacum officinale G.H. Weber ex Wiggers	1884	10	14	48		1887
Tragopogon dubius Scop.	1926	0	19	59		1932
Tragopogon porrifolius L.	1920	0	10	16		1933
Xanthium spinosum L.	1938	0	1	18		1975
Berberidaceae						
Berberis thunbergii DC.**	—	0	0	0	X	1976
Betulaceae						
Alnus glutinosa (L.) Gaertn.*	1939	0	1	2		1987
Boraginaceae						
Asperugo procumbens L.	1952	0	0	2		1959
Buglossoides arvensis (L.) I.M. Johnston FGP: *Lithospermum arvense* L.	1896	5	5	38		1913
Cynoglossum officinale L.	1887	15	2	19		1946
Echium vulgare L.	1891	1	2	7		1938
Heliotropium indicum L.	1995	0	0	1	X	1947
Lappula squarrosa (Retz.) Dumort. FGP: *Lappula echinata* Gilib.	1878	8	2	16		1884
Brassicaceae						
Alliaria petiolata (M. Bieb.) Cavara & Grande	1895	1	4	17		1947
Alyssum alyssoides (L.) L.	1984	0	0	1	X	1975
Alyssum desertorum Stapf	—	0	0	0	X	1996
Alyssum minus *(L.) Rothm.*	—	0	0	0	X	1973
Arabidopsis thaliana (L.) Heynh.	—	0	0	0	X	1984
Barbarea vulgaris Ait. f.	1898	1	1	20		1933
Berteroa incana (L.) DC.	1897	1	1	4		1975
Brassica juncea (L.) Czern.	1898	1	8	15		1933
Brassica napus L.	2000	0	0	1		—

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Brassica nigra (L.) W.D.J. Koch	1887	29	6	37		1929
Brassica rapa L.	1894	15	3	23		1937
Camelina microcarpa DC.	1887	5	13	49		1929
Camelina rumelica Velen.*	1947	0	0	4		1970
Capsella bursa-pastoris (L.) Medik.	1879	22	20	64		1911
Cardaria chalapensis (L.) Hand.-Mazz.	1932	0	3	4	X	1929
Cardaria draba (L.) Desv.	1892	5	16	45		1935
Chorispora tenella (Pall.) DC.	1956	0	0	23		1957
Cleome hassleriana Chod.	1896	1	0	2		—
Conringia orientalis (L.) Dumort.	1886	1	10	18		1923
Descurainia sophia (L.) Webb ex Prantl	1930	0	2	16		1931
Diplotaxis muralis (L.) DC.	—	0	0	0	X	1972
Eruca vesicaria (L.) Cav.	1908	0	1	1		2001
Erucastrum gallicum (Willd.) O.E. Schulz	1945	0	0	1		1967
Erysimum repandum L.	1896	1	9	53		1940
Hesperis matronalis L.	1932	0	6	22		1956
Lepidium campestre (L.) Ait. f.	1896	1	0	4		1952
Lepidium latifolium L.	—	0	0	0	X	1985
Lepidium perfoliatum L.	1919	0	7	10		1957
Malcolmia africana (L.) Ait. f.	1956	0	0	23		1975
Microthlaspi perfoliatum (L.) F.K. Mey. FGP: *Thlaspi perfoliatum* L.	1993	0	0	4	X	1969
Raphanus sativus L.	1885	5	2	7		1971
Rorippa sylvestris (L.) Besser	1978	0	0	1	X	1972
Sinapis alba L.	1935	0	1	1		—
Sinapis arvensis L.	1892	20	8	39		1933
Sisymbrium altissimum L.	1930	0	14	28	X	1929
Sisymbrium loeselii L.	1945	0	0	1		1976
Sisymbrium officinale (L.) Scop.	1879	27	2	37		1911
Thlaspi arvense L.	1870	4	27	76		1931
Campanulaceae						
Campanula rapunculoides L.	1977	0	0	1		—
Cannabaceae						
Cannabis sativa L.	1884	16	14	49		1913
Humulus japonicus Siebold & Zucc.	1930	0	1	7		1947
Caprifoliaceae						
Dipsacus fullonum L.	1945	0	0	6		1947
Dipsacus laciniatus L.	1979	0	0	4	X	1966
Lonicera japonica Thunb.	1893	1	2	12		1928

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Lonicera maackii (Rupr.) Herder	1935	0	1	7		1981
Lonicera tatarica L.	1892	1	1	4		1899
Scabiosa atropurpurea L.**	1928	0	2	4		1995
Caryophyllaceae						
Agrostemma githago L.	1873	3	6	14		1930
Arenaria serpyllifolia L.	1930	0	4	23		1946
Cerastium brachypetalum Desp. in Pers.	1892	3	9	20		1930
Cerastium fontanum Baumg.	1891	5	6	19		1941
Cerastium glomeratum Thuill.	1971	0	0	2	X	1946
Cerastium pumilum W. Curtis	—	0	0	0	X	1965
Dianthus armeria L.	1940	0	0	16	X	1937
Holosteum umbellatum L.	1946	0	0	22		1955
Myosoton aquaticum (L.) Moench	—	0	0	0	X	1970
Saponaria officinalis L.	1879	18	11	42		1929
Scleranthus annuus L.	—	0	0	0	X	1967
Silene latifolia Poir.	1921	0	2	3		1932
Silene noctiflora L.	1909	0	4	7		1975
Silene vulgaris (Moench) Garcke	1888	2	1	5		—
Stellaria graminea L.	—	0	0	0	X	1947
Stellaria media (L.) Vill.[1]	1892	1	26	47		1940
Stellaria pallida (Dumort.) Crép.[1]	1931	0	4	8		1974
Vaccaria hispanica (Mill.) Rauschert FGP: *V. pyramidata* Medik.	1888	4	3	13		1932
Celastraceae						
Euonymus fortunei (Turcz.) Hand.-Mazz.**	—	0	0	0	X	1995
Clusiaceae						
Hypericum perforatum L.	1889	5	2	29		1929
Commelinaceae						
Commelina communis L.	1937	0	1	7	X	1911
Convolvulaceae						
Calystegia pellita (Ledeb.) G. Don	1894	1	2	6		1932
Convolvulus arvensis L.	1887	33	85	143		1912
Ipomoea coccinea L.	1894	2	3	14		1929
Ipomoea hederacea Jacq.	1878	39	8	66	X	1866
Ipomoea purpurea (L.) Roth	1892	39	10	59	X	1866
Crassulaceae						
Hylotelephium telephium (L.) H. Ohba**	1897	1	0	1		—
Diascoreaceae						
Dioscorea oppositifolia L. FGP: *D. batatas* Decne.	1993	0	0	1	X	1981

Family/Species[1, 4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Elaeagnaceae						
Elaeagnus angustifolia L.	1891	1	2	10		1944
Elaeagnus umbellata Thunb.**	1993	0	0	1		1995
Euphorbiaceae						
Euphorbia cyparissias L.	1887	7	6	14		1897
Euphorbia esula L.	1933	0	4	12		1967
Ricinus communis L.**	1924	0	3	6		1977
Fabaceae						
Coronilla varia L.	1946	0	0	14		1956
Kummerowia stipulacea (Maxim.) Makino FGP: *Lespedeza stipulacea* Maxim.	1933	0	3	23		1937
Kummerowia striata (Thunb.) Schindl. FGP: *Lespedeza striata* (Thunb.) Hook. & Arn.	1897	3	2	5		1976
Lathyrus latifolius L.	—	0	0	0	X	1965
Lespedeza bicolor Turcz.**	1996	0	0	2	same	1996
Lespedeza cuneata (Dum.-Cours.) G. Don	1950	0	0	31		1960
Lotus corniculatus L.	1953	0	0	7		1966
Lotus tenuis Waldst. & Kit. ex Willd.	—	0	0	0	X	1973
Medicago lupulina L.	1892	4	20	54		1911
Medicago minima (L.) L.	1940	0	0	6		1973
Medicago sativa L.	1886	44	17	70		1912
Melilotus alba Medik.	1879	40	14	71		1911
Melilotus officinalis (L.) Lam.	1887	14	21	55		1913
Pueraria montana (Lour.) Merr.**	—	0	0	0	X	1975
Senna occidentalis (L.) Link FGP: *Cassia occidentalis* L.	1896	1	0	1		1988
Sphaerophysa salsula (Pall.) DC.	—	0	0	0	X	1979
Trifolium campestre Schreb.	1888	2	2	10		1929
Trifolium dubium Sibthorp	1938	0	1	4		1972
Trifolium fragiferum L.	—	0	0	0	X	1985
Trifolium hybridum L.	1890	4	3	11		1974
Trifolium incarnatum L.	1885	1	1	2		1998
Trifolium pratense L.	1889	29	14	52	X	1882
Trifolium repens L.	1884	29	10	52		1887
Trifolium resupinatum L.	1932	0	4	6		—
Vicia sativa L.	1895	1	0	2		2001
Vicia villosa Roth	1891	1	5	18		1933
Geraniaceae						
Erodium cicutarium (L.) L'Hér. ex Ait.	1935	0	2	14		1957

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Geranium pusillum L.	1933	0	2	9	X	1929
Haloragidaceae						
Myriophyllum aquaticum (Vell.) Verdc.	1935	0	1	1		—
FGP: *M. brasiliense* Camb.						
Hydrocharitaceae						
Egeria densa Planch.	1934	0	1	1		1973
FGP: *Elodea densa* (Planch.) Caspary						
Iridaceae						
Belamcanda chinensis (L.) DC.	1897	5	13	22		1929
Iris germanica L.**	1895	1	2	6		1999
Iris pseudacorus L.	1992	0	0	2	X	1959
Lamiaceae						
Ajuga reptans L.	1957	0	0	2		1958
Chaiturus marrubiastrum (L.) Rchb.	1940	0	0	1		—
FGP: *Leonurus marrubiastrum* L.						
Glechoma hederacea L.	1892	7	5	17		1897
Lamium amplexicaule L.	1929	0	20	54		1933
Lamium purpureum L.	1940	0	0	10	same	1940
Leonurus cardiaca L.	1876	8	8	25		1929
Marrubium vulgare L.	1890	29	15	59		1912
Mentha x *gracilis* Sole (pro sp.)	1961	0	0	2	X	1912
FGP: *Mentha cardiaca* (Gray) Gerarde ex Baker						
Mentha x *piperita* L. (pro sp.)	1899	1	2	4		1983
Mentha spicata L.	1930	0	2	2		1975
Nepeta cataria L.	1880	24	11	44		1912
Perilla frutescens (L.) Britton	1924	0	7	10	same	1924
Salvia nemorosa L.	1935	0	1	4		1995
Salvia pratensis L.	1930	0	1	1		1955
Salvia sclarea L.	1945	0	0	2		1992
Stachys annua (L.) L.	1896	1	0	1		—
Liliaceae						
Allium porrum L.	1930	0	2	4		—
Allium sativum L.	1943	0	0	4		1957
Allium vineale L.	1931	0	3	9	same	1931
Asparagus officinalis L.	1884	16	4	25		1911
Hemerocallis fulva (L.) L.	1940	0	0	8	X	1929
Muscari botryoides (L.) Mill.	1967	0	0	1	X	1949
Ornithogalum umbellatum L.	1888	1	2	7		1937
Linaceae						
Linum perenne L.	1897	1	1	6		—
Linum usitatissimum L.	1887	21	2	26		1913

Family/Species[1,4]	**KSC:**				**KANU:**	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Lythraceae						
Lythrum salicaria L.	1995	0	0	4	X	1989
Malvaceae						
Abutilon theophrasti Medik.	1878	43	11	81		1911
Alcea rosea L.	1932	0	1	4		1941
FGP: *Althaea rosea* (L.) Cav.						
Hibiscus trionum L.	1878	46	23	98		1911
Malva neglecta Wallr.	1892	8	11	33		1911
Malva parviflora L.	1919	0	2	6		—
Malva pusilla Sm.[3]	1895	3	8	14		1929
Malva sylvestris L.	1931	0	2	2		—
Molluginaceae						
Glinus lotoides L.	1980	0	0	3	X	1952
Moraceae						
Broussonetia papyrifera (L.) L'Hér. ex Vent.	—	0	0	0	X	1965
Morus alba L.	1887	2	20	43		1915
Papaveraceae						
Fumaria officinalis L.	—	0	0	0	X	1961
Glaucium corniculatum (L.) J.H. Rudolph	—	0	0	0	X	1979
Papaver dubium L.	1983	0	0	1	X	1975
Papaver rhoeas L.	1927	0	2	4		1948
Plantaginaceae						
Plantago lanceolata L.	1999	0	0	1	X	1912
Poaceae						
Aegilops cylindrica Host	1924	0	30	55		1926
×*Aegilotriticum sancti-andreae* (Degen) Soó**	1924	0	4	11		—
Agropyron cristatum (L.) Gaertn.	1960	0	0	1	same	1960
Agrostis gigantea Roth	1886	39	10	61	same	1886
FGP: *A. stolonifera* L., in part						
Agrostis stolonifera L.[6]	—	0	0	0	X	1930
Arthraxon hispidus (Thunb.) Makino**	1999	0	0	2	X	1984
Arundo donax L.**	1984	0	0	1	X	1974
Avena fatua L.	1947	0	0	1		1966
Avena sativa L.	1896	1	3	7		1967
FGP: *Avena fatua* L., in part						
Bothriochloa bladhii (Retz.) S.T. Blake	1952	0	0	12	same	1952
Bothriochloa ischaemum (L.) Keng	1935	0	4	23		1973
Bromus catharticus Vahl	1921	0	10	23		1949
FGP: *Bromus unioloides* Kunth						

Family/Species[1,4]	**KSC:**				**KANU:**	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Bromus commutatus Schrad.	1894	1	12	52		1929
Bromus hordeaceus L. FGP: *B. mollis* L.; *B. racemosus* auct. non. L.	1888	1	1	2		1975
Bromus inermis Leyss.	1894	1	12	47		1935
Bromus japonicus Murray	1889	5	35	111		1917
Bromus secalinus L.	1869	23	24	57		1887
Bromus tectorum L.	1920	0	26	91		1936
Cynodon dactylon (L.) Pers.	1897	1	13	28		1935
Dactylis glomerata L.	1879	14	13	39		1903
Digitaria ischaemum (Schreb.) Schreb. ex Muhl.	1892	6	1	11		1948
Echinochloa colona (L.) Link	—	0	0	0	X	1974
Echinochloa crus-galli (L.) P. Beauv.	1893	2	9	37		1913
Echinochloa crus-pavonis (Kunth) J.A. Schultes	1895	5	1	7		1929
Echinochloa muricata (P. Beauv.) Fern.	1879	112	43	187		1902
Eleusine indica (L.) Gaertn.	1895	5	3	16	X	1886
Elymus repens (L.) Gould FGP: *Agropyron repens* (L.) P. Beauv.	1921	0	2	16		1972
Eragrostis barrelieri Daveau	1933	0	2	2		1937
Eragrostis cilianensis (All.) Vignolo ex Janch.	1886	102	37	163	X	1884
Eragrostis curvula (Schrad.) Nees	—	0	0	0	X	1967
Eragrostis minor Host	1933	0	2	5		1935
Holcus lanatus L.	1921	0	1	1		1953
Hordeum vulgare L.	1941	0	0	1	same	1941
Lolium arundinaceum (Schreb.) S.J. Darbyshire FGP: *Festuca arundinacea* Schreb.	1952	0	0	5	same	1952
Lolium perenne L.	1887	2	17	32		1888
Lolium pratense (Huds.) S.J. Darbyshire FGP: *Festuca pratensis* Huds.	1886	15	14	39		1902
Lolium temulentum L.	1948	0	0	1		—
Panicum miliaceum L.	1896	1	2	11		1976
Paspalum urvillei Steud.**	—	0	0	0	X	1936
Phalaris canariensis L.	1896	1	12	16		1969
Phleum pratense L.	1879	25	10	42		1913
Poa annua L.	1886	7	6	18		1936
Poa bulbosa L.	1936	0	2	11		1976

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Poa compressa L.	1888	12	5	29		1938
Poa trivialis L.**	1937	0	1	1		—
Polypogon monspeliensis (L.) Desf.	1931	0	3	8	X	1912
Saccharum ravennae (L.) L. FGP: *Erianthus ravennae* (L.) P. Beauv.	1925	0	1	3		1975
Sclerochloa dura (L.) P. Beauv.	1975	0	0	16	X	1961
Secale cereale L.	1920	0	3	5		1974
Setaria faberi Herrm.	1942	0	0	21	X	1929
Setaria italica (L.) P. Beauv.	1886	15	12	31		1912
Setaria pumila (Poir.) Roemer & Schult.**	1886	62	12	100		1902
Setaria verticillata (L.) P. Beauv.	1921	0	3	8		1975
Setaria viridis (L.) P. Beauv.	1885	87	27	148		1900
Sorghum halepense (L.) Pers.	1892	17	22	81		1902
Themeda quadrivalvis (L.) Kuntze**	1998	0	0	2		—
Thinopyrum ponticum (Podp.) Z.-W. Liu & R.-C. Wang FGP: *Agropyron elongatum* (Host) P. Beauv.	1921	0	3	10		1964
Vulpia myuros (L.) K.C. Gmel. FGP: *Festuca myuros* L.	—	0	0	0	X	1973
Polygonaceae						
Fagopyrum esculentum Moench	1892	6	2	10		1940
Polygonum arenastrum Boreau	1938	0	1	5	X	1929
Polygonum aviculare L.	1879	33	17	76		1995
Polygonum bellardii All. FGP: *Polygonum aviculare* L.	1897	1	4	6		—
Polygonum caespitosum Blume var. *longisetum* (Bruijn) Steward	—	0	0	0	X	1995
Polygonum convolvulus L.	1887	57	4	70	same	1887
Polygonum cuspidatum Siebold & Zucc.	1951	0	0	6		1965
Polygonum hydropiper L.	1897	1	0	2		1964
Polygonum orientale L.	1886	4	1	7		—
Polygonum persicaria L.	1887	41	8	65		1911
Rumex acetosella L.	1874	12	10	31		1930
Rumex crispus L.	1879	35	12	65		1912
Rumex cristatus DC.	—	0	0	0	X	1980
Rumex obtusifolius L.	1892	10	1	17		1932
Rumex patientia L.	1888	8	9	21		1913
Rumex stenophyllus Ledeb.	1945	0	0	10		1948

Family/Species[1,4]	KSC:				KANU:	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Portulacaceae						
Portulaca grandiflora Hook.	1925	0	3	5		2002
Potamogetonaceae						
Potamogeton crispus L.	1955	0	0	6	same	1955
Primulaceae						
Anagallis arvensis L.	1887	5	2	11	same	1887
Lysimachia nummularia L.	1901	0	1	2		1931
Ranunculaceae						
Ceratocephala testiculatus (Crantz) Roth	1961	0	0	11		1975
Clematis terniflora DC.	1955	0	0	5	same	1955
Consolida ajacis (L.) Schur FGP: *Delphinium ajacis* L.	1896	2	8	19		1932
Ranunculus acris L.	1890	2	0	2		—
Ranunculus arvensis L.	—	0	0	0	X	1969
Ranunculus sardous Crantz	1993	0	0	7	X	1974
Rhamnaceae						
Rhamnus cathartica L.	—	0	0	0	X	1998
Rosaceae						
Malus floribunda Siebold ex Van Houtte**	—	0	0	0	X	1995
Potentilla recta L.	1887	3	2	19		1948
Prunus armeniaca L.	1925	0	2	3		—
Prunus cerasus L.	1933	0	1	1		1969
Prunus mahaleb L.	1897	1	3	9		1930
Prunus persica (L.) Batsch	1893	1	1	9		1941
Pyrus communis L.	1999	0	0	2	same	1999
Rosa eglanteria L.	1887	5	0	5		—
Rosa multiflora Thunb.	1958	0	0	8	X	1957
Rosa spinosissima L.	1897	2	0	2		—
Rubiaceae						
Cruciata pedemontana (Bellardi) Ehrend.**	—	0	0	0	X	1982
Galium verum L.	1926	0	1	1		—
Sherardia arvensis L.	1931	0	1	1		1991
Salicaceae						
Populus alba L.	1915	0	9	12	X	1913
Populus nigra L.	1926	0	7	9		2002
Salix alba L.	1927	0	1	4		1972
Salix fragilis L.	1896	4	2	8		1913
Sapindaceae						
Koelreuteria paniculata Laxm.**	1934	0	1	1		1996
Scrophulariaceae						
Chaenorhinum minus (L.) Lange	1984	0	0	2	X	1968
Digitalis lanata Ehrh.**	—	0	0	0	X	1994

Family/Species[1, 4]	**KSC:**				**KANU:**	
	earliest	prior to 1900	1900–1940	total records	earlier than KSC?[5]	earliest
Kickxia elatine (L.) Dumort.	1941	0	0	1		1949
Linaria dalmatica (L.) Mill.	1986	0	0	1	X	1967
Linaria vulgaris Mill.	1896	3	5	15		1913
Verbascum blattaria L.	1888	8	6	46		1929
Verbascum thapsus L.	1885	22	13	52		1929
Veronica arvensis L.	1890	3	10	35		1929
Veronica biloba L.	—	0	0	0	X	1997
Veronica hederifolia L.	—	0	0	0	X	1993
Veronica persica Poir.	—	0	0	0	X	1975
Veronica polita Fr.	1931	0	11	29		1943
FGP: *Veronica agrestis* L.						
Veronica serpyllifolia L.	1942	0	0	1	same	1942
Veronica triphyllos L.	1943	0	0	4	same	1943
Simaroubaceae						
Ailanthus altissima (Mill.) Swingle	1874	9	11	27		1936
Solanaceae						
Datura stramonium L.	1878	73	13	103	X	1877
Lycium barbarum L.	1891	6	14	35		1913
FGP: *Lycium halimifolium* Mill.						
Nicandra physalodes (L.) Gaertn.	1896	1	2	3		—
Petunia axillaris (Lam.) Britton, Sterns, & Poggenb.**	—	0	0	0	X	2002
Solanum dulcamara L.	1887	3	3	8		1929
Tamaricaceae						
Tamarix parviflora DC.	—	0	0	0	X	1892
Tamarix ramosissima Ledeb.	1877	1	8	32		1929
Thymelaeaceae						
Thymelaea passerina (L.) Lange	—	0	0	0	X	1970
Typhaceae						
Typha angustifolia L.	1946	0	0	7	same	1946
Ulmaceae						
Ulmus pumila L.	1926	0	7	18		1927
Violaceae						
Viola arvensis Murray	1931	0	3	4		—
Viola patrini DC.	1953	0	0	2		—
Viola tricolor L.**	1937	0	2	4		—
Zygophyllaceae						
Tribulus terrestris L.	1909	0	55	99		1912
Zygophyllum fabago L.**	1924	0	1	2		—

---

[1] Taxa were recognized only to the species level, with one exception: when infraspecfic taxa of a species differ with respect to nativity (native versus introduced) and the introduced taxon occurs in Kansas, the infraspecific name was included in the list (we had only one such case, *Achillea millefolium* var. *millefolium*).

[2] Changes relative to the PLANTS list are outlined in Appendix 2.

APPENDIX 2

Revisions to the list generated by PLANTS for angiosperms introduced to Kansas.

Excluded names:

Native species listed erroneously in PLANTS as introduced:

Amaranthus blitoides S. Watson [see Mosyakin and Robertson 2003], *Amaranthus retroflexus* L. [see Mosyakin and Robertson 2003], *Datura quercifolia* Kunth, *Euphorbia davidii* R. Subils [see Mayfield 1997]

Cultivated species, not persisting in the Kansas flora:

Allium cepa L., *Alopecurus myosuroides* Huds., *Alopecurus pratensis* L., *Amaranthus caudatus* L., *Anethum graveolens* L., *Arachis hypogaea* L., *Armoracia rusticana* P. G. Gaertn., B. Mey. & Scherb., *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl, *Berberis vulgaris* L., *Calamagrostis epigeios* (L.) Roth, *Canavalia ensiformis* (L.) DC., *Carthamus tinctorius* L., *Celosia cristata* L., *Centaurea iberica* Trevir. ex Spreng., *Cicer arietinum* L., *Citrullus lanatus* (Thunb.) Matsumura & Nakai, *Convallaria majalis* L., *Cucumis melo* L., *Cucumis sativus* L., *Cucurbita pepo* L., *Forsythia suspensa* (Thunb.) Vahl, *Forsythia viridissima* Lindl., *Gypsophila elegans* M. Bieb., *Gypsophila paniculata* L., *Ipomoea batatas* (L.) Lam., *Ipomoea quamoclit* L., *Lobularia maritima* (L.) Desv., *Lycium chinense* Mill., *Malus pumila* Mill., *Melissa officinalis* L., *Nicotiana tabacum* L., *Pennisetum glaucum* (L.) R. Br.[1], *Periploca graeca* L., *Petroselinum crispum* (Mill.) Nyman, *Petunia atkinsiana* D. Don ex Loud., *Physalis philadelphica* Lam., *Pisum sativum* L., *Potentilla argentea* L., *Prunus domestica* L., *Reseda lutea* L., *Rheum rhabarbarum* L., *Solanum lycopersicum* L., *Sorghum bicolor* (L.) Moench, *Spergula arvensis* L., *Spinacia oleracea* L., *Triticum aestivum* L., *Ulmus glabra* Huds., *Ulmus procera* Salisb., *Zea mays* L.

Species for which we found no vouchers of non-cultivated material at KSC or in the KANU database (some do not occur in Kansas; some may occur and may be naturalized, but require further study and documentation; cultivated species are indicated):

Agropyron desertorum (Fisch. ex Link) Schult. [cult./crop], *Arctium vulgare* (Hill) A. H. Evans, *Artemisia absinthium* L., *Artemisia vulgaris* L., *Balsamita major* Desf., *Berteroa mutabilis* (Vent.) DC., *Bromus arvensis* L., *Bromus racemosus* L., *Bromus squarrosus* L., *Camelina sativa* (L). Crantz[2], *Cardaria pubescens* (C A. Mey.) Jarm [voucher was misidentified], *Consolida orientalis* (J. Gay) R. Schrödinger [cult.], *Dianthus deltoides* L., *Eriochloa villosa* (Thunb.) Kunth, *Euphorbia agraria* M. Bieb., *Euphorbia helioscopia* L, *Geranium rotundifolium* L., *Matthiola longipetala* (Vent.) DC. [cult.], *Nigella damascena* L., *Raphanus raphanistrum* L., *Rosa canina* L. [cult.], *Syringa vulgaris* L. [cult.], *Tragopogon pratensis* L., *Trifolium arvense* L., *Tripleurospermum perforata* (Merat) M. M. Laínz, *Trisetum flavescens* (L.) P. Beauv., *Veronica agrestis* L.

Additions (authorities listed in App. 1):

Introduced species listed erroneously in PLANTS as native:

Continued from page 1719.

[3] The name *Malva pusilla* here replaces *M. rotundifolia* L., nom rej. (Greuter et al. 2000).

[4] Assessment of the impact of each species (e.g., relatively benign, agricultural weed, ecological invasive, etc.) and determination of particular geographical origin was beyond the scope of the present study, and the reader is referred to other sources (e.g., the PLANTS database; Great Plains Flora Association 1986) for this information

[5] For the 20 cases for which simultaneous first records (by year) are present at both KSC and KANU ("same"), 10 are apparent cases of duplicate collections between the two institutions, with the biggest contributor to the duplicate set being McGregor (KANU) with three records.

[6] KSC material of *Agrostis gigantea* (considered a synonym of *A. stolonifera* in FGP) has not been recently studied and annotated, and it is possible some of the KSC specimens counted here as *A. gigantea* may truly represent *A. stolonifera*.

Agrostis stolonifera, *Camelina rumelica* [see Brooks 1991]

Additional taxa for Kansas discussed by Freeman et al. (1998):

Alyssum desertorum, *Atriplex prostrata*, *Chenopodium pumilio*, *Digitalis lanata*, *Elaeagnus umbellata*, *Euonymus fortunei*, *Lespedeza bicolor*, *Malus floribunda*, *Polygonum caespitosum*, *Rhamnus cathartica*, *Trifolium incarnatum*, *Veronica biloba*, *Veronica hederifolia*, *Veronica persica*

Taxa recognized at the species level, rather than the infraspecific level:

Stellaria pallida[3]

Additional taxa for Kansas recognized here[4]:

×*Aegilotriticum sancti-andreae*, *Crepis capillaris*, *Leontodon hispidus*, *Melilotus alba* [Great Plains Flora Association 1986], *Setaria pumila*[1], *Themeda quadrivalvis* [see Towne and Barnard 2000], *Viola patrini*

ACKNOWLEDGMENTS

This study grew out of a class project in collaboration with faculty members CJF (instructor) and MHM. We are grateful to Craig Freeman and Caleb Morse, University of Kansas, for input regarding KANU specimens and assistance with database queries, and we gratefully acknowledge the use of specimen data from KANU. Joanne Whittier was generous in her expertise for development of the ArcView maps, and we are indebted to her. We extend our appreciation to Walter Dodds, Lorena Passarelli and Jason Graves for technical assistance. We thank Alan Prather, Craig Freeman, Robert Kaul, Mark Ungerer and Harmony Dalgleish, for providing valuable comments on the manuscript. We also thank the Konza Prairie LTER program for in-kind support. This is publication number 05-244-J of the Kansas Agricultural Experiment Station.

REFERENCES

Angiosperm Phylogeny Group. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Bot. J. Linnean Soc. 141:399–436.

Barkley, T.M. 1965. J.B. Norton's grass investigation trip through central Kansas in 1898. Kansas Academy Science, Trans. Kans. Acad. Sci. 68:363–383.

---

[1] *Setaria pumila* ssp. *pumila* is the correct name for plants treated as *S. glauca* (L.) P. Beauv. in FGP, and later as *Pennisetum glaucum* in PLANTS (see draft treatment of *Setaria* by J. M. Rominger for *Flora of North America North of Mexico*; herbarium.usu.edu/treatments/Setaria.htm).

[2] There is actually one KANU specimen of *Camelina sativa* that is equivocal with regard to cultivated status; however, the specimen apparently lacks temporal data (no year, and no locality data, in addition) and therefore was not included in this study (see Methods).

[3] In one case, a taxon recognized at the subspecific level in PLANTS is here recognized at the specific level, following the preference of regional floristics workers: *Stellaria media* ssp. *pallida* (Dumort.) Asch. & Graebn. = *S. pallida* (Freeman et al. 1998; App. 1).

[4] In some cases inclusion is based on small numbers of KSC specimens examined (App. 1), and may well be refined by future workers; in the case of *Melilotus alba*, a different taxonomic concept is favored. Relevant references are provided where available.

Barnard, I. 2003. The 137-year history of the Kansas State University Herbarium. Trans. Kans. Acad. Sci. 106:81–91.

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.B. Grace, J.E. Keeley, J.M. DiTomaso, R.J. Hobbs, M. Pellant, and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. Bioscience 54:677–688.

Brooks, R. E. 1991. Supplement to the flora of the Great Plains (1990). In: Great Plains Flora Association, eds. Flora of the Great Plains, second printing. University Press of Kansas, Lawrence.

Callaway, R.M. and E.T. Aschehoug. 2000. Invasive plants versus their new and old neighbors: a mechanism for exotic invasion. Science 290:521–523.

Callaway, R.M., G.C. Thelen, A. Rodriguez, and W.E. Holben. 2004. Soil biota and exotic plant invasion. Nature 427:731–733.

Costello, C. and C. McAusland. 2003. Protectionism, trade, and measures of damage from exotic species introductions. Amer. J. Agric. Econ. 85:964–975.

Cox, G.W. 2004. Alien species and evolution. Island Press, Washington, D.C.

Daehler, C.C. 1994. Variable reproductive output among clones of *Spartina alterniflora* (Poaceae) invading San Francisco Bay, California: the influence of herbivory, pollination and establishment site. Amer. J. Bot. 81:307–313.

Daehler, C.C. 2003. Performance comparisons of co-occurring native and alien invasive plants: implications for conservation and restoration. Annu. Rev. Ecol. Evol. Syst. 34: 183–211.

Daehler, C.C. and D.R. Strong. 1997. Hybridization between introduced smooth cordgrass (*Spartina alterniflora*; Poaceae) and native California cordgrass (*S. foliosa*) in San Francisco Bay, California, USA. Amer. J. Bot. 84:607–611.

Dalton, R. 2003. Natural history collections in crisis as funding is slashed. Nature 423:575.

D'Antonio, C.M. and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Ann. Rev. Ecol. Syst. 23:63–87.

Davis, L.W. 1993. Weed seeds of the great plains: a handbook for identification. University Press of Kansas, Lawrence, Kansas.

Delisle, F., C. Lavoie, M. Jean, and D. Lachance. 2003. Reconstructing the spread of invasive plants: taking into account biases associated with herbarium specimens. J. Biogeogr. 30:1033–1042.

Division of Plant Health. 2003. Kansas noxious weed law. Kansas Department of Agriculture. Topeka, Kansas.

Dybos, C.L. 2004. Invasive species: the search for solutions. Bioscience 54:615–621.

Freeman, C.C., R.L. McGregor, and C.A. Morse. 1998. Vascular plants new to Kansas. Sida 18: 593–604.

Gordon, D.R. 1998. Effects of invasive, non-indigenous plant species on ecosystem processes: lessons from Florida. Ecol. Appl. 8:975–989.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence, Kansas.

Greuter, W., J. McNeill, F.R. Barrie, H.M. Burdet, V. Demoulin, T.S. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth. 2000. International Code of Botanical Nomenclature (Saint Louis Code). Koeltz Scientific: Königstein, Germany.

Gropp, R.E. 2003. Are university natural science collections going extinct? Bioscience 53:550.

Kellogg, C.H. and S.D. Bridgham. 2004. Disturbance, herbivory, and propagules dispersal control dominance of an invasive grass. Biol. Invasions 6:319–329.

Klironomos, J.N. 2002. Feedback with soil biota contributes to plant rarity and invasiveness in communities. Nature 417:67–70.

Kolar, C.S. and D.M. Lodge. 2001. Progress in invasion biology: predicting invaders. Trends Ecol. Evol. 16:199–204.

Lambrinos, J.G. 2001. The expansion history of a sexual and asexual species of *Cortaderia* in California, USA. J. Ecol. 89:88–98.

Laughlin, D.C. 2003. Geographic distribution and dispersal mechanisms of *Bouteloua curtipendula* in the Appalachian Mountains. Amer. Midl. Nat. 149:268–281.

Lavoie, C., M. Jean, F. Delisle, and G. Létourneau. 2003. Exotic plant species of the St. Lawrence River wetlands: a spatial and historical analysis. J. Biogeogr. 30:537–549.

Mack, R.N. 2000. Assessing the extent, status, and dynamism of plant invasions: current and emerging approaches. In: H.A. Mooney and R.J. Hobbs, eds. Invasive species in a changing world. Island Press, Washington, D.C.

Mack, R.N. and W.M. Lonsdale. 2001. Humans as global plant dispersers: getting more than we bargained for. Bioscience 51:95–102.

Mayfield, M.H. 1997. A systematic treatment of *Euphorbia* subgenus *Poinsettia* (Euphorbiaceae). Ph.D. dissertation, University of Texas at Austin.

Meekins, J.F., H.E. Ballard, Jr., and B.C. McCarthy. 2001. Genetic variation and molecular biogeography of a North American invasive plant species (*Alliaria petiolata*, Brassicaceae). Int. J. Plant. Sci. 162:161–169.

Mihulka, S. and P. Pyšek. 2001. Invasion history of *Oenothera* congeners in Europe: a comparative study of spreading rates in the last 200 years. J. Biogeogr. 28:597–609.

Mosyakin, S.L. and K.R. Robertson. 2003. *Amaranthus*. In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico, Vol. 4. Oxford University Press, New York.

Natural Science Collections Alliance. 2004. Collective knowledge: the value of natural science collections. Booklet, Natural Science Collections Alliance, Washington, D.C.

Naylor, R.L. 2000. The economics of alien species invasions. In: H.A. Mooney and R.J. Hobbs, eds. Invasive species in a changing world. island Press, Washington, D.C.

Nesom, G.L. 2000. Which non-native plants are included in floristic accounts? Sida 19: 189–193.

Novak, S.J. and R.N. Mack. 2001. Tracing plant introduction and spread: genetic evidence from *Bromus tectorum* (Cheatgrass). Bioscience 51:114–122.

Parker, I.M. and K.A. Haubensak. 2002. Comparative pollinator limitation of two non-native shrubs: do mutualisms influence invasions? Oecologia 130:250–258.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of nonindigenous species in the United States. Bioscience 50:53–65.

Prather, L.A., O. Alvarez-Fuentes, M.H. Mayfield, and C.J. Ferguson. 2004a. The decline of plant collecting in the United States: a threat to the infrastructure of biodiversity studies. Syst. Bot. 29:15–28.

Prather, L.A., O. Alvarez-Fuentes, M.H. Mayfield, and C.J. Ferguson. 2004b. Implications of the decline in plant collecting for systematic and floristic research. Syst. Bot. 29:216–212.

Pyšek. P., B. Mandak, T. Francírková, and K. Prach. 2001. Persistence of stout clonal herbs as invaders in the landscape: a field test of historical records. In: G. Brundu, J. Brock, I. Camarada, L. Child and M. Wade, eds. Plant invasions: species ecology and ecosystem management. Backhuys Publishers, Leiden.

Pyšek, P., K. Prach, and B. Mandák. 1998. Invasions of alien plants into habitats of Central European landscape: an historical pattern. In: U. Starfinger, K. Edwards, I. Kowarik and M. Williamson, eds. Plant invasions: ecological mechanisms and human responses. Backhuys Publishers, Leiden.

Reichard, S.H. and P. White. 2001. Horticulture as a pathway of invasive plant introductions in the United States. Bioscience 51:103–113.

Ricciardi, A., W.W.M. Steiner, R.N. Mack, and D. Simberloff. 2000. Toward a global information system for invasive species. Bioscience 50:239–244.

Richardson, D.M., N. Allsopp, C.M. D'Antonio, S.J. Milton, and M. Rejmánek. 2000a. Plant invasions – the role of mutualisms. Biol. Rev. 75:65–93.

Richardson, D.M., P. Pyšek, M. Rejmánek, M.G. Barbour, F.D. Panetta, and C.J. West. 2000b. Naturalization and invasion of alien plants: concepts and definitions. Divers. Distrib. 6:93–107.

Sheeley, S.E. and D.J. Raynal. 1996. The distribution and status of species of *Vincetoxicum* in Eastern North America. Bull. Torrey Bot. Club 123:148–156.

Siemann, E. and W.E. Rogers. 2003. Reduced resistance of invasive varieties of the alien tree *Sapium sebiferum* to a generalist herbivore. Oecologia 135:451–457.

Simberloff, D. and B. Von Holle. 1999. Positive interactions of nonindigenous species: invasional meltdown? Biol. Invasions 1:21–32.

Simpson, A. 2004. The global invasive species information network: what's in it for you? Bioscience 54:613–614.

Soberón, J., J. Llorente, and H. Benítez. 1996. An international view of national biological surveys. Ann. MO Bot. Gard. 83:562–573.

Soberón, J.M., J.B. Llorente, and L. Onate. 2000. The use of specimen-label databases for conservation purposes: an example using Mexican Papilionid and Pierid butterflies. Biodivers. Conserv. 9:1441–1466.

Stubbendieck, J., G.Y. Friisoe, and M.R. Bolick. 1994. Weeds of Nebraska and the Great Plains. Nebraska Department of Agriculture, Bureau of Plant Industry, Lincoln, Nebraska. p. 589.

Suarez, A.V. and N.D. Tsutsui. 2004. The value of museum collections for research and society. Bioscience 54:66–74.

Ter Steege, H., M.J. Jansen-Jacobs, and V.K. Datadin. 2000. Can botanical collections assist in a National Protected Area Strategy in Guyana? Biodivers. Conserv. 9:215–240.

Towne, E.G. and I. Barnard. 2000. *Themeda quadrivalvis* (Poaceae: Andropogoneae) in Kansas: an exotic plant introduced from birdseed. Sida 19:201–203.

Vilá, M., E. Weber, and C.M. D'Antonio. 2000. Conservation implications of invasion by plant hybridization. Biol. Invasions 2:207–217.

Weber, E. 1998. The dynamics of plant invasions: a case study of three exotic goldenrod species (*Solidago* L.) in Europe. J. Biogeog. 25:147–154.

Zavaleta, E. 2000. The economic value of controlling an invasive shrub. Ambio 29:462–467.

BOOK NOTICES

Timber Press

PERRY D. SLOCUM. 2005. **Waterlilies and Lotuses: Species, Cultivars, and New Hybrids.** (ISBN 0-88192-684-1, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 260 pp., over 325 color photos, b/w drawings, 7 1/2" × 10 1/2".

This new updated book describes nearly 500 waterlily and lotus species and cultivars. Genera covered in the book include *Nymphaea, Nuphar, Victoria, Euryale, Barclaya, Ondinea,* and *Nelumbo*. Two genera, *Nymphaea* and *Nelumbo* receive special emphasis. "All species and major cultivars, including day- and night-blooming tropical and hard waterlilies and lotuses, are described, with the author's and hybridizers' comments on the best landscape uses for each plant."

DONALD J. LEOPOLD. 2005. **Native Plants of the Northeast: A Guide for Gardening and Conservation.** (ISBN 0-88192-673-6, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 308 pp., color photos, 7 1/2" × 10 1/2".

This book is about a selection of nearly 700 species of native trees, shrubs, vines, ferns, grasses, and wildflowers of the northeast United States with great potential as horticultural and landscape plants. Everything we can do to promote our native plants for horticultural use and to promote their conservation is worthwhile. Each plant description includes a common name, **Zones**, **Soil**, **Light** [Requirements], **Attributes**, **Propagation**, **Notes**, and **Natural Range**. For those wishing to garden with native plants, this book is a good source of information on a significant number of native plants of eastern North America.

BEVERLEY NICHOLS with drawings by WILLIAM MCLAREN. 2002. **Garden Open Today.** (ISBN 0-88192-533-0, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 258 pp., b/w figs., 5 1/2" × 8".

This book was originally published in 1963 by Jonathan Cape. The new Timber Press printing comes with a Foreword and Index copyrighted by Timber Press, Inc.

THE VASCULAR PLANTS OF A FOREST FRAGMENT IN SOUTHERN BAHIA, BRAZIL

André M. Amorim

Departamento de Ciências Biológicas–DCB
Universidade Estadual de Santa Cruz–UESC
Ilhéus, 45.650-000, Bahia, BRAZIL
aamorimm@terra.com.br

Pedro Fiaschi

Herbário André Maurício V. de Carvalho–CEPEC
Centro de Pesquisas do Cacau
Caixa Postal 07, Itabuna, 45600-970, Bahia, BRAZIL
pedrofiaschi@hotmail.com

Jomar G. Jardim

Departamento de Ciências Biológicas–DCB
Universidade Estadual de Feira de Santana–UEFS
Feira de Santana, 44031-460, Bahia, BRAZIL
jgjard@yahoo.com.br

Wm. Wayt Thomas

The New York Botanical Garden
Bronx, New York 10458-5126, U.S.A.
wthomas@nybg.org

Brenda C. Clifton

Herbário André Maurício V. de Carvalho–CEPEC
Centro de Pesquisas do Cacau
Caixa Postal 07, Itabuna, 45600-970, Bahia, BRAZIL
clifton@u.washington.edu

André Maurício V. de Carvalho
(Deceased)

Herbário André Maurício V. de Carvalho–CEPEC
Centro de Pesquisas do Cacau
Caixa Postal 07, Itabuna, 45600-970, Bahia, BRAZIL

ABSTRACT

The Serra do Teimoso, in southern Bahia, Brazil, is a mountain reaching 850 m at the transition from tropical moist forest to tropical semideciduous forest. A floristic survey of a 200 ha reserve established on the mountain was carried out and a checklist of the vascular flora produced. The survey was conducted by random collecting efforts and the sampling of all specimens ≥ 5 cm diameter within a one hectare plot. The flora of the Serra do Teimoso Reserve (STR) comprised 727 species in 400 genera and 119 families. The angiosperms comprised 667 species in 363 genera and 100 families and the pteridophytes included 60 species in 37 genera and 19 families. Floristic relationships of the STR flora were discussed with regard to some florest types of eastern Brazil, especially those found at southern Bahia.

RESUMEN

La Serra do Teimoso, en el sur de Bahia, Brasil, es una montaña alcanzando 850 m en la transición de los bosques tropicales húmedos hacia los bosques tropicales semideciduales. Un inventario florístico de una reserva forestal con ca. 200 ha establecida en la montaña fue hecho y un checklist producido. El levantamiento fue conducido por medio de esfuerzos de coleta aleatorios y el muestro de todos los espécimens ≥ 5 cm DAP dentro de um plot de uma hectárea. La flora de plantas vasculares da la Reserva Serra do Teimoso (STR) incluió 727 especies en 400 géneros y 119 familias. Las angiospermas incluiron 667 especies en 363 géneros y 100 familias, y las pteridofitas incluiron 60 especies en 37 géneros y 19 familias. Relacciones florísticas de la flora de STR fueran discutidos con base en algunos tipos de bosques del este de Brasil, en especial aquellos localizados en el sur de Bahia.

SIDA 21(3): 1727–1752. 2005

INTRODUCTION

Brazil's Atlantic coastal forest originally stretched some 3,500 kilometers from the state of Rio Grande do Norte to Rio Grande do Sul. In southern Bahia, the coastal forests occupied a zone approximately 100–200 km wide along the Atlantic coast. The forests gradually become drier inland, changing from tropical moist forest ("mata higrófila") to tropical semideciduous forest ("mata mesófila") to tropical deciduous forest ("mata de cipó"). Each of these forest types occupies a narrow zone up to 50 km wide within the coastal forest belt and varies in floristic composition depending on elevation, soils, and drainage (Gouvêa et al. 1976).

Only about 7.6 percent of the original coastal forest remains standing (Morellato & Haddad 2000; Myers et al. 2000). In southern Bahia, for example, the forest has been reduced to 3.5 percent of its original extent (Thomas et al. 1998) with most of the deforestation due to logging, clearing for pastures, or planting of cocoa.

The few existing floristic or ecological studies of southern Bahian forests are of moist forest and confirm the uniqueness of these forests (Mori et al. 1983; Sambuichi 2002; Amorim et al. in press; Thomas et al. 1998, in press). Recent collections continue to reveal new species and augment the known distributions of many species.

In the Neotropics, seasonal, dry forests are comparatively more threatened, less studied, and less conserved than evergreen, moist forests (Janzen 1988; Gentry 1997; Pennington et al. 2000). In Bahia, the dry forests were cleared earlier and more completely than the moist forests (Mendonça et al. 1994) and now support large areas of pasture and coffee plantations (Vinha et al. 1976; Mori & Mattos Silva 1979). There are no federal protected areas in Bahia's coastal dry forests.

The Serra do Teimoso Reserve (STR) is situated in the transition between the moist forest and the semideciduous forest. The study of its flora offered us the opportunity to learn about the species of this transitional zone and their affinities.

Study Site

The Serra do Teimoso, in Jussari, Bahia (Fig. 1), is one of the easternmost ridges of the Serra da Ouricana and reaches ca. 850 m elevation (Fig. 2). At 15°12'S, 39°29'W, it is the source of the Água Preta River, an important component of the Rio Cachoeira Basin (CEI 1993).

As the Portuguese colonists moved into the interior of Bahia in the region of Jussari, they displaced members of the indigenous Botocudo tribe (Maximiliano 1940). The Berbert family moved to the Jussari region and acquired the Serra do Teimoso. The persistence of the squatters who were living on the mountain in returning after they had been forcibly removed led to the mountain being called the Serra do Teimoso ("teimoso" means stubborn in Portuguese). In 1997, 200 ha, or 40 percent of the Berbert farm was officially recognized by Brazil as a private reserve, here called the Serra do Teimoso Reserve (STR), offi-

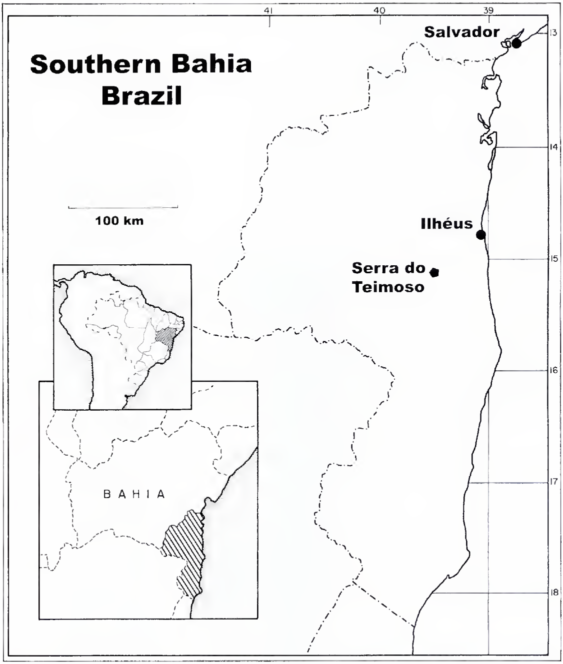


Fig. 1. Serra do Teimoso Reserve and its location in southern Bahia, Brazil and South America.

cially known as the "Reserva Particular do Patrimônio Natural Serra do Teimoso" established by IBAMA decree n° 93/97-N.

As a consequence of Teimoso's geological basement of granites and moderate rains, the soils of the STR are fertile and have low acidity (Gonçalves 1975). In the higher regions the soils are red-yellow laterites and on the mid-slopes they are shallow lithosols with gneiss outcrops (Carvalho Filho et al. 1987).

The median annual temperature of the STR varies from 23–24°C and the

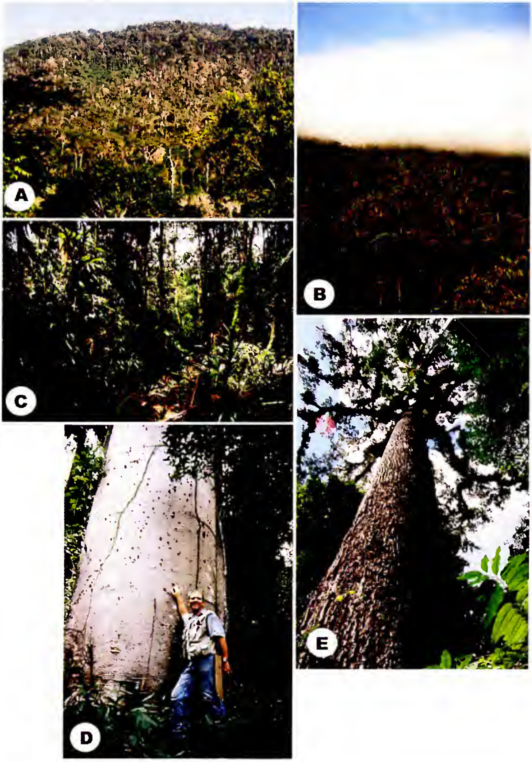


FIG. 2. Vegetation of the Serra do Teimoso Reserve. **A.** View of the forested mountainside. **B.** View of the mountainside with the uppermost forest hidden by the clouds. **C.** Interior of montane forest at the top of the mountain. **D.** Trunk of a large *Cavanillesia arborea*, one of the species characteristic of semideciduous forests. **E.** *Cariniana legalis*, one of the emergent species, with 45 m tall. All photos by W.W. Thomas.

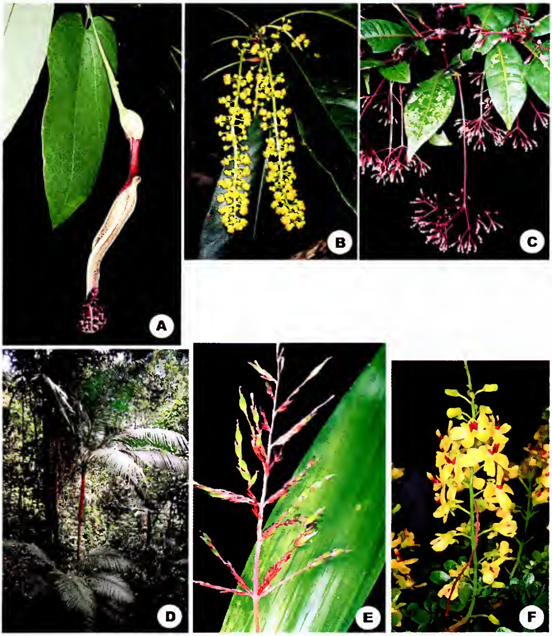


Fig. 3. Some plants characteristic of the Serra do Teimoso Reserve. **A.** *Aristolochia longispathulata* (WT 11741), a species recently described from this forest. **B.** *Quiina glaziovii* (WT 11727), a tree species endemic to the Atlantic coastal forest. **C.** *Guapira laxiflora* (WT 11885), a shrub endemic to the Atlantic coastal forest. **D.** *Euterpe edulis* (JJ 3902), from which Palm Hearts are harvested, is an Atlantic coastal forest endemic and is an indicator of humid forests. **E.** *Sucrea monophylla* (AC 6821), an herbaceous bamboo and is one of many bamboos endemic to southern Bahia. **F.** The inflorescence of *Caesalpinia echinata* (JP 343), the Brazil-wood, another Atlantic coastal forest endemic, and the tree that gave rise to the name of the country. All photos by W.W. Thomas.

annual precipitation averages 1250–1500 mm with two to three dry months a year (Roeder 1975). Thus, the climate can be categorized as Am (a transitional type between Af and Aw) in Köppen's (1948) classification.

Edaphic and climatic factors present a gradient from warmer and drier at the base of the mountain (about 350 m elevation) to cooler and moister at the summit. This difference is expressed in the vegetation, which changes from a forest with elements of semideciduous forest at the base to submontane moist forest near the summit (Gouvêa et al. 1976; Vinha et al. 1976; Mori & Silva 1979; Brazão & Araújo 1981).

Because of the efforts of its owners, the STR still has a remarkable number of striking species (Fig. 3). In this forest fragment, we found mature trees of species sought-after for their valuable wood, such as *Brosimum guianense* ("oiticica"), *Caesalpinia echinata* ("pau-brasil"), *Cariniana legalis* ("jequitibá"), *Cedrela odorata* ("cedro-rosa"), *Copaifera lucens* ("pau-óleo"), *Hymenaea* spp. ("jatobá"), *Lecythis pisonis* ("sapucaia"), *Tabebuia billbergii* ("pau-d'arco"), *Plathymenia reticulata* ("vinhático"), *Peltogyne pauciflora* ("pau-roxo"), *Pouteria procera* ("mucuri"), and *Virola gardneri* ("bicuíba-vermelha"). Some individuals are very large, reaching over 50 m in height. These emergents include *Cariniana* spp. (Lecythidaceae), *Cavanillesia arborea* and *Sterculia curiosa* (Malvaceae), *Goniorrhachis marginata* and *Hymenaea* spp. (Fabaceae), and *Virola gardneri* (Myristicaceae).

Research on the diversity of the fauna of the STR has revealed two endangered primates, *Callicebus melanochir* ("guigó") and *Leonthophitecus chrysomelas* ("mico-leão-de-cara-dourada") (Oliver & Santos 1991); 243 species of birds (J.F. Pacheco, pers. comm.); 123 species of arachnids (A. B. Brescovit & R. Bertani, pers. comm.); and 79 species of ants, including several species new to science (J. H. Delabie, pers. comm.).

METHODS

The floristic inventory was generated by repeated visits between 1997 and 2004 to the STR during which fertile plants were collected, both on and off the Reserve's trails. In addition, a quantitative inventory of woody plants ≥ 5 cm diameter at breast height was carried out, during which many vouchers (mostly sterile) were collected and identified. Also, collections made in the 1980's in an adjacent property whose forest is contiguous with the STR were included resulting in a total of 2028 voucher collections.

Vouchers of the collections are stored at CEPEC and NY with all unicates at CEPEC. Exceptions to this are some pteridophytes which are found only at BHCB and some Orchidaceae which are stored only at HUEFS. While duplicates of some collections were sent to specialists for identification, the majority of the collections were identified by the authors using the well-documented collections at CEPEC and specific bibliography.

All of the species documented through collections were included in a checklist of the whole Reserve. In the checklist, the angiosperms are arranged alphabetically by family, genus, and species, with the families circumscribed according to the system proposed by the Angiosperm Phylogeny Group (2003). The pteridophytes are organized according to Moran (1995). Authors of species are abbreviated according to Brummit and Powell (1992). Occasionally a specimen was identifiable only to genus or family, but was clearly distinct from all other members of that taxon. These were included in the list as "sp." or where there were more than one, "sp. 1," "sp. 2" and so on.

RESULTS

The vascular plant flora of the STR is represented by 727 species in 400 genera and 119 families (Appendix 1). The angiosperms comprised 667 species in 363 genera and 100 families and the pteridophytes included 60 species in 37 genera and 19 families. Of the total number of species, 571 were identified to species, 132 identified to genus (but distinct from all other species of the genus) and 24 only to family (but differing from all other species in the family).

Several species collected during this study were or are being described as new by specialists. These include: *Aristolochia longispathulata* (Aristolochiaceae), *Discocarpus pedicellatus* (Phyllanthaceae), *Heteropterys nordestina* (Malpighiaceae), and *Lymania spiculata* (Bromeliaceae). Ten others have been indicated by specialists as being new, but have not yet been described, including species of: *Daphnopsis* (Thymelaeaceae—L. Rossi, pers. comm.), *Heteropterys* (Malpighiaceae—A. Amorim, pers. comm.), *Hiraea* (Malpighiaceae—W. Anderson, pers. comm.), *Nematanthus* (Gesneriaceae—A. Chautems, pers. comm.), *Neoraputia* (Rutaceae—J. Kallunki, pers. comm.), *Pleurostachys* (Cyperaceae—W. Thomas & M. Alves, pers. comm.), *Pleiochiton* (Melastomataceae—R. Goldenberg, pers. comm.), *Rosenbergiodendron* (Rubiaceae—J. Jardim, pers. comm.), and *Thelypteris* (Thelypteridaceae—A. Salino, pers. comm.).

Some genera and species are the first known collections from northeastern Brazil or just from state of Bahia. For northeastern Brazil, these include: *Ampelocera glabra* (Cannabaceae), *Casearia melliodora* (Salicaceae), *Edmundoa lindenii* (Bromeliaceae), *Faramea oligantha* and *F. rivularis* (Rubiaceae), *Heteropterys bicolor* and *Tetrapterys crispa* (Malpighiaceae), and *Pleiochiton* sp. nov. (Melastomataceae). For the state of Bahia, they include: *Agonandra excelsa* (Opiliaceae), *Mandevilla permixta* (Apocynaceae), *Picrasma crenata* (Simaroubaceae), and *Rosenbergiodendron* sp. nov. (Rubiaceae).

Species occurring in the STR that are rarely collected in Bahia include *Andradea floribunda* and *Ramisia brasiliensis* (Nyctaginaceae), *Banisteriopsis patula* and *Byrsonima cacaophila* (Malpighiaceae), *Bracteanthus atlanticus* (Siparunaceae), *Chrysophyllum subespinosum* (Sapotaceae), *Citronella paniculata* (Icacinaceae), *Coussapoa curranii* (Urticaceae), *Licania naviculistipula*

(Chrysobalanaceae), *Naucleopsis oblongifolia* and *Pseudolmedia macrophylla* (Moraceae), *Meriania tetramera* (Melastomataceae), and *Porcelia macrocarpa* (Annonaceae).

The most diverse families were Fabaceae (52 species), Myrtaceae (39), Rubiaceae (31), Orchidaceae (25), Sapotaceae and Solanaceae (24), Bromeliaceae (23), and Araceae, Rutaceae and Sapindaceae (19). These ten families comprised 37.8 percent of the Teimoso Reserve flora. The most species-rich genera were *Eugenia* (20), *Solanum* (16), *Pouteria*, *Trichilia* (12), and *Peperomia* (10).

As mentioned above, the forest of STR becomes more and more humid as one goes up the slope. At the bottom, the forest includes species characteristic of semideciduous forest. Some of the species commonly found and characteristic of this zone are *Averrhoidium gardnerianum* (Sapindaceae), *Byrsonima cacaophila* and *Mascagnia sepium* (Malpighiaceae), *Cavanillesia arborea* (Malvaceae), *Celtis iguanaea* (Cannabaceae), *Chrysophyllum subspinosum* (Sapotaceae), *Discocarpus pedicellatus* (Phyllanthaceae), and *Raddia* spp. and *Sucrea monophylla* (Poaceae). Near the top of the slope, the forest is characterized by elements of montane tropical moist forest (Veloso 1992) and includes *Bathysa cuspidata* and *Simira glaziovii* (Rubiaceae), *Bertolonia carmoi* (Melastomataceae), *Cyathea* spp. (Cyatheaceae), *Dalbergaria sanguinea* and *Sinningia barbata* (Gesneriaceae), *Diplazium* spp. (Woodsiaceae), *Euterpe edulis* (Arecaceae), *Huperzia mandiocana* (Lycopodiaceae), and *Prunus sellowii* (Rosaceae).

At all elevations, the subcanopy is dominated by Rubiaceae, Rutaceae, and Solanaceae. Among the herbs, the most diverse families are the Bromeliaceae, Marantaceae, Orchidaceae, and Piperaceae, as well as the pteridophytes—these groups together comprise 18.8 percent of the flora. The most diverse families of lianas include Bignoniaceae, Fabaceae and Malpighiaceae.

Along the forest edges, disturbed areas and areas under cultivation (e.g. areas where *Theobroma cacao* L. is grown, as well as pastures), weedy species such as *Centropogon cornutus* (Campanulaceae), *Euphorbia heterophylla* (Euphorbiaceae), *Lablab purpureus* (Fabaceae), *Lantana camara* (Verbenaceae), *Maclura tinctoria* (Moraceae), *Momordica charantia* (Cucurbitaceae), *Thunbergia alata* (Acanthaceae), and *Triumfetta semitriloba* (Malvaceae) can be found.

DISCUSSION

Endemism

Of the 515 species of angiosperms identified at the STR, 7.3 percent are endemic to southern Bahia and northern Espírito Santo according with Thomas et al. (2003). This percentage is much lower than the estimates made by Thomas et al. (1998) for the tropical moist forests of the Una Biological Reserve (28.1%) and the Serra Grande forest (26.5%). Nevertheless, the STR is home to *Aristolochia longispathulata* (Aristolochiaceae), *Bracteanthus atlanticus* (Siparunaceae), *Byrsonima cacaophylla* (Malpighiaceae), *Chrysophyllum subspinosum*

(Sapotaceae), *Conchocarpus diadematus* (Rutaceae), *Discocarpus pedicellatus* (Phyllanthaceae), *Licania naviculistipula* (Chrysobalanaceae), *Sucrea monophylla* (Poaceae), and *Trichilia florbranca* (Meliaceae), all of these being examples of local endemics not found in either of the two forests studied by Thomas et al. (1998).

Floristic Relationships

A comparison of the STR checklist with lists from other tropical moist forests in southern Bahia reveals a high number of genera and species in common. One hundred ninety-three genera are shared with the flora of the Una Biological Reserve (Amorim et al. in press) and 214 with that of the Serra do Conduru State Park (Martini et al. 2004).

Nevertheless, 122 genera found in the STR have not been encountered at either the Una Reserve or the Serra do Conduru. Some of these (e.g. *Allophylus, Bougainvillea, Clavija, Diplazium, Huperzia, Pachystroma, Pseudolmedia, Sarcaulus, Scyphonychium,* and *Sucrea*) are quite common in the Teimoso Reserve in the lower elevation, drier portion of the forest and may be genera characteristic of southern Bahian seasonal submontane semideciduous forests (Veloso 1992; Thomas & Barbosa, In press).

The STR has both moist and semideciduous forests, the moist forests being found at higher elevations where orographic effects augment rainfall, especially during the dry season. The juxtaposition and gradual transition from moist to seasonal dry forests in southern Bahia can be explained by the region's varied topography and elevational gradients. In contrast, to the south, the abrupt change from flat, lowland forest to very steep mountainside moist forests in the mountains of Serra do Mar clearly delimit these formations (Oliveira-Filho & Fontes 2000).

Oliveira-Filho & Fontes (2000) analyzed the relationship between climate and species composition in the Atlantic coastal forest. They compared submontane and lowland forests, as well moist and semideciduous forests using TWINSPAN analysis. Their results are discussed in the following floristic comparisons with the STR.

Comparison with Tropical Moist Forests.—Some of the indicator tree species associated with "eastern low-altitude semideciduous coastal forests" of Oliveira-Filho & Fontes (2000) are present in the STR: *Acacia polyphylla, Chrysophyllum gonocarpum, Eugenia moraviana, Guarea guidonia, G. kunthiana, Maytenus aquifolium, Ocotea puberula, Prunus sellowii, Trichilia casaretti,* and *T. elegans.* In addition, some of their indicator species for "northern low-altitude rain forests" (tropical moist lowland and submontane forests) are found at STR: *Brosimum guianense, Campomanesia guaviroba, Carpotroche brasiliensis, Cedrela odorata, Chrysophyllum lucentifolium, Ecclinusa ramiflora, Gallesia integrifolia, Inga edulis, I. striata, Jacaranda puberula, Jacaratia heptaphylla, Lecythis pisonis, Metrodorea *nigra*, *Mouriri chamissoana*, *Ocotea elegans*, *O. indecora*, *O. puberula*, *Protium warmingianum*, *Pterocarpus rohrii*, *Schizolobium parahyba*, *Solanum swartzianum*, *Tabebuia roseo-alba*, *Tetrastylidium grandifolium*, and *Virola gardneri*.

Comparison with Seasonal Dry Forests.—The seasonal dry forests of South America have been suggested as a new phytogeographic unit based on a distinct floristic composition (Prado 2000). These forests are found in areas subjected to a distinct seasonality, like the Chaco and Cerrado (Prado 1993a, 1993b; Ratter et al. 1996). On the other hand, Oliveira-Filho & Fontes (2000) demonstrated that the seasonal semideciduous forests of southeastern Brazil are a part of the same floristic block as the coastal forests, even though these are subjected to a well-defined dry season.

The flora of the STR is composed of species clearly distinct from those mentioned as characteristic of the Seasonal Dry Tropical Forests (SDTF) by Pennington et al. (2000). Indeed, out of the 33 genera endemic from SDTF (Prado 2000), only *Brasiliopuntia* was documented at STR, this one being also very common in the Restinga Forests of Southern Bahia and Espírito Santo (Taylor & Zappi 2004).

The floristic similarity of the STR forest with the moist forests from southeastern Brazil and those from southern Bahia corroborates the widely accepted view that the Atlantic forests should encompass all forest physiognomies east of the dry corridor (Prado & Gibbs 1993, Prado 2000). As stated by Oliveira-Filho & Fontes (2000), these semideciduous forests should be viewed simply as a "physionomic and floristic expression of a single great Atlantic Forest domain", and not as an evidence of floristic connection with the Seasonal Dry Tropical Forests.

Disturbed Areas.—The forest margins and tree fall gaps in the STR are characterized by species quite different from those in the gaps and margins of the lowland moist forest of many areas in southern Bahia (Amorim et al. in press; Martini et al. in press), where species characteristic of disturbed areas include *Baccharis calvescens* DC., *Cyrtocymura scorpioides* (Lam.) H. Rob. and *Vernonanthura diffusa* (Less.) H. Rob. (Asteraceae), *Henriettea succosa* (Aubl.) DC. and *Miconia mirabilis* (Aubl.) L.O. Williams (Melastomataceae), *Schefflera morototoni* (Aubl.) Maguire, Steyermark & Frodin (Araliaceae), *Scleria secans* (L.) Urban (Cyperaceae), and *Tapirira guianensis* Aubl. (Anacardiaceae). In contrast, *Caesalpinia pluviosa* var. *paraensis* (Fabaceae), *Dicella bracteosa* and *Heteropterys bicolor* (Malpighiaceae), *Celtis iguanaea* and *Trema micrantha* (Cannabaceae), and *Maclura tinctoria* (Moraceae) are not found in the disturbed areas of the Una Biological Reserve or adjacent areas.

Taxonomic Difficulties

A high number of collections were not identifiable to species. This is a result of the high diversity of the region's flora and the difficulty of identifying Neotropical plants in general. Identification is particularly problematic in diverse or poorly studied families such as Fabaceae, Lauraceae, Meliaceae, Myrtaceae, Sapindaceae and Sapotaceae—over 37.6 percent of the unidentified species belonged to one of these six families. The high number of sterile samples of trees also limited identification to species. The collection of sterile specimens of unusual plants, however, documents potentially new species or new distribution records. These can be re-collected at a later date in flower or fruit for more precise identification.

APPENDIX 1

Checklist of the vascular plants in the Serra do Teimoso Reserve, Jussari, Bahia, Brazil. Voucher collections are listed for each species using the initials of the primary collector and the collector´s number. Voucher collections are deposited at CEPEC with a second set at NY. Full name of collectors are as follows: **AA** = André M. Amorim, **AC** = André M. de Carvalho, **AS** = Alexandre Salino, **EL** = Elton Leme, **ES** = Eric C. Smidt, **FJ** = Fabrício S. Juchum, **FF** = Flávio França, **FN** = Fabiana R. Nonato, **HP** = Harvey Pengel, **IF** = Irene Fernandes, **JJ** = Jomar G. Jardim, **JK** = Jacquelyn Kallunki, **LM** = Luiz Alberto Mattos Silva, **MS** = Milene M. Silva, **PF** = Pedro Fiaschi, **RF** = Rafaela C. Forzza, **RO** = Reyjane P. Oliveira, **SS** = Sérgio C. Sant´Ana, and **WT** = Wm. Wayt Thomas. A collection number followed by an asterisk (*) is one that is a voucher for a forest inventory plot in the Teimoso Reserve.

ANGIOSPERMS

ACANTHACEAE

Aphelandra blanchetiana (Nees) Hook.—WT 11815, 13353

Aphelandra nitida Nees & Mart.—AA 2584; PF 1091; WT 11926

Jacobinia paniculata (Nees) Oerst.—AA 2291; AC 6825; JJ 1729

Justicia clausseniana (Nees) Profice—AA 2474; JJ 3915; PF 1578

Lophostachys nemoralis Mart.ex Nees—AA 2899; JJ 1707, 1757

Mendoncia sp.—JJ 2346*

Pseuderanthemum sp.—JJ 3168

Pseuderanthemum verbenaceum (Nees & Mart.) Radlk.—JJ 1751, 1854

Ruellia affinis (Nees) Lindau—HP 15; JJ 1528, 3734

Ruellia cearensis Lindau—JJ 3928; PF 1583

Ruellia curviflora Nees & Mart.—AC 6823; JJ 1859; WT 11746

Schaueria gonyostachya Nees—AA 2589; JJ 1511; PF 1094

Thunbergia alata Bojer ex Sims—AA 4142

ACHARIACEAE

Carpotroche brasiliensis (Raddi) A. Gray—WT 13395

AMARANTHACEAE

Alternanthera cf. *ramosissima* (Mart.) Chodat—AA 2481

Amaranthus spinosus L.—AA 3751

Celosia grandifolia Moq.—AA 3778; HP 21; WT 13359

Celosia longifolia Mart.—AA 3789; HP 19; WT 11811

Chamissoa acuminata Mart.—AA 4129; WT 11795

Chamissoa altissima (Jacq.) H.B.K.—AA 2894

Hebanthe sp.—AA 2451

AMARYLLIDACEAE

Griffinia sp.—JJ 1531

ANACARDIACEAE

Spondias macrocarpa Engl.—AA 2279*; JJ 2440*, 3778*

ANNONACEAE

Duguetia sp.—JJ 1900*
Duguetia bahiensis Maas—AA 2896; JJ 1484
Guatteria sp.—PF 1095
Hornschuchia sp.—WT 13393
Porcelia macrocarpa (Warm.) R.E. Fr.—JJ 1657*; PF 1196
Rollinia sp.—JJ 3811*
Xylopia aff. *laevigata* (Mart.) R.E. Fr.—JJ 1551*, 1650*, 1661*

APIACEAE

Hydrocotyle callicephala Cham.—JP 202; WT 11737

APOCYNACEAE

Apocynaceae sp.—AA 2196*
Aspidosperma parvifolium A. DC.—AA 2254*
Mandevilla permixta Woodson—AA 4134
Marsdenia sp.—AC 6854
Prestonia sp.—JJ 2486
Rauvolfia sp.—AA 3730*
Tabernaemontana laeta Mart.—AC 6870; JJ 3747*;WT 12142

ARACEAE

Anthurium bellum Schott—AA 3741; JJ 1741
Anthurium blanchetianum Engl.—AC 6826; AA 2446, 2597
Anthurium ianthinopodum Schott—AC 6830; JJ 1750; WT 11721
Anthurium illepidum Schott—JJ 1871, 3731; PF 1218
Anthurium jilekii Schott—PF 1087
Anthurium pentaphyllum (Aubl.) G. Don—AA 2377, 3708; WT 11734
Anthurium scandens (Aubl.) Engl.—AA 2322, 3719; WT 11822
Asterostigma riedelianum (Schott) Kuntze—AA 2333, JJ 1736, 2699
Monstera adansonii Schott var. *adansonii*—AA 2369; PF 1929
Monstera adansonii Schott var. *klotzschiana* (Schott) Madison—WT 11801
Philodendron sp.—AA 3795
Philodendron longilaminatum Schott—PF 1935
Philodendron ornatum Schott—AA 3788; PF 1978; WT 11813
Philodendron pedatum (Hook.) H.B.K.—PF 1934
Philodendron propinquum Schott—WT 11819
Philodendron scandens C. Koch. & Sello—AA 3794
Rhodospatha latifolia Poepp.—WT 11812
Syngonium podophyllum Schott var. *vellozianum* (Schott) Croat—AA 3742; PF 1097; WT 11814
Xanthosoma maximanii Schott—HP 17; WT 13321

ARECACEAE

Bactris ferruginea Burret—JJ 1666*; JP 176; PF 1925
Bactris pickelli Burret—AA 2702; JJ 1863; PF 1939
Desmoncus polyacanthos Mart. var. *polyacanthos*—JJ 1538; WT 11738, 12143
Euterpe edulis Mart.—JJ 3902; JP 192
Geonoma pauciflora Mart.—PF 1585
Geonoma pohliana Mart.—AA 3787
Syagrus botryophora (Mart.) Mart.—PF 1646

ARISTOLOCHIACEAE

Aristolochia gigantea Mart. & Zucc.—WT 11904
Aristolochia longispathulata F. González—WT 11741

ASTERACEAE

Asteraceae sp.—JP 205
Cephalopappus sonchifolius Nees & Mart.—WT 11910
Heterocondylus vitalbae (DC.) R.M. King & H. Rob.—AA 2480, 3749; JJ 3729
Piptocarpha ramiflora (Spreng.) Baker—AA 2449

BALANOPHORACEAE

Helosis cayennensis (Sw.) Spreng.—JJ 3735
Langsdorffia sp.—WT 11741
Lophophytum mirabile Schott & Endl. subsp. *mirabile*—JJ 3736, 3923; PF 1221

BEGONIACEAE

Begonia bahiensis A. DC.—AA 6840; JJ 1752; WT 11947
Begonia besleriaefolia Schott var. *sthuriana* Brade—AA 2473; AC 6698
Begonia convolvulacea (Klotzsch) A. DC.—AA 2460
Begonia itaguassuensis Brade—AC 6704; JJ 1497, 1733
Begonia subacida Irmsch.—AA 2370; LM 2152

BIGNONIACEAE

Bignoniaceae sp. 1—AA 2452
Bignoniaceae sp. 2—AA 2287; FJ 4
Bignoniaceae sp. 3—WT 11878
Adenocalymna sp.—AA 2705; HP 8; JJ 1877
Arrabidaea sp.—WT 11920

Glaziovia bauhinioides Bureau ex Baill.—JJ 2377*; JP 213; WT 11916
Jacaranda puberula Cham.—AA 2673*
Mansoa difficilis (Cham.) Bureau & K. Schum.—JJ 2478*; JP 218
Stizophyllum riparium (Kunth) Sandwith—PF 1864
Tabebuia sp.—AA 2455*; JJ 2417*
Tabebuia billbergii (Bureau & K.Schum.) Standl.—AA 2630
Tabebuia roseo-alba (Ridl.) Sandwith—AA 1641*, 2340*; PF 1652

BORAGINACEAE

Cordia sp.—JJ 2405*, 3849*
Cordia aberrans I.M. Johnst.—AA 2693; PF 1669
Cordia alliodora (Ruiz & Pav.) Oken—JJ 3834*
Cordia curassavica (Jacq.) Roem. & Schult.—AA 3797
Cordia longifolia A. DC.—WT 13360
Cordia magnoliaefolia Cham.—AA 3789, 3892
Cordia superba Cham.—AA 2620, 2696; JJ 1502
Tournefortia bicolor Sw.—WT 11915
Tournefortia breviflora DC.—AA 2349; PF 1969

BROMELIACEAE

Aechmea sp.—AA 4139
Aechmea curranii (L.B. Sm.) L.B. Sm. & M. A. Spencer—AA 2613; JJ 2085
Aechmea lingulata (L.) Baker—AA 2343, 2629
Aechmea perforata L.B. Sm.—AA 2344
Araeococcus parviflorus (Mart. ex Schult. f.) Lindman—AA 2617
Billbergia morelii Brong.—AA 2097; PF 1202; WT 11918
Canistropsis billbergioides (Schult. f.) Leme—AA 2340; AC 6695; RF 1275
Cryptanthus beuckeri E. Morren—AA 2371; WT 11909, 13397
Edmundoa lindenii (Regel) Leme—JJ 2485; WT 11805
Hohenbergia augusta (Vell.) E. Morren—AA 2479
Hohenbergia disjuncta L.B. Sm.—AA 4126
Lymania alvimii (L.B. Sm. & Read) Read—WT 10871
Lymania azurea Leme—LM 406
Lymania smithii Read—LM 407
Lymania spiculata Leme & Forzza—EL 4638
Nidularium innocentii Lem.—AA 2342
Nidularium procerum Lindman—WT 11808, 11809
Tillandsia geminiflora Brong.—AA 2341, 2464; WT 13358
Tillandsia stricta Sol.—AA 2339; JP 193
Tillandsia tenuifolia L. var. *vaginata* (Wawra) L.B. Sm.—AA 2458; JP 49; PF 1581
Tillandsia usneoides (L.) L.—JJ 1704
Vriesea duvaliana E. Morren—AA 2345
Vriesea psittacina (Hook.) Lindl.—LM 2404; WT 11818, 13348

BURSERACEAE

Protium aracouchini (Aubl.) Marchand—JJ 3756*, 3833*, 3851*
Protium warmingianum Marchand—JJ 1619*, 1649*, 3932

CACTACEAE

Brasiliopuntia brasiliensis (Willd.) A. Berger—AA 2616; JJ 1888; PF 1214
Epiphyllum phyllanthus (L.) Haw.—JJ 1701
Hatiora salicornioides (Haw.) Britton & Rose—WT 13356
Rhipsalis baccifera (J. S. Muell.) Stearn. subsp. *hileiabahiana* N.P. Taylor & Barthlott—AA 3697; JJ 3737; WT 11876
Rhipsalis floccosa Salm-Dyck ex Pfeiff.—AA 3717; JJ 1758

CAMPANULACEAE

Centropogon cornutus (L.) Druce—AA 2917

CANNABACEAE

Ampelocera glabra Kuhlm.—AA 2619, 2690; JJ 1485
Celtis iguanaea (Jacq.) Sarg.—AA 2688; HP 10; PF 1980
Trema micrantha (L.) Blume—JJ 1582

CAPPARACEAE

Capparis frondosa Jacq.—LM 2385
Crataeva tapia L.—JJ 1505; PF 1868

CARICACEAE

Jacaratia dodecaphylla A. DC.—JJ 1573*, 1914*, 2339*
Jacaratia heptaphylla (Vell.) A. DC.—JJ 3767*

CELASTRACEAE

Cheiloclinium cognatum (Miers) A. C. Sm.—AA 2304, 2332; PF 1192
Hippocratea volubilis L.—AA 2232*
Maytenus sp.—JJ 3871*
Maytenus aff. *aquifolium* Mart.—AA 2245*
Maytenus cf. *macrodonta* Reissek—AA 2627, 2712; WT 11898

Maytenus brasiliensis Mart.—AA 2255*; JJ 4048; PF 1866

CHRYSOBALANACEAE

Couepia sp.—AA 2198*, 2205*; JJ 3898*

Hirtella triandra Sw. subsp. *triandra*—AA 2256*; JJ 1556*, 1933*

Licania naviculistipula Prance—JJ 1500, 1548*, 2382*

CLUSIACEAE

Garcinia gardneriana (Planch. & Triana) D. C. Zappi—JJ 2338*; PF 1215; WT 12188

COMBRETACEAE

Bucihenavia sp.—JJ 2458*

Terminalia oblonga (Ruiz & Pav.) Steud.—AA 2272*; JJ 1936*, 2416*

COMMELINACEAE

Commelina rufipes Seubert—WT 13350

Dichorisandra sp.—JJ 2328

Dichorisandra acaulis Cogn.—JJ 1472, 2083; SS 1019

Dichorisandra hexandra (Aubl.) Standl.—WT 11923

Dichorisandra leucophthalmos Hook.—JJ 2087, PF 1992; WT 13398

Dichorisandra cf. *thyrsiflora* J.C. Mikan—AA 2586, 3782; PF 1675

CONNARACEAE

Connarus blanchetii Planch. var. *laurifolius* (Baker) Forero—AC 6837; JJ 1864, 3930

Rourea discolor Baker—AA 4135

COSTACEAE

Costus subsessilis (Nees & Mart.) Maas—AA 2365; WT 11937, 13401

Costus spiralis (Jacq.) Roscoe—HP 01; JJ 1744; WT 10860

CUCURBITACEAE

Fevillea sp.—WT 11768

Fevillea trilobata L.—PF 1660; WT 13357

Gurania cf. *spinulosa* (Poepp. & Endl.) Cogn.—HP 22; WT 11743, 13367

Melothria pendula L.—PF 1077

Melothrianthus smilacifolius (Cogn.) Mart. Crov.—PF 1982

Momordica charantia L.—LM 2372

Psiguria sp.—AA 2457

Psiguria cf. *grandiflora* Cogn.—AC 6688; WT 11882

Sicydium cf. *giracile* Cogn.—AA 2346; HP 31; JJ 3726

Wilbrandia verticillata (Vell.) Cogn.—AA 2582; JP 194

CUNONIACEAE

Lamanonia sp.—JJ 3897*, 3914*

CYCLANTHACEAE

Evodianthus funifer (Poit.) Lindman—WT 13320

CYPERACEAE

Cyperus laxus Lam.—PF 1962

Hypolytrum schraderianum Nees—WT 11803

Pleurostachys sp. nov. 1—JJ 3922; PF 1579; WT 13370

Pleurostachys sp. nov. 2—PF 1219, 1220; WT 13388

Pleurostachys tenuiflora Brongn.—WT 13365

Rhynchospora comata (Link) Roem. & Schult.—JJ 1477

Scleria sp.—AA 4264

DICHAPETALACEAE

Stephanopodium blanchetianum Baill.—AA 2687; JJ 1947*; WT 11897

DIOSCOREACEAE

Dioscorea sp. 1—AA 2923

Dioscorea sp. 2—WT 13140

EBENACEAE

Diospyros sp.—PF 1078

Diospyros ebenaster Retz.—JJ 1953*; PF 1195*, 1861

ELAEOCARPACEAE

Sloanea garckeana K. Schum.—PF 1083; WT 11728, 13379

Sloanea monosperna Vell.—AA 2257*; AC 6822; JP 169

ERYTHROXYLACEAE

Erythroxylum columbinum Mart.—AA 2363; LM 2391; WT 11928

Erythroxylum cf. *compressum* Peyr.—JJ 1488

Erythroxylum cf. *petrae-caballi* Plowman—FJ 3; JJ 3749*

EUPHORBIACEAE

Acalypha brasiliensis Müll. Arg.—JJ 1885

Acalypha villosa Jacq.—AA 2361; PF 1673

Actinostemon appendiculatus Jabl.—AA 2612; LM 2408; WT 13378

Actinostemon klotzschii (Didr.) Pax—WT 12531

Alchornea iricurana Casar.—JJ 2398*
Argithamnia tricocca Müell. Arg.—AA 2456, 2593; JJ 1498
Cnidoscolus oligandrus (Müell. Arg.) Pax—WT 11756*, 12201
Dalechampia sp.—AA 2466
Dalechampia brasiliensis Lam.—PF 1181
Euphorbia comosa Vell.—WT 11949
Euphorbia heterophylla L.—LM 2376
Manihot pilosa Pohl—AA 2711
Omphalea brasiliensis Müell. Arg.—AA 2193*, 2214*; JJ 3774*
Pachystroma longifolium (Nees) I.M.Johnst.—AC 6861; JJ 1742; LM 2401
Pera sp.—WT 11788*
Sapium sp.—AA 3766*; JJ 2434*
Sebastiania brasiliensis Spreng.—AA 2694, JJ 1879; PF 1074

FABACEAE

Fabaceae sp. 1—JJ 1671*
Fabaceae sp. 2—JJ 1926*
Fabaceae sp. 3—JJ 1583a*
Acacia adhaerans Benth.—JJ 1519, 1585*
Acacia polyphylla DC. var. *giganticarpa* G.P. Lewis—AA 3784; JJ 1530; JP 209
Albizia polycephala (Benth.) Killip—JJ 1584*, 1615*
Andira sp.—AA 2213*, 2220*
Andira fraxinifolia Benth.—AA 2296
Andira lewisii R.T. Penn.—JJ 1637*, 1920*
Bauhinia sp.—WT 13361
Bauhinia aff. *forficata* Link subsp. *forficata*—AA 2462; PF 1096; WT 13141
Bauhinia grandifolia (Bong.) Steud.—JJ 1580*
Bauhinia integerrima Mart. ex Benth.—AA 2592; AC 6838; JJ 1533
Caesalpinia echinata Lam.—AA 2228*; JP 343
Caesalpinia ferrea Mart.—AA 4269
Caesalpinia pluviosa DC. var. *paraensis* (Ducke) G.P. Lewis—AA 4136; JP 215; WT 12134
Caesalpinia pluviosa DC. var. *peltophoroides* (Benth.) G.P. Lewis—JP 201
Canavalia sp.—AA 2450; AC 6852; JP 347
Centrolobium tomentosum Guillem. ex Benth.—LM 2377; WT 11906
Chamaecrista sp.—JJ 1509
Copaifera lucens Dwyer—JJ 1672*, 2393*, 2449*
Cratylia hypargyrea Mart. ex Benth.—AA 2925; AC 6865
Crotalaria retusa L.—MS 533
Exostyles venusta Schott—AA 2248*; JJ 2399*
Goniorrhachis marginata Taub. var. *bahiana* Cowan—AA 2288; JJ 1540; PF 1931
Hymenaea sp.—JJ 1544*, 2375*, 3786*
Hymenaea oblongifolia Huber var. *latifolia* Lee & Langenheim—JJ 1645*, 1911*; PF 1933
Inga sp.—JJ 3829*, 3886*
Inga capitata Desv.—JJ 1610*, 2388*, 3853*
Inga edulis Mart.—JJ 3893*
Inga marginata Willd.—JJ 1521, 1954*, 3839*
Inga striata Benth.—AA 3760; JJ 1590*, 1938*
Inga tenuis (Vell.) Mart.—JJ 3899*
Lablab purpureus (L.) Sweet—WT 12391
Lonchocarpus cultratus (Vell.) H. C. Lima—WT 11790*
Machaerium sp. 1—JP 217; LM 2382
Machaerium sp. 2—WT 11775*, 11778*
Machaerium angustifolium Vog.—AC 6706
Mucuna urens (L.) DC.—PF 1641
Peltogyne pauciflora Benth.—AA 2231*; JJ 1595*
Piptadenia sp.—JJ 3828*, 3865*
Piptadenia killipi J.F. Macbr. var. *cacaophila* G.P. Lewis—JJ 3802*
Piptadenia moniliformis Benth.—JJ 1682*
Platycyamus regnellii Benth.—AA 3718; JJ 1644*, 2372*
Pterocarpus rohrii Vahl—JJ 1679*, 3785*, 3793*
Plathymenia reticulata Benth.—AA 4270
Pseudopiptadenia bahiana G.P. Lewis & M. P. Lima—JJ 3741*, 3753*
Schizolobium parahyba (Vell.) Blake—JJ 2333*
Senna macranthera (Collad.) H. S. Irwin & Barneby—AA 2911; JJ 3907*; JP 340
Swartzia macrostachya Benth. var. *riedelii* R.S. Cowan—AA 2210*, 2924; JJ 3727
Swartzia simplex (Sw.) Spreng. var. *ochnacea* (DC.) R.S. Cowan—AA 3713; JJ 2448*; PF 1205
Zollernia sp.—AA 2227*; JJ 3804*

GESNERIACEAE

Codonanthe sp.—PF 1644
Dalbergaria sanguinea (Pers.) Steud.—AA 2308, 2912
Nematanthus sp. nov.—AA 2913
Sinningia barbata (Nees & Mart.) Nichols—AA 2352; JJ 2091; WT 11747

HELICONIACEAE

Heliconia aemygdiana Burle-Marx subsp. *aemygdiana*—HP 27; SS 1018; WT 13364

Heliconia episcopalis Vell.—AC 6847; WT 11899, 12138
Heliconia psittacorum L. f.—AA 3721
Heliconia spathocircinata Aristeg.—HP 02; JJ 3924; WT 12136

ICACINACEAE

Citronella paniculata (Mart.) R. A. Howard—AA 2892; LM 2396; PF 1206

LAMIACEAE

Lamiaceae sp.—AA 2576
Ocimum gratissimum L.—AA 3750; LM 2398
Vitex orinocensis H.B.K.—JJ 1593*, 2446*

LAURACEAE

Lauraceae sp. 1—JJ 3906*
Lauraceae sp. 2—JJ 3769*
Lauraceae sp. 3—JJ 2473*
Aniba firmula (Nees & Mart.) Mez—AA 2347; JJ 1945*, 2336*
Cryptocarya aschersoniana Mez—AA 2226*; JJ 2104, 2351*
Ocotea sp. 1—JJ 1694*
Ocotea sp. 2—AA 2887; JJ 3824*
Ocotea sp. 3—JJ 2466*
Ocotea divaricata (Nees) Mez—LM 2378
Ocotea elegans Mez—JJ 1668*, 3808*
Ocotea indecora (Schott) Mez—JJ 1935*, 3789*; WT 11884
Ocotea macrophylla (Meisn.) Mez—JJ 2392*
Ocotea puberula (Rich.) Nees—JJ 2454*

LECYTHIDACEAE

Cariniana sp.—PF 1182
Cariniana legalis (Mart.) Kuntze—JJ 1630*, 1527, 2421*
Lecythis pisonis Cambess.—JJ 1622*

LILIACEAE

Hagenbachia brasiliensis (Nees & Mart.) Ravenna—JJ 2094

LOASACEAE

Loasa parviflora Schrad.—JJ 3931; WT 11820, 11913

LOGANIACEAE

Strychnos sp.—PF 1649

LORANTHACEAE

Struthanthus sp.—AA 2632

LYTHRACEAE

Cuphea sp.—AA 4146

MALPIGHIACEAE

Malpighiaceae sp. 1—JJ 1687*
Malpighiaceae sp. 2—AA 2215*
Banisteriopsis patula B.Gates—AA 3722; JJ 3934; JP 189
Byrsonima cacaophila W.R. Anderson—AA 2286; JJ 1499; PF 1217
Dicella bracteosa (A. Juss.) Griseb.—AA 2703, 3217; PF 1989
Heteropterys sp. nov.—AA 3218; JJ 1893
Heteropterys bicolor A. Juss.—AA 2710; JJ 1883, 3978
Heteropterys coleoptera A. Juss.—JJ 1560*; PF 1932
Heteropterys leschenaultiana A. Juss.—WT 12199
Heteropterys nordestina Amorim—AA 2199*
Hiraea sp. nov.—JJ 3878*; PF 1668
Mascagnia rigida (A. Juss.) Griseb.—AA 4127; WT 11954
Mascagnia sepium (A. Juss.) Griseb.—PF 1869
Stigmaphyllon cavernulosum C. Anderson—AA 2469, 2921; PF 1930
Tetrapterys acutifolia Cav.—AA 2699; JJ 1880; PF 1963
Tetrapterys crispa A. Juss.—AA 2919

MALVACEAE

Byttneria catalpaefolia Jacq.—JP 341; PF 1948
Cavanillesia arborea (Willd.) K.Schum.—AA 2467; JJ 1653*
Ceiba ventricosa (Nees & Mart.) Ravenna—AA 2373; JJ 2472*, 3740*
Eriotheca macrophylla (K. Schum.) A. Robyns—AA 3765*; JJ 3809*, 3831*
Guazuma ulmifolia Lam.—JJ 1508
Luehea cymulosa Spruce ex Benth.—AA 3768*; JJ 3838*, 3882*
Quararibea penduliflora K.Schum.—AA 2908; HP 23; JJ 2443*
Sterculia curiosa (Vell.) Taroda—AA 2222*, 2229*
Triumfetta semitriloba Jacq.—JP 344
Urena lobata L.—AA 4140; PF 1867

MARANTACEAE

Calathea sp. 1—WT 13336
Calathea sp. 2—PF 1952
Calathea brasiliensis Körn.—AA 2897; PF 1959
Calathea oblonga (Mart.) Körn.—AA 3745; JJ 4047; PF 1093
Calathea cf. *rotundifolia* Poepp. & Endl.—AA 3705

Calathea cf. *rufibarba* Fenzl—AA 2470; JJ 3921; PF 1582
Calathea zebrina Lindl.—PF 1986; WT 11810
Ctenanthe sp.—AC 7139
Maranta arundinacea L.—AA 4145; JJ 1739, 2088
Maranta bicolor Ker Gawl.—AA 2356, 2895; WT 11880
Stromanthe porteana Griseb.—JJ 1700; WT 13373
Stromanthe schottiana (Körn.) Eichler—AA 2293; PF 1085, 1993

MELASTOMATACEAE

Bertolonia carmoi Baumgratz—AA 2318; JK 439; WT 10232
Leandra ionopogon (Mart.) Cogn.—AA 2325; WT 11824, 13325
Leandra reversa (DC.) Cogn.—AA 2324; WT 13344
Miconia sp.—JJ 3885*
Miconia calvescens DC.—JJ 2457*, 3912*
Miconia centrodesma Naudin—AA 2889
Miconia nervosa (Sm.) Triana—JJ 1495
Meriania cf. *tetramera* Wurdack—JJ 3929
Mouriri chamissoana Cogn.—AA 2891
Pleiochiton sp. nov.—JJ 3916

MELIACEAE

Meliaceae sp.—JJ 1669*, 3751*
Cedrela odorata L.—JJ 2475*
Guarea guidonia (L.) Sleumer—JJ 3909*
Guarea kunthiana A. Juss.—AA 2247*; JJ 1572, 2337*
Guarea macrophylla Vahl subsp. *pachycarpa* (C. DC.) T. D. Penn.—AA 2681*; JJ 1732; JP 188
Trichilia sp. 1—JJ 1692*, 3783*; JP 199
Trichilia sp. 2—JJ 3817*, 3864*
Trichilia sp. 3—JJ 1640*, 3813*
Trichilia sp. 4—PF 1216
Trichilia blanchetii C. DC.—WT 11964
Trichilia casaretti C. DC.—JJ 1865; WT 11875, 13133
Trichilia elegans A. Juss. subsp. *richardiana* (A. Juss.) T. D. Penn.—JP 350; PF 1973; WT 11912
Trichilia florbranca T. D. Penn.—AA 2583; PF 1666, 1927
Trichilia martiana C. DC.—JP 349; WT 11952, 11732
Trichilia pleeana (A. Juss.) D. DC.—AA 2295; JJ 2401*; JP 167
Trichilia pseudostipularis (A. Juss.) C. DC.—AA 2241*, 2372; HP 09
Trichilia silvatica C. DC.—AA 2674*; JJ 3742*; WT 11733

MENISPERMACEAE

Menispermaceae sp.—PF 1587
Chondodendron microphyllum (Eichler) Moldenke—AA 2888; PF 1090, 1662
Odontocarya sp.—PF 1089
Orthomene schomburgkii (Miers) Barneby & Krukoff—WT 12197

MOLLUGINACEAE

Mollugo verticillata L.—WT 11883

MONIMIACEAE

Mollinedia sp.—PF 1200
Mollinedia selloi (Spreng.) A. DC.—WT 13333

MORACEAE

Brosimum cf. glaziovii Taub.—WT 11752*
Brosimum guianense (Aubl.) Huber—JJ 1627*, 1946*
Clarisia ilicifolia (Spreng.) Lanj. & Rossberg—JJ 1479, 3891*; PF 1204
Clarisia racemosa Ruiz & Pav.—JJ 1589*, 1609*; WT 11794a*
Dorstenia bahiensis Fisch. & C.A. Mey.—JJ 1537; PF 1657; WT 11739
Dorstenia cayapia Vell. subsp. *cayapia*—AC 6710; WT 11957
Dorstenia contensis Carauta & C. C. Berg—WT 11908
Dorstenia turneraefolia Fisch. & C.A. Mey.—AC 6851; JJ 1706; PF 1648
Ficus sp.—JJ 2341*
Ficus gomelleira Kunth & Bouché—AA 2280*; JJ 1534
Ficus mexiae Standl.—JJ 3870*
Ficus nymphaeifolia Mill.—JJ 3760*
Maclura tinctoria (L.) Steud.—JJ 1887; JP 214; PF 1645
Naucleopsis oblongifolia (Kuhlm.) Carauta—JJ 1555*, 1658*, 2432*
Pseudolmedia macrophylla Trécul—JJ 1899*, 1941*, 2389*
Sorocea guilleminiana Gaudich.—JP 212; LM 2141; PF 1577

MYRISTICACEAE

Virola gardneri (A. DC.) Warb.—AA 3786; JP 170, 203

MYRSINACEAE

Ardisia semicrenata Mart.—LM 2136

Cybianthus sp.—AA 2317
Myrsine umbellata Mart.—JJ 2381*, 2397*, 2470*

MYRTACEAE

Myrtaceae sp. 1—AA 2665*
Myrtaceae sp. 2—JJ 2438*
Calyptranthes sp.—JJ 1586*, 3764*; PF 1076
Campomanesia guaviroba (DC.) Kiaersk.—JP 208
Eugenia sp. 1—JJ 1673*, 1907*, 2436*
Eugenia sp. 2—JJ 3745*, 3788*; PF 1075
Eugenia sp. 3—AA 2281*, 3736*, 2704
Eugenia sp. 4—JJ 1614*, 2367*; WT 11776*
Eugenia sp. 5—JJ 3762*, 3895*; WT 13394
Eugenia sp. 6—JJ 1616*, 3884*
Eugenia sp. 7—JJ 1520, 3768*, 3840*
Eugenia sp. 8—AA 2208*; PF 1937; WT 11757*
Eugenia sp. 9—JJ 1588*, 1943*, 3799*
Eugenia sp. 10—AA 3724*; WT 13331
Eugenia sp. 11—WT 11879
Eugenia cf. *beaurepaireana* (Kiaersk.) D. Legrand—JJ 2411*, 3872*
Eugenia cf. *candolleana* DC.—AA 2190*, 2250*; JJ 2355*
Eugenia cf. *flamingensis* O. Berg—AA 2907; AC 6701; JJ 2387*
Eugenia itapemirimensis Cambess.—AA 2331; WT 11828, 13335
Eugenia mandioocensis O. Berg—JJ 3819*; PF 1102; WT 13329
Eugenia cf. *moraviana* O. Berg—JJ 1697*, 2352*; JP 175
Eugenia platyphylla O. Berg—AA 2590, 2689; AC 6686
Eugenia pruniformis Cambess.—JJ 3863*, 3900*
Eugenia aff. *stricta* Kiaersk.—PF 1943
Marlierea sp.—JJ 1675*, 1688*, 2465*
Marlierea cf. *regeliana* O. Berg—AA 2218*, 2251*; JJ 2462*
Marlierea cf. *strigipes* O. Berg—JJ 3847*, 3848*, 3859*
Marlierea cf. *tomentosa* Cambess.—JJ 2442*, 2467*
Myrcia sp. 1—AA 3793; PF 1588
Myrcia sp. 2—AC 6829; PF 1088
Myrcia sp. 3—WT 11758*
Myrcia acuminatissima O. Berg—AC 6850; JJ 1922*; PF 1186
Myrcia bicolor Kiaersk.—AC 6829; JJ 1617*, 2409*
Myrcia fallax (Rich.) DC.—JJ 3795*, 3815*, 3845*
Myrciaria sp.—AA 2211*; JJ 3758*; LM 2149
Myrciaria floribunda (Willd.) O. Berg—AA 2237*, 3855*; JJ 3772*
Plinia sp.—JJ 1491, 1869; WT 13135
Plinia grandifolia (Mattos) Sobral—JJ 2361*, 3752*, 3854*
Plinia rivularis (Cambess.) Rotman—AA 2626

NYCTAGINACEAE

Andradea floribunda Allemao—AA 2294; JJ 1686*
Bougainvillea spectabilis Willd.—PF 1655
Guapira laxiflora (Choisy) Lundell—AA 2311; WT 11885, 13323
Guapira opposita (Vell.) Reitz—AA 2253*; JJ 1674*, 3777*
Guapira venosa (Choisy) Lundell—JJ 1567*, 1611*, 3823*
Ramisia brasiliensis Oliv.—JJ 1507; JP 216; WT 6822

OCHNACEAE

Ouratea decipiens Tiegh.—HP 33; PF 1966

OLACACEAE

Heisteria perianthomega (Vell.) Sleumer—AA 2675*; JJ 2464*; PF 1185
Tetrastylidium grandifolium (Baill.) Sleumer—JJ 1516; JP 168; PF 1072

OLEACEAE

Chionanthus sp.—JJ 1652*, 2459*

OPILIACEAE

Agonandra excelsa Griseb.—AA 2598; JJ 2476*; PF 1647

ORCHIDACEAE

Acianthera sp.—ES 307
Anathallis rubens (Lindl.) Pridgeon & M. W. Chase—ES 303
Bulbophyllum sp. 1—ES 309
Bulbophyllum aff. *ipanemense* Hoehne—JJ 1480
Catasetum luridum (Link) Lindl.—PF 1988
Cattleya warneri T. Moore ex Warner—PF 1870
Chytroglossa marileoniae Rchb. f.—PF 1656
Cyclopogon congestus (Vell.) Hoehne—AA 3698
Lockhartia aff. *lunifera* (Lindl.) Rchb. f.—PF 1212
Gongora quinquenervis Ruiz & Pav.—JJ 4051
Microchilus lamprophyllus (Linden & Rchb. f.) Ormerod—JJ 3733, 4044; PF 1580
Miltonia flavescens Lindl.—AA 4137; JP 68
Notylia hemitricha Barb. Rodr.—AA 2609
Octomeria sp.—JP 50

Oeceoclades maculata (Lindl.) Lindl.—AA 2357; AC 6824
Oncidium barbatum Lindl.—JJ 3738
Phymatidium tillandsioides Barb. Rodr.—WT 11804
Pleurothallis sp.—PF 1865
Pleurothallis hypnicola Lindl.—JJ 1703, 1747; WT 11896
Prosthechea aemula (Lindl.) W.E. Higgins—AA 4138
Prosthechea fragrans (Sw.) W.E. Higgins—JJ 1482, 1740
Sarcoglottis grandiflora Klotzsch—PF 1661; RO 743
Schomburgkia crispa Lindl.—JJ 4262
Stanhopea sp.—WT 13349
Xylobium variegatum (Ruíz & Pav.) Garay & Dunst.—JJ 1524

OXALIDACEAE

Oxalis alata Mart. ex Zucc.—AA 2303; JJ 1857; PF 1081
Oxalis debilis Kunth—AA 4144

PASSIFLORACEAE

Passiflora sp.—JJ 2106
Passiflora contracta Vitta—JP 174; WT 11720, 13351

PHYLLANTHACEAE

Discocarpus pedicellatus Fiaschi & Cordeiro—AA 2682*; PF 1672; WT 11750*
Margaritaria nobilis L. f.—AA 3699; WT 10852, 11914

PHYTOLACCACEAE

Gallesia integrifolia (Spreng.) Harms—JJ 3877*; LM 2402; WT 11770*
Hilleria latifolia (Lam.) H.Walter—AA 3780; HP 11; PF 1101
Petiveria alliacea L.—HP 04; JJ 1749
Phytolacca dioica L.—JP 206; JJ 1665*, 1693*
Rivina humilis L.—AA 2289

PICRAMNIACEAE

Picramnia glazioviana Engl.—WT 11902
Picramnia ramiflora Planch.—AC 6690; JJ 1515, 1705

PIPERACEAE

Peperomia sp. 1—JJ 1761
Peperomia sp. 2—JJ 1760; PF 1210
Peperomia alata Ruiz & Pav.—AA 2623; PF 1965
Peperomia gardneriana Miq.—AA 2290; AC 6857; PF 1983
Peperomia glabella (Sw.) A. Dietr.—JJ 1730; WT 13347
Peperomia magnoliifolia (Jacq.) A.Dietr.—JJ 1754
Peperomia rhombea Ruiz & Pav.—AA 2465, 3746; JJ 1875
Peperomia serpens (Sw.) Loudon—JJ 1763
Peperomia trichocarpa Miq.—AA 2445
Peperomia urocarpa Fisch. & C.A. Mey.—AA 2355, 2448; PF 1183
Piper amalago L.—PF 1946; WT 13372
Piper amplum Kunth—AA 2302; HP 25; JP 166
Piper caldense C. DC.—WT 11827; 13345
Piper dilatatum Rich.—PF 1651
Piper miquelianum C. DC.—AA 2591, 4123; PF 1922
Piper obliquum Ruiz & Pav.—WT 11826, 13324
Piper umbellatum L.—AA 2376; PF 1658; WT 11725

POACEAE

Atractantha sp. 1—WT 11903
Atractantha sp. 2—WT 13334
Digitaria ciliaris (Retz.) Koeler—WT 11951
Eremitis sp.—JJ 4041
Ichnanthus hirtus (Raddi) Chase—WT 11901, 13380
Ichnanthus umbraphilus Renvoize—WT 11726, 11905, 13376
Lasiacis ligulata Hitchc. & Chase—AA 2607
Merostachys sp. 1—WT 11800
Merostachys sp. 2—WT 13330
Olyra latifolia L.—JJ 1860; WT 11744, 12394
Oplismenus hirtellus (L.) P. Beauv.—JJ 3730
Pharus latifolius L.—AA 2893
Pharus lappulaceus Aubl.—WT 11907
Raddia brasiliensis Bertol.—JJ 2089
Raddia portoi Kuhlm.—WT 11942
Sucrea monophylla Soderstr.—AC 6821; JJ 1487

POLYGONACEAE

Coccoloba sp.—AA 2263*
Coccoloba declinata (Vell.) Mart.—AA 2709, 3747; JJ 2453*
Coccoloba oblonga Lindau—JJ 1489
Ruprechtia sp. 1—JJ 3759*, 3820*, 3825*
Ruprechtia sp. 2—AA 2618

PROTEACEAE

Roupala sp.—JJ 3911*

PUTRANJIVACEAE

Drypetes sessiliflora Allemão—AA 2292, 2581; JJ 1955

QUIINACEAE

Quiina glaziovii Engl.—WT 11727

RAFFLESIACEAE

Pilostyles sp.—AA 2898

ROSACEAE

Prunus sellowii Koehne—AA 2274*; JJ 3910*; PF 1586

RUBIACEAE

Alseis floribunda Schott—AA 2605; LM 2394

Amaioua sp.—JJ 3888*

Amaioua guianensis Aubl.—WT 11816

Bathysa cuspidata (A. St.-Hil.) Hook.f.—AA 2886; JP 191; WT 13366

Borreria pulchristipula (Bremek.) Bacigalupo & E. L. Cabral—JJ 3933

Coussarea bahiensis Müll. Arg.—AA 2329, 2350; JJ 3919, 4046

Faramea hyacinthina Mart.—AA 3711; JJ 3977; PF 1991

Faramea oligantha Müll. Arg.—AA 3735; JJ 4049; PF 1863

Faramea rivularis Gardner—AA 2906; JJ 4043

Guettarda viburnoides Cham. & Schltdl.—JJ 3830*

Hamelia patens Jacq.—AC 6699; HP 28; JP 196

Hoffmannia peckii K. Schum.—AA 2453

Ixora sp.—WT 13132

Posoqueria latifolia (Rudge) Roem. & Schult.—AA 2461; AC 6864; JJ 3732

Psychotria sp.—PF 1979

Psychotria colorata (Roem. & Schult.) Müll. Arg.—AA 2330, 2900; AC 6697

Psychotria deflexa DC.—WT 13327

Psychotria ostreophora (Wernham) C.M. Taylor—AC 6697

Psychotria phyllocalymnoides Müll. Arg.—WT 13326

Psychotria platypoda DC.—AA 2338; WT 13319

Psychotria racemosa (Aubl.) Raeusch.—AA 2353, JJ 2371*

Psychotria tenuifolia Sw.—AA 2884; JP 200; PF 1976

Randia armata (Sw.) DC.—AA 2905; PF 1193; WT 11724

Randia spinosa (Jacq.) Karst.—AA 2587; JJ 1501; PF 1199

Rosenbergiodendron sp. nov.—JJ 4042

Rudgea sp. 1—JJ 3875*, 3935

Rudgea sp. 2—AA 3704, 3743

Rudgea aff. *crassifolia* Zappi & E. Lucas—PF 1985; WT 11917

Rudgea jasminoides (Cham.) Müll. Arg.—AA 2316; JJ 4045; WT 11825

Simira glaziovii (K. Schum.) Steyerm.—JJ 3846*, 3883*

Simira viridiflora (Allem. & Saldanha) Steyerm.—AA 2217*; JJ 1684*, 2376*

RUTACEAE

Almeidea rubra A. St.-Hil.—AA 3744; JK 763; WT 11893

Angostura bracteata (Nees & Mart.) Kallunki—AA 2374; JK 758

Conchocarpus sp.—AC 6835; LM 2399; WT 13390

Conchocarpus adenantherus (Rizzini) Kallunki & Pirani—AA 2603, 2624; JK 764

Conchocarpus cuneifolius Nees & Mart.—JK 752; PF 1977; WT 11890

Conchocarpus diadematus Pirani—AA 2601

Conchocarpus fontanesianus (A. St.-Hil.) Kallunki & Pirani—AC 6708

Conchocarpus macrophyllus (J.C. Mikan) Kallunki & Pirani—AA 2602, 2708; AC 6692

Erythrochiton brasiliensis Nees & Mart.—AA 2692; JJ 1702, 1873

Metrodorea nigra A. St.-Hil.—JJ 1481; WT 10851, 11729

Neoraputia sp. nov.—AC 6855; JJ 1478; LM 2395

Pilocarpus sp.—PF 1974

Pilocarpus riedelianus Engl.—WT 6818, 11894

Rauia resinosa Nees & Mart.—WT 11886, 11888, 13371

Zanthoxylum acuminatum (Sw.) Sw.—JJ 2390*, 2484, 3784*

Zanthoxylum fagara (L.) Sarg.—JK 438; LM 2383

Zanthoxylum gardneri Engl.—WT 13382

Zanthoxylum nemorale Mart.—JJ 1655*

Zanthoxylum rhoifolium Lam.—JJ 2105; WT 10865

SALICACEAE

Banara sp.—JJ 1618*, 2330*; WT 11763*

Banara kuhlmannii (Sleumer) Sleumer—AA 6689; JJ 1606*; WT 12530

Casearia sp. 1—AA 2321; JJ 3818*

Casearia sp. 2—JJ 1506; PF 1944

Casearia decandra Jacq.—JJ 3901*, 3908*

Casearia melliodora Eichler—JJ 1594*, 2342*; JP 197

SAPINDACEAE

Sapindaceae sp.—AA 3707; JJ 1908
Allophylus leucoclados Radlk.—WT 13328
Allophylus cf. *leucophloeus* Radlk.—AA 2625; AC 6848; WT 13387
Allophylus sericeus (Cambess.) Radlk.—PF 1211
Averrhoidium gardnerianum Baill.—HP 05; WT 11922
Cardiospermum integerrimum Radlk.—AA 2297; WT 13396
Cupania bracteosa Radlk.—JJ 3841*
Matayba sp.—JJ 1662*, 2365*, 2400*
Melicoccus sp.—AA 2223*; JJ 1553*, 1908
Paullinia sp.—AA 2201*
Paullinia revoluta Radlk.—AA 2482
Scyphonychium multiflorum (Mart.) Radlk.—AA 2261*; JJ 1583*, 1932*
Serjania sp.—AA 3732*
Serjania caracasana (Jacq.) Willd.—AA 2666*; AC 6814
Serjania clematidifolia Cambess.—AC 6813; WT 12198
Serjania faveolata Radlk.—JJ 2099; LM 2373
Talisia cerasina (Benth.) Radlk.—JJ 2095, 2482; PF 1187
Thinouia sp.—JP 211
Urvillea laevis Radlk.—AC 6833; JJ 2101

SAPOTACEAE

Sapotaceae sp. 1—AA 2265*, 2335; JJ 1654*
Sapotaceae sp. 2—PF 1928
Chrysophyllum sp.—JJ 1574*
Chrysophyllum flexuosum Mart.—JJ 2384*, 3807*
Chrysophyllum gonocarpum (Mart. & Eichler) Engler—JJ 1529; PF 1198; WT 12190
Chrysophyllum lucentifolium Cronq.—JJ 2410*, 2480*; WT 11755*
Chrysophyllum subspinosum Monach.—JJ 2428*
Diploön cuspidatum (Hoehne) Cronq.—JJ 1631*, 2423*, 3856*
Ecclinusa ramiflora Mart.—JJ 3913*
Manilkara longifolia (A. DC.) Dubard—AA 2269*
Pouteria sp. 1—JJ 3797*
Pouteria sp. 2—JJ 1587*, 1620*, 2415*
Pouteria sp. 3—JJ 2331*; WT 13340
Pouteria sp. 4—JJ 1561*, 2461*
Pouteria sp. 5—JJ 1597*, 2463*
Pouteria aff. *bangii* (Rusby) T. D. Penn.—JJ 1514, 3765*
Pouteria bapeba T. D. Penn.—JJ 2362*; WT 11785*, 11789*
Pouteria butyrocarpa (Kuhlm.) T. D. Penn.—AA 2224*, 2275*; JP 165
Pouteria aff. *hispida* Eyma—JJ 2364*, 2414*
Pouteria aff. *macrophylla* (Lam.) Eyma—JJ 3837*; PF 1924
Pouteria procera (Mart.) T. D. Penn.—JJ 1676*, 1918*; JP 198
Pouteria reticulata (Engl.) Eyma—AA 2700*; JJ 1598*, 1629*
Pradosia lactescens (Vell.) Radlk.—JJ 1648*, 2396*; WT 11730
Sarcaulus brasiliensis (A. DC.) Eyma—JJ 1939*, 2350*, 2483

SIMAROUBACEAE

Picrasma crenata (Vell.) Engl.—WT 11919

SIPARUNACEAE

Bracteanthus atlanticus Jangoux—JJ 1930*, 2427*; JP 164

SMILACACEAE

Smilax sp. 1—WT 13384
Smilax sp. 2—PF 1926
Smilax sp. 3—PF 1957

SOLANACEAE

Acnistus arborescens (L.) Schltdl.—AA 3798; JJ 2100
Aureliana fasciculata (Vell.) Sendtn. var. *longifolia* (Sendtn.) Hunz. & Barboza—JJ 1512, 1731, 1868
Capsicum frutescens L.—AC 6863
Cestrum sp. 1—JJ 2378; WT 11924
Cestrum sp. 2—WT 13392
Cestrum laevigatum Schltdl.—AA 2477, 3748; AC 6815
Datura suaveolans Humb. & Bonpl. ex Willd.—AA 2336
Solandra longiflora Tussac—JJ 1535; WT 11877
Solanum sp. 1—JJ 2407*; WT 13381
Solanum sp. 2—JJ 1486
Solanum sp. 3—AA 2621
Solanum alternato-pinnatum Steud.—AA 2915
Solanum bahianum S. Knapp—AA 2351
Solanum caavurana Vell.—WT 11911
Solanum depauperatum Dunal—AA 2468; AC 6818
Solanum hexandrum Vell.—AA 2706; JJ 1743; PF 1987
Solanum melissarum Bohs—JJ 3890*

Solanum megalonyx Sendtn.—AA 2475; AC 6834; PF 1990
Solanum ovum-fringillae (Dunal) L. Bohs—JJ 1492, 1892, 2391*
Solanum paniculatum L.—AA 2579
Solanum cf. *paralum* Bohs—JJ 4050; SS 1002; WT 13322
Solanum pensile Sendtn.—AA 2249*, 2326, 2914
Solanum robustum H.L.Wendl.—WT 11821
Solanum swartzianum Roem. & Schult.—HP 24

STYRACACEAE
Styrax sp.—JJ 1559*

THEOPHRASTACEAE
Clavija caloneura Mart. & Miq.—AC 6702; LM 2405; WT 13138

THYMELAEACEAE
Daphnopsis sp. nov.—AA 2334
Daphnopsis racemosa Griseb.—LM 2397

URTICACEAE
Boehmeria sp.—WT 13341
Cecropia glaziovii Snethl.—JJ 1913*
Cecropia hololeuca Miq.—JJ 1579*
Cecropia lyratiloba Miq.—AA 3769*; JJ 2335*, 2374*
Coussapoa curranii Blake—JJ 1931*; WT 11766*, 11769*
Myriocarpa cordifolia Liebm.—JJ 1493, 3827
Pilea pubescens Liebm.—JJ 1735; JP 345; WT 13375
Pilea rhizobola Miq.—AA 2314; HP 20; WT 13355
Urera baccifera (L.) Gaudich.—JJ 1753; JP 56; WT 12392
Urera caracasana (Jacq.) Griseb.—AA 2298; JJ 1504; JP 346
Urera mitis (Vell.) Miq.—JP 187

VERBENACEAE
Aegiphila cf. *sellowiana* Cham.—LM 2381
Aegiphila vitelliniflora Klotzsch ex Walp.—AA 2920; FF 3404; JJ 1884
Casselia sp.—AA 2594
Casselia veronicaefolia Cham.—JJ 1756, 1855; PF 1954
Lantana camara L.—MS 536

VIOLACEAE
Amphirrhox latifolia Mart.—AA 2614; JJ 1621*, 1891
Hybanthus cf. *brevicaulis* (Mart.) Baill.—AA 2301
Noissetia orchidiflora (Rudge) Ging.—SS 1021; WT 13343

VITACEAE
Cissus nobilis Kuhlm.—JJ 2700; JP 195
Cissus verticillata (L.) Nicolson & C. E. Jarvis—AA 2926; PF 1860

ZINGIBERACEAE
Renealmia alpinia (Rottb.) Maas—JJ 1490

PTERIDOPHYTA

ASPLENIACEAE
Antigramma balansae (Baker) Sylvestre & P.G. Windisch—AA 2615; AS 8171; JJ 1881
Asplenium auritum Sw.—WT 11900
Asplenium kunzeanum Klotzsch—AA 2320; AS 8201; FN 1036
Asplenium serratum L.—AS 8165; FN 1040; WT 11748
Asplenium scandicinum Kaulf.—WT 13363

BLECHNACEAE
Blechnum binervatum (Poir.) C. V. Morton & Lellinger subsp. *acutum* (Desv.) R.M.Tryon & Stolze—AS 8182
Blechnum occidentale L.—AS 8168; FN 1034

CYATHEACEAE
Alsophila setosa Kaulf.—IF 1491
Cyathea sp.—AA 2882
Cyathea phalerata Mart.—IF 1493, 1494

DAVALLIACEAE
Nephrolepis cf. *pectinata* (Willd.) Schott—AS 8174

DENNSTAEDTIACEAE
Dennstaedtia globulifera (Poir.) Hieron—AS 8189
Saccoloma elegans Kaulf.—AS 8180
Saccoloma inaequale (Kunze) Mett.—AS 8183

DRYOPTERIDACEAE
Didymochlaena truncatula (Sw.) J.Sm.—AA 2313, 2368; FN 1043
Stigmatopteris prionites (Kunze) C.Chr.—AS 8194
Tectaria incisa Cav.—AA 2360, 2903, 3716

HYMENOPHYLLACEAE
Hymenophyllum cf. *hirsutum* (L.) Sw.—AS 8214
Trichomanes collariatum Bosch—WT 11804
Trichomanes radicans Sw.—AS 8159; FN 1046, 1047

LOMARIOPSIDACEAE
Elaphoglossum sp.—AS 8199
Lomariopsis marginata (Schrad.) Kuhn—AA 2367

LYCOPODIACEAE

Huperzia mandiocana (Raddi) Trevis.—AA 2306

MARATTIACEAE

Danaea elliptica J. Sm.—AS 8181; FN 1039
Marattia laevis J. Sm.—AS 8187

POLYPODIACEAE

Campyloneurum phyllitidis (L.) C. Presl.—AA 2909; PF 1099; WT 11722
Dicranoglossum furcatum J. Sm.—AA 3706; AS 8176
Microgramma percussa (Cav.) E. R. de la Sota—AA 2472; JJ 1746
Microgramma vacciniifolia (Langsd. & Fisch.) Copel.—AA 2358, 2459; WT 13346
Pecluma dispersa (Evans) M.G. Price—AA 3720
Pecluma plumula (Humb. & Bonpl. ex Willd.) M.G. Price—AS 8190; WT 12193
Pleopeltis sp.—FN 1045
Pleopeltis angusta H.B.K. ex Willd.—WT 13362
Polypodium bombycinum Maxon—WT 12190
Polypodium chnoophorum Kunze—AA 3785
Polypodium monoides Weath.—AA 2471, 3714; WT 13337

PTERIDACEAE

Adiantopsis radiata (L.) Fée—AS 8153
Adiantum cf. *abscissum* Schrad.—AA 2364; AC 6868; FN 1033
Doryopteris sagittifolia (Raddi) J. Sm.—AS 8205
Hemionitis tomentosa (Lam.) Raddi—FN 1031
Pteris denticulata Sw.—WT 13374
Pteris dissimilis (Fée) H. Christ—AA 3700; FN 1037; JJ 1870
Pteris propinqua J. Agardh.—AC 6867; FN 1035

SALVINIACEAE

Azolla caroliniana Willd.—AS 8211

SCHIZAEACEAE

Anemia hirta (L.) Sw.—AS 8169
Anemia phyllitidis (L.) Sw.—AA 3796

SELAGINELLACEAE

Selaginella muscosa Spring—AS 8195
Selaginella sulcata (Desv.) Spring—AA 2312; AS 8184; WT 11797

TECTARIACEAE

Ctenitis distans (Brack.) Ching—AS 8162
Ctenitis falciculata (Raddi) Ching—AS 8173
Ctenitis submarginalis (Langsd. & Fisch.) Ching—AA 2362; FN 1038; WT 13369
Megalastrum sp.—AS 8193, 8203

THELYPTERIDACEAE

Thelypteris sp. nov.—AA 2366, 3715; AS 8160
Thelypteris opposita (Vahl) Ching—AC 6869; FN 1032

VITTARIACEAE

Polytaenium lineatum (Sw.) J. Sm.—AS 8207

WOODSIACEAE

Diplazium expansum Willd.—AS 8150
Diplazium moccenianum (Sodiro) C. Chr.—AS 8185
Diplazium plantaginifolium (L.) Urban—AA 2902; AS 8206
Diplazium roemerianum (Kunze) C. Presl.—AA 2359; AS 8192
Diplazium turgidum Rosenst.—AS 8198

ACKNOWLEDGMENTS

We thank the National Science Foundation (NSF 9972116 to Thomas, Carvalho and Amorim), the Beneficia Foundation, The National Geographic Society, and the John D. and Catherine T. MacArthur Foundation for financial support for this research. We are grateful to Henrique F. Berbert de Carvalho and Lucélia de Melo Berbert, owners of the Serra do Teimoso Reserve, for their hospitality and helpfulness. We thank José Lima da Paixão, Rondineli Q. Nascimento, and Sergio C. Sant'Ana for invaluable assistance in the field. While we take full responsibility for all names listed here, we are indebted to the many botanists who assisted us by identifying specimens or collecting at the Teimoso Reserve; these include Reyjane P. Oliveira (Poaceae), Marcos Sobral (Myrtaceae), Jacquelyn Kallunki and José. R. Pirani (Rutaceae), Maria de Fátima Agra (Solanaceae), Cássio van den Berg and Eric C. Smidt (Orchidaceae), Renato Goldenberg (Melastomataceae), Alexandre Salino (pteridophytes). We thank Flávio Leopoldino, Pablo Vilanueva and Raquel Moura for their help in suggesting useful literature.

REFERENCES

Amorim, A.M., W.W. Thomas, A.M.V. Carvalho, and J.G. Jardim. (In press). Floristic of the Una Biological Reserve, Bahia, Brazil. In: Thomas, W., ed. The Atlantic Coastal forests of northeastern Brazil. Mem. New York Bot. Gard.

Angiosperm Phylogeny Group. 2003. An updated classification for the families of flowering plants. Bot. J. Linn. Soc. 141:399–436.

Brazão, J.E.M. and A.P. de Araujo. 1981. Vegetação. In: Projeto RadamBrasil: Programa de Integração Nacional, vol. 24:405–456. Ministério das Minas e Energia, Rio de Janeiro.

Brummit, R.K. and C.E. Powell. 1992. Authors of plant names. London: Royal Botanic Gardens, Kew.

Carvalho Filho, R., A.A.O. de Melo, S.O. de Santana, and A.C. Leão. 1987. Solos do Município de Ilhéus. Bol. Técnico 147. Ilhéus, Bahia, Brasil: Comissão Executiva do Plano da Lavoura Cacaueira.

CEI (Centro de Estatística e Informações). 1993. In: Informações básicas dos municípios baianos—Jussari, 5 (II):722–740. Salvador, Bahia.

Gentry, A.H. 1997. Regional Overview: South America. In: Davis, S.D., Heywood, V.H., Herrera-MacBryde, O., Villa-Lobos, J. and A.C. Hamilton, eds. Centers of plant diversity, Volume 3: The Americas. IUCN Publications Unit, Cambridge, U.K. Pp. 269–307.

Gonçalves, E. 1975. Diagnóstico Socioeconômico da Região Cacaueira, vol. 6: Geologia Econômica e Recursos Minerais. Comissão Executiva do Plano da Lavoura Cacaueira and Instituto Interamericano de Ciências Agrícolas—OEA. Ilhéus, Bahia, Brasil.

Gouvêa, J.B.S., L.A. Mattos Silva, and M. Hori. 1976. Fitogeografia. In: Diagnóstico Socioeconômico da Região Cacaueira, vol. 7: Recursos Florestais. Comissão Executiva do Plano da Lavoura Cacaueira and Instituto Interamericano de Ciências Agrícolas—OEA. Ilhéus, Bahia, Brasil. Pp. 1–7.

Janzen, D.H. 1988. Tropical dry forests: the most endangered major tropical ecosystem. In: Wilson, E.O., ed. Biodiversity. National Academy Press, Washington, D.C. Pp. 130–137.

Köppen, W. 1948. Climatología con un estudio de los climas de la tierra. Fondo de Cultura Economica, Mexico, Bueno Aires.

Maximiliano, Principe de Wied-Neuwied. 1940. Viagem ao Brasil nos anos 1815 a 1817. Tradução de Ed. Sussekind de Mendonça e Flávio Poppe de Figueredo. Companhia Editora Nacional, São Paulo.

Martini, A.M.Z., J.G. Jardim, and F.A.M. Santos. (in press). Natural Regeneration in the forest understory, clearings, and burned areas in the Reserva Biológica de Una, Bahia, Brazil. In: Thomas, W., ed. The Atlantic Coastal forests of northeastern Brazil. Mem. New York Bot. Gard.

Martini, A.M.Z., A.M. Amorim, and P. Fiaschi. 2004. Vegetação. In: SEMARH, Plano de Manejo do Parque Estadual da Serra do Conduru, Bahia, Brasil. Banco Mundial/UCE/IESB.

Mendonça, J.R., A.M. de Carvalho, L.A. Mattos Silva, and W.W. Thomas. 1994. 45 Anos de Desmatamento no Sul da Bahia, Remanescentes da Mata Atlântica—1945, 1960, 1974, 1990. Projeto Mata Atlântica Nordeste, CEPEC, Ilhéus, Bahia, Brasil.

Moran, R.C. 1995. Clave para las familias de pteridofitas. In: Davidse, G., Sosa, M.S. and S. Knapp, eds. Flora Mesoamericana, vol. 1. Universidad Nacional Autónoma de México, México, D.F. Pp. 1–2.

Morellato, L.P. and C.F.B. Haddad. 2000. The Brazilian Atlantic Forest. Biotropica 32:786–792.

Mori, S.A. and L.A. Mattos Silva. 1979. The herbarium of the "Centro de Pesquisas do Cacau" at Itabuna, Brazil. Brittonia 31: 177–196.

Mori, S. A., B.M. Boom, A.M. Carvalho, and T.S. Santos. 1983. A southern Bahian moist forests. Bot. Rev. 49:155–232.

Myers, N., R. Mittermeier, C.G. Mittermeier, G.A.B. Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403:853–858.

Oliver, W.L.R. and I.B. Santos. 1991. Threatened endemic mammals of the Atlantic Forest region of south-east Brazil. Wildlife Preservation Trust, Special Scientific report n°. 4.

Oliveira-Filho, A. T. and M.A.L. Fontes. 2000. Patterns of Floristic Differentiation among Atlantic Forests in Southeastern Brazil and the Influence of Climate. Biotropica 32: 793–810.

Pennington, R.T., D.E. Prado, and C.A. Pendry. 2000. Neotropical seasonally dry forests and Quaternary vegetation changes. J. Biogeogr. 27:261–273.

Prado, D.E. 1993a. What is the Gran Chaco vegetation in South America? I. A review. Contribution to the study of flora and vegetation of the Chaco V. Candollea 48:145–172.

Prado, D.E. 1993b. What is the Gran Chaco vegetation in South America? II. A redefinition. Contribution to the study of flora and vegetation of the Chaco VII. Candollea 48: 615–629.

Prado, D.E. 2000. Seasonally dry forests of tropical South America: from forgotten ecosystems to a new phytogeographic unit. Edin. J. Bot. 57:437–461.

Prado, D.E. and P.E. Gibbs. 1993. Patterns of species distribution in the dry seasonal forests of South America. Ann. Missouri Bot. Gard. 80:902–927.

Ratter, J.A., S. Bridgewater, R. Atkinson, and J.F. Ribeiro. 1996. Analysis of the floristic composition of the Brazilian cerrado vegetation II: comparison of the woody vegetation of 98 areas. Edinburgh J. Bot. 53:153–180.

Roeder, M. 1975. Diagnóstico Socioeconômico da Região Cacaueira, vol. 4: Reconhecimento climatológico. Comissão Executiva do Plano da Lavoura Cacaueira and Instituto Interamericano de Ciências Agrícolas—OEA. Ilhéus, Bahia, Brasil.

Sambuichi, R.H.R. 2002. Fitossociologia e diversidade de espécies arbóreas em cabruca (Mata Atlântica raleada sobre plantação de cacau) na região sul da Bahia, Brasil. Acta Bot. Bras. 16:89–101.

Taylor, N.P. and D.C. Zappi. 2004. Cacti of Eastern Brazil, vol. 1. Ed. Kew: Royal botanic Gardens.

Thomas, W.W. and M.R.V. Barbosa. (In press). Natural vegetation types in the Brazilian Atlantic Coastal Forest Biome north of the Rio Doce. In: Thomas, W., ed. The Atlantic Coastal forests of northeastern Brazil. Mem. New York Bot. Gard.

Thomas, W.W., A.M.V. Carvalho, A.M. Amorim, J. Garrison, and A.L. Arbelaez. 1998. Plant endemism in two forests in southern Bahia, Brazil. Biodiversity and Conservation 7:311–322.

Thomas, W.W., J.G. Jardim, P. Fiaschi, and A.M. Amorim. 2003. Lista preliminar de angiospermas endêmicas do sul da Bahia e norte do Espírito Santo, Brasil. In: Prado, P.I., E.C. Landau, R.T. Moura, L.P.S. Pinto, G.A.B. Fonseca and K. Alger (orgs.). Corredor de Biodiversidade da Mata Atlântica do Sul da Bahia. Publicação em CD-ROOM, Ilhéus, IESB/CI/CABS/UFMG/UNICAMP. ISBN 85 8931-X.

Thomas, W.W., A.M.V. Carvalho, A.M. Amorim, J. Garrison, and T.S. Santos. (In press). Diversity of woody plants in the Atlantic coastal forest of southern Bahia, Brazil. In: Thomas, W., ed. The Atlantic Coastal forests of northeastern Brazil. Mem. New York Bot. Gard.

Veloso, H. P. 1992. Sistema Fitogeográfico. In: Manual Técnico da Vegetação Brasileira. Fundação Instituto Brasileiro de Geografia e Estatística. IBGE, Rio de Janeiro. Pp. 9–38.

Vinha, S.G. da, T.J.S. Ramos, and M. Hori. 1976. Inventário Florestal. In: Diagnóstico Socioeconômico da Região Cacaueira, vol. 7: Recursos Florestais. Comissão Executiva do Plano da Lavoura Cacaueira and Instituto Interamericano de Ciências Agrícolas—OEA. Ilhéus, Bahia, Brasil. Pp. 10–212.

THE VASCULAR FLORA OF RATTLESNAKE FALLS: A POTENTIAL STATE NATURAL AREA ON THE WESTERN HIGHLAND RIM ESCARPMENT IN TENNESSEE

Dwayne Estes

The University of Tennessee
Department of Botany
437 Hesler Biology Building
Knoxville, Tennessee 37996-1100, U.S.A.
tnplants@yahoo.com

Jeffrey L. Walck

Department of Biology
Middle Tennessee State University
Murfreesboro, Tennessee 37132, U.S.A.
jwalck@mtsu.edu

ABSTRACT

Rattlesnake Falls is located in the dissected Western Highland Rim Escarpment of Maury County, Tennessee. The central feature of this site is the largest known waterfall on the escarpment which falls 18 m over two ledges into a large splash pool at the head of a narrow, wooded gorge. The waterfall is surrounded by a 62.5 ha tract of rugged, mostly forested land, in which a botanical survey was conducted from February 2000 to August 2001. Six hundred twenty-seven taxa representing 348 genera and 107 families were found; 81 taxa (13%) were introduced. Families with the largest numbers of species were Asteraceae, Poaceae, and Fabaceae. County records (294) increased the number of plant taxa of Maury County to 915. Rare taxa included the federally threatened species *Helianthus eggertii* and tentatively, *Apios priceana*. Species listed at the state level as threatened were *Lilium michiganense* and *Juglans cinerea*, and as special concern were *Castanea dentata*, *Parnassia grandifolia*, *Phlox pilosa* ssp. *ozarkana*, and *Symphyotrichum oolentangiense*. Compared to 13 other floristic studies in various physiographic regions of Tennessee, Rattlesnake Falls had the second highest numbers of native and rare taxa per ha but also the second highest number of nonnative taxa per ha.

RESUMEN

Las Rattlesnake Falls se localizan en el Western Highland Rim Escarpment del condado de Maury, Tennessee. La característica principal de este lugar es la gran cascada que cae 18 m por dos repisas en un gran estanque de salpicadura en la cabecera de una garganta boscosa estrecha. La cascada está rodeada por una extensión de tierra accidentada de 62.5 ha en su mayoría forestal, en la que se realizó un estudio botánico desde febrero de 2000 hasta agosto 2001. Se encontraron seiscientos veintisiete taxa de 348 géneros y 107 familias; 81 taxa (13%) eran introducidos. Las familias con mayor número de especies fueron Asteraceae, Poaceae, y Fabaceae. Las citas del condado (294) incrementaron el número de taxa vegetales del condado de Maury a 915. Los taxa raros incluidos en las especies federalmente amenazadas son *Helianthus eggertii* y tentativamente, *Apios priceana*. Las especies listadas a nivel estatal como amenazadas son *Lilium michiganense* y *Juglans cinerea*, y con especial preocupación *Castanea dentata*, *Parnassia grandifolia*, *Phlox pilosa* ssp. *ozarkana*, y *Symphyotrichum oolentangiense*. Comparado con otros 13 estudios florísticos en varias regiones fisiográficas de Tennessee, las Rattlesnake Falls tienen el segundo mayor número de taxa nativos y raros por hectárea, pero sólo el segundo número más alto de taxa no nativos por hectárea.

SIDA 21(3): 1753–1780. 2005

INTRODUCTION

Rattlesnake Falls, with its encompassing tract of rugged, mostly forested land, is located in southwestern Maury County, Tennessee. Since the late 1800s, it has been a popular recreational landmark (Garrett 1966). In 1874, the name of the waterfall was changed to Antoinette Falls in honor of the Columbian socialite Antoinette Polk, daughter of the wealthy Civil War blockade-runner Captain Andrew Jackson Polk (Turner 1955). However, the name Rattlesnake Falls was too firmly entrenched and the new name was soon discarded. The original name apparently was reasonable given the abundance of snakes reported from the area (Garrett 1966).

Quarterman and Powell (1978) listed Rattlesnake Falls as a potential geological and ecological landmark of the Interior Low Plateaus Physiographic Province. Ecologically, they noted that the ravine was the "best" one they had surveyed on the Western Highland Rim and was nationally significant. Moreover, Rattlesnake Falls is one of the tallest waterfalls (ca. 18 m) in this region of Middle Tennessee (Tennessee Valley Authority 1938).

The purpose of the present study was to document the vascular flora of the tract of land surrounding Rattlesnake Falls. Communities were qualitatively described. The community and relative abundance were recorded for each taxon. In particular, the presence and status of rare plants, their habitat, and potential threats to their continued existence, were determined in order to augment the evaluation of the site as an important natural area deserving protection.

STUDY AREA

Rattlesnake Falls is located ca. 27 km southwest of Columbia, near Summertown, in Maury County, Tennessee (centered 35°27'00" N, 87°15'38" W). The study unit included 62.5 ha (Fig. 1). It was bound by United States Highway 43 on the west, at about mid-slope on the eastern side of Falls Creek, and in major ravines north and south of Rattlesnake Falls Creek Gorge. The major tributary is an unnamed stream (hereafter referred to as Rattlesnake Falls Creek) formed by three streams merging approximately 300 m upstream from the Falls. Elevations within the study site range from 243 m along Falls Creek, to 304 m above mean sea level, at the ridgetops (Marcher & Lounsberry 1966).

Encompassing Rattlesnake Falls Gorge are two narrow ridges that roughly parallel one another in a west-east direction. Rattlesnake Falls Creek bisects these ridges, resulting in a deep, narrow gorge with steep-sided slopes descending directly to the margin of Rattlesnake Falls Creek in most places. Throughout the gorge, these steep slopes have rugged rock outcrops and small bluffs, and only in a few places adjacent to the creek may level to slightly sloping alluvial deposits be found. Two small caves are located on the north side of Rattlesnake Falls Creek near its confluence with Falls Creek. A cave spring occurs on

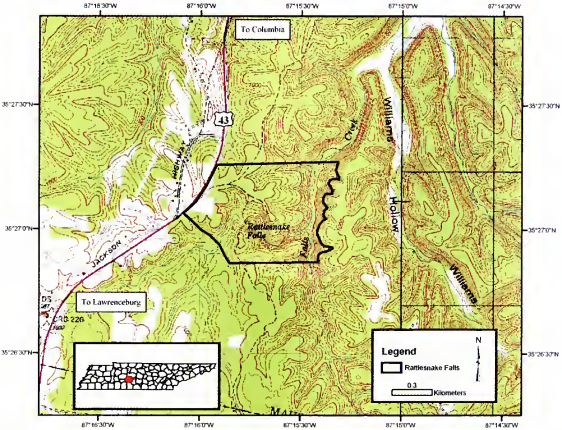


Fig. 1. Location of Rattlesnake Falls, and boundaries of the study area (Summertown USGS topographic quad).

the north side of Rattlesnake Falls Creek approximately 100 m upstream from Rattlesnake Falls.

The site is within the Highland Rim Escarpment portion of the Duck River Basin Subsection, Central Basin Section of the Interior Low Plateaus Physiographic Province (Quarterman & Powell 1978). This area represents the interface of the Western Highland Rim (71f) and the Outer Nashville Basin (71h) of Griffith et al. (1998). Strata of the Mississippian-aged Fort Payne Formation underlie most of the study area. The Fort Payne Formation consists of limestone with cherty and siltstone facies. Only along Falls Creek is limestone of Ordovician-aged Leipers and Catheys Formations exposed (Marcher & Lounsbury 1966; Quarterman & Powell 1978).

Four land/soil types are found in the study area (Harmon et al. 1959): Riverwash, Rockland, Bodine series, and Mountview series. Riverwash is in a very narrow band along Rattlesnake Falls Creek and Falls Creek. This land type mostly occurs along swift, forested streams and contains a mixture of chert, other rock fragments, and soil particles that have washed down from adjacent slopes. The steep Rockland land type of Harmon et al. (1959) is found along the edges of Rattlesnake Falls Gorge and ascends from the bottom nearly to the ridge-tops in some localities and varies in slope from 12–60% with occasional vertical rock cliffs present on lower slopes of the gorge. The Rockland type is characterized by well-drained shallow soil. Portions of the slopes of the gorge below Rattlesnake Falls and of the small ravines, as well as the narrow ridgetops, are composed of cherty silt loam of the Bodine series. These soils have slopes that vary from 4–60%, and are strongly to very strongly acid, well drained, and cherty. The Mountview series occurs in the highest elevated areas of the study site. This soil series is a silt loam or silty clay loam, has slopes that range from 0–12%, and soils that are low in fertility and highly acidic (Harmon et al. 1959).

The study site is in Köppen's Cfa climatic type, i.e., a mild rainy climate with hot summers but without a distinct dry season (Ackerman 1941). In Maury County, the average growing season is 192 days and extends from April 12 to October 21. The mean annual temperature is 15.3°C. July is typically the hottest month with an average temperature of 25.6°C, while January is the coldest with an average temperature of 4.9°C. Annual precipitation totals 128.6 cm. Snowfall is about 20.1 cm. January and March are the wettest months, while September and October are the driest (Harmon et al. 1959).

The study site lies within Braun's (1950) Western Mesophytic Forest Region and Küchler's (1964) Oak-Hickory Vegetation Type. Generally, ridge and slope forests are oak-dominated and ravines contain forests characterized as mesophytic (Bryant et al. 1993; Chester 1995).

METHODS

The study site was regularly sampled from late February 2000 to mid-November 2000 and from March 2001 to August 2001 with about three visits per month. Ten trips also were made during 1998 and 1999, prior to the beginning of the project. Thus, the site was visited during 55 trips over the entire study period. The area sampled included the gorge that contains Rattlesnake Falls, the ridges adjacent to the falls and associated ravines, a section along Falls Creek, the access road and trails leading to the falls, and an upland field near the northern edge of the study site. Vouchers for all but 14 species encountered during fieldwork were collected.

Identifications were made using standard manuals: Small (1933), Fernald (1950), Radford et al. (1968), Cronquist (1980), Isely (1990), Gleason and Cronquist (1991), and Yatskievych (1999). County records were determined using Chester et al. (1993, 1997). Specimens were deposited in herbaria of the University of Tennessee-Knoxville (TENN), Vanderbilt University (VDB) now housed at the Botanical Research Institute of Texas (BRIT), and/or Austin Peay State University (APSC). Element occurrence records for federal and state-listed rare species were provided to the Tennessee Division of Natural Heritage and to the Natural Resources Division of the Tennessee Valley Authority to aid in the protection of rare plant populations within the study area.

A literature search was performed to compile a list of other floristic studies from Tennessee; 13 of these were selected for comparison with Rattlesnake Falls. The numbers of native and nonnative taxa were calculated, and the floristic lists examined for rare species (cf. Tennessee Natural Heritage Program 2001). The numbers of taxa were converted to an area basis according to the area published in the study.

RESULTS AND DISCUSSION

Floristic Summary

Based on 938 collections, a total of 627 species and infraspecific taxa from 348 genera and 107 families comprise the known vascular flora of Rattlesnake Falls. Families containing the largest number of taxa were the Asteraceae (94), Poaceae (69), and Fabaceae (44). These families also are among the largest in the flora of Tennessee (Wofford & Kral 1993). Trees, shrubs, and woody vines accounted for 135 species (21% of the flora), with the greatest numbers of taxa in the following genera: *Quercus* (11), *Carya* (5), and *Rubus* (5). The following genera each had four woody taxa: *Cornus*, *Smilax*, *Ulmus*, *Vaccinium*, and *Vitis*. *Acer*, *Celtis*, *Crataegus*, *Hypericum*, *Rhododendron*, *Rhus*, *Rosa*, and *Salix* each had three taxa. There were 492 (78%) herbaceous species in the flora. The largest genera of herbaceous plants (15%) were *Carex* (19), *Solidago* (14), *Dichanthelium* (11), *Desmodium* (9), *Lespedeza* (9), *Symphyotrichum* (9), *Eupatorium* (7), *Polygonum* (7), and *Viola* (7). Twenty-seven (4%) ferns and fern-allies were present. Ten state rare taxa, including two federally listed species, were found. Five hundred forty-six taxa were native (87%) and 81 taxa (13%) were not native. County records (294) increased the number of plant species and subspecific taxa in Maury County from 621 to 915.

Plant Communities

Six communities were recognized at Rattlesnake Falls, delineated mostly along topographical contours and physical aspect. The most extensive, comprising approximately 50% (31 ha) of the study area, and least floristically diverse was the oak-hickory forest of the upland ridgetops and upper slopes of ridges. Ravine forest, occupying 43% (27 ha), was the most floristically diverse. An old field at the western edge of the site was about 1 ha (2%). The remaining three communities, representing ca. 5% (2 ha) of the study area, included bluff or rock outcrop areas, calcareous seeps, and disturbed sites.

Oak-Hickory Forests.—The canopy of the oak-hickory forest was dominated primarily by *Quercus alba*, *Q. coccinea*, *Q. prinus*, *Q. stellata*, and *Q. velutina* and by *Carya alba* and *C. glabra*. On xeric slopes and ridgetops, individuals of *Q. marilandica*, *Pinus echinata* and *P. virginiana* were present. The subcanopy and shrub layer were dominated by *Amelanchier arborea*, *Nyssa sylvatica*, and various ericaceous species. *Smilax* spp. and *Toxicodendron radicans* were common woody vines. Notable herbaceous species included *Antennaria plantaginifolia*, *Aureolaria pectinata*, *Carex picta*, *Cunila origanoides*, *Desmodium rotundifolium*, *Ionactis linariifolius*, *Lechea tenuifolia*, *Lespedeza procumbens*, *Spiranthes tuberosa*, and *Viola hirsutula*.

Ravine Forests.—A much greater abundance and diversity of plants distinguished the ravine forest from the oak-hickory forest. The difference in floristic diversity and composition was most likely correlated with moisture availability. The dominant canopy species in the ravine forest included a wider representation of genera than in the oak-hickory forest. Common species were *Acer saccharum*, *Liriodendron tulipifera*, and *Quercus muehlenbergii*. Small trees and shrubs that comprised the understory included *Asimina triloba*, *Carpinus caroliniana*, *Cornus alternifolia*, *Hamamelis virginiana*, *Hydrangea cinerea*, *Lindera benzoin*, and *Staphylea trifolia*. The diversity and abundance of herbaceous species was particularly impressive in the portion of the gorge just downstream from the waterfall. Notable representatives included *Actaea pachypoda*, *Geranium maculatum*, *Maianthemum racemosum*, *Phlox divaricata*, *Solidago curtisii*, *Waldsteinia fragarioides*, and *Valeriana pauciflora*. More than 20 species of ferns and fern-allies were found. The bryoflora also was noted for its significance and diversity, particularly in the gorge near the waterfall (Quarterman & Powell 1978; P. Davison, pers. comm.).

Old Fields.—The floristic composition of the old field exhibited some characteristics of barrens (DeSelm 1994; Baskin et al. 1994): areas dominated by perennial grasses that are successional but maintained as open communities by anthropogenic disturbances. In fact, Rattlesnake Falls is located in the portion of southwestern Maury County that was included in the "barrens of the Southwestern Rim" floristic region by Shanks (1958; DeSelm 1988). The field was maintained by occasional mowing. Important grass species were *Andropogon virginicus*, *Dichanthelium* spp., *Panicum anceps*, *Saccharum alopecuroidum*, *Schizachyrium scoparium*, and *Tridens flavus*. Forbs were well represented by numerous species of *Desmodium*, *Helianthus*, *Lespedeza*, *Solidago*, and *Symphyotrichum*. The field was undergoing succession with low-statured, dense growth of *Ceanothus americanus* and *Rhus copallinum*. Much of the field also contained invasive species like *Lespedeza bicolor*, *L. cuneata*, *Lolium arundinaceum*, *Lonicera japonica*, and *Rubus bifrons*.

Bluffs and Rock Outcrops.—Large boulders and rock promontories covered with shallow soil and open sparse vegetation characterized the bluff and rock outcrop community. The largest and best-developed section was located on the north side of Rattlesnake Falls Creek, downstream from the waterfall. Other bluff and rock outcrop communities were present throughout Rattlesnake Falls Gorge and along Falls Creek. Noteworthy species included *Hypericum frondosum*, *Philadelphus hirsutus*, *Aquilegia canadensis*, *Asclepias verticillata*, *Heuchera villosa* var. *macrorhiza*, *Parietaria pensylvanica*, *Schizachyrium* *scoparium, Sisyrinchium albidum, Asplenium resiliens, Cheilanthes lanosa,* and *Cystopteris bulbifera.*

Calcareous Seeps.—The calcareous seep community was characterized by an open canopy and gravelly, continuously waterlogged, substrate. Two types of seeps were found in the study area. The most common type was dominated by *Impatiens capensis.* A large *Impatiens* dominated seep was present on the steep slope adjacent to Rattlesnake Falls, and a few other ones were found along Falls Creek. The other type of seep was dominated by *Parnassia grandifolia.* One rather extensive *Parnassia* dominated seep was found on a steep slope on the eastern side of Falls Creek. Frequent species found in both seep types were *Alnus serrulata, Chelone glabra, Cuscuta compacta, Juncus coriaceus, Oxypolis rigidior, Phlox glaberrima, Rudbeckia fulgida* var. *umbrosa,* and *Solidago patula.*

Disturbed Areas.—Examples of disturbed areas included access (dirt) roads, trails, a campsite, and a recently constructed utility substation. They were subjected to regular human disturbance and often had higher numbers of non-native species compared to areas less frequented and affected by humans. Some of the common species included exotics, such as *Albizia julibrissin, Carduus nutans, Ligustrum sinense, Lolium arundinaceum, Lonicera japonica, Microstegium vimineum, Paulownia tomentosa,* and *Rosa multiflora.* In Tennessee, these species are considered severe or significant threats to native plant communities (Tennessee Exotic Pest Plant Council 2002).

Rare Plants

Apios priceana is listed as federally threatened and as endangered in Tennessee (Tennessee Natural Heritage Program 2001). Unfortunately, the plants at Rattlesnake Falls did not flower during the period of study, and the morphology of the flowers is the diagnostic identification feature. Vegetative characteristics and habitat were used to tentatively determine the identity of the plants (US Fish and Wildlife Service 1993; E.W. Chester, pers. comm.). About five clumps were found in two types of habitat in Rattlesnake Falls Gorge: a moist semi-open streambank and on a rocky wooded hillside. The individuals along the streambank were located close to a trail, and trampling might impact the population. Associated taxa included *Carya cordiformis, Quercus alba, Ostrya virginiana, Parthenocissus quinquefolius, Agrimonia rostellata, Dioscorea quaternata,* and *Passiflora lutea.*

Helianthus eggertii is listed as federally and state threatened (Tennessee Natural Heritage Program 2001). Many individuals were found along a dirt road as well as in the adjacent upland field. The area along the road was subjected to infrequent disturbance by vehicular traffic until a gate was erected at the road entrance in 1999. Consequently, the road margins where *H. eggertii* occurs are becoming overgrown. Moreover, the plants in the field may be shaded out due to encroachment of woody species if periodic mowing or prescribed fire is not implemented. Prolonged absence of mowing has allowed the growth of *Lespedeza bicolor, Lonicera japonica, Rhus copallinum, Rubus bifrons,* and *Sassafras albidum.* Jones (1994) considered competition from weedy species, shading due to succession of habitat to woodland, and major soil disturbance events such as bulldozing to be the leading factors in population declines or extirpations of *H. eggertii.* In addition to the woody competitors mentioned above, other associated species, some of which Jones (1994) listed as typically occurring with *H. eggertii,* were found. These included *Coreopsis tripteris, Eurybia hemispherica, Helianthus hirsutus, Lespedeza virginica, Rudbeckia hirta, Silphium mohrii, Solidago ulmifolia, Symphyotrichum patens, Andropogon virginicus, Schizachyrium scoparium,* and *Tridens flavus.*

Lilium michiganense is listed as threatened in Tennessee (Tennessee Natural Heritage Program 2001). Three plants, only one in flower, were found upstream of Rattlesnake Falls and an additional five vegetative individuals were found downstream. The flowering specimen occurred along Rattlesnake Falls Creek on a wet bank with *Alnus serrulata, Impatiens capensis, Lycopus rubellus,* and *Oxypolis rigidior.* The remaining seven plants were found on a rich streambank and on a wooded alluvial flat. Associates included *Arundinaria gigantea, Corallorhiza wisteriana, Lindera benzoin, Phegopteris hexagonoptera, Platanthera peramoena,* and *Polystichum acrostichoides.*

Juglans cinerea is threatened in Tennessee (Tennessee Natural Heritage Program 2001) due to the fungal pathogen, *Sirococcus clavigignenti-juglandacearum,* or Butternut Canker. This disease has caused a dramatic decline of the species throughout its range in eastern North America (Ostry 1997). Butternut was occasionally found in the ravine forests of the study area. Many older specimens showed signs of disease, but there were a few apparently healthy saplings.

Symphyotrichum oolentangiense is listed as special concern in Tennessee (Tennessee Natural Heritage Program 2001). The species previously was reported from two counties in the Coastal Plain physiographic region of Tennessee, and the collection from Rattlesnake Falls was the first from the Western Highland Rim of Tennessee (Chester et al. 1997). The plant was collected in low density oak-hickory woods on a xeric slope above Rattlesnake Falls.

Parnassia grandifolia is listed as special concern in Tennessee (Tennessee Natural Heritage Program 2001). Hundreds of plants were found growing densely in one calcareous seep with an area of approximately 25 m^2. Associated species included *Alnus serrulata, Apios americana, Impatiens capensis, Salix caroliniana, Oxypolis rigidior, Phlox glaberrima, Rudbeckia fulgida* var. *umbrosa, Solidago patula,* and *Osmunda regalis* var. *spectabilis.*

Phlox pilosa ssp. ***ozarkana*** is listed as special concern in Tennessee (Tennessee Natural Heritage Program 2001). Only a few individuals were found in the upland field and edges adjacent to US Highway 43. The plants were growing with *Helianthus eggertii* and with *H. eggertii's* previously mentioned associates.

The major threat to the population of this phlox at Rattlesnake Falls would be woody plant encroachment.

Panax quinquefolius is listed as special concern in Tennessee as a result of commercial exploitation (Tennessee Natural Heritage Program 2001). About 20 individuals were found in cherty, humus-rich soil of moist woods at scattered localities in Rattlesnake Falls Gorge and adjacent ravines.

Hydrastis canadensis is listed as special concern in Tennessee as a result of commercial exploitation (Tennessee Natural Heritage Program 2001). The population consisted of about 30 individuals located in three separate forested ravines.

***Castanea dentata*,** once a prominent forest tree, is listed as special concern in Tennessee (Tennessee Natural Heritage Program 2001). It was found mostly in oak-hickory forests on dry ridges in the study area. Most of the specimens were small, with only a couple 5–15 cm in diameter. *Quercus alba*, *Q. coccinea*, *Q. prinus*, *Q. velutina*, *Carya alba*, *C. glabra*, *Nyssa sylvatica*, *Smilax rotundifolia*, *Toxicodendron radicans*, *Vitis aestivalis* var. *aestivalis*, and *Vitis rotundifolia* were common associates.

Comparison to Other Floristic Studies

Rattlesnake Falls had approximately 8.7 native and 1.3 nonnative taxa per ha, and 0.16 rare plants (Table 1). Compared to 13 other areas in Tennessee, Rattlesnake Falls had the second largest numbers of native, rare, and nonnative taxa per ha. Barnett Woods in Montgomery County, Tennessee had the largest numbers of native, rare, and nonnative taxa per ha. The average numbers of native, rare, and nonnative taxa per ha among these 13 studies were 0.63, 0.01, and 0.11, respectively.

ANNOTATED CHECKLIST

The following vascular plants represent the known flora of Rattlesnake Falls. They are arranged alphabetically by family within six groups: Lycopodiophyta, Equisetophyta, Polypodiophyta, Pinophyta, and Magnoliophyta, including the Magnoliopsida and Liliopsida. Nomenclature mostly follows Kartesz (1999) except for ferns, fern allies, and gymnosperms which follow the Flora of North America Editorial Committee (1993); recently described species follow Campbell (2000) and Naczi et al. (2001, 2002). Also, we depart from Kartesz (1999) in recognizing *Melilotus alba*, in accordance with the USDA, NRCS (2004), and *Dichanthelium dichotomum* var. *ramulosum* and *D. yadkinense* based on LeBlond (2001). The acceptance of *Heuchera villosa* var. *macrorhiza* is based on Fernald (1950). County records are denoted by a cross (†) and non-native taxa are indicated by an asterisk (*). Species native to portions of Tennessee but not to the study area are indicated by two asterisks (**). Rare taxa are listed in **bold** type. Collection numbers are those of the senior author. For 14 specimens

TABLE 1. Comparison of the flora of Rattlesnake Falls with those of other study areas in Tennessee according to physiographic regions.

	Number of taxa (taxa per ha)		
	Native	Rare	Nonnative
Highland Rim			
Rattlesnake Falls	546 (8.72)	10 (0.160)	81 (1.296)
Barnett Woods[1]	400 (24.69)	4 (0.247)	43 (2.654)
Bear Creek[2]	610 (1.88)	9 (0.028)	123 (0.378)
Cross Creeks National Wildlife Refuge[3]	501 (0.14)	6 (0.002)	132 (0.037)
Land Between the Lakes[4]	915 (0.04)	28 (0.001)	247 (0.010)
Short Mountain[5]	401 (0.33)	3 (0.002)	76 (0.063)
Cumberland Plateau			
Fall Creek Falls State Park[6]	769 (0.09)	16 (0.002)	110 (0.012)
Obed Wild and Scenic River[7]	675 (0.17)	18 (0.004)	59 (0.015)
Savage Gulf[8]	636 (0.16)	17 (0.004)	44 (0.011)
Wolf Cove[9]	544 (0.54)	8 (0.008)	29 (0.029)
Valley and Ridge			
Oak Ridge Reservation[10]	708 (0.05)	19 (0.001)	134 (0.009)
Red Clay State Historical Area[11]	416 (3.96)	2 (0.019)	78 (0.743)
Unaka Mountains			
Big Frog Mountain[12]	458 (0.16)	17 (0.006)	21 (0.007)
Chilhowee Mountain[13]	825 (0.03)	20 (0.001)	128 (0.005)

[1] Chester (1986) – 16.2 ha, Montgomery County;
[2] Carpenter and Chester (1987) – 325 ha, Stewart County;
[3] Joyner and Chester (1994) – 3588 ha, Stewart County;
[4] Chester (1993) – 25090 ha, only Stewart County;
[5] McKinney (1986) – 1214 ha, Cannon County;
[6] Fleming (2004) – 8900 ha, Bledsoe and Van Buren counties;
[7] Schmalzer et al. (1985) – 4000 ha, Cumberland and Morgan counties;
[8] Wofford et al. (1979) – 4047 ha, Grundy County;
[9] Clements and Wofford (1991) – 1000 ha, Franklin County;
[10] Mann et al. (1985) – 15000 ha, Anderson and Roane counties;
[11] Houck (1990) – 105 ha, Bradley County;
[12] Murrell and Wofford (1987) – 2843 ha, Polk County;
[13] Thomas (1976) – 25899 ha, Blount and Sevier counties.

not collected, the words "not collected" are listed in parenthesis. Although several specimens were collected for many of the species and given separate collection numbers, only one number is given per taxon in this checklist. Unless otherwise indicated voucher specimens are deposited at TENN. A brief description of the habitat in which each species was collected is given. A qualitative assessment of the relative abundance of each taxon in their characteristic habitat was made, and classified as follows (Murrell & Wofford 1987):

Very rare —a single locale, few individuals
Rare —one or two localities, generally small populations
Scarce —several localities or scattered small populations
Infrequent —scattered localities throughout
Occasional —well-distributed but not anywhere abundant
Frequent —generally encountered
Common —characteristic and dominant

LYCOPODIOPHYTA

SELAGINELLACEAE

Selaginella apoda (L.) Spring, wet rocks under waterfall; rare (00576).

EQUISETOPHYTA

EQUISETACEAE

†*Equisetum hyemale* L. ssp. *affine* (Engelm.) Calder & Roy L.Taylor, wooded streambank; rare (00302).

POLYPODIOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) B.S.P., woods; frequent (00498).

Asplenium resiliens Kunze, limestone bluffs; very rare (03502).

Asplenium rhizophyllum L., limestone bluffs; frequent (01007).

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desvaux) L.Underwood ex A.Heller, old field and upland woods; occasional (01172).

DRYOPTERIDACEAE

Athyrium filix-femina (L.) Mertens var. *asplenioides* (Michx.) Farw., wooded ravines; common (00539).

Cystopteris bulbifera (L.) Bernh., limestone bluffs and boulders; frequent (00515).

Cystopteris protrusa (Weatherby) Blasdell, rich wooded ravine; very rare (01879).

†*Deparia acrostichoides* (Sw.) M.Kato, rich wooded ravines; rare (01356).

Diplazium pycnocarpon (Spreng.) Broun, rich wooded ravines; scarce (01355).

†*Dryopteris celsa* (W.Palmer) Knowlt., Palmer, & Pollard, calcareous seeps and moist streambank; scarce (01367).

†*Onoclea sensibilis* L., streambank; very rare (00891).

Polystichum acrostichoides (Michx.) Schott. var. *acrostichoides*, woods and ravines; common (00444).

Woodsia obtusa (Spreng.) Torr. ssp. *obtusa*, limestone bluff; scarce (02673).

OPHIOGLOSSACEAE

Botrychium dissectum Spreng., rich alluvial terrace; rare (01504).

Botrychium virginianum (L.) Sw., woods and ravines; frequent (00729).

†*Ophioglossum vulgatum* L., rich alluvial terrace; rare (01838).

OSMUNDACEAE

Osmunda cinnamomea L., rich wooded ravine; very rare (00537).

Osmunda regalis L. var. *spectabilis* (Willd.) A.Gray, calcareous seep and rich wooded ravine; rare (02532).

POLYPODIACEAE

Pleopeltis polypodioides (L.) Andrews & Windham ssp. *michauxiana* (Weath.) Andrews & Windham, limestone bluffs and boulders; infrequent (00319).

PTERIDACEAE

Adiantum pedatum L., rich wooded ravines; frequent (00482).

Cheilanthes lanosa (Michx.) D.C. Eaton, dry limestone bluffs; rare (00742).

Pellaea atropurpurea (L.) Link, dry limestone bluffs; scarce (00892).

THELYPTERIDACEAE

Phegopteris hexagonoptera (Michx.) Fée, rich wooded ravines; frequent (00538).

†*Thelypteris noveboracensis* (L.) Nieuwl., rich wooded ravine; very rare (01352).

Thelypteris palustris Schott var. *pubescens* (Lawson) Fernald, calcareous seeps; very rare (01245).

PINOPHYTA

CUPRESSACEAE

Juniperus virginiana L., dry limestone bluff and margin of old field; scarce (00633).

PINACEAE

†*Pinus echinata* Mill., dry, thin upland woods; scarce (02677).

†***Pinus taeda* L., old field margin; very rare (01487).

†*Pinus virginiana* Mill., dry wooded slope; very rare (00441).

MAGNOLIOPHYTA

MAGNOLIOPSIDA

ACANTHACEAE

†*Ruellia caroliniensis* (J.F.Gmel.) Steud., old field and dry woods; occasional (00870).

ACERACEAE

Acer negundo L., rich wooded ravine; very rare (01159).

†*Acer rubrum* L. var. *trilobum* Torr. & A. Gray ex K.Koch, upland woods; frequent (00534).

Acer saccharum Marshall var. *saccharum*, rich wooded ravines; frequent (00013).

ANACARDIACEAE

Rhus aromatica Aiton, dry wooded bluff; rare (01241).

Rhus copallinum L. var. *latifolia* Engl., old field; common (00616).

†*Rhus glabra* L., woodland clearing; rare (00690).

†*Toxicodendron pubescens* Mill., dry woods; rare (00686).

†*Toxicodendron radicans* (L.) Kuntze, woods and old field; common (00737).

ANNONACEAE

Asimina triloba (L.) Dunal, rich woods and streambanks; frequent (01363).

APIACEAE

Angelica venenosa (Greenway) Fernald, old field; scarce (00634).

Chaerophyllum procumbens (L.) Crantz, rich wooded streambank; infrequent (05976).

Cryptotaenia canadensis (L.) DC., rich woods; frequent (01023).

**Daucus carota* L., old field; frequent (00724).

Ligusticum canadense (L.) Britton, rich woods; rare (02465).

†*Osmorhiza claytonii* (Michx.) C.B.Clarke, rich woods; frequent (00728).

Oxypolis rigidior (L.) Raf., calcareous seeps; common (01115).

Sanicula canadensis L. var. *canadensis*, woods; common (00754).

†*Sanicula smallii* E.P.Bicknell, dry upland woods; scarce (00620).

†*Sanicula trifoliata* E.P.Bicknell, rich wooded slope; very rare (00727).

Thaspium trifoliatum (L.) A.Gray var. *aureum* Britton, rich woods and streambanks; common (00526).

†*Thaspium trifoliatum* (L.) A.Gray var. *trifoliatum*, rich woods; rare (02215 VDB).

**Torilis arvensis* (Huds.) Link var. *arvensis*, disturbed site and old field; scarce (00709).

APOCYNACEAE

†*Apocynum cannabinum* L., dry upland woods; very rare (02551).

ARALIACEAE

†*Aralia racemosa* L., rich woods; very rare (00853).

†*Aralia spinosa* L., edge of old field and woods; rare (01543).

†***Panax quinquefolius*** L., rich woods; scarce (00739).

ARISTOLOCHIACEAE

†*Aristolochia serpentaria* L., rich woods; scarce (00736).

Asarum canadense L., rich woods; frequent (04291).

ASCLEPIADACEAE

†*Asclepias exaltata* L., rich wooded streambank; very rare (02605).

Asclepias quadrifolia Jacq., rocky wooded bank; rare (02155).

Asclepias tuberosa L. ssp. *interior* Woodson, old field; scarce (00759).

Asclepias variegata L., old field; scarce (02230).

Asclepias verticillata L., dry rocky wooded bluffs; very rare (02675).

ASTERACEAE

**Achillea millefolium* L., old field; frequent (00871, 02228).

†*Ageratina altissima* (L.) R.M.King & H.Rob. var. *altissima*, old field and woods; occasional (01232).

Ambrosia artemsiifolia L., old field and disturbed site; occasional (01212).

†*Ambrosia trifida* L. var. *trifida*, old field and disturbed site; scarce (01214).

Antennaria plantaginifolia (L.) Richardson, upland woods; frequent (01819).

†*Antennaria solitaria* Rydb., upland woods; infrequent (01841).

†*Arnoglossum atriplicifolium* (L.) H.Rob., rich woods; occasional (01231).

†*Arnoglossum muehlenbergii* (Schultz-Bip) H.Rob., rich woods; rare (02587).

†**Baccharis halimifolia* L., disturbed site; very rare (not collected).

†*Bidens aristosa* (Michx.) Britton, old field; infrequent (01215).

Bidens frondosa L., old field, disturbed site, and streambanks; occasional (01218).

**Carduus nutans* L., disturbed site; rare (00710).

†*Chrysopsis mariana* (L.) Elliott, dry upland woods; scarce (01221).

Cirsium discolor (Muhl. ex Willd.) Spreng., old field; occasional (01096).

†*Cirsium muticum* Michx., calcareous seeps and wet streambanks; infrequent (01236).

Conoclinium coelestinum (L.) DC., streambanks and old field; infrequent (01230).

Conyza canadensis (L.) Cronquist var. *canadensis*, old field and disturbed site; occasional (01106).

†*Coreopsis major* Walter, old field; frequent (00692).

Coreopsis tripteris L., old field; occasional (01079).

Eclipta prostrata (L.) L., disturbed site; very rare (01410).

Elephantopus carolinianus Raeusch., woods, roadsides, and trails; occasional (00880).

†*Elephantopus tomentosus* L., dry upland woods; infrequent (02536).

Erechtites hieraciifolia (L.) Raf. ex DC., old field, disturbed site, and dry burned-over woods; frequent (01210).

Erigeron annuus (L.) Pers., old field; infrequent (00723).

†*Erigeron philadelphicus* L. var. *philadelphicus*, disturbed site; infrequent (02014).

†*Erigeron pulchellus* Michx. var. *pulchellus*, rocky wooded streambanks; infrequent (01840).

Erigeron strigosus Muhl. ex Willd. var. *strigosus*, old field; occasional (00644).

†*Eupatorium capillifolium* (Lam.) Small, old field; infrequent (01402).

†*Eupatorium fistulosum* Barratt, streambanks; infrequent (01116).

†*Eupatorium hyssopifolium* L., old field; common (01175).

†*Eupatorium perfoliatum* L., old field; very rare (02961).

†*Eupatorium rotundifolium* L. var. *ovatum* (Bigelow) Torr., old field; common (00625).

†*Eupatorium serotinum* Michx., disturbed site; rare (01297).

Eupatorium sessilifolium L., old field; occasional (00875).

†*Eurybia hemispherica* (Alexander) Nesom, dry wooded slopes and old field; occasional (01293).

†*Eurybia macrophylla* (L.) Cass., rich wooded streambank; very rare (01122 VDB).

†*Gamochaeta purpurea* (L.) Cabrera, disturbed site; infrequent (01008).

†*Helianthus divaricatus* L., dry bluffs; very rare (02579).

Helianthus eggertii Small, old field and edge of oak-hickory forest; infrequent (00643).

†*Helianthus hirsutus* Raf., old field and margins; frequent (00863).

Helianthus microcephalus Torr. & A. Gray, woods and margins; infrequent (01217).

Heliopsis helianthoides (L.) Sweet, rich woods and ravines; occasional (00903).

Hieracium gronovii L., dry woods; occasional (02680).

†**Hypochaeris radicata* L., grassy bank; very rare (01396).

†*Ionactis linariifolius* (L.) Greene, dry wooded slopes; rare (01466).

Krigia biflora (Walter) Blake, upland woods; frequent (00541).

†*Krigia caespitosa* (Raf.) Chambers, disturbed site; rare (04516).

†*Krigia virginica* (L.) Willd., upland woods and disturbed site; rare (04508).

†*Lactuca canadensis* L., old field; infrequent (00886).

†*Lactuca floridana* (L.) Gaertn., woods and old field; infrequent (01125).

†**Lactuca serriola* L., disturbed site; rare (01084).

**Leucanthemum vulgare* Lam., old field and disturbed site; occasional (00721).

Packera anonyma (Wood) W.A.Weber & A.Löve, old field; common (00218).

†*Packera glabella* (Poir.) C.Jeffrey, streambanks, wet soil; rare (00440).

Packera obovata (Muhl. ex Willd.) W.A.Weber & A.Löve, upland woods and rocky banks; scarce (not collected).

Polymnia canadensis L., rich wooded ravines among boulders and on bluffs; common (02468).

†*Prenanthes altissima* L., rich woods and bluffs; occasional (01361).

†*Pseudognaphalium obtusifolium* (L.) Hilliard & Burtt., old field; frequent (01216).

Pyrrohopappus carolinianus (Walter) DC., old field; frequent (00867).

Rudbeckia fulgida Aiton var. *umbrosa* (Boynton & Beadle) Cronquist, calcareous seeps and streambanks; common (01123).

†*Rudbeckia hirta* L. var. *pulcherimma* Farw., old field; frequent (00574).

Rudbeckia triloba L. var. *triloba*, old field; rare (01108).

†*Sericocarpus linifolius* (L.) B.S.P., old field; rare (02545).

Silphium asteriscus L. var. *asteriscus*, slope in woods; infrequent (00682).

Silphium mohrii Small, old field and disturbed site; rare (01081).

†*Smallanthus uvedalius* (L.) Mack. ex Small, rich woods; infrequent (01281).

†*Solidago altissima* L., old field; frequent (01404).

Solidago arguta Aiton var. *caroliniana* A.Gray, old field and dry woods; occasional (01061).

Solidago caesia L., rich woods and bluffs; frequent (01167).

†*Solidago curtisii* Torr. & A. Gray, rich woods; infrequent (01362 VDB).

†*Solidago erecta* Pursh, dry upland woods; frequent (01511).

†*Solidago gigantea* Aiton, streambanks, mesic clearings, and old field; infrequent (01104).

Solidago hispida Muhl. ex Willd., dry upland woods and rocky banks; infrequent (01058).

Solidago juncea Aiton, old field; common (01102).

†*Solidago missouriensis* Nutt. var. *fasciculata* Holz., old field; infrequent (00866).

†*Solidago nemoralis* Aiton, old field; common (01401).

†*Solidago odora* Aiton, old field; occasional (01219).

Solidago patula Muhl. ex Willd., calcareous seeps and streambanks; frequent (01364).

†*Solidago rugosa* Mill. ssp. *aspera* (Aiton) Cronquist, woods and streambanks; occasional (01062).

Solidago ulmifolia Muhl. ex Willd., upland woods; common (01090).

**Sonchus asper* (L.) Hill, disturbed site; rare (02240).

Symphyotrichum cordifolium (L.) Nesom, rich woods; infrequent (01490).

†*Symphyotrichum dumosum* (L.) Nesom, old field and dry woods; frequent (01376).

Symphyotrichum lateriflorum (L.) A. & D. Löve, woods and streambanks; frequent (01372).

†***Symphyotrichum oolentangiense*** (Riddell) Nesom, dry woods; very rare (number unavailable VDB).

Symphyotrichum patens (Aiton) Nesom, old field; frequent (01398).

Symphyotrichum pilosum (Willd.) Nesom var. *pilosum*, old field and disturbed site; occasional (01380).

Symphyotrichum shortii (Lindl.) Nesom, woods; frequent (01369).

†*Symphyotrichum undulatum* (L.) Nesom, dry field; infrequent (02967 VDB).

†*Symphyotrichum urophyllum* (Lindl.) Nesom, rich woods and rocky banks; frequent (00638).

†**Taraxacum officinale* G.H.Weber ex Wiggers, disturbed site; scarce (02219).

Verbesina alternifolia (L.) Britton ex Kearney, rich wooded streambank; very rare (01168).

Verbesina virginica L., old field; rare (01242).

Vernonia gigantea (Walter) Trel., old field; occasional (01044).

BALSAMINACEAE

†*Impatiens capensis* Meerb., calcareous seeps and streambanks; common (01114).

BERBERIDACEAE

Podophyllum peltatum L., rich wooded stream terrace; scarce (00400).

BETULACEAE

Alnus serrulata (Aiton) Willd., streambanks and seeps; occasional (not collected).

Carpinus caroliniana Walter ssp. *virginiana* (Marsh.) Furlow, rich wooded ravines and streambanks; occasional (00481).

Corylus americana Walter, woods and streambanks; common (00489).

Ostrya virginiana (Mill.) K.Koch, rocky upland woods; occasional (01368).

BIGNONIACEAE

Bignonia capreolata L., woods; occasional (00005).

Campsis radicans (L.) Seem.ex Bureau, disturbed site; very rare (01551).

***Catalpa* cf. *speciosa* (Warder) Warder ex Engelm., disturbed site; very rare (05974).

BORAGINACEAE

†*Cynoglossum virginanum* L., upland woods; frequent (01270).

Myosotis macrosperma Engelm., woods; occasional (01887).

BRASSICACEAE

Arabis laevigata (Muhl. ex Willd.) Poir. var. *laevigata*, rich rocky woods, boulders, and bluffs; frequent (00814).

†*Barbarea vulgaris* Ait.f., disturbed site; rare (01977).

†*Cardamine angustata* O.E.Schulz., woods; frequent (00451).

Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., seeps and streambanks; infrequent (01883).

Cardamine concatenata (Michx.) Sw., rich woods; infrequent (00327).

**Cardamine hirsuta* L., woods, bluffs, and disturbed site; frequent (00301).

†*Cardamine parviflora* L., dry rocks; rare (01010).

Cardamine pensylvanica Muhl. ex Willd., calcareous seeps; scarce (01999).

**Rorippa nasturtium-aquaticum* (L.) Hayek, streams; infrequent (00522).

BUXACEAE

Pachysandra procumbens Michx., rich wooded ravines and streambanks; common (not collected).

CALLITRICHACEAE

Callitriche heterophylla Pursh. ssp. *heterophylla*, swift, shallow stream; very rare (00480).

†*Callitriche terrestris* Raf., disturbed site; very rare (04511).

CAMPANULACEAE

†*Lobelia cardinalis* L., streambanks and seeps; infrequent (01112).

†*Lobelia inflata* L., upland woods and disturbed site; occasional (00902).

Lobelia puberula Michx., old field; frequent (01087).

Lobelia siphilitica L., streambanks and seeps; occasional (01165).

CAPRIFOLIACEAE

**Lonicera japonica* Thunb., old field and woods; common in old field, occasional elsewhere (00046).

Lonicera sempervirens L., dry, rocky wooded slopes; rare (00090).

†*Sambucus nigra* L. ssp. *canadensis* (L.) R.Bolli, moist openings and streambanks; infrequent (01580).

Symphoricarpos orbiculatus Moench, dry upland woods and edge of old field; infrequent (00978).

Triosteum angustifolium L., dry upland thicket; very rare (00889).

Viburnum rufidulum Raf., dry rocky wooded banks; infrequent (00676).

CARYOPHYLLACEAE

**Cerastium brachypetalum* Desp. ex Pers. ssp. *brachypetalum*, disturbed site; rare (02227 VDB).

†*Cerastium brachypodum* (Engelm. ex A. Gray) B.L.Rob., dry rock outcrops; rare (00815).

**Cerastium glomeratum* Thuill., disturbed site; rare (04510).

Cerastium nutans Raf., rocky woods; infrequent (00387).

†**Cerastium pumilum* W.Curtis, disturbed site; rare (01821 VDB).

†*Silene stellata* (L.) Ait.f., upland wooded ravines and streambanks; scarce (00843).

Silene virginica L., wooded banks and rocky slopes; frequent (01028).

**Stellaria media* (L.) Vill., disturbed site, gravel bars in streams, and moist creek banks; occasional (00396).

†*Stellaria pubera* Michx., rich ravines and streambanks; frequent (00071).

CELASTRACEAE

†*Euonymus americana* L., woods and streambanks; frequent (00525).

Euonymus atropurpurea Jacq., rich wooded stream terrace; very rare (not collected).

CHENOPODIACEAE

**Chenopodium album* L., disturbed site; rare (01379).

CISTACEAE

†*Lechea mucronata* Raf., old field; rare (01405).

†*Lechea tenuifolia* Michx., dry wooded slope; rare (01069).

CLUSIACEAE

†*Hypericum drummondii* (Grev. & Hook.) Torr. & A. Gray, old field; scarce (01579).

Hypericum frondosum Michx., dry bluffs; rare (02471).

†*Hypericum hypericoides* (L.) Crantz. ssp. *hypericoides*, dry upland woods; occasional (00857).

†*Hypericum hypericoides* (L.) Crantz ssp. *multicaule* (Michx. ex Willd.) Robson, dry upland oak-hickory forest; common (01512).

†*Hypericum mutilum* L., disturbed site; very rare (03495).

Hypericum punctatum Lam., old field and along edge of woods; frequent (00888).

CONVOLVULACEAE

†*Calystegia catesbeiana* Pursh, dry upland thicket; very rare (02154).

Ipomoea pandurata (L.) G.Mey., dry woods; scarce (00905).

CORNACEAE

Cornus alternifolia L.f., rich woods and streambanks; frequent (00075).

Cornus amomum Mill., streambanks and seeps; rare (00738).

Cornus drummondii C.A.Mey., upland woods; very rare (01170).

†*Cornus florida* L., woods; common (00105).

Nyssa sylvatica Marsh., upland woods; common (00544).

CRASSULACEAE

†*Sedum ternatum* Michx., Moist rocks by stream; very rare (01493).

CUCURBITACEAE

Sicyos angulatus L., Moist opening along streambank; very rare (02459).

CUSCUTACEAE

†*Cuscuta compacta* Juss. ex Choisy, streambanks and calcareous seeps; infrequent (01223).

†*Cuscuta gronovii* Willd. ex Schult. Calcareous seep; very rare (01235).

Cuscuta pentagona Engelm., at edge of woods and old field; very rare (01107).

EBENACEAE

Diospyros virginiana L., upland woods and thickets; very rare (00548).

ELAEAGNACEAE

†**Elaeagnus umbellata* Thunb., upland woods; very rare (00839).

ERICACEAE

†*Kalmia latifolia* L., dry upland slopes and rocky banks; frequent (00530).

Oxydendrum arboreum (L.) DC., dry woods and slopes; common (01489).

Rhododendron alabamense Rehder, dry to moist wooded banks and terraces; frequent (01164).

Rhododendron canescens (Michx.) Sweet, dry woods and banks; occasional (00684).

Rhododendron periclymenoides (Michx.) Shinners, upland woods; rare (01498).

†*Vaccinium arboreum* Marsh., dry woods and slopes; frequent (00488).

†*Vaccinium corymbosum* L., wooded bank; very rare (00508).

Vaccinium pallidum Aiton, dry woods; common (00540).

Vaccinium stamineum L., dry woods and rocky banks; occasional (00617).

EUPHORBIACEAE

†*Acalypha gracilens* A. Gray, dry woods and roadsides; scarce (02717).

Acalypha ostryifolia Riddell, disturbed site; very rare (01503).

Acalypha rhomboidea Raf., upland woods, rich woods, and streambanks; occasional (00859).

Chamaesyce nutans (Lag.) Small, old field and disturbed site; infrequent (01412).

†*Chamaesyce prostrata* (Aiton) Small, disturbed site; rare (01575).

Croton capitatus Michx., disturbed site; rare (01243).

Croton monanthogynus Michx., dry upland disturbed site; rare (01099).

Euphorbia corollata L., old field; frequent (00711).

FABACEAE

†**Albizia julibrissin* Durazz., upland woods; rare (01488).

Amphicarpaea bracteata (L.) Fernald, rich woods and streambanks; frequent (01154).

Apios americana Medik. Calcareous seep; rare (not collected).

†***Apios priceana*** B.L.Rob., rich streambank and rocky hillside; very rare (02679).

Cercis canadensis L., woods; occasional (00674).

†*Chamaecrista fasciculata* (Michx.) Greene, old field and disturbed site; occasional (00862).

†*Chamaecrista nictitans* (L.) Moench, old field; rare (04267).

Clitoria mariana L., old field; infrequent (00868).

†*Desmodium ciliare* (Muhl. ex Willd.) DC., old field; occasional (01097).

Desmodium glabellum (Michx.) DC., upland woods; infrequent (02945 VDB).

†*Desmodium glutinosum* (Muhl. ex Willd.) Wood, rich woods and streambanks; infrequent (00677).

Desmodium nudiflorum (L.) DC., upland woods; frequent (00852).

Desmodium paniculatum (L.) DC., upland woods, rich wooded streambank, old field, and disturbed site; infrequent (01394).

†*Desmodium pauciflorum* (Nutt.) DC., rich woods and streambanks; occasional (00846).

†*Desmodium perplexum* Schub., old field; frequent (01101).

†*Desmodium rotundifolium* DC., dry upland woods; infrequent (01109).

†*Desmodium viridiflorum* (L.) DC., old field; infrequent (01284 VDB).

Galactia volubilis (L.) Britton, old field; frequent (00865).

†**Kummerowia stipulacea* (Maxim.) Makino, disturbed site; rare (01213).

†**Kummerowia striata* (Thunb.) Schindl., old field and disturbed site; infrequent (01103).

†**Lathyrus hirsutus* L., disturbed site; rare (02167).

†**Lespedeza bicolor* Turcz., old field; frequent (00873).

†**Lespedeza cuneata* (Dum.-Cours.) G.Don, old field; frequent (01098).

Lespedeza frutescens (L.) Hornem., old field; occasional (01095).

†*Lespedeza hirta* (L.) Hornem., dry woods and edge of old field; infrequent (01171).

†*Lespedeza procumbens* Michx., old field and dry woods; frequent (01100).

†*Lespedeza repens* (L.) W.Bartram, old field and dry woods; infrequent (00752).

†*Lespedeza stuevei* Nutt., old field; rare (01285 VDB).

†*Lespedeza violacea* (L.) Pers., old field; scarce (01161).

†*Lespedeza virginica* (L.) Britton, old field; occasional (01383).

**Medicago lupulina* L., disturbed site; infrequent (00713).

†**Medicago sativa* L., disturbed site; very rare (03509).

**Melilotus alba* Medik., disturbed site and old field; infrequent (00703).

†*Mimosa microphylla* Dry., old field; rare (02538).

†*Orbexilum pedunculatum* (Mill.) Rydb., old field and dry woods; scarce (00977).

Robinia pseudoacacia L., upland woods and edges of old field; infrequent (01573).

Senna marilandica (L.) Link, disturbed site and streambanks; scarce (01211).

†*Tephrosia virginiana* (L.) Pers., old field and dry woods; infrequent (00630).

**Trifolium campestre* Schreb., old field and disturbed site; scarce (01979).

**Trifolium pratense* L., old field and disturbed site; scarce (01075).

†**Trifolium repens* L., disturbed site; scarce (02168).

†*Vicia caroliniana* Walter, rich ravines; occasional (00125).

**Vicia sativa* L. ssp. *nigra* Ehrh., disturbed site; scarce (02018).

**Vicia villosa* Roth ssp. *varia* (Host) Corb., disturbed site; scarce (02237).

FAGACEAE

†***Castanea dentata*** (Marsh.) Borkh., dry upland woods; rare (00491).

Fagus grandifolia Ehrh., rich ravines; occasional (01016).

Quercus alba L., woods; common (00628).

Quercus coccinea Muenchh., dry upland woods; occasional (00635).

†*Quercus falcata* Michx., upland woods; occasional (01510).

†*Quercus marilandica* Muenchh., dry ridges; infrequent (01163).

Quercus muehlenbergii Engelm., rich rocky wooded slopes and ravines; occasional (00731).

†*Quercus phellos* L., old field; rare (00631).

Quercus prinus L., dry upland slopes and ridges; common (01014).

†*Quercus rubra* L., rich woods and ravines; scarce (00740).

Quercus × *saulii* Schneid. [*alba* × *prinus*], upland woods; very rare (not collected).

Quercus stellata Wangenh., upland woods; frequent (00545).

Quercus velutina Lam., upland woods; frequent (01015).

FUMARIACEAE

Corydalis flavula (Raf.) DC., rich wooded stream terrace; rare (00335).

GENTIANACEAE

Frasera caroliniensis Walter, rich woods and stream terraces; infrequent (03732).

†*Gentiana villosa* L., dry upland woods; very rare (06054).

†*Obolaria virginica* L., upland woods and ravines; rare (03177).

Sabatia angularis (L.) Pursh, old field and disturbed site; rare (02682).

GERANIACEAE

Geranium carolinianum L. var. *carolinianum*, disturbed site; scarce (02217).

†*Geranium maculatum* L., rich woods and banks; occasional (00078).

HAMAMELIDACEAE

†*Hamamelis virginiana* L., woods and ravines; frequent (00513).

†*Liquidambar styraciflua* L., upland woods; infrequent (00841).

HYDRANGEACEAE

†*Hydrangea cinerea* Ser., rich bluffs and streambanks; common (00573).

Philadelphus hirsutus Nutt., rocky woods and bluffs; rare (00517).

HYDROPHYLLACEAE

Nemophila aphylla (L.) Brummitt, rich wooded streambank terrace; scarce (00344).

Phacelia bipinnatifida Michx., rich woods often among rocks and boulders; infrequent (01890).

JUGLANDACEAE

†*Carya alba* (L.) Nutt. ex Elliott, upland woods; common (00627).

Carya cordiformis (Wangenh.) K.Koch, rich woods and ravines; scarce (00900).

Carya glabra (Mill.) Sweet, upland woods; occasional (not collected).

Carya ovalis (Wangenh.) Sarg., upland woods; infrequent (00725).

†*Carya ovata* (Mill.) K.Koch, rich rocky slopes and ravines; infrequent (02674).

Juglans cinerea L., rich ravines; scarce (00898).

Juglans nigra L., rich ravines, rare (01540).

LAMIACEAE

†*Blephilia ciliata* (L.) Benth., rich woods and streambanks; infrequent (00911).

†*Collinsonia canadensis* L., rich woods and ravines; occasional (01353).

†*Cunila origanoides* (L.) Britton, dry upland woods and slopes; occasional (01209).

**Glechoma hederacea* L., disturbed site; scarce (00450).

†*Lycopus rubellus* Moench. In streams, wet banks, and calcareous seeps; frequent (01111).

Monarda bradburiana Beck, upland woods and rocky slopes; occasional (00523).

Monarda fistulosa L., old field and disturbed site; infrequent (00701).

†**Perilla frutescens* (L.) Britton, disturbed site; rare (01556).

**Prunella vulgaris* L., disturbed site and streambanks; occasional (00543).

Pycanthemum loomisii Nutt., old field; common (00872).

†*Pycanthemum tenuifolium* Schrad., old field; frequent (00632).

Salvia lyrata L., old field and woods; occasional (00609).

Salvia urticifolia L., upland woods; rare (04509).

†*Scutellaria elliptica* Muhl. ex Spreng. var. *hirsuta* (Short & Peter) Fernald, woods and streambanks; occasional (00572).

Teucrium canadense L., rich streambank; very rare (03503).

LAURACEAE

†*Lindera benzoin* (L.) Blume, rich woods; frequent (00487).

Sassafras albidum (Nutt.) Nees, upland woods and edges of old field; infrequent (00689).

LOGANIACEAE

Spigelia marilandica (L.) L., streambank; very rare (00890).

MAGNOLIACEAE

Liriodendron tulipifera L., rich woods; occasional (00840).

MALVACEAE

Sida spinosa L., disturbed site; rare (01576).

MENISPERMIACEAE

†*Menispermum canadense* L., rich wooded ravine; rare (02611).

MONOTROPACEAE

†*Monotropa uniflora* L., upland oak-hickory woods; very rare (02942).

MORACEAE

Morus rubra L., rich wooded ravines; scarce (00696).

OLEACEAE

Chionanthus virginicus L., rich streambanks; rare (00741).

Fraxinus americana L., woods and ravines; frequent (00730).

Fraxinus pennsylvanica Marsh., moist upland depression; very rare (00718).

**Ligustrum sinense* Lour., streambanks; scarce (00045).

ONAGRACEAE

†*Circaea lutetiana* L. ssp. *canadensis* (L.) Asch. & Magnus, rich woods and streambanks; occasional (00894).

†*Oenothera biennis* L., old field and disturbed site; scarce (01577).

†*Oenothera laciniata* Hill, disturbed site; very rare (02239).

ORBANCHACEAE

†*Conopholis americana* (L.) Wallr.f., woods beneath oak trees; occasional (00606).

OXALIDACEAE

†*Oxalis dillenii* Jacq., dry field; infrequent (01828).

Oxalis stricta L., dry rocky woods and disturbed site; occasional (00510).

Oxalis violacea L., dry rock outcrops; infrequent (00397).

PAPAVERACEAE

Sanguinaria canadensis L., rich woods; scarce (00449).

PASSIFLORACEAE

Passiflora incarnata L., old field and disturbed site; infrequent (00623).

Passiflora lutea L., rich woods and streambanks; infrequent (00732).

PHYTOLACCACEAE

Phytolacca americana L., disturbed soil; scarce (00858).

PLANTAGINACEAE

†**Plantago lanceolata* L., disturbed site; occasional (00720).

†*Plantago rugelii* Dcne., disturbed site; occasional (00712).

PLATANACEAE

Platanus occidentalis L., streambanks; infrequent (00253).

POLEMONIACEAE

Phlox amoena Sims, rocky woods; rare (00529).

Phlox amplifolia Britton, old field; very rare (00626 VDB).

Phlox divaricata L., rich woods and rocky banks; common (not collected).

Phlox glaberrima L., Calcareous seeps; very rare (01494).

†***Phlox pilosa*** **L. ssp.** ***ozarkana*** (Wherry) Wherry, old field; very rare (02233).

Polemonium reptans L., rich woods and streambanks; common (00117).

POLYGONACEAE

†**Polygonum caespitosum* Blume var. *longisetum* (Bruyn) Steward, disturbed site and gravel bars of streams; occasional (01152).

Polygonum pensylvanicum L., disturbed site; rare (01411).

†**Polygonum persicaria* L., disturbed site; scarce (00844).

†*Polygonum punctatum* Elliott, disturbed site; scarce (00640).

Polygonum scandens L., Edge of old field and woods; rare (01229).

†*Polygonum setaceum* Baldw., wet streambanks; infrequent (01153).

Polygonum virginianum L., rich woods and streambanks; occasional (01110).

†**Rumex acetosella* L., old field; scarce (00622).

†**Rumex crispus* L., disturbed site; rare (00546).

†**Rumex obtusifolius* L., wet streambank; very rare (00897).

PORTULACACEAE

Claytonia virginica L., rich woods; common (00077).

PRIMULACEAE

†*Lysimachia ciliata* L., wet streambanks; infrequent (01060).

Lysimachia cf. *hybrida* Michx., upland woods; frequent (00756).

Lysimachia quadrifolia L., upland woods and old field; rare (02165).

†*Samolus valerandi* L. ssp. *parviflorus* (Raf.) Hultén, wet streambank; very rare (00849).

PYROLACEAE

†*Chimaphila maculata* (L.) Pursh, upland woods; common (00027).

RANUNCULACEAE

Actaea pachypoda Elliott, rich woods; infrequent (01024).

†*Anemone quinquefolia* L., rich woods and streambanks; scarce (00076).

Anemone virginiana L., old field and upland woods; scarce (01070).

Aquilegia canadensis L., rich bluffs and slopes; occasional (00979).

Clematis versicolor Small ex Rydb., rich woods; very rare (01025).

†*Clematis virginiana* L., rich wooded ravines; rare (01357).

†*Hepatica nobilis* Schreb. var. *acuta* (Pursh) Steyermark, rich woods and slopes; common (00446).

†***Hydrastis canadensis*** L., rich wooded ravines; scarce (01354).

†**Ranunculus bulbosus* L., old field; very rare (00415 VDB).

Ranunculus hispidus Michx. var. *hispidus*, rocky woods and banks; occasional (00068).

Ranunculus micranthus Nutt., limestone bluffs; rare (01822).

†*Ranunculus recurvatus* Poir., streambanks; frequent (00519).

**Ranunculus sardous* Crantz, disturbed site and old field; infrequent (01584).

Thalictrum revolutum DC., rich wooded streambanks; infrequent (00878).

Thalictrum thalictroides (L.) Eames & Boivin, rich woods; frequent (00127).

RHAMNACEAE

Ceanothus americanus L., old field and edge of dry woods; infrequent (00566).

Frangula caroliniana (Walter) A. Gray, woods and edges of old field; scarce (01486).

ROSACEAE

†*Agrimonia parviflora* Aiton, wet streambank; rare (01057).

Agrimonia rostellata Wallr., woods and streambanks; frequent (00850).

†*Amelanchier arborea* (Michx.f.) Fernald, upland woods; frequent (00357).

Crataegus calpodendron (Ehrh.) Medik., rocky woods and slopes; infrequent (00518).

Crataegus cf. *flabellata* (Spach) Kirchn., old field; very rare (01030 VDB).

†*Crataegus pruinosa* (Wendl.f.) K.Koch, dry rocky slope forest; rare (02602 VDB).

†**Duchesnea indica* (Andr.) Focke, disturbed sites and gravel bars of streams; rare (05975).

Geum canadense Jacq., woods and bluffs; occasional (00094).

†*Malus angustifolia* (Aiton) Michx. var. *angustifolia*, dry rocky wooded slope; very rare (02957).

†*Porteranthus stipulatus* (Muhl. ex Willd.) Britton, dry woods; infrequent (00726).

Potentilla simplex Michx., dry woods and old field; frequent (00514).

Prunus mexicana S.Watson, dry woods and rocky slopes; rare (00528).

Prunus serotina Ehrh., upland woods and edges of old field; scarce (00058).

Rosa carolina L., edge of woods and old field; scarce (00570).

†**Rosa multiflora* Thunb. ex Murr., moist streambanks; infrequent (00520).

Rosa setigera Michx., limestone outcrops in woods; very rare (01124).

†*Rubus allegheniensis* Porter, upland woods; infrequent (00883).

†**Rubus bifrons* Vest ex Tratt., old field; common (00621).

†*Rubus invisus* (L.H.Bailey) Britton, upland woods; infrequent (02021).

Rubus occidentalis L., woods; infrequent (00042).

†*Rubus pensilvanicus* Poir., upland woods and disturbed site; infrequent (00637).

†*Waldsteinia fragarioides* (Michx.) Tratt., rich woods; rare (00073).

RUBIACEAE

Cephalanthus occidentalis L., streambank; very rare (00845).

Diodia teres Walter, old field; frequent (00882).

†*Galium aparine* L., rich woods; occasional (00509).

Galium circaezans Michx., rich woods; occasional (00483).

Galium pilosum Aiton, old field; occasional (00624).

Galium triflorum Michx., rich woods and moist bluffs; frequent (00641).

†*Houstonia caerulea* L., upland woods; frequent (00386).

Houstonia purpurea L. var. *purpurea*, woods and banks; frequent (00536).

†*Houstonia pusilla* Schoepf, grassy roadbed; very rare (00813).

Mitchella repens L., moist woods; infrequent (00303).

SALICACEAE

†*Populus deltoides* Bartram ex Marsh., gravel bar in stream; very rare (01233).

†*Salix caroliniana* Michx., calcareous seep; very rare (01496).

Salix humilis Marsh. var *humilis*, old field and thickets; infrequent (00060).

†*Salix nigra* Marsh., wet streambank; rare (01156).

SAPOTACEAE

Sideroxylon lycioides L., rocky banks; rare (00910).

SAXIFRAGACEAE

†*Heuchera americana* L. var. *americana*, rich woods; scarce (00533).

Heuchera villosa Michx. var. *macrorhiza* (Small) Rosend., Butters, & Lakela, limestone bluffs and boulders; frequent (00511).

Parnassia grandifolia DC., calcareous seep; rare (01495).

Saxifraga virginiensis Michx., limestone bluffs and boulders; frequent (00081).

†*Tiarella cordifolia* L., rich woods and banks; frequent (00070).

SCROPHULARIACEAE

†*Agalinis gattingeri* (Small) Small, dry rocky woods; rare (01375).

Aureolaria flava (L.) Farw., dry woods; rare (not collected).

†*Aureolaria pectinata* (Nutt.) Pennell, dry woods; rare (00899).

†*Chelone glabra* L., wet streambanks and calcareous seeps; infrequent (01360).

Mimulus alatus Aiton, wet streambanks; infrequent (01067).

†**Paulownia tomentosa* (Thunb.) Sieb. & Zucc. ex Steud., disturbed site; rare (01515).

Pedicularis canadensis L., rich streambanks; infrequent (00080).

†*Scrophularia marilandica* L., streambanks; rare (01467).

**Verbascum blattaria* L., disturbed site; rare (01344).

†**Verbascum thapsus* L., disturbed site; scarce (00876).

**Veronica arvensis* L., disturbed site; infrequent (02019).

†**Veronica serpyllifolia* L., rich mossy streambanks; rare (00562).

Veronicastrum virginicum (L.) Farw., old field and disturbed site; very rare (00887).

SIMAROUBACEAE

**Ailanthus altissima* (Mill.) Swingle, clearing in woods; very rare (00879).

SOLANACEAE

†**Datura stramonium* L., disturbed site; very rare (01409).

Physalis heterophylla Nees, old field and upland thicket; scarce (01574).

†*Physalis longifolia* Nutt. var. *subglabrata* (Mack. & Bush) Cronquist, old field; infrequent (00708).

†*Physalis pubescens* L. var. *integrifolia* (Dunal) Waterf., gravel bar in stream; scarce (04292).

Solanum carolinense L., old field and disturbed site; infrequent (00707).

Solanum ptychanthum Dunal, moist woods; scarce (01027).

STAPHYLEACEAE

Staphylea trifolia L., rich wooded ravines and streambanks; occasional (01359).

STYRACACEAE

Styrax grandifolius Aiton, upland woods and ravines; occasional (00479).

THYMELAEACEAE

Dirca palustris L., rich wooded stream bank; rare (00639).

TILIACEAE

Tilia americana L. var. *heterophylla* (Vent.) Loud., rich wooded streambank; very rare (01506).

ULMACEAE

Celtis laevigata Willd., disturbed site; rare (00716).

Celtis occidentalis L., rich wooded ravines and stream terraces; rare (01019).

Celtis tenuifolia Nutt., dry wooded, rocky slope; very rare (01149 VDB).

Ulmus alata Michx., upland woods; infrequent (00349).

Ulmus americana L., rich stream bank; rare (00082).

Ulmus rubra Muhl., rich woods; occasional (00389).

Ulmus serotina Sarg., limestone bluffs and rocky slopes; rare (01017).

URTICACEAE

Boehmeria cylindrica (L.) Sw., wet streambanks and seeps; occasional (00848).

Laportea canadensis (L.) Wedd., rich woods; infrequent (01022).

Parietaria pensylvanica Muhl. ex Willd., Bluffs and rock outcrops; infrequent (01880).

†*Pilea pumila* (L.) A.Gray, streambanks and seeps; frequent (01225).

VALERIANACEAE

†*Valeriana pauciflora* Michx., rich wooded stream terrace; rare (01878).

Valerianella radiata (L.) Dufr., disturbed site; scarce (01992).

VERBENACEAE

†*Phryma leptostachya* L., rich woods; occasional (00847).

Verbena simplex Lehm., old field, scarce (00688).

†*Verbena urticifolia* L., disturbed soil and gravel bars of streams; infrequent (00693).

VIOLACEAE

Hybanthus concolor (T.F.Forst) Spreng., rich woods; rare (01885).

Viola bicolor Pursh, disturbed site; rare (04507).

†*Viola cucullata* Aiton, wet streambanks and seeps; occasional (01832).

†*Viola hirsutula* Brainerd, dry upland woods; occasional (02541).

Viola sororia Willd., rich woods; infrequent (01826).

Vilola striata Aiton, rich streambanks and terraces; infrequent (01884).

Viola triloba Schwein., rich woods; infrequent (01843).

Viola tripartita Elliott var. *glaberrima* (DC.) R.M.Harper, upland woods and ravines; occasional (01877).

VITACEAE

Parthenocissus quinquefolia (L.) Planch., moist woods and bluffs; occasional (00507).

†*Vitis aestivalis* Michx., dry upland woods; occasional (00490).

†*Vitis cinerea* (Engelm.) Millard var. *baileyana* (Munson) Comeaux, rich woods; infrequent (00485).

†*Vitis rotundifolia* Michx., upland woods; common (01076).

Vitis vulpina L., moist upland thicket; rare (02540).

MAGNOLIOPHYTA, LILIOPSIDA

ARACEAE

Arisaema triphyllum (L.) Schott ssp. *triphyllum*, woods; frequent (00568).

COMMELINACEAE

**Commelina communis* L., streambanks and moist trails; infrequent (00901).

Commelina virginica L., streambanks; infrequent (01063).

Tradescantia subaspera Ker Gawl. var. *subaspera*, rich wooded ravine; rare (02588).

CYPERACEAE

†*Carex amphibola* Steud., rich wooded ravines; occasional (05979).

†*Carex cumberlandensis* Naczi, Kral, & Bryson, rich wooded ravines; frequent (02608).

Carex albicans Willd. ex Spreng var. *albicans*, woods; common (01846).

†*Carex albursina* E.Sheld., rich wooded ravines; occasional (02590).

†*Carex blanda* Dewey, wooded ravines and streambanks; frequent (s.n.).

Carex cephalophora Willd. ex Willd., woods; occasional (00755).

Carex digitalis Willd. var. *macropoda* Fernald, upland woods and dry ravines; occasional (05983).

Carex frankii Kunth, wet depression along road; rare (01689).

Carex granularis Muhl. ex Willd., Calcareous seep; very rare (02604).

†*Carex hirsutella* Mack., old field; frequent (01042).

†*Carex kraliana* Naczi & Bryson, rich wooded ravines, infrequent (05982).

†*Carex laevivaginata* (Kük.) Mack., streambank and gravel bar; rare (05981).

†*Carex laxiculmis* Schwein. var. *laxiculmis*, upland woods; rare (05980).

†*Carex lurida* Wahlenb., streambanks; infrequent (00442).

†*Carex pensylvanica* Lam., upland woods; rare (01834).

†*Carex picta* Steud., upland woods and dry ravines; common (00443).

†*Carex radiata* (Wahlenb.) Small, rich alluvial terraces and adjacent slopes; scarce (06056).

Carex rosea Schkuhr ex Willd., rich wooded ravines; infrequent (03500).

†*Carex torta* Boott ex Tuckerman, streambanks; scarce (01833).

Cyperus echinatus (L.) A.W.Wood, old field; occasional (01041).

Cyperus odoratus L., old field and waste places; scarce (01578).

Eleocharis obtusa (Willd.) Schult., moist streambank; very rare (03727).

†*Scirpus atrovirens* Willd., streambanks; rare (02460).

†*Scirpus polyphyllus* Vahl, streambanks; infrequent (01054).

Scleria oligantha Michx., upland woods; scarce (06053).

DIOSCOREACEAE

†*Dioscorea quaternata* J.F.Gmel., rich woods; frequent (00484).

IRIDACEAE

†*Iris cristata* Aiton, woods and streambanks; frequent (01829).

Sisyrinchium albidum Raf., dry limestone bluff; rare (01817).

Sisyrinchium angustifolium Mill., wooded ravine and streambanks; infrequent (00531).

JUNCACEAE

†*Juncus coriaceus* Mack., calcareous seeps and streambanks; frequent (00683).

Juncus tenuis Willd., old field, roads and paths; occasional (00714).

†*Luzula acuminata* Raf. var. *carolinae* (S.Watson) Fernald, upland woods; occasional (01985).

Luzula echinata (Small) F.J.Herm., upland woods; common (01830).

LILIACEAE

Allium canadense L. var. *canadense*, old field; occasional (00535).

†*Allium canadense* L. var. *mobilense* (Regel) Ownbey, old field; rare (02456).

†*Chamaelirium luteum* (L.) A. Gray, rich wooded ravine; rare (00673).

†*Hymenocallis caroliniana* (L.) Herbert, wooded ravines, stream terraces and streambanks; infrequent (00753).

†***Lilium michiganense*** Farw., wet streambank and wooded alluvial terrace; rare (00636).

Maianthemum racemosum (L.) Link. ssp. *racemosum*, rich woods; frequent (00681).

**Narcissus pseudonarcissus* L., Old field; rare (not collected).

Polygonatum biflorum (Walter) Elliott, wooded ravines and streambanks; frequent (02004).

Prosartes lanuginosa (Michx.) D.Don, rich woods; rare (02591).

Trillium stamineum Harbison, rich woods; infrequent (00390).

†*Uvularia grandiflora* Sm., rich woods; occasional (01026).

†*Uvularia sessilifolia* L., rich woods and streambanks; scarce (00675).

ORCHIDACEAE

Corallorrhiza wisteriana Conrad, rich wooded streambank; very rare (not collected).

†*Cypripedium parviflorum* Salisb. var. *pubescens* (Willd.) Knight, rich wooded ravine; very rare (00699).

†*Goodyera pubescens* (Willd.) R.Br. ex Ait.f., rich stream terrace; very rare (04293).

†*Liparis liliifolia* (L.) Rich. ex Ker Gawl., rich wooded slope and stream terrace; rare (not collected).

†*Platanthera clavellata* (Michx.) Luer, mossy, rocky streamside; very rare (02678).

†*Platanthera peramoena* (A. Gray) A. Gray, wooded alluvial terrace and streambank; rare (02533).

†*Spiranthes tuberosa* Raf., upland oak-hickory forest; rare (01150).

†*Tipularia discolor* (Pursh) Nutt., rich woods; infrequent (00895).

POACEAE

†*Agrostis perennans* (Walter) Tuckerman, upland woods; frequent (01169).

**Agrostis stolonifera* L., old field and disturbed site; infrequent (00704).

†*Andropogon gerardii* Vitman, old field at edge of oak-hickory forest; very rare (02962).

Andropogon virginicus L. var. *virginicus*, old field; common (01541).

†**Anthoxanthum odoratum* L., old field; infrequent (02162).

†**Arthraxon hispidus* (Thunb.) Makino, disturbed site; scarce (not collected).

†*Arundinaria gigantea* (Walter) Muhl., wooded streamside terrace; rare (01547).

**Avena sativa* L., disturbed site; very rare (02243).

Brachyelytrum erectum (Schreb. ex Spreng.) Beauv., rich woods; frequent (00691).

†**Bromus commutatus* Schrad., disturbed site, infrequent (00702).

**Bromus japonicus* Thunb. ex Murr., old field; infrequent (02166).

Bromus pubescens Muhl. ex Willd., rich woods and streambanks; infrequent (00577 VDB).

Chasmanthium latifolium (Michx.) Yates, woods and streambanks; occasional (01358).

†*Cinna arundinacea* L., rich woods and wet streambanks; infrequent (01546).

**Cynodon dactylon* (L.) Pers., disturbed site; rare (01408 VDB).

†**Dactylis glomerata* L., old field; infrequent (00706).

Danthonia spicata (L.) Beauv. ex Roemer. & Schult., oak-hickory forest; frequent (00749).

Dichanthelium acuminatum (Sw.) Gould & C.A.Clark var. *acuminatum*, old field; occasional (00618).

Dichanthelium boscii (Poir.) Gould & C.A.Clark, dry to mesic woods; occasional (00751).

†*Dichanthelium clandestinum* (L.) Gould, margin of woods and old field; infrequent (00698).

Dichanthelium commutatum (Schult.) Gould, dry to mesic woods and streambanks; common (00532).

†*Dichanthelium dichotomum* (L.) Gould. var. *dichotomum*, dry oak-hickory forest; common (00750).

†*Dichanthelium dichotomum* (L.) Gould. var. *ramulosum* (Torr.) R.J.LeBlond, moist streambanks; occasional (01059).

Dichanthelium laxiflorum (Lam.) Gould, dry woods; common (00629).

Dichanthelium malacophyllum (Nash) Gould, old field; rare (01039).

†*Dichanthelium scoparium* (Lam.) Gould, old field; rare (02234).

†*Dichanthelium sphaerocarpon* (Elliott) Gould var. *isophyllum* (Scribn.) Gould & C.A.Clark, old field and wooded streambanks; infrequent (02544).

†*Dichanthelium yadkinense* (Ashe) Mohlenbr., moist to wet streambanks and calcareous seeps; scarce (00685).

†*Digitaria ciliaris* (Retz.) Koeler, disturbed site; rare (01407).

**Digitaria ischaemum* (Schreb.) Schreb. ex Muhl., disturbed site; rare (02944).

**Echinochloa colona* (L.) Link, moist depressions along road; rare (02529).

†**Echinochloa crus-galli* (L.) Beauv., moist depressions along road; rare (01074).

†*Elymus hystrix* L., woods and streambanks; occasional (00679).

†*Elymus macgregorii* R.E.Brooks & J.J.N.Campbell, rich wooded streambank; scarce (not collected).

†*Elymus villosus* Muhl. ex Willd., dry woods and banks; occasional (00854).

Elymus virginicus L. var. *virginicus*, woods and edges of disturbed sites; occasional (00697).

†*Eragrostis spectabilis* (Pursh) Steud., old field; infrequent (01295).

Festuca subverticillata (Pers.) Alexeev, wooded streambanks and terraces; infrequent (02609).

Glyceria striata (Lam.) Hitchc., wet streambanks and calcareous seeps; occasional (00672).

†*Hordeum pusillum* Nutt., disturbed site; rare (02178).

Leersia virginica Willd., Moist streambanks and seeps; occasional (02960).

†*Lolium arundinaceum *(Schreb.) Darbysh., old field, road edges; common (00705).*

†**Lolium perenne* L. ssp. *multiflorum* (Lam.) Husn., old field and disturbed site; occasional (00547).

Melica mutica Walter, Limestone bluffs and rocky woods; occasional (00391).

†**Microstegium vimineum* (Trin.) A.Camus, moist alluvial terraces, calcareous seeps, and gravel bars in streams, frequent (00671).

†*Muhlenbergia schreberi* J.F.Gmel., disturbed site; scarce (01378).

Muhlenbergia sylvatica Torr. ex A. Gray, woods, streambanks, and calcareous seeps; frequent (02720).

†*Panicum anceps* Michx., old field; common (00881).

†*Panicum dichotomiflorum* Michx. var. *dichotomiflorum*, wet road ruts; rare (02939).

†**Paspalum dilatatum* Poir., old field and disturbed site; infrequent (04269).

Paspalum setaceum Michx., old field; infrequent (02964).

†**Phleum pratense* L., disturbed site; rare (03497).

**Poa annua* L., disturbed site; rare (01984 VDB).

†*Poa autumnalis* Muhl. ex Elliott, Moist woods, bluffs, and streambanks; frequent (00524).

†*Poa chapmaniana* Scribn., old field; rare (02220 VDB).

†**Poa compressa* L., disturbed site; rare (01978).

†**Poa pratensis* L., old field; occasional (04519).

Poa sylvestris A. Gray, moist woods, bluffs, and streambanks; occasional (00527).

†*Saccharum alopecuroidum* (L.) Nutt., old field; occasional (01399).

†*Saccharum giganteum* (Walter) Pers., old field, rare (01583).

Schizachyrium scoparium (Michx.) Nash var. *scoparium*, old field and in thin oak-hickory forests; occasional (01542).

†**Setaria faberi* Herrm., disturbed site; rare (02528).

†*Setaria parviflora* (Poir.) Kerguélen, old field; occasional (01345).

†*Sorghastrum nutans* (L.) Nash, old field; very rare (03506).

†**Sorghum halapense* (L.) Pers., old field and disturbed site; infrequent (02526).

†*Sphenopholis nitida* (Biehler) Scribn., woods; occasional (01983).

Tridens flavus (L.) Hitchc. var. *flavus*, old field; frequent (01040).

**Triticum aestivum* L., disturbed site; very rare (02245).

†*Vulpia octoflora* (Walter) Rydb. var. *octoflora*, dry soil in old field; very rare (01980).

SMILACACEAE

Smilax bona-nox L., dry wooded slope; scarce (00719).

†*Smilax ecirrata* (Engelm. ex Kunth) S. Watson, rich wooded streambank; very rare (01158).

†*Smilax glauca* Walter, dry woods and thickets; common (00694).

Smilax rotundifolia L., dry woods and thickets; common (00542).

†*Smilax tamnoides* L., rich woods; infrequent (00842).

ACKNOWLEDGMENTS

An Undergraduate Research Award from Middle Tennessee State University and an Undergraduate Research Assistantship from the Center of Excellence for Field Biology, Austin Peay State University, provided financial support for this project. We appreciate the helpful insight of E.W. Chester during the beginning phases of the project. Our sincere gratitude is extended to R. Kral for confirming our identification of several difficult specimens, and to R. Naczi for verification of *Carex radiata*. Chris Fleming kindly prepared the map of the study site. Two anonymous reviewers and Robert Kral reviewed the manuscript. Finally, we would like to thank E. Pahler, the landowner, for permission to conduct this study.

REFERENCES

Ackerman, E.A. 1941. The Köppen classification of climates in North America. Geogr. Rev. 31:105–111.

Baskin, J.M., C.C. Baskin, and E.W. Chester. 1994. The Big Barrens region of Kentucky and Tennessee: further observations and considerations. Castanea, 59:226–254.

Braun, E.L. 1950. Deciduous forests of eastern North America. Hafner Publ. Co., New York.

Bryant, W.S., W.C. McComb, and J.S. Fralish. 1993. Oak-hickory forests (Western Mesophytic/ oak-hickory forests). In: W.H. Martin, S.G. Boyce, and A.C. Echternacht, eds. Biodiversity of the southen United States: upland terrestrial communities. John Wiley and Sons, New York. Pp. 143–201.

Campbell, J.J.N. 2000. Notes on North American *Elymus* species with paired spikelets I: *E. macgregorii* sp. nov. and *E. glaucus* ssp. *mackenzii* comb. nov. J. Kentucky Acad. Sci. 61: 88–98.

Carpenter, J.S. and E.W. Chester. 1987. Vascular flora of the Bear Creek Natural Area, Stewart County, Tennessee. Castanea 52:112–128.

Chester, E.W. 1986. The vascular flora of Barnett Woods Natural Area, Montgomery County, Tennessee. J. Tennessee Acad. Sci. 61:24–28.

Chester, E.W. 1993. Vascular flora of Land Between the Lakes, Kentucky and Tennessee: an updated checklist. J. Tennessee Acad. Sci. 68:1–14.

Chester, E.W. 1995. An overview of forest diversity in the Interior Low Plateaus Physiographic Province. In: T.D. Landis and B. Cregg, tech. Cords. National Proceedings, Forest and Conservation Nursery Associations. USDA Forest Service, Pacific Northwest Research Station, Gen. Tech. Rep. PNW-GTR-365. Pp. 109–115

Chester, E.W., B.E. Wofford, R. Kral, H.R. DeSelm, and A.M. Evans. 1993. Atlas of Tennessee vascular plants. Vol. 1. Pteridophytes, gymnosperms, angiosperms: monocots. Misc. Publ. No. 9. Center for Field Biology, Austin Peay State Univ., Clarksville, Tennessee.

Chester, E.W., B.E. Wofford, and R. Kral. 1997. Atlas of Tennessee vascular plants, Vol. 2. Angiosperms: dicots. Misc. Publ. No. 13. Center for Field Biology, Austin Peay State Univ., Clarksville, Tennessee.

Clements, R.K. and B.E. Wofford. 1991. The vascular flora of Wolf Cove, Franklin County, Tennessee. Castanea 56:268–286.

Cronquist, A. 1980. Vascular flora of the southeastern United States, Vol. 1. Asteraceae. Univ. North Carolina Press, Chapel Hill, North Carolina.

DeSelm, H.R. 1988. The barrens of the Western Highland Rim of Tennessee. In: D.H. Snyder, ed. Proceedings of the first annual symposium on the natural history of lower Tennessee and Cumberland River valleys. Center for Field Biology, Austin Peay State Univ., Clarksville, Tennessee. Pp. 199–219

DeSelm, H.R. 1994. Tennessee barrens. Castanea 59:214–225.

Fernald, M.L. 1950. Gray's manual of botany, 8th edition. American Book Co., New York.

Fleming, C. 2004. The vascular flora of Fall Creek Falls State Park, Van Buren and Bledsoe counties, Tennessee. Castanea 69:164–184.

Flora of North America Editorial Committee (eds.). 1993. Flora of North America north of Mexico. Volume 2. Pteridophytes and gymnosperms. Oxford University Press, New York, New York.

Garrett, J.K. 1966. Footprints in stone. First Farmers & Merchants National Bank, Columbia, Tennessee.

Gleason, H.A. and A. Cronquist. 1991. Manual of the vascular plants of northeastern United States and adjacent Canada, 2nd edition. New York Botanical Garden, Bronx, New York.

Griffith, G.E., J.M. Omernik, and S.H. Azevedo. 1998. Ecoregions of Tennessee (Two-sided color poster with map, descriptive text, summary tables, and photographs). US Geological Survey, Reston, Virginia. Scale 1:940,000.

Harmon, A.B. Jr., E. Lusk, J. Overton, J.H. Elder Jr., and L.D. Williams. 1959. Soil survey of Maury County, Tennessee. US Dept. Agriculture, Washington, DC.

Houck, D.F. 1990. Vascular flora of Red Clay State Historical Area, Bradley County, Tennessee. J. Tennessee Acad. Sci. 65:75–82.

Isely, D. 1990. Vascular flora of the southeastern United States, Vol. 3, Part 2. Leguminosae (Fabaceae). Univ. North Carolina Press, Chapel Hill, North Carolina.

Jones, R.L. 1994. The status of *Helianthus eggertii* Small in the southeastern United States. Castanea 59:319–330.

Joyner, J.M. and E.W. Chester. 1994. The vascular flora of Cross Creeks National Wildlife Refuge, Stewart County, Tennessee. Castanea 59:117–145.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland, 1st ed. In: J.T. Kartesz and C.A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, North Carolina.

Küchler, A.W. 1964. Vegetation maps of North America: potential natural vegetation of the conterminous United States. Am. Geograph. Soc. Spec. Publ. 36.

LeBlond, R.J. 2001. Taxonomy of the *Dichotoma* group of *Dichanthelium* (Poaceae). Sida 19:821–837.

Mann, L.K., T.S. Patrick, and H.R. DeSelm. 1985. A checklist of the vascular plants on the Department of Energy Oak Ridge Reservation. J. Tennessee Acad. Sci. 60:8–13.

Marcher, M.V. and R.E. Lounsberry. 1966. Geologic map of the Summertown Quadrangle, Tennessee. Tennessee Div. Geol., Nashville, Tennessee.

McKinney, L.E. 1986. The vascular flora of Short Mountain (Cannon County) Tennessee. J. Tennessee Acad. Sci. 61:20–24.

Murrell, Z.E. and B.E. Wofford. 1987. Floristics and phytogeography of Big Frog Mountain, Polk County, Tennessee. Castanea 52:262–290.

Naczi, R.F.C., C.T. Bryson, and T.S. Cochrane. 2002. Seven new species and one new combination in *Carex* (Cyperaceae) from North America. Novon 12:508–532.

Naczi, R.F.C., R. Kral, and C.T. Bryson. 2001. *Carex cumberlandensis*, a new species of section *Careyanae* (Cyperaceae) from the eastern United States of America. Sida 19:993–1014.

Ostry, M.E. 1997. Butternut canker: history, biology, impact, and resistance. In: J.W. Van Sambeek, ed. Knowledge for the future of black walnut. USDA Forest Service, North Central Forest Experiment Station, Gen. Tech. Rep. NC-191. Pp. 192–199.

Quarterman, E., and R.L. Powell. 1978. Potential ecological/geological natural landmarks on the Interior Low Plateaus. US Dept. Interior, Washington, DC.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. North Carolina Press, Chapel Hill, North Carolina.

Schmalzer, P.A., T.S. Patrick, and H.R. DeSelm. 1985. Vascular flora of the Obed Wild and Scenic River, Tennessee. Castanea 50:71–88.

Shanks, R.E. 1958. Floristic regions of Tennessee. J. Tennessee Acad. Sci., 33:195–210.

Small, J.K. 1933. Manual of the southeastern flora. Univ. North Carolina Press, Chapel Hill, North Carolina.

Tennessee Exotic Pest Plant Council. 2002. Invasive exotic pest plants in Tennessee. J. Tennessee Acad. Sci. 77:45–48.

Tennessee Natural Heritage Program. 2001. Tennessee rare plant list. Tennessee Division of Natural Heritage, Dept. Environ. Conserv., Nashville, Tennessee.

Tennessee Valley Authority. 1938. The scenic resources of the Tennessee Valley: a descriptive pictorial inventory. Tennessee Valley Authority, Dept. Regional Planning Studies, Knoxville, Tennessee.

Thomas, R.D. 1976. The vascular flora of Chilhowee Mountain, Blount and Sevier counties, Tennessee. J. Tennessee Acad. Sci. 51:118–123.

Turner, W.B. 1955. History of Maury County, Tennessee. Parthenon Press, Nashville, Tennessee.

USDA, NRCS. 2004. The PLANTS Database, version 3.5 (plants.usda.gov). National Plant Data Center, Baton Rouge, Louisiana [as accessed December 16, 2004].

US Fish and Wildlife Service. 1993. Recovery plan for *Apios priceana.* US Fish and Wildl. Service, Jackson, Mississippi.

Wofford, B.E. and R. Kral. 1993. Checklist of the vascular plants of Tennessee. Sida, Bot. Misc. No. 10.

Wofford, B.E., T.S. Patrick, L.R. Phillippe, and D.H. Webb. 1979. The vascular flora of Savage Gulf, Tennessee. Sida 8:135–151.

Yatskievych, G. 1999. Steyermark's flora of Missouri, Vol. 1. Revised edition. Missouri Botanical Garden, St. Louis.

ENDEMIC VASCULAR PLANTS OF THE INTERIOR HIGHLANDS, U.S.A.

Douglas Zollner

The Nature Conservancy
601 North University
Little Rock, Arkansas 72205, U.S.A.

Michael H. MacRoberts

Bog Research
740 Columbia
Shreveport, Louisiana 71104, U.S.A.

Barbara R. MacRoberts

Herbarium, Museum of Life Sciences
Louisiana State Univ-Shreveport
Shreveport, Louisiana 71115, U.S.A.

Douglas Ladd

The Nature Conservancy
2800 S. Brentwood
St. Louis, Missouri 63144, U.S.A.

ABSTRACT

We evaluate the 36 endemic vascular plants of the Interior Highlands of Arkansas, Illinois, Kansas, Missouri, and Oklahoma. Most of the endemic flora of the region are herbaceous perennials, although nearly a quarter of the endemic plant taxa are annuals. An analysis of the community affiliations of the region's endemic flora reveals that most endemic taxa are associated with glade habitats maintained by edaphic conditions and fire. Riparian habitats and fire-maintained pine-oak woodlands are other habitat associations with significant endemic flora. The Ouachita Mountains region of the Interior Highlands contains a disproportionate representation of the endemic taxa relative to its area, although there is also a smaller cohort of endemics restricted to the Ozark portion of the Interior Highlands.

Key words: Interior Highlands, endemic flora, biogeography, biodiversity, Ozarks, Ouachitas, Arkansas, Illinois, Kansas, Missouri, Oklahoma

RESUMEN

Hemos evaluado las 36 plantas vasculares endémicas de las Interior Highlands de Arkansas, Illinois, Kansas, Missouri, y Oklahoma. La mayor parte de la flora endémica de la región son herbáceas perennes, aunque casi la cuarta parte de las plantas endémicas son taxa anuales. Un análisis de las preferencias de las comunidades de la flora endémica de la región revela que la mayoría de los taxa endémicos están asociados con hábitats pantanosos que se mantienen por las condiciones edáficas y el fuego. Los hábitats riparios y bosques de pino-roble mantenidos por el fuego son los otros hábitats con elementos de flora endémica significativos. La región de las Montañas de Ouachita del Interior Highlands contiene una representación desproporcionada de taxa endémicos de esta área, aunque hay también una pequeña cohorte de endemismos restringidos a la parte de Ozark de las Interior Highlands.

INTRODUCTION

Lists of endemic taxa are valuable tools for defining the uniqueness and conservation significance of biogeographic regions (Takhtajan 1986) and in establishing biodiversity "hotspots" for conservation priorities (Diamond et al. 1997; Ricketts et al. 1999; Myers et al. 2000; Stein et al. 2000; Estill & Cruzan 2001). Few biogeographic regions, however, have detailed endemic vascular plant lists.

SIDA 21(3): 1781–1791. 2005

For example, only recently have endemic plant lists been developed for the Atlantic and Gulf Coastal Plain and the West Gulf Coastal Plain (Sorrie & Weakley 2001; MacRoberts et al. 2002).

The Interior Highlands physiographic region has been relatively well-described physically and biotically (Fenneman 1938; Foti 1974; Nelson 1985; Thom & Wilson 1980; Bryant et al. 1993; Nigh and Schroeder 2002; Skeen et al. 1993; Foti & Bukenhofer 1998; Delcourt & Delcourt 2000). The region has an extensive botanical literature, including floras and atlases (Steyermark 1963; Peck & Peck 1988; Smith 1988, 1994; Taylor & Taylor 1989; Peck et al. 2001; Yatskievych 1999), but it has no comprehensive list of endemic vascular plants, and most botanical information is compartmentalized by state.

As shown in Figure 1, the Interior Highlands are comprised of the Ozarks, Ouachitas, and Arkansas Valley sections, and include significant portions of Arkansas, Missouri, and Oklahoma, along with minor areas of Illinois and Kansas. This region has long been recognized as a geologically, physiographically, ecologically, and culturally distinct region of North America, and constitutes the only highlands in midcontinental North America. The Ouachita Mountains are east-west trending fold-belt ranges of intensely deformed sandstone, shale, and chert (Miser 1929). The northern ranges are long hogback ridges of sandstone separated by broad valleys. The southern ranges are sharp ridges of novaculite separated by narrow, stony valleys (Croneis 1930). The Arkansas Valley is a broad alluvial plain with isolated mountains that generally separates the Ouachita Mountains from the Ozark Plateau. Structurally, the Ozark Plateau is a dome that has been slowly uplifted and eroded, resulting in high levels of topographic, geologic, edaphic, and hydrologic diversity. Bedrock geology includes exposures of Precambrian igneous rocks surrounded by alternating zones of Paleozoic sandstone and carbonate sedimentary rocks (Nigh and Schroeder 2002). Both the Ouachita and Ozark portions of the highlands are characterized by rugged, dissected uplands with abundant exposed rocks and highly variable soil depths.

This paper enumerates the endemic vascular plants of the Interior Highlands, along with information about each species, its plant community affiliations and the ecological processes that maintain these species. These data can be used to focus activities on the habitats, ecological systems, and ecological process regimes in greatest need of conservation action. Glade is used here to mean, open herbaceous-dominated habitats with sparse tree and shrub cover, shallow soils, and abundant exposed rock.

METHODS

For this study, a taxon is considered to be endemic if its range essentially does not extend outside the Interior Highlands. Hybrid taxa are excluded from this list. Nomenclature generally follows Kartesz (1999).

We searched all available sources of information, including extensive consultation with knowledgeable experts, to determine global ranges of species in the vascular flora of Arkansas, Illinois, Kansas, Missouri, and Oklahoma. This included general references such as Kartesz (1999), Kral (1983), Mohlenbrock (2002), Robison and Allen (1995), Smith (1988), Steyermark (1963), Taylor and Taylor (1989), Yatskievych (1999), Flora of North America Editorial Committee (1993–), and more specific papers (e.g. Tucker 1974; Weckman 2002). Also included were various lists of species of concern kept by the Arkansas, Illinois, Kansas, Missouri, and Oklahoma Natural Heritage programs and the Ozark, Ouachita, Mark Twain, and Shawnee National Forests[1].

Once the preliminary list was compiled, we investigated many of the same sources and additional ecological references to determine the plant community affiliation(s) of each species throughout the Interior Highlands. This determination involved developing a general plant community list for the Interior Highlands and assigning each taxon to the most appropriate plant community. We used The Nature Conservancy's classification at the ecological system level (Comner et al. 2003), making ecological system conceptually analogous to plant community as applied here. Some taxa were characteristically affiliated with two or more ecological systems. Ecological systems of the Interior Highlands are listed in Table 2.

RESULTS

Included below (Table 1) is an annotated list of the 36 vascular taxa endemic to the Interior Highlands, arranged alphabetically by family and genus. For each taxon, one or more characteristic plant community types are indicated in brackets after the plant name, using the numbers designated for each community in Table 2. For each species in this list, we also indicate the family, physiognomic profile, distribution pattern within the Interior Highlands – Ozarks (Oz), Ouachitas (Ou), or both – and additional relevant information and comments where applicable. The Arkansas Valley is included in the Ouachita section.

DISCUSSION

We identified a total of 36 endemic vascular taxa within the Interior Highlands; there are no endemic families or genera. There are 24 endemic species, and 12

---

[1] In addition to the taxa treated in this paper, six species of *Crataegus* (Rosaceae), *C. carollensis* Sarg., *C. harveyana*Sarg., *C. lanuginosa* Sarg. *C. latebrosa* Sarg., *C. nuda* Sarg., and *C. thermopegaea* Palmer, are recognized by Kartesz (1999) as being endemic to the region and other potentially endemic hawthorns have been proposed (e.g. *C. ouachitensis* Palmer) but Smith (1994) does not recognize them. Even though endemism is high in *Crataegus*, we have left this complex and incompletely understood genus off the list. There are reports of *Hamamelis vernalis* Sarg. (Hammamelidaceae) from southeastern Texas by Correll and Johnston (1970), Vines (1977), Nixon (1985), Jones et. al., (1997), and Turner et al. (2003), although Flora of North America (1997) states that this species is endemic to the Interior Highlands. Consequently, we have omitted *Hamamelis vernalis* from this treatment. A revision of the genus *Talinum* (Portulacaceae) currently underway may result in the addition of two endemic species to the Interior Highlands flora.

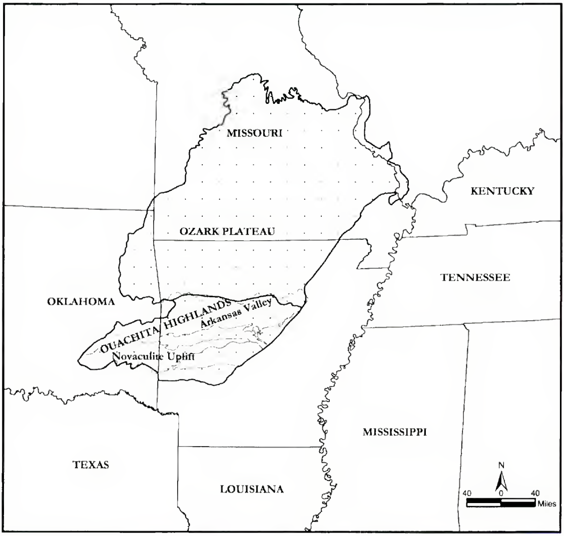


Fig. 1. Map of the Interior Highlands Physiographic Region.

endemic subspecies or varieties of more widely distributed species. Most of the endemic plant taxa in the Interior Highlands are on the Arkansas, Illinois, Kansas, Missouri, and/or Oklahoma Natural Heritage programs "species of concern" lists.

Most (58%) of the endemic vascular plants of the Interior highlands are perennial forbs; this parallels the physiognomy of the overall vascular flora of the region, as well as the ecoregions of midcontinental North America. Only three endemic taxa (8%) are woody, and there is a single endemic fern. Although only nine endemic taxa (25%) are annuals, this is a higher proportion of annuals than in the total native vascular flora of the region, and is likely reflective of the harsh conditions that characterize glade environments, which harbor a disproportionate component of annual species as compared to other habitats in the region.

TABLE 1. Endemic vascular flora of the Interior highlands with community associations in brackets (see Table 2), **Ou** = Ouachita Mountains, **Oz** = Ozark Plateau, **both** = both sections.

APOCYNACEAE

Amsonia hubrichtii Woods. [12] **both;** perennial forb

ASTERACEAE

Echinacea paradoxa var. *paradoxa* (J.B.S. Norton) Britt. [7] **Oz;** perennial forb

Liatris squarrosa (L.) Michx. var. *compacta* Torr. & A. Gray [8] **Ou;** perennial forb; center of distribution in the Novaculite Uplift subsection of the Ouachita Mountains.

Polymnia cossatotensis A.B. Pittman & V. Bates [14] **Ou;** annual forb; known only from the Novaculite Uplift subsection of the Ouachita Mountains.

Solidago ouachitensis C. & J. Taylor [6] **Ou;** perennial forb; center of distribution in the Novaculite Uplift subsection of the Ouachita Mountains.

Vernonia lettermanni Engelm. ex A. Gray [12] **Ou;** perennial forb

BRASSICACEAE

Cardamine angustata O.E. Schulz var. *ouachitana* E.B. Smith [4,5] **Ou;** perennial forb; known only from the Novaculite Uplift subsection of the Ouachita Mountains.

Lesquerella filiformis Rollins [7] **Oz;** winter annual forb; restricted to limestone glades, almost totally within the Springfield Plain subsection of the Ozarks.

Streptanthus maculatus Nutt. ssp. *obtusifolius* (Hook.) Rollins [8] **Ou;** annual forb

Streptanthus squamiformis Goodman [6] **Ou;** annual forb; known only from the Novaculite Uplift subsection of the Ouachita Mountains.

CAPRIFOLIACEAE

Viburnum ozarkense Ashe [5,12,14] **both;** shrub

COMMELINACEAE

Tradescantia longipes E.S. Anderson & Woods. [4,6] **both;** perennial forb; although known from both the Ouachitas and Ozarks, this species is especially characteristic in acidic woodlands on dissected uplands in the Current River drainage, and relatively rare elsewhere in the Interior Highlands.

Tradescantia ozarkana E.S. Anderson & Woods. [4,5,14] **both;** perennial forb

CYPERACEAE

Carex latebracteata Waterfall [5,6,12] **Ou;** perennial sedge

FABACEAE

Amorpha ouachitensis Wilbur [12] **both;** shrub

FAGACEAE

Quercus acerifolia (Palmer) Hess & Stoynoff [1,13] **Ou;** tree; although long thought to be closely related to, or even conspecific with *Q. shumardii*, recent research indicates that this taxon is more closely affiliated with *Q. arkansana* (Williams 2003). The global population is less than 600 individuals.

HYDROPHYLLACEAE

Hydrophyllum brownei Kral & Bates [12] **Ou;** perennial forb; center of distribution in the Novaculite Uplift subsection of the Ouachita Mountains.

LAMIACEAE

Monarda fistulosa ssp. *fistulosa* L. var. *stipitatoglandulosa*, comb. nov. ined. [6,8] **both;** perennial forb; this taxon has apparently not been validly published at the varietal level, although Waterfall (1970) first described it at the species level, which was conceptually endorsed by Smith (1988).

Scutellaria bushii Britt. [7] **Oz;** perennial forb; restricted to dolomite glades, with the majority of the world's population in the drainages of the Current, Eleven Point, and White rivers.

LILIACEAE

Nemastylis nuttallii Pickering [7] **Oz;** perennial forb

POACEAE

Elymus glaucus Buckley ssp. *mackenzii* (Bush) J.J.N. Campbell [7,8] **both;** perennial forb

PTERIDACEAE

Pellaea glabella Mett. ex Kuhn ssp. *missouriensis* (Gastony) Windham [14] **Oz;** fern; this is the di-ploid, sexual variety of a wide-ranging species. Except for the spores, it is morphologically indistinguishable from the apomictic ssp. *glabella* (Wagner et al. 1965).

TABLE 1. continued

RANUNCULACEAE

Delphinium newtonianum D.M. Moore [4,5] **both;** perennial forb

Delphinium treleasei Bush ex K.C. Davis [7] **Oz;** perennial forb

RUBIACEAE

Galium arkansanum A. Gray var. *arkansanum* [6,8] **both;** perennial forb

Galium arkansanum A. Gray var. *pubiflorum* E.B. Smith [6,8] **Ou;** perennial forb; morphologically, this taxon appears closely related to the parent variety and needs further genetic evaluation. Known only from the Novaculite Uplift subsection of the Ouachita Mountains.

Houstonia ouachitana (E.B. Smith) Terrell [6, 8] **Ou;** perennial forb; center of distribution in the Novaculite Uplift subsection of the Ouachita Mountains.

SAXIFRAGACEAE

Heuchera villosa Michx. var. *arkansana* (Rydberg) E.B. Smith [12,14] **both;** perennial forb

Saxifraga palmeri Bush [12] **both;** perennial forb

Saxifraga virginiensis Michx. var. *subintegra* Goodman [1,13] **both;** perennial forb

SCROPHULARIACEAE

Agalinis nuttallii Shinners [17] **Ou;** annual forb

Penstemon cobaea Nutt. var. *purpureus* Pennell [7] **Oz;** perennial forb; although the typical variety is a wide ranging species of the prairie biome, this variety is restricted to glades on carbonate bedrock in the Interior Highlands.

VALERIANACEAE

Valerianella longiflora (Torr. & A. Gray) Walp. [1] **both;** annual forb

Valerianella nuttallii (Torr. & A. Gray) Walp. [1,8] **both;** annual forb

Valerianella ozarkana Dyal [7] **both;** annual forb

Valerianella palmeri Dyal [1,12] **Ou;** annual forb; center of distribution in the Novaculite Uplift subsection of the Ouachita Mountains.

The Ouachita Mountains comprise 25% of the total area of the Interior Highlands, but support 81% of the endemic taxa of the Interior Highlands. Fourteen taxa, representing 39% of the region's endemic plants, are found only in the Ouachita Mountains. Fifteen taxa (42%) are found in both the Ouachita and Ozark regions, while seven taxa (19%) are restricted to the Ozark Plateau. Also significant is that 25% of the endemic Interior Highlands flora is associated with the Novaculite Uplift subsection of the Ouachitas. This geologic substrate with its glades, woodlands, and stream complexes is an ecological hotspot for endemism within the Interior Highlands.

More than half (58%) of the endemic species in the Interior Highlands are associated with glade habitats (acidic, calcareous, novaculite). As defined by Nelson and Ladd (1982), glades are open habitats with strong lithologic control that are dominated by a characteristic herbaceous vegetation, with sparse tree and shrub cover, shallow soils, and often with abundant exposed rock. These exposed xeric or hydro-xeric habitats have extreme environmental parameters including long, usually annual drought periods in the growing season, limited water retention in the shallow soils, and intense solar heating. Many glades are also saturated through much of the dormant season, with frequent freeze-thaw cycles and associated soil upheavals. Drought and fire maintain most glades in a nearly treeless state.

The life histories of the endemic plants associated with glades show diverse

TABLE 2. Characteristic plant community affiliations of 36 endemic Interior Highland vascular plants. Numbers in the percent column refer to the percent of Interior Highlands endemic taxa occurring in this habitat type. All habitat types listed.

Community Complex	**Number**	**Percent**
1. Central Interior Highlands Dry Acidic Glade and Barrens	5	14
2. Ouachita Montane Oak Forest	0	0
3. Ozark-Ouachita Dry Oak Woodland	0	0
4. Ozark-Ouachita Dry-Mesic Oak Forest	4	11
5. Ozark-Ouachita Mesic Hardwood Forest	5	14
6. Ozark-Ouachita Shortleaf Pine-Oak Woodland	8	22
7. Central Interior Highlands Calcareous Glade and Barrens	8	22
8. Ouachita Novaculite Glade and Woodland	8	22
9. Arkansas Valley Prairie and Woodlands	0	0
10. Central Interior Highlands and Appalachian Sinkhole and Depression Pond	0	0
11. Ouachita Forested Seep	0	0
12. Ozark-Ouachita Riparian	9	25
13. Central Interior Acidic Cliffs and Talus	2	6
14. Central Interior Calcareous Cliffs and Talus	5	14
15. Ozark-Ouachita Fen	0	0
16. North-Central Maple-Basswood Forest	0	0
17. South-Central Interior Large Floodplain	1	3
18. Southeastern Great Plains Tallgrass Prairie	0	0

evolutionary traits that allow for survival in these habitats, but which presumably confer no competitive advantages in surrounding wooded habitat. For example, *Echinacea paradoxa* var. *paradoxa* and *Liatris squarrosa* var. *compacta* are shade-intolerant, long-lived perennials with either deep roots or water-holding subterranean tissues and grow in open habitats. The *Valerianella* species are vernal annuals that quickly complete their life cycles in the spring when conditions are relatively cool and wet; they are usually associated with those areas of the glade habitat that remain seasonally saturated due to water seepage. Species distributions may also be controlled by an affinity to particular substrates with specific lithological characteristic and mineral availability. For example, *Scutellaria bushii* is found only on dolomite; these glades are characterized by high levels of soluble cations such as magnesium and calcium.

Twenty-eight percent of the endemic flora occur in riparian habitats. Three (*Amsonia hubrichtii*, *Vernonia lettermannii*, *Valerianella palmeri*) of the ten endemic species found in riparian areas are associated with glade-like habitat structures, i.e. rocky, open habitats along ephemeral or intermittent streams. These habitats are xero-hydric, and maintained by flashy stream flows and soil conditions that make them seasonally xeric and nearly treeless.

We found that 22% of the endemic species are characteristically associated with dry pine-oak and oak woodlands. These plant communities are relatively open, with sparse to moderate tree cover, a diverse and well-developed herbaceous understory with a prominent graminiod component, and a relatively frequent fire regime. The endemic species associated with woodland habitats appear to be intolerant of both extreme exposure and deep shade. *Solidago ouachitensis*, for example, appears to require filtered sunlight but is not found in closed canopy forests or the more exposed glade habitats. Woodland plant communities are maintained in an open condition by fire and intermittent drought but have prevailing environmental conditions relatively less extreme and dynamic than the exposed glades.

Across the Interior Highlands region glades, open woodlands, and intermittent streams form landscape complexes that are closely associated on the landscape. These plant community complexes are maintained in an open or treeless condition by drought, fire, and flood. More than 80% of the endemic flora of the Interior Highlands occur in these landscape complexes.

The list of endemics presented in this paper will change as new information becomes available on plant community associations and species distributions, and as new taxa are discovered and others relegated to synonymy. However, it is now possible to compare the Interior Highlands region with adjacent regions that are physiographically different. For example, the 36 endemic vascular taxa of the Interior Highlands represent perhaps 2% of the native flora, but exhibit no patterns of endemism at or above the genus level. In fact, the Interior Highlands for all of its physiographic uniqueness, including age, long-term isolation from its moiety—the Appalachian Region—and its reputation as a "well-known refugium" (Meyer 1997) shows surprisingly little floristic uniquity from surrounding regions. By comparison, the West Gulf Coastal Plain with virtually no relief and no antiquity, has about 100 endemic taxa (about three percent of its flora) of which three are above the species level (MacRoberts et al. 2002). It is not known whether this same pattern and level of endemism occurs among other organismal groups, but there are suggestions that endemism rates may be higher than among the vascular flora. For example, there are 24 endemic crayfish taxa in the Ozarks (The Nature Conservancy 2003); this represents more than seven percent of North American Crayfish diversity. Preliminary data (Harris & Ladd 2003) indicate that the Ozark region is characterized by an unusually high level of undescribed lichen taxa, including at least two new genera, but current data gaps preclude determining levels of endemism.

ACKNOWLEDGMENTS

Appreciation is extended to several people who contributed information or comments to this project: Theo Witsell, Arkansas Natural Heritage Commission, Kaushik Mysorekar, The Nature Conservancy, Phil Hyatt, US Forest Service, Julian Campbell, The Nature Conservancy, Alan Weakley, University of North

Carolina Botanical Garden-Herbarium, Scott Simon, The Nature Conservancy, Rob Evans, NatureServe, Ayn Shilsky, The Nature Conservancy, George Yatskievych, Missouri Botanical Garden, and Ron Lance, Chimney Rock. We also thank Gary Tucker, Staria Vanderpool, and two anonymous reviews for suggestions in improving the manuscript.

REFERENCES

Bryant, W.S., W.C. McComb, and J.S. Fralish. 1993. Oak-hickory forests (western mesophytic/ oak-hickory forests). In: W.H. Martin, S.G. Boyce, and A.C. Echternacht, eds. Biodiversity of the southeastern United States: upland terrestrial communities. John Wiley, New York. Pp. 143–201.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, Virginia. www.natureserve.org/explorer/

Correll, D.S. and N.C. Johnston. 1970. Manual of the vascular flora of Texas. Texas Research Foundation, Renner, Texas.

Croneis, C. 1930. Geology of the Arkansas Paleozoic Era. Little Rock, AR: Arkansas Geologic Comm. Bulletin #3.

Delcourt, H.R. and P.A. Delcourt. 2000. Eastern deciduous forests. In: M.G. Barbour and W.D. Billings, eds. North American terrestrial vegetation. Cambridge University Press, New York. Pp. 357–395.

Diamond, D.D., C.D. True, and K. He. 1997. Regional priorities for conservation of rare species in Texas. Southw. Naturalist 42:400–408.

Estill, J.C. and M.B. Cruzan. 2001. Phytogeography of rare plant species endemic to the southeastern United States. Castanea 66:3–23.

Fenneman, N.M. 1938. Physiography of eastern United States. McGraw-Hill, New York.

Flora of North America Editorial Committee, eds. 1993–. Flora of North America. Oxford University Press, New York. [8 volumes published to date]

Foti, T.L. 1974. Natural divisions of Arkansas. In: Arkansas Natural Area Plan. Arkansas Department of Planning. Little Rock. Pp. 1–34.

Foti, T.L. and G.A. Bukenhofer. 1998. A description of the sections and subsections of the Interior Highlands of Arkansas and Oklahoma. J. Arkansas Acad. Sci. 52:53–62.

Harris, R.C. and D. Ladd. 2003. Lichens of the Ozarks: floristics and implications for biodiversity conservation. New York Botanical Garden and The Nature Conservancy. www.nybg.org/bsci/lichens/ozarks/

Jones, S, D., J. K. Wipff, and P.M. Montgomery. 1977. Vascular plants of Texas. Univ. Texas Press, Austin, Texas.

Kartesz, J.T. 1999. A synonymized checklist and atlas with botanical attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T. and C.A. Meacham. Synthesis of North American Flora. Version 1.0. North Carolina Botanical Garden. Chapel Hill.

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the south. Technical Publ. R8-TP 2, USDA Forest Service, Atlanta, Georgia.

MacRoberts, M.H., B.R. MacRoberts, B.A. Sorrie, and R.E. Evans. 2002. Endemism in the West Gulf Coastal Plain: importance of xeric habitat. Sida 20:767–780.

Meyer, F.G. 1997. Hamamelidaceae. In: Flora of North America Editorial Committee, eds. Flora of North America, volume 3. Oxford University Press, New York. Pp. 362–367.

Miser, H.D. 1929. Structure of the Ouachita Mountains of Arkansas and Oklahoma. Oklahoma City, OK: Oklahoma Geologic Survey, Bulletin no. 50.

Mohlenbrock, R.H. 2202. Vascular flora of Illinois. Southern Illinois University Press, Carbondale.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Foncesca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403:853–858.

Nelson, P.W. 1985. The terrestrial natural communities of Missouri. Missouri Natural Areas Committee, Jefferson City.

Nelson, P. and D. Ladd. 1982. Ecological synopsis of Missouri Glades. In: McGinnes, E. A. Ed. Proceeding of the Cedar Glade Symposium. Missouri Academy of Science Occasional Paper 7. Pp. 1–20.

Nigh, T.A. and W.A. Schroeder. 2002. Atlas of Missouri ecoregions. Jefferson City, MO: Missouri dept. of Conservation.

Nixon, E. S. 1985. Trees, shrubs, and woody vines of east Texas. Bruce Lyndon Cunningham Productions, Nacogdoches, Texas.

Peck, J.H. and C.J. Peck. 1988. A bibliographic summary of Arkansas field botany. Proc. Arkansas Acad. Sci. 42:58–73.

Peck, J.H., C.T. Witsell, and T.L. Foti. 2001. Arkansas field botany (flora and vegetation) bibliography (1988–2000). J. Arkansas Acad. Sci. 55:104–114.

Robison, H.W. and R.T. Allen. 1995. Only in Arkansas: a study of the endemic plants and animals of the state. University of Arkansas Press, Fayetteville.

Ricketts, T.H., E. Dinerstein, and D.M. Olson. 1999. Terrestrial ecoregions of North America: a conservation assessment. Island Press, Washington, D.C.

Skeen, J.N., P.D. Doerr, and D.H. Van Lear. 1993. Oak-hickory-pine forests. In: W.H. Martin, S.G. Boyce, and A.C. Echternacht, eds. Biodiversity of the southeastern United States: upland terrestrial communities. John Wiley, New York. Pp. 1–33.

Smith, E.B. 1988. An atlas and annotated list of the vascular plants of Arkansas. Privately Printed, Fayetteville, Arkansas.

Smith, E.B. 1994. Keys to the flora of Arkansas. University of Arkansas Press, Fayetteville.

Sorrie, B.A. and A.S. Weakley. 2001. Coastal plain vascular plant endemics: phytogeographic patterns. Castanea 66:50–82.

Stein, B.A., L.S. Kutner, G.A. Hammerson, L.L. Master, and L.E. Morse. 2000. State of the states: geographic patterns of diversity, rarity, and endemism. In: Stein, B.A., L.S. Kutner, and J.S. Adams, eds. Precious heritage: the status of biodiversity in the United States. Oxford University Press, New York. Pp. 119–157.

Steyermark, J.A. 1963. Flora of Missouri. Iowa State University Press. Ames.

Takhtajan, A. 1986. Floristic regions of the world. University of California Press, Berkeley.

Taylor, R.J. and C.E.S. Taylor. 1989. An annotated list of the ferns, fern allies, gymnosperms and flowering plants of Oklahoma. Southeastern Oklahoma State University, Durant.

The Nature Conservancy, Ozarks Ecoregional Assessment Team. 2003. Ozarks Ecoregional Conservation Assessment. Minneapolis, MN: The Nature Conservancy Midwestern Resource Office.

Thom, R.H. and J.H. Wilson. 1980. The natural divisions of Missouri. Trans. Missouri Acad. Sci. 14:9–23.

Tucker, G.E. 1974. Threatened native plants of Arkansas. In: Arkansas Natural Area Plan. Arkansas Department of Planning. Little Rock. Pp. 39–65.

Turner, B.L., H. Nicols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Vol. 1. Sida Bot. Misc. 24:1–648.

Vines, R.A. 1977. Trees of east Texas. University Texas Press, Austin.

Wagner, W.H. Jr., D.R. Farrar, and K.L. Chen. 1965. A new sexual form of *Pellaea glabella* var. *glabella* from Missouri. American Fern Journal 55: 171–178.

Waterfall, U.T. 1970. *Monarda stipitatoglandulosa*, a new species from Oklahoma. Rhodora 72: 502–504.

Weckman, T.J. 2002. Reinstatement of *Viburnum ozarkense* (Caprifoliaceae): an endemic taxon of the Interior Highlands of Arkansas, Missouri and Oklahoma. Sida 20:849–860.

Williams, D.X. 2003. Status of maple-leaf oak, and Arkansas endemic. In: Arkansas vascular flora committee, eds. Rare and invasive plants of Arkansas conference abstracts, unpaginated, Fayetteville.

Yatskievych, G. 1999. Steyermark's flora of Missouri, Vol. 1. Missouri Department of Conservation. Jefferson City.

BOOK NOTICES

Timber Press

John Dawson and Rob Lucas. 2005. **The Nature of Plants: Habitats, Challenges, and Adaptations.** (ISBN 0-88192-675-2, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 314 pp., color photos, diagrams, 7 1/2" × 10 1/2".

"*The Nature of Plants* takes the reader on a tour of plant habitats from the seashore up into the mountains, and from the tropics to poles." Check out the table of contents. **1)** The Freeloaders—Plants Using Plants; **2)** Not Enough Water—The Plants of Deserts and Seasonally Arid Places; **3)** Rising from the Ashes—Plants and Fires; **4)** Serpentine and Salt—Coping with Toxic Soils; **5)** Too Much Water—Plants of Rivers, Lakes, Swamps, and Margins of the Sea; **6)** Too Cold for Trees—Mountain and Arctic Plants; **7)** A Love-Hate Relationship—Plants and Animals; **8)** Mostly Hidden Relationships—Plants, Fungi, and Bacteria; and **9)** Plant Evolution Through the Ages—An Overview.

David Stuart. 2004. **Classic Garden Plans.** (ISBN 0-88192-643-4, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 160 pp., color photos, diagrams, 9" × 10 1/2".

Classic Garden Plans include: **1)** A Chinese Scholar's Garden; **2)** The Meditation Garden; **3)** The Moonlight Garden; **4)** A Baroque Parterre Garden; **5)** Gone With The Wind; **6)** A Copse Garden; **7)** An Edwardian Colour Border; **8)** A Monet Water Garden; **9)** A World of Roses; **10)** A Desert Garden; **11)** A Topiary Room; **12)** The English Garden Dream; **13)** The Quintessential Cottage Garden; **14)** The Perfect Potager; **15)** The Artful Orchard; and **16)** The Sunset Prairie.

W. George Schmid. 2005. **Timber Press Pocket Guide to Shade Perennials.** (ISBN 0-88192-709-2, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. and 2 Station Road, Swavesey, Cambridge CB4 5QJ, U.K. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $19.95, 252 pp., 310 color photos, 5 3/4" × 8 1/4".

"...the *Timber Press Pocket Guide to Shade Perennials* provides descriptions of more than 1000 readily available species and cultivars that will enliven and thrive in shade garden." No matter where you garden you probably have some garden area with shade and this is the book to help you liven up those areas. Basic information provided includes definitions of shade intensities, cultivation, maintenance, and pests and diseases.

REFERENCE CONDITIONS OF THE RED RIVER FLOODPLAIN AND UPLAND, CADDO PARISH, LOUISIANA

Michael H. MacRoberts and Barbara R. MacRoberts

Bog Research, 740 Columbia
Shreveport, Louisiana 71104, U.S.A.
and
Herbarium, Museum of Life Sciences
Louisiana State University-Shreveport
Shreveport, Louisiana 71115, U.S.A.
and
Red River Watershed Management Institute
Louisiana State University-Shreveport
Shreveport, Louisiana 71115, U.S.A.

ABSTRACT

We studied the presettlement woody vegetation of the Red River floodplain and adjacent upland in Caddo Parish, Louisiana, by analyzing the 1830s Government Land Office surveyors' records. We looked for evidence of monospecific pine savanna/forest in the uplands as historical accounts relate and compared the woody vegetation of the floodplain with that of the upland. We found that the upland was a mixed hardwood-pine forest with some areas almost exclusively hardwood, that there were no areas that were monospecific pine forest, and that the upland and floodplain are floristically different. Oak was rare on the floodplain but occurred near prairies lying within the floodplain.

Key Words: Red River, Louisiana, Caddo Parish, floristics, Government Land Office, land plat

RESUMEN

Hemos estudiado la vegetación leñosa previa a la colonización de la llanura de inundación del Red River y las tierras adyacentes en Caddo Parish, Louisiana, analizando los registros de los supervisores del Government Land Office en los años1830. Hemos buscado pruebas de los bosque/sabana monoespecíficos de pinos en las tierras altas tal como lo relatan las crónicas históricas y se compara la vegetación leñosa de la llanura de inundación con la de las tierras altas. Hemos encontrado que en las tierras altas había un bosque mixto de pino y árboles de madera dura con algunas áreas que casi tienen exclusivamente árboles de madera dura, que allí no había áreas en las que hubiese bosques monoespecíficos de pinos, y que las tierras altas y las llanuras de inundación son florísticamente diferentes. Los robles son raros en la llanura de inundación pero se dan el las praderas próximas a estas llanuras.

INTRODUCTION

The prerequisite to ecological management, conservation, and restoration is knowing what existed in the past (Egan & Howell 2001). There are two main methods of discovering this. The first, and most desirable, is to have some of the original functioning ecosystem left to study. If none of the original remains, or if it is uncertain if any remains, the next recourse is historical records.

Unfortunately, little, if any, of northwestern Louisiana remains in a natural

SIDA 21(3): 1793–1806. 2005

condition, certainly not large landscapes. Thus, we turned to historical materials to understand the reference conditions of the region. These included accounts of travelers, naturalists, and others, and Government Land Office land surveys. Unfortunately, travelers' accounts are brief and focused. Naturalists did better, but again, the accounts are limited and incomplete (e.g., Freeman and Custis Red River expedition [Flores 1984]). Foresters and others interested in exploitable resources also gave descriptions, but these are often so concerned with a single resource that the overall picture is missing (e.g., Mattoon 1915).

Consequently, we focused on 1830s Government Land Office surveyors' records. Our objectives were to determine, in so far as these sources would allow, 1) whether the upland was pine savanna/forest or mixed hardwood-pine forest, and 2) if and in what ways the floodplain and upland differed in woody vegetation.

RED RIVER FLOODPLAIN AND UPLAND: CADDO PARISH

The Red River originates in the Great Plains of eastern New Mexico and the panhandle of Texas and flows east and southeast until it reaches the Mississippi River in central Louisiana (Fig. 1). Red and brownish-red silt and clay particles, eroded from mainly Paleozoic rock, give the river its distinctive color. It is a sluggish river with a low-lying, flat, extensive Pleistocene/Holocene alluvial floodplain valley five to thirty km wide, with oxbows, sloughs, and backwater swamps. As the glaciers receded and the sea levels rose, the gradient of the river lessened, making it braid and meander widely with resultant deposition of alluvium that we see today (Newkirk & Mueller 1980).

Native American hunters entered the Red River area about 12,000 years ago at the end of the last glaciation, long before the present climate and biota were established. Settled agriculturists along the river probably do not exceed 3000 BP. Their effect on the ecology is not known, but it was probably comparatively minor (Neuman 1984; Ames 1999). The Red River was first seen by European explorers in the sixteenth century. Its lower portion was colonized by the French in the eighteenth century, but because of the Great Raft—hundreds of log jams measuring from a hundred meters to a kilometer in length, damming the river and causing overflow resulting in extensive flooding including the creation of numerous raft lakes adjacent and upstream from the rafts—its upper portions were not explored until the nineteenth century when, in 1806, the Freeman and Custis expedition went through and around the Raft to near the present day border of Oklahoma and Arkansas (Flores 1984). Marcy and McClellan (1854) completed exploring the river in the mid-nineteenth century. The Raft was cleared in two stages between 1833 and 1873, with the result that the extensive raft lakes drained, the river lowered and became navigable, allowing rapid exploitation of the floodplain with the establishment of farms, plantations, towns, and cities (see Talfor 1873; Triska 1984; Bagur 2001 for full description of the rafts and raft lakes).

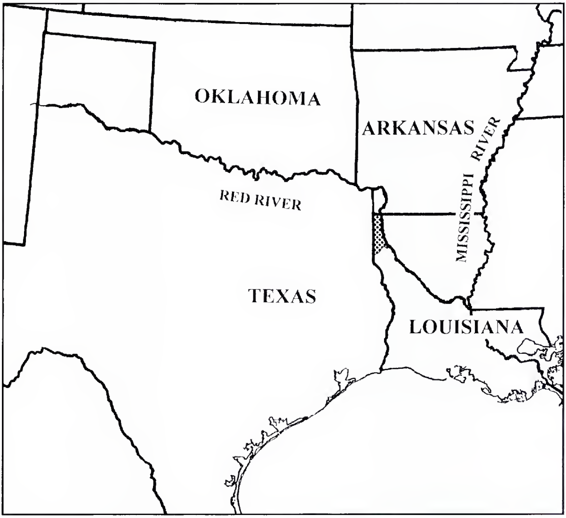


Fig. 1. Course of Red River and location of Caddo Parish, Louisiana (stippled area).

The topography of Caddo Parish is relatively simple. The Red River alluvium or floodplain covers about 28% of the 2,283 sq. km parish (Fig. 2). It forms a continuous north-south border along the eastern edge of the parish. The floodplain can be very narrow as when the river approaches a bluff, but it is generally several km wide. At the edge of the river are natural levees and swales. Farther inland, the topography rises in a slight terrace. Nonetheless, the landscape is relatively flat. Floodplain elevations range from approximately 60 m at the northern edge of the parish to about 43 m at the southern edge. The overall north-south slope is about 0.28 m per km. Sediments are almost entirely of Red River alluvial origin (Edwards et al. 1980).

Flanking the floodplain at its western edge is the upland. This often involves an abrupt elevation transition generally in the range of 20 to 40 m. The upland is geologically older than the alluvium, generally consisting of Tertiary

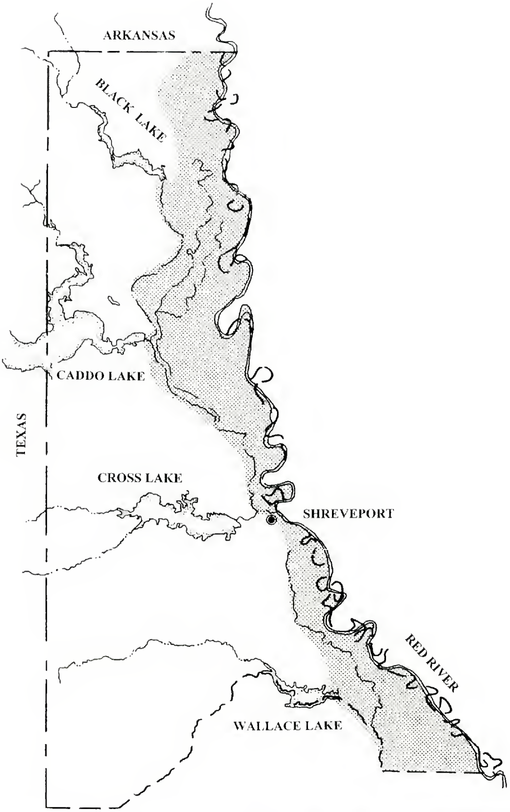


Fig. 2. Caddo Parish (2,283 sq. km) showing Red River, floodplain (stippled), and uplands (not stippled).

deposits. Elevations rise to no more than 137 m, and topography is rolling low hills or relatively flat terraces.

The river, its floodplain, and adjacent upland ecosystems have undergone major modification over the past two centuries. Virtually the entire landscape has been converted to farms and plantations and, more recently, urban sprawl. What once was a continuous savanna/forest with numerous plant communities covering hundreds of thousands of hectares is now virtually gone with only fragments of the natural vegetation remaining and few, if any, in virgin condition. Bald-cypress swamps, black willow riverbank shrublands, and cottonwood forests persist while some floodplain communities such as eastern red-cedar forests, canebrakes, and prairies have vanished entirely (MacRoberts et al. 1997). The upland has also been modified, mainly by urban sprawl, logging, and clearing for farms. Vast areas of forest were clear-cut in the latter part of the nineteenth and early part of the twentieth century.

While floodplains in general have received substantial phytogeographical and ecological attention and there are numerous generalized descriptions and classifications according to hydrologic conditions, soils, and vegetation (e.g., Sharitz & Mitsch 1993; Messina & Conner 1998; Mitsch & Grosselink 2000), the Red River floodplain is poorly known especially floristically (see Newkirk & Mueller 1980). Aside from checklists of parishes and counties along the Red River (e.g., MacRoberts 1979; Thomas & Allen 1993-1998), its last floristic survey was in 1806. The Red River floodplain has never been the subject of an ecological assessment or community study; however, Van Kley and Hine (1998) described the wetland vegetation of Caddo Lake, a raft lake; Ware (1956) briefly described the vegetation on a sand bar near Natchitoches; Teague and Wendt (1994), concentrating on Bossier and Caddo parishes, conducted the first parish-wide comprehensive survey of high quality natural communities in Louisiana, only a few of which turned out to be floodplain communities; and Mundorff (1998) studied bottomland hardwood forests on the Angelina and Neches rivers in east Texas. Dale and Ware (2004) studied wetland tree species in relation to flooding gradient in Arkansas but excluded from their analysis areas dominated by baldcypress, black willow, and cottonwood. Two non-quantified reports round out the list: Palmer (1923) provided an anecdotal report of the Red River forest at Fulton, Arkansas, and the Henderson State University Biology Department (1979) prepared a report for the Army Corps of Engineers that purports to be a "biological inventory of the Red River waterway," but it is of limited value since few details of data collection are provided.

Except in the longleaf pine region of central Louisiana (Bridges & Orzell 1989; Van Kley 1999), the upland in the Red River drainage is no better studied and in general is taken to have been continuous with what characterized the upland of the remainder of the upper West Gulf Coastal Plain: south Arkansas, northeast Texas, and north Louisiana; that is, a mixed pine-hardwood savanna/

forest or a monospecific pine savanna/forest (Teague & Wendt 1994; Carr 2000). Furthermore, there are conflicting historical accounts: were the upland forests dominated by pine, were they sometimes even monospecific pine extending over many hundreds of square km, were they mixed hardwood-pine, or were they a combination of all three (Hilgard 1873, Lockett 1876; Mohr 1898, Mattoon 1915; see reviews in Carr 2000 and Bragg 2002)?

METHODS

1. Bearing tree data. We used the 1830s Government Land Office, Caddo Parish, Tree Book (a summary of the surveyors' notes that gives only the bearing trees to species at each section and quarter section corner, their diameter, and their distance from the corner), surveyors' line notes, and land plats to determine the woody vegetation of Caddo Parish just before Anglo-European settlement. In general, in these surveys four bearing trees were recorded for each section corner and two bearing trees at each quarter section corner. In addition, for each mile, surveyors gave impressionistic "line notes" describing the timber and land quality. Surveyors only used common names, and in many cases were not specific as in the case of hickory, ash, elm, willow, hackberry, locust, and occasionally oak. Nonetheless, using modern information, it is usually possible to determine which species or group of species they meant. Since the limitations of GLO surveys are well known and discussed, little needs to be said here (Delcourt 1976; Whitney & DeCant 2001; Bragg 2002, 2003) except to point out that we analyzed four townships to see if there was bias. We found that there was not (Appendix 1). Using topographic maps, we divided the landscape into upland and floodplain and then entered each bearing tree listed in the Tree Book according to where it occurred on the landscape. The sample involved 5974 trees in the upland and 1805 trees in the floodplain for a total of 7779 trees.

2. Monospecific pine forest. We looked for evidence of monospecific pine savanna/forest in each township by examining the total percentages of various species recorded and, in townships with a high percent of pine recorded, for regional clumping of pine.

3. Roadside surveys. We surveyed both the Red River floodplain and upland by driving highways and backroads between Natchitoches, Louisiana, and the Louisiana-Arkansas border to form an impression of the present day woody vegetation of both. We did not attempt to quantify this aspect of the study. While clearly extensively modified by human activity especially over the last two centuries, it is possible by these surveys to see what species grow in the uplands and floodplain today.

4. Because of the lack of overlap in tree species between uplands and floodplain (see results), we were especially interested in any situation where taxa from one area occurred in the other. We therefore carefully examined areas of the floodplain that had oaks.

RESULTS

1. Bearing tree data. Table 1 lists the Government Land Office bearing tree abundance data for the Red River floodplain and upland for all of Caddo Parish. Surveyors' designations are given as common names; modern interpretations follow in parenthesis. Only taxa with 0.5 percent or higher presence are included.

2. Monospecific pine forest. We found no evidence for monospecific pine savanna/forest. The closest to this condition was in sandy areas in the very northern tier of the parish in T23NR15-16W where pine reached 50 percent of the bearing trees. Nonetheless, even here the surveyors' line notes most commonly read: "oak, hickory, pine & etc," although occasionally "poor rolling pine land," or "poor land oak & pine." There is no mention of the ground cover, and there is no indication in the surveyors' records of pine savanna/forest. Some upland areas had little or no pine, notably T17NR14-15-16W and T19NR15-16W where pine ranged from zero to six percent of the trees and the line notes confirm the absence of pine. Here the notes repeatedly read "oak, hickory." These uplands were oak-hickory woodland/forest.

3. Roadside surveys. Distributed all across the floodplain and often intermixed with one another are ash (*Fraxinus pennsylvanica* Marsh), bald cypress (*Taxodium distichum* (L.) Rich.), boxelder (*Acer negundo* L.), button bush (*Cephalanthus occidentalis* L.), cottonwood (*Populus deltoides* Bart. ex Marsh.), elm (*Ulmus americana* L.), hackberry (*Celtis laevigata* Willd.), honey locust (*Gleditsia triacanthos* L.), mulberry (*Morus rubra* L.), Osage orange (*Maclura pomifera* (Raf.) C.K. Scheid.), pecan (*Carya illinoensis* (Wang.) K. Koch.), persimmon (*Diospyros virginiana* L.), rough-leaved dogwood (*Cornus drummondii* C.A. Mey.), swamp privet (*Forestiera acuminata* (Michx.) Poir.), sycamore (*Platanus occidentalis* L.), and willow (*Salix nigra* Marsh). Chinese tallow (*Sapium sebiferum* (L.) Roxb.) was common and Chinaberry tree (*Melia azedarach* L.) was occasionally encountered. The absence of oak, notably flood-tolerant oaks such as overcup (*Quercus lyrata* Walt.) and willow (*Q. phellos* L.) remains puzzling since we are aware that most southeastern floodplain descriptions have these species (see Sharitz & Mitsch 1993; Messina & Conner 1998; Mitsch & Grosselink 2000).

Our roadside surveys of the upland showed an entirely different woody flora consisting largely of white oak (*Quercus alba* L.), southern red oak (*Q. falcata* Michx.), post oak (*Q. stellata* Wangenh.), blackjack oak (*Q. marilandica* Muenchh.), black oak (*Q. velutina* Lam.), shumard oak (*Q. shumardii* Buckl.), bluejack oak (*Q. incana* Bartr.), water oak (*Q. nigra* L.), loblolly pine (*Pinus taeda* L.), shortleaf pine (*Pinus echinata* P. Mill.), sweet gum (*Liquidambar styraciflua* L.), black gum (*Nyssa sylvatica* Marsh), dogwood (*Cornus florida* L.) black hickory (*Carya texana* Buckl.), mockernut hickory (*C. tomentosa* (Poir.) Nutt.), bitternut hickory (*C. cordiformis* Wangenh.) K. Koch). Oak and pine dominated.

Table 1. Tree abundance data (as percent of total for each landscape) for floodplain and upland based on General Land Office witness trees.

TREES	UPLAND	FLOODPLAIN
Black, Red, and Spanish Oak (*Quercus velutina* Lam. *Q. shumardii* Buckl., *Q. falcata* Michx., *Q. texana*, Buckl.) *Q. pagoda* Raf.	31.5	2.7
Pine (*Pinus echinata* Mill., *P. taeda* L.)	16.3	
Post Oak (*Quercus stellata* Wang.)	11.2	0.6
Hickory (*Carya texana* Buckl., *C. tomentosa* (Poir.) Nutt., *C. cordiformis* (Wangenh.) K. Koch)	10.3	1.2
Blackjack Oak (*Q. marilandica* Muenchh.)	10.2	
White Oak (*Quercus alba* L., *Q. michauxii* Nutt.)	10.0	1.5
Sweet Gum (*Liquidambar styraciflua* L.)	3.1	6.0
Pin Oak (*Quercus phellos* L., *Q. nigra* L., *Q. laurifolia* Michx., *Q. texana* Buckl.)	1.6	0.9
Dogwood (*Cornus florida* L.)	1.3	
Ash (*Fraxinus pennsylanica* Marsh)	0.7	10.0
Elm (*Ulmus americana* L.)	0.6	6.2
Willow (*Salix nigra* Marsh)		16.3
Hackberry (*Celtis laevigata* Willd.)		11.8
Cottonwood (*Populus deltoides* Bart. ex Marsh.)		9.1
Cypress (*Taxodium distichum* (L.) L. Rich.)		7.0
Box Elder (*Acer negundo* L.)		5.1
Locust (*Gleditsia triacanthos* L.)		4.7
Sycamore (*Platanus occidentalis* L.)		4.6
Tupelo Gum (*Nyssa aquatica* L.)		2.5
Persimmon (*Diospyros virginiana* L.)		1.5
Pecan (*Cayra illinoensis* (Wang.) K. Koch)		1.3
Oak (*Quercus* species not designated)		1.1
Mulberry (*Morus rubra* L.)		0.9
Overcup Oak (*Quercus lyrata* Walt.)		0.8
Red Elm (*Ulmus rubra* Muhl.)		0.7
Privet (*Forestiera acuminata* (Michx.) Poir.)		0.7
Sassafras (*Sassafras albidum* (Nutt.) Nees)		0.6
Other	3.2	2.2
Total	100.0	100.0

4. In the 1830s, on the floodplain, oak and hickory were found to occur mainly in and around the Caddo Prairies in northern Caddo Parish. These long vanished prairies were briefly described by Freeman and Custis in 1806, but Anglo-American settlement soon eraced all evidence of them (Flores 1984; MacRoberts et al. 1997). What these prairies were like will, unfortunately, remain a mystery; the two plants collected from them by Peter Custis in 1806 (*Veronicastrum virginicum* (L.) Farw. and *Eustoma russellianum* (Hook.) G.Don) have never been found in the region again (MacRoberts and MacRoberts 2004).

Surveyors' line notes mention "small cane" being present, and that the prairies were "dry and rich;" the soil was "black and first quality." This condition contrasts markedly with the surrounds, which were described as "overflow land," and "inundated." Additionally, the difference is marked by the fact that by 1838—a year after the Great Raft had been first cleared—there was a "cotton field," "corn field," "Scott's Improvement," "Scotts field," and "Hamilton's Farm" in Caddo Prairie. These were the only fields, farms, or "improvements" in the entire Township, indicating that natural prairies were a very different habitat than characterized surrounding areas. These prairies appear to have been an atypical part of the floodplain—they were on higher elevations, had different soil, and were open as indicated by the number of times the surveyors had to construct a mound for lack of trees to mark corners. This topography and soil difference probably accounted for the oaks and hickories.

DISCUSSION

We found that the woody vegetation of the Caddo Parish floodplain and upland is different. There is virtually no overlap in tree species today nor was there 170 years ago.

Upland forest structure of Caddo Parish appears to have been mixed oak-hickory and mixed oak-pine-hickory savanna/forest. The GLO surveys (both bearing trees and line notes) show that there were only a few areas of the Caddo Parish upland that were dominated by pine and probably none where pine alone dominated. Other areas were hardwood dominated, and this undoubtedly was the more characteristic canopy structure for the entire region, both east and west of the Mississippi River (Skeen et al. 1993; Dale and Ware 1999), notably where the fire return interval was less frequent than further south (Frost 1998).

A comparison of our Caddo Parish surveyors' record results with those of Bragg (2002, 2003) and Williams (1993) for the upland areas of Ashley and Union counties, southern Arkansas, and Williams and Smith (1995) for the Caney Ranger District in north central Louisiana, supports this conclusion. Bragg found oak, pine, and hickory in about the same proportions as we did. Williams (1993) found pine to vary from 51 percent to 4 percent depending on landform, and Williams and Smith found pine only slightly better represented than it is in Caddo Parish but with oak again dominant. Thus, at the time of Anglo-American settlement, pine was probably not as common as it is today (Skeen et al. 1993; Bragg 2003) and was definitely less common overall than oak.

These findings contrast markedly with the GLO survey records for areas with monospecific pine savanna/forest such as within the longleaf pine region of central Louisiana (Bridges & Orzell 1989). On the 182 sq. km Vernon Ranger District of the Kisatchie National Forest, 95 percent of the bearing trees were pine and only along stream courses were there hardwoods and cypress. Pine was the only bearing tree in the upland areas (Grace & Smith 1995; see review by Platt 1999). Historical documents describe monospecific pine savanna/forest for the upper West Gulf Coastal Plain (Hilgard 1873; Lockett 1876; Mohr 1898; Mattoon 1915; see review in Bragg 2002), but the surveyor's notes for such areas have not been analyzed to see how they compare with other pine-dominated savanna/forest.

Our floodplain findings are also somewhat unusual. We had expected oak to be common—notably flood tolerant species. Except in the vicinity of Caddo Prairies, this was not the case. Oak was virtually absent from the floodplain. While there were distinct communities such as cypress swamps, oxbows, and others, the vegetation in general was what has been described as "Batture" or "*Populus deltoides* temporary flooded forest alliance" (Louisiana Natural Heritage 1988; Weakley et al. 1998).

Bois d'arc (*Maclura pomifera*), which is now common on the floodplain, did not appear in the Tree Book and presumably was not present until recently (Weniger 1996; Schambach 2003), although Peter Custis reported a large bois d'arc at Natchitoches in 1806 (Flores 1984), and Chinese tallow tree (*Sapium*) is now ubiquitous in the floodplain, as it is over so much of the south (Bruce et al. 1997).

The floodplain vegetation of the Red River has not been studied. Ours is the first study to use the original Government Land Office records to reconstruct reference conditions. Caddo Parish consists of only a fraction of the Red River floodplain, and until the surveyors notes are fully studied along the entire course of the river, generalizations are not possible. Nonetheless, on the basis of our road surveys, it looks like oak is largely missing from the lower stretches of the floodplain, at least from Natchitoches north to Arkansas. This situation may not prevail north of the Arkansas line. Palmer (1923) described the Red River forest at Fulton, Arkansas and found a combination of plant associations that closely parallels those described in textbooks (e.g., Sharitz & Mitsch 1993; Messina & Conner 1998; Mitsch & Grosselink 2000): cottonwood, sycamore, willow forests next to oak dominated bottomlands, next to cypress swamps, and so on.

APPENDIX 1

Since it has been suggested that there was sometimes bias in a surveyor's selection of bearing trees (Whitney & DeCant 2001; Bragg 2003), we checked for bias. We did this by comparing the frequency with which pine and oak was mentioned in the line notes with the frequency with which they were used as bearing trees in four townships that lacked or virtually lacked pine and two Townships that had the highest percentage of pine. We assumed that if pine or oak was being discriminated against, this would show up in the line notes where there was no reason to not mention a species. Except for pine in T17NR14-15-16W, we did not expect a close agreement of numbers since line notes and section and quarter section tree selection constitute two independent and very different

Table 2. Results of line notes comparison with bearing trees reported for T17NR14-15-16W and T23NR16W.

		Species		
		Pine	Oak	Other
T17NR14-15-16W				
Tree book				
	No.	32	570	187
	%	4	72	24
Surveyors' line notes				
	No.	24	200	200
	%	6	47	47
T23NR16W				
Tree book				
	No.	196	112	74
	%	51	29	19
Surveyors' line notes				
	No.	62	54	61
	%	35	31	33

sampling methods. Nonetheless, we did expect that line notes would not disagree totally with corner results, and they did not.

The results, given in Table 2, show that there is no reason to suppose bias. Line notes for the areas with high percentages of pine as a bearing tree most commonly read: "Timber oak & hickory & etc.," "oak & etc.," and "oak & pine," "pine & oak." Where pine was absent, they read: "oak & hickory."

ACKNOWLEDGMENTS

Gary Loftin, Clerk of Court, and John Basco, Karen Gilbert, and Ron Looney, Clerk of Court Office, Caddo Parish, were instrumental in making this study possible by providing access to land plats and the Tree Book. The research was partly supported by a Louisiana Board of Regents Grant "Floristic Baseline Inventory for Watershed Research and Education," which Virginia Simons Lincove, Associate Vice Chancellor, Louisiana State University in Shreveport, was instrumental in securing. Further support and assistance were provided by Gary Hanson and Patricia Peyton of the Red River Watershed Management Institute, Louisiana State University in Shreveport. Don Bragg, USDA Forest Service, made useful comments on an earlier draft of the paper. Guy Nesom, Botanical Research Institute of Texas, and an anonymous reviewer made many helpful suggestions.

REFERENCES

Ames, K.M. 1999. Myth of the hunter-gatherer. Archaeology 52(5):44–49.

Bagur, J.D. 2001. A history of navigation on Cypress Bayou and the lakes. Univ. North Texas Press, Denton.

Bragg, D.C. 2002. Reference conditions for old-growth pine forests in the Upper West Gulf Coastal Plain. J. Torrey Bot. Soc. 129:261–288.

Bragg, D.C. 2003. Natural presettlement features of the Ashley County, Arkansas area. Amer. Midl. Naturalist 149:1–20.

Bridges, E.L and S.L. Orzell. 1989. Longleaf pine communities of the west gulf coastal plain. Natural Areas J. 9:246–262.

Bruce, K.A., G.N. Cameron, P.A. Harcombe, and G. Jubinsky. 1997. Introduction, impact on native habitats, and management of a woody invader, the Chinese tallow tree, *Sapium sebiferum* (L.) Roxb. Natural Areas J. 17:255–260.

Carr, S.C. 2000. Composition and structure of pine-hardwood forests of central and northwest Louisiana. MS Thesis, Louisiana State University, Baton Rouge.

Dale, E.E. and S. Ware. 1999. Analysis of oak-hickory-pine forest of Hot Springs National Park in the Ouachita Mountains, Arkansas. Castanea 64:163–174.

Dale, E.E. and S. Ware. 2004. Distribution of wetland tree species in relation to a flooding gradient and backwater versus streamside location in Arkansas, U.S.A. J. Torrey Bot. Soc. 131:177–186.

Delcourt, H.R. 1976. Presettlement vegetation of the north of the Red River District, Louisinana. Castanea 41:122–139.

Egan, D. and E.A. Howell. 2001. The historical ecology handbook. Island Press, Washington, D.C.

Edwards, J.P., P.G. Martin, J.W. Magoun, W.W. Kilpatrick, and C. Henry. 1980. Soil survey of Caddo Parish, Louisiana. U.S.D.A. Soil Conservation Service, Washington, D.C.

Flores, D.L. 1984. Jefferson and southwestern exploration: the Freeman and Custis accounts of the Red River expedition of 1806. Univ. Oklahoma Press, Norman.

Frost, C.C. 1998. Presettlement fire frequency regimes of the United States: a first approximation. Tall Timbers Fire Ecology Conference Proceedings 20:70–81.

Grace, S.L. and L.M. Smith. 1995. A survey and description of the natural plant communities of the Kisatchie National Forest, Vernon District. Unpublished report. Louisiana Dept. Wildlife and Fisheries, Baton Rouge.

Henderson State University Biology Department. 1979. Biological inventory of the Red River waterway from Index, Arkansas to Shreveport, Louisiana. U.S. Corps of Engineers, New Orleans District, New Orleans.

Hilgard, E.W. 1873. Supplementary and final report of a geological reconnaissance of the state of Louisiana, made under the auspices of the New Orleans Academy of Sciences, and of the Bureau of Immigration of the state of Louisiana. Picayune Steam Job Print, New Orleans.

LOCKETT, S. 1876. Louisiana as it is. A geographical and topographic description of the state. Reprinted 1969. Louisiana State University Press, Baton Rouge.

LOUISIANA NATURAL HERITAGE PROGRAM. 1988. Communities of Louisiana. Unpublished report, Louisiana Natural Heritage Program, Dept. Wildlife and Fisheries, Baton Rouge.

MACROBERTS, D.T. 1979. Checklist of the plants of Caddo Parish, Louisiana. Bull. Mus. Life Sci., Louisiana State Univ.ersity-Shreveport 1:1–54.

MACROBERTS, D.T., B.R. MACROBERTS, and M.H. MACROBERTS. 1997. A floristic and ecological interpretation of the Freeman and Custis Red River Expedition of 1806. Bull. Mus. Life Sci., Louisiana State University-Shreveport 12:1–26.

MACROBERTS, M.H. and B.R. MACROBERTS. 2004. About 450 miles up the Red River in a large prairie: Peter Custis' surviving botanical information from the Red River expedition of 1806. Sida 21:945–957.

MARCY, R.B. and G.B. MCCLELLAN. 1854. Exploration of the Red River of Louisiana 1852.
Beverley Tucker, Senate Printer, Washington, D.C.

MATTOON, W.R. 1915. Life history of shortleaf pine. Bull. U.S. Dept. Agric. 224:1–46.

MESSINA, M.G. and W.H. CONNER. 1998. Southern forested wetlands: ecology and management. Lewis Publ., New York.

MITSCH, W.J. and J.G. GROSSLINK. 2000. Wetlands. John Wiley, New York.

MOHR, C. 1898. The timber pines of the southern United States. U.S. Dept. Agriculture, Forestry Division. Govt. Printing Office, Washington, D.C.

MUNDORFF, K.T. 1998. Ecological classification of bottomland hardwood forests in east Texas and central Louisiana. Thesis, Stephen F. Austin State University, Nacogdoches.

NEUMAN, R.W. 1984. An introduction to Louisiana archaeology. Louisiana State University Press, Baton Rouge.

NEWKIRK, J.A. and J.W. MUELLER. 1980. Cultural resources survey of the Red River waterway from Shreveport to the Mississippi River. Rept. 2021. Commonwealth Association, Inc., Jackson, Michigan.

PALMER, E.J. 1923. The Red River forest at Fulton, Arkansas. J. Arnold Arboretum 4:8–33.

PLATT, W.J. 1999. Southeastern pine savannas. In: R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds. Savannas, barrens and rock outcrop plant communities of North America. Cambridge Univ. Press, New York. Pp. 23–51.

SCHAMBACH, F.F. 2003. Osage orange bows, Indian horses, and the blackland prairie of northeastern Texas. In: E. Peacock and T. Schauwecker, eds. Blackland prairies of the gulf coastal plain: nature, culture, and sustainability. University of Alabama Press, Tuscaloosa. Pp. 213–236.

SHARITZ, R.R. and W.J. MITSCH. 1993. Southern floodplain forests. In: W.H. Martin, S.G. Boyce, and A.C. Echternacht, eds. Biodiversity of the southeastern United States: lowland terrestrial communities. John Wiley, New York. Pp. 311–372.

SKEEN, J.N., P.D. DOERR, and D.H. VAN LEER. 1993. Oak-Hickory-Pine forests. In: W.H. Martin. S.G. Boyce, and A.C. Echternacht, eds. Biodiversity of the southeastern United States. John Wiley, New York. Pp. 1–33.

Talfor, R.B. 1873. Photographic views of Red River raft. Made under the direction of C.W. Howell, Captain, Corps of Engineers, and E.A. Woodruff, 1st Lient., Corps of Engineers, to accompany their annual report on the operations for the removal of the raft duing the year ending June 30th, 1873. On file, Archives Department, Noel Memorial Library, Louisiana State University, Shreveport.

Teague J. and T. Wendt. 1994. Caddo and Bossier parishes: natural areas survey. The Nature Conservancy, Baton Rouge.

Thomas, R.D. and C.M. Allen. 1993–1998. Atlas of the vascular flora of Louisiana. The Nature Conservancy, Baton Rouge.

Triska, F.J. 1984. Role of wood debris in modifying channel geomorphology and riparian areas of a large lowland river under pristine conditions: a historical case study. Verh. Internat. Verein. Limnol. 22:1876–1892.

Van Kley, J.E. 1999. The vegetation of the high terrace rolling uplands, Louisiana. Castanea 64:64–80.

Van Kley, J.E. and D.N. Hine. 1998. The wetland vegetation of Caddo Lake. Texas J. Sci. 50: 267–290.

Ware, G.H. 1956. Vegetation zonation on a Red River sand bar near Natchitoches, Louisiana. Proc. Louisiana Acad. Sci. 19:21–24.

Weakley, A.S., K.D. Patterson, S. Landaal, and M. Pyne. 1998. International classification of ecological communities, terrestrial vegetation of the southeastern United States. The Nature Conservancy, Chapel Hill, North Carolina.

Weniger, D. 1996. Catalpa (*Catalpa bignonioides*, Bignoniaceae) and bois d'arc (*Maclura pomifera*, Moraceae) in early Texas records. Sida 17:231–242.

Whitney, G.G. and J.P. DeCant. 2001. Government Land Office surveys and other early land surveys. In: D. Egan and E.A. Howell, eds. The historical ecology handbook. Island Press, Washington, D.C. Pp. 147–172.

Williams, G.I. 1993. Environmental setting. In: A.M. Early, ed. Caddoan saltmakers in the Ouachita Valley: the Hardman site. Arkansas Archeological Survey Research Series. No. 43. Pp. 15–28.

Williams, R.A. and L.M. Smith. 1995. A survey and description of the natural plant communities of the Kisatchie National Forest, Caney District. Louisiana Dept. Wildlife and Fisheries, Baton Rouge.

ANNOTATED CHECKLIST OF THE VASCULAR FLORA OF THE TURKEY CREEK UNIT OF THE BIG THICKET NATIONAL PRESERVE, TYLER AND HARDIN COUNTIES, TEXAS

Larry E. Brown

Houston Community College
1300 Holman
Houston, Texas 77004, U.S.A.
Herbarium, Spring Branch Science Center
8856 Westview Drive
Houston, Texas 77055, U.S.A.

Paul A. Harcombe, Warren W. Pruess, and I. Sandra Elsik

Department of Ecology and Evolutionary Biology
Rice University, P. O. Box 1892
Houston, Texas 77251-1892, U.S.A.

Barbara R. MacRoberts and Michael H. MacRoberts

Bog Research
740 Columbia
Shreveport, Louisiana 71104, U.S.A.
Herbarium, Museum of Life Sciences
Louisiana State University in Shreveport
Shreveport, Louisiana, 71115, U.S.A.

Dan Johnson

12406 Wedgewood Lane
Houston, Texas 77077, U.S.A.

ABSTRACT

An annotated, vouchered checklist is provided of the vascular plant taxa of the 3150 hectare Turkey Creek Unit, Big Thicket National Preserve, Tyler and Hardin counties, southeastern Texas. Six hundred ninety one (691) native taxa and 47 exotic taxa are documented for the unit. The communities of the Turkey Creek Unit are provided.

RESUMEN

Se aporta un listado comentado de los taxa de plantas vasculares junto con los testigos, de las 3150 hectáreas de la unidad Turkey Creek, Big Thicket National Preserve, en los condados de Tyler y Hardin, Sureste de Texas. Se documentan seiscientos noventa y un (691) taxa nativos y 47 taxa exóticos en esta unidad. Se aportan las comunidades de la unidad Turkey Creek.

INTRODUCTION

This is the second part of an intended inventory, based upon available voucher specimens, of the flora of the Big Thicket National Preserve, southeastern Texas. In a previous paper we provided an annotated checklist with community associations of the vascular flora of the Hickory Creek Unit (MacRoberts et al. 2002). In this paper we provide an annotated checklist for the Turkey Creek Unit without community affiliations for species.

SITE AND METHODS

The Big Thicket is located mostly within the longleaf pine region of the West Gulf Coastal Plain in southeastern Texas (Parks & Cory 1936; McLeod 1971;

SIDA 21(3): 1807–1827. 2005

Harcombe & Marks 1979; Marks & Harcombe 1981; Harcombe et al. 1993). The Big Thicket National Preserve consists of 12 units scattered over seven Texas counties. The units range in size from 222 hectares to 10,100 hectares and total about 34,000 hectares (Peacock 1994). We selected the Turkey Creek Unit for the second part of the floristic survey, a 3150 hectare area located in southern Tyler and northern Hardin counties (Fig. 1). The Turkey Creek Unit, which consists of twelve plant communities, was chosen for inclusion in the Big Thicket National Preserve because it is centrally located, is a corridor unit along Turkey Creek, and is diverse (Ajilvsgi 1979; Watson 1979; Harcombe & Marks 1981; MacRoberts & MacRoberts 1998). The unit is about 18 km from north to south and is about 4 km at its widest east-west point. The unit ranges from about 15 to 45 meters in elevation. Details regarding edaphic and climatic factors can be found in Deshotels (1978), Watson (1979), and Marks and Harcombe (1981). A community map of the unit is in Harcombe and Marks (1979).

Like all units of the Big Thicket National Preserve, the Turkey Creek Unit has not been the subject of a floristic inventory although extensive but desultory collecting has occurred there (Watson 1982; MacRoberts & MacRoberts 1998).

The MacRoberts' collected 620 specimens from the Turkey Creek Unit during 11 field days beginning 13 September 2001 and ending 3 April 2003. These are temporarily deposited at Rice University. In addition, in 1997 and 1998, the MacRoberts collected and deposited 65 specimens from the Turkey Creek Unit at TEX for a study of wetland pine savannas (MacRoberts & MacRoberts 1998). Larry Brown collected 243 specimens during 2 field days on 24 July 2002 and 25 October 2003 and about 60 specimens between October 1981 and September1996. Dan Johnson collected about 168 specimens on 7 days between 25 October 2002 and 20 July 2003. Geraldine Watson collected about 236 Turkey Creek specimens over several years in the late 1970s and early 1980s.

Since our purpose is to produce a list of taxa known to occur on the Turkey Creek Unit, a vouchered specimen was considered to be the only evidence acceptable for inclusion in the list. In all, about 1340 herbarium specimens form the data for this report. All specimens have been annotated by Larry Brown except for William Carr's four collections at TEX (which have all been recollected) and the MacRoberts' 65 specimens deposited at TEX for a wetland savanna study. These taxa are listed in MacRoberts and MacRoberts (1998) and most have been recollected during our current survey. The following taxa in the 1998 paper have not been recollected, thus the vouchers for them reside only at TEX: *Lycopodiella appressa*, *Hypoxis hirsuta*, *Eleocharis tuberculosa*, *Rhynchospora gracilenta*, *Rhynchospora rariflora*, *Scleria georgiana*, *Scleria reticularis*, *Aletris aurea*, *Schoenolirion croceum*, *Calopogon tuberosus*, *Panicum verrucosum*, *Paspalum praecox*, *Smilax laurifolia*, *Xyris ambigua*, *Xyris baldwiniana*, *Xyris caroliniana*, *Coreopsis linifolia*, *Marshallia graminifolia* var. *cynanthera*,

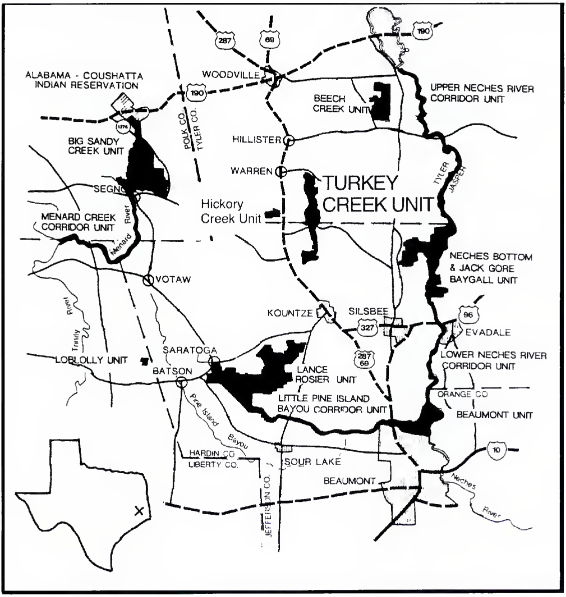


Fig. 1. Location of Turkey Creek Unit within the Big Thicket National Preserve, Texas.

Drosera brevifolia, Drosera capillaris, Polygala cruciata, Photinia pyrifolia (as *Aronia arbutifolia*), and *Viola primulifolia.*

On August 29, 2004, Joe Liggio took the senior author to a new addition of the Turkey Creek Unit. It ranges on the east side of Highway 69/287 between Highway 420 north to Village Creek. In a savanna community north of Highway 420, we collected the following, *Rhynchospora pusilla, Fuirena bushii, Xyris stricta* var. *obscura, Bigelowia nuttallii, Silphium gracile,* and *Tephrosia onobrychoides.* Only *R. pusilla* and *B. nuttallii* were new.

In most cases the nomenclature follows Jones et al. (1997) and Kartesz (1999). Some recent literature sources were followed, especially some nomenclatural adjustments published in the *Flora of North America* volumes. In cases of multiple collections, no more than four are listed for each taxon. For each taxon we list the county of collection if known. Some of Geraldine Watson's collections do not designate county.

The following is a list of communities (mostly using the nomenclature of Marks and Harcombe {1981}) in the Turkey Creek Unit. For each community, except for ponds, we list up to three of the dominant woody species as presented by Marks and Harcombe (1981).

Sandhill Pine Forest: *Quercus incana*, *Q. margaretta*, and *Cornus florida*.
Upland pine forest: *Pinus palustris*, *P. taeda*, and *Callicarpa americana*.
Wetland pine savanna: *Pinus palustris*, *Nyssa biflora*, and *Cyrilla racemiflora*.
Upper slope pine oak forest: *Pinus echinata*, *Quercus falcata*, and *Ilex vomitoria*.
Mid slope oak pine forest: *Pinus taeda*, *Quercus falcata*, and *Cornus florida*.
Lower slope hardwood pine forest: *Magnolia grandifolia*, *Quercus nigra*, and *Ilex opaca*.
Floodplain hardwood pine forest: *Pinus taeda*, *Fagus grandifolia*, and *Carpinus caroliniana*.
Cypress tupelo forest: *Taxodium distichum*, *Nyssa aquatica*, and *Planera aquatica*.
Floodplain hardwood forest: *Quercus nigra*, *Liquidambar styraciflua*, and *Carpinus caroliniana*.
Baygall/stream course: *Cyrilla racemiflora*, *Ilex coriacea*, and *Magnolia virginica*.
Ponds: *Juncus repens*, *Quercus laurifolia*, and *Crataegus opaca*

RESULTS

Annotated list of the Turkey Creek Unit vascular taxa. The following abbreviations are used in the annotated checklist.

CL = C. Lui. His 15 collections are at Rice University.
DJ = Dan Johnson. His 163 specimens are temporarily at Rice University.
GW = Geraldine Watson. Her National Park Service specimens are at Rice University.
LB = Larry Brown. All of his Turkey Creek specimens are at SBSC.
MM = Barbara and Michael MacRoberts. Their collections are temporarily at Rice University except for the 23 taxa whose vouchers are at TEX.
KC = Katie Caldwell. Her collections are at Rice University.
PH = Paul Harcombe. His 15 specimens are at Rice University.
SE = Sandy Elsik. Her 13 collections are at Rice University.
WC = William Carr. His 4 collections are at TEX/LL.
(H) = Collected from Hardin County.
(T) = Collected from Tyler County.
(NC) = A Geraldine Watson collection with no county indicated.
***** = exotic (not native to North America).
+ = see note at end of list.

ACANTHACEAE

Hygrophila lacustris (Schlecht.& Cham.) Nees, (H T) *DJ 1948, 1728*

Justicia ovata (Walter.) Lindau var. *lanceolata* (Chapm.) R.W.Long, (H T) *MM 5634,5421; GW 215*

Ruellia caroliniensis (J.F. Gmel.) Steud., (H) *DJ 2002,1678*

Ruellia humilis Nutt., (H T) *MM 5675,5451; GW 2566,2761*

Yeatesia viridiflora (Nees) Small, (H) *MM 5635; LB 27090*

ACERACEAE

Acer barbatum Michx., (T) *DJ 2079; LB 11093*

Acer rubrum L., (H T) *LB 27476; MM 4963, 5231*

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose, (T) *MM 5770*

Yucca louisianensis Trel., (T) *MM 5286*

ALISMATACEAE

Sagittaria latifolia Willd., (T) *DJ 1894*

Sagittaria papillosa Buchenau, (H) *MM 5667, 2608b; DJ 1993*

AMARANTHACEAE

Froelichia floridana (Nutt.) Moq., (H) *MM 5144; GW 2373,2748*

ANACARDIACEAE

Rhus glabra L., (H T) *MM 5194,5117, 4973; LB 27155*

Rhus copallinum L., (H) *DJ 1664*

Toxicodendron radicans (L.) Kuntze, (T) *DJ 2101, 2088*

ANNONACEAE

Asimina parviflora (Michx.) Dunal, (H T) *MM 5000; SE 2009; LB 27508*

APIACEAE

Centella erecta (L.f.) Fernald, (H T) MM 5664,5077

Chaerophyllum tainturieri Hook. var. *tainturieri*, (H) *MM 5309, 6039*

**Cyclospermum leptophyllum* (Pers.) Sprague ex Britton & P. Wilson, (T) *DJ 1886; MM 6064*

Eryngium integrifolium Walter, (H T) *MM 3507; LB 6589*

Eryngium prostratum Nutt. ex DC., (H T) *DJ 1812, 1843*

Eryngium yuccifolium Michx., (T) *MM 5754, 5059*

Hydrocotyle verticillata Thunb., (NC) *GW 2767, 2676*

Oxypolis filiformis (Walter.) Britton, (T) *MM 5202*

Oxypolis rigidior (L.) Raf., (T) *MM 5203, 5888*

Ptilimnium capillaceum (Michx.) Raf., (H T) *GW 2608, 3421*

Ptilimnium costatum (Elliott) Raf., (T) *MM 5774, 5602; GW 2759; LB 6659*

Sanicula canadensis L., (H T) *MM 5473; GW 2609c; DJ 1780; LB 27138*

Thaspium trifoliatum (L.) A. Gray var. *aureum* Britton, (H) *GW 2471, 2610b*

APOCYNACEAE

Amsonia tabernaemontana Walter, (NC) GW 3241

Trachelospermum difforme (Walter) A. Gray, (H) DJ 1682

AQUIFOLIACEAE

Ilex ambigua (Michx.) Torr., (H T) *GW 2631,2752; DJ 1681*

Ilex coriacea (Pursh) Chapm., (T) *MM 5245, 3892; GW 2452, 3444*

Ilex decidua Walter, (NC) *GW 2693a, 2673*

Ilex longipes Chapm. ex Trel., (H T) *MM 5922, 6063; LB 27481, 27552*

Ilex opaca Aiton, (H T) *MM 5004, 5285*

Ilex vomitoria Aiton, (H T) *MM 4978, 5284*

ARACEAE

Arisaema triphyllum (L.) Schott, (H T) *MM 5317, 5260; GW 1033*

ARALIACEAE

Aralia spinosa L., (T) *MM 5423*

ARECACEAE

Sabal minor (Jacq.) Pers., (H T) *MM 5930, 5316; LB 27459a*

ARISTOLOCHIACEAE

Aristolochia reticulata Jacq., (T) *MM 5052*

Aristolochia serpentaria L., (H) *GW 2645, 2651; DJ 1790*

ASCLEPIADACEAE

Asclepias longifolia Michx., (T) *MM 5080*

Asclepias obovata Elliott, (T) MM *5758, 5050, 5190; LB 27588*

Asclepias perennis Walter, (H) *MM 5636*

Asclepias rubra L., (H) *GW 544*

Asclepias tuberosa Woodson, (T) *MM 5468*

Asclepias variegata L., (H) GW 76, 2627; *MM 5379, 5410*

Asclepias verticillata L., (T) *GW 1167, 2749*

Matelea cynanchoides (Engelm.) Woodson, (H) *LB 27126; GW 2649*

Matelea gonocarpos (Walter) Shinners, (H) *LB 27462*

ASPLENIACEAE

Asplenium platyneuron (L.) Britton, Sterns & Poggenb., (H) *DJ 1789*

ASTERACEAE

Ageratina altissima (L.) R.M. King & H. Rob., (H) *MM 5911, 5919; LB 27506, 27460*

Ambrosia artemisiifolia L., (H T) *LB 27499; MM 5155; CL 901113*

Ambrosia psilostachya DC., (H) *MM 5933*

Ambrosia trifida L., (T) *DJ 2092*

Arnoglossum ovatum (Walter) H. Rob., (T) *MM 5070, 3508; GW 2685*

Baccharis halimifolia L., (T) *GW 2860*

Berlandiera pumila (Michx.) Nutt. var. *pumila*, (H T) *MM 5463, 5395*

Berlandiera pumila (Michx.) Nutt. var. *scabrella* Nesom & B.L. Turner, (H) *MM 5463; LB 27146*

Bidens aristosa (Michx.) Britton, (H T) *MM 5660, 5409; GW 2826, 2629*

Bidens bipinnata L., (H) *DJ 2000*

Bidens frondosa L., (H T) *GW 2895; DJ 1945, 2041*

Bigelowia nuttallii L.C. Anderson, (H) *Brown 30128*

Boltonia diffusa Elliott, (H T) *MM 5673, 5185, 3509; GW 2440*

Chaptalia tomentosa Vent., (T) *MM 5288, 3625*

Chrysopsis mariana (L.) Elliott, (H T) *MM 5898, 5761; LB 5578, 8155*

Chrysopsis pilosa Nutt., (H T) *CL 901190, 901195; GW 2389*

Cirsium horridulum Michx., (T) *MM 6069*

Conoclinium coelestinum (L.) DC., (H T) *MM 5768, 5809 5917; LB 27075*

Conyza canadensis (L.) Cronquist var. *pusilla* (Nutt.) Cronquist, (H T) *MM 5819; DJ 1852*

+*Coreopsis intermedia* Sherff, (T) *DJ 2088a*

Coreopsis linifolia Nutt., (T) *MM 3627*

Coreopsis tinctoria Nutt., (H) *DJ 2012*

Croptilon divaricatum (Nutt.) Raf., (H T) *LB 27484; MM 5146, GW 2379; CL 901184*

Echinacea pallida (Nutt.) Nutt. var. *sanguinea* (Nutt.) Gandhi & R.D. Thomas, (H T) *LB 27575; MM 5378, 5462*

Elephantopus carolinianus Raeusch., (H T) *MM 5796; LB 27513*

Elephantopus nudatus A. Gray, (T) *GW 2868, 2865*

Elephantopus tomentosus L., (H T) *MM 5745, 5116; LB 27120*

Erechtites hieracifolia (L.) Raf. ex DC., (H T) *DJ 1788*

Erigeron philadelphicus L., (H T) *MM 5445, 6035*

Erigeron strigosus Muhl. ex Willd., (H T) *MM 5445, 6046; GW 2541; DJ 2104*

Eupatorium capillifolium (Small) Lam., (T) *LB 27586*

Eupatorium compositifolium Walter, (T) *DJ 2083, 1888; LB 14892*

Eupatorium lancifolium (Torr. & A. Gray) Small, (T) *MM 5748, 5114; LB 27526; DJ 2052*

Eupatorium leucolepis (DC.) Torr. & A. Gray, (T) *MM 5747, 5059*

Eupatorium mohrii Greene, (H T) *GW 2179; DJ 2067*

Eupatorium perfoliatum L., (H) *DJ 1981*

Eupatorium rotundifolium L., (T) *MM 5102*

Eupatorium semiserratum DC, (H T) *LB 27581; GW 2180; DJ 1946, 1994*

Eupatorium serotinum Michx., (H) *MM 5148*

Eurybia hemispherica (Alexander) Nesom, (T) *MM 5891, 5188, GW 2847; LB 6660*

Euthamia leptocephala (Torr. & A. Gray) Greene ex Porter & Britton, (T) *GW 2864b*

Gaillardia aestivalis (Walter) H. Rock var. *aestivalis*, (H) *MM 4964*

Gaillardia pulchella Foug. var. *pulchella*, (H) *MM 5678*

Gamochaeta coarctata (Willd.) Kergerulen, (H) *GW 2479; MM 6059*

Gamochaeta purpurea (L.) Cabrera, (H) *GW 2473; 2615*

Helenium amarum (Raf.) H. Rock var. *amarum*, (H T) *MM 5762, 5140*

Helenium drummondii H. Rock, (H) *MM 5301*

Helenium flexuosum Raf., (T) *GW 2626; MM 5439; LB 18654*

Helianthus angustifolium L., (T) *LB 27590*

Helianthus debilis Nutt. var. *silvestris* (Heiser) Cronquist, (H) *LB 27131a*

Heterotheca subaxillaris (Lam.) Britton & Rusby, (H) *MM 5156*

Hieracium gronovii L., (H T) *LB 27464a, 27130, 27547; MM 5145*

Hymenopappus artemisiifolius DC. var. *artemisiifolius*, (T) *MM 5450, 5281*

Iva angustifolia DC., (H) *DJ 2102*

Iva annua L., (T) *GW 2850*

Krigia cespitosa (Raf.) K.L. Chambers, (H) *GW 2534, 2617b*

Krigia wrightii (A. Gray) K.L Chambers ex K.J. Kim, (T) *MM 5277*
Lactuca canadensis L., (H) *DJ 2109*
Lactuca floridana (L.) Gaertn., (H) *DJ 1793*
Liatris acidota Engelm. & A. Gray, (H T) *MM 5676, 5082; LB 27153*
Liatris elegans (Walter) Michx. var. *elegans*, (H T) *MM 5896, 5915, 5184*
Liatris pycnostachya Michx., (T) *MM 5091*
Liatris squarrosa (L.) Michx. var. *squarrosa* (T) *MM 5771*
*Marshallia graminifolia (*Walter) Small var. *cynanthera* (Elliott) Beadle & F.A. Boynt., (T) *MM 4006*
Mikania scandens (L.) Willd, (H) *DJ 1689*
Oligoneuron nitidum (Torr. & A. Gray) Small, (H T) *MM 5755, 5062, GW 2846; DJ 1693*
Palafoxia reverchonii (Bush) Cory, (H) *MM 4130; GW 2380*
Pityopsis graminifolia (Michx.) Nutt., (T) *MM 5283, 3715*
Pluchea camphorata (L.) DC., (H T) *MM 5804; GW 2764; DJ 1939*
Pluchea foetida (L.) DC., (H T) *MM 5680, 5196*
Pluchea rosea Godfrey, (H T) *MM 5669, 3653*
Pseudognaphalium obtusifolium (L.) Hillard & Burtt, (H) *MM 5913, 5161, 5159; GW 2367*
Rudbeckia hirta L., (H T) *MM 4972, 5367, PH 291*
Pyrrhopappus carolinianus (Walter) DC.,(T) *DJ 1723*
Silphium gracile A. Gray, (T) *MM 5189*
Smallanthus uvedalius (L.) Mack. ex Small, (H) *MM 5388; LB 27124*
Solidago caesia L., (T) *GW 3464, 3465*
Solidago canadensis L., (T) *GW 2862, 2863, 3470, 3471*
Solidago ludoviciana (A. Gray) Small, (H T) *MM 5767, 5788; GW 3468; LB 27150*
Solidago odora Aiton var. *odora*, (T) *GW 2372, 2864a; LB 27566*
Solidago petiolaris Aiton, (T) *GW 2751, 3459*
Solidago rugosa Mill. ssp. *asper* (Aiton) Cronquist, (H T) *LB 27486; GW 2431, 2832*
Solidago rugosa Mill. ssp. *rugosa*, (T) *DJ 1964*
Solidago tortifolia Elliott, (NC) *GW 3458b*
**Sonchus asper* (L.) Hill, (T) *MM 5902*
**Sonchus oleraceus* L., (T) *MM 5294*
Symphyotrichum dumosum (L.) Nesom, (H T) *GW 2429b, 2430a; MM 3743; LB 27113*
Symphyotrichum divaricatum (Nutt.) Nesom (T) *GW 2429a, 2866*
Symphyotrichum lateriflorum (L.) A. & D. Love, (H T) *GW 2834, 3445*
Symphyotrichum pratense (Raf.) Nesom, (T) *MM 5908; CL 901189; GW 2897*
Symphyotrichum racemosum (Elliott) Nesom, (T) *LB 27570*
Thelesperma flavodiscum (Shinners) B.L. Turner, (H) *GW 2653, 2827; LB 27129*
Verbesina helianthoides Michx., (H) *DJ 1663*
Verbesina virginica L., (H) *MM 5924, 5171*
Vernonia missurica Raf., (H) *GW 206b, 2680; DJ 1815*
Vernonia texana (A. Gray) Small, (T) *MM 5752*

BERBERIDACEAE

Podophyllum peltatum L., (H T) *MM 5239, 5298*

BETULACEAE

Alnus serrulata (Aiton) Willd., (T) *DJ 1739, 1730*
Betula nigra L., (H) *DJ 1673*
Carpinus caroliniana Walter, (H T) *LB 27491; MM 4987, 5437; GW 918*
Ostrya virginiana (Mill.) K. Koch, (H) *GW 206a*

BIGNONIACEAE

Bignonia capreolata L., (H T) *MM 6052, 6043*
Catalpa speciosa (Warder) Warder ex Engelm., (H T) *GW 2624; DJ 1680*

BLECHNACEAE

Woodwardia areolata (L.) T. Moore, (T) *MM 5261*
Woodwardia virginica (L.) Small., (T) *MM 5087; DJ 1706*

BORAGINACEAE

Heliotropium indicum L., (H) *MM 5644*
Lithospermum caroliniense (Walter ex J.F. Gmel.) MacMill., (H) *LB 27131*
Myosotis macrosperma Engelm., (H) *MM 5304*

BROMELIACEAE

Tillandsia usneoides (L.) L., (H) LB 27469; *MM 5173*

BUDDLEJACEAE

Polypremum procumbens L., (H) *MM 4994, 5364, 5393*

BURMANNIACEAE

Apteria aphylla Nutt., (T) *DJ 1895*
Burmannia capitata (J.F. Gmel.) Mart., (T) *MM 5772*

CACTACEAE

Lobelia appendiculata A.DC., (H T) *MM 5365, 5456*
Lobelia cardinalis L., (H) *DJ 1953*
Lobelia puberula Michx., (H T) *MM 5894, CL 901197, 901112; LB 8148*
Lobelia reverchonii B.L.Turner, (H T) *MM 5895; GW 2831*
Triodanis perfoliata (L.) Nieuwl., (H) *GW 2614*
**Wahlenbergia marginata* (Thunb.) A. DC., (H T) *DJ 2062; MM 6056*

CAMPANULACEAE

Lobelia appendiculata A.DC., (H T) *MM 5365, 5456*
Lobelia cardinalis L., (H) *DJ 1953*
Lobelia puberula Michx., (H T) *MM 5894, CL 901197, 901112; LB 8148*
Lobelia reverchonii B.L.Turner, (H T) *MM 5895; GW 2831*
Triodanis perfoliata (L.) Nieuwl., (H) *GW 2614*
**Wahlenbergia marginata* (Thunb.) A. DC., (H T) *DJ 2062; MM 6056*

CAPPARACEAE

**Cleome hassleriana* Chodat., (H) *DJ 1963, 2070*

CAPRIFOLIACEAE

**Lonicera japonica* Thunb., (H) *MM 5391*
Lonicera sempervirens L., (H) *MM5244; DJ 1685*
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, (H) *MM 5384; LB 27110*
Viburnum acerifolium L., (H T) *LB 27487; GW 2629*
Viburnum dentatum L., (H T) *MM 5795, 5005, 4970; LB 27077*
Viburnum nudum L. var. *cassinoides* (L.) Torr & A. Gray (including *V. nitidum* Aiton), (T) *DJ 1731*
Viburnum rufidulum Raf., (H T) *DJ 2003, 2085*

CARYOPHYLLACEAE

**Cerastium glomeratum* Thuill., (H) *MM 5307, 6053*
Sagina decumbens (Elliott) Torr. & A. Gray, (H) *MM 6005*
Silene subciliata B.L. Rob.., (H T) *MM 5801, 5157; DJ 1684*

CELASTRACEAE

Euonymus americanus L., (H) *MM 6042*

CHENOPODIACEAE

+*Dysphania ambrosioides* (L.) Mosyakin & Clements, (H) *MM 5932; LB 27457*

CISTACEAE

Helianthemum carolinianum (Walter) Michx., (H T) *DJ 1646, 1891; MM 6057*
Helianthemum georgianum Chapm., (T) *DJ 2064*
Lechea mucronata Raf., (H T) *MM 5786, 5012; DJ 2053 1701*
Lechea tenuifolia Michx., (H) *DJ 1700*

CLETHRACEAE

Clethra alnifolia L., (T) *SE 2034; LB 18634; DJ 1787*

COMMELINACEAE

Commelina erecta L., (H T) *MM 5806, 4772; LB 27070; GW 2668*
Commelina virginica L, (H) *DJ 1677*
Tradescantia reverchonii Bush, (H) *MM 4996*

CONVOLVULACEAE

Dichondra carolinensis Michx., (H T) *MM 5251; SE 2018; LB 27095a*
Jacquemontia tamnifolia (L.) Griseb., (T) *DJ 2044*
**Ipomoea hederacea* Jacq., (T) *MM 5799*
Ipomoea pandurata (L.) G. F.W. Mey., (T) *DJ 1733, 1736*
Ipomoea cordatotriloba Dennst., (T) *DJ 1784*
Stylisma pickeringii (Torr. ex. M.A. Curtis) A. Gray var. *pattersonii* (Fernald & B.G. Schub.) Myint, (H) *DJ 1650*

CORNACEAE

Cornus florida L., (H T) *LB 27470; MM 5170, 5238; SE 2019*
Nyssa aquatica L., (T) *DJ 1740*
Nyssa biflora Walter, (H T) *MM 5197, 5086; DJ 2004; LB 27565*
Nyssa sylvatica Marshall, (H T) *MM 5116a, 5001*

CRASSULACEAE

Penthorum sedoides L., (H) *GW 2675*

CUPRESSACEAE

Juniperus virginiana L., (H) *MM 4975*
Taxodium distichum (L.) L.C. Rich. var. *distichum*, (H) *MM*
5271; LB 27463

CUCURBITACEAE

Melothria pendula L., (H) *DJ 1792*

CUSCUTACEAE

Cuscuta compacta Juss. ex Choisy, (T) *LB 8157; DJ 2090*

CYPERACEAE

*+*Bulbostylis barbata* (Rottb.) C. B. Clark, (T) *DJ 2037*
Bulbostylis ciliatifolia (Elliott) Fernald var. *coarctata* (Elliott) Kral, (H T) *MM 5158, 5002; DJ 1961, 2035*

Carex atlantica Bailey ssp. *capillacea* (Bailey) Reznicek, (T) *MM 5256*
Carex brevior (Dewey) Mack. ex Lunell, (T) *DJ 1880*
Carex caroliniana Schwein., (T) *MM 5418*
Carex crebriflora Wiegand, (T) *MM 5415*
Carex debilis Michx. var. *debilis*, (H T) *MM 5419, 5270; LB 27083*
Carex flaccosperma Dewey, (T) *MM 5430*
Carex glaucescens Elliott, (T) MM *5775, 5073*
Carex intumescens Rudge, (H T) *MM 5413; LB 27086*
Carex joorii Bailey, (H T) *MM 5789; LB 27459; DJ 2075, 1813*
Carex lonchocarpa Willd., (H) *MM 5649; LB 27072a*
Carex louisianica Bailey, (H) *MM 5642; LB 27093*
Carex lurida Wahlenb., (T) *DJ 2036*
Carex muehlenbergii Schkuhr ex Willd. var. *enervis* Boott, (H) *MM 5405*
Carex styloflexa Buckley, (T) *MM 5414, 5262*
Carex tenax Chapm., (H) *MM 5632*
Carex texensis (Torr.) Bailey, (T) *MM 5431*
Carex tribuloides Wahlenb., (T) *DJ 1746*
Cyperus compressus L., (T) *DJ 2024*
Cyperus croceus Vahl, (H T) *MM 5153, 5006; DJ 1794; LB 27071*
Cyperus digitatus Roxb., (H T) *DJ 1969, 2050*
Cyperus echinatus (L.) Wood, (T) *LB 18631*
**Cyperus entrerianus* Boeck., (T) *MM 5784*
Cyperus esculentus L., (T) *DJ 2040*
Cyperus grayioides Mohlenbr., (H) *MM 4131, 5652; DJ 1803; LB 27071a*
Cyperus haspan L., (T) *LB 27594; WC 10844*
Cyperus hystricinus Fernald, (H) *MM 5923, 4968; LB 27454*
Cyperus plukenetii Fernald, (H) *DJ 1653*
Cyperus retroflexus Buckley, (T) *DJ 2023*
Cyperus retrorsus Chapm., (H) *MM 4961; LB 27482*
Cyperus strigosus L., (H) *MM 5151*
Eleocharis microcarpa Torr., (T) *LB 6662; MM 3937; DJ 1870*
Eleocharis montana (Kunth) Roem. & Schult., (T) *DJ 1861*
Eleocharis montevidensis Kunth, (T) *MM 5247*
Eleocharis tuberculosa (Michx.) Roem. & Schult., (T) *MM 3883*
Fimbristylis autumnalis (L.) Roem. & Schult., (H T) *DJ 1971, 1835*
Fuirena breviseta (Coville) Coville, (T) *LB 6664*
Fuirena bushii Kral, (T) *MM 3511*
Kyllinga odorata Vahl, (T) *DJ 1753*
Rhynchospora cephalantha A. Gray, (T) *DJ 1822*
Rhynchospora colorata (L.) Pfeifer, (H) *MM 5375*
Rhynchospora corniculata (Lam.) A. Gray, (H T) *MM 5811, 5643*
Rhynchospora divergens Chapm. ex M.A. Curtis, (H) *DJ 2009, 2016, 2017*
Rhynchospora elliottii A. Gray, (T) *MM 5432; DJ 1705*
Rhynchospora fascicularis (Michx.) Vahl, (T) *DJ 1707, 1710*
Rhynchospora filifolia A. Gray, (T) *DJ 1827, 1824*
Rhynchospora globularis (Chapm.) Small var. *globularis*, (T) *DJ 2094*
Rhynchospora globularis (Chapm.) Small var. *pinetorum* (Britton & Small) Gale, (H) *DJ 1992, 2006*
Rhynchospora glomerata (L.) Vahl, (H T) *MM 5665; D J 2096, 1864; LB 27066*
Rhynchospora gracilenta A. Gray, (T) *MM 3496*
Rhynchospora grayi Kunth, (H) *LB 27137*
Rhynchospora harveyi W. Boott, (T) *LB 18632, 18659*
Rhynchospsora inexpansa (Michx.) Vahl, (H T) *LB 27084, 6680*
Rhynchospora latifolia (Baldwin ex Elliott) W. W. Thomas, (T) *MM 3891; LB 18656*
Rhynchospora macrostachya Torr ex A. Gray., (T) *DJ 2096a*
Rhynchospora mixta Britton, (H T) *MM 5653; LB 27123, 18636*
Rhynchospora oligantha A. Gray, (T) *LB 11092; MM 3495*
Rhynchospora perplexa Britton, (T) *DJ 1819, 1832, 1826*
Rhynchospora plumosa Elliott, (T) *MM 3885; DJ 1708*
Rhynchospora pusilla M.A. Curtis, (H) *LB 30124a*
Rhynchospora rariflora (Michx.) Elliott, (T) *MM 3884*
Rhynchospora recognita (Gale) Kral, (T) *DJ 1760, 1781*
Sclera ciliata Michx., (T) *KC 55*
Scleria georgiana Core, (T) *MM 3882*
Scleria oligantha Michx., (T) *MM 5471*
Scleria reticularis Michx., (T) *MM 3499*
Scleria triglomerata Michx., (T) *MM 5269*
Scirpus cyperinus (L.) Kunth, (T) *DJ 1823*

CYRILLACEAE

Cyrilla racemiflora Raf., (H T) *LB 27473a; MM 3505, 5089*

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn, (H T) *MM 5120, 5313; LB 27121*

DIOSCOREACEAE

+*Dioscorea villosa* L., (H) *DJ 1796, 1811, 1962; MM 6036*

DROSERACEAE

Drosera brevifolia Pursh, (T) *MM 3789*
Drosera capillaris Poir., (T) *MM 3889*

DRYOPTERIDACEAE

Athyrium filix-femina (L.) Roth var. *asplenioides* (Michx.) Farw., (T) *MM 5429, 5258; DJ 1967, 1729*
Onoclea sensibilis L., (H) *DJ 1683*
Polystichum acrostichoides (Michx.) Schott, (H) *MM 5310; GW 109*

EBENACEAE

Diospyros virginiana L., (T) *MM 5474*

ERICACEAE

Lyonia mariana (L.) D. Don, (H T) *MM 4064; DJ 1807*
Rhododendron canescens (Michx.) Sweet, (H T) *MM 5226, 5237, SE 2020*
Rhododendron viscosum (L.) Torr., (T) *PH 004*
Vaccinium arboreum Marshall, (H) *MM 5008, 5407*
Vaccinium corymbosum L., (H T) *MM 5280, 5312; DJ 1742, 2086*
Vaccinium stamineum L., (T) *LB 27580; PH 008, 237*

ERIOCAULACEAE

Eriocaulon decangulare L., (T) *MM 5083*
Lachnocaulon anceps (Walter) Morong, (H T) *MM 5059; GW 2556*

EUPHORBIACEAE

Acalypha gracilens A. Gray, (T) LB 27523; DJ 1774
Acalypha rhomboidea Raf., (H T) GW 2671; DJ 1775
Chamaesyce cordifolia (Elliott) Small, (H) *LB 27068, 27448; MM 5150; GW 2377*
Chamaesyce maculata (L.) Small, (T) *LB 27554; DJ 2100*
Chamaesyce nutans (Lag.) Small, (T) *LB 27562*
Cnidoscolus texanus (Mull. Arg.) Small, (H) *MM 4988, 5389; LB 27118*
Croton argyranthemus Michx., (H T) *MM 5058, 5449, GW 2613; LB 27141*
Croton capitatus Michx., (T) *MM 5208, 5064; CL 901188*
Croton glandulosus L. var. *septentrionalis* Mull. Arg. (T) *MM 5204, GW 2656*
Croton michauxii G.L. Webster, (H) *GW 2423b, 2438; LB 27119*
Croton willdenowii G.L. Webster, (T) *DJ 2063; LB 19685*
Euphorbia corollata L., (T) LB 27529; *MM 5759, 5109, 5192*
Phyllanthus caroliniensis Walter, (T) *DJ 1773*
**Phyllanthus urinaria* L., (T) *LB 27561*
Sebastiania fruticosa (W. Bartram) Fernald, (H T) *LB 27498, 27073; MM 5053, 4962;*
Stillingia sylvatica Garden ex L., (T) *MM 5054, 5448*
Tragia smallii Shinners, (T) *MM 5056; LB 18633*
Tragia urens L., (H) *GW 2382, 2650, 2658; LB 27119a*
Tragia urticifolia Michx., (T) *MM 5205, 5101, 5464*
**Triadica sebifera* (L.) Small, (H) *MM 4998; LB 27091*

FABACEAE

**Albizia julibrissin* Durazzo, (H) *MM 5167; LB 27108*
Amorpha paniculata Torr. & A. Gray, (T) *MM 5800*
Apios americana Medik., (H) *DJ 1951*
Baptisia nuttalliana Small, (H) *LB 27128*
Centrosema virginianum (L.) Benth., (T) *MM 5798; GW 2709a, 2745*
Cercis canadensis L. var. *canadensis*, (T) *MM 5183*
Chamaecrista fasciculata (Michx.) Greene, (T) *MM 5760, 5065; GW 2744; CL 901118*
Chamaecrista nictitans (L.) Moench, (NC) *GW 2739*
Clitoria mariana L., (H) *LB 27081*
Crotalaria sagittalis L., (T) *DJ 1851; CL 90191*
Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald, (T) *DJ 1854*
Desmodium ciliare (Muhl. ex Willd.) DC., (H T) *MM 5893; GW 2738; DJ 2107, 1804*
Desmodium glabellum (Michx.) DC., (NC) *GW 2366, 2743*
Desmodium laevigatum (Nutt.) DC., (T) *DJ 2018*
Desmodium nuttallii (Schindl.) B. G. Schub., (H T) *DJ 2111, 1656, 1853*
Desmodium obtusum (Muhl. ex Willd.) DC., (H) *LB 27507*
Desmodium paniculatum (L.) DC., (H) *MM 5143; GW 2740*
Desmodium rotundifolium DC., (T) *DJ 1959*
Desmodium viridiflorum (L.) DC., (T) *GW 2741, 2742*
Erythrina herbacea L., (T) *DJ 1750*
Galactia volubilis (L.) Britton, (H) *LB 27477; GW 2643*

**Kummerowia striata* (Thunb.) Schindl., (H) *DJ 1696*

Indigofera suffruticosa Mill., (H) *MM 5928, 5160; LB 27452*

**Lespedeza cuneata* (Dum.Cours.) G. Don, (H) *DJ 1697*

Lespedeza hirta (L.) Hornem. (H T) *DJ 1809, 1764*

Lespedeza repens (L.) Barton, (T) *DJ 2030*

Lespedeza stuevei Nutt., (H T) *DJ 2107a, 1853, 1848*

Mimosa hystricina (Small ex Britton & Rose) B.L. Turner, (T) *MM 5443; PH 009*

Mimosa latidens (Small) B.L. Turner, (H) *LB 27139, 27449*

Mimosa strigillosa Torr. & A. Gray, (T) *DJ 1847*

Rhynchosia difformis (Elliott) DC., (H T) *LB 27464, 18657; GW 2430b; DJ 1988a*

Rhynchosia latifolia Nutt. ex. Torr. & A. Gray, (H) *DJ 1691*

Rhynchosia reniformis DC., (H) LB 27127; *MM 5392, 5460*

Senna obtusifolia (L.) Irwin & Barneby, (T) *DJ 1855*

**Senna occidentalis* (L.) Link, (T) *DJ 2022*

Sesbania drummondii (Rydb.) Cory, (T) *DJ 1779*

Strophostyles helvula (L.) Elliott, (T) LB *27546*

Strophostyles umbellata (Muhl. ex Willd.) Britton, (H T) *MM 5785, 5746; LB 27097; GW 2760*

Stylosanthes biflora (L.) Britton, Sterns & Poggenb., (T) *MM 5051, 5454*

Tephrosia onobrychoides Nutt., (T) *LB 27584*

Tephrosia virginiana (L.) Person, (H) *DJ 1659; LB 27082*

**Trifolium campestre* Schreb., (H) *MM 5248*

**Trifolium repens* L., (H) *MM 6041*

Wisteria frutescens (L.) Poir., (H T) *MM 5311; DJ 1786; LB 27112*

Zornia bracteata J.F.Gmel., (HT) *GW 2746; DJ 1988, 1988a; MM 6045*

FAGACEAE

Castanea pumila (L.) Mill. var. pumila, (T) *MM 5807*

Fagus grandifolia Ehrh., (H T) *MM 5115, 5264; LB 27493*

Quercus alba L., (H T) *LB 27480; MM 5063, 4977, 5422*

Quercus falcata Michx., (H T) *MM 4956, 5382, 5368; LB 27564*

Quercus hemisphaerica W. Bartram ex Willd., (H) *MM 4984, 4957, 5406; LB 27502*

Quercus incana W. Bartram, (H) *MM 5394, 5396; LB 27144*

Quercus laurifolia Michx., (H T) *MM 5074, 5075; LB 27497, 27494*

Quercus margaretta (Ashe) Ashe, (H T) *LB 27455; MM 5112, 4979, 4995*

Quercus marilandica Munchh.., (T) *MM 6051*

Quercus michauxii Nutt., (H T) *LB 27483; MM 4982, 5434, 5233*

Quercus nigra L., (H) *MM 4985, 5386*

Quercus phellos L., (H) *LB 27485*

+*Quercus velutina* Lam., (T) *PH 313*

Quercus virginiana Mill., (H) *LB 27468*

GENTIANACEAE

Bartonia verna (Michx.) Raf. ex Barton, (T) *MM 5670*

Sabatia gentianoides Elliott, (H T) *MM 5670, 4007*

GERANIACEAE

Geranium carolinianum L., (H T) *MM 6066, 6058, 6054*

GROSSULARIACEAE

Itea virginica L., (H T) *LB 27473a, 27092; GW 2632*

HALORAGACEAE

Myriophyllum pinnatum (Walter) Britton, Sterns &Poggenb., (T) *GW 2308*

Proserpinaca palustris L., (T) *MM 5776*

Proserpinaca pectinata Lam., (H T) *GW 2670b; LB 18658*

HAMMAMELIDACEAE

Hamamelis virginiana L., (H T) *MM 5010, 5436, 5267*

Liquidambar styraciflua L., (H T) *LB 27496; MM 4997, 5383, 5297*

HIPPOCASTANACEAE

Aesculus pavia L., (H) *MM 5234*

HYDROPHYLLACEAE

Hydrolea ovata Nutt. ex Choisy, (H T) *MM 5779; GW 2683*

HYPERICACEAE

Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray, (H T) *DJ 1997; PH 901136*

Hypericum crux-andreae (L.) Crantz, (T) *DJ 1702*

Hypericum galioides Lam., (T) *MM 5663, 3502; LB 6681*

Hypericum gentianoides (L.) Britton, Sterns & Poggenb., (T) *MM 5751; LB 5580*

Hypericum gymnanthum Engelm. & A. Gray, (T) *KC 38*

Hypericum hypericoides (L.) Crantz, (H T) *MM 5055, 4983*

Hypericum mutilum L., (H) *LB 27122*

Triadenum tubulosum (Walter) Gleason, (H) *MM 5921, 5638; LB 27451, 27103*

Triadenum walteri (J.G.Gmel.) Gleason, (H T) *MM 5814; LB 27462, 27451; GW 2893*

IRIDACEAE

Alophia drummondii (R. A. Graham) R. C. Foster, (T) *MM 5061*

Sisyrinchium angustifolium Mill., (T) *MM 5412*

Sisyrinchium campestre E.P Bicknell, (T) *MM 5220; GW 2545*

Sisyrinchium rosulatum E. P. Bicknell, (H T) *MM 5458; GW 2477*

Sisyrinchium sagittiferum E. P. Bicknell, (H T) *MM 6067, 6044*

JUGLANDACEAE

Carya aquatica (Michx. f.) Nutt., (H) *MM 5640, 5639*

Carya cordiformis (Wangenh.) K. Koch, (H) *MM 5926; LB 27456*

Carya glabra (Mill.) Sweet, (H) *DJ 1984, 1985*

Carya texana Buckley, (H) *MM 5654, 5655, 5164; LB 27132*

Carya tomentosa (Lam. ex Poir.) Nutt., (H T) *MM 5815, 5433; DJ 1987; LB 27142*

JUNCACEAE

Juncus acuminatus Michx., (T) *DJ 1747*

Juncus dichotomus Elliott, (T) *DJ 2099, 1862*

Juncus marginatus Rostk., (T) *DJ 1860, 1767*

Juncus repens Michx., (T) *MM 5778; DJ 1836*

Juncus scirpoides Lam., (T) *DJ 2032, 2089, 1768, 1887*

Juncus tenuis Willd., (H) *LB 27115*

Juncus validus Coville, (T) *MM 5067; DJ 2091, 1763*

LAMIACEAE

Hedeoma drummondii Benth., (H) *GW 2617a*

Hyptis alata (Raf.) Shinners, (T) *MM 5071, 3625; DJ 1759, 1899*

Lycopus rubellus Moench, (T) *MM 5805; GW 2867*

Lycopus virginicus L., (H T) *GW 2894; DJ 2082, 2087*

Monarda punctata L., (H T) *MM 5816, 5145*

**Perilla frutescens* (L.) Britton, (H) *LB 8149, 27147*

Physostegia digitalis Small, (T) *DJ 1777, 1722*

Prunella vulgaris L., (T) *MM 5467*

Pycnanthemum albescens Torr. & A. Gray, (T) *DJ 1856*

Salvia azurea var. *grandiflora*. Michx ex Lam., (T) *MM 5180; GW 2899; LB 27578*

Salvia lyrata L., (H T) *MM 4981, 5254*

Scutellaria cardiophylla Engelm. & A.Gray, (H) *GW 2654*

Scutellaria elliptica Muhl. ex Spreng., (H) *MM 5377, 5356; LB 27149, 18629*

Scutellaria integrifolia L., (H T) *MM 3881, 5440; GW 2612*

Stachys crenata Raf., (H) *MM 5308*

Stachys tenuifolia Willd., (H) *GW 2674*

Teucrium canadense L., (H) *DJ 1670*

Trichostema dichotomum L., (H T) *MM 5914, 5899, 5817, CL 901185*

Trichostema setaceum Houtt., (H) *GW 2376*

LAURACEAE

Persea borbonia (L.) Spreng., (H) *DJ 1668*

Persea palustris (Raf.) Sarg., (H T) *MM 5918, 5195, 5181, 5105*

Sassafras albidum (Nutt.) Nees, (H) *LB 27080*

LENTIBULARIACEAE

Pinguicula pumila Michx., (H T) *MM 5094, 5303, 3790*

Utricularia subulata L., (T) *MM 5222; LB 11091*

LILIACEAE

Aletris aurea Walter, (T) *MM 3629*

Allium canadense L. var. *mobilense* (Regel) Ownbey, (H) *MM 5373*

Hypoxis curtissii Rose, (H T) *MM 5783, 5438; GW 2670; DJ 1737*

Hypoxis hirsuta (L.) Coville, (T) *MM 3720*

Hypoxis rigida Chapm., (T) *GW 2757*

Hypoxis sessilis L., (T) *DJ 2034*

*+*Lilium formosanum* Wallace, (T) *DJ 1896*

Nothoscordum bivalve (L.) Britton, (T) *MM 529; SE 2014*

*+*Ophiopogon jaburan* Lodd., (H) *DJ 1797*

Schoenolirion croceum (Michx.) Wood, (T) *MM 3792*

Triantha racemosa (Walter) Small, (T) *MM 3513; PH 011*

+*Trillium recurvatum* Beck, (H) *MM 5318*

LINACEAE

Linum medium (Planch.) Britton var. *texanum* (Planch.) Fernald, (H T) *MM 5072, 5347; DJ 2051*

Linum striatum Walter, (NC) *GW 2427*

LOGANIACEAE

Gelsemium sempervirens (L.) J. St.-Hil., (H T) *MM 5057, 5236*

Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray, (T) *MM 5787; DJ 1758*
Mitreola sessilifolia (J.F. Gmel.) G. Don, (T) *MM 5773,3510*

LYCOPODIACEAE
Lycopodiella appressa (Chapm.) Cranfill, (T) *MM 3506*

LYGODIACEAE
**Lygodium japonicum* (Thumb. ex Murr.) Sw., (H T) *MM 5119, 5225; LB 27094*

LYTHRACEAE
Ammannia coccinea Rottb., (T) *GW 2855*
**Cuphea carthagenensis* (Jacq.) J.F. Macbr., (T) *MM 5812, 5650; WC 10841; GW 2432*
Rotala ramosior (L.) Koehne, (H) *DJ 1938*

MAGNOLIACEAE
Magnolia grandiflora L., (H T) *LB 27489; MM 4999, 5266*
Magnolia virginiana L., (T) *MM 5085*

MALVACEAE
Hibiscus moscheutos L., (NC) *GW 2560*
Malvaviscus arboreus Dill. ex Cav. var. *drummondii* (Torr. & A. Gray) Schery, (H) *MM 5633; GW 2836; LB 27136*
Sida rhombifolia L., (H) *MM 5645*
Sida spinosa L., (T) *DJ 2056*

MELASTOMATACEAE
Rhexia lutea Walter, (T) *MM 3944; DJ 1714*
Rhexia mariana L., (T) *MM 5756, 3942; GW 2753, 2873*
Rhexia petiolata Walter, (T) *GW 2433*

MENISPERMACEAE
Cocculus carolinus (L.) DC., (T) *GW 2646*

MOLLUGINACEAE
Mollugo verticillata L., (H) *MM 5003; DJ 1675*

MONOTROPACEAE
Monotropa uniflora L., (T) *MM 5892; SE 2033*

MORACEAE
Morus rubra L., (H T) *MM 5769, 5427; GW 2464b, 2621*

MYRICACEAE
Morella caroliniensis (Mill.) Small, (H T) *MM 5092, 5424; DJ 1748*
Morella cerifera (L.) Small, (T) *MM 5093, 5246; GW 2833*

OLEACEAE
Chionanthus virginicus L., (T) *MM 6061*
Forestiera acuminata (Michx.) Poir., (T) *GW 2293*
Fraxinus americana L., (H T) *MM 5808; GW 1446a, 2454; LB 27096*
Fraxinus caroliniana Mill., (H) *DJ 1970*
Fraxinus pennsylvanica Marshall, (H T) *MM 5791, 5792; LB 27461a*
**Ligustrum sinense* Lour., (H) *MM 5385; LB 27105*

ONAGRACEAE
Gaura lindheimeri Engelm. & A. Gray, (H) *MM 5671*
Gaura longiflora Spach, (H T) *MM 5889, 5141; DJ 2103*
Ludwigia alternifolia L., (T) *DJ 1772*
Ludwigia decurrens Walter, (T) *GW 2755a, 2861*
Ludwigia glandulosa Walter, (H T) *GW 2672, 2762; DJ 1986*
Ludwigia hirtella Raf, (T) *DJ 1770*
Ludwigia linearis Walter, (H T) *MM 5781, 5668, 5069; GW 2871*
+*Ludwigia microcarpa* Michx., (T) *DJ 1885*
Ludwigia octovalvis (Jacq.) Raven, (H) *DJ 2008*
Ludwigia palustris (L.) Elliott, (H) *DJ 1943*
Ludwigia pilosa Walter, (H T) *GW 2758; MM 3599; DJ 1979*
Oenothera biennis L., (H T) *DJ 2054, 2110*
Oenothera laciniata Hill, (T) *MM 6065*
Oenothera mexicana Spach, (H) *MM 5380*

OPHIOGLOSSACEAE
Botrychium biternatum (Sav.) Underwood, (H T) *MM 5909, 5299; LB 27467*
Botrychium virginianum (L.) Sw., (H) *GW 2667*

ORCHIDACEAE
Calopogon tuberosus (L.) Britton, Sterns & Poggenb., (T) *MM 3945*
Spiranthes cernua (L.) L.C. Rich., (T) *MM 5897, 5903; LB 27531*
Spiranthes tuberosa Raf., (T) *PH 312*
Spiranthes vernalis Engelm. & A. Gray, (H) *MM 5376*
Tipularia discolor (Pursh) Nutt., (T) *MM 5296*

OROBANCHACEAE
Epifagus virginiana (L.) Barton, (T) *MM 5257*

OSMUNDACEAE
Osmunda cinnamonea L., (T) *MM 3794; DJ 1846*
Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray, (T) *MM 3793*

OXALIDACEAE
+*Oxalis corniculata* L. var. *wrightii* (A. Gray) B.L. Turner, (T) *GW 2524; MM 5206, 5447, 5276*

***Oxalis debilis* Kunth var. *corymbosa* (DC.) Lourteig, (T) *DJ 1771*
Oxalis lyonii Pursh, (T) *M 5252*
Oxalis violacea L., (T) *MM 5193, 5469*

PASSIFLORACEAE

Passiflora lutea L., (H) *MM 5674, 5169; LB 27450, 27154*

PHYTOLACCACEAE

Phytolacca americana L., (H T) *MM 5813; GW 306*

PINACEAE

Pinus echinata Mill., (H T) *MM 5242; GW 822; LB 27067*
**Pinus elliottii* Engelm., (T) *MM 5223*
Pinus palustris Mill., (T) *MM 5088; GW 823, 917*
Pinus taeda L., (H) *MM 4959,5243*

PLANTAGINACEAE

Plantago aristata Michx., (H) *GW 2610a*
**Plantago major* L., (T) *LB 27151*
Plantago virginica L., (H) *MM 5390, 5305; GW 2609a*

PLATANACEAE

Platanus occidentalis L., (H) *MM 5166*

POACEAE

Agrostis elliottiana Schult., (H) *GW 2547*
Agrostis hyemalis (Walter) Britton, Sterns & Poggenb., (H T) *GW 2552; DJ 1884*
Agrostis perennans (Walter) Tuck.,(H T) *DJ 1952, 2080*
Andropogon gerardii Vitman, (T) *KC 103*
Andropogon gyrans Ashe var. *gyrans*, (H) *GW 2369b*
Andropogon glomeratus (Walter) Britton, Sterns & Poggenb., (T *MM 6060*
Andropogon ternarius Michx., (T) *PH 901129, 901131; GW 2904*
Andropogon virginicus L., var. *virginicus*, (H T) *MM 5916; GW 2369a; LB 27527, 8159*
Anthaenantia texana (Nutt.) Kral, (T) *LB 6679, 27542; GW 2900; MM 3619*
Aristida desmantha Trin. & Rupr., (H) *GW 2361, 2383, 2828*
Aristida lanosa Muhl. ex Willd., (H) *GW 2362, 2835, 2393, 2825*
Aristida longispica Poir. var. *geniculata* (Raf.) Fernald, (H) *GW 2824*
Aristida *longispica* Poir. var. *longispica*, (T) *LB 27533*
Aristida palustris (Chapm.) Vasey, (T) *MM 3618; LB 19685*
Aristida purpurascens Poir. var *purpurascens*, (T) *KC 126*
Aristida purpurascens Poir. var. *virgata* (Trin.) Allred, (T) *MM 5744, 3498; LB 27537, 19683*
Arundinaria gigantea (Walter) Muhl., (H) *MM 5168, 5265, GW 1305; LB 27488*
Axonopus fissifolius (Raddi) Kuhlm., (H T) *MM 5198, 5111, LB 27104; GW 2669b*
**Briza minor* L., (H T) *MM 5306, 5274; GW 2543*
Cenchrus spinifex Cav., (H) *DJ 1674*
Chasmanthium latifolium (Michx.) Yates, (H T) *MM 5794; LB 27495*
Chasmanthium laxum (L.) Yates var. *laxum*, (H T) *MM 5177, 5172, 5679, 5753*
Chasmanthium laxum (L.) Yates var. *sessiliflorum* (Poir.) Wipff & S. Jones, (H) *MM 5174, 4960; GW 2678*
Coelorachis rugosa (Nutt.) Nash, (T) *MM 5199; GW 2686*
**Cynodon dactylon* (L.) Pers., (T) *DJ 1761*
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark var. *aciculare*, (T) *LB 27501*
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark var. *angustifolium* (Elliott) S.L. Hatch, (H T) *DJ 2061, 2065*
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*, (T) *MM 5465, 5452; Brown 16013*
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *longiligulatum* (Nash) Gould & C.A. Clark, (H) *MM 5366*
Dichanthelium boscii (Poir.) Gould & C.A. Clark, (H) *MM 5387; LB 27107, 18635*
Dichanthelium commutatum (Schult.) Gould ssp. *commutatum*, (H T) *MM 5420, 5098; LB 27501; DJ 1935*
Dichanthelium consanguineum (Kunth) Gould & C.A. Clark, (T) *MM 5106*
Dichanthelium depauperatum (Muhl.) Gould, (H) *LB 27145*
Dichanthelium dichotomum (L.) Gould var. *dichotomum*, (T) *MM 5097, 5416, 5417*
Dichanthelium dichotomum (L.) Gould var. *microcarpon*, (T) *DJ 1966*
Dichanthelium laxiflorum (Lam.) Gould, (H T) *MM 5315; LB 19682, 11088*
Dichanthelium oligosanthes (Schult.) Gould, (T) *LB 16012*

Dichanthelium ovale (Elliott) Gould & C.A. Clark ssp. *ovale* (T) *MM 6277*

Dichanthelium polyanthes Mohlenbr., (T) *LB 11089; MM 5453*

Dichanthelium scabriusculum (Elliott) Gould & C.A. Clark, (T) *MM 3938* and at SBSC *3949*

Dichanthelium sphaerocarpon (Elliott) Gould, (H) *DJ 2001*

Digitaria ciliaris (Retz.) Koel., (H T) *MM 5647, 5648; GW 2851; LB 27595*

Digitaria cognata (Schult.) Pilg., (H T) *GW 2370, 2902; CI 901192*

**Digitaria ischaemum* (Schreb.) Schreb., (T) *LB 27525; PH 901137*

Digitaria filiformis (L.) Koel. var. *villosa* (Walter) Fernald, (H) *MM 5925; LB 27453; GW 2368, 2384*

**Echinochloa colona* (L.) Link, (T) *GW 2854*

**Eleusine indica* (L.) Gaertn., (T) *LB 27544*

Eragrostis elliottii S. Wats., (T) *KC105*

Eragrostis hirsuta (Michx.) Nees, (H) *MM 4971*

Eragrostis hypnoides (Lam.) Britton, Sterns & Poggenb., (H) *GW 2681*

Eragrostis intermedia Hitchc., (T) *DJ 1849*

Eragrostis lugens Nees, (T) *DJ 2028, 2024*

Eragrostis refracta (Muhl.) Scribn., (T) *MM 3623; GW 2434, 2901*

Eragrostis secundiflora J. Presl & C. Presl ssp. *oxylepis* (Torr.) S.D. Koch, (H T) *MM 5658, 5661; DJ 2057, 2055*

Eragrostis spectabilis (Pursh) Steud., (T) *MM 5743, 5900; DJ 2021*

**Eremochloa ophiuroides* (Munro) Hack., (T) *DJ 1844*

Eustachys petraea (Sw.) Desv., (H) *DJ 1998*

Gymnopogon ambiguus (Michx.) Britton, Sterns & Poggenb., (T) *CL 901183*

Leersia hexandra Sw., (T) *DJ 1838*

Leersia virginica Willd., (T) *DJ 1751*

Melica mutica Walter, (H T) *MM 4966, 5268; GW 2451, 2553*

Oplismenus hirtellus (L.) Beauvis., (T) *LB 27577*

Panicum anceps Michx., (H T) *MM 5757, 5646; DJ 1940, LB 27085a*

Panicum brachyanthum Steud., (T) *MM 5901, 3634; LB 27522, CL 901117, 901193*

Panicum gymnocarpon Elliott, (T) *DJ 1744*

Panicum rigidulum Bosc ex Nees, (H T) *MM 5797; DJ 1816, LB 27085*

Panicum tenerum Beyr. ex Trin., (H T) *MM 5657, 5095; DJ 2007*

Panicum verrucosum Muhl., (T) *MM 3634b*

Paspalum dilatatum Poir., (T) *DJ 1762*

Paspalum floridanum Michx., (T) *MM 3626; LB 27555*

Paspalum langei (Fourn.) Nash, (H) *DJ 1698*

Paspalum laeve Michx., (T) *LB 27536, 27539*

**Paspalum notatum* Flugge, (H) *MM 4969*

Paspalum plicatulum Michx., (H T) *MM 5656, 5103, 5370; GW 2664*

Paspalum praecox Walter, (T) *MM 3933, 3719, 3937*

Paspalum repens Bergius, (H T) *DJ 1975, 2081*

Paspalum setaceum Michx., (H T) *GW 2381, 2363; LB 27079, 27140*

**Paspalum urvillei* Steud., (T) *MM 5191, 5066*

Piptochaetium avenaceum (L.) Parodi, (H T) *MM 5255, 5408; GW 2546*

**Poa annua* L., (T) *MM 5275, 5290*

Poa autumnalis Muhl, ex Elliott, (H) *GW 2523a, 2551*

Saccharum giganteum (Walter) Pers., (T) *DJ 1830*

Schizachyrium scoparium (Michx.) Nash var. *divergens* (Hack.) Gould, (H T) *MM 5201; GW 2364, 2371; LB 27524*

Setaria parviflora (Poir.) Kerguelen, (T) *DJ 1783*

Sorghastrum elliottii (Mohr.) Nash, (T) *KC 108*

Sorghastrum nutans (L.) Nash, (H) *DJ 1975*

Sphenopholis obtusata (Michx.) Scribn., (H) *MM 5362*

Sporobolus clandestinus (Biehler) Hitchc., (H) *LB 27505*

Sporobolus compositus (Poir.) Merr. var. *macer* (Trin.) Kartesz & Gandhi, (T) *DJ 2069*

Sporobolus indicus (L.) R. Br., (H) *LB 27101*

Steinchisma hians (Elliott) Nash, (T) *DJ 1766*

Sporobolus junceus (Beauvis.) Kunth, (H T) *GW 2365; LB 27532*

Tridens ambiguus (L.) Schult., (H T) *MM 5677, 3620, 5666; DJ 2015*

Tridens flavus (L.) Hitchc. var. flavus, (H T) *DJ 1991, 2026*

Tridens strictus (Nutt.) Nash, (H) *MM 5666*

Urochloa platyphylla (C. Wright) R.D. Webster, (T) *DJ 2047*

Urochloa texana (Buckley) R.D. Webster, (T) *DJ 2045*

Vulpia octoflora (Walter) Rydb., (H) *GW 2622*

POLEMONIACEAE

Phlox pilosa L., (T) *MM 5455*

POLYGALACEAE

Polygala cruciata L., (T) *MM 3943*
Polygala leptocaulis Torr. & A. Gray, (H) *DJ 2014, 2005*
Polygala mariana Mill., (T) *MM 5078*
Polygala polygama Walter, (T) *MM 5461; DJ 1857*
Polygala ramosa Elliott, (T) *MM 5081*

POLYGONACEAE

Brunnichia ovata (Walter) Shinners, (H) *DJ 1643*
Eriogonum longifolium Nutt. var. *longifolium,* (H) *DJ 1655*
Polygonum punctatum Elliott, (H) *MM 5927, 5637; LB 27458; DJ 1686*
Polygonum hydropiperoides Michx., (T) *DJ 1877, 1820, 1841*

POLYPODIACEAE

Pleopeltis polypodioides Andrews & Windham ssp. *michauxiana* (Weath.) Andrews & Windham (H) *MM 5235; LB 27134*

PORTULACACEAE

Portulaca pilosa L., (H) *DJ 1695*

PRIMULACEAE

**Anagallis arvensis* L., (H) *MM 5372*
Anagallis minima (L.) Krause, (T) *DJ 1845*
Lysimachia radicans Hook., (H T) *MM 5782, 5641, GW 2677; LB 27096a*

RANUNCULACEAE

Clematis crispa L., (H) *GW N05, 2609b*
Clematis reticulata Walter, (H T) *LB 27478; MM 5910, 4991*
**Clematis ternifolia* DC., (H) *DJ 2112*

RHAMNACEAE

Berchemia scandens (Hill) K. Koch, (H T) *MM 5765, 5118; LB 27466, 27133*
Ceanothus americanus L., (T) *DJ 2027*
Rhamnus caroliniana Walter, (T) *MM 5186, PH 012*

ROSACEAE

Agrimonia microcarpa Wallr., (H) *GW 2747; LB 27116*
Crataegus brachyacantha Sarg. & Engelm., (T) *MM 5076*
Crataegus marshallii Egglest., (H T) *MM 5229; LB 27479, 27143*
Crataegus opaca Hook. & Arn., (T) *LB 27538; SE 2008, 2011; DJ 1863*
Crataegus spathulata Michx., (T) *DJ 2097*
**Duchesnea indica* (Andr.) Focke, (T) *MM 5457, 5293*
Photinia pyrifolia (Lam.) Robertson & Phipps, (T) *MM 3759*
Prunus caroliniana (Mill.) Aiton, (H) *DJ 1646*
Prunus gracilis Engelm. & A. Gray, (T) *DJ 1756*
Prunus serotina Ehrh., (H) *MM 5381*
Prunus umbellata Elliott, (H T) *GW 1667, 2453; MM 6049*
Rubus trivialis Michx., (T) *MM 5287*

RUBIACEAE

Cephalanthus occidentalis L., (H) MM 4990
Diodia teres Walter, (H T) *MM 5750, 5068; LB 27093; CL 901182*
Diodia virginiana L., (T) *MM 5777, 5179; LB 27530*
Galium aparine L., (H) *MM 6040*
Galium circaezans Michx., (H) *GW 2623*
Galium hispidulum Michx., (H) *MM 5929; LB 27509*
Galium pilosum Aiton, (H) *GW 2657*
Galium tinctorium (L.) Scop., (H) *MM 6038*
Houstonia micrantha (Shinners) Terrell, (T) *MM 5273*
Houstonia pusilla Schoepf, (T) *MM 5272; SE 2016*
Mitchella repens L., (T) *MM 5108, 5259; LB 27109*
Oldenlandia uniflora L., (T) *GW 2843*
Richardia scabra L., (T) *DJ 2020*
**Sherardia arvensis* L., (T) *SE 2027*
Stenaria nigricans (Lam.) Terrell (T) *PH 242*

RUTACEAE

Ptelea trifoliata L., (H T) MM 5466; *GW 1126, 2648*
**Poncirus trifoliata* (L.) Raf., (H) *DJ 2108*
Zanthoxylum clava-herculis L., (H) *MM 5163; GW 2550a*

SALICACEAE

Salix nigra Marshall, (T) *DJ 1889; MM 6050*

SAPOTACEAE

Sideroxylum lanuginosum Michx., (H) *MM 4989, 5398, 5241*

SARRACENIACEAE

Sarracenia alata Alph. Wood, (T) *MM 5084; PH 541*

SAURURACEAE

Saururus cernuus L., (H T) *LB 27471; MM 5428*

SCROPHULARIACEAE

Agalinis fasciculata (Elliott) Raf., (T) *GW 2750; LB 27535*
Agalinis oligophylla Pennell, (T) *GW 2896*
Agalinis purpurea (L.) Pennell, (H T) *MM 5906; GW 2830; LB 27541, 14886*
Agalinis viridis (Small) Pennell., (H) *LB 6663*

Aureolaria flava (L.) Farw. (H) *MM 5639*
Aureolaria grandiflora (Benth.) Pennell, (H) *MM 5764, 5651; GW 2679; LB 27074*
Bacopa caroliniana (Walter) B.L. Robins., (T) *DJ 1821*
Buchnera americana L., (H T) MM 5662; *DJ 2038*
Gratiola brevifolia Raf., (T) GW 2765; *MM 3936*
Gratiola pilosa Michx., (H) *GW 2655*
Gratiola virginiana L., (H T) *MM 5228; DJ 1944, 1947*
*+*Lindernia crustacea* (L.) F. Muell., (T) *DJ 1881*
Lindernia dubia (L.) Pennell, (H) *DJ 1937, 1982, 1942, 1985*
Mecardonia acuminata (Walter) Small, (H T) *GW 2844, 2859, LB 27548; DJ 1936*
Micranthemum umbrosum (J.G. Gmel.) S.F. Blake, (H) *DJ 1949*
Mimulus alatus Aiton, (H) *DJ 1791*
Nuttallanthus canadensis (L.) D.A. Sutton, (H) *GW 2554*
Penstemon laxiflorus Pennell, (H T) MM 5446; *GW 2544*
Scoparia dulcis L., (H T) MM 5763, 5780, 5672; *WC 10842*
**Verbascum thapsus* L., (T) *GW 2647*
**Veronica arvensis* L., (H) MM 5249

SELAGINELLACEAE
Selaginella apoda (L.) Spring, (H) *MM 5314*

SMILACACEAE
Smilax bona-nox L., (H) *DJ 1688*
Smilax glauca Walter, (H T) *MM 5411, 4976; GW 2877; LB 27582*
Smilax laurifolia L., (T) *MM 3632*
Smilax pumila Walter, (H T) *LB 27473, 27465; MM 5059, 5289*
Smilax rotundifolia L., (H T) *MM 4980, 5253, 6068*
Smilax smallii Morong, (H T) *MM 4986, 5113, 5278; DJ 1741*

SOLANACEAE
Datura wrightii Regel, (T) *KC 85*
Physalis heterophylla Nees, (H T) *GW 2644, N11; DJ 1892*
Physalis pubescens L., (T) *DJ 1882*
Physalis pumila Nutt., (H) *MM 5369, 5404; GW 2660*
**Solanum capsicastrum* Link ex Schauer, (T) *DJ 2084*
Solanum carolinense L., (H T) MM 5804; *LB 27114*
Solanum ptychanthum Dunal, (H) *GW 2550b*

STYRACACEAE
Halesia diptera L., (H T) *MM 5232, 5240; DJ 2076; LB 27492*
Styrax americanus Lam., (H) *GW 2616*
Styrax grandifolius Aiton, (T) *DJ 2076, 2095, 2078*

SYMPLOCACEAE
Symplocos tinctoria (L.) L' Her., (H T) *MM 5187, 5300; LB 27111*

THELYPTERIDACEAE
+*Thelypteris hispidula* (Dcne.) C.F. Reed var. *versicolor* (R. St. John) Lellinger, (T) *DJ 1726*
Thelypteris kunthii (Desv.) Morton, (H T) *MM 5227; DJ 1950, 1974, 1776*

TILIACEAE
Tilia americana L. var. *caroliniana* (Mill.) Castigl., (NC) *GW 2297*

ULMACEAE
Celtis laevigata Willd., (H) *LB 27474, 27069; GW 2625*
Planera aquatica J.F Gmel., (H) *LB 27069*
Ulmus alata Michx., (H T) *MM 5162, 5399; GW 2455; DJ 2043*
Ulmus americana L., (H T) *DJ 2105, 2070*

URTICACEAE
Boehmeria cylindrica (L.) Sw., (H) *LB 27087, 27472*
Pilea pumila (L.) A. Gray, (T) *GW 2906*

VALERIANACEAE
Valerianella radiata (L.) Dufr., (H) *MM 5250; SE 2015*

VERBENACEAE
Callicarpa americana L., (H) *MM 4993, 5409*
Glandularia canadensis (L.) Nutt., (T) *KC 95*
**Glandularia pulchella* (Sweet) Tronc., (H T) *MM 5152, 5370, 5221*
Phyla nodiflora (L.) Greene, (H) *DJ 1694*
Stylodon carneus (Medik.) Moldenke, (H) *GW N01*
**Verbena brasiliensis* Vell., (H) *DJ 1690*
Verbena halei Small, (H) *GW 2659*

VIOLACEAE
Viola lanceolata L., (H T) *MM 5302, GW 2538, 2539, 2540*
Viola palmata L., (T) *MM 5292, 5282, 6048; SE 2013*
Viola primulifolia L., (T) *MM 3788*

VITACEAE
Ampelopsis arborea (L.) Koehne, (H T) *MM 5802, 4974; LB 27089*
Parthenocissus quinquefolia (L.) Planch., (H T) *MM 5110, 5432, 5263*

Vitis aestivalis Michx., (H) *GW 1451b, N03*

Vitis cinerea (Engelm.) Millardet var. *cinerea*, (T) *MM 5359,5470; GW 1451a, 2568*

Vitis rotundifolia Michx., (H T) *MM 5104, 4965, 5358, 5279*

XYRIDACEAE

Xyris ambigua Beyr. ex Kunth, (T) *MM 3631; GW 2642b; DJ 1875; LB 27148*

Xyris baldwiniana Schult., (T) *MM 3879*

Xyris jupicai L.C. Rich., (H T) *WC 10843; DJ 2046, 1876*

Xyris stricta Chapm. var. *obscura* Kral, (H T) *MM 3501; DJ 2011, 1866*

Xyris torta Sm., (T) *MM 5096, 3946*

Notes

***Bulbostylis barbata*.**—Jones and Wipff (1992) reported this exotic sedge new to Texas from Newton County. Turner et al. (2003) mapped it only in Newton County. Our Tyler County collection is a new county record. At SBSC, there is one additional collection from the Liberty County portion of the Menard Creek Unit.

***Coreopsis intermedia*.**—This west gulf coastal plain endemic has appeared on some Texas endangered and threatened species list. Smith (1976) mapped it in six northeastern counties. Turner et al. (2003) mapped it in 15 counties mostly in northeast Texas centering largely in Leon, Freestone, Anderson, and Houston counties. Tyler County is a new county record. At SBSC, there are collections from Harris and Jasper counties that were also not mapped in Turner et al. (2003).

***Dioscorea villosa*.**—We follow Raz (2002) in merging *D. quaternata* with *D. villosa* even though Al-Shehbaz and Schubert (1989) maintained them as distinct species and provided some characters to separate them.

***Dysphania ambrosioides*.**—We follow Clemants and Mosyakin (2003) in segregating the glandular *Chenopodium* taxa into the genus *Dysphania*.

***Lilium formosanum*.**—Brown and Elsik (2002) reported this exotic lily, as *Lilium longiflorum* Thunb., new to Texas from Newton and Tyler counties. However, in a re-examination of these two collections and the one from the Turkey Creek Unit, we found that the perianth segments were basally papillose on the adaxial surface. This trait is not present in *L. longiflorum* but is present in both *L. formosanum* A. Wallace and *L. phillippinense* Baker fide Skinner (2002). The shorter perianth segments and wider leaves best fit the description of *L. formosanum*, but our collections lack the reported wine-purple tinge on the abaxial perianth surface. Skinner (2002) indicated that most reports of *L. formosanum* in the United states are referable to *L. phillippinense*, which according to him, is becoming somewhat frequent in Florida especially in the Tallahassee area. For now the correct name to apply to the Texas collections of this escaped lily is problematic.

***Lindernia crustacea*.**—Brown and Marcus (1998) reported this Asian native new to Texas from the Trinity River National Wildlife Refuge in Liberty County and Turner et al.(2003) mapped it only in this county. At SBSC there are additional collections from Hardin and Harris counties. Our Tyler County collection adds another county to its Texas distribution.

***Ludwigia microcarpa*.**—Bridges and Orzell (1989) reported this small flowered seedbox new to Texas from Hardin County. Brown and Marcus (1998) reported collections from Hardin and Chambers counties. Our Tyler County collection is a new county record and at SBSC there is also a recent collection from Polk County. It is now known from four Texas counties.

***Ophiopogon jaburan*.**—Kartesz (1999) mapped this Asian native only in Arkansas, and Smith (1988) indicated that it was escaping in areas around Pine Bluff, Arkansas. This species is commonly planted for ground cover and is commonly referred to as monkey grass. The Hardin County collection came from the Kirby Nature Trail near Turkey Creek far from any house or farm land.

***Oxalis corniculata* var. *wrightii*.**—Turner (1994) used the varietal rank for some east Texas populations of yellow-flowered *Oxalis*. The names *O. dillenii* and *O. stricta* have been applied to this complex in Texas. We concur with Turner's taxonomic designation in light of the present state of knowledge regarding the complex.

***Quercus velutina*.**—Although Turner et al. (2003) mapped this species in a number of east Texas counties. It is a rare species in the more southern counties of east Texas. Shade leaf collections of *Q. velutina* and *Q. falcata* are difficult to separate and may account somewhat for the numerous mapped counties. The Tyler County collection, deposited at Rice University, and one from the Lance Rosier Unit in Hardin County are the most southern county records known to us. The label name on the Hardin County collection was *Q. marilandica* and it was subsequently annotated to *Q. velutina* (shade form) by the oak expert D.M. Hunt.

***Thelypteris hispidula* var. *versicolor*.**—Correll and Johnston (1970) called this fern *T.* x *versicolor*. They considered it a hybrid between *T. dentata* and *T. kunthii* and stated that it was usually found in Texas with one or both of its suspected parents. It is currently treated as a variety of the tropical *T. hispidula* (Alan R. Smith 1993). Turner et al. (2003) mapped it only in San Jacinto, Jasper, and Orange counties. Our Tyler County collection is a new county record.

***Trillium recurvatum*.**—Nixon et al. (1970) and Turner et al. (2003) reported this *Trillium* only from Rusk and Nacogdoches counties. Singhurst et al. (2002) reported an additional collection from Shelby County. Our Hardin County collection is a significant range extension and a new station for this rare species in Texas.

DISCUSSION

There are 123 families and 388 genera for the 738 taxa on the species list. Five families; Asteraceae (96 taxa), Poaceae (98 taxa), Cyperaceae (69 taxa), Fabaceae (47 taxa), and Euphorbiaceae (20 taxa) account for 44% of all taxa collected. The largest genera are *Rhynchospora* (23 taxa), *Carex* (17 taxa), *Dichanthelium* (16 taxa), *Cyperus* (13 taxa), and *Quercus* (12 taxa).

While it is the case that our list is incomplete, as are all floras, and that a few taxa may no longer exist in the unit, most taxa that have grown in the Turkey Creek Unit during the past quarter century have been collected (probably 90+ percent). We estimate that the Turkey Creek Unit has about 710 to 735 native species/taxa.

ACKNOWLEDGMENTS

This study was supported in part by a National Park Service Cooperative Agreement No. CA 14001004 to Paul Harcombe. Brooke Wheeler added some of the early collections into the data base and also aided the new database manager in his use of this program. We also thank Guy Nesom and Barney Lipscomb of BRIT and Eric Keith of Raven Environmental in Huntsville, Texas for their many suggestions that improved the paper. Publications funds were provided by Rice University.

REFERENCES

AJILVSGI, G. 1979. Wild flowers of the Big Thicket, east Texas, and western Louisiana. Texas A&M Press, College Station.

Al-SHEHBAZ, I.A. and B.G. SCHUBERT. 1989. The Dioscoreaceae in the southeastern United States. J. Arnold Arbor. 70:57–95.

CLEMANTS, S.E., and S.L. MOSYAKIN. *Dysphania*. In Flora of North America, vol. 4. Oxford University Press. New York, N.Y.

CORRELL, D.S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation. Renner, Texas.

BRIDGES, E.L. and S.L. ORZELL. 1989. Additions and noteworthy vascular plant collections from Texas and Louisiana, with historical, ecological, and geographical notes. Phytologia 66:12–69.

BROWN, L.E. and S.J. MARCUS. 1998. Notes on the flora of Texas with additions and other significant records. Sida 18:315–324

BROWN, L.E. and I.S. ELSIK. 2002. Notes on the flora of Texas with additions and other significant records. II. Sida 20:437–444.

DESHOTELS, J.D. 1978. Soil survey for the Big Thicket National Preserve, Texas. U.S.D.A. Soil Conservation Service, College Station, Texas.

HARCOMBE, P.A. and P.L. MARKS. 1979. Forest vegetation of the Big Thicket National Preserve. Unpublished report: U.S. Park Service, Santa Fe, New Mexico.

HARCOMBE, P.A., J.S. GLITZENSTEIN, R.G. KNOX, S.L. ORZell, and E.L. BRIDGES. 1993. Vegetation of the longleaf pine region of the West Gulf Coastal Plain. Proc. Annual Tall Timbers Fire Ecol. Conf. 18:83–103.

JONES, S.D. and J.K. WIPFF. 1992. *Bulbostylis barbata* (Cyperaceae), previously unreported for Texas. Phytologia 73:381–383.

JONES, S.D., J.K. WIPFF, and P.M. MONTGOMERY. 1997. Vascular plants of Texas. A comprehensive checklist including synonymy, bibliography, and index. Univ. of Texas Press. Austin.

KARTESZ, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: J.T. Kartesz and C.A. Meacham. Synthesis of North American flora. Version 1.0. North Carolina Botanical Garden. Chapel Hill.

MacRoberts, B.R. and M.H. MacRoberts. 1998. Floristics of wetland pine savannas in the Big Thicket National Preserve, southeast Texas. Phytologia 85:40–50.

MacRoberts, B.R., M.H. MacRoberts, and L.E. Brown. 2002. Annotated checklist of the vascular flora of the Hickory Creek Unit of the Big Thicket National Preserve, Tyler County, Texas. Sida 20:781–795.

Marks, P.L. and P.A. Harcombe. 1981. Forest vegetation of the Big Thicket, southeast Texas. Ecol. Monogr. 51:287–305.

McLeod, C.A. 1971. The Big Thicket forest of east Texas. Texas J. Sci. 23:221–233.

Nixon, E.L., J.R. Sullivan, J.T. Brown, J.B. Lacy, and J.D. Freeman. 1970. Notes on the distribution of *Trillium gracile* and *Trillium recurvatum* (Liliaceae) in Texas. Sida 3:528–530.

Parks, H.B. and V.L. Cory. 1936. Biological survey of the east Texas Big Thicket area. Texas Agricultural Experiment Station, College Station.

Peacock, H.H. 1994. Nature lover's guide to the Big Thicket. Texas A&M Press, College Station.

Raz, L. 2002. Dioscoreaceae. In: Flora of North America, vol.28. Oxford University Press. New York, N.Y.

Singhurst, J.R., E.S. Nixon, W.F. Caldwell, and W.C. Holmes. 2003. The genus *Trillium* (Liliaceae) in Texas. Castanea 67:316–323.

Skinner, M.A. 2002. *Lilium*. In Flora of North America, vol.26. Oxford University Press. New York, N.Y.

Smith, A.R. 1993. *Thelypteris*. In Flora of North America, vol.2. Oxford University Press. New York, N.Y.

Smith, E.B. 1976. A biosystematic survey of *Coreopsis* in eastern United States and Canada. Sida 6:123–215.

Smith, E.B. 1988. An atlas and annotated list of the vascular plants of Arkansas. 2nd edition. University of Arkansas, Fayetteville.

Turner, B.L. 1994. Regional variation in the North American elements of *Oxalis corniculata* (Oxalidaceae). Phytologia 77:1–7.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of vascular plants of Texas, vols .1 and 2. Sida Bot. Misc. 24.

Watson, G.E. 1979. Big Thicket plant ecology: an introduction. Big Thicket Mus. Publ. Ser., No. 5, Saratoga, Texas.

Watson, G.E. 1982. Vegetational survey of Big Thicket National Preserve. Unpublished report. Big Thicket National Preserve, Beaumont, Texas.

BOOK NOTICES

Texas A&M University Press

C. ALLAN JONES. 2005. **Texas Roots: Agriculture and Rural Life Before the Civil War.** (ISBN 0-58544-429-4, pbk.). Texas A&M University Press, John H. Lindsey Bldg., Lewis St. 4354 TAMU, College Station, TX 77843-4354, U.S.A. (**Orders:** wlawrence@tamu.edu, http://www.tamu.edu/upress, 800-826-8911). $19.95, 256 pp., b/w figs, 6 1/8" × 9 1/4".

The objective of this book according to the author, "... is to bring alive a part of Texas history that is rarely addressed: the relationship of Texans to their land before the Civil War—the time when the foundations of Texans' identity were forged." This book is divided into two parts: **1)** Los Tejanos: Farming and Ranching in Hispanic South Texas and **2)** The Texians: Antebellum Farmers and Stock Raisers.

GEOFF CUNFER. Foreword by DAN L. FLORES. 2005. **On the Great Plains: Agriculture and Environment.** (ISBN 0-58544-400-6, pbk.). Texas A&M University Press, John H. Lindsey Bldg., Lewis St. 4354 TAMU, College Station, TX 77843-4354, U.S.A. (**Orders:** wlawrence@tamu.edu, http://www.tamu.edu/upress, 800-826-8911). $28.00, 292 pp., b/w figs, tables, maps, 6 1/8" × 9 1/4".

From the Introduction.—The book is an agricultural and environmental history of the U.S. Great Plains from the advent of agricultural settlement around 1870 to the end of the twentieth century." Table of contents: **1)** Introduction, **2)** Pasture and Plows, **3)** Grassland Grazing, **4)** Crop Diversity, **5)** Horsepower, **6)** Drought and the Dust Bowl, **7)** Ogallala Irrigation, **8)** Fertile Ground, and **9)** Conclusion.

Blackwell Publishing

CEES LEEUWIS with contributions from ANNE VAN DEN BAN. 2004. **Communication for Rural Innovation: Rethinking Agricultural Extension.** (ISBN 0-632-05249-X, pbk.). Blackwell Publishing Ltd., 2121 State Avenue, Ames, IA, 50014, U.S.A. (**Orders:** 800-862-6657; 1-515-292-3348; www.blackwellpublishing.com). $49.99, 412 pp., b/w figures, graphs, tables, index, 7" × 10".

From the back cover:—"This important book is the re-titled third edition of the extremely well received and widely used Agricultural Extension (van den Ban & Hawkins, 1988, 1996). Building on the previous editions, *Communication for Rural Innovation* maintains and adapts the insights and conceptual models of value today, while reflecting many new ideas, angles and modes of thinking concerning how agricultural extension is taught and carried through."

CHECKLIST OF THE VASCULAR PLANTS OF GREENE COUNTY, PENNSYLVANIA

Robert Coxe

Western Pennsylvania Conservancy/
Pennsylvania Natural Heritage Program
209 4th Avenue
Pittsburgh, Pennsylvania 15223, U.S.A.

Cynthia M. Morton

Section of Botany
Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania 15213, U.S.A.

Mary Joy Haywood

Division of Natural Sciences and Mathematics
Carlow University
3333 Fitfh Avenue
Pittsburgh, Pennsylvania 15213, U.S.A.

Bonnie L. and Joseph A. Isaac

Section of Botany
Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, Pennsylvania 15213, U.S.A.

ABSTRACT

Although Greene County, located in the southwest corner of Pennsylvania, has been botanized since the early 1800s, a checklist of its vascular flora has not previously been compiled. A search of herbaria augmented by targeted fieldwork has resulted in a list of 890 taxa of native and naturalized plants comprising 438 genera and 118 families. The five largest families, by number of species, were Asteraceae, Poaceae, Cyperaceae, Rosaceae, and Fabaceae. The six largest genera were *Carex, Solidago, Galium, Rubus, Polygonum,* and *Viola.*

RESUMEN

El Condado de Greene, se localiza en la esquina suroeste del estado de Pennsylvania. Este condado es considerado una de las áreas más diversas y de impacto en el estado, sin embargo hasta ahora no ha sido completada una lista de verificación. Esta lista de verificación contiene familias, géneros, y taxa específicos están ordenados alfabéticamente dentro de los grupos de plantas vasculares tales como Pteridófitas, Gimnospermas y Angiospermas. Esta lista incluye los nombres de especies nativas y naturalizadas conocidas que ocurren en el Condado de Greene. Un total de al menos 118 familias, 438 géneros, y 890 especies fueron encontradas. Las cinco familias más grandes, por el número de especies, fueron Asteraceae, Poaceae, Cyperaceae, Rosaceae, y Fabaceae. Los seis géneros más grandes, por el número de especies, fueron *Carex, Solidago, Galium, Rubus, Polygonum* y *Viola.*

INTRODUCTION

Even though Pennsylvania lacks checklists for most of its counties, the vascular flora known thus far is quite diverse; Rhoads and Klein (1993) reported 3318 taxa of vascular plants for the state, including 2076 native and 1242 introduced. Of the 67 counties in Pennsylvania approximately 24 have floras completed, however a number are unavailable to the public because they are unpublished theses and surveys. The exact number of genera and species in the flora of Greene County was not previously known as a checklist had never been compiled. However, Greene County is currently being seriously impacted by coal

SIDA 21(3): 1829–1859. 2005

mining, making documentation of the flora all the more urgent. This checklist will be needed when reclamation and revegetation decisions are made of the areas that have been mined for coal. Checklist contain baseline information that can be used to monitor changes in our environment and to help us make wise conservational decisions.

Site Description

Greene County, Pennsylvania is located in the southwestern corner of the state (Fig. 1). It is bordered by the counties of Washington to the north, Fayette to the east, Monongalia and Wetzel counties, West Virginia to the south and Marshall County, West Virginia to the west. The county was named for Nathaniel Greene on February 9, 1796; it contains approximately 371,000 acres. Greene County receives total annual precipitation of approximately 38 inches, of which 55 percent usually falls in April through September. Average seasonal snowfall is 31 inches. The last frost of the season is usually around May 18th and the first frost of the season approximately September 25th. The length of the growing season, from the last killing frost in spring to the first killing frost in autumn, is about 149 days (USDA 1983).

The soils of the county consist of three main series: Dormont-Culleoka association, Dormont-Culleoka-Newark association, and Glenflord-Dormont-Library association.

The Dormont-Culleoka association consists of hills with benches and ridges that make up about 75 percent of Greene County. Dormont soils are found predominantly on hillsides and benches and commonly have slips on them. These soils are deep and moderately well drained. They consist of shale, siltstone, limestone and colluvium. The Culleoka soils are mostly on ridges and hilltops but some areas are on hillsides. They consist of limestone, sandstone, siltstone, and shale.

The Dormont-Culleoka-Newark association consists of hills and flood plains. Dormont and Culleoka soils are as described above. The Newark soils are on flood plains. These soils are deep and somewhat poorly drained. These areas were formed from an alluvium derived from limestone, sandstone, siltstone, and shale.

The Glenford-Dormont-Library association consists of terraces, hills, ridges and benches. Glenford soils are on terraces. These soils are deep and moderately well drained. These areas were formed in slackwater alluvium derived from calcareous shale and sandstone. Dormont soils are as described above. Library soils are mostly uplands. These soils are deep and somewhat poorly drained. These areas were formed in slackwater alluvium derived from siltstone, calcareous shale, and limestone (USDA 1983).

Greene County is part of the Kanawha section of the Appalachian Plateau Province. The Kanawha section consists in most places of rounded hills and

Fig. 1. Top. Counties of Pennsylvania. Adapted from Map 2, The Plants of Pennsylvania (Rhoads & Block 2000). **Bottom.** Townships of Greene County. Origin unknown.

ridges, products of the submature dissection of a once featured plain whose character is suggested by the few flat summit areas. The maximum elevation is about 1,600 feet. The entire Greene County drainage area is a tributary of the Mississippi River system, the Ohio River being the immediate master stream (USDA 1983).

History

Indians and fur traders were in Greene County long before the white settlers. In 1760 Pennsylvania and Maryland agreed to the Mason and Dixon Line as a boundary between the two colonies. Obstacles such as Indian attacks retarded the actual demarcation. The line was extended to its western limits in the autumn of 1784 and drawn northward in 1785, finally fixing the southern and western boundaries of Washington County, which included Greene County. Washington County was apart of Virginia until Pennsylvania and Virginia finally agreed upon this boundary line. The first wave of frontier settlement came after the French and Indian War ended in 1763. From the outbreak of the Dunmore's war in 1774 to the end of the American Revolution in 1783 the Indians and early colonists were in conflict. Most of the settlement by colonists took place after the American Revolution. By 1790 the American Indians in Greene County were virtually extinct.

By 1796 the best lands were taken and there was sufficient population to warrant the formation of Greene County, separate from Washington County. As mentioned above, Greene County was named in February 9, 1796, in honor of General Nathanael Greene, one of George Washington's great generals during the American Revolution. The gradual opening of roads, improvement of the Monongahela River for navigation and construction of railroads were important in the development of the county. The first railroad to enter Greene County was the Waynesburg and Washington Railroad in 1877.

Agriculture was the mainstay of Greene County's economy from its earliest settlement. Most of the residents farmed or raised stock. The 1890 census indicate that almost 90 percent of the people lived on farms, most were engaged in agricultural pursuits, and most of the wealth was agricultural in nature. There were no large-scale commercial mines in Greene County in 1886, however, coal had been mined in the county for many years in dirt mines. In the early 1890s improved transportation brought outside investors and the beginning of large-scale coal mining. The gas and oil boom of 1894-1905 changed Greene County. Major oil and gas companies leased thousands of acres and drilled scores of wells attracting new people and outside capital. The 1900 census ranked the progress of manufacturing for the county near the bottom of all Pennsylvania counties. Up until the 1940s agriculture, coal mining and oil and gas production were the main industries in the county. During the 1950s agriculture became less important and coal mining has become dominant in the economy. In 1945 there were 2,860 farms in the county but by 1992 only 633 farms remained. The decline of agriculture may be partly due to the inevitable subsidence of the surface of land that accompanies to coal mining. Subsidence can cause a loss of ground water in wells and springs creating problems for the farmers and other landusers, as well as changing the vegetation. Subsidence and water loss for the lands and people of Greene County has been the subject of much controversy in recent years. Documentation such as what is contained in this report is a necessary precursor to land restoration needed in order to restore the land back to its original state (Smith 1996).

Major Collectors

Collecting in Greene County for the Carnegie Museum Herbarium began in the early 1800s and has continued to the present. Most of the collectors have been members of the Botanical Society of Western Pennsylvania and the staff of the Section of Botany at Carnegie Museum.

Botanists who have made significant contributions to the knowledge of the Greene County flora are: F.H. Beer, F. Bell, W.E. Buker, R. Coxe, M.J. Haywood, L.K. Henry, B.L. Isaac, J.A. Isaac, O.E. Jennings, C.M. Morton, S.A. Thompson, and J.H. Nishida.

METHODS

The checklist was compiled by searching the herbaria of the Carnegie Museum of Natural History (CM) and the Morris Arboretum of the University of Pennsylvania (MOAR) for Greene county specimens. In addition, fieldwork was conducted targeting under-represented areas of the county. Most of the collections were made during the last two years however several specimens due date back as early as 1895 and 1896. The majority of the specimens except for 28 samples, from which collection information was obtained from the Morris Arboretum, are deposited at the Carnegie Museum of Natural History (CM) Herbarium. Other herbaria that were examined for specimens include the Academy of Natural Sciences of Philadelphia and Kent State University. The flora of Rhoads and Block (2000) was the primary source for plant identification. For generic and species names, we have generally followed the Synthesis of North American Flora (Kartesz 1999). Authorities are abbreviated for the majority of taxa according to Brummitt and Powell (1992).

RESULTS AND DISCUSSION

This list includes the names of all native and naturalized species known to occur in Greene County. It includes a total of 118 families, 438 genera, and 890 species. The five families, with the largest number of species, are Asteraceae, Poaceae, Cyperaceae, Rosaceae, and Fabaceae. *Carex*, *Solidago*, *Galium*, *Rubus*, *Polygonum* and *Viola*, are the largest genera. There are approximately 179 non-native species that have been introduced mainly from Europe and Eurasia. This checklist recognizes 3 species of Lycophytes, 39 species of Pteridophytes, 7 species of Gymnosperms and 841 species of Angiosperms. Twenty-six species have global or state ranking.

Of the 26 plants that have global or state ranking only *Scutellaria saxatilis* has a global ranking of G3 or vulnerable status. The remaining 25 plants are either a G4 or G5 status, indicating an apparently secure or secure condition. The genus *Scutellaria*, a member of the mint family, is very distinctive and easily identified by the protuberance on the upper lip of the corolla. This species is a stoloniferous plant with leaves broadly lanceolate to triangular and has cordate leaves at the base. The leaves are coarsely crenate, 4-5 cm long, with a long petiole. The flowers are in panicles. Most of the collections are from semi-shaded areas in dry woods or, occasionally, in moist areas along streams. This species is not common but is inconspicuous and may be overlooked. Its recovery potential is unknown but will be poor unless people search for its existence.

There are five taxa listed by the Pennsylvania Department of Agriculture (2004) as noxious weeds. It is therefore illegal to propagate, sell or transport the following taxa in the commonwealth: *Cirsium arvense* (Canadian thistle), *Rosa multiflora* (multiflora rosa), *Cirsium vulgare* (bull or spear thistle), *Datura stramonium* (jimsonweed), and *Lythrum salicaria* (purple loosestrife). Other mentionable offenders to our native ecosystem listed by the Department of Conservation and Natural Resources (2000) are: *Alliaria petiolata* (garlic mustard), *Lonicera japonica* (Japanese honeysuckle), *Lonicera morrowi* (morrow's honeysuckle), *Celastrus orbiculatus* (oriental bittersweet), and *Elaeagnus umbellata* (autumn olive).

While this list is probably not all-inclusive, it is the most comprehensive list available.

Plant Communities

Based on our field observations and the classifications of Fike (1999), the study area contains the following nine major community types; terrestrial forests, palustrine forests, terrestrial woodlands, palustrine woodlands, terrestrial shrublands, palustrine shrublands, terrestrial herbaceous openings, herbaceous wetlands, and community complexes. In the discussion below additional divisions are made within these nine categories. In categories dominated by woody plants the division is based on the phenology of the dominant species. In herbaceous wetlands the division is between persistent and non-persistent vegetation. Community complex section represents a special situation rather than a parallel classification system. Overall species diversity is high, and many species occur in more than one community type.

Terrestrial forest.—The two subcatagories of this plant community are conifer broadleaf terrestrial forests and broadleaf terrestrial forests.

The conifer broadleaf terrestrial forest is defined by communities of pitch pine–mixed oak forest, dry white pine (hemlock)–oak forest, hemlock (white pine)–northern hardwood forest, hemlock (white pine)–red oak–mixed hardwood forest, hemlock–tuliptree–birch forest, and hemlock–mesic hardwoods forest.

The pitch pine–mixed oak forest community generally occurs on acidic, sandy soils, often on ridgetops and dry southern exposures. Typical shrubs include *Kalmia latifolia* and *Gaylussacia baccata*. The herbaceous layer is sparse with *Pteridium aquilinum*, *Aralia nudicaulis*, *Gaultheria procumbens*, *Cypripedium acaule* and various graminoids.

The dry white pine (hemlock)–oak forest community occurs on fairly dry sites, often with portions of the forest floor covered by rocks, boulders and/or exposed bedrock. The canopy is open and tree growth can be suppressed. The dominant species are *Pinus strobus* or *Tsuga canadensis* and a mixture of dry-site hardwoods, predominantly oaks. *Kalmia latifolia* is an important shrub with typically a sparse herbaceous layer present.

The hemlock (white pine)-northern hardwood forest community can be comprised by any of the three named components. The forests occur mostly on mesic sites, often north-facing, sometimes rocky and steep. *Rhododendron maximum* is usually abundant. The herbaceous layer is generally sparse with a rich bryophyte layer.

The hemlock (white pine)-red oak-mixed hardwood forest contains *Tsuga canadensis* and/or *Pinus strobus* with usually *Quercus rubra* and other hardwoods present. Shrubs include *Viburnum acerifolium*, *Rhododendron periclymenoides* and *Amelanchier* spp. Herbaceous species include *Maiantheumum racemosa*, *Polygonatum biflorum*, *Gaultheria procumbens* and *Podophyllum peltatum*.

The hemlock-tuliptree-birch forest contains tuliptrees and a mix of more southern species. It is generally a lower slope or cove type. *Tsuga canadensis* usually contributes 25% or more of the canopy with *Liriodendron tulipifera* and *Betula* sp. as the characteristic hardwood species. Shrubs include *Hamamelis virginiana*, *Rhododendron maximum* and others. The herbaceous layer is highly variable.

The hemlock—mesic hardwood forests are species-rich lower slope forests with a strong *Tsuga canadensis* component. Shrubs such as *Rhododendron maximum*, *Hamamelis virginiana* and *Lindera benzion* are common. The herbaceous diversity under the hardwood is diverse while under the dense hemlock the vegetation reflects a more northern flora.

The broadleaf terrestrial forest is defined by communities of dry oak—heath forest, dry oak—mixed hardwood forest, red oak- mixed hardwood forest, tuliptree—beech—maple forest, sugar maple—basswood forest, mixed mesophytic forest, red maple (terrestrial) forest, aspen/gray birch forest and black locust forest.

The dry oak—heath forest community is fairly broadly defined and usually occurs on xeric to moderately dry, acidic sites, often on shallow sandy soils. The most characteristic tree species is *Quercus montana* occurring with a mixture of other oak species. The shrub layer is dominated by ericaceous species. Because of the resistant oak leaf litter, the herbaceous layer is generally sparse.

The dry oak—mixed hardwood forest occurs on somewhat calcareous moderately dry soils. It is frequently found on south and southwest-facing slopes. Characteristic shrubs include *Cornus florida*, *Caprinus caroliniana* and *Amelanchier arborea*. The herbaceous species include *Maiantheumum racemosa*, *Polygonatum biflorum*, *Asplenium platyneuron*, *Desmodium* spp., *Hieracium venosum*, *Aralia nudicaulis*, *Carex pensylvanica*, *Carex communis* and *Lysimachia quadrifolia*.

The red oak- mixed hardwood forest is a broadly defined community occurring on mesic sites. *Quercus rubra* is dominant/codominant with various taxa of

Quercus spp., *Betula* spp., *Fagus grandifolia* among others. The shrubs include taxa of *Viburnum*, *Amelanchier*, *Kalmia latifolia*, *Capinus caroliniana* among others. The herbaceous layer is highly variable.

The tuliptree-beech-maple forest occur on fairly deep, slightly acidic soils, at a mid to lower-slope position. *Acer ruburm*, *Liriodendron tulipifera* and *Fagus grandifolia* are the most consistent species for this very mixed forest. Typical shrubs include viburnum, *Capinus caroliniana*, *Cornus florida*, and *Ostrya virginiana*. The herberbaceous layer may be rich.

The sugar maple-basswood forest type occurs on a wide range of sites. Dominant tree species are *Acer saccharum* and *Tilia americana*. Shrubs include *Lindera benzion*, *Hamamelis virginiana* and *Asimina triloba*. There is usually a rich vernal flora.

The mixed mesophytic forest is an extremely rich community type that occurs on deep soils at the base of slopes. Dominant tree species are *Liriodendron tulipifera*, *Acer saccharum*, *Fagus grandifolia*, *Tilia americana* and *Magnolia acuminata*. The herbaceous layer is very rich and includes *Trillium* sp., *Dicentra* sp., *Tiarella cordifolia*, *Hepatica nobilis*, *Sanguinaria canadensis*, *Botrychium virginianum* and *Mitella diphylla*.

The red maple (terrestrial) forest is an early to mid successional type that is becoming common in Pennsylvania. *Acer rubrum* is dominant, but more information needed for the species composition of the community type.

The aspen/gray birch forest is frequently mixed, but can contain nearly pure stands of *Betula* sp. or *Populus* sp. The forest type is commonly found on former agricultural lands or where forestry practices maintain an early successional stage.

The last type of terrestrial forest is the black locust forest. This community type occurs on highly disturbed sites. *Robinia pseudoacacia* is the dominant species with *Betula lenta* being the codominant species. There is usually a dense graminoid understory with many exotic species common.

Palustrine Forest.—The one subcatagory of this plant community has broadleaf palustrine forest, defined by communities of bottomland oak-hardwood palustrine forest, red maple-black-gum palustrine forest, sycamore-(river birch)-box-elder floodplain forest, silver maple floodplain forest and red maple-elm-willow floodplain swamp.

The bottomland oak-hardwood palustrine forest are characterized by the dominance of *Quercus palustris* and/or *Q. bicolor*. Shrubs include *Lindera benzoin*, *Vaccinium corymbosum*, *Dirca palustris* and *Viburnum* sp. The understory includes *Impatiens* sp., *Thelypteris palustris*, *Polygonum* sp. and *Agrimonia parviflora*.

The red maple-black-gum palustrine forest is dominated by *Acer rubrum* and/or *Nyssa sylvatica*. The shrub layer is variable and may include *Vaccinium* *corymbosum*, *Ilex verticillata*, *Alnus* spp. and *Cornus* spp. The herbaceous layer includes such taxa as *Viola* spp., *Osmunda cinnamomea*, *Carex* spp. and *Onoclea sensibilis*.

The sycamore-(river birch)-box-elder floodplain forest occurs along the floodplains of the larger or mid-size river systems. Dominant tree species are *Platanus occidentalis* and *Acer negundo* with shrubs consisting of *Salix* spp., *Cornus* spp. *Vitis riparia*, *Lindera benzoin* and *Toxicodendron radicans* along with several invasive exotics. The herbs include *Impatiens* spp., *Pilea pumila*, and *Urtica dioica*.

In the silver maple floodplain forest community the forest occur along large rivers with a well-developed floodplain. Various *Acer* spp. and *Ulmus* spp. are dominant with shrubs including *Cornus* spp., *Lindera benzoin* and *Toxicodendron radicans* along with several invasive exotics. The herbaceous layer includes *Impatiens* spp., *Pilea pumila*, and *Alliaria petiolata*.

The last community of palustrine forests, the red maple-elm-willow floodplain swamp lands, is primarily associated with lands surrounding the major river systems that are subject to periodic flooding. Besides the above mentioned taxa of red maple, elm and willow, *Carya cordiformis*, *Cornus amomum*, *Lindera benzoin*, *Vitis riparia*, *Onoclea sensibilis* and *Polygonum* spp. are also found.

Terrestrial Woodlands.—The three subcatagories of this plant community are coniferous terrestrial woodlands, conifer-broadleaf terrestrial woodlands and broadleaf terrestrial woodlands. The coniferous terrestrial woodlands consist of communities of pitch pine-heath woodland and pitch pine-scrub oak woodland.

The pitch pine-heath woodland is a community that occurs on rocky ridgetops typically with sandy soils. Soils are usually acidic and dry and the associated tree species are drought-stressed and small in stature. Hardwoods if present only contribute less than 25% of the tree layer. Various shrubs, mostly ericads, form a low shrub layer. Herbaceous species include *Pteridium aquilinum*, *Carex* spp., *Lespedeza* spp. and lichens.

The pitch pine-scrub oak woodlands are very similar to the pitch pine-heath community except for the understory species which consist of *Pteridium aquilinum*, *Carex* spp., various grasses and *Aralia nudicaulis*.

The conifer-broadleaf terrestrial woodlands community is defined by pitch pine—mixed hardwoods woodlands. Soil, drought tolerance, shrub layer, and percent hardwoods are similar to the pitch pine-heath woodland type. Some of the associated taxa are slightly different.

The broadleaf terrestrial woodlands are defined by communities of dry oak-heath woodland, birch (black-gum) rocky slope woodland and yellow oak-redbud woodland.

The dry oak-heath woodland occurs on dry, acidic soils. Dominant tree species are *Quercus* spp., *Nyssa sylvatica*, *Sassafras albidum*, *Betula* spp. and *Acer* *rubrum* with pines species contributing less than 25%. The shrub layer is variable composed of either low shrubs like *Vaccinium* spp. or there may be an additional layer of taller shrubs like *Kalmia latifolia*. Herbaceous layer contains taxa like *Pteridium aquilinum*, *Carex* spp., *Oryzopsis* spp., and *Aralia nudicaulis*.

The birch (black-gum) rock slope woodland occurs most commonly on rocky slopes although it may occur on benches, ridgetops or boulderfields. Birch is usually present with either birch or black-gum dominant. Shrubs such as *Kalmia latifolia*, *Viburnum acerifolium* and *Hamamelis virginiana* are usually present. The herbaceous layer is commonly sparse with an often rich bryophyte and lichen assemblage.

Palustrine woodlands.—The one subcatagory of this plant community, broadleaf palustrine woodlands, is defined by red maple-sedge palustrine woodlands and red maple-mixed shrub palustrine woodlands.

The red maple-sedge palustrine woodlands is a type which occur in disturbed areas frequented by beavers. *Acer rubrum* is often the only tree species, however others may be scattered. The shrub layer is variable and may be dense in upland areas to nearly absent in wetter areas. The herbaceous layer is dominated by sedges.

The red maple-mixed shrub palustrine woodlands occurs on mineral soil with a thin layer of muck. *Acer rubrum* dominates the tree layer with *Cornus amomum*, *Ilex verticillata*, *Lindera benzoin*, *Alnus serrulata*, and *Salix sericea* as representative shrubs. The herbaceous layer is dominated by ferns.

Terrestrial shrublands.—The two subcatagories of this plant community are conifer-broadleaf terrestrial shrublands and broadleaf terrestrial shrublands.

The conifer-broadleaf terrestrial shrublands are defined by red-cedar-redbud shrubland. The red-cedar-redbud shrubland occurs on calcareous soils in areas where the conditions are dry enough to prevent forest development. *Juniperus virginiana* and *Cercis canadensis* are both characteristic taxa of these sites. The herbaceous layer contains various grass species along with *Lithospermum latifolium* and *Aquilegia canadensis*.

The broadleaf terrestrial shrublands are defined by low heath shrubland and scrub oak shrubland. The low heath shrubland are found on either sandy soil or on thin soil over bedrock. Typically found in exposed areas such as ridgetops where frost or drought conditions limit the establishment of trees and tall shrubs. Dominant species are *Vaccinium* spp., and/or *Gaylussacia baccata*. There is an herbaceous and creeping shrub layer with a moss and lichen cover that may be considerable.

The scrub oak shrublands have soil conditions similar to the low heath shrublands, however the former are usually situated in areas where frequent or recent disturbance has removed the tree layer. Scrub oak is the dominant species, occurring along with low growing shrubs such as *Vaccinium* spp., *Gault-*

heria procumbens, and *Gaylussacia baccata*. The herbaceous layer contains mostly various grasses.

Palustrine shrublands.—The one subcatagory of this plant community broadleaf palustrine shrublands, is defined by buttonbush wetland, alder-ninebark wetland, alder-sphagnum wetland, highbush blueberry-meadow-sweet wetland and black willow scrub/shrub wetland.

The buttonbush wetlands are characterized by prolonged flooding. Other shrubs besides *Cephalanthus occidentalis* would include *Cornus* spp., *Salix* spp., and *Sambucus canadensis*.

The alder-ninebark wetlands are shrub swamps dominated by *Alnus* spp. and *Physocarpus opulifolius*. They occur at the upland edge of marshes, at the wetter edge of red maple wetlands, in small upland depressions, or at the base of slopes. The soil generally contains minerals with a thin organic layer, although it may occur on shallow peat. The species composition is variable, and dominance may be shared by various shrubs species. The herbaceous layer contains *Thelypteris palustris*, *Typha latifolia*, and *Galium* spp.

The alder-sphagnum wetlands are dominated by *Alnus serrulata* and/or *A. incana* with a sphagnum layer. The substrate may be peat or a mineral layer with organic matter. Shrubs associated with this community are *Vaccinium corymbosum*, *Ilex verticillata*, and *Cornus racemosa* along with a variety of ferns and sedges.

The highbush blueberry-meadow-sweet wetland is dominated by *Vaccinium corymbosum*, *Spiraea latifolia* or *S. alba* with associates of *Amelanchier* spp, and *Sambucus canadensis*. The herbaceous layer is generally dominated by graminoids and ferns with the sphagnum either forms a continuous layer or forms a hummock.

The black willow scrub/shrub wetlands are types most typical of stream and riverbanks. *Salix nigra* dominates with *Alnus* spp., *Cornus* ssp. and *Salix* spp. also present. The herbaceous layer is variable and includes *Polygonum* spp., *Bidens* spp. along with *Phalaris arundinacea*.

Terrestrial herbaceous openings.—This type is defined by little bluestem-Pennsylvania sedge openings and calcareous opening/cliff lands.

The little bluestem-Pennsylvania sedge opening are grasslands that are on dry, acidic sites which discourage woody species growth. Mosses and lichens are abundant on some sites.

The calcareous opening/cliff lands are on calcareous cliffs, outcrops and rocky slopes. Species composition varies with the amount of moisture, shade and exposure. Woody species may occur at the margins or scattered and would include *Juniperus virginiana*, *Rhus aromatica*, *Toxicodendron radicans*, and *Cercis canadensis* to name a few. The herbaceous layer would include such species as *Aquilegia canadensis*, *Dodecatheon meadia*, and *Aster* spp.

Herbaceous wetlands.—The two subcategories are persistent emergent wetlands and non-persistent emergent wetlands. The persistent emergent wetlands are defined by the following fourteen types: bluejoint—reed canary grass marsh, cat-tail marsh, tussock sedge marsh, mixed forb marsh, herbaceous vernal pond, wet meadow, bulrush marsh, prairie sedge—spotted joe-pye-weed marsh, golden saxifrage—sedge rich seep, skunk cabbage—golden saxifrage forest seep, golden saxifrage—Pennsylvania bitter-cress spring run, water-willow (*Justicia ameicana*) smart weed riverbed community, riverside ice scour community, and big bluestem—Indian grass river grassland.

These wetlands maybe flooded for most of the year as are the marsh communities, or they are subject to seasonal flooding and/or ice scour. The substrate is usually peat, muck, mineral soil, sand deposits or rock; however, clay or clay-loam soils are found in the prairie sedge-spotted joe-pye-weed marsh. The water can be acidic, alkaline, calcareous or spring-like in nature. Although most of the communities are dominated by a herbaceous layer, shrubs and small trees may be present. Some communities are dominated by a single genus and/or species such as the bulrush marsh (*Schoenoplectus* spp.), the cat-tail marsh (*Typha* spp.), and the tusock sedge march (*Carex stricta*). Some areas are dominated by a general type of plant, such as the mixed forb marsh, where broad-leaved plants occur, or the wet meadow, where graminoids are typical. In the herbaceous vernal pond community the species composition varies between sites, as well as annually and seasonally. These habitats, especially the herbaceous vernal pond communities, are critical breeding habitat for amphibians and supply important habitat resources for many species of birds, mammals, reptiles, amphibians and invertebrates. The most common taxa include *Carex* spp., *Scirpus* spp. and *Typha* spp. Invasive species, such as *Lythrum salicaria* are found in some of the communities.The non-persistent emergent wetlands are defined by spatterdock—water lily wetland. These areas contain a combination of emergent and floating-leafed vegetation dominates this community where the substrate is seldom dry. The substrate is mineral soil, muck, or peat. Dominate species are *Nymphaea odorata* and *Nuphar lutea*, along with other aquatic vegetation.

Community complexes.—The one subcatagory is the river bed—bank—floodplain complex. Community types that characterize this complex are sycamore-(river birch)-box elder floodplain forest, silver maple floodplain forest, red maple-elm-willow floodplain swamp, river birch-sycamore floodplain scrub, black willow scrub/shrub wetland, riverside ice scour community, big bluestem-indian grass river grassland, and water-willow-smartweed riverbed community. All of these communities have been described except for the river birch-sycamore flood plain scrub that does not occur in Greene County.

ANNOTATED CHECKLIST OF THE SPECIES OF GREENE COUNTY, PENNSYLVANIA

Taxa are listed according to the following format: taxon name, author(s), (year) collector and number; **global:state ranking** [*Synonyms*] and * = exotic with non-native source. We follow the state (**S**) and global (**G**) ranking systems developed by The Nature Conservancy (1996 version). The global numbers are designated from **1** (critically imperiled) to **5** (secure). Other notations include **SH** = historical occurrence, and SR=reported without persuasive documentation. Synonyms have been included for recognized genera that are not yet in common usage in the state or regional manuals. In cases where there was more than one specimen present in the collection, the use of current known collectors for the western Pennsylvania region was used.

Families, genera, specific and infraspecific taxa are arranged alphabetically within vascular plant groups Lycophytes, Pteridophytes, Gymnosperms, and Angiosperms.

LYCOPHYTES

LYCOPODIACEAE

Huperzia lucidula (Michx.) Trevis., (1971) Buker, W.E.; Leighter, L.D.

Lycopodium digitatum Dill. ex. A. Braun, (1995) Isaac, B.L.; Isaac, J.A. 7543

Lycopodium tristachyum Purch, (1951) Henry, L.K.; Beer, F.H.

PTERIDOPHYTES

ASPLENIACEAE

Asplenium pinnatifidum Nutt., (1996) Grund, S.P. 1444; **G4:S3**

Asplenium platyneuron (L.) Britton, Sterns & Poggenb., (1995) Isaac, J.A.; Isaac, B.L 7097

Asplenium rhizophyllum L., (2003) Isaac, J.A.; Isaac, B.L 15860

Asplenium trichomanes L., (1907) Jennings, O.E.

BLECHNACEAE

Woodwardia areolata (L.) T. Moore, (1971) Buker, W.E.; **G5:S2**

DENNSTAEDTIACEAE

Dennstaedtia punctilobula (Michx.) T. Moore, (1993) Haywood, M.J. 251

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw. ex A. Heller, (2003) Isaac, J.; Coxe, R. 17128

DRYOPTERIDACEAE

Athyrium filix-femina (L.) Roth var. *angustum* (Willd.) Clausen, (1951) Henry, L.K.; Beer, F.H.

Cystopteris bulbifera (L.) Bernh., (2003) Isaac, J.A. 16363

Cystopteris fragilis (L.) Bernh., (1996) Haywood, M.J. 651

Cystopteris protrusa (Weath.) Blasdell, (1994) Isaac, J.A. 6007

Cystopteris tenuis (Michx.) Desv., (2002) Isaac, J.A.; Takacs, M. 14492

Deparia acrostichoides (Sw.) M. Kato, (1994) Isaac, J.A. 6006

Diplazium pycnocarpon (Spreng.) M. Broun, (2002) Isaac, J.A. & Takacs. M. 14401

Dryopteris carthusiana (Vill.) H.P. Fuchs, (1995) Isaac, B.L.; Isaac, J.A. 7534

Dryopteris cristata (L.) Gray, Wherry & Bell

Dryopteris goldiana (Hook. ex Goldie) Gray, (1996) Isaac, B.L.; Isaac, J.A. 8878

Dryopteris intermedia (Muhl.ex Willd.) A. Gray, (1996) Isaac, B.L.; Isaac, J.A. 8857

Dryopteris marginalis (L.) A. Gray, (1996) Isaac, B.L.; Isaac, J.A. 8892

Onoclea sensibilis L., (1995) Isaac, B.L.; Isaac, J.A. 7132

Polystichum acrostichoides (Michx.) Schott, (1996) Isaac, B.L.; Isaac, J.A. 8877

Woodsia obtusa (Spreng.) Torr., (1951) Henry, L.K.; Buker, W.E.

EQUISETACEAE
Equisetum arvense L., (2003) Haywood, M.J. 581
Equisetum hyemale L., (2003) Isaac, J.A.; Isaac, B.L. 15857

OPHIOGLOSSACEAE
Botrychium dissectum Spreng., (1996) Haywood, M.J. 407
Botrychium matricariifolium (A. Braun ex Dowell) A. Braun ex Koch, (2003) Isaac, J.A 16044
Botrychium oneidense (Gilbert) House, (1998) Grund, S.P. 2024
Botrychium simplex E. Hitchc., (1996) Isaac, B.L.; Isaac, J.A. 8910
Botrychium virginianum (L.) Sw., (1996) Isaac, B.L.; Isaac, J.A. 8875
Ophioglossum vulgatum L., (2003) Isaac, J.A.; Coxe, R.; Ernst, S. 15894; **G5:S3**

OSMUNDACEAE
Osmunda cinnamomea L., Myers
Osmunda claytoniana L., (1996) Isaac, B.L.; Isaac, J.A. 8852

POLYPODIACEAE
Polypodium appalachianum Haufler & Windham, (1907) Jennings, O.E.
Polypodium virginianum L., (1995) Isaac, B.L.; Isaac, J.A. 7165

PTERIDACEAE
Adiantum pedatum L., (2003) Isaac, J.A. 16005
Pellaea glabella Mett. ex Kuhn, (1950) Henry, L.K.; Buker, W.E.

THELYPTERIDACEAE
Phegopteris hexagonoptera (Michx.) Fée, (2003) Isaac, J.A.; Coxe, R. 16278
Thelypteris noveboracensis (L.) Nieuwl., (2004) Isaac, J.A. 17619
Thelypteris palustris Schott var. *pubescens* (Lawson) Fern, (1993) Haywood, M.J. 264

GYMNOSPERMS

CUPRESSACEAE
Juniperus virginiana L., (1950) Henry, L.K.; Buker, W.E.

PINACEAE
**Picea abies* (L.) Karst., (1922) Jennings, O.E.; Europe
Pinus rigida P. Mill., (1921) Jennings, O.E.; Jennings, G.K.; et al.
Pinus strobus L., (1952) Henry, L.K.; Buker, W.E.
Pinus virginiana P. Mill., (1955) Henry, L.K.; Buker, W.E.
Tsuga canadensis (L.) Carr., (1985) Thompson, S.A.; Nichida, J.H.; Macdonald, M. 2255

TAXACEAE
Taxus canadensis Marsh., (2004) Isaac, J.A. 17307

ANGIOSPERMS

ACANTHACEAE
Justicia americana (L.) Vahl, (1995) Isaac, B.L.; Isaac, J.A. 7507
Ruellia strepens L., (1942) Davis, H.A.; Davis, T. 5405; **G4G5:S2**

ACERACEAE
Acer negundo L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15795
Acer nigrum Michx. f., (2003) Isaac, J.A. 16167
Acer rubrum L., (1993) Haywood, M.J. 294
Acer saccharinum L., (2003) Isaac, J.A. 16029
Acer saccharum Marsh., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15817
Acer spicatum Lam., (1969) Buker, W.E.

ACORACEAE
**Acorus calamus* L., (2003) Isaac, J.A. 16393} Europe

ALISMATACEAE
Alisma subcordatum Raf., (1950) Henry, L.K.; Beer, F.H.
Sagittaria latifolia Willd., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1971

AMARANTHACEAE
Amaranthus hybridus L., Bell 641

ANACARDIACEAE
Rhus copallina L. var. *copplina*, (1907) Jennings, O.E.
Rhus copallina L. *var latifolia* Engl., (1951) Henry, L.K.; Beer, F.H.
Rhus glabra L., (2003) Isaac, J.A. 16404
Rhus typhina L., (2003) Isaac, J.A. 16180
Toxicodendron radicans (L.) Kuntze, (1995) Isaac, B.L.; Isaac, J.A. 7515

ANNONACEAE
Asimina triloba (L.) Dunal, (2003) Isaac, J.A.; Isaac, B.L 15833

APIACEAE
Angelica venenosa (Greenway) Fern., (1951) Henry, L.K.; Beer, F.H.

Chaerophyllum procumbens (L.) Crantz, (2003) Isaac, J.A. 15879; Europe
Cicuta maculata L., (2003) Isaac, J.A. 16322
**Conium maculatum* L., (2003) Isaac, J.A. 16179; Europe
Cryptotaenia canadensis (L.) DC., (2003) Isaac, J.A. 16131
**Daucus carota* L., (1993) Haywood, M.J. 305; Eurasia
Erigenia bulbosa (Michx.) Nutt., (2004) Isaac, J.A. 17304; **G5:S2**
Heracleum maximum Bartr., (1992) Haywood, M.J. 57
Osmorhiza claytonii (Michx.) C.B. Clarke, (1995) Isaac, B.L.; Isaac, J.A. 7532
**Osmorhiza longistylis* (Torr.) DC., (1993) Haywood, M.J. 253; Eurasia
**Pastinaca sativa* L., (2003) Isaac, J.A. 16168; Eurasia
Sanicula canadensis L., (1998) Grund, S.P. 2057
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, (2003) Isaac, J.A. 15991
Sanicula trifoliata Bickn., (1953) Buker, W.E.
Taenidia integerrima (L.) Drude, (2003) Isaac, J. 17134
Thaspium barbinode (Michx.) Nutt, (2003) Isaac, J.A. 16111
Thaspium trifoliatum (L.) Gray, (1996) Haywood, M.J. 436
**Torilis japonica* (Houtt.) DC., (2003) Isaac, J.A. 16627; Eurasia
Zizia aurea (L.) W.D.J. Koch, (1993) Haywood, M.J. 214

APOCYNACEAE

Apocynum androsaemifolium L., (1952) Henry, L.K.; Beer, F.H.
Apocynum cannabinum L., (2003) Isaac, J.A 16406
**Vinca minor* L., (1993) Haywood, M.J. 107; Europe

AQUIFOLIACEAE

Ilex montana Torr. & Gray ex Gray, (1936) Bell, F.H.
Ilex verticillata (L.) Gray, (1921) Dickey, S.S.

ARACEAE

Arisaema dracontium (L.) Schott, (2003) Isaac, J.A.; Coxe, R. 16287
Arisaema triphyllum (L.) Schott ssp. *pusillum* (Peck) Huttleston, (1951) Henry, L.K.; Beer, F.H.
Arisaema triphyllum (L.) Schott ssp. *triphyllum*, (1996) Isaac, B.L.; Isaac, J.A 8886
Symplocarpus foetidus (L.) Salisb. ex Nutt., (2003) Isaac, J.A.; Isaac, B.L. 15851

ARALIACEAE

Aralia nudicaulis L., (2004) Isaac, J.A. 17625
Aralia racemosa L., (1996) Haywood, M.J. 644
Aralia spinosa L., Bell 304
Panax quinquefolius L., (2003) Isaac, J.A. 16581

ARISTOLOCHIACEAE

Aristolochia macrophylla Lam., (1974) Buker, W.E.
Aristolochia serpentaria L., (2003) Isaac, J.A. 16045
Asarum canadense L., (1996) Isaac, B.L.; Isaac, J.A. 8891

ASCLEPIADACEAE

Asclepias exaltata L., (2003) Isaac, J.A. 16205
Asclepias incarnata L., (1996) Haywood, M.J. 645
Asclepias quadrifolia Jacq., (1996) Isaac, B.L.; Isaac, J.A 8858
Asclepias syriaca L., (1995) Isaac, B.L.; Isaac, J.A. 7502
Asclepias tuberosa L., (1993) Haywood, M.J. 116

ASTERACEAE

**Achillea millefolium* L., (2003) Isaac, B.L.; Isaac, J.A. 16164; Eurasia
Ageratina altissima (L.) King & H.E. Robins, (1993) Haywood, M.J. 156
Ambrosia artemisiifolia L., (2003) Isaac, J.A. 17140
Ambrosia trifida L., (2003) Isaac, J.A. 17139
Antennaria howellii Greene ssp. *neodioica* (Greene) Bayer, (2003) Coxe, R.; Bradburn, M.
Antennaria neglecta Greene, (1994) Haywood, M.J. 467
Antennaria parlinii Fern., (1995) Isaac, J.A.; Isaac, B.L. 7168
Antennaria plantaginifolia (L.) Richards., (1995) Isaac, B.L.; Isaac, J.A 7114
Antennaria solitaria Rydb., (2002) Isaac, J.A.; Takacs, M 14413; **G5:S1**
**Anthemis arvensis* L., (2003) Isaac, J.A. 16601; Europe
**Anthemis cotula* L., (1971) Buker, W.E.; Europe
**Arctium lappa* L., (1993) Haywood, M.J. 167; Eurasia
**Arctium minus* Bernh., (1984) Thompson, S.A.; Nishida, J.H; Bier, C.W. 1974; Eurasia
Bidens bipinnata L., (1921) Jennings, O.E.
Bidens cernua L., (1993) Haywood, M.J. 181
Bidens frondosa L., (1984) Thompson, S.A.; Nishida, .H.; Bier, C.W. 1951

Bidens tripartita L., (1949) Jennings, O.E.

**Centaurea jacea* L., (1993) Haywood, M.J. 93; Europe

**Cichorium intybus* L., (1995) Isaac, B.L.; Isaac, J.A. 7487; Europe

**Cirsium altissimum* (L.) Spreng., (1951) Henry, L.K.; Beer, F.H.; Europe

**Cirsium arvense* (L.) Scop., (1995) Isaac, B.L.; Isaac, J.A. 7493; Eurasia

Cirsium muticum Michx., (1993) Haywood, M.J. 92

Cirsium pumilum (Nutt.) Spreng., (1998) Grund, S.P. 2039

**Cirsium vulgare* (Savi) Ten., (2003) Isaac, J.A. 16630; Eurasia

Conoclinium coelestinum (L.) DC., (1991) Isaac, J.A. 3671; **G5 S3**

Conyza canadensis (L.) Cronq., (1993) Haywood, M.J. 168

Doellingeria infirma (Michx.) Greene, (1951) Henry, L.K.; Beer, F.H.; [*Aster infirmus* Michx.]

Eclipta prostrata (L.) L., (1974) Buker, W.E.

Erechtites hieraciifolia (L.) Raf. ex DC., (2004) Isaac, J.A. 18497

Erigeron annuus (L.) Pers., (2003) Isaac, J.A. 16380

Erigeron philadelphicus L., (1996) Isaac, B.L.; Isaac, J.A. 8889

Erigeron pulchellus Michx., (1995) Isaac, B.L.; Isaac, J.A. 7163

Erigeron strigosus Muhl. ex Willd., (1993) Haywood, M.J. 125

Eupatorium altissimum L., (1974) Buker, W.E.

Eupatorium fistulosum Barratt, (1993) Haywood, M.J. 124

Eupatorium maculatum L., (1951) Henry, L.K.; Beer, F.H.

Eupatorium perfoliatum L., (1993) Haywood, M.J. 153

Eupatorium purpureum L., (2003) Isaac, J.A. 16576

Eupatorium sessilifolium L., (2003) Isaac, J.A. 17137

Eurybia divaricata (L.) Nesom, (1998) Grund, S.P. 2044; [*Aster divaricatus* L.]

Eurybia schreberi (Nees) Nees, (1993) Haywood, M.J. 198; [*Aster schreberi* Nees]

Euthamia graminifolia (L.) Greene, (1949) Jennings, O.E.

**Galinsoga quadriradiata* Cav., (2003) Isaac, J.A. 16310; Central & South America

Hasteola suaveolens (L.) Pojark., (2004) Isaac, J.A. 18568

Helenium autumnale L., (1993) Haywood, M.J. 152

Helianthus decapetalus L., (1993) Haywood, M.J. 143

Helianthus divaricatus L., (1907) Jennings, O.E.

Helianthus microcephalus Torr. & Gray, (2003) Isaac, J.; Haywood, M.J.; Coxe, R.; Bradburn, M. 17228; **G5 S3**

Helianthus strumosus L., (1940) Jennings, O.E.

Helianthus tuberosus L., (1993) Haywood, M.J. 148

Heliopsis helianthoides (L.) Sweet, (1993) Haywood, M.J. 145

**Hieracium caespitosum* Dumort., (2003) Isaac, J.A. 16047; Europe

Hieracium gronovii L., (1976) Buker, W.E.

**Hieracium pilosella* L., (1993) Haywood, M.J. 94; Europe

Hieracium scabrum Michx., (1974) Buker, W.E.

**Hieracium venosum* L., (1993) Haywood, M.J. 131; Eurasia

**Hypochaeris radicata* L., (1993) Haywood, M.J. 163; Eurasia

**Lactuca biennis* (Moench) Fern., (1969) Buker, W.E.; Eurasia

Lactuca canadensis L., (1993) Haywood, M.J. 149

Lactuca floridana (L.) Gaertn., (1993) Haywood, M.J. 162

**Lactuca saligna* L., (1971) Buker, W.E.; Europe

**Lactuca serriola* L., (2003) Isaac, J.A. 16619; Europe

**Lapsana communis* L., (2004) Isaac, J.A. 17525; Europe

**Leucanthemum vulgare* Lam., (2003) Isaac, J.A. 16049; Exotic

Matricaria discoidea DC., (1995) Isaac, J.A.; Isaac, B.L. 7152

Packera aurea (L.) A.&D. Löve, (1996) Isaac, B.L.; Isaac, J.A. 8906; [*Senecio aureus* L.]

Packera glabella (Poir.) C. Jeffrey, (2003) Isaac, J.A. 16035; [*Senecio glabellus* Poir.]

Packera obovata (Muhl. Ex Willd.) W.A. Weber & A. Löve, (1995) Isaac, B.L.; Isaac, J.A. 7173; [*Senecio obovatus* Muhl. Ex Willd.]

Polymnia canadensis L., (2003) Isaac, J.; Coxe, R.; Bradburn, M. 17217

Prenanthes altissima L., (1969) Buker, W.E.

Prenanthes crepidinea Michx., (2003) Isaac, B.L.; Isaac, J.A. 15861

Pseudognaphalium obtusifolium (L.) Hilliard & Burtt, (1954) Henry, L.K.; Buker, W.E.

Rudbeckia hirta L. var. *pulcherrima* Farw., (1995) Isaac, B.L.; Isaac, J.A. 7526

Rudbeckia laciniata L., (2003) Isaac, J. 17143

Sericocarpus asteroides (L.) B.S.P., (1951) Henry, L.K.; Beer, F.H.

Silphium asteriscus L., (1958) Buker, W.E.

Silphium trifoliatum L. var. *trifoliatum*, (2003) Isaac, J. 16633

Smallanthus uvedalius (L.) Mackenzie ex. Small, (2003) Isaac, J.A.; Coxe, R. 16289; **G4G5**:**SR** [*Polymnia uvedalia* L.]

Solidago altissima L., (1991) Isaac, J.A. 3676

Solidago bicolor L., (2004) Isaac, J.A. 18522

Solidago caesia L., (1969) Buker, W.E.

Solidago curtisii Torr. & A. Gray, (1984) Thompson, S.A.; Nishida, J.H. 2010; **G4G5**:**S1**

Solidago flexicaulis L., (1993) Haywood, M.J. 397

Solidago gigantea Aiton, (1949) Jennings, O.E.

Solidago juncea Aiton, (1993) Haywood, M.J. 130

Solidago nemoralis Aiton, (2004) Isaac, J.A. 18521

Solidago rugosa P. Mill. ssp. *rugosa* var. *rugosa*, (1950) Henry, L.K.; Buker, W.E.

Solidago squarrosa Nutt., (1954) Henry, L.K.; Buker, W.E.

Solidago ulmifolia Muhl. ex Willd., (1992) Haywood, M.J. 406

**Sonchus asper* (L.) Hill, (2003) Isaac, J.A. 16124; Europe

Symphyotrichum cordifolium (L.) Nesom, (1984) Thompson, S.A.; Nishida, J.H. 2060; [*Aster cordifolius* L.]

Symphyotrichum lanceolatum (Willd.) Nesom *ssp lanceolatum* var. *lanceolatum*, (1954) Henry, L.K.; Buker, W.E.; [*Aster lanceolatus* Willd. ssp. *lanceolatus* var. *lanceolatus*]

Symphyotrichum lateriflorum (L.) A. & D. Love var. *lateriflorum*, (2003) Isaac, J.A.; Haywood, M.J.; Coxe, R.; Bradburn, M. 17231; [*Aster lateriflorus* (L.) Britton.]

Symphyotrichum lowrieanum (Porter) Nesom [*Aster lowrieanus* Porter], (1984) Thompson, S.A.; Nishida, J.H. 2060

Symphyotrichum novae-angliae (L.) Nesom, (1993) Haywood, M.J. 203; [*Aster novae-angliae* L.]

Symphyotrichum pilosum (Willd.) Nesom, (1984) Thompson, S.A.; Nishida, J.H. 2024; [*Aster pilosus* Willd.]

Symphyotrichum prenanthoides (Muhl. ex Willd.) Nesom, (1993) Haywood, M.J. 397; [*Aster prenanthoides* Muhl. ex Willd.]

Symphyotrichum puniceum (L.) A. & D. Löve, (1984) Thompson, S.A.; Nishida, J.H. 2064; [*Aster puniceus* L.]

Symphyotrichum shortii (Lindl.) Nesom, (1995) Grund, S.P. 1419; [*Aster shortii* Lindl.]

**Taraxacum laevigatum* (Willd.) DC., (1925) Wood, S.; Eurasia

**Taraxacum officinale* G.H. Weber ex Wiggers, (1992) Haywood, M.J. 21; Eurasia

**Tussilago farfara* L., (1996) Haywood, M.J. 412; Eurasia

Verbesina alternifolia (L.) Britt. ex Kearney, (1993) Haywood, M.J. 132

Vernonia gigantea (Walt.) Trel., (1993) Haywood, M.J. 113

**Xanthium strumarium* L. var. *canadense* (P. Mill.) Torr. & A. Gray, (1957) Henry, L.K.; Beer, F.H.; Europe

**Xanthium strumarium* L. var. *glabratum* (DC.) Cronq., (1921) Jennings, O.E.; et al.; Europe

BALSAMINACEAE

Impatiens capensis Meerb., (2003) Isaac, J.A. 16375

Impatiens pallida Nutt., (2003) Isaac, J.A. 16374

BERBERIDACEAE

Berberis thunbergii DC., (2003) Isaac, J.A.; Isaac, B.L. 15849

Caulophyllum thalictroides (L.) Michx., (1996) Isaac, B.L.; Isaac, J.A. 8894

Jeffersonia diphylla (L.) Pers., (2003) Isaac, J.A. 15862

Podophyllum peltatum L., (2003) Isaac, J.A. 16415

BETULACEAE

Alnus serrulata (Aiton) Willd., Donley 153

Betula alleghaniensis Britt., (1974) Buker, W.E.

Betula nigra L., (2003) Coxe, R.

Carpinus caroliniana Walt., (2003) Isaac, J.A.; Isaac, B.L. 15825

Corylus americana Walt., (2003) Isaac, J.A.; Coxe, R. 16290

Ostrya virginiana (P. Mill.) K. Koch, (1954) Henry, L.K.; Buker, W.E.

BIGNONIACEAE

Campsis radicans (L.) Seem. ex Bureau, (1993) Haywood, M.J. 61

Catalpa bignonioides Walt., (2004) Isaac, J.A. 17641

BORAGINACEAE

**Cynoglossum officinale* L., (1904) Jennings, O.E.; Eurasia

Cynoglossum virginianum L., (1996) Isaac, B.L.; Isaac, J.A. 8867

**Echium vulgare* L., (2003) Isaac, J.A.; Coxe, R. 16280; Europe

Hackelia virginiana (L.) I.M. Johnston, (1994) Isaac, J.A. 6011

Lithospermum latifolium Michx., (2003) Isaac, J.A.; Coxe, R.; Ernst, S. 15890; **G4:S3**

Mertensia virginica (L.) Pers. ex Link, (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15809

**Myosotis arvensis* (L.) Hill, (1996) Isaac, B.L.; Isaac, J.A. 8913; Eurasia

Myosotis macrosperma Engelm., (1996) Isaac, B.L.; Isaac, J.A. 8854

**Symphytum officinale* L., (1994) Haywood, M.J. 516; Eurasia

BRASSICACEAE

**Alliaria petiolata* (Bieb.) Cavara & Grande, (2003) Isaac, J.A. 16011; Europe

**Arabidopsis thaliana* (L.) Heynh., (1971) Buker, W.E.; Leighter, L.D.; Europe

Arabis canadensis L., (2003) Isaac, J.A. 16154

Arabis laevigata (Muhl. ex Willd.) Poir., (2003) Isaac, J.A.; Isaac, B.L. 15843

Arabis lyrata L., (1950) Henry, L.K.; Beer, F.H.

**Barbarea vulgaris* Aiton f., (1996) Isaac, B.L.; Isaac, J.A. 8882; Eurasia

**Brassica juncea* (L.) Czern., (1952) Henry, L.K.; Beer, F.H.; Eurasia

**Brassica nigra* (L.) W.D.J. Koch, (2003) Isaac, J.A. 16618; Eurasia

**Brassica rapa* L., (1924) Wood, S.; Europe

**Capsella bursa-pastoris* (L.) Medik., (2003) Isaac, J.A. 16188; Eurasia

Cardamine angustata O.E. Schulz, (1992) Haywood, M.J. 6

Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., (1970) Buker, W.E.; Henry, L.K.

Cardamine concatenata (Michx.) Sw., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15803

Cardamine diphylla (Michx.) Wood, (2003) Isaac, J.A.; Isaac, B.L. 15847

Cardamine douglassii Britt., (2003) Isaac, J.A.; Isaac, B.L. 15831

**Cardamine hirsuta* L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15804; Europe

Cardamine parviflora L. var. *arenicola* (Britt.) O.E.Schulz, (1951) Henry, L.K.; Buker, W.E.

Cardamine pensylvanica Muhl. ex Willd., (2003) Isaac, J.A. 15871

Cardamine rotundifolia Michx., (2002) Haywood, M.J. 584

**Draba verna* L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15798; Europe

**Hesperis matronalis* L., (1996) Isaac, B.L.; Isaac, J.A. 8908, Europe

Iodanthus pinnatifidus (Michx.) Steud., (1922) Stewart; **G5:S1**

**Lepidium campestre* (L.) Aiton f., (1995) Isaac, B.L.; Isaac, J.A. 7123; Eurasia

Lepidium virginicum L., (2003) Isaac, J.A. 16123

**Microthlaspi perfoliatum* (L.) F.K. Mey., (1996) Isaac, B.L.; Isaac, J.A. 8843; Exotic

Rorippa palustris (L.) Bess. ssp. *fernaldiana* (Butters & Abbe) Jonsell, (2003) Isaac, J.A. 16318

**Rorippa sylvestris* (L.) Bess., (1952) Henry, L.K.; Beer, F.H.; Europe

**Sisymbrium officinale* (L.) Scop., (1995) Isaac, B.L.; Isaac, J.A. 7103; Europe

**Thlaspi alliaceum* L., (2003) Isaac, J.A. 16122; Europe

CAMPANULACEAE

Campanulastrum americana (L.) Small, (2003) Isaac, J. 17146

Lobelia inflata L., (1993) Haywood, M.J. 177

Lobelia siphilitica L., (1993) Haywood, M.J. 141

Lobelia spicata Lam. var. *leptostachys* (A. DC.) Mackenzie & Bush, (1951) Henry, L.K.; Beer, F.H.

Lobelia spicata Lam. var. *spicata*, (1993)Haywood, M.J. 360

Triodanis perfoliata (L.) Nieuwl., (1995) Isaac, B.L.; Isaac, J.A. 7093

CAPRIFOLIACEAE

Diervilla lonicera P. Mill., (1922) Dickey, S.S.

Lonicera canadensis Bartr. ex Marsh., (1993) Haywood, M.J. 103

Lonicera dioica L., (1952) Henry, L.K.; Buker, W.E.

**Lonicera japonica* Thunb., (2003) Isaac, J.A. 16136; Asia

**Lonicera morrowi* Gray, (2003) Isaac, J.A. 16024; Japan

Lonicera sempervirens L., (1896) Hoge, M.K.

Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, (2003) Isaac, J.A. 16177

Symphoricarpos orbiculatus Moench, (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1976

Triosteum aurantiacum Bickn. var. *glaucescens* Wieg., (2003) Isaac, J.A. 15978

Triosteum aurantiacum Bickn. var. *illinoense* (Wieg.) Palmer & Steyermark, (2002) Isaac, J.A.; Takacs, M. 14488

Viburnum acerifolium L., (1996) Isaac, B.L.; Isaac, J.A. 8860

Viburnum dentatum L., (2003) Coxe, R.

Viburnum nudum L. var. *cassinoides* (L.) Torr. & A. Gray, (1993) Haywood, M.J. 112

Viburnum prunifolium L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15796

CARYOPHYLLACEAE

**Agrostemma githago* L., (1896) Hoge, M.K.; Europe

**Arenaria serpyllifolia* L., Bell 555; Europe

Cerastium arvense L., (2002) Isaac, J.A.; Takacs, M. 14400

**Cerastium fontanum* Baumg. ssp. *vulgare* (Hartman) Greuter & Burdet, (2003) Coxe, R.; Bradburn, M.; Eurasia

Cerastium nutans Raf., (1949) Henry, L.K.

**Dianthus armeria* L., (1995) Isaac, B.L.; Isaac, J.A. 7541; Europe

**Myosoton aquaticum* (L.) Moench, (1995) Isaac, B.L.; Isaac, J.A. 7175; Europe

Paronychia canadensis (L.) Wood, (2002) Isaac, J.A.; Takacs, M. 14415

Paronychia fastigiata (Raf.) Fern., (1997) Grund, S.P. 1975

**Saponaria officinalis* L., (2003) Isaac, J.A. 16613; Europe

**Silene latifolia* Poir., (2003) Isaac, J.A. 16626; Europe

Silene stellata (L.) Aiton f., (2003) Isaac, J. 17136

Silene virginica L., (1996) Isaac, B.L.; Isaac, J.A. 8865

**Stellaria graminea* L., (2003) Isaac, J.A. 16398; Europe

Stellaria longifolia Muhl. ex Willd., (1992) Haywood, M.J. 59

**Stellaria media* (L.) Vill., (2003) Isaac, J.A.; Isaac, B.L. 15818; Europe

Stellaria pubera Michx., (1955) Henry, L.K.; Buker, W.E.

CELASTRACEAE

**Celastrus orbiculatus* Thunb., (2003) Coxe, R.; Japan

Euonymus atropurpurea Jacq., (2003) Isaac, J.A.; Coxe, R. 16296

CHENOPODIACEAE

Chenopodium album L. var. *missouriense* (Aellen) I.J. Bassett & C.W. Crompton, (1954) Henry, L.K.; Buker, W.E.

**Chenopodium ambrosioides* L., (1984) Thompson, S.A.; Nishida, J.H. 2042; Tropic America

**Chenopodium botrys* L., (1955) Buker, W.E.; Europe

CISTACEAE

Lechea racemulosa Michx., (1995) Isaac, B.L.; Isaac, J.A. 7149

CLUSIACEAE

Hypericum gentianoides (L.) B.S.P., (1951) Henry, L.K.; Buker, W.E.

Hypericum hypericoides (L.) Crantz, (1951) Henry, L.K.; Beer, F.H.

Hypericum mutilum L., (1959) Henry, L.K.; Beer, F.H.

**Hypericum perforatum* L., (2003) Isaac, J.A. 16185; Europe

Hypericum prolificum L., (2003) Isaac, J.A. 16147

Hypericum punctatum Lam., (1993) Haywood, M.J. 120

COMMELINACEAE

Commelina communis L., (1993) Haywood, M.J. 133

CONVOLVULACEAE

Calystegia sepium (L.) R. Br., (1951) Henry, L.K.; Beer, F.H.

Calystegia silvatica (Kit.) Griseb., (2003) Isaac, J.A. 16611

Calystegia spithamaea (L.) Pursh, (1994) Haywood, M.J. 470

**Convulvulus arvensis* L., (1896) Hoge, M.K.; Europe

Ipomoea pandurata (L.) G. Mey., (1958) Buker, W.E.

CORNACEAE

Cornus alternifolia L. f., (1995) Isaac, B.L.; Isaac, J.A. 7091

Cornus amomum P. Mill., (1995) Isaac, B.L.; Isaac, J.A. 7514

Cornus florida L., (2003) Isaac, B.L.; Isaac, J.A. 15819

Cornus racemosa Lam., (2003) Isaac, J.; Haywood, M.J.; Coxe, R.; Brandburn, M. 17229

Nyssa sylvatica Marsh., (1951) Henry, L.K.; Beer, F.H.

CRASSULACEAE

Penthorum sedoides L., (2003) Isaac, J.A. 16588

Sedum ternatum Michx., (1996) Isaac, B.L.; Isaac, J.A. 8873

CUCURBITACEAE

Echinocystis lobata (Michx.) Torr. & Gray, (1950) Henry, L.K.; Beer, F.H.

Sicyos angulatus L., (2003) Isaac, J.; Coxe, R., Bradburn, M. 17216

CUSCUTACEAE

Cuscuta gronovii Willd. ex J.A. Schultes, (1984) Thompson, S.A.; Nishida, J.H. 2046

CYPERACEAE

Carex albicans Willd. ex Spreng. var. *albicans*., (1950) Henry, L.K.; Beer, F.H.

Carex albursina Sheldon, (1996) Isaac, B.L.; Isaac, J.A. 8869

Carex amphibola Steud., (1967) Duman, M.G.

Carex appalachica J. Webber & P.W. Ball, (2003) Isaac, J.A.; Isaac, B.L.; Isaac, H.R. 16107

Carex blanda Dewey, (2003) Isaac, J.A. 16305

Carex bromoides Schkuhr ex Willd., Bell 180

Carex bushii Mackenzie, Bell 192

Carex cephaloidea (Dewey) Dewey, (2003) Isaac, J.A. 16379

Carex cephalophora Muhl. ex Willd., (1993) Isaac, J.A. 4512

Carex communis Bailey, (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15800

Carex conjuncta Boott, (2003) Isaac, J.A. 16303

Carex cristatella Britt., (1993) Isaac, J.A. 4379

Carex debilis Michx. var. *rudgei* Bailey, Bell 181

Carex digitalis Willd., Bell 190

Carex frankii Kunth, (1995) Isaac, B.L.; Isaac, J.A. 7512

Carex gracilescens Steud., (1951) Henry, L.K.; Beer, F.H.

Carex granularis Muhl. ex Willd., (2003) Isaac, J.A. 16331

Carex hirsutella Mackenzie, (1995) Isaac, B.L.; Isaac, J.A. 7519

Carex hirtifolia Mackenzie, Bell 243

Carex hitchcockiana Dewey, Bell 166

Carex intumescens Rudge, Bell 179

Carex laevivaginata (Kükenth.) Mackenzie, (1951) Henry, L.K.; Beer, F.H.

Carex laxiculmis Schwein. var. *copulata* (Bailey) Fern., (1951) Henry, L.K.; Beer, F.H.

Carex laxiflora Lam., (1951) Henry, L.K.; Buker, W.E.

Carex lucorum Willd. ex Link, (1997) Grund 1852

Carex lupulina Muhl. ex Willd., Bell 273

Carex lurida Wahlenb., (2003) Isaac, J.A. 16368

Carex normalis Mackenzie, (1995) Isaac, B.L.; Isaac, J.A. 7092

Carex oligocarpa Schkuhr ex Willd., Duman, M.G.

Carex pensylvanica Lam., (1995) Grund, S.P.; Novak, J. 1029

Carex plantaginea Lam., (2003) Isaac, J.A 15875

Carex platyphylla Carey, (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15810

Carex prasina Wahlenb., (1951) Henry, L.K.; Beer, F.H.

Carex rosea Schkuhr ex Willd., (1995) Isaac, B.L.; Isaac, J.A. 7096

Carex scoparia Schkuhr ex Willd., (2003) Isaac, J.A. 16372

Carex sparganioides Muhl. ex Willd., (1997) Grund, S.P. 1831

Carex squarrosa L., Bell 274

**Carex stipata* Muhl. ex Willd. var. *stipata*, (2003) Isaac, J.A. 15982; Europe

Carex swanii (Fern.) Mackenzie, (2003) Isaac, J.A. 16585

Carex torta Boott ex Tuckerman, (1952) Henry, L.K.; Buker, W.E.

Carex tribuloides Wahlenb., (1952) Henry, L.K.; Beer, F.H.

Carex vulpinoidea Michx., (1995) Isaac, B.L.; Isaac, J.A. 7500

Carex willdenowii Schkuhr ex Willd., Bell 250

Carex woodii Dewey, (1998) Grund, S.P. 1897

Cyperus bipartitus Torr., (1921) Jennings, O.E.; Jennings, G.K.; et al.

Cyperus esculentus L., Donley 95

Cyperus flavescens L., (1984) Thompson, S.A.; Nishida, J.H. 2013

Cyperus strigosus L., (2003) Isaac, J.A. 16567

Eleocharis obtusa (Willd.) J.A. Schultes, (2003) Isaac, J.A. 16195

Scirpus cyperinus (L.) Kunth, (1955) Buker, W.E.

Scirpus georgianus Harper, (2003) Coxe, R.

Scirpus hattorianus Makino, (2003) Isaac, J.A. 16570

Scirpus polyphyllus Vahl, Lohr 160

DIOSCOREACEAE

Dioscorea villosa L., (1996) Isaac, B.L.; Isaac, J.A. 8863

DIPSACACEAE

**Dipsacus fullonum* L., (2003) Isaac, J.A. 16629; Exotic

ELAEAGNACEAE

**Elaeagnus umbellata* Thunb., (2003) Isaac, J.A.; Isaac, B.L. 15820; Asia

ERICACEAE

Epigaea repens L., (1951) Buker, W.E.

Gaultheria procumbens L., (1950) Henry, L.K.; Buker, W.E.

Gaylussacia baccata (Wangenh.) K. Koch, (2004) Isaac, J.A. 17375

Kalmia latifolia L., (1951) Henry, L.K.; Beer, F.H.

Oxydendrum arboreum (L.) DC., (2004) Isaac, J.A. 17638; **G5:S3S4**

Rhododendron maximum L., Bell 580

Rhododendron periclymenoides (Michx.) Shinners, (2004) Isaac, J.A. 17377

Vaccinium corymbosum L., (1907) Jennings, O.E.

Vaccinium pallidum Aiton, (2002) Isaac, J.A.; Takacs, M. 14402

Vaccinium stamineum L., (2002) Isaac, J.A.; Takacs, M. 14404

EUPHORBIACEAE

Acalypha rhomboidea Raf., (1992) Haywood, M.H. 404

Acalypha virginica L., (1993) Haywood, M.J. 211

Chamaesyce maculata (L.) Small, (1955) Buker, W.E.

Chamaesyce nutans (Lag.) Small, (1993) Haywood, M.J. 170

Euphorbia commutata Engelm., (1997) Grund, S.P.; Gray, A.; Folman, J.; Gardner, M. 1820

Euphorbia corollata L., (2003) Isaac, J.A. 16390

FABACEAE

Amphicarpaea bracteata (L.) Fern., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1945

Apios americana Medik., (1993) Haywood, M.J. 159

Cercis canadensis L., (2003) Isaac, J.A.; Isaac, B.L. 15821

Chamaecrista nictitans (L.) Moench, (1953) Buker, W.E.

**Coronilla varia* L., (1995) Isaac, B.L.; Isaac, J.A. 7505; Europe

Desmodium canadense (L.) DC., (1993) Haywood, M.J. 194

Desmodium glutinosum (Muhl. Ex Willd.) Wood, (2003) Isaac, J.A. 16349

Desmodium marilandicum (L.) DC., (1966) Buker, W.E.

Desmodium nudiflorum (L.) DC., (1951) Henry, L.K.; Beer, F.H.

Desmodium paniculatum (L.) DC., (2003) Isaac, J.A. 17156

Desmodium perplexum Schub., (1993) Haywood, M.J. 157

Desmodium rotundifolium DC., (1954) Henry, L.K.; Buker, W.E.

Gleditsia triacanthos L., (2004) Isaac, A.A. 17508

Gymnocladus dioicus (L.) K. Koch, Donley 160

**Lathyrus sylvestris* L., (1995) Isaac, B.L.; Isaac, J.A. 7485; Exotic

Lespedeza hirta (L.) Hornem., (1974) Buker, W.E.

Lespedeza procumbens Michx., (1921) Jennings, O.E.; Jennings, G.K.; et al.

Lespedeza repens (L.) W. Bart., (1954) Henry, L.K.; Buker, W.E.

Lespedeza violacea (L.) Pers., (1969) Buker, W.E.

Lespedeza virginica (L.) Britt, Lohr 174

**Lotus corniculatus* L., (2003) Isaac, J.A. 16176; Europe

**Medicago lupulina* L., (1995) Isaac, B.L.; Isaac, J.A. 7495; Eurasia

**Medicago sativa* L., (1958) Buker, W.E.; Eurasia

**Melilotus officinalis* (L.) Lam., (2003) Isaac, J.A. 16113; Eurasia

Robinia pseudoacacia L., (2003) Isaac, J.A. 16039

Senna hebecarpa (Fern.) Irwin & Barneby, (2003) Isaac, J. 17153

Senna marilandica (L.) Link, (1951) Henry, L.K.; Beer, F.H.; **G5:S1**

**Trifolium aureum* Pollich, (2003) Isaac, J.A. 16324; Eurasia

**Trifolium campestre* Schreb., (2003) Isaac, J.A. 15988; Europe

**Trifolium hybridum* L., (1985) Thompson, S.A.; Nishida, J.H. 2351; Eurasia

**Trifolium pratense* L., (1995) Isaac, B.L.; Isaac, J.A. 7496; Europe

**Trifolium repens* L., (2003) Isaac, J.A. 16117; Europe

Vicia caroliniana Walt., (1994) Haywood, M.J. 446

**Vicia cracca* L., (1896) Hoge, M.K.; Eurasia

**Vicia villosa* Roth, (2003) Isaac, J.A. 16401; Europe

FAGACEAE

Castanea dentata (Marsh.) Borkh., (2003) Isaac, J.A. 16586

Fagus grandifolia Ehrh., (2004) Isaac, J.A. 17633
Quercus alba L., (1985) Thompson, S.A. 2435
Quercus bicolor Willd., (1921) Dickey, S.S.
Quercus coccinea Muenchh., (1954) Henry, L.K.; Buker, W.E.
Quercus imbricaria Michx., (2003) Isaac, J.A. 16159
Quercus muehlenbergii Engelm., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 2002
Quercus prinus L., (1991) Isaac, J.A. 3647
Quercus rubra L., (1985) Thompson, S.A. 2432
Quercus stellata Wangenh., (1948) Bryner, C.L. 501
Quercus velutina Lam., (1985) Thompson, S.A. 2434
Quercus x leana Nutt. (pro sp.), (1948) Bryner, C.L. 502

FUMARIACEAE

Corydalis aurea Willd., (1996) Haywood, M.J. 634
Corydalis flavula (Raf.) DC., (2003) Isaac, B.L.; Isaac, J.A. 15827
Dicentra canadensis (Goldie) Walp., (2003) Isaac, B.L.; Isaac, J.A. 15844
Dicentra cucullaria (L.) Bernh., (2003) Isaac, B.L.; Isaac, J.A. 15858

GENTIANACEAE

Gentiana andrewsii Griseb. var.andrewsii, (2003) Coxe, R.; Block, R.; Bradburn, M.
Gentiana clausa Raf., (1954) Henry, L.K.; Buker, W.E.
Obolaria virginica L., (1952) Henry, L.K.; Buker, W.E.
Sabatia angularis (L.) Pursh, (1998) Grund, S.P. 2061

GERANIACEAE

**Geranium columbinum* L., (1993) Isaac, J.A. 4505; Europe
Geranium maculatum L., (2003) Isaac, J.A.; Isaac, B.L. 15838
**Geranium sibiricum* L., (1984) Thompson, S.A.; Nishida, J.H., Bier, C. 1954; Eurasia
**Geranium thunbergii* Sieb. & Zucc. ex Lindl. & Paxton, (1984) Thompson, S.A.; Nishida, J.H. 2007; Exotic

GROSSULARIACEAE

Ribes cynosbati L., (2003) Isaac, J.A. 16334
**Ribes rubrum* L., Rhoads, A.; Eurasia

HALORAGRACEAE

Myriophyllum heterophyllum Michx., (2003) Coxe, R.; **G5:S1**

HAMAMELIDACEAE

Hamamelis virginiana L., (2004) Isaac, J.A. 17635

HIPPOCASTANACEAE

Aesculus flava Aiton, (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15811
Aesculus glabra Willd., (2003) Isaac, J.A. 15883

HYDRANGEACEAE

Hydrangea arborescens L., (2003) Isaac, J.A. 16366
**Philadelphus coronarius* L., (1896) Hoge, M.K.; Eurasia

HYDROPHYLLACEAE

Hydrophyllum appendiculatum Michx., (1995) Isaac, B.L.; Isaac, J.A. 7183
Hydrophyllum canadense L., (1995) Isaac, B.L.; Isaac, J.A. 7164
Hydrophyllum macrophyllum Nutt., (2003) Isaac, J.A. 15882; **G5:S1**
Hydrophyllum virginianum L., (1996) Isaac, B.L.; Isaac, J.A. 8846
Phacelia purshii Buckl., (2003) Isaac, J.A. 16040

IRIDACEAE

Iris cristata Aiton, (2004) Isaac, J.A. 17380; **G5:S1**
Iris pseudacorus L., (2003) Isaac, J.A. 16193
Sisyrinchium angustifolium P. Mill., (1993) Isaac, J.A. 4377

JUGLANDACEAE

Carya alba (L.) Nutt. ex Ell., (1921) Jennings, O.E.
Carya cordiformis (Wangenh.) K. Koch, (1993) Haywood, M.J. 197
Carya glabra (P. Mill.) Sweet, (1905) Jennings, O.E.
Carya ovalis (Wangenh.) Sarg., (1954) Henry, L.K.; Buker, W.E.
Carya ovata (P. Mill.) K. Koch, (1921) Jennings, O.E.
Juglans cinerea L., (2003) Isaac, J.A. 16392
Juglans nigra L., (1951) Henry, L.K.; Beer, F.H.

JUNCACEAE

Juncus acuminatus Michx., (2003) Coxe, R.; Bradburn, M.
Juncus effusus L. var. *pylaei* (Laharpe) Fern. & Wieg., (1954) Henry, L.K.; Buker, W.E.
Juncus effusus L. var. *solutus* Fern. & Wieg., (2003) Isaac, J.A. 16190
Juncus marginatus Rostk., (1951) Henry, L.K.; Beer, F.H.
Juncus tenuis Willd., (2003) Isaac, J.A. 16307
Juncus torreyi Coville, (2002) Paluh, A.T. 1
Luzula acuminata Raf., (1996) Isaac, B.L.; Isaac, J.A. 8888
Luzula echinata (Small) F.J. Herm., Bell 422

Luzula multiflora (Ehrh.) Lej., (1996) Isaac, B.L.; Isaac, J.A. 8887

LAMIACEAE

Agastache nepetoides (L.) Kuntze, (1975) Buker, W.E.

Blephilia hirsuta (Pursh) Benth., (1995) Isaac, B.L.; Isaac, J.A. 7520

**Clinopodium vulgare* L., (2003) Isaac, J.A. 16370; Europe

Collinsonia canadensis L., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1992

Cunila origanoides (L.) Britt., (1951) Henry, L.K.; Beer, F.H.

**Glechoma hederacea* L., (1996) Isaac, J.A.; Isaac, B.L. 8840; Eurasia

Hedeoma pulegioides (L.) Pers., (1994) Thompson, S.A.; Rawlins, J.E. 11731

Isanthus brachiatus (L.) B.S.P., 1921) Jennings, O.E.

**Lamium amplexicaule* L., (1996) Haywood, M.J. 631; Eurasia

**Lamium maculatum* L., (1947) Henry, L.K.; Eurasia

**Lamium purpureum* L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15802; Eurasia

**Leonurus cardiaca* L., (1995) Isaac, B.L.; Isaac, J.A. 7481; Asia

Lycopus americanus Muhl. ex W. Bart., (1984) Thompson, S.A.; Nishida, J.H. 2026

Lycopus uniflorus Michx. var. uniflorus, (1993) Haywood, M.J. 154

Lycopus virginicus L., (2003) Isaac, J.A. 16572

Meehania cordata (Nutt.) Britt., Bell 619; **G5**:**S1**

Mentha arvensis L., (1950) Henry, L.K.; Buker, W.E.

**Mentha x piperita* L. (pro sp.), (1951) Henry, L.K.; Beer, F.H.; Eurasia

**Mentha spicata* L., (1951) Henry, L.K.; Beer, F.H.; Europe

Monarda clinopodia L., (2003) Isaac, J.A. 16388

Monarda fistulosa L., (1995) Isaac, B.L.; Isaac, J.A. 7538

Monarda media Willd., (1907) Jennings, O.E.

**Nepeta cataria* L., (1954) Henry, L.K.; Buker, W.E.; Europe

Prunella vulgaris L. ssp. *lanceolata* (W. Bart.)

Hulten, (1995) Isaac, B.L.; Isaac, J.A. 7529

Pycnanthemum incanum (L.) Michx., (1951) Henry, L.K.; Buker, W.E.

Pycnanthemum tenuifolium Schrad., (1951) Henry, L.K.; Buker, W.E.

Salvia lyrata L., (2003) Isaac, J.A. 16048

Scutellaria incana Biehler, (2003) Isaac, J.A. 16579

Scutellaria lateriflora L., (1984) Thompson, S.A.; Nishida, J.H. 2077

Scutellaria nervosa Pursh, (2003) Isaac, J.A. 16332

Scutellaria saxatilis Riddell, (2003) Isaac, J.; Haywood, M.J.; Coxe, R.; Brandburn, M. 17230; **G3**:**S1**

Stachys nuttallii Schuttlw. ex. Benth., (2003) Isaac, J.; Coxe, R.; Bradburn, M. 17214

Stachys tenuifolia Willd., (2003) Isaac, J.; Coxe, R.; Bradburn, M. 17223

Teucrium canadense L., (1993) Haywood, M.J. 127

Trichostema dichotomum L., (1921) Dickey, S.S.

LAURACEAE

Lindera benzoin (L.) Blume, (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15799

Sassafras albidum (Nutt.) Nees, (1995) Isaac, B.L.; Isaac, J.A. 7095

LEMNACEAE

Lemna minor L., (2003) Isaac, J.A. 16402

LILIACEAE

Allium canadense L., (2003) Isaac, J.A. 16132

Allium cernuum Roth, (2003) Isaac, J.A. 16583

Allium tricoccum Aiton, (1996) Haywood, M.J. 411

**Allium vineale* L., (2003) Isaac, J.A. 16139; Europe

Clintonia umbellulata (Michx.) Morong, Bell 377

**Convallaria majalis* L., (1896) Hoge, M.K.; Europe

Erythronium albidum Nutt., (1993) Haywood, M.J. 77; **G5**:**S3**

Erythronium americanum Ker-Gawl., (2003) Isaac, J.A.; Isaac, B.L. 15832

**Hemerocallis fulva* (L.) L., (2003) Isaac, J. 16317; Asia

**Hyacinthus orientalis* L., (1941) Henry, L.K.; Exotic

Hypoxis hirsuta (L.) Coville, Sebben

Lilium superbum L., (2003) Coxe, R.; Bradburn, M.

Maianthemum racemosa (L.) Link, (2003) J.A. Isaac 16023

Medeola virginiana L., (1993) Isaac, J.A. 4367

**Narcissus poeticus* L., (1896) Hoge, M.K.; Europe

**Ornithogalum umbellatum* L., (1995) Isaac, B.L.; Isaac, J.A. 7182; Europe

Polygonatum biflorum (Walt.) Ell. var. *commutatum* (J.A. & J.H. Schultes) Morong

{(1975) Buker, W.E.

Polygonatum pubescens (Willd.) Pursh, (1996) Isaac, B.L.; Isaac, J.A. 8899

Prosartes lanuginosa (Michx.) D.Don, (1970) Buker, W.E.; [*Disporum lanuginosa* (Michx.) Nichols.]

Trillium erectum L., (2003) Isaac, B.L.; Isaac, J.A. 15854

Trillium grandiflorum (Michx.) Salisb., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15807

Trillium nivale Riddell, (1997) Grund, S.P.; Gray, A.; Folman, J.; Gardner, M. 1818; **G4:S3**

Trillium sessile L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15808

Uvularia grandiflora Sm., (2003) Isaac, J.A.; Isaac, B.L. 15841

Uvularia perfoliata L., (1993) Haywood, M.J. 79

LIMNANTHACEAE

Floerkea proserpinacoides Willd., (2003) Isaac, J.A.; Isaac, B.L. 15830

LINACEAE

Linum virginianum L., (1951) Henry, L.K.; Beer, F.H.

LYTHRACEAE

Cuphea viscosissima Jacq., (1991) Isaac, J.A. 3674

**Lythrum salicaria* L., (1993) Haywood, M.J. 151; Europe

MAGNOLIACEAE

Liriodendron tulipifera L., (1996) Isaac, B.L.; Isaac, J.A. 8868

Magnolia acuminata (L.) L., (1904) Jennings, O.E.

MALVACEAE

**Abutilon theophrastii* Medik., (1951) Henry, L.K.; Beer, F.H.; Asia

**Hibiscus trionum* L., (1984) Thompson, S.A.; Nishida, J.H. 2044; Europe

**Malva moschata* L., Lohr; Europe

**Malva neglecta* Wallr., Lohr 260; Eurasia/ N. Africa

**Sida spinosa* L., (1951)Henry, L.K.; Beer, F.H.; Tropics

MELASTOMACEAE

Rhexia virginica L., (2003) Isaac, J.A. 17150

MENISPERMACEAE

Menispermum canadense L., (2003) Isaac, J.A. 16339

MOLLUGINACEAE

**Mollugo verticillata* L., (1951) Henry, L.K.; Beer, F.H.; Tropic America

MONOTROPACEAE

Monotropa hypopithys L., (2004) Isaac, J.A. 17653

Monotropa uniflora L., (2003) Isaac, J.A. 16414

MORACEAE

Maclura pomifera (Raf.) Schneid., (2003) Isaac, J.A. 16316

**Morus alba* L., (1951) Henry, L.K.; Beer, F.H.; Asia

Morus rubra L., (1996) Isaac, B.L.; Isaac, J.A. 8864

OLEACEAE

Chionantheus virginicus L., (1896) Hoge, M.K.

Fraxinus americana L., (2003) Isaac, J.A. 16403

Fraxinus nigra Marsh., Bell

**Syringa vulgaris* L., (1896) Hoge, M.K.; Europe

ONAGRACEAE

Circaea lutetiana L. ssp. *canadensis* (L.) Aschers. & Magnus, (1996) Haywood, M.J. 620

Epilobium coloratum Biehler, (1984) Thompson, S.A.; Nishida, J.H. 2043

Gaura biennis L., (1993) Haywood, M.J. 179

Ludwigia alternifolia L., (2003) Isaac, J.A. 17149

Ludwigia palustris (L.) Ell., (2003) Coxe, R.; Bradburn, M.

Oenothera biennis L., (2003) Isaac, J.A. 16605

Oenothera fruticosa L., (1896) Hoge, M.K.

Oenothera parviflora L., Donley, B.F.

Oenothera perennis L., (1994) Haywood, M.J. 468

ORCHIDACEAE

Aplectrum hyemale (Muhl. ex Willd.) Torr., (1997) Shriver, J.S.; Shriver, A.; Smith C. 868; **G5:S3**

Cypripedium acaule Aiton, (1922) Dickey, S.S.

Goodyera pubescens (Willd.) R. Br. ex Aiton f., (1997) Shriver, J.S.; Shriver, A.; Smith, C. 867

Isotria medeoloides (Pursh) Raf., (1922) Bright, J.

Isotria verticillata Raf., (1922) Dickey, S.S.

Liparis liliifolia (L.) L.C. Rich. ex Ker-Gawl., (1995) Isaac, B.L.; Isaac, J.A. 7159

Platanthera lacera (Michx.) G. Don, (2003) Isaac, J.A.; Coxe, R. 16292

Platanthera orbiculata (Pursh) Lindl., (1953) Krouse, D.H.

Spiranthes cernua (L.) L.C. Rich., Lohr, W.N.

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer, (2004) Isaac, J.A.; Smith, C. 18488

Spiranthes ochroleuca (Rydb.) Rydb., (1969) Buker, W.E.

Spiranthes ovalis Lindl., (2003) Isaac, J.; Coxe, R.; Bradburn, M. 17225

OROBANCHACEAE

Conopholis americana (L.) Wallr. f., (2003) Isaac, J.A. 16165

Epifagus virginiana (L.) W. Bart., (1969) Buker, W.E.

Orobanche uniflora L., (1996) Isaac, B.L.; Isaac, J.A. 8871

OXALIDACEAE

Oxalis dillenii Jacq., (2003) Isaac, J.A. 16376
Oxalis grandis Small, (2003) Isaac, J.A. 16326
Oxalis stricta L., (1993) Haywood, M.J. 100
Oxalis violacea L., (1996) Haywood, M.J. 629

PAPAVERACEAE

**Chelidonium majus* L., (1994) Haywood, M.J. 426; Europe
Sanguinaria canadensis L., (2003) Isaac, J.A.; Isaac, B.L. 15855

PASSIFLORACEAE

Passiflora lutea L., (2003) Isaac, J.; Coxe, R.; Bradburn, M. 17221; **G5:S1**

PHYTOLACCACEAE

Phytolacca americana L., (1993) Haywood, M.J. 308

PLANTAGINACEAE

Plantago aristata Michx., (1954) Henry, L.K.; Buker, W.E.
**Plantago lanceolata* L., (1996) Isaac, B.L.; Isaac, J.A. 8900; Europe
**Plantago major* L., (1984) Thompson, S.A.; Nishida, J.H. 2050; Europe
Plantago rugelii Dcne., (2003) Isaac, J.A. 16399
Plantago virginica L., (1975) Buker, W.E.

PLATANACEAE

Platanus occidentalis L., (1995) Isaac, B.L.; Isaac, J.A. 7491

POACEAE

**Agrostis gigantea* Roth, (2003) Isaac, J.A.; Coxe, R. 16285; Europe
Agrostis perennans (Walt.) Tuckerman, (1994) Thompson, S.A.; Rawlins, J.E. 11969
Agrostis scabra Willd., Pohl 5922
Andropogon virginicus L., (1951) Henry, L.K.; Beer, F.H.
**Anthoxanthum odoratum* L., (2003) Isaac, J.A. 15989; Eurasia
Aristida dichotoma Michx. var. *dichotoma*, Bell 334
**Arrhenatherum elatius* (L.) Beauv. ex J. & C. Presl, (1995) Isaac, B.L.; Isaac, J.A. 7516; Europe
**Avena fatua* L., (1971) Buker, W.E.; Europe
Bromus ciliatus L., (2003) Coxe, R.
**Bromus commutatus* Schrad., (2003) Isaac, J.A. 16175; Europe
**Bromus inermis* Leyss., (1995) Isaac, B.L.; Isaac, J.A. 7489; Europe
**Bromus japonicus* Thunb. ex Murr., (1995) Isaac, B.L.; Isaac, J.A. 7488; Eurasia
Bromus latiglumis (Shear) A.S. Hitchc., Fogg 18323
Bromus pubescens Muhl. ex Willd., (2003) Isaac, J.A. 16416
**Bromus racemosus* L., (1985) Thompson, S.A.; Nishida, J.H. 2419; Europe
**Bromus sterilis* L., (1996) Isaac, B.L.; Isaac, J.A. 8844; Europe
Chasmanthium latifolium (Michx.) Yates, (2003) Coxe, R.; Bradburn, M.; **G5:S1**
Cinna arundinacea L., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1987
**Dactylis glomerata* L., (2003) Isaac, J.A.; Isaac, B.L.; Isaac, H.R. 16096; Europe
Danthonia compressa Austin ex Peck, (2003) Isaac, J.A. 16151
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes, (2003) Isaac, J.A. 16352
Diarrhena americana Beauv., (2002) Isaac, B.L.; Isaac, J.A. 15787; **G4?:S1**
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark, (2004) Isaac, J.A. 17733
Dichanthelium boscii (Poir.) Gould & C.A. Clark, (1995) Isaac, B.L.; Isaac, J.A. 7162
Dichanthelium clandestinum (L.) Gould, (1995) Isaac, B.L.; Isaac, J.A. 7535
Dichanthelium commutatum (J.A. Schultes) Gould, (2003) Isaac, J.A. 16409
Dichanthelium dichotomum (L.) Gould, (1904) Jennings, O.E.
Dichanthelium latifolium (L.) Gould & C.A. Clark, (2003) Isaac, J.A. 16346
Dichanthelium linearifolium (Scribn. ex. Nash) Gould, (2004) Isaac, J.A. 17629
Dichanthelium sabulorum (Lam.) Gould & C.A. Clark var. *thinium* (A.S. Hitchc. & Chase) Gould & C.A. Clark, (2002) Isaac, J.A.; Takacs, M. 14416
**Digitaria ischaemum* (Schreb.) Schreb. ex Muhl, (1984) Thompson, S.A.; Nishida, J.H. 2075; Eurasia
**Echinochloa crus-galli* (L.) Beauv., (1993) Haywood, M.J. 165; Eurasia
**Eleusine indica* (L.) Gaertn., (2003) Isaac, J.A. 16616; Old World Tropics

Elymus canadensis L., (1951) Henry, L.K.; Buker, W.E.
Elymus hystrix L., (2003) Isaac, J.A. 16299
**Elymus repens* (L.) Gould, (2003) Isaac, J.A. 16119; Exotic
Elymus riparius Wieg., (2003) Isaac, J.A. 16172
Elymus villosus Muhl. ex Willd., (2003) Isaac, J.A 16135
Elymus virginicus L., (1951) Henry, L.K.; Buker, W.E.
Eragrostis spectabilis (Pursh) Steud., (1941) Davis, H.A.; et al.
Festuca subverticillata (Pers.) Alexeev, (2003) Isaac, J.A.; Isaac, B.L.; Isaac, H.R. 16103
Glyceria septentrionalis A.S. Hitchc., Bell 271
Glyceria striata (Lam.) A.S.Hitchc., (2003) Isaac, J.A. 16192
**Holcus lanatus* L., (2003) Isaac, J.A. 16172; Europe
Leersia oryzoides (L.) Sw., (1951) Henry, L.K.; Beer, F.H.
Leersia virginica Willd., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1999
**Lolium perenne* L., (1995) Isaac, B.L.; Isaac, J.A. 7498; Europe
**Lolium pratense* (Huds.) S.J. Darbyshire, (2003) Isaac, J.A.; Isaac, B.L.; Isaac, H.R. 16097; Europe
Muhlenbergia frondosa (Poir.) Fern, Bell 3645
Muhlenbergia schreberi J.F. Gmel., (1984) Thompson, S.A.; Nishida, J.H. 2076
Panicum dichotomiflorum Michx., (1984) Thompson, S.A.; Nishida, J.H. 2045
Panicum philadelphicum Bernh. ex Trin., (1985) Thompson, S.A.; Nishida, J.H. 2516
**Pennisetum glaucum* (L.) R. Br., (1993) Haywood, M.J. 164; Exotic
Phalaris arundinacea L., (2003) Isaac, J.A. 16309
**Phleum pratense* L., (1954) Henry, L.K.; Buker, W.E.; Europe
Poa alsodes A. Gray, (1951) Henry, L.K.; Beer, F.H.
**Poa annua* L., (1996) Thompson, S.A.; Rawlins, J.E. 12466; Eurasia
**Poa compressa* L., (1993) Isaac, J.A. 4375; Europe
Poa cuspidata Nutt., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15805
**Poa pratensis* L., (1984) Nishida, J.H.; Bier, C.W. 709; Europe
Poa sylvestris Gray, (1951) Henry, L.K.; Beer, F.H.
**Poa trivialis* L., (2003) Isaac, J.A. 16198; Europe
Schizachyrium scoparium (Michx.) Nash, (1904) Jennings, O.E.
Schizachyrium scoparium (Michx.) Nash var. *scoparium*, (1904) Jennings, O.E.
**Setaria faberi* Herrm., (1951) Henry, L.K.; Beer, F.H.; Asia
**Setaria viridis* (L.) Beauv. var. *viridis*, (2003) Isaac, J. 16389; Eurasia
Sphenopholis intermedia (Rydb.) Rydb., (1996) Thompson, S.A.; Rawlins, J.E. 12459
Sphenopholis nitida (Biehler) Scribn., (2003) Isaac, J.A. 16160
Sporobolus vaginiflorus (Torr. ex Gray) Wood, (2003) Isaac, J.; Coxe, R.; Bradburn, M. 17227
Tridens flavus (L.) A.S. Hitchc., (2004) Isaac, J.a. 18557

POLEMONIACEAE

Phlox divaricata L., (1999) Haywood, M.J. 607
Phlox maculata L. ssp. *maculata*, Wherry
Phlox paniculata L., (2003) Isaac, J.A. 16607
Phlox stolonifera Sims, (1952) Henry, L.K.; Buker, W.E.
Polemonium reptans L., (2003) Isaac, J.A. 16170

POLYGALACEAE

Polygala sanguinea L., (2003) Isaac, J.A. 16639
Polygala verticillata L. var. *verticillata*, (1954) Henry, L.K.; Buker, W.E.

POLYGONACEAE

**Polygonum aviculare* L., (1994) Thompson, S.A.; Rawlins, J.E. 11730; Europe
**Polygonum caespitosum* Blume, (2003) Isaac, J.A. 16189; Asia
**Polygonum convolvulus* L., (1954) Henry, L.K.; Buker, W.E.; Europe
Polygonum erectum L., (2003) Isaac, J.A. 16571
**Polygonum hydropiper* L., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1986; Europe
Polygonum hydropiperoides Michx., (2003) Isaac, J.A. 16589
Polygonum pensylvanicum L., (1984) Thompson, S.A.; Nishida, J.H. 2054
**Polygonum persicaria* L., (1984) Thompson, S.A.; Nishida, J.H. 2055; Europe
Polygonum punctatum Ell. var. *confertiflorum* (Meisn.) Fassett, (2003) Isaac, J.A. 16590
Polygonum sagittatum L., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1975
Polygonum.scandens L. var. *scandens*, (2004) Isaac, J.A. 18515
Polygonum virginianum L., (1998) Grund, S.P. 2048

**Rumex acetosella* L., (1996) Isaac, B.L.; Isaac, J.A. 8874; Europe

**Rumex crispus* L., (2003) Isaac, J.A. 16110; Europe

**Rumex obtusifolius* L., (2003) Isaac, J.A. 16302; Europe

PORTULACACEAE

Claytonia caroliniana Michx., (2003) Isaac, J.A.; Isaac, B.L. 15853

Claytonia virginica L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15797

Portulaca oleracea L., (2003) Isaac, J.A. 16624

PRIMULACEAE

Lysimachia ciliata L., (1995) Isaac, B.L.; Isaac, J.A. 7525

Lysimachia lanceolata Walt., (1993) Haywood, M.J. 69

**Lysimachia nummularia* L., (1995) Isaac, B.L.; Isaac, J.A. 7508; Europe

Lysimachia quadrifolia L., (1995) Isaac, B.L.; Isaac, J.A. 7531

PYROLACEAE

Chimaphila maculata (L.) Pursh, (2004) Isaac, J.A. 17654

Pyrola americana Sweet, (1968) Buker, W.E.

RANUNCULACEAE

Aconitum uncinatum L., (1932) Bright, J. 7641; **G4:S2**

Actaea pachypoda Ell., (1969) Buker, W.E.

Actaea racemosa L. var. *racemosa*, (2003) Isaac, J.A. 16575

Anemone quinquefolia L., Lohr

Anemone virginiana L., (2003) Isaac, J.A. 16121

Aquilegia canadensis L., (2003) Isaac, J.A. 15900

Caltha palustris L. var. *palustris*, Bell 423

Clematis occidentalis (Hornem.) DC., (1896) Hoge, M.K.

Clematis virginiana L., (2003) Isaac, J. 17138

Delphinium tricorne Michx., (1996) Isaac, B.L.; Isaac, J.A. 8850

**Helleborus viridis* L., (1940) Baker; Exotic

Hepatica nobilis Schreber var. *acuta* (Pursh) Steyermark, (2003) Isaac, B.L.; Isaac, J.A.; Morton C.M. 15814

Hepatica nobilis Schreber var. *obtusa* (Pursh) Steyermark, (1952) Henry, L.K.; Buker, W.E.

Hydrastis canadensis L., (2003) Isaac, J.A. 16335

Ranunculus abortivus L., (2003) Isaac, J.A.; Isaac, B.L.; Isaac, H.R. 16098

**Ranunculus acris* L., (1995) Haywood, M.J. 561; Europe

Ranunculus allegheniensis Britt., (1996) Isaac, B.L.; Isaac, J.A. 8909

**Ranunculus ficaria* L., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15812; Eurasia

Ranunculus hispidus Michx. var. *hispida*, (2003) Isaac, J.A.; Isaac, B.L. 15835

Ranunculus hispidus Michx. var. *nitidus* (Chapman) T. Duncan, (1994) Haywood, M.J. 25

Ranunculus micranthus Nutt., (2003) Isaac, J.A.; Isaac, B.L. 15828

Ranunculus recurvatus Poir., (1996) Isaac, J.A.; Isaac, B.L. 8902

**Ranunculus repens* L., (1995) Isaac, J.A.; Isaac, B.L. 7178; Europe

Thalictrum dioicum L., (2003) Isaac, J.A.; Isaac, B.L. 15842

Thalictrum pubescens Pursh, (2003) Isaac, J.A. 16356

Thalictrum thalictroides (L.) Eames & Boivin, (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15815

RHAMNACEAE

Ceanothus americanus L., (2003) Isaac, J.A. 16378

ROSACEAE

Agrimonia gryposepala Wallr., (1993) Haywood, M.J. 95

Agrimonia parviflora Aiton, (1951) Henry, L.K.; Beer, F.H.

Agrimonia pubescens Wallr., (1998) Grund, S.P. 2058

Agrimonia rostellata Wallr., (2003) Coxe, R.; Isaac, J.; Haywood, M.J.

Amelanchier arborea (Michx. f.) Fern., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15806

Amelanchier stolonifera Wieg., (1949) Henry, L.K.

Aruncus dioicus (Walt.) Fern., (2003) Isaac, J.A. 16178

Crataegus crus-gallii L., (2003) Coxe, R.; Isaac, J.A.; Ernst, S.

Crataegus punctata Jacq., (2003) Isaac, J.A. 16020

Fragaria virginiana Duchesne, (1994) Haywood, M.J. 39

Geum aleppicum Jacq., (1993) Haywood, M.J. 68

Geum canadense Jacq. var. *canadense*, (1995) Isaac, J.A.; Isaac, B.L. 7517

Geum vernum (Raf.) Torr. & Gray, (1996) Isaac, J.A.; Isaac, B.L. 8856

Geum virginianum L., (1950) Henry, L.K.; Buker, W.E.

Malus coronari (L.) P. Mill., (2003) Isaac, J.A. 16417

**Malus pumila* P. Mill, (2003) Isaac, J.A.; Isaac, B.L. 15822; Eurasia

Physocarpus opulifolius (L.) Maxim., (1994) Haywood, M.J. 477

Potentilla canadensis L., (1999) Haywood, M.J. 05

Potentilla norvegica L. ssp. *monspeliensis* (L.) Aschers. & Graebn., (1995) Isaac, B.L.; Isaac, J.A. 7501

**Potentilla recta* L., (1995) Isaac, B.L.; Isaac, J.A. 7533, Europe

Potentilla simplex Michx., (1996) Isaac, B.L., Isaac, J.A. 8896

Prunus americana Marsh., (1951) Henry, L.K.; Beer, F.H.

**Prunus avium* (L.) L., (2003) Coxe, R.; Bradburn, M.; Eurasia

Prunus serotina Ehrh., (2003) Isaac, J.A. 16027

Prunus virginiana L., (1975) Buker, W.E.

**Rhodotypos scandens* (Thunb.) Makino, (2003) Isaac, J.A. 15977; Japan

Rosa carolina L. var. *carolina*, (2003) Isaac, J.A.; Coxe, R. 16281

**Rosa eglanteria* L., (1992) Haywood, M.J. 377; Europe

**Rosa multiflora* Thunb. ex Murr., (1995) Isaac, B.L.; Isaac, J.A. 7539; Asia

Rosa palustris Marsh., (1951) Henry, L.K.; Beer, F.H.

Rubus allegheniensis Porter, (1997) Grund, S.P. 1856

Rubus alumnus Bailey, (1950) Davis, H.A.; Davis, T. 9145

Rubus bellobatus Bailey, (1950) Davis, H.A.; Davis, T. 9154

Rubus flagellaris Willd., (2003) Isaac, J.A. 16046

Rubus laudatus Berger, (1951) Davis, H.A.; Davis, T. 9495

Rubus multifer Bailey, (1951) Davis, H.A.; Davis, T. 9479

Rubus occidentalis L., (2003) Isaac, J.A. 16030

Rubus odoratus L., (1958) Buker, W.E.

Rubus pensilvanicus Poir., (1951) Davis, H.A.; Davis, T. 9496

Rubus pergratus Blanch., (1951) Davis, H.A., Davis, T. 9480

Rubus roribaccus (Bailey) Rydb., (1949) Davis, H.A.; Davis, T. 8882

Spiraea alba Du Roi var. *latifolia* (Aiton) Dippel, (1993) Haywood, M.J. 102

**Spiraea japonica* L. f., (1998) Grund, S.P. 2056; Japan

Waldsteinia fragarioides (Michx.) Tratt., (1895) Guttenberg, G.

RUBIACEAE

Diodia teres Walt., (1951) Henry, L.K.; Beer, F.H.

Galium aparine L., (1996) Isaac, B.L.; Isaac, J.A. 8872

Galium asprellum Michx., (1984) Thompson, S.A.; Nishida, J.H. 2031

Galium circaezans Michx. var. *circaezans*, (2003) Isaac, J.A.; Isaac, B.L.; Isaac, H.R. 16102

Galium circaezans Michx. var. *hypomalacum* Fern., (1950) Henry, L.K.; Buker, W.E.

Galium concinnum Torr. & Gray, (1966) Buker, W.E.

Galium lanceolatum Torr., (1921) Jennings, O.E.

**Galium mollugo* L., (2003) Isaac, J.A.; Coxe, R. 16284; Eurasia

Galium pilosum Aiton, (1951) Henry, L.K.; Beer, F.H.

Galium tinctorium (L.) Scop., Donley 151

Galium triflorum Michx., (2003) Isaac, J.A. 16012

**Galium verum* L., (1921) Dickey, S.S.; Eurasia

Houstonia caerulea L., (1996) Isaac, B.L.; Isaac, J.A. 8897

Houstonia canadensis Willd. ex Roemer & J.A. Schultes, (1921) Dickey, S.S.

Mitchella repens L., (1970) Buker, W.E.; Henry, L.K.

SALICACEAE

Populus grandidentata Michx., (1974) Buker, W.E.

Salix caroliniana Michx., (1951) Henry, L.K.; Beer, F.H.; **G5 S1**

Salix discolor Muhl., (1985) Thompson, S.A.; Nishida, J.H. 2253

Salix eriocephala Michx., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15794

Salix exigua Nutt., (1995) Isaac, B.L.; Isaac, J.A. 7122

Salix nigra Marsh., (1952) Henry, L.K.; Buker, W.E.

Salix sericea Marsh., (1955) Henry, L.K.; Buker, W.E.

SAXIFRAGACEAE

Chrysosplenium americanum Schwein. ex Hook., (2003) Isaac, J.A. 15903

Heuchera americana L., (1995) Isaac, B.L.; Isaac, J.A. 7118

Mitella diphylla L., (2003) Isaac, J.A.; Isaac, B.L. 15859

Saxifraga virginiensis Michx., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15816

Tiarella cordifolia L., (1996) Isaac, B.L.; Isaac, J.A. 8895

SCROPHULARIACEAE

Agalinis tenuifolia (Vahl) Raf., (1969) Buker, W.E.

**Antirrhinum majus* L., (1896) Hoge, M.K.; Europe

Aureolaria flava (L.) Farw. var. *flava*, (1975) Buker, W.E.

Aureolaria laevigata (Raf.) Raf., (1993) Haywood, M.J. 97

Aureolaria virginica (L.) Pennell, (1969) Buker, W.E.

**Chaenorhinum minus* (L.) Lange, (2003) Isaac, J.A. 16138; Europe

Collinsia verna Nutt., (2003) Isaac, J.A.; Isaac, B.L. 15850

Gratiola neglecta Torr., (2003) Isaac, J.A. 16397

**Linaria vulgaris* P. Mill., (1974) Buker, W.E.; Eurasia

Lindernia dubia (L.) Pennell var. *dubia*, (1974) Buker, W.E.

Mimulus alatus Aiton, (2003) Isaac, J.A. 16587

Mimulus ringens L., (1951) Henry, L.K.; Beer, F.H.

Pedicularis canadensis L., (1995) Isaac, B.L.; Isaac, J.A. 7166

Penstemon digitalis Nutt. ex Sims, (2003) Isaac, J.A.; Coxe, R. 16288

Penstemon laevigatus Aiton, (2002) Isaac, J.A.; Takacs, M. 14399; **G5**:**S3**

Scrophularia marilandica L., (1984) Thompson, S.A.; Nishida, J.H.; Bier, C.W. 1973

**Verbascum blattaria* L., (1995) Isaac, B.L.; Isaac, J.A. 7504; Eurasia

**Verbascum thapsus* L., (1995) Isaac, B.L.; Isaac, J.A. 7540; Eurasia

Veronica americana Schwein. ex Benth., (2002) Isaac, J.A.; Takacs, M. 14403

Veronica anagallis-aquatica L., (1996) Haywood, M.J. 627

**Veronica arvensis* L., (2003) Isaac, J.A. 15867; Eurasia

**Veronica hederifolia* L., (2003) Isaac, J.A. 15880; Eurasia

**Veronica officinalis* L., (1996) Isaac, B.L.; Isaac, J.A. 8881; Europe

**Veronica persic* Poir., (1920) Dickey, S.S.; Eurasia

**Veronica serpyllifolia* L., (1995) Isaac, B.L.; Isaac, J.A. 7177; Europe

SMILACACEAE

Smilax glauca Walt., (1951) Henry, L.K.; Beer, F.H.

Smilax herbacea L., (1993) Haywood, M.J. 327

Smilax rotundifolia L., (1995) Isaac, B.L.; Isaac, J.A. 7105

Smilax tamnoides L., (1970) Buker, W.E.

SOLANACEAE

**Datura stramonium* L., (1994) Isaac, J.A. 6015

**Nicandra physalodes* (L.) Gaertn., (1921) Jennings, O.E.; Jennings, G.K.; et al.; Peru

Physalis longifolia Nutt., (1951) Henry, L.K.; Beer, F.H.

Physalis pubescens L. var. *pubescens*, (1921) Jennings, O.E.

Solanum carolinense L., (1993) Haywood, M.J. 60

**Solanum nigrum* L., (2004) Isaac, J.A. 18556; Europe

STAPHYLEACEAE

Staphylea trifolia L., (2003) Isaac, J.A.; Isaac, B.L. 15834

THYMELAEACEAE

Dirca palustris L., (2002) Isaac, J.A.; Haibach, M. 14412

TILIACEAE

Tilia americana L. var. *americana*, (2003) Isaac, J.A. 16166

Tilia americana L. var. *heterophylla* (Vent.) Loud., (1951) Henry, L.K.; Beer, F.H.

TYPHACEAE

**Typha angustifolia* L., (2003) Isaac, J.A.; Coxe, R. 16283; Exotic

Typha latifolia L., Donley 97

ULMACEAE

Celtis occidentalis L., (1921) Jennings, O.E.

Ulmus americana L., (1985) Thompson, S.A.; Nishida, J.H. 2293

Ulmus rubra Muhl., (2003) Isaac, J.A. 16026

URTICACEAE

Boehmeria cylindrica (L.) Sw., (2003) Isaac, J.A. 16362

Laportea canadensis (L.) Weddell, (2003) Isaac, J.A. 16319

Parietaria pensylvanica Muhl. ex Willd., (2003) Isaac, J.A. 16157

Pilea pumila (L.) Gray, (1993) Haywood, M.J. 142

Urtica dioica L. ssp. *gracilis* (Aiton) Seland., (2003) Isaac, J.A. 16320

VALERIANACEAE

Valeriana pauciflora Michx., (1992) Isaac, J.A. 3910

Valerianella chenopodiifolia (Pursh) DC., (1996) Isaac, B.L.; Isaac, J.A. 8855

Valerianella radiata (L.) Dufr., (1999) Haywood, M.J. 606

VERBENACEAE

Phryma leptostachya L., (2003) Isaac, J.A. 16408

Verbena hastata L., (1985) Thompson, S.A.; Rawlins, J.E. 12882

Verbena urticifolia L. var. *urticifolia* Perry & Fern., (1993) Haywood, M.J. 169

VIOLACEAE

Hybanthus concolor (T.F. Forst.) Spreng., (2003) Isaac, B.L.; Isaac, J.A. 15839

Viola bicolor Pursh, (1950) Henry, L.K.; Buker, W.E.

Viola blanda Willd., (1951) Henry, L.K.; Beer, F.H.

Viola canadensis L. var. *canadensis*, (1994) Haywood 422

Viola cucullata Aiton, (1996) Haywood, M.J. 432

Viola hirsutula Brainerd, (2003) Isaac, J.A.; Isaac, B.L. 15824

Viola labradorica Schrank, (1976) Buker, W.E.

Viola pubescens Aiton var. *scabriuscula* Schwein. Ex Torr. & Gray, (2003) Isaac, J.A.; Isaac, B.L. 15846

Viola sagittata Aiton var. *sagittata*, (1993) Haywood 540

Viola sororia Willd., (2003) Isaac, J.A.; Isaac, B.L.; Morton, C.M. 15813

Viola striata Aiton, (1996) Isaac, B.L.; Isaac, J.A. 8901

Viola x eclipes H.E. Ballard, (1976) Buker, W.E.

Viola x palmata L. (pro. sp.), (1994) Haywood, M.J. 41

VITACEAE

Parthenocissus quinquefolia (L.) Planch., (1951) Henry, L.K.; Beer, F.H.

Vitis aestivalis Michx., (1995) Isaac, B.L.; Isaac, J.A. 7104

Vitis cinerea (Engelm.) Millard var. *baileyana* (Munson) Comeaux, (1995) Isaac, J.A. 6017; **G4G5?:SH**

Vitis labrusca L., (1994) Isaac, J.A. 6024

Vitis riparia Michx., (1994) Isaac, J.A. 6026

Vitis vulpina L., (2003) Isaac, J.; Coxe, R.; Bradburn, M. 17222

ACKNOWLEDGMENTS

Our thanks go to the Wild Resource Conservation Fund of the Pennsylvania Department of Conservation and Natural Resources for partial funding of the field work. We would also like to thank Dr. Ann Rhoads, an anonymous reviewer and the editor for their helpful comments. We are also thankful to Melanie Van Olffen and Matthew Oborski for data entry.

REFERENCES

Brummitt, R.K. and C.E. Powell. 1992. Authors of plant names. Royal Botanic Gardens, Kew.

Fike, J. 1999. Terrestrial & palustrine plant communities of Pennsylvania. Bureau of Forestry, PA. and Department of Conservation and Natural Resources, Harrisburgh, PA.

Kartesz, J.T. 1999. A synonomized checklist and atlas with biological attributes for the vascular flora of the United States, Canada and Greenland. 1st. ed. In: Kartesz, J.T. and C.A. Meacham. Synthesis of the North American flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill.

Rhoads, A.F. and W.M. Klein, Jr. 1993. The vascular flora of Pennsylvania: annotated checklist and atlas. American Philosophical Society, Philadelphia, Pennsylvania.

Rhoads, A.F. and T.A. Block 2000. The Plants of Pennsylvania. University of Pennsylvania Press, Philadelphia, Pennsylvannia.

Smith, G.W. 1996. History of Greene County, Pennsylvania. Cornerstone Genealogical Society, Waynesburg, PA.

The Nature Conservancy (1996 version). Element ranking list—Pennsylvania Natural Heritage Program. http://www.dcnr.state.pa.us/forestry/pndi/rank.htm

USDA. 1983. Soil survey of Greene and Washington counties Pennsylvania. USDA Soil Conservation Service. US Government Printing Office, Washington, D.C.

BOOK NOTICE

Douglas J. Futuyma, H. Bradley Shaffer, and Daniel Simberloff (eds). 2004. **Annual Review of Ecology, Evolution, and Systematics: Volume 35, 2004.** (ISBN 0-8243-1435-2, hbk; ISSN 1543-592X). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $168.00 (USA), $173.00 (Int'l.), 732 pp., 6" × 9".

Volume 35, 2004 of *Annual Review of Ecology, Evolution, and Systematics*, has 24 articles covering an array of topics.

Vertebrate Dispersal of Seed Plants Through Time. B.H. Tiffney
Are Diseases increasing in the Ocean? K.D. Lafferty, J.W. Porter, and S.E. Ford
Bird Song: the interface of Evolution and Mechanism. J. Podos, S.K. Huber, and B. Taft
Application of Ecological indicators. G.J. Niemi and M.E. McDonald
Ecological Impacts of Deer Overabundance. S.D. Côté, T.P. Rooney, J.-P. Tremblay, C. Dussault, and D.M. Waller
Ecological Effects of Transgenic Crops and the Escape of Transgenes into Wild Populations. D. Pilson and H.R. Prendeville
Mutualisms and Aquatic Community Structure: the Enemy of my Enemy is my Friend. M.E. Hay, J.D. Parker, D.E. Burkepile, C.C. Caudill, A.E. Wilson, Z.P. Hallinan, and A.D. Chequer
Operational Criteria for Delimiting Species. J.W. Sites, Jr. and J.C. Marshall
The New View of Animal Phylogeny. K.M. Halanych
Landscapes and Riverscapes: the influence of Land Use on Stream Ecosystems. J.D. Allan
Long-Term Stasis in Ecological Assemblages: evidence from the Fossil Record. W.A. DiMichele, A.K. Behrensmeyer, T.D. Olszewski, C.C. Labandeira, J.M. Pandolfi, S.L. Wing, and R. Bobe
Avian Extinctions from Tropical and Subtropical forests. N.S. Sodhi, L.H. Liow, and F.A. Bazzaz
Evolutionary Biology of Animal Cognition. R. Dukas
Pollination Syndromes and Floral Specialization. C.B. Fenster, W.S. Armbruster, P. Wilson, M.R. Dudash, and J.D. Thomson
On the Ecological Roles of Salamanders. R.D. Davic and H.H. Welsh, Jr.
Ecological and Evolutionary Consequences of Multispecies Plant-Animal interactions. S.Y. Strauss and R.E. Irwin
Spatial Synchrony in Population Dynamics. A. Liebhold, W.D. Koenig, and O.N. Bjornstad
Ecological Responses to Habitat Edges: mechanisms, Models, and Variability Explained. L. L. Ries, R.J. Fletcher, Jr., J. Battin, and T.D. Sisk
Evolutionary Trajectories and Biogeochemical Impacts of Marine Eukaryotic Phytoplankton. M.E. Katz, Z.V. Finkel, D. Grzebyk, A.H. Knoll, and P.G. Falkowski
Regime Shifts, Resilience, and Biodiversity in Ecosystem Management. C. Folke, S. Carpenter, B. Walker, M. Scheffer, T. Elmqvist, L. Gunderson, and C.S. Holling
Ecology of Woodland Herbs in Temperate Deciduous forests. D.F. Whigham
The Southwest Australian Floristic Region: evolution and Conservation of a Global Hot Spot of Biodiversity. S.D. Hopper and P. Gioia
Predator-induced Phenotypic Plasticity in Organisms with Complex Life Histories. M.F. Benard
The Evolutionary Ecology of Novel Plant-Pathogen interactions. I.M. Parker and G.S. Gilbert

VEGETATION AND FLORA OF AMERICAN BEECH WOODS NATURE PRESERVE, CLARK COUNTY, ILLINOIS

Bob Edgin

Illinois Nature Preserves Commission
Springfield, Illinois 62701, U.S.A.

Gordon C. Tucker[1] and John E. Ebinger

Department of Biological Sciences
Eastern Illinois University
Charleston, Illinois 61920, U.S.A.

ABSTRACT

American Beech Woods Nature Preserve is located on Illinoian till in the Wabash Border Division of eastern Illinois. The plant life of this 8 ha site was examined during the 1999–2001 growing seasons. We documented a total of 207 vascular plant species in 148 genera of 71 families (10 pteridophytes, 1 gymnosperm, 49 monocots, and 147 dicots). We also sampled the vegetation using a stratified-random line-strip method. Tree density averaged 249 trees/ha with a basal area of 22.91 m^2/ha. *Fagus grandifolia* Ehrh. (American beech) was the dominant tree species with 63 trees/ha, a basal area of 7.34 m^2/ha, and an importance value 26.1 (possible 100). *Acer saccharum* Marsh. (sugar maple) ranked second in importance value (IV = 15.7) with most individuals in the 10–19.9 cm diameter class. *Quercus velutina* Lam. (black oak) and *Carya glabra* (Mill.) Sweet (pignut hickory) were the only other overstory trees with an importance value greater than 10. In comparison with an earlier study in 1973, the site has experienced a decrease in both tree density (399 trees/ha vs. 249 trees/ha) and basal area (33.35 m^2/ha vs. 22.91 m^2/ha).

RESUMEN

La Reserva Natural de Haya Americana esta ubicada en terreno Illinois en la frontera del Río Wabash en Illinois oriental. La flora del bosque que mide 8 hectáreas fue examinada durante la temporada de crecimiento en los años 1999–2001. Hemos identificado 207 especies de plantas vasculares que incluyen 148 géneros de 71 familias distintas: 10 pteridófitas, una gimnosperma, 49 monocotitedóneas, y 147 dicotiledóneas. Muestreamos la vegetación usando el método de línea-franja aleatoria. La densidad promedia era 249 árboles por hectárea con una área basal de 22.91 m2/ha. *Fagus grandifolia* Ehrh. (haya) era la especie de árbol dominante. Había 63 árboles por hectárea con una área basal de 7.32 m^2/ha y un valor de importancia de 26.1 (posibilidad de 100). *Acer saccharum* (arce de azúcar) tenía una importancia secundaria con un valor de importancia de 15.7. La mayoría de los individuos pertenecían a la clase de tamaño entre 10-19.9 cm. *Quercus velutina* Lam. (roble negro) y *Carya glabra* Mill. (nuez de cerdo) eran los únicos árboles que tenían un valor de importancia de más de 10. En comparación con el estudio de 1973 el bosque ha sufrido una perdida de densidad (399 árboles por ha v. 249 árboles por ha) y área basal (33.35 m^2/ ha v. 22.91 m^2/ha.)

INTRODUCTION

At the beginning of extensive European settlement (ca. 1800), about 61% of Illinois was prairie and savanna. The remainder, mostly the more rugged terrain, was woodland and forest (Küchler 1964; Anderson 1970; Iverson et al. 1991; Ebinger 1997). In such areas of rugged terrain, tree species composition varied

---

[1] Corresponding author; cfgct@eiu.edu.

SIDA 21(3): 1861–1878. 2005

locally with oaks (*Quercus* spp.) and hickories (*Carya* spp.) being the common forest species on drier mostly upland sites. Mesophytic species such as elm (*Ulmus* spp.), ash (*Fraxinus* spp.), and sugar maple (*Acer saccharum* Marsh.) were associated with the dissected ravines and narrow river floodplains (Braun 1950; Anderson 1983; Cowell & Jackson 2002). At the eastern edge of Illinois, particularly in the Wabash Border Natural Division, many of these forests contained American beech (*Fagus grandifolia* Ehrh.), tulip tree (*Liriodendron tulipifera* L.), and other tree species typically found in forests to the east of Illinois (Schwegman 1973). American beech has a wide range comparable to that of other major Eastern Deciduous Forest trees.

Beech-maple forests usually included some species of oaks and hickories and reached the western limit of their range in east-central and southern Illinois. In Illinois, the few remaining examples of this community type are associated with steep, deeply dissected ravine systems, narrow valleys, and narrow to broad ridges. The beech-maple component has a rich herbaceous layer on the mesic slopes and an oak-hickory component on the ridges and more level uplands. These remnants have been variously disturbed by logging, grazing, and exotic species invasion.

Three examples of this forest community located in the Wabash River Valley have been dedicated as Illinois Nature Preserves (McFall & Karnes 1995). Occurrences of American beech in this region have enhanced significance as these populations represent the western edge of the range of a wide ranging eastern North American species. The American Beech Woods Nature Preserve contains one of these protected beech-maple forests. The objectives of our study were to document the vascular flora; to determine the composition and structure of the woody and herbaceous vegetation; and to analyze changes in the forest composition that occurred since the forest was last studied in 1973.

DESCRIPTION OF THE STUDY AREA

The American Beech Woods Nature Preserve, dedicated as a nature preserve in 1985, is located in Lincoln Trail State Park (Fig. 1), about 5 km south of Marshall, Clark County, Illinois (SE/4, NW/4, S2, T10N, R12W; 39°20'30"N, 87°42'45"W). Located in the Southern Upland Section of the Wabash Border Natural Division about 15 km from the Indiana state line, the preserve is situated on Illinoian glacial till about 20 km south of the terminal moraine of Wisconsin glaciation (Schwegman 1973). The preserve, about 8 ha in size, has rugged topography, ranging in elevation from 167 m at the edge of Lincoln Trail Lake to 190 m at the highest point. Topographic features include steep-sided ravines, valley walls of various slope aspects, and narrow ridges. The western boundary of the preserve follows the shoreline of Lincoln Trail Lake. Presently most of the preserve is high quality, old second growth, mesic and dry-mesic upland forest (White & Madany 1978). Based on the original Government Land Office survey records

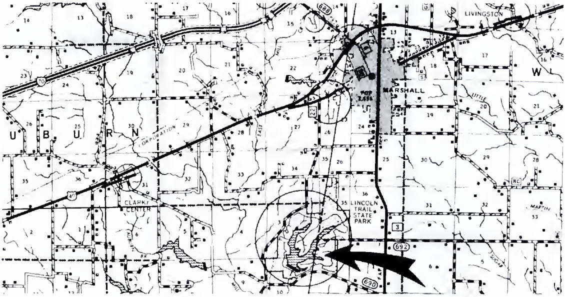


Fig. 1. The location of Clark County in eastern Illinois, and the location of American Beech Woods Nature Preserve in Lincoln Trail State Park, S of Marshall, Illinois (courtesy of the Illinois Nature Preserves Commission).

at the Illinois State Archives in Springfield (Hutchison 1988), the woods still retains many of the species present prior to settlement by Europeans.

The overstory of the preserve was sampled in 1973 as part of an extensive study that examined the structure and composition of beech-maple forests in Illinois, Indiana, Michigan, and Wisconsin (Dunn 1978). Two prescribed burns (Nov 1993 and Dec 1998) have been conducted in the preserve, while seedlings and saplings of sugar maples have been removed recently from the flat uplands and ridgetops.

The soils of the ridgetops are Stoy silt loam, a somewhat poorly drained soil that formed in loess underlain by Illinoian glacial till (Awalt 1979). Soils of the wooded slopes and drainages are Hickory loam, a well-drained soil that developed in Illinoian glacial till. These soils overlay bedrock composed of Pennsylvanian shale and sandstone (Dunn 1978).

The climate is continental, characterized by hot, humid summers and cold winters. Weather station records for Marshall, Illinois, about 6 km north of the preserve, indicate that the area receives an average annual precipitation of 104 cm which falls mostly as rain during the period of April through September (Weather.com 2002). January is the coldest month with an average high temperature of 1° C and an average low temperature -8° C. The record high for the month was 27° C on January 9, 1932 and the record low was -31° C on January 18, 1930. July is the hottest month with an average high temperature of 31° C and an average low of 17° C. The record high for the month was 43° C on July 14, 1936 and the record low was 7° C on July 1, 1937 (weather.com 2002).

MATERIALS AND METHODS

The area was visited numerous times during the 1999, 2000, and 2001 growing seasons. During each trip, all new flowering or fruiting species encountered were collected, the specimens identified, and deposited in the Stover-Ebinger Herbarium (EIU) of Eastern Illinois University, Charleston. Native status and nomenclature follows Mohlenbrock (2002). All vascular plant taxa observed are enumerated in the Annotated Species List (Appendix I).

Vegetation sampling to determine quantitative abundance of woody and herbaceous species was conducted on August 29 and 30, 2000. We employed the stratified-random line-strip method of Lindsay (1955) as modified by Donselman (1973), Levenson (1973), and Dunn (1978). Using this method, overstory trees, saplings, shrubs, and ground layer strata were sampled simultaneously in rectangular plots positioned along transect lines.

Sample plots for the overstory trees (≥10.0 cm dbh) were delimited using a 100 m tape divided into 25 m sections. Overstory trees were sampled in 10 m × 25 m (0.025 ha) with four located along each transect. All trees whose centers were located within the plots were included in the sample. Aspect of the plot, species, and diameter at breast height (dbh) were recorded for each individual located within the boundaries of each plot. Large saplings (5.0 cm dbh – 9.9 cm dbh), intermediate saplings (≥2.5 cm dbh; ≤ 4.9 cm dbh), small saplings (≥ 50.0 cm tall; ≤ 2.4 cm dbh), shrubs, and the groundlayer (woody seedlings <50.0 cm tall and all herbaceous taxa) were sampled in rectangular plots located at the zero, 25 m, 50 m, and 75 m mark of the tape. Aspect, species, and the number of individuals were recorded for all vascular plants in each category that fell within one meter from the tape along a section 2.5 m long (0.00025 ha plot).

When all plots along the 100 m transect line were sampled, a section of 1/2" steel conduit marked "Edgin 2000" was driven at each end of the tape to facilitate the relocation of the transect line for future studies. A new 100 m transect line, located a minimum of 25 m distant from the first line and perpendicular to the ravine was then established and the sampling procedures repeated. This process was replicated along ten 100 m transect lines providing a total of 40 plots in each category.

Density (trees/ha), basal area (m^2/ha), frequency (%), relative density, relative dominance, relative frequency, importance value (relative density + relative dominance + relative frequency/3) and average basal area were determined for each species in the overstory tree stratum. Density (stems/ha), frequency (%), relative density, relative frequency, and importance value (relative density + relative frequency/2) were determined for each species in the small, intermediate, and large sapling, shrub, and ground layer strata.

The Floristic Quality Index (FQI) of the site was determined using the Coefficient of Conservatism (CC) assigned to each species by Taft et al. (1997). The

CC for each species in the Illinois flora was determined by assigning an integer from 0 to 10 for each species based on its tolerance to disturbance and its fidelity to habitat integrity. The FQI is a weighted index of species richness (N = number of species present), and is the arithmetic product of the average Coefficient of Conservatism (C-Value = the average of all species CC's) multiplied by the square root of the species richness ($\surd$N): FQI = C-Value ($\surd$N). Therefore the FQI indicates the level of habitat degradation and provides an assessment of the quality of each tract based on the taxa present. It is particularly useful when combined with quadrat-based sampling methods and provides a way of making quantitative comparisons among sites. The Sørenson Coefficient of Community (Sørenson 1948) was used to determine the similarity of the ground layer vegetation on the different slope aspects in the study area. The index is calculated as $2c/(a + b + 2c)$, where *a* is the number of species unique to sample *a*, *b* is the number of species unique to sample *b*, and *c* is the number of species shared by both samples (Small & McCarthy 2001).

RESULTS AND DISCUSSION

Overstory and woody understory composition and structure.—During the sampling of the overstory, a total of 17 tree species was encountered, including two understory species having little chance of reaching the canopy; seven additional tree species were found elsewhere on the preserve, i.e., outside the sampling transects, accounting for a total of 24 species. Overall tree density was 249.0 trees/ha and total basal area was 22.91 m^2/ha. American beech ranked first in basal area, relative density, relative dominance, and importance value (Table 1). It was the most frequently encountered species, occurred in 70% of the plots, and was evenly distributed throughout most diameter classes. Sugar maple ranked second in importance value and relative density and third in basal area. It occurred in 57.5 % of the plots and was most abundant in the smaller diameter classes with 63% of the individuals encountered being in the 10–19.9 cm diameter class. *Quercus velutina* Lam. (black oak) (IV = 11.7) and *Carya glabra* (Mill.) Sweet (pignut hickory) (IV = 10.0) were the only other taxa encountered with importance values greater than 10. Black oak was most abundant in the medium and large diameter classes while pignut hickory was most abundant in the smaller diameter classes.

Of the remaining overstory trees, tulip tree was the only species to be represented in most diameter classes, being present in low numbers in all but the largest diameter class (Table 1). *Carya ovata* (Mill.) K. Koch (shagbark hickory) was present only in the smaller diameter classes with no individuals over 39.9 cm dbh being encountered. *Carya tomentosa* (Poir. ex Lam.) Nutt. (mockernut hickory) was present in low numbers in the small and medium diameter classes while *Quercus alba* L. (white oak) was present only in the medium diameter

TABLE 1. Density (#/ha) by diameter classes (cm), total density (#/ha), basal area (m^2/ha), frequency (%), relative density, relative dominance, relative frequency, importance value, and average dbh are given for tree taxa encountered during sampling of American Beech Woods Nature Preserve, Clark County, Illinois. Also included is the importance value and average dbh per tree taxa from the 1973 study (Dunn 1978).

	10.0 -19.9	20.0 -29.9	30.0 -39.9	40.0 -49.9	50.0 -59.9	60.0 -69.9	70.0 -79.9	80.0+	Total Density (#/ha)	Basal Area (m^2/ha)	Freq. (%)	Rel. Den.	Rel. Dom.	Rel. Freq.	IV	Avg. Basal Area/ tree	1973 IV	1973 Basal Area/ tree
Fagus grandifolia	16.0	12.0	12.0	10.0	8.0	4.0	- -	1.0	63.0	7.34	70.0	25.3	32.0	21.1	26.1	0.12	25.9	0.09
Acer saccharum	29.0	6.0	4.0	5.0	- -	2.0	- -	- -	46.0	2.59	57.5	18.5	11.3	17.3	15.7	0.06	15.5	0.06
Quercus velutina	- -	4.0	9.0	6.0	2.0	3.0	1.0	- -	25.0	3.72	30.0	10.0	16.2	9.0	11.7	0.15	7.3	0.13
Carya glabra	12.0	7.0	8.0	2.0	1.0	- -	- -	- -	30.0	1.87	32.5	12.1	8.2	9.8	10.0	0.06	4.3	0.08
Liriodendron tulipifera	3.0	3.0	4.0	2.0	1.0	1.0	1.0	- -	15.0	1.80	25.0	6.0	7.9	7.5	7.1	0.12	5.4	0.18
Carya ovata	11.0	9.0	4.0	- -	- -	- -	- -	- -	24.0	0.95	25.0	9.6	4.1	7.5	7.1	0.04	0.8	0.02
Carya tomentosa	4.0	2.0	2.0	3.0	1.0	1.0	- -	- -	13.0	1.02	20.0	5.2	4.5	6.0	5.2	0.08	4.1	0.06
Quercus alba	- -	- -	4.0	1.0	1.0	1.0	- -	- -	7.0	1.12	17.5	2.9	4.9	5.3	4.4	0.16	11.0	0.11
Quercus rubra	- -	- -	- -	- -	1.0	1.0	- -	1.0	3.0	1.06	10.0	1.2	4.6	3.0	2.9	0.36	8.2	0.14
Ulmus americana	6.0	1.0	- -	- -	- -	- -	- -	- -	7.0	0.13	10.0	2.8	0.6	3.0	2.1	0.02	0.4	0.03
Fraxinus pennsylvanica	- -	1.0	- -	2.0	- -	- -	- -	- -	3.0	0.44	7.5	1.2	1.9	2.2	1.8	0.15	0.7	0.11
Nyssa sylvatica	- -	- -	3.0	- -	- -	- -	- -	- -	3.0	0.29	7.5	1.2	1.3	2.2	1.6	0.10	6.2	0.04
Ulmus rubra	1.0	1.0	- -	1.0	- -	- -	- -	- -	3.0	0.22	7.5	1.2	1.0	2.2	1.5	0.08	- -	- -
Sassafras albidum	3.0	- -	- -	- -	- -	- -	- -	- -	3.0	0.04	5.0	1.2	0.2	1.5	1.0	0.01	0.7	0.09
Acer rubrum	- -	- -	- -	- -	1.0	1.0	- -	- -	2.0	0.23	2.5	0.4	1.0	0.8	0.9	0.23	- -	- -
Juglans nigra	- -	- -	1.0	- -	- -	- -	- -	- -	1.0	0.08	2.5	0.4	0.3	0.8	0.5	0.09	- -	- -
Cornus florida	1.0	- -	- -	- -	- -	- -	- -	- -	1.0	0.01	2.5	0.4	0.0	0.8	0.4	0.01	0.8	0.01
Others (7 taxa)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	8.7	- -
Totals	86.0	46.0	51.0	32.0	16.0	14.0	2.0	2.0	249.0	22.91		100.0	100.0	100.0	100.0		100.0	

classes. Of the remaining trees, most were present as widely scattered individuals with two, *Sassafras albidum* (Nutt.) Nees (sassafras) and *Cornus florida* L. (flowering dogwood) being understory trees.

The overall tree density declined from 399.0 trees/ha in 1973 to 249.0 trees/ha in this study (Dunn 1978) (Table 1). Total basal area also decreased from 33.35 m^2/ha in 1973 to 22.91 m^2/ha in 2000. However, the importance values for American beech, sugar maple, and most other species were very similar to those reported in the previous study. The importance value of shagbark hickory was considerably higher in the present study while those of white oak and red oak were considerably lower.

Seven species having a combined importance of 8.7 in the 1973 study were not encountered during the sampling in this study. Of those species, *Carya cordiformis* (Wang.) Koch (bitternut hickory) and *Fraxinus americana* L. (white ash) had IV's totaling 1.5 in the 1973 study. *Amelanchier arborea* (Michx. f.) Fernald (shadbush), *Carpinus caroliniana* Walt. (musclewood), and *Ostrya virginiana* (Mill.) K. Koch (ironwood) are understory trees that had a combined importance value of 4.8 in the 1973 study. Since no permanent transects were established in the previous study, these changes may be more reflective of sampling error rather than changes in the composition of the forest stand. *Tilia americana* L. (basswood) (IV = 2.4 in 1973) was encountered neither during the sampling, nor the site visits and appears to have been extirpated from the preserve.

In the understory, sugar maple and American beech ranked first and second, respectively in all three sapling categories. Of the remaining understory trees, only flowering dogwood and ironwood were present in all of the sapling categories (Table 2). Hickories were not common in the understory and no oaks were encountered.

A total of 26 dead-standing saplings were encountered in 11 plots. These stems were all in the medium and small sapling categories and occurred in plots located on ridgetops or slopes with an east, west, or southwest aspect. Of 26 stems encountered, 19 appeared to have been top-killed by fire (14 sugar maple, two ironwood, two American beech, and one hickory). Seven dead-standing dogwood saplings were encountered, but it was not clear as to whether these individuals were dead as a result of fire or anthracnose.

Hydrangea arborescens L. (wild hydrangea) and *Lonicera maackii* (Rupr.) Maxim. (bush honeysuckle) were the only shrub taxa encountered. Wild hydrangea was present in one plot located in a creek bottom while one bush honeysuckle shrub was encountered in a plot with a north-facing aspect.

Groundlayer composition and structure.—A total of 70 taxa was encountered in the groundlayer (Table 3). The *Carex* spp. (sedges) as a group ranked first in importance value (IV = 8.8) and occurred in 50% of the plots. *Pilea pumila* (L.) A. Gray (clearweed) ranked second in importance value, being most abundant in plots that occurred in creek bottoms and on the northeast-facing slopes. *Sanicula*

TABLE 2. Density (stems/ha) arranged by aspect, total density (#/ha), frequency (% of plots in which each taxon was observed), relative density, relative frequency, and importance value for large saplings (≥5.0 cm dbh–9.9 cm dbh), intermediate saplings (≥ 2.5 cm dbh–< 5.0 cm dbh), and small saplings (>50 cm tall–2.5 cm dbh) encountered during sampling of American Beech Woods Nature Preserve, Clark County, Illinois.

	Aspect									All plots				
	Crk. Bot.	SW	Ridge top	N	W	E	S	NE	SE	Total Density (#/ha)	Freq. (%)	Rel. Den.	Rel. Freq.	IV
						Large Saplings (5–10cm dbh)								
Acer saccharum	--	114	66	198	--	400	400	--	--	130	17.5	65.0	46.7	55.9
Fagus grandifolia	57	--	--	66	80	--	--	--	--	30	7.5	15.0	20.0	17.5
Carpinus caroliniana	114	--	--	--	--	--	--	--	--	20	5.0	10.0	13.3	11.7
Cornus florida	--	57	--	--	--	--	--	--	--	10	5.0	5.0	13.3	9.1
Carya ovata	--	--	--	--	--	--	--	--	--	10	2.5	5.0	6.7	5.8
Totals	171	171	66	264	80	400	400	--	--	200		100.0	100.0	100.0
						Intermediate Saplings (2.5–4.9 cm dbh)								
Acer saccharum	228	--	198	132	--	400	133	800	400	200	30.0	52.6	46.3	49.4
Fagus grandifolia	57	160	66	198	160	--	266	--	400	120	22.5	31.7	34.6	33.2
Cornus florida	--	--	132	--	80	--	--	--	--	30	5.0	7.9	7.7	7.8
Carpinus caroliniana	--	--	--	--	80	--	--	--	--	10	2.5	2.6	3.8	3.2
Ulmus rubra	--	--	--	--	--	80	--	--	--	10	2.5	2.6	3.8	3.2
Carya ovata	--	80	--	--	--	--	--	--	--	10	2.5	2.6	3.8	3.2
Totals	285	240	396	330	320	480	399	800	800	380		100.0	100.0	100.0
						Small Saplings (>50 cm tall–2.4 cm dbh)								
Acer saccharum	513	720	462	924	--	80	266	3200	800	600	47.5	43.4	31.1	37.3
Fagus grandifolia	456	320	66	330	320	--	133	200	--	240	37.5	17.4	24.5	20.9
Ostrya virginiana	--	--	--	528	80	--	--	400	400	120	12.5	8.7	8.2	8.5
Ulmus rubra	114	80	--	66	--	--	--	800	--	90	15.0	6.5	9.9	8.2
Cornus florida	57	80	198	66	80	--	--	--	--	70	15.0	5.1	9.9	7.5
Asimina triloba	--	--	--	--	--	1280	--	--	--	160	2.5	11.6	1.6	6.6

Table 2. continued

	Aspect									All plots				
						Small Saplings (>50 cm tall–2.4 cm dbh)								
	Crk. Bot.	SW	Ridge top	N	W	E	S	NE	SE	Total Density (#/ha)	Freq. (%)	Rel. Den.	Rel. Freq.	IV
Carpinus caroliniana	57	- -	- -	- -	80	- -	- -	- -	- -	20	5.0	1.5	3.4	2.5
Fraxinus pennsylvanica	57	- -	- -	66	- -	- -	- -	- -	- -	20	5.0	1.5	3.4	2.5
Prunus serotina	- -	- -	- -	- -	- -	- -	- -	400	- -	20	2.5	1.5	1.6	1.6
Liriodendron tulipifera	- -	- -	- -	- -	- -	- -	- -	200	- -	10	2.5	0.7	1.6	1.1
Morus rubra	- -	- -	- -	- -	- -	- -	- -	200	- -	10	2.5	0.7	1.6	1.1
Sassafras albidum	- -	- -	- -	66	- -	- -	- -	- -	- -	10	2.5	0.7	1.6	1.1
Fraxinus americana	- -	- -	- -	66	- -	- -	- -	- -	- -	10	2.5	0.7	1.6	1.1
Totals	1254	1200	726	2112	560	1360	399	5400	1200	1380		100.0	100.0	100.0

Table 3. Density (#/ha) arranged by aspect, total density (#/ha), frequency (% of plots in which each taxon was observed), relative density, relative frequency, and importance value for groundlayer taxa including woody species (<50 cm tall) encountered during sampling of American Beech Woods Nature Preserve, Clark County, Illinois.

	Aspect									All plots				
	Crk. Bot.	SW	Ridge top	N	W	E	S	NE	SE	Density (#/ha)	Freq. (%)	Rel. Den.	Rel. Freq.	IV
Carex spp.	9324	2880	25974	13320	1332	- -	6660	2000	- -	14100	50.0	10.4	7.2	8.8
Pilea pumila	46620	- -	1998	1332	- -	- -	333	70000	- -	14600	22.5	10.8	3.3	7.0
Sanicula spp.	1332	- -	2664	666	22644	800	4662	28000	- -	10500	30.0	7.7	4.3	6.0
Asarum canadensis	- -	- -	- -	87246	- -	800	4662	- -	- -	14600	7.5	10.8	1.1	5.9
Viola sororia	11988	800	10656	666	4995	4000	1998	1400	- -	7800	35.0	5.7	5.1	5.4
Liriodendron tulipifera	888	7200	1998	3996	999	800	7326	- -	- -	4500	35.0	3.3	5.1	4.2
Solidago caesia	- -	8800	7992	9324	333	- -	333	18000	- -	4800	32.5	3.5	4.7	4.1
Impatiens capensis	11544	- -	- -	6660	2664	- -	333	2000	- -	4600	20.0	3.4	2.9	3.1

Table 3. continued

	Aspect									All plots				
	Crk. Bot.	SW	Ridge top	N	W	E	S	NE	SE	Density (#/ha)	Freq. (%)	Rel. Den.	Rel. Freq.	IV
Acer saccharum	1332	1600	7326	1998	333	3200	333	-	- -	2500	30.0	1.8	4.3	3.0
Polystichum acrostichoides	1332	1600	666	1332	- -	- -	333	8000	16000	1700	27.5	1.3	4.0	2.7
Sassafras albidum	- -	8800	4662	- -	333	1600	333	- -	- -	2200	22.5	1.6	3.3	2.5
Parthenocissus quinquefolius	1776	3200	666	6660	- -	1600	- -	- -	- -	2200	20.0	1.6	2.9	2.3
Arisaema triphyllum	444	4800	1998	- -	- -	12000	333	- -	- -	2600	17.5	1.9	2.5	2.2
Ageratina altissima	2664	- -	7326	666	- -	800	- -	2000	- -	2000	20.0	1.5	2.9	2.2
Leersia virginica	20424	- -	- -	- -	- -	- -	- -	- -	- -	4600	7.5	3.3	1.0	2.1
Antenoron virginianum	11544	- -	- -	- -	999	- -	- -	2000	- -	4000	10.0	2.9	1.4	2.1
Phryma leptostachya	1776	800	666	- -	1332	- -	- -	32000	- -	2600	15.0	1.9	2.2	2.1
Galium concinnum	444	- -	1332	- -	333	- -	333	40000	- -	2500	15.0	1.8	2.2	2.0
Ulmus rubra	444	800	2664	- -	- -	3200	666	- -	- -	1200	20.0	0.9	2.9	1.9
Fraxinus americana	888	800	2664	- -	- -	- -	333	2000	- -	900	20.0	0.7	2.9	1.8
Osmorhiza claytonii	1332	- -	666	330	- -	5600	- -	- -	- -	1600	15.0	1.2	2.2	1.7
Laportea canadensis	8436	2400	- -	- -	- -	1600	- -	- -	- -	2400	7.5	1.8	1.1	1.4
Prunus serotina	- -	- -	1998	3330	- -	- -	1332	- -	- -	900	12.5	0.7	1.8	1.3
Aster spp.	888	- -	666	- -	- -	800	- -	2000	- -	600	15.0	0.4	2.2	1.3
Carya spp.	- -	3200	3996	- -	- -	- -	- -	- -	- -	1000	12.5	0.7	1.8	1.3
Equisetum arvense	12432	- -	- -	1332	- -	- -	- -	- -	- -	2800	2.5	2.0	0.4	1.2
Vitis aestivalis	- -	- -	- -	666	- -	- -	8325	- -	- -	2500	2.5	1.8	0.4	1.1
Oxalis spp.	9768	- -	- -	- -	- -	- -	- -	- -	- -	2200	5.0	1.6	0.7	1.1
Galium circaezans	- -	- -	4662	- -	999	- -	- -	2000	- -	1100	7.5	0.8	1.1	1.0
Hepatica acutiloba	- -	- -	- -	- -	- -	- -	- -	- -	8000	1800	5.0	1.3	0.7	1.0
Muhlenbergia spp.	- -	- -	7326	- -	2331	- -	- -	- -	- -	1800	5.0	1.3	0.7	1.0
Cornus florida	- -	- -	666	- -	- -	- -	- -	- -	- -	100	2.5	0.1	0.4	0.3
Others (39 taxa)	12876	16000	7992	7326	3996	12800	5661	3200	800	12800	140.0	9.5	20.3	14.9
Totals	170496	63680	109224	146850	43623	49600	44289	214600	24800	136100		100.0	100.0	100.0

Table 4. Ranking of tree species by importance value for plots that occurred on 9 slope aspects at American Beech Woods Nature Preserve, Clark County, Illinois. The species listed are those with the 10 highest overall importance values throughout the preserve and are arranged by descending importance value. Ranking by importance value for each aspect is in parentheses.

	Aspect						All plots	
Species	Creek Bottom (7 plots)	Southwest (7 plots)	Ridge top (5 plots)	North (5 plots)	South & Southeast (5 plots)	West (4 plots)	East (4 plots)	Northeast (3 plots)
Fagus grandifolia	28.3 (1)	33.9 (1)	10.0 (5)	30.2 (1)	20.4 (2)	26.7 (1)	33.3 (1)	53.7 (1)
Acer saccharum	17.7 (3)	19.2 (2)	5.4 (7)	16.9 (2)	4.5 (10)	27.2 (2)	15.3 (3)	20.2 (2)
Quercus velutina	—	12.2 (3)	26.5 (1)	6.8 (5)	13.8 (3)	12.1 (3)	—	12.7 (4)
Carya glabra	—	6.8 (6)	23.9 (2)	15.0 (3)	4.8 (9)	9.2 (4)	—	—
Liriodendron tulipifera	28.1 (2)	6.8 (5)	—	5.6 (6)	10.2 (4)	6.3 (5)	—	—
Carya ovata	—	4.0 (7)	8.4 (6)	4.9 (8)	22.0 (1)	9.2 (6)	12.7 (4)	—
Carya tomentosa	5.9 (6)	2.3 (9)	10.3 (4)	—	6.2 (6)	—	4.7 (8)	13.4 (3)
Quercus alba	—	—	10.7 (3)	4.7 (9)	5.9 (7)	—	16.4 (2)	—
Quercus rubra	—	7.2 (4)	—	10.7 (4)	—	—	—	—
Sassafras albidum	2.8 (8)	—	—	—	—	4.5 (7)	—	—

Table 5. Sørenson Index for groundlayer taxa encountered during sampling of American Beech Woods Nature Preserve, Clark County, Illinois.

	Creek Bottom (30 taxa)	Southwest (20 taxa)	Ridge top (27 taxa)	North (23 taxa)	West (20 taxa)	East (18 taxa)	South (25 taxa)	Northeast (18 taxa)
Southwest	44.0							
Ridge top	56.1	63.8						
North	49.1	32.6	52.0					
West	36.0	40.0	55.3	41.9				
East	45.8	42.1	48.9	39.0	26.3			
South	43.6	48.9	53.8	50.0	44.4	46.5		
Northeast	50.0	31.6	57.8	39.0	47.4	22.2	41.9	
Southeast (3 species)	6.1	8.7	6.7	15.4	8.7	0	7.1	9.5

spp. (snakeroot), *Asarum canadense* L. (wild ginger) and *Viola sororia* Willd. (woolly blue violet) were the only other herbaceous taxa with IV's greater than five. Snakeroot was most abundant in plots that had a west and northeast aspect while wild ginger was most common on the north-facing slopes. Woolly blue violet was present in low to moderate numbers in most plots. Tulip tree, sugar maple, and sassafras were the most commonly encountered tree seedlings. Oak seedlings were rare with only one seedling being encountered on a north-facing slope.

Slope aspects.—Among the overstory trees, American beech ranked first in importance value in plots located on most slope aspects (Table 4). It ranked second in plots with a south or southeast aspect and fifth in plots that occurred on ridge tops. Sugar maple ranked second in importance value in plots having a southwest, north, west, or northeast aspect. Black oak ranked first in plots that occurred on the ridge tops, but no higher than third on the remaining aspects. White oak ranked second and third in plots with an easterly aspect and on the ridge tops, respectively, but was only a minor component or was absent from plots occurring on the remaining aspects. Red oak ranked fourth in plots with a southwest or north aspect and was not encountered in the remaining plots. Among the hickories, shagbark hickory ranked first in plots with a south or southeast aspect while pignut hickory ranked second in plots that occurred on the ridge tops.

The plots located on the ridgetops and the southwest-facing slopes had greatest similarity (63.8% Sørenson Coefficient of Community, Sørenson 1948) (Table 5). Plots located on the southeast-facing slopes were considerably dissimilar to plots located on other slope aspects having Sørenson Coefficient of Community percentages that ranged from 0 to 15.4. These low values may be attributed to the low number of plots with southeast aspects (1) and the low species richness of the plot (3). Most other plots had similarity indices that ranged from 36.1% and 57.8%.

During the study, we observed 207 vascular plant taxa in the study area: 11 ferns, fern allies, and gymnosperms, 49 monocots, and 147 dicots. Of that number, 23 (11.1%) had a Coefficient of Conservatism (CC) of seven or greater and 10 (4.8%) were non-native taxa. The average CC, when calculated for all taxa, was 3.88 and the FQI was 55.8. When calculated for native taxa only, the average CC and FQI were 4.04 and 57.0, respectively. Sites that have an FQI greater than 35 are considered regionally noteworthy, while sites with an FQI greater than 45 are defined as statewide-significant natural areas (Taft et al. 1997).

The composition of American Beech Woods is similar to other beech-maple forests in Illinois and Indiana, having American beech and sugar maple as co-dominants on the mesic slopes with oaks and hickories predominating on the drier slopes or more level uplands (Ebinger 1997; Cowell & Jackson 2002). The decline in overall tree density and total basal area in this preserve is typical of many similar forest stands in the region (Petty & Lindsey 1961; Lindsey &

Schmelz 1964; Barton & Schmelz 1987). Oak density declines as mature individuals die while shade-intolerant and successional species such as tulip tree, ash, and sassafras, persist as minor components because of gap-phase disturbances (Cowell & Jackson 2002).

APPENDIX 1

Vascular flora of American Beech Woods Nature Preserve, Lincoln Trail State Park, Clark County, Illinois arranged alphabetically by taxonomic group. Nomenclature follows Mohlenbrock (2002). Collection numbers with the T prefix are those of Tucker; while the E prefix indicates specimens collected by Ebinger. All specimens were deposited in the Stover-Ebinger Herbarium at Eastern Illinois University, Charleston, Illinois, with some duplicates at ILLS. Taxa preceded by an asterisk (*) are non-native.

FERNS AND FERN ALLIES

ADIANTACEAE

Adiantum pedatum L. T11770

ASPLENIACEAE

Asplenium platyneuron (L.) Oakes E29720
Cystopteris protrusa (Blasd.) Weatherby T11750
Polystichum acrostichoides (Michx.) Schott E29605

EQUISETACEAE

Equisetum arvense L. T11736

OPHIOGLOSSACEAE

Botrychium dissectum Spreng. var. *dissectum* E29719
Botrychium dissectum Spreng. var. *obliquum* (Muhl.) Clute E30427
Botrychium virginianum (L.) Sw. E29501
Ophioglossum vulgatum L. E29889

THELYPTERIDACEAE

Phegopteris hexagonoptera (Michx.) Fée E29604

GYMNOSPERMS

CUPRESSACEAE

Juniperus virginiana L. E29890

DICOTYLEDONS

ACERACEAE

Acer saccharum Marsh. E2989
Acer rubrum L. (Observed)

ANACARDIACEAE

Toxicodendron radicans (L.) Kuntze E30232

ANNONACEAE

Asimina triloba (L.) Dunal E30430

APIACEAE

Cicuta maculata L. T 11739
Cryptotaenia canadensis (L.) DC. T11738
Osmorhiza claytonii (Michx.) Clarke T11752
Sanicula canadensis L. var. *canadensis* T11744
Sanicula odorata (Raf.) Pryer & Phillippe E29622

ARALIACEAE

Aralia racemosa L. E30157
Panax quinquefolius L. E29892

ARISTOLOCHIACEAE

Aristolochia serpentaria L. E29618
Asarum canadense L. E29497

ASTERACEAE

Ageratina altissima (L.) R.M. King & H. Robins. E30158
Antennaria plantaginifolia (L.) Richards. E29500
Arnoglossum atriplicifolium (L.) H.Robins. E30233
Aster lateriflorus (L.) Britt. E30437
Aster sagittifolius Wedem. ex Willd. E30438
Aster shortii Lindl. E30436
Erechtites hieracifolia (L.) Raf. E30439
Erigeron annuus (L.) Pers. T11742
Erigeron philadelphicus L. T12047
Eupatorium sessilifolium L. var. *brittonianum* Porter E30159
Euthamia graminifolia (L.) Nutt. ex Cass. E30293
Helianthus divaricatus L. E30160
Hieracium gronovii L. E30235
Krigia biflora (Walt.) Blake T12041
Lactuca canadensis L. E30236

Prenanthes altissima L. E30440
Senecio glabellus Poir. E29608
Senecio obovatus Muhl. T12044
Solidago caesia L. E30442
Solidago canadensis L. E30294
Solidago nemoralis Aiton E30443
Solidago ulmifolia Muhl. ex Willd. E30237

BALSAMINACEAE
Impatiens capensis Meerb. E30161

BERBERIDACEAE
Podophyllum peltatum L. E29487

CORYLACEAE
Carpinus caroliniana Walt. var. *virginiana* (Marsh.) Fernald T11775
Corylus americana Walt. E29895
Ostrya virginiana (Mill.) K. Koch E29897

BORAGINACEAE
Cynoglossum virginianum L. E29620
Hackelia virginiana (L.) I.M. Johnst. E29894

BRASSICACEAE
Dentaria laciniata Muhl. E29490

CAESALPINIACEAE
Cercis canadensis L. Tl1765

CAMPANULACEAE
Campanulastrum americanum (L.) Small E30162
Lobelia inflata L. Tl1782
Lobelia siphilitica L. E30295

CAPRIFOLIACEAE
**Lonicera maackii* (Rupr.) Maxim. E29610
Sambucus canadensis L. T 11756
Symphoricarpos orbiculatus Moench E30164
Viburnum prunifolium L. E29898

CARYOPHYLLACEAE
Silene stellata (L.) Aiton E30165

CORNACEAE
Cornus florida L. E29726

EBENACEAE
Diospyros virginiana L. E29900

ELAEAGNACEAE
**Elaeagnus angustifolia* L. T11773

EUPHORBIACEAE
Acalypha rhomboidea Raf. E30238

FABACEAE
Amphicarpaea bracteata (L.) Rickett & Stafleu E30299
Desmodium nudiflorum (L.) DC. Tl1741
Desmodium paniculatum (L.) DC. E30298
**Robinia pseudoacacia* L. E29901

FAGACEAE
Fagus grandifolia Ehrh. T12051
Quercus alba L. E29727
Quercus imbricaria Michx. E30296
Quercus palustris Muenchh E30433
Quercus rubra L. E30434
Quercus velutina Lam. T12305

GENTIANACEAE
Frasera caroliniensis Walt. E29904

GERANIACEAE
Geranium maculatum L. E29492

HAMAMELIDACEAE
Liquidambar styraciflua L. E30239

HYDRANGEACEAE
Hydrangea arborescens L. E29903

HYDROPHYLLACEAE
Hydrophyllum virginianum L. E30168

HYPERICACEAE
Hypericum punctatum Lam. Tl1776

JUGLANDACEAE
Carya cordiformis (Wangenh.) K. Koch E30431
Carya glabra (Mill.) Sweet E30301
Carya ovata (Mill.) K. Koch E30432
Carya tomentosa (Poir.) Nutt. E30300
Juglans nigra L. E30241

LAMIACEAE
Collinsonia canadensis L. E30242
Lycopus virginicus L. E30302
Monarda bradburiana Beck E29617
**Prunella vulgaris* L. T11771
Pycnanthemum tenuifolium Schrad. E29905
Scutellaria incana Biehl. E29906
Teucrium canadense L. T11735

LAURACEAE
Sassafras albidum (Nutt.) Nees T11759
Lindera benzoin (L.) Blume T11764

MAGNOLIACEAE
Liriodendron tulipifera L. E29728

MENISPERMACEAE
Menispermum canadense L. E29615

MORACEAE
Morus rubra L. E30169

NYSSACEAE
Nyssa sylvatica Marsh. E29908

OLEACEAE
Fraxinus americana L. E29729
Fraxinus pennsylvanica Marsh. E30435
**Ligustrum vulgare* L. E29730

ONAGRACEAE
Circaea lutetiana L. ssp. *canadensis* (L.) Aschers. & Magnus E29910

OROBANCHACEAE
Conopholis americana (L.) Wallr. E29619

OXALIDACEAE
Oxalis stricta L. E29624
Oxalis violacea L. E29625

PAPAVERACEAE
Sanguinaria canadensis L. E29498

PHRYMACEAE
Phryma leptostachya L. T11760

PHYTOLACCACEAE
Phytolacca americana L. E29911

POLEMONIACEAE
Phlox divaricata L. spp. *laphamii* (Wood) Wherry T12045
Polemonium reptans L. E29731

POLYGONACEAE
Persicaria punctata (Elliott) Small E30303
Antenoron virginianum (L.) Roberty & Vautier E30170
**Rumex crispus* L. T11767

PORTULACACEAE
Claytonia virginica L. E29488

RANUNCULACEAE
Actaea pachypoda Elliott E29616
Hepatica acutiloba DC. E29496
Ranunculus abortivus L. E29495
Ranunculus recurvatus Poir. T12046
Ranunculus septentrionalis Poir. E29494
Thalictrum dioicum L. T12034

ROSACEAE
Agrimonia gryposepala Wallr. E30173
Agrimonia parviflora Soland. ex Aiton E30243
Agrimonia pubescens Wallr. E30172
Amelanchier arborea (Michx. fil.) Fernald T12050
Geum canadense Jacq. T11761
Geum vernum (Raf.) Torrey & A. Gray E29629
Potentilla simplex Michx. E29630
Prunus serotina Ehrh. E29631
**Rosa multiflora* Thunb. ex Murr. E29628
Rubus allegheniensis Porter ex L.H. Bailey E29634
Rubus flagellaris Willd. E29632
Rubus occidentalis L. T11777
Rubus pensilvanicus Poir. ex Lam. T11732

RUBIACEAE
Cephalanthus occidentalis L. T11734
Galium aparine L. E29489
Galium circaezans Michx. Tl1740
Galium concinnum Torrey & A. Gray E29733
Galium triflorum Michx. T11743
Houstonia purpurea L. E29732

SAXIFRAGACEAE
Penthorum sedoides L. E30244

SCROPHULARIACEAE
Mimulus alatus Aiton T11774
Pedicularis canadensis L. E29735
Scrophularia marilandica L. E30174

ULMACEAE
Ulmus americana L. T11737
Ulmus rubra Muhl. T11768

URTICACEAE
Boehmeria cylindrica (L.) Sw. E30247
Laportea canadensis (L.) Wedd. E30246
Parietaria pensylvanica Muhl. ex Willd. E29915
Pilea pumila (L.) A. Gray E30304

VERBENACEAE
Verbena urticifolia L. E29917

VIOLACEAE
Viola palmata L. E29503
Viola pratincola Greene E29502
Viola sororia Willd. E29623

VITACEAE
Parthenocissus quinquefolia (L.) Planch. E30248
Vitis aestivalis Michx. E30305

MONOCOTYLEDONS

ALISMACEAE
Alisma triviale Pursh T11733

ARACEAE

Arisaema dracontium (L.) Schott E29626
Arisaema triphyllum (L.) Schott T12043

COMMELINACEAE

Tradescantia subaspera Ker T12033
Tradescantia virginiana L. E29505

CYPERACEAE

Carex albicans Willd. E29510
Carex blanda Dewey E29511
Carex cephalophora Muhl. ex Willd. E29637
Carex glaucodea Tuckerm. E30176
Carex gracilescens Steudel T12039
Carex hirsutella Mack. E29927
Carex hirtifolia Mack. T12048
Carex lurida Wahl. Tl1762
Carex pensylvanica Lam. E29509
Carex rosea Schk. ex Willd. T12037
Scirpus georgianus Harper Tl1763

DIOSCOREACEAE

Dioscorea quaternata (Walt.) J.F. Gmel. E29925

JUNCACEAE

Juncus tenuis Willd. T11772
Luzula multiflora (Retz.) Lej. T11753

LILIACEAE

Allium tricoccum Aiton E29508
Smilacina racemosa (L.) Desf. E29611
Trillium recurvatum Beck E29507
Uvularia grandiflora Sm. E29612

ORCHIDACEAE

Corallorhiza odontorhiza (Willd.) Nutt. (Observed)
Galearis spectabilis (L.) Raf. E29926
Liparis liliifolia (L.) Rich. E30307

POACEAE

**Agrostis gigantea* Roth T11766
Agrostis hyemalis (Walt.) BSP. E30230
Brachyelytrum erectum (Schreb.) Beauv. E29918
Bromus pubescens Muhl. T11751
Cinna arundinacea L. E30177
Danthonia spicata (L.) Roem. & Schult. E29721
Dichanthelium boscii (Poir.) Gould & Clark Tl1748
Dichanthelium clandestinum (L.) Gould Tl1757
Dichanthelium dichotomum (L.) Gould E29723
Dichanthelium lindheimeri (Nash) Gould T11746
Dichanthelium microcarpon (Muhl.) Mohlenbr. T11747
Elymus hystrix L. E29922
Elymus villosus Muhl. E29921
Elymus virginicus L. E30178
**Festuca arundinacea* Schreb. T11780
Festuca subverticillata (Pers.) Alekseev T12036
Glyceria striata (Lam.) Hitchc. T11754
Leersia virginica Willd. E29923
Muhlenbergia schreberi J.F. Gmel. E30429
Muhlenbergia sobolifera (Muhl.) Trin. E30179
**Poa compressa* L. E30306
Poa sylvestris A. Gray T12049

SMILACACEAE

Smilax tamnoides L. var. *hispida* (Muhl.) Fernald E30180

ACKNOWLEDGMENTS

We wish to thank the Illinois Department of Natural Resources (IDNR) and the Illinois Nature Preserves Commission for granting permission to conduct the study and collect specimens. Appreciation is also extended to Matt Bowyer, Robert Gillespie, and Amy Young (IDNR) for their assistance with data collection and manuscript preparation. Scott Meiners provided helpful comments on data analysis and manuscript revision. Identification of *Carex* specimens was confirmed by Tony Reznicek (MICH). The abstract was translated into Spanish by Daniel Johnson (U.S. State Dept.).

REFERENCES

Anderson, R.C. 1970. Distribution of forest and prairie in Illinois about 1820. Illinois Nature Preserves Commission, Rockford (Map.)

Anderson, R.C. 1983. The eastern prairie-forest transition - an overview. In: R. Brewer, ed. Proceedings of the 8th North American Prairie Conference, 1982, Western Michigan University, Kalamazoo. Pp. 86–92.

Awalt, F.L. 1979. Soil Survey of Clark County, Illinois. U.S. Dept. Agric., Washington, D.C.

Barton, J.D. and D.M. Schmelz. 1987. Thirty years of growth records in Donaldson's Woods. Trans. Indiana Acad. Sci. 96:209–214.

Braun, E.L. 1950. Deciduous forest of Eastern North America. Blakiston Books, Philadelphia.

Cowell, C.M., and M.T. Jackson. 2002. Vegetation change in a forest remnant of the eastern presettlement prairie margin, USA. Nat. Areas Jour. 22:53–60.

Donselman, H.M. 1973. An ecological analysis of the shrub stratum of the beech-maple forest type. M.S. Thesis #1085, Indiana State University, Terre Haute, Indiana.

Dunn, C.P. 1978. An ecological analysis of the tree stratum of the beech-maple forest type. M.S. Thesis #1299, Indiana State University, Terre Haute, Indiana.

Ebinger, J.E. 1997. Forest communities of the Midwestern United States. In: M.W. Schwartz, ed. Conservation in Highly Fragmented Landscapes, Chapman and Hall, New York. Pp. 3–23.

Hutchison, M. 1988. A guide to understanding, interpreting, and using the public land survey field notes in Illinois. Natural Areas Jour. 8: 245–255.

Iverson, L.R., G.L. Rolfe, T.J. Jacob, A.S. Hodgins, and M.R. Jeffords. 1991. Forests of Illinois. Illinois Council on Forest Development, Urbana, and Illinois Natural History Survey, Champaign, Illinois.

Kuchler, A.W. 1964. Potential natural vegetation of the coterminous United States. Am. Geograph. Soc. Spec. Publ. 36.

Levenson, J.B. 1973. The herbaceous stratum of the beech-maple forest: A community structure analysis. M.S. Thesis # 1088, Indiana State University, Terre Haute, Indiana.

Lindsey, A.A. 1955. Testing the line-strip method against full tallies in diverse forest types. Ecology 36:485–495.

Lindsey, A.A. and D.V. Schmelz. 1964. Comparison of Donaldson's Woods in 1964 with its 1954 forest map of 20 acres. Trans. Indiana Acad. Sci. 74:169–177.

McFall, D. and J. Karnes. (eds.). 1995. A directory of Illinois nature preserves. Volume 2. Northwestern, Central, and Southern Illinois. Illinois Department of Natural Resources, Division of Natural Heritage, Springfield, Illinois.

Mohlenbrock, R.H. 2002. Vascular flora of Illinois. Southern Illinois University Press, Carbondale and Edwardsville, Illinois.

Petty, R.O. and A.A. Lindsey. 1961. Hoot's Woods, a remnant of virgin timber, Owen County, Indiana. Trans. Indiana Acad. Sci. 71:320–326.

Schwegman, J.E. 1973. Comprehensive plan for the Illinois nature preserves system. Part 2. The natural divisions of Illinois. Illinois Nature Preserves Commission, Springfield, Illinois. 32 pp. + map.

Small, C.J. and B.C. McCarthy. 2001. Vascular flora of the Waterloo Wildlife Research Station, Athens County, Ohio. Castanea 66:363–382.

Sørenson, T. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. Det. Kong. Danske Vidensk. Selsk. Biol. Skr. (Copenhagen) 5:1–34.

Taft, J.B., G.S. Wilhelm, D.M. Ladd, and L.A. Masters. 1997. Floristic quality assessment for vegetation in Illinois, a method for assessing vegetation integrity. Erigenia 15:1–95.

Weather.com. 2002. Monthly averages and records for Marshall, Illinois. The Weather Channel.

White, J. and M.H. Madany. 1978. Classification of natural communities in Illinois. In: White, J. Illinois Natural Areas Inventory Technical Report. Natural Areas Inventory, Urbana, IL. Pp. 311–357.

SOIL AND ECOLOGICAL FEATURES OF *HEXALECTRIS* (ORCHIDACEAE) SITES

Annie B. Collins

Biology Department
University of Dallas
1845 E. Northgate Drive
Irving, Texas 75062, U.S.A.

James E. Varnum

14524 Tamerisk lane
Farmers Branch, Texas 75234, U.S.A.

Margaret Brown-Marsden[1]

Biology Department
University of Dallas
1845 E. Northgate Drive
Irving, Texas 75062, U.S.A.

ABSTRACT

Soil and ecological features of the orchid genus *Hexalectris* were examined to obtain a more accurate description of the factors influencing its distribution and to direct future conservation efforts. Data on canopy and ground cover, tree species diversity, and soil series were obtained for *Hexalectris* in Dallas County, and overlaid with historic data on *Hexalectris* in Texas. We determined that *Hexalectris* does associate with oak and juniper, but the amount of cover at *Hexalectris* sites did not exceed 60%. Ground cover, tree species diversity, and percent oak/juniper did not differ between sites with and without *Hexalectris*. The soil series associated with *Hexalectris* in this region were Eddy-Brackett entisols of 8–20% slope. Soil type was an accurate predictor of areas in which *Hexalectris* could be found. *Hexalectris* appear to be strongly dependent on soil series, a factor which can aid in predicting areas in which *Hexalectris* is likely to be found but has not yet been located, as well as in conservation of this less well-studied genus.

RESUMEN

Se examinaron las características ecológicas y del suelo de la especie de orquídea *Hexalectris* para obtener una descripción más precisa de los factores que influyen su distribución y para futuros esfuerzos de conservación. Se obtuvieron datos de la canopia y el recubrimiento, diversidad de especies arbóreas, y series de suelo de *Hexalectris* en el condado de Dallas, y sobrepuestos con datos históricos sobre *Hexalectris* en Texas. Determinamos que *Hexalectris* sí se asocia con roble y enebro, pero la cantidad de los sitios de *Hexalectris* no excedieron el 60% y además el área cubierta, la diversidad de especies arbóreas, y el porcentaje roble/enebro no cambió entre sitios observados con o sin *Hexalectris*. Las series del suelo asociadas a *Hexalectris* en esta región eran suelo Eddy-Brackett con 8 al 20 por ciento de inclinación. El tipo de suelo fue un indicador preciso para poder predecir el área en que se encontraría *Hexalectris*. *Hexalectris* parece depender fuertemente en la clase de suelos, un factor que puede ayudar a predecir áreas en las que pueda encontrarse *Hexalectris* pero todavía no pueden ser descritas, al igual que la conservación de este género mucho menos estudiado.

---

[1] Author to whom correspondence should be addressed.

INTRODUCTION

Most orchids begin life by forming a mycorrhizal relationship, as seed germination is dependent on a mycorrhizal association to supply the seedling with carbon during its early stages; a relationship known as myco-heterotrophy (Dressler 1981; Leake 1994; Smith & Read 1997). Ultimately, approximately 80% of orchids switch from the myco-heterotrophic lifestyle to one in which carbon exchange occurs in the opposite direction, from orchid to fungus (Atwood 1986). Only 20% of orchid species maintain this symbiosis throughout their lifetime, which can evolve to a high degree of mycorrhizal specialization (Rasmussen 1995; Taylor et al. 2002). Within the recognized orchid subfamilies, the appearance of myco-heterotrophic species is nearly ubiquitous, and these kinds of orchids can be found within all tribes of the Orchidaceae (Dressler & Dodson 1960; Chase et al. 2003). Although recent work has sought to understand the nature of the mycorrhizal associations for orchids and how they relate to orchid taxonomy (Zelmer et al. 1996), less is known about how myco-heterotrophy is related to geographic distribution. It is thought that a high degree of specificity between orchid and fungus may have broader conservation implications, as protection of endangered myco-heterotrophic forms requires both the maintenance of the orchid itself as well as its associated fungus (Taylor et al. 2003). Because these orchids have a relatively low ability to withstand transplantation from the wild (Liggio 1999), determining the specific features found in the habitat of myco-heterotrophic orchids can provide a key to understanding their geographic distribution, and ultimately aid their conservation worldwide.

Corallorrhiza Gagnebin and *Hexalectris* Rafinesque are the only two genera of myco-heterotrophic orchid that occur in Texas. Members of both genera are commonly called "coral root" orchids, due to the presence of anthocyanin in the rhizome, stalk, and flowers (Liggio 1999), although the genera differ in their broader appearance, habitat, and distribution. *Corallorrhiza* includes ten species, of which nine are native to North and Central America (Freudenstein 1997). The genus *Corallorrhiza* is found within all the lower 48 states and Alaska. *Hexalectris* is found in a much narrower range, with a center of diversity in northern Mexico (Luer 1975). As a result, only five of the *Hexalectris* species occur in the United States, and of these species four are limited to parts of Texas (*H. warnockii* Ames & Correll, *H. revoluta* Correll, *H. nitida* L.O. Williams, and *H. grandiflora* (A. Richard & Galeotti) L.O. Williams), Arizona (*H. warnockii*), and New Mexico (*H. nitida*) (Fig. 1). Only *Hexalectris spicata* (Walter) Barnhart ranges widely, occurring along the eastern seaboard as far north as Maryland and West Virginia. The range of two *Hexalectris* species (*H. grandiflora* and *H. revoluta*) is restricted to only two counties in west Texas (Jeff Davis County for *H. grandiflora*, Jeff Davis and Culberson counties for *H. revoluta*; Liggio 1999; Hatch et al. 1990).

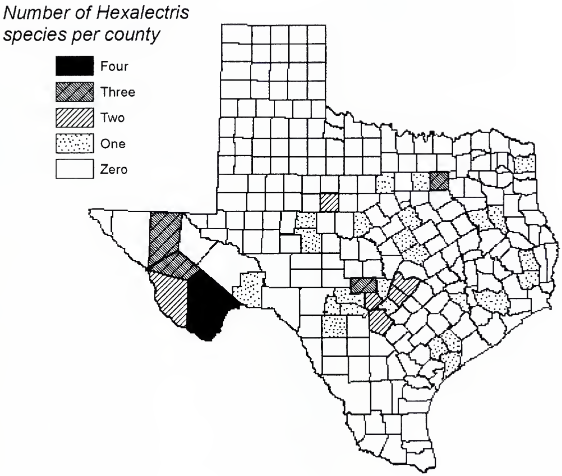


Fig. 1. Distribution map of *Hexalectris* in Texas (based on counties, divided by species, using information from Hatch et al. 1990) Most counties with only one species have either *H. spicata* or *H. nitida*. Most counties with two species have *H. spicata* and *H. nitida*.

In Texas, most of the counties with *Hexalectris* populations are within only three of the state's 11 ecological regions: the Trans-Pecos, the Edwards Plateau, and the Blackland Prairies (Fig. 1; Hatch et al. 1990; Turner et al. 2003). Only *H. spicata* extends beyond these three regions, occurring in all but the High Plains and Rolling Plains of the Texas panhandle. Dallas County (in the Blackland Prairies ecological region) is only one of four counties (Gillespie in the Edwards Plateau, Jeff Davis and Brewster in the Trans-Pecos are the other three) that have three or more species of *Hexalectris*. Dallas County shows a high recorded diversity for Hexalectris, but this is in part related to recently reported range extensions for *H. warnockii* and *H. nitida* (Engel 1987; Mahler 1988), and the new combination *H. spicata* var. *arizonica*, which was described in part based on specimens from the Dallas Nature Center (now Cedar Ridge Preserve) in southwest

Dallas County. However, as most information on *Hexalectris* has appeared only within the last fifty years (Liggio 1999), and relatively few herbarium collections have been made for this genus, *Hexalectris* may perhaps be present over a very large geographic area, and thus be more common than previously thought (Goldman et al. 2002).

In this study we wished to expand the information known about *Hexalectris* abundance and distribution by conducting a detailed census of Cedar Ridge Preserve (CRP) in southwest Dallas County. This is an ideal site for a broad study of *Hexalectris* due to its large area (approximately 256 hectares) and its protected status as both a Dallas County Open Space Preserve and a park within the Dallas Parks and Recreation Department. CRP is also the location of extensive historic study by several orchid hobbyists (V. Engel, D. Williams), long-term plant research and inventory by the Dallas Nature Center (G. Stanford, J. Varnum) and the University of Dallas (M. Brown, A. Collins), as well as the range expansions for H *warnockii* and *H. nitida*, and the discovery of *H. spicata* var. *arizonica* (Catling and Engel 1993). The goals of this study were to 1) compile historic data for *Hexalectris* at Cedar Ridge Preserve, 2) assess the number of *Hexalectris* at the preserve in 2004, 3) determine the ecological characteristics of *Hexalectris* sites, to help provide a more complete description of its habitat, and 4) provide a map of orchid locations at the preserve, to determine whether there are any predictors that may be used to help identify other potential *Hexalectris* sites in Texas.

MATERIALS AND METHODS

All data were collected at Cedar Ridge Preserve, in southwest Dallas County, Texas. CRP is located in one of the few remaining undeveloped areas of the Austin Chalk Escarpment, a geological region of lower Cretaceous limestone that extends northeast from Dallas to the Oklahoma border, and southwest past Waco and Austin into the Edwards Plateau (Dallas Department of Urban Planning 1977)). In Dallas County the escarpment forms a series of steep slopes, with erosion of the bedrock creating a variety of diverse habitats (Kennemer 1987). CRP has been a subject of longtime plant study and monitoring by virtue of its historic role as an environmental center (Greenhills Environmental Center, Dallas Nature Center) and research site (University of Dallas, M. Brown). As a result, we were able to use historic data as well as newly-collected data to create a more complete picture of *Hexalectris* occurrence at the preserve.

Historical data on specific *Hexalectris* locations were obtained by conducting a walk-through of the site (outside of the *Hexalectris* blooming season in November 2003) with Dale Williams, who had significant background knowledge of past orchid records at CRP (Williams 1986). At each site identified by Williams, GPS coordinates were recorded using a Garmin eTrex Legend. Information on dates of specific range extensions for particular species were identified from published accounts by V. Engel, who had conducted surveys similar to Williams (Engel 1987) and had co-described *H. spicata* var. *arizonica* 11 years earlier (Catling & Engel 1993).

Recent data were obtained through both casual sightings as well as detailed censusing. Casual sightings of *Hexalectris* were recorded during ongoing botanical inventory of the preserve (Brown et al., in prep). During that botanical inventory of approximately 75 hectares of the preserve in 2003 and 2004 we recorded GPS coordinates for any *Hexalectris* observed on study transects. Each *Hexalectris* found during surveys was identified by species, and photographed whenever possible.

On July 23 and 24, 2004 we conducted more extensive surveys to specifically count and map all *Hexalectris* found blooming at the preserve. Survey dates corresponded to dates when *Hexalectris* were found on the preserve in 2003 (S. McCabe, pers. obs.). Survey areas were of two different types: 1) areas where historic data on *Hexalectris* were available or 2) areas that were ecologically similar to places where *Hexalectris* were found in the past. GPS coordinates for these sites were logged and mapped. Censusing was conducted with the help of volunteers from the Master Naturalist Program and other volunteers with significant background knowledge of plants. For most census locations we obtained data from small transects on both the right and left sides of the trail whenever possible, and each transect counted as a sampling point. Transects were 20 m long and approximately 3 m wide. In each transect we counted 1) number of *Hexalectris* colonies, 2) total number of *Hexalectris* stems, and 3) number of *Hexalectris* of each species. Data on plant height were recorded for some *Hexalectris* if they appeared to fall outside the typical height values for the species. In each transect, general ecological data on tree species, canopy, and ground cover were obtained for all sites regardless of whether *Hexalectris* were counted or not. Canopy cover was measured as a percentage value, and ground cover values were estimated as percentage of deciduous leaves, juniper scales/leaves, and bare ground.

Statistical analyses were conducted using Microsoft Excel 2000. During analysis, the actual value of the canopy was used, as well as canopy class (< 20%, 21–40%, 41–60%, 61–80%, >80%). Ground cover was divided into five different groups as a ratio of juniper leaves to deciduous leaves (0/100, 25/75, 50/50, 75/25, and 100/0). Diversity of tree species was calculated for each transect using the Shannon Index, to account for both the diversity and evenness of tree species within the transect. Diversity was compared between sites where orchids were present and sites where orchids were absent. We also compared the percent of trees belonging to the genus *Juniperus* at each sampling point and orchid presence/absence, as well as the percent of trees belonging to genus *Quercus* and orchid presence/absence.

GPS data for all *Hexalectris* sites (both current and historic) were converted to ArcView shape files using DNR Garmin Version 4.0.28 (Minnesota Department of Natural Resources 2001), and imported into ArcView 8.3. Arc interchange files for soil data were obtained from the Soil Survey Geographic (SSURGO) Database, available from the Soil Survey Laboratory, National Soil Survey Center (Soil Survey Staff 2004). Details on soil series found in Dallas County were obtained from the Soil Survey of Dallas County (Coffee et al. 1980).

RESULTS

Historic and current *Hexalectris* distribution at Cedar Ridge Preserve

The oldest records of *Hexalectris* at Cedar Ridge Preserve are those described in the paper by Engel (1987). In that paper he describes several orchids originally thought to be *Corallorrhiza* in 1981, although their identification was not confirmed until 1986, when they reappeared and were identified as *H. nitida*. A second species, *H. warnockii*, was identified in that same year by Williams (1986). These records remained the last published account of *Hexalectris* at Cedar Ridge Preserve, until the description of *H. spicata* var. *arizonica* in 1991, partly based on specimens collected at the preserve (Catling & Engel 1993).

We were able to identify eight sites at Cedar Ridge Preserve where *Hexalectris* were historically found (Fig. 2, based on D. Williams, pers. comm.), all of which fell on two trails in the southeastern part of the preserve, within an area dominated by mixed hardwoods and the two coniferous species *Juniperus virginiana* (Eastern red cedar) and *Juniperus ashei* (ashe juniper). This matched the common description of *Hexalectris* habitat, variously described as conifer woods on calcareous soils (Diggs et al. 1999), oak litter and decaying juniper scales/leaves (Engel 1987), leaf mold in the shade of cedars or oaks (Luer 1975), and often upon a slight slope (Coleman et al. 2002). In 2003, the preserve's *Hexalectris* were rediscovered during botanical inventories (S. McCabe, pers. obs.), and ultimately we counted a total of 39 *H. warnockii* that year (K. Gempel, J. Varnum, M. Brown, pers. obs.). However, in 2003 *H. spicata* and *H. nitida* were not found/counted anywhere on the preserve.

In 2004 we conducted transect sampling of 89 different locations which were either 1) areas for which historic data on *Hexalectris* were available (N=12) or 2) areas that were ecologically similar to places where *Hexalectris* were found in the past (N=77) (Fig. 2). In 39 (43.8%) of the 89 sites *Hexalectris* was present. In seven out of eight of the sites identified by Williams *Hexalectris* was present, indicating a reasonable degree of accuracy in the historical data obtained outside the *Hexalectris* blooming season. We counted a total of 308 stems in 141 colonies, or an average of 2.2 stems/colony. The breakdown according to species was as follows: 176 stems of *H. nitida* at 25 different locations (57% of all stems, 64% of all locations), 113 stems of *H. warnockii* at 12 different locations (37% of all stems, 31% of all locations), and 15 stems of *H. spicata* at two locations (5% of all stems, 5% of all locations). In addition, we found four stems of

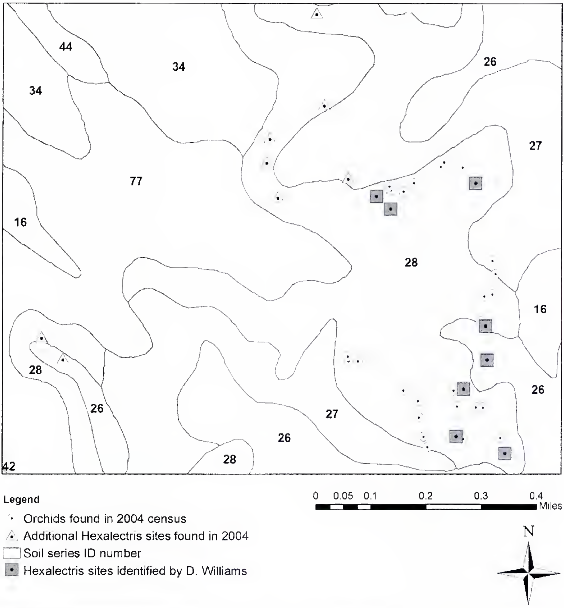


Fig. 2. Distribution map of *Hexalectris* found at Cedar Ridge Preserve. Soil ID numbers are as follows: 16 (Brackett loam, 3–5% slopes), 26 (Eddy clay loam, 1–3% slopes), 27 (Eddy clay loam, 3–8% slopes), 28 (Eddy-Brackett complex, 8–20% slopes), 34 (Ferris-Heiden complex, 5–12% slopes), 44 (Houston Black clay, 1–3% slopes), 77 (Vertel clay, 5–12% slopes). The category "Additional *Hexalectris* sites found in 2004" refers to areas where *Hexalectris* were found outside of the formal survey on July 23/24 2004.

Hexalectris in one colony that were atypical, in that they appeared to completely lack any anthocyanin pigment, and thus were pale yellow to light green. Williams had also noted these atypical individuals during his exploration of the preserve. A sample of this type was later tentatively identified as *H. nitida* by researchers at the Botanical Research Institute of Texas (B. Lipscomb, pers. comm.), although further examination of the sample is pending. Due to the large numbers of *Hexalectris* counted in 2004 and limited time, we were unable to identify plants of the variety *H. spicata arizonica*, but more detailed censusing with trained orchid observers is recommended for inclusion of this type in future censuses. Of the transects studied, only three out of the 39 (8%) had more than one species (2 sites with *H. warnockii* and *H. nitida*, 1 site with *H. nitida* and *H. spicata*).

In the course of sampling we identified several individuals that were taller than the plant heights recorded in the literature. *H. warnockii* is described as ranging up to 30 cm tall (Luer 1975; Diggs et al. 1999), although more recent published accounts have them within a range of 15-40 cm tall (Coleman et al. 2002). In our study we routinely found *H. warnockii* within 30 to 40 cm, with the tallest of this species being 64 cm. For *H. nitida*, published plant heights range from 10–32 cm (Coleman et al. 2002), 15 – 30 cm (Diggs et al. 1999), and up to 30 cm (Luer 1975). Our *H. nitida* were frequently found to be greater than 30 cm tall, with the tallest at 44 cm.

Ecological characteristics of *Hexalectris* sites

Data on canopy cover, ground cover, and tree diversity were obtained from 89 different locations in 2004 *Hexalectris* censusing. To determine whether the presence/absence of orchids is affected by level of canopy cover, canopy was divided into five categories (≤20%, 21–40%, 41–60%, 61–80%, and >80%), which were compared. We found that there was a significant association between canopy cover and orchid presence/absence (χ^2 of association = 13.36, $P < 0.01$, df=4, Fig. 3). Fifty-four percentof the sites with orchids had canopy of between 40 and 60%, and 71% of the sites without orchids had over 60% cover. We found no significant association between the type of ground cover present and orchid presence/absence (χ^2 of association = 5.38, df=3), although all areas on which orchids were found had a ground cover of ≤ 50% juniper leaves.

Diversity of tree species was not significantly different between sites with and without *Hexalectris* (Independent two-tailed $t_{0.05,85}$ = 1.054, n.s.). Sites without *Hexalectris* had a Shannon diversity index of 1.09, compared to 1.17 for sites with *Hexalectris*. Overall, 59% of the trees counted in transects were *Juniperus* spp. (either *J. virginiana* or *J. ashei*), followed by oaks (28% of all trees counted). Sites with and without *Hexalectris* did not significantly differ from one another in the percent of *Juniperus* spp. present (χ^2 of association = 5.43, df=3, n.s.), or in the percent of *Quercus* spp. present (χ^2 of association = 11.42, df=5, n.s.) Only 14% of trees were something other than oak or juniper, and included (in order from highest to lowest number of individuals counted): *Cornus drummondi* (rough-leaf dogwood), *Ilex decidua* (possumhaw), *Fraxinus texensis* (Texas ash), *Viburnum rufidulum* (rusty blackhaw viburnum), and *Rhus* (sumac) spp.

Soil characteristics of *Hexalectris* sites

When soil survey maps were overlaid with maps of *Hexalectris* sites, we were able to show some association between soil type and *Hexalectris* presence (Fig.

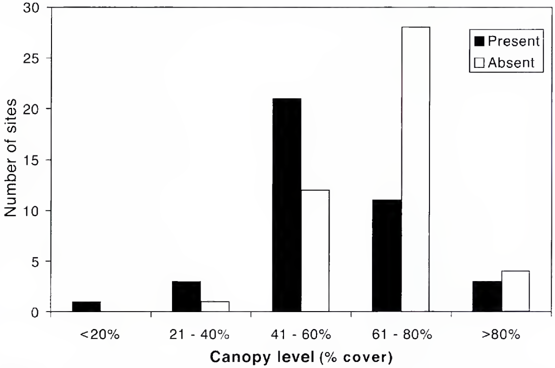


Fig. 3. Relationship between cover class and orchid presence/absence at *Hexalectris* sites

2). Nearly all (93.7% total) of the orchids found were on the Dallas County soil series Eddy-Brackett complex (8–20% slopes). This soil series is classified as a loamy-skeletal, carbonatic, thermic, shallow typic ustorthent (within the entisols), and is often found on strong to moderately sloping hillsides, with a soil depth to approximately 11 inches and a surface layer of grayish brown clay loam 4 inches thick (Coffee et al. 1980). Soils within this complex have rapid runoff, with severe erosion hazard.

Unfortunately, although the data appear to point to an association between soil series and *Hexalectris* presence, interpretation of these data is hampered by the fact that only 16 of the 89 sites examined were something other than the Eddy-Brackett complex (8–20% slopes). To further examine the relationship between soil type and *Hexalectris*, following our initial two-day survey we specifically searched two other areas of the preserve with this soil series, and also mapped datapoints for *Hexalectris* detected during ongoing botanical surveys for other projects at the preserve. Overall, nine additional *H. nitida* were found outside of the 89 areas that we originally surveyed (bringing the total *Hexalectris* count for 2004 to 317). Of these sites, seven (77.7%) were within the Eddy-Brackett complex (8–20% slopes), and the remainder were found on similar soils with less slope. *Hexalectris* found outside of Eddy-Brackett complex (8–20% slopes) were on Eddy clay loam (1–8% slopes) (Coffee et al. 1980).

DISCUSSION

In this study we have been able to provide what is perhaps the largest known count of multiple species of *Hexalectris* orchids at a single research site in the United States. With the initial census from this study, we will be able to follow up our data with future censusing at the preserve and perhaps expansion of the study area into other sites with ecological and soil characteristics similar to those found in this year's census. It is possible that the large number of *Hexalectris* seen this year may be a result of the late spring rains that occurred in Dallas County. In June 2004 Dallas experienced record-breaking rainfall, reaching over 10 inches of rain for the month, or over 250% above the normal June precipitation (Office of the Texas State Climatologist 2004). It is thought that generous rainfall in late spring is necessary for flowering of *Hexalectris* (Engel 1987), although currently there are no published data showing the relationship between rainfall and *Hexalectris* abundance. However, with ongoing censusing of these orchids, we should be able to better elucidate the climatological factors that influence flowering.

Based on the general ecological data collected in this study, we cannot necessarily provide any new information on the plant community with which *Hexalectris* is associated. Oak and juniper are clearly the primary genera that make up both the canopy and ground cover, providing both shelter and a source of decaying organic matter for the fungal symbiont. Yet oak and juniper alone do not necessarily make for good *Hexalectris* habitat. Having a relatively open canopy may also be important, as our study has shown these orchids to be almost completely absent in oak-juniper sites with 60% canopy or greater. As this is not believed to be due to a need for sunlight for photosynthesis (these species do not have chlorophyll and are nonphotosynthetic), cover may influence other factors such as soil or air temperature. Temperature records of microclimate at key sites where *Hexalectris* have been found may be a useful future direction for studies of these species.

The most important result derived from this study is that we were able to predict the occurrence of *Hexalectris* orchids based on soil maps After our initial census efforts, we were able to identify areas on the soil map where a particular soil complex, and consequently the orchids, should occur, and confirm their occurrence through targeted searches. Predictions based on soil type were also corroborated by information from other areas in other parts of Dallas County. *Hexalectris* have frequently been found in Dogwood Canyon, an area approximately 2 kilometers to the southwest of our study area (D. Hurt, pers. comm.). Soil maps reveal that most of the canyon is composed of Eddy-Brackett complex (8–20% slope), with the exception of the lowest levels of the canyon along the creekbed. In addition, long-term observations of areas less than half a kilometer west of the preserve and north of Dogwood Canyon that fall within Cedar Hill State Park show the only recorded orchids to be *Spiranthes* L. C. Rich.

and *Corallorrhiza*, rather than *Hexalectris* (Paul Baldon, CHSP, pers. comm.). Cedar Hill State Park lies mostly on chromustert soils of the Heiden or Vertel complex, which are vertisols, rather than an entisol such as Eddy-Brackett. Finally, we were advised of two small colonies of *Hexalectris* in east Dallas, adjacent to Lower White Rock Creek known as the Scyene overlook (J. Flood, pers. com.) These colonies were located in city parks within an area geologically similar to Austin Chalk Escarpment, and were confirmed to be on Eddy-Brackett complex (8–20% slope). This confirmation helps to solidify the connection between soils and *Hexalectris* incidence in Dallas County.

Based on the information from this study, we have planned to extend this research to other areas with similar soil types. In Dallas County, approximately 1.3% of the land area (3127 hectares) falls within the Eddy-Brackett (8–20%) soil series, and nearly all of these soils are found at 36 locations in the county. With a broader search area, we have the potential to expand the known range of *Hexalectris* within Dallas County, and to protect these areas from expanding development within the county. If the soil-orchid relationship is confirmed in Dallas County, it can potentially be applied to all of Texas. The map of *Hexalectris* distribution in Texas indicates that Dallas County has a high *Hexalectris* diversity compared to most other counties, yet this may be an artifact of a lack of censusing in other areas, or perhaps a limited knowledge of the precise soil and ecological characteristics that this genus requires. With the information from this study, we are confident that the missing pieces of the *Hexalectris* distribution map can be filled, and our knowledge about this genus can be expanded.

ACKNOWLEDGMENTS

Many thanks to Dale Williams for providing his background knowledge of the orchids at Cedar Ridge Preserve, and for his historical information about the orchid search at Cedar Ridge Preserve. The initial observations of orchids in 2003 that set in motion this study would not have been possible without the efforts of Sussann McCabe. Karen Gempel assisted in our informal census of *Hexalectris* in 2003. Stephanie Varnum assisted greatly in survey efforts, data compilation and manuscript editing. Survey efforts in 2004 were aided by members of North Texas Chapter, Master Naturalist programs (Marguerite Kaufman, Annie Smirmaul, Holly Toland, Dana Wilson), other plant enthusiasts (Joann Cross, Shirley Lusk, and Kathy Saucier) and the University of Dallas (Heather McWilliams, John Rueda). Ken Garrison provided photography expertise and photos of these species. Richard Marsden, Winwaed Software Technology, constructed the range map for *Hexalectris* used in this paper. We acknowledge the support of the Botanical Research Institute of Texas, particularly Gary Jennings, Barney L. Lipscomb, and George M. Diggs, Jr. (and Austin College), Jim Flood (North Texas Chapter, Master Naturalist programs), Paul Baldon (Texas Parks

and Wildlife, Cedar Hill State Park) and David Hurt (Dogwood Canyon) provided historic data on *Hexalectris* in other Dallas locations.

REFERENCES

Atwood, J.T. 1986. The size of the Orchidaceae and the systematic distribution of epiphytic orchids. Selbyana 7:171–186.

Catling, P.M. and V.S. Engel. 1993. Systematics and distribution of *Hexalectris spicata* var. *arizonica* (Orchidaceae). Lindleyana 8:119–125.

Chase, M.W., K.M. Cameron, R.L. Barrett, and J.V. Freudenstein. 2003. DNA data and Orchidaceae systematics: a new phylogenetic classification. In: Orchid conservation. K.M. Dixon, S.P. Kell, R.L. Barrett, and P.J. Cribb, eds. Natural History Publication, Kota Kinabalu, Sabah, Malaysian. Pp. 69–89

Coffee, D.R., R.H. Hill, and D.D. Ressell. 1980. Soil survey of Dallas County, Texas. United States Department of Agriculture, Washington, DC.

Dallas Department of Urban Planning. 1977. The escarpment report. Department of Urban Planning of the City of Dallas, Texas.

Diggs, Jr., G.M., B.L. Lipscomb and R.J. O'Kennon 1999 Shinners & Mahler's illustrated flora of north central Texas Botanical Research Institute of Texas, Fort Worth.

Dressler, R.L. 1981. The orchids: Natural history and classification. Harvard University Press, Cambridge, MA. Pp. 76–79.

Dressler, R. L. and C.H. Dodson. 1960. Classification and Phylogeny in the Orchidacea. Ann. Missouri Bot. Gard. 47:25–68

Engel, V. 1987. Saprophytic orchids of Dallas. Amer. Orchid Soc. Bull. 56:831–835.

Freudenstein, J.V. 1997. A monograph of *Corallorhiza* (Orchidaceae). Harvard Pap. Bot. 1:5–51.

Goldman, D.H., R.A. Coleman, L.K. Magrath, and P.M. Catling. 2002. Hexalectris. In Flora of North America, Vol. 26. Oxford University Press, New York and Oxford., Pp. 603–607.]

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Stat. Misc. Publ. 1655: 1–158.

Kennemer, G.W. 1987. A quantitative analysis of the vegetation on the Dallas County white rock escarpment. Sida, Bot. Misc. 1:1–10.

Leake, J.R. 1994. Tansley review no. 69. The biology of myco-heterotrophic ('saprophytic') plants. New Phytologist 127:171–216.

Liggio, J. 1999. Wild orchids of Texas. University of Texas Press, Austin.

Luer, C.A. 1975. The native orchids of the United States and Canada, excluding Florida. The New York Botanical Garden, Bronx.

Mahler, W.F. 1988. Shinners' manual of the North Central Texas flora. Sida, Bot. Misc. 3: 1–313.

Office of the State Climatologist. 2004. Texas Climatic Bulletin. Vol. 17. Department of Atmospheric Sciences, College of Geosciences, Texas A & M University, College Station.

Rasmussen, H.N. 1995. Terrestrial orchids: from seed to mycotrophic plant. Cambridge University Press, New York, NY.

SMITH, S.E. and D.J. READ. 1997. Mycorrhizal symbiosis. 2nd ed. Academic Press, San Diego, California.

SOIL SURVEY STAFF. 2004. National Soil Survey Characterization Data, Soil Survey Laboratory. National Soil Survey Center. USDA-NRCS, Lincoln, NE. (Thursday July 29, 2004)

TAYLOR, D.L, T.D. BRUNS, J.R. LEAKE, and D.J. READ. 2002. Mycorrhizal specificity and function in myco-heterotrophyic plants. In: The ecology of mycorrhizas. Vol. 157. M.G.A. van der Heijden and I.R. Sanders, eds. Springer-Verlag, Berlin, Germany. Pp. 375–414.

TAYLOR, D.L., T. D. BRUNS, T.M. SZARO, and S.A. HODGES. 2003. Divergence in mycorrhizal specialization within *Hexalectris spicata* (Orchidaceae), a nonphotosynthetic desert orchid. Amer. J. Bot. 90:1168–1179.

TURNER, B.L, H. NICHOLS, G. DENNY, and O. DORON. 2003. Atlas of the vascular plants of Texas Volume 2. Sida, Bot. Misc, 24:769–770.

WILLIAMS, D. 1986. Native orchid species. Friends of Greenhills (a publication of the Greenhills Environmental Center, Dallas, TX, USA 5:1–2.

ZELMER, C.D., L. CUTHBERTSON, and R.S. CURRAH. 1996. Fungi associated with terrestrial orchid mycorrhizae, seeds, and protocorms. Mycoscience 37:439–448.

BOOK NOTICES

Blackwell Publishing

John A. Miranowski and Colin G. Scanes (Eds). 2005. **Perspectives in World Food and Agriculture, Volume 2.** (ISBN 0-8138-2021-9, hbk.). Blackwell Publishing Professional, 2121 State Avenue, Ames, IA, 50014, U.S.A. (**Orders:** 800-862-6657; 1-515-292-3348; www.blackwellprofessional.com). $124.99, 334 pp., b/w figures, graphs, tables, index, 6" × 9".

From the back cover—"The second volume in a series designed to keep agricultural leaders abreast of the most up-to-date information concerning global agriculture, Perspectives in World Food and Agriculture, Volume 2 brings together cutting-edge agricultural research and the latest views on agricultural policy."

Alexander Krings and Richard R. Braham. 2005. **Guide to Tendrillate Climbers of Costa Rican Mountains.** (ISBN 0-632-05249-X, hbk.). Blackwell Publishing Professional, 2121 State Avenue, Ames, IA, 50014, U.S.A. (**Orders:** 800-862-6657; 1-515-292-3348; www.blackwellprofessional.com). $99.99, 182 pp., b/w line drawings, tables, index, 7" × 10".

Krings and Braham include all native and naturalized tendrillate climbers, lianas and vines, known to occur at elevations over 700 m in the mountains of Costa Rica. This taxonomic guide includes keys to families, genera, and species. "Most family and genus entries contain information on distinguishing the family or genus from other similar-looking taxa." Synonymy, Description, Phenology, and Distribution are provided for each taxon as well as detailed b/w line drawings.

Alain Peeters with contributions from Cecile Vanbellinghen and John Frame. 2004. **Wild and Sown Grasses: Profiles of a Temperate Species Selection: Ecology, Biodiversity and Use.** (ISBN Blackwell 0-4051-0529-1; FAO ISBN 92-5-105159-3, hbk.). Food and Agriculture Organization of the United Nations and Blackwell Publishing Professional, 2121 State Avenue, Ames, IA, 50014, U.S.A. (**Orders:** 800-862-6657; 1-515-292-3348; www.blackwellprofessional.com). $119.99, 311 pp., color photos, b/w line drawings, tables, index, 7" × 10".

From the back cover—"...this book contains profiles of 43 temperate species, many of which are regaining importance in the context of agricultural extensification. Amply illustrated, each profile includes a description of the plant, its ecological requirements, its agronomic characteristics and its uses, including the innovative and unusual." In addition, each species summary includes: Synonymy; Etymology, Common Names (English, French, German), and Distribution.

THE ECOLOGY OF *TRILLIUM TEXANUM* (TRILLIACEAE) ON THE ANGELINA NATIONAL FOREST, TEXAS

Michael H. MacRoberts and Barbara R. MacRoberts

Bog Research, 740 Columbia
Shreveport, Louisiana 71104, U.S.A.
and
Herbarium, Museum of Life Sciences
Louisiana State University in Shreveport, Shreveport, Louisiana 71115, U.S.A.

ABSTRACT

Trillium texanum Buckley, a member of the *Trillium pusillum* Michx. complex, is rare over its range, occurring in scattered populations in baygalls, streamsides, and wooded seeps. We collected information on the habitat, phenology, population, and soils of *Trillium texanum* on the Angelina National Forest in southeast Texas.

KEY WORDS: *Trillium pusillum*, *Trillium texanum*, baygall, Angelina National Forest, Texas

RESUMEN

Trillium texanum Buckley, miembro del complejo *Trillium pusillum* Michx., es raro en todo su areal, apareciendo en poblaciones dispersas en arroyos e infiltraciones boscosas. Hemos colectado información sobre su hábitat, fenología, población, y suelos de *Trillium texanum* en el Angelina National Forest en el Sureste de Texas.

INTRODUCTION

Except for taxonomy, morphological variation, and distribution, little is published about the *Trillium pusillum* Michx. complex, of which *Trillium texanum* Buckley (or *Trillium pusillum* Michx. var. *texanum* (Buckley) J. Reveal & Broome), is a member (Kral 1983; Freeman 1994; Cabe 1995; Cabe & Werth 1995; Case & Case 1997; Farmer & Schilling 2002; Singhurst et al. 2002; Timmerman-Erskine et al. 2002a, 2002b). Only a decade ago, Freeman (1994:49) pointed out that "ecological parameters have not been measured in any population of *T. pusillum*." More recently, Singhurst (1996), in his summary of *T. texanum*, stated that not only is there virtually nothing known about *T. texanum* ecologically, there are currently no research programs that include it. Since we now know a great deal about the distribution, morphology, and taxonomy of the *T. pusillum* complex, what would be of interest would be ecological/autecological descriptions of *T. pusillum* over its range. What is known is that all members of this complex are shade plants of moist hardwood bottoms, creek sides, or swamps. They occur on a variety of soils from sandy to cherty-flinty, fertile to infertile, alkaline to basic. They occur in the Appalachians and Interior Highlands and on the Coastal Plain (Kral 1983).

Trillium texanum is rare, occurring in small, disjunct populations (Singhurst et al. 2002). It has been found at several locations in Caddo Parish in northwest Louisiana (MacRoberts 1977; Teague & Wendt 1994) and nine east Texas counties (Nixon et al. 1977; MacRoberts & MacRoberts 1998; Singhurst et al. 2002; Turner et al. 2003). It is rated state critically imperiled in Louisiana and imperiled in Texas and globally rare/imperiled (Louisiana Natural Heritage Program 1999; Poole et al. 2004). Its habitat preference has been variously reported as baygalls and wooded seeps (Ajilsvgi 1979; Teague & Wendt 1994; Singhurst et al. 2002).

From 1995 to 1997, we collected information on population, associated flora, and soils for *T. texanum* on the Angelina National Forest in Angelina and Jasper counties in southeast Texas. General descriptions of the area and edaphic conditions are given in Orzell (1990) and Bridges and Orzell (1989).

METHODS

1. In 1995 and 1996, while conducting overall surveys for rare plants on the National Forests and Grasslands in Texas (MacRoberts & MacRoberts 1998), we surveyed for *T. texanum* by walking baygalls, streamsides, and branchbanks in various mesic to xeric sandy longleaf pine uplands in southern Sabine National Forest, Sabine County, and in southern Angelina National Forest in Angelina and Jasper counties. This was slow work because the plants are rare, scattered, and inconspicuous. On the Angelina National Forest, *T. texanum* puts up only a few early spring (March–May) flowers, and although it puts up many inconspicuous single leaves, these are soon overtopped and hidden by later developing herbaceous species, particularly ferns such as *Osmunda* and *Woodwardia*. Since our time was limited and there are many kilometers of potentially suitable habitat along streams in the area, this survey is not exhaustive.

2. In May 1995, we established seven permanent one meter sq. plots in three *T. texanum* populations. Because of the limited number of known populations the sites were chosen as typical of what we had encountered and were accessible to repeated visits. Number of plants and their developmental stage (e.g., single leaf, three leaves but no flower, three leaves with flower, Fig. 1) were recorded for each plot.

3. To define the plant community in which *T. texanum* occurs, we established two permanent plots centered on two of our one meter sq. plots (called plot 2 and plot 4 hereafter). These were chosen because they were typical and accessible. Each measured 18 m × 13.5 m and was divided into three 6 m × 13.5 m sections running parallel to the topographic/moisture/light gradient (Fig. 2). The upper section (highest elevation) was farthest from the stream course; the lower section was closest to the stream course. In the center of the middle section was the one meter sq. plot with *T. texanum*. We surveyed the flora in each plot every two to three weeks between February and November 1996.

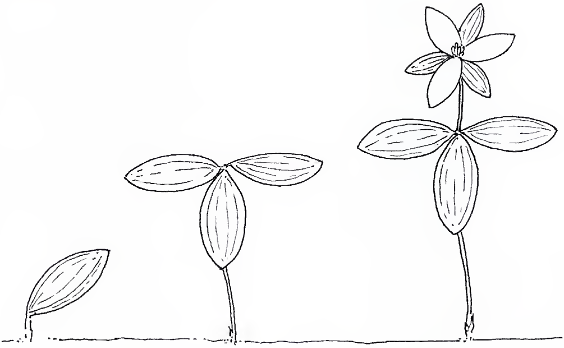


Fig. 1. Above-ground growth forms of *Trillium texanum* (left to right: single leaf, three leaves, three leaves with flower).

4. We collected soil samples to a depth of 15 cm in each of the center plots near the *Trillium* and had them processed at A & L Laboratories, Memphis, Tennessee.

RESULTS

1. We found eight populations of *T. texanum* in Angelina and Jasper counties in the Angelina National Forest. These populations were scattered over an area about 6 km east-west along the Angelina-Jasper county line and were near the headwaters of Trout Creek, Buck Branch, Clear Creek, and Shearwood Creek. These are south-flowing, intermittent streams. The eight populations ranged from a single group of plants consisting of only a few single leaves and scapes occurring within an area less than one meter square to fairly large populations with thousands of leaves and dozens of flowering scapes scattered over a hectare. We did not find *T. texanum* in the Sabine National Forest, although there appeared to be suitable baygall habitat.

The dominant habitat of the whole area where *T. texanum* occurs on the Angelina National Forest is arenic longleaf pine uplands grading into grossarenic uplands (see Bridges & Orzell 1989; Orzell 1990; Harcombe et al. 1993; Turner et al. 1999, for habitat classifications). This area is locally know as Longleaf Ridge. Common upland vegetation of this area consists of *Andropogon ternarius* Michx., *Croton argyranthemus* Michx., *Cnidoscolus texanus* (Muell.-Arg.) Small, *Berlandiera pumila* (Michx.) Nutt., *Dichanthelium aciculare* (Desv.

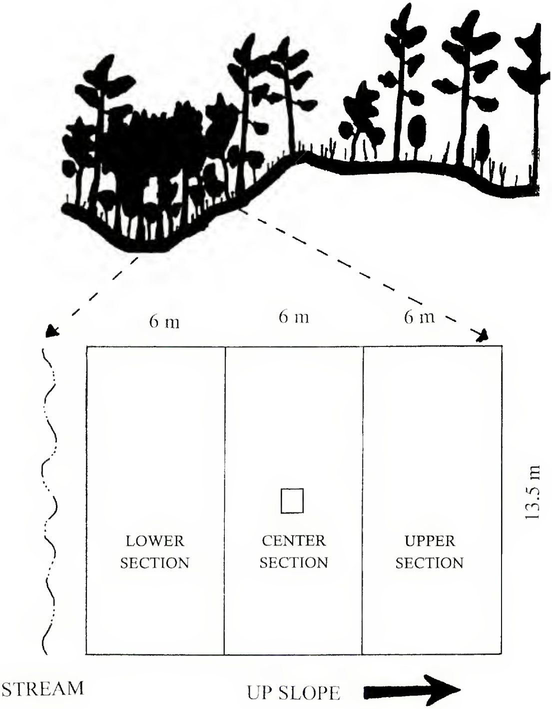


Fig. 2. Study plot layout for plant communities of *Trillium texanum*. Two permanent plots were established, each centered on a one meter sq. plot. Each of the three 6 m × 13.5 m sections of the two plots runs parallel to the topographic/moisture/light gradient. The upper section (highest elevation) is farthest from the stream course; the lower section is closest to the stream course. The center section contains the one meter sq. plot with *T. texanum*.

ex Poir) Gould & C.A. Clark, *Froelichia floridana* (Nutt.) Moq., *Ilex vomitoria* Ait., *Pinus palustris* P. Mill., *Pinus echinata* P. Mill., *Pityopsis graminifolia* (Michx.) Nutt., *Pteridium aquilinum* (L.) Kuhn, *Quercus incana* Bartr., *Q. stellata* Wang., *Q. marilandica* Muenchh., *Schizachyrium scoparium* (Michx.) Nash., *Tephrosia virginiana* (L.) Pers., *Toxicodendron radicans* (L.) Kuntze, *Tradescantia reverchonii* Bush, *Tragia urens* L., and *Vernonia texana* (A. Gray) Small.

2. Table 1 gives the data on the developmental stage of plants in the seven one meter square plots. The vast majority of above-ground growth was single leaves, not scapes with leaves or flowers. In the seven plots, there were only 15 flowering stems in three years, and a total of only 31 scapes. This pattern was typical for all *T. texanum* we observed on the Angelina National Forest. In April and May, the ground cover for the seven plots was always below 30%.

These figures for flowering stems are exceptionally low when compared with recent surveys by Singhurst (1996), who reported populations of *T. texanum* in Cass and Nacogdoches counties of 1000 to 2000 flowering scapes.

3. Table 2 lists the taxa in the different sections of Plots 2 and 4. Counting *Sphagnum*, plots 2 and 4 had 59 species, 50 genera, and 33 families. Plot 4 had 52 species; plot 2 had 37 species. The index of similarity (Sorenson's) between plots 2 and 4 was 67 and between the middle sections of 2 and 4 (where *T. texanum* was) was 65 indicating that both plots were the same community. Seventy percent of these species were found in six baygalls in central Louisiana (MacRoberts et al. 2004) suggesting that these *T. texanum* sites may be part of the general baygall community type that is widespread over much of the West Gulf Coastal Plain (Brooks et al. 1993; Nesom et al. 1997). However, the species has not been found in central Louisiana although there are many baygalls and we have searched for it.

Table 3 examines some of these data further. The upper sections of the plots were the richest, both in number of species and in number of herbaceous species. The lowest section was the least diverse, and the middle section, where *T. texanum* occurred, was intermediate. The lower section was dominated by woody vegetation; whereas the upper section was dominated by herbaceous species. The upper edges of baygalls in the Angelina National Forest are often essentially narrow bogs, with such characteristic bog genera as *Sphagnum*, *Pogonia*, *Eriocaulon*, and *Xyris*. Just upslope of the plots (and of most baygalls in this region) was arenic/grossarenic longleaf pine upland.

The difference in vegetation among the three sections of the plots is undoubtedly due to differences in soil moisture and sunlight. The upper sections received the most sunlight (thinnest canopy and located on the baygall edge next to arenic/grossarenic, relatively open longleaf pine uplands) and had the least saturated soil. The middle section was intermediate, and the lower section received the least sunlight (dense canopy; no open edge) and was often mucky wet.

TABLE 1. *Trillium texanum* developmental stage in seven one meter sq. plots.

Year	single leaf	three leaves	flowering plant
1995	169	3	5
1996	345	3	3
1997	308	10	7

TABLE 2. Vascular plants occurring in three sections of two permanent plots. Plants in plot 2 are designated "2" and plants in plot 4 are designated "4." The sections within each plot are: upper, middle, lower depending on their elevation and proximity to the stream. Nomenclature follows Kartesz and Meacham (1999).

Family/species	Upper	Middle	Lower
Aceraceae			
Acer rubrum L.	24	24	24
Anacardiaceae			
Toxicodendron vernix (L.) Kuntze	24	24	24
Apiaceae			
Centella erecta (L.f.) Fern.	24		
Eryngium integrifolium Walt.		4	
Oxypolis rigidior (L.) Raf.	4	4	
Ptilimnium capillaceum (Michx.) Raf.	4		
Aquifoliaceae			
Ilex coriacea (Pursh) Chapman	4	24	24
Ilex opaca Ait.		24	2
Araceae			
Arisaema triphyllum (L.) Schott			4
Asteraceae			
Arnoglossum ovatum (Walt.) H E. Robins	4	4	4
Doellingeria sericocarpoides Small		4	4
Eupatorium fistulosum Barratt		24	24
Eupatorium rotundifolium L.	24	2	
Helianthus angustifolius L.	4		
Liatris pycnostachya Michx.	4		
Solidago rugosa P. Mill.	4	4	
Symphyotrichum dumosum (L.) Nesom	4	4	
Symphyotrichum lateriflorum (L.) A. & D. Love	4		
Blechnaceae			
Woodwardia areolata (L.) T. Moore		24	24
Woodwardia virginiana (L.) Sm.	4		4

Table 2. continued.

Family/species	Upper	Middle	Lower
Burmanniaceae			
Aptera aphylla (Nutt.) Barnh. ex Small	24	24	24
Campanulaceae			
Lobelia puberula Michx.		4	
Cornaceae			
Nyssa biflora Walt.	2		
Clusiaceae			
Hypericum crux-andreae (L.) Crantz.	2		
Hypericum galioides Lam.	4	4	
Cyperaceae			
Carex glaucescens Ell.	4		
Rhynchospora gracilenta A. Gray	24	4	4
Scleria triglomerata Michx.	4	4	4
Dennstaedtiaceae			
Pteridium aquilinum (L.) Kuhn	2		
Ericaceae			
Lyonia ligustrina (L.) DC.	4	24	
Rhododendron canescens (Michx.) Sw.	24	24	4
Vaccinium corymbosum L.	2	24	2
Eriocaulaceae			
Eriocaulon decangulare Ell.	4		
Lachnocaulon anceps (Walt.) Mrong.	24		
Hamamelidaceae			
Liquidambar styraciflua L.	2		
Lauraceae			
Persea palustris (Raf.) Sarg.	24	24	24
Lentibulariaceae			
Pinguicula pumila Michx.		24	
Liliaceae			
Aletris aurea Walt.	24		
Melanthium virginicum L.	4	4	
Loganiaceae			
Gelsemium sempervirens (L.) Aition.f.	4	24	
Magnoliaceae			
Magnolia virginiana L.	4	4	24
Melastomataceae			
Rhexia petiolata Walt.	24		
Orchidaceae			
Pogonia ophioglossoides (L.) Ker. Ga.	24	24	

Table 2. continued.

Family/species	Upper	Middle	Lower
Osmundaceae			
Osmunda cinnamomea L.	4	24	
Osmunda regalis L.	4	24	2
Pinaceae			
Pinus palustris P. Mill.	2	2	2
Pinus taeda L.	4		4
Poaceae			
Chasmanthium laxum (L.) Yates	24		
Dichanthelium dichotomum (L.) Gould	24	24	
Polygalaceae			
Polygala nana (Michx.) DC.	2		
Rubiaceae			
Mitchella repens L.	24	4	24
Smilacaceae			
Smilax laurifolia L.	24	4	4
Trilliaceae			
Trillium texanum Buckley		24	
Verbenaceae			
Callicarpa americana L.		4	
Violaceae			
Viola primulifolia L.	24	4	
Xyridaceae			
Xyris ambigua Bey. ex Kunth	4		
Xyris caroliniana Walt.	2		
Xyris scabrifolia Harper	4		
Sphagnum	24	4	

Table 3. Floristic breakdown of plots by section.

Plot 2	Upper	Middle	Lower
Total species in sections:	27	19	13
Total % of all species:	73	51	35
Total woody species:	8	9	7
Total % woody species:	30	47	54
Plot 4			
Total species in sections:	41	35	18
Total % of all species:	79	65	35
Total woody species:	9	11	8
Total % woody species:	22	32	44

Table 4. Soil characteristics of two baygalls.

		Exchangeable Ions (ppm)				
Sample	**pH**	**P**	**K**	**Ca**	**Mg**	**Organic Matter %**
Plot 2	5.0	7	21	90	20	4.1
Plot 4	5.2	15	22	110	25	3.3

4. *Trillium texanum* occurred in the Tehran-Letney-Melhomes soil series. These are sandy soils that are deep, gently sloping, poorly drained but rapidly permeable (Dolezel et al. 1988; Neitsch et al. 1982) (Table 4). In the baygalls, these soils are wet most, if not all, of the year. Like bog and baygall soils throughout the West Gulf Coastal Plain, they are acidic and nutrient poor (Nesom et al. 1997; MacRoberts & MacRoberts 2001; MacRoberts et al. 2004).

DISCUSSION

While our observations are local and limited, some ecological information has been gained. In the area of this study, *Trillium texanum* is associated with stream courses, and the typical flora of baygalls that occur below arenic/grossarenic longleaf pine uplands. These sandy uplands hold and slowly discharge water and are often associated with hillside bogs, baygalls, and seepage areas. *Trillium texanum* prefers wet but not inundated soils that are acidic and nutrient poor. It occurs under a deciduous canopy, putting up leaves and scapes in March and April before the canopy blocks light and before other herbaceous plants overtop it. In our study, most of the above-ground vegetation was single leaves with a few scapes. Why these populations should be weighed so heavily in juvenile, non-reproductive individuals, is not known. Habitat preferences and population characteristics in other parts of its range definitely need study before this species complex will be both taxonomically and ecologically understood.

ACKNOWLEDGMENTS

The work was undertaken as part of a Cost-Share Agreement with the National Forests and Grasslands in Texas. Larry Brown, Rob Evans, Stanley Jones, John Logan, Tom Wendt, Joseph Wipff, Jason Singhurst, and Edwin Smith aided in various ways. Jason Singhurst, Guy Nesom, and two anonymous reviewers made many useful comments on the paper.

REFERENCES

Ajilvsgi, G. 1979. Wild flowers of the Big Thicket. Texas A & M Univ. Press, College Station.

Bridges, E.L. and S.L. Orzell. 1989. Longleaf pine communities of the West Gulf Coastal Plain. Natural Areas J. 9:246–263.

Brooks, A.R.. E.S. Nixon, and J.A. Neal. 1993. Woody vegetation of wet creek bottom communities in eastern Texas. Castanea 58:185–263.

Cabe, P.R. 1995. The *Trillium pusillum* Michaux (Liliaceae) complex in Virginia. I. morphological investigations. Castanea 60:1–14.

Cabe, P.R. and C. Werth . 1995. The *Trillium pusillum* Michaux (Liliaceae) complex in Virginia. II: isozome evidence. Castanea 60:15–29.

Case, F.W. and R.B. Case. 1997. Trilliums. Timber Press, Portland, Oregon.

Dolezel, R., C. Fuchs, L. Gray. T. Holt, and L. Steptoe. 1988. Soil survey of Angelina County, Texas. U.S.D.A. Soil Conservation Service, Washington, D.C.

Farmer, S.B. and E.E. Schilling. 2002. Phylogenetic analysis of Trilliaceae based on morphological and molecular data. Syst. Bot. 27:674–692.

Freeman, J.D. 1994. Status survey of the *Trillium pusillum* complex. Unpublished report, Alabama Natural Heritage, Montgomery, Alabama.

Harcombe, P.A., J.S. Glitzenstein, R.G. Knox, S.L. Orzell, and E.L. Bridges. 1993. Vegetation of the longleaf pine region of the West Gulf Coastal Plain. Proc. Tall Timber Fire Ecol. Conf. 18:83–103.

Kartesz, J.T. and C.A. Meacham. 1999. Synthesis of North American flora. Version 1.0. North Carolina Botanical Garden, Chapel Hill.

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South. Vol. 1. U.S.D.A. Forest Service, Tech. Publ. R8-TP2: 1–718.

Louisiana Natural Heritage Program. 1999. Rare plant species of Louisiana. Unpublished report. Baton Rouge.

MacRoberts, D.T. 1977. Additions to the Louisiana flora. Sida 7:220–222.

MacRoberts, M.H. and B.R. MacRoberts. 1998. Noteworthy vascular plant collections on the Angelina and Sabine National Forests, Texas. Phytologia 84:1–27.

MacRoberts, M.H. and B.R. MacRoberts. 2001. Bog communities of the West Gulf Coastal Plain: a profile. Bog Res. Pap. Bot. Ecol. 1:1–151.

MacRoberts, B.R., M.H. MacRoberts, and L.S. Jackson. 2004. Floristics of baygalls in central Louisiana. Phytologia 86:1–15.

Neitsch, C.L., K.L. Griffith, N.L. McCaleb, L.F. Matula, and D.E. McKay. 1982. Soil survey of Jasper and Newton counties, Texas. U.S.D.A. Soil Conservation Service, Washington, D.C.

Nesom, G.L., B.R. MacRoberts, and M.H. MacRoberts. 1997. A new community type in southeast Texas related to baygalls. Phytologia 83:371–383.

Nixon, E.S., N. Lewis, and J.D. Freeman. 1977. Trilliums in trouble. Texas Parks & Wildlife 15(1): 12–14.

Orzell, S.L. 1990. Texas Natural Heritage Program inventory of National Forests and National Grasslands in Texas. Unpublished report. Texas Parks and Wildlife, Austin.

Poole, J.M., J.R. Singhurst, D.M. Price, and W.R. Carr. 2004. A list of the rare plants of Texas. Texas Parks and Wildlife Department, Austin.

Singhurst, J.R. 1996. The status of nine endangered plants of east Texas: historical, ecological, and phytogeographical notes. M.S. Thesis, Stephen F. Austin State University, Nacogdoches.

Singhurst, J.R., E.S. Nixon, W.F. Caldwell, and W.C. Holmes. 2002. The genus *Trillium* (Liliaceae) in Texas. Castanea 67:316–323.

Teague, J. and T. Wendt. 1994. Caddo and Bossier parishes, Louisiana: Natural areas survey. Unpublished report, The Nature Conservancy, Baton Rouge.

Timmerman-Erskine, M., R.L. Dute, and R.S. Boyd. 2002a. Morphometric analysis of the *Trillium pusillum* Michaux complex (Trilliaceae) of the southeast United States. Castanea 67: 109–119.

Timmerman-Erskine, M., R.R. Dute, and R.S. Boyd. 2002b. The *Trillium pusillum* Michaux complex (Trilliaceae): Analysis of pollen and leaf epiderman micromorphology. J. Torrey Bot. Soc. 129:175–186.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Sida, Bot. Misc. 24: 1–888.

Turner, R.L., J.E. Van Kley, L.S. Smith, and R.E. Evans. 1999. Ecological classification system for the national forests and adjacent areas of the West Gulf Coastal Plain. The Nature Conservancy, Nacogdoches.

BOOK NOTICES

Blackwell Publishing

JIM L. BOWYER, RUBIN SHMULSKY, and JOHN G. HAYGREEN. Drawings by KAREN LILLEY. 2003. **Forest Products and Wood Science: An Introduction. Fourth Edition.** (ISBN 0-8138-2654-3, hbk.). Iowa State University Press, A Blackwell Publishing Company, 2121 State Avenue, Ames, IA, 50014, U.S.A. (**Orders:** 800-862-6657; 1-515-292-3348; www.blackwellprofessional.com). $69.99, 554 pp., b/w figures, graphs, tables, index, 7" × 10".

From the back cover:—"*Forest Products and Wood Science* provides a comprehensive overview of the anatomical and physical nature of wood and the relationship of these characteristics to its use as an industrial raw material."

Missouri Botanical Garden Press
Monographs in Systematic Botany

JAMES S. MILLER, MARY SUE TAYLOR, and ERIN REMPALA. 2005. **Ivan M. Johnston's Studies in the Boraginaceae.** (ISBN 1-930723-44-X; ISSN 0161-1542, pbk.). *Monographs in Systematic Botany from the Missouri Botanical Garden*, Vol. 101. Missouri Botanical Garden Press, P.O. Box 299. St. Louis, MO 63166-0299, U.S.A. (**Orders:** Missouri Botanical Garden Press, Dept. 46, PO Box 299, St. Louis, MO 63166-0299, U.S.A.; 877-271-1930; http://www.mbgpress.org/). $29.95, 132 pp., 7" × 10".

Ivan Johnston was the chief student of the borage family until his death in 1960. He published 200+ new taxa in Boraginaceae along with numerous new combinations, 13 of the 16 new genera described by him were borages. Among his 107 publications was a series of 31 journal articles entitled "Studies in the Boraginaceae." He also studied various other families, though with less intensity, and conducted floristic studies in South America, Central America, and Mexico—including long periods in the field.

Johnston began his botanical career as a high school student in southern California and continued there for an A.B. (1920 and M.A. (1922), then spent the next 38 years centered at Harvard, as a student (through 1925) and Research Associate and faculty member (1931–1960). From 1925 to 1931, he traveled, collected, and worked as an assistant in the Gray Herbarium.

The volume by Miller, Taylor, and Rempala presents various indexes and lists intended as a "tool for further monographic studies on the Boraginaceae." There is an interesting and nicely written botanico-biographical sketch and these:

* A catalog of the correspondence of IMJ
* An index to the botanical names treated in IMJ's "Studies in the Boraginaceae"
* Publications of IMJ
* Types of IMJ by binomial
* Types of IMJ by collector

—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

DICHANTHIUM (POACEAE) NEW TO ARIZONA: OPEN DOOR FOR A POTENTIALLY INVASIVE SPECIES

Richard Felger

Drylands Institute
PMB 405, 2509 N. Campbell Avenue
Tucson, Arizona 85719, U.S.A.

Tony L. Burgess

Institute of Environmental Studies
P.O. Box 298830
Texas Christian University
Ft. Worth, Texas 76129, U.S.A.

Samuel Dorsi

Department of Earth and Environmental Science
Columbia University, 2336 Lerner Hall
New York, New York 10027, U.S.A.

John R. Reeder

Herbarium, Herring Hall
University of Arizona
Tucson, Arizona 85721, U.S.A.

Thomas R. Van Devender

Arizona-Sonora Desert Museum
2021 North Kinney Road
Tucson, Arizona 85743, U.S.A.

ABSTRACT

Dichanthium annulatum has become locally established in southern Arizona and is a new generic record for the state. This tenacious perennial grass is a potentially invasive species of concern and we offer specimen-vouchered documentation for its *entrada* into Arizona. There are three, simultaneous, and independent routes for its spread.

RESUMEN

Dichanthium annulatum se ha establecido localmente en el Sur de Arizona y es una cita de un nuevo género para el estado. Esta gramínea perenne y tenaz, es una especie potencialmente invasora y ofrecemos documentación con especimenes testigo de su entrada en Arizona. Hay tres rutas simultáneas e independientes para su dispersión.

Three species of *Dichanthium*, a genus native to the Old World, have been introduced into North America as forage grasses and are established from Texas to Florida and in northern Mexico (Barkworth 2003), including Sonora: *D. annulatum* (Forsskal) Stapf, *D. aristatum* (Poir.) C.E. Hubb. (Reeder & Reeder 1998), and *D. sericeum* (R. Br.) A. Camus (Beetle & Johnston 1991). Ringed dichanthium, *D. annulatum*, is a highly variable species with a long history as a valued forage and fodder grass widely introduced in tropical and subtropical regions (Barkworth 2003; Bor 1960; Duke 1983; Reeder & Reeder 1998). It was "introduced for forage" and has become well established in thornscrub and tropical deciduous forest in southern Sonora (Reeder & Reeder 1998:504; they report it from 10 localities).

Ringed dichanthium was introduced into the Savanna Biome section inside the very large greenhouse/habitat of the Biosphere 2 near Oracle, AZ, shortly before the system was sealed in 1991 for a 2-year manned mission and then a 5-month and another 6-month mission. After the first two years people went in and out frequently. This wiry perennial is a tropical grass that is "widespread in India and Burma, and tropical and North Africa" (Bor 1960:133). It was selected for the Savanna Biome largely because it was not expected to survive the hard freezes in desert grassland at nearly 1220 meters elevation. It was grown from seeds obtained from CSIRO in Australia. Sometime after 1994, it escaped from the habitat and became established out-of-doors (Dorsi & Burgess 2003). After 1994 the Biosphere 2 campus was managed by Columbia University until they abandoned the project in summer 2004. Large numbers of people went in and out of the greenhouse prior to closure in 1991 and after it was reopened.

In 1995, Biosphere 2 was opened to tourists who passed through the Savanna area on a narrow, well-trodden trail. Tony Burgess, then a faculty member at the Biosphere 2 campus, first noted ringed dichanthium outside of the closed system in 2001. By 2003, a population of this grass had become locally established and was spreading rapidly (Dorsi & Burgess 2003). We speculate that the readily disarticulating spikelets or spikelet clusters with their long awns might have been carried outside inadvertently on shoes or clothing. During the first few years of partial opening people exiting the greenhouse had their shoe soles disinfected with Lysol for control of a nematode in the rainforest areas of the greenhouse but no control was done for pant legs, shoe tops nor socks.

The southern Sonora populations of ringed dichanthium, the only previously known ones from west of the continental divide in southwestern North America, occur in an essentially frost-free region about 620 km south of the Biosphere 2 locality. In southern Sonora and elsewhere this C-4 grass is reproductive with hot-season rains of summer and fall, and when it was introduced into the Biosphere 2 greenhouse it was presumed to be winter-spring dormant. The population sampled in June 2004 at Biosphere 2 had recently-disarticulated as well as fully-ripened spikelets, demonstrating that this species can be reproductive in late spring even at higher elevation. We also found that the plants in this population are tenaciously rooted in very hard, rocky soil and are very difficult to dig up.

In March 2005, Tom Van Devender and Ana Lilia Reina collected ringed dichanthium south of San Nicolás, Sonora, in tropical deciduous forest about 150 km north of the previous collections in the Alamos area (Reeder & Reeder 1998). It apparently was a recent arrival in 2005. They also found the grass in 2002 near Querobabi, about 380 km north of the previously known Sonora records in the non-desert southern part of the state. The northern Sonora population occurs in the Sonoran Desert in an area of presumed minimal winter-freezing. In 2004, Tom and Ana Lilia collected an unusual grass near the Pima County Fairgrounds at the southeastern edge of greater Tucson (about 65 km south of Biosphere 2) that John Reeder identified as *Dichanthium annulatum*. In April 2005, it was discovered in Nogales just north of the Sonora border. Both the fairground and Nogales experience moderate freezes.

Ringed dichanthium has been shown to be potentially invasive in a rather wide range of environments (e.g. Duke 1983). We predict ringed dichanthium will spread widely from the three presently known Arizona sites and at the time of this writing it is probably too late to control it effectively in Arizona except by immediate and concerted effort. The northern Sonora population is also likely to spread, even to southern Arizona only 150 km to the north. Thus this newly arrived non-native perennial grass has three potential and simultaneous routes of expansion in southern Arizona and could become a seriously invasive species.

Voucher specimens: *Dichanthium annulatum*. **U.S.A. ARIZONA. Pima Co.:** W side of Tucson Kart Speedway, just W of Houghton Road (south of I-10), S part of greater Tucson; creosotebush desertscrub; 32°02'02"N, 110°47'12"W; 938 m elevation; locally abundant perennial in dense patch in roadside ditch, 21 Sep 2004, *T.R. Van Devender 2004-1093 & A.L. Reina G.* (ARIZ, ASDM, ASU, NMC, TEX) **Pinal Co.:** Columbia University Biosphere 2 Campus, E side of access road W of Biosphere 2 Savanna Biome, 32°34.692'N, 110°50.963'W, NAD 27, grass 80 cm tall, growing near roadway in elongated patch, 25 Sep 2003, *S. Dorsi 1 & T.L. Burgess* (ARIZ, MO, NMCR, SD, TEX, UC, US); N of Biosphere 2 Rainforest Biome, 32°34.762'N, 110°50.966'W, NAD 27, grass 60 cm tall, growing in *Dichanthium* dominated patch along railing in landscaped area with a tendency to collect runoff, 25 Sep 2003, *S. Dorsi 2 & T.L. Burgess* (ARIZ); W side of access road W of Biosphere 2 Savanna Biome, 32°34.692'N, 110°50.963' W, NAD 27, grass 50 cm tall, growing along roadway as single isolated plants, *S. Dorsi 5 & T.L. Burgess*, 25 Sep 2003 (BRIT); handicap ramp west of Biosphere 2 Savanna Biome near Savanna airlock, 32°34.701'N, 110°51.034'W, NAD 27, grass 60 cm tall, growing along walkway in dispersed patches and coexisting with other grasses, 25 Sep 2003, *S. Dorsi 4 & T.L. Burgess* (USON); Biosphere 2 Campus, W of Oracle, above Cañada del Oro, 70 m E of desert biome of Biosphere 2 structure (also another small colony about 200 m to the E), ca. 3950 ft, roadside and also adjacent semi-landscaped area, ruderal landscape, rocky grassland with some shrubs; perennial with hard, knotty bases, 6 Jun 2004, *R.S. Felger 04-2, T.L. Burgess & S. Schneider* (ARIZ, ASU, RSA). **Santa Cruz Co.:** Fiesta Market on Mariposa Road, Nogales, 31°21'25"N 110°57'27"W; 1194 m elevation; common perennial on edge of pavement, 27 Apr 2005, *T.R. Van Devender 2005-731, A.L. Reina G.* (ARIZ, ASC, CAS, MEXU, NMC, TEX, US, USON). **MEXICO. Sonora: Municipio de Opodepe:** 2.6 km W of Querobabi; Plains of Sonora desertscrub; 30°03'14"N 110°03'31"W; 690 m elevation; uncommon perennial on roadside; 21 Aug 2001, *T.R. Van Devender 2001-734 & A.L. Reina G.* (ARIZ, USON). **Municipio de Yécora**: Road to La Quema on SON 117, 1.8 km S of San Nicolás junction with MEX 16; tropical deciduous forest; 28°22'11"N 109°15'42"W; 558 m elevation; locally abundant perennial on roadside, 18 Mar 2005, *T.R. Van Devender 2005-389 & A.L. Reina G.* (ARIZ, ASU, MEXU).

REFERENCES

BARKWORTH, M.E. 2003. *Dichanthium* Willemet. In: Flora of North America Editorial Committee. Flora of North America North of Mexico, vol. 25. Oxford University Press, New York. Pp. 637–638.

BEETLE, A.A. and D. JOHNSON. 1991. Gramíneas de Sonora. Gobierno del Estado de Sonora, Secretaría de Fomento Ganadero. Hermosillo, Sonora.

Bor, N.L. 1960. The grasses of Burma, Ceylon, India and Pakistan (excluding Bambuseae). Pergamon Press, New York.

de Wet, J.M.J. and J.R. Harlan. 1968. Taxonomy of *Dichanthium* section *Dichanthium* (Gramineae). Bol. Soc. Argentina Bot. 12:206–227.

de Wet, J.M.J. and J.R. Harlan. 1970. Apomixis, polyploidy and speciation in *Dichanthium*. Evolution 24:270–277.

Dorsi, S. and T. Burgess. 2003. Spread of the exotic grass *Dichanthium annulatum* (Forssk.) Stapf at the Biosphere 2 Center, Oracle, Arizona. Unpublished manuscript, on deposit at ARIZ.

Duke, J.A. 1983. Handbook of energy crops, unpublished. www.hort.purdue.edu/newcrop/duke_energy/Dichanthium_annulatum.html (accessed February 17, 2005).

Reeder, J.R. and C.G. Reeder. 1998. Poaceae. In: P.S. Martin, D. Yetman, M. Fishbein, P. Jenkins, T.R. Van Devender, and R.K. Van Devender, eds. Gentry's Río Mayo Plants. University of Arizona Press, Tucson. Pp. 498–520.

STATE RECORDS AND OTHER NOTEWORTHY COLLECTIONS FOR KENTUCKY

Ross C. Clark, Ronald L. Jones and Timothy J. Weckman

Department of Biological Sciences
Eastern Kentucky University
Richmond, Kentucky 40475, U.S.A.
ross.clark@eku.edu

Ralph L. Thompson

Department of Biology
Berea College
Berea, Kentucky 40404, U.S.A

John W. Thieret

Department of Biological Sciences
Northern Kentucky University
Highland Heights, Kentucky 41099, U.S.A

Kentucky State Nature Preserves Commission

801 Schenkel Lane
Frankfort, Kentucky 40601, U.S.A.

Kim Feeman

Department of Biological
and Environmental Sciences
Morehead State University
Morehead, Kentucky 40351, U.S.A.

ABSTRACT

Twenty-four species or varieties of vascular plants, all native to or naturalized in the southeastern U.S.A., are reported as new or noteworthy for Kentucky. Fourteen of these are native and ten are non-native. Fifteen of the taxa are reported as state records, and the accounts for the other nine taxa provide clarifications or updates on their status in the state. Taxa reported as state records are: *Acanthopanax sieboldianus, Callicarpa dichotoma, Castanea sativa, Cladium mariscoides, Hydrocotyle ranunculoides, Ilex cornuta, Ipomoea quamoclit, Ipomoea turbinata, Lonicera* × *minutiflora, Lonicera xylosteum, Magnolia grandiflora, Quercus texana, Ribes americanum, Salix cinerea* subsp. *oleifolia*, and *Symphyotrichum divaricatum*.

RESUMEN

Se citan veinticuatro especies o variedades de plantas vasculares, todas nativas o naturalizadas en el Sureste de U.S.A., como nuevas o notables para Kentucky. Catorce de ellas son nativas y diez son introducidas. Quince de los taxa son citados como nuevos para el estado, y de otros nueve se hacen aclaraciones o puestas al día de su estatus en el estado. Los taxa citados como nuevos para el estado son: *Acanthopanax sieboldianus, Callicarpa dichotoma, Castanea sativa, Cladium mariscoides, Hydrocotyle ranunculoides, Ilex cornuta, Ipomoea quamoclit, Ipomoea turbinata, Lonicera* × *minutiflora, Lonicera xylosteum, Magnolia grandiflora, Quercus texana, Ribes americanum, Salix cinerea* subsp. *oleifolia*, y *Symphyotrichum divaricatum*.

INTRODUCTION

Recent field and herbarium work has resulted in the discovery of 24 species of native and naturalized flowering plants new or noteworthy for Kentucky. These findings update occurrences and distributions as reported by Beal and Thieret (1986), Browne and Athey (1992), Medley (1993), and Jones (2005). Kentucky rarity status—Special Concern, Threatened, Endangered, or Historical—is based on lists published by Kentucky State Nature Preserves Commission (KSNPC 2000, 2001). Nomenclature, as well as abbreviations for physiographic regions (**AP**—Appalachian Plateaus, **IP**—Interior Low Plateaus, **ME**—Mississippi Embayment), are based on Jones (2005), and herbarium abbreviations follow Holmgren et al. (1990). State distributions in the United States are based on USDA, NRCS (2004). Many of these records have resulted from an on-going statewide survey of woody plants by R.C. Clark, and also from analyses by R.C. Clark and R.L. Jones of recent additions to EKY of major sets of collections from E.T. Browne, H.R. Athey, and M.E. Wharton. Additional records have resulted from recent field work by staff of the KSNPC and other authors listed above.

TAXA NEW OR NOTEWORTHY FOR KENTUCKY

Acanthopanax sieboldianus Makino [*Eleutherococcus pentaphyllus* (Siebold & Zucc.) Nakai] (Araliaceae). Previous reports of fiveleaf aralia were based on specimens persistent after cultivation (Medley 1993). This species has been documented as an escape in Utah, Ohio, West Virginia, Pennsylvania, and in a few states in New England. It was included in Jones (2005) only as a brief note under the family account. The following records from the n. IP of Kentucky are from plants escaped from cultivation.

Voucher specimens. **Grant Co.:** roadside thicket near Zion Station, 7 Jun 1994, *Thieret & Buddell 57455* (KNK). **Jefferson Co.:** woodland edge, Jefferson Hill Rd, ca. 2 mi SW of jct Key's Ferry Road, 1 Jun 1994, *Medley 20021-94* (KNK).

Acer floridanum (Chapm.) Pax (Aceraceae). There has been disagreement on the existence of the Florida maple (or southern sugar maple) in Kentucky. It was accepted by Browne and Athey (1992), rejected by Gueitg and Jones (1991) and Medley (1993), but included as *A. barbatum* Michx. by Jones (2005). Ward (2004) concluded that the Michaux name, *A. barbatum*, was originally linked to specimens of *A. saccharum*, and therefore cannot be used for the Florida maple. The taxon is known from all contiguous states except Indiana, Ohio, and West Virginia. Most of the following records are from the ME of Kentucky.

Voucher specimens: **Butler Co.:** woods along KY 105, 3.8 mi W of Grayson Co. line, 8 Jul 1963, *Browne & Browne 7556* (KY) **Calloway Co.:** Hancock Biological Station, Murray State University, mesic upland oak-hickory forest, 14 Jun 1998, *Thompson 98-162* (BEREA). **Carlisle Co.:** loess bluffs on road off KY 62 to Beech Grove Church Rd, 13 May 1971, *Browne & Browne 71E13.1* (EKY, MDKY). **Fulton Co.:** lower slopes of loess bluffs, 8 Oct 1986, *Campbell s.n* (KY). **Graves Co.:** KY 1763, 1.5 mi W of jct U.S. 45, deciduous woods, 27 Jun 1973, *Browne et al. 73D11* (EKY). **Hickman Co.:** oak-hickory woods, base of loess bluffs, 21 Jul 1995, *Weckman & Rozeman 1758* (EKY). **Marshall Co.:** woods along KY 80, 1.8 mi E Graves Co. line, 12 May 1963, *Browne & Browne 7046* (KY). **Owen Co.:** upland woods near Kentucky River off KY 355, 2 Jun 1996, *Weckman et al. 2815* (EKY).

Callicarpa dichotoma (Lour.) K. Koch (Verbenaceae). The purple beautybush, a native of China and Japan, was previously known as an escape only in North and South Carolina, Tennessee, and Virginia. This report from the n. IP is the first for Kentucky.

Voucher specimen: **Madison Co.:** adventive at woodland edge in Hilltop Acres Subdivision, ca. 6 mi W of Richmond, 4 Oct 2004, *Clark 25570* (EKY).

Castanea sativa Mill. (Fagaceae). Spanish chestnut, native in western Asia, has previously been documented for Alabama, Pennsylvania, and several New England states. It has not been reported in previous literature as naturalized in Kentucky. The following specimens from the AP and IP were determined by R.C. Clark.

Voucher specimens: **Fleming Co.:** swamp forest near Plummer's Landing, 15 Sep 1974, *Meijer s.n.* (KY). **McCreary Co.:** near Whitley City, Summer, 1989, *Campbell s.n.* (KY).

Cladium mariscoides (Muhl.) Torr. (Cyperaceae). Smooth sawgrass is known from all surrounding states except West Virginia and Missouri. It has been reported from Kentucky (see Beal & Thieret 1986) but no previous vouchers are known, and it was not included in Jones (2005). This recent collection from the ne. IP now confirms the presence of this sedge in Kentucky.

Voucher specimen: **Bath Co.:** shallow drainage ditch of wooded wetlands, Hog Hollow drainage of Licking River just SW of Cave Run Dam, elevation 820 ft, 23 Nov 2004, *Feeman s.n.* (MDKY).

Cornus sericea L. [*C. stolonifera* Michx.] (Cornaceae). Red-osier dogwood is known from all contiguous states (except Missouri) to the east, north, and west of Kentucky. The species was accepted for Kentucky by Browne and Athey (1992), but rejected by Medley (1993), and considered a species of questionable documentation by Jones (2005). The following specimens determined by R.C. Clark document the presence of red-osier dogwood in the AP and IP of Kentucky.

Voucher specimens: **Henry Co.:** no locality, 23 Aug 1910, *Garman s.n.* (KY). **Wolfe Co.:** oak-pine woods, along trail to Sky Bridge; single clone of 4 stems, 4 Oct 2004, *Clark 25569* (EKY).

Drosera intermedia Hayne (Droseraceae). Narrow-leaved sundew has been documented from most of the eastern United States, but is known in Kentucky only from specimens collected in the 1800s (see Beal & Thieret 1986 and Medley 1993), and considered Historical in the most recent listings by the KSNPC (2000, 2001). It was recently rediscovered in the s. IP of the state by the KSNPC, in wet, heavily disturbed woodland openings.

Voucher: a digital image deposited at EKY: **Russell Co.:** several hundred plants observed in ruts of wet fields in bush-hogged (previously bulldozed) openings of flatwoods, plants still persistent the following summer, ca. 3 miles N of Russell Springs, on farm along Berry Road, 23 Jul 2003, *Hines & Drozda s. n.* (EKY).

Hydrocotyle ranunculoides L.f. (Apiaceae). Buttercup pennywort has been documented from all contiguous states except Indiana and Missouri. It was not listed by Beal & Thieret (1986), Browne and Athey (1992), or Medley (1993), but was included in Jones (2005), based on the following voucher collected in the far western portion of the ME.

Voucher specimen: **Graves Co.:** Terrapin Creek Nature Preserve, edge of large marsh, forming floating mats, 3 Jul 2003, *White s.n.* (EKY).

Ilex cornuta Lindl. & Paxton (Aquifoliaceae). Chinese holly has previously been reported as an escape only in Alabama and North Carolina, and has not been listed in earlier publications on the Kentucky flora. This collection is from the n. IP.

Voucher specimen. **Madison Co.:** several plants escaping on campus of Eastern Kentucky University, behind Keith Hall, 4 Oct 2004, *Clark 25571* (EKY).

Ipomoea quamoclit L. (Convolvulaceae). Cypressvine is native to tropical America, and is known to escape in all states surrounding Kentucky except Indiana, Ohio, and West Virginia. Medley (1993) rejected this taxon from the Kentucky flora, and it was treated as a "to be expected" species in Jones (2005). This collection is from the n. IP.

Voucher specimen: **Madison Co.:** twining on *Helianthus annuus* in a landfill off South Dogwood Drive and KY 21, Berea, where the species has persisted for two years, 30 Aug 2003, *Thompson & FitzGerald 04-1264* (BEREA).

Ipomoea turbinata Lag. (Convolvulaceae). Purple moonflower, a native of India, has been reported as an escape from most southern states (North Carolina to Texas to Arkansas, except for Alabama and Tennessee). This collection from the far western portion of the ME is a considerable range extension, and is the northernmost record. It was not observed at the site in a follow-up visit in summer, 2003 (M.J. McWhirter, pers. comm.).

Voucher specimen: **Hickman Co.:** Wolf Island, in open field, a cottonwood plantation in bottomland of Mississippi River, Jul 2002, *McWhirter s.n.* (EKY). Determination by R.L. Jones, verified by D.F. Austin, Arizona-Sonora Desert Museum.

Lonicera ×minutiflora Zabel [*Lonicera ×muendeniensis* Rehder] (Caprifoliaceae) This taxon has a complex hybrid origin, and has previously been documented only in Illinois, Indiana, Michigan, and Wisconsin. This collection determined by R.C. Clark is from the n. IP of Kentucky.

Voucher specimen: **Woodford Co.:** along railroad tracks, near U.S. 60 bypass at 2nd railroad crossing W of Lexington-Versailles Pike, 11 May 1962, *Browne & Browne 5176* (EKY).

Lonicera xylosteum L. (Caprifoliaceae). European fly honeysuckle is known from all contiguous states except West Virginia and Tennessee. It was not listed for Kentucky by Browne and Athey (1992), rejected by Medley (1993), but was included in Jones (2005) on the basis of inaccurate specimen determinations.

Voucher specimen: **Laurel Co.:** uplands of Rock Creek Gorge, ruderal community near white pine stand, 4 Jul 1989, *Thompson & Skeese 89-1425* (EKY).

Magnolia grandiflora L. (Magnoliaceae). Southern magnolia occurs across the Coastal Plain from North Carolina to east Texas, north to Arkansas, Tennessee, and Virginia. It is not native to Kentucky, and both Browne & Athey (1992) and Medley (1993) rejected it as occurring outside of cultivation in the state. Specimens listed below document the first spontaneous establishment of *Magnolia grandiflora* in Kentucky. It was included in Jones (2005) as a rare adventive on the basis of these vouchers. The collections are from the ME and the n. IP. A similar distribution pattern has been documented in Tennessee (Chester et al. 1997). Both sites in Kentucky were similar, remnant woodlands with poorly drained, acidic soils, adjacent to urban areas.

Voucher specimens: **McCracken Co.:** single individual in disturbed oak woods and intermittent drainage below baseball field, Paducah Community College, 5 Nov 1994, *Weckman & Weckman 1190* (EKY). **Madison Co.:** low remnant pin oak-red maple woodlot, between KY 595 and Rash Rd, just N of Berea, 23 Jan 1999, *Weckman et al. 4527* (EKY).

Nyssa biflora Walter (Nyssaceae). Swamp tupelo occurs in all contiguous states except Indiana, Ohio, and West Virginia. It was accepted by Browne and Athey (1992), rejected by Medley (1993), and treated as a questionable taxon by Jones (2005). It has now been verified by R.C. Clark for several counties in the ME and IP of Kentucky.

Voucher specimens: **Calloway Co.:** flatwoods on Tobacco Road near Murray, 11 Jul 1996, *Campbell s.n.* (KY). **Cumberland Co.:** low ground near Cloyd's Landing, 2 Oct 1999, *Clark 25351* (EKY). **Fleming Co.:** low ground along Big Run Creek, 0.3 mi N of jct KY 1013, 19 Jul 1999, *Clark & Bauer 25226* (EKY). **Livingston Co.:** 1.2 mi E of Ledbetter, 2.2 mi NE of Tennessee River bridge, 24 Mar 1972, *Wilson s.n.* (MUR). **Marshall Co.:** Sledd Creek embayment, S of KY 641, ca. 2 mi W of Kentucky Dam, shoreline, 30 May 1989, *Grubbs 1437* (MUR) and **Rockcastle Co.:** bank of Copper Creek, 15 Jun 1938, *Wharton 2691* (KY).

Populus balsamifera L. (Salicaceae). Balsam poplar is native to mesic woods of northeastern North America, and has been documented in all contiguous states to Kentucky except Tennessee and Missouri. There long has been confusion about whether this species occurs naturally in Kentucky. Medley (1993) was of the opinion that previous reports of the plants in Kentucky should be referred to *P.* × *jackii* Sargent, a hybrid between *P. balsamifera* L. and *P. deltoides* W. Bartram ex Marshall. Some specimens have been referred to *Populus* × *gileadensis* Rouleau (Balm-of-Gilead poplar), but this taxon is known to be a pistillate clone (Hardin et al. 2001), and several of the cited specimens have staminate catkins. These collections, all verified by R.C. Clark, document the species in both the AP and IP of Kentucky.

Voucher specimens: **Carter Co.:** KY 182, 5.9 mi W of jct U.S. 60, flood plain, 30 Jul 1965, *Browne & Browne 10978* (EKY). **Casey Co.:** Turkey Creek Road, 6 May 1962, *Murphy & Browne 413* (KY). **Lee Co.:** Beartrack, 8 Sep 1974, *Black 10* (KY). **Letcher Co.:** old strip mine area, 0.6 mi from Virginia border, near Eolia, 4 Oct 1978, *Hannan & Phillippe KEP-01-017-00637* (EKY). **Menifee Co.:** bench above Wolfpen Creek, ca. 1 mi N of KY 715, 6 Sep 1989, *Clark & Taylor 22338* (EKY). **Powell Co.:** Anders Branch, 1 May 1993, *Campbell s.n.* (KY).

Potamogeton amplifolius Tuck. (Potamogetonaceae). Largeleaf pondweed is known from most eastern states. Medley (1993) noted that the species was collected in Kentucky in the mid-1800s by C.W. Short, but that it was likely later extirpated. It was included in Jones (2005), based on the following voucher collected by the KSNPC from the s. IP.

Voucher specimen: **Pulaski Co.:** submersed in stream over a 2 × 3 meter area, in Buck Creek near Reynold Hollow, 10 Aug 1999, *White & Fields s.n.* (KNK). Verified by J.W. Thieret.

Prenanthes racemosa Michx. (Asteraceae). Purple rattlesnakeroot is known from most northeastern and northcentral states. The only record of this species in Kentucky was a historical collection from Pendleton County, and the species was considered to be extirpated in the state by Medley (1993). It was listed as "to be expected" in Jones (2005), and the following recent collection by the KSNPC from the n. AP reaffirms its presence in Kentucky.

Voucher specimen: **Lewis Co.:** siltstone/calcareous shale glade, in Crooked Creek Barrens State Nature Preserve, 27 Sep 2004, *Hines & Evans s. n.* (EKY).

Quercus nigra L. (Fagaceae). There have been persistent reports of water oak in Kentucky. Browne and Athey (1992) accepted the species, based on reports from the 19th century. Medley (1993) questioned many of the records, suggesting that some were based on misidentifications or were from trees in cultivation. The species has now been firmly documented from the s. IP by the KSNPC, and other records confirm the ability of the species to naturalize in the ME of Kentucky. The native range of the species in south-central U.S. now includes Kentucky and all contiguous states except Indiana, Ohio, and West Virginia.

Voucher specimens: **Wayne Co.:** large tree on edge of bottomland in Meadow Creek Swamp, S of KY 90, 14 Jul 2000, *Hardin et al. s.n.* (EKY).

Quercus texana Buckley (Fagaceae). Nuttall's oak was not accepted as a member of Kentucky's flora by Browne and Athey (1992) or by Medley (1993). It was included in Jones (2005), based on the following voucher from the ME. It is also known from adjacent Tennessee, Missouri, and Illinois.

Voucher specimen. **Calloway Co.:** common along trail, end of gravel road off KY 444, seeps into Blood River, N of New Concord, 22 Jul 1995, *Weckman & Rozeman 1778* (EKY).

Ribes americanum Mill. (Grossulariaceae). Wild black currant grows from Montana to New England to Missouri, Illinois, Indiana, Ohio, West Virginia, and Virginia. It was not accepted by Browne and Athey (1992) or by Medley (1993). It was included in Jones (2005), based on the following collections from the AP and n. IP.

Voucher specimens. **Lee Co.:** mixed woods, S-facing ravine of Walker Creek, 27 Apr 1996, *Kirk & Clark 41* (EKY). **Madison Co.:** bottomland forest, Bluegrass Army Depot, 14 Jul 1993, *Libby & Mears OB-526* (EKY).

Rosa virginiana Mill. (Rosaceae). Virginia rose has been documented from all states contiguous to Kentucky except Indiana, Ohio, and West Virginia. It was accepted by Browne and Athey (1992), rejected by Medley (1993), and treated as a taxon of unknown status by Jones (2005). The following collections from the AP and IP have now been verified for Kentucky by R.C. Clark.

Voucher specimens: **Harrison Co.:** upland pasture and woodlots, W of Dividing Ridge Road and N of KY 32, 7 Jun 1999, *Clark & Bauer 24680* (EKY). **Menifee Co.:** KY 77, roadside, 0.25 mi from iron bridge, 9 Jul 1969, *Higgins 1618* (KY). **Mercer Co.:** woodland edges between Shakertown and High Bridge, 23 Jul 1955, *Wharton 9217* (KY). **Rowan Co.:** KY 174, 0. 6 mi W of Haldeman P.O., fallow land, 28 Jun 1965, *Browne & Browne 10492* (EKY).

Salix cinerea L. subsp. **oleifolia** (Sm.) Macreight (Salicaceae). Large gray willow, a native of the Mediterranean region, is known to escape in the eastern United States, and has previously been documented from North Carolina, Pennsylvania, New York, Massachusetts, and Maine. Earlier reports of this species in Kentucky were based on specimens from cultivated plants (Argus 1986), and it was not included in Jones (2005). This collection from the ME is therefore the first documentation of the species in Kentucky.

Voucher specimen: **Hickman Co.:** N on Old Milburn Road, E on new logging road to Obion Creek, slough, 23 Aug 1988, *Grubbs 1226* (MUR). Determined by R.C. Clark.

Symphyotrichum divaricatum (Nutt.) G.L. Nesom [*Aster subulatus* Michx. var. *ligulatus* Shinners] (Asteraceae). Southern annual saltmarsh aster was previously known from most southern and midwestern states, including adjacent Tennessee and Missouri, but has not been reported in previous literature on the Kentucky flora. It was known from adjacent counties (Lake and Obion) in the Reelfoot Lake region of Tennessee (Chester et al. 1997). This species was discovered in Kentucky during an Eastern Kentucky University class trip to western Tennessee and Kentucky. The plants were first observed by two students, Amy V. McIntosh and James Storm, who noted the plants growing along a roadside just north of the upper reaches of Reelfoot Lake. This discovery from the ME came too late for inclusion in Jones (2005), where it was treated as "to be expected."

Voucher specimen: **Fulton Co.:** open wet fields, along KY 1282, at jct gravel road, 2.7 mi W of jct KY 311, 2 Oct 2004, *Bio 525/725 class collection # 45* (EKY).

ACKNOWLEDGMENTS

The authors wish to thank Robert Paratley (KY) and an anonymous reviewer whose helpful comments improved the manuscript.

REFERENCES

Argus, G. 1986. The genus *Salix* (Salicaceae) in the southeastern United States. Syst. Bot. Monogr. 9:1–170.

Beal, E.O. and J.W. Thieret. 1986. Aquatic and wetland plants of Kentucky. Kentucky Nature Preserves Commission, Scientific and Technical Series, Number 5, Frankfort.

Browne, E.T., Jr. and R. Athey. 1992. Vascular plants of Kentucky: an annotated checklist. University Press of Kentucky, Lexington.

Chester, E.W., B.E. Wofford, and R. Kral. 1997. Atlas of Tennessee vascular plants. Vol. 2. Misc.

Publ. No. 13. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee.

Hardin, J.W., D.J. Leopold, and F.M. White. Harlow & Harrar's textbook of dendrology. McGraw-Hill, New York, NY.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett (eds.). 1990. Index herbariorum. Part I: The herbaria of the world, 8th ed. New York Botanical Garden, Bronx, NY.

Jones, R.L. 2005. Plant life of Kentucky, an illustrated guide to the vascular flora. University Press of Kentucky, Lexington.

[KSNPC] Kentucky State Nature Preserves Commission. 2000. Rare and extirpated biota of Kentucky. J. Kentucky Acad. Sci. 61:115–132.

[KSNPC] Kentucky State Nature Preserves Commission. 2001. Rare and extirpated biota of Kentucky: 2001 update. J. Kentucky Acad. Sci. 62:145–146.

Medley, M.E. 1993. An annotated catalog of the known or reported vascular flora of Kentucky. Ph.D. dissertation, University of Louisville, Louisville, Kentucky.

REDISCOVERY OF *PONTHIEVA BRITTONIAE* (ORCHIDACEAE) IN EVERGLADES NATIONAL PARK[1]

Jimi L. Sadle, Steven W. Woodmansee,
George D. Gann

The Institute for Regional Conservation
22601 SW 152 Ave.
Miami, Florida 33170, U.S.A.
sadle@regionalconservation.org

Thomas V. Armentano

South Florida Natural Resources Center
South Florida Ecosystem Office
950 N. Krome Ave.
Homestead, Florida 33030, U.S.A.

ABSTRACT

The rediscovery of *Ponthieva brittoniae* is reported. The two populations found in Everglades National Park, Miami-Dade County, Florida, represent the only plants currently known from the United States.

RESUMEN

Se cita el redescubrimiento de *Ponthieva brittoniae*. Las dos poblaciones encontradas en el Parque Nacional de los Everglades, en el condado de Miami-Dade, estado de Florida, representan actualmente las únicas plantas conocidas de los Estados Unidos.

Reports of *Ponthieva brittoniae* Ames in the United States have been few since its initial discovery. This species was first collected in southern Florida by botanists J.K. Small and J.J. Carter. Plants were collected in 1909 near Perrine, Florida, and in the Long Pine Key area of what is now Everglades National Park. Fifty-two years later, F.C. Craighead Sr. made a collection in the eastern portion of Long Pine Key near Osteen Hammock. The next report of *P. brittoniae* was made by R.L. Hammer, who found a population of plants growing along a firebreak road in central Long Pine Key in 1979 (McCartney 1997; Gann et al. 2002). Plants persisted along the road until 1986, when the re-grading of the firebreak is thought to have destroyed them. The last recorded sighting of *P. brittoniae* in the United States occurred in 1987 when a single plant was observed in a solution hole by Chuck McCartney northeast of the Hammer station (McCartney 1997). Since then, multiple searches of the historical locations in Everglades National Park have been carried out by Hammer, McCartney, staff of The Institute for Regional Conservation (IRC) and others. The failure of these efforts to locate plants resulted in the listing of this species as "Historical" in South Florida by IRC (Gann et al. 2002). Currently, *P. brittoniae* is listed as endangered by the state of Florida and critically imperiled by Florida Natural Areas Inventory (Chafin et al. 2000).

---

[1] **Disclaimer**: "The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government."

SIDA 21(3): 1917–1920. 2005

Although *Ponthieva brittoniae* has been reported for two other Florida counties, Brown (2002) identified these populations as the closely related *P. racemosa* (Walter) Mohr. These two species closely resemble one another but can be distinguished on the basis of sepal and labellum shape (Sauleda & Adams 1980). In addition, *P. racemosa* has petals with green striping while *P. brittoniae* does not. The leaves of *P. racemosa* are present at anthesis while the leaves of *P. brittoniae* are usually absent at anthesis (Luer 1972).

Outside of Florida, *Ponthieva brittoniae* is known from the Bahamas (Ackerman 2002), the Turks and Caicos Islands (J.L. Sadle, unpublished), Cuba (Correll & Correll 1982; Nir 2000) and Hispaniola (J.D. Ackerman, pers. comm.). The current status of this species in the Bahamas is unknown, but it has been reported from New Providence and Andros Island. Pine rockland is still present and protected in some areas on both islands. However, the decline of other pine rockland species on New Providence has been attributed to land clearing (Bahamas Environment Technology and Science Commission 1999). In the Turks and Caicos, plants are known from a single, small, protected population on North Caicos Island. The status of *P. brittoniae* in Cuba and Hispaniola is uncertain. This species is considered to be rare and threatened throughout its range (J.D. Ackerman, pers. comm.).

While conducting rare plant surveys as part of the Critical Ecosystems Study Initiative (CESI) in the Long Pine Key region of Everglades National Park, two populations of *Ponthieva brittoniae* were encountered. The first, initially seen in December 2003, was located in the vicinity of where the last plant was seen in 1987. The site was revisited several times between December and February and 102 plants were observed. These plants undoubtedly represent the population last seen by McCartney. The second population, discovered in January 2004, was located approximately 2 km southwest of the original site. In this population, 139 plants were observed. Of the 241 plants, 72 were flowering.

Populations were found in open pine rockland characterized by exposed limestone substrate with extensive solution holes and minimal leaf litter. The majority of the plants were growing on the vertical walls of solution holes within 0.5m of the pineland's exposed limestone surface. A few plants were found in soil filled cracks on limestone surfaces of the limestone and a single plant was observed growing between a downed log and limestone. Prescribed fires had been carried out in both locations between 2003 and 2004.

In an effort to characterize the habitat of this species, three 5m radius plots were centered on solution holes in which *Ponthieva brittoniae* was growing. Plots were located in both populations. A total of 73 species of flowering plants were recorded in the plots. Associated species found within the solution holes of all plots were *Anemia adiantifolia* (L.) Sw., *Bletia purpurea* (Lam.) DC., *Eupatorium leptophyllum* DC., *Metopium toxiferum* (L.) Krug & Urb., *Mikania* *scandens* (L.) Willd., *Mitreola sessilifolia* (J.F. Gmel.) G. Don, *Phyllanthus pentaphyllus* C. Wright ex Griseb. var. *floridanus* G.L. Webster, *Polygala grandiflora* Walt., *Pteris bahamensis* (J.G. Agardh) Fée, *Samolus ebracteatus* Kunth and *Sideroxylon salicifolium* (L.) Lam. Species growing on the upland portions of all three plots were *Anemia adiantifolia*, *Echites umbellata* Jacq., *Guapira discolor* (Spreng.) E.L. Little Jr., *Ilex cassine* L., *Jacquemontia curtisii* Peter ex Small, *Mikania scandens*, *Myrica cerifera* L., *Passiflora suberosa* L., *Phyllanthus pentaphyllus* var. *floridanus*, *Physalis walteri* Nutt., *Pteris bahamensis*, *Rapanea punctata* (Lam.) Lundell, *Sabal palmetto* (Walt.) Lodd. ex J.A. & J.H. Schultes, *Samolus ebracteatus*, *Schizachyrium gracile* (Spreng.) Nash and *Tetrazygia bicolor* (P. Mill.) Cogn.

Voucher Specimen: **FLORIDA. Miami-Dade Co.:** Everglades National Park, Long Pine Key, S of Winkley Hammock; in recently burned, previously fire suppressed pine rockland, in solution hole 30 cm from top on vertical face; collected with Everglades National Park permit #EVER-2003-SCI-0084 and Florida Department of Agriculture and Consumer Services Regulated Plant Index Harvesting Permit #561,10 Feb 2004, *Sadle 396* (EVER).

ACKNOWLEDGMENTS

The authors thank Chuck McCartney, J.D. Ackerman and Roger L. Hammer for providing information, comments and inspiration. Bryan Naqqi Manco, the Turks and Caicos National Trust and the United Kingdom Overseas Territories Conservation Forum provided financial and logistical support for work conducted in the Turks and Caicos Islands. Barbara S. Carlsward, David L. Martin and an anonymous reviewer provided useful comments on this manuscript. Fairchild Tropical Botanic Garden (FTG) and New York Botanical Garden (NY) provided information on herbarium specimens and label data. Funding for the project that led to this rediscovery was provided by the Critical Ecosystems Study Initiative of the U.S. Department of the Interior through Cooperative Agreement #H5284-03-0044, Rare Plant Monitoring and Restoration on Long Pine Key, Everglades National Park, G.D. Gann and T.V. Armentano, principal investigators.

REFERENCES

Ackerman, J.D. 2002. *Ponthieva*. In: Flora of North America Editorial Committee, eds. Fl. North Amer. 26:547–549. Oxford Univ. Press, New York and Oxford.

Bahamas Environment Technology and Science Commission. 1999. The Commonwealth of the Bahamas National Biodiversity Strategy and Action Plan. Published online by the Convention on Biological Diversity, United Nations Environment Programme www.biodiv.org/doc/world/bs/bs-nbsap-01-en.pdf

Brown, P.M. 2002. Wild orchids of Florida. University Press of Florida. Gainesville.

Chafin, L.G., J.C.P. Hancock, and G. Nelson. 2000. Field guide to the rare plants of Florida. Florida Natural Areas Inventory. Tallahassee, FL.

Correll, D.S. and H.B. Correll. 1982. Flora of the Bahama Archipelago (including the Turks and Caicos Islands). A.R.G. Gantner Verlag, Vaduz.

Gann, G.D., K.A. Bradley, and S.W. Woodmansee. 2002. Rare plants of South Florida: their history, conservation, and restoration. Institute for Regional Conservation. Miami, FL.

Luer, C.A. 1972. The native orchids of Florida. New York Botanical Garden, Bronx.

McCartney, C.L. 1997. Mrs. Britton's shadow witch, *Ponthieva brittoniae*. Palmetto 17:10–11.

Nir, M.A. 2000. Orchidaceae Antillanae. DAG Media Publishing, Inc., NY.

Sauleda, R.P. and R.M. Adams. 1980. The taxonomic status of *Ponthieva brittonae* Ames (Orchidaceae). Bull. Torrey Bot. Club 107:544–545.

QUERCUS MONTANA (FAGACEAE), NEW TO MISSOURI

Marian Smith
Southern Illinois University
Edwardsville, Illinois 62026, U.S.A.
msmith@siue.edu

Nancy Parker
Southern Illinois University
Edwardsville, Illinois 62026, U.S.A.
njrparker@charter.net

ABSTRACT

Quercus montana (Fagaceae) is a new species for Missouri, extending the western edge of the range for the species in North America.

RESUMEN

Quercus montana (Fagaceae) es una nueva especie para Missouri, que extiende el extremo occidental de su área en Norte América.

Quercus montana Willd., rock chestnut oak, is common in the NE US, and known to occur in AL, CT, DE, GA, IL, IN, KY, ME, MD, MA, MI, MS, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV (Nixon & Muller 1997). The species also has been called *Q. prinus* L. in some of the North American botanical literature, but because of persistent problems with the typification and application of that epithet, we are following Nixon and Muller (1997) in using the name *Q. montana*. There has been a recent proposal to reject the name *Q. prinus* (Whittemore & Nixon 2005). We report it from four sites in Wayne Co in southern Missouri, on land owned and managed by the US Army Corps of Engineers (USACE) surrounding Lake Wappapello. The lake was created in 1941 by the USACE to control flooding of farmland on the St. François River (USACE 2002). The Wappapello Project consists of 44,000 acres of land and water; the lake varies in size from 5,200 to 23,200 acres in surface area, depending upon the season. The original vegetation of the area consisted of woodlands that were part of the eastern temperate deciduous forest (Yatskievych 1999). This is the first report of *Q. montana* in Missouri, and a range extension of ca. 50 km for the species on its western boundary. Because of the proximity of the *Q. montana* populations in southern Illinois (Nixon & Muller 1997; see distribution map in FNA, Vol. 3, pg. 476) and the number of populations discovered in Wayne Co, MO, the current report suggests that forested areas in counties lying between the Missouri and Illinois populations should be surveyed for the species.

The populations reported below were from three glades and an oak-hickory forest. In all cases, the specimens were collected from saplings (1–1.5 m) growing in well-drained rocky soil. All specimens were verified by Alan Whittemore (US National Arboretum, Washington, DC). Although saplings appeared to be abundant in the areas, the parent trees were not identified. At glade 1, associ-

SIDA 21(3): 1921–1922. 2005

ated species included *Acer saccharum* Michx., *Carya ovata* (Miller) K. Koch, *Platanus occidentalis* L., *Quercus alba* L., *Q. imbricaria* Michx., *Q. marilandica* Moench., *Q. rubra* L., *Q. ×tridentata* Engelm. and *Ulmus americana* L; at glade 2, *A. negundo* L., *Cercis canadensis* L., *Q. alba*, *Q. imbricaria*, *Q. muehlenbergii* Engelm., *Q. rubra*, and *Q.×tridentata*; and *A. saccharum*, *Q. marilandica*, *Q. muehlenbergii*, *Q. rubra* and *U. alata* Michx. at glade 3. Associated species at the oak-hickory site included *A. saccharum*, *Celtis occidentalis* L., *C. canadensis*, *Q. imbricaria*, *Q. marilandica*, *Q. stellata* Wang var *stellata*, *Q. ×tridentata*, *Q. rubra* and *U. alata*.

Voucher specimen: **MISSOURI. Wayne Co.:** go S on US67 to Hwy 34, go <1 mi W and turn N on Rebel Cave Rd (Co Rd 310); go ca. 0.25 mi, take right fork on Co Rd 311 and continue N ca. 1.25 mi to first USACE parking lot; go through gate for ca. 0.5 mi; limestone glade on left of road (glade 1); N37.12.35 W090.29.49; 7 Aug 2004, *M. Smith 04-151* (MO).

ACKNOWLEDGMENTS

This study was funded by a USACE, St Louis District, contract (DACW43-02-P-1010) awarded to M. Smith. We thank James Gracey and the staff at USACE Wappapello Lake Project Office for logistical support; Alan Whittemore, US National Arboretum, for verification of the oaks; George Yatskievych, Flora of Missouri Project, for help in specimen identification; Paul McKenzie, USFWS, for editing suggestions, and Paige Mettler, Lindenwood University, and Genneth Wells, SIUE, for help in the field. George Yatskievych and Robin C. Kennedy reviewed an earlier draft of the manuscript.

REFERENCES

Nixon, K.C. and C.H. Muller. 1997. *Quercus*, Linnaeus sect. *Quercus*. In: Flora of North America Editorial Committee, eds. Flora of North America, Vol. 3. Magnoliophyta: Magnoliidae and Hamamelidae. Oxford University Press, New York. Pp. 471–506.

USACE. 2002. Lake Wappapello Master Plan. [Online] Available www.mvs.usace.army.mil/pm/wappapelloplan/masterplan.html. January 10, 2002.

Whittemore, A.T. and K.C. Nixon. 2005. (1683) Proposal to reject the name *Quercus prinus* (Fagaceae). Taxon 54:213–214.

Yatskievych, G. 1999. Steyermark's flora of Missouri. Revised edition, Vol. 1. Missouri Department of Conservation, Jefferson City. Pp. 51–76.

SPOROBOLUS HETEROLEPIS (POACEAE), NEW TO TENNESSEE

Dwayne Estes

The University of Tennessee
Department of Botany
437 Hesler Biology Building
Knoxville, Tennessee 37996-1100, U.S.A.
tnplants@yahoo.com

John Beck

The University of Tennessee
Department of Botany
437 Hesler Biology Building
Knoxville, Tennessee 37996-1100, U.S.A.
jbeck1@utk.edu

ABSTRACT

Sporobolus heterolepis (Poaceae) is reported as a new addition to the flora of Tennessee. This species is a very rare component of limestone cedar glades and barrens in the central portion of the state. The Tennessee Natural Heritage Program is currently tracking it as a species of special concern.

RESUMEN

Se cita *Sporobolus heterolepis* (Poaceae) como una nueva adición a la flora de Tennessee. Esta especie es un componente muy raro de los claros en los bosques de cedros sobre calizas y lugares áridos en la porción central del estado. El Tennessee Natural Heritage Program está haciendole actualmente un seguimiento como especie de especial preocupación.

Sporobolus R. Br. is a genus of ca. 100-160 species found nearly throughout the tropical and warm-temperate regions of the world (Yatskievych 1999). Chester et al. (1993) listed nine species and infraspecific taxa for Tennessee, including eight natives. In the autumn of 2003, while conducting fieldwork in the limestone cedar glades of middle Tennessee, we discovered a small population of *Sporobolus heterolepis* (A. Gray) A. Gray (prairie dropseed), a species previously unknown from the state.

Voucher specimen: **U.S.A. TENNESSEE. Rutherford Co.:** Interior Low Plateau Physiographic Province, Central Basin Section, Inner Central Basin Subsection, ca. 7.5 km E of Murfreesboro, Flat Rock Cedar Glades and Barrens State Natural Area, growing near edges and among shrub islands of gravelly limestone cedar barrens and glades, 28 Sep 2003, *D. Estes 05437, 05438* with *J. Beck* (TENN).

Sporobolus heterolepis is a perennial, tussock-forming species of prairies, dry woods, glades, savannas, and other open habitats (Yatskievych 1999). The species ranges from southern Canada (Ontario, Quebec, Saskatchewan) south to Georgia and New Mexico (United States Department of Agriculture 2000). Although widely distributed across central and eastern North America, it is most frequent in a large area of the Midwest from the Dakotas to the western Great Lakes region south to the Ozarks. Prairie dropseed is considered locally rare throughout much of its range. For example, it is presumed extirpated in Massachusetts and considered critically imperiled in Quebec, as well as in Connecticut, Georgia, Kentucky, Maryland, North Carolina, Pennsylvania, Virginia, and Wyoming (Nature Serve Explorer 2004). In Illinois, New York, and Ohio, *S. heterolepis* is an imperiled species, and it is considered vulnerable in Michigan, Ontario, and Saskatchewan (Nature Serve Explorer 2004).

All of the individuals we discovered were located on Flat Rock Cedar Glades and Barrens State Natural Area. The Natural Area, cooperatively managed by The Nature Conservancy and the Tennessee Department of Environment and Conservation's Natural Heritage Program, is one of the largest cedar glade preserves in the southeastern United States with over 400 ha (The Nature Conservancy 2004). Five tussocks were found at the edge of high quality limestone cedar barrens and among shrub islands within the glades (Fig. 1).

Interestingly, the Natural Area is home to several rare limestone cedar glade endemics and western disjuncts. Notable glade endemics or near-endemics known to occur on the nearby glades and barrens include *Aster priceae* Britt., *Astragalus bibulatus* Barneby & Bridges, *A. tennesseensis* A. Gray ex Chapman, *Dalea gattingeri* (Heller) Barneby, *Delphinium carolinianum* Walt. ssp. *calciphilum* Warnock, *Onosmodium molle* Michx. ssp. *molle*, *Pediomelum subacaule* (Torr. & A. Gray) Rydb, and *Solidago gattingeri* Chapman. Rare western disjuncts known from the vicinity, some in association with the *Sporobolus*, include *Ammoselinum popei* Torr. & A. Gray, *Dalea purpurea* Vent., and *Oenothera macrocarpa* Nutt. Native grasses such as *Andropogon gerardii* Vitman, *Bouteloua curtipendula* (Michx.) Torr., *Schizachyrium scoparium* (Michx.) Nash, *Sorghastrum nutans* (L.) Nash, and *Sporobolus vaginiflorus* (Torr. ex A. Gray) Wood var. *vaginiflorus* were also common associates.

The Rutherford County population is significantly disjunct from all other known populations. The nearest is located ca. 140 km to the southeast in cedar glades of Chickamauga and Chattanooga National Military Park, Catoosa County, northwestern Georgia (J. Allison, Georgia Natural Heritage Program, pers. comm.). The next closest populations are located ca. 220 km to the northwest and ca. 230 km to the north-northeast in Crittenden and Bullitt counties, Kentucky, respectively (J.J.N. Campbell, The Nature Conservancy, pers. comm.).

Approximately one week after our discovery of *S. heterolepis* in Tennessee, Al Good and Todd Crabtree, members of the Tennessee Native Plant Society who were unaware of our find, independently discovered two additional sites on nearby barrens in the Natural Area (pers. comm.). The Tennessee Division of Natural Heritage has been informed of the presence of *S. heterolepis* in the state and is now tracking it as a species of special concern. It is quite remarkable that given all the attention that the glades of Middle Tennessee have received over the last fifty plus years, especially those in the vicinity of the Natural Area, that this species has only now been discovered in the state.

Fig. 1. **Upper photo:** clump of *Sporobolus heterolepis* (arrow) among shrub island in cedar glade at Flat Rock Cedar Glades and Barrens State Natural Area, Rutherford County, Tennessee, 28 September 2003. **Lower photo:** close-up of *S. heterolepis* at edge of cedar barren, same date.

ACKNOWLEDGMENTS

We wish to thank Forrest Evans, Stewardship Ecologist with the Tennessee Natural Heritage Program, and Sally Rollins Palmer, ILP Program Manager with the Tennessee Chapter of The Nature Conservancy for reviewing this manuscript. Gene Wofford and an anonymous reviewer also reviewed the paper. The Breedlove-Dennis Fund and the University of Tennessee Department of Botany provided funding for travel. Hal DeSelm, retired botany professor at the University of Tennessee confirmed our identification. Lastly, we extend a sincere thanks to Gene Wofford, curator at the University of Tennessee Herbarium, for continued support and appreciation of our collecting efforts.

REFERENCES

Chester, E.W., B.E. Wofford, R. Kral, H.R. DeSelm, and A.M. Evans. 1993. Atlas of Tennessee vascular plants. Volume 1. Pteridophytes, gymnosperms, angiosperms: monocots. Misc. Publ. No. 9. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee.

NatureServe Explorer: An online encyclopedia of life [web application]. 2004. Version 3.1. NatureServe, Arlington, Virginia. Available www.natureserve.org/explorer. (Accessed: 24 June 2004).

The Nature Conservancy. 2004. Nature Conservancy celebrates 25th anniversary in Tennessee. Available nature.org/wherewework/northamerica/states/tennessee/press/press1224.html. (Accessed: 24 June 2004).

USDA (United States Department of Agriculture). 2000. Natural Resources Conservation Service. The PLANTS database (plants.usda.gov/plants/). National Plant Data Center, Baton Rouge, Louisiana (Accessed: 24 June 2004).

Yatskievych, G. 1999. Steyermark's flora of Missouri. Volume 1. Revised edition. The Missouri Botanical Garden Press, St. Louis.

A SECOND POPULATION OF *AGALINIS NAVASOTENSIS* (SCROPHULARIACEAE) CONFIRMED FROM TYLER COUNTY, TEXAS

Monique Dubrule Reed

Biology Department Herbarium
TAMU 3258
Texas A&M University
College Station, Texas 77845-3258, U.S.A.

John F. Hays

Florida Department of Environmental Protection
Wetland Evaluation & Delineation Section
Office of Submerged Lands & Environmental Resources
2600 Blair Stone Road, M.S. 2500
Tallahassee, Florida 32399-2400, U.S.A.

Judith M. Canne-Hilliker

Department of Botany
University of Guelph
Guelph, Ontario
N1G2W1, CANADA

Dana Price and Jason Singhurst

Wildlife Diversity Program
Texas Parks and Wildlife Department
3000 South IH-35, Suite 100
Austin, Texas 78704, U.S.A.

Eric Keith

Raven Environmental Services, Inc.
P.O. Box 6482
Huntsville, Texas 77342, U.S.A.

ABSTRACT

A second population of the rare *Agalinis navasotensis* Dubrule & Canne-Hilliker (Navasota False Foxglove) has been confirmed from a Catahoula Barren in Tyler County, Texas. Previously, the only known locality was an Oakville formation sandstone outcrop in Grimes County, Texas, some 100 miles to the west.

RESUMEN

Se ha confirmado una segunda población de la rara *Agalinis navasotensis* Dubrule & Canne-Hilliker (Navasota False Foxglove) de Catahoula Barren en el condado de Tyler, Texas. Previamente, la única localidad conocida era un afloramiento de arenisca en Oakville en el condado de Grimes, Texas, unas 100 millas al Oeste.

Agalinis navasotensis Dubrule & Canne-Hilliker (Navasota False Foxglove) was described from a single population in a remnant prairie centered on a sandstone outcrop in Grimes County (Canne-Hilliker & Dubrule 1993.) Since the initial discovery, botanists have searched for the plant on other Oakville formation outcrops in Grimes County and on floristically-similar outcrops in Washington County. Aside from a few individuals within a mile of the original site (well within bee-flight and so considered part of the same population) and on soils derived from the Oakville, no specimens were found.

SIDA 21(3): 1927–1929. 2005

In the fall of 2003, John Hays, who with Judith Canne-Hilliker is working on the genus for the Flora of North America, confirmed the identification of about fifty individuals of *A. navasotensis* along a dirt road in Tyler County. [Voucher specimen: **TEXAS: Tyler Co.:** pine plantation and surrounding pine savannah, *J. Hays 3411* 24 Sep 2003 (MMNS)]. Interestingly, he discovered that Donovan Stuart Correll had collected *A. navasotensis* (as *A. pulchella*) at this same site in 1967 [TEXAS: Tyler Co.: xeric Oligocene outcrop, longleaf pine-grassland, flowers pink, *D.S. Correll 35187-A*, 19 Oct 1967 (TEX-LL)]

During the 2004 season, several of the authors had the opportunity to visit the site independently of one another. Each trip found plants that correspond in all respects with plants of the type population of *A. navasotensis*. (The calyx lobes were originally described as minute (Canne-Hilliker & Dubrule 1993), but some individuals in this population had calyx lobes to as long as 1.25 mm.) There were approximately thirty plants divided among several spots on both sides of the road. Persistent rainy weather and impassable roads made searching for more plants on side roads all but impossible.

Voucher specimens: U.S.A. **TEXAS. Tyler Co.:** roadside, sandy clay. *Monique Dubrule Reed and Dana Price 2872*, 8 Oct 2004 (TAMU). **Tyler Co.:** Catahoula Barrens on a high ridge top outcrop, *Singhurst 12501*, 5 Oct 2003 (BAYLU).

The site includes a small outcrop of the Catahoula Barren type, which is somewhat similar in composition to the Oakville formation, but many of the plants were not near exposed rock as in Grimes County. Soils at the site tend to be hard and dry during droughty weather and thick, sticky, and slick under wet conditions. The *A. navasotensis* plants were growing in close proximity to *A. oligophylla* Penn. but were easily distinguishable from that species by the more paniculate inflorescence, smoother foliage, straight rather than curved buds, larger and unrecurved upper corolla lobes, oblong rather than globose fruits, anthers of a deeper yellow, and greener stigmas. *Bigelowia nuttallii* L.C. Anders., *Liatris mucronata* DC., and *Schizachyrium scoparium* (Michx.) Nash were very common at the site, and *A. fasciculata* (Elliott) Raf. was also present.

Agalinis navasotensis is a very rare plant with G1S1, TOES V status (Poole et al. 2004; Jones et al. 1997.) No more than a few hundred individuals may be found in any given year. Thus the discovery of a second population is good news, especially since the type locality is becoming somewhat overgrown and the number of *A. navasotensis* plants has been falling from year to year. However, this new site is so far (over 100 miles) from the type locality and has such different vegetation that we are now faced with new questions. Just how rare is *A. navasotensis*? Is it an outcrop plant or a prairie/savannah plant, does it require both an outcrop-like substrate and an open, grassy, undisturbed habitat, or is it tolerant of a wide range of conditions? Does it require an alkaline soil? Where should we be looking for more populations—in deep East Texas on or near outcrops of non-Oakville formations, nearer the type locality on non-Oakville formations, or on similar formations between the type locality and the new location? Which set of plant associates—dry prairie vs. moist pine savannah—is most typical and has the greatest predictive value? What moisture conditions—well-drained or poorly-drained—are most favorable? How similar are plants of the two localities genetically?

Obviously, having additional localities would be invaluable for understanding the biology of *A. navasotensis*. Anyone who finds plants they believe belong to this species should contact the first author. The key in Canne-Hilliker and Dubrule (1993) will serve to separate *A. navasotensis* from other long-pediceled, slender-leaved members of the genus. Plants should be looked for from mid-September to early October and before early afternoon (the corollas drop after being open only a few hours, making the plants nearly impossible to spot). Images of the species may be found at www.csdl.tamu.edu/FLORA/cgi/gallery_query?q=agalinis+navasotensis.

ACKNOWLEDGMENTS

Thanks go to Larry E. Brown for reviewing the manuscript and to everyone who has looked for *Agalinis navasotensis* over the years.

REFERENCES

Canne-Hilliker, J. and M. Dubrule. 1993. A new species of *Agalinis* (Scrophulariaceae) from Grimes County, Texas. Sida 15:425–440.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas: A comprehensive checklist including synonymy, bibliography, and index. Univ. of Texas Press, Austin.

Keeney, T.M. 1967. Flora and ecological relationships of the easternmost extension of the Oakville Formation of Texas. M.A. thesis, Sam Houston State College.

Poole, J.P., J.R. Singhurst, D.M. Price, and W.R. Carr 2004. A list of rare plants of Texas. Wildlife Diversity Program, Texas Parks and Wildlife Department, Austin, Texas.

BOOK NOTICES

Missouri Botanical Garden Press
Monographs in Systematic Botany

FERNANDO O. ZULOAGA y OSVALDO MORRONE. 2005. **Revisión de las Especies de *Paspalum* para America del sur Austral (Argentina, Bolivia, Sur del Brasil, Chile, Paraguay y Uruguay).** (ISBN 1-930723-42-3; ISSN 0161-1542, pbk.). *Monographs in Systematic Botany from the Missouri Botanical Garden*, Vol. 102. Missouri Botanical Garden Press, P.O. Box 299, St. Louis, MO 63166-0299, U.S.A. (**Orders:** Missouri Botanical Garden Press, Dept. 46, PO Box 299, St. Louis, MO 63166-0299, U.S.A.; 877-271-1930; http://www.mbgpress.org/). $64.95, 297 pp., 55 b/w line drawings, 7" × 10".

The authors present 129 species representing about one third of the recognized species in the genus *Paspalum*. This monographic taxonomic treatment includes a key to all 129 species. Each taxon is supplied with a full detailed description, common name, distribution and ecology, observations and specimens examined. Nearly one half of the taxa are beautifully illustrated with black and white line drawings. As the title indicates, the book is in Spanish.

AGUSTIN RUDAS LLERAS and ADRIANA PRIETO CRUZ. 2005. **Florula del Parque Nacional Natural Amacayacu Amazonas, Colombia.** (ISBN 1-930723-39-3, hbk.). *Monographs in Systematic Botany from the Missouri Botanical Garden*, Vol. 99. Missouri Botanical Garden Press, P.O. Box 299, St. Louis, MO 63166-0299, U.S.A. (**Orders:** Missouri Botanical Garden Press, Dept. 46, PO Box 299, St. Louis, MO 63166-0299, U.S.A.; 877-271-1930; http://www.mbgpress.org/). $80.00, 680 pp., 356 b/w line drawings, 8 1/2" × 11".

Florula del Parque Nacional Natural Amacayacu Amazonas, Colombia is one of the many botanical inventory projects developed in the 1980s by the Missouri Botanical Garden to study biodiversity in the Neotropics. This book presents, in Spanish, the results of a truly collaborative effort between the Missouri Botanical Garden, the national Institute of Natural Sciences of Colombia, and the Division of National Parks of the Colombian government with funding provided primarily by the John D. and Catherine T. MacArthur Foundation.

GIBASIS PELLUCIDA (COMMELINACEAE), A NEW AND POTENTIALLY WEEDY GENUS AND SPECIES FOR TEXAS

David J. Rosen

U.S. Fish & Wildlife Service
17629 El Camino Real, Suite 211
Houston, Texas 77058-3051, U.S.A.

Robert B. Faden

Department of Botany, MRC 166
Smithsonian Institution
PO Box 37012
Washington, DC 20013-7012, U.S.A.

ABSTRACT

Gibasis pellucida (Commelinaceae) is reported as a new naturalized weed in Texas. A description of the species and key to Texas genera of Commelinaceae are provided.

RESUMEN

Gibasis pellucida (Commelinaceae) se cita como una nueva mala hierba naturalizada en Texas. Se aporta una descripción de la especie y una clave de los géneros de Commelinaceae de Texas.

Gibasis Raf. (Commelinaceae), comprising 11 species, has a neotropical distribution centered in Mexico (Hunt 1986, 1993, 1994; Faden 2000). *Gibasis pellucida* (M. Martens & Galeotti) D.R. Hunt is native to México, mainly on the Atlantic side, and possibly El Salvador, occurring in moist shady places, such as forests and woodlands to 2200 m (Hunt 1986, 1994). In the United States it is mainly grown as an ornamental, but it also occurs as an introduced weed in citrus groves, disturbed sites, and waste places in Florida (Wunderlin 1998; Faden 2000). It has not been previously reported outside of cultivation from Texas (Correll & Johnston 1970; Hatch et al. 1990; Jones et al. 1997).

Recent collections from Galveston and Harris Counties suggest that *Gibasis pellucida* has naturalized in at least three locations in Texas. Plants appear to escape from cultivation, establish and spread readily in disturbed riparian areas under broken- to closed-canopy forests. The species might continue to spread into less disturbed areas, potentially becoming a pernicious weed in Texas and eventually throughout the southeast coastal plain.

The species propagates vegetatively by means of decumbent stems rooting at the nodes followed by fragmentation or death of the older parts. A few seeds have been found on *Rosen 3026* (BRIT) which demonstrates the species' potential to reproduce sexually, although it is usually self-incompatible (Hunt 1986). Potentially, the seeds could have been formed through apomixis, but apomixis has not been reported in Commelinaceae, so sexual reproduction seems more likely.

The following is a key to the Texas genera of Commelinaceae and a description of *G. pellucida*. With the addition of *Gibasis*, all native and naturalized genera of Commelinaceae in the U.S. are now recorded from Texas (Faden 2000).

KEY TO TEXAS GENERA OF COMMELINACEAE

1. Flowers sessile or subsessile; petals inconspicuous; ovary and capsule bilocular ____ **Callisia repens**
1. Flowers distinctly pedicellate; petals conspicuous; ovary and capsule trilocular.
  2. Inflorescences composed of pairs of contracted, sessile, umbel-like cymes; stamens 6, all fertile
    3. Cyme pairs enclosed in or subtended by pairs of large, conspicuous, spathaceous or foliaceous bracts; plants usually not mat-forming ____ **Tradescantia**
    3. Cyme pairs subtended by small inconspicuous bracts; plants mat-forming ____ **Callisia micrantha**
  2. Inflorescences composed of individual, often elongate, pedunculate, usually not umbellate cymes; stamens 6 or fewer, usually some staminodial (rarely all fertile).
    4. Inflorescences enclosed in or closely subtended by leafy bracts (spathes); flowers strongly bilaterally symmetric
      5. Stamens 6, all fertile, some filaments bearded; foliage glaucous ____ **Tinantia anomala**
      5. Stamens 6(–5), polymorphic, 3 fertile and 3(–2) staminodial, all filaments glabrous; foliage not glaucous ____ **Commelina**
    4. Inflorescences not enclosed in or closely subtended by leafy bracts; flowers radially or weakly bilaterally symmetric.
      6. Flowers weakly bilaterally symmetric; petals pinkish purple to violet; stamens 6, 2 fertile and 4 staminodial; annuals ____ **Murdannia nudiflora**
      6. Flowers radially symmetric; petals white, stamens 6, all fertile; perennials ____ **Gibasis pellucida**

Gibasis pellucida (M. Martens & Galeotti) D.R. Hunt (**Fig. 1**). TAHITIAN BRIDAL-VEIL; BRIDAL-VEIL. *Tradescantia pellucida* M. Martens & Galeotti, Bull. Acad. Roy. Sci. Bruxelles 9:376. 1842. *Gibasis pellucida* (M. Martens & Galeotti) D.R. Hunt, Kew Bull. 38:132. 1983. TYPE: MÉXICO: *Galeotti* 49965 (HOLOTYPE: BR).

Tradescantia schiedeana Kunth, Enum. Pl. 4:90. 1843. *Tradescantia geniculata* var. *schiedeana* (Kunth) C.B. Clarke, Monogr. Phan. 3:301. 1881. *Gibasis schiedeana* (Kunth) D.R. Hunt, Curtis's Bot. Mag. 179: pl. 636. 1972. TYPE: MÉXICO. *Schiede* 975 (HOLOTYPE: B).

Herbs, perennial, decumbent, rooting at the nodes, nearly glabrous or sparsely pubescent. Roots fibrous. Leaves 2-ranked, decreasing in size distally on the flowering shoots, blade sessile, narrowly lanceolate to ovate-elliptic, 3–7 × 0.7–2.5 cm, base oblique, apex usually acuminate, margins scabrous, surfaces usually glabrous; sheaths with a vertical line of pubescence, ciliate at the apex. Inflorescences terminal and also axillary from the distalmost, reduced leaves, composed of pairs of umbel-like, peduncluate cymes; spathaceous bract absent; bracteoles persistent. Flowers bisexual, radially symmetric; pedicels 5–15 mm long; sepals free, subequal, 2–2.5 mm long; petals free, equal, not clawed, broadly ovate, ca. 5 mm long, white; stamens 6, equal, all fertile, filaments bearded at the base and above the middle; ovary 3-locular, ovules 2 per locule, 1-seriate. Capsules 3-valved, 3-locular. Seeds 2 per locule, ovate to elliptic in outline, ca. 1 mm long, testa gray, rugose, hilum linear; embryotega dorsal.

Voucher specimens. **TEXAS. Galveston Co.:** on private property about 100 m N of the intersection of FM 528 and Clear Creek, an apparent escape from an abandoned and overgrown home-site, frequent

BOTANICAL RESEARCH CENTER HERBARIUM (BRCH)

COMMELINACEAE

TEXAS
Harris County

Gibasis pellucida (M. Martens & Galeotti) D.R. Hunt

Houston. In the flood plain of White Oak Bayou, about 0.6 mi. SW of the intersection of Hwy. 610 and Ella Blvd., a local green-space known as Little Thicket Park with about 7 acres of disturbed remnant of riparian forest. Abundant herb forming thick cover in shaded forest floor with *Platanus*, *Salix*, *Acer* *Populus*, *Fraxinus*, and *Ulmus* spp., flowers white.

GPS - N29° 48' 24.0" W95° 25' 53.8" (NAD83)

D.J. Rosen 3026 26 July, 2004

Fig. 1. *Gibasis pellucida* (M. Martens & Galeotti) D.R. Hunt (*Rosen 3026*—US3463486).

in swales of floodplain forest with *Carya aquatica*, *Celtis laevigata* var. *laevigata*, *Quercus nigra*, *Q. similis*, *Ulmus americana*, and *U. crassifolia*, N29° 31' 07.6" W95° 10' 45.1", 13 Aug 2003, *Rosen 2583* (BRIT, SBSC). **Harris Co.:** Houston, in the flood plain of White Oak Bayou, about 0.6 mi. SW of the intersection of Hwy. 610 and Ella Blvd., a local green-space known as Little Thicket Park with about 7 acres of disturbed remnant riparian forest, abundant herb forming thick cover in shaded forest floor with *Acer* sp., *Platanus occidentalis*, *Populus deltoides*, *Fraxinus pennsylvanica*, *Salix nigra*, and *Ulmus* spp., N29° 48' 24.0" W95° 25' 53.8", 26 Jul 2004, *Rosen 3026* (BRIT, SBSC, TEX, US); floodplain forest adjacent to the San Jacinto River, S of Highland Shores Drive, 2 miles W of its intersection with FM 2100, S of Crosby, locally common on forested terrace above slough with *Celtis laevigata* var. *laevigata*, *Halesia diptera*, *Liquidambar styraciflua*, *Platanus occidentalis*, *Quercus michauxii*, *Ulmus americana*, and *U. crassifolia*, N29° 50' 06.2" W95° 05' 26.3", 09 November 2004, *Rosen & Yeargan 3201* (BRIT, SWSL, VSC, US).

ACKNOWLEDGMENTS

We thank two anonymous reviewers for their helpful comments.

REFERENCES

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Faden, R.B. 2000. Commelinaceae. In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico, Vol. 22. Oxford Univ. Press, New York. Pp. 170–197.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Bull. MP-1655.

Hunt, D.R. 1986. A revision of *Gibasis* Rafin. American Commelinaceae: XII. Kew Bull. 41: 107–129.

Hunt, D.R. 1993. Commelinaceae. In: McVaugh, R., Flora Novo-Galiciana, Vol. 13: Limnocharitaceae to Typhaceae. University of Michigan, Ann Arbor. Pp. 130–201.

Hunt, D.R. 1994. Commelinaceae. In: Flora Mesoamericana, Vol. 6: Alismataceae a Cyperaceae. Universidad Nacional Autónoma de México, Ciudad Universitaria. Pp. 157–173.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas: A comprehensive checklist including synonymy, bibliography, and index. University of Texas Press, Austin.

Wunderlin, R.P. 1998. Guide to the vascular plants of Florida. University Press of Florida, Gainesville.

STEMODIA COAHUILENSIS (SCROPHULARIACEAE), A NEW RECORD FOR THE UNITED STATES

B.L. Turner

Plant Resources Center
The University of Texas
Austin, Texas 78712, U.S.A.

Henrickson (1989) first described *Stemodia coahuilensis* (as *Leucospora coahuilensis*) and mapped its distribution. The species was subsequently transferred to the genus *Stemodia* (s.l.) by Turner (in Turner & Cowan 1993). Previously reported collections have all been confined to north central Mexico (easternmost Chihuahua, Coahuila, northernmost Durango, and Zacatecas).

Recent collections of the species have been obtained from the Big Bend region of trans-Pecos, Texas, as attested to by the following:

UNITED STATES: TEXAS. Jeff Davis Co.: 5.1 mi S of Hwy 90 along Farm Road 2017, bottom of gullies, silty limestone soils, 8 Oct 2004, *Turner 24-492B* (SRSC, TEX). **Presidio Co.:** Big Bend State Natural Area, "vicinity of Sauceda Ranch," 7 Oct 1995, *Worthington 25254* (SRSC).

Henrickson (1989) has presented an excellent line drawing of the species. His description of its habit, however, stands in variance with my observations. He describes the taxon as "Woody rooted [and] woody-based," when in fact all of the plants which I examined in the field were rather slender-rooted annuals; this appears to be also true of Henrickson's material, including the type (LL!) itself. In his defense, however (pers. comm.), he maintains that the slender annual roots are in fact woody.

REFERENCES

Henrickson, J. 1989. A new species of *Leucospora* (Scrophulariaceae) from the Chihuahuan desert of Mexico. Aliso 12:435–439.

Turner, B.L. and C.C. Cowan. 1993. Taxonomic overview of *Stemodia* (Scrophulariaceae) for North America and the West Indies. Phytologia 74:61–103.

SIDA 21(3): 1935. 2005

BOOK NOTICES

Missouri Botanical Garden Press

Flora of China

Flora of China Editorial Committee. 2005. **Flora of China, Volume 14, Apiaceae through Ericaceae.** (ISBN 1-930723-41-5, hbk.). Science Press (Beijing), 16 Donghuangchenggen North Street, Beijing 100717, CHINA and Missouri Botanical Garden Press, P.O. Box 299, St. Louis, MO 63166-0299, U.S.A. (**Orders:** Missouri Botanical Garden Press, Dept. 46, PO Box 299, St. Louis, MO 63166-0299, U.S.A.; 877-271-1930; http://www.mbgpress.org/). $115.00, 581 pp., 8 1/2" × 11".

Flora of China Editorial Committee. 2005. **Flora of China Illustrations, Volume 5, Ulmaceae through Basellaceae.** (ISBN 1-930723-40-7, hbk.). Science Press (Beijing), 16 Donghuangchenggen North Street, Beijing 100717, CHINA and Missouri Botanical Garden Press, P.O. Box 299, St. Louis, MO 63166-0299, U.S.A. (**Orders:** Missouri Botanical Garden Press, Dept. 46, PO Box 299, St. Louis, MO 63166-0299, U.S.A.; 877-271-1930; http://www.mbgpress.org/). $125.00, 377 pp., 352 full page b/w line drawings, 8 1/2" × 11".

Flora of China, Volume 14, Apiaceae through Ericaceae includes the following families: Apiaceae, Cornaceae, Aucubaceae, Helwingiaceae, Mastixiaceae, Toricelliaceae, Diapensiaceae, Clethraceae, and Ericaceae. Taxonomic treatments are presented from the level of family to species and infraspecific ranks.

Flora of China Illustrations, Volume 5, Ulmaceae through Basellaceae includes the following families: Ulmaceae, Rhoipeteleaceae, Moraceae, Cannabaceae, Urticaceae, Podostemaceae, Proteaceae, Olacaceae, Opiliaceae, Santalaceae, Loranthaceae, Viscaceae, Aristologhicaceae, Rafflesiaceae, Balanophoraceae, Polygonaceae, Chenopodiaceae, Amaranthaceae, Nyctaginaceae, Phytolaccaceae, Molluginaceae, Aizoaceae, Portulacaceae, and Basellaceae.

EMILIA FOSBERGII (ASTERACEAE: SENECIONAE) IN TEXAS REVISITED

W.P. Spencer
Department of Agricultural Sciences
Sam Houston State University
Huntsville, Texas 77341, U.S.A.

J.K. Williams
Department of Biological Sciences
Sam Houston State University
Huntsville, Texas 77341, U.S.A.

In a remarkable example of botanical coincidence, the first author has made the second collection of the same species of non-native weed first reported for Texas by the second author (Williams 1994). The first collection was made 10 years to the day previously.

Emilia fosbergii Nicolson is a pantropical weed of "low elevation, dry, urban and disturbed habitats (Wagner et al. 1999)." Smith (1991) reported that the species is "probably indigenous in central or eastern Africa but widely established in the New World ... centering in the U.S. (Florida), West Indies, and subsequently from Mexico to northern South America." The species, was first reported in Texas growing in a disturbed site in Travis County. The second known collection of this plant is from Walker Co., collected about 9 miles north of Huntsville and 165 miles east of Travis County. Despite having been reported in Texas 10 years ago, *Emilia* has not been reported from other counties in Texas (Turner et al. 2003).

Williams (1994) speculated that the weed was brought into Texas as a hitchhiker on nursery plants supplied from Florida. Due to the proximity of a house in the second collection, it was again assumed the plant made its way to Texas through nursery stock.

Following the hunch, the second author visited all of the nurseries in Huntsville to look for evidence of *Emilia*. Indeed, the first nursery visited had an abundance of *Emilia fosbergii* growing as a weed in several pots of *Cycas revoluta* Thunb. and *Morea* sp., both supplied from Florida. Cycads were found growing approximately 60 feet from the collection made along Hwy 19 in Walker County. It is still not known if *Emilia* will become an established weed in Texas, but the disjunct distribution of the species and the increase in urban development suggests that it has ample opportunity to spread.

Voucher specimens. **TEXAS. Travis Co.:** City of Austin, A-1 Grass Nursery, two blocks S of Barton Skyway along S Lamar St., growing in gravel parking lot and planting area, 20 Nov 1993, *Williams s.n.* (TEX). **WALKER Co.:** 8.3 mi N of Hwy 30 along Hwy 19, on the N side of Hwy 19, growing in ditch along highway easement in front of residential area (30° 48' 33.01944" N, 95° 26' 39.76872" W), 20 Nov 2003, *Spencer 1* (SHST); Huntsville, Home Depot nursery, growing as a weed within pots of *Cycas revoluta* and *Morea* sp., 6 Dec 2003, *Williams s.n.* (SHST).

SIDA 21(3): 1937–1938. 2005

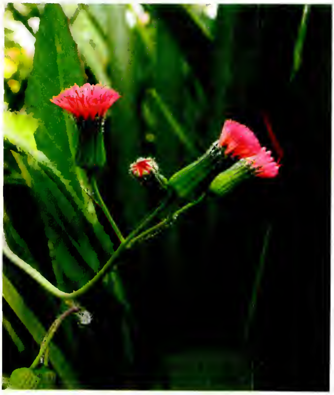


Fig. 1. Heads of *Emilia fosbergii*. Photo by J. K. Williams.

Emilia is a member of the tribe Senecionae as evidenced by the presence of disk flowers, alternate leaves without punctate glands, and non-overlapping phyllaries that are arranged in a single series (Fig. 1). *Emilia fosbergii* is the only species of Texas Senecionae with red corollas.

REFERENCES

Smith, A.C. 1991. Flora Vitiensis nova: a new flora of Fiji. Lawai, Kauai, Hawaii. National Tropical Botanical Garden. 5:318.

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Sida, Bot. Misc. 24:1–888.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawai'i. Revised edition. University of Hawai'I Press, Honolulu. P. 312.

Williams, J.K. 1994. *Emilia fosbergii* (Asteraceae: Senecioneae), a new introduction to Texas. Sida 16:378–379.

A NEW RECORD OF THE DEVIL'S CIGAR, *CHORIOACTIS GEASTER* (PEZIZALES: ASCOMYCOTA), FROM COLLIN COUNTY, TEXAS

John E. Ubelaker

Department of Biological Sciences
Southern Methodist University
Dallas, Texas 75275, U.S.A.

Jane K. Starks

3321 Rankin
Dallas, Texas 75205, U.S.A.

ABSTRACT

A first report of a rare operculate discomycete, the devil's cigar, *Chorioactis geaster*, from near McKinney, Collin County, Texas.

RESUMEN

Ha sido confirmada ahora una población del devil's cigar, de *Chorioactis geaster*, un discomicete operculado raro, y se han tomado testigos en Collin County, Texas.

Chorioactis geaster (Sarcosomataceae) was first reported from Austin, Texas in 1893 by Charles Peck as *Urnula geaster* based on specimens collected November 24, 1891 and received from L.M. Underwood (Report of the State Botanist, page 39 (or 119 for the inserted report), in the 46 Annual Report of the New York State Museum, 1893). Later, (Report of the State Botanist, NY State Museum Report #62, 1908, page 31) Peck presents further discussion based on additional specimens from Texas. Kupfer (1902:142) placed it in the genus *Chorioactis*, also see Eckblad (1968). Although Imazeki (1938) reported it from Kyushu, Japan, Petterson et al. (2004) suggests the fungi from Japan and Texas represent two separate lineages that diverged at least 19 MYA. In Texas the fungus has been found in Austin (Travis Co.) by Peck and Seaver (1939) Rudy (2001), Dallas Co., near Joe Pool Lake by Rudy and Keller (1996), Ruby (2001), Guadalupe Co. by Mims (2004 on website), Denton Co. by Buller (1934), reported as uncertain by Rudy (2001), Tarrant Co., by Rudy and Keller (1996), Rudy (2001), and Hunt Co., by Rudy and Keller (1996), Rudy (2001). Rudy (2001) also lists Burnet or possibly Llano, and Palo Pinto counties.

In November, 2004 one of us (JS) collected a specimen in a pasture located near Altoga, Texas, in Collin Co., Texas. The specimen was found growing in moist soil 700 yards west of farm road 470, 0.8 miles west of its junction with FR 1827, west of Altoga, Collin Co., Texas. The pasture was a large open field on the east side of Sistergrove Creek within the flood plain in an open area with clumps of *Rumex crispus* L. The pasture had been maintained as pasture for over 30 years. There was no evidence of tree stumps, or shrubs in the area.

SIDA 21(3): 1939–1940. 2005

Voucher specimen. **U.S.A TEXAS. Collin Co.:** in tall growth pasture in moist soil of a flood plain ca. 200 yards E of Sistergrove Creek, 700 yards from farm road 470, 0.8 mi W of jct. with FR 1827, W of Altoga, 20 Nov 2004 (BRIT).

ACKNOWLEDGMENTS

We are grateful to Barney Lipscomb and David Lewis for their help in identification of the specimen. Ellen Bloch kindly located a voucher specimen of *Choriactis geaster* (Peck) Eckblad, Texas, Tarrant Co, City of Arlington, River Legacy Parks by *K.C. Rudy s. n.*, H.W. Keller 8 October, 1994 in the Cryptogamic Herbarium, New York Botanical Garden. John Haines kindly located the type specimen in the New York State Museum. Donald H. Pfister (FH) and David Lewis contributed many useful comments.

REFERENCES

Buller, A.H.R. 1934. Researches on fungi (Vol. 4) Reprinted 1958. Hafner Publ., New York.

Eckblad, F.-E. 1968. The genera of the operculate Discomycetes: are-evaluation of their taxonomy, phylogeny and nomenclature. Nytt Mag. Bot. 15:1–191.

Imazeki, R. 1938. A rare fungus. *Urnula geaster* Peck grows in Kyusyu, Japan. J. Japanese Bot. 14:680–684.

Kupfer, E.M. 1902. Studies on *Urnula* and *Geopyxis*. Bull Torrey Bot. Club 29:137–144.

Peterson, K.R., C.D. Bell, S. Kurogi, and D.H. Pfister. 2004. Phylogeny and biogeography of *Chorioactis geaster* (Pezizales, Ascomycota) inferred from nuclear ribosomal DNA sequences. Harvard Pap. Bot. 8:141–152.

Rudy, K.C. 2001. The devil's cigar—the hunt continues. Mycophile 42(6):1, 4–5.

Rudy K.C. and H.W. Keller. 1996. The rare and fascinating devil's cigar, *Chorioactis geaster*. The Mycologist 10(1):33–35.

Seaver, F.J. 1937. Photographs and descriptions of cup-fungi-XXV. *Urnula geaster*. Mycologia 29:60–65.

Seaver, F.J. 1939. *Urnula gesaster* (in Notes and Brief Articles). Mycologia 31:367–368.

WILBUR HOWARD DUNCAN
1910–2005

Wendy B. Zomlefer and David E. Giannasi

Department of Plant Biology
University of Georgia
2502 Plant Sciences
Athens, Georgia 30602-7271, U.S.A.

ABSTRACT

Wilbur Howard Duncan (1910–2005) is remembered as the Curator of the University of Georgia Herbarium (1938–1978), skilled field botanist, gifted teacher, field guide author, plant photographer, and friend.

RESUMEN

Wilbur Howard Duncan (1910–2005) será recordado como el curador del Herbario de la Universidad de Georgia (1938–1978), como un botánico de campo con talento, profesor dedicado, autor de guías de campo, fotógrafo naturalista y un gran amigo.

We are saddened to report the passing of Wilbur Howard Duncan (Figs. 1, 2), University of Georgia Professor Emeritus of Botany and retired Curator of the GA Herbarium. He died at his home attended by his family on 25 March 2005 in Athens, Georgia. He was over 94 years old (Anonymous 2005; Zomlefer & Giannasi 2005a, b, c, d).

Wilbur was born on 15 October 1910, in Buffalo, New York, attended Bloomington High School in Indiana, and received an A. B. (1932) and M.A. (Botany, 1933) from Indiana University. After earning a Ph.D. from Duke University under the forest ecologist Clarence F. Korstian in 1938, he began his distinguished forty-year teaching and research career at the University of Georgia, Department of Botany (now Department of Plant Biology). He was also curator of the GA Herbarium. His faculty position at the university was interrupted by four years of service as First Lieutenant and ultimately, Major, in the U. S. Public Health Service (1943–1946) as an entomologist in charge of mosquito control for Charleston, South Carolina (and other locales in the Southeast) during World War II (Powell 2005; Smith 2005).

Wilbur Duncan had an illustrious career spanning seven decades during which he generously shared his enthusiasm and expertise in botany with students, professionals, and amateurs alike. He was direct in imparting information in the classroom setting, but in the field he took on the role of gentle guide: he would ask questions to help students discover the answer, i.e., to "see" the plant for themselves and thereby better commit the information to memory.

SIDA 21(3): 1941–1950. 2005

Fig. 1. Wilbur Howard Duncan, circa 1990, attired with his trademark bowtie.

Students often had difficulties keeping up with Professor Duncan's long-legged strides in the field, but he always waited for them to catch up to examine an interesting plant. After his patient and inquisitive expository, he was off again with a crowd of students trailing far behind him!

He inspired several generations of students via over 20 popular hands-on field courses (UGA 1939, 1942, 1950a, b, 1962, 1971a, b, 1977a b), including: Elementary Botany, Plant Ecology, Field Botany, Taxonomy of Seed Plants (also listed as Plant Taxonomy), Agrostology (also listed as Taxonomy of Grasses; Identification of Grasses; Taxonomy of Grasses, Sedges, and Rushes), Aquatic Plants, Identification of Flowering Plants, Identification of Trees and Shrubs (also under Trees and Shrubs; Taxonomy of Woody Plants), and Local Flora for Teachers. For many years he also taught a course in poisonous plant identification required by the Veterinary School (M. Duncan, pers. comm). Wilbur also supervised six Master's students and ten Ph.D. students, whose studies focused primarily on floristics of the southeast (e.g., Duncan & Pullen 1962; Pullen 1963; Jones 1964; Yates 1969; Yates & Duncan 1970; Gibbs Russell & Duncan 1972; Givens 1971; Faircloth 1971, 1975; Gunn 1974).

Wilbur was a mega-collector in the spirit of Cyrus G. Pringle and Alan H. Curtiss, collecting over 30,000 plant specimens in his lifetime (in multiple sets) that he deposited at GA and distributed to other herbaria throughout the southeastern United States (see Fig. 2). Through his efforts, the GA Herbarium grew from 16,000 to 135,000 specimens during his tenure there. Among these specimens is his first: a collection of *Trillium sessile* (Fig. 3). Wilbur's field work included photographing the plants, as well as making specimens of them. His photographs emphasized features needed for accurate identification—requiring, for example, illumination of the inside of a *Liriodendron tulipifera* L. flower (Duncan & Duncan 1988, p. 151) or the anthers of *Rhexia alifanus* Walter (Duncan & Duncan 1987, p. 106) via a series of homemade handheld reflectors (L. Duncan, pers. comm.). He even flicked droplets of water on floating *Nymphaea odorata* Willd. leaves (Duncan & Duncan 1999, p. 193) to provide proper size contrast.

According to his most recent resume on file in our department, Wilbur published 65 articles in scientific journals, mainly on the floristics of the Southeast (e.g., Duncan 1954a, 1964, 1966a, 1967, 1969, 1977, 1979a; Duncan et al. 1955, 1957), particularly of Georgia (e.g., Duncan 1948, 1950a, 1954b, 1955, 1957, 1960, 1962a, 1966b, 1971, 1979b, 1984; Duncan & Blake 1965; Duncan & Kartesz 1981). Besides floristics, his interests in these species ranged from nomenclature (e.g., Duncan 1950b), descriptions of new taxa (Duncan 1940, 1944, 1950c, 1977; Duncan et al. 1971), morphology (e.g., Duncan 1933, 1950d, 1959a; Duncan & Brown 1954), to natural history (e.g., Duncan 1959b, 1962b; Duncan & DeJong 1964). His discovery of a new rare oak species, *Quercus oglethorpensis* W.H. Duncan (Oglethorpe oak; Duncan 1940, 1950e; Bishop & Duncan 1941), in Oglethorpe County, Georgia, was the first new oak found east of the Mississippi in 90 years (summary in Coder 2003).

The University of Georgia Press published three plant identification books authored by Wilbur during his tenure as faculty member: *Guide to Georgia Trees* (Duncan 1941), *Woody Vines of the Southeastern United States* (Duncan 1975), and *Wildflowers of the Southeastern United States* (Duncan & Foote 1975). Wilbur's greatest claim to fame, however, are his popular field guides produced after his "retirement:" *The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts* (Duncan & Duncan 1987), *Trees of the Southeastern United States* (Duncan & Duncan 1988), and *Wildflowers of the Eastern United States* (Duncan & Duncan 1999). All three are still in print; the latter, covering over 1,000 species, is currently a best-seller for the University of Georgia Press. At the time of his death, he was completing the manuscript for *Shrubs of the Southeastern*

FIG. 2. Wilbur Howard Duncan, circa 1983, on a trip collecting for his field guides.

Fig. 3. Wilbur Duncan's first specimen (*Duncan 1*; *Trillium sessile* L., Cedar Cliffs, Indiana; 18 April 1932; GA). Wilbur collected over 30,000 sets of vascular plant exsiccatae in his lifetime.

United States, a significant guide including 700 of his color photographs (Sheurer 1999).

Wilbur belonged to 18 professional societies and associations. He was a charter member of the Association of Southeast Biologists and a Fellow of the American Association for the Advancement of Science. He held several offices with the Botanical Society of America and was President of the Georgia Academy of Science for two terms. He was also active in the American Society of Plant Taxonomists, serving four years as a member of the council; the American Institute of Biological Sciences; the International Association of Plant Taxonomists; and the Georgia Botanical Society. He was awarded the 1990 *Elizabeth Ann Bartholomew Service Award* by the Southern Appalachian Botanical Club (Martin 1990). In 1998, the Department of Plant Biology, University of Georgia, initiated the *Wilbur*

Duncan Award for Outstanding Graduate Student in his honor to recognize outstanding graduate student contributions to research, teaching, and service to the department. The single yearly recipient, who demonstrates excellence in these three areas, is awarded $1,000 and an inscribed plaque.

In his retirement Wilbur continued to be a botanical resource for the GA Herbarium and to the many students sharing space with him, especially those involved in floristic studies for their degrees. When students had difficulties identifying a plant, they would finally consult Wilbur–who would absentmindedly rattle off a plant name that inevitably was correct, much to the amazement of the students. Indeed, many were the students sent back to their desks muttering as to why they hadn't thought of the answer themselves!

The faculty and staff of our department were impressed to observe Wilbur here at work five days a week (and often also on the weekends), sitting upright at his microscope in "his corner" or editing portions of his latest book manuscript(s). When most older faculty were looking forward to retirement as a time of rest and passage to other areas of interest, Wilbur had already begun his second botanical career resulting in his well-written popular field guides, beautifully illustrated with his own photographs. His books brought botany to more people at an understandable level than any academic text. These guides are coauthored by his wife of 64 years, Marion Duncan, also a professional botanist. The Duncans logged over 80,000 miles together compiling these field books (McCarthy 1999).

Always busy in the herbarium and nattily dressed in coat and bowtie, Wilbur was an enviable model of a true botanist devoted to his craft. He was efficient, focused, and direct with an acute attention to detail, coupled with a notoriously understated sense of humor. He practiced the art of seeing beauty in everything and readily shared this vision with others. As age and health issues encroached on his schedule, he willed himself to continue until his shrub book was completed, a testament to his strength of character. And the latter, he admitted, was due to the unequivocal support of his loving wife, Marion, who was his best friend, field partner and confidant. Wilbur refused to autograph copies of their field guides unless Marion also provided her signature as coauthor and partner. He was unstinting in his praise and respect for Marion as the steady fulcrum of his life and also never failed to proudly discuss his children and grandchildren. It is often said of certain people that we shall not see their like again, and while perhaps a cliché in today's world, the statement holds a high timbre for the life of Wilbur H. Duncan.

Wilbur Duncan is survived by his wife Marion Duncan; three children (Douglas, Lucia, and Mack Duncan); and four grandchildren (Amber, Laramie, Laura, and Ross Duncan). To honor him, the family has requested donations to the *Wilbur and Marion Duncan Publishing Fund*, a charitable trust established with the University of Georgia Foundation to ensure the publication of the

Duncans' last manuscript, *Shrubs of the Southeastern United States*. Those wishing to participate may send tax-deductible contributions to: The University of Georgia Foundation, *Wilbur and Marion Duncan Publishing Fund*, 394 S. Milledge Avenue, Suite 100, Athens, GA 30602-5582.

ACKNOWLEDGMENTS

We are especially grateful to Marion and Lucia Duncan for graciously taking time in their grief to reminisce about Wilbur; Lucia also generously supplied scanned photographs of her father. Many thanks also to Carla Ingram (Department of Plant Biology) for locating Wilbur's departmental files and for searching our departmental archives for dissertations and Master's theses of his former students. We thank Lynn Cahoon (Remote Reference, Main Library, UGA) and the staff of the Georgia Room, Hargrett Library (UGA) for assistance in tracking down uncatalogued course schedules for 1938–1978 in UGA library archives; Kelly A. Bettinger for editorial criticisms; and Eric Fuchs, for translating the abstract into Spanish. The Department of Plant Biology, University of Georgia, funded production of high-resolution digital scans and photographic prints of Wilbur's first specimen.

REFERENCES

Anonymous. 2005. Obituary: Duncan, Wilbur H. The Athens Banner-Herald, March 27: C3.

Bishop, G.N. and W.B. Duncan. 1941. A new white oak from Georgia: its associates and habitat. J. Forestry 39:730–731.

Coder, K.D. 2003. Oglethorpe oak: sunset of a species. University of Georgia, Warnell School of Forest Resources, Publication FOR03-28, 8 pp. Also available at www.urbanforestrysouth.org/Resources/Library/Citation.2004-05-28.1812/file_name/.

Duncan, W.H. 1933. Ecological comparison of leaf structures of *Rhododendron punctatum* Andr. and the ontogeny of epidermal scales. Amer. Midland Naturalist 14:83–96.

Duncan, W.H. 1940. A new species of oak from Georgia. Amer. Midland Naturalist 24: 755–756.

Duncan, W.H. 1941. Guide to Georgia trees. University of Georgia Press, Athens, Georgia.

Duncan, W.H. 1944. A new species of *Baptisia*. Rhodora 46:29–31.

Duncan, W.H. 1948. Preliminary reports on the flora of Georgia – 1. The distribution in Georgia of spermatophytes new and rare to the state. Castanea 13:70–83.

Duncan, W.H. 1950a. Preliminary reports on the flora of Georgia – 4. Notes on the distribution of flowering plants including species new to the state. Castanea 15:145–159.

Duncan, W.H. 1950b. Synonymy in *Viburnum obovatum* and *V. cassinoides*. Rhodora 52: 179–182.

Duncan, W.H. 1950c. A new variety of *Arenaria*. Phytologia 3:282.

Duncan, W.H. 1950d. Stamen numbers in *Cuphea*. Rhodora 185–188.

Duncan, W.H. 1950e. *Quercus oglethorpensis* – range extensions and phylogenetic relationships. Lloydia 13:243–248.

Duncan, W.H. 1954a. *Polypodium aureum* in Florida and Georgia. Amer. Fern J. 44:155–158.

Duncan, W.H. 1954b. More and more weeds in Georgia. Bulletin of the Georgia Academy of Science 12:99–102.

Duncan, W.H. 1955. New records for Georgia ferns. Amer. Fern J. 45:1–10.

Duncan, W.H. 1957. *Asimina* (Annonaceae) in Georgia. Bulletin of the Georgia Academy of Science 15:9–15.

Duncan, W.H. 1959a. Leaf variation in *Liquidambar styraciflua* L. Castanea 24:99–111.

Duncan, W.H. 1959b. A naturally occurring F_1 hybrid of *Monarda media* and *M. fistulosa*. Rhodora 61:301–305.

Duncan, W.H. 1960. *Azolla caroliniana* Willd. in Georgia. Amer. Fern J. 50:266–267.

Duncan, W.H. 1962a. Stemmed white violets of Georgia. Bulletin of the Georgia Academy of Science 19:75–76.

Duncan, W.H. 1962b. Data on sessile-flowered *Trillium* (Liliaceae). Castanea 27:165–173.

Duncan, W.H. 1964. New *Elatine* (Elatinaceae) populations in the southeastern United States. Rhodora 66:48–53.

Duncan, W.H. 1966a. Disjuncts in the southeastern United States. Amer. J. Bot. 53:633.

Duncan, W.H. 1966b. *Asplenium × kentuckiense* on granitic gneiss in Georgia. Amer. Fern J. 56:145–149.

Duncan, W.H. 1967. Woody vines of the southeastern United States. Sida 3:1–76.

Duncan, W.H. 1969. *Celastrus* (Celastraceae) in the southeastern United States. Sida 3: 309–310.

Duncan, W.H. 1971. *Angelica triguinata* (Umbelliferae) southward and *Lotus helleri* (Leguminosae) westward into Georgia. Castanea 36:163–164.

Duncan, W.H. 1975. Woody vines of the southeastern United States. University of Georgia Press, Athens, Georgia.

Duncan, W.H. 1977. A new species of *Galactia* (Fabaceae) in the southeastern United States. Phytologia 37:59–61.

Duncan, W.H. 1979a. Changes in *Galactia* (Fabaceae) of the southeastern United States. Sida 8:170–180.

Duncan, W.H. 1979b. *Zamia* (Cycadaceae) new for Georgia. Sida 8:115–116.

Duncan, W.H. 1984. Additions to the vascular flora of Georgia. Castanea 50:52–54.

Duncan, W.H. and D. Blake. 1965. Observations on some ferns in Georgia. Amer. Fern J. 55: 145–153.

Duncan, W.H. and C.L. Brown. 1954. Connate anthers in *Gentiana* (Gentianaceae). Rhodora 56:133–136.

Duncan, W.H. and D.W. DeJong. 1964. Taxonomy and heterostyly of North American *Gelsemium* (Loganiaceae). Sida 1:346–357.

Duncan, W.H. and M.B. Duncan. 1987. The Smithsonian guide to seaside plants of the Gulf and Atlantic coasts. Smithsonian Institution Press, Washington, D.C.

Duncan, W.H. and M.B. Duncan. 1988. Trees of the southeastern United States. University of Georgia Press, Athens, Georgia.

DUNCAN, W.H. and M.B. DUNCAN. 1999. Wildflowers of the eastern United States. University of Georgia Press, Athens, Georgia.

DUNCAN, W.H. and L.E. FOOTE. 1975. Wildflowers of the southeastern United States. University of Georgia Press, Athens, Georgia.

DUNCAN, W.H., J.F. GARST, and G.A. NEECE. 1971. *Trillium persistens* (Liliaceae), a new pedicellate-flowered species from northeastern Georgia and adjacent North Carolina. Rhodora 73:244–248.

DUNCAN, W.H. and J.T. KARTESZ. 1981. Vascular flora of Georgia: an annotated checklist. The University of Georgia Press, Athens, GA.

DUNCAN, W.H., P.L. PIERCY, S.D. FEURT, and R.J. STARLING. 1957. Toxicological studies of southeastern plants. II. Compositae. Econ. Bot. 11:75–85.

DUNCAN, W.H., P.L. PIERCY, and R.J. STARLING. 1955. Toxicological studies of southeastern plants. I. Leguminosae. Econ. Bot. 9:243–255.

DUNCAN, W.H. and T. PULLEN. 1962. Lepidote rhododendrons of the southern United States. Brittonia 14:290–298.

FAIRCLOTH, W.R. 1971. The vascular flora of central south Georgia. Ph.D. dissertation, University of Georgia, Athens, Georgia.

FAIRCLOTH, W.R. 1975. Ferns and other primitive vascular plants of central south Georgia. Castanea 40:217–228.

GIBBS RUSSELL, G.E. and W.H. DUNCAN 1972. An annotated checklist of *Carex* (Cyperaceae) in Georgia. Castanea 37:200–214.

GIVENS, F.M. 1971. The vascular flora of Echols Mill granitic outcrop. M. A. thesis, University of Georgia, Athens, Georgia

GUNN, W.D. 1974. Aquatic vascular flora of some artificial ponds of the western piedmont of Georgia. Ph.D. dissertation, University of Georgia, Athens, Georgia.

JONES, S.B. 1964. Taxonomy of the narrow-leaved *Vernonia* of the southeastern United States. Ph.D. dissertation, University of Georgia, Athens, Georgia.

MARTIN, W.H. 1990. 1990 Elizabeth Ann Bartholomew Award recipient – Wilbur H. Duncan. Castanea 55:137–139.

MCCARTHY, R. 1999. To conserve and protect. The Atlanta Journal-Constitution, Home & Garden Section. June 24: 12–13.

POWELL, K. 2005. Obituaries. Dr. Wilbur Duncan, 94, botanist, author. The Atlanta Journal-Constitution, March 31: 9C.

PULLEN, T.M. 1963. The *Cassia fasciculata* complex (Leguminosae) in the United States. Ph.D. dissertation, University of Georgia, Athens, Georgia.

SHEURER, L. 1999. Wild about wildflowers. Athens Daily News, Oct. 24: 1E, 3E.

SMITH, J. 2005. Wilbur H. Duncan, 1910–2005. BotSoc. News (Georgia Botanical Society Newsletter). 79(3):1.

UNIVERSITY OF GEORGIA [UGA]. 1939. Bulletin: the University of Georgia, College of Arts and Sciences and general information, vol. 39(7), serial no. 739. University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1942. Bulletin: the University of Georgia, general catalog, 1942–1943, vol. 42(5), serial no. 822. University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1950a. Bulletin: University of Georgia Graduate School, 1950–1951, vol. 50(9a), serial no. 990. University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1950b. Bulletin: the University of Georgia, the College of Arts and Sciences, 1950–1951, vol. 50(10e), serial no. 996. University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1962. Bulletin of the University of Georgia, general catalogue, vol. 62(7), serial no. 1209. University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1971a. The University of Georgia bulletin, Graduate School, vol. 72(1), serial no. 1332. University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1971b. The University of Georgia bulletin 1971–1973, vol. 72(2), serial no. 1333. University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1977a. The University of Georgia bulletin 1977–79, vol. 76(2). University of Georgia, Athens, Georgia.

University of Georgia [UGA]. 1977b. The University of Georgia bulletin 1977–79, Graduate School, [no vol.]. University of Georgia, Athens, Georgia.

Yates, I.E. 1969. Comparative studies of *Smilax*, Section *Eusmilax*, of the southeastern United States. M. S. thesis, University of Georgia, Athens, Georgia.

Yates, I.E. and W.H. Duncan. 1970. Comparative studies of *Smilax*, Section *Smilax* of the southeastern United States. Rhodora 72:289–312.

Zomlefer, W.B. and D.E. Giannasi. 2005a. In memoriam, Wilbur H. Duncan, 1910–2005. ASPT Newsletter 19: (1):3. Available at www.inhs.uius.edu/~kenr/ASPT/in_memoriam.html.

Zomlefer, W.B. and D.E. Giannasi. 2005. Wilbur H. Duncan—A Remembrance. Castanea 70:81–84.

Zomlefer, W.B. and D.E. Giannasi. 2005c. Announcements. In Memoriam. Wilbur Howard Duncan, 1910–2005. Pl. Sci. Bull. 51:1. Available at www.botany.org/PlantScienceBulletin/2005/psb51-2.html.

Zomlefer, W.B. and D.E. Giannasi. 2005d. Wilbur H. Duncan, 1910–2005. Southeastern Biology 52: (in press).

BOOK REVIEWS

BRIAN CAPON. 2005. **Botany for Gardeners. Revised Edition.** (ISBN 0-88192-655-8, pbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $19.95, 240 pp., 147 color photos, 3 color drawings, 1 b/w photo, 53 line drawings, 4 tables, 6" × 9".

Botany for Gardeners by Brian Capon is a handy and well-written book for those who wish to learn more about botany and plant ecology. Many naturalists and gardeners already appreciate plants, but often have unanswered questions about the plants they enjoy. For instance—why do roots grow down and shoots grow up? How do water and nutrients move through a plant? What are all the parts of a plant and flower? How do plant grafts work? What are mycorrhizae? What is the purpose of all the different nutrients in fertilizer? These and so many other botanical questions are answered and explained in this book. *Botany for Gardeners* is lavishly peppered with color photographs and black and white drawings that coordinate with ideas and topics being discussed in the text. These images, some of which are from a microscope, enhance the readers understanding of plant structure and make-up.

There are five main sections in the book: growth, organization of plant structures, adaptations, plant functions and reproduction. Each main section is broken down into reasonably sized sub-chapters.

The section discussing plant growth starts with the basics of a plant cell through seed germination and continues into the roots, shoots, leaf growth, and leaf maturity. The section on organization gives the reader an inside look at stems and roots, emphasizing their cellular organization and cell types. The adaptation section introduces the reader to all the ways that plants adapt to various environmental challenges; among these are climate variations, protection from animal browsing, wound healing, chemical protection, and finally enhancing a plants ability to compete in and among other plants for space, light, water, and nutrients. This section also includes an interesting discussion about plant food sources, water storage, and beneficial relationships with fungi.

The section on plant functions covers growth responses to light, gravity, touch, branching, adventitious root formation, and the hormones and environmental conditions involved in those functions. Mineral nutrient requirements, water and mineral uptake and transport within the plant are discussed, as well as the process of photosynthesis.

The final section covering plant reproduction includes discussion of flower parts, pollination, pollination strategies, fruit types, seed formation, and seed dispersal. The final chapter of the reproduction section includes a plant genetics primer that introduces readers to the life cycles of mosses, ferns, and flowering plants, Punnet squares, and gene expression. Some of the valuable tidbits included throughout the chapters are a table listing the origins of garden and many agricultural crop plants, distinct definitions and photographs of spines, thorns and prickles, a list of poisonous household plants, a primer on plant genetics, and an appendix discussing plant naming classification.

Botany for Gardeners not only cover the basics, but also can take a reader much deeper into the details of photosynthesis and plant genetics. Some of the topics may be beyond what any particular reader would like to know. The author does a good job of presenting topics such as photosynthesis, respiration and genetics, which, by nature can be frustrating to understand. The photographs and figures will really help the reader understand what is being discussed; especially items such as cellular organization or structural development where a microscope would be needed to view and understand the topic properly. Whether you are looking for that book that will introduce you to the basics of plant biology, are looking to answer gardening questions, or need a book to help you create a botanical background to learn to use an identification text, *Botany for Gardeners* is the book for you!—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Robert Ornduff, Phyllis M. Faber, and Todd Keller-Wolf. 2003. **Introduction to California Plant Life: Revised Edition.** (ISBN 0-520-23704-8, pbk.). California Natural History Guides No. 69. University of California Press, Berkeley, CA 94704, U.S.A (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax; www.ucpress.edu). $16.95, 341pp., charts, color photos, glossary, 4 1/2" × 7 1/4".

Introduction to California Plant Life has been revised from the 1974 edition and is one of the best resources for learning about the ecology of California flora The text is best suited for people who already have an understanding of biology and ecology because it sometimes uses botanical terms to define other botanical terms.

Introduction to California Plant Life covers all bases in regards to the many varied ecosystems that exist in California, a state known for a wide range of plant life. The opening chapters describe the topology, climate, and soils of California; they do an excellent job of explanation and provide examples of how both the non-living characteristics and the biological components of an area can influence which plant species grow where. An example of these relationships is that of the salt grass (*Distichilis spicata*), a grass species that can tolerate extreme saline conditions that would kill most plants. Also discussed are the effects of other physical/biological parameters in the environment including exposure, microbial, fungal, allelopathy, pollinators and moisture. Finally, the topic of variation within species because of adaptations to local climate and soil conditions, i.e. ecotypes, is developed with reasonable detail.

Three chapters of the book discuss the broad plant communities in California cismontaine (west of the Sierra Nevada crest), montane (high mountain areas), and transmontane (East of Sierra Nevada crest including deserts). Each broad plant community category includes a number of smaller vegetation categories. For example, the montane regions include areas of alpine fell field, montane meadow, and montane coniferous forest The method and focus of the discussion of each broad category allows the reader to follow the included color photos and maps to get a physical understanding of what plants they should find where.

The authors provide a thorough explanation of their classification system for this book. Information on each plant community and indicator species is placed in charts for easy comparison. The authors also provide a chart comparing the common California plant classification systems in the literature. The chapters describing each broad classification community include specific climatic and environmental conditions: among these being strong winds, elevation, rainfall, length of growing season, salinity, fire and poor soil nutrients This type of discussion is very helpful in relating species adaptations to local conditions. A good example is the discussion of the growth habits of species in areas frequented by fire, a common occurrence in parts of California.

An especially intriguing chapter is that of the history of botanical exploration in California The detailed study includes not only the explorers and collectors, but also the notable species they found in the Golden State One example is that of red rose sand verbena (*Abronia umbellata*). Found in California, it was the first plant in western North America to be named using the Linnaean taxonomic rules. This chapter also highlights the fact that many of the important people in plant taxonomy were all involved in California botanical research at one point in time; among the notables are Pursh, Parry, Bigelow, Torrey, Gray and Engleman.

In addition to the history of the California researchers, the authors also include valuable historical information on the evolution of California vegetation itself The changes in California flora are presented by discussion of geoflora and climate change, the focus being on the redistribution of flora throughout geological time. This approach was helpful for this reader to better understand the influence of a regions physical characteristics as well as climatic influence that occur with time. This chapter ends with an overview of the fossil history of coastal redwoods.

Included in the final chapter are modern topics including climate change, human practices, distribution of plants, agriculture and grazing practices, invasive weeds, habitat loss, habitat restoration and biodiversity.

The new edition of *Introduction to California Plant Life* is a wonderful resource for anybody looking to learn more about the ecology of California flora. Keep in mind that some familiarity with botany and ecology concepts will greatly increase the usefulness and ease of reading. Throughout the book, the information and discussions are accented with color photos of plant species and regional characteristics. The authors' inclusion of historical information, anecdotes, and interesting factoids enhances the readers understanding of plant life throughout the state of California. The next time you embark on a California adventure, be sure to bring along this book.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Ronald L. Jones. 2005. **Plant Life in Kentucky: An Illustrated Guide to the Vascular Flora.** (ISBN 0-8131-2331-3, hbk.). The University Press of Kentucky, 663 South Limestone Street, Lexington, KY 40508-4008, U.S.A. (**Orders:** 800-839-6855, fax 859-257-8481, www.universitypress.com). $75.00, 834 pp., 1984 b/w line drawn illustrations, 16 tables, 20 figures, 7" × 10".

Plant Life in Kentucky: An Illustrated Guide to the Vascular Flora is a monumental work—it will serve as a comprehensive reference guide to the plant life in Kentucky and an identification manual of the vascular plants for generations of botanists in the Commonwealth. Jones' manual provides the first complete comprehensive treatment of all the known native and naturalized vascular plants of Kentucky, and presents the first set of identification keys for any state flora in the south-central United States. It is the first state flora to incorporate a significant number of the recently proposed major changes in the classification and nomenclature of vascular plants, e.g., Asteraceae and Liliaceae (Jones 2005; SE Biology 52:118), while basically following Gleason and Cronquist's (1991) *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. Individuals will also find it valuable for the flora of Tennessee as most vascular plants in east-central, central, and western Tennessee are included in the keys.

Jones' *Plant Life in Kentucky: An Illustrated Guide to the Vascular Flora* is essentially two books combined: Part I, Introduction, and Part II, Taxonomic Treatment.

Part I, Introduction, the outstanding reference guide to Kentucky flora, is comprised of 12 sections: Section 1, Overview of This Book—covers plants treated, arrangement of taxa, abbreviated family descriptions, use of keys and abbreviations, sources of information, nomenclature, flowering period, habitats, distributions by physiographic province, relative abundance, non-native species, wetland categories, and a summary of the flora; Section 2, The Physical Setting of Kentucky—contains Kentucky descriptive material, climate, and natural regions by physiographic provinces, forest regions, and ecoregions (Appalachian Plateaus, Interior Low Plateaus, and Mississippi Embayment); Section 3, Vegetation of Kentucky—discusses the forest regions and various plant communities of Kentucky including endangered, threatened, and rare plants; Section 4, Floristic Affinities—intraneous and extraneous floristic affinities are discussed for taxa among the Kentucky floristic regions or ecoregions; Section 5, Endemics—lists plants endemic to Kentucky or to Kentucky and nearby states; Section 6, Conservation Status—covers levels of plant protection in the United States on the international, national, and state-listed species; Section 7, Status of Old-growth Forest—discusses the historical reports and current old-growth forest in Kentucky; Section 8, History of Plant Conservation in Kentucky—deals with biodiversity issues and the preservation of Kentucky biodiversity by state, federal, and private agencies; Section 9, History of Plant Life in Kentucky—begins with a Geological Overview through the Paleozoic, Mesozoic, and Cenozoic eras, their respective geological periods, and the origins of the flora and then concludes with the impact on the vegetation and flora by the Native Americans and influence of Presettlement Conditions; Section 10, Postsettlement Changes in the Plant Life of Kentucky—begins with the effects of habitat alterations from logging, coal mining, wetland losses, acid precipitation and ozone damage, global warming, fungal, animal, and naturalized pests, and concludes with the effects of overzealous harvesting of plants for medicinal or ornamental uses; Section 11, History of Floristic Botany in Kentucky—commemorates the significant men and women contributors to the Kentucky flora from the Antebellum Period, Civil War and Postbellum Period, and Modern Field Botany to the Present; and Section 12, Current Status of Floristic Botany in Kentucky—presents an overview of today's needs to document the botanical biodiversity by geographical regions and counties. Part I consists of 105 pages and ends with an extensive Literature Cited of 439 references.

Part II, the Taxonomic Treatment, consists of diagnostic keys to families, genera, and species present or to be discovered in Kentucky. A total of 179 families, 856 genera, and 2600 specific and infraspecific taxa are treated. Illustrations consist of 1984 black-and-white line drawings, most from Britton and Brown's (1913) three volume work, *An Illustrated Flora of Northern United States and Canada*.

Plant families are determined from the General Keys to Vascular Plants of Kentucky, which lead to four groups: Chapter 1, Pteridophytes of Kentucky; Chapter 2, Gymnosperms of Kentucky; Chapter 3, Dicotyledonae of Kentucky, and Chapter 4, Monocotyledonae of Kentucky. All four chapters have the families, genera, and species listed alphabetically—a highly convenient way to present taxa to workers. These four groups includes family descriptions (habit, leaf arrangement, composition, stipules, flower sex and symmetry, inflorescence type, floral formula, and fruit type), family notes (information on wildlife use and/or human use, important weeds, poisonous plants, and medicinal herbs), and relevant references. The species accounts lists the scientific name, an accepted common name, relevant synonymy, flowering periods, habitat, physiographic distribution, relative abundance, and state/federal designations, and national wetland classification rating. Also, workers can readily locate a family by using the Family Index inside the back cover, then finding the alphabetically-listed genera and species.

The family, genera, and species keys work remarkably well and it is enlightening to find keys that work for plant identification which are complete enough to make accurate identifications, yet not overly complicated to use. A complete, well-defined glossary is available for the vegetative and reproductive morphological terms used in the keys.

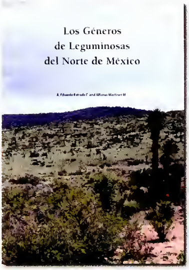
The Literature Cited contains 288 references cited in Part II, Taxonomic Treatment. Five appendices follow the Literature Cited: Appendix One, Glossary, consists of nearly 1500 terms as modified from Diggs, Lipscomb, and O'Kennon's (1999) *Shinners & Mahler's Illustrated Flora of North Central Texas*; Appendix Two, Index of Part I; Appendix Three, Index of Scientific Names in Part II; Appendix Four, Index of Common Names in Part II; and Appendix Five, Index of Poplar Books (with Color Photographs) on the Flora of the South-central United States and the Southern Appalachians. Part II consists of 728 pages with the total book composed of 834 pages.

Plant Life in Kentucky: An Illustrated Guide to the Vascular Flora is essential for all persons interested in natural history and vascular plants of Kentucky and the south-central United States in general—it is indispensable for botanists in the Commonwealth. Jones' manual is the most comprehensive and encyclopedic state flora east of the Mississippi River. This remarkable book should be is an important addition to the library of every botanist in the eastern United States—*Ralph L. Thompson, Herbarium, Department of Biology, Berea College, Berea, KY 40404-2121, U.S.A., ralph_thompson@berea.edu*

This illustrated monograph is the most comprehensive generic treatment of legumes for any geographical area of Mexico. The book covers the genera of legumes known to be present in northern Mexico from Tamaulipas to Baja California Sur. The introductory material covers topography, climate, and vegetation types of northern Mexico. Included are 121 genera treated in three families: Fabaceae, Mimosaceae, and Caesalpiniaceae. The Fabaceae is the most abundant family with 87 genera followed by Mimosaceae (19) and Caesalpiniaceae (15). Keys to the families, tribes (only in Fabaceae), genera, and detailed line drawings of distinguishing characteristics are included for most of the genera to facilitate identification. Each genus is provided with a description, followed by distributional information, species number, chromosome number, and economic, ecological, and potential food importance.

Available from
Botanical Research Institute of Texas Press
509 Pecan Street
Fort Worth, TX 76102-4060, USA
E-mail: sida@brit.org • Fax 1-817-332-4112
www.brit.org/Sida/Sida25.htm

Sida, Bot. Misc. No. 25, 2004
issn 0833-1475, isbn 1-889878-13-8 • 7" × 10", x + 134 pp,
over 500 individual drawings.
$25 + p&h • (USA $3; International $7)
Texas residents add $2.06 sales tax



**Los Géneros
de Leguminosas
del Norte de México
(The Genera of Legumes
of Northern Mexico)**

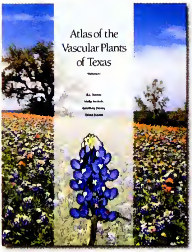
By
A. Eduardo Estrada C.
and
Alfonso Martínez M.

BRIT
PRESS

The Atlas of Texas covers about 6000 taxa. This is the result of 54 years of herbarium and fieldwork by B.L. Turner, beginning in 1948 at Sul Ross State University, Alpine, Texas. In short, the senior author has examined personally, touched, or "pored over" an estimated several hundred thousand sheets in the preparation of the forthcoming Atlas volumes. Contents include an introduction, atlas of Texas plants arranged alphabetically by family, by genus, by species, and an index.

Available from
Botanical Research Institute of Texas Press
509 Pecan Street
Fort Worth, TX 76102-4060, USA
E-mail: sida@brit.org • Fax 1-817-332-4112
www.brit.org/Sida/Sida/24.htm

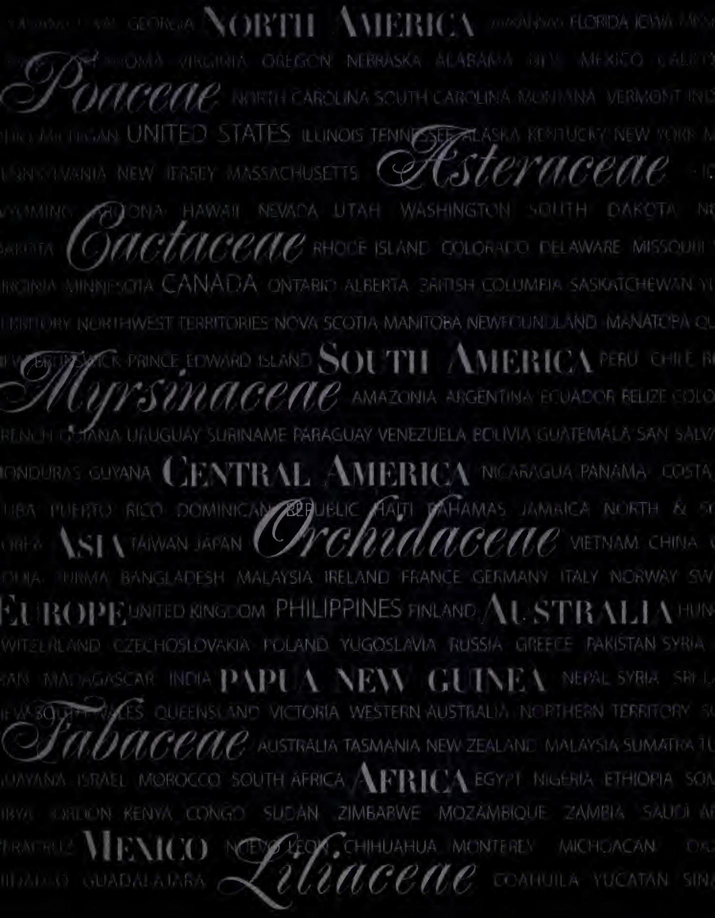
Sida, Bot. Misc. No. 24, 2003, issn 0833-1475,
isbn (vol. 1) 1-889878-08-1 • isbn (vol. 2) 1-889878-09-X • 7 1/2" × 10"
Vol. 1 approx. 630 pp. • Vol. 2 approx. 275 pp.
Vol. 1 $50 + p&h* • Vol. 2 $40 + p&h* • Set $80 + p&h*
*USA: $10 (vol. 1); $9.50 (vol. 2); $12 (set)
*International: $12.50 (vol. 1) • $11.50 (vol. 2); $25 (set)
Texas residents add sales tax: $4.13 (vol. 1) • $3.30 (vol. 2) • $7.43 (set)



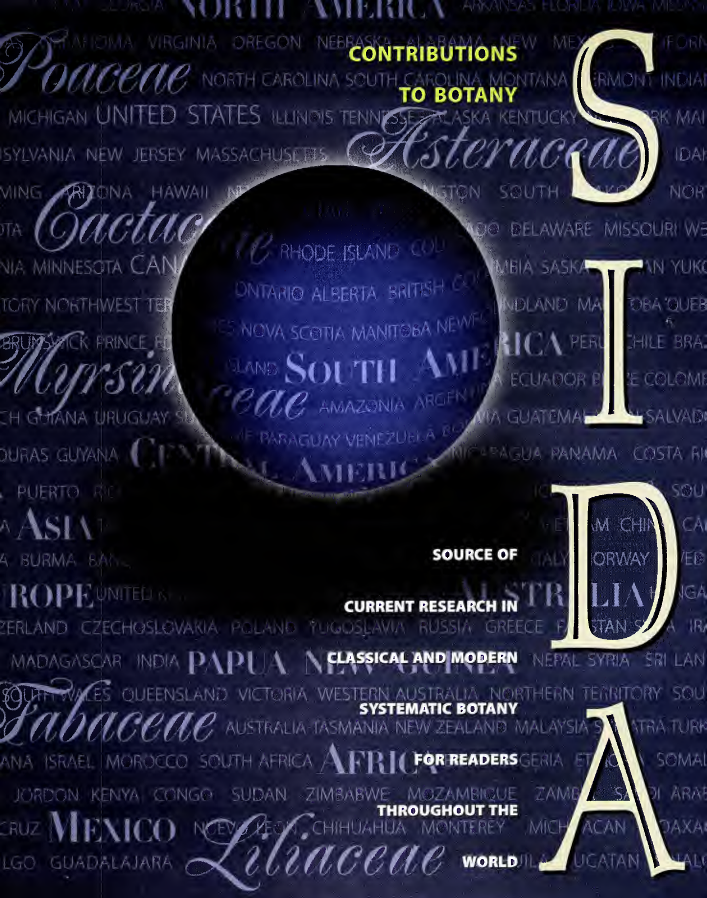
**Atlas of the
Vascular Plants of Texas**

By
B.L. Turner,
Holly Nichols, Geoffrey Denny,
Oded Doron

BRIT
PRESS



ISSN 0036-1488



CONTRIBUTIONS
TO BOTANY

SIDA

SOURCE OF
CURRENT RESEARCH IN
CLASSICAL AND MODERN
SYSTEMATIC BOTANY
FOR READERS
THROUGHOUT THE
WORLD

VOLUME 21 NUMBER 4 21 DECEMBER 2005

BOTANICAL RESEARCH INSTITUTE OF TEXAS

SIDA CONTRIBUTIONS TO BOTANY WAS FOUNDED BY LLOYD H. SHINNERS (LEFT) IN 1962. INHERITED BY WILLIAM F. MAHLER (RIGHT), DIRECTOR EMERITUS OF BRIT IN 1971, AND SINCE 1993, IT HAS BEEN PUBLISHED BY BRIT PRESS.

◆

BARNEY L. LIPSCOMB, EDITOR

Botanical Research Institute of Texas

509 Pecan Street

Fort Worth, Texas 76102-4060, USA

817 332 4441 / 817 332-4112 FAX

Electronic mail: sida@brit.org

Home page at the URL: http://www.brit.org/sida/

JOHN W. THIERET, ASSOCIATE EDITOR

Dept. of Biological Sciences

Northern Kentucky University

Highland Heights, KY 41099 USA

FÉLIX LLAMAS, CONTRIBUTING SPANISH EDITOR

Dpto. de Botánica, Facultad de Biologia

Universidad de León

E 2471 León, SPAIN

Guidelines for contributors are available upon request and on our SIDA home page as well as the last pages of each volume.

Subscriptions for year 2006.

$39. Individual

$75. USA Institutions

$85. Outside USA

numbers issued twice a year

SIDA, CONTRIBUTIONS TO BOTANY

BRIT
PRESS

SIDA, CONTRIBUTIONS TO BOTANY

VOLUME 21, NUMBER 4, PAGES 1955–2511.

21 DECEMBER 2005

PRINTED IN THE UNITED STATES OF AMERICA

ISSN 0036-1488

TABLE OF CONTENTS

SYSTEMATICS

CHROMOSOME NUMBERS

ETHNOBOTANY

BOTANICAL HISTORY

FLORISTICS, ECOLOGY, AND CONSERVATION

Index to new names and new combinations in Sida 21(4), 2005

TWO NEW SPECIES OF *CALYPTRANTHES* (MYRTACEAE) FROM ECUADOR

Maria Lúcia Kawasaki

Botany Department, The Field Museum
1400 South Lake Shore Drive
Chicago, Illinois 60605-2496, U.S.A.
lkawasaki@fmnh.org

Bruce K. Holst

Marie Selby Botanical Gardens
811 South Palm Avenue
Sarasota, Florida 34236, U.S.A.
bholst@selby.org

ABSTRACT

Calyptranthes glandulosa and **Calyptranthes ishoaquinicca**, two new species from Ecuador, are described and illustrated.

RESUMEN

Se describen y se ilustran dos especies nuevas de Myrtaceae del Ecuador, **Calyptranthes glandulosa** y **Calyptranthes ishoaquinicca**.

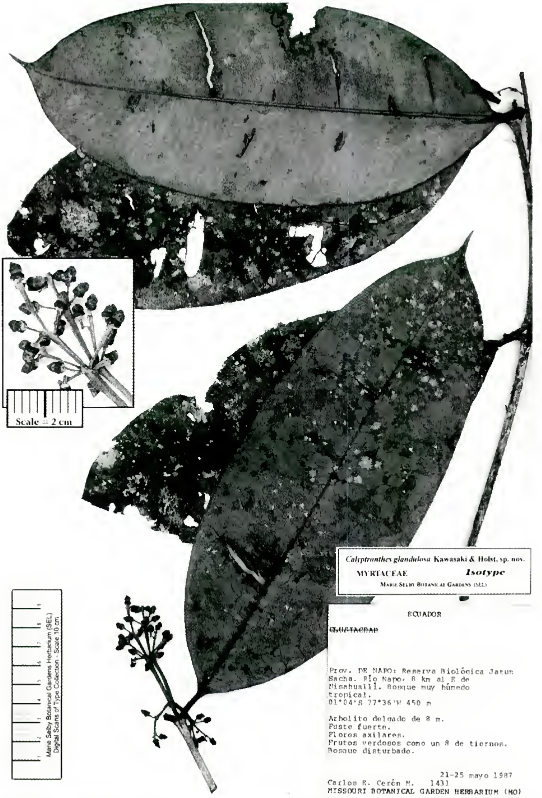
INTRODUCTION

Calyptranthes is a genus of more than 100 species ranging from Mexico to northern Argentina (Landrum & Kawasaki 1997). It is characterized by the usually paired panicles, the closed calyx opening as a calyptra, and, in many species, dichotomous branching. About 30 species are found in Ecuador, many of them new to science (Holst 1999). Two of these, *Calyptranthes glandulosa* and *Calyptranthes ishoaquinicca*, are described and illustrated in this paper.

Calyptranthes glandulosa M.L. Kawasaki & B. Holst, sp. nov. (**Fig. 1**). TYPE: ECUADOR. ORELLANA ("NAPO" on label): Reserva Biológica Jatun Sacha, Río Napo, 8 km al E de Misahualli, 01°04'S, 77°36'W, 450 m, 21–25 May 1987 (fl), *C. Cerón 1431* (HOLOTYPE: QCNE; ISOTYPES: F, MO, NY, SEL).

Arbuscula. Folia elliptico-oblonga, siccata supra olivacea, subtus brunnea, utrinque grosse pellucido-punctata; nervo medio supra sulcato. Panicula pauciflora; alabastra ochraceo-pilosa. Bacca globosa, glabra.

Small shrubs or trees 2–6 m tall, the trichomes where present yellowish, bifurcate. **Leaf blades** elliptic to oblong or less commonly obovate, 16.6–28(–34) × 5.1–10.5(–20) cm, coriaceous, with conspicuous, dark, convex glands on both surfaces, discolorous when dry, the upper surface olive-green, glabrous, the lower surface brownish-green to light-brown, nearly glabrous, with a few scattered trichomes; apex abruptly acuminate, the acumen 1–2 cm long; base obtuse to cuneate; midvein sulcate above, convex below; lateral veins 20–25 pairs, convex on both surfaces; marginal veins 2, the innermost 3–5 mm from blade margin; petiole 1.1–2 cm long, canaliculate, glabrous, drying blackish. **Inflorescences** paired reduced panicles with ca. 5–20 flowers per panicle, 1.5–5.5 cm long, the



Calyptranthes glandulosa Kawasaki & Holst, sp. nov.
MYRTACEAE **Isotype**
Marie Selby Botanical Gardens (SEL)

ECUADOR

~~CLUSIACEAE~~

Prov. DE NAPO: Reserva Biológica Jatun
Sacha. Río Napo, 8 km al E de
Misahuallí. Bosque muy húmedo
tropical.
01°04'S 77°36'W 450 m

Arbolito delgado de 8 m.
Fuste fuerte.
Floros axilares.
Frutos verdosos como un 8 de tiernos.
Bosque disturbado.

21-25 mayo 1987
Carlos E. Cerón M. 1431
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)

Fig. 1. *Calyptranthes glandulosa* M.L. Kawasaki & B. Holst (*Cerón 1431*: isotype, SEL).

axes pubescent; flower buds ovoid, somewhat constricted in the middle, ca. 4 mm long, distinctly gland-dotted, sessile; bracteoles deciduous, not seen; calyx calyptrate, glabrescent, deciduous; petals absent; stamens ca. 90, the filaments ca. 6 mm long, the anthers ca. 0.5 mm long; style ca. 6 mm long; hypanthium prolonged 1–2 mm beyond the ovary, tomentose without; ovary 2-locular, with 2 ovules per locule. **Fruits** globose, ca. 1.5–2 cm diam., crowned by a circular hypanthium scar, gland-dotted, glabrous; seeds 1–2, ca. 9 × 7 mm, the seed coat membranous; embryo myrcioid, the cotyledons leafy and folded, the radicle well developed, equaling cotyledons in length.

Distribution.—Known only from Amazonian Ecuador, in lowland humid forests, at 200–450 m elevation.

Among the large-leaved species of *Calyptranthes* in Ecuador, *Calyptranthes glandulosa* is readily recognized by the leaf-blades with conspicuous, dark glands on both surfaces. The flowers appear distorted in bud as though diseased. No specimens are known at anthesis, though pollination is evidently occuring as several specimens bear fruit. It is possible that this species has cleistogamous flowers or perhaps a pathogen is present that is interrupting the normal flowering and fruiting sequence.

Additional collections examined: **ECUADOR. Orellana:** Payamino, Reserva Florística "El Chuncho," bosque primário, Estación Experimental INIAP-Napo, 5 km al NW de Coca, 00°30'S, 77°01'W, 250 m, 13 Dec 1987 (fl), *C. Cerón & W. Palacios 3002* (MO, SEL). Yasuní Forest Reserve, 1–2 km E of Pontificia Universidad Católica del Ecuador Sci. Station, 00°40.853'S, 76°23.697'W, 225 m, 23 Jun 1995 (fr), *P. Acevedo-Rodriguez & J.A. Cedeño 7502* (SEL); Orellana, Parque Nacional Yasuní, Carretera y oleoducto de Maxus en construcción Km. 32, al S del Río Tiputini, 00°37'S, 76°29'W, 250 m, 8–10 Feb 1994 (fl), *M. Aulestia 1720* (MO, SEL); Estación Científica Yasuní, Tiputini River, NW of confluence with Tivacuno River; 6 km E of Km 44 on main Maxus Road, on spur road toTivacuno oilwell, 00°38'S, 76°30'W, 200–300 m, 23 Oct 1996 (st), *R. Foster, K. Romoleroux, M. Bass & G. Villa 15700* (F, QCA); Estación Científica Yasuní, Río Tiputini, al NO de la confluencia con el Río Tivacuno, E de la carretera Maxus, Km 44, desvio hacia el pozo Tivacuno, parcela de 50 ha, 00°38'S, 76°30'W, 200–300 m, 12 Jun 1995 (fr), *K. Romoleroux & R. Foster 1697* (F, QCA); Estación Científica Yasuní, Río Tiputini, al NO de la confluencia con el Río Tivacuno, 6 km E de la carretera Maxus, Km 44, desvio hacia el pozo Tivacuno, parcela de 50 ha, 00°38'S, 76°30'W, 200–300 m, 21 Nov 1995 (fl), *K. Romoleroux & R. Foster 2031* (F, QCA); Estación Científica Yasuní, Río Tiputini, al NO de la confluencia con el Río Tivacuno, 6 km E de la carretera Maxus, Km 44, desvio hacia el pozo Tivacuno, parcela de 50 ha, árbol #102694, 00°59'S, 77°45'W, 200–300 m, 30 Oct 1997 (fl), *K. Romoleroux, G. Villa & P. Asimbaya 3191* (F, QCA), Estación Científica Yasuní, Río Tiputini, al NO de la confluencia con el Río Tivacuno, E de la carretera Repsol-YPF, Km 7 desvío hacia el pozo Tivacuno, Laguna Herradura, 00°38'S, 76°09'W, 200–300 m, 15 Oct 1999 (fl), *G. Villa & C. Flores 192* (F, QCA). **Pastaza:** Pastaza Canton, Pozo petrolero "Ramirez," 20 km al S de la población de Curaray, 01°32'S, 76°51'W, 300 m, 21–28 Feb 1990 (fl, fr), *V. Zak & S. Espinoza 4906* (MO, SEL).

Calyptranthes ishoaquinicca M.L. Kawasaki & B. Holst, sp. nov. (**Fig. 2**). TYPE: ECUADOR. SUCUMBÍOS: Fundación Sobrevivencia Cofán, Sinangoe Station, Río Sieguyo, near confluence with Río Alto Aguarico, across from Puerto Libre, NW of Lumbaqui, foothills of the Andes, 40m tall lowland hill-forest on gentle ridgeslopes with clay soils, 00°10'45"N,

Fig. 2. *Calyptranthes ishoaquinicca* M.L. Kawasaki & B. Holst (*Aguinda et al. 1345*: isotype, F).

77°29'50"W, 600–800m, 16 Aug 2001 (buds, fr), *R. Aguinda, N. Pitman & R. Foster 1345* (HOLOTYPE: QCNE; ISOTYPES: F, SEL).

Frutex. Folia lanceolata, supra olivacea, subtus flavo- vel pallide-viridia; nervo medio supra sulcato; apice longiuscule acuminata. Inflorescentia 3-flora; alabastra ochraceo-pilosa, apiculata. Bacca globosa, glabra.

Shrubs 1–2 m tall, the trichomes where present yellowish-brown, bifurcate; young stems narrowly 4-winged to 4-angled, quadrangular in cross section. **Leaf blades** lanceolate, 8–14.3 × 1.8–3.6 cm, chartaceous, discolorous when dry, the upper surface olive-green, glabrous, the lower surface yellowish- to brownish-green, nearly glabrous, with a few scattered trichomes especially on the midvein; apex narrowly acuminate to caudate-acuminate with a slender acumen to 3.5 cm long; base obtuse to cuneate; midvein sulcate above, convex below; lateral veins ca. 14–17 pairs, impressed to strongly impressed above, raised below; marginal veins 2, the innermost 1–3 mm from blade margin; glandular dots indistinct on the upper surface, numerous and convex on the lower surface; petiole 1–2 mm long, canaliculate, puberulous, drying blackish. **Inflorescences** paired, (1–)3(–4)-flowered spikes, 2–6 cm long, the axes glabrous, nodding; bracts lanceolate, ca. 5 × 1 mm, puberulous, deciduous; flower buds obovoid, 2–3 mm long, pubescent, apiculate, sessile; bracteoles deciduous, not seen; calyx calyptrate, glabrescent, deciduous in mature fruit; petals absent; stamens ca. 50, the filaments ca. 6 mm long, the anthers ca. 0.5 mm long; style ca. 10 mm long; hypanthium prolonged ca. 1 mm beyond the ovary, tomentose to strigose without; ovary 2-locular, with 2 ovules per locule. **Fruits** globose, 7–9 mm diam., crowned by circular hypanthium scar, orange-red to dark-purple, glabrous; seeds 1–2, ca. 6 × 5 mm, the seed coat membranous; embryo myrcioid, the cotyledons leafy and folded, the radicle well developed, equaling cotyledons in length.

Distribution.—Known only from Ecuador (Sucumbíos and Pastaza), in lowland to montane forests, at 430–800 m elevation.

Calyptranthes ishoaquinicca, well known as "ishoa quinicco" in the Cofán villages (Pitman et al. 2002), has traditionally been used in a Cofán coming-of-age ceremony for young men (12–15 years old), as a purgative to impart strength for their adult lives; they drink a concoction prepared from this plant for ca.10 days, accompanied by much vomiting. It is distinguished from all other species of the genus in Ecuador by having short, 3-flowered inflorescences and chartaceous, narrowly acuminate leaves, with impressed lateral veins.

Additional collections examined: **ECUADOR. Pastaza:** Villano, Pandanuque, encima de colina al S del pozo petrolero Villano 2 de ARCO, 01°28'S, 77°27'W, 550 m, 30 Ago 1987 (fr), *A. Alvarez, H. Vargas & E. Freire 2410* (F, MO, QCNE, SEL); Cantón Arajuno, Parroquia Villano, linea propuesta por ARCO para el oleoducto, Campamentos 4 a 5, Km 10 de Villano, 430 m, 01°28'S, 77°31'W, 3–7 Jul 1998 (fl), *E. Freire & M. Innunda 3182* (MO, SEL). **Sucumbíos:** Alto Río Aguarico, Río Sieguyo, upriver from Sinangue along Northern border of Reserva Cayambe-Coca, small tributary across Aguarico SE of Puerto Libre, steep forested ridgeslopes, 00°10'82"N, 77°29'83"W, 580–700m, 13 Jul 2000 (fr), *R. Aguinda, R. Foster, M. Metz & T. Theim 955* (F, QCNE).

ACKNOWLEDGMENTS

We thank Robin Foster and the herbaria cited in the manuscript for the collections. Thanks to Anna Balla for preparing the digital images. Helpful suggestions from Fred Barrie, Robin Foster, and Les Landrum are also acknowledged.

REFERENCES

Holst, B. 1999. Myrtaceae. In: P.M. Jørgensen and S. León-Yánez, eds. Catalogue of the vascular plants of Ecuador. Monogr. Syst. Bot. Missouri Bot. Gard. 75:618–622.

Landrum, L.R. and M.L. Kawasaki. 1997. The genera of Myrtaceae in Brazil: an illustrated synoptic treatment and identification keys. Brittonia 49:508–536.

Pitman, N., R. Foster, and R. Aguinda. 2002. Endemic plants. In Pitman, N., D.K. Moskovits, W.S. Alverson, and R. Borman A., eds. Ecuador: Serranías Cofán – Bermejo, Sinangoe. Rapid Biological Inventories Report 3. Chicago, Illinois: The Field Museum.

REVISION OF *SIOLMATRA* (CUCURBITACEAE: ZANONIEAE)

George L. Robinson
USDA APHIS, Plant Protection and Quarantine
Port Everglades
1800 Eller Drive, Suite 414
Fort Lauderdale, Florida 33316, U.S.A.

Richard P. Wunderlin
Department of Biology, SCA 110
University of South Florida
Tampa, Florida 33620-5200, U.S.A.

ABSTRACT

A treatment of the neotropical genus *Siolmatra* is presented. Two species are recognized with descriptions, illustrations, distribution data, and a key to the species provided.

RESUMEN

Se presenta un tratamiento del género neotropical *Siolmatra*. Se reconocen dos especies con descripciones, ilustraciones, datos de distribución, y se aporta una clave de identificación de especies.

The genus *Siolmatra* (Cucurbitaceae) was erected by Baillon (1885) to accommodate *Siolmatra brasiliensis* (Cogn.) Baill. which had resided in the heterogenous genus *Alsomitra* (Blume) M. Roem., now restricted to the Old World. The name *Siolmatra* is an anagram of *Alsomitra*. Subsequently, Baillon (1886) abandoned *Siolmatra*, but Cogniaux (1893) resurrected it and described a second species (*S. paraguayensis*). Cogniaux (1916) later added one new species (*S. amazonica*) and two transferred from *Alsomitra* (*S. pedatifolia* (Cogn.) Cogn. and *S. peruviana* (Huber) Cogn.). Harms (1926) described a sixth species (*S. pentaphylla*), later a seventh (Harms 1933) (*S. simplicifolia*), and Standley (1937) an eighth (*S. mexiae*).

Jeffrey (1962) noted the incongruent mixture of taxa in *Siolmatra* which had been distinguished from *Fevillea* on the basis of leaf type; viz., simple in *Fevillea* versus 3- to 5-foliolate in *Siolmatra*. He redefined the two genera and transferred all taxa to *Fevillea* except *S. brasiliensis*, *S. pentaphylla*, and *S. paraguayensis*. These were maintained by Jeffrey (1978) in his enumeration of the New World Cucurbitaceae. Two species of *Siolmatra* are recognized here. The main distinctions between *Fevillea* and *Siolmatra* are presented in the following key.

1. Leaves with petiolar or laminar glands; calyx with 5 free lobes, these with glandular squamellae (except *F. passiflora*); petals with a medial adaxial flap-like appendage or ridge; staminate flowers with bilocular anthers; fruit globose, usually indehiscent; seeds not winged ______ **Fevillea**
1. Leaves lacking glands; calyx with two pairs of calyx lobes connate, the fifth one free (calyx appearing 3-lobed), glandular calycine squamellae lacking; petals lacking a medial adaxial flap-like appendage or ridge; staminate flowers with unilocular anthers; fruit opening apically by 3 triangular valves; seeds with marginal wings ______ **Siolmatra**

SYSTEMATIC TREATMENT

Siolmatra Baill., Bull. Mens. Soc. Linn. Paris 1:458. 1885. TYPE: *Siolmatra brasiliensis* (Cogn.) Baill. BASIONYM: *Alsomitra brasiliensis* Cogn.

Dioecious tendriled vine or liana; stems slender, sulcate. Leaves pedately 3- to 5-foliolate, petiolate, the leaflets ovate to elliptic, petiolulate or rarely subsessile. Tendrils slender, slightly sulcate, bifurcate distally, coiling both above and below the bifurcation. Staminate inflorescences many-flowered, in axillary panicles on the upper part of the stem, the leaves often reduced upwards; flower buds globose, pedicellate; bracts minute; hypanthium pedicelloid, slender; calyx 5-merous, with 2 pairs of calyx lobes connate, the fifth free (the calyx appearing 3-lobed); petals 5, white, greenish white, or greenish yellow, obdeltoid or obcordate, short-clawed, the inner surface papillate; stamens 5, the filaments slender, the anthers 1-loculate, the locules horizontal or vertical, the filament extension with a dorsal, glandular, hornlike projection. Pistillate inflorescences many-flowered, in axillary racemes or panicles, the leaves often reduced on the flowering branches; flower buds conical; bracts minute; hypanthium conical; calyx 5-merous, with 2 pairs of calyx lobes, these connate, the fifth free (the calyx appearing 3-lobed); petals 5, white, greenish white, or greenish yellow, obovate, the apex emarginate, papillose on the ventral surface; ovary 3-loculate, the styles separate, conical, the stigmas 2-lobed, the lobes strongly divergent. Fruit conical, 3-loculate, obscurely ribbed, shallowly and obscurely pitted, coriaceous, opening apically by 3 triangular valves, the perianth scars evident at the distal end below the area of dehiscence; seeds compressed, oblong or elliptic, with broad marginal wings, woody with chartaceous tips or wholly chartaceous.

1. Leaves 3-foliolate (rarely 4- to 5-foliolate), if the lower leaflets further divided then usually having a common petiolule; petiolule not articulate from the petiole; petals of the staminate flowers obcordate; fruit 6–8 cm long ____ **S. brasiliensis**
1. Leaves 5-foliolate; petiolule articulate from the petiole; petals of the staminate flowers obdeltoid; fruit 3.5–4.5(–7) cm long ____ **S. pentaphylla**

Siolmatra brasiliensis (Cogn.) Baill., Bull. Mens. Soc. Linn. Paris 1:458. 1885. (**Fig. 1**). *Alsomitra brasiliensis* Cogn., in Martius, Fl. Bras. 6(4):115. 1878. TYPE: BRAZIL. s.d., *Saint-Hilaire s.n.* (HOLOTYPE: P, n.v., photo ex P: F, US).

Alsomitra brasiliensis var. *pubescens* Griseb., Symb. Fl. Argent. 136. 1879. *Siolmatra brasiliensis* var. *pubescens* (Griseb.) Cogn., in Engler, Pflanzenr. 4(Heft 66):29. 1916. TYPE: ARGENTINA. JUJUY: San Lorenzo, 4 Nov 1873, *Lorentz & Hieronymus 228* (LECTOTYPE: BR, lectotype here designated; ISOLECTOTYPES: B (destroyed), NY, photo ex B: F, MO, NY, US.).

Siolmatra paraguayensis Cogn., Bull. Herb. Boissier 1:611. 1893. TYPE: PARAGUAY. ALTO PARANA: near Guarapi, 1880, *Balansa 3184* (HOLOTYPE: G?, n.v.; ISOTYPES: B (destroyed), BM, BR, F-fragment, K; photo ex B: F, MO, NY, US).

Vine or liana; stem glabrous, to 5 cm in diameter, the bark scaly, light brown. Leaves 3-foliolate, the lower leaflets occasionally further divided into 2 segments, but usually with a common petiolule, the leaves rarely 4- to 5-foliolate,

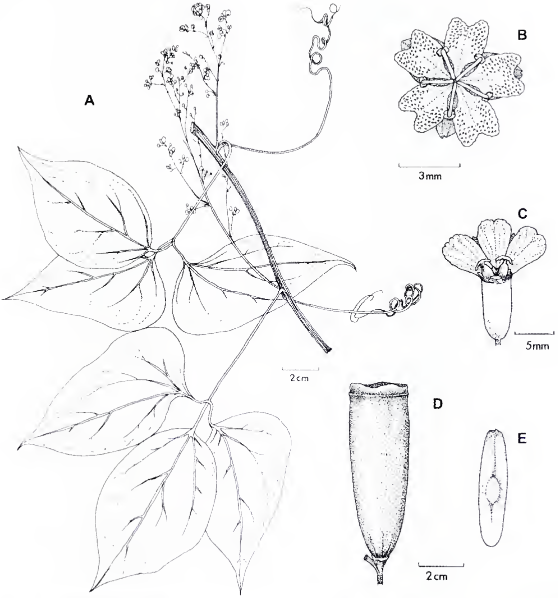


Fig. 1. ***Siolmatra brasiliensis*****. A.** Habit, staminate inflorescence (*Woolston 1149*, K). **B.** Staminate flower (*Venturi 5582*, US). **C.** Pistillate flower (*Hassler 6793*, BM). **D.** Fruit (*Venturi 5394*, F). **E.** Seed (*Venturi 5394*, F).

the blade chartaceous to subcoriaceous, the margin entire or irregularly undulate to lobed (lateral leaflets), ovate to elliptic, the base of the lateral leaflets broadly cuneate to cordate, oblique, unequal, the base of the central leaflets broadly cuneate to subcordate, occasionally oblique and unequal, the apex acuminate, 6–10(–20) cm long, 4–8(–10) cm wide, the upper surface moderately rugose-veined, minutely pustulate, but smooth or nearly so to the touch, tomentellous to glabrate on the veins, occasionally with a few scattered trichomes on the blade, the lower surface with scattered short glandular-capitate trichomes and straight or curved non-glandular trichomes; petiolule 0.5–2 cm long, the median one slightly longer than the laterals, tomentellous; petiole 4–8 (–12) cm long, canaliculate, tomentellous to glabrate; tendrils glabrous or occasionally sparsely strigose near the base. Staminate inflorescences many-flowered, in axillary panicles on the upper part of the stem, 8–30(–40) cm long, the branches with glandular-capitate and straight to curved non-glandular trichomes; pedicel to 1 mm long; bracts up to 0.5 mm long, lanceolate, strigose-tomentellous; flower buds globose, 2–3 mm in diameter; hypanthium pedicelloid, slender, 1–2 mm long; calyx glabrous, the lobes ovate-lanceolate, ca. 2 mm long; petals white, greenish white, or greenish yellow, obcordate, ca. 3 mm long, 2–2.5 mm wide, broadly clawed in the lower 1/4, the apex retuse, the inner surface papillate distally; stamens ca. 2 mm long, glabrous, the filaments slender, the theca oblong, horizontal, ca. 0.4 mm long, the filament extension with a dorsal glandular projection. Pistillate inflorescences many-flowered, in axillary racemes or panicles, 8–15 cm long, the leaves often reduced on the flowering branches and the entire structure to 40 cm long, the indumentum as in the staminate; pedicel and bracts as in the staminate; flower buds conical, 8–15 cm long; hypanthium conical 5–8 mm long, glabrous; calyx lobes triangular, 3–4 mm long, glabrous; petals white, greenish white, or greenish yellow, obovate, 4–6 mm long, the margins erose, the apex emarginate, minutely papillose on ventral surface; styles conical, ca. 2 mm long, the stigma branches diverging at right angles, papillate. Fruit narrowly conical, yellow or yellow-brown, 6–8 cm long, 2–3 cm wide, obscurely ribbed, the surface shallowly and obscurely pitted, the perianth scar at the distal end evident; seeds compressed, with broad marginal wings, narrowly elliptic-oblong, 4.2–5.5 cm long, 0.8–1.5 cm wide (including the wings), the central portion elliptic, 5–7 mm long, 5–6 mm wide, both ends acuminate, the surface papillate, the wings submembranaceous, smooth, with the median rib extending from the central portion to the funicular end.

Distribution and ecology.—The species occurs from eastern Peru south to northwestern Argentina, east to Paraguay and eastern Brazil. It is widespread but generally uncommon, although locally abundant in western chaco forests in Depto. Tarija, Bolivia (Michael Nee, pers. comm.). It occurs in wet forests at low elevations.

Siolmatra brasiliensis is usually readily distinguished from *S. pentaphylla* by its 3-foliolate leaves. However, three collections from Loreto, Peru (*Vásquez et al. 2827; Vásquez et al. 2829; Vásquez & Jaramillo 5532*) have 3-, 4-, or 5-foliolate leaves. However, in *S. pentaphylla* the petiolules are articulate from the petiole, while in they are not in *S. brasiliensis.*

Siolmatra paraguayensis was distinguished by Cogniaux (1916) from *S. brasiliensis* on the basis of its more membranaceous leaves and the ovate rather than triangular sepals of the staminate flowers. *Siolmatra brasiliensis* var. *pubescens* was distinguished by the pubescent lower leaf surface and peduncles.

However, these distinctions are trivial and inconsistent, so the segregates are here reduced to synonymy.

Additional specimens examined. **PERU. Loreto:** Reserva Nacional Pacaya-Samiria, 04°51'–05°12'S, 73°50'–74°40'W, 90 m, 1993, *Carpio 2104* (MO); Florida, Río Putumayo, mouth of Río Zubineta, ca. 200 m, Mar-Apr 1931, *Klug 2033* (F, K, MO, NY, US); Río Marañón basin, near mouth of the Río Santiago at Pongo Manserichi, ca. 77°30'W, 1924, *Tessmann 4527* (G, NY); Estación Biológica Callicebus Río Nanay-Mishana, 1 Jan 1982, *Vásquez et al. 2827* (MO), *Vásquez et al. 2829* (MO); Puerto Almendras (Río Nanay), 122 m, 7 Sep 1984, *Vásquez & Jaramillo 5532* (MO); Iquitos, 120 m, 4 Apr 1930, *Williams 8112* (F). **Madre de Dios:** Cuzco Amazónico, 15 km ENE of Puerto Maldonado, 12°35'S, 69°05'W, 200 m, 12 Dec 1989, *Gentry et al. 68606* (MO); Cuzco Amazónico, across Río Madre de Dios on road to Lago Sandoval, 12°35'S, 69°05'W, 200 m, 19 Dec 1989, *Gentry et al. 68963* (MO); Las Piedras, Cusco Amazónico, 12°29'S, 69°03'W, 200 m, 9 Oct 1991, *Timaná & Jaramillo 2502* (MO); Las Piedras, Cusco Amazónico, near the river and Quebrada Cicha, 12°29'S, 69°03'W, 200 m, 15 Oct 1991, *Timaná & Jaramillo 2605* (MO); Las Piedras, Cusco Amazónico, 12°29'S, 69°03'W, 200 m, 2 Nov 1991, *Timaná & Jaramillo 2958* (MO). **BRAZIL. Acre:** basin of Rio Purus, right bank of Rio Iaco, Novo Olinda, between Igarapé Santo Antoñio and Igarapé Boa Esperança, 10°07'S, 69°13'W, 21 Oct 1993, *Daly et al. 7831* (MO, NY), 30 Oct 1993, *Daly et al. 7981* (NY); São Francisco, Aug 1911, *Ule 9378* (G, K, US). **Bahia:** Estrada Barreiras-Corrente, km 33, 520 m, 16 Jun 1983, *Coradin et al. 5727* (MO, NY); Ferreira, Nov 1912, *Zehntner 4097* (M); Faixão, Nov 1912, *Zehntner 5005* (M). **Maranhão:** 27 km S of Entroncamento, intersection of Hwy 6 & Hwy 222, along Hwy 6, 4°23'S, 46°14'W, 20 Mar 1983, *Schatz et al. 943* (NY). **Rio de Janeiro:** near Rio de Janeiro, s.d., *Burchell 1685* (K); Cabo Frio, s.d., *Glaziou 10071* (K). **BOLIVIA. El Beni:** Espirítu, floodplain of Río Yacuma, 200 m, 5 Jul 1984, *Beck 5648* (NY); Cachuela Esperanza, Río Beni, Oct 1922, *Meyer 235* (NY). **El Beni/Pando:** junction of Río Beni and Río Madre de Dios, Aug 1887, *Rusby 547* (NY). **La Paz:** Parque Nacional Madidi, near Arroyo Aguapolo and Río Tuichi, 270 m, 16 Mar 2002, *Macía et al. 6855* (NY). **Santa Cruz:** Santa Cruz Botanical Garden, 12 km E of Santa Cruz, 17°46'S, 63°04'W, 375 m, 9 May 1991, *Gentry et al. 73605* (MO); Campamento El Rufugio, 14°45'20"S, 61°01'32"W, 180 m, 29 Jun 1994, *Guillén 1987* (MO); Parque Nacional Noel Kempff Mercado, 24 km W of San José de Campamento, on way to Piso Firme, 15°14'46"S, 61°14'34"W, 300 m, 28 Apr 1996, *Guillén et al. 4240* (NY); Las Trancas, 16°32'40"S, 61°59'28"W, 500 m, 11 Nov 1994, *Killeen et al. 7116* (MO); study area of "BOLFOR" project, Las Trancas-95, 16°31'13"S, 61°50'47"W, 450 m, 12 Dec 1994, *Mamani & Jardim 390* (MO, NY); Cerro San Miguel, Mar 1989, *Mereles & Ramella 2784* (FCQ, G); Parque Nacional Amboró, steep slopes above and 1 km S of Río Saguayo, 17°41'S, 63°44'W, 750 m, 20 Jan 1988, *Nee 36027* (MO, NY); Estancia San Rafael de Amboró, 17°36'S, 63°36'W, 420, 11 Jun 1998, *Nee 49747* (NY); Jardín Botánico de Santa Cruz, 12 km E of center of Santa Cruz, on road to Cotaco, 17°47'S, 63°04'W, 375 m, 5 Jun 1998, *Nee and Bohs 49613* (MO, NY); Cerro San Miguel, 7 Mar 1989, *Ramella & Mereles 2575* (G). **PARAGUAY.Canindeyú:** Estación Biológica Mbaracayú, ca. 10 km E of Villa Ygatimí, trail from main road through reserve to Mirador de los Chanchitos de Monte (Mirador Bojerkue), 24°07.41'S, 55°30.57'W, ca. 200 m, 24 Nov 2003, *Bohs & Nee 3184* (MO, NY); Mbaracayú Reserve, around Ñandurokai, 23°59'39"S, 55°28'44"W, 27 May 1999, *Zardini & Chaparro 50833* (NY). **Chaco:** proposed Biosphere Reserve "Gran Chaco Americano", Agua Dulce, 19°59'04"S, 59°45'28"W, 170 m, 8 Feb 2002, *Zardini & Apestegui 58247* (NY). **Concepción:** Estancia Primavera-Vallemi, 22°24'07"S, 57°37'33"W, 150 m, 3 Nov 2001, *Zardini & Guerrero 57291* (NY). **Guairá:** Cordillera de Ybytyruzú, W of Cerro Peró, 2 km E of Destacamento Tororo, 12 Nov 1988, *Zardini 8044* (MO); Río Yhacá, 10 km N of Tebicuary, 16 Nov 1990, *Zardini & Velázquez 23941* (MO, NY, USF). **La Cordillera:** Cordillera de Altos, Dec 1902, *Fiebrig 1025* (F); Cordillera de Altos, Dec 1898, *Hassler 3635* (G, NY); near Lago Ypacaraí, Nov 1913, *Hassler 12370* (BM, G, MO, NY), Dec 1913, *Hassler 12370a* (BM, G, K, MO, NY). **San Pedro:** Primavera, 15 Nov 1959, *Woolston 1149* (K, NY, US). **Paraguarí:** Río Yacá Valley, near Chololó, Dec 1900, *Hassler 6793* (BM, BR, G, NY). **ARGENTINA. Jujuy:** s.d., *Lorentz s.n.* (BR, K); Campamento Caimancito de YPF, 7 Dec 1986, *Zuloaga et al. 2525* (MO). **Salta:** Río Seco, 340 m, 2 Apr 1945, *Meyer 8451* (NY); 30

km from Colonia San Andrés on road to Orán, *Morrone et al. 3998* (MO); Senda Hachada, 9 Dec 1979, *Schinini 19560* (K); Finca San Andrés, La Marona, bank of Río San Andrés, ca. 23°04'23"S, 64°45'07"W, 800 m, 30 Oct 1997, *Schinini et al. 33083* (NY); Abra Grande, 12 Nov 1927, *Venturi 5582* (US).

Siolmatra pentaphylla Harms, Notizbl. Bot. Gart. Berlin-Dahlem 9:989. 1926. (**Fig 2**). Type. PERU. Loreto: upper Río Marañón, mouth of Río Santiago at Pongo Manserichi, ca. 77°30'W, 160 m, 18 Nov 1924, *Tessmann 4575* (lectotype: G, here designated to replaced destroyed B holotype; photo ex B: F, MO, NY, US; isolectotypes: NY, Bassler Herb. [Peru], n.v.; photograph of isotype in Bassler Herb.: US).

Vine or liana; stem glabrous or rarely sparsely pilose when young, soon glabrescent. Leaves 5-foliolate, the petiolules articulate from the petiole, the blade chartaceous to subcoriaceous, the margin entire, narrowly ovate to elliptic, the base cuneate to rounded, often unequal, the apex acuminate, (5–)7–11 cm long, 3–5.5 cm wide, the upper surface moderately rugose-veined, minutely pustulate, but smooth to the touch, occasionally with a few short trichomes on the midvein, otherwise glabrous, the lower surface glabrate or occasionally pubescent and sparsely short glandular-capitate; petiolules 0.5–1.5 cm long, rarely subsessile, the median one slightly longer than the lateral, pilose and sparsely short glandular-capitate or glabrous; petiole 5–10 cm long, caniculate, glabrate; tendrils glabrous. Staminate inflorescences many-flowered, in axillary panicles on the upper part of the stem, 20–50 cm long, the leaves often reduced upward and the entire floriferous part of the stem to 2 m long, the branches sparsely pilose and short stipitate-glandular or glabrous; pedicel up to 1 mm long; bracts up to 2.5 mm long, linear, with scattered stipitate-glandular and non-glandular trichomes; flower buds globose, 2–3 mm in diameter; hypanthium pedicelloid, slender, 1–3 mm long; calyx glabrous, the lobes ovate-lanceolate, 2–3 mm long; petals white, greenish white, or greenish yellow, 2–3 mm long, ca. 1.5 mm wide, narrowly obdeltoid, clawed on the lower 1/4, the apex retuse, the inner surface papillate distally and at the base; stamens ca. 1.5 mm long, free or variously connate, the filament ca. 1 mm long, the anther vertical, the filament extension with a dorsal triangular, glandular projection. Pistillate inflorescences many-flowered, axillary racemes or panicles, 10–15 cm long, the leaves often reduced on the flowering branches and the entire structure to 40 cm long, the indumentum as in the staminate; pedicels and bracts as in the staminate; flower buds conical, 7–10 mm long; hypanthium conical, 5–7 mm long, glabrous; calyx lobes triangular, ca. 3 mm long, glabrous; petals white, greenish white, or greenish yellow, obovate, 4–6 mm long, the margins erose, the apex emarginate, papillose on the ventral surface; styles conical, ca. 2 mm long, the stigma branches diverging at right angles, papillate, the staminodes 5, ca. 0.5 mm long. Fruit short-conical, yellowish brown (rarely reddish brown), 3.5–4.5(–7) cm long, 2–3 cm wide, obscurely ribbed, the surface shallowly and obscurely pitted, the perianth scars at the distal end evident; seeds compressed, with broad marginal wings, oblong, 3–3.5 cm long, 1–1.3 cm wide (including wings), the central portion

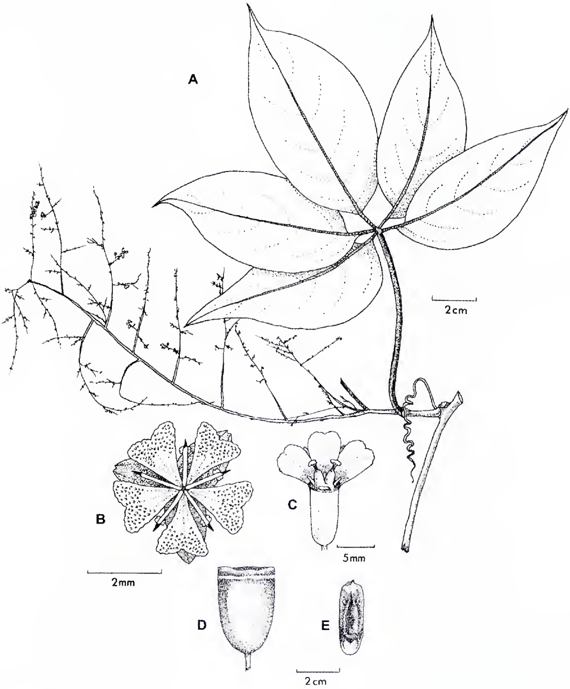


Fig. 2. ***Siolmatra pentaphylla.*** **A.** Habit, staminate inflorescence (*Prance et al. 8039,* NY). **B.** Staminate flower (*Gentry & Revilla 20798,* USF). **C.** Pistillate flower (*Williams 2453,* F). **D.** Fruit (*Mori et al. 9134,* NY). **E.** Seed (*Mori et al. 9134,* NY).

13–17 mm long, 5–6 mm wide, both ends acuminate, the surface smooth, the wings smooth, woody, the distal 3–6 mm submembranaceous and yellow-colored.

Distribution and ecology.—The species occurs in the Amazonian basin from southeastern Colombia and northern Peru, south to northern Bolivia, and east to Pará in Brazil and Guyana. Although apparently widespread in the Amazonian basin, the species is not commonly collected. It occurs in wet forests along riverbanks and flooded lake shores at 100–300 m.

The staminal condition is surprisingly highly variable, more so than that of the other species. The stamens may be entirely free, the filaments connate at base into two groups (2 + 3), two pairs of filaments connate for part or nearly their entire length (2 + 2 + 1), or apparently all short-connate at base.

Although the leaves are typically glabrate on the lower surface, two collections have leaves distinctly pubescent (*Pires 3857*; *Prance et al. 8039*). The fruits are usually 3.5–4.5 cm long and light in color. However, *Pires 3857* has fruits 7 cm long and dark in color. These two collections may represent a distinct taxon, but with so little material available, we are reluctant to describe it.

Additional specimens examined. **COLOMBIA. Amazonas:** Río Loreto-yacú, ca. 100 m, Oct 1945, *Schultes 6732* (F). **GUYANA.** Oronoque, New River and Amazon divide, ca. 280 m, Nov 1937, *Beddington 29* (K). **ECUADOR. Napo:** Aguarico, Reserva Etnica Huaorani, km 60–61 along road and oil pipeline Maxus, S of Río Tivacuno, 00°51'S, 76°26'W, 250 m, 21–25 Oct 1993, *Aulestia & Andi 890* (MO). **Pastaza:** Vía Auca, 115 km S of Coca, 10 km S of the Napo-Pastaza border, near the Río Tigüino, Petro-Cañada road, 01°15'S, 76°55'W, 320 m, 26–31 Jan 1989, *Hurtado & Neill 1550* (MO). **PERU. Amazonas:** Yamayakat Bosque, 04°55'S, 78°19'W, 320 m, 22 Jan 1996, *Jaramillo et al. 951* (MO); Quebrada Kusú, 05°03'20"S, 78°20'23"W, 380 m, 6 Nov 1996, *Vásquez et al. 21531* (MO). **Loreto:** Río Yavarí between Emilia and Brazilian village of Paumari (above Atalaia del Norte), 22 Nov 1977, *Gentry & Revilla 20798* (MO, USF); Airico (native community of Shimaco-Santa Rosa), 150 m, 11 Dec 1984, *Vásquez 6069* (MO, NY); Explor Camp at Río Sucusari, 03°20'S, 72°55'W, 120 m, 19 Mar 1996, *van der Werff & Vásquez 13921* (MO); Caballococha on the Río Amazonas, 13 Aug 1929, *Williams 2453* (F). **Pastaza:** Vía Auca, 115 km S of Coca, 10 km S of Napo-Pastaza border, near Río Tiguino, along Petro-Cañada highway under construction, 01°15'S, 76°55'W, 320 m, 26–31 Jan 1989, *Hurtado & Neill 1550* (MO). **BRAZIL. Amazonas:** Rio Japurá, 01°50'S, 65°40'W, 3 Nov 1982, *Cid & Lima 3492* (NY); Rio Solimões, Igarapé Jandiatuba, 6 Jan 1949, *Fróes 23837* (NY); basin of Rio Solimões, basin of creek Belém, 26 Oct–11 Dec 1936, *Krukoff 9046* (BM, F, MO, NY); mouth of Rio Içа, on bank of Rio Solimões, 24 Feb 1977, *Mori et al. 9073* (NY), Rio Jandiatuba, 10 km upstream from mouth, 26 Feb 1977, *Mori et al. 9134* (K, NY); Lago Preto on Rio Purus, 3 km N of Lábrea, 29 Oct 1968, *Prance et al. 8039* (K, NY). **Para:** Igarapé Ipixuna, tributary of Rio Xingu, 04°49'S, 52°31'W, 5 km S of settlement, Araweté Indian Reserve, 23 Mar 1986, *Balée 2024* (NY); left bank of the Rio São Manuel [Telespires], Igarapé Fernando de Noronha, downstream from Cachoeira do Cladeirão, 7 Jan 1952, *Pires 3857* (US). **BOLIVIA. Pando:** Nuevo Mundo, Campamento 18, 18 km N of airstrip, 10°39'S, 66°46'W, 160 m, 2 Jul 1992, *Gentry et al. 77663* (MO).

EXCLUDED SPECIES

The following five taxa previously placed in *Siolmatra* by various workers are here referred to *Fevillea*.

Siolmatra amazonica Cogn., in Engler, Pflanzenr. 4(Heft 66):30. 1916. [=*Fevillea pedatifolia* (Cogn.) C. Jeffrey].

Siolmatra mexiae Standl., in J.F. Macbride, Publ. Field Mus. Nat. Hist., Bot. Ser. 13(6):329. 1937. [=*Fevillea cordifolia* L.].

Siolmatra pedatifolia (Cogn.) Cogn., in Engler, Pflanzenr. 4(Heft 66):30. 1916. BASIONYM: *Alsomitra pedatifolia* Cogn., in Martius, Fl. Bras 6(4):115. 1878. [=*Fevillea pedatifolia* (Cogn.) C. Jeffrey]

Siolmatra peruviana (Huber) Cogn., in Engler, Pflanzenr. 4(Heft 66):30. 1916.

Basionym: *Alsomitra peruviana* Huber, Bol. Mus. Paraense Hist. Nat. 4: 616. 1908. [=*Fevillea pedatifolia* (Cogn.) C. Jeffrey].

Siolmatra simplicifolia Harms, Notizbl. Bot. Gart. Berlin-Dahlem 11:769. 1913. [= *Fevillea pedatifolia* (Cogn.) C. Jeffrey].

ACKNOWLEDGMENTS

We gratefully acknowledge the curators of BM, BR, F, G, K, MO, NY, and US for making specimens available for our study. We thank Lorenzo Ramella (G) for providing information from his collections in Bolivia, Bruce F. Hansen (USF) for his many helpful suggestions on the manuscript, and Kathleen Hotchkiss (USF) for assistance with graphics. We also thank Michael Nee (NY) and an anonymous reviewer for their helpful comments.

REFERENCES

Baillon, H. 1885. La fleur femelle de l'*Alsomitra brasiliensis*. Bull. Mens. Soc. Linn. Paris 1: 457–458.

Baillon, H. 1886. Histoire des plantes. 8:417-418. L. Hatchette et Cie, Paris.

Cogniaux, A. 1893. Genre *Siolmatra* H. Baill. et la tribe des Zanoniées. Bull. Herb. Boissier 1:609–613.

Cogniaux, A. 1916. Cucurbitaceae: Fevilleae et Melothrieae. In: A. Engler, ed. Das Pflanzenreich 66(4) 275(1):1–277. W. Engelmann, Berlin.

Harms, H. 1926. Cucurbitaceae. In: J. Mildbraed, Plantae tessmannianae peruvianae III. Notizbl. Bot. Gart. Berlin-Dahlem 9:989–996.

Harms, H. 1933. Cucurbitaceae americanae novae. Notizbl. Bot. Gart. Berlin-Dahlem 11: 769–776.

Jeffrey, C. 1962. Notes on some species of *Fevillea* L., *Siolmatra* Baill., and *Pseudosicydium* Harms (Cucurbitaceae) in the Amazon Basin. Kew Bull. 16:199–202.

Jeffrey, C. 1978. Further notes on Cucurbitaceae: IV, some New-World taxa. Kew Bull. 33: 347–380.

Standley, P.C. 1937. Cucurbitaceae. In: J.F. Macbride, ed. Flora of Peru. Publ. Field Mus. Nat. Hist., Bot. Ser. 13(6):329.

BOOK REVIEW

ROBERT H. MOHLENBROCK. 2005. **Aquatic and Standing Water Plants of the Central Midwest: Cyperaceae-Sedges.** (ISBN 0-8093-2628-0, hbk.). Southern Illinois University Press. P.O. Box 3697, Carbondale, IL 62902-3697. (**Orders:** 618-459-6633, 618-453-1221 fax, www.siu.edu/˜siupress). $65.00, 272 pp, 183 line drawings, 6" × 9".

Aquatic and Standing Water Plants of the Central Midwest: Cyperaceae-Sedges by Mohenbrock is a flora, which consists of the Cyperaceae portion of the larger Aquatic and Standing Water Plants of the Central Midwest series. The book's central Midwest range includes: Ohio, Indiana, Kentucky, Illinois, Iowa, Missouri, Nebraska, and Kansas.

The flora includes information on 183 Cyperaceae species, including members of the genera *Carex, Schoenoplectus, Eriophorum, Fimbristylis, Fuirena, Trichophorum, Dulichium, Cyperus, Eleocharis, Psilocarya, Scirpus, Hemicarpha, Lipocarpha*, and *Rhynchospora*. There is an overall key to determine genus, as well as within genus keys to determine species. Each species is presented in the book by black and white drawings, which includes images of the whole plant and the spikelet, achene, perigynium, scales and/or sheath, and a detailed description.

The description for each species contains a great deal of information, including the current accepted specific epithet, synonyms, as well as the authority and references for publications for each specific epithet. Each species' description includes plant habit information, descriptions and measurements of culms, root types, bracts, scales, spikelets, notable colors and, where applicable, details on perigynium. The description includes habitat information, with a listing of which states the species are typically found in, and any applicable category assignments (i.e. FACW) within the U.S. Fish and Wildlife Wetlands Inventory. The author has included a handy quick field traits section within the plant description to help determine that species from similar looking others.

The *Aquatic and Standing Water Plants of the Central Midwest: Cyperaceae-Sedges* Flora would be a nice addition to the library of any person who works with aquatic plants. Although focused on the Midwest, a number of the species included in this flora are found in various regions of North America. The black and white drawings are crisp, easy to read images that show major identification traits for the species. The key is straightforward, but the flora does contain a glossary for any unfamiliar terms, and is fairly user friendly. The description for each species is thorough, which can help you decide that you have determined the correct species or not, and includes those very helpful "in the field" identification hints. If you need to identify sedges, be sure to look into this helpful book. —*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

REVISION OF *FEVILLEA* (CUCURBITACEAE: ZANONIEAE)

George L. Robinson

USDA APHIS, Plant Protection and Quarantine
Port Everglades
1800 Eller Drive, Suite 414
Fort Lauderdale, Florida 33316, U.S.A.

Richard P. Wunderlin

Department of Biology, SCA 110
University of South Florida
Tampa, Florida 33620-5200, U.S.A.

ABSTRACT

A revision of the neotropical genus *Fevillea* with keys, descriptions, and distribution is provided. Two subgenera are recognized: subgenus *Fevillea* with six species and subgenus *Anisosperma* with one species. **Fevillea bahiensis** G. Robinson & Wunderlin from Brazil is described as new and subgenus **Anisosperma** (Silva Manso) G. Robinson & Wunderlin is proposed.

RESUMEN

Se aporta una revisión del género neotropical *Fevillea* con claves, descripciones, y distribución. Se reconocen dos subgéneros: subgénero *Fevillea* con seis especies y subgénero *Anisosperma* con una especie. Se describe como nueva **Fevillea bahiensis** G. Robinson & Wunderlin de Brasil y se propone el subgénero **Anisosperma** (Silva Manso) G. Robinson & Wunderlin.

Fevillea (Cucurbitaceae: Zanonieae), a neotropical genus of seven species, is characterized by leaves with glands, calyx with glandular squamellae (except *F. passiflora*), petals with a medial adaxial flap-like appendage or ridge, staminate flowers with five bilocular anthers, and a globose, usually indehiscent, large-seeded fruit.

TAXONOMIC HISTORY

Fevillea was established by Linnaeus (1753) in honor of Louis Éconches Feuillée, (1660–1732), a French clergyman, explorer, astronomer, and botanist. Linnaeus recognized two species, *F. trilobata* and *F. cordifolia*.

Adanson (1763) published the pre-Linnaean name *Nhandiroba*, of Marcgrave (Piso & Marcgrave 1648), but placed Linnaeus's name *Fevillea* in synonymy, thereby making *Nhandiroba* illegitimate. No species were listed. The name *Nhandiroba* remained unused until resurrected by Kuntze (1891–1898).

The first comprehensive treatment of *Fevillea* since Linnaeus (1753) was that of Seringe (1828) who recognized four species. In addition to *F. cordifolia* and *F. trilobata*, Seringe recognized *F. punctata* (L.) Poir. [=*Trichosanthes* sp.] and *F. javilla* Kunth [=*F. cordifolia*].

Silva Manso (1836) established the monotypic *Hypanthera* with *H. guapeva* [=*Fevillea trilobata*] and *Anisosperma* with *A. passiflora* (Vell.) Silva Manso [=*Fevillea passiflora* Vell.]. Both monotypic genera were accepted by most subsequent workers until recently.

Roemer (1846) recognized *Hypanthera* and *Fevillea*. He placed ten species in *Fevillea*, incorporating some taxa now placed in *Trichosanthes* L., *Pteropepon* Cogn., and *Sicydium* Schltdl. *Fevillea passiflora* was also recognized, but without reference to Silva Manso's placement of the species in *Anisosperma*. Roemer erected two sections: section *Fevillea* with nine species and section *Javilla* with only *F. javilla* Kunth [=*F. cordifolia* L.].

Cogniaux (1878) recognized three species of *Fevillea* for Brazil: *F. trilobata*, *F. albiflora* Cogn., and *F. deltoidea* Cogn. (the latter now in *Pteropepon*). In addition, he recognized the monotypic genus *Anisosperma* and expanded the generic limits of the previously Old World genus *Alsomitra* (Blume) M. Roem. to include two new neotropical species: *A. brasiliensis* [=*Siolmatra brasiliensis* (Cogn.) Baill.] and *A. pedatifolia* [=*Fevillea pedatifolia* (Cogn.) C. Jeffrey]. In a more comprehensive treatment, Cogniaux (1881) expanded *Fevillea* to six species, maintaining *Anisosperma* and *Alsomitra*.

The genus *Siolmatra*, a segregate of *Alsomitra* created by Baillon (1885) to acommodate *Alsomitra brasiliensis* Cogn. [=*Siolmatra brasiliensis* (Cogn.) Baill.], was accepted by Cogniaux (1893) who described a second species (*S. paraguayensis*). Three additional species were later added by Cogniaux (1916), one new (*S. amazonica*) and two transferred from *Alsomitra* (*S. pedatifolia* (Cogn.) Cogn. and *S. peruviana* (Huber) Cogn.). Harms (1926) added a sixth species (*S. pentaphylla*), later (Harms 1933) a seventh (*S. simplicifolia*), and Standley (1937) an eighth (*S. mexiae*). Jeffrey (1962b), noting the incongruent mixture of taxa in *Siolmatra*, recircumscribed the genus and transferred four species to *Fevillea*. In reviewing the New World taxa of the Cucurbitaceae, Jeffrey (1978) listed nine species in *Fevillea*, including *F. passiflora*, considering *Anisosperma* congeneric with *Fevillea*.

FLORAL AND FRUIT MORPHOLOGY

The staminate inflorescence consists of numerous, small, pentamerous flowers that are paniculate in subgenus *Fevillea* or fasciculate to subumbelliform in subgenus *Anisosperma*.

In subgenus *Fevillea*, the midrib of the adaxial surface of the sepals is fused with the lower margins of the petals. At or above this point of fusion extends a small glandular protuberance of uncertain ontogenic origin which is here referred to as a "glandular calycine squamella." The exudate from the squamellae is clear and remains visible on most herbarium specimens. Each petal has a median, adaxial, uncinate appendage or slightly raised glandular midrib which is adnate with the base of the stamen filament. In subgenus *Anisosperma*, the sepals and petals are united at their base and lack squamellae. Instead, the petals have a median, adaxial, glandular ridge.

An articulation occurs between the filiform hypanthium and the pedicel. The indumentum on the staminate flowers is quite variable in most species and is similar (when present) on both the hypanthium and pedicel. However, *F. trilobata* has a stipitate-glandular pubescence on the hypanthium above the articulation in rather sharp contrast to the non-glandular trichomes on the pedicel below.

The presence of five free, bilocular anthers in *Fevillea* is unique for the family and is considered plesiomorphic. The general trend within the Cucurbitaceae is the reduction of stamen number from five to three or to two and the reduction in locule number from two to one.

The pistillate flowers are rarely collected and are thus imperfectly known or unknown for some species. We have seen them in only four of the seven species. Those of *F. pergamentacea* and *F. passiflora* are known to us only through the literature while those of *F. moorei* are unknown.

The petals of the pistillate flowers have a slightly raised median appendage extending from the base to the center, reminiscent of those of the staminate flowers. Two small glands occur at the base of the petal on either side of this median appendage. A large, subrotund, flattened, glandular protuberance extends from the base of the calyx lobe between each petal. These protuberances may represent staminodes. Cogniaux (1878, 1881, 1916) reported these structures, counting 20 small "glands" at the base of the petals. This probably included the sum total of glands, ridges, and protuberances.

The fruits of subgenus *Fevillea* are large, subglobose, mottled green or brown, and gourd-like. The size ranges from 8 to 16 cm in length and from 7 to 13 cm in diameter. An individual plant may produce as many as 50 to 100 fruits at a time (Gentry & Wettach 1986). The fleshy rind of the fruit is zonate above the middle with the hypanthium lip scar (ovary partly inferior). The fruits are typically indehiscent, but reportedly sometimes dehiscent along the hypanthium lip scar in *F. pedatifolia* (A. Gentry, pers. comm.). In contrast, the fruits of subgenus *Anisosperma* are ovoid or oblong, subtrigonous, short-apiculate at the apex, and not zonate above the middle (ovary fully inferior). The seeds (up to 15 per fruit) vary from 3 to 6 cm in diameter and weigh 3 to 9 g when dry. They are among the largest in the Cucurbitaceae and are comparable in size only to those of the paleotropical genera *Telfairia* (Cucurbitoideae: Joliffieae) and *Hodgsonia* (Cucurbitoideae: Trichosantheae). The seed coat consists of three layers. The innermost layer surrounding the cotyledon is spongy and aeriferous. This layer is enclosed in a thin, hard, woody layer. The outermost layer is thin, smooth, and of a corky texture which tends to obscure the margin of the woody layer below but usually does not persist.

DISTRIBUTION AND HABITAT

Fevillea cordifolia has the widest distribution, ranging from southern Mexico, east into the Caribbean to Puerto Rico, south through Central America and into South America to northern Argentina. Dieterle (1976) notes that it is cultivated in some or all Central American countries and is found in most Central American markets, especially in Guatemala. Three species (*F. trilobata*, *F. bahiensis*, and *F. passiflora*) are endemic to eastern Brazil and *F. pedatifolia* and *F. pergamentacea* occur in Ecuador, Peru, and Bolivia, with *F. pedatifolia* extending into adjacent Amazonian Brazil. *Fevillea moorei* is known only from the type material cultivated in England and is probably from Guyana or Amazonian Brazil.

Fevillea typically occurs along river banks, along the edge of tropical primary or secondary forests, and along the edge of seasonally inundated riverine forests, occasionally climbing to heights of 35 m in forest canopy openings. It also is found in forest clearings and along roadsides. It occurs at elevations from near sea level to about 500 m, less commonly up to 1,700 meters.

Fruits and seeds of *Fevillea* are quite buoyant and thus apparently are well suited to dispersal in fresh water. Gentry and Wettach (1986) report that at least one species (*F. cordifolia* or *F. pedatifolia*) of Amazonian Peru occurs in seasonally inundated forests, a habitat in which water dispersal is prevalent. Seed drift materials of *Fevillea cordifolia* have been found within the Caribbean basin well outside the species natural range. Gunn and Dennis (1976), Morton (1981), and the senior author have identified seeds of *F. cordifolia* collected from beaches of southern Florida. Guppy (1917) reported materials found along beaches of the Turks Islands, Tobago, and Grenada. Guppy (1917) and Gunn and Dennis (1976) found that seeds of *F. cordifolia* germinated in fresh water while afloat after the disintegration of the fruit wall, but were generally rendered non-viable in salt water. Although *F. cordifolia* is sometimes listed as an estuarine plant, the seeds are probably not capable of over-sea transport for any distance. However, dispersal by seed drift via salt water can not be disregarded. Guppy (1917) estimated that 5% of the *Fevillea cordifolia* drift seeds reaching the Turks Islands were viable while Gunn and Dennis (1976) found 20% of the undamaged drift seeds on Florida beaches were viable. The high salinity of the beach is probably lethal, thus preventing colonization.

ECONOMIC IMPORTANCE

The high seed oil content of *Fevillea trilobata* was recognized centuries ago by indigenous Brazilians whose use of it was first documented by Marcgrave (Piso & Marcgrave 1648). *Fevillea cordifolia* is similarly well known in the ethnobotanical literature (cf. Gentry & Wettach 1986). It has been used as a purgative, reputed antidote for many kinds of poisoning, and as a treatment for numerous diseases. In Jamaica it is called "antidote caccoon" or "antidote vine" (Adams 1972; Gunn & Dennis 1976; Morton 1981). Lindley and Moore (1870) first reported the use of *Fevillea* seeds by Peruvians as candles. Gentry and Wettach (1986) report that "abiria" (*Fevillea pedatifolia*) is used as candles by the Campa Indians of the Pichis Valley of Peru.

Fevillea seeds may have potential as an edible or fuel oil source. Calculated on a weight per fruit basis, the seed oil content of *Fevillea* is higher than that of any other dicotyledon (Gentry & Wettach 1986). Preliminary analysis of oils extracted from the seeds of two Peruvian species (*F. cordifolia* and *F. pedatifolia*) by Gentry and Wettach show the oil to be simple triglycerides, slightly heavier than those of refined cottonseed oil. All species were rich in the saturated low-weight fatty acids, palmitic (21–60%) and stearic (10–42%), and the unsaturated oleic (17–17%) and linoleic (6–7%). When compared with previous results from the Brazilian *F. trilobata* (Tulloch & Bergter 1979), Gentry and Wettach suggest that the Peruvian species with 60–70% low-weight, saturated fatty acids would be a good sources of fuel oil while the Brazilian species with 57% unsaturated fatty acids would be a good source of polyunsaturated edible oils. However, the relatively high concentration of high molecular weight fatty acids in *F. trilobata*, probably correlated with its purgative properties, may reduce its value as an edible oil. The high percent of stearic acid in *F. cordifolia* might also suggest its use in the candle industry where this chemical is used to harden waxes and in the rubber industry where used as an extender. Preliminary laboratory analysis of *F. cordifolia* at the University of South Florida gave highly variable results thought to be related to the different ages of the seeds tested, further complicating the use of *Fevillea* seeds as a potential commercial oil source (unpublished data). Although *Fevillea* as an oil source is documented in the literature, to date it remains a genus of little or no economic importance.

INFRAGENERIC RELATIONSHIPS

Jeffrey (1962a) recognized two genera within the subtribe Fevilleinae, *Fevillea* and *Anisosperma*. In our treatment, *Anisosperma* is reduced to a subgenus of *Fevillea*. Subgenus *Anisosperma* differs from subgenus *Fevillea* by the shape of the corolla lobes, the character of the median adaxial glandular ridge of the staminate petals, the congested staminate inflorescence, the lack of glandular calycine squamellae on the staminate flowers, and the fruit shape. However, with the presence of the foliar glands, the median adaxial glandular ridge on the petals, and overall similarity in fruit and seed morphology, the single species of subgenus *Anisosperma* is easily accommodated in *Fevillea*.

Within subgenus *Fevillea*, three species groups can be distinguished on the basis of foliar gland characters. The first group consists of *F. pergamentacea* and *F. pedatifolia* which have conspicuous petiolar glands and inconspicuous laminar glands. The others are characterized by having laminar glands only. Of these, *F. cordifolia* and *F. trilobata* have glands terminating the veins on the lamina and lack basal laminar glands while *F. moorei* and *F. bahiensis* both have basal laminar glands only.

SYSTEMATIC TREATMENT

Fevillea L., Sp. Pl. 1013. 1753. *Nhandiroba* Adan., Fam. Pl. 2:139. 1763, nom. illegit.

TYPE: *Fevillea trilobata* L. Lectotype designated by M.L. Green (in Sprague et al., Nom. Prop. Brit. Bot. 190. 1929). This lectotypification replaces the lectotype of *Fevillea cordifolia* L. of Britton and P. Wilson (Sci. Surv. Porto Rico 6:270. 1925) under Art. 10.5b of the St. Louis Code.

Anisosperma Silva Manso, Enum. Subst. Braz. 38. 1836. TYPE: *Anisosperma passiflora* (Vell.) Silva Manso [=*Fevillea passiflora* Vell.].

Hypanthera Silva Manso, Enum. Subst. Braz. 37. 1836. TYPE: *Hypanthera guapeva* Silva Manso [=*Fevillea trilobata* L.].

Dioecious vines or lianas; stems sulcate; tendrils axillary, sulcate, distally 2-fid, coiling both above and below the bifurcation. Leaves alternate, petiolate, the blade unlobed, or palmately 3- to 7-lobed, or 3- to 5-foliolate, with glands on the leaf margins terminating the primary lateral veins and/or 2 glands at the blade base or on the petiole, the petiole canaliculate, sometimes bearing 2 glands at or above the middle. Staminate inflorescences paniculate or subumbelliform, many-flowered, bracteate; flowers short-pedicellate; hypanthium pedicelloid; calyx lobes 5, fused to the petals above, not completely enclosing the petals in bud, with a glandular calycine squamella on each calyx lobe at or near the point of fusion with the petals (except in *F. passiflora*); petals 5, fused to the sepals below, the lobes each with a median, adaxial, uncinate, flap-like appendage or a slightly raised ridge or (in *F. passiflora*) with a thick, glandular ridge; stamens 5, equal, free, inserted near the center of the flower, the anthers bilocular, extrorse, dehiscing longitudinally, the connective with an adaxial glandular protuberance or projection; pollen prolate, 18–22 µ in length, tricolporate, coarsely striate. Pistillate flowers solitary or in pairs; hypanthium deeply cupular; sepals and petals as in the staminate flowers or sometimes the petals differing in shape; ovary partly inferior, 3-locular, the styles 3, free, outwardly curved, the stigmas reniform, capitate, the ovules pendulous, usually 4 in each locule. Fruit globose, gourd-like with a thick, fleshy rind, zonate above the middle with the hypanthium lip scar or non-zonate, indehiscent or rarely circumscissile dehiscent along the hypanthium lip scar; seeds large, orbicular, somewhat compressed, the seed coat consisting of a thick, spongy, aeriferous inner layer surrounded by a thin woody layer, and an outer, usually non-persistent layer, the lateral surface smooth or striate-verrucose, the outer edges smooth or tuberculate, the inner kernel disk-like, oily.

Two subgenera are distinguished as follows:

1. Corolla lobes of the staminate flowers suborbicular, the base cuneate, with a median adaxial uncinate appendage or sharply defined ridge; glandular calycine squamellae present between the petals and the calyx lobes; staminate flowers in spreading panicles; fruit subglobose, zonate above the middle, the apex rounded ____ subg. **Fevillea**

1. Corolla lobes of staminate flowers oblong-hastate, the base with a median adaxial glandular ridge broadening downward; glandular calycine squamellae absent; staminate flowers in congested panicles or subumbelliform; fruit ovoid to oblong, not zonate, the apex short-apiculate ____ subg. **Anisosperma**

Fevillea subgenus **Fevillea**

Fevillea section *Javilla* M. Roem., Fam. Nat. Syn. Monogr. 2:116. 1946. TYPE: *Fevillea javilla* Kunth [=*Fevillea cordifolia* L.].

Staminate inflorescences paniculate; glandular calycine squamellae present; corolla lobes suborbicular with a median adaxial uncinate appendage or slightly raised ridge. Fruit subglobose, zonate above the middle, the apex rounded.

1. Leaves pedately 3- to 5-foliolate ____ **F. pedatifolia**
1. Leaves lobed or unlobed, but not pedately foliolate.
  2. Leaf blade without glands at the base or on the petiole, with marginal glands terminating the veins.
    3. Leaf blade with angled or rarely with rounded lobes, the marginal glands inconspicuous; staminate flowers with the hypanthium densely stipitate-glandular pubescent, the pedicel with non-glandular trichomes ____ **F. trilobata**
    3. Leaf blade unlobed or occasionally with rounded lobes, the marginal glands conspicuous; staminate flowers with the hypanthium and pedicel variously pubescent but not as above ____ **F. cordifolia**
  2. Leaf blade with glands at the base or on the petiole, with or without marginal glands terminating the leaf veins.
    4. Leaves with glands only at the blade base, without marginal glands terminating the leaf veins of the blade.
      5. Staminate flowers 3–5 mm wide; leaves drying reddish-brown, the blade with a conspicuous uncinate-ciliate margin ____ **F. bahiensis**
      5. Staminate flowers 15–20 mm wide; leaves drying green, the blade with a smooth margin ____ **F. moorei**
    4. Leaves with glands either at the blade base or on the petiole, also with marginal glands terminating the veins of the blade.
      6. Leaves with glands at the blade base ____ **F. pergamentacea**
      6. Leaves with glands on the petiole ____ **F. pedatifolia**

Fevillea bahiensis G. Robinson & Wunderlin, sp. nov. (**Fig. 1**). TYPE: BRAZIL. BAHIA: 8 km to the N of Ubaitaba on BR 101, 16 Jun 1972, *dos Santos 2307* (HOLOTYPE: CEPEC; ISOTYPE: K).

Species haec a *Fevillea moorei* Hook. f. differt floribus staminatis minoribus, foliis in siccitate badiis usque atrobrunneis marginibus uncinato-ciliatibus.

Vine or liana; stem glabrous to lightly appressed golden brown-pubescent; tendrils glabrous to lightly pubescent. Leaves unlobed, the blade ovate, (2.5–)6.5–10.5(12) cm long, (3.5–)5.5–9 cm wide, membranaceous, drying dark brown to reddish brown, 5-nerved, the apex acuminate, the base cordate to truncate, the margin entire, with two irregularly shaped glands at the base near the petiole, the upper and lower surfaces glabrous or with scattered, appressed, golden brown trichomes, these usually denser along the leaf veins, the margin uncinate-ciliate, the petiole (1.5–)3.5–5 cm long, glabrous to lightly pubescent. Staminate flowers in a paniculate inflorescence on reduced subterminal, lateral branches, the branches subtended by a reduced leaf; pedicel 1.5–2 mm long, glabrous or sparsely pubescent; bracts linear, ca. 1 mm long; hypanthium 1.5–2 mm long, lightly golden brown-pubescent; calyx shallowly cupular, the lobes

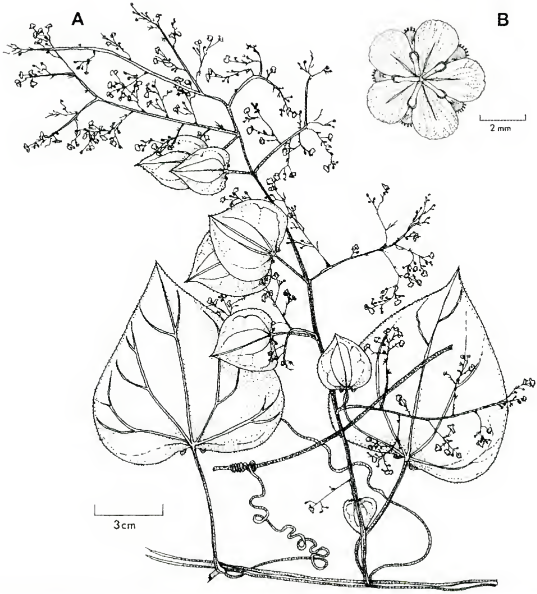


Fig. 1. *Fevillea bahiensis*. **A.** Habit, staminate inflorescence (*dos Santos 2307*). **B.** Staminate flower (*dos Santos 2307*).

up to 1.5 mm long, 1 mm wide, glabrous to sparsely pubescent abaxially, the margin entire, the apex rounded, with scattered stipitate glands, with a glandular calycine squamella at or near the point of fusion with the petals; petals suborbicular, 2.5–3 mm long, ca. 1.5 mm wide, cream-colored, the margin entire, the median adaxial ridge slightly raised; stamens 1–1.5 cm long, the anthers ca. 0.25 mm long, slightly longer than wide, the filaments ca. 0.5 mm long. Pistillate flowers solitary; calyx deeply cupular, the lobes ca. 1.5 mm long, ca. 1 mm wide, dark brown, fleshy; petals strap-shaped, ca. 2 mm long, ca. 1.5 mm wide, cream-colored. Immature fruit subglobose, 2–4 cm long and wide, the surface smooth; mature fruit not seen.

Distribution and ecology.—Endemic to Brazil in southern Bahia.

Additional specimens examined. **BRAZIL. Bahia:** Nova Esperança, São Lourenço, 32 km W of Wenceslau Guimarães, 26 Jul 2001, *Mattos-Silva et al. 4479* (NY); Ramal da Torre da Embratel, entrance 15 km from the Ubaitabe/Itacaré Road (BR 654), 5.8 km from the entrance, 6 Jun 1978, *Mori & dos Santos 10135* (CEPEC, K, NY); km 3, Uruçuca-Taboquinha highway, 19 Jun 1972, *dos Santos 2316* (CEPEC); access road to Torre da Embratel, entrance to the right of road to Ubaitabe/Itacaré (BR 654), 24 Sep 1977, *dos Santos 3130* (CEPEC, K); Almadina Mata da Serra Pancadinho, 10 Mar 1971, *Pinheiro 1076* (CEPEC, K).

Fevillea bahiensis is most similar and probably most closely related to *Fevillea moorei* of Guyana Amazonian Brazil. Both species have glands only at the base of the leaf blade. *Fevillea bahiensis* differs by having smaller staminate flowers (petals 2.5–3 mm long vs. ca. 1 cm long in *F. moorei*) and the leaves drying a dark reddish brown and with conspicuous uncinate-ciliate margins.

Fevillea cordifolia L., Sp. Pl. 1013. 1753. (**Fig. 2**). *Fevillea scandens* L., Sp. Pl. ed. 2. 1457. 1763, nom. illegit. *Nhandiroba scandens* Descourt., Fl. Méd. Antilles, index 66 [t. 198]. 1829, nom. illegit. *Nhandiroba cordifolia* (L.) Kuntze, Revis. Gen. Pl. 1:257. 1891. *Fevillea cordifolia* L. var. *typica* Stehlé, M. Stehlé, & Quentin, Fl. Guadeloupe 2(3):133. 1949, nom. inadmiss. TYPE: "Habitat in America Calidiore" (LECTOTYPE: "Nhandiroba," Plumier, Pl. Amer. 20, t. 27. 1703). Lectotypified by C. Jeffrey, (in C.E. Jarvis et al., eds. Regnum Veg. 127:47. 1993).

Fevillea hederacea Poir., in Lamarck, Encycl. 4:418. 1798. *Fevillea cordifolia* [var.] *hederacea* (Poir.) Cogn., in Alph. de Candolle & C. de Candolle, Monogr. Phan. 3:943. 1881. TYPE: "On la cultive au jardin des plantes. Elle est originaire de l'Amerique (v.s.)" (HOLOTYPE: P?, n.v.).

Fevillea javilla Kunth, in Humboldt, Bonpland, & Kunth, Nov. Gen. Sp. 2:124. 1817. TYPE: COLOMBIA. Bolívar: Turbaco, *Humboldt & Bonpland 1403* (HOLOTYPE: P, n.v. [microfiche IDC 6209 39:III. 7]).

Fevillea karstenii Cogn., in Alph. de Candolle & C. de Candolle, Monogr. Phan. 3:943. 1881. *Nhandiroba karstenii* (Cogn.) Kuntze, Revis. Gen. Pl. 1:257. 1891. TYPE: VENEZUELA. DISTRITO FEDERAL: Capaya, near Caracas, *Karsten s.n.* (HOLOTYPE: W, n.v.; photo ex W: F, MO). The type sheet contains a mixed collection of *F. cordifolia* and probably *Selysia prunifera* (Poepp. & Endl.) Cogn. The material of the latter in the lower left portion of the sheet is excluded

Fevillea triloba Sessé & Mociño, Fl. Mexic. ed. 2. 231. 1894. TYPE: MEXICO. n.v.

Siolmatra mexiae Standl., in J.F. Macbride, Publ. Field Mus. Nat. Hist., Bot. Ser. 13(6):329. 1937. TYPE: PERU. LORETO: left bank of Río Marañón, above Rancho Indiana, 110 m, 22 Jan 1932, *Mexia 6406* (HOLOTYPE: F; photo ex F: F; ISOTYPES: BM, K, MO, NY, U, US).

Fevillea uncipetala Kuhlm., Arch. Jard. Bot. Rio de Janeiro 4:365. 1925. TYPE: BRAZIL. PARÁ: Rio Branco de Obidos, Castanhal Grande, 4 Nov 1919, *Ducke s.n.* (RB 15924) (HOLOTYPE: RB, n.v.; ISOTYPE: B, destroyed; photograph ex B: F, MO, NY, US).

Vine or liana; stem glabrous or lightly to densely pubescent or tomentose; tendrils glabrous to lightly glandular-pubescent. Leaves with the blade unlobed or occasionally 3- to 5-lobed, suborbicular to cordate, (4–)7.5–13(–18) cm long, (2.5–)5–12(–19) cm wide, membranaceous or coriaceous, 5-nerved, the apex acute, the base cordate to truncate or rarely rounded, the main lateral veins terminating in small irregularly shaped glands, the upper and lower surfaces glabrous to densely pubescent, the petiole (2–)3–7 cm long, glabrous or pubescent. Staminate flowers in a paniculate inflorescence on reduced subterminal, lateral branches, the branches subtended by a glandular bract 0.5–4 mm long;

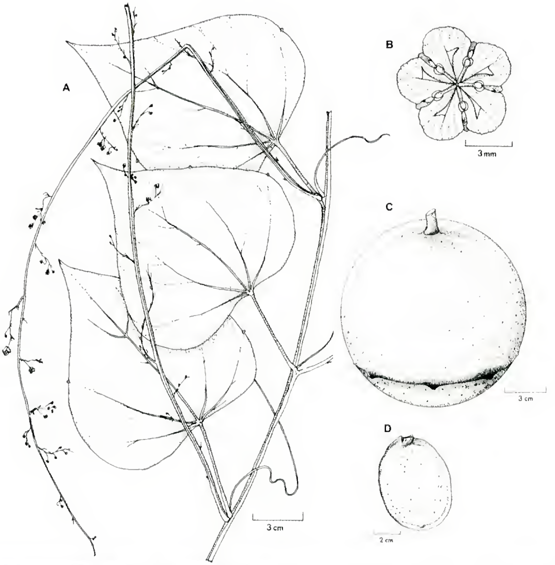


Fig. 2. *Fevillea cordifolia*. **A.** Habit, staminate inflorescence (*Lent 3288*). **B.** Staminate flower (*Klug 3090*). **C.** Fruit (*Huashikat 1078*). **D.** Seed (*Huashikat 1078*).

pedicel 2–4 mm long, glabrous to densely pubescent; bracts linear, glandular, ca. 0.5 mm long; hypanthium 3–4 mm long, glabrous to densely pubescent; calyx shallowly cupular, the lobes 1–2.5 mm long, 1–1.5 mm wide, obtuse or rounded, densely to sparsely glandular-pubescent, the margin entire, the apex rounded, with a small glandular calycine squamella protruding from each sepal at or near the point of fusion with the petal; petals suborbicular, 3.5–5 mm long, 2.5–4 mm wide, white, whitish green, cream-colored, light brown, pink or pinkish orange, dark red, or reddish purple, the margin undulate, the median, adaxial ridge with an uncinate appendage; stamens ca. 1 mm long, the anthers ca. 0.5 mm wide, slightly longer than wide, the filaments ca. 0.5 mm long. Pistillate flowers solitary or in pairs; calyx deeply cupular, the lobes suborbicular, ca. 3 mm long and wide, pustulate, fleshy; petals oblong, ca. 5 mm long, ca. 3.5 mm wide, cream-colored, the median adaxial appendage slightly raised, with 2 small suborbicular glands on each side of the ridge at the base. Fruit subglobose, gourd-like, 10–12 cm in diameter, 10–16 cm long, the surface pustulate, mottled green, zonate above the middle with the hypanthium lip scar and marked at the apex by a raised triradiate line; seeds orbicular, compressed, 1–2.5 cm thick, 4–6(–7.5) cm wide, the lateral surface of the woody layer striate-verrucose or pustulate, with the outer edges smooth or occasionally tuberculate, the tubercles 2–3 mm long.

Distribution and ecology.—Southern Mexico east to Puerto Rico, south through Central America, and into South America to Bolivia. A canopy plant of wet forests from sea level to 1,700 meters.

Selected specimens examined. **MEXICO. Guerrero:** Acapulco, 1894–1895, *Palmer 335* (MO). **GUATEMALA. Sacatepéquez:** near Antigua, 1500–1600 m (cultivated, found in market), Nov 1938–Feb 1939, *Standley 63809* (F). **NICARAGUA. Río San Juan:** 1 km E of the village of Sábalo, 11°02'N, 84°29'W, 50 m, 6 Sep 1985, *Moreno 26249* (MO); between Pueblo de San Juan del Norte Nuevo and La Casa de Ramón Castillo Viajando by San Juanillo, 10°55'N, 83°49'W, 0–100 m, 7 Jul 1994, *Rueda et al. 1839* (MO); Río Pigibaye, 18 Feb 1995, *Rueda et al. 3199* (MO); Reserva Indio-Maiz, along Río Indio, 11°06'N, 83°58'W, 5–20 m, 19 Sep 1998, *Rueda et al. 8822* (MO). **Rivas:** Isla Ometepe, Volcán Maderas, Hacienda "La Argentina," 11°27'–28'N, 85°31'W, 700–900 m, 15 Jun 1984, *Robleto 864* (MO); "Las Cuchillas," Isla Ometepe-Volcán Maderas, 11°27'N, 85°28'W, 400–800 m, 2 Jun 1985, *Robleto 1972* (MO). **Zelaya:** Caño Monte Cristo, "La Grupera," 11°33'N, 87°48'W, ca. 10 m, 4 Feb 1982, *Moreno & Sandino 14743* (MO, NY). **COSTA RICA. Heredia:** Finca La Selva, OTS field station on the Río Puerto Viejo just E of its junction with the Río Sarapiquí, 24 Mar 1980, *Hammel 8251* (MO). **Limón:** Tortuguero-Sierpe basin, near Río Sierpe and Río Penetencia, 10°32'40"N, 83°32'50"W, 20 m, 21 Jan 1997, *Hammel & Grayum 20720* (MO); Río Jiménez, 18 Mar 1973, *Lent 3288* (F, MO); Cordillera de Talamanca, Reserva Biológica Hitoy Cerere, road between Estación de la Reserva and Cerere, 9°40'20"N, 83°01'35"W, 100 m, 23 Feb 1989, *Herrera & Chacón 2434* (MO). **Puntarenas:** Península de Osa, Estación de Oro, along the Aquaduct, 08°42'00"N, 83°29'10"W, 150 m, 10 Feb 1996, *Angulo 517* (MO, NY); Península de Osa, La Palma, Guadalupe, Finca de Efraín González, 08°38'30"N, 83°28'00"W, 50 m, 17 Aug 1993, *Aquilar 2119* (MO); Península de Osa, Rancho Quemado, road to Draque, 08°42'00"N, 83°33'00W, 100 m, 30 Jan 1991, *Nielsen 895* (MO); Valle de Coto Colorado, 08°46'00"N, 83°15'00"W, 100 m, 25 Jun 1993, *Quesada & Segura 705* (MO); Playa San Josecito, Península de Osa, 08°37'00"N, 83°44'00"W, 10–100 m, 10 Dec 1993, *Quesada et al. 848* (MO); Valle de Coto Colorado, shore of Río Esquinas, mouth of Río Esquinas, 08°44'00"N, 83°20'00"W, 30 m, 17 Dec 1993, *Segura et al. 255* (NY); Forest de Santo Domingo de Golfo Dulce, Mar 1896, *Tonduz 10078* (BR). **San José:** Cordillera de Talamanca, Las Nubes, Estación Santa Elena, 09°23'30"N, 83°36'30"W, 1150 m, 14 Feb 1996, *Alfaro 477* (MO). **PANAMA. Chiriqui:** Burica Peninsula, Rabo de Puerco, 8 km along road W from Puerto Armuelles, 150 m, 19 Feb 1973, *Busey 440* (F, MO, NY, USF). **Colón:** Barro Colorado Island, 100 m S of Zetek Trail, 600 m, 26 Aug 1970, *Croat 11918* (F, MO, NY, USF). **Darién:** Río Sabana, above Sante Fe, 14 Sep 1967, *Duke 14107* (MO). **Los Santos:** 17.8 mi S of Macaracas, ca. 300 m, 25 May 1967, *Burch 1605* (MO). **Panamá:** 12.4 km E of Canita, 10 Oct 1975, *Witherspoon 8704* (MO). **CUBA. Oriente:** Bayate at Río Jagua, 4 May 1919, *Ekman 9613* (G, K, NY, US). **JAMAICA. Portland:** gorge of the Swift River at Eden, 0.5 mi N of Paradise, ca. 30 m, 19 Mar 1956, *Proctor 11871* (MO). **St. Andrew:** Hope Gardens, 29 May 1902, *Harris 8381* (BM, NY). **St. Ann:** cave near St. Ann's Bay, Dec 1873, *Purdie s.n.* (K). **St. Mary:** Wapping Stairs, N side of Guys Hill, 20 Mar 1960, *Proctor 20713* (NY). **St. Thomas:** near Dove Hall, 10 Feb 1850, *Alexander s.n.* (K, NY). **HAITI.** Massif du Nord, Le Borgne, edge of RiviPre du Borgne, 12 Sep 1925, *Ekman 4851* (US). **DOMINICAN REPUBLIC.**

El Seibo: Cordillera Oriental, ca. 6–8 km S of Miches-Las Lgunas de Nisibon Highway, on road to Batey Arroyo Santiago, basin of Río Yeguada (S of Miches), 18°55'N, 69°04'W, 80–100 m, 28 Jun 1990, *Zanoni & Jiménez 44609* (MO). **La Vega:** Jarabocoa, Monabao, Los Calabazos, Arroyo Frio entrance, 19°4'23"N, 70°43'34.6"W, ca. 774 m, 19 Mar 2001, *Ososki & Saborio 299* (NY). **PUERTO RICO.** Along road between Utuado and Adjuntas, km 40, 2 Feb 1997, *Acevedo & Angell 9419* (NY); Bayamón, 31 Mar 1885, *Sintenis 986* (BM, BR, G, K, M, NY, US). **COLOMBIA. Amazonas:** Loreto-Yacú River, ca. 100 m, Sep 1946, *Schultes & Black 83351* (K). **Antioquia:** near Río León ca. 20–30 km upstream and S of the river mouth ca. 15 km W of Chigorodó, ca. 7°45'N, 76°50'W, ca. 100 m, 14 Mar 1962, *Feddema 1907* (NY) ; Murrí la Blanquita, Río Murrí, 06°35'N, 76°50'W, 960 m, 28 Feb 1992, *Gentry et al. 75799* (MO); km 28.8, Nutibara-La Blanquita road, 06°40'N, 76°27'W, 1020 m, 5 Nov 1988, *Zarucchi et al. 7172* (MO). **Atlántico:** Barranquilla and vicinity, Jan 1934, *Elias 1173* (F, US). **Bolivar:** vicinity of Turbaco, Nov 1920, *Heriberto 469* (F, US). **Chocó:** Río San Juan, Quebrada del Taparal, 5–20 m, 30 May 1946, *Cuatrecasas 21504* (F); Rio Chintado, 1–2 1/2 hrs. above La Nueva, 6 Feb 1967, *Duke 9865* (NY); right bank of Río Baudó, ca. 18.5 km upstream of estuary, between estuary of Quebrada Porquera and the sawmill Porquera, ca. 5 m, 6 Feb 1967, *Fuchs & Zanella 21791* (NY) **Cundinamarca:** Sierra de Subia, 6.6 km N of Cumaca along road to Viota, 1700 m, 22 Jun 1972, *Barclay et al. 3521* (US). **Magdalena:** Santa Marta, 5 mi S of Ciénaga, near sea level, 12 Sep 1898-1899, *Smith 1607* (BM, BR, F, G, MO, NY, US). **Meta:** Serranía de la Macarena, Plaza Bonita, bank of Río Güejar, 400 m, 14 Nov 1949, *Philipson et al. 1423* (F, BM, US). **Putamayo:** Frontera Colombia-Ecuatoriana, along Río San Miguel, at mouth of the Río Conejo, 300 m, 9 Dec 1940, *Cuatrecasas 10915* (US); San Antonio, Alto Campucana path, Finca La mariposa, 1350–1420 m, 01°12'N, 76°38'W, 10 Apr–1 May 1994, *Fernández et al 10745* (NY). **Vaupés:** Río Guayabero, 240 m, 8 Nov 1939, *Cuatrecasas 7499* (US). **VENEZUELA. Apure:** Reserva Forestal San Camilo, vicinity of Chirocoa, 9–10 km E of Caserío San Camilo (El Nula), 200 m, 1 Apr 1968, *Steyermark et al. 101665* (MO, NY). **Aragua:** Parque Nacional Henri Pittier, Estación Biológica de Rancho Grande, 6 Jun 1987, *Rojas & Rojas 3617* (MO, NY); Parque Nacional Henry Pittier, between trail up Periquito and Fila de Periquito, along upper slopes of tributary to Quebrada Palo Vaco on side towards Lago Valencia, opposite Rancho Grande Biological Station, 1300–1400 m, 25 Oct 1961, *Steyermark 89886* (F, NY, US). **Carabobo:** Río Morón, E of Morón, 10°17–18'N, 68°10–16'W, 0–50 m, 20–21 Jul 1991, *Diaz & Jiménez 487* (MO) **Delta Amacuro:** between La Margarita and Puerta Miranda, Río Cure, 80–100 m, 26 Nov 1960, *Steyermark 87780* (NY, US); Río Acure, 29 Jan 1980, *Trujillo & Sulbaran 16234* (MO). **Distrito Federal:** Hacienda Chichiriviche, ca. 300 m, Jul 1958, *Aristeguieta 3225* (NY, US). **Mérida:** 0.5–2 km above dam site on Río Guaimaral, 7°45'N, 71°29'W, 15 Mar 1981, *Liesner & González 10637* (MO). **Miranda:** Carretera Santa Teresa–Guatopo, ca 300 m, 4 Jun 1959, *Trujillo 4149* (US). **Yaracuy:** Sierra de Aroa, 2 Jul 1953, *Aristeguieta & Pannier 1854* (NY). **Zulia:** ca. 5 km SSE of Destacamento Guasare No. 1 (La Yolanda), 10°52'10"N. 72°29'30"W, 250–350 m, 16 Nov 1982, *Bunting et al. 12420* (NY); 8 km from San José de Los Altos on road to Caño Colorado, 390 m, 27 Nov 1977, *Jeffrey & Trujillo 2396* (F, K, MO); 6 km W of main road and 2 km S of Río Catatumbo, 09°6'N, 72°42'W, ca. 20–100 m, 29 Mar 1982, *Liesner & González 13347*(MO, NY). **ECUADOR. Morona Santiago:** El Centro Shuar Pampants, Río Kankaim (Cangaime), 02°47'S, 77°36'W, 300 m, 10 Sep 1985, *Warush RBAE85* (NY). **Napo:** 5 km SE of Las Sachas, 300 m, 13 Apr 1985, *Baker et al. 5995* (NY); Parroquia Dureno, indigenous Colán-Dureno community, 00°02'S, 76°42'W, 350 m, 29–31 Dec 1987, *Cerón & Cerón 3107* (MO, NY); Estación Biológica Jatun Sacha, Río Napo, 8 km E of Misahuallí, 01°04'S, 77°36'W, 450 m, 22 Oct 1988, *Cerón & Iguago 5510* (MO); Hollin-Loreto-Coca highway, between Avila and Río Pucuno, 00°39'S, 77°22'W, 800 m, 10 Dec 1987, *Cerón et al. 2871* (MO, NY); Parque Nacional Yasuní, along Maxus road and pipeline construction project, km 54–54, 13–16 Sep 1993, *Dik 436* (MO, USF); km 2, new Cotundo-Coca highway, 1130 m, 5 Aug 1984, *Dodson et al. 15057* (MO); Coca-Auca oilfields road, km 53, 00°50'S, 76°52'W, 400 m, 20 Aug 1979, *Jaramillo & Coello 19710* (NY, US); Maxus road, km 1.8, 00°27'S, 76°38'W, 21 Sep 1997, *Klitgaard et al. 617* (NY); Parque Nacional Yasuní, Añangu, along Río Añangu near junction with Río Napo, 0°31'S, 76°23'W, ca 270 m, 16 Jun 1982, *Luteyn et al. 8498* (NY); near NW corner of Lake Limóncocha, Sep 1969, *Mowbray 69951* (MO); along Río Indillama, tributary of Río Napo, Comuna Pompeya, 00°30'S, 76°40'W, 220 m, 5 Dec 1992, *Neill et al. 10192* (MO, NY); right bank of Río Napo, 8 km from Puerto Misahuallí, 01°04'S, 77°37'W, 450 m, 7–16 Sep 1988, *Palacios 3006* (MO, NY); Codo Sinclair, 00°08'S, 77°27'W, 650 m, 16–20 Sep 1990, *Palacios 5719* (MO); Río Huataraco, towards Ishpano, 00°44'S, 77°23'W, 700 m, 30 Nov 1992, *Palacios 10510* (MO, USF); 6 km N of Shushufindi, towards Dureno, 0°10'S, 76°40'W, 450 m, 23 Sep 1985, *Palacios et al. 829* (MO); Dureno on Río Aguarico, 2 Jul 1966, *Pinkley 103* (MO); Yusuní National Park, along Maxus road and pipeline construction project, km 21, 00°33'S, 76°31'W, 250 m, 24 Jul 1994, *Pitman 646* (MO, USF); 20 km N of Coca, Palmoriente property, 00°20'S, 77°05'W, 250 m, 3–21 Nov 1989, *Rubio 332* (MO, NY). **Pastaza:** ARCO oil well Villano 2, 01°25'S, 77°20'W, 400 m, 1–18 Dec 1991, *Hurtado 2908* (MO); Petro-Cañada highway under construction, Via Auca, 115 km S of Coca, 5 km S of Río Tigüino, 01°15'S, 76°55'W, 320 m, 1–6 Mar 1989, *Zak 4135* (MO). **Pichincha:** Santo Domingo de los Colorados, 800 m, 10 Aug 1945, *Solis 10928* (F). Carchi: Reserva Indígena Awá, Parroquia Tobar Donoso, sector El Baboso, 78°20'W, 00°53'N, 1600 m, 3 Oct 1991, *Rubio & Talcuz 295* (MO, USF). **PERU. Amazonas:** S of Huampami across Río Cenepa, 700–900 m, 27 Dec 1972, *Berlin 716* (MO); Río Santiago, Cantón de la Quebrada Caterpiza, 1 km from community of Caterpiza, 200 m, 11 Sep 1979, *Huashicat 552* (MO, USF); Yamayakat Brosque, 04°55'S, 78°19'W, 320 m, 16 Jan 1996, *Jaramillo et al. 881* (MO). **Huánuco:** vicinity of Tingo María Insupte, 670 m, 16 Aug 1961, *Schunke 5645* (F, US). **Loreto:** Flor de Yarina-Río Samiria, 20 Oct 1982, *Ayala et al. 3922* (NY); Explorer's Inn, Río Amazonas near Indiana, 03°30'S, 73°03'W, 130 m, 20 Feb 1988, *Gentry et al. 61736* (MO); Santa Rosa, lower Río Huallaga below Yurimaguas, ca. 135 m, 1–5 Sep 1929, *Killip & Smith 28720* (NY); Balsapuerto, ca. 220 m, May 1933, *Klug 3090* (BM, F, G, MO, NY, US); Quebrada de Tamishaco above Tamishaco, 7 Nov 1978, *Rimachi 4046* (MO); Florida, 8 Feb 1980, *Rimachi 4856* (NY); Río Itaya, highway to San Antonio, near Venezia, 90 m, 21 Sep 1994, *Rimachi 11120* (NY); Bosque Nacional de Iparía, along the Río Ucayali near Iparía (80 km at the confluence with Río Pachitea), 250–300 m, 23 Aug 1968, *Schunke 2670* (NY); San Antonio, Río Itaya, 04°10'S, 73°20'W, 150 m, 13 Dec 1982, *Vásquez & Jaramillo3597* (MO); Cocha Pastor, Isla Padre, 03°45'S, 76°10'W, 116 m, 21 Dec 1982, *Vásquez et. al. 3683* (NY); Indiana, Explorama Inn, 03°30'S, 73°05'W, 108 m, 12 Apr 1992, *Vásquez et al. 18213* (MO). **Madre de Dios:** Parque Nacional del Manu, Cocha Cashu Biological Station, 21 Aug 1976, *Foster & Augspurger 3394* (K, MO, NY, US); Cocha Cashu Camp, Parque Nacional de Manu, along Río Manu, 380 m, 22 Oct 1979, *Gentry et al. 27161* (NY); Cuzco Amazónico Lodge, 15 km NE of Puerto Maldonado, 12°35'S, 69°03'W, 200 m, 18 Jun 1990, *Núñez 12192* (MO); Las Piedras, Cusco Amazónico, Río Madre de Dios, 12°29'S, 69°03'W, 200 m, 13 Aug 1991, *Timaná 1997* (MO). **San Martín:** Valley of San Martín, E of Tarapoto, Funde de San Isidro near Codo Creek, 1000 m, 15 Aug 1937, *Belshaw 3230* (NY); Pongo de Cainarachi, Río Cainarachi, tributary of Río Huallaga, ca. 230 m, Sep–Oct 1932, *Klug 2749* (BM, F, G, MO, NY, US); Rioja-Pomacochas road, below Venceremos, ca. 20 km NW of Rioja, 05°45'S, 77°38'W, 1600 m, 8 Feb 1984, *Gentry & Smith 45128* (MO); above Chazuta, W of Quebrada Chazuta, 06°34'S, 76°12'W, 200–300 m, 28 Aug 1986, *Knapp 8177* (NY); W of Nueva Aspusana (2 hrs down Río Huallaga from La Roca), 8 Aug 1962, *Mathias & Taylor 6116* (MO); Fundo La Campiña, 2 km below Tocache Nuevo, right bank of Río Huallaga, ca. 400 m, 23 Aug 1969, *Schunke 3377* (NY); Tananta (left bank of Río Huallaga), 6 Oct 1970, *Schunke 4479* (NY), Nueva Unión below Puerto Huicte (right bank of Río Huallaga), 450–500 m, 1 Aug 1974, *Schunke 7965* (NY). **Ucayali:** Bosque Nacional de Iparía, along the Río Ucayali near the village of Iparía (ca. 80 km above the confluence with Río Pachitea), 200–300 m, 23 Aug 1968, *Schunke 2670* (F, G); Río Novia, right bank at native community San José, 10°12'S, 70°57'W, 189 m, 26 Feb 2002, *Schunke & Graham S14909* (NY). **BRAZIL. Acre:** margin of Rio Azul, ca. 07°29'S, 73°39'W, 13 Oct 1986, *Campbell et al. 8995* (NY); Sena Madureira, 28 Sep 1980, *Cid & Nelson 2596* (NY); basin of Rio Juruá, right bank of Rio Tarauacá, 8°32'51"S, 71°28'39"W, 17 Nov 1995, *Daly et al. 8562* (MO, NY); near mouth of Rio Macauã (tributary of Rio Iaco), 9°20'S, 69°W, 23 Aug 1933, *Krukoff 5610* (BM, F, G, M, MO, US). **Amazonas:** near mouth of Rio Embira (tributary of Rio Tarauacá), 7°30'S, 70°15'W, 6 Jul 1933, *Krukoff 5209* (BM, F, G, M, MO, NY, US). **Pará:** Belém, 20 Dec 1950, *Black 50-10925* (NY); Rio Pacajá 2°50'S, 50°50'W, 15 Oct 1965, *Prance et al. 1636* (NY); Rio Mocoões, 45 min. below Frances, 00°45'S, 49°41'W, 10 Nov 1987, *Prance et al. 30399* (MO, NY); Altamira, left bank of lower

Rio Xingu, 19 Oct 1986, *Souza et al. 385* (NY); Travessão do CNEC, between D13 and edge of Rio Xingu, 2 Dec 1986, *Souza et al. 635* (NY); Ilha de Marajó, Cuantã, above Anajás, Rio Anajás, 00°57'S, 49–48°W, 2 Nov 1987, *Tavares 334* (NY) **Rondônia:** E bank of Rio Madeira at Misericórdia between Cachoeiras Misericórdia and Madeira, 30 Jul 1968, *Prance et al. 6620* (NY). **BOLIVIA. Cochabamba:** Proyecto Valle del Sacta, km 240 on Santa Cruz-Villa Tunari highway, 17°00'S, 64°46'W, 290 m, 12–14 Jul 1989, *Smith et al. 13711* (MO). **El Beni:** Río Beni, above confluence with Río Quiquibey, 3.5 hrs. upstream from Rurrenabaque, 14°44'S, 67°25'W. 320 m, 23 May 1990, *Daly et al. 6590* (MO, NY). **La Paz:** Parque Nacional Madidi, 10.2 km NW of turnoff in Tumupasa, 200–500 km from summit, 14°09'57"S, 67°55'02"W, 830 m, 9 Aug 2000, *Croat et al. 84416* (MO), Santa Fe, NE of community,13°40'S, 68°12'W, 250 m, 10 Aug 1995, *DeWalt et al. 823* (MO, NY); basin of Rio Bopi, San Bartolomé near Calisaya, 750–900 m, 1–22 Jul 1939, *Krukoff 10528* (F, G, K, MO, NY, US); Parque Nacional Madidi, near Arroyo Aguapolo and Río Tuichi, 270 m, 16 Mar 2002, *Macía et al. 6850* (NY). **Santa Cruz:** Parque Nacional Amboró, along Río Isamá ["Río Pitasamá"], 17°42–43'S, 63°37–38'W, 475 m, 11 Oct 1990, *Nee 39252* (NY); Estancia San Rafael de Amboró, 15 km (by air) SSE of Buena Vista, 17°35'S, 63°37'W, 375 m, 28 Jul 1987, *Nee et al. 35391* (NY); Río Palometilla, 400 m, 16 Jun 1927, *Steinbach 7904* (F, G, MO, NY, BM).

Fevillea cordifolia is a polymorphic species exhibiting considerable variation throughout its range. The species can be readily distinguished from other members of the genus by its conspicuous marginal laminar glands. It is most similar to *F. trilobata* of eastern Brazil and is distinguished from that species by the typically rounded leaf lobes (when lobes are present), rather than the angular lobes characteristic of *F. trilobata*. *Fevillea trilobata* also has a distinctive stipitate-glandular pubescence on the hypanthium of the staminate flowers, which is sharply differentiated from the uncinate pubescence of pedicel. This pattern of pubescence is lacking in *F. cordifolia*.

Fevillea moorei Hook. f., Bot. Mag. t. 6356. 1878. *Nhandiroba moorei* (Hook. f.) Kuntze, Revis. Gen. Pl. 1:257. 1891. TYPE: GUYANA or BRAZIL: Cultivated at Liverpool Botanic Garden, 1871, *Tyreman s.n.* (HOLOTYPE: K; ISOTYPE: BR-fragment).

Vine or liana; stem glabrous; tendrils glabrous. Leaves with the blade unlobed, broadly ovate, 6–12 cm long, 3.5–7 cm wide, membranaceous, drying light green, 3-nerved, the apex acuminate, the base rounded, with 2 small, irregularly shaped glands near the petiole, the upper and lower surfaces glabrous, the petiole 1–2.5 cm long, glabrous. Staminate flowers in a racemose inflorescence ca. 6 cm long, (10–12 cm fide Hooker f.); pedicel 1–4 mm long, glabrous; hypanthium 5–6 mm long, glabrous; bracts linear, ca. 0.5 mm long; calyx shallowly cupular, the lobes oblong, ca. 6 mm long, 4 mm wide, the apex obtuse, the margin entire, with a glandular calycine squamella protruding at or near the point of fusion with the petals; petals suborbicular, somewhat broader at the apex, ca. 1 cm long, 1 cm wide, pale brick-red, the margin undulate; stamens ca. 4 mm long, the anthers ca. 1 mm long, slightly longer than wide, the filament ca. 3 mm long. Pistillate flowers and fruit not seen.

Distribution and ecology.—Known only from the type material received by J.D. Hooker from David Moore, curator of the Glasnevin Botanic Garden, Dublin, Ireland, who received it from Mr. Tyreman of the Liverpool Botanic Garden.

The material was labeled as "Strychnos curari" and said to have come from Gambia. As suggested by Hooker in the protologue, it is probable that the plant is from South America, possibly Guyana or the Amazon River basin of Brazil where *Strychnos toxifera*, the source of the drug curare is native and was known to occur at that time. Hooker named the plant in honor of his friend, Dr. Moore.

Fevillea moorei is most similar to *F. bahiensis* of southern Bahia, Brazil. It is easily distinguished by its larger staminate flowers, its leaf margins lacking uncinate trichomes, and its 3-nerved leaves which dry to a light green color.

Fevillea pedatifolia (Cogn.) C. Jeffrey, Kew Bull. 16:199 1962. (**Fig. 3**). *Alsomitra pedatifolia* Cogn., in Martius, Fl. Bras. 6(4):116. 1878. *Siolmatra pedatifolia* (Cogn.) Cogn., in Engler, Pflanzenr. 4(Heft 66):30. 1916. TYPE: BRAZIL. AMAZONAS: Rio Solimões, 1819–1820, *Martius s.n.* (HOLOTYPE: M; photo ex M: F, MO, NY, US; ISOTYPES: BR-fragment).

Alsomitra peruviana Huber, Bol Mus Paraense Hist. Nat. 4:616. 1908. *Siolmatra peruviana* (Huber) Cogn., in Engler, Pflanzenr. 4(Heft 66):30. 1916. *Fevillea peruviana* (Huber) C. Jeffrey, Kew Bull. 16:200. 1962. TYPE: PERU. UCAYALI: Río Ucayali, near Canchahuaya, 28 Oct 1898, *Huber 1390* (HOLOTYPE: MG, n.v.; photo ex MG: F; ISOTYPE: F-fragment).

Siolmatra amazonica Cogn., in Engler, Pflanzenr. 4(Heft 66):30. 1916. *Fevillea amazonica* (Cogn.) C. Jeffrey, Kew Bull. 16:199. 1962. TYPE. BRAZIL. AMAZONAS: Rio Juruá, Juruá Miry, Oct 1901, *Ule 5819* (LECTOTYPE: here designated, K; ISOLECTOTYPES: F-fragment, MG, n.v.; photo ex MG: F; B, destroyed; photo ex B: F, MO, NY, US).

Siolmatra simplicifolia Harms, Notizbl. Bot Gart. Berlin-Dahlem 11:769. 1933. *Fevillea simplicifolia* (Harms) C. Jeffrey, Kew Bull 16:200. 1962 TYPE: PERU. LORETO: Lower Río Huallaga, Yurimaguas, Puerto Arturo, 15 Nov 1929, *Williams 5072* (HOLOTYPE: B, destroyed; LECTOTYPE: here designated, F; ISOLECTOTYPE: US).

Vine or liana; stem glabrous to densely glandular-pubescent; tendrils sparsely pubescent or glabrous. Leaves with the blade unlobed, or 3- to 5-lobed, or 3- to 5-foliolate, membranaceous to coriaceous, the unlobed or the lobed leaves ovate to ovate-oblong, (6–)8–15(–18) cm long, 9–14(–17.5) cm wide, 5- to 7-nerved, the divisions of the lobed leaves or the leaflets of the foliolate leaves (6–)8–15(–18) cm long, 4–8 cm wide, 1- to 2-nerved, with a petiolule up to 2 cm long, the apex of the blade or leaf divisions acuminate, the base of the blade or leaf divisions oblique or rounded, the margin entire or coarsely crenate-toothed, the primary lateral veins terminating in a small irregularly shaped marginal gland, the upper and lower surfaces glabrous or lightly pubescent, especially along the leaf veins, the petiole 3.5–5(–7) cm long, glabrous to sparsely pubescent, with 2 opposite, prominent, irregularly shaped median to subapical glands. Staminate flowers in a paniculate inflorescence on reduced lateral branches, each branch subtended by a thin scale-like glandular-pubescent bract 0.5–2 mm long; pedicel 0.5–1 mm long, sparsely glandular-pubescent to glabrate; hypanthium 0.5–1.5 mm long, sparsely glandular-pubescent to glabrate; calyx shallowly cupular, the lobes light green or greenish brown, suborbicular, 0.5–1 mm long and wide, the apex rounded or obtuse, glandular-pubescent or glabrous, the margin slightly erose and glandular-ciliate, with a glandular calycine squamella

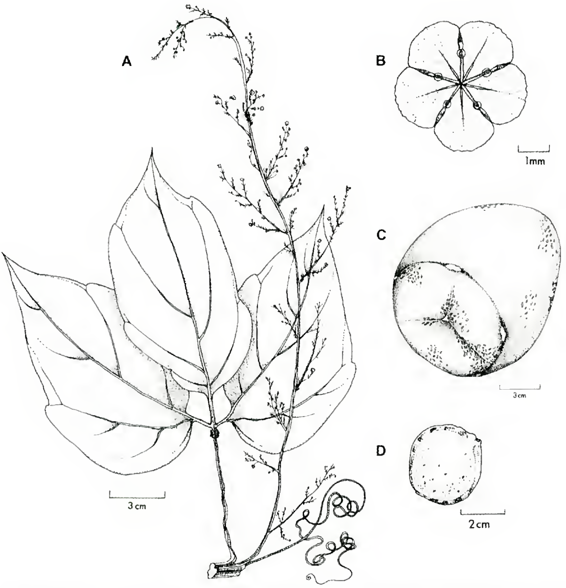


Fig. 3. ***Fevillea pedatifolia*. A.** Habit, staminate inflorescence (*Klug 4187*). **B.** Staminate flower (*Klug 2678*). **C.** Fruit (*Barbour 5533*). **D.** Seed (*Barbaur 5533*).

protruding at or near the point of fusion with the petals; petals suborbicular, 1–2 mm long, 1–1.5 mm wide, white or greenish white, greenish yellow, or yellowish, the margin slightly erose, the median adaxial ridge slightly raised; stamens 0.25– 0.5 mm long, the anthers ca. 0.25 mm long, slightly longer than wide, the filament ca. 0.5 mm long. Pistillate flowers in pairs; pedicel 1.2–2 mm long; calyx deeply cupular, the lobes ca. 3 mm long, ca. 2 mm wide, dark greenish brown, the surface pustulate; petals white. Fruit subglobose, ca. 14 cm long, 13 cm wide, gourd-like, indehiscent or rarely circumscissile dehiscent along the hypanthium lip scar (A. Gentry, pers, comm.), the surface smooth or pustulate, usually a mottled green color; seeds orbicular, compressed, 4–5 cm long and wide, 1.5–2.5 cm thick, silver-white upon drying, the woody layer smooth to slightly pustulate, the winged margin ca. 0.5 cm wide.

Distribution and ecology.—Amazonian Ecuador and Peru, south to Bolivia, and east to Acre and Amazonas, Brazil. A plant of moist to wet forests, occurring at 130–800 meters in elevation.

Selected specimens examined. **ECUADOR. Napo:** Estación Biológica Jatun Sacha, 8 km E of Misahuallí, 01°04'S, 77°36'W, 400 m 23–31 Jan 1989, *Cerón 6076* (MO); km 2, new road from Cotundo to Coca, 1130 m, 5 Aug 1984, *Dodson et al. 15072* (NY). **PERU. Amazonas:** 1 km from La Poza, W of Río Santiago, 180 m, 21 Aug 1979, *Huashikat 111* (MO); valley of Río Santiago, Quebrada Caterpiza, 2–3 km behind the community of Caterpiza, 3°50'S, 77°40'W, 200 m, 8 Feb 1980, *Tunqui 783* (MO). **Ayachucho:** between Santa Rosa and Hacienda Luisiana, 640 m, 9 Sep 1976, *Wasshausen & Encarnación 632* (NY). **Huánuco:** Codo de Puzuzo, floodplain of Río Puzuzo, S of settlement to main river, 9°40'S, 75°25'W, 450 m, 21 Oct 1982, *Foster 9370* (USF). **Junín:** Río Negro, 800 m, 14 Aug 1960, *Woytkowski 5795* (G, MO, US). **Loreto:** Yanamono, Explorama Tourist Camp on Río Amazonas between Indiana and mouth of Río Napo, 03°28'S, 72°48'W, 120 m, 26 Jul 1980, *Gentry et al. 29043* (MO); Yanamono, Explorama Tourist Camp, Río Amazonas halfway between Indiana and mouth of Río Napo, 03°28'S, 72°50'W, 130 m, 13 Jul 1983, *Gentry et al. 42937A* (MO); Balsapuerto, 220 m, Feb 1933, *Klug 2896* (BM, F, G, MO, NY, US); Indiana, Reserva Explorama (Yanamono), 03°30'S, 72°50'W, 90 m, 28 Sep 1990, *Pipoly et al. 12592* (MO); Yanamono tourist camp, 50 mi. NE of Iquitos, 3°30'S, 72°50', ca. 106 m, 19 Oct 1980, *Vásquez & Jaramillo 586* (NY); Indiana, Iquique, 03°30'S, 72°58'W, 115 m, 16 Dec 1987, *Vásquez & Jaramillo 10164* (MO); Indiana, Explorama Reserve, 03°28'S, 72°50'W, 106 m, 9 Nov 1989, *Vásquez & Jaramillo 13140* (MO). **Madre de Dios:** Tambopata, 12°50'S, 69°17'W, 260 m, 8 Nov 1988, *Alexiades et al. 81* (MO, NY); Río Piedras, near confluence with Río Pariamanu, 12°40'S, 69°17'W, 260 m, 11 Jan 1991, *Alexiades et al. 1071* (NY); Lago Tres Chimbadas, ca. 65–70 river km SSW of Puerto Maldonado, ca. 10–15 air km NW effluence of Río La Torre (Río D'Orbigny) Río Tambopata, 12°49'S, 69°17'W, ca. 260 m, 7 Jun 1980, *Barbour 5533* (MO); Río Manu, Cocha Cashu Biologial Station, 350 m, 1 Oct 1980, *Foster 5439* (NY); Cocha Cashu, vicinity of ox-bow lake of Río Manu, between Panaqua and Tayakome, 17–24 Aug 1974, *Foster et al. 3492* (K, MO, US). Las Piedras, Cusco Amazónico, 12°29'S, 69°03'W, 200 m, 24 Jun 1991, *Timaná 1844* (MO). **Pasco:** Río Pichis, 1 hr. below Puerto Bermudez, between Puerto Bermedez and Paujil, 10°10'S, 74°50'W, 200 m, 17 Jun 1983, *Gentry et al. 42148* (MO); Iscozacín, near confluence of Río Palcazu and Río Iscozacín, 10°12'S, 75°13'W, 430 m, 16 Jun 1982, *Smith 1911* (NY); Palcazu Valley, Río Chuchurras drainage, 10°09'S, 75°20'W, 400 m, 13 May 1983, *Smith 4009* (MO, US). **San Martín:** Pongo de Cainarachi, Río Cainarachi, tributary of Río Huallaga, 230 m, Sep-Oct 1932, *Klug 2755* (BM, F, G, K, MO, NY, US); Quebrada Cachiyacu de Huaquisha, ca. 500–650 m, 7 Dec 1980, *Schunke 12451* (NY). **Ucayali:** Bosque Nacional von Humboldt, Pucallpa-Tingo María Road, 8°40'S, 75°0'W, 250 m, 13 Feb 1981, *Gentry et al. 31307* (MO, USF). **BRAZIL. Acre:** N bank of Rio Juruá opposite Cruzeiro do Sul, 27 Oct 1966, *Prance et al. 2936* (K, MO, NY, US). **Amazonas:** near Palmares, 11 Sep 26–Oct 1936, *Krukoff 8475* (BM, BR, F, G, K, MO, NY, US). **BOLIVIA. La Paz:** basin of Río Bopi, Asunta (near Evenay), 690–750 m, 27–31 Jul 1939, *Krukoff 10666* (F, G, K, MO, NY).

Plants with 3- to 7-foliolate leaves are easily distinguished from other species of *Fevillea*. They previously had been considered a species of *Siolmatra* because of this feature, but the presence of the foliar glands, the bilocular anthers, and the large globose fruit with large unwinged seeds clearly separates it. *Siolmatra*, in contrast, lacks foliar glands, has unilocular anthers, and has a cylindric fruit with winged seeds.

Fevillea peruviana and *F. amazonica* were separated from *F. pedatifolia* on the basis of leaflet number (3 rather than 5). *Fevillea amazonica* was further separated on the basis of the petiolar gland position (median rather than subapical). These characters are not constant and thus *F. peruviana* and *F. amazonica* are here reduced to synonymy as suggested by Jeffrey (1962b).

Plants with unlobed leaves have been called *F. simplicifolia*. Since specimens with leaves intermediate between simple and 3-foliolate are occasionally found (although rare) and there are otherwise no other floral or vegetative differences, *F. simplicifolia* is here reduced to synonomy. Plants with unlobed leaves are sometimes confused with *F. pergamentacea*. However that species is readily distinguished by the presence of a pair of glands at the base of the blade, while the glands in *F. pedatifolia* are on the petiole.

Fevillea pergamentacea (Kuntze) Cogn., in Engler, Pflanzenr. 4(Heft 66):8. 1916. **(Fig. 4)**. *Nhandiroba pergamentacea* Kuntze, Revis. Gen. Pl. 3(2):104. 1898 TYPE: BOLIVIA. SANTA CRUZ: Río Yapacaní, 400 m, Jun 1892, *Kuntze s.n.* (LECTOTYPE: here designated, NY; ISOLECTOTYPES: NY, B, destroyed; photo ex B: F, MO, NY, US).

Nhandiroba harmsii Kuntze, Revis. Gen. Pl. 3(2):103. 1898. *Fevillea harmsii* (Kuntze) K. Schum., Just's Bot. Jahresber. 26:383. 1898. TYPE. BOLIVIA. SANTA CRUZ: Velasco, 200 m, Jul 1892, *Kuntze s.n.* (LECTOTYPE: here designated, NY; ISOLECTOTYPES: US, B, destroyed; photo ex B, F, MO, NY, US).

Vine or liana; stem glabrous to lightly pubescent; tendrils glabrous. Leaves with the blade unlobed or occasionally 2- to 3- lobed, ovate, 10–11(–15) cm long, (4–) 6–8(–15) cm wide, subcoriaceous, drying very light brown or green, the apex or the lobe tips acuminate or acute to slightly rounded, the base cordate to truncate, the upper surface glabrous, the lower surface lightly pubescent along the veins, the margin entire, occasionally with scattered trichomes, the lateral veins occasionally terminating with a small gland, with 2 small, opposite, irregularly auriculate glands at the base of the blade, the petiole 2.5–4 cm long, glabrous to sparsely pubescent. Staminate flowers in a paniculate inflorescence on reduced lateral branches; pedicel 1–2 mm long, densely to sparsely pubescent; hypanthium 0.5–1 mm long, glabrous; calyx crateriform, the lobes lanceolate, 0.5–1 mm long, ca. 0.5 mm wide, obtuse, slightly erose-margined, sparsely to densely pubescent, with a prominent glandular calycine squamella protruding from each sepal at or near the point of fusion with the petals; petals narrowly obovate, 2–2.5 mm long, 1.5–2 mm wide, cream to yellowish brown, the margin entire, the median appendage slightly raised; stamens ca. 0.5 mm long, the anthers ca. 0.25 mm wide, slightly longer than wide. Pistillate flowers not seen. Fruit globose, 6–7 cm long and wide, green, the surface minutely pustulate; seeds orbicular, compressed, 1.5 cm thick, 3.5–4.5 cm long and wide, the lateral surface of the woody layer smooth to minutely pustulate, the marginal nerve ca. 0.5 cm wide, completely enclosing the seed.

Distribution and ecology.—Amazonian Colombia, Ecuador, eastern Peru, and central Bolivia. A plant of wet forests, occurring between 180 and 500 meters.

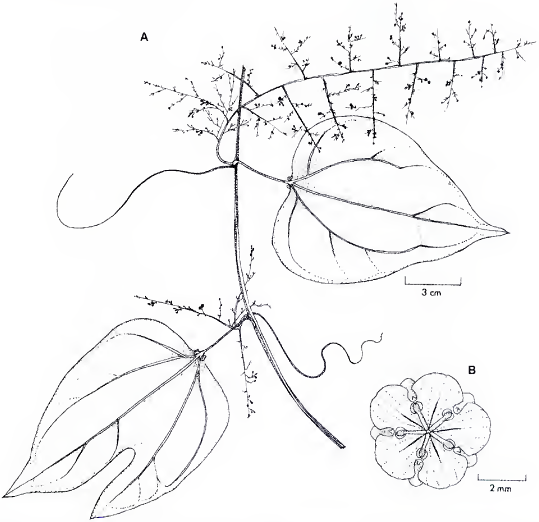


Fig. 4. *Fevillea pergamentacea*. **A.** Habit, staminate inflorescence (*Klug 2198*). **B.** Staminate flower (*Klug 2198*).

Additional specimens examined. **COLOMBIA. Guaviare:** Vereda Miraflores, 02°19'N, 72°26'W, 300 m, 27 Jan 1990, *Marulanda & Márquez 1766* (MO). **Putamayo:** Vereda "La Kofania," 1°1'N, 77°17'W, 500–700 m, 2 Sept 1993, *Cogollo et al. 6839* (MO). **ECUADOR. Napo:** Yasuní Forest Reserve, along road from PUCE Scientific Station to end of road towards Waoroni Territory, 00°40.901'S, 76°24.348'W, 240–310 m, 29 Jun 1995, *Acevedo & Cedeno 7571* (NY); Río Eno NE of Shushufindi, ca. 00°10'S, 76°40'W, 300 m, 11 Apr 1982, *Balslev 2321* (NY); Estación Biológica Jatun Sacha, 8 km E of Misahuallí, 01°04'S, 77°36'W, 400 m, 23–31 Jan 1989, *Cerón 6076* (MO, NY); Estación Biológica Jatun Sacha, Río Napo, 8 km E of Misahuallí, 01°04'S, 77°36'W, 400 m, 10 Aug 1989, *Cerón 7379* (MO, NY); Hollín-Loreto highway, between Avila and Loreto, Huiruno (Quichua community), 00°43'S, 77°19'W, 450 m, 29 Nov 1982, *Cerón 7853* (MO); km 2, new Cotundo-Coca highway, 1130 m, 5 Aug 1984, *Dodson et al. 15072* (MO, US); Pompeya, S of Río Napo, Río Jivino, Maxus highway, km 1–5, 00°25'S, 76°37'W, 220 m, 23–29 Nov 1992, *Grijalva et al. 231B* (MO); E of the mission in Ahuano on Río Napo, 550 m, 15 Feb 1973, *Humbles 6214* (F, MO); Yasuní National Park, Río Indillama, small southern tributary of Río Napo, Comuna Pompeya, 00°30'S, 76°40'W, 220 m, 26 Aug 1992, *Neill & Gudiño 10120* (MO, NY); S of Volcán Sumaco, Hollín-Loreto highway, km 31, Comuna Challua Yacu, 00°43'S, 77°40'W, 1200 m, 20–25 Mar 1989, *Palacios 4102* (MO); Río Aguarico, Shushufindi, 244 m, 14 Feb 1975, *Vickers 116* (F). **PERU. Loreto:**

Florida, Río Putamayo, at mouth of Río Yubineto, 180 m, May–Jul 1931, *Klug 2198* (BM, F, G, K, MO, NY, US). **BOLIVIA. Cochabamba:** Cochabamba, *Bang 1264* (BM, K, MO). **El Beni:** Trinidad, 164 km towards Santa Cruz, 28 Aug 1985, *Beck 12212* (NY). **Santa Cruz:** km 11, Río Tres Quebradas road, 14 Aug 1991, *Acevedo et al. 4598* (NY); border of Río Piraí, along Montero-Portachuelo road, 1994, *Mostacedo 2288* (NY); 12 km SE of Comunidad Don Lorenzo, 0.5 km E of Estancia Caracore, W side of Río Grande, 17°51'S, 62°47'W, 300 m, 17 Nov 1990, *Nee 39986* (MO, NY); Parque Nacional Amboró, 0–2 km SW of El Carmen, along trail to Quebrada Yapoje and Río Saguayo, 17°32'S, 63°42'W, 360 m, 15 Jun 1991, *Nee 41079* (NY); Parque Nacional Amboró, 1–2 km NE of El Carmen on trail to crossing of Río Surutu, 17°31'S, 63°41'W, 350 m, 21 Jul 1991, *Nee 41796* (MO, NY); along Quebrada Salada and oil pipeline, first rocky foothills of the Andes, 4 km W of highway bridge over Rio Piraí, 18°06'S, 63°30'W, 750 m, 11 Dec 1991, *Nee 42017* (MO, NY); 2 km (by air) NW of center of Bermejo, around Laguna Volcán, 18°07'S, 63°39'W, 1125–1175 m, 24 Dec 1994, *Nee 46129* (MO, NY); Parque Nacional Amboró, along Río Verde, 1 km E of Campamento Mataracú, 17°33'S, 63°52'W, 375 m, 31 May 1998, *Nee & Bohs 49540* (NY); 4 km (by air) NE of Bermejo, valley of "Rufugios Los Volcanes," 18°06.3'S, 63°36'W, 1070–1150 m, 29 Jul 2003, *Nee 52385* (NY); Estancia San Rafael de Amboró, 15 km SSE of Buena Vista, 17°35'S, 63°37'W, 375 m, 30 Jul 1987, *Nee & Saldias 35454* (NY, USF); Parque Nacional Amboró, 0.5 km upstream from the last Andean foothills, 17°40'S, 63°43'30"W, 450 m, 20 Dec 1988, *Nee & Saldias 37265* (NY); Rio Piray, 450 m, 19 Jul 1924, *Steinbach 6259* (G, K); Parque Nacional Amboró, before Río Saguayo, 5 km SW of El Carmen, ca. 17°33'S, 63°44'W, 400 m, 15–22 Nov 1991, *Vargas et al. 1225* (MO, NY); Reserva de Vida Silvestre Rios Blanco y Negro, Rio Negro de Caimanes, ca. 4 km SE of Río San Pablo, 14°45'07"S, 63°56'W, 250 m, 18 Jun 1993, *Vargas 2605* (MO, NY); Reserva de Vida Silvestre Ríos Blanco y Negro, 5 km from meeting of Ríos San Pablo and Negro de Caimanes, 14°48'05"S, 63°58'W, 200 m, 18–20 Jun 1993, *Vargas 2623* (NY).

Fevillea pergamentacea is most similar to simple-leaved forms of *F. pedatifolia*, but differs in the position and form of its foliar glands and in the shape of the staminate flowers. *Fevillea pergamentacea* is characterized by flat, elongate-elliptic glands at the base of the leaf blade rather than petiolar glands well below the base of the leaf blade as in *F. pedatifolia*. *Fevillea pergamentacea* also has a distinctive crateriform staminate flower as opposed to the shallow cup-shaped flowers of *F. pedatifolia*. The distinction between *F. pergamentacea* and *F. harmsii* on the basis of the leaf shape cannot be maintained and *F. harmsii* is here reduced to synonymy as suggested by Jeffrey (1962b).

Fevillea trilobata L., Sp. Pl. 1014. 1753. (**Fig. 5**). *Fevillea marcgravii* Guib., Hist. Nat. Drog. Simpl. ed. 4. 3:244. 1850, nom. illegit. *Nhandiroba trilobata* (L.) Kuntze, Revis. Gen. Pl. 1:257. 1891. TYPE: BRAZIL: (LECTOTYPE: here designated, Marcgrave, in Piso & Marcgrave, Hist. Nat. Bras. 2:46, unnumbered pl, 1648).

Fevillea cordifolia Vell., Fl. Flumin., Icon. 10:t. 102. 1831 ("1827"); non L., 1753. *Fevillea triangularis* M. Roem., Fam. Nat. Syn. Monogr. 2:114. 1846. TYPE: BRAZIL. RIO DE JANEIRO: (LECTOTYPE: here designated, Vellozo, Fl. Flumin., Icon. 10:t. 102. 1831 ("1827")).

Hypanthera guapeva Silva Manso, Enum. Subst. Braz. 38. 1836. TYPE: BRAZIL. SÃO PAULO: São Ignácio (n.v.).

Fevillea tomentosa Gardner, London J. Bot. 2:355. 1843. *Fevillea trilobata* var. *tomentosa* (Gardner) Cogn., in Martius, Fl. Bras. 6(4):118. 1878. TYPE: BRAZIL. RIO DE JANEIRO: Serra dos Orgãos, s.d., *Gardner 425* (HOLOTYPE: BM; ISOTYPES: G, K, photo ex G: F, MO, US).

Fevillea albiflora Cogn., in Martius, Fl. Bras. 6(4):118. 1878. *Nhandiroba albiflora* (Cogn.) Kuntze, Revis. Gen. Pl. 1:257. 1891. TYPE: BRAZIL. BAHIA: without precise locality, s.d., *Blanchet 2380* (LECTOTYPE: here designated, G; ISOLECTOTYPES: BR, G, K, NY). SYNTYPE MATERIAL: BRAZIL.

Fig. 5. *Fevillea trilobata*. **A.** Habit, staminate inflorescence (*Saint-Hilaire s.n.* [*Glaziou 87201*]). **B.** Staminate flower (*Saint-Hilaire s.n.* [*Glaziou 8720*]).

Minas Gerais: near Contendas, 1818, *Martius 1581* (M); near Contendas, s.d., *Saint-Hilaire s.n.* (BR, F).

Fevillea albiflora var. *glaziovii* Cogn., Bull. Acad. Roy. Sci. Belgique, ser. 3. 14:364. 1887. Type: BRAZIL. Minas Gerais: Serra do Inficionado, near Caracas, 6 Sep 1882, *Glaziou 13906* (lectotype: here designated, BR; isolectotypes: B, destroyed, K, NY, photo ex B; F, MO, NY, US).

Fevillea trilobata var. *longipedicellata* Cogn., in Martius, Fl. Bras. 6(4):118. 1878. Type: BRAZIL. Rio de Janeiro: near Copacabana, s.d., *Riedel [et Langsdorff*, fide Cogn. (1881)] *706* (lectotype: here designated, BR; isolectotypes: K, M). Syntype material: BRAZIL. Rio de Janeiro: Copacabana, Dec 1840, *Gardner 5469* (BM); Copacabana, *Lund 213* (n.v.); s.d., *Sello s.n.* (BM).

Fevillea trilobata var. *subintegrifolia* Cogn., in Martius, Fl. Bras. 6(4):118. 1878. Type: BRAZIL. Rio de Janeiro: Copacabana, s.d., *Luschnath 552* (lectotype: here designated: BR). Syntype material: BRAZIL. Rio de Janeiro: Copacabana, *Luschnath 950* (n.v.); *Blanchet 955* (n.v.).

Fevillea trilobata var. *subuniflora* Cogn., in Martius, Fl. Bras. 6(4):118. Type: BRAZIL. Rio de Janeiro: Gávea, *Glaziou 3986* (n.v.).

Vine or liana; stem densely pubescent, tomentose to lightly pubescent, or subglabrous; tendrils pubescent or glabrous. Leaves with the blade 3-lobed, or occasionally 5-lobed, 6–10 cm long, (2–)5–10(–15) cm wide, membranaceous, the apex acute or acuminate, the main lateral veins occasionally terminating in a small apical gland, the upper and lower surfaces densely to lightly pubescent. Staminate flowers in a paniculate inflorescence on reduced lateral branches; pedicel with uncinate trichomes, 1–3(5) mm long; hypanthium (2–)3–5 mm long, densely to sparsely stipitate-glandular pubescent; bracts glandular, linear, 0.5–1 mm long, densely to sparsely pubescent, the ones subtending the panicle branches, larger, less glandular, more leaf-like, often with a distinct stipe; calyx shallowly cupular, the lobes slender, ca. 2.5 mm long, ca. 1 mm wide, obtuse, densely to sparsely glandular-pubescent with a glandular calycine squamella protruding from each sepal at or near the point of fusion with the petals; petals suborbicular, 3–6 mm long, 1–4 mm wide, pale yellow, cream-colored or pink, each with a median adaxial uncinate appendage; stamens ca. 1 mm long, the anthers ca. 0.5 mm long, slightly longer than wide. Pistillate flowers (fide Cogniaux 1878, 1881, 1916) 1–3; pedicel ca. 6 mm long, densely to sparsely pubescent; hypanthium ca. 2 mm long, densely to sparsely pubescent; calyx campanulate, the lobes with a glandular calycine squamella at the point of fusion between the sepals and the petals; petals strap-shaped, broadened at the base, cream-colored; styles 3; ovary 5–7 mm long. Fruit (fide Cogniaux 1878, 1881, 1916) subglobose, reddish brown, 7–9 cm wide, pubescent or lightly glandular-pubescent, the locules 4-seeded; seeds orbicular, compressed, ca. 4 cm long and wide, ca. 1 cm thick, the lateral surface of the woody layer striate-verrucose, the outer edge tuberculate.

Distribution and ecology.—Brazil from Ceará southwest to Minas Gerais and São Paulo.

Selected specimens examined **BRAZIL. Bahia:** Ilheus, 1836, *Blanchet 2380* (G, F, K, MO, NY, US); km 22 on Ilheus/Itabuna road (BR 415), near Palmoreto, 50 m, 1 Sep 1997, *Jardim et al. 1101* (NY). **Ceara:** Serra do Araripe, Sep 1828, *Gardner 1629* (BM, K). **Espirito Santo:** Reserva Florestal de Sooretama, 9

Aug 1965, *Belém 1499* (CEPEC, NY); Reserva Florestal da C.V.R.D., Linhares, Estrada Farinha Seca, Ant. 221, km 1100, 17 Jul 1986, *Folli 130* (NY); Reserva Florestal da C.V.R.D., Linhares, Estrada Farinha Seca, ant. 221, km 1100, 7 Aug 1990, *Folli 373* (NY); Reserva Florestal da C.V.R.D., Linhares, 28 Oct 1992, *Folli 1715* (NY). **Goiás:** Formosa, 1814–1817, *Bowie & Cunningham 913* (BM). **Minas Gerais:** near Viçosa, 8 km from Fazenda de A. Cocerro toward São Miguel, 900 m, 26 Jun 1930, *Mexia 4798* (BM, F, G, MO, NY, US). **Paraíba:** Cidade Universitária, 6 km SE of Centro de João Pessoa, 7°57'S, 34°53'W, 30–45 m, 10 Aug 1990, *Agra 1165* (MO). **Paraná:** Barra do Turvo, 10 Oct 1973, *Hatschbach 32631* (K, MO, NY); Barra do Lageado Grande, 31 Aug 1978, *Hatschbach 41560* (NY); along road to landing of Porto Byington on bank of Rio Paraná, 200 m, 26 Jun 1966, *Lindeman & de Haas 1778* (NY); Parque Estadual Vila Rica do Espírito Santo, 18 Feb 1998, *Silva s.n.* (NY). **Pernambuco:** Tapera, border of Rio Tapacura, Oct 1933, *Pickel 524* (US). **Rio de Janeiro:** Gávea, s.d., *Glaziou 1344* (BR, US); Serra dos Orgãos, Alto Macabé, s.d., *Glaziou 17010* (NY). **São Paulo:** Campinas, 27 Aug 1938, *Krug 1593* (US).

Fevillea trilobata is most similar to *F. cordifolia* from which it can be distinguished by its usually angular (vs. rounded) leaf lobes and staminate flowers with stipitate-glandular trichomes on the hypanthium which are sharply differentiated from the uncinate ones on the pedicel.

Fevillea subgenus **Anisosperma** (Silva Manso) G. Robinson & Wunderlin, comb. et stat. nov. BASIONYM: *Anisosperma* Silva Manso, Enum. Subst. Braz. 38. 1836. TYPE: *Anisosperma passiflora* (Vell.) Silva Manso [=*Fevillea passiflora* Vell.].

Staminate inflorescences of congested panicles or subumbelliform; glandular calycine squamellae absent; corolla lobes oblong-hastate with a thick glandular adaxial ridge. Fruit ovate or oblong, subtrigonous, not zonate, the apex apiculate.

Fevillea passiflora Vell., Fl. Flumin., Icon. 10:t. 104. 1831 ("1827"). (**Fig. 6**). *Anisosperma passiflora* (Vell.) Silva Manso, Enum. Subst. Braz. 38. 1836. TYPE: BRAZIL. RIO DE JANEIRO: (LECTOTYPE: here designated, Vellozo, Fl. Flumin., Icon. 10:t. 104. 1831 ("1827")).

Vine or liana; stem glabrous or sparsely glandular-pubescent; tendrils glabrous. Leaves with the blade unlobed, ovate to broadly lanceolate, 5–13 cm long, 4.5–7.5 cm wide, membranaceous, with a distinct marginal nerve, the apex acute to acuminate, the base rounded, with 2 small irregular, auriculate glands near the petiole, the upper and lower surfaces minutely pustulate, sometimes sparsely glandular-pubescent, the petiole 1–3 cm long. Staminate flowers in a congested panicle or subumbelliform inflorescence; pedicel (2–)4–5 mm long, sparsely glandular-pubescent; hypanthium 4–5(–13) mm long, sparsely glandular-pubescent; calyx shallowly cupular, glandular-pubescent, the lobes ca. 2.5 mm long, lanceolate, acute; petals oblong-hastate, 5–7 mm long, green or cream-colored, the median adaxial ridge glandular, slightly raised, broadest at the base, gradually tapering to about the center; stamens 1.5–2 mm long, the anthers ca. 1 mm long, slightly longer than wide. Pistillate flowers 2–4 on a short, thick peduncle; styles with the lower part somewhat thickened, the upper part dilated and broadly obcordate, curved inward longitudinally; ovary 6–9 mm long and 4–5 mm wide, glabrous. Fruit ovoid to oblong, 8–15 cm long, 5–11 cm wide, subtrigonous, smooth or irregularly verrucose, fleshy with thickened outer

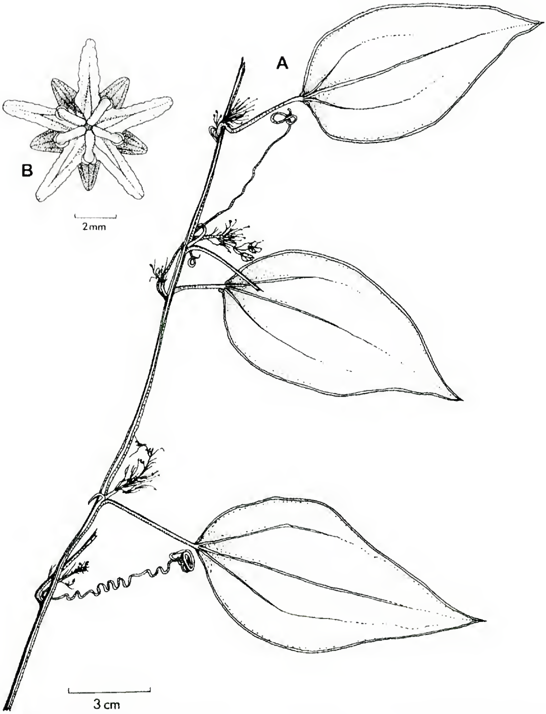


FIG. 6. *Fevillea passiflora*. **A.** Habit, staminate inflorescence (*Hatschbach 19205*). **B.** Staminate flower (*Hatschbach 9106*).

cortex, the apex short-apiculate; seeds suborbicular, compressed, 3.5–3.5 cm long, 3–4 cm wide, ca. 1.5 cm thick, pale brown, with a thin erose-margined cover.

Distribution and ecology.—Coastal Brazil in southeastern Bahia, Rio de Janeiro, eastern São Paulo, and eastern Paraná. In gallery forests near sea level.

Additional specimens examined. **BRAZIL. Bahia:** ca. 5 km W of Itamaraju, 20 Sep 1878, *Mori et al. 10742* (CEPEC). **Paraná:** Guaratuba, Rio Cubatão, 27 Dec 1911, *Dusén 13640* (F, NY); highway between Rio Branco do Sul and Cerro Azul along Rio P. Grossa, 26 Apr 1962, *Hatschbach 9106* (US); Ribeirinha, 7 May 1968, *Hatschbach 19205* (K); Morro do Inglês, 18 Feb 1976, *Hatschbach 38090* (K). **São Paulo:** Campinas, 1873, *Corrêa de Mello s.n.* (BR); Cabital, 26 Dec 1941, *Pickel 5566* (US); 1816–1821, *Saint-Hilaire D600* (F). **Rio de Janeiro:** 1894, *Glaziou 20335* (BR); Nov 1987, *Glaziou 10870* (K); Cantagalo, 1859, *Peckolt 8* (BR); Cantagalo, 1861, *Peckolt s.n.* (BR); Teresópolis, Serra dos Orgãos, 27 Feb 1887, *Schenck 2898* (BR). **Without precise locality:** 1859, *Peckolt s.n.* (BR); s.d., *Martius s.n.* (BR).

EXCLUDED NAMES

Fevillea deltoidea Cogn., in Martius, Fl. Bras. 6(4):119. 1878. [=*Pteropepon deltoideus* (Cogn.) Cogn.].

Fevillea monosperma Vell., Fl. Flumin., Icon. 10:t. 103. 1831 ("1827"). [=*Pteropepon monospermus* (Vell.) Cogn.].

Fevillea pedata Smith ex Sims, Bot. Mag. t. 2681. 1826. [=*Telfairia pedata* (Smith ex Sims) Hooker].

Fevillea punctata (L.) Poir., in Lamarck, Encycl. 4:418. 1796. BASIONYM: *Bryonia punctata* L., Demonstr. Pl. 26 1753. TYPE: Herb. Linn. No. 1180.1 (two sheets); apparently a mixed collection, possibly a *Trichosanthes* and a *Momordica*.

Fevillea tamnifolia Kunth, in Humboldt, Bonpland & Kunth, Nov. Gen. Sp. 7:175. 1825. [=*Sicydium tamnifolium* (Kunth) Cogn.].

Fevillea trilobata Reichard, Syst. Pl. 4:253. 1780, nom. illegit.; non L., 1753. (BASIONYM: *Bryonia punctata* L., 1753.) [See *Fevillea punctata* above.]

ACKNOWLEDGMENTS

We gratefully acknowledge the curators of BM, BR, CEPEC, F, G, K, M, MO, NY, US, and USF for making specimens available to us for study. We thank Bruce Hansen (USF) for his many helpful suggestions on the manuscript and Kathleen Hotchkiss (USF) for assistance with graphics. We also thank Michael Nee (NY) and an anonymous reviewer for their helpful comments.

REFERENCES

ADAMS, C.D. 1972. Flowering plants of Jamaica. The University Press, Glasgow.

BAILLON, H. 1885. La fleur femelle de l'*Alsomitra brasiliensis*. Bull. Mens. Soc. Linn. Paris 1: 457–458.

COGNIAUX, A. 1878. Cucurbitaceae: Zanonieae–Fevilleae. In: C.F.P. von Martius, ed. Flora Brasiliensis 6(4):114–122. München.

COGNIAUX, A. 1881. Cucurbitaceae: Zanonieae–Fevilleae. In: Alph. de Candolle & C. de Candolle, eds. Monographiae phanerogamarum. 3:925–946. G. Mason, Paris.

COGNIAUX, A. 1893. Genre *Siolmatra* H. Baill. et la tribe des Zanoniées. Bull. Herb. Boissier 1:609–613.

Cogniaux, A. 1916. Cucurbitaceae: Zanonieae–Fevillieae. In: A. Engler, ed. Das Pflanzenreich 66, IV, fam. 275, I:3–41. Wilhelm Engelmann, Berlin.

Dieterle, J.V.A. 1976. Cucurbitaceae. Flora of Guatemala. Fieldiana, Bot. 24(11):306–395.

Gentry, A.H. and R.H. Wettach. 1986. *Fevillea*–a new oil seed from Amazonian Peru. Econ. Bot. 40:177–185.

Gunn, C.R. and J.V. Dennis. 1976. World guide to tropical drift seeds and fruits. Quadrangle/ The New York Times Book Co., New York.

Guppy, H.B. 1917. Plants, seeds, and currents in the West Indies and Azores. Williams & Norgate, London.

Harms, H. 1926. Cucurbitaceae. In J. Mildbraed, Plantae Tessmannianae Peruvianae III. Notizbl. Bot. Gart. Berlin-Dahlem 9:989–996.

Harms, H. 1933. Cucurbitaceae americanae novae. Notizbl. Bot. Gart. Berlin-Dahlem 11: 769–776.

Jeffrey, C. 1962a. Notes on Cucurbitaceae, including a proposed new classification of the family. Kew Bull. 15:337–373.

Jeffrey, C. 1962b. Notes on some species of *Fevillea* L., *Siolmatra* Baill., and *Pseudosicydium* Harms (Cucurbitaceae) in the Amazon Basin. Kew Bull. 16:199–202.

Jeffrey, C. 1978. Further notes on Cucurbitaceae: IV. Some New World taxa. Kew Bull. 33: 347–380.

Kuntze, C. 1891–1898. Revisio generum plantarum. G.E. Schechert, Leipzig.

Lindley, J. and T. Moore. 1870. The treasury of botany, ed. 2. Longmans, Green & Co., London.

Linnaeus, C. 1753. Species plantarum. Impensis Laurentii Salvii, Stockholm.

Morton, J.F. 1981. Atlas of medicinal plants of Middle America–Bahamas to Yucatan. Charles Thomas, Springfield, IL.

Piso, G. and G. Marcgrave. 1648. Historia naturalis Brasiliae. Leiden/Amsterdam.

Roemer, M.J. 1846. Nhandirobaceae ["Nhandirobée"], in Familiarum naturalium regni vegetabilis synopses monographicae 2:111–118. Landes-Industrie-Comptior, Weimar.

Seringe, N.C. 1828. Cucurbitaceae. In: A.P. de Candolle, ed. Prodromus systematis naturalis regni vegetabilis. 3:297–320. Treuttel & Wurtz, Paris.

Silva Manso, A.L.P. da. 1836. Enumeração das substancias Brazileiras. Typographia Nacional, Rio de Janeiro.

Standley, P.C. 1937. Cucurbitaceae. In: J.F. Macbride, ed. Flora of Peru. Publ. Field Mus. Nat. Hist., Bot. Ser. 13(6):321–383.

Tulloch, A.P. and L. Bergter. 1979. Analysis of the conjugated trienoic acid containing oil from *Fevillea trilobata* by ^{13}C nuclear magnetic resonance spectroscopy. Lipids 14: 996–1002.

BROMUS HALLII (POACEAE), A NEW COMBINATION FOR CALIFORNIA, U.S.A., AND TAXONOMIC NOTES ON *BROMUS ORCUTTIANUS* AND *BROMUS GRANDIS*

Jeffery M. Saarela

Department of Botany, and
UBC Botanical Garden and Centre for Plant Research
University of British Columbia
Vancouver, B.C., CANADA
jsaarela@interchange.ubc.ca

Paul M. Peterson

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.
peterson@si.edu

Jacques Cayouette

National Program on Environmental Health–Biodiversity
Agriculture and Agri-Food Canada
Wm. Saunders Building (#49)
Central Experimental Farm
Ottawa, Ontario, CANADA, K1A 0C6
cayouettej@agr.gc.ca

ABSTRACT

Herbarium study of *Bromus grandis*, *B. orcuttianus*, and *B. orcuttianus* var. *hallii* from western North America has indicated that these taxa are morphologically and geographically distinct, and best treated as species. A new combination **Bromus hallii** (Hitchc.) Saarela & P.M. Peterson is made. *Bromus hallii* differs from *B. orcuttianus* by having densely pubescent blades (verses glabrous in *B. orcuttianus*), lower sheaths with dense short stiff hairs 1 mm long or less (vs. long soft hairs 2–4 mm long), and 1–2(–3) culm nodes (vs. 2–4). *Bromus hallii* differs from *B. grandis* by having blades that are 7.5–16.5 cm long [vs. (13–)18–38 cm long in *B. grandis*], 1–2(–3) culm nodes (vs. 3–7), and lower glumes that are 1(–3)-nerved [vs. 3(1)-nerved]. We provide the first report of differences in the type of pubescence on the lower sheaths between *B. orcuttianus* and *B. hallii*. We confirm the diploid chromosome number of $2n = 14$ for *B. grandis*. We include descriptions, synonymies, and representative specimens examined for *B. grandis*, *B. hallii*, and *B. orcuttianus*, a key to all sections of *Bromus* in California, and a key to *Bromus* sect. *Bromopsis* in California.

RESUMEN

El estudio de *Bromus grandis*, *B. orcuttianus* y *B. orcuttianus* var. *hallii* de Norteamérica occidental ha indicado que estos taxa son morfológica y geográficamente diferentes, y están tratados mejor como especies distintas. Se hace una nueva combinación **Bromus hallii** (Hitchc.) Saarela y P.M. Peterson. *Bromus hallii* se diferencia de *B. orcuttianus* por tener láminas densamente pubescentes (contra glabras en *B. orcuttianus*), vainas inferiores con los pelos rígidos cortos de 1 mm largo o menos (contra los pelos suaves largos de 2–4 mm), y 1 ó 2(–3) nudos en el culmen (contra 2–4). *Bromus hallii* se diferencia de *Bromus grandis* por tener las láminas de 7.5–16.5 cm de largo (contra 18–38 cm en *B. grandis*), 1 ó 2 nudos en el culmen (contra 3–6), y glumas inferiores 1(–3)-nervadas [contra 3(1)-nervadas]. Proporcionamos el primer informe de diferencias en el tipo de pubescencia en las vainas inferiores entre *B. orcuttianus* y *B. hallii*. Confirmamos el número diploide de cromosomas de $2n = 14$ para *B. grandis*. Incluimos descripciones, sinonimias, y especímenes representativos examinados de

SIDA 21(4): 1997–2013. 2005

B. grandis, *B. hallii* y *B. orcuttianus*, una clave de todas las secciones de *Bromus* en California, y una clave de *Bromus* sect. *Bromopsis* en California

Bromus L. is a large genus of approximately 160 species that are distributed worldwide in temperate regions. The genus is distinguished from other grass genera by the combination of leaf sheaths that are connate for most of their length, awns that are inserted subapically, and hairy appendages on the apices of the ovary (Clayton & Renvoize 1986). In the New World, 79 native and introduced species are currently recognized (Pavlick et al. 2003), although new species are being described (e.g., Saarela et al. in review) and the taxonomic boundaries of several difficult species complexes have been reevaluated (e.g., Peterson et al. 2002; Oja et al. 2003; Massa et al. 2004). Molecular phylogenetic investigations have clarified several aspects of the evolutionary history of *Bromus*, and have identified major lineages in the genus, some of which correspond to commonly recognized intrageneric taxa (Pillay & Hilu 1990, 1995; Ainouche & Bayer 1997; Saarela et al. in press). A new classification of the genus has not yet been proposed, pending further study of morphological and molecular variation.

Bromus sect. *Bromopsis* Dumort., the largest of the traditionally recognized sections in the genus, is a non-monophyletic taxon comprised of several lineages that occur in North America, Mexico, South America, and Eurasia (Saarela et al. in press). The section is characterized morphologically by 1(3)- and 3(5)-nerved first and second glumes, lemmas that are dorsally flattened, and a perennial habit (Smith 1970), although some of these characteristics may be symplesiomorphies. In North America north of Mexico, there are 16 native species in section *Bromopsis* that have diversified in a variety of habitats (Pavlick 1995; Pavlick & Anderton, in press). Some species are wide-ranging (e.g., *B. ciliatus* L.), whereas others are highly restricted in distribution [e.g., *B. texensis* (Shear) Hitchc.]. Several taxa (*B. laevipes* Shear, *B. orcuttianus* Shear, *B. orcuttianus* var. *hallii* Hitchc., *B. pseudolaevipes* Wagnon, and *B. suksdorfii* Vasey) are restricted to mountainous regions in the southwestern part of the continent, largely in California (Pavlick 1995). Others [e.g., *B. porteri* (J.M. Coult.) Nash, *B. richardsonii* Link, *B. vulgaris* (Hook.) Shear] have broader distributions in western North America. While studying *Bromus* specimens from California to support preparation of the taxonomic treatment of *Bromus* for the Second Edition of the Jepson Manual (Saarela & Peterson, in prep.), it became clear that *B. orcuttianus* var. *hallii*, despite its varietal rank, is a readily identifiable taxon that can be consistently and reliably distinguished from both *B. orcuttianus* var. *orcuttianus* and *B. grandis*. These preliminary observations stimulated a more detailed investigation of its morphological variation and taxonomic status.

Vasey (1885) named and described *B. orcuttianus* based on collections by C.R. Orcutt from the mountains near San Diego, and collections by W.N. Suksdorf from Mt. Adams in Washington. In his revision of the North American species of *Bromus*, Shear (1900) recognized *B. orcuttianus*, and described larger plants from La Maite, San Diego, with pubescent sheaths, leaves, culms, and spikelets as a new variety, *B. orcuttianus* var. *grandis* Shear. Hitchcock (in Jepson 1912) described plants from the mountains of southern California with densely pubescent blades and cataphylls, and pubescent glumes and lemmas as a new variety, *B. orcuttianus* var. *hallii* Hitchc. Hitchcock (in Jepson 1912) also elevated *B. orcuttianus* var. *grandis* to a species, *B. grandis* (Shear) Hitchc., indicating that it is similar to *B. orcuttianus* var. *hallii*, but differs in its drooping panicle and distinctly 3-nerved lower glumes. Subsequent authors have recognized *B. grandis*, *B. orcuttianus*, and *B. orcuttianus* var. *hallii* in their treatments (e.g., Hitchcock & Chase 1951; Wagnon 1952; Munz & Keck 1959; Hitchcock et al. 1969; Munz 1974; Wilken & Painter 1993; Pavlick 1995; Pavlick & Anderton, in press) although Clayton and Williamson (2002 onwards) synonymized *B. orcuttianus* var. *hallii* with *B. orcuttianus*. In his revision of *Bromus* sect. *Bromopsis* in North America, Wagnon (1952) hypothesized that *B. orcuttianus* var. *hallii* is equally related to *B. grandis* and *B. orcuttianus*, and indicated that it requires further study. Among species of *Bromus* sect. *Bromopsis* in North America, *B. orcuttianus* var. *hallii* is the only taxon recognized currently at the varietal level, even though the characteristics separating it from *B. orcuttianus* var. *orcuttianus* and *B. grandis* are similar in degree to those separating other morphologically similar species of *Bromus*. Here we discuss the morphological, cytological, geographical, and ecological characteristics of these three taxa, and propose a new combination, *B. hallii* (Hitchc.) Saarela & P.M. Peterson. We include synonymies, species descriptions, distributions, and specimens examined for *B. grandis*, *B. hallii*, and *B. orcuttianus*, and keys to the sections of *Bromus* in California, and *Bromus* section *Bromopsis* in California.

MATERIAL AND METHODS

This study is based on examination of over 425 herbarium specimens from CAS, DAO, K, OSU, UBC, UC/JEPS, US, W, and WTU, including most type specimens. Specimens were measured to generate morphological descriptions. Data on geographic distribution, elevation, and habitat were obtained from herbarium specimen labels. Cytological observations of *B. grandis* were carried out by the third author on living material germinated from seeds collected in 1994 (*Cayouette & Darbyshire C7947*). Detailed procedures for the chromosome count are provided in Peterson et al. (2002). The taxonomic key was generated through study of the literature and representative herbarium specimens at US.

RESULTS AND DISCUSSION

Bromus orcuttianus, *B. orcuttianus* var. *hallii*, and *B. grandis* are morphologically similar taxa that have been recognized as distinct for almost a century. Examination of morphological variability among individuals from across the range of these three taxa indicates that they are each easily distinguished by a combination of quantitative and qualitative characteristics, and each has a distinctive geographic distribution. The degree of difference among the three taxa is approximately the same, although one taxon is recognized currently at the varietal level while two are recognized as species. It would be equally logical (although not valid nomenclaturally) to classify individuals currently included in *B. orcuttianus* var. *hallii* as an intraspecific taxon of *B. grandis*, if emphasis were placed on vegetative rather than reproductive characteristics when making taxonomic decisions. To minimize such ambiguity, either one wide-ranging polymorphic species could be recognized, or each morphologically and geographically distinct taxon could be treated as a species. We prefer the latter approach, and propose a new combination, *B. hallii* (Hitchc.) Saarela & P.M. Peterson to accommodate this. This morphological-geographical approach to circumscribing species follows existing treatments of *Bromus* sect. *Bromopsis* in North America, in which taxa with consistent morphological characteristics throughout their ranges are treated as species (e.g., Pavlick 1995; Pavlick & Anderton, in press; Saarela & Peterson, in prep).

Bromus hallii and *B. orcuttianus* are distinguished morphologically by several qualitative characteristics, including the presence or absence of pubescence on the blades, the type of pubescence, and the number of culm nodes (Table 1). *Bromus hallii* is characterized by blades that are densely pubescent abaxially and adaxially, lower sheaths that are densely pubescent with short, stiff hairs up to 1 mm long, and culms with 1–2(–3) nodes. In contrast, *B. orcuttianus* has blades that are glabrous abaxially and adaxially (sometimes with pilose margins towards the base), lower sheaths that are sparsely to densely pilose (occasionally glabrous) with long, soft hairs up to 4 mm long that are easily visible with the naked eye, and culms with 2–4 nodes. Previous authors (e.g., Hitchcock 1951; Pavlick 1995) noted that these two taxa differ in the distribution of the pubescence on the leaves, but they were apparently not aware of the differences noted here in the type of pubescence on the lower sheaths. Additional morphological characteristics distinguish *B. hallii* and *B. orcuttianus*, but there is some overlap in these character states. *Bromus hallii* consistently has pubescent glumes, lemmas, and blades that range in length from 7.5–16.5 cm long, whereas *B. orcuttianus* has glumes that are usually glabrous but sometimes scabrous or pubescent, lemmas that range from glabrous to pubescent, and leaf blades that range in length from 7–24 cm long. The morphology of the inflorescence is the same in both taxa, with stiff branches that are erect and appressed to spreading not more than 90° from the rachises. Good illustrations of the general habit and inflorescence morphology of *B. orcuttianus* and *B. hallii* are found in Pavlick (1995), but these do not adequately emphasize the diagnostic differences of the type of pubescence found on the lower leaf sheaths or the differences in culm node number.

TABLE 1. Diagnostic characters separating *Bromus grandis*, *B. hallii*, and *B. orcuttianus*.

Characters	***B. grandis***	***B. halli***	***B. orcuttianus***
Leaf blades	pubescent	pubescent	glabrous, occasionally pilose near base
Lower leaf sheaths	densely pubescent, hairs up to 1(–3) mm long	densely pubescent, hairs up to 1 mm long	sparsely to moderately pilose, hairs 2–4 mm long, occasionally glabrous
Culm nodes	3–7	1–2(–3)	2–4
Leaf blade length	(13)18–38 cm	7.5–16.5 cm	7–24 cm
Glume surface	pubescent	pubescent	glabrous, scabrous, or pubescent
Lemma surface	pubescent	pubescent	glabrous or pubescent
Lower glumes, number of veins	3(1)	1(3)	1(3)
Awn length	3–6 mm	3.5–7 mm	(4–)5.5–8 mm
Inflorescence branches	flexuous, usually spreading > 90° from culm axis	stiff, erect, ascending and appressed, to spreading not > 90° from culm axis	stiff, erect, ascending and appressed, to spreading not > 90° from culm axis

Stebbins and Love (1941) reported a diploid chromosome count of $2n = 14$ for *B. orcuttianus*, and this was confirmed by counts by Wagnon (1952). Stebbins and Love (1941) synonymized *B. orcuttianus* var. *hallii* with *B. orcuttianus*, thus it is unclear if they obtained counts for material that we are treating here as *B. halli*. Wagnon (1952) was unable to obtain living material of *B. hallii*, and attempts to germinate seeds of *B. hallii* for chromosome counts in this study were unsuccessful. The chromosome number of *B. hallii* remains unknown.

Bromus hallii and *B. orcuttianus* differ in their geographic distributions and mean (μ) elevations. *Bromus hallii* is a narrowly distributed species that occurs in southern California in the mountains of Kern, Fresno, Los Angeles, Monterey, Santa Barbara, San Bernardino, and Tulare counties, at high elevations ($\mu = 6658$ ft; $n = 29$). *Bromus orcuttianus* has a much wider range, occurring in the mountains throughout California, Oregon, southern Washington, eastern Nevada, and southeastern Arizona (Piper 1906; Wagnon 1952; Kearney et al. 1960; Pavlick 1995), generally at lower elevations ($\mu = 5306$ ft; $n = 40$).

Bromus hallii and *B. grandis* are distinguished morphologically by a combination of vegetative and reproductive characteristics (Table 1). The distribution and type of pubescence on the blades, sheaths, and spikelets is similar in *B. hallii* and *B. grandis*, although two specimens of *B. grandis* seen (*Wolf 6888* and

Silveus 2829) have longer hairs up to 3 mm long on the blades and sheaths. The taxa differ in their blade lengths, number of culm nodes, number of nerves on the lower glume, and inflorescence morphology. *Bromus hallii* has blades that are 7.5–16.5 cm long [vs. (13–)18–38 cm long in *B. grandis*], 1–2(–3) culm nodes (vs. 3–7), and lower glumes that are 1(3)-nerved [vs. 3(1)-nerved]. *Bromus hallii* has panicles with stiff branches that are erect or spreading not more than 90° from the culm axis, whereas *B. grandis* has panicles with flexuous branches that are spreading often more than 90° from the culm axis. In immature specimens of *B. grandis* (those collected in late May and early June), the panicles appear similar in morphology to those found in *B. orcuttianus* and *B. hallii*, thus this characteristic should only be used on fully mature specimens. A good illustration of the inflorescence morphology of *B. grandis* is found in Hitchcock (1951). Wagnon (1952) indicated in his taxonomic keys that *B. halli* differs from *B. grandis* in having cucullate (boat-shaped) blade tips, but thorough examination of this character indicates that several individuals of *B. grandis* share this character state, making this an unreliable character. Stebbins and Love (1941) reported a diploid chromosome number of $2n = 14$ for *B. grandis*. Wagnon (1952) did not have fresh material of *B. grandis* for chromosome counts. Our cytological observations of *B. grandis* confirm the diploid number $2n = 14$. Like *B. hallii*, *B. grandis* is a narrowly distributed species endemic to southern California, known from the mountains in the southern counties and in the coastal ranges from Santa Cruz to San Diego counties. *Bromus grandis* generally occurs at much lower elevations ($\mu = 3267$ ft; $n = 25$) than *B. hallii* ($\mu = 6658$ ft; $n = 29$).

Recognition of *B. hallii* as a distinct species increases the number of species in *Bromus* section *Bromopsis* in California to 11, 10 of which are native, and one that is introduced (*B. inermis* Leyss.). Keys distinguishing the sections of *Bromus* and the species of sect. *Bromopsis* in California are presented below. A revised key distinguishing all 34 native and introduced species of *Bromus* in California will be published in the Second Edition of the Jepson Manual (Saarela and Peterson, in prep).

TAXONOMIC TREATMENT

Bromus grandis (Shear) Hitchc., Fl. Calif. 1:175. 1912. *Bromus orcuttianus* var. *grandis* Shear, Bull. Div. Agrostol., U.S.D.A. 23:43. 1900. *Bromopsis grandis* (Shear) Holub, Folia Geobot Phytotax. 8(2):167. 1973. TYPE: U.S.A. CALIFORNIA. San Diego Co.: La Maite, 25 Jun 1883, *C.R. Orcutt 472* (HOLOTYPE: US-81613!)

Bromus porteri var. *assimilis* Burtt Davy, Univ. Calif. Publ. Bot 1:55. 1902. TYPE: U.S.A. CALIFORNIA: south side, San Jacinto Mts, 1901, *H.M. Hall 2228* (HOLOTYPE: UC-37692!; ISOTYPE: US-865453 fragm. ex UC!).

Loosely caespitose perennial. Culms 70–180 cm tall, erect, glabrous to pubescent; nodes 3–7, dark brown, retrorsely pilose below, often covered by sheaths. Leaf sheaths 3.5–12 cm long, closed for most of their length; sheaths densely pubescent, hairs up to 1 mm long; margins smooth, occasionally hyaline at apex; collars densely pilose, with hairs up to 2 mm long, auricles sometimes present; cataphylls and basal sheaths pubescent, sometimes shredding; ligules 1–3 mm long, membranous, densely pubescent to pilose adaxially, glabrous abaxially, apex obtuse, erose; blades (13–)18–38 cm long, 3–12 mm wide, flat, membranous, apically cucullate, sparsely to densely pubescent adaxially and abaxially, hairs up to 1(–3) mm long; margins glabrous, sparsely papillate or scabrous. Panicles 15–26 cm long, 6–17.5 cm wide, open; lower branches 5–26 cm long with 1–6 spikelets, flexuous, nodding and usually spreading more than 90° from the rachises, pubescent; lower inflorescence nodes with 1–4 branches. Spikelets 2.5–3.5(–4.5) cm long, 4–9-flowered, terete to conspicuously distichous at maturity with rachis visible; glumes subequal, shorter than lemmas, pubescent, margins sometimes hyaline; lower glumes 5–8.5 mm long, 3(1)-nerved, apex acute; upper glumes 7–10(–12) mm long, 3(5)-nerved, apex acute; lemmas 11–14 mm long, margins pubescent, backs glabrous to densely pubescent, marginal hairs sometimes longer; backs flattened dorsally; apex entire or minutely bifid, the teeth not greater than 0.2 mm long; awned just below apex, awns 3–6 mm long, straight; paleas 8–11 mm long, shorter than lemma, backs glabrous or slightly pubescent, margins usually pubescent; apex acute; anthers 3–5 mm long, yellowish-orange. Caryopses about 9 mm long, linear, dark brown. Chromosome number $2n = 14$.

Distribution.—Endemic to southern California; San Gabriel Mts., Santa Lucia Mts., San Bernardino Mts., San Antonio Mts., San Jacinto Mts., San Rafael Mts., and Topatopa Mts.

Habitat.—Dry areas in open pine woods, hillsides, and rocky slopes; elevation 1200–8000 ft.

Specimens examined. **U.S.A. California: Fresno Co.:** junction N of South Fork of Kings River, 1 May 1923, *Duncan s.n.* (CAS); Kings Canyon road 4.3 mi W of Horseshoe Bend, 3600 ft, 6 Jun 1960, *Howell 35330* (CAS); Kaiser, 27 Jun 1935, *Bullard 95* (UC/JEPS). **Los Angeles Co.:** San Dimas Canyon, San Gabriel Mts, 1750 ft, 4 Jul 1933, *Wheeler 1894* (CAS, US); San Gabriel Mts, 3500 ft, 4 Jul 1933, *Ewan 7857* (US); San Gabriel Mts, East Fork, Big Santa Anita Canyon, 2250 ft, 30 May 1931, *Ewan 4249* (US); Little Santa Anita Canyon, 2 July 1902, *Abrams 2632* (CAS, US); San Gabriel Mts, Bell Canyon, 2300 ft, 8 Jun 1936, *Wheeler 4134* (CAS); San Gabriel Mts, Indian Canyon Camp, 2 mi off Soledad Canyon, 3000 ft, 27 May 1936, *Wolf 7845* (CAS, W); San Gabriel Peak, 9 Jul 1900, *Dudley s.n.* (CAS); San Gabriel Mts., 990 m, 1 Sep 1994, *Cayouette & Darbyshire C7947* (DAO); Summit of Mt. Wilson, 29 Jun 1902, *Abrams 2600* (CAS, US); San Gabriel Mts, Big Tujunga Creek between Coldwater and Wickiup Canyons, 10 Jul 1992, *Ross 6671* (UC/JEPS); Horse Flats, San Gabriel Mts, 16 Aug 1991, *Ross 5873* (UC/JEPS); Roundtop Mtn, San Gabriel Mts, Chilao Flat, 14 Aug 1991, *Ross 5780* (UC/JEPS). **Madera Co.:** 0.5 mi S of Southfork, 17 Jun 1933, *Hormay 26* (UC/JEPS). **Monterey Co.:** Pico Blanco, 11 May 1901, *Davy 7339* (US); Santa Lucia Mts, Jun 1901, *Davy 7691* (US); Tassajara Hot Springs, Jun 1901, *Elmer 3398* (CAS, US); Little Sur, 14 May 1901, *Davy 7385* (US); coast range W of King City, 8 Jun 1927, *Swallen 596* (US); Gavilan Peak, 3000 ft, 1 Jul 1861, *Brewer 740* (US); Alder Creek, Santa Lucia Mts, 3000 ft, 23 Jul 1958, *Hardham 3789* (CAS), Arroyo Seco River Canyon near Hanging Valley, 2 Jun 1957, *Howell 32566* (CAS); Arroyo Seco River, Santa Lucia Mts, 5 Jun 1959, *Hardham 4796* (CAS); Cruikshank Trail, Santa Lucia

Mts, 26 May 1963, *Howitt 1589* (CAS); Frances Simes Hastings Natural History Reservation, Santa Lucia Mts, 22 Jul 1944, *Linsdale s.n.* (CAS); Frances Simes Hastings Natural History Reservation, upper Carmel Valley, about 2 mi NE of Jamesburg, 22 Aug 1942, *Durham s.n.* (CAS); Nacimiento Summit, Santa Lucia Mts, 2800 ft, 18 Jun 1955, *Munz 20886* (CAS); near Carmel River, 26 Jun 1905, *Dudley s.n.* (CAS); near Nacimiento Summit Camp, Santa Lucia Mts, 26 Jun 1957, *Raven 10987* (CAS); Santa Lucia Mts, bank by road from Arroyo Seco Camp to Escondido Camp, 24 Jun 1956, *Howitt 980* (CAS); Santa Lucia Mts, between Middle and South Forks of Devil's Creek near Canogas Falls, 2000 ft, 23 May 1983, *Carpenter 218* (CAS); Santa Lucia Mts, Landels-Hill Big Creek Reserve, Gamboa Point Section, 27 May 1982, *Genetti & Engles 393* (CAS); Santa Lucia Mts, San Miguel Creek, below confluence with Anthony Creek, ca. 5 air km WNW of San Miguelito Ranch Ruins, 390 m, 5 Jun 1999, *Wilken 15707* (CAS); Santa Lucia Mts, South Fork Devil's Canyon, along Gamboa Trail near saddle of Twin Peak and Peak 3850, 4 Jun 1983, *Carpenter 257* (CAS); Santa Lucia Mts, Jun 1901, *Davy 7653, 7718, 7720* (UC/JEPS). **Orange Co.:** Santiago peak, 20 Jun 1927, *Swallen 640* (US), Silverado Canyon., 640 m, 3 Sep 1994, *Cayouette & Darbyshire C7953* (DAO); Santa Lucia Mts, Mill Creek, 25 May 1941, *Hoover 5260* (K). **Placer Co.:** N branch of Middle Fork of American River, at road crossing E of Forest Hill, 20 Jul 1952, *Stebbins et al. 5132* (CAS). **Riverside Co.:** San Jacinto Mts, Idyllwild Area, N of Strawberry Valley, between Bear Trap Cyn and Lily Creek, 5200–5300 ft, 1 Aug 1996, *White 4442* (CAS), Colorado Desert, 1889, *Palmer s.n.* (US), Fuller Creek, 29 Jun 1936, *Yates 6383* (UC/JEPS). **San Benito Co.:** Pinnacles National Monument, 3 Jun 1939, *Stebbins 2773* (UC/JEPS). **San Bernardino Co.:** San Bernardino Mts, 29 May & 28 Jun 1888, *Parish 2053* (US); San Bernardino Mts., 3300 ft, 13 Jun, *Reed 1011* (US); San Bernardino Mts, 29 May 1890, *Parish s.n.* (US); San Bernardino Mts, road below Highland and Running Springs, 26 Jun 142, *Beetle 3645* (UBC); San Antonio Mts, 8000 ft, 28 Jul 1917, *Johnston 1407* (UC/JEPS, US); N of Snow Canon, 5500 ft, 20 Jun 1901, *Parish 5038* (CAS); San Bernardino Mts, 2500 ft, 5 Jun 1917, *Parish 11304* (CAS, UC/JEPS); San Bernardino Mts, road between Highland and Running Springs, 26 Jun 1942, *Beetle 3645* (CAS); San Bernardino Mts, 29 May 1888, *Parish s.n.* (CAS); San Bernardino Mts, 3000 ft, 29 Jun 1888, *Parish 2053* (CAS); San Bernardino Mts, Dobbs trail, Mill Creek, 2 Jul, *Crawford s.n.* (CAS); San Bernardino Ntl Forest, road 38, near Angelus, 1654 m, 2 Sep 1994, *Cayouette & Darbyshire C7949* (DAO); 0.5 mi S of Santa Ana River, 26 Jun 1937, *Yates 6688* (UC/JEPS). **San Diego Co.:** Cleveland National Forest, 30 Jun 1915, *Hitchcock 13160* (US). **San Luis Obispo Co.:** between Rocky Butte and Pine Mt., Santa Lucia Mts, 21 Jun 1950, *Hoover 7998* (CAS, UC/JEPS); near Rocky Butte Fire Lookout, 12 June 1964, *Hoover 9076* (CAS). **Santa Barbara Co.:** San Rafael Mts, Potrero on SE side of Cachuma Peak, 4000 ft, 12 Jun 1961, *Blakley 4491* (CAS, US); N side of La Cumbre Peak, Santa Ynez Mts, 3600 ft, 5 Dec 1958, *Pollard s.n.* (CAS); Romero Canyon, Santa Ynez Mts, 7 Jul 1951, *Pollard s.n.* (CAS); W fork of Cold Spring Canyon, Santa Barbara, 16 Jun 1965, *Pollard s.n.* (CAS); Santa Ynes Mountains, 5 mi E of Santa Barbara, 12 Sep 1994, *Cayouette & Darbyshire C7971* (DAO); bank of Camino Cielo, E of and near San Marcos Pass, 2000 ft, 10 Jun 1958, *Pollard s.n.* (W); Zaca Lake Forest Reserve, 19–30 Jun 1906, *Eastwood 719* (UC/JEPS). **Santa Cruz Co.:** near Eagle Rock, 2500 ft, *Hesse 2731* (CAS); Santa Cruz, 27 Jun 1938, *Silveus 2829* (CAS). **Tuolumne Co.:** Tuolumne River at Early Intake dam, 10 mi W of Mather, 1 Jul 1951, *Stebbins 5000* (UC/JEPS). **Ventura Co.:** Red Reef Canyon, Topatopa Mts, 2800–3500 ft, 8 Jun 1908, *Abrams & McGregor 161* (US); above Murietta-Santa Ynez divide, Santa Ynez Mts, Ojai District, 4300 ft, 27 Jun 1963, *Pollard s.n.* (CAS); Matilija Canyon, 3 Jun 1945, *Pollard s.n.* (CAS); Murrieta Canyon, 15 Jun 1946, *Pollard s.n* (CAS); Red Reef Canyon, Topatopa Mts, 2800–3500 ft, 8 Jun 1908, *Abrams & McGregor 161* (CAS); Santa Ynez Mts, Camino Cielo, 3500 ft, 29 Jul 1967, *Pollard s.n* (CAS); Upper North Fork, Matilija Canyon, Ojai District, 27 Jun 1962, *Pollard s.n.* (CAS); Ventura River Basin, Camino Cielo, 4000 ft, 25 May 1946, *Pollard s.n.* (CAS); Santa Ynez Mts, Ojai to Cuyama Valley Road, N Fork of Ventura River, 2.2 mi below Wheelers Hot Springs, 1200 ft, 21 May 1935, *Wolf 6888* (CAS); 0.5 mi N of Whiteacre Pk, 18 Jun 1935, *Simontacchi 120* (UC/JEPS).

Bromus hallii (Hitchc.) Saarela & P.M. Peterson, comb. nov. *Bromus orcuttianus* var. *hallii* Hitchc., Fl. Calif. 1:175. 1912. TYPE: U.S.A. CALIFORNIA: west side, San Jacinto Mts, 27 Jun 1901, *H.M. Hall 2301* (HOLOTYPE: US-412894!).

Loosely caespitose perennial. Culms 90–150 cm tall, erect, puberulent or occasionally glabrous; nodes 1–2(–3), dark brown, retrorsely pilose to densely pubescent below. Leaf sheaths 6–12.5 cm long, 1/4–3/4 as long as internodes, closed for most of their length, densely pubescent, hairs 0.3–1 mm long; margins smooth, occasionally hyaline at apex; collars densely pilose, with hairs up to 2 mm long, auricles absent; cataphylls and basal sheaths densely pilose, sometimes shredding; ligules 0.5–2.5 mm long, membranous, sparsely to densely pubescent adaxially, glabrous abaxially, apex obtuse, erose; blades 7.5–16.5 cm long, 3–12 mm wide, flat, membranous, apically cucullate, densely pubescent abaxially and adaxially, hairs 0.2–0.5 mm long, occasionally longer hairs up to 1.2 mm on margins near base; margins scabrous or smooth. Panicles 5–16 cm long, 2–11 cm wide, open to densely branched; branches erect, ascending and appressed to spreading not more than 90° from the rachises, pubescent; lower inflorescence nodes with 1–2 branches, lower branches 3.5–11 cm long with 1–2(–3) spikelets, upper spikelets occasionally sessile and spike-like. Spikelets 2.5–3.5(–4.5) cm long, 3–7-flowered, terete to conspicuously distichous at maturity with rachis visible, lowest rhachilla 2.5–4 mm long; glumes subequal, shorter than lemmas; sparsely to densely pubescent, margins sometimes hyaline; lower glumes 5–8(–9) mm long, 1(3)-nerved, apex acute; upper glumes (7–)8–9 mm long, 3-nerved, apex acute, acuminate, or mucronate, the mucro less than 1 mm long; lemmas 10–14 mm long, 5- to 7-nerved, sparsely to densely pubescent across back, marginal hairs sometimes longer, up to 0.5 mm long, backs flattened dorsally to slightly keeled; apex entire or minutely bifid, the teeth not greater than 0.2 mm; awned just below the apex, awns 3.5–7 mm long, straight; paleas 9–13 mm long, shorter than the lemmas, backs glabrous or slightly pubescent, margins usually pubescent; apex acute; anthers 3–6 mm long, yellowish-orange. Caryopses 9–11 mm long, linear, amber to dark brown. Chromosome number unknown.

Distribution.—Endemic to southern California; known only from Fresno, Kern, Los Angeles, Monterey, Santa Barbara, San Bernardino, and Tulare counties.

Habitat.—Dry, open or shady areas on hillsides, rocky slopes, and pine woods in the mountains; elevation 5200–8800 ft.

Specimens examined. **U.S.A. California: Fresno Co.:** between Vidette Meadow and Bullfrog Lake, 9 Aug 1940, *Howell 16079* (CAS); Bubbs Creek Canyon in vicinity of Vidette Meadows, 9,500–10,000 ft, 23 Jul 1948, *Howell 24942* (CAS); Simpson Meadow, Middle Fork of the Kings River, 6000 ft, 25 Jul 1958, *Howell 33926* (CAS); Wood's Creek, 19 Jul 1910, *Clemens s.n.* (CAS). **Kern Co.:** 1.5 mi W of Greenhorn Summit, 5200 ft, 22 Jun 1970, *Howell & True 46599* (CAS); Breckenridge Mountain Road, 0.4 mi E of Barrel Spring, 6500 ft, 19 Aug 1958, *Twisselmann 4725* (CAS); Greenhorn Mountains, 1.5 mi SE of Summit, 5000 ft, 8 Jul 1962, *Howell 38312* (CAS); Greenhorn Pass Road, about 0.5 mi E of Sprout Spring, Greenhorn Range, 5750 ft, 13 Aug 1958, *Twisselmann 4666* (CAS); Greenhorn Range, NW of Calf Creek, 17 Sep 1963, *Twisselmann 9010* (CAS); Greenhorn Range, Greenhorn Pass Road just S of Tiger Flat, 6600 ft, 13 Aug 1958, *Twisselmann 4653* (CAS); Kern Plateau, road to Bartolas Country E of Little Cannell Meadow, 7200 ft, 12 Jul 1966, *Howell & True 41851* (CAS); Kern Plateau, trail to Little Cannell

Meadow above Pine Flat, 7450 ft, 24 Jul 1964, *Twisselmann 9880* (CAS); Old Kernville Road, 4.4 mi E of Greenhorn Summit, Greenhorn Range, 5200 ft, 21 Jun 1957, *Twisselmann 3716* (CAS). **Los Angeles Co.:** Buckhorn, San Gabriel Mts, 6500 ft, 20 Jul 1933, *Duran 3521* (CAS, OSU, US); San Antonio Mts, S Fork of Lytle Creek, 6000 ft, 15 Jul 1917, *Johnston 1454* (CAS, US); San Antonio Canyon, 27 Jun 1927, *Swallen 679* (US); San Bernardino Mts, 2 mi N of Big Pine Camp, 25 Jun 1942, *Beetle 3640* (CAS); San Gabriel Mts, Blue Ridge, 8000–8500 ft, 18 Jul 1947, *Howell 23389* (CAS); San Antonio Mountains, Prairie Fork of San Gabriel River, 6500 ft, 6 Jul 1918, *Johnston 2070* (CAS); San Gabriel Mts., 1826 m, 1 Sep 1994, *Cayouette & Darbyshire C7948* (DAO). **Monterey Co.:** Tassajara Hot Springs, Jun 1901, *Elmer 3314* (CAS, K, OSU, US); Santa Lucia Mts, Jun 1901, *Davy 7709* (US), *7710* (OSU); NW of Tassajara Road summit, Chews Ridge, Los Padres National Forest, 15 Jun 1973, *Griffin 3625* (UC/JEPS). **San Bernardino Co.:** San Bernardino Mts, Little Bear Valley, Aug 1907, *Wilbur 1071* (US); San Bernardino Mts, 22 Jul 1902, *Abrams 2799* (CAS, K); San Bernardino Mts, Bear Valley, 6600 ft, 19 Jul 1900, *Jones s.n.* (CAS); San Jacinto Mts, W fork of Snow Creek, 5000 ft, Jul 1901, *Hall 2538* (CAS, K); San Gorgonio Mts., S of Barton Flats, 2251 m, 2 Sep 1994, *Cayouette & Darbyshire C7950* (DAO); San Bernardino Mts, Deep Creek, 6500 ft, 19 Jul 1899, *Hall 1348* (K); above Arrowhead Lake, San Bernardino Mts, 1 Jul 1927, *Swallen 700* (OSU, US); 2 mi W of Barton Flat, 26 Jun 1937, *Yates 6694* (UC/JEPS). **Santa Barbara Co.:** Mission Pine, San Rafael Mts, 6200 ft, 25 Apr 1930, *Hoffman 90* (US); San Bernardino Mts., Santa Ana Canyon above Clark's Ranch, 7400 ft, Jul 1926, *Quibell 59* (US). **Tulare Co.:** trail from Bakeoven to Templeton Meadows, 8800 ft, 17 Jul 1950, *Howell 27005* (US, CAS); Kaweah River Valley, 29 Jul 1891, *Coville & Funston 1346* (US); Kings Canyon National Park, below Mist Falls, S. Fork Kings River, 13 Jul 1927, *Swallen 770* (US); Copper Creek trail to Granite Basin, 11 Jul 1927, *Swallen 753* (US); Aug 1897, *Dudley s.n.* (CAS); Kern Plateau, about 2 mi NW of Beach Meadow, 8200 ft, 7 Aug 1967, *Howell & True 43419* (CAS); Kern Plateau, N of Cain Meadow, ca. 7200 ft, 24 Jun 1966, *Twisselmann 12421* (CAS); Kern Plateau, North Manter Creek, Big Meadow, 7700–8000 ft, 24 Jun 1970, *Howell & True 46696* (CAS); Monarch Lakes Trail, ca. 8000 ft, 19 Jul 1951, *Howell 27943* (CAS); Portugese Pass, 7400 ft, 5 Aug 1957, *Twisselman 3946* (CAS); Quaking Aspen Road, 1.3 mi N of Ice Creek, 6600 ft, 8 Jul 1959, *Twisselmann 5497* (CAS); Sequoia National Forest, Lloyd Meadows Basin, 1.25 mi W of the Pyles Boys Camp in the Freeman Redwood Grove, 5800 ft, 19 Jun 1973, *Shevock 2770* (CAS); Sequoia National Forest, Lloyd Meadows Basin, along USFS road 22S82, E base of the Needles, about 3 mi from the Pyles Boys Camp, 5800 ft, 4 Jun 1974, *Shevock 3580* (CAS); Sequoia National Forest, Lloyd Meadows Basin, approximately 2 mi NW of the Pyles Boys Camp, 5700 ft, 10 Jul 1974, *Shevock 3716* (CAS); Sequoia National Forest, near Belknap Creek, 26–28 Jul 1941, *Bacigalupi, Wiggins, & Ferris 2655* (CAS); Sequoia Ntl Forest, N limit of Sequoia Ntl Park road, 2010 m, 5 Sep 1994, *Cayouette & Darbyshire C7955* (DAO); Long Meadow, 8000–9000 ft, 14 Jun 1888, *Palmer 233* (K, US); Mt. Silliman, Clover Creek, 29 Jul 1896, *Dudley 1481* (CAS).

Bromus orcuttianus Vasey, Bot. Gaz. 10:223. 1885. *Bromopsis orcuttiana* (Vasey) Holub, Folia Geobot. Phytotax 8(2):168. 1973. TYPE: U.S.A. CALIFORNIA: in the mountains near San Diego, 1884, *C.R. Orcutt s.n.* (HOLOTYPE: US!)

Bromus brachyphyllus Merr., Rhodora 4:146. 1902. TYPE: U.S.A. OREGON: Crook Co.: Black Butte, open dry pine forests, 19 Jul 1901, *Cusick 2677* (HOLOTYPE: unknown; ISOTYPE: US!).

Loosely caespitose perennial. Culms 90–150 cm tall, erect, glabrous to pubescent; nodes 2–4, dark brown, retrorsely pilose to densely pubescent below. Leaf sheaths 3.5–11 cm long, usually 1/3–2/3 as long as internodes, closed for most of their length; lower sheaths sparingly to densely pilose, hairs 2–4 mm long, occasionally glabrous; upper sheaths pubescent, hairs up to 1 mm long; margins smooth, occasionally hyaline at apex; collars pilose with hairs up to 4 mm long or glabrous, auricles absent; cataphylls and basal sheaths glabrous, sometimes shredding; ligules 1–3 mm long, membranous, glabrous, occasionally pilose adaxially, apex obtuse, erose; blades 7–24 cm long, 3–12 mm wide, flat, membranous, apically cucullate, glabrous, edges sometimes pilose with hairs up to 2 mm or pubescent on lower 15–25%; margins scabrous or smooth. Panicles 7–13.5 cm long, 2–10 cm wide, open to densely branched; branches erect, ascending and appressed to spreading not more than 90° from the rachises, pubescent; lower inflorescence nodes with 1–2(–3), lower branches 3–7.5 cm long with 1–5 spikelets, upper spikelets occasionally sessile and spike-like. Spikelets 2–3.7 cm long, 3–9-flowered, terete to conspicuously distichous at maturity with rachis visible; glumes subequal, shorter than lemmas, glabrous, occasionally scabrous on veins or pubescent, margins sometimes hyaline; lower glumes 5–9 mm long, 1(3)-nerved, apex acute; upper glumes 7–11 mm long, 3-nerved, apex acute or mucronate, the mucro up to 1 mm long; lemmas 9–15 mm long, glabrous, scabrous, or sparsely to densely pubescent, marginal hairs sometimes longer, the hairs up to 0.5 mm long; backs flattened dorsally to slightly keeled; apex entire or minutely bifid, the teeth not greater than 0.2 mm, awned just below the apex, awns (4–)5.5–8 mm long, straight; paleas 8–11 mm long, shorter than lemmas, backs glabrous or slightly pubescent, margins usually pubescent; apex acute; anthers 3–5 mm long, yellowish-orange. Caryopses 6–9 mm long, linear, brown to purple-black. Chromosome number $2n = 14$.

Distribution.— Known from California, Nevada, Oregon, Washington, Arizona, and Utah.

Habitat.—Dry areas in open pine woods, on hillsides and rocky slopes, and in meadows in the mountains; elevation 1850–11500 ft.

Specimens examined. **U.S.A. ARIZONA: Cochise Co.:** Huachuca Mts, Sept 1883, *Lemmon s.n.* (US). **CALIFORNIA: Alpine Co.:** N side of Pigeon Flat, 22 Jul 1940, *Hoover 4423* (K). **Amador Co.:** Pioneer, 3500 ft, 13 Jul 1896, *Hansen 1835* (K, US); Jackson, 7 Sep 1937, *Johannsen 1247* (UC/JEPS). **Butte Co.:** Butte Meadows, 4600 ft, 26 Jul 1917, *Heller 12819* (CAS, OSU, US); Butte Creek, 5000 ft, 21 Jul 1930, *Copeland 1348* (CAS); Jackson Ranch Ridge, along Road 21N25Y ca 0.6 mi E of the W end of the ridge, 3750 ft, 27 Jul 1995, *Janeway 4877* (CAS); W side of Hwy. 32 ca. 1/4 mi N of Forest Ranch, 2357 ft, 18 Jul 1978, *Taylor 1674* (CAS); along Big Bar Mountain Road, about 3 mi SW of Coyote Gap, SE of Pulga, 8 Jul 1987, *Ahart 5796* (CAS). **Calaveras Co.:** near Dorrington, 26 Jun 1978, *Howell, Menzies, & Shockey 53063* (CAS); Dorrington, 1976, *Menzies s.n* (CAS). **Colusa Co.:** Trout Creek, SE Snow Mt, 30 Jul 1981, *Heckard & Hickman 5763* (UC/JEPS). **El Dorado Co.:** along US hwy 50, 3 mi E of Camino, 3400 ft, 15 Jul 1945, *Robbins 2062* (US): Chute Champ Road, 3000 ft, 15 Jun 1937, *White 1078* (US); Fallen Leaf Lake, 27 Jul 1928, *Abrams 12630* (CAS); Fallen Leaf Lake, 9 Jul 1928, *Abrams 12627* (CAS); Glen Alpine region, Camp Agassiz, 21 Jul–15 Aug 1906, *Eastwood 998* (CAS); Echo Summit, 1 Sep 1946, *Howell 22986* (CAS); 0.5 mi W of Omo Ranch Post Office, 22 Jun 1956, *Crampton 3596* (CAS). **Fresno Co.:** Pine Ridge, 5300 ft, 15–25 Jun 1900, *Hall & Chandler 316* (UC/JEPS, US); Huntington Lake, 22 Jul 1927, *Swallen 810* (US); Bearskin Meadow, 2 Jul 1899, *Eastwood s.n.* (US); Granite Basin, 10 July 1927, *Swallen 743* (US); above Deer Creek, N shore of Huntington Lake, 7100 ft, 8 Aug 1951, *Quibell 486* (CAS); Dinkey Creek, Jul 1901, *Dudley s.n.* (CAS); Huntington Lake and vicinity, near ranger station, 7000 ft, 3 Aug 1951, *Pollard s.n.* (CAS); John Muir Trail N of Bear Creek, 9400 ft, 5 Aug 1954, *Raven 7789* (CAS); Mono Creek, 8200 ft, 9 Aug 1953, *Raven 6142* (CAS); Tehipite Valley, Middle Fork of the Kings River, 4650 ft, 26 Jul 1958, *Howell 33958* (CAS); drainage of Deer Creek, above Lakeshore Post

Office, Huntington Lake, 23 Aug 1958, *Bacigalupi & Quibell 6717* (UC/JEPS); E slope of Converse Mt, drainage of Indian Creek, along Kings Canyon Road, 23 Jul 1958, *Bacigalupi & Alava 6498* (UC/JEPS); Huckleberry Creek, Huntington Lake, 28 Jul 1928, *Jepson 13330* (UC/JEPS). **Glenn Co.:** Plaskett Meadows, 6000 ft, 4 Aug 1943, *Howell 19020* (CAS, US); road 168, a few miles E of Shaver Lake, 2100 m, 6 Sep 1994, *Cayouette & Darbyshire C7958* (DAO); Mendocino National Forest, 5500 ft, 21 Jul 1956, *Burcham 368* (K); near Fish Pond Plaskett Meadows, 5 Aug 1943, *Baker 10583* (CAS). **Humboldt Co.:** Orleans Mt., 2 Sep 1946, *Pollard s.n.* (CAS); Trinity Summit, on ridge 2 mi E of Grove's Prairie, 15 Aug 1948, *Tracy 18125* (UC/JEPS); Grouse Mt, 27 Jun 1934, *Clarks & Tracy 11079* (UC/JEPS). **Lake Co.:** N of Hoberg's, 14 Jul 1944, *Hoffman 1967* (UC/JEPS, US); foothills S of Mt. Sanhedrin, midway between Potter Valley and Hullville, 25 Jul 1902, *Heller 5987* (US); S base of Mt. Sanhedrin, 25 Jul 1902, *Heller & Brown 5987* (US), Bartlett Mtn, 23 Jun 1948, *Wagnon 1509* (K); 15 mi N of Lakeview, 6 Jul 1927, *Peck 15517* (CAS); summit of Bartlett Mt, 11 Jul 1939, *Stebbins 2971* (UC/JEPS); NW of Timber Lake, Snow Mt, 16 Jun 1979, *Heckard & Hickman 5086a* (UC/JEPS) **Lassen Co.:** 5 mi S of Susanville, 27 Jul 1927, *Swallen 872* (US); Black's Mt, 10 Jul 1934, *Howell 12554* (CAS); Elysian Valley, W of Janesville, 28 Jun 1973, *Howell, True & Williams 49472* (CAS); Gold Run Creek road S of Susanville, Diamond Range, 1 Aug 1973, *Howell & True 50180* (CAS), Gold Run Creek SW of Susanville, 19 Jul 1976, *Howell 51973* (CAS); on road from Janesville to Thompson Peak, Diamond Range, 31 Jul 1973, *Howell & True 50029* (CAS). **Madera Co.:** 9 mi above Bass Lake on Beasore Meadow Road, 18 Jul 1933, *Springer 505* (OSU); Bass Lake Fish Hatchery, 1 Sep 1951, *Holt s.n.* (CAS). **Mariposa Co.:** 11 Aug 1895, *Congdon s.n.* (US); Signal Peak, Chowchilla Mt., 25–31 Jul 1938, *Quick 2003* (CAS); road 41, Sierra Ntl Forest, 5 miles of Yosemite Ntl Park, 1914 m, 8 Sep 1994, *Cayouette & Darbyshire C7964* (DAO); Yosemite to Wawona, 28 Jun 1911, *Jepson 4295* (UC/JEPS). **Mendocino Co.:** along roadside enroute to summit of Mt. Sanhedrin from Towhead Flat, 7 Jul 1981, *Knight & Knight 4295* (CAS). **Modoc Co.:** Forestdale, 4500 ft, 25 Aug 1894, *Baker & Nutting s.n.* (US); 13 July, *Baker & Nutting s.n.* (US). **Nevada Co.:** Truckee, 14–16 Jul 1913, *Hitchcock 10516* (K, US, W); Banner Mt, 4 mi E of Nevada City, 15 Sep 1961, *True 261* (CAS); Hwy 20, ca. 2.5 mi E of Washington Jct., 5000 ft, 10 Jul 1968, *True 4341* (CAS); Omega Rd, between Omega Diggings and Diamond Creek 14 mi NE of Skillman Flat on Hwy 20, 15 Jul 1965, *True & Howell 2359* (CAS); Mayflower Mine, 5 Jun 1966, *Mott s.n.* (CAS); Banner Mt, ca. 4 mi E of Nevada City, 15 Jul 1965, *True & Howell 2319A* (CAS); on road to Pierce Meadows, short distance from the S Fork of the Yuba River, Tahoe National Forest, 30 Jun 1931, *Smith 2575* (UC/JEPS). **Placer Co.:** Tahoe, 5 Aug 1908, 6225–7000 ft, *Hitchcock 3091* (US); railroad crossing at Blue Canyon, 17 Jul 1956, *Crampton 3723* (CAS); about 2 mi SW of French Meadows on the road to Big Meadow, 2 Aug 1981, *Best s.n.* (CAS); 1 mi from Blue Canyon on road to Emigrant Gap, 4 Aug 1956, *Raven 9999* (CAS); Truckee, 8 Aug 1936, *Yates 5981* (UC/JEPS); Eldorado Canyon, above Bullion Mine, Tahoe National Forest, 4 Jun 1926, *Smith 1883* (CAS, UC/JEPS); Antone Meadow, 7 Sep 1967, *Hoover 10858* (UC/JEPS). **Plumas Co.:** between Blairsden and Gold Lake, 5500 ft, 5 Jul 1938, *Wood 7* (US); Truckee River, July 1888, *Sonne 21* (US, CAS); Butterfly Botanical Area, confluence of Spanish Creek and Butterfly Creek, 2900 ft, 11 Jun 1968, *Howell, Knight, Knight, & True 2352* (CAS); Fern Glen, 26 Jul 1966, *Knight, Knight & Howell 1576* (CAS); Drakesbad, 5500–6000 ft, 17 Jul 1960, *Howell 35494* (CAS); Drakesbad, 5500–6000 ft, 20 Aug 1960, *Howell 36274* (CAS); Gold Lake Road above Blairsden, 5500 ft, 25 Jun 1934, *Ewan 8227* (CAS); Johnsville, 5200 ft, 28 Jun 1951, *Howell 27656* (CAS), Lassen Volcanic National Park, trail to Little Willow Lake, 21 Jul 1960, *Howell 35860* (CAS); near Prattville, Lake Almanor, 14–26 Aug 1944, *Kearney 7* (CAS); near the summit of Soapstone ridge 12 mi W of Bucks, 5500 ft, 7 Jul 1915, *Heller 12053* (CAS, OSU); Quincy, 31 Jul 1942, *Quick 42-46* (CAS); Willow Lake Meadow near the east inlet, 5450 ft, 17 Jul 1957, *Gillett 805* (CAS, UC/JEPS), 3 mi W of Keddir, Butterfly Valley, 3600 ft, 10 Jul 1967, *Rose 67152* (W); near Prattville, 20 Jul 1926, *Howell 2088* (CAS), Round Valley, 9 Jul 1973, *Howell 49722* (CAS); 2 mi NW of Spring Garden, 22 Jul 1975, *Howell 51363* (CAS); Butterfly Valley, 3 mi. W of Keddie, 27 Jul 1966, *Rose 66060* (CAS); about 0.5 mi N of Humboldt Summit, 23 Jul 2001, *Ahart & Oswald 8998* (UC/JEPS). **San Diego Co.:** Cleveland National Forest, E of San Diego, near Cuyamaca Lake, 1700 m, 29, 30 Jul 1915, *Hitchcock 13168* (K, UC/JEPS, US, W); Cuyamaca Mts, 30 Jun 1903, *Abrams 3945* (OSU). **Shasta Co.:** Goose

Valley, 29 Jun–11 Jul 1912, *Eastwood 930*, 985 (CAS, US); 4 Jul 1914, *Smith 735* (CAS); 0.25 mi above Manzanita Creek on Chaos Crags trail, 11 Jul 1957, *Gillett 705* (UC/JEPS, CAS); Goose Valley, 29 Jun, 11 Jul 1912, Eastwood 930 (CAS); Redding, 5 Jun 1934, *Kraebel 25* (UC/JEPS); Logan Mt, 13 mi N of Lassen Peak, Lassen National Forest, 12 Jul 1934, *Whitney 2163* (UC/JEPS); Little Hatchet Creek, 4 Jul 1940, *Jepson 20131* (UC/JEPS). **Sierra Co.:** near summit of Yuba Pass, 6350 ft, 17 Aug 1944, *Beetle 3041* (US); Tahoe Forest, 10 Sep 1925, *Smith 1727* (CAS); Tahoe Forest, 10 Jun 1926, *Smith 1906* (CAS); Tahoe forest, 19 Jul 1926, *Smith 1994* (CAS); Tahoe Forest, 4 Jul 1926, *Smith 1883* (CAS); Independence Lake watershed, W of Independence Lake, 7200 ft, 26 Jul 1977, *True 8380* (CAS); 2 mi E of Bassett station, North Fork of Yuba River, 4 Aug 1934, *Jepson 16850* (UC/JEPS). **Siskiyou Co.:** base of Mt. Eddy, 18 Jul 1915, *Heller 12124* (CAS, OSU, US); S Fork of Shasta River, Mount Eddy, Shasta Forest, 1850–2000 m, 11, 12 Aug 1915, *Eggleston 11635* (US); Sisson, 30 Jul 1894, *Howe 122* (US); near Shasta Springs, 13 Jun 1905, *Heller 8026* (CAS, US); between upper reaches of China and Blind Horse Creeks, S side of South Fork of Salmon River, 24 Jul 1955, *Wiggins 13497* (CAS, UC/JEPS); toward Black Fox, 15 Aug 1899, *Dudley s.n.* (CAS); Trinity Mts, about 6 mi SE of Cecilville, W side of Rush Creek, 21 Jul 1954, *Thomas & Thomas 4432* (CAS); on Everitt Memorial Hwy, 4.7 mi N of McCloud River railroad crossing, 13 Jul 1963, *Frenkel 229* (CAS); English Lake, Salmon Mts, 16 Aug 1969, *Oettinger 1392* (UC/JEPS); below Pine Lake Basin, Salmon Mts, 6 Aug 1969, *Oettinger & Thorne 1246* (UC/JEPS); Humbug Creek, 20 Jul 1908, *Butler 469* (UC/JEPS). **Tehama Co.:** Deer Creek Canon, 17 Jul 1911, *Eggleston 7284* (US); 5.1 mi from Whitlock Camp, 12 Jul 1953, *Baker & Wagnon 12861* (UC/JEPS); E side of Willow Creek, about 1.25 mi N of Jonesville, 24 Jul 1994, *Ahart 7513* (UC/JEPS). **Trinity Co.:** Grasshopper Public Camp, 2.5 mi NW of Stuart Gap, North Yolla Bolly Mts, 17 Jul 1951, *Munz 16575* (CAS); North Fork of Trinity River, Hobo Gulch Camp vicinity, 18 mi NW of Weaverville, along backbone Creek Trail near Keystone, 15 Jun 1972, *Carter 435* (CAS). **Tulare Co.:** S Fork of Kaweah River, 20 Jul 1904, *Culbertson 4512* (US); above Mineral King, 30 Jul 1927, *Swallen 883* (US); Sequoia National Park, 18 Jul 1927, *Swallen 882* (US); Grant Park, 4000–8000 ft, 11 Aug 1895, *Dudley 1205* (CAS), Hollow Log Camp, Jul 1900, *Dudley s.n.* (CAS); middle Kaweah River, 2 Aug 1900, *Dudley 3031* (CAS); Mineral King road, 6000 ft, 15 Jul 1951, *Howell 27780* (CAS); Sequoia National Park, 12 Aug 1896, *Dudley 1625*, Sequoia Forest. Freeman Creek, 2 Aug 1916, 7500 ft, *Cunningham 3* (CAS); Sequoia National Forest, 11500 ft, 23 Jul 1912, *Hopping 22* (CAS); Kaweah River, 20 Jul 1904, *without collector* (US); Sequoia National Park, road to Crystal Cave, near start of Black Oak trail, 21 Jul 1948, *Bailey & Bailey 2446* (UC/JEPS); Lloyd Meadow, near trail to Quaking Aspen on the Springville Road, 24 Jul 1964, *Smith 1316* (UC/JEPS). **Tuolumne Co.:** Yosemite National Park, Echo Creek Canyon, 17–25 Aug 1908, *Hitchcock 3352*, *3355* (US), Yosemite National Park, Tenaya Trail, 6500 ft, 21–22 Jul 1915, *Hitchcock 13136* (US); Yosemite to Wawona, 28 Jun 1911, *Jepson 4295* (US); Yosemite Valley, 4060 ft, 5 Jul 1909, *Jepson 3125* (US), Yosemite National Park, 1 Jul 1938, *Silveus 2873* (CAS); Yosemite National Park, Glacier Point, 11 Aug 1915, *Abrams 5428* (CAS); Yosemite Valley, Sierra Nevada Mts, 5000–8000 ft, 4–12 Jul 1901, *Parish 4360* (CAS); Yosemite, Jul 1902, *Bacon s.n.* (CAS); along Hwy 108, between Twain Harte and Confidence, 10 Jul 1972, 4000 ft, *Wiggins 21785* (CAS); along South Fork road, 2.6 mi E of Twain Harte, 4000 ft, 11 Jul 1971, *Wiggins 21679* (CAS); Dodge Ridge SE of Pinecrest, 21 Jul 1953, *Quick 53-42* (CAS); Herring Creek, 4 mi from Strawberry, 17 Jul 1936, *Wiggins 8543* (CAS); Mather, in the Sierra Nevada in the lower borders of the Transition Zone, 1400 m, 6 Jun 1931, *Keck 1252* (CAS); near Cow Creek Research Station, 5750 ft, 11 Jul 1941, *Quick 41-69* (CAS); Twain Horte, 3700 ft, 6 Jun 1954, *Howell 29944* (CAS); Long Barn, 16 Jul 1941, *Hoover 5470* (K). **Yuba Co.:** about 2 mi NE of Dobbins on Oregon Hill road, 22 Jun 1981, *Howell, Fuller & Barbe 54081* (CAS); about 200 yards S of the 4-H Camp, on W side of Oregon Hill Road, about 0.5 mi N of Marysville Road, about 2 mi NE of Dobbins, 2 Jul 2003, *Ahart 10340* (UC/JEPS). **NEVADA: Washoe Co.:** Incline, 1 Aug 1928, *Smith s.n.* (CAS). **OREGON:** Gayhart Buttes, 1850 m, 8 Aug 1896, *Leiberg 2887* (OSU); East Eagle Creek, 5500 ft, 10 Aug 1909, *Cusick 3369*, *3370* (OSU). **Crook Co.:** base of Black Butte, 19 Jul 1901, *Cusick 2677* (UC/JEPS, US). **Douglas Co.:** along Golden Stairs Trail, E fork of Abbott Creek, ca. 20 mi W of Crater Lake, near Abbott Butte, 19 Jul 1972, *Mitchell 241* (OSU). **Grant Co.:** Strawberry Lake, Strawberry Mts, 17 Jul 1910, *Cusick 3525* (OSU, US).

Jackson Co.: Klamath Forest, 4800 ft, 19 Jul 1934, *Wheeler 2931* (CAS, UC/JEPS, US); Ashland Butte, Siskiyou Mountains, 20 Jul 1887, *Howell 253, 369* (OSU, UC/JEPS, US, W, WTU); summit of Cascades, 10 Jul 1931, *Peck 16747* (OSU); Carberry Creek, 3 mi from mouth of Applegate River, 25 Jun 1931, *Peck 16386* (OSU). **Jefferson Co.:** Suttle Lake, 18 Jul 1925, *Peck 14421* (CAS, K, OSU); Abbot Butte Spring Road, 15 September 1959, *Swedberg 100* (OSU); NW of Sisters, 23 July 1960, *Johnson 543* (OSU); NW of Sisters, 27 Aug 1960, *Johnson 611* (CAS, OSU); near Hwy. 20, W of Black Butte, 20 Jul 1962, *West s.n.* (OSU); Siskiyou, 21 Jul 1908, *Hitchcock 2879, 2909, 2916* (US). **Klamath Co.:** Klamath Valley at Keno, 27 Jun 1902, *Cusick 2838* (CAS, OSU, UC/JEPS, US, W), Pelican Bay, W side of Upper Klamath, 16 Jul 1920, *Peck 9516* (CAS, WTU); Fort Klamath, 29 Jul 1908, *Hitchcock 3012* (US). **Lake Co.:** 15 mi N of Lakeview, 6 Jul 1927, *Peck 15517* (OSU). **Wallowa Co.:** Imnoha River, Wallowa Mountains, 10 Aug 1909, *Cusick 3310* (OSU, WTU). **Washington Co.:** Dixie Mountain, 15 Jul 1910, Cusick 3518 (US). **UTAH:** 1876, *McLean s.n.* (US). **WASHINGTON: Yackima Co.:** Klickitat River, near Mt. Paddo, 12 Jun 1885, *Suksdorf s.n.* (CAS, K, US); Mt. Paddo, 21 Aug 1905, *Suksdorf 5265* (US); Mt Paddo, 27 Aug 1884, *Suksdorf 120* (US). **Klickitat Co.:** Falcon Valley, 13 Jul 1924, *Suksdorf 11754* (CAS, K, OSU, UBC, UC/JEPS, US, WTU); 6 Jun 1891, *Suksdorf 826* (UC/JEPS).

KEY TO THE SECTIONS OF *BROMUS* IN CALIFORNIA

1\. Spikelets laterally compressed; lemmas compressed and keeled ______ sect. **Ceratochloa** (P. Beauv.) Griseb.
1\. Spikelets not laterally compressed; lemmas not keeled.
  2. Lemma apex bidentate, teeth 3–7 mm, awn-like to acuminate.
    3. Awn of the lemma geniculate and/or twisted ______ sect. **Neobromus** (Shear) Hitchc.
    3. Awn of the lemma straight, not twisted ______ sect. **Genea** Dumort.
  2. Lemma apex entire or bidentate, teeth 0–3 mm, not awn-like or acuminate.
    4. Plants perennial, with or without rhizomes, the bases fibrous; lower glume 1- or 3-nerved; upper glume 3- or 5-nerved ______ sect. **Bromopsis**
    4. Plants annual; lower glume 3- or 5-nerved; upper glume 5- or 7-nerved ______ sect. **Bromus** L.

KEY TO *BROMUS* SECTION *BROMOPSIS* IN CALIFORNIA

1\. Plants with rhizomes; awns absent or up to 3 mm long ______ **B. inermis**
1\. Plants without rhizomes; awns present, 1.5–11 mm long.
  2. Most lower glumes on a plant 3-veined.
    3. Upper glumes 5-veined.
      4. Ligule 0.4–1 mm long; glumes scabrous or pubescent; upper glume 6–9 mm long; blades and sheaths pubescent or glabrous ______ **B. pseudolaevipes**
      4. Ligule (1.5–)2–4 mm long; glumes glabrous; upper glumes 7–11mm long; blades and sheaths glabrous ______ **B. laevipes**
    3. Upper glumes 3-veined.
      5. Lemma awns 1.5–3(–4) mm long; blades 2–5 mm wide; anthers 1.5–3.5 (–4) long ______ **B. porteri**
      5. Lemma awns 3–9 mm long; blades 3–12 mm wide; anthers 3.5–5 mm long.
        6. Blades glabrous; lower sheaths pilose, hairs 2–4 mm long; nodes 2–4; inflorescence branches mostly ascending to spreading ≤ 90° from the rachises ______ **B. orcuttianus**
        6. Blades pubescent; lower sheaths pubescent, hairs up to 1(–3) mm long; nodes 3–7; inflorescence branches mostly spreading >90° from the rachises ______ **B. grandis**
  2. Most lower glumes on a plant 1-veined.
    7. Glumes pubescent.

8. Panicles narrow at anthesis, ≤ 2 cm wide; branches erect or tightly ascending; blades and sheaths glabrous **B. suksdorfii**

8. Panicles broad at anthesis, > 2 cm wide; branches erect, ascending, or nodding, usually spreading or divaricate; blades and sheaths pubescent or glabrous.

9. Ligules (2–)3–6(–7) mm long; lemma awns (4–)6–11 mm long; branches of inflorescence glabrous or scabrous **B. vulgaris**

9. Ligules 0.5–3 mm long; lemma awns 3–7(–9) mm long; branches of inflorescence pubescent.

10. Lower sheaths pilose with hairs 2–4 mm long, or glabrous; blades glabrous **B. orcuttianus**

10. Lower sheaths densely pubescent with hairs up to 1 mm long; blades densely pubescent.

11. Longest blades 7.5–16.5 cm long; 1–2(–3) nodes per culm **B. hallii**

11. Longest blades (13–)18–38 cm long; 3–6(–7) nodes per culm **B. grandis**

7. Glumes glabrous.

12. Panicles narrow at anthesis, ≤ 2 cm wide; branches erect or tightly ascending **B. suksdorfii**

12. Panicles broader at anthesis, > 2 cm wide; branches erect, ascending, or nodding, usually spreading or divaricate.

13. Ligules (2–)3–6(–7) mm long; awns (4–)6–11 mm long **B. vulgaris**

13. Ligules 0.5–3 mm long; awns 4–7(–9) mm long.

14. Lemmas not densely pubescent along margins; lemma awns (4–) 5–7(–9) mm long; inflorescence branches mostly ascending to spreading ≤ 90° from the rachises **B. orcuttianus**

14. Lemmas densely pubescent along margins; lemma awns (2–) 3–5(–6) mm long; inflorescence branches spreading to drooping >90° from the rachises.

15. Lemmas glabrous on lower back between pubescent margins; anthers (0.9–)1–1.4(–1.6) mm; second glumes (6.2–) 7.1–8.5(–9.5) mm long; basal sheaths glabrous or with long hairs; top culm blades with hairs on upper surface; top culm nodes usually hairy; caryopses (5.4–)6.2–7.2(–7.5) mm; top culm sheath usually pubescent **B. ciliatus**

15. Lemmas with scattered hairs on lower back between pubescent margins; anthers (1.2–)1.6–2.7(–3.4) mm long; second glumes (7.8–)8.9–11.3(–13.2) mm long; basal sheaths with dense, short, or medium hairs; top culm blades glabrous on the upper surface; top culm nodes usually glabrous; caryopses (6.9–)7.7–9.7(–10.5) mm long; top culm sheath glabrous **B. richardsonii**

ACKNOWLEDGMENTS

We thank Dieter Wilken, an anonymous reviewer, and Barney Lipscomb for constructive comments on the manuscript; the curators of the cited herbaria for the loan of specimens or assistance during visits; Cindy Sayre (UBC) for assistance in the herbarium; and Nicole Fillion (Ottawa) for assistance with the chromosome count. J.M.S. was supported by a Canada Graduate Scholarship from the Natural Sciences and Engineering Research Council of Canada, the University of British Columbia, and a travel grant from the Lawrence R. Heckard Fund of the Jepson Herbarium to visit the U.S. National Herbarium.

REFERENCES

Ainouche, M.L. and R.J. Bayer. 1997. On the origins of the tetraploid *Bromus* species (section *Bromus*, Poaceae): insights from the internal transcribed spacer sequences of nuclear ribosomal DNA. Genome 40:730–743.

Clayton, W.D. and S.A. Renvoize. 1986. Genera graminum. Grasses of the world. Kew Bull. Add. Ser. 13:1–389.

Clayton, W.D. and H. Williamson. 2002 onwards. World grass flora: Nomenclature. Royal Botanic Gardens, Kew.

Hitchcock, A.S. 1951. Manual of grasses of the United States (ed. 2, revised by A. Chase). U.S. Department of Agriculture, Washington, D.C.

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1969. Vascular cryptogams, gymnosperms, and monocotyledons. Vascular plants of the pacific northwest. University of Washington Press, Seattle. 1:1–194.

Jepson, W.L. 1912. A flora of California. Volume 1. University of California, Berkeley.

Kearney, T.H., R.H. Peebles, and collaborators. 1960. Arizona flora. University of California Press, Berkeley.

Massa, A.N., K. B. Jensen, S. R. Larson, and D.J. Hole. 2004. Morphological variation in *Bromus* sect. *Ceratochloa* germplasm of Patagonia. Canad. J. Bot. 82:136–144.

Munz, P.A. 1974. A flora of southern California. University of California press, Berkely.

Munz, P.A. and D.D. Keck. 1959. A California flora. University of California Press, Berkely. 1–1681.

Oja, T., V. Jaaska, and V. Vislap. 2003. Breeding system, evolution and taxonomy of *Bromus arvensis*, *B. japonicus* and *B. squarrosus* (Poaceae). Pl. Syst. Evol. 242:101–117.

Pavlick, L.E. 1995. *Bromus* L. of North America. Royal British Columbia Museum, Victoria.

Pavlick, L.E. and L.K. Anderton. In Press. *Bromus*. In: Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Flora of North America North of Mexico, volume 24. Oxford University Press, New York.

Pavlick, L.E., A.M. Planchuelo, P.M. Peterson, and R.J. Soreng. 2003. *Bromus*. Pp. 154–191. In: Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone, Catalogue of New World grasses (Poaceae): IV. Subfamily Pooideae. Contr. U.S. Natl. Herb. 48:1–730.

Peterson, P.M., J. Cayouette, Y.S.N. Ferdinandez, B. Coulman, and R.E. Chapman. (2001) 2002. Recognition of *Bromus richardsonii* and *B. ciliatus*: evidence from morphology, cytology, and DNA fingerprinting (Poaceae: Bromeae). Aliso 20:21–36.

Pillay, M. and K.W. Hilu. 1990. Chloroplast DNA variation in diploid and polyploid species of *Bromus* (Poaceae) subgenera *Festucaria* and *Ceratochloa*. Theor. Appl. Genet. 80: 326–332.

Pillay, M. and K.W. Hilu. 1995. Chloroplast-DNA restriction site analysis in the genus *Bromus* (Poaceae). Amer. J. Bot. 82:239–249.

Piper, C.V. 1906. Flora of the State of Washington. Contr. U.S. Natl. Herb 11:1–635.

Saarela, J.M., P.M. Peterson, R.M. Keane, J. Cayouette, and S.W. Graham. 2005. Molecular systematics of *Bromus* (Poaceae: Pooideae) based on chloroplast and nuclear DNA sequence data. Pp. xxx–xxx . In: Columbus, J.T., E.A. Friar, J.M. Porter, L.M. Prince and M.G. Simpson, eds. Monocots: comparative biology and evolution, 2 vols. Rancho Santa Ana Botanic Garden, Claremont, CA. In Press.

Saarela, J.M., P.M. Peterson, and N.F. Refulio-Rodriguez. In review. *Bromus ayacuchensis* (Poaceae: Pooideae: Bromeae), a new species from Peru. Syst. Bot.

Shear, C.L. 1900. A revision of the North American species of *Bromus* occurring north of Mexico. Bull. U.S.D.A. (1895–1901) 23: 1–66.

Smith, P. 1970. Taxonomy and nomenclature of the brome-grasses (*Bromus* L. s. l.). Notes Roy. Bot. Gard. Edinburgh 30:361–375.

Stebbins, G.L., Jr., and R.M. Love. 1941. A cytological study of California forage grasses. Amer. J. Bot. 28:371–382.

Vasey, G. 1885. Some new grasses. Bot. Gaz. 10:223–224.

Wagnon, H.K. 1952. A revision of the genus *Bromus*, section *Bromopsis*, of North America. Brittonia 7:415–480.

Wilken, D.H. and E.L. Painter. 1993. *Bromus*. In: J.C. Hickman, ed., The Jepson manual: higher plants of California. University of California Press, Berkeley. Pp. 1239–1243.

BOOK REVIEW

VIRGINIA D. NAZAREA. 2005. **Heirloom Seeds and Their Keepers: Marginality and Memory in the Conservation of Biological Diversity.** (ISBN 0-8165-2435-1, hbk.). The University of Arizona Press, 355 S. Euclid, Ste. 103, Tucson, AZ 85719, U.S.A. (**Orders:** 520-621-1441, fax 520-621-8899, www.uapress.arizona.edu). $35.00 pbk., $29.95 hbk., 190 pp., 31 b/w, author notes, glossary, index, 6" × 9."

The term "seed savers" refers to those persons who grow traditional, heirloom, or handed-down varieties of fruits, grains or vegetables in personal, family or community gardens. In her book, *Heirloom Seeds and Their Keepers*, author Virginia Nazarea presents an analytical approach concerning of the role of seed savers in the preservation and conservation of plant genetic diversity and cultural practices. Such analyses of this mechanism of biodiversity conservation are very timely given increasing concern over the loss of both crop diversity and tradition agricultural practices. Nazarea uses both metaphors and personal histories collected during research to relate the importance of the seed savers, which in continuing to grow heirloom varieties are preserving cultural heritage, family/locality memories, as well as different plant varieties for potential future use. Alternative species of food crops, such as heirloom varieties, help protect farmers and gardeners from complete loss of specific crops as a result of damage or disease, and are important resources for the future of farming.

The author includes short personal stories of persons met through a variety of different research interviews. These stories put a real face on those persons who participate in seed saving. Often, these seed savers are not intentionally saving seeds as a method of retaining biodiversity, but may be subsistence farmers, collect interesting varieties from the wild, retaining seeds as part of their family history, planting seeds that have been handed down over generations, or preserving plants given to them by friends and neighbors. Often these "seed savers" cultivate plants in a way familiar to their family or region; practices that are dying out as a result of increasing development of commercial farming or highly managed agricultural sites. Other seed savers, may have immigrated to new locations, bringing with them plant species from an ancestral country with unique cultivation practices.

You may think this review glosses the surface of this book, and you are correct. I found the topic of *Heirloom Seeds and Their Keepers* to be very interesting, however it was a very challenging book for me to read. Perhaps the language used in this book is common for books written on topics in anthropology and/or sociology, perhaps others are more familiar with the descriptive phrases used to present research in this book, or maybe the author loves her thesaurus, but the need to decipher many phrases left me feeling as though I may not have gleaned all the information the author was providing. A suggestion I offer other readers is to be sure to take your time in reading this book, and keep a dictionary handy for careful consideration of terms and phrases such as "..decolonization of human consciousness and imagination..," "hermeneutic," "...enigmatic proclivities...," "..texture and serendipity of encounters." If life stories of seed savers preserving cultural memory, &/or an analysis of seed savers in protecting biodiversity interests you, read Nazarea's *Heirloom Seeds and Their Keepers* for yourself.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

TAXONOMIC REVIEW OF *ASTRANTHIUM INTEGRIFOLIUM* (ASTERACEAE: ASTEREAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

Astranthium integrifolium (Michx.) Nutt. has been treated as comprising two taxa (var./subsp. *integrifolium* and var. *triflorum*/subsp. *ciliatum*) or simply as a single species without formal infraspecific designation. The two taxa are completely allopatric and separated by features of vegetative, floral, and cypselar morphology. Consistent with taxonomic ranking of other *Astranthium* species pairs, these two taxa are treated here at specific rank: *Astranthium integrifolium* sensu stricto and **Astranthium ciliatum** (Raf.) Nesom, comb. nov. A neotype is selected for *Bellis ciliata* var. *triflora* Raf. (= *A. ciliatum*).

RESUMEN

Astranthium integrifolium (Michx.) Nutt. se ha tratado comprendiendo dos taxa (var./subsp. *integrifolium* y var. *triflorum*/subsp. *ciliatum*) o simplemente como una sola especie sin designación formal infraespecífica. Los dos taxa son completamente alopátricos y se separan por la morfología vegetativa, floral, y de la cipsela. De acuerdo con el rango taxonómico de otros pares de especies de *Astranthium*, estos dos taxa se tratan aquí con rango específico: *Astranthium integrifolium* sensu stricto y **Astranthium ciliatum** (Raf.) Nesom, comb. nov. Se selecciona un neotipo para *Bellis ciliata* var. *triflora* Raf. (= *A. ciliatum*).

The genus *Astranthium* Nutt. includes 12 species (De Jong 1965), all but three of them restricted to Mexico. *Astranthium integrifolium* (Michx.) Nutt. occurs in northeastern Mexico, but its range is mostly in the central U.S.A. Larsen (1933) and De Jong (1965) treated eastern and western population systems of *A. integrifolium* (Fig. 1) as var. *integrifolium* and var. *ciliatum* (Raf.) Larsen, respectively, or as subsp. *integrifolium* and subsp. *triflorum* (Raf.) De Jong. Shinners (1950) added a third taxon at varietal rank, *A. integrifolium* var. *robustum* Shinners, which subsequently was raised to specific rank by De Jong (1965). Since De Jong's treatment, Texas botanists have maintained *A. robustum* (Shinners) De Jong as a Texas endemic (Fig. 1), but the taxonomy of the more broadly distributed *A. integrifolium* sensu lato has not been critically reevaluated. De Jong's geographic and morphological delimitation of the '*integrifolium* complex' has been accepted in national checklists (e.g., Kartesz 1999), but Cronquist (1980) treated both geographic segments as *A. integrifolium* without formal recognition of infraspecific taxa. Other floristic accounts have dealt

SIDA 21(4): 2015–2021. 2005

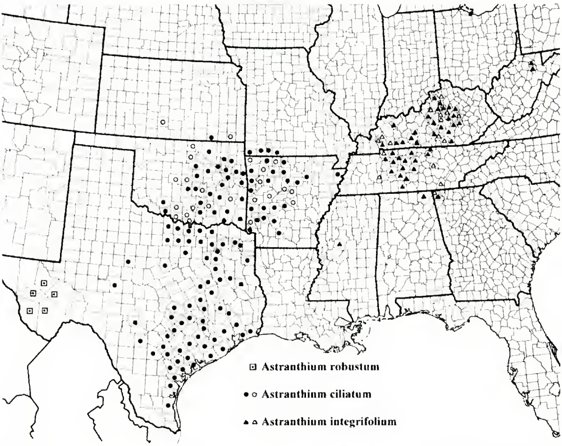


Fig. 1. Geographic distribution of *Astranthium integrifolium*, *A. ciliatum*, and *A. robustum*. Squares and solid circles and triangles are from specimens at KY, MO, SMU-BRIT, TEX-LL, and VDB. Open symbols are from published sources (De Jong 1965; Chester et al. 1997; Great Plains Flora Association 1977; Smith 1988; USDA, NRCS 2001). Populations of *A. ciliatum* also occur in Mexico (Nuevo León and Tamaulipas).

with only one or the other of the two taxa. Accounts for Oklahoma and Arkansas (e.g., Taylor & Taylor 1994; Smith 1994) also have referred to *A. integrifolium* without finer taxonomic distinction, while those for Texas and the Great Plains have recognized infraspecific variants (e.g., Correll & Johnston 1970; Barkley 1986; Diggs et al. 1999).

A reevaluation of *Astranthium integrifolium* sensu lato indicates that the two previously recognized geographic segments are allopatric and distinguished by vegetative, floral, and cypselar features. Consistent with taxonomic ranks of other *Astranthium* species (see comments below), the two taxa are treated here at specific rank.

TAXONOMY

1. Astranthium ciliatum (Raf.) Nesom, comb. nov. *Bellis ciliata* Raf., New Fl. N. Amer. 2:24. 1837. *Astranthium integrifolium* (Michx.) Nutt. var. *ciliatum* (Raf.) Larsen, Ann. Missouri Bot. Gard. 20:35. 1933. *Astranthium integrifolium* (Michx.) Nutt. subsp. *ciliatum* (Raf.) De Jong, Michigan State Univ. Mus. Publ. Biol. Ser. 2:504. 1965. Lectotype (De Jong 1965): USA.

TEXAS. AUSTIN CO.: San Felipe de Austin, 1835, *T. Drummond II. 221* (NY website photo!, as "*Bellis integrifolia* Michx."; ISOLECTOTYPES: K, NY, P, PH).

Bellis ciliata Raf. var. *triflora* Raf., New Fl. N. Amer. 2:25. 1837. *Astranthium integrifolium* (Michx.) Nutt. var. *triflorum* (Raf.) Shinners, Sida 2:348. 1966. NEOTYPE (selected here): USA. TEXAS. Fannin Co., 4 mi N of Bonham, sandy ditch bank, 10 Jun 1945, *L.H. Shinners 7842* (SMU!).

Rafinesque noted that "it [presumably '*Bellis ciliata*'] has also a var. *triflora*, with leaves all acutish and only 3 [ray] flowers. The folioles of the perianthe are lanceolate acuminate in all the sp. not linear as Hooker says, the seeds are obovate pubescent." Because Rafinesque noted that his new species, *Bellis ciliata*, occurs "in Texas and probably extending to Louisiana and Arkansas," it seems reasonable to infer that *Bellis ciliata* var. *triflora* also was based on a Texas collection, perhaps from Drummond, whose collections provided the basis for the description of *B. ciliata*. De Jong (1965) also made this inference in noting that the type locality of var. *triflora* was "Texas." Rafinesque, however, provided no indication of the type, and no type material of var. *triflora* has been found or cited in previous literature.

Small capitula with relatively few and small ray florets are commonly produced late in the season in *Astranthium integrifolium* and *A. ciliatum*, but I have seen no plants with fewer than six florets. Plants of the neotype were described as producing 6–8 ray florets. It seems likely that the capitulum observed and described by Rafinesque had lost several ray florets during collecting, mounting, or handling.

Astranthium integrifolium (Michx.) Nutt. var. *rosulatum* Larsen, Ann. Missouri Bot. Gard. 20:36. 1933. TYPE: UNITED STATES. TEXAS. Matagorda Co.: Matagorda, sandy prairies, 5 Mar 1914, *E.J. Palmer 4855* (HOLOTYPE: MO!). Shinners (1950) accurately noted that the presence of rosulate clusters of leaves reflects early growth stages of a single plant.

2. Astranthium integrifolium (Michx.) Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:312. 1841. *Bellis integrifolia* Michx., Fl. Bor. Amer. 2:131. 1803. TYPE: UNITED STATES. [TENNESSEE] "Cumberland," *A. Michaux s.n.* (HOLOTYPE: P, fide De Jong 1965). De Jong (pp. 434–435) inferred from historical accounts that Michaux probably made the collection in June 1795 in the vicinity of Nashville. Michaux himself (1803) noted that the species occurred "ad ripas rivulorum et in collibus umbrosis Tennassée." "Cumberland" is the only geographic reference on the holotype.

Distinctions between *Astranthium integrifolium* and *A. ciliatum* are in the following contrasts.

Plants fibrous-rooted; basal and lower cauline leaves 3–6 cm long × 7–22 mm wide; involucres 3.5–6 mm high; ray corollas (6–)8–17 mm long; cypselae (1.4–)1.6–2 (–2.2) mm long × 0.9–1.1 mm wide, surface minutely papillate-pebbly with linear striations barely discernible, glabrous or sometimes sparsely glochidiate-pubescent near the apex, or (in northern Kentucky and West Virginia) glochidiate-pubescent over the whole surface ______ **Astranthium integrifolium**

Plants slender-taprooted, rarely fibrous-rooted; basal and lower cauline leaves 1.5–4 (–5) cm long × 3–11(–14) mm wide; involucres (2–)2.5–4.5 mm high; ray corollas (4–)6–10(–12) mm long; cypselae 1–1.6 mm long × 0.6–0.8 mm wide, surface with minute longitudinal striae but otherwise nearly smooth, not papillate-pebbly, sparsely to densely glochidiate-pubescent from base to apex ______ **Astranthium ciliatum**

The morphological distinction of *Astranthium integrifolium* and *A. ciliatum* corresponds with their geography, as mapped in Figure 1. The two are essentially completely separate in distribution: *A. ciliatum* occurs west of the Mississippi

River, *A. integrifolium* to the east. The disjunct outlier in Holmes Co., Mississippi (*Woodson and Anderson 1555*, MO!), is typical *A. integrifolium*; the outlier in Mississippi Co., Arkansas (*Pyle 669*, TEX!), is typical *A. ciliatum*.

Astranthium integrifolium was first reported for West Virginia by Duppstadt (1992), without citation of vouchers. Details are given below. The limited, disjunct distribution and the occurrence primarily along roadsides suggest that this extended population system might be of recent origin, perhaps by accidental dispersal from Kentucky, but the habitats appear to be otherwise natural.

Collections examined. **WEST VIRGINIA. Barbour Co.:** along Pleasant Creek Public Hunting Area road, extending 1.5 mi, both sides of road into Taylor Co., 26 May 1991, *Bush s.n.* (WVA); Pleasant Creek Hunting & Fishing Area, roadside, 6 Jun 1991, *Clarkson s.n.* (WVA); along Co. Road 10, between Hwy 119 and Tygart Lake, N side of Pleasant Creek in Pleasant Creek Public Hunting Area; area of *Prunus, Liriodendron, Acer, Cornus,* and *Crataegus*, with much invasive *Rosa multiflora* and *Lonicera maackii*; *Astranthium* locally abundant in grassy habitats on roadsides, roadbanks, and adjacent fields, 3 Jun 2002, *Nesom FW154* (BRIT, GH, KY, NCU, OS, TENN, TEX, UARK, US, WVA). **Taylor Co.:** along Pleasant Creek Public Hunting Area road, extending 1.5 mi, both sides of road into Barbour Co., 2 Jun 1991, *Baer s.n.* (WVA).

DISCUSSION

De Jong (1965, p. 510) observed that "The two subspecies [of *Astranthium integrifolium*] are separated from one another by quantitative characters and may be recognized throughout their respective ranges. The occasional failure of a single character is compensated for by other characters. The key differences between the two subspecies hold true when they are grown in the greenhouse under uniform conditions." Nevertheless, De Jong noted that in Arkansas, subsp. *ciliatum* "overlaps" and "hybridizes" with subsp. *integrifolium* (p. 474 and p. 505). "The number of specimens which are thought to be putative hybrids is relatively numerous, but not enough specimens are available from different localities to assess the pattern of variation accurately" (p. 511). "The recognition of subspecies rather than varieties is prompted by the considerable ranges of subsp. *integrifolium* and subsp. *ciliatum* and the relatively narrow zone of intergradation" (p. 510).

Intergrades between *Astranthium integrifolium* and *A. ciliatum* were cited by De Jong (1965) from Arkansas (e.g., *Demaree 16912*-SMU!, *Harvey 45*-MO!, SMU!, *Engelmann 129*-MO!), Oklahoma (not seen), and Missouri (e.g., *Bush 7534*-MO!, *Steyermark 22642*-MO!). He did not specify the nature of the intergradation, but from sheets annotated by him, it can be inferred that this was primarily an interpretation of root morphology and general vigor (stem height and leaf size). The 'intergrades' cited from these states (all within the range of *A. ciliatum*, as recognized here) tend to be fibrous-rooted rather than taprooted, but rare plants from Texas (e.g., Gonzales Co., *Turner 3711*-SMU; Harrison Co., *Orr 182*-SMU) also are weakly fibrous-rooted; all of these are interpreted here as population variants rather than intergrades, because they belong with *A. ciliatum* in involucral height, ray corolla length, and especially in cypselar size, surface morphology, and vestiture. The same is true for two Arkansas collections cited by De Jong as *A. integrifolium* subsp. *integrifolium* (Hot Springs Co., *Soulard s.n.*-MO!; Washington Co., *Harvey s.n.*-MO!) and for Missouri collections annotated as "aff. subsp. *integrifolium*" (e.g., *Palmer 39297*-MO!, *Palmer 39483*-MO!, *Steyermark 10393*-MO!). Some Arkansas collections cited by De Jong as intermediate between the subspecies were annotated by him simply as "*A. integrifolium* subsp. *ciliatum*" (e.g., *Bush 929*-MO!, *Palmer 5992*-MO!).

Robust plants of *Astranthium ciliatum* are similar in habit to *A. integrifolium*, and depauperate plants of *A. integrifolium* are similar in habit to *A. ciliatum*. The Arkansas collections interpreted by De Jong as "subsp. *integrifolium*" or as reflecting hybridization were made around Hot Springs (Hot Springs Co.) and Fayetteville (Washington Co.). These plants are generally taller than average for the species (up to 32 cm tall) and have leaves that range larger, and some have fibrous roots, but in involucral size, ray length, and cypselar morphology, they belong with *A. ciliatum*. Cypselae of plants from Arkansas and Missouri also range longer (1.1–1.6 mm) than in Texas and Oklahoma (1–1.2 mm). Whether the larger sizes of these plants might reflect convergence or an ancestral similarity with *A. integrifolium* sensu stricto is not clear. Even though various features overlap in variation, features of cypselar morphology (vestiture and epidermal surface) provide consistent distinction between the two taxa, especially with recognition of the disjunction in their geographic ranges, and I have not seen any plant that could be regarded as intermediate.

In summary, the present study finds that there is no unequivocal evidence for hybridization between plants of *Astranthium integrifolium* and *A. ciliatum*. In fact, their allopatric distribution allows no opportunity for genetic interchange, and differences in cypselar morphology suggest that isolation is complete.

CONSISTENCY IN TAXONOMIC RANK

Morphological distinctions between *Astranthium integrifolium* and *A. ciliatum* are relatively small, but their pattern of relationship and treatment at specific rank are analogous and consistent with the taxonomy of species pairs (as recognized by De Jong 1965) of *Astranthium* found in Mexico. The two are essentially identical in chromosome number ($2n = 8$) and chromosome morphology (De Jong 1965). Their northern distributions and morphological similarity suggest that they have an evolutionary sister relationship. De Jong (p. 523) noted that *A. robustum* ($2n = 6$) "is related to *A. integrifolium*" ... but "the species also shows resemblance to *A. condimentum* and *A. orthopodum* and has the same chromosome number and karyotype as these two species."

The relationship of *Astranthium orthopodum* (B.L. Rob.) E. Larsen and *A.*

condimentum De Jong parallels that of *A. integrifolium* and *A. ciliatum*. They are similar to each other in chromosome number ($2n = 6$) and chromosome morphology and probably are evolutionary sister taxa. Each has a substantial geographic range, but they are allopatric in distribution. They are morphologically separated primarily on the basis of root characters: plants of *A. condimentum* are annuals from a slender taproot; plants of *A. orthopodum* are biennials or short-lived perennials from a fibrous-rooted caudex, sometimes with short rhizomes or basal offsets. Additionally, there are small and overlapping differences in stem orientation and leaf shape and size.

Astranthium splendens De Jong ($2n = 18$) and *A. beamanii* De Jong ($2n = 24$) both apparently have a base chromosome number of $x = 3$ and also probably are evolutionary sister taxa. They are sympatric but grow at different elevations and are otherwise distinguished on the basis of cypselar vestiture (and apparently nothing else): cypselae of *A. splendens* are glochidiate-hairy over the whole surface while those of *A. beamanii* are glabrous or sparsely glochidiate-hairy only near the apex.

ACKNOWLEDGMENTS

Loans of specimens from KY, MO, WKU, and WVA, help of TEX-LL staff during a recent visit, help from Donna Ford-Werntz (WVA) and Bill Grafton in the investigation of the West Virginia plants, and review comments of George Yatskievych are gratefully acknowledged.

REFERENCES

Barkley, T.M. 1986. *Astranthium*. In: Great Plains Flora Association. Flora of the Great Plains. Univ. Press of Kansas, Lawrence. P. 886.

Chester, E.W., B.E. Wofford, and R. Kral. 1997. Atlas of Tennessee vascular plants. Volume 2. Angiosperms: Dicots. Misc. Publ. 13, Center for Field Biology, Austin Peay State University, Clarksville, TN.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Cronquist, A. 1980. Vascular flora of the southeastern United States, Vol. I. Asteraceae. Univ. of North Carolina Press, Chapel Hill.

De Jong, D.C.D. 1965. A systematic study of the genus *Astranthium* (Compositae, Asteraeae). Michigan State Univ. Mus. Publ. Biol. Ser. 2:429–528.

Diggs, G.M., Jr., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners and Mahler's illustrated flora of north central Texas. Sida, Bot. Misc. No. 16.

Duppstadt, W.H. 1992. Updates on the vascular flora of West Virginia: 8. Proc. West Virginia Acad. Sci. 64:15.

Great Plains Flora Association . 1976. Atlas of the flora of the Great Plains. Iowa State University Press, Ames.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. In: Kartesz, J.T. and C.A. Meacham. Synthesis of the North American Flora, North Carolina Botanical Garden, Chapel Hill.

Larsen, E.L. 1933. *Astranthium* and related genera. Ann. Missouri Bot. Gard. 20:23–44.

Michaux, A. 1803. Flora Boreali-Americana. Levrault, Paris.

Shinners, L.H. 1950. Notes on Texas Compositae–VI. Field & Lab. 18:156–159.

Smith, E.B. 1988. An atlas and annotated list of the vascular plants of Arkansas (ed. 2). Dept. of Botany & Microbiology, Univ. of Arkansas, Fayetteville.

Smith, E.B. 1994. Keys to the flora of Arkansas. Univ. of Arkansas Press, Fayetteville.

Taylor, R.J. and C.E.S. Taylor. 1994. An annotated list of the ferns, fern allies, gymnosperms and flowering plants of Oklahoma (ed. 3). Biology Dept. Herbarium, Southeastern Oklahoma State Univ., Durant.

USDA, NRCS. 2001. The Plants Database, Version 3.1 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490, USA. <accessed November 2001>

BOOK REVIEW

LYNNE RICHARDS and RONALD J. TYRL. 2005. **Dyes from American Native Plants: A Practical Guide.** (ISBN 0-88192-668-X, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $29.95, 340 pp., 155 color photos, 6" × 9".

This book covers 158 natural dye plants that are native to the continental US. Introductory chapters cover the history of natural dyes, natural dyeing processes, and supplies needed to use natural dyes at home.

The authors tested 158 native dye plants using five different mordants and two different dyeing processes. The results are carefully catalogued in seven detailed chapters arranged by color: purple, red, green, yellow, orange, brown, and black. Each chapter includes a table of dye plants, dye process, mordant, and the color produced, along with chips of each color.

A field guide at the end of the book includes color photographs of live plants, common and scientific names, and a short description of each plant included in the book. This guidebook to natural dyes is an excellent reference book for economic botanists, textile artists, and crafters interested in natural dyes.—*Marissa Oppel, Herbarium Assistant, Botanical Research Institute of Texas, Fort Worth, TX, 76012-4060, U.S.A.*

STUDIES OF NEOTROPICAL COMPOSITAE—I. NOVELTIES IN *CALEA*, *CLIBADIUM*, *CONYZA*, *LLERASIA*, AND *PLUCHEA*

John F. Pruski

Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166-0299, U.S.A.

ABSTRACT

The combinations **Calea mediterranea** (Vell.) Pruski (syn.: *Calea platylepis*) and **Calea triantha** (Vell.) Pruski, (syn.: *Calea hispida*) (Heliantheae) are proposed for two species lectotypified herein by Velloso illustrations. A lectotype of *Meyeria hispida* DC. is designated. A key to the species centering about *Calea myrtifolia* is given. **Clibadium arriagadae** Pruski (Heliantheae) from Ecuador is named as a new segregate of *Clibadium pentaneuron*. *Clibadium arriagadae* is the same taxon as represented by the invalid *Clibadium zakii*. *Clibadium arriagadae* differs from *C. pentaneuron* by leaf blades palmately 3- or 5-veined from or near base (vs. subpalmately or plinerved from above blade base) and hirsute (vs. strigose) abaxially. A lectotype (BM-CLIFF folio page 405, *Conyza* 3) is designated for *Conyza bifrons* L. (= *Inula bifrons* L., Inuleae), and this name, once misapplied to an American species of *Pluchea*, is excluded from the flora of the New World. The combination **Conyza popayanensis** (Hieron.) Pruski (Astereae), replacing the illegitimate *Conyza uliginosa* (Benth.) Cuatr., non. Pers., is proposed. The combination **Llerasia macrocephala** (Rusby) Pruski (Astereae) is validated for a Bolivian species originally described in tribe Mutisieae, and *Llerasia lucidula* is treated as a synonym of *L. macrocephala*. Philip Miller's *Conyza baccharis* is lectotypified and is an earlier name for *Pluchea rosea*. The combination **Pluchea baccharis** (Mill.) Pruski (Plucheeae) is made for this coastal plain species, which occurs from eastern North America southward into Nicaragua.

RESUMEN

Se proponen las combinaciones **Calea mediterranea** (Vell.) Pruski (syn.: *Calea platylepis*) y **Calea triantha** (Vell.) Pruski, (sin.: *Calea hispida*) (Heliantheae) para dos especies que se lectotipifican aquí mediante ilustraciones de Velloso. Se designa un lectotipo para *Meyeria hispida* DC. Se ofrece una clave para las especies próximas a *Calea myrtifolia*. **Clibadium arriagadae** Pruski (Heliantheae) de Ecuador se nombra como un nuevo segregado de *Clibadium pentaneuron*. *Clibadium arriagadae* es el mismo taxon representado por el nombre inválido *Clibadium zakii*. *Clibadium arriagadae* difiere de *C. pentaneuron* por los limbos de las hojas palmatinervias con 3 ó 5 nervios desde de la base o cerca (vs. subpalmatinervias o triplinervias desde más arriba de la base) e hirsutas (vs. estrigosas) abaxialmente. Se designa un lectotipo (BM-CLIFF folio página 405, *Conyza* 3) para *Conyza bifrons* L. (= *Inula bifrons* L., Inuleae), y este nombre, por haberse aplicado a una especie americana de *Pluchea*, se excluye de la flora del Nuevo Mundo. Se propone la combinación **Conyza popayanensis** (Hieron.) Pruski (Astereae), para reemplazar a la ilegítima *Conyza uliginosa* (Benth.) Cuatr., non. Pers. Se valida la combinación **Llerasia macrocephala** (Rusby) Pruski (Astereae) para una especie de Bolivia descrita originalmente en la tribu Mutisieae, y *Llerasia lucidula* se trata como un sinónimo de *L. macrocephala*. *Conyza baccharis* de Philip Miller se lectotipifica y es un nombre anterior para *Pluchea rosea*. Se hace la combinación **Pluchea baccharis** (Mill.) Pruski (Plucheeae) para esta especie de la llanura costera, que aparece desde el Este de Norte América hasta Nicaragua en el Sur.

SIDA 21(4): 2023–2037. 2005

The purpose of this note is to validate names in *Calea* L., *Clibadium* F. Allam. ex L., *Conyza* Less., *Llerasia* Triana, and *Pluchea* Cass. needed in various floristic works of Neotropical Compositae being done at the Missouri Botanical Garden, and to lectotypify *Conyza bifrons* L., which is excluded from the flora of the Americas.

CALEA

Jose Velloso prepared *Flora fluminensis*, a landmark flora for the environs of Rio de Janeiro, Brazil in 1790, but died in 1811 prior to its publication. The text was printed in 1825 (Velloso 1825) and distributed in 1829. The text, however, remains incomplete, treating species corresponding to icones published only in volumes 1–8 (8 pro parte). No text is available for species illustrated volume 8 (pro parte), nor for those in volumes 9–11. The Compositae comprise all of volume 8 and part of volume 10, but text is available for about only the first half of the 164 icones (Velloso 1827) published in volume 8. The 11 volumes of figures are dated 1827 (Velloso 1827), but were distributed only in 1831. Thus, 1831 is taken as the date of validation of species represented only by these diagnostic icones, but without corresponding text. It is the plates of two such Velloso names (**Figs. 1 & 2**) that are clearly identifiable with two South American species of *Calea* (Heliantheae; syn. Neurolaeneae), new combinations for which are made below. No type specimens of these two names are known to exist, and consequently the illustrations are designated as the lectotypes.

Calea mediterranea (Vell.) Pruski, comb. nov. (**Fig. 1**). *Buphthalmum mediterraneum* Vell., Fl. Flumin. (Icones) 8. t. 135. 1827 [1831]. LECTOTYPE (designated here): t 135, Vell., Fl Flumin. (Icones) 8. 1827 [1831].

Calea platylepis Schultz-Bip. ex Baker in Martius, Fl. bras. 6(3):267. 1884. Lectotypification from among the dozen or so syntypes is deferred

Distribution and ecology.—*Calea mediterranea* (Vell.) Pruski is a xylopodial subshrub flowering from October to April. It occurs in the Brazilian planalto southwards into Paraguay and northern Argentina.

Calea mediterranea is a member of *Calea* sect. *Haplocalea* (Less.) Pruski (Pruski 1998 sub *Calea platylepis*), and is closely related to *C. cymosa* Less., the type of the section. This section is characterized by generally whorled leaves and umbelliform capitulescences. *Calea mediterranea* differs from *C. cymosa* Less. by narrower, pubescent, pinnately veined (vs. broader, nearly glabrous, 3- or 5-plinerved) leaves and by lanceolate, pubescent (vs. ovate, glabrous) outer phyllaries. Additionally, the lower most whorl of leaves in *C. mediterranea* is often reduced, as illustrated by Velloso (1827), a feature not typical of *C. cymosa*. The radiate capitula of *C. mediterranea* and *C. cymosa* distinguish each of them from the otherwise closely related *C. hassleriana* Chod. and *C. reticulata* Gardner (syn. *Ichthyothere ternifolia* Baker), which have discoid capitula.

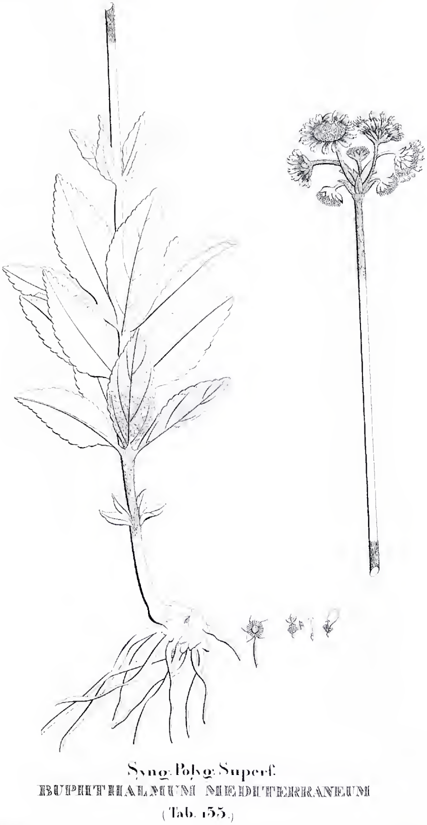


Fig. 1. Lectotype of *Buphthalmum mediterraneum* Vell. [= *Calea mediterranea* (Vell.) Pruski], from Velloso, Fl. Flumin. (Icones) 8: t. 135. 1827 [1831].

Fig. 2. Lectotype of *Aster trianthus* Vell. [≡ *Calea triantha* (Vell.) Pruski], from Velloso, Fl. Flumin. (Icones) 8: t. 120. 1827 [1831].

Calea triantha (Vell.) Pruski, comb. nov. (**Fig. 2**). *Aster trianthus* Vell., Fl. Flumin. (Icones) 8: t. 120. 1827 [1831]. LECTOTYPE (designated here): t. 120, Vell., Fl. Flumin. (Icones) 8. 1827 [1831].

Meyeria hispida DC., Prod. 5:671. 1836. *Calea hispida* (DC.) Baker in Martius, Fl. Bras. 6(3):261. 1884. LECTOTYPE (chosen here from among syntypes): BRAZIL: SÃO PAULO, campis editis, Nov. 1833, *Lund 866* (LECTOTYPE: G-DC [IDC microfiche 800. 975.III.3]; ISOLECTOTYPES: C-4, S). The G-DC lectotype also has a small twig of *H. Imp. Bras. 405* mounted to the lower right of the Lund collection. [Lectoparatype: *Herb. Imperial Brasil* (probably *Vauthier*) *405*: G-DC (fragment of a sheet from P), F (fragment of a sheet from P), P-2.]

Distribution and ecology.—*Calea triantha* (Vell.) Pruski is a subshrub to shrub endemic to Brazil, where it is centered in the state of Paraná. It is known to flower from December to April.

Calea triantha is one of 13 species of the *C. myrtifolia* DC. species group (sensu Pruski 1984; Pruski & Urbatsch 1988) of *Calea* section *Meyeria* (DC.) Benth. & Hook.f. Pruski and Urbatsch (1988) provided a key to the then-known members of this group. Their key is revised herein, incorporating the above new synonymy and *C. semirii* Pruski & Hind, which was described subsequently (Pruski & Hind 1998).

KEY TO THE SPECIES CENTERING ABOUT *CALEA MYRTIFOLIA* (*CALEA* SECT. *MEYERIA*)

1. Leaves glabrous, entire, margins thickened (São Paulo and Paraná, Brazil) ___ **Calea marginata** S.F. Blake
1. Leaves glabrous to hispid, entire to serrate, margins not thickened.
    2. Leaves lanceolate, ca. 6–12 cm long, venation parallel, ca. 3–7-veined (Goias, Brazil) ___ **Calea nervosa** Barroso
    2. Leaves lanceolate to cordate, less than 6.5 cm long, venation pinnate to trinervate.
        3. Capitula one per branch.
            4. Leaves lanceolate-elliptic, foveolate below (São Paulo and Paraná, Brazil) ___ **Calea parvifolia** (DC.) Baker
            4. Leaves elliptic-ovate, smooth below.
                5. Peduncle ca. 8–15 cm long (Paraná and Santa Catarina, Brazil) ___ **Calea ilienii** Malme
                5. Peduncle ca. 1.5–6 cm long (Paraná, Brazil) ___ **Calea monocephala** Dusén
        3. Capitulescence cymose.
            6. Leaves whorled.
                7. Leaves generally four per node, essentially sessile, smooth, pinnate; peduncles 3–15 cm long; ray corolla limb 5–13-nerved; outer phyllaries and leaves green below; pappus scales subequal in length (Distrito Federal and Goias, Brazil) ___ **Calea quadrifolia** Pruski & Urbatsch
                7. Leaves generally three per node, shortly petiolate, rugulose, trinervate; peduncles 0.5–6 cm long; ray corolla limb 5-nerved; outer phyllaries and leaves rust-colored below, less commonly green; pappus scales slightly to greatly unequal in length (Minas Gerais, Brazil).
                    8. Leaves adaxially glabrous or nearly so; involucres campanulate to hemispherical; outermost phyllaries at least apically herbaceous, about as long as the next series; ray corollas yellow, tube 2.7–3.5 mm long, limb 12–14.5 mm long, commonly abaxially glandular; disk

corolla tube shorter than the throat; cypselae 2.5–3.2 mm long, with 1–3 pappus scales often much longer than the others ____ **Calea heteropappa** Pruski & Urbatsch

8. Leaves adaxially hispidulous to sparsely pilose; involucres turbinate to cylindrical; outermost phyllaries mostly scarious, usually much shorter than the next series; ray corollas pale yellow, tube 3.6–4.5 mm long, limb 7–8.5 mm long, abaxially eglandular; disk corolla tube about as-long-as the throat; cypselae 3.8–4.8 mm long, pappus scales generally slightly unequal ____ **Calea semirii** Pruski & Hind

6. Leaves opposite.
   9. Leaves ovate, hispidulous to hispid, serrate, basally cordate, usually shorter than 2.5 cm (Minas Gerais south to Santa Catarina, Brazil; syn. nov. *Calea hispida*) ____ **Calea triantha** (Vell.) Pruski
   9. Leaves elliptic to elliptic-ovate, glabrous to pubescent, entire to serrate, basally cuneate, longer than 2.5 cm.
      10. Leaves to 3.5 cm wide, shiny, serrate, glabrous; foliaceous outer phyllaries serrulate (Paraguay) ____ **Calea chodatii** Hassler
      10. Leaves less than 2.5 cm wide, somewhat shiny or not, entire to serrulate, glandular or puberulent; foliaceous outer phyllaries entire.
          11. Leaves narrowly elliptic; capitula ca. 65-flowered; ray corolla limb 8–10-nerved; disk corolla lobes longer than 1.5 mm; cypselae glabrous (Rio Grande do Sul, Brazil and Uruguay) ____ **Calea kristiniae** Pruski
          11. Leaves elliptic to broadly elliptic; capitula ca. 35-flowered; ray corolla limb 5(–7)-nerved; disk corolla lobes shorter than 1.5 mm; cypselae pubescent on angles.
              12. Leaves entire, ca. 1.5 cm wide (Minas Gerais south to Rio Grande do Sul, Brazil) ____ **Calea myrtifolia** (DC.) Baker
              12. Leaves serrulate, to ca. 2.5 cm wide (coastal São Paulo south to Rio Grande do Sul, Brazil) ____ **Calea phyllolepis** Baker

CLIBADIUM

Arriagada (1995) provided an overview of *Clibadium* (Compositae: Heliantheae), including full synonymy and a key to species. In this overview, Arriagada reduced to synonymy all four northern South American names of *Clibadium* proposed by Robinson (1992). A monograph of *Clibadium* has now been published (Arriagada 2003), and again all names in *Clibadium* proposed by Robinson (1992) are listed as synonyms. I agree with Arriagada (1995, 2003) that *C. pentaneuron* S.F. Blake includes the synonymous *C. funkiae* H. Rob.; *C. laxum* S.F. Blake includes *C. alatum* H. Rob.; and *C. glabrescens* S.F. Blake includes *C. napoense* H. Rob. Thus, three validly described species in Robinson (1992) are encompassed within more widespread taxa, these originally described by Blake in the 1920s and 1930s. A fourth name (*C. zakii*) in Robinson (1992) was based on *Zak & Jaramillo 2881* (MO, US) but without "the single herbarium" housing the holotype being "specified." This name is consequently invalid (Art. 37.6 of the Code, Greuter et al. 2000) and does not exist nomenclaturally. This plant belonging to *Clibadium* section *Clibadium* is validated here with a new type collection and a new epithet honoring my friend Dr. Jorge Arriagada, the monographer of the genus.

Clibadium arriagadae Pruski, sp. nov. (**Fig. 3**). TYPE: ECUADOR. COTOPAXI: road between Quevedo & Lacacunga, 76 km E of Quevedo, 0°57'S, 79°01'W, 2300 m, 5 Apr 1983, *Croat 55804* (HOLOTYPE: MO; ISOTYPE: QCNE).

A *C. pentaneuron* affinis, sed laminae palmativenosae (non subpalmativenosae vel pinnativenosae), rotundata vel truncata (non cuneata), et subtus hirsuta (non strigosa) diversa.

Shrubs to ca. 2 m tall; stems sometimes vining, subterete to subhexagonal, hirsutulous. **Leaves** simple, opposite, petiolate; petioles 0.8–3.5 cm long, hirsute; blades broadly ovate, 4–15.5 cm long, 2–11 cm wide, stiffly chartaceous, palmately 3- or 5-veined from or near base, secondary and tertiary reticulation prominent, base rounded to truncate, margins serrulate, apex acute to acuminate, the adaxial surface scabrid, hirsutulous, the abaxial surface hirsute, eglandular. **Capitulescence** terminal, many-headed, loosely corymbiform paniculate, branches 2–14 cm long, hirsute, ultimate branching trichotomous. **Capitula** 10–12-flowered, disciform, shortly pedunculate, 4–5 mm tall; involucre hemispherical; phyllaries ca. 3-seriate, subequal to weakly graduated, stiffly chartaceous, weakly 3–5-veined adaxially, apically hirsutulous, otherwise glabrous, to ca. 4.5 mm long, 2–2.5 mm wide, outer ones pyriform, apically acute to acuminate, mid-series and inner ones ovate, apically obtuse to rounded; receptacle convex-conical, to ca. 1 mm broad, weakly paleate; paleae lanceolate, to ca. 3 mm long, weakly conduplicate; peduncles 1–2 mm long, terete, glabrous to hirsutulous, one-bracteolate, bracteole lanceolate, 1–2 mm long, hirsute. **Marginal florets** uniseriate, pistillate, 5 or 6, mostly included within involucre; corolla ca. 2 mm long, tubular, cream-colored, apically pilosulose with non-glandular trichomes, minutely ca. 3-lobed, style branches ca. 1 mm long, weakly exserted. **Disk florets** functionally staminate, 5 or 6, mostly included within involucre; corolla broadly funnelform, ca. 2.5 mm long, cream-colored, 5-lobed, lobes deltoid, erect, 0.5–0.9 mm long, pilosulose with non-glandular trichomes; anthers generally included, to ca. 1.7 mm long, dark greenish to black, appendage elongated but not greatly sculptured, basally short-sagittate, filaments ca. 0.3 mm long; style undivided, apex often exserted from corolla; ovary rudimentary. **Cypselae** oblong, flattened, 2–2.5 mm long, apically papillose, otherwise glabrous or nearly so, epappose.

PARATYPE: ECUADOR. BOLÍVAR: Carretera Chillanes-Bucay, en la hacienda "Tiquibuso" del Sr. Gonzalo Gómez, 1°55' S, 79°05' W, 2100 m, 10 Sep 1987, *Zak & Jaramillo 2881* (F, MO, US).

Distribution and ecology.—This species is known only from the Pacific drainage slopes of the Andes in Bolívar and Cotopaxi, Ecuador. It has been collected in flower in April and September from 2100–2300 meters elevation.

Clibadium arriagadae differs from *C. pentaneuron* by leaf blades mostly palmately 3- or 5-veined from or near base (vs. subpalmately or plinerved from

FIG. 3. *Clibadium arriagadae* Pruski. Above: Branches of capitulescence showing patent (not strigose) indumentum. Below: Abaxial surface of leaf showing trinerved venation from very base of blade. (Photographs of the holotype, *Croat 55804*, MO).

well above blade base), these rounded (vs. cuneate) basally and hirsute (vs. strigose) abaxially. The types of the *C. funkiae* H. Rob., *C. pileorubrum* Cuatrec., *C. sarmentosum* Cuatrec., and *C. scandens* Cuatrec. each have leaves strigose abaxially and these four names are accepted as synonyms of *C. pentaneuron*, as proposed by Arriagada (1995, 2003). The stems of *C. arriagadae* are hirsutulous throughout, thus differing from those of *C. pentaneuron* (Ecuador and Colombia), which are sometimes strigose.

Arriagada (1995, 2003) reduced *C. funkiae* (Antioquia, Colombia) to synonymy of *C. pentaneuron*. At one point, I thought that the prominent resin ducts in the phyllaries some material from Antioquia and in *Forero et al. 2279* (MO; Chocó, Colombia near border with the northern limits of Valle, Colombia) could be used to distinguish this material from the generally more southern *C. pentaneuron*. However, the collection from Chocó is near the center of distribution of *C. pentaneuron*, and other material of *C. pentaneuron* from Antioquia lacks the prominent phyllary resin ducts. Thus, there seems to be no meaningful morphological features that one could use to split the Colombia material of *C. pentaneuron* into more than a single taxon. Indeed, this was the observation of Arriagada (1995, 2003), the monographer who reduced *C. funkiae* to synonymy. Moreover, no case for geographic separation of *C. funkiae* as distinct from *C. pentaneuron* can be made. Thus, I recognize *C. pentaneuron* in a slightly narrower concept than does Arriagada (1995, 2003), and segregate only *Clibadium arriagadae* from it.

The morphological distinctions among relatives of *C. pentaneuron* are provided below in the key to species, which modifies couplet #27 of Arriagada (1995, 2003).

KEY TO THE SPECIES CENTERING ABOUT *CLIBADIUM PENTANEURON*

27. Abaxial leaf surface hirsute; leaf blade generally palmately veined from or near base (Ecuador) ____ **Clibadium arriagadae** Pruski
27. Abaxial leaf surface generally strigose; leaf blade pinnately veined or if plinerved then from well above base.
    27.1 Most phyllaries apically acute to acuminate; capitula 24–28-flowered; marginal florets 9–13; disk florets ca. 15 (Ecuador) ____ **Clibadium manabiense** H. Rob.
    27.1 Most phyllaries apically obtuse to acute; capitula 10–14-flowered; marginal florets 5 or 6; disk florets 5–8 (Colombia and Ecuador) ____ **Clibadium pentaneuron** S.F. Blake

CONYZA

Conyza bifrons L. (= *Inula bifrons* L., Inuleae) is lectotypified upon material from the Old World, and this name is thus excluded from the flora of the New World. The new combination *C. popayanensis* (Hieron.) Pruski (Astereae) from the Andes is proposed to replace the illegitimate *C. uliginosa* (Benth.) Cuatr., non Pers. Although *C. primulifolia* (Lam.) Cuatrec. (which includes as a synonym

C. chilensis Spreng., the type of *Conyza*) was transferred to *Erigeron* L. by Greuter (2003), I recognize *Conyza* at the generic rank.

Inula bifrons L., Sp. Pl. (ed. 2) 1236. 1763. LECTOTYPE (designated by Anderberg, Taxon 47:363. 1998): EUROPE: "Habitat in Italia, Galloprovincia, Pyrenaeis," *sin. coll.* (LINN 993.11 [IDC microfiche 177. 577.II.5]).

Conyza bifrons L. var. *bifrons*, Sp. Pl. 861. 1753. *Pluchea bifrons* (L.) DC., Prodr. 5:451. 1836. LECTOTYPE (designated here): EUROPE: "Habitat in Pyrenaeis. Canada," *sin. coll.* (BM-CLIFF folio page 405, *Conyza* 3 [barcode BM000647043], photograph MO).

Conyza bifrons var. *flosculosa* L., Sp. Pl 862. 1753. LECTOTYPE (designated by Reveal, Taxon 47:358 1998): EUROPE: "Habitat in Pyrenaeis, Canada," *sin. coll.* (BM-SLOANE vol. 96, page 26).

Conyza bifrons var. *radiata* L., Sp Pl. 861. 1753. LECTOTYPE (designated by Anderberg, Taxon 47:358 1998). t. 127 as "*Conyza pyraenaica foliis primulae veris*" in Hermann, Parad. Bat., 127. 1698.

Distribution and ecology.—*Inula bifrons* is a summer flowering herb to 1 m tall. It occurs from the Pyrenees of southern France eastwards into Romania and Bulgaria (Tutin et al. 1976).

Linnaeus (1753) named *Conyza bifrons* L. and two varieties of it, giving the locality of "Habitat in Pyrenaeis, Canada" for all three names. Later, Linnaeus (1763: 1207) treated *C. bifrons* as being solely American and represented by Plukenet plate 87 figure 4 (1705), thought to have been drawn from Canadian material, whereas simultaneously Linnaeus proposed the heterotypic *Inula bifrons* L. (1763: 1236), with similar auriculate-clasping leaves, for the European elements. *Pluchea bifrons* (L.) DC. (Plucheeae) was misapplied to material from the Americas by Candolle (1836), as noted by Godfrey (1952), who used the name *P. foetida* (L.) DC. for American plants formerly called *P. bifrons*. Gray (1884: 225) noted that the Plukenet plate was drawn from material collected in Europe, not Canada; thus no original material of either *C. bifrons* L. or *I. bifrons* L. is from the Americas.

Conyza bifrons L., however, has not previously been lectotypified (C. Jarvis, pers. comm.). Linnaeus (1763) restricted the concept *C. bifrons* (1753) to plants he thought to be American, thus potential for misapplication of this name to plants from the Americas remains. Because Linnaeus (1753, 1763) cited a polynomial from Linnaeus (1737), *C. bifrons* L. is lectotypified here by a specimen in the Clifford herbarium, this specimen referable taxonomically to *I. bifrons* L. (Inuleae). *Conyza bifrons* L. is thus excluded formally from the flora of the New World, in agreement with Godfrey (1952) and Tutin et al. (1976).

The name *C. uliginosa* (Benth.) Cuatrec., used for a northern Andean herb (e.g., Aristeguieta 1964; Cuatrecasas 1967; Jorgensen & León-Yánez 1999), is an illegitimate later homonym of *C. uliginosa* Pers., Synops. 2:427. 1807. A new combination based on the senior synonym given by Cuatrecasas (1969) is thus proposed.

Conyza popayanensis (Hieron.) Pruski, comb. nov. *Erigeron popayanensis* Hieron., Bot. Jahrb. Syst. 28:586. 1901. TYPE: COLOMBIA. CAUCA: Páramo de Guanacas, Andium centralium popayanensium, 3000–3500 m, Aug, no year given, *Lehmann 7962* (HOLOTYPE: B, destroyed, photograph sub Field neg. #14855: MO; LECTOTYPE (designated by Cuatrecasas, Webbia 24:217. 1969): K; ISOTYPES: FI, P, US [photograph: MO]).

Erigeron uliginosus Benth., Pl. Hartw. 204. 1845, as "*uliginosum*." *Conyza uliginosa* (Benth.) Cuatrec., Webbia 24:216. 1969, non Pers. 1807. TYPE: ECUADOR: PICHINCHA: In uliginosis ad Hacienda de Chisinche sub Volcán Illiniza (as "monte Ilinissa" in protologue), 1842, *Hartweg 1131* (HOLOTYPE: K; ISOTYPES: G [photograph sub F neg. 28634: MO], NY [photograph: MO], P, W). "Hacienda de Chisinche" is a few kms NE of Illiniza, thus presumably in Prov. Pichincha.

Erigeron sulcatus var. *columbianus* Hieron., Bot. Jahrb. Syst. 28:586. 1901, as "*columbiana*." *Conyza uliginosa* var. *columbiana* (Hieron.) Cuatrec., Phytologia 9:5. 1963. COLOMBIA: CUNDINAMARCA: In silvis montanis densis locis humidis supra Sibaté, 2800 m, 3 Feb 1883, *Lehmann 2535* (HOLOTYPE: B, destroyed; ISOTYPE: US).

Erigeron bonariensis var. *meridensis* Cuatrec., Trab. Mus. Nac. Ci. Nat., Ser. Bot. 33:132. 1936. LECTOTYPE (chosen from among syntypes by Cuatrecasas, Webbia 24:216. 1969): VENEZUELA: MÉRIDA: Serra Nevada de Mérida, s.d., *Moritz 1373* (LECTOTYPE: P). "*Moritz 1373*" was not cited specifically in the protologue, but rather only indirectly by name attribution of "Sch. Bip. in schedam." It seem best to accept the lectotypification of Cuatrecasas (1969).

Distribution and ecology.—*Conyza popayanensis* (Hieron.) Pruski occurs from 2500–4400 meters elevation in the Andes of Venezuela, Colombia, Ecuador, and Peru.

Conyza popayanensis is a branched perennial herb with sessile leaves and a generally dense corymbiform capitulescence with peduncles generally much shorter than 5 mm. The capitula have pubescent subequal long-triangular phyllaries with a broad central colored portion and broad stramineous margins, and the marginal florets have entire or nearly so corolla limbs generally about 0.5 mm long. Cuatrecasas (1969) noted that one of the two plants on the destroyed Berlin holotype had an open capitulescence. Nevertheless, this plant on the destroyed holotype has weakly pubescent leaves typical of this species.

Colombian *Conyza uliginosa* var. *hirsuta* (Hieron.) Cuatrec. [syn.: *Erigeron uliginosus* var. *hirsutus* Hieron., Bot. Jahrb. Syst. 28:587 1901, as "hirsuta"] was recognized by Cuatrecasas (1969). This taxon resembles *C. popayanensis*, but has more densely pubescent herbage, an open capitulescence, peduncles to 20 mm long, narrower phyllaries, and marginal florets with sometimes deeply bifid corolla limbs often to about 1 mm long. Because I have not seen type material of this name, I decline to synonymize it or to recognize it at the species rank. If further study shows that *C. uliginosa* var. *hirsuta* deserves specific recognition, it should be noted that Chinese *C. hirsuta* L. blocks the transfer to *Conyza* of this varietal name.

LLERASIA

The below combination is provided for a Bolivian species of Compositae tribe Astereae, originally described as a species of tribe Mutisieae.

Llerasia macrocephala (Rusby) Pruski, comb. nov. *Moquinia macrocephala* Rusby, Descr. S. Amer. Pl. 162. 1920. *Gochnatia macrocephala* (Rusby) Cabrera, Notas Mus. La Plata, Bot. 15:41.

1950. TYPE: BOLIVIA. LA PAZ: North Yungas, Unduavi, 3300 m [as "3000 m" in protologue], Nov 1910, *Buchtien 3080* (HOLOTYPE: NY; ISOTYPE: US [holotype of *Haplopappus lucidulus* S.F. Blake]).

Haplopappus lucidulus S.F. Blake, Amer. J. Bot. 14:114. 1927 (as "*Aplopappus*"). *Llerasia lucidula* (S.F. Blake) Cuatrec., Biotropica 2:43. 1970. TYPE: BOLIVIA. LA PAZ: North Yungas, Unduavi, 3300 m, Nov 1910, *Buchtien 3080* (HOLOTYPE: US; ISOTYPE: NY [holotype of *Moquinia macrocephala* Rusby]).

Distribution and ecology.—*Llerasia macrocephala* (Rusby) Pruski is a vining shrub occurring from 2500–3300 meters elevation in Bolivia.

Because of similar leaf surfaces occasionally closely tomentose abaxially, species of Vernonieae (especially those of *Piptocarpha*) and discoid species of Mutisieae (especially those of *Gochnatia* H.B.K.) are occasionally confused. For example, Badillo (1994), Pruski (1997), and Sancho (1999) treated *Piptocarpha upatensis* V.M. Badillo as a species *Gochnatia*. *Stifftia axillaris* G.M. Barroso & Vinha, described by Barroso and Vinha (1970) as a species of Mutisieae, was recognized by Robinson (1979) as a species of *Piptocarpha* (Vernonieae). Similarly, *Moquinia macrocephala*, described by Rusby (1920) as having leaf surfaces closely tomentose abaxially and as a species of Mutisieae (in the *Gochnatia* generic alliance), is here treated as a member of tribe Astereae.

Rusby (1920) described *Buchtien 3080* (NY) as *Moquinia macrocephala* (Mutisieae). Later, Blake (1927) noted that at US *Buchtien 3080* was filed as an undetermined species of *Gochnatia*, but actually belonged to tribe Astereae, where he described it as *Haplopappus lucidulus*. Blake (1927) treated most of the 11 species of *Llerasia* as *Haplopappus* [sub "*Aplopappus*"] sect. *Diplostephioides* (Benth. & Hook. f.) S.F. Blake, whereas Cuatrecasas (1970) resurrected *Llerasia* (tribe Astereae) from synonymy of *Haplopappus*.

In a pollen review, Wodehouse (1929: figure 8) noted that by spiny pollen *Moquinia macrocephala* stands apart from taxa of the *Moquinia-Gochnatia* plexus. Cabrera (1971) treated most Moquinias under *Gochnatia*, but excluded *Gochnatia macrocephala* (Rusby) Cabrera from *Gochnatia*. I agree with Blake (1927), Wodehouse (1929), and Cabrera (1971) that *Buchtien 3080* belongs to Astereae rather than to Mutisieae. Here I provide the combination *Llerasia macrocephala* (Rusby) Pruski, which replaces the synonymous *L. lucidula* (S.F. Blake) Cuatrec., the latter recognized by Cuatrecasas (1970).

PLUCHEA

Britten (1898) noted that *Conyza baccharis* Miller, partly characterized by auriculate-clasping leaves with broad serrulate blades and reddish florets, is conspecific with *Pluchea bifrons* (L.) DC. sensu Candolle (1836). Godfrey (1952), however, recognized the white-flowered North American populations formerly called *P. bifrons* as *P. foetida* (L.) DC. *Conyza bifrons* L., as lectotypified above on European material, indeed is a heterotypic synonym of European *Inula bifrons* L. Godfrey (1952) also segregated most of the reddish-purple flowered populations formerly called *P. bifrons* as *P. rosea* R.K. Godfrey, which subsequently has been widely recognized (e.g., Cronquist 1980; Nesom 1989; Arriagada 1998). The lectotype of *Conyza baccharis* has very densely pubescent outer phyllaries and florets with reddish corollas. The earlier *C. baccharis* is thus conspecific with *P. rosea*, and the needed new combination for *Flora Mesoamericana* and *Flora North America* is proposed herein, this updating the earlier identification of *C. baccharis* by Britten (1898).

Pluchea baccharis (Mill.) Pruski, comb. nov. *Conyza baccharis* Mill., Gard. Dict. (ed. 8) *Conyza* no. 16. 1768. Lectotype (designated here): MEXICO: Campeche: "Grows naturally at Campeachy," *sin. coll.* (BM [barcode BM000833507], photograph MO). Material grown in the Chelsea garden by Philip Miller is not extant. The Mexican material was presumably gathered by Robert Millar, who also sent *Conyza* no. 15 from "Campeachy" to Philip Miller.

? *Baccharis viscosa* Walter, Fl. Carol. 202. 1788, hom. illegit., non Lam. 1785. Type: U.S.A.: locality unknown, not seen in BM microfiche of Walter's herbarium. Walter's description partly reads "Varietates, floribus albis, et floribus rubris." I do not know of this name being lectotypified, but if it were to be lectotypified on the reddish-flowered material it would seemingly belong here in synonymy.

Pluchea rosea R.K. Godfrey, J. Elisha Mitchell Sci. Soc. 68:266. 1952. Type: U.S.A. Florida. Lake Co.: lake shores, vicinity of Eustis, 16–31 May 1894, *Nash 758* (holotype: GH; isotypes: F, MO, NY, UC, US).

Distribution and ecology.—This is a coastal plain species occurring (see Godfrey 1952; Nesom 1989; Arriagada 1998) in the southeastern United States (North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas), the Bahamas, Cuba, Mexico, and Mesoamerica (Campeche, Quintana Roo, Belize, Honduras, Nicaragua).

Pluchea baccharis (Mill.) Pruski is very similar and most closely related to *P. foetida* (L.) DC. (Cronquist 1980; Nesom 1989; Arriagada 1998), from which it differs most notably by pinkish or reddish (vs. generally white) corollas. *Pluchea baccharis* also tends to have a less dense capitulescence, shorter and more densely pubescent phyllaries, and narrower capitula than does *P. foetida*. Villaseñor (1989) noted that the report by Sousa and Cabrera (1983) of *P. foetida* as occurring in Quintana Roo was based on a misdetermination. A collection from Veracruz, Mexico is the sole Mexican or Central American collection of *P. foetida* reported by Nesom (1989), and the material from Veracruz seen by me is referred here to *P. baccharis*.

Pluchea baccharis is also similar to *P. longifolia* Nash, *P. mexicana* (R.K. Godfrey) G.L. Nesom (described as a var. of *P. rosea*), and *P. yucatanensis* G.L. Nesom. *Pluchea baccharis* differs from *P. longifolia* by smaller capitula and smaller leaves, from *P. mexicana* by abaxially sessile-glandular (vs. stipitate glandular) leaves, and from *P. yucatanensis* by abaxially hirsute and glandular (vs. solely sessile-glandular) leaves. Godfrey (1952) listed the illegitimate and non-typified *Baccharis viscosa* as a synonym of *P. foetida* (L.) DC.

ACKNOWLEDGMENTS

I appreciate the reviews of Jorge Arriagada (SCL) and Guy Nesom (BRIT), who kindly read this manuscript for SIDA. I am very grateful that Lucia Kawasaki (F) verified that the abaxial leaf surfaces are indeed strigose on the holotypes of both *Clibadium sarmentosum* and *Clibadium scandens*. I would also like to thank Anna Balla (F), Charles Jarvis (BM), and Michael Nee (NY) for help in various aspects of this work. Frederick Keusenkothen (MO) is thanked for taking the photographs of the Velloso illustrations.

REFERENCES

Aristeguieta, L. 1964. Compositae. In: T. Lasser, ed. Flora de Venezuela, vol. 10. Instituto Botánico, Caracas. Pp. 1–941.

Arriagada, J.E. 1995. Key to species of *Clibadium* (Compositae, Heliantheae) with notes on synonymy and morphological variation. Rev. Acad. Colomb. Cienc. 19(74):453–461.

Arriagada, J.E. 1998. The genera of Inuleae (Compositae; Asteraceae) in the southeastern United States. Harvard Pap. Bot. 3(1):1–48

Arriagada, J.E. 2003. Revision of the genus *Clibadium* (Asteraceae, Heliantheae). Brittonia 55:245–301.

Badillo, V.M. 1994 [1995]. Enumeración de las Compuestas (Asteraceae) de Venezuela. Revista Fac. Agron. (Maracay) 45:1–191.

Barroso, G.M. and S.G. da Vihna. 1970. *Stifftia axillaris,* uma espécie nova de Compositae. Loefgrenia 44:1–2.

Blake, S.F. 1927. The section *Diplostephioides* of *Aplopappus*. Amer. J. Bot. 14:107–115.

Britten, J. 1898. The Conyzas of Miller's dictionary (ed. 8). J. Bot. 36:51–55.

Cabrera, A.L. 1971. Revisión del género *Gochnatia* (Compositae). Revista Mus. La Plata, n.s., Bot. 12(66):1–160.

Candolle, A.P. de. 1836. Prodromus systematic naturalis regni vegetabilis, vol. 5. Treuttel and Würtz, Paris.

Cronquist, A. 1980. Asteraceae. Vascular flora of the southeastern United States, vol. 1. The University of North Carolina Press, Chapel Hill.

Cuatrecasas, J. 1969. Prima flora Colombiana. 3. Compositae-Astereae. Webbia 24:1–335.

Cuatrecasas, J. 1970. Reinstatement of the genus *Llerasia* (Compositae). Biotropica 2: 39–45.

Godfrey, R.K. 1952. *Pluchea*, section *Stylimnus*, in North America. J. Elisha Mitchell Sci. Soc. 68:238–271 + four plates.

Gray, A., 1884. Caprifoliaceae - Compositae. Synoptical flora of North America. 1(2):1–474.

Greuter, W. 2003. The Euro + Med treatment of Astereae (Compositae) - generic concepts and required new names. Willdenowia 33:45–47.

Greuter, W., J. McNeill, F. R. Barrie, H.M., Burdet, V. Demoulin, T. S. Filgueiras, D. H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth (eds.). 2000. International code of botanical nomenclature (Saint Louis Code). Adopted By The Sixteenth International Botanical Congress St. Louis, Missouri, July – August 1999. Regnum Veg. 138.

Jorgensen, P.M. and S. León-Yánez (eds.). 1999. Catalogue of the vascular plants of Ecuador. Monogr. Syst. Bot. Missouri Bot. Gard. 75:i–viii, 1–1182.

Linnaeus, C. 1737. Hortus Cliffortianus. Amsterdam.

Linnaeus, C. 1753. Species plantarum. Stockholm.

Linnaeus, C. 1763. Species pantarum. Ed. 2. Stockholm.

Nesom, G.L. 1989. New species, new sections, and a taxonomic overview of American *Pluchea* (Compositae: Inuleae). Phytologia 67:158–167.

Plukenet, L. 1705. Amaltheum botanicum. London.

Pruski, J.F. 1984. *Calea brittoniana* and *Calea kristiniae*: Two new Compositae from Brazil. Brittonia 36:98–103.

Pruski, J.F. 1997. Asteraceae. In: J.A. Steyermark, P.E. Berry, and B.K. Holst, eds. Flora of the Venezuelan Guayana, vol. 3. Missouri Botanical Garden, St. Louis. Pp. 177–393.

Pruski, J.F. 1998. Novelties in *Calea* (Compositae: Heliantheae) from South America. Kew Bull. 53:683–693.

Pruski, J.F. and D.J.N. Hind. 1998. Two new species of *Calea* (Compositae: Heliantheae) from Serra do Grão Mogol and the surrounding area, Minas Gerais, Brazil. Kew Bull. 53: 695–701.

Pruski, J.F. and L.E. Urbatsch. 1988. Five new species of *Calea* (Compositae: Heliantheae) from Planaltine Brazil. Brittonia 40:341–356.

Robinson, H. 1979. New species of Vernonieae (Asteraceae). III. Additions to *Piptocarpha.* Phytologia 44:300–306.

Robinson, H. 1992. Four new species of *Clibadium* from northern South America (Asteraceae: Heliantheae). Phytologia 73:149–154.

Rusby, H.H. 1920. Descriptions of three hundred new species of South American plants: with an index to previously published South American species by the same author. Privately published, New York.

Sancho, G. 1999. *Gochnatia calophylla* - a synonym of *Gochnatia oligocephala* (Gardner) Cabrera (Asteraceae, Mutisieae). Willdenowia 29:235–237.

Sousa S., M. and E.F. Cabrera C. 1983. Listados florísticos de México. II. Flora de Quintana Roo. Instituto de Biología, UNAM, Mexico City.

Tutin, T.G., V.H. Heywood, N.A. Burges, D.H. Valentine, S.M. Walters, and D.A. Webb (eds.). 1976. Flora Europaea, vol. 4. Cambridge University Press, Cambridge.

Velloso, J.M. da. 1825 [1829]. Florae fluminensis. Typographia nationali, Rio de Janeiro.

Velloso, J.M. da. 1827 [1831]. Florae fluminensis (Icones). A. Senefelder, Paris.

Villaseñor, J.L. 1989. Manual para la identification de las Compositae de la Peninsula de Yucatán y Tabasco. Techn. Rep. Rancho Santa Ana Bot. Gard. 4:iii + 1–122.

Wodehouse, R.P. 1929. Pollen grains in the identification and classification of plants. IV. The Mutisieae. Amer. J. Bot. 16:297–313 + 2 plates.

BOOK REVIEWS

C.M. MENZEL and G.K. WAITE (eds.). 2005. **Litchi and Longan: Botany, Production, and Uses.** (ISBN 0-85199-696-5, hbk.). CABI Publishing, 875 Massachusetts Avenue, 7th floor, Cambridge, MA 01239, U.S.A. (**Orders:** 617-395-4056, fax 617-354-6875, email cabinao@cabi.org, www.cabi-publishing.org/bookshop). $140.00 hbk., 336 pp., 72 color, 7" × 9 3/4".

Litchi and longan fruit are extremely important economic plants throughout Asia and are popular in Asian cuisine. Pacific Rim countries are the biggest producers of litchi and longan fruit, but the plants are cultivated and used all over the world.

This book is edited by two experts from the Queensland Department of Primary Industries and Fisheries and covers information on the many cultivars of litchi and longan fruit, including *Litchi chinensis* Sonn. and *Dimocarpus longan* Lour (Sapindaceae). Written by experts in the field, this review book covers the research and science of litchi and longan cultivation, horticulture, and production.

The editors include chapters on litchi and longan taxonomy, history, propagation, fruit disorders, pests, irrigation, flowering, harvesting, diseases, and fruit maturation. This is an excellent resource for growers, horticulturists and other researchers who study and litchi and longan. Beautiful color and black-and-white photographs are included.—*Marissa Oppel, Herbarium Assistant, Botanical Research Institute of Texas, Fort Worth, TX, 76012-4060, U.S.A.*

BARBARA BOSWORTH. 2005. **Trees: National Champions.** (ISBN 0-262—2592-2, hbk.). The MIT Press, 55 Hayward Street, Cambridge, MA 02142-1315, U.S.A. (**Orders:** 617-253-5643 800-405-1619, mitpress-orders@mit.edu, http://mitpress.mit.edu). $39.95, 169 pp., b/w photos throughout, 12" × 9 1/2".

A collection of panoramic views of remarkable trees seen through the eyes of an artist. "Currently, there are 889 national champions and cochampions among the 826 eligible species in the United States." The book pictures 70 of these, including natives and non-natives, as black & white photos taken by Barbara Bosworth from 1991 to 2004, using an 8 × 10 camera. Tree champions are judged on an index of circumference, height, and crown spread, and some of the photographs show obvious behemoths. For others, the viewer is aware that the tree is the biggest of its species, but its isolation and stark contrast with surroundings underlie the sense of beauty and awe conveyed by the photograph. So many of these individuals are lone survivors.—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76012-4060, U.S.A.*

UNA NUEVA ESPECIE DE *GUAREA* (MELIACEAE) PARA COSTA RICA

Alexánder Rodríguez

Instituto Nacional de Biodiversidad (INBio),
Apdo. 22-3100, Santo Domingo, Heredia, COSTA RICA
arodrig@inbio.ac.cr

RESUMEN

Se describe e ilustra **Guarea subsessilifolia**, una nueva especie endémica del cerro Turrubares en el pacífico central de Costa Rica, además, se comenta su relación con otras especies del género.

ABSTRACT

Guarea subsessilifolia, a new and endemic species from cerro Turrubares in the central pacific of Costa Rica, is described and illustrated and relationships with related taxa are discussed.

Guarea es uno de los géneros más grandes de la familia Meliaceae en América tropical y fue establecido por Linneo en 1753 bajo el nombre *Guara*, aunque en 1771 el mismo Linneo corrigió su escritura a *Guarea* (Coronado 2003).

Este género ha sido estudiado taxonómicamente en varias ocasiones. Entre los primeros aportes importantes encontramos el presentado por Casimir de Candolle (1878) quien en una monografía completa para la familia Meliaceae reconoció 2 secciones, *EuGuarea* (actualmente *Guarea*) con 67 especies y la sección *Ruagea* (actualmente reconocido como un género distinto) con tres especies (Coronado 2003). Casi 100 años transcurrieron para que la familia fuera nuevamente revizada y fueron Pennington y B.T. Styles (1981) quienes elaboraron una nueva monografía de la familia para el neotrópico. En esta revisión se reconocen 35 especies de *Guarea* para América tropical, se indica la presencia de otras 5 especies en África tropical y solamente 10 especies fueron reconocidas del trabajo de Casimir de Candolle, además, se reportó para Costa Rica la presencia de 7 especies. También, algunas floras locales han sido aportes regionales importantes en la revisión de este género, tal es el caso de Flora de Guatemala (Standley & Steyermark 1946), Flora de Panamá (Smith 1965) y Flora de Nicaragua (Pennington & Styles 2001).

Recientemente, Coronado (2003) en su estudio relacionado con el complejo de *Guarea glabra* Vahl entre México y Panamá, indicó la presencia de 10 especies para Costa Rica, 3 de las cuales actualmente inéditas, *G. arcuata* Coronado, *G. gentryi* Coronado y *G. zarceronensis* Coronado y distintas a la especie aquí descrita

El género *Guarea* se caracteriza por estar constituido de árboles o arbustos, con hojas alternas, compuestas, generalmente pinnadas y con una yema terminal de crecimiento intermitente, por su condición dioica, flores unisexuales por aborto, aunque pareciendo perfectas, cáliz cupuliforme, pétalos libres, en la mayoría de los casos valvados, estambres con filamentos completamente unidos y formando un tubo cilíndrico, con disco nectarífero intraestaminal, ovario 2–13 locular, lóculos con 1–2 óvulos, frutos capsulares, 2–10(–14) valvados y finalmente por mostrar lóculos con 1–2 semillas, las cuales se encuentran rodeadas por una sarcotesta carnosa, roja o anaranjada.

Las recientes exploraciones en la vertiente pacífica de la cordillera de Tilarán, en Monteverde y en el cerro Turrubares localizado en el pacífico central de Costa Rica ha producido el hallazgo de ésta notable especie de *Guarea* cuyos caracteres difieren de los taxa anteriormente reportados para el género (Pennington et al. 1981; Coronado 2003). A continuación se presenta la descripción de esta especie insólita.

Guarea subsessilifolia Al. Rodr., sp. nov. (**Figs. 1, 2**). Tipo: COSTA RICA. San Jose: Turrubares, San Luis, Faldas del cerro Pelón, 09°48'55"N, 84°28'48"W, 1190 m, 19 May 2005 (fls), *Rodríguez 9613* (holotipo: INB; isotipos: BRIT, CAS, CR, DUKE, GH, MEX, MEXU, MO, NY, TEX, UC, US, USJ, W).

Ab omnibus congeneribus folia subsessilia vel brevipetiolata, foliola proxima redacta diversa

Arbusto 2.5–4 m de altura, dioico. Tronco con corteza interna rosada; tallitos glabrescentes a cortamente hirsutos en ramitas terminales, con o sin esparcidas lenticelas. Hojas pinnadas, con una yema terminal de crecimiento intermitente; subsésiles o pecíolos hasta 0.7 cm de largo, subteretes a levemente aplanados en el lado adaxial, ferrugíneo-puberulentos a hirsutulos, glabrescentes con la edad; raquis 1–17 cm de largo, subterete a canaliculado en el lado adaxial, ferrugíneo-puberulento a hirsutulo, glabrescente con la edad; foliolos 1–10 pares, opuestos, súbsésiles o peciolulos hasta 2 mm de largo y 1.25–1.75 mm de ancho, teretes; lámina 1.5–13 cm de largo y 0.8–4 cm de ancho, oblongo-elípticos, elípticos a ovados, foliolos proximales marcadamente reducidos, 3–8.5 más cortos que los distales, base cuneada a obtusa, en ocasiones levemente oblicua, ápice acuminado o agudo, 5–14 pares de venas secundarias, concolora y verde-grisácea a gris-rojiza al secar, haz y envés puberulentos a esparcidamente pubescentes sobre el nervio principal, glabrescentes con la edad, eglandulosos. Inflorescencias terminales o axilares en ramitas terminales, solitarias, tirsos o cimas, erectas; masculinas con 8–35 flores, 2–6 cm de largo y 1.5–3 cm de ancho, pedúnculo 0.1–2 cm de largo, ferrugíneo-puberulento a hirsutulo, glabrescente con la edad, raquis 0.5–4 cm de largo, ferrugíneo-puberulento a hirsutulo, glabrescente con la edad; femeninas con 4–13 flores, 1–3 cm de largo y 1–2 cm de ancho, pedúnculo 0.2–0.5 cm de largo, ferrugíneo-puberulento a hirsutulo, glabrescente con la edad, raquis 0.3–0.7 cm de largo, ferrugíneo-puberulento a hirsutulo, glabrescente con la edad. Flores estaminadas con pedicelos 2–4 mm de largo, articulados, esparcidamente ferrugíneo-puberulentos, 1–2 bracteolados,

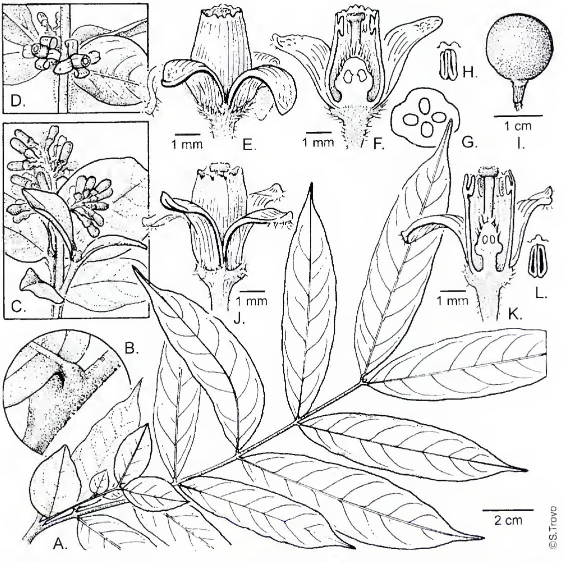


Fig. 1. *Guarea subsessilifolia* Al. Rodr. (*Rodríguez 9613*). **A.** Hábito. **B.** Base de la hoja. **C.** Inflorescencia masculina. **D.** Inflorescencia femenina. **E.** Flor femenina. **F.** Corte longitudinal de flor femenia. **G.** Corte transversal del ovario. **H.** Anterodio. **I.** Fruto. **J.** Flor masculina. **K.** Corte longitudinal de flor masculina. **L.** Antera

bractéolas 0.5–1 mm de largo; cáliz 1–1.5 mm de altura, ciatiforme, verde a pardo hacia la parte distal, esparcida y diminutamente pubescente, lóbulos 4, 0.2–0.35 mm de largo; corola con 4 pétalos, 5–5.5 mm de largo y 1.25–1.5 mm de ancho, blanco-rosados, aunque rosados en botones florales, ápice agudo, lado externo esparcida y diminutamente pubescente, interno papilado hacia el ápice; tubo estaminal 4–5 mm de largo y 1.5–2 mm de ancho, ápice irregularmente dentado, lado externo papilado; anteras 8, 0.75–1 mm de largo y 0.3–0.45 mm de ancho, oblongas a oblongo-obovadas; ginóforo 1–1.25 mm de largo y 0.75–0.9 mm de ancho, glabro, disco nectarífero 0.4–0.5 mm de largo y 1.1–1.3 mm de ancho; ovario 0.7–0.85 mm de largo y 1–1.2 mm de ancho, con esparcidos y largos tricomas; pistilo sobresaliendo levemente sobre el tubo estaminal, estilo 2.25–2.5 mm de largo, glabro, estigma 0.3–0.45 mm de largo y 0.6–0.75 mm de ancho. Flores pistiladas con pedicelos 1.5–4 mm de largo, articulados, esparcidamente ferrugíneo-puberulentos, 1–2 bracteolados, bractéolas 0.5–1 mm de largo; cáliz 0.75–1 mm de altura, ciatiforme, verde a pardo hacia la parte distal, esparcida y diminutamente pubescente, lobos 4, 0.2–0.4 mm de largo; pétalos 4, 5–5.5 mm de largo y 1.7–2 mm de ancho, blanco-rosados, aunque rosados en botones florales, ápice agudo, lado externo esparcida y diminutamente pubescente, interno papilado hacia el ápice; tubo estaminal 4–5 mm de largo y 2–2.5 mm de ancho, ápice irregularmente dentado, lado externo papilado; anterodios 8, 0.75–1 mm de largo y 0.3–0.45 mm de ancho, oblongos a oblongo-obovados; ginóforo 0.5–0.6 mm de largo y 0.75–0.9 mm de ancho, glabro, disco nectarífero 0.3–0.5 mm de largo y 1.3–1.5 mm de ancho, inconspicuo; ovario 4 locular, 0.7–0.85 mm de largo y 1.3–1.5 mm de ancho, seríceo, un óvulo por lóculo; pistilo similar en largo al tubo estaminal, estilo 1.6–1.8 mm de largo, glabro, estigma 0.25–0.3 mm de largo y 0.6–0.7 mm de ancho. Frutos 1–1.5 cm de largo y 1–2 cm de ancho, globosos, lisos, base obtusa, ápice obtuso a subtruncado, rojizos al madurar, glabrescentes a esparcidamente pubescentes, (3–)4 loculado, pericarpo 0.5–1 mm de grosor. Semillas 1 por lóculo, 0.6–0.8 cm de diámetro, subrodeadas por una sarcotesta rojo-anaranjada.

Fenología.—Flores en Mayo y frutos en Abril y Noviembre.

Distribución.—Endémica de Costa Rica, conocida en la vertiente pacífica de la cordillera de Tilarán, en Monteverde y en el pacífico central sobre el cerro Turrubares, en bosques húmedos a elevaciones entre 850–1600 m.

Guarea subsessilifolia se reconoce y distingue de otras especies por su hábito arbustivo y por sus hojas subsésiles o con peciolos muy cortos y por sus foliolos proximales conspicuamente reducidos (en ocasiones caedizos); hojas hasta con 10 pares de foliolos, inflorescencias cortas y escasamente floreadas, flores pistiladas con el ovario seríceo, 4 loculado y con un óvulo por lóculo, finalmente por sus pequeños y globosos frutos, (3–)4 loculares, con una semilla por lóculo, con valvas leñosas y delgadas.

A pesar de que las diferencias florales entre los individuos estaminados y pistilados no es evidentes, se encontraron diferencias significativas entre los individuos de ambos sexos. Los individuos masculinos muestran inflorescencias conspicuamente más largas y con mayor número de flores, el cáliz, el ginóforo y el estilo son ligeramente más largos, además, el ovario y el disco nectarífero son más angosto y menos pubescente que los individuos femeninos.

Esta especie se podría relacionar con *G. glabra* Vahl, *G. guidonia* (L.) Sleumer, *G. jamaicensis* Proctor, *G. pubescens* (Rich.) A. Juss. y *G. macrophylla* Vahl al considerar conceptos taxonómicos usados por Pennington (1981) que incluyen ovario (3–)4 loculado, pubescente, con un óvulo por lóculo, corola pequeña, nunca alcanzando 12 mm de largo, frutos globosos, pequeños, no sobrepasando 2.5 cm de diámetro, lisos, con ausencia de costillas o lenticelas evidentes, pericarpio delgado, menos de 3 mm de grosor e inflorescencias cortas. Sin embargo, estas especies se distinguen fácilmente por mostrar pecíolos evidentes y claramente diferenciados. También, con base en el trabajo de Coronado (2003) y utilizando los mismos conceptos taxonómicos adoptados por Pennington (1981), dentro del complejo de *G. glabra* Vahl la especie podría relacionarse con *G. bullata* Radlk., *G. chiricana* Standl. y *G. petensis* Coronado, sin embargo, estas especies se distinguen igualmente por mostrar pecíolos evidentes y claramente diferenciados.

Esta especie es notablemente rara, se conoce únicamente de 2 localidades, el cerro Turrubares y Monteverde, regiones en las cuales las poblaciones observadas son muy reducidas. Es probable que esta especie se encuentre en alto riesgo de extinción, más considerando que la regiones específicas de recolecta no se encuentran en una estricta categoría de protección y corresponde a sitios con alto uso del suelo en actividades como ganadería y agricultura.

En los bosques de esta región, se observó que *G. subsessilifolia* crece simpátricamente con *G. kegelii* Turcz., además, otras especies comunes en el sitio son *Croton megistocarpus* Gonz. Ram. & Poveda (Euphorbiaceae), *Chrysophyllum brenesii* Cronquist (Sapotaceae), *Daphnopsis folsomii* Barringer & Nevling (Thymelaeaceae), *Hirtella triandra* Sw. (Chrysobalanaceae), *Krugiodendron acuminatum* Gonz. Ram. & Poveda (Rhamnaceae), *Piper subfuscum* C. DC. (Piperaceae), *Hoffmannia psychotriifolia* (Benth.) Griseb. (Rubiaceae), *Lippia cardiostegia* Benth. (Verbenaceae), *Picramnia antidesma* Sw. (Simaroubaceae), *Rondeletia calycosa* Donn. Sm. (Rubiaceae), *Siparuna gesnerioides* (Kunth) A. DC. (Monimiaceae), *Trophis mexicana* (Liebm.) Bureau (Moraceae), entre otras.

Etimología.—El epíteto latino *subsessilifolia* hace alusión a la presencia de hojas casi sésiles.

Paratipos. **COSTA RICA. Puntarenas:** 2.5 km oeste de Monteverde sobre la carretera a Lagarto, Los Llanos, 10°18'N, 84°50'W, 1200 m, 6 Feb 1997 (frs), *Haber 12028* (CAS, CR, GH, INB, MO, NY, US); 3.5 km oeste de Monteverde sobre la carretera a Lagarto, Los Llanos, 10°18'N, 84°50'W, 1200 m, 6 Feb 1997 (frs), *Haber 12109* (BM, CAS, CR, DUKE, GH, INB, MEXU, MO, NY, TEX, US). **San José:** Turrubares, Faldas del cerro Bares, Zona Protectora Cerros de Turrubares, 09°47'30"N, 84°28'30"W, 1600 m, 6 Nov 1990 (frs), *Zúñiga 376* (CR, INB, MO); San Luis, Faldas del cerro Pelón, 09°48'55"N, 84°28'48"W, 1190 m, 7 Oct 2004 (fls), *Rodríguez 9344* (CAS, CR, GH, INB, MO, NY, US), *Rodríguez 9614* (BRIT, CAS, CR, DUKE, GH, INB, MEXU, MO, NY, TEX, US, W); Zona Protectora Turrubares, Cuenca del río Grande de Tárcoles, 09°47'N, 84°29'W, 850–1100 m, 6 Abr 1993 (frs), *Grayum 10551* (INB).

AGRADECIMIENTOS

El autor desea agradecer cordialmente a María T. Germán Ramírez y a un revisor anónimo por la revisión y los comentarios al artículo, a Silvia Troyo por su magnífica ilustración y finalmente a John Pruski por su ayuda en las diagnosis del latín.

REFERENCIAS

Coronado, I.M. 2003. Systematic revision and multivariate analysis of the *Guarea glabra* Vahl (Meliaceae) complex from Mexico to Panama. Thesis for master of science degree. University of Saint Louis, Missouri.

De Candolle, C. 1878. Meliacées. Monogr. Phan. 1:399–758.

Pennington, T.D., B.T. Styles, y D.A.H. Taylor. 1981. A monograph of Neotropical Meliaceae. Fl. Neotrop. Monogr. 28:1–470.

Pennington, T.D. y B.T. Styles. 2001. Meliaceae. En: Stevens, W.D., C. Ulloa, A. Pool, y O. Montiel, eds. Flora de Nicaragua, Tomo II. Monogr. Syst. Bot. Missouri Bot. Gard. 85:1419–1430.

Smith, C.E. 1965. Meliaceae. Flora of Panama. Ann. Missouri Bot. Gard. 52:55–79.

Standley, P.C. y J.A. Steyermark. 1946. Meliaceae. Flora of Guatemala. Fieldiana, Bot. 24(5): 444–468.

DIOSPYROS TORRESII (EBENACEAE): A NEW BLACK ZAPOTE FROM TROPICAL MEXICO

Mitchell C. Provance

Department of Botany and Plant Sciences
College of Natural and Agricultural Sciences
University of California, Riverside
Riverside, California 92521-0102, U.S.A
mitchtell@prodigy.net

Andrew C. Sanders

Herbarium (UCR)
University of California, Riverside
Riverside, California 92521-0102, U.S.A.
andrew.sanders@ucr.edu

ABSTRACT

A new species of black zapote from tropical Mexico is described, and photos of the holotype are provided. **Diospyros torresii** M.C. Provance & A.C. Sanders is based on collections from two localities in north and central Oaxaca. This species appears to belong to a group of closely related American *Diospyros* with fruits that are dark-colored and sweet at maturity.

Key Words: black zapote, *Diospyros torresii*, Ebenaceae, Mexican persimmons, systematics, taxonomy, Tehuacán-Cuicatlán Valley, zapote negro

RESUMEN

Se describe una nueva especie del México tropical y se presentan fotos del holotipo. La descripción de **Diospyros torresii** M.C. Provance & A.C. Sanders se basa en colecciones de dos localidades en el norte y centro de Oaxaca. Se cree que esta especie pertenece a un grupo cercanamente relacionado de *Diospyros* de América que tienen frutos de color oscuro y que son dulces cuando maduran.

A monograph of the Mexican *Diospyros* (Ebenaceae) is the current focus of studies by the first author of this paper. During the course of reviewing thousands of collections of American *Diospyros*, it has become clear that there are several undescribed taxa in Mexico. This paper describes one such species based on collections from Oaxaca, Mexico, that do not belong to any currently recognized species. A comprehensive key to the Mexican species of *Diospyros* has not been published since that by P.C. Standley (1924). Such a key and classification will soon be published by the first author in connection with his current work on the genus in Mexico. The new species described here is best considered a member of what we informally recognize as the *Diospyros rosei* Complex.

The flowering sepals of this complex tend to have vermiform glandular hairs at their apices. The sepals of female flowers tend to be strongly accrescent and are 5–8 in number. The species of this group produce medium size fleshy fruits that are dark-colored and sweet at maturity, and may contain from 10 to 16 ovules. In addition to the species described here, this group includes: *Diospyros rosei* Standl., *Diospyros palmeri* Eastw., *Diospyros californica* I.M. Johnst., *Diospyros oaxacana* Standl., *Diospyros sonorae* Standl., *Diospyros texana* Scheele, *Diospyros riojae* Gomez-Pompa, *Diospyros conzattii* Standl., *Diospyros rekoi*

SIDA 21(4): 2045–2050. 2005

Standl., and *Diospyros xolocotzii* Madrigal & Rzed. Some South American species may belong to this group as well. However, sufficient material from that continent was not available for investigation. We have evaluated the holotype of *D. morenoi* A. Pool, a species recently described from Nicaragua (Pool 1997). In our opinion, this material is consistent with *D. rekoi*, a species for which we have seen material from Mexico and El Salvador.

SPECIES DESCRIPTION

Diospyros torresii M.C. Provance & A.C. Sanders, sp. nov. (**Fig. 1**). TYPE. MEXICO. OAXACA: Mpio. Santiago Texcalcingo: 11 km al E de Teotitlán del Camino carr. a Huautla de Jiménez, [approx. 18° 11'N, 97° 02'W], 1710 m, 17 Mar 1985, *R. Torres C. & M.A. Martínez 6636* (HOLOTYPE: MO; ISOTYPE. CHAPA).

Frutices vel arbores 4 m alta; laminae lanceolatae vel ovatae, petioli decurrentes; petala ovalia vel quadrata, ac manifeste introrsa secus marginem dextrum adaxialum; calyces 5–7 partiti; sepala florentia dense minuta clavata glandulosa adaxialiter; fructus ellipsoidei, atropurpurei ubi desiccati.

Shrubs or trees 4 m tall, probably facultatively deciduous; **old stems** often pulverulent, rarely smooth, dark reddish-brown to dark gray; **current years stems** with stiff, erect, reddish hairs densely covering surface, occasionally retrorse, some slightly wavy, densely appressed at the shoot apex; **lenticels** common, filling tissue yellowish to off-white; **bud scales** convex, ovate, densely appressed reddish hairy; **petioles** 2–4 mm long, both sides densely erect white hairy, sometimes clavate glandular hairy, convex below, ± flat and minutely V-grooved above, distal half minutely winged along the margin, sometimes winged the entire length; **mature leaves** entire, alternate, chartaceous, lanceolate to ovate, 3–6 cm long including the petiole, 2–3 cm wide, blade abruptly decurrent on the petiole, mostly grayish in herbarium material, base rounded, obtuse or acute, margin revolute, apex obtusely rounded, sometimes acutely rounded, below sparsely to moderately erect white hairy, hairs sometimes slightly wavy, sometimes clavate glandular hairy, minutely papillate, usually minutely black gland-dotted, above irregularly wavy to ± rugose, glabrate to minutely erect white hairy, sparsely and minutely papillate, sometimes sparsely clavate glandular hairy; **laminar extrafloral nectaries** abaxial, minute, roundish, mostly raised, probably green in living material; **venation** ± brochidodromous; **midrib** prominent below, sub-terete, densely to very densely erect white to reddish hairy, above flush or barely raised, rarely slightly impressed, yellowish, sparsely to densely erect hairy, less hairy distally, often becoming glabrate, often clavate glandular hairy near the petiole; **2° venation** 5–7 major lateral veins on each side of midrib, below raised, above flush with surface or barely raised, very obscure; **3° venation** reticulated below raised or not, visible or not, above impressed, often obscure, sometimes not visible; **new leaves** strigillose below, especially along the midrib, clavate glandular hairy, above minutely hairy, the hairs mostly erect, sometimes appressed, clavate glandular hairy; **female flowers** solitary on young

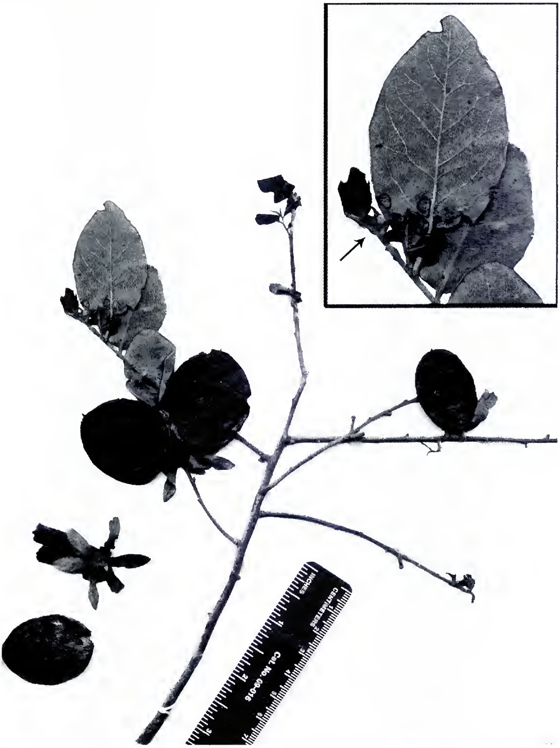


Fig. 1. *Diospyros torresii* M.C. Provance & A.C. Sanders. Holotype, *R. Torres C. & M. A. Martínez 6636* (MO) with detail of leaf (inset) and female flower (indicated by the arrow).

stems; **flowering pedicels** 2 mm long; **pedicel bracts** 2, sub-opposite, 4–7 mm long, 0.75 mm wide, linear, densely minute erect hairy, densely clavate glandular hairy; **fruiting pedicels** 5–10 mm long, ± 1.5 mm wide, somewhat stout, densely but minutely erect hairy, apex hat-shaped; **calyx** 5–7-merous, sinuses rounded, acute; **calyx tube** cupulate, exterior sparsely to moderately minutely appressed hairy; **flowering sepals** 5–6 mm long, ± 2 mm wide, sparsely hairy, the hairs containing a reddish-brown compound, exterior moderately to sparsely appressed hairy, sparsely and minutely clavate glandular hairy, apically dark glandular vermiform hairy, interior densely but minutely clavate glandular hairy, with low to moderate numbers of simple hairs, especially towards base; **fruiting sepals** accrescent in fruit, 16–17 mm long, 5–6 mm wide, thick, ± spreading, lance-ovate to elliptic, apices acutely-rounded, venation obscure, minutely hairy on both sides, sparser towards the apex, minutely black gland-dotted on both sides; **female corolla** 3 mm long; **corolla tube** 1.25 mm long, 2.0–2.5 mm wide, exterior densely appressed hairy, interior glabrous; **lobes** 5, ± 1.75 mm long, oval to quadrate, exterior densely appressed hairy, inside glabrous, involute, more so on the right margin than the left; **ovary** globose, smooth, sparsely minute hairy; **styles** 5, one third of length of ovary, connate, becoming distinct distally; **stigmas** 5, short, labiate; **staminodes** none seen; **male flowers** unknown; **fruit** a berry, ellipsoid, ± 4 cm long, 3 cm wide; **mesocarp** fibrous, orange in herbarium material; **exocarp** ± 2 mm thick, hypodermis moderately thick, sclerified, epidermis minutely blistered, glabrous, atropurpureous in dried material.

Distribution and Ecology.—To our knowledge, *Diospyros torresii* has so far only been collected in the state of Oaxaca, Mexico, however, the type was collected within ca. 2 km of the Puebla state line, and we believe that it probably occurs in that state also. The type collection was made in oak woodlands of the Sierra Mazateca west of Huautla. The condition of the material from the Sierra Mazateca leads us to believe that *D. torresii* is facultatively deciduous. Both sheets of Torres 6636 demonstrate ripe fruit, new female flowers and relatively few mature leaves, but there are a number of young shoots with very young leaves. The paratype was collected from the Tlacolula Valley, but unfortunately is without specific ecological data.

Etymology.—This species is named in honor of Rafael Torres Colín, an authority on *Bauhinia* (Fabaceae) and Oaxacan floristics, and also the collector of the type.

PARATYPE: **MEXICO. Oaxaca:** Mpio. Villa Díaz Ordaz: Barranca of Díaz Ordaz, NW of Mitla, 1700 m, 11 Feb 1966, *M. & A. Kirkby 2739* (NA)

DISCUSSION

Diospyros torresii is currently known from two localities in Oaxaca. The material used to describe this new species was previously identified as *D. palmeri*

Eastwood (*R. Torres C. & R Cedillo T. 6636*) or *D. aequoris* Standley (*M. & A. Kirkby 2739*). Morphologically it most resembles *Diospyros oaxacana* Standley, *Diospyros riojae* Gomez-Pompa and *Diospyros conzattii* Standley. It can easily be distinguished from these species provided fertile material is available. In fact, even though identification of sterile *Diospyros* material is sometimes difficult, in the case of *D. torresii* sterile material should not pose a major problem. The paratype is sterile but we are confident that this material represents the new species. Vegetative features that distinguish *D. torresii* from *D. conzattii* include its smaller, usually thicker leaves and shorter petioles. In addition, the lamina of *D. torresii* is abruptly decurrent on the petiole, and decurrent for a shorter distance than in *D. conzattii*, whereas the leaves of *D. conzattii* are typically tapered basally and often decurrent on the petiole for nearly the entire length. The leaves and petioles of *D. oaxacana* are velutinous to densely pilose, often on both sides, while in *D. torresii* they are glabrous or have only sparse, minute, erect hairs. Furthermore, the leaves of *D. oaxacana* tend to be oval to obovate versus the lanceolate to ovate leaves of *D. torresii*. The leaves of *D. riojae* tend to be larger than those of the new species, but more importantly, the 2°and 3°veins as viewed from the adaxial surface of the leaves are raised and contrast sharply with the lamina. In *D. torresii* the 2° and 3° veins are scarcely visible adaxially.

An interesting detail concerning the type locality is that it is only about 20 km from Coxcatlán, Puebla, and other archaeological sites that have yielded evidence of early agriculture in Mexico (e.g. Smith 1965; Eubanks 2001). Most close relatives of *D. torresii* are known to produce fruits that are edible or even highly desirable. *Diospyros oaxacana* has been recorded as a useful plant in the Tehuacán-Cuicatlán Valley (Casas et al. 2001), and *D. conzattii* has been recorded as a useful plant in Chinantec-speaking communities of the Oaxacan highlands in the District of Cuicatlán (Lipp 1971). Given the large size of the ripe fruits, their probable edibility, and the nearness of this species to some of the oldest agricultural sites in the New World, it may be worthwhile to reevaluate the identification of putative *Diospyros digyna* seeds associated with nearby archaeological sites (e.g. Smith 1965; Callen 1965). Similarly, herbarium vouchers, if they exist, associated with ethnobotanical reports of *Diospyros* usage by nearby indigenous populations (Lipp 1971) should also be reviewed.

Few specimens of this new taxon are known to us, and although this makes it tempting to recommend formal protection for *D. torresii*, we first recommend focused collecting in Oaxaca before such action is taken.

ACKNOWLEDGMENTS

The authors of this paper would like to express their gratitude to Brett Provance for preparation of the Latin diagnosis, Jeffrey Ross-Ibarra for translating the abstract into Spanish, Victor Steinmann for reviewing a very preliminary manuscript and subsequently making many useful suggestions, and also the anonymous reviewers for there recommendations. We would like to thank all of the herbaria that have loaned material for the revision of Mexican *Diospyros*, but especially CHAPA, MO and NA for the loan of specimens that brought this new species to our attention. We would like to thank E.O. Plummer for all of his technical assistance.

REFERENCES

Callen, E.O. 1965. Food habits of some Pre-Columbian Mexican Indians. Econ. Bot.19: 335–343.

Casas, A., A. Valiente-Banuet, J.L. Viveros, J. Caballero, L. Cortés, P. Dávila, R. Lira, and I. Rodríguez. 2001. Plant resources of the Tehuacán-Cuicatlán Valley. Econ. Bot. 55:129–166.

Eubanks, M.W. 2001. The mysterious origin of maize. Econ. Bot. 55:492–514.

Lipp, F.J. 1971. Ethnobotany of the Chinantec Indians, Oaxaca, Mexico. Econ. Bot. 25: 234–244.

Pool, A. 1997. *Diospyros morenoi* (Ebenaceae), a new species from Nicaragua. Novon 7: 189–190.

Smith, C.E., Jr. 1965. The archeological record of cultivated crops of New World origins. Econ. Bot. 19:323–334.

Standley, P.C. 1924. Trees and shrubs of Mexico. Contr. U.S. Natl. Herb. 23(4):1124–1129.

STAUROCHILUS LEYTENSIS, A PHILIPPINE SEGREGATE OF *STAUROCHILUS FASCIATUS* (ORCHIDACEAE: AERIDINAE)

Eric A. Christenson

4503 21st Avenue West
Bradenton, Florida 34209, U.S.A.
orchideric@juno.com

ABSTRACT

The new combination **Staurochilus leytensis** (Ames) E.A. Christenson (Orchidaceae) is made.

RESUMEN

Se hace la nueva combinación **Staurochilus leytensis** (Ames) E.A. Christenson (Orchidaceae).

Oakes Ames and his associates at Harvard University accepted extremely broadly defined species during the first half of the 20th century and in the process reduced many taxa to synonymy. *Vandopsis leytensis* Ames was treated as a synonym of *Staurochilus fasciatus* by Ames and Quisumbing (1932). This species is here recognized as distinct and a new combination is published in *Staurochilus*.

Staurochilus fasciatus (Rchb.f.) Ridl., J. Linn. Soc., Bot. 32:350. 1896. *Trichoglottis fasciata* Rchb.f., Flora 55(9):137. 1872; *Stauropsis fasciata* (Rchb.f.) Benth., Index Kewensis 982. 1885. TYPE: "Hinterindien," collector unknown (HOLOTYPE: W).

Distribution.—Thailand, Laos, Kampuchea. Vietnam, Peninsular Malaysia, Sumatra, Borneo (following Seidenfaden 1988).

Staurochilus leytensis (Ames) E.A. Christenson, comb. nov. BASIONYM: *Vandopsis leytensis* Ames, Orchid. 5:222. 1915. TYPE: THE PHILIPPINES: Leyte, Dagami, 60 m, 14 Dec 1912, *C.A. Wenzel 14* (LECTOTYPE: AMES; ISOLECTOTYPE: NY[1], designated by Seidenfaden 1988).

Ames and Quisumbing (1932) illustrated S. leytensis (as *Stauropsis fasciata* (Rchb.f.) Benth.) with photographs, black and white drawings, and colored drawings without noting its distinctive features.

Distribution.—*Staurochilus leytensis* has been collected on Agusan, Leyte, Quezon, Rizal and Sorsogon at elevations of 60–800 m (Valmayor 1984, as *Trichoglottis fasciata* Rchb.f.). While these records need to be reexamined, there is no reason to believe that any of them represent a far disjunct population of true *Staurochilus fasciatus* which is native to Southeast Asia, adjacent Indonesia, and reportedly Borneo.

While *S. fasciatus* and *S. leytensis* are clearly sister species, they are amply

---

[1] An image of the isolectotype is available online at nybg.org

distinct and geographically quite isolated from each other. In *S. fasciatus* the leaves are V-shaped in cross section and ligulate, the lateral sepals are falcate-incurved ("bowlegged"), the petals are flat, the large lateral lip lobes lie in the same plane as the midlobe, and the sepals and petals are densely marked. In contrast, *S. leytensis* has leaves that are flat and proportionately broader, divergent lateral sepals, incurved petals, shallowly suberect-incurved lateral lip lobes, and different floral markings. The species can be distinguished in following key:

Leaves ligulate, V-shaped in cross-section, up to 12 × 2.5 cm; lateral sepals incurved-falcate such that the three sepals form a tall isosceles triangle; petals flat and held rigidly at 180°, large lateral lip lobes lie in one plane together with the midlobe ____ **Staurochilus fasciatus**

Leaves oblong-elliptic, flat with only a depressed midvein, up to 10 × 3 cm; lateral sepals strongly divergent such that the three sepals form an equilateral triangle; petals incurved yielding a shallowly cupped flower, petals of *S. leytensis* appear to be more narrowly clawed than those of *S. fasciatus* but more specimens are needed to quantify this difference, lateral lip lobes shallowly erect-incurved and do not lie in the same plane as the midlobe ____ **Staurochilus leytensis**

While both *S. fasciatus* and *S. leytensis* have pale yellow sepals and petals with transverse brown bars, the markings are different. In *S. fasciatus* the bars are thick and often coalesce toward the segment apices forming nearly solid brown patches. The bars of *S. leytensis* are narrower, cover significantly less of the surface, and do not appear to coalesce into solid patches.

On an historical note, when Ridley (1896) first described *Staurochilus* with *S. fasciatus* as the sole species he stated that "It is commonly stated in horticultural books that this is a native of the Philippines. I have not seen any thence." It appears that he was on the right track after all and that the species does not occur in the Philippines.

REFERENCES

Ames, O. and E. Quisumbing 1932. New or noteworthy Philippine orchids, II. Philippine J. Sci. 47:197–220, + 29 plates. [*Stauropsis fasciata* p. 214]

Ridley, H.N. 1896. The Orchidaceae and Apostasiaceae of the Malay Peninsula. J. Linn. Soc., Bot. 32:213–416. [*Staurochilus* p. 351]

Seidenfaden, G. 1988. Orchid genera in Thailand: 14. Fifty-nine vandoid genera. Opera Bot. 95:1–398. [*Staurochilus* pp. 88–96]

Seidenfaden, G. and J. Wood 1992. The Orchids of Peninsular Malaysia and Singapore. Olsen & Olsen, Fredensborg.

Valmayor, H.L. 1984. Orchidiana Philippiniana. Eugenio Lopez Foundation, Metro Manila.

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES XVII: UNA REVISIÓN DEL GÉNERO *GALACTOPHORA* (APOCYNACEAE: APOCYNOIDEAE)

J. Francisco Morales

Instituto Nacional de Biodiversidad (INBio)
Apto 22-3100
Santo Domingo de Heredia, COSTA RICA

RESUMEN

Las especies del género *Galactophora* Woodson (Apocynaceae: Apocynoideae), son tratadas en una monografía. Seis especies son aceptadas, incluyendo una nueva especie, **G. angustifolia** y se proponen dos nuevos sinónimos. Se brindan claves, descripciones, ilustraciones y especímenes examinados.

ABSTRACT

The species of the genus *Galactophora* Woodson (Apocynaceae: Apocynoideae) are treated in a monograph. Six species are accepted, including a new species, **G. angustifolia**, and two new synonyms are proposed. Keys, descriptions, illustrations and specimens examined are provided.

Galactophora (Apocynaceae, Apocynoideae) es un pequeño género de 6 especies, originalmente descrito por Woodson (1932) y distribuido en el SE de Colombia, Venezuela, Perú, Bolivia y Brasil, que se puede reconocer fácilmente por su hábito usualmente erecto o suberecto (raramente escandente), hojas con la lámina coriácea o subcoriácea, usualmente revolutas marginalmente, sin coléteres en el nervio central adaxialmente, inflorescencias cortamente racemosas o cimas reducidas, terminales o subterminales, usualmente con pocas flores, sépalos sin coléteres en la base de la cara adaxial, anteras aglutinadas a la cabeza estigmática, cabeza estigmática con cinco crestas o proyecciones longitudinales, restringidas a la base, y la ocasional presencia de pelos glandulares en tallos, inflorescencias y sépalos. La presencia de otros géneros en Sur América con caracteres morfológicos similares no es común, pudiéndose confundirse solamente con algunas especies de *Mandevilla* y *Macrosiphonia* con hábito erecto e inflorescencias terminales. Sin embargo, estos géneros se pueden separar con facilidad por la presencia usual de coléteres, ya sea en el nervio central de las hojas adaxialmente, así como en la base de la cara adaxial de los sépalos. Por otro lado, aunque *Prestonia erecta* (Malme) J.F. Morales también tiene hábito erecto e inflorescencias terminales, la presencia de una corona anular alrededor de la boca en esa especie la separa al instante, así como hojas con la lámina foliar membranácea.

Siguiendo con la revisión de géneros de las tribus Echiteae y Mesechiteae (sensu Endress & Bruyns 2000), una monografía del género *Galactophora* es

SIDA 21(4): 2053–2079. 2005

presentada a continuación. Para tal fin, la mayoría de colecciones tipo fueron revisadas, así como las colecciones depositadas en los principales herbarios de Europa, Norte América y del N de S América (Colombia, Ecuador, Perú y Bolivia). El esquema utilizado acá sigue el empleado anteriormente en otras revisiones y monografías de la misma serie (e.g., Morales 2002, 2003).

Características morfológicas notables

Hojas.—Las hojas son opuestas, aunque raramente hojas verticiladas puedan ser encontradas en algunos especímenes, careciendo de coléteres en el nervio central (adaxialmente). Las láminas son invariablemente coriáceas, con los márgenes usualmente revolutos al secar y es común que las venas secundarias apenas estén impresas en ambas superficies, mientras que las venas terciarias raramente están impresas (e.g., *G. schomburgkiana* Woodson).

Pubescencia.—La pubescencia de tallos, hojas e inflorescencias (cuando presente) es típica de *Galactophora* y está compuesto por pelos unicelulares, relativamente rígidos y usualmente de color oscuro al secar, con la parte distal y apical, conspicuamente engrosada y glandular (Fig. 1). Este tipo de pubescencia no está presente en el resto de los miembros de las tribus Mesechiteae ni Echiteae, a pesar de la alta variabilidad de patrones de pubescencia presentes en géneros como *Mandevilla*. Solamente en *M. pachyphylla* Woodson, pelos cortos, bulbosos y a veces levemente uncinados están presentes, pero nunca como los descritos en *Galactophora*. En forma tradicional y continua, la pubescencia ha sido utilizada por varios taxónomos para separar múltiples taxones, entre ellos De Candolle (1844), Müller (1860) y Woodson (1933, 1935, 1936). Sin embargo, la variación intraespecífica en forma general en las Apocynaceae puede ser muy alta y este carácter debe ser usado en la medida de lo posible con precaución y en conjunción con otros caracteres morfológicos. De esta manera, tomando en cuenta la relativamente escasez de cantidad de material disponible en el siglo 18 y en la primera mitad del siglo 19, muchas especies fueron separadas basados en rangos extremos de pubescencia, sin especímenes intermedios que permitieran definir la conexión entre estos extremos. El relativamente alto número de material disponible hoy en día, ha demostrado que varias de esas especies solo representan variaciones extremas de la pubescencia dentro de un mismo taxón y han debido ser sinonimizadas en monografías o revisiones recientes (e.g., Fallen 1983; Hansen 1985; Leeuwenberg 1994 a; Morales 1997, 1998, 1999, 2002, 2003; Williams 1998). De esta manera, la misma situación se ha presentado en *Galactophora*, donde *G. crassifolia* y *G. calycina* han sido separadas básicamente por el indumento presente en la primera y ausente en la segunda (Woodson 1936; Morillo 1995). Tanto los ejemplares tipo como el resto de colecciones examinadas son idénticos en su morfología general y se encuentran una serie de especímenes con grados intermedios de pubescencia, lo que impediría aún más el pensar en reconocer estas dos formas a nivel de variedad.

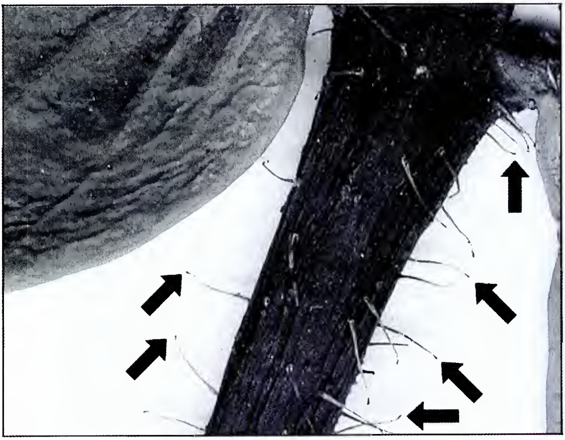


Fig. 1. Detalle de los pelos glandulares de *Galactophora crassifolia* (*Cárdenas & Bangi 4627*, INB).

Esta variabilidad de la pubescencia en este género, reafirma nuevamente la alta variabilidad intraespecífica en las Apocynaceae neotropicales de ese carácter.

Inflorescencias.—Woodson (1936) originalmente describió que las inflorescencias en este género eran subumbeliformes o escorpioidales y corimbosas, pero el análisis y estudio de este carácter ha determinado que en realidad las inflorescencias son cortamente racemosas o reducidas a cimas (ocasionalmente con apariencia subumbeliforme), algunas veces con solo 1 ó 2 flores. En forma usual tienen pocas flores, con un rango de 1 a 5 por inflorescencia, aunque ocasionalmente se encuentran grupos de hasta 11 flores. Las brácteas florales son siempre escariosas y no se reporta la presencia de bracteolas a lo largo del pedicelo.

Cáliz.—El cáliz presenta cinco sépalos, los cuales pueden ser totalmente glabros o presentar en diferentes grados de densidad, el típico indumento de *Galactophora*. La presencia o ausencia del indumento no es determinante para separar especies, pero la longitud de los sépalos en algunos casos puede ser útil para separar algunos taxones. Sin embargo, la más notable e importante diferencia respecto a tratamientos monográficos previos se refiere a la presencia de coléteres en la base de la cara adaxial de los sépalos. Woodson (1936) reportó que los sépalos tenían "several to many indefinitely distributed squamellae," es decir, que albergaban una serie de coléteres fusiformes, pequeños y diminutos, similares a los presentes en otros géneros de las Echiteae, como por ejemplo, *Peltastes*. Sin embargo, después de examinar numerosos sépalos de diferentes especímenes de todas las especies, es claro que *Galactophora* no tiene coléteres, tal y como fueron descritos e ilustrados en la monografía de Woodson (1936). La ausencia de coléteres fue previamente notado por Morillo (1995), quién en su tratamiento de *Galactophora* para la Flora de la Guyana Venezolana, citó que los sépalos, al parecer, carecían de coléteres en la base interna. En forma usual, los coléteres están presentes en casi todos los miembros de las Echiteae y Mesechiteae, con la excepción de *Laubertia* y *Rhabdadenia*.

Corolas.—En forma general, es común que las corolas presenten cinco costillas o crestas longitudinales externas que corren desde la base del tubo hasta el márgen de los lóbulos (Fig. 2). Aunque en material fresco las crestas son apenas evidentes, son mucho más evidentes en material seco. Este tipo de crestas no están presentes en ningún otro miembro de las Mesechiteae o Echiteae y es un carácter bastante distintivo que nos ayuda a reconocer con facilidad las especies de este género. Las partes de la corola mencionadas a través de las descripciones siguen a Morales & Fuentes (2004 b).

Ovario y folículos.—En todas las especies, los dos carpelos se hayan fusionados postgenitalmente en forma basal, separándose ligeramente por encima del nectario. Esto provoca que los folículos, casi en forma invariable, se hallen fusionados en el área basal proximal al cáliz en un área inferior a 2(–2.5) cm de su longitud, para luego separarse de manera definitiva, continuando de forma divergente, continua y rígida. Este tipo de fusión basal, da una falsa apariencia de que los folículos fueran estipitados (Fig. 3). Este carácter no está presente en el resto de las Mesechiteae o Echiteae y es bastante distintivo para el género.

Notas en la clasificación intragenérica

El género *Galactophora* fue descrito en forma relativamente reciente por Woodson (1932), por lo que no fue incluido como tal en clasificaciones infragenéricas previas (e.g., Schumann 1895). En forma posterior, Pichon fue el primero en proponer una extensa clasificación de las Apocynaceae (1948 a, b, c; 1949; 1950 a, b) , clasificando a *Galactophora* en la subfamilia Echitoideae ("Echitoïdees"), tribu Parsonsieae ("Parsonsiées"), junto con la mayoría de los miembros de las Echitoideae sensu Woodson (1935, 1936), excepto *Mandevilla* y sus géneros satélites (e.g., *Allomarkgrafia*, *Mesechites*). Adicionalmente, en su clasificación de las Echotoideae, Pichon (1950 a), ubicó a *Galactophora* dentro de una subtribu propia (*Galactophorinae*), basado en algunos caracteres de la corola y frutos. Posteriormente, Leeuwenberg (1994 b) propuso otro sisterma de clasificación, tratando a *Galactophora* dentro de la tribu *Echiteae* subtribu

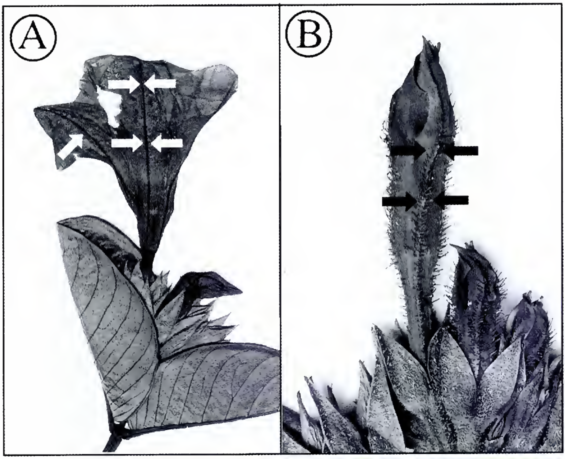


Fig. 2. Detalle de las costillas o crestas longitudinales en corolas de *Galactophora* **A.** *G. crassifolia* (*Prance et al. 25006*, INB). **B.** *G. shomburgkiana* (*Boom & Weitzman 5757*, INB).

Echiteae, donde tanto *Mandevilla*, *Echites* y los géneros relacionados, fueron tratados en la misma subtribu. Sin embargo, en forma general, las tribus propuestas por Leeuwenberg son artificiales (Sennblad et al. 1998) y confusas, debido a la ausencia de una explicación de los criterios utilizados en su delimitación. Ahora bien, Endress & Bruyns (2000) propusieron la más reciente clasificación de las Apocynaceae, incluyendo por primera vez Asclepiadaceae, tal y como fue sugerido por análisis moleculares previos (e.g., Judd et al. 1994; Sennblad & Bremer 1996). En el sistema de Endress & Bruyns (2000), *Galactophora* fue tratado en la tribu *Mesechiteae*, junto con *Mandevilla* y sus géneros relacionados. La inclusión de *Galactophora* dentro de esta tribu, fue basado probablemente por la presencia de las cinco proyecciones o costillas basales de la cabeza estigmática. Sin embargo, sus hojas carecían de coléteres en la superficie adaxial del nervio, carácter común al resto de géneros en esa tribu, con la excepción de *Secondatia*, otro género que fue excluido de esa tribu en forma preliminar por Morales (2003), basado en las caracteres de la cabeza estigmática. Las relaciones intergenéricas de los miembros de las Mesechiteae

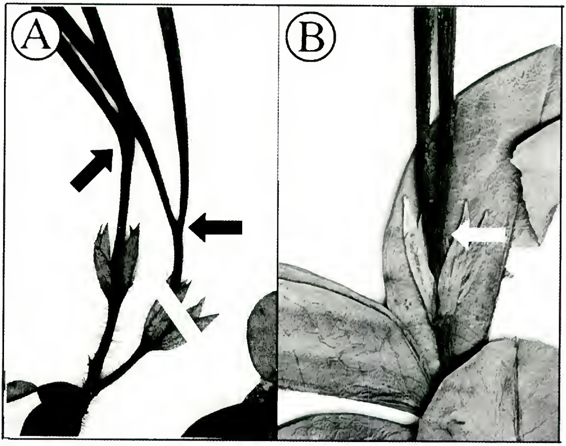


Fig. 3. Detalle de la fusión basal de los folículos en *Galactophora crassifolia*. **A.** *Liesner & Carnevali 22881*, MO. **B.** *Guillén & Roca 2853*, INB.

han sido confusas, debido a los caracteres algunas veces relativamente débiles usados en su separación. En forma reciente, Simões et al. (2004), realizaron un estudio molecular y morfológico para probar la monofilia de la tribu Mesechiteae, donde se confirmó que *Galactophora* debe ser excluido de la tribu Mesechiteae, al igual que Secondatia. Por lo tanto, dado que su ubicación tribal actual es incierta, no se puede comentar en forma apropiada las relaciones intergenéricas de *Galactophora*.

TRATAMIENTO SISTEMÁTICO

Galactophora Woodson, Ann. Missouri Bot. Gard. 19:49. 1932. Tipo: *Galactophora crassifolia* (Müll. Arg.) Woodson

Hierbas arbustivas, raramente escandentes o lianas; las ramitas tiernas algunas veces aplanadas o anguladas, usualmente teretes o subteretes con la edad, con secreción lechosa o acuosa, glabras, glabrescentes a variadamente glandular-pubescentes, los coléteres inter e intrapeciolares, fusiformes e inconspicuos. Hojas opuestas, raramente verticiladas, sésiles, subsésiles a pecioladas, pecíolos eglandulares, sin coléteres a lo largo de la costa adaxialmente, pero con inconspicuos coléteres en los axilas; láminas glabras, glabrescentes a variadamente glandular-pubescentes, coriáceas a subcoriáceas, eglandulares, sin coléteres en el nervio central adaxialmente, usualmente variadamente revolutas, la venación secundaria y terciaria usualmente inconspicua, más raramente levemente impresas en alguna de las caras de la hoja. Inflorescencias racemosas o cimas reducidas, terminales o subterminales, usualmente con pocas flores (1 a 11), glabras, glabrescentes a variadamente glandular-pubescentes, pedunculadas a sésiles o subsésiles, brácteas escariosas, inconspicuas, bracteolas ausentes; sépalos 5, esencialmente iguales, algo imbricados basalmente, escariosos, subfoliáceos, o foliáceos, sin coléteres en la base de la cara interna; corola infundibuliforme, glabra, glabrescente a variadamente glandular-pubescente exteriormente, sin corona anular o corona epiestaminal (apéndices coronales libres) interiormente, usualmente con cinco crestas o costillas longitudinales externamente, distribuidas desde la base del tubo hasta la base de los lóbulos, el limbo dividido en cinco lóbulos, estos variadamente nervados longitudinalmente, con aestivación dextrorsa; estambres cinco, insertos dentro del tubo, incluidos, los filamentos variadamente pubescentes, indumento infraestaminal usualmente presente; anteras conniventes y aglutinadas en dos puntos a la cabeza estigmática, las bases estériles agudas o acuminadas; carpelos dos, unidos apicalmente al estilo, fusionados postgenitalmente en su región basal, usualmente hasta la altura del nectario; cabeza estigmática con cinco proyecciones o costillas longitudinales basales, el resto relativamente cilíndrico, con el ápice algo engrosado; óvulos numerosos, multi-seriados, dispuestos en una placenta axilar y biseriada; nectario anular, entero, subentero o irregularmente lobulado, mucho más corto que el ovario. Folículos 2, apocárpicos, teretes a subteretes, continuos, fusionados en su parte basal y luego separados y divergentes entre sí, glabros, glabrescentes o variadamente pubescentes, dehiscentes a lo largo de la sutura ventral; semillas numerosas, secas, truncadas apicalmente, comosas en el ápice micropilar, usualmente rugosas, más raramente casi lisas.

Género neotropical con 6 especies, distribuido principalmente en el SE de Colombia, Venezuela y Brasil, con una especie extendiéndose hasta Perú y el NE de Bolivia.

CLAVE PARA LAS ESPECIES DE *GALACTOPHORA*

1. Sépalos 15–25 mm de largo ________ **3. G. crassifolia**
1. Sépalos 4–12.5 mm de largo.
    2. Parte inferior del tubo de la corola de 19–31 mm de largo, la boca de (18–)23–32 mm en diámetro; láminas foliares con la venación secundaria y terciaria impresa adaxialmente; distribución geográfica en tepuís entre 750–2000 m ________ **6. G. schomburkiana**
    2. Parte inferior del tubo de la corola de 5.5–14 mm de largo, la boca de 5–16 mm en diámetro; venación secundaria levemente o no impresa adaxialmente, las

venas terciarias no impresas en ambas caras; distribución geográfica en sabanas y áreas diversas entre 100–1200 m.

3. Láminas foliares de 8.5–15.5(–17) × (4–)5–8 cm, ovadas a ovado-elípticas, levemente cordadas basalmente ______ **2. G. colellana**
3. Láminas foliares de 1.7–6.2 × 0.5–2.4 cm, elípticas a angostamente elípticas, cuneadas, obtusas a redondeadas basalmente.
    4. Hojas con la base cordada, sésiles o subsésiles ______ **1. G. angustifolia**
    4. Hojas con la base cuneada, redondeada a obtusa, pecioladas o si cortamente pecioladas, la base nunca cordada.
        5. Inflorescencias con 5 a 11 flores, pedúnculo de 7–42 mm de largo; sépalos de 4–6 mm de largo; parte superior del tubo de la corola de 15–16 mm de longitud ______ **3. G. pulchella**
        5. Inflorescencias con 1 a 2 flores, pedúnculo menos de 2 mm de largo; sépalos de 8–11 mm de largo; parte superior del tubo de la corola de 23–31 mm de longitud ______ **4. G. pumila**

1. Galactophora angustifolia J.F. Morales, sp. nov. (**Fig. 4**). Tipo: COLOMBIA. Caqueta: parque nacional natural Chiribiquete, alrededores del campamento base, borde de quebrada, 19 Nov 1992 (fl), *M. Velayos, J. Cardiel, J. Pedrol & M. Telleria 6319* (holotipo: MA; isotipo: P, fotografía, INB).

A G. *pulchella* Woodson, cui affinis, foliis cordatis, sessilis vel subsessilis et 1–1.4 cm latis differt.

Hábito desconocido; tallos subteretes a teretes, sólidos, glabros o glabrescentes e inconspicuamente glandular-hirsutulos, los pelos glándulares (cuando presentes) negros; coléteres inter e intrapeciolares inconspicuos, ca. 1 mm de largo. Hojas sésiles a subsésiles, el pecíolo menos de 1 de largo; lámina 6.8–9 × 1–1.6 cm, angostamente ovadas a angostamente ovado-elípticas, agudas apicalmente, cordadas basalmente, coriáceas a subcoriáceas, glabras o glabrescentes y con inconspicuos pelos esparcidos abaxialmente, levemente revolutas marginalmente o no revolutas, la venación secundaria levemente impresa abaxialmente, algunas veces inconspicua, las venas terciarias no impresas. Inflorescencia terminal, glabrescente, con más de 6 flores, pedúnculo 5–6 mm de largo, pedicelos 2.5–3 mm de largo, brácteas 1–1.5 × 0.5–1 mm, escariosas; sépalos 5–6 × 1–1.3 mm, angostamente ovados a angostamente ovado-elípticos, acuminados, subfoliáceos, glabrescentes a muy esparcidamente glandular-hirsutulos exteriormente; corola de color desconocido, glabrescente exteriormente, con solo pelos distribuidos en las líneas externas de la corola, el ápice del botón floral cortamente acuminado; parte inferior del tubo 6–7 × 1.5–2 mm, la parte superior 14–15 mm de largo, angostamente cónica, 3–4 mm en diámetro en el orificio; lóbulos 7–8 × 4–5 mm, angostamente obovados; anteras 4–4.2 mm de largo, glabras, las bases estériles cortamente acuminadas, cabeza estigmática 1.5–1.8 mm de largo; ovario 2–2.6 mm de largo, glabro; nectario 0.8–1 mm de largo, entero a subentero. Folículos desconocidos.

Distribución, hábitat y ecología.—Endémica a Colombia al Departamento de Caquetá, donde es conocida únicamente de la localidad tipo, creciendo en

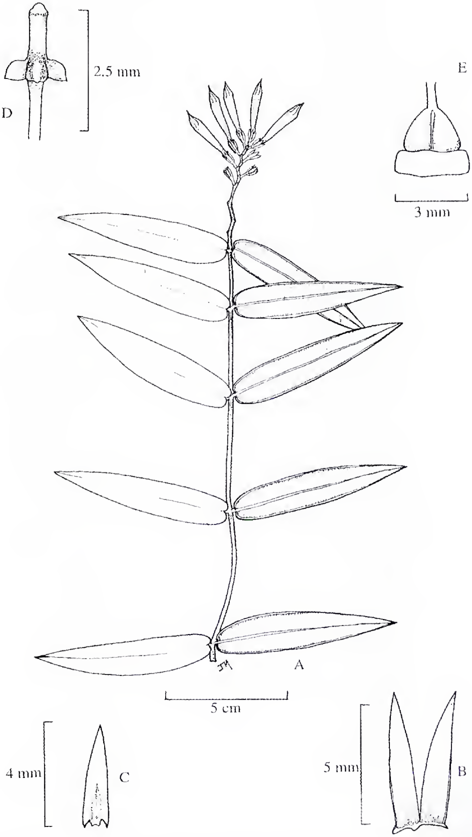


Fig. 4. *Galactophora angustifolia* (*Velayos et al. 6319*, P). **A.** Ramita con inflorescencias. **B.** Sépalos, vista adaxial, mostrando la ausencia de coléteres. **C.** Antera, vista dorsal. **D.** Cabeza estigmática. **E.** Nectario y ovario.

vegetación en bordes de quebradas, en elevaciones de 645 m. Especímenes con flores han sido recolectados en Noviembre.

Galactophora angustifolia es una especie muy distintiva, que se podría confundir con *G. pulchella*, pero se diferencia con facilidad por sus hojas sésiles o subsésiles, con el pecíolo inferior a 1 mm de largo, hojas angostamente ovadas o angostamente ovado-elípticas, con la lámina 1–1.6 cm de ancho y con la base cordada, así como la corola con la parte inferior del tubo de 6–7 mm de largo.

Tanto el hábito como el color de las flores de esta especie son aún desconocidos, debido a que ambos caracteres no son especificados en la etiqueta del holotipo.

2. Galactophora colellana Morillo, Anales Jard. Bot. Madrid. 48:27. 1990. (**Fig. 5**). Tipo: VENEZUELA. AMAZONAS: Río Negro, Cerro de la Neblina, NNE del Pico Phelps, 15 Mar 1984 (fl), *Liesner 16644* (HOLOTIPO: VEN; ISOTIPOS: INB, MO, NY).

Arbusto erecto hasta 1.3 m de altura; tallos aplanados en ramitas jóvenes, subteretes a teretes cuando viejos, sólidos o levemente huecos, esparcidamente glandular-hirsutulos, los pelos glandulares negros; coléteres inter e intrapeciolares inconspicuos, ca. 1 mm de largo. Hojas sésiles a subsésiles, el pecíolo 1–1.5 mm de largo; lámina 8.5–15.5(–17) × (4–)5–8 cm, ovadas a ovado-elípticas, obtusas, agudas, agudo-mucronuladas a obtusas apicalmente, levemente cordadas basalmente, coriáceas a subcoriáceas, muy esparcida y diminutamente papilado-puberulentas en ambas superficies, algo revolutas marginalmente, la venación secundaria levemente impresa, algunas veces inconspicua, las venas terciarias no impresas. Inflorescencia terminal, diminutamente puberulenta, esparcidamente glandular-setosa, con 5 a 8 flores, pedúnculo 14–28 mm de largo, pedicelos 5–8 mm de largo, brácteas 1–1.5 × 0.5 mm, escariosas; sépalos 4–5 × 2–2.5 mm, ovados, acuminados, subfoliáceos, muy esparcidamente glandular-hirsutos exteriormente; corola blanca, muy esparcida e inconspicuamente glandular puberulenta a glabrescente exteriormente, el ápice del botón floral agudo; parte inferior del tubo 13–14 × 1.5–2 mm, la parte superior 15–16 mm de largo, angostamente cónica, 6–7 mm en diámetro en el orificio; lóbulos 9–10 × 4–5 mm, angostamente obovados; anteras 4.5–5 mm de largo, glabras, las bases estériles cortamente acuminadas, cabeza estigmática 1.5–1.8 mm de largo; ovario 2–2.5 mm de largo, glabro; nectario 0.8–1 mm de largo, entero a subentero. Folículos desconocidos.

Distribución, hábitat y ecología.—Esta especie se encuentra distribuida en Colombia, Venezuela y Brasil, donde crece en vegetación arbustiva enana, sabanas arbustivas y afloramientos rocosos en elevaciones de 400–800 m. Especímenes con flores han sido recolectados en Marzo, Julio, Septiembre y Octubre.

Galactophora colellana es una especie que se puede confundir con *G. crassifolia* y *G. schomburgkiana* por el tamaño y forma de sus hojas, pero que se

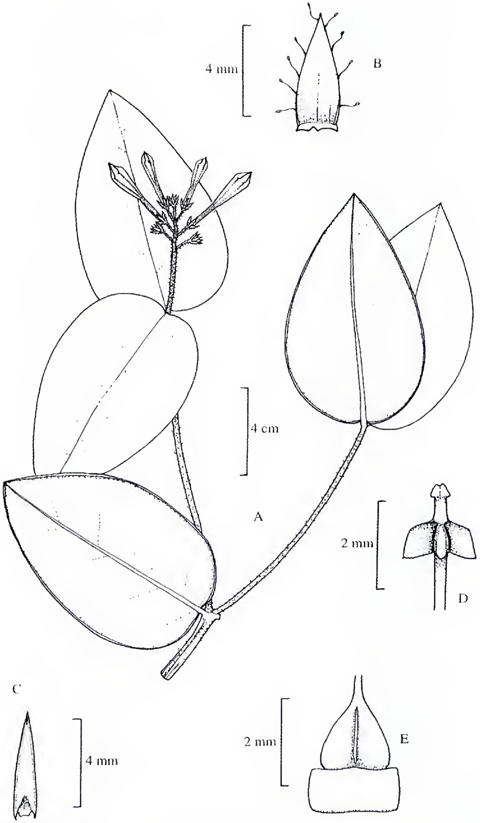


Fig. 5. *Galactophora colellana* (*Liesner 16644*, INB). **A.** Ramita con inflorescencias. **B.** Sépalo, vista adaxial. **C.** Antera, vista dorsal. **D.** Cabeza estigmática. **E.** Nectario y ovario.

separa fácilmente por sus flores con la parte inferior del tubo de la corola de 13-14 mm de largo (vs. 19–32 mm), así como sépalos de 4–5 mm de largo (vs. 5–25 mm).

Especímenes examinados. **COLOMBIA. Amazonas:** río Caquetá, La Pedrera, 2 Oct 1952 (fl), *Schultes & Cabrera 17673* (US).

VENEZUELA. Amazonas: Atabapo, Cerro Huachamacarí, 5 Nov 1988 (fl), *Liesner 25878* (MO).

BRASIL. Amazonas: São Gabriel do Cachoeira, Morro dos Seis Lagos, Lago do Dragão, Oct 1987 (fl), *Farney et al. 1723* (NY); Rio Negro, Morro do Seis Lagos, sin fecha (fl), *Weber & Knob 1719* (NY).

3. Galactophora crassifolia (Müll. Arg.) Woodson, Ann. Missouri Bot. Gard. 19:50. 1932. (**Figs. 3, 6**). *Amblyanthera crassifolia* Müll. Arg., Fl. Bras 6(1):143. 1860. *Rhodocalyx crassifolius* (Müll. Arg.) Miers, Apocyn. S. Amer. 139. 1878. Tipo: BRASIL. Amazonas: cerca de San Carlos, Río Negro, 1853–1854 (fl, fr), *Spruce 3136* (holotipo: K; isotipos: B (destruido, foto F neg 38739), BM (foto, INB), BR, CGE, G (foto F neg 26870), K [2 láminas], NY, P, W).

Dipladenia calycina Huber, Bol. Mus. Goeldi 7:113. 1913, nom. nud.

Dipladenia calycina Huber ex Ducke, Arch. Jard. Bot. Rio de Janeiro 3:247. 1922. *Galactophora calycina* (Huber ex Ducke) Woodson, Ann. Missouri Bot. Gard. 19:50. 1932. Tipo: BRASIL. Para: río Mapuera, Trombetas, al NE de los rápidos de Taboleirinho, 12 Dic 1907 (fl, fr), *Ducke 9124* (holotipo: MG, foto en INB).

Galactophora magnifica Woodson, Ann. Missouri Bot. Gard. 19:382–383. 1932, syn. nov. Tipo: BRASIL. Mato Grosso: Juruena, Abr 1909 (fl), *Hoehne 1759* (holotipo: US).

Arbusto erecto (0.5–)1–2.5 m altura, algunas veces escandente y más raramente una liana; tallos conspicuamente aplanados y angulados en ramitas jóvenes, subteretes con la edad, sólidos, densamente glandular-hirsutos en ramitas jóvenes, esparcidamente glandular-hirsutos a glabrescentes o glabros en tallos viejos, los pelos glandulares negros; coléteres interpeciolares inconspicuos, 1 mm o menos de largo. Hojas sésiles a subsésiles, el pecíolo 1–2 mm de largo; lámina (2.5–)3–11 × 2.1–8 cm, ovadas, ovado-elípticas, obtuso-mucronuladas a emarginado-mucronuladas apicalmente, cordadas a subcordadas basalmente, coriáceas a subcoriáceas, glabras a glabrescentes adaxialmente, diminuta y esparcidamente papiladas a glabras o glabrescentes abaxialmente, algunas veces con puntuaciones negras, variadamente revolutas marginalmente, la venación secundaria levemente impresa, algunas veces inconspicua, las venas terciarias usualmente no impresas. Inflorescencia terminal a subterminal, esparcidamente glandular-puberulenta,con 1 a 5 flores, pedúnculo 8–23 mm de largo, pedicelos 10–16 mm de largo, brácteas 0.5–1 × 0.5–1 mm, escariosas; sépalos 15–25 × 4–6 (–7) mm, ovados, angostamente ovados a ovado-elípticos, agudos o acuminados, foliáceos, esparcidamente hirsútulos a glabrescentes; corola con el tubo crema, blanco a blanco-rosado, los lóbulos rosados, muy esparcidamente glandular-puberulentas a glabrescentes, el ápice del botón floral agudo; parte inferior del tubo 22–32 × 2.5–3 mm, la parte superior 24–32 mm de largo, cónica, 11–16 (–24) mm en diámetro en el orificio; lóbulos 24 × 18 mm, angostamente obovados; anteras 7–8 mm de largo, glabras, las bases estériles cortamente acuminadas, cabeza estigmática 1.9–2.2 mm de largo; ovario 2.9–3.2 mm de largo,

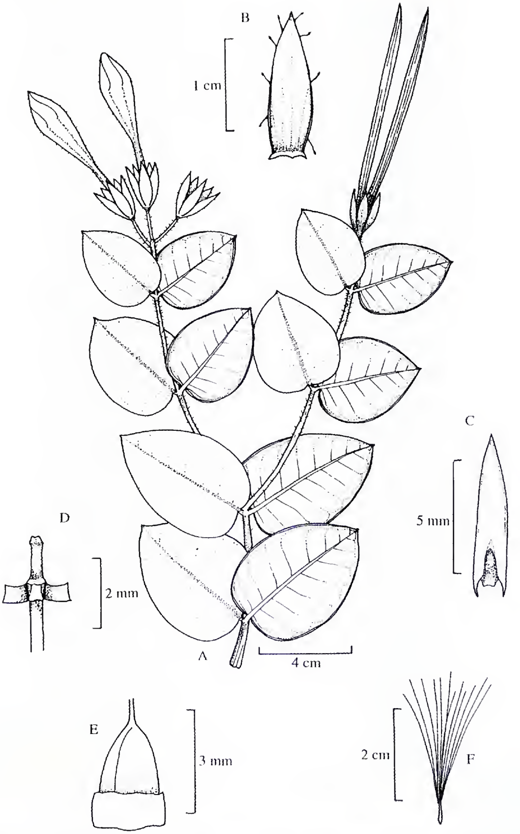


FIG. 6. *Galactophora crassifolia* (*Guillén & Roca 2853*, INB). **A.** Ramita con flores y frutos. **B.** Sépalo, vista adaxial. **C.** Antera, vista dorsal. **D.** Cabeza estigmática. **E.** Nectario y ovario. **F.** Semilla.

glabro; nectario 1–1.2 mm de largo, leve e irregularmente pentalobulado. Folículos 10–17 × 0.3–0.5 cm, continuos, glabros, glabrescentes o variadamente glandular-puberulentos; semillas 3–4 mm de largo, glabras, coma 19–27 mm de largo, crema a blanco-crema.

Distribución, hábitat y ecología.—Se encuentra en Colombia, Venezuela, Brasil, Perú y Bolivia, donde crece en sabanas, bosques enanos en formaciones de arena blanca y en afloramientos rocosos con vegetación arbustiva enana, en elevaciones de 50–600 m. Especímenes con flores han sido recolectados en todos los meses del año. Frutos se reportan de Junio a Febrero.

Nombres comunes.—cupia blanco (Venezuela, Amazonas); bejuco de carbón (Venezuela, Amazonas).

Galactophora crassifolia es la especie más común y ampliamente distribuida, así como la más fácil de reconocer dentro del género por la longitud de sus sépalos, los cuales varían de 15 a 25 mm de largo (vs. 5–12.5 mm en el resto de los taxones). Es común que esta especie sea una hierba erecta o un arbusto pequeño, pero también se conocen especímenes que reportan su hábito en forma de liana (e.g., *Liesner 3415*, MO; *Guillén & Roca 2853*, INB).

Galactophora calycina es reducida a la sinonimia. Básicamente, la única diferencia en los ejemplares tipo de ambas especies es la presencia del indumento de pelos glandulares en *G. crassifolia* y la ausencia de los mismos en *G. calycina*, siendo similares en la longitud de las corolas, sépalos, anteras y demás caracteres. Esto fue comentado en forma previa por Morales y Fuentes (2004 a), quienes sugirieron la sinonimia de *G. calycina*. En el tiempo de la monografía de Woodson (1936), estas especies eran conocidas por solo 17 colecciones (*G. crassifolia* con 7 y *G. calycina* con 10), de las cuales solamente 9 (7 y 2 resperctivamente) fueron revisadas por Woodson. El número evidentemente mayor de material disponible hoy en día, ha permitido conocer mejor la variación morfológica intraespecífica de esta especie y demilitar más claramente sus límites reales. Por otro lado, varias estados intermedios son encontrados, con colecciones con muy escasos pelos, lo que impide aún más la segregación de ambas especies. Es importante recalcar que la pubescencia por sí sola en un carácter bastante variable dentro de las tribus Echiteae y Mesechiteae, donde existen géneros y especies con una alta variabilidad morfológica en ese carácter y que por lo tanto, la separación de taxones por únicamente esa característica es insostenible. Basado en los comentarios y conclusiones anteriores, *G. magnifica* es también reducida a la sinonimia, pues no existen diferencias con la colección tipo de *G. crassifolia*, excepto por la ausencia del indumento en la primera.

Especímenes examinados. **COLOMBIA. Amazonas:** río Apaporis, raudal de Jirijirimo, 11 Sep 1986 (fl), *Bernal et al. 1243* (COL); Leticia, río Caquetá, Santa Isabel, 9 Abr 1994 (fl), *Cárdenas & Gangi 4627* (COAH, INB, MO), río Caquetá, 25 Jul 1977 (fl), *Fernández-Péres 20121* (COAH, COL); río Caquetá, Araracuara, sabana de la Angostura, 21 Dic 1951 (fl), *García-Barriga & Schultes 14149* (COL, US), Araracuara, río Caquetá, 7 Ago 1977 (fl), *Idrobo 8932* (COL); Araracuara, 8 Ago 1977 (fr), *Idrobo 8965* (COL); río Caquetá, Araracuara, Nov 1982 (fl), *Idrobo et al. 11266* (COL), *Idrobo et al. 11465* (COL); Araracuara, río Caquetá, 6 Sep 1959 (fl), *Maguire et al. 44167* (INB, NY, U); Araracuara, balcón del diablo, 16 Oct 1984 (fl), *Palacios et al. 458* (COAH), 18 Feb 1986 (fr), *Palacios & Plazas 855* (COAH), 3 Mar 1986 (fr), *Palacios & Plazas 1168* (COAH), 5 Mar 1986 (fl, fr), *Palacios & Plazas 1220* (COAH); Araracuara, 21 Sep 1990 (fl), *Restrepo & Sánchez 11* (COAH, MO); río Caquetá, Araracuara, 1 Abr 1976 (fl), *Sastre & Reichel 5190* (COL, P); río Apaporis, Raudal de Jerijerimo, Mar 1951 (fl), *Schultes 12109* (COL, GH, MO); río Apaporis, Cachivera de Jirijirimo, 11 Jun 1951 (fl), *Schultes & Cabrera 12368* (COL, MO, NY, U, US); río Apaporis, Cachivera de Jirijirimo, 7 Jul 1951 (fr), *Schultes & Cabrera 12968* (COL, GH, MO, US); río Apaporis, Cachivera de Jirijirimo, 16 Sep 1951 (fl), *Schultes & Cabrera 14060* (COL, MO, US); NE de San Carlos de Río Negro, 9 Abr 1984 (fl), *Stein 1492* (MO). **Amazonas-Vaupés:** Río Apaporis, Jirijirimo, Nov 1951 (fl), *García-Barriga 13752* (COL, NY, US); río Apaporis, 28 Feb 1952 (fl), *Mora & van der Hammen 154* (COL); río Apaporis, raudal de Jirijirimo, 27 Nov 1951 (fl), *Schultes & Cabrera 14626* (COL). **Caquetá:** Solano, río Caquetá, Paujil, NO de Araracuara, 6 Nov 1992 (fl), *Arbelaéz & Sueroque 314* (HUA); Solano, río Caquetá, Araracuara, 15 Nov 1992 (fl), *Arbelaéz & Matapi 347* (COAH, HUA); Solano, Araracuara, 10 Nov 1993 (fl), *Arbelaéz 426* (COAH, HUA); Santa Isabel, Sabanas del Solarte, 4 Dic 1996 (fr), *Arbelaéz et al. 626* (COAH, HUA, U); parque nacional natural Chiribiquete, serranía norte, 26 Nov 1992 (fl, fr), *Barbosa & Rueda 8063* (MA); Araracuara, río Caquetá, balcón del diablo, 19 Nov 1993 (fl), *Cárdenas et al. 4121* (COAH); Araracuara, 13 Nov 1991 (fl), *Duivenvoorden et al. 2743* (COAH); Araracuara, Balcón del diablo, 13 Dic 1983 (fl, fr), *Forero & Pabón 9815* (COAH, COL, MA); sierra del Chiribiquete, refugio Bernardo, 22 Nov 1992 (fl), *Franco et al. 4264* (COL, MA); sierra de Chiribiquete, 13 Dic 1991 (fl), *Galeano et al. 2252* (COL, MA); Araracuara, Balcón del Diablo, 25 Jan 1989 (fl), *Gentry & Sánchez 65166* (MO). **Guainía:** serranía de Naquén, Maimachi, 24 Jul 1992 (fl), *Cortés et al. 129* (COAH); Puerto Inírida, 15 Ago 1975 (fl), *García-Barriga 20879* (COL, F, US); Caño Colorado, La Esperanza, 15 Abr 1993 (fl), *Madriñán & Barbosa 1057* (COL, GH, MO); caserío de Santa Rita, río Guainía, 15 Oct 1977 (fl), *Pabón et al. 355* (COL); Puerto Colombia, río Negro, 27 Oct 1977 (fl), *Pabón et al. 427*[a] (COL). **Vaupés:** río Vaupés, cachoeira de Yuruparí, 10 Nov 1943 (fl), *Allen 3163* (COL); serranía de Taraira, al NO de raudal de la Libertad, 4 Ago 1993 (fl), *Cortés & Rodríguez 788* (COAH, COL); 5 Ago 1993 (fl), *Cortés & Rodríguez 805* (COL); Mitú, entre Timbo y Bogotá Cachivera, 7 Jul 1993 (fl), *Galeano et al. 95* (COL); Mitú, Mandí, río Vaupés, 29 Jul 1993 (fl), *Galeano et al. 1135* (COAH, COL); río Vaupés, Mirití, 24 Nov 1993 (fl), *Galeano et al. 1873* (COAH, COL); río Kubiyú, Guranjudá, 30 Jun 1958 (fl), *García-Barriga et al. 16037* (COL); Cerro de Chiribiquete, río Macaya, 17 Jan 1944 (fl), *Gutiérrez & Schultes 684* (MEDEL); río Negro, San Felipe, 13 Nov 1952 (fl), *Humbert 27444* (P); caño Cubiyú, comunidad Indígena La Sabana, 26 Abr 1993 (fr), *Madriñán et al. 1109* (COL); Mitú, río Vaupés, 28 Oct 1993 (fr), *Mejía et al. 2678* (COL); río Piraparaná, tributario del río Apaporis, 6 Sep 1952 (fl), *Schultes & Cabrera 17228* (US), 18 Sep 1952 (fl), *Schultes & Cabrera 17508* (US); río Negro, San Felipe, 25 Oct 1952 (fl, fr), *Schultes et al. 18003* (MO, US); río Vaupés, entre Mitú y Javareté, 14 May 1953 (fl), *Schultes & Cabrera 19381* (COL, MO, U, US), río Vaupés, Raudal de Yuruparí, Nov 1951 (fl, fr), *Schultes & Cabrera 19713* (MO, U); Mitú, río Paraná-pichuna, 2 Jul 1975 (st), *Zarucchi 1364* (COL); Mitú, río Kuubiyú y río Paraná-Pichuna, 7 Jul 1975 (fl, fr), *Zarucchi 1395* (COL, GH, K), 9 Jul 1975 (fl, fr), *Zarucchi 1407* (COL, GH, K); Mitú, sobre el río Vaupés, Circasia, 13 Sep 1976 (fl), *Zarucchi 2030* (COL, GH, K); Mitú, río Vaupés, entre río Tí y rápidos de Mandí, 23 Sep 1976 (fl), *Zarucchi 2116* (COAH, COL, GH, K, MO, US); Mitú y cercanías, 11 Nov 1976 (fl, fr), *Zarucchi 2213* (COL, GH, K, MO, US); Mitú, río Kubiyú, 15 Jul 1979 (fl), *Zarucchi 2463* (COAH, COL, GH, MA, MO, U, WAG).

VENEZUELA. Amazonas: Atures, N de Santa Rosa de Ucata, 21 Jun 1992 (fl, fr), *Berry et al. 5197* (MO); Yuri, banco del río Temi, 24 Nov 1995 (fl, fr), *Berry et al. 5587* (MO); Bana, S de Yavita, 28 Nov 1995 (fl), *Berry et al. 5709* (MO); San Carlos de Río Negro, 3 Abr 1978 (fl), *Clark 6587* (QCNE); Santa Cruz, río Atabapo, 9 Set 1960 (fl), *Foldats 3804* (NY, VEN); cerro Yapacana, río Orinoco, Abr 1931 (fl), *Holt & Blake 716* (US); Atures, Valle del Caño Camani, O de Cerro Morrocoy, 10 Oct 1979 (fl), *Huber 4636* (MO, MYF, NY, VEN, Z); Río Negro, carretera San Carlos-Soano, 16 Sep 1980 (fl), *Huber et al. 5658*

(COL, K, MO, NY, VEN); E de San Carlos de Río Negro, 13 Nov 1977 (fl, fr), *Liesner 3415* (MO); Bana, NE de San Carlos de Río Negro, 26 Nov 1977 (fl, fr), *Liesner 3903* (MO); Río Negro, faldas de Cerro Aracamuni, 24 Oct 1987 (fl), *Liesner & Carnevali 22403* (MO); Río Negro, NE de San Carlos de Río Negro, 8 Nov 1987 (fl, fr), *Liesner & Carnevali 22881* (MO); Cerro Yavita, ríos Atabapo y Orinoco, 19 Oct 1950 (fl), *Maguire 29300* (NY); río Guainía, E de Maroa, 25 Nov 1953 (fl, fr), *Maguire et al. 36399* (K, NY, US); río Guania, E de Maroa, 6 Oct 1957 (fl), *Maguire et al. 41711* (COL, NY, P, W), 7 Oct 1957 (fl), *Maguire et al. 41739* (NY, US); N de Puerto Colombia, Río Guainia, 12 Oct 1957 (fl), *Maguire et al. 41842* (NY); Río Negro, San Carlos do Río Negro, camino a Solano, 21 Abr 1984 (fl), *Plowman 13708* (F, WAG); N de Raudalito, río Sopapo, 10 Oct 1988 (fl), *Romero & Guánchez 1629* (GH, NY); E de Santa Rosa de Ucata, 23 Oct 1989 (fl), *Romero & Melgueiro 2234* (GH, MO, NY); Río Negro, San Carlos, 15 Dic 1947 (fl), *Schultes & López 9372* (MO); Río Orinoco, cerca de Fernando de Atabapo, 25 Abr 1954 (fl), *Silverio 10* (MO, NY, P); Río Negro, San Carlos de Río Negro, 23–29 Jul 1982 (fl), *Stergios & Aymard 4266* (PORT, US); cerca de San Carlos de Río Negro, 1984 (fl), *Stergios & Aymard 7725* (MO, PORT); entre sabana Esmeralda y base SE de Cerro Duida, 22 Ago 1944 (fl), *Steyermark 57840* (F, MO); Sabanita Morocoto, río Orinoco, 30 May 1959 (fl, fr), *Wurdack & Adderley 42683* (NY); Atabapo, río Cuchaken, Oct 1989 (fl), *Velasco 763* (MO, PORT).

PERU. Madre de Dios: río Health, Santuario Nacional de las Pampas del Health, 14 Jun 1992 (fl, fr), *Castillo & Foster 6910* (F, USM).

BRASIL. Amazonas: río Uatumã, Itapiranga, 18 Ago 1979 (fl), *Cid et al. 475* (NY); carretera Manaus-Caracaraí, 20 Feb 1979 (fl, fr), *Coêlho et al. 940* (BM, INPA); Airão, entre Manaus-Caracaraí, 27 Mar 1979 (fl), *Coêlho et al. 1395* (BM, COL, INPA), Ponta Negra, cerca de Manaus, 20 Nov 1910 (fl), *Ducke 11197* (MG, foto en INB); Manicoré, camino a Humaitá, 24 Abr 1985 (fl), *Ferreira 5798* (INPA, K, NY, US, WAG); entre Vaupés y río Arary, Cachoeira Uapuhy, 2 Nov 1945 (fl), *Fróes 21314* (NY); carretera Manaus-Ponta Negra, cerca de Ponta Negra, 6 Abr 1974 (fl), *Gentry & Prance 11218* (MO); Presidente Figueiredo, Campina das Pedras, Jun 1985 (fl), *Huber & Texeira 10679* (NY, WAG); río Uaupés, camino a Cova do Diabo, 18 Nov 1997 (fr), *Kawasaki 199* (NY); carretera Manaus-Caracaraí, Igarapé Lages, 10 May 1974 (fl), *Nelson & Lima 21094* (NY); carretera Manaus-Itacoatiará, río Urubu, 4 Abr 1967 (fl), *Prance et al. 4749* (INPA, K, NY, US); río Urubu, 29 May 1968 (fl), *Prance et al. 4871* (COL, K, NY, US); Manaus-Itacoatiara, 10 Jun 1968 (fl, fr), *Prance et al. 5125* (NY, US); entre Manaus y Caracaraí, 9 May 1974 (fl), *Prance et al. 21045* (NY, U, US, Z); camino a Terra Preta, 1 Jul 1975 (fl), *Prance 23531* (NY); margen del río Aracá, cerca de Serrinha, 25 Jul 1985 (fr), *Prance et al. 29762* (NY, WAG); Manaus, Ponta Negra, 22 Jun 1961 (fl), *Rodrigues & Lima 2863* (INPA, NY); carretera Manaus-Itacoatiara, 5 Jul 1968 (fl), *Rodrigues et al. 8503* (INPA, US), Presidente Figueiredo, Represa de Balbina, 4 Jul 1986 (fl), *Thomas et al. 5324* (NY, WAG); Manaus, Jul 1900 (fl), *Ule 5175* (G, MG, foto en INB); entre Manaus-Caracaraí, 14 Sep 1979 (fl, fr), *Zarucchi et al. 2565* (MO, NY); E de Humaitá, carretera do Estanho, 27 Sep 1979 (fl), *Zarucchi et al. 2592* (INB, MO, NY); S de Borba, 22 Jun 1983 (fl), *Zarucchi et al. 2847* (INPA, K, NY), Axinim, río Abacaxis, 7 Jul 1983 (fl), *Zarucchi 2979* (NY); Presidente Figueiredo, carretera Manaus-Caracaraí, 9 Ago 1983 (fl, fr), *Zarucchi et al. 3235* (NY). **Mato Grosso:** entre Reserva do Cabaçal y Chapada dos Parecis, 26 Oct 1995 (fl), *Hatschbach et al. 63903* (MBM, US). **Pará:** Itaituba, carretera Santarém-Cuiabá, Serra do Cachimbo, 25 Abr 1983 (fl), *Amaral et al. 935* (INPA, NY); Alto Tapajós, rio Cururú, 11 Feb 1974 (fl, fr), *Anderson 10768* (COL, K, MO, NY, US, Z); Oriximiná, río Mapuera, 30 Jun 1980 (fl), *Davidson & Martinelli 10606* (NY); Faro, 21 Ago 1907 (fl, fr), *Ducke 8434* (G, foto F neg. 26869, MG, foto F neg. 45951, P, US); Faro, Ago 1907 (fl), *Ducke 8695* (U); Faro, 17 Ene 1910 (fl, fr), *Ducke 10477* (MG, foto en INB), campina de Infiry, 12 Feb 1910 (fl), *Ducke 10686* (G, foto F neg. 26869, MG, foto en INB); Ariramba, 4 Dic 1910 (fl), *Ducke 11343* (MG, foto en INB); Trombetas, Mariapixy, 17 Dic 1910 (fl), *Ducke 11943* (MG, foto en INB; Itapecurú, 30 Jul 1912 (fl), *Ducke 12090* (MG, foto en INB); Tapajós, rio Cururú, 25 Jul 1959 (fl, fr), *Egler 1034* (MG, NY), 28 Ene 1960 (fl, fr), *Egler 1188* (MG, NY); Oriximiná, río Mapuera, campina de Três Ihlas, 25 Nov 1987 (fr), *Farney et al. 2008* (NY); Oriximiná, río Mapuera, 30 Jun 1980 (fl, fr), *Ferreira et al. 1202* (INPA, MO, NY, US, WAG); Oriximiná, río Mapuera, 19 Ago 1986 (fl), *Ferreira et al. 7802* (INPA, K, MO, NY, US, WAG); cuenca del río Trombetas, río Mapueira, 6 Jun 1974 (fl), *Campell et al. 22535* (INPA, K, MO, NY, U, US, Z); Infiry, 12 Feb 1910 (fl), *Ducke s.n.* (F, MG); Serra do Cachimbo, 15 Dic 1956 (fl), *Pires et al. 6289* (NY); entre Cuiabá-Santarém, 7 Nov 1977 (fl), *Prance et al. 25006* (INB, INPA, K, NY, US). **Rondônia:** Costa Marques, O del río Guatarinho, 25 Mar 1987 (fl), *Nee 34491* (NY).

BOLIVIA. La Paz: Iturralde, Luisita, 9 Feb 1988 (fl), *Haase 827* (LPB). **Santa Cruz:** Velasco, entre Florida y Bella Vista, 4 Nov 1994 (fl), *Guillén et al 2545* (INB, MO, USZ); Velasco, localidad El Refugio, 18 Ene 1995 (fl, fr), *Guillén & Roca 2853* (INB, MO, USZ); Velasco, parque nacional Noel Kempff Mercado, Pampa Grande de Bella Vista, 11 Ago 1995 (fl), *Guillén et al. 3908* (INB, MO, USZ).

4. **Galactophora pulchella** Woodson, Ann. Missouri Bot. Gard. 19:51–52. 1932. (**Fig. 7**). TIPO: BRASIL. AMAZONAS: Cano Pimicheiro, Jun 1854 (fl), *Spruce 3718* (HOLOTIPO: K; ISOTIPOS: P (foto F neg. 38740), W).

Galactophora petiolata Markgr., Notizbl. Bot. Gart. Berlin-Dahlem 14:129. 1938, syn. nov. TIPO: BRASIL. AMAZONAS: Ríos Curuicuriary y Negro, 26 Feb 1936 (fl), *Ducke 30109* (HOLOTIPO: RB; ISOTIPOS: G, K, MG, P, U, US).

Arbusto erecto, 0.5–2 m de altura; tallos aplanados en ramitas jóvenes, teretes a subteretes cuando viejos, sólidos, usualmente glabros; coléteres interpeciolares inconspicuos, menos de 1 mm de largo. Hojas con el pecíolo de 1–5 mm de largo; lámina 2.7–6.2 × 1.3–2.6(–2.9) cm, elípticas a angostamente-elípticas, raramente ovado-elípticas, obtusas a anchamente agudas apicalmente, coriáceas, cuneadas basalmente, glabras a glabrescentes en ambas superficies, usualmente revolutas marginalmente, la venación secundaria levemente impresa en ambas caras o inconspicua, las venas terciarias usualmente no impresas. Inflorescencia terminal a subterminal, diminutamente puberulenta, con unos pocos y esparcidos pelos glandulares, con 5 a 11 flores, pedúnculo 7–42 mm de largo, pedicelos 7–10 mm de largo, brácteas 1–1.5 × 0.5–0.9 mm, escariosas; sépalos 4–6× 1–1.5 mm, muy angostamente ovados a linear-ovados, acuminados, escariosos, esparcida a moderadamente glandular puberulentos, algunas veces algo glabrescentes cuando viejos; corola rosado pálido o blanco-rosadas, el tubo rosado basalmente, con varios pelos glandulares exteriormente, algunas veces glabrescentes cuando viejas, el ápice del botón floral angostamente agudo; parte inferior del tubo 5.5–7 × 1.5–2 mm, la parte superior 15–16 mm de largo, angostamente cónica, 5–7 mm en diámetro en el orificio, lóbulos 11–17 × 7–10 mm, obovados; anteras 4–5 mm de largo, glabras, las bases estériles angostamente agudas, cabeza estigmática 1.1–1.4 mm de largo; ovario 2.1–2.5 mm de largo, glabro; nectario 0.8–1 mm de largo, levemente pentalobulado. Folículos 7–12 × 0.2–0.3 cm, continuos, glabros; semillas 6.5–7.5 mm de largo, glabras, coma 17–23 mm de largo, crema.

Distribución, hábitat y ecología.—Restringida a Venezuela y el N de Brasil, donde crece en vegetación de sabanas y bosques arbustivos enanos en zonas de arena blanca, en elevaciones de 100–200 m. Especímenes con flores han sido recolectados entre Enero y Junio y en Septiembre. Especímenes con frutos han sido recolectados en Septiembre y Octubre.

Galactophora pulchella se puede confundir con *G. pumila*, pero se separa

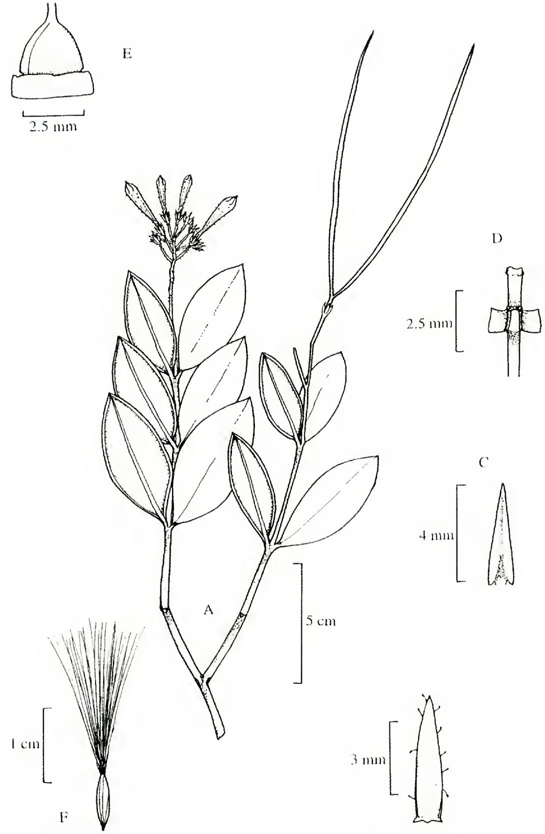


Fig. 7. *Galactophora pulchella* (*Froes 12558*, INB). **A.** Ramita con flores y frutos. **B.** Sépalo, vista adaxial. **C.** Antera, vista dorsal. **D.** Cabeza estigmática. **E.** Nectario y ovario. **F.** Semilla.

por sus inflorescencias con mucho más flores (5–11 vs. 1–2), con los pedúnculos presentes y conspicuos, usualmente de más de 7 mm de largo (vs. ausente o inferior a 2 mm de largo).

Las diferencias entre las colecciones tipo de *Galactophora pulchella* y *G. petiolata* son mínimas y la única diferencia permisible son las hojas más angostas en el tipo de la última especie, siendo concordantes en el resto de los caracteres morfológicos.

Especímenes examinados. **VENEZUELA. Amazonas:** Atures, Caño Ucata, aluente del río Orinoco, 20 Jun 1992 (fl), *Berry et al. 5155* (INB, MO); Atabapo, Cucurital de Caname, Caño Caname, 30 Abr–1 May 1979 (fl), *Davidse et al. 16996* (INB, MO); Río Negro, río Siapa, 6 Feb 1981 (fl), *Huber & Medina 5765* (MO, MYF, NY, U, VEN); Alto río Orinoco, base NO del Cerro Yapacana, 16 Mar 1953 (fl), *Maguire & Wurdack 34481* (NY); Casiquiare, río Pacimoni, 7 Feb 1954 (fl), *Maguire et al. 37595* (NY); Casiquiare, Caño Hechimoni, río Siapa, 9 Feb 1954 (fl), *Maguire et al. 37609* (MO, NY, US); ríos Pacimoni-Yatua, Casiquiare, Piedra Arauicaua, 28 Sep 1957 (fr), *Maguire et al. 41631* (K, NY, US).

BRASIL. Amazonas: Rios Negro y Vaupés, Serra do Tucano, 10 May 1942 (fl), *Froes 12558* (F, NY); Igarapé Tibuiari, afluente do río Vaupés, 22 Nov 1987 (fl), *Kawasaki 247* (WAG).

5. Galactophora pumila Monachino, Mem. New York Bot. Gard. 10:126–127, fig. 16 a–b. 1958. (**Fig. 8**). TIPO: VENEZUELA. AMAZONAS: Río Guainía, Sabana el Venado, banco del Caño Pimichín, 14 Abr 1953 (fl), *Maguire & Wurdack 35563* (HOLOTIPO: NY; ISOTIPO: US).

Hierba erecta hasta 0.3 m de altura; tallos aplanados y algunas veces levemente alados en ramitas jóvenes, teretes a subteretes cuando viejas, sólidos, muy esparcida e inconspicuamente puberulentos, glabrescentes con la edad; coléteres interpeciolares inconspicuos, menos de 1 mm de largo. Hojas con el pecíolo 0.5–1.5 mm de largo; lámina (1.7–)2.1–3.8 × (0.6–)0.8–1.7 cm, angostamente elípticas, obtusas a redondeadas apicalmente, algunas veces muy inconspicuamente mucronuladas, anchamente cuneadas a obtusas basalmente, coriáceas, glabras, algunas veces con puntuaciones negras abaxialmente, revolutas marginalmente, la venación secundaria levemente impresa adaxialmente a más comúnmente inconspicua, venas terciarias usualmente no impresas. Inflorescencia terminal, glabrescente, con 1 a 2 flores, pedúnculo inconspicuo o ausente, pedicelos 8–13.5 mm de largo, brácteas menos de 1 mm, escariosas; sépalos 8–11 × 1.4–2 mm, angostamente ovados a linear-ovados, acuminados, escariosos, glabrescentes; corola púrpura, rosado-púrpura a rosada, con unos escasos pelos glandulares antes de la antesis, usualmente glabrescentes cuando viejas, el ápice del botón flora agudo; parte inferior del tubo 10–11 × 1.5–2 mm, la parte superior 23–31 mm de largo, cónica a angostamente cónica, 14–16 mm en diámetro en el orificio; lóbulos 14–19 × 8–16 mm, obovados; anteras 4.8–5.2 mm de largo, glabras, las bases estériles conspicuamente acuminadas, cabeza estigmática 1.9–2.2 de largo; ovario 1.6–2.1 mm de largo, glabro; nectario 0.4–0.5 mm de largo, usualmente muy leve e irregularmente lobulado. Folículos 8.5–15 × 0.2–0.3 cm, continuos, glabros; semillas desconocidas.

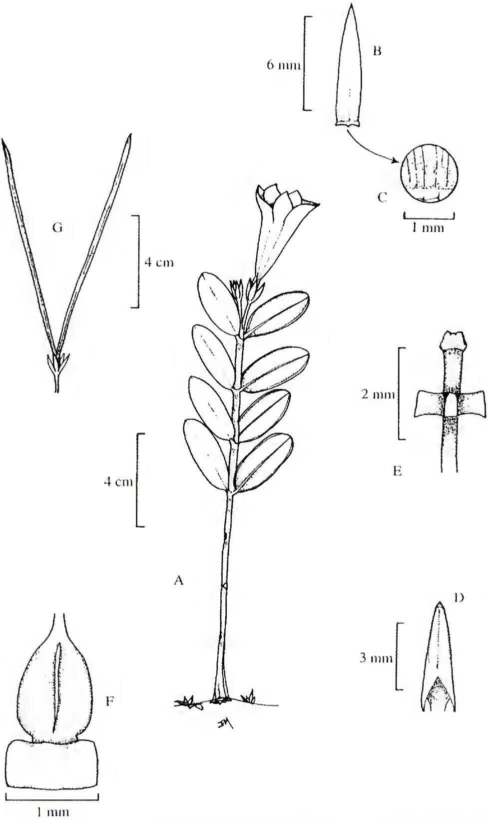


FIG. 8. *Galactaphora pumila* (A-F de *Huber 2594*, INB; G de *García-Barriga 20893* COL). **A.** Hábito. **B.** Sépalo, vista adaxial, mostrando un detalle de la ausencia de coléteres en la base. **C.** Detalle de los coléteres. **D.** Antera, vista dorsal. **E.** Cabeza estigmática. **F.** Nectario y ovario. **G.** Folículos.

Distribución, hábitat y ecología.—Conocida en las partes bajas de la cuenca amazónica en Colombia y Venezuela, donde crece en sabanas y vegetación arbustiva asociada a afloramientos rocosos en elevaciones de 100–400 m. Especímenes con flores han sido recolectados en Abril, Junio, Agosto y Noviembre.

Galactophora pumila es una especie muy distintiva que se reconoce con facilidad por su pequeño tamaño, raramente excediendo los 30 cm de altura, hojas angostas y pequeñas, inflorescencias reducidas a 1 ó 2 flores, y corolas con los lóbulos relativamente pequeños, raramente excediendo los 19 mm de largo.

Especímenes examinados. **COLOMBIA. Guainía:** Puerto Inírida, 14 Ago 1975 (fl), *García-Barriga 20841* (COL, F, US); Puerto Huesito, sabanas del Alto de La Cruz, 18 Ago 1975 (fr), *García-Barriga 20893* (COL, US); Cacagual, río Atabapo, 13 Set 1957 (fl), *Maguire et al. 41434* (COL, NY, US); Puerto Inírida, Cacahual, río Atabapo, 25 Nov 1998 (fl, fr), *Márin 659* (COAH).

VENEZUELA. Amazonas: Santa Cruz, río Atabapo, 9 Set 1960 (fl), *Foldats 3824* (NY, VEN); Atabapo, alrededores de Canaripó, bajo río Ventuari, 30 May 1978 (fl), *Huber 1934* (NY), Atabapo, Laguna de Yagua, 24 Ago 1978 (fl), *Huber 2559* (NY); Casiquiare, sabana al O de Pimichín, 25 Ago 1978 (fl), *Huber 2594* (INB, MO, MYF, NY, VEN); Atabapo, Guarinuma, río Atabapo, 25 Ago 1978 (fl), *Huber 2664* (NY); Atabapo, base del Cerro Cucurito, 8 Dic 1978 (fl), *Huber & Tillet 2953* (NY); río Atabapo, al O de Cacagual, 19 Nov 1953 (fl), *Maguire et al. 36274* (NY); río Guainía, Sabana El Venado, 23 Nov 1953 (fr), *Maguire et al. 36358* (NY, US); río Guainía, caño Pimichín, Sabana El Venado, 10 Oct 1957 (fl), *Maguire et al. 41809* (NY); río Atabapo, Caño Cumare, San Fernando de Atabapo, 3 Jun 1959 (fl), *Wurdack & Adderley 42773* (G, K, NY, U, US), Sabana Manacal, río Atabapo, cerca de Guarinumo, 12 Jun 1959 (fl, fr), *Wurdack & Adderley 42951* (NY, W).

6. Galactophora schomburgkiana Woodson, Ann. Missouri Bot. Gard. 19:50–51. 1932. (**Fig. 9**). Tipo: GUYANA: Datos perdidos (fl, fr), *Schomburgk s.n.* (HOLOTIPO: K).

Galactophora schomburgkiana var. *megaphylla* Monac., Mem. New York Bot. Gard. 10:127, 129. 1958. Tipo. VENEZUELA. Amazonas: Cerro Duida, río Cunucunuma, 22 Nov 1958 (fr), *Maguire et al. 29706* (HOLOTIPO: NY; ISOTIPOS: F (foto F neg. 51104), US).

Hierba erecta, 0.5–2 m de altura; los tallos teretes a subteretes, algo aplanados en ramitas jóvenes, sólidos, diminuta y moderada a esparcidamente glandular-puberulentos, los pelos glandulares negros, glabrescentes con la edad; coléteres interpeciolares inconspicuos, ca. 1 mm de largo o menos. Hojas con el pecíolo 2–7(–9) mm de largo; lámina (3.5–)4–8.5 _ (1.9–)2.8–5 cm, ovadas, angostamente elípticas a ovado-elípticas, obtusas a redondeado-mucronuladas apicalmente, cordadas a subcordadas basalmente, coriáceas, esparcida y diminutamente glandular- puberulentas en ambas caras, algo revolutas marginalmente, las venas terciarias y secundarias conspicuamente impresas en ambas caras. Inflorescencia terminal, diminutamente glandular-puberulenta, con 3 a 5 flores, pedúnculo 1.4–50 mm de largo, pedicelos 8–15 mm de largo, brácteas 1–3 _ 0.5–1 mm, escariosas; sépalos 5–11(–12.5) _ 2–2.5 mm, angostamente ovados a angostamente ovado-elípticos, acuminados, escariosos a subfoliáceos, muy diminuta y esparcidamente glandular-puberulentos, algunas veces algo glabrescentes cuando viejos; corola púrpura, rosado-púrpura a rojizo-rosado,

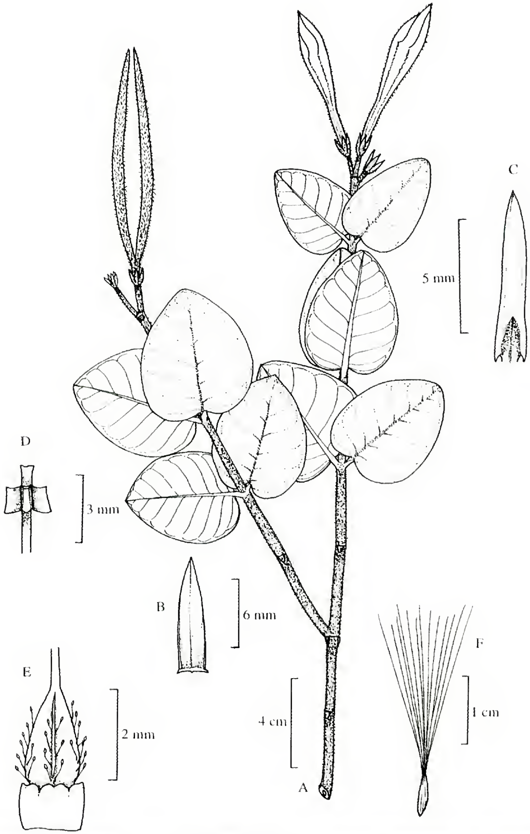


Fig. 9. *Galactophora schomburgkiana* (*Liesner 18551*, MO). **A.** Ramita con flores y frutos. **B.** Sépalo, vista adaxial. **C.** Antera, vista dorsal. **D.** Cabeza estigmática. **E.** Nectario y ovario. **F.** Semilla.

muy esparcidamente glandular puberulentas exteriormente, algunas veces glabrescentes cuando viejas, el ápice del botón floral agudo; parte inferior del tubo 19–31 × 3–3.5 mm, la parte superior 25–42 mm de largo, cónica, (18–)23–32 mm en diámetro en el orificio; lóbulos 23–30 × 22–32 mm, obovados; anteras 7.2–8 mm de largo, glabras, las bases estériles muy cortamente acuminadas, cabeza estigmática 1.9–2.2 mm de largo; ovario 2.8–3.1 mm de largo, con varios pelos glandulares; nectario 1–1.2 mm de largo, irregularmente pentalobulado. Folículos 9–14 × 0.5 cm, continuos, diminuta y densa a moderadamente glandular-puberulentos; semillas 5–6.5 mm de largo, glabras, coma 20–25 mm de largo, canela o amarillo-canela.

Distribución, hábitat y ecología.—bosques enanos y ventosos, áreas de vegetación en lajas graníticas, sabanas y bosques enanos y mezclados con pastizales en elevaciones de 750–2000 m. Floración ocurre de Octubre a Junio. Especímenes con frutos se han recolectado entre Marzo y Junio, Noviembre y Diciembre.

Galactophora schomburgkiana puede confundirse con *G. crassifolia*, pero se puede separar por sus hojas cortamente pecioladas, con pecíolos de 2–4.5 (-6.5) mm de largo (vs. 0–1.5 mm de longitud), hojas con la venación terciaria usualmente impresa en ambas caras (vs. no impresa) y sépalos más cortos, de 5–12.5 mm de largo (vs. 15–25 mm).

La variación intraespecífica extrema e intergradada en el tamaño de las hojas presentes en algunos miembros de las Apocynoideae, no permite reconocer la segregación de variedades basado en ese variable carácter, máxime si no existen en forma adicional, caracteres morfológicos discontinuos para separarlas. Por lo tanto, *G. schomburgkiana* var. *megaphylla* es reducida a la sinonimia.

Especímenes examinados. **VENEZUELA. Amazonas:** Cerro de la Neblina, NNO de Pico Phelps, 12 Feb 1985 (fl), *Boom & Weitzman 5757* (INB, MO, NY); Serranía Parú, río Parú, 31 Ene 1951 (fl), *Cowan & Wurdack 31085* (NY), 2 Feb 1951 (fl), *Cowan & Wurdack 31135* (NY), 4 Feb 1951 (fl), *Cowan & Wurdack 31203* (F, NY, US); Atures, cerca de la comunidad indígena de la etnia Piaroa, 6 Nov 1984 (fl), *Guanchez & Melgueiro 3296* (WAG); Atabapo, cerca de Salto Los Monos, tributario de río Iguapo, 11 Mar 1985 (fl, fr), *Liesner 18551* (MO); río Negro, cima del Cerro Aracamuni, 25 Oct 1987 (fl, fr), *Liesner & Carnevali 22411* (MO). **Bolivar:** sabanas del altiplano de Auyantepui, Sep 1937 (fl), *Cardona 112* (US); Piar, Auyantepui, río Churum, 27 Mar 1987 (fl), *Delascio 13199* (MO, VEN); Gran Sabana, 28 Mar–12 Abr 1988 (fl), *Hernández et al. 1* (1), *Hernández et al. 24* (P); Piar, cima del Auyan-tepui, río Churum, 30 Mar 1987 (fl, fr), *Holst 3807* (MO, NY, U, US); Piar-Sifontes, área del río Uaiparú, NNO de Ikabarú, 18 Feb 1986 (fr), *Huber & Fernández 11338* (MO, NY, WAG); E de El Paujil, O de Santa Elena, río Las Ahallas, 30 Oct 1985 (fl), *Liesner 19167* (MO); S de El Paujil, Moricahl, 8 Nov 1985 (fl), *Liesner 19711* (MO); río Kamarang, NO de San Rafael, 26 Mar 1952 (fl), *Maguire 33622* (NY, US); Kavanayén, 4 Abr 1952 (fl, fr), *Maguire 33745* (NY); falda SO del Ptari-tepui, 18 Dic 1952 (fl), *Maguire & Wurdack 33822* (F, NY), 17 Dic 1952 (fl), *Maguire & Wurdack 33855* (NY); laldas SE del Ptari-tepui, 10 Nov 1944 (fl), *Steyermark 59975* (F, MO); base del Carrao-tepui, 4 Dic 1944 (fl, fr), *Steyermark 60845* (F); Auyan tepui, río Churún, 4 May 1964 (fl), *Steyermark 93359* (NY, , PUS, VEN), 12 May 1964 (fl, fr), *Steyermark 93755* (F, NY, VEN); Auyán-tepui, Guayaraca, 18 May 1964 (fl), *Steyermark 94184* (NY); quebrada El Cajón, E de Icabarú, 18 Dic 1978 (fl), *Steyermark 117817* (MO, VEN); Auyán-tepui, Dic 1937–Ene 1938 (fl), *Tate 1134* (NY).

GUYANA. Región Cuyuni-Mazaruni, Holitipu, 7 Feb 1996 (fl, fr), *Clarke 1040* (P, US); Kavanayen, 28 May 1946 (fl, fr), *Lasser 1806* (F [2 láminas], NY, VEN); montañas Pakaraima, cerro Aymatoi, 17 Oct 1981 (fl, fr), *Mass et al. 5825* (U, WAG); Cuyuni-Mazaruni, al O de cima del Holitipu, 31 May 1990 (fl, fr), *McDowell & Gopaul 3015* (CAY, F, P, MO, NY, P, U, US)

APÉNDICE 1: LISTA NUMÉRICA DE TAXAS ACEPTADOS

Galactophora angustifolia J.F. Morales
Galactophora colellana Morillo
Galactophora crassifolia (Müll.Arg.) Woodson
Galactophora pulchella Woodson
Galactophora pumila Monachino
Galactophora schomburgkiana Woodson

APÉNDICE 2: ÍNDICE A NOMBRES EN EL TRATAMIENTO SISTEMÁTICO

- Amblyanthera
  - *crassifolia* Müll.Arg. (= *G. crassifolia*)
- Dipladenia
  - *calycina* Huber ex Ducke (= *G. crassifolia*)
- Galactophora
  - angustifolia J.F. Morales
  - *calycina* (Huber ex Ducke) Woodson (= *G. crassifolia*)
  - colellana Morillo
  - crassifolia (Müll.Arg.) Woodson
  - *magnifica* Woodson (= *G. crassifolia*)
  - *petiolata* Markgraf (= *G. pulchella*)
  - pulchella Woodson
  - pumila Monachino
  - schomburgkiana Woodson
- **Rhodocalyx**
  - *crassifolius* (Müll.Arg.) Miers (= *G. calycina*)

APÉNDICE 3: ÍNDICE A EXSICADOS

Hernández, S. et al., 1 (6), 24 (6).
Hoehne, F., 1759 (3).
Holst, B., 3807 (6).
Holt, E. & E. Blake, 716 (3).
Huber, O., 1934 (5); 2559 (5); 2594 (5); 2664 (5); 4636 (3).
Huber, O. & A. Fernández, 11338 (6).
Huber, O. & E. Medina 5765 (4).
Huber, O. & Texeira, 10679 (3).
Huber, O. & S. Tillet, 2953 (5).
Huber, O. et al., 5658 (3).
Humbert, H., 27444 (3).
Idrobo, J., 8932 (3); 8965 (3).
Idrobo, J. et al., 11266 (3); 11465 (3).
Kawasaki, M., 199 (3); 247 (4).
Lasser, T., 1806 (6).
Liesner, R., 3415 (3); 3903 (3); 16644 (2); 18551 (6); 19167 (6); 19711 (6); 25878 (2).
Liesner, R. & G. Carnevali, 22403 (3); 22411 (6); 22881 (3).
Maas, P. et al., 5825 (6).
Madriñán, S. & C. Barbosa, 1057 (3).
Madriñán, S. et al., 1109 (3).
Maguire, B., 29300 (3); 33622 (6); 33745 (6).
Maguire, B. & J. Wurdack, 33822 (6); 33855 (6); 34481 (4); 35563 (5).
Maguire, B. et al., 29706 (6); 36274 (5); 36358 (5); 36399 (3); 37609 (4); 37595 (4); 41434 (5); 41631 (4); 41711 (3); 41739 (3); 41809 (5); 41842 (3); 44167 (3).
Marín, C., 659 (5).
McDowell, T. & D. Gopaul, 3015 (6).
Mejía, A., et al., 2678 (3).
Mora, L. & T. Van der Hammen, 154 (3).
Nee, M., 34491 (3).
Nelson, B. & Lima, 21094 (3).
Pabón, M. et al., 355 (3); 427ª (3).
Palacios, P. & B. Plazas, 855 (3); 1168 (3); 1220 (3).
Palacios, P. et al., 458 (3).
Pires, M. et al., 6289 (3).
Plowman, T., 13708 (3).
Prance, G. et al., 4749 (3); 4871 (3); 5145 (3); 21045 (3); 23531 (3); 25006 (3); 29762 (3).
Restrepo D. & M. Sánchez, 11 (3).
Rodrigues, W. & Lima, 2863 (3).
Rodrigues, W. et al., 8503 (3).
Romero, G. & F. Guánchez, 1629 (3).
Romero-Castañeda, R. & E. Melgueiro, 2234 (3).
Sastre, C. & H. Reichel, 5190 (3).
Schomburgk, R., s.n. (6).
Schultes, R., 12109 (3).
Schultes, R. & I. Cabrera, 12368 (3); 12968 (3); 14060 (3); 14626 (3); 17228 (3); 17508 (3); 17673 (2); 19381 (3); 19713 (3).
Schultes, R. & F. López, 9372 (3).
Schultes, R. et al., 18003 (3).
Silveiro, J., 10 (3).
Spruce, R., 3136 (3); 3718 (4).
Stein, B., 1492 (3).
Stergios, B. & G. Aymard, 4266 (3); 7725 (3).
Steyermark, J., 57840 (3); 59975 (6); 60845 (6); 3359 (6); 93755 (6); 94184 (6); 117817 (6).
Tate, G., 1134 (6).
Thomas, W. et al., 5324 (3).
Ule, E., 5175 (3).
Weber, A. & A. Knob, 1719 (2).
Wurdack, J. & L. Adderley, 42683 (3); 42773 (5); 42951 (5).
Velasco, J., 763 (3).
Velayos, M. et al., 6319 (1).
Zarucchi, J., 1364 (3); 1395 (3); 1407 (3); 2030 (3); 2116 (3); 2213 (3); 2463 (3); 2979 (3).
Zarucchi, J. et al., 2565 (3); 2592 (3); 2847 (3); 3235 (3).

AGRADECIMIENTOS

Se agradece a los siguientes herbarios por el envío de material en préstamo o por permitir el uso de sus colecciones; ALCB, ASE, BHCB, BM, CAY, CEN, CGE, COAH, COL, CVRD, ESA, ESAL, F, G, G-BOIS, G-DC, GH, HB, HUA, INPA, K, LPB, MEDEL, MG, MO, MOL, NY, P, QCNE, RB, SPF, US, USM, USZ, VEN, VIC, W, Z. Se agradece la autorización del Missouri Botanical Garden (MO) y a James Solomon, por la fotografía de *Galactophora crassifolia* aquí utilizada. Un especial reconocimiento al Herbario del Museo Paraense Emilio Goeldi (MG) en Belém, Pará, Brasil y en especial a Ione Bemerguy, por el envio de fotografías del holotipo y paratipos de *Dipladenia calycina*. También quiero agradecer a Luci-

lle Allorge, por permitirme el acceso a las colecciones de los herbarios del Museo de Historia Natural de Francia (P), así como a Bruno Wallnöfer (W) en Vienna, Austria y a Paul e Hiltje Maas por las facilidades brindadas para la visita de varios herbarios en Holanda. Otras personas que colaboraron con facilidades en el trabajo o logística en diferentes herbarios en Sur América fueron Julio Betancur (COL), Ricardo Callejas y Javier Francisco Roldán (HUA), Stephan Beck (LPB), Alvaro Cogollo (JAUM), Homero Vargas (QCNE), Asunción Cano (USM) y Alfredo Fuentes (USZ). Asimismo, quiero agradecer la ayuda de Rodolfo Vásquez y Rocío Rojas por facilitar mis visitas a Lima, Perú.

REFERENCIAS

De Candolle, A. 1844. Apocynaceae. En: A de Candolle, ed. Prodromus systematis naturalis regni vegetabilis, Treuttel & Würtz, Paris. Paris. 8:317–489.

Endress, M.E. y Bruyns P. 2000. A revised classification of the Apocynaceae s.l. Bot. Rev. 66: 1–56.

Fallen, M. 1983. A taxonomic revision of *Condylocarpon* (Apocynaceae). Ann. Missouri Bot. Gard. 70:149–169.

Hansen, B.F. 1985. A monographic revision of *Forsteronia* (Apocynaceae). Ph. D. dissertation, Univ. of South Florida, Tampa. [University Microfilms International, Ann. Arbor.].

Judd, W., W. Sanders, y M. Donoghue. 1994. Angiosperm family pairs: preliminary phylogenetic analyses. Harvard. Pap. Bot. 5:1–51.

Leeuwenberg, A.J.M. 1994a. A revision of *Tabernaemontana* Two. The New World species and *Stemmadenia*. The Royal Botanic Gardens, Kew, Richmond, England.

Leeuwenberg, A.J.M. 1994b. Taxa de the Apocynaceae above of the genus level. Agric. Univ. Wageningen Pap. 94:45–60.

Morillo, G.N. 1995. *Galactophora* (Apocynaceae), En: J.A. Steyermark et al., eds. Flora of the Venezuelan Guayana. Timber Press; Missouri Botanical Garden, Portland; St. Louis, U.S.A. 2:498, 501–504.

Morales, J.F. 1997. A synopsis of the genus *Prestonia* (Apocynaceae) section *Tomentosae* in Mesoamerica. Novon 7:59–66.

Morales, J.F. A synopsis of the genus *Mandevilla* (Apocynaceae) in Mexico and Central America. Brittonia 50:214–233.

Morales, J.F. 1999. A synopsis of the genus *Odontadenia* (Apocynaceae) en A. J. M. Leeuwenberg (ed.), Series of revisions of Apocynaceae XLV. Bull. Jard. Bot. Nat. Belg. 67:381–477.

Morales, J.F. 2002. Studies in Neotropical Apocynaceae II: A revision of the genus *Fernaldia*. Rhodora 104:186–200

Morales, J.F. 2003. Studies in Neotropical Apocynaceae III: A revision of the genus *Secondatia*, with discussion of generic classification. Candollea 58:305–319.

Morales, J.F. y A. Fuentes. 2004a. Estudios en las Apocynaceae Neotropicales V: una nueva especie, nuevos reportes y nueva sinonimia en las Apocynaceae de Bolivia. Sida 21: 165–174.

MORALES, J.F. y A. FUENTES. 2004b. Estudios en las Apocynaceae Neotropicales VIII: nuevas especies de *Mandevilla* (Apocynoideae, Mesechiteae) para Perú y Bolivia, con notas sobre la morfología floral en corolas infundibuliformes. Candollea 59:167–174.

MULLER ARGOVIENSIS, J. 1860. Apocynaceae. En: C.F.P. von Martius, ed. Flora Brasiliensis München, Wien, Leipzig. 6(1):1–180.

PICHON, M. 1948a. Classification des Apocynacées. I. Carissées et Ambelaniées. Mém. Mus. Natl. Hist. Nat., Sér. B., Bot. 24:111–181.

PICHON, M. 1948b. Classification des Apocynacées. V. Cerbérroïdées. Not. Syst. Paris 13: 212–229.

PICHON, M. 1948c. Classification des Apocynacées. XIX. Le rétinacle des Echitoïdées. Bull. Soc. Bot. France 95:211–216.

PICHON, M. 1949. Classification des Apocynacées. IX. Rauvolfiées, Alstoniées, Allamandées et Tabernaémontanoidées. Mém. Mus. Natl. Hist. Nat. 27:153–251.

PICHON, M. 1950a. Classification des Apocynacées. XXV. Echitoïdées. Mém. Mus. Natl. Hist. Nat., Sér. B., Bot. 1:1–143.

PICHON, M. 1950b. Classification des Apocynacées. XXVIII. Supplément aux Plumérioïdées. Mém. Mus. Natl. Hist. Nat., Sér. B., Bot. 1:145–173.

SCHUMANN, K.M. 1895. Apocynaceae. In: A. Engler & K. Prantl, eds. Die natürlichen Pflanzenfamilien Vol 4(2):109–189.

SENNBLAD, B. y B. BREMER. 1996. The familial and subfamilial relationships of Apocynacecae and Asclepiadaceae evaluated with rbcL data. Pl. Syst. Evol. 202:153–175.

SENNBLAD, B., M.E. ENDRESS, y B. BREMER. 1998. Morphology and molecular data in phylogenetic fraternity: the tribe Wrightieae (Apocynaceae) revisited. Amer. J. Bot. 85:1143–1158.

SIMÕES, A., M. ENDRESS, T. VAN DER NIET, L. KINOSHITA, y E. CONTI. 2004. Tribal and intergeneric relationships of Mesechiteae (Apocynoideae, Apocynaceae): evidence from three noncoding DNA regions and morphology. Amer. J. Bot. 91:1409–1418.

WILLIAMS, J.K. 1998. A revision of *Thenardia* Kunth (Apocynaceae, Apocynoideae). Lundellia 1:78–94.

WOODSON, R.E. 1932. New or otherwise Noteworthy Apocynaceae of Tropical America II. Ann. Missouri Bot. Gard. 19:45–76.

WOODSON, R.E. 1933. Studies en the Apocynaceae IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 20:605–790.

WOODSON, R.E. 1935. Studies in the Apocynaceae. IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 22:153–306.

WOODSON, R.E. 1936. Studies in the Apocynaceae. IV. The American genera of Echitoideae. Ann. Missouri Bot. Gard. 23:169–438.

BOOK REVIEW

DAVID MORE (illustrations) and JOHN WHITE (text). 2002. **The Illustrated Encyclopedia of Trees.** (ISBN 0-88192-520-9, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $79.95, 800 pp., water color paintings, 6" × 9".

This book is the immediate predecessor of the 2004 *Collins Tree Guide* by Owen Johnson (text) and David More (illustrations) (reviewed in the previous Sida issue [21(3):1322]. The illustrations are extremely accurate and distinctive, but there is remarkable little duplication of illustrations between the two. My comment about the HarperCollins volume also holds for the Timber Press one: "For those interested in cultivated trees in the U.S.A., this is a prime reference." *Anyone* interested in trees will find it interesting and useful (and that's a broad recommendation).

Notes from the coverleaf of *The Illustrated Encyclopedia* are good: "Years ago, artist David More set himself the task of observing and meticulously painting the trees found in Britain, France, Germany, and the Low Countries—common or rare, native or introduced, growing wild or cultivated in arboreta, parks, and gardens. Deciduous trees were painted in the dead of winter as well as in full leaf; he also painted precise details of leaves or needles, bark, blossoms, fruit, nuts and cones. This enormous undertaking required years of study, travel, sketching, painting, and repainting until he was satisfied with each leaf on each page. The results are to be found in this extraordinary book. Well over a thousand species are shown together with as many cultivars. John White's accompanying text describes the native range of each species, the date of its introduction into cultivation, and other key facts. The trees to be found in British and European landscapes are mostly those to be found in North America as well—not surprising, since so many popular trees cultivated in Europe are in fact American natives. Thus, this magnum opus will prove as useful and inspiring in the Western Hemisphere as in the lands of its origin."—*Guy Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76012-4060, U.S.A.*

LECTOTYPIFICATION AND A NEW COMBINATION IN *MATELEA* (APOCYNACEAE: ASCLEPIADOIDEAE) FOR AN ENDEMIC HISPANIOLAN VINE

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

A new combination in *Matelea* is proposed **Matelea domingensis**.

RESUMEN

Se propone una nueva combinctión in *Matelea*: **Matelea domingensis**

Critical study of West Indian specimens of subtribe Gonolobinae (Apocynaceae: Asclepiadoideae) has resulted in the need for a new combination for an endemic Hispaniolan vine:

Matelea domingensis (Alain) Krings, comb. nov. BASIONYM: *Gonolobus domingensis* Alain, Moscosoa 3:46. 1978. TYPE: REPUBLICA DOMINICANA: trepadora de 50–60 cm de largo; flores verde amarillentas; sobre rocas, al pie de un farallón, estribo sur del Isabel de Torres, Puerto Plata, alt. 750 m, 16–17 Aug 1975, *Alain & Perfa Liogier 23780* (LECTOTYPE, here designated: JBSD!)

The critical character defining placement in *Gonolobus* Michx.—laminar dorsal anther appendages (Woodson 1941; Rosatti 1989; Stevens 2001)—is lacking, although mistakenly attributed to the species by Alain Henri Liogier (loc. cit., 1994). When pressed, the apically bilobed, staminal coronal segments (Cs sensu Liede & Kunze 1993; Kunze 1995) of the single prominent open flower of the type specimen were flattened in such a manner to perhaps superficially appear as dorsal anther appendages (Cd sensu Kunze 1995) (Fig. 1, A). However, close scrutiny, as well as study of an additional flower on the type (pressed sideways), reveals that the 'appendages' are in fact erect staminal coronal segments (Fig. 1, B; Fig. 2). Other characters that have been used to refer taxa to *Gonolobus* include winged follicles and the absence of glandular hairs (see Woodson 1941). Follicles are unknown for *Matelea domingensis*, but this character appears to be moot. Few fruit collections were apparently available to Woodson (1941) and more recent analysis has shown the character not to be useful in generic delimitation (Krings, unpubl.). Glandular hairs, although thought characteristic

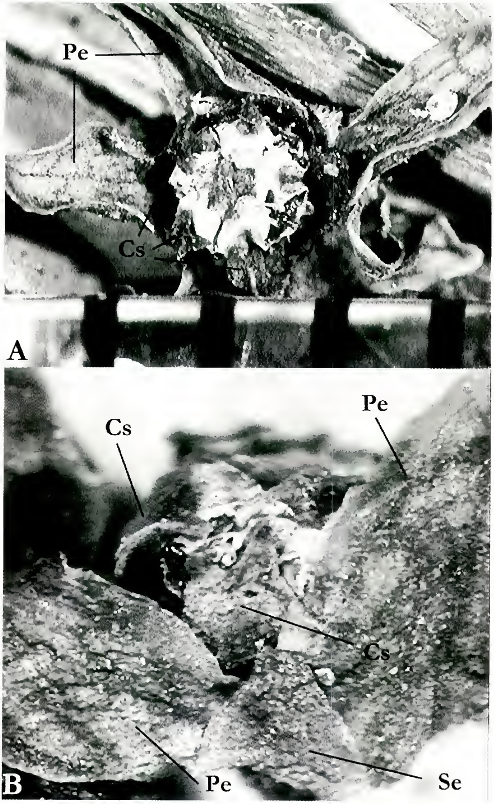


Fig. 1. Flowers of the lectotype of *Matelea domingensis* (Alain) Krings (*Alain & Perfa Liogier 23780*, JBSD): **A**, Openly pressed flower, showing reticulate petals and staminal corona segments arching over the gynostegium; **B**, sideways pressed flower, showing an apically bilobed, erect staminal coronal segment (center). **Cs** = staminal coronal segment; **Pe** = petal; **Se** = sepal. Scale in millimeters.

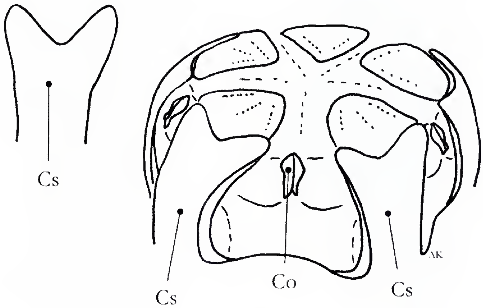


Fig. 2. Corona of *Matelea domingensis* (Alain) Krings (based on *Alain & Perfa Liogier 23780*, JBSD). **Co** = corpusculum; **Cs** = staminal coronal segment.

of *Matelea* Aubl. by Woodson (1941), are also without circumscriptional value in the *Gonolobus-Matelea* question, being present in both the type of *Gonolobus* Michx. (i.e., *G. suberosus* (L.) R. Br.) and numerous species lacking dorsal anther appendages (Rosatti 1989). From study of *Gonolobus* species in the West Indies and the southeastern United States (including the type; see Krings & Xiang 2004), it appears that characters useful for the recognition of *Gonolobus* s.s. include the combined presence of dorsal anther appendages and cordate leaf bases, although at least *G. pubescens* Griseb., *G. stellatus* Griseb., and *G. stapelioides* Desv. ex Ham. have rounded to cuneate leaf bases. A cushion-like gynostegial corona of fused staminal and interstaminal segments that is more or less prostrate, rather than erect, is also nearly ubiquitous among West Indian and southeastern United States *Gonolobus* taxa, including *G. suberosus*, *G. martinicensis* Decne., *G. stellatus*, and *G. stephanotrichus* Griseb. It appears absent in *G. jamaicensis* Rendle, although additional material is needed for further study. A reticulate corolla, as found in *M. domingensis*, does not occur in West Indian or Southeast United States taxa bearing dorsal anther appendages (these referable to *Gonolobus*). Reticulate corollas however, are common in several West Indian taxa that bear winged follicles but lack dorsal anther appendages (see Krings 2005a, b). On-going research aims to resolve the relationships among these taxa using molecular data. Recent progress has shown monophyly for the Gonolobinae (Liede-Schumann et al. 2005), however, with the inclusion of only five *Matelea* and *Gonolobus* taxa, intra-subtribal relationships were not a focus of the study and were not resolved. The emergence of '*Matelea gonocarpa*' (type for *Gonolobus*) within a clade of other *Gonolobus* taxa supports prior treatment of the taxon in *Gonolobus* (see Rosatti 1989; Krings & Xiang 2004). Until a better resolution is achieved and rather than maintaining two internally very polymorphic genera, taxa lacking laminar, dorsal anther appendages, including *M. domingensis*, appear best treated in *Matelea*.

Some discrepancies exist between the protologue and the type specimen for *Matelea domingensis*. Two syntypes were cited in the protologue: "*Alain & Perfa Liogier 13780* (SDM, NY)"; "*A.& P. Liogier & N. Melo 23348* (SDM)." As cited, "SDM" is not an official *Index Herbariorum* acronym, rather an abbreviation for the herbarium of the Jardín Botánico Nacional Dr. Rafael M. Moscoso in Santo Domingo, Dominican Republic or JBSD. However, on the sheet at JBSD, the collection number is typed as 23780. The rest of the label information on the sheet is consistent with the protologue. A handwritten determination on the label reads: "*Gonolobus domingensis* Alain, sp. nov." The collection number "13780" is also cited by Liogier (1994), although the collector recently indicated that it should be 23780 as on the specimen label (Liogier, pers. comm.). Specimens were requested as well from NY, however, *G. domingensis* does not appear to be part of their collections. The additional syntype "*A.& P. Liogier & N. Melo 23348* (SDM)" was not included in a loan from JBSD and it remains unclear whether it is extant. Considering that no other specimens could be found, *Alain & Perfa Liogier 23780* (JBSD) is here designated lectotype for *Gonolobus domingensis* Alain.

ACKNOWLEDGMENTS

I thank the curators and staff of the following herbaria for access to their collections or loans of specimens: BH, BM, BOLO, BREM, BRIT, C, CGE, DUKE, E, F, FI, FLAS, FR, FTG, G, GA, GH, GOET, H, HAC, HAJB, HBG, IJ, JBSD, JE, K, KY, LL, M, MICH, MIN, MISS, MO, NCU, NO, NY, O, OK, OXF, P, PH, RSA, S, TENN, TEX, U, UC, UNA, US, USCH, USF, WILLI, WU, Z. I also thank the curators and staff of the following herbaria for searching their collections for West Indian Gonolobinae material, although finding no representation: BG, BKL, BR, BUF, COLO, CR, FLAS, IA, ISC, LD, MSU, NEU, NSW, UPS, TUR. The thoughtful review of a previous version of the manuscript by Alain Liogier and Mary Endress is gratefully acknowledged.

REFERENCES

Krings, A. 2005a. Notes on the *Matelea bayatensis-correllii-tigrina* complex (Apocynaceae – Asclepiadoideae - Gonolobinae) in the Greater Antilles and Bahamas. Sida 21: 1525–1533.

Krings, A. 2005b. A new combination in *Matelea* (Apocynaceae - Asclepiadoideae) for an endemic Jamaican vine. Sida 21:1515–1517.

Krings, A. and Q.-Y. Xiang. 2004. The *Gonolobus* complex (Apocynaceae - Asclepiadoideae) in the southeastern United States. *Sida* 21:103–116.

Kunze, H. 1995. Floral morphology of some Gonolobeae (Asclepiadaceae). Bot. Jahrb. Syst. 117:211–238.

Liede, S. and H. Kunze. 1993. A descriptive system for corona analysis in Asclepiadaceae and Periplocaceae. Pl. Syst. Evol. 185:275–284.

Liede-Schumann, A. Rapini, D.J. Goyder, and M.W. Chase. 2005. Phylogenetics of the New World subtribes of Asclepiadeae (Apocynaceae – Asclepiadoideae): Metastelmatinae, Oxypetalinae, and Gonolobinae. Syst. Bot. 30:184–195.

Liogier, A.H. 1994. La flora de la Española. VI. Familia 178.-Asclepiadaceae. Universidad Central del Este 50, ser. 27:11–49.

Rosatti, T.J. 1989. The genera of suborder Apocynineae (Apocynaceae and Asclepiadaceae) in the southeastern United States. J. Arnold Arbor. 70:443–514.

Stevens, W.D. 2001. Flora de Nicaragua: Asclepiadaceae. Monogr. Syst. Bot. Missouri Bot. Gard. 85:234–270.

Woodson, R.E. 1941. The North American Asclepiadaceae. Ann. Missouri Bot. Gard. 28: 193–244.

BOOK NOTICE

GEORGE W. COX. 1999. **Alien species in North America and Hawaii: Impacts on natural ecosystems.** (ISBN 1-55963-680-7, pbk.). Island Press, 1718 Connecticut Avenue, N.W., Suite 300, Washington, DC 20009, U.S.A. (**Orders:** University of Chicago Distribution Center, 11030 S. Landley Ave., Chicago, IL 60628, U.S.A.; 800-621-2736, custserv@pres.uchicago.edu). $45.00, 387 pp., 6" × 9".

Hopefully, most biologists have known of this book for several years. Tightly organized, easily readable, laden with interesting information and interpretation, a truly remarkable overview.

Introduction

1. The threat of exotics: Biotic pollution
2. North American invaders: the invited and uninvited
3. A brief history of invasions: Human history — an exotic's perspective

Part II. Regional Perspectives

4. The eastern seaboard: Exotics discover America
5. West coast bays and estuaries: Swamping the natives
6. Northern temperate lakes: Chaos along the food chain
7. Western rivers and streams: Pollution that won't wash away
8. Eastern forests: The dark side of forest biodiversity
9. Florida and the Gulf lowlands: Hostile ecosystem takeovers
10. Plains and intermontane grasslands: Exotics at home on the range
11. Western floodplains: Disturbing the disturbance regime
12. The Pacific states: Mediterranean mixing pot
13. Hawaiian Islands: Exotics in the islands of Eden

Part III. Biotic Perspectives

14. Exotic game and fish: Addiction to game and fish introduction
15. Homegrown exotics: Natives out of place
16. Human domesticates and associates: Our best friends and closest associates

Part IV. Theoretical Perspectives

17. Exotics and community structure: Biodiversity bombs
18. Exotics and ecosystems impacts: Changing the way nature works
19. Exotics and evolution: Assimilation or conquest?

Part V. Policy Perspectives

20. Living with exotics: The ecological economics of exotics
21. Exotics and public policy. Are all exotics undesirable?

PALAEOANTHELLA HUANGII GEN. AND SP. NOV., AN EARLY CRETACEOUS FLOWER (ANGIOSPERMAE) IN BURMESE AMBER

George Poinar Jr.
Department of Zoology
Oregon State University
Corvallis, Oregon 97331, U.S.A.

Kenton L. Chambers
Department of Botany and Plant Pathology
Oregon State University
Corvallis, Oregon 97331, U.S.A.

ABSTRACT

Palaeoanthella huangii gen. & sp. nov., is described from an Early Cretaceous staminate flower in Burmese amber. The genus is characterized by small, staminate flowers composed of a cup-shaped perianth of 8 fused lobes (tepals) arranged in one series with 8 equal subsessile, unappendaged stamens in a single whorl, more or less alternating with the tepals, and having 2 lobed, 4-locular anthers opening by longitudinal slits. Adjacent pollen considered to have originated from the anthers is inaperturate with finely ridged and grooved exines. The fossil shows possible affinities with the eumagnoliid angiosperm family Monimiaceae.

Key words: Burma, fossil, fossilized resin, Monimiaceae, Myanmar

RÉSUMÉ

Paleoanthella huangii gen. et sp. nov., est décrit à partir d'une fleur du Crétacé inférieur de l'ambre de Birmanie. Le genre est caractérisé par ses fleurs petites, staminées, composées d'un périanthe en forme de cupule, formé de huit tépales fusionnés en une série simple et alternant plus ou moins avec huit étamines sans appendice. Les anthères possèdent deux lobes et quatre locules s'ouvrant par des fentes longitudinales marginales. Le pollen trouvé à côté des anthères est considéré comme provenant de ceux-ci ; il est inaperturate, avec des exines finement carénées et rainurées. Ce fossile montre des affinités possibles avec les Angiospermes Eumagnolides de la famille Monimiaceae.

INTRODUCTION

A new genus and species of angiosperm with possible affinities with the family Monimiaceae is described from Early Cretaceous Burmese amber. Since the Early Cretaceous was a period of early angiosperm diversification, all specimens from this time period are extremely important in establishing a minimum age for the appearance of various floral characters. While only a single staminate specimen is available for study, it is well preserved and presents an interesting arrangement of staminal features.

MATERIALS AND METHODS

The piece of amber containing the flower weighs 2.8 gm and is more or less trapezoidal in outline, with a greatest length of 25 mm, greatest width of 19 mm and greatest depth of 7 mm. The flower is situated about 5 mm under the surface of the amber. Due to the presence of insect fossils adjacent to the flower,

SIDA 21(4): 2087–2092. 2005

the amber could not be re-polished further. Examination and photographs were made with a Nikon stereoscopic microscope SMZ-10 R at 80× and a Leica Wild M3Z stereoscopic microscope at 400×. Pollen grains in the amber adjacent to the flower were photographed with a Nikon Optiphot microscope at 600×.

Amber from Burma occurs in lignitic seams in sandstone-limestone deposits in the Hukawng Valley, southwest of Maingkhwan in the state of Kachin (26°20'N, 96°36'E). Nuclear magnetic resonance (NMR) spectra of amber samples taken from the same locality as the fossils indicated an araucarian (possibly *Agathis*) source of the amber (Lambert & Wu, unpublished data, 2002). Palynomorphs from the amber beds where the fossil originated have been assigned to the Upper Albian of the Early Cretaceous (97–110 million years ago) (Cruickshank & Ko 2003); however, since the amber is secondarily deposited, the age could be older.

DESCRIPTION

The flower is approximately 1 mm in diameter. The conspicuous anthers are situated in a whorl at the edge of the receptacle. Since the flower is funnel-shaped, it was difficult to obtain a photo from the top with all its features in focus. Pollen grains attached to the anthers and tepals and in the amber adjacent to the flower indicate that the flower was in anthesis when it entered the resin. The pollen grains illustrated here are considered to have originated from the flower since 1) they are the same size as those on the anthers, 2) they are adjacent to the flower, and 3) a search through the rest of the amber matrix did not reveal any grains similar to those adjacent to the flower.

Palaeoanthella Poinar & Chambers, gen. nov. TYPE SPECIES: **Palaeoanthella huangii** Poinar & Chambers, sp. nov.

Unisexual; staminate flowers small, actinomorphic, perianth cup-shaped, united, bearing 8 lobes (tepals) arranged in one series; tepals connate below, separate above, low, rounded at tip; receptacle bearing 8 equal, subsessile stamens in a single whorl; stamens unappendaged, alternating with tepals; anthers 4- locular, opening lengthwise by marginal slits; pistillate flowers unknown.

Palaeoanthella huangii Poinar & Chambers, sp. nov. (**Figs. 1–2**). TYPE: MYANMAR (BURMA): KACHIN: northern Myanmar, Amber mine in the Hukawng Valley, SW of Maingkhwan, (26°20'N, 96°36'E), Jul 2004, *Chialang Grand Huang, Burmese-97* (HOLOTYPE: male flower deposited in the collection of Chialang Grand Huang, Edison, New Jersey 08820, U.S.A.).

Single staminate flower: dimensions of 945 µm across shorter axis and 1094 µm across longer axis (the difference between the axes is because the tepals on one axis have been eaten by an herbivorous insect); perianth cup-shaped, 34 µm long, externally hispidulous; stamen length, 270–338 µm; stamens subsessile, the four visible filaments ranging from 27–40 µm in length; anthers 270–338 µm in length, basifixed, opening by lateral slits; center of receptacle

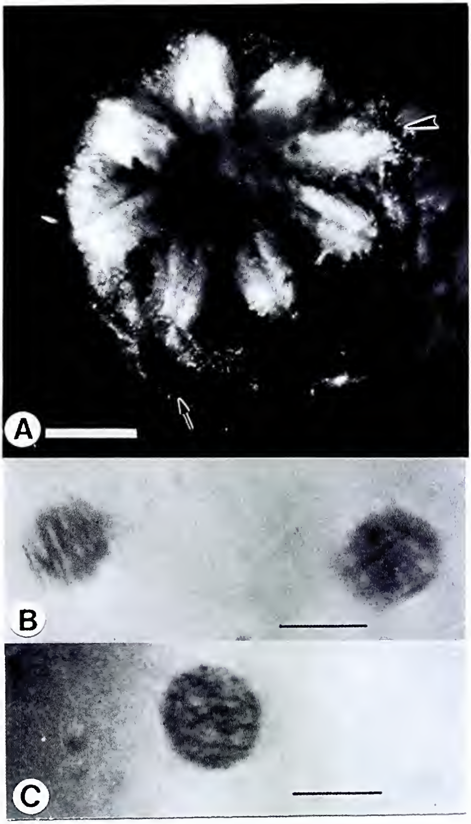


Fig. 1. **A.** *Palaeoanthella huangii* in Burmese amber. Scale bar = 217 μm. Arrow shows a complete tepal; arrowhead shows tepal damaged by a micro-herbivore. **B.** Two pollen grains adjacent to *P. huangii*. Scale bar = 15 μm. **C.** Single pollen grain adjacent to *P. huangii*. Scale bar = 15 μm.

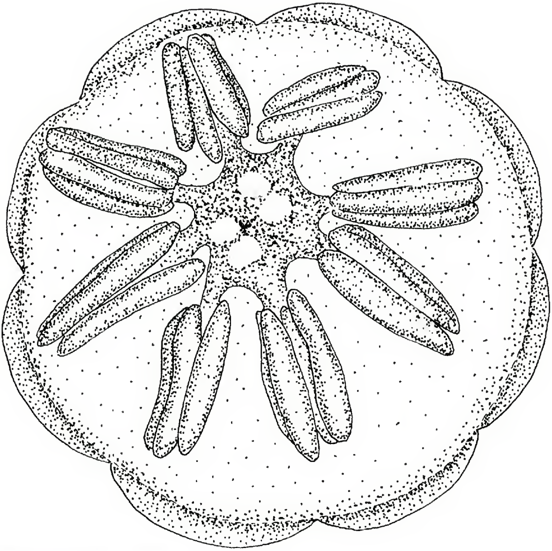


Fig. 2. Partly reconstructed flower of *Palaeoanthella huangii* in Burmese amber. Scale bar = 500 μm.

filled with spongy tissue; pollen grains inaperturate, nearly spherical, 17–20 μm in diameter, exine finely ridged and grooved.

Etymology.—Genus name from the Greek "palaios" for ancient, old, the Greek "anthos" for flower and -ella as a diminutive ending for small. Species named after Chialang Grand Huang, who loaned this valuable specimen for study.

DISCUSSION

It is impossible to assign this flower to a present day family with certainty. However, it does possess some characters [small, unisexual, actinomorphic flowers, cup-shaped monochlamydeous perianth, subsessile stamens, reduction in size of tepals; four-locular anthers opening by 2 lateral longitudinal slits (in staminate flowers with a relatively open floral cup)] found in the family Monimiaceae (Melchior 1964; Hutchison 1966; Endress 1980; Philipson 1986, 1993). Several extant genera of the Monimiaceae have similar features. *Mollinedia* has unisexual flowers with a cup-shaped floral base. While there are numerous stamens in this genus, the filaments are very short and the anthers open lengthwise by slits (Perkins 1901). Another genus is *Kibara* with small unisexual flowers in a hemispherical cup with 8 lobes arranged in 4 series, and 4 stamens. However the anthers open by a single apical slit (Perkins 1901). No extant members of this family have 8 stamens arranged in a single whorl, with the number of stamens equal to the number of tepals and more or less alternating with the tepals.

Pollen of the Monimiaceae varies considerably in size and shape, ranging from spherical to ellipsoidal and from 10 to 50 microns in diameter (Money et al. 1950). Erdtman (1966) describes the grains as usually nonaperturate, 2(–3)-sulcate or oligofor(aminoid)ate, tenui-exinous. The exine can be thick or thin and can appear as granular, finely pitted-reticulate, spinuliferous, ridged or grooved (Money et al. 1950; Sampson 1993). Acolpate pollen with ridged and grooved exines similar to those adjacent to the fossil occurs in the extant genus *Tambourissa* (Money et al. 1950).

It is difficult to identify any defined structures in the center of the flower that might represent stamen appendages, nectaries, or vestigial carpels.

The occurrence of the Monimiaceae in the Lower Cretaceous would be consistent with the primitive status of this family as determined by morphological and molecular findings. Based on their analysis of the plastid *matK* gene sequences of various angiosperms, Hilu et al. (2003) placed the Monimiaceae, together with the rest of the Laurales, in the informal group eumagnoliids, which together with the Chloranthales and monocots, form a sister group to the eudicots. The separation of Monimiaceae sensu stricto from the related families Siparunaceae, Gomortegaceae, and Atherospermataceae is supported by the molecular studies of Renner (1999) based on data from six plastid genome regions. The Monimiaceae occur in warm temperate to tropical areas of the southern hemisphere and enter the Eurasian mainland in Malaysia and Thailand. There are no records of this family in Burma today.

The chewed tepals on *P. huangii* are evidence of herbaceous insect activity, possibly by a beetle or moth larva. The tip of one of the anthers also shows bite marks, indicating indiscriminate feeding on flower parts. The disturbance caused by the herbivore could have dislodged the flower and caused it to fall in the resin.

Several insects groups appear to be involved in the pollination of members of the Monimiaceae. A species of thrips (*Thrips setipennis*) was reported as the sole pollinator of *Wilkiea huegeliana* in an Australian subtropical rainforest, with both male and female flowers serving as brood sites for thrip larvae (Williams et al. 2001). In Ecuador, members of the genus *Siparuna* are pollinated by gall midges of the family Cecidomyiidae. These insects deposit their eggs in the male flowers where the larvae presumably feed on the tissues (Feil 1992). Both gall midges and thrips occur in Burmese amber and representatives of these groups could have pollinated *P. huangii*. A gall midge is preserved near the fossil flower.

Since the amber mines are located on the Burma Plate, which is part of Laurasia (Mitchell 1993), *P. huangii* can be considered of Old World origin.

ACKNOWLEDGMENTS

The authors thank Chialang Grand Huang for loaning this specimen for study, Marcos Kogan for the use of his Leica Wild microscope, Jean-François Voisin for providing the résumé, and Peter K. Endress and Roberta Poinar for helpful comments on earlier versions of this paper.

REFERENCES

Cruickshank, R.D. and K. Ko. 2003. Geology of an amber locality in the Hukawng Valley, northern Myanmar. J. Asian Earth Sci. 21:441–455.

Endress, P.K. 1980. Ontogeny, function and evolution of extreme floral construction in Monimiaceae. Plant Syst. Evol. 134:79–120.

Erdtman, G. 1966. *Pollen morphology and plant taxonomy.* Angiosperms. Hafner Publishing Company, New York.

Feil, J.P. 1992. Reproductive ecology of dioecious *Siparuna* (Monimiaceae) in Ecuador: a case of gall midge pollination. J. Linn. Soc. Bot. 110:171–203.

Hilu, K.W. et al. 2003. Angiosperm phylogeny based on *matK* sequence information. Amer. J. Bot. 90:1758–1776.

Hutchinson, J. 1966. The genera of flowering plants (Angiospermae). Vol. 1. Dicotyledones, Clarendon Press, Oxford.

Melchior, H. 1964. A. Engler's Syllabus der Pflanzenfamilien. Vol. 2, Angiospermen, Gebrüder Borntraeger, Berlin.

Mitchell, A.H.G. 1993. Cretaceous-Cenozoic tectonic events in the western Myanmar (Burma)-Assam region. J. Geol. Soc. London, 150:1089–1102.

Money, L.L., I.W. Bailey, and B.G. Swamy. 1950. The morphology and relationships of the Monimiaceae. J. Arnold Arbor. 31:372–404.

Perkins, J. and E. Gilg. 1901. Monimiaceae. In: A. Engler, ed. Das Pflanzenreich, IV. 101. Verlag von Wilhelm Engelmann, Leipzig. Pp. 1–122.

Philipson, W.R. 1986. Monimiaceae. Flora Malesiana Part 1, 10:255–326.

Philipson, W.R. 1993. Monimiaceae. In: K. Kubitzki, J.G. Rohwer, and V. Billrich, eds. The families and genera of vascular plants. II. Springer-Verlag, Berlin. Pp. 426–437.

Renner, S.S. 1999. Circumscription and phylogeny of the Laurales; evidence from molecular and morphological data. Amer. J. Bot. 86:1301–1315.

Sampson, F.B. 1993. Pollen morphology of the Amborellaceae and Hortoniaceae (Hortonioideae: Monimiaceae). Grana 32:154–162.

Williams, G.A., P. Adam, and L.A. Mound. 2001. Thrips (Thysanoptera) pollination in Australian subtropical rainforests, with particular reference to pollination of *Wilkiea huegeliana* (Monimiaceae). J. Nat. Hist. (London) 35:1–21.

A NEW COMBINATION IN *STENOTUS* (ASTERACEAE)

Caleb A. Morse

R.L. McGregor Herbarium
University of Kansas Campus West
2045 Constant Avenue
Lawrence, Kansas 66047, U.S.A.

A new combination is necessitated by the forthcoming treatment of the genus *Stenotus* Nutt. (Asteraceae) for the *Flora of North America*.

The combination *Stenotus lanuginosus* (A. Gray) Greene var. *andersonii* (Rydb.) was attributed to H.M. Hall by Kartesz (1994a, 1994b), and has been perpetuated in other publications (International Plant Names Index 2004; USDA, NRCS 2004). However, Hall's combinations were published as subspecies in the genus *Haplopappus* Cass., not varieties in *Stenotus*. Recent treatments, including the one prepared by the present author for a forthcoming volume of the *Flora of North America* project, have regarded North American sections of *Haplopappus* sensu Hall as distinct genera. Therefore, a new combination for this well-marked taxon is necessitated.

Stenotus lanuginosus (A. Gray) Greene var. **andersonii** (Rydb.) C.A. Morse, comb. nov. *Stenotus andersonii* Rydb., Bull. Torrey Bot. Club 27:615. 1900. *Aplopappus andersonii* Blank., Montana Coll. Agric. Sci. Stud., Bot. 1:100. 1905. *Haplopappus lanuginosus* ssp. *andersonii* H.M. Hall, Publ. Carnegie Inst. Wash. 389:172. 1928. *Haplopappus lanuginosus* var. *andersonii* Cronquist, Univ. Wash. Publ. Biol. 17(5):219. 1955. TYPE: U.S.A. MONTANA: Belt Mountains. 1886, *Anderson 3561* (HOLOTYPE: NY, UC [fragment]!)

Tonestus linearis A. Nelson & J.F. Macbr., Bot. Gaz. 56:478. 1913. TYPE: U.S.A. IDAHO: Payette National Forest, 1912, *G.B. Mains J.V-6* (HOLOTYPE: RM!, ISOTYPE: RM!).

ACKNOWLEDGMENT

I thank Kanchi Gandhi for discussion of this issue.

REFERENCES

HALL, H.M. 1928. The genus *Haplopappus*: A phylogenetic study in the Compositae. Carnegie Institute of Washington Publication 389.

KARTESZ, J.T. 1994a. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland (2nd Ed.) Volume 1 – Checklist. Timber Press, Portland.

KARTESZ, J.T. 1994b. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland (2nd Ed.) Volume 2 – Thesaurus. Timber Press, Portland.

THE INTERNATIONAL PLANT NAMES INDEX. 2004. Published on the Internet http://www.ipni.org [accessed 2 Dec 2004].

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov/). National Plant Data Center, Baton Rouge, LA 70874-4490 USA. [accessed 2 Dec 2005]

BOOK REVIEW

E.G. BOBROV and N.N. TZVELEV (eds.) STANWYN G. SHETLER (General Scientific ed.). 2004. **Flora of the USSR: Alphabetical Indexes to Volumes I-XXX** (translated from Russian). (ISBN not given). Smithsonian Institution Libraries, Washington, D.C. $99.50 (hbk.), 241 pp., 2 maps, 6 1/4" × 9 1/2".

"The Alphabetical Indexes are cumulative indexes to all 30 volumes of the *Flora of the USSR* and together constitute the thirty-first and final volume of this monumental work. This volume consists mainly of separate indexes to the scientific (Latin) names of (1) the families and (2) the genera and species in the Flora, but it also includes a list or index of the authors of the Latin names, alphabetized by the standard abbreviations used for them in the text, and summaries of other commonly used abbreviations" (from the Scientific Editor's Preface). Synonyms for genera are included but not for species. Two maps are at the very back: "Floristic regions of the USSR" (a foldout) and "Regions used to indicate general distributions of species in the 'Flora of the USSR'."

The whole set (in Russian) was "initiated under the supervision and chief editorship of Academician V.L. Komarov." The original publications were issued 1934–1960; English translations appeared 1968–2002, begun by the Israel Program for Scientific Translations and finished by the Amerind Publishing Co. in New Delhi. The Asteraceae, recognized by some as highly significant, are published as volumes 25 through 30; they are now complemented by a treatment (translated to English) of the family for the "*Flora of Russia*: The European part and bordering regions" (vols. VII in 2002 and VIII in 2003). It is extremely useful to have an English-readable flora for this huge part of the earth. *Flora Europea* and various detailed treatments for Australia are generally comparable, but these are only now being approached in kind by the *Flora of China* and *Flora of North America (north of Mexico)*.—*Guy Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

PHARUS PRIMUNCINATUS (POACAE: PHAROIDEAE: PHAREAE) FROM DOMINICAN AMBER

George Poinar Jr.

Department of Zoology
Oregon State University
Corvallis, Oregon 97331, U.S.A.
poinarg@science.oregonstate.edu

Emmet J. Judziewicz

Department of Biology
University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
emmet.judziewicz@uwsp.edu

ABSTRACT

A grass spikelet with a cylindrical, sigmoidal, uncinate floret in Dominican amber is described as the new species **Pharus primuncinatus** Judz. & Poinar (Poaceae: Pharoideae: Phareae). The fossil can be distinguished from all extant members of the genus by the small (9.9 mm long), curved female floret; relatively short glumes; and the uncinate portion of the floret extending downwards to the middle or slightly below the middle of the lemma. The closest extant relative may be the Mesoamerican *P. mezii*. This is the earliest record of a fossil grass that can be assigned to an extant genus; the earliest record of a member of the basal subfamily Pharoideae; and the only known fossil *Pharus* spikelet.

Key words: fossil grass, *Pharus*, *P. latifolius*, *P. mezii*, *P. primuncinatus*, Poaceae, Pharoideae, Phareae, Dominican amber

RESUMEN

En base a una espiguilla fósil con un flósculo cilíndrico, sigmoide y uncinado se describe una nueva especie, **Pharus primuncinatus** Judz. & Poinar (Poaceae: Pharoideae: Phareae), del ámbar de la República Dominicana. Se diferencia de todas las especies del genéro existentes por su espiguilla pistilada pequeña (9.9 mm de largo); flósculo pistilado curvado; glumas relativamente cortas; y la porción uncinada del lema extendida de la mitad hasta el ápice. La especie existente más relacionada es posiblemente *P. mezii* de América Central. Este es el registro más antiguo de una gramínea fósil que puede asignarse a un género existente; el registro más antiguo del miembro de la subfamilia Pharoideae; y el único fósil de una espiguilla de *Pharus*.

INTRODUCTION

Grass fossils are rare. Those that have been reported mostly occur in sedimentary deposits and their identification at the generic level is problematic. However, amber has remarkable preservative qualities for both plant and animal fossils (Poinar 1992) and a number of angiosperm remains identifiable to extant genera occur in Dominican Republic amber (Poinar & Poinar 1999). Dominican amber originated from resin of the extinct tree, *Hymenaea protera* Poinar (Leguminosae: Caesalpinioideae) that thrived some 20–40 million years ago in Hispaniola (Poinar 1991; Poinar & Poinar 1999). One especially interesting fossil in this amber was a spikelet belonging to the grass genus *Pharus* P. Browne which was associated with mammalian hair (Poinar & Columbus 1992).

SIDA 21(4): 2095–2103. 2005

Pharus was long placed in the Bambusoideae (Judziewicz 1987; Watson & Dallwitz 1992), but recent molecular evidence indicates that it is much more basal than the bamboos and indeed is the second earliest-diverging basal clade in the Poaceae (Clark & Judziewicz 1996; Judziewicz et al. 1999; Grass Phylogeny Working Group 2001).

Daghlian (1981) considered at least 11 reported macrofossils as true fossil grasses but cautioned against assigning fossil pollen grains to the Poaceae since other members of the Poales have similar pollen types. In his review of paleoagrostology, Thomasson (1987) listed 11 published reports of fossil grasses, but determined only three of these to be undoubted representatives of the Poaceae. While the oldest-known unequivocal fossil grass is from the Paleocene/ Eocene boundary in Tennessee (Crepet & Feldman 1991), bambusoid-like monocots extend back into the Early Cretaceous (Poinar 2004), thus the origin of the family may be quite ancient. The present study describes the fossil female *Pharus* spikelet reported earlier (Poinar & Columbus 1992).

MATERIALS AND METHODS

The small triangular piece of amber (7 gm, 37 mm longest length × 25 mm longest width, 15 mm thick) containing the fossil came from La Toca mine, situated between Santiago and Puerto Plata in the Cordillera Septentrional of the northern portion of the Dominican Republic. Dating of Dominican amber is still controversial with the latest proposed age of 20–15 mya based on foraminifera (Iturralde-Vinent & MacPhee 1996) and the earliest as 45–30 mya based on coccoliths (Cêpek in Schlee 1999). A range of ages for Dominican amber may be likely since the amber fossils are associated with turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994). Dominican amber is secondarily deposited in sedimentary rocks, which makes a definite age determination difficult (Poinar & Mastalerz 2000). Observations and photographs were made with a Nikon stereoscopic microscope SMZ-10 R and Nikon Optiphot TM at magnifications up to 600×.

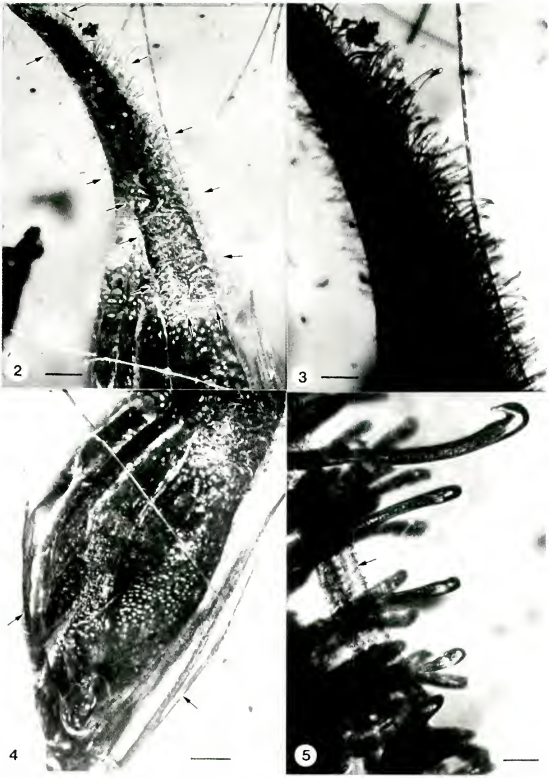
RESULTS

The following characters of the fossil place it in the genus *Pharus*: A single-flowered female spikelet with relatively short, glabrous glumes and an inrolled, cylindrical, tapering, 7-nerved lemma covered with uncinate (hooked) macrohairs.

Order Poales, Family Poaceae, Subfamily Pharoideae (Stapf) L.G. Clark & Judz., Tribe Phareae Stapf

Pharus primuncinatus Judz. & Poinar, sp. nov. **(Figs. 1–5)**. TYPE: DOMINICAN REPUBLIC: La Toca amber mine located between Santiago and Puerto Plata in the Cordillera Septentrional of the northern portion of the Dominican Republic. A female spikelet depos-

Fig. 1. Spikelet of *Pharus primuncinatus* in Dominican amber. Bar = 860 μm.



Figs. 2–5. *Pharus primuncinatus* in Dominican amber (elongate strands in all photos are segments of mammalian hair). **2.** Tip of lemma showing bearded portion (delineated with arrows) covered with uncinate macrohairs. Bar = 36 μm. **3.** Upper portion of lemma showing range in size of uncinate macrohairs. Bar = 278 μm. **4.** Lower portion of lemma and two glumes (arrows). Note papillose surface of lemma. Bar = 450 μm. **5.** Detail of uncinate macrohairs. Note one strand of mammalian hair (arrow) enclosed by the plant macrohairs. Bar = 56 μm.

ited in the George Poinar amber collection (accession # M-1-4) maintained at Oregon State University, Corvallis, OR 97331.

Fossil female spikelet 9.9 mm long (without pedicel) and 2.3 mm wide subtended by a short pedicel (0.93 mm long), consisting of two glumes and a single floret. First glume 5.2 mm long; second glume 3.3 mm long (the tip bent back and could have been damaged, thus it may have been longer); lemma approximately twice the length of the glumes, somewhat sigmoid, tapered apically into a beak, 7-nerved, with strongly inrolled margins; with a discrete area, beginning approximately 2/5 from the base of the lemma and extending all the way to the tip, densely covered with uncinate macrohairs, the hairs extending from the tip 1/3 of the length of the lemma on the ventral side (3.5 mm from apex), but over half the length of the lemma (5.4 mm from the apex) on the dorsal side; macrohairs 0.22–0.56 mm in length; basal portion of the lemma covered with numerous small papillae (Fig. 4).

Currently, seven extant species of *Pharus* are recognized; they range from Mexico and Florida to Argentina and Uruguay. Using the keys provided by Judziewicz (1987, 1991), the fossil falls into a group of three species with curved to sigmoid female lemmas: *P. latifolius* L., *P. mezii* Prodoehl, and *P. vittatus* Lem. *Pharus vittatus* has female lemmas 19–26 mm long, much longer than those of the fossil, which has a mature lemma 9.9 mm long. The extant species *P. latifolius* and *P. mezii* (Table 1, Fig. 6) have smaller female spikelets than *P. vittatus*, but the floret (9.9 mm long and 2.3 mm wide) and first glume (5.2 mm long) of *P. primuncinatus* are significantly shorter yet wider than those of *P. latifolius* [florets (12–)13–17(–19) mm long, 1–2.3 mm wide, first glume 9–13 mm long] and *P. mezii* [florets 10.5–13.5 mm long, 0.9–1.8 mm wide, first glume 5.3–7.3(–8) mm long]. Also, the female floret of the fossil is bearded with uncinate macrohairs over the majority of its exposed (i.e., not covered by the glumes) surface, while in *P. latifolius* and *P. mezii* the beard is restricted to the apex of the floret (Fig. 6).

Etymology.—The specific epithet *primuncinatus* is from the Latin "first uncinate one," alluding to the first fossil record of hooked macrohairs on a spikelet.

DISCUSSION

Presently, four species of *Pharus* occur in Hispaniola, including *P. lappulaceus* Aubl., *P. latifolius*, *P. parvifolius* Nash, and *P. virescens* Doell. *Pharus mezii*, perhaps the closest relative of the fossil species, is a Mesoamerican and northern South American species of seasonally dry forests. The morphological evidence does not exclude the possibility that *P. primuncinatus* is directly ancestral to both *P. latifolius* and *P. mezii*.

The manner by which the female spikelet arrived in amber has already been cited as the first example of epizoochory in the fossil record (Poinar & Columbus 1992). This condition is obvious from the number of mammalian hairs associated with the spikelet, one of which is still attached to the lemma

TABLE 1. Comparison of *Pharus primuncinatus* to two closely related species.

	Pharus latifolius	***Pharus primuncinatus sp nov.***	***Pharus mezii***
Distribution	Widespread in wet forests in the Neotropics, including Hispaniola	Fossil (Eocene to Miocene) from Hispaniola	Seasonally dry forests, mostly along the Pacific coast from Mexico to Panama; rare in dry forests of Colombia, Venezuela, and Ecuador; not in the West Indies
Female floret length (mm)	(12–)13–17(–19)	9.9	10.5–13.5
Female floret width (mm)	1–2.3	2.3	0.9–1.8
Female floret: Length/width ratio	7.5–12	4.3	7.5–10
Female first glume length (mm)	9–13	5.2	5.3–7.3(–8.0)
Female first glume: Female floret ratio	0.6–0.8(–0.9)	ca. 0.5	0.5–0.6
Distribution of uncinate hairs on the female	Restricted to apical 10–20%; rarely sparse hairs	Found over most of the exposed surface (33–60%)	Restricted to apical 15–25%; rarely sparse hairs elsewhere

by the uncinate macrohairs (Fig. 5). These hairs were identified as the guard hairs of a carnivore (Poinar & Columbus 1992).

There is circumstantial evidence that many species of mammals disperse the adhesive female florets of *Pharus* species, as attested by such local common names of *P. latifolius* and *P. lappulaceus* (Judziewicz 1987: 296–297, 387–388) as "fruta de perro" [fruit of the dog] (Cuba), "riz chien" [dog rice] (French Guiana), "alcusa" [dog in Quichua] (Ecuador), "barba de puma" and "barba de tigre" [beard of the jaguar] (Peru), "yaguá-arroz [jaguar rice] (Paraguay), "barba de paca" [beard of the paca, a large rodent] (Brazil), and "barba de macuco" [beard of the monkey] (several Brazilian collections). The genus may apparently be dispersed by birds as well; common names include "pega pollo" [stick-to-the-chicken] (Dominican Republic), and herbarium specimens with feathers adhering to the inflorescence have been observed.

The present report is the earliest record of a fossil grass that can be assigned to an extant genus, the earliest undoubted record of a member of the basal subfamily Pharoideae and tribe Phareae, and the only described fossil spikelet of a member of the Pharoideae. In 1986, the second author also examined a plastic

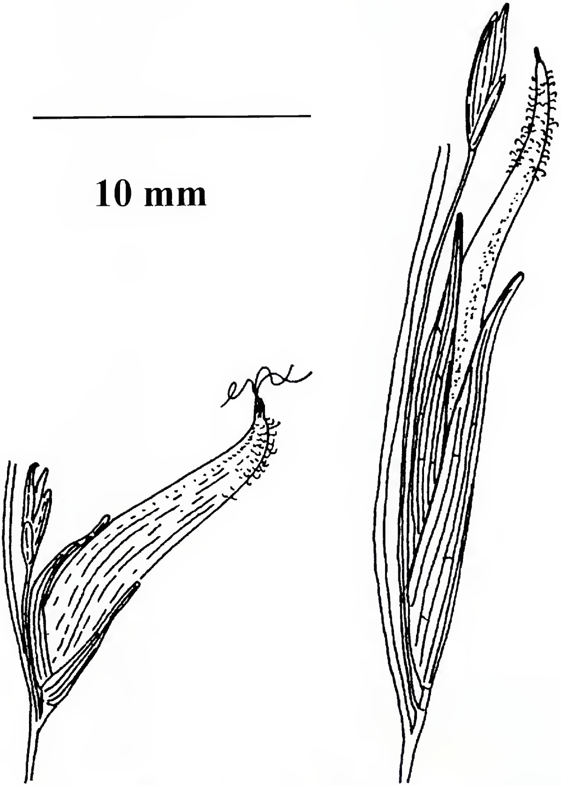


Fig. 6. Spikelet pairs of the extant species *Pharus latifolius* (left) and *P. mezii* (right). The pistillate spikelets are large and curved and the staminate spikelets small and pedicellate. Illustration by Judziewicz.

cast of a leaf blade of an undoubtedly pharoid grass (presumably *Leptaspis* R. Br., sister genus of *Pharus*), from mid-Miocene (12 million years old) volcanic ash northwest of Lake Baringo, Kenya (ca. 1°N, 36°E) kindly provided by Christine Kabuye and Bonnie F. Jacobs; a duplicate cast is on deposit at the University of Wisconsin-Madison herbarium (Judziewicz 1987; Clark & Judziewicz 1996).

ACKNOWLEDGMENTS

The authors thank J. Travis Columbus for originally identifying the fossil grass and lending assistance to this study, and thank him and Lynn G. Clark for their helpful reviews.

REFERENCES

Clark, L.G. and E.J. Judziewicz. 1996. The grass subfamilies Anomochloideae and Pharoideae (Poaceae). Taxon 45:641–645.

Crepet, W.L. and G.D. Feldman. 1991. The earliest remains of grasses in the fossil record. Amer. J. Bot. 78:1010–1014.

Daghlian, C.P. 1981. A review of the fossil record of Monocotyledons. Bot. Rev. 47:517–555.

Draper, G., P. Mann P., and J.F. Lewis. 1994. Hispaniola. In: Donovan, S. and T.A. Jackson, eds. Caribbean geology: an introduction. The University of the West Indies Publishers' Association, Kingston, Jamaica. Pp. 129–150.

Grass Phylogeny Working Group. 2001. Phylogeny and subfamilial classification of the grasses (Poaceae). Ann. Missouri Bot. Gard. 88:373–457.

Iturralde-Vinent, M.A. and R.D.E. MacPhee. 1996. Age and paleogeographic origin of Dominican amber. Science 273:1850–1852.

Judziewicz, E.J. 1987. Taxonomy and morphology of the tribe Phareae (Poaceae: Bambusoideae). Ph.D. dissertation. University of Wisconsin, Madison.

Judziewicz, E.J. 1991 [as 1990]. Poaceae (Gramineae). In: Görts-Van Rijn, A.R.A, ed. Flora of the Guianas. Series A, fascicle 8, Koeltz Scientific Books, Koenigstein. Pp. 1–727.

Judziewicz, E.J., L.G. Clark, X. Londoño, and M.J. Stern. 1999. American Bamboos. Smithsonian Institution Press, Washington, DC.

Poinar Jr., G.O. 1991. *Hymenaea protera* sp. nov. (Leguminosae: Caesalpinioideae) from Dominican amber has African affinities. Experientia 47:1075–1082.

Poinar Jr., G.O. 1992. Life in Amber. Stanford, CA: Stanford Univ. Press.

Poinar Jr., G.O. 2004. *Programinis burmitis gen. et sp. nov.*, and *P. laminatus sp. nov.*, early Cretaceous grass-like monocots in Burmese amber. Austral. Syst. Bot. 17:497–504.

Poinar Jr., G.O. and J.T. Columbus. 1992. Adhesive grass spikelet with mammalian hair in Dominican amber: First fossil evidence of epizoochory. Experientia 48:906–908.

Poinar Jr., G.O. and R. Poinar. 1999. The Amber forest. Princeton University Press, Princeton.

Poinar Jr., G.O. and M. Mastalerz. 2000. Taphonomy of fossilized resins: determining the biostratinomy of amber. Acta Geol. Hispanica 35:171–182.

SCHLEE, D. 1990. Das Bernstein-Kabinett. Stuttgarter Beitr. Naturk., Ser. C, 28:1–100.

THOMASSON, J.R.. 1987. Fossil grasses: 1820–1986 and beyond. In: Soderstrom, T.R., K.W. Hilu, C.S. Campbell, and M.E. Barkworth, eds. Grass systematics and evolution. Washington, Smithsonian Institution. Pp. 159–167.

WATSON, L. and M.F. DALLWITZ. 1992. The grass genera of the world. CAB international: Wallingford.

BOOKS RECEIVED

José M. Manzanares. 2002. **Jewels of the Jungle: Bromeliaceae of Ecuador. Part I: Bromelioideae.** (ISBN 9978-42-547-0, hbk.). Imprenta Mariscal, Quito Ecuador. (**Orders:** Betty Patterson, e-mail bromeliad@airmail.net). $120.00 plus $5 p&h (USA, please request shipping for overseas), 1-240 pp., color figures and line drawings, 9" × 11 3/4".

José M. Manzanares with collaboration of W. Till, E. Gouda, and E. Patterson. 2005. **Jewels of the Jungle: Bromeliaceae of Ecuador. Part II: Pitcairnioideae.** (ISBN 9978-42-022-4, hbk.). Imprenta Mariscal, Quito Ecuador. (**Orders:** Betty Patterson, e-mail bromeliad@airmail.net). $120.00 plus $5 p&h (USA, please request shipping for overseas), 241-544 pp., color figures and line drawings, 9" × 11 3/4".

According to the author and collaborators, volumes II and IV (The Tillandsioideae) will probably be published in three years.

Joel E. Holloway (edited by Amanda Neill). 2005. **A Dictionary of Common Wildflowers of Texas & the Southern Great Plains.** (ISBN 0-87565-309-X, pbk.). TCU Press, TCU Box 298300, Fort Worth, Texas 76129, U.S.A., (**Orders:** www.prs.tcu.edu/). $29.95, 178 pp., b/w line drawings, 7" × 10".

Stephen Freer (translator). 2003. **Linnaeus' Philosophia Botanica.** (ISBN 0-19-856934-3, pbk.). Oxford University Press. (**Orders:** Oxford University Press, 2001 Evans Road, Cary, NC 27513, U.S.A., 800-451-7556, 919-677-1303 fax, www.oup.com). $89.50, 402 pp., b/w figures, 7 1/2" × 9 3/4".

Paperback edition, 2005. Linnaeus' *Philosophia Botanica* (The Science of Botany) was first published in 1751.

NOTES ON *LIBERTIA* (IRIDACEAE: SISYRINCHIEAE) IN SOUTH AMERICA

Peter Goldblatt

B.A. Krukoff Curator of African Botany
Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166-0299, U.S.A.
peter.goldblatt@mobot.org

Marcela Celis

Instituto de Ciencias Naturales
Universidad Nacional de Colombia
A.A. 7495 Bogotá
COLOMBIA
ymcelisp@.unal.edu.co

ABSTRACT

Comparison of collections of *Libertia colombiana* (Foster 1939) from Colombia, Ecuador, and Peru show that the Bolivian *L. boliviana* (Foster 1946) cannot be upheld as a separate species. We provide an expanded description of *L. colombiana* and establish its range across the Andean paramo as far south as Bolivia, noting the first collections for Ecuador and Peru. We also provide a key to the South American species of *Libertia*, which also occurs in New Guinea, New Zealand, and eastern Australia where there are some six species currently recognized, and possibly three more awaiting description, making a total for the genus of 13 species.

RESUMEN

Mediante comparaciones de ejemplares de *Libertia boliviana* (Foster 1946) y *L. colombiana* (Foster 1939) de Colombia, Ecuador y Perú se propone que *L. boliviana* no puede ser considerada como una especie aparte. Presentamos una descripción ampliada de *L. colombiana* y determinamos su rango de distribución en los páramos andinos hasta el sur de Bolivia, al igual que las primeras colecciones para Ecuador y Perú. Así mismo, incluimos una clave para las especies suramericanas de *Libertia* que también se distribuyen en Nueva Guinea, Nueva Zelanda y el este de Australia, en donde se reconocen cerca de seis especies y posiblemente tres adicionales que están en proceso de descripción para un total de 13 especies para el género.

A member of tribe Sisyrinchieae of Iridaceae subfamily Iridoideae (Goldblatt 1990), *Libertia* is one of two genera of the family with species in Australasia and South America, the other being *Orthrosanthus* (Goldblatt & Henrich 1987; Goldblatt 1990). *Libertia* is recognized mainly by the outer tepals being smaller than the inner, and often much smaller, and more or less green while the inner tepals are usually white, but blue in *L. sessiliflora*. Like other species of Sisyrinchieae, the filaments are partly united and the style divides at the top of the filament column into three slender, diverging branches. A relatively unspecialized member of the tribe, *Libertia* appears to have no other synapomorphies except for a unique basic chromosome number, $x = 19$ (Goldblatt & Takei 1997).

Australasian species include *L. paniculata* (R. Brown) Sprengel and *L. pulchella* (R. Brown) Sprengel, in Australia and New Guinea and four currently recognized in New Zealand, *L. grandiflora* (R. Brown) Sweet, *L. ixioides* (Foster f.) Sprengel, *L. micrantha* A. Cunningham, *L. peregrinans* Cockayne et Allan. Three more were recognized for New Zealand by Blanchon (1998) in an unpublished Ph. D. thesis, *L. cranwelliae*, *L. edgariae* and *L. mooreae*. Of the 14 species of *Libertia* described from South America (Index Kewensis), only five are generally recognized, three in Chile (Skottsberg 1928, 1953; Munoz 1966; Rodríguez & Marticorena 2000), and one each for Bolivia and Colombia (Foster 1939, 1945).

New collections made in the Colombian paramo (Celis 2000) show that *Libertia* is represented there by one relatively uniform species, *L. colombiana* R.C. Foster that was described in 1939. The first collections of *Libertia* from Ecuador and Peru, made in 1998 and 1975 respectively, fall within the range of variation for *L. colombiana*. The presence of *L. colombiana* in Ecuador had not been established when Jorgensen and León-Yánez (1999) published their checklist of the flora of Ecuador and *Libertia* was not included in a checklist of the flora of Peru (Brako & Zarucchi 1993).

A second species, *Libertia boliviana*, was distinguished from *L. colombiana* (and from the closely related Chilean *L. tricocca* Philippi) by its smaller and fewer flowers and in having the filaments free to the base (rather than partly united) (Foster 1946). New collections from Bolivia show that Foster's distinction was incorrect. The filaments are united in the proximal half in the type (*Buchtien 701*, GH), and in two additional collections (Table 1). Morever, there is no significant difference in the size and number of the flowers per inflorescence unit in specimens from Bolivia and those from Colombia and Ecuador. In fact, we can find no character separating *L. colombiana* from Bolivian collections of *Libertia* (Table 1). We thus unite *L. colombiana* and *L. boliviana*. The poor documentation of *L. colombiana* from Bolivia (three collections), Ecuador (one collection), and Peru (one collection) may indicate its rarity in these countries or may be due to its inconspicuous flowers. Until recently, there was also a paucity of records from Colombia, now remedied by specialist collecting there.

The immediate relationships of *Libertia colombiana* are evidently with the Chilean *L. tricocca* which is broadly similar in general appearance, modest stature, and flowers with long pedicels. *Libertia tricocca* is readily distinguished by its narrower leaves, mostly 2–3 mm wide, of firm texture with thickened midribs and margins, its normally a smaller stature, seldom exceeding 20 cm, and short rhizome to 2 cm long. Flowers of *L. tricocca* also have shorter inner tepals, ca. 4.5 mm long, and the filaments united for ca. one fourth their length (versus inner tepals 6.5–7 mm long and filaments united for about half their length in *L. colombiana*).

The remaining species of South American *Libertia* are the robust, large-flowered plant known as *L. chilensis* (Molina) Gunckel (also known by the later name *L. formosa* Graham) and the remarkable *L. sessiliflora* (Poepp.) Skottsb. (syn. *L. caerulescens* Kunth & Bouche). This last species has blue flowers borne

Table 1. Comparison of quantitative characteristics of *Libertia colombiana* and *L. boliviana*.

Character	*L. colombiana*	*L. boliviana*
Height	20–40 cm	30–39 cm
Rhizome length	(2)5–18 cm	7.5–9 cm
Cauline leaves	6.5–28 cm × 3–6 mm	10–26.5 cm × 4–5 mm
Flowering stem length	17–34 cm	10–15 cm
Cauline leaves	2.7–11 cm × 1–3 mm	6 cm × 2 mm
Peduncles (of rhipidia)	2–4.5 cm × 1 mm	2–4.5 cm × 1 mm
Rhipidial spathe length	Outer 9–13 mm	Outer 7–9 mm
	Inner 6–10 mm	Inner 6–7 mm
Pedicel length	(0.3–)1.2–2 cm	0.7–2.5 cm
Flowers per rhipidium	2–3(–4)	2–3
Color flowers	white	white
Outer tepal length	4 mm	3.8–4 mm
Inner tepal length	7 mm	6.5 mm
Filament length	1.8–2 mm, united in lower half	2 mm, united in lower half
Anthers	1.1–1.3 mm, subasifixed	1 mm, subasifixed
Ovary	1–2.5 × 1.5–2.8 mm	2.3 × 2.2 mm
Style	0.8 mm	1 mm
Style branch length	2 mm	2 mm
Capsule	4 × 4–4.5 mm	4 × 5 mm
Seed length	1 mm	1 mm

in sessile rhipidia (the cymose inflorescence units of many Iridaceae) on a straight, unbranched flowering stem.

We include an emended description of *Libertia colombiana* below, a key to the South American species, and outline the complex synonymy of the South American species following Rodríguez and Marticorena (2000).

Libertia colombiana R.C. Foster, Contr. Gray Herb. 127:44. 1938. (**Fig. 1**). Type: COLOMBIA: Risaralda ("Caldas"), río San Rafael, abajo del Cerro Tatamá, 2600–2800 m, 7 Sep 1922, *Pennell 10357* (holotype: GH!; isotype: NY!).

Libertia boliviana R.C. Foster, Contr. Gray Herb. 161:4. 1946, syn. nov. Type: BOLIVIA: La Paz, Región Andina, 3200 m, Nov 1910, *O. Buchtien 701* (holotype: GH!).

Evergreen, often tufted herb 20–40 cm high, with a creeping rhizome up to 18 cm long. *Leaves* 6.5–28 cm × 3–6 mm, in two ranks, sword-shaped, apex attenuate, the margins ciliate, sometimes conspicuously so toward the apex. *Flowering stem* 10–34 cm long, subterete, usually branched, bearing cauline leaves progressively smaller above, 2.7–11 cm long. *Inflorescences* rhipidia, terminal on the main and secondary branches, or sessile in axils of branches 2–4.5 cm long, 2–4-flowered; spathes subequal, the outer 7–13 × 0.4–2 mm, slightly longer than the inner (5–10 × 0.4 mm), lanceolate, apex slightly curvate, with marginal cilia conspicuous toward the apex. *Flowers* on pedicels mostly 12–25 mm

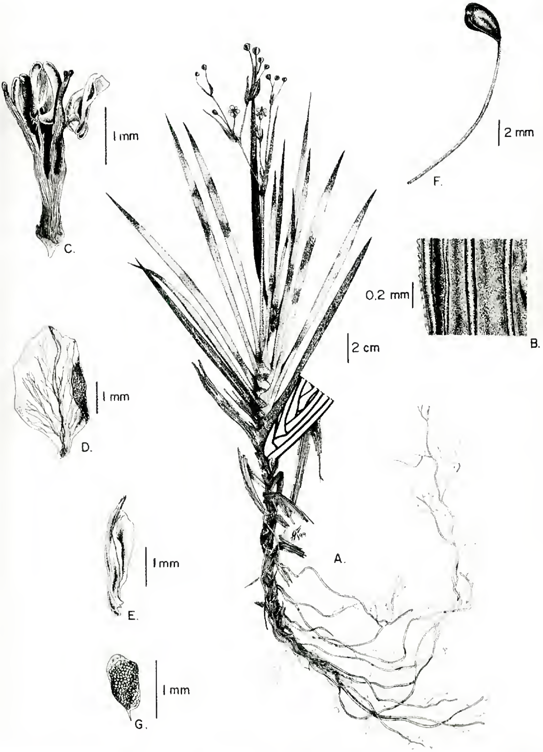


Fig. 1. *Libertia colombiana* R.C. Foster. **A.** Habit. **B.** Detail of leaf. **C.** Stamens and style branches. **D.** Inner tepal. **E.** Side view of outer tepal. **F.** Capsule. **G.** Seed. (*Idrobo 3991*).

long, well exserted from the spathes, subtended by a bract 1-6 mm long, white; *tepals* unequal, the outer whorl smaller than the inner, basally connate for 0.3-0.5 mm, the outer 3.8–4 × 2.2 mm, elliptical-oblong, obtuse, cucullate, venation acrodromus-parallelodromous, with 5 veins conspicuous, the inner 6.5–7 × 3-3.2 mm, spathulate-ovate, obtuse, venation dendroid. *Filaments* 1.8–2 mm long, partially united in the lower half for 0.8–1 mm; *anthers* subasifixed, 1-1.3 mm long. *Ovary* 1-2.5 mm long × 1.5–2.8 mm diameter, spheroidal to ellipsoid; *style* dividing just beyond the top of the filament column into three branches, each 2 mm long, terminally stigmatic. *Capsules* 3–4 × 4–5 mm, subglobose, borne on pedicels 1.5–3 cm long; *seeds* ca. 36 in each capsule, 1 mm long, rounded, surface rugose, reddish brown.

Distribution.—Andean southern America mainly in paramo, 2200–3900 m, fairly common in Colombia in the Vertiente Caucana, Vertiente Magdalenense, and Vertiente Occidental, and evidently local and rare in Ecuador, Peru, and Bolivia.

Additional specimens examined: **BOLIVIA. La Paz:** provincia Nor Yungas, 4.7 km al NE (abajo) de Chuspipata, 16°17' S - 67°47' W, 2800 m, 11 Nov 1987, *Solomon, J 17343* (MO); provincia Sud Yungas, 1.3 km al oeste de Unduavi, 16°18'S - 67°55'W, 3400 m, 12 Nov 1987, *Solomon, J. 17418* (MO). **COLOMBIA. Antioquia:** Abriaquí, Parque Nacional Natural Las Orquídeas, 6°37'2 N - 76°18.2 W, 29 Abr 1990, *Ramírez, J. 3844* (MEDEL); Andes, vereda La Siria, 6°37.2 N - 76°18.2 W, 2200 m, 03 Mar 1995, *Sánchez, D. 4160* (MEDEL). **Cauca:** Páez, Cordillera central, cabeceras del río Palo, quebrada del río López y quebrada del Duende, 2°57.3'N - 76°9.45'W, 3400–3450 m, 03 Dic 1944, *Cuatrecasas 18944* (GH, VALLE); Inza, alrededores de la Laguna de Cusiyaco, 2°33'N - 76°12'W, 3017 m, 07 Oct 1951, *Idrobo 3991* (COL). **Quindío:** Génova, Camino finca Servia-Valle Chiquito, 4°13'N - 75°48'W, 2700–3900 m, 16 Jul 1990, *Vélez, M. 2086* (HUQ); Génova, Vereda alto San Juan, finca La Caucasia, páramo, 4°13'N - 75°48'W, 3200–3500 m, 15 Dic 1995, *Vélez, M. 6534* (HUQ). **Risaralda:** Santuario, Cerro Tatamá, 5°2.6'N - 76°3.4'W, 3200–3400 m, 08 Sep 1922, *Pennell 10474* (GH); Santuario, Vereda Las Colonias, 400 m arriba del campamento, 5°2.6'N - 76°3.4'W, 2910 m, 02 Feb 1983, *Torres 1495* (COL). **Tolima:** Ibagué, Parque Nacional Natural los Nevados, parte alta del río Toche, principalmente en la margen derecha del río, 4°36'N - 75°23'W, 3200 m, 29 Jun 1985, *Barbosa, C. 3556* (FMB); Ibagué, corregimiento de Juntas, faldas del Nevado del Tolima, del Rancho hacia la Cueva, 4°36'N - 75°23'W, 2900-3100 m, 08 Ago 1975, *Jaramillo 5122* (COL). **Valle:** Jamundí, Los Farallones de Cali, cerca a las cuevas de los Osos, 3°9.3'N - 76°50'W, 3600 m, 26 Ago 1991, *Calderón 44A* (COL). **ECUADOR. Tunguragua:** Banos Cantón, Parque Nacional Llanganates, faldas del Cerro Negro, valle de Los Frailejones, 01°10'S-78°15'W, 3500 m, 11 Oct 1998, *Vargas H. et al. 2738* (MO). PERU. **Cuzco:** near Machu Picchu, along old Inca path to Cuzco, Dec 1975, *Rafinski s.n.* (K).

REVISED KEY TO *LIBERTIA* IN SOUTH AMERICA

1\. Flowers pale blue, sessile or with short pedicels less than 3 mm long; ovary ca. 4 mm long; capsules ellipsoid, 7–10 × 5–6 mm **L. sessiliflora**

1\. Flowers white, outer tepals green at least outside, pedicels (7–)10–25 mm long; ovary 1–2.5 mm long; capsules subglobose, 2–4 × 2–5 mm.

  2\. Stem more or less straight, with rhipidia sessile except the terminal; flowers 4–10 per rhipidium; inner tepals 10 × 6.5 mm; filaments 6 mm long, anthers 2.5 mm long; style branches 5 mm long **L. chilensis**

  2\. Stem flexuose, rhipidia pedicellate except in axils of branches; flowers 2–4 per rhipidium; inner tepals 4.5–7 × ca. 3 mm; filaments 1.8–2.5 mm long, anthers 1–1.3 mm long; style branches 2(–3) mm long.

3. Plants less than 20 cm high; creeping rhizome up to 2 cm long; leaves 1–3 mm wide, firm-textured with thickened midribs and margins; inner tepals 4.5 mm long; filaments united for ca. one fourth their length; capsules 2 × 3 mm ________ **L. tricocca**
3. Plants 20–40 cm high; creeping rhizome (2–)5–18 cm long; leaves 3–6 mm wide, without thickened midribs and margins; inner tepals 6.5–7 mm long; filaments united for ca. half their length; capsules 4 × 4–5 mm ________ **L. colombiana**

SYNONYMY OF THE SOUTH AMERICAN SPECIES (EXCLUDING *LIBERTIA COLOMBIANA*)

1. Libertia chilensis (Molina) Gunckel, Rev. Chil. Hist. Nat. 31:87. 1927. *Strumaria chilensis* Molina, Sagg. Stor. Nat. Chili ed. 2:130. 1810. Type: unknown—the identity of the basionym is convincingly demonstrated by Gunckel (1927) to be the plant better known as *L. formosa* R. Grah. based on an analysis of the protologue.

Libertia formosa R. Grah., Edinb. N. Phil. J. 1833:383. Oct 1833. Type: CHILE [as Chili, Cape Horn]: imported by J. Anderson and cultivated first at the Clapton Nursery, London, and then in Edinburgh, Scotland, no preserved specimen known. Illustrations published in Edwards's Botanical Register (Lindley 1833) and in Curtis's Botanical Magazine (Graham 1834) serve to identify the species and may be regarded as type material as they were grown from the same stock originally collected in Chile and cultivated in London and then in Edinburgh. According to Lindley (1833) the plants were collected by J. Anderson on the coast of Chiloe Island. We designate the illustration in Curtis's Botanical Magazine as lectotype.

Libertia crassa R. Grah., Edinb. N. Phil. J. 1833:383. Oct. 1833. Type: CHILE [as Chili, Cape Horn]: imported by J. Anderson and cultivated first at the Clapton Nursery, London, and then in Edinburgh, Scotland, known only from the description.

Libertia elegans Poepp., Fragm. Syn. Pl. Chil. 3. 1833. *Roterbe elegans* (Poepp.) Steud. in Lechler, Pl. Chil. Exsicc. no. 569, comb. inval. non publ. Type: CHILE: near Valdivia, without date, *Lechler s.n.* (ISOTYPE: K).

Libertia grandiflora Phil., Bot. Zeit. 14:648. 1856, nom. illeg. non *L. grandiflora* (R. Br.) Sweet, Hort. Brit. 1:498. 1826. Type: CHILE: Juan Fernandez, collector and date not known (ISOTYPE: SGO).

Notes.—We prefer not to designate lectotypes for *Libertia elegans* and *L. grandiflora* because there may be additional material unknown to us.

Libertia chilensis Klotzsch mss was included by Baker (1877) in the synonymy of *L. elegans* Poepp. and is not a valid name. It therefore does not invalidate the combination *L. chilensis* (Molina) Gunckel. The plant referred to in the literature as *Libertia ixioides* C. Gay (Fl. Chil. 6:31. 1854) is incorrectly attributed to that author. Gay merely called a Chilean plant by this name, citing Forster fil. and Sprengel as authors of the basionym and combination in *Libertia* respectively, i.e., *L. ixioides* (Forster f.) Spreng., which is a New Zealand species. Likewise, the plant called *Libertia ixioides* Klatt [in Mart. Fl. Bras. 2:530, pl. 68, fig. 2. 1871] was not intended as a new species and *L. ixioides* Spreng. was cited in the text as the source of the name. This is the same New Zealand species, and was presumably cultivated in Brazil where there are no native species of *Libertia*.

Libertia macrocarpa Klatt, Linnaea 31:384 (1861–1862) is sometimes cited as a synonym of *L. chilensis* and a possible type has been located at K. This sheet is annotated "Chile, Valparaiso, cultivated at Hort. Gl." and the collector is not recorded. The specimen is a New Zealand species of *Libertia*, perhaps *L. ixioides*, which it matches in the oboviod capsules.

2\. **Libertia sessiliflora** (Poepp.) Skottsb., Nat. Hist. Juan Fernández & Easter Island 2:778. 1928. *Sisyrinchium sessiliflorum* Poepp., Notiz. Geb. Natur.-Heilk. (ed. L. F. Froriep) 23‘):277. 1829; et Fragm. Syn. Pl. 2. 1833. *Tekel sessiliflora* (Poepp.) Kuntze, Revis. Gen. Pl. 2:703. 1891. TYPE: CHILE: without precise locality, Sep, *Poeppig* 283 (HOLOTYPE: B, not seen but extant; MO, photo!).

Sisyrinchium sessiliflorum Hook. & Arn., Bot. Beechey Voy. 1:47. 1830, nom. illeg. non *S. sessiliflorum* Poepp. 1829. TYPE: CHILE: Concepcion, *Beechey s.n.* (probable HOLOTYPE: K!).

Libertia caerulescens Kunth & Bouché, Linnaea 19:382. 1847. TYPE: CHILE: Valparaiso, Lagunillia, cultivated in Berlin, May 1845, without collector (HOLOTYPE: B, not seen but extant; MO, photo!).

Note.—It is not clear whether the name *Sisyrinchium sessiliflorum* J.D. Hook. & Arn., Bot. Beechey Voy. 1:47. 1830 (listed as valid, for example, in Index Kewensis) was intended as a new species or merely the use of Poeppig's epithet, published a year earlier but not cited. While it seems prudent to assume the latter, thus simplifying the nomenclature of this species, the Code of Botanical Nomenclature requires citation of an author or the name must be treated as a new species.

3\. **Libertia triccoca** Phil., Linnaea 29:63. 1857–1858. TYPE: CHILE: Valdivia, without date, *Philippi* 944 (SYNTYPES: B, K!, SGO, not seen; MO, photos!), near Tomé (environs of Concepcion at K), without date, *Germain s.n.* (possible SYNTYPES: K!, SGO, not seen; MO, photo!).

ACKNOWLEDGMENTS

We are grateful to the Instituto de Ciencias Naturales at the Universidad Nacional de Colombia and The Missouri Botanical Garden, specially Colombia Project and their coordinators Olga Marta Montiel and Rosa Ortiz-Gentry for the given facilities to do this investigation. We thank to Henry Arellano by for his illustration, to Rodrigo Bernal for his comments about the synonymies and to the curators and staffs of COL, FMB, GH, HUQ, K, MEDEL, MO and VALLE for allowing us to study their collections.

REFERENCES

BAKER, J.G. 1877. Systema Iridearum. J. Linn. Soc. Bot. 16:61–180.

BAKER, J.G. 1892. Handbook of the Irideae. George Bell & Sons, London.

BLANCHON, D. 1998. The genus *Libertia* (Sprengel): Systematics, hybridisation and evolution. Doctoral Dissertation, School of Biological Sciences, University of Auckland, New Zealand.

BRAKO, L. and J.L. ZARUCCHI. 1993. Catalogue of the flowering plants and gynmosperms of Peru. Monogr. Syst. Bot. Missouri Bot. Gard. 45.

CELIS, M. 2000. Iridaceae. In: O. Rangel, ed. Colombia Diversidad Biótica III, La región de vida paramuna. Instituto de Ciencias Naturales, Facultad de Ciencias, Universidad Nacional de Colombia, Bogotá, Colombia. Pp. 256–260.

Graham, R. 1834. *Libertia formosa*. Beautiful Libertia. Curtis's Bot. Mag. 61: plate 3294.

Gunckel, H. 1927. Notas botanicas. Rev. Chilena Hist. Nat. 31:86–89.

Foster, R.C. 1939. Studies in the Iridaceae. 1. Contr. Gray Herb. 127:33–48.

Foster, R.C. 1946. Studies in the flora of Bolivia. 1. Iridaceae. Contr. Gray Herb. 161:3–19.

Goldblatt, P. 1990. Phylogeny and classification of Iridaceae. Ann. Missouri Bot. Gard. 77: 607–627.

Goldblatt, P. 1998. Iridaceae. In: K. Kubitzki, ed. Families and genera of flowering Plants Springer Verlag, Heidelberg [with contributions from J.C. Manning and P. Rudall]. 2: 295–335.

Goldblatt, P. and J.E. Henrich. 1987. A review of the New World species of *Orthrosanthus* Sweet (Iridaceae). Ann. Missouri Bot. Gard. 74:577–582.

Jorgensen, P.M. and S. León-Yanez. 1999.Vascular plants of Ecuador. Missouri Botanical Garden Press, St. Louis, Missouri.

Lindley, J. 1833. *Libertia formosa*. Handsome Libertia. Edwards's Bot. Register 6: plate 1630.

Rodríguez, R. and C. Marticorena. 2000. Commentarios taxonomicos en Iridaceae Chilenas. Gayana Bot. 57(2):169–179.

Skottsberg, C. 1928. The natural history of the Juan Fernandez Islands. A supplement to the pteridophytes and phanerogams of Juan Fernandez and Easter Island. Almqvist & Wiksells, Uppsala.

ARISTIDAE ELUDENDAE: *ARISTIDA HITCHCOCKIANA* (POACEAE)—A VALID SPECIES?

Kelly W. Allred

Range Science Herbarium
Department of Animal & Range Sciences
New Mexico State University
Las Cruces, New Mexico 88003, U.S.A.
kallred@nmsu.edu

ABSTRACT

The original descriptions and prologues, type specimens, and available material of *Aristida hitchcockiana* Henrard and *A. appressa* Vasey were compared. Based on morphology, distribution, and habitat, there seems to be no reason to recognize *A. hitchcockiana* as a valid species, and it is synonymized within *A. appressa*.

RESUMEN

Se compararon las descripciones y protólogos originales, ejemplares tipo, y demás material disponible de *Aristida hitchcockina* Henrard y *A. appressa* Vasey. Basándose en la morfología, la distribución geográfica, y el hábitat, parece no haber indicios suficientes para reconocer como especie valida a *A. hitchcockiana*. Por lo tanto, se la sinonimiza a *A. appressa*.

Aristida hitchcockiana was described in 1927 by J.T. Henrard, in his monumental "A Critical Revision of the Genus *Aristida*" (Henrard 1926, 1927, 1928). His new species was described and illustrated as having long narrow panicles, subequal glumes, the second truncate or emarginate, and unequal awns (Fig. 1). In his earlier work on the North American species of *Aristida*, A.S. Hitchcock included the type-to-be of *A. hitchcockiana* within *A. arizonica* (Hitchcock 1924). Accordingly, Henrard called attention to the shorter spikelets and awns, and truncate, emarginate glumes of *A. hitchcockiana* as compared to *A. arizonica*. The new species was known only from the original description and from the type collection at Las Sedas, Oaxaca, México (Hitchcock 1935), and largely ignored or not relevant to subsequent works on Mexican *Aristida* until Beetle's Las Gramineas de México (Beetle 1983), in which he recorded the species from seven states in México. I do not know to which plants he applied the name, only that the illustration is at variance with both Henrard's and Beetle's own descriptions, in that it shows an open panicle with spreading branches and pedicels, acuminate glumes, and long equal awns. In these publications and in Henrard's prodigious "A Monograph of the Genus *Aristida*" (Henrard 1929, 1932, 1933), *A. hitchcockiana* was compared most closely to *A. arizonica*, from which it was distinguished by having longer glumes, lemmas, and awns, but which belied its more obvious similarities.

SIDA 21(4): 2113–2118. 2005

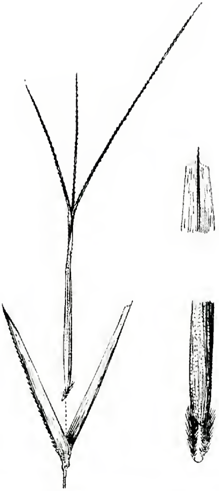


Fig. 1. Spikelet, 2nd glume apex, and callus of *Aristida hitchcockiana* [from Henrard (1932)].

A comparison of *Aristida hitchcockiana* with *A. appressa* Vasey (Fig. 2), based on original descriptions, type material, and specimens, failed to reveal any morphological characters by which to distinguish them (Table 1). For Henrard, the single most diagnostic feature of *A. hitchcockiana* was the truncate and shortly awned apex (the "curious tip") of the second glume, clearly illustrated in the original description and relied upon solely and explicitly in the keys of his Monograph (Henrard 1932, p. 237). This feature is seen clearly in the type, but even there, some of the second glumes are acutish and not very truncate. Examination of nearly 100 specimens of *A. appressa* showed a nearly complete gradation from glumes with truncate and shortly awned apices, through a series with progressively longer awns and more narrow apices, to the other extreme of glumes with long awns, acuminate apices, and noticeable lateral setulae. The truncate apex can be easily overlooked or obscured when the glume is folded or rolled. Perhaps this has lead to the characterization of the glumes of *A. appressa* as being acute or acuminate (Henrard 1932; Beetle 1983),

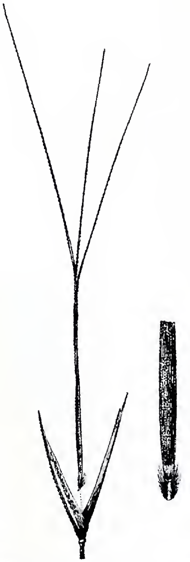


Fig. 2. Spikelet and callus of *Aristida appresssa* [from Henrard (1932)].

when in fact obtuse to truncate glume apices are frequently encountered in that species as well. In addition, I could find no correlation of this condition (a truncate apex) to any other feature. Both species develop long internodes (longer than the sheaths), a line of hairs across the collar (represented by a rim in older material, or glabrate), noticeably long hairs above the ligule on the upper surface of the blade, and lateral awns shorter than the central awn.

Henrard (1929) called particular attention to the "very curious crisp pubescence" of the culms, panicle branchlets, and lower glumes of *Aristida appressa*. This is caused by a scaberulous type of pubescence, usually in lines along the ridges or nerves of the afore-named parts. It is well-expressed in the type of *A. appressa*, but much less so in many other specimens, and can commonly be absent. This same scaberulous pubescence is found in the type of *A.*

TABLE 1. Comparison of *Aristida hitchcockiana* and *A. appressa*.

Feature	***Aristida hitchcockiana*, type**	***Aristida appressa***
Culm height (cm)	75	40–120
Peduncle length (cm)	13	10–40
Internode pubescence	glabrous	glabrous to puberulent
Middle sheath length (cm)	6–10	4–11
Sheath pubescence	glabrous to scaberulous	glabrous to scaberulous
Ligule length (mm)	0.2	0.1–0.2
Auricle region	flaring, ciliolate, with hairs to 2.8 mm	flaring, ciliolate to glabrate, often with hairs to 3 mm
Collar	scaberulous in a line	glabrous to scaberulous in a line
Longest blade length (cm)	17	14–30
Blade width when flat (mm)	1.8–2.0	1.5–2.5
Blade involution	flat, appearing to be rolled due to drying	convolute when young, flat & curling when mature
Blade margin	slightly thickened	slightly thickened
Blade upper pubescence	puberulent/scaberulous with scattered long hairs near ligule	puberulent/scaberulous with scattered long hairs near ligule
Panicle length (cm)	17–24	14–30
Lower branch length (cm)	4–6	5–12
Pulvini	absent	absent
First glume length (mm)	8–10	5–12
First glume apex	acute	truncate to acuminate
Second glume length (mm)	9–11	6–12
Second glume apex	truncate to acute	truncate to acute
Glume pubescence	scaberulous on the nerves	glabrous to scaberulous on the nerves
Lemma length to awns (mm)	11–12	7–13(–16)
Lemma vestiture	glabrous in the lower part, scaberulous in the upper	glabrous in the lower part, scaberulous in upper
Lemma beak	slightly exceeding the glumes	equal to much exceeding the glumes
Callus length (mm)	0.6–0.8	0.6–1
Central awn length (mm)	12–15	15–22
Lateral awn length (mm)	6–9	7–17

hitchcockiana, on culm internodes, branchlets, and the lower glumes. This feature has the same degree of inconsistency as the truncate glume apex: ranging from noticeably present to absent.

Henrard's holotype came from Las Sedas, Oaxaca, México (approximately 100 km northwest of the city of Oaxaca on highway 131, at N17.3523° W96.9444°), collected by Charles L. Smith sometime in 1894. The village was a former railroad station, and sits at about 2100 m in a pine-matorral transition zone, a common elevation and habitat for *Aristida appressa*. *Aristida appressa* is found in all the surrounding states (Chiapas, Veracruz, Puebla, Guerrero), as well as in Oaxaca itself.

The basis for *Aristida hitchcockiana* seems to be simply one end of a single line of variation. Its recognition is partly an artifact of observation: noticed in a few plants where the glumes are not folded or rolled, but overlooked in other plants where the glume apices are obscured. It lacks any distinctive morphology, distribution, or habitat. For these reasons, the name *A. hitchcockiana* Henrard is subsumed without recognition under the older name *A. appressa* Vasey, as detailed below.

Aristida appressa Vasey, Contr. U.S. Natl. Herb. 1(8):282. 1893. TYPE: MÉXICO. JALISCO: Guadalajara, 1886, *E. Palmer s.n.* (HOLOTYPE: US-745676!; ISOTYPES: L fragm., W).

Aristida hitchcockiana Henrard, Meded. Rijks-Herb. Leiden No. 54A:233–234. 1927. TYPE: MÉXICO. OAXACA: Las Sedas, 1894, *C.L. Smith 918* (HOLOTYPE: US-991670!).

Selected specimens examined (of 76 total): **COSTA RICA. Guanacaste:** 4 km W of the Inter-American Hwy on the road to Murcielago, 320 m, 24 Oct 1968, *R. Pohl 11324* (F). **EL SALVADOR. Chalatenango:** along Hwy 4, 4 km SSE of La Palma, pine forest, 950 m, 11 Jun 1970, *R. Pohl 11890* (F). **GUATEMALA. Chimaltenagno:** near Rio Pixcayo, oak and pine forest, 1650–188 m, 3 Feb 1939, *P. Standley 64492* (F). **Huehuetenango:** about Laguna de Ocubila, E of Huehuetenango, 1900 m, 7 Jan 1941, *P. Standley 82725* (F). **HONDURAS. Comayagua:** half-way between Comayagua and Villa San Antonio, 25 Jan 1936, *W. Archer 3841* (US). **El Paraíso:** grassy pine forest of Cuesta Galeras road to Guinope, 1400 m, 24 Nov 1970, *A. Molina R. 25913* (US). **Morazán:** open hillside, Sta. Clara Creel, Rio Yeguane Valley, 800 m, 17 Dec 1946, *L. Williams 11259* (G); region of Las Mesas, steep pine-wooded slopes, 800–900 m, 14 Oct 1951, *J. Swallen 10740* (US). **MÉXICO. Chiapas:** steep rocky slope with Quercus along Mexican Hwy 190 in the Zinacantan paraje of Muctajoc, 3500 ft, 17 Aug 1965, *D. Breedlove 11869* (F); 11 km W of Tuxtla Gutierrez in rolling hills, 24 Oct 1973, *F. Gould 14433* (NMCR). **Distrito Federal:** Villa Guerrero, 21 Oct 1960, *T. Tateoka 1139* (US). **Guerrero:** Manchon, 26 Sep 1936, *G. Hinton 9593* (MO). **Guanajuato:** about 6 km east of Guanajuato, rocky soil on an eroded hillside, 17 Oct 1952, *E. Sohns 312* (US); km 40, Guanajuato City-Dolores Hidalgo, 15 Sep 1946, *E. Hernandez Xolocotzi 2445* (US); Sta. Cruz de Jventino Rosas rumbo a Guanajuato, 1 Sep 1981, *A. Beetle 7359* (MO). **México:** 1.7 km W of Tejupilco on Mexican Hwy 134 towards Temascaltepec, 1430 m, 6 Oct 1991, *P. Peterson 11058* (NMCR). **Oaxaca:** Las Sedas, in 1894, *Chas. L. Smith 918* (US-type); 4.8 km e of Mitla on Mexican Hwy 179 towards Ayutla, gentle slopes near small creek and cultivated fields, 1760 m, 14 Sep 1990, *P. Peterson 9861* (NMCR); NE of Oaxaca, 13 km N of El Punto on Mexican Hwy 175 and 10.8 km S of Guelatao, 1970 m, 17 Sep 1990, *P. Peterson 9936* (NMCR); 151 km SW of Oaxaca on Mexican Hwy 190, oak woods, 1100 m, 15 Oct 1976, *J. Brunken 369* (MO); from Temascalapa to San Ildefonso de Villa Alta proper, on open and rocky mountain slopes, 29–30 Oct 1944, *J. Vera Santos 3543* (US); savanna near Revolucion Mexicana, 800 m, 3 Nov 1981, *D. Breedlove 54518* (G). **Puebla:** near Cholula, around the Cholula pyramid and Church Nuestra Senora de la Remedios, 14 Dec 1972, *A. Beetle 2276* (MO). **Veracruz:** 3 km al N de Chacalapa, 400 m, 26 Sep 1965, *J. Rzedowski 21211* (F).

ACKNOWLEDGMENTS

Many thanks to the curators of F, G, MO, US, and WIS, who kindly supplied material for study, and to P.M. Peterson and S.L. Hatch for their helpful comments as reviewers. David Lee Anderson generously rendered the abstract in Spanish. Thanks to Jesus Valdés-Reyna for additional information about Las Sedas.

REFERENCES

Beetle, A.A. 1983. Las Gramíneas de México, vol. 1. COTECOCA [Comisión Técnico Consultiva de Coeficientes de Agostadero], México, D.F., México.

Henrard, J.T. 1926. A critical revision of the genus Aristida. I. Meded. Rijks-Herb. 54:1–220.

Henrard, J.T. 1927. A critical revision of the genus Aristida. II. Meded. Rijks-Herb. 54A: 221–464.

Henrard, J.T. 1928. A critical revision of the genus Aristida. III. Meded. Rijks-Herb. 54B: 465–701.

Henrard, J.T. 1929. A monograph of the genus Aristida. I. Meded. Rijks-Herb. 58:1–137.

Henrard, J.T. 1932. A monograph of the genus Aristida. II. Meded. Rijks-Herb. 58A:157–325.

Henrard J.T. 1933. A monograph of the genus Aristida. Index. Meded. Rijks-Herb. 58B:I–XII.

Hitchcock, A.S. 1924. The North American species of *Aristida*. U.S. Natl. Herb. 22:517–586.

Hitchcock, A.S. 1935. *Aristida*. North American flora 17:376–406.

A LECTOTYPE FOR *STACHYS FLORIDANA* (LAMIACEAE)

John B. Nelson
Department of Biological Sciences
University of South Carolina
Columbia, South Carolina 29208, U.S.A.

Daniel B. Ward
Department of Botany
University of Florida
Gainesville, Florida 32611, U.S.A.

ABSTRACT

In the absence of possible holotype material, a lectotype is designated for *Stachys floridana* Shuttlew. ex Benth. in DC. (1848) from material not clearly cited by Bentham but probably in his possession at time of publication.

KEY WORDS: *Stachys*, Lamiaceae, lectotype selection

ABRISS

Aufgrund des Fehlens von Originalmaterial wird für *Stachys floridana* Shuttlew. ex Benth. in DC. (1848) ein Lektotyp aus Belegen ausgewählt, die Bentham zwar nicht zitiert hat, die aber wahrscheinlich zur Zeit des Publikation in seinem Besitz waren.

A review of the genus *Stachys* (Lamiaceae) in the southeastern United States (Nelson 1981) left unresolved some difficult but noncritical nomenclatural details. One of the most vexatious of these remaining inquiries has been the search for a suitable type and type locality for a widespread southeastern species, *Stachys floridana*. Since no single specimen was designated by its author, George Bentham, which can be interpreted as a holotype, our intent here is to document the steps taken in this search and its ultimate resolution by choice of an appropriate replacement, a lectotype.

Bentham (Prodr. 12:478, 1848) published *Stachys floridana* using a name coined by Robert J. Shuttleworth for specimens collected for him by Ferdinand Rugel. (See Geiser 1948, for a brief biography of Rugel.) Bentham published his new *Stachys* by first indicating the source of the name, "(Shuttlew.! pl. Rüg mss.)." He then provided a 41-word diagnostic description based upon materials "Ad Tampa Bay Floridae." As indicated by the further notation "(h. Torr! Rügel!)," Bentham's material apparently consisted of two collections, a specimen from the herbarium of John Torrey and a second from Rugel. Bentham concluded his presentation by providing a 21-word supplemental description that applies to a commonly observed, full-sun variant.

The following relevant collections have been located, presented here in (apparent) order of date of collection:

1. *Unknown collector* 72: Handwritten label bearing "72" and reading "*Stachys floridana* Shuttl.," "Tampa Bay [Hillsborough County] Florida," and "Torrey 18[?]6." Specimen seen: K (photo only). The hand is undetermined.

2. *Rugel s.n.*: Printed labels from the Shuttleworth herbarium, reading "*Stachys floridana* Shuttl. n. sp. Ad margines agrorum, prope Tallahassee [Leon County], Florida, legit Rugel, Mai 1843." Specimens seen: BASBG, BM, K, MIN, MO, NY, USCH, Z [3]. Since Shuttleworth sold and distributed sets of Rugel's 1843 collections (Geiser 1948), additional specimens may exist.

3. *Rugel 176*: Labels headed "From The United States National Herbarium," bearing the printed words "Florida—F. Rugel: 1842–1849. Ex Herb. Mus. Brit.," a handwritten "176," and the plant name. Specimens seen: BM, F, MO [2], NY, US. Apparent duplicates of this collection are at FLAS and NCU, but accompanied by labels printed with the words "Ex Herbario Musei Brittanici," and modern typescript indicating the specimen to be *Rugel 176*, from Lake Monroe [Volusia County], Florida, collected June 1848 (cited imprecisely as from "near Jacksonville" in Nelson 1981).

Since Bentham indicated he had seen two collections of his new species, no holotype can be cited. It would indeed be a straightforward matter to designate the Tampa Bay collection as lectotype if it were not for a series of uncertainties that time and continued investigation have not resolved.

The collector and date of collection of the Tampa Bay specimen remain obscure. Since correspondence and specimen exchanges between Alvan Wentworth Chapman of Apalachicola, Florida, and John Torrey, New York, and between Torrey and George Bentham are well known, our first assumption was that Chapman was either the collector or responsible for transmitting the collection. Certainly Chapman knew the plant; his *Flora of the Southern United States* (1860) recorded the species as occurring in "Middle and South Florida."

But the date borne by the specimen is too early for Chapman's involvement. The unclear digit, as shown by a photograph, is most likely a "2"; a date of 1826 would have required Chapman, born in 1809, to have been 17 at the time of collection. Even if the digit were a "3," as seems marginally possible, Chapman is unlikely to have been the collector or communicator; he did not move to Florida (to Quincy, Gadsden County), as a young physician, until 1835 (Barnhart 1921).

Other early Florida collectors were considered as the possible source. The Seminole Wars, which began in 1818, resumed in 1835 and continued intermittently until the 1840s, made the Florida peninsula an inhospitable place for travel and collection. Yet the military forces sent into the state permitted a few soldier-botanists to reach areas otherwise inaccessible and unknown. Of those whose duties brought them into central Florida, at least three served at Fort Brooke, modern Tampa, or reasonably would have passed through that area to duty stations elsewhere. Gilbert White Hulse, an army surgeon, was based at Fort Brooke beginning in 1836, and sent specimens to Torrey (Ewan 1971). Bradford Ripley Alden, a West Point officer, arrived at Fort King, near present-day Ocala, in 1832 or 1833 and is also known to have sent specimens to Torrey. Melines Conkling Leavenworth, a doctor also stationed at Fort King, collected widely in the northern peninsula during the 1830s. Other botanical explorers in pioneer Florida are also known (Wunderlin et al. 2000). But no records present clear evidence as to the identity of this first collector of *Stachys floridana*.

We have been unable to discover either at K, within the Torrey herbarium (now NY), or in other herbaria, any further early collections of *Stachys floridana* from the Tampa Bay region. It is not apparent why Torrey, who is indicated as the source of the Tampa Bay collection now at K, would have parted with his only specimen. Though the handwriting cannot be confirmed as Bentham's, neither is it clearly that of Torrey. The possibility thus remains that Torrey transmitted a unicate of little perceived value, and that the "Tampa Bay" designation was added by someone other than its collector. But whoever the collector and the place of collection, Bentham's notation of "Torrey"—and the absence of other Torrey specimens available to Bentham—strongly suggests that the collection now marked "72" was among the material in Bentham's possession at time of description.

Rugel's Tallahassee collection of *Stachys floridana* is also imperfectly documented. It is probable his 1843 specimen reached Bentham (at K) as part of a set purchased from Shuttleworth; Rugel's collections of that year apparently were distributed in no other way (Geiser 1948). These sets may have been available for purchase as early as 1844—at a price of 24 Swiss francs per 100 (per "century")—well before publication in 1848. Why Bentham failed to indicate his knowledge of the 1843 specimen is unclear; "ad Tampa Bay" may have seemed sufficient to encompass also Tallahassee. But Bentham did refer to Rugel as a source, and it appears likely that at least one of the specimens collected by Rugel near Tallahassee in May 1843, which consist of a mixture of shade and full-sun variants, was among the original material upon which Bentham based his description.

The Tallahassee specimen available to Bentham at Kew Gardens (K) is on a sheet bearing two collections [Fig. 1]. Two excellent plants of *Stachys floridana* on the right side of the sheet have been mounted alongside an unrelated *Stachys* sp., apparently from Chiapas, Mexico.

The pathway of *Rugel 176* is similarly unclear. The more detailed labels accompanying this collection at FLAS and NCU—as from Lake Monroe, Florida—suggests that BM may have retained (and distributed to other herbaria) only an abbreviated version of the information available from the original labels. The year of collection, 1848, as stated by the FLAS and NCU specimens, is the same as publication of the name. Since the date is in typescript and of recent application, it may merely reflect an archivist's assignment of the publication date to accompany the older printed label. If indeed this were the year of collection, there would have been scant opportunity for timely transmittal of those specimens from Rugel to Shuttleworth and then to Bentham. Moreover, there is no annotation or other marking on the specimen to indicate that Bentham (at K)

Fig. 1. Lectotype of *Stachys floridana* Benth. Two plants, right side: Ferdinand *Rugel s.n.*, Tallahassee, Florida, May 1843. (Plant, left side: unrelated collection of *Stachys* sp., apparently from Chiapas, Mexico.)

had occasion to view the holdings at BM. The bulk of the Shuttleworth herbarium was not acquired by the British Museum until 1877 (Geiser 1948), and if Rugel 176 were part of that transfer it would of course not have reached England until long after Bentham's publication.

Thus none of the early collections are fully satisfactory choices as lectotype for Bentham's *Stachys floridana.* Yet none of the three collections examined can be categorically excluded. Fortunately, the morphological uniformity of this species, as represented by these collections, is such that no taxonomic consequence will follow the selection of one rather than another.

But *Rugel 176*, though the collector's name was cited by Bentham, is clearly a marginal choice as lectotype; it seems unlikely that the specimen at BM, if seen by Bentham, was available to him until after his publication of the name. The second possible lectotype, from Tampa Bay, was probably in Bentham's hands prior to publication, but it is of uncertain provenance and without known duplicates, and is of tenuous quality upon which to base a name.

We have chosen the third possibility, the specimen from Tallahassee, Florida, as our lectotype:

Stachys floridana Shuttlew. ex Benth. in DC., Prodr. 12:478. 1848. TYPE: U.S.A. FLORIDA: [Leon Co.]: Tallahassee, May 1843, *Rugel s.n.* (LECTOTYPE, designated here: K, two plants, right half of sheet [**Fig. 1**]; ISOLECTOTYPES: BASBG, BM, MIN, MO, NY, USCH, Z; (USCH is a mixture, bearing a flowering stem of *Physostegia* in addition to the *Stachys*).

Even though Bentham made no reference to material from Tallahassee, the low probability of his having seen Rugel 176, from Lake Monroe, gives a correspondingly high probability to him having seen Rugel s.n., from Tallahassee; that collection may reasonably be interpreted as the "Rügel" specimen which he cited. The Kew Gardens collection is representative of a common full-sun form of the plant and will, we trust, serve to anchor future understanding of this name.

ACKNOWLEDGMENTS

We are grateful to the curators and staff of the above-mentioned herbaria for the loan of specimens or gift of photographs for this study, especially Ray M. Harley (K), Roy Vickery (BM), and Thomas A. Zanoni (NY); to Hartmut Hilger (BSB) for composition of the German abstract; and to Loran C. Anderson (FSU), Fred R. Barrie (F), Victoria C. Hollowell (MO) for their helpful suggestions in review of our manuscript.

REFERENCES

BARNHART, J.H. 1921. In: W. Kimball, Reminiscences of Alvan Wentworth Chapman. J. New York Bot. Gard. 22: 1–11.

BENTHAM, G. 1848. Labiatae. In: A.P. de Candolle, Prodromus Systematis Naturalis Regnum Veg. 12:478.

CHAPMAN, A.W. 1860. Flora of the southern United States. Ivison, Phinney & Co., New York.

Ewan, J. 1971. In: R. W. Long and O. Lakela, A flora of tropical Florida. Univ. of Miami Press, Coral Gables.

Geiser, S.W. 1948. Biographical note on Dr. Ferdinand Rugel, American botanist. Field & Lab. 16:113–119.

Nelson, J.B. 1981. *Stachys* (Labiatae) in southeastern United States. Sida 9: 104–123.

Wunderlin, R.P., B.F. Hansen, and J. Beckner. 2000. Botanical exploration in Florida. In: Wunderlin and Hansen, Flora of Florida, vol. I. Univ. Press of Florida, Gainesville.

TAXONOMY OF THE *SYMPHYOTRICHUM* (ASTER) *SUBULATUM* GROUP AND *SYMPHYOTRICHUM* (ASTER) *TENUIFOLIUM* (ASTERACEAE: ASTEREAE)

Guy L. Nesom

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

North American and Central American taxa of *Symphyotrichum* sect. *Oxytripolium* (*S. subulatum* sensu lato and *S. tenuifolium* sensu lato) have been treated at both specific and varietal rank. As interpreted here, morphological discontinuities and reproductive isolation indicate that specific rank is appropriate for the five annual taxa, including the South American native *S. squamatum*, which is recorded primarily as a waif in the U.S.A. A key is provided to the annual taxa under consideration and summaries of synonymy are given for each. State distribution records are documented for the following: *S. subulatum*—Arkansas, Nebraska; *S. divaricatum*—New Mexico; *S. bahamense*—Georgia; *S. expansum*—Florida, Oklahoma; *S. squamatum*—Alabama, California, Florida, Louisiana, Texas.

RESUMEN

Los taxa de Norte América y América Central de *Symphyotrichum* sect. *Oxytripolium* (*S. subulatum* sensu lato y *S. tenuifolium* sensu lato) se han tratado tanto con rango específico como varietal. Tal como se interpreta aquí, las discontinuidades morfológicas y aislamiento reproductor indican que el rango específico es el apropiado para los cinco taxa anuales, incluyendo la nativa Sur Americana *S. squamatum*, que se cita principalmente como una planta abandonada en U.S.A. Se ofrece una clave para los taxa anuales en consideración y se hacen resúmenes de las sinonimias para cada uno de ellos. Se documenta la distribución en estados de los siguientes: *S. subulatum*—Arkansas, Nebraska; *S. divaricatum*—Nuevo México; *S. bahamense*—Georgia; *S. expansum*—Florida, Oklahoma; *S. squamatum*—Alabama, California, Florida, Texas.

Seven taxa of *Symphyotrichum* sect. *Oxytripolium* (DC.) Nesom (*Symphyotrichum* subg. *Astropolium* (Nutt.) Semple) comprise *Symphyotrichum* (*Aster*) *subulatum* (Michx.) Nesom sensu lato and *Symphyotrichum* (*Aster*) *tenuifolium* (L.) Nesom sensu lato. Six of these taxa are native primarily to North America and Central America (including the Antilles and Bahamas); one is native to South America. One or several of them occur as cosmopolitan weeds, but identifications need to be reexamined for accuracy and consistency. Sundberg (1986, 2004, 2005) has followed a broad species concept, emphasizing putative intergradation among the taxa (see comments below), and treated *S. subulatum* as a single species with five varieties and *S. tenuifolium* with two varieties. All seven of these taxa are treated here (and in Nesom 1994) at specific rank; bases for the taxonomic decisions are differences among the taxa in morphology, geography and ecology, chromosome number, self compatibility, and sterility in

SIDA 21(4): 2125–2140. 2005

natural and experimental hybrids. Information on reproductive biology, chromosome numbers, and hybridization is from Sundberg (1986).

The observations and considerations here are predicated on the initial study and sorting of the North American oxytripolioid taxa by Sundberg (1986, 2004), who found the larger patterns in a taxonomically difficult complex and provided detailed information regarding typification. My disagreements with Sundberg are primarily in asssignments of rank, based largely on interpretation of data, as I mostly agree with his delimitation of taxa. While I have seen plants in the field and studied a large number of specimens, Sundberg collected this group widely and for his dissertation research had on hand several thousand specimens from various herbaria. The lesser intensity of the present analysis and commentary, however, does not invalidate the conclusions. The key provided below is based on Sundberg's dissertation study (1986) but has been modified as I worked through collections. Hopefully, the present overview will supplement that of Sundberg's FNA treatment (2005) in facilitating more accurate identifications of these taxa.

Documentation is provided for various distribution records, which have not been given in Sundberg's dissertation or publications. His distribution maps (1986) were small-scale and did not show U.S.A. counties. Some points of the present discussion were made earlier in brief (Nesom 1994).

Annual taxa—*Symphyotrichum subulatum* sensu lato

A map compiled by Sundberg (1986) shows that in their native (New World) ranges, the five annual taxa are discrete in geographic distribution, each almost completely allopatric with the others. In those with partially contiguous ranges, he indicated in text that intermediates occur in relatively small areas, but intermediates were not shown on the map. The taxa are morphologically distinct although by relatively small differences.

Symphyotrichum squamatum and *S. bahamense* are tetraploids ($2n = 20$), while the other taxa are diploids ($2n = 10$). Sundberg reported naturally occurring intermediates between (1) *S. bahamense* [$2n = 20$] and *S. subulatum* [$2n = 10$], (2) *S. bahamense* [$2n = 20$] and *S. expansum* [$2n = 10$], and (3) *S. divaricatum* [$2n = 10$] and *S. expansum* [$2n = 10$]. His own study, however, provided evidence regarding internal reproductive isolation among these taxa. "Artificial hybrids produced in the greenhouse among these [five] varieties are highly sterile" (Sundberg 1986, p. 63). He obtained plump achenes (presumably those that were germinable) only from crosses between *S. bahamense*-*S. divaricatum*, *S. bahamense*-*S. expansum*, and *S. expansum*-*S. squamatum*, and each of these pairings was between a diploid and tetraploid. A photo in Sundberg (1986) shows 15 mitotic chromosomes of a triploid artificial hybrid between *Symphyotrichum bahamense* and *S. expansum*.

Notwithstanding the significance of naturally occurring intermediates to

Sundberg's view of the variation patterns, he did not report the occurrence of a naturally occurring triploid plant among the 86 natural populations of annual oxytripolioid taxa from which he made chromosome counts. Nor, apparently (judging from his vouchers at TEX), did he make a chromosome count of a plant suspected of being a natural hybrid of a diploid-tetraploid parental cross. Semple (1992) noted that of 6908 chromosome counts reported for North American asters (mostly *Symphyotrichum*) and goldenrods, only 8 (0.12%) were triploid. This suggests that intergradation may not be as prevalent as Sundberg surmised, if it can be inferred from Semple's data that triploids survive at a very low frequency.

Sundberg (2004, p. 906) pointedly summarized his rationale for treatment of these taxa at infraspecific rank: "**The varieties intergrade morphologically where their distributions approach one another**." I have been unable to corroborate this implied ubiquity of intergradation, certainly not to the extent that would suggest treating all taxa as a single species. The annual taxa appear to be essentially discrete in morphology at their points of geographic contact and overlap. Tendencies for overlapping variation in one or a few morphological features, as described by Sundberg (2004), are not necessarily the result of intergradation, which characteristically is understood to imply the existence of a zone of morphological intermediacy with continous gene exchange. Discontinuities in morphology imply the existence of reproductive isolation. Sundberg's sentence immediately following the one above suggests that his view of "intergradation" reflected a broad interpretation of that process: "**This [intergradation] may be the result of past hybridization events and limited gene flow across reproductive barriers**."

Even with recognition that reproductive isolation exists among the annual oxytripolioid taxa, morphological differences often are subtle. Infraspecific variability and parallel variation, especially within *Symphyotrichum divaricatum* and *S. bahamense*, produce individuals that might be misidentified without an understanding of the morpho-geographic patterns. Differences among the diploid taxa, however, are clearer, and the tetraploid *S. bahamense* apparently is reproductively isolated from the three closely related diploid taxa with which it is contiguous-sympatric. The species concept underlying the present analysis emphasizes biological discontinuities.

Annual plants of sect. *Oxytripolium* adventive in Australia and various Pacific islands have mostly been identified simply as *Aster subulatus* (e.g., Walker 1976; Harden 1992; Jones 1999), although Soejima and Peng (1998) reported the occurrence of two taxa (as *A. subulatus* var. *subulatus* and *A. subulatus* var. *sandwicensis*) in Taiwan. Smith (1991) included *A. subulatus* for Fiji, noting that it probably existed only as a ballast waif. Naturalized plants from other parts of the world have been identified as *A. squamatus*, e.g. Europe (Tutin et al. 1976), Russia (Tamamschyan 1959), and Zimbabwe (Mapaura & Timberlake

2004). Where two or more of these taxa may co-occur as adventives in regions outside of their native range, observations and perspective of the present commentary suggest that they will remain morphologically discrete. For example, *S. squamatum*, *S. bahamense*, and *S. expansum* in characteristic morphology have been recorded from Japan (see below).

The name *Aster exilis* Elliott (Sketch Bot. S.Carolina 2:344. 1823) has often been applied to these plants, but as noted by Shinners (1953), a type has never been located and Elliott's description may well have applied to some form of *Symphyotrichum dumosum*. With heads on the upper branches "in racemes on peduncles two to four lines long," ray florets "twice as long as the involucrum," and occurring "in the western districts of Georgia," the plants that Elliott described could hardly be any of the annual taxa considered here.

Symphyotrichum subulatum (Michx.) Nesom, Phytologia 77:293. 1994. *Aster subulatus* Michx., Fl. Bor-Amer. 2:111. 1803. *Symphyotrichum subulatum* var. *subulatum* (sensu Sundberg 2004). TYPE: U.S.A "PENNSYLVANIA."

Aster subulatus var. *euroaster* Fernald & Griscom, Rhodora 37:183. 1935. TYPE: U.S.A VIRGINIA.
Aster subulatus var. *obtusifolius* Fernald, Rhodora 16:61. 1914. TYPE: CANADA. NEW BRUNSWICK.
Aster ensifer Bosserdet, Taxon 19:250. 1970. TYPE: U.S.A. MASSACHUSETTS.

$2n = 10$. Self-compatible. Primarily outer coastal plain of the Gulf and Atlantic coasts of Canada (New Brunswick) and the eastern U.S.A. (Texas, Louisiana, Mississippi, Alabama, Florida-northeastern counties disjunct to the western panhandle region, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey, Pennsylvania, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Maine); coastal salt and brackish marshes, depressions between sand ridges, spoil banks along canals, shorelines near the coast. Also in inland marshes and saline areas of various states (Arkansas, Nebraska, Illinois, Indiana, Ohio, Michigan, and Ontario). Semple et al. (2002) noted that the species may have been introduced into Ontario only after salt mining began in the region. It was first collected in Michigan in 1914 at a salt mine and "survives now along well salted highways" (Voss 1996). In Illinois, it is "adventive along highways, rapidly spreading in ne. Ill." (Mohlenbrock 2002). Label data and photos of herbarium collections made in eight counties of the Chicago region (V Plants 2005) indicate that the plants there grow mostly in ditches and road shoulders. Collections from south-central Arkansas (citations below) are from an area apparently polluted by salt from oil drilling.

First reports for **Arkansas. Union Co.:** 5 mi S of Calion, sandy oil spill barrens, 8 Oct 1988, *Sundell 8794* (VDB); edge of bare vegetation-less area in salty runoff area from oil wells beside Union Co. Rd. 25, 1 mi N of Urbana near a branch of Richmond Creek, 22 Oct 1987, *Thomas 103,102* (NLU); salty runoff area beside small stream just E of Lawson and S end of Ark. 129, area graded in attempt to clean up runoff from oil wells, 22 Oct 1987, *Thomas 103,117* (NLU); salty area from oil well runoff beside branch of Mill Creek, 2 mi N of Old Union and Ark. 15, 7 Oct 1988, *Thomas 107,952* (NLU, TEX); 1 mi N of Urbana, salty area along a branch of Richmond Creek, beside Union Co. Rd. 25, 7 Oct

1988, *Thomas 108,025* (NLU, VDB); sandy soil in oil field N of Ark. 335 along E bank of Hayes Creek 2 mi E of Norphlet, 15 Sep 1989, *Thomas 112,871* (NLU). First reports for **Nebraska. Lancaster Co.:** just W of Lincoln, Oak Lake, plant very common along saline shore, 7 Oct 1974, *Churchill 4862* (BRIT, NLU); artificial pond by Salt Creek, N of University campus, *Shildneck C-14017* (TEX). *Symphyotrichum divaricatum* also occurs in Lancaster County (e.g., *Shildneck C-14016*, TEX).

Symphyotrichum subulatum usually is distinctive in its heads in a dense, elongate, pyramidal-paniculate arrangement (or corymbiform in small plants with relatively few heads), relatively long involucres, phyllaries without a distinct apical green zone, ray florets 1.5–2.5(–3) mm long and coiling back distally in 1/2–1 coils, disc florets 4–10(–13), accrescent pappus, and typical salt marsh habitat (the only one of the annual taxa adapted to saline substrate). Axillary heads sometimes mature as sessile to subsessile, as is characteristic of *S. bahamense*, but other features of *S. subulatum* establish its identity. It perhaps forms triploid hybrids with *S. bahamense* (fide Sundberg) but apparently is more completely isolated from the other annual taxa (see comments under *S. divaricatum*).

Symphyotrichum divaricatum (Nutt.) Nesom, Phytologia 77:279. 1994. *Tripolium divaricatum* Nutt., Trans. Amer. Philos. Soc. 2, 7:296. 1841. *Aster divaricatus* (Nutt.) Torrey & A. Gray, Fl. N. Amer. 2:163. 1841 (not *Aster divaricatus* L.). TYPE: U.S.A. MISSISSIPPI: "inundated banks of the Mississippi," collected by Thomas Nuttall, probably in December 1811, in the vicinity of Natchez, Mississippi, or around New Orleans, Louisiana (Graustein 1967).

Aster subulatus var. *ligulatus* Shinners, Field & Lab. 21:159. 1953. *Symphyotrichum subulatum* var. *ligulatum* (Shinners) Sundberg, Sida 21:907. 2004. TYPE: U.S.A. TEXAS.

Aster neomexicanus Wooton & Standley, Contr. U.S. Natl. Herb. 16:187. 1913. TYPE: U.S.A. NEW MEXICO (see citation and comments below).

2*n* = 10. Self-incompatible. Common in the south-central U.S.A. (Texas, Oklahoma, Kansas, Nebraska, New Mexico, Arkansas, Louisiana, Mississippi, Alabama, Kentucky (fide Clark et al. 2005), Tennessee, Missouri (in the southeasternmost two counties), apparently spreading eastward (e.g., Virginia; Nesom 2000) and expected to appear elsewhere along the Atlantic coastal plain. Mexico (Tamaulipas southward to the vicinity of Tampico in Veracruz, northern Coahuila, and Chihuahua, in the area of Cd. Chihuahua, Cd. Delicias, and Meoqui). Figure 1. Disturbed habitats, often moist (but usually not wet), sand, loam, and clay, common and often extremely abundant along roadsides and ditches and in lawns; in the drier Great Plains region, it occurs on lake shores, marsh and playa margins, depressions, and flats. Sometimes flowering into February.

Documentation for occurrence in **New Mexico. Chaves Co.:** Roswell, 3800 ft, Aug 1900, *Earle & Earle 327* (US, holotype of *Aster neomexicanus*; NMC isotype). **Eddy Co.:** Carlsbad Springs, *Standley 40329* (US). **Guadalupe Co.:** Los Esteros Creek, *Tschaikowsky 401* (ARIZ). The collections from Eddy and Guadalupe cos. were recorded by Sundberg on exsiccatae lists filed in herbarium TEX.

Symphyotrichum divaricatum is distinct from the other annual taxa in its relatively long and conspicuous ray florets and in its tendency to produce heads in a diffuse arrangement (vs. sessile to subsessile axillary (*S. bahamense*), distally clustered (*S. squamatum*, *S. expansum*), or densely elongate, pyramidal-paniculate (*S. subulatum*). Before production and maturation of axillary heads, the aspect of young plants of *S. divaricatum* may resemble that of *S. bahamense*. Heads in small plants of *S. divaricatum* and in plants from Mississippi and Alabama often are produced in a corymbiform arrangement, more characteristic of *S. expansum*, but the larger heads, long-acuminate phyllaries, and much longer ray corollas indicate their identity.

Sundberg (2004) noted that *Symphyotrichum divaricatum* is "the least variable taxon" [among the annual oxytripolioids], but I observe that it is markedly variable at least in head size (inner phyllaries (4–, 4.5–)5–5.5(–6.5) mm long) and in height (plants (3–)20–100(–200, 300) cm tall). A collection from Hidalgo Co., Texas (*Cory 51331*, SMU), was noted by its collector to be of plants up to 3 meters tall, "the largest aster plant I have ever seen." Plants in lawns will continue to produce small heads even after being mowed to about 3 centimeters in height.

The combined geographic range of *Symphyotrichum divaricatum*, *S. bahamense*, and *S. expansum* is roughly doughnut-shaped, with the Gulf of Mexico as the hole—each of the three taxa occupies a major portion of the circumference. As noted below, *S. divaricatum* and *S. expansum* are slightly, intermittently sympatric at the extremities of their ranges in west Texas and adjacent Mexico (Fig. 1). The geographic ranges of *S. bahamense* and *S. divaricatum* approach each other but apparently do not make contact—the easternmost portion of the range of the latter is in southern to central Alabama, while the former reaches its westernmost point in Bay, Gulf, and Franklin cos., Fla., in the central panhandle region (Fig. 1). *Symphyotrichum bahamense* and *S. expansum* are sympatric in southernmost Florida.

The geographic range of *Symphyotrichum divaricatum* closely approaches that of *S. subulatum* in places along the Gulf Coast. Plants of *S. divaricatum* even grow to terrestrial edges of marsh and deeper water along the coast, but habitats of the two taxa are distinct and they appear to be completely reproductively isolated.

Representative coastal localities for *Symphyotrichum divaricatum* (closely approaching habitats of *S. subulatum*). **Alabama. Mobile Co.:** Battleship Park, brackish moist sands, 22 Oct 1969, *Kral 38290* (VDB); E of Theodore in Deer River area, sandy open dock area (Navy) along Mobile Bay, 25 Oct 1999, *Kral 89064* (NLU, VDB). **Louisiana. Vermilion Par.:** Redfish Point, W side of Vermilion Bay, vicinity USL field station, scattered in marsh (brackish) [growing near *Symphyotrichum subulatum*], 28 Oct 1961, *Reese 5726* (VDB). **Texas. Jefferson Co.:** 3.5 mi SW of Port Arthur, moist places of coastal flats, 18 Nov 1945, *Cory 50949* (SMU); 10 mi W of Sabine Pass on Hwy 87, sand above intertidal zone, 19 Nov 1968, *Mahler 5175* (SMU). Locality for *Symphyotrichum subulatum* sensu stricto sympatric (as noted on label) with *S. divaricatum*. **Mississippi. Jackson Co.:** Pascagoula, vic. Bayou Casotte, S of jct of Louise St. and Washington Ave., heavily disturbed fill area, clay soil with oyster fragments, growing within 100 yds of *Aster subulatus* var. *ligulatus*, 5 Nov 1994, *MacDonald 8179* (VDB).

See further comments following *S. expansum*.

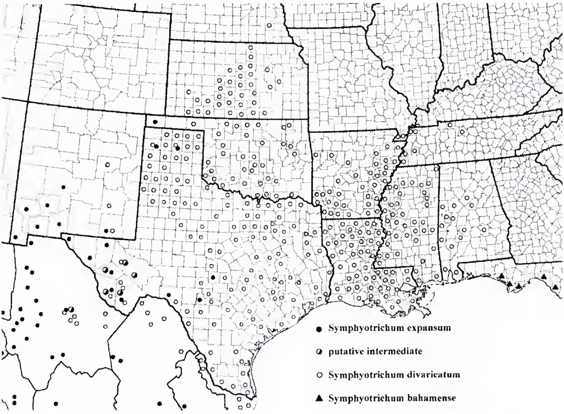


Fig. 1. Geographic distribution of *Symphyotrichum divaricatum*. Also shown are the eastern approach of *S. bahamense* in the Florida panhandle and the western approach and sympatry of *S. expansum*. U.S.A. records for *S. divaricatum* are from BRIT-SMU, MO, NLU, NMC, OKL, TEX-LL, VDB, and various sources of literature; a few (as cited) are from Sundberg (1986). Records for *S. expansum* in Mexico are from TEX-LL and from various other herbaria, accumulated in a yet unpublished taxonomic treatment (Nesom) of Mexican Astereae. Records for *S. bahamense* are from USF and VDB.

Symphyotrichum bahamense (Britton) Nesom, Phytologia 77:276. 1994. *Aster bahamensis* Britton, Bull. Torrey Bot. Club 41:14. 1914. *Aster subulatus* var. *bahamensis* (Britton) Bosserdet, Taxon 19:249. 1970. Type: BAHAMAS: Grand Bahama.

Aster subulatus var. *elongatus* Bosserdet ex Jones & Lowry, Adansonia, ser. 4, 8:406. 1986 (not Bosserdet, Taxon 19:250. 1970, nom. invalid., without designation of a type). *Symphyotrichum subulatum* var. *elongatum* (Bosserdet ex Jones & Lowry) Sundberg, Sida 21:907. 2004. Type: U.S.A. Florida.

$2n = 20$. Self-compatible. From the eastern portion of the Florida panhandle throughout most of peninsular Florida to the Keys (43 counties recorded for Florida in this study); also in a few localities of coastal Georgia and in the Bahama Islands (including the type). Hispaniola: Santo Domingo, 25 Oct 1929, *Ekman 13918* (LL); Alain (1962) included *S. bahamense* in the flora of Cuba. Japan: Chiba Pref., Futtsu City, abandoned rice paddy, 8 Oct 1985, *Enomoto s.n.* (TEX). Ditches and depressions, pond edges, edge and upper part of salt marsh, fresh water marsh, fields, grassy roadsides, lawns, disturbed sites, woods edges.

Documentation for occurrence in **Georgia. Glynn Co.:** ca. 0.4 mi S of E end of bridge of Jekyll Island, upper part of salt marsh, 25 Oct 1975, *Duncan 29660* (VDB); ca. 1.7 mi NW of St. Simons, higher part of salt marsh, 17 Sep 1971, *Duncan 23665* (VDB); exposed, low roadside at Super 8 Motel, 23 Oct 2001, *McNeilus 01-339* (NLU). **McIntosh Co.:** ca. 2.4 mi due N of southern tip of Sapelo Island, marshy area, usually fresh water, just back of narrow strip of oaks along Duplin River, 14 Oct 1956, *Duncan 20635* (BRIT, TEX).

Symphyotrichum bahamense is characterized by its distinctive arrangement of heads (at first at ends of long, bracteate branches, then produced and maturing as axillary and nearly sessile or on very short lateral branches, commonly appearing secund to subsecund) and ray corollas mostly 2–3.5(–4) mm long, with blue to purple laminae coiling back in 2–3 coils. The ray corollas are shorter than in *S. divaricatum* and the disc florets fewer.

According to Sundberg (1986), intermediates between *Symphyotrichum bahamense* and *S. subulatum* "occur sporadically" in Florida on northern extremities of the range of the former (Duval Co. and along the coast of the panhandle region). He noted (2004, p. 907) that "Intergradation [with *S. subulatum*] is demonstrated in the compactness of the capitulescence and the number of disk and ray florets." Such putative intermediates do not appear to be common, however, and F1's would be triploid and sterile (Sundberg 1986). There is no specimen at TEX indicated to be such a hybrid.

Putative intergradation between *Symphyotrichum bahamense* and *S. expansum* in southern Florida was noted by Sundberg (2004, p. 907) to be evidenced by "individuals of [*S. expansum*] ... more robust (to 1.5 m tall) than elsewhere and [with] the ligules ... often pink, instead of white." If any of these putative intermediates are *S. bahamense-expansum* hybrids, the F1's would be triploid and sterile. Plants of *S. bahamense* from southern Florida have a tendency for early heads to develop on relatively shorter peduncles in a corymboid arrangement; these have the general appearance of *S. expansum* but can be identified as *S. bahamense* by their larger involucres and larger, blue to purple ray florets (examples: Hendry Co: *Brass 33406*, USF; Levy Co: *Semple 3966*, USF), and the later (axillary) heads tend to be sessile or short-pedunculate, more like typical *S. bahamense*. The couplet below give details of differences.

Heads at first at ends of long, bracteate branches, then produced and maturing as axillary and nearly sessile or on very short lateral branches, commonly on one side of the main stem and appearing secund to subsecund, in paniculiform arrangements; inner phyllaries 5–6.5 mm long; ray florets in 2–3 series, laminae blue to purple, (2–)2.5–4 mm long and 0.2–0.4 mm wide (dried), coiling back in 2 or more coils; disc florets 11–23 ____ **Symphyotrichum bahamense**

Heads usually corymbiform to thyrsiform in arrangement (borne primarily on distal branches, distally clustered); inner phyllaries 4–5.5 mm long; ray florets in 1(–2) series, laminae white to light pinkish or slightly blue, 2–3 mm long and 0.1–0.3 mm wide (dried), remaining straight or coiling back in 1–2 coils; disc florets (6–)8–15 ____ **Symphyotrichum expansum**

Sundberg (1986) suggested that the tetraploid *Symphyotrichum bahamense* may have had an alloploid origin, with parents the diploids *S. divaricatum* and either

S. expansum or *S. subulatum*. Such an origin would account for at least some aspects of morphological intermediacy in *S. bahamense*.

Symphyotrichum expansum (Poepp. ex Spreng.) Nesom, Phytologia 77:281. 1994. *Erigeron expansus* Poepp. ex Spreng., Syst. Veg. 3:518. 1826. TYPE: CUBA.

Aster inconspicuus Less., Linnaea 5:143. 1830. *Aster exilis* var. *inconspicuus* (Less.) Hieron., Engl. Bot. Jahrb. 29:19. 1900. TYPE: CUBA: homotypic with *Erigeron expansus*.

Erigeron multiflorus Hook. & Arn., Bot. Beechey Voy. 87. 1832. TYPE: U.S.A. HAWAII. Synonymy fide Jones (1984).

Tripolium subulatum (Michx.) DC. var. *parviflorum* Nees, Gen. sp. Aster. 157, 286. 1833. *Symphyotrichum subulatum* var. *parviflorum* (Nees) Sundberg, Sida 21:907. 2004. TYPE: U.S.A. HAWAII: as lectotypified by Sundberg (2004); homotypic with *A. divaricatus* var. *sandwicensis*.

Tripolium subulatum (Michx.) DC. var. *cubense* DC., Prodr. 5:254. 1836. *Aster subulatus* var. *cubensis* (DC.) Shinners, Field & Lab. 21:161. 1953. TYPE: CUBA: homotypic with *Erigeron expansus*.

Aster divaricatus (Nutt.) Torr. & A. Gray var. *sandwicensis* A. Gray, Proc. Amer. Acad. Arts 7:173. 1867. *Aster sandwicensis* (A. Gray) Hieron., Bot. Jahrb. Syst. 29:20. 1901. *Aster subulatus* var. *sandwicensis* (A. Gray) A.G. Jones, Brittonia 36:465. 1984. TYPE: U.S.A. HAWAII: as lectotypified by Jones (1984). Jones (1984) lectotypified *Aster sandwicensis* and interpreted it to represent the taxon identified here as *S. squamatum*. Sundberg followed this interpretation in 1986, but later (2004) decided that the type is correctly identified as *S. expansum*, in the sense of the present study.

Aster pauciflorus Nutt. var. *gracilis* Benth. ex Hemsley, Biol. Centr. Amer. Bot., 122. 1881. TYPE: COSTA RICA. Synonymy fide Sundberg (1986).

Aster exilis Elliott var. *australis* A. Gray, Synopt. Fl. N. Amer. 1(2):203. 1884. *Aster subulatus* var. *australis* (A. Gray) Shinners, Field & Lab. 21:158. 1953. TYPE: U.S.A. HAWAII: homotypic with *A. divaricatus* var. *sandwicensis*.

Aster madrensis M.E. Jones, Contr. Western Bot. 12:43. 1908. TYPE: MEXICO. CHIHUAHUA.

$2n = 10$. Self-compatible. Moist or wet places, southwestern USA (Texas, New Mexico, Oklahoma, Arizona, California, Nevada, Utah), Florida (southernmost counties and other scattered localities), Mexico (all states, including southern Tamaulipas, Nuevo León, Coahuila, Chihuahua, and Sonora), Central America (Guatemala, Belize, Nicaragua, Costa Rica), Antilles (Jamaica, Hispaniola-D.R.). Hawaii. Japan: Okayama Pref., Kasaoka City, on newly reclaimed land at Kasaoka Bay Polder, 14 Sep 1984, *Enomoto s.n.* (TEX).

First report for **Oklahoma. Cimarron Co.:** along a small creek ca. 7 mi E of Kenton, 25 Sep 1976, *J. Taylor 23717* (BRIT). Cimarron County is the western extremity of the Oklahoma panhandle, relatively close to the Texas panhandle localities in Hartley and Hutchinson cos., cited below.

Disjunct localities in **Texas. Hartley Co.:** sandy soil along Punta de Agua Creek, between Romero and Middle Water, in water of stream, 9 Oct 1964, *Correll 30339* (LL, SMU). **Hutchinson Co.:** Lake Meredith Natl. Rec. Area, Spring Creek picnic and fishing area around small lake and adjacent marsh area, NE side (immediately downstream) of Sanford Dam, in water of ditch beside marsh, 20 September 2002, *Nesom & O'Kennon 853* (BRIT). **Mason Co.:** 5 air mi NNW of Mason, 2.1 mi N of jct. of Hwy 29 and Hwy 398,; then 2.4 mi NW on dirt road, 24 Sep 1999, *Singhurst 8248* (TEX). **Real Co.:** Dry Creek, 0.1 mi S of (downstream from) mouth of Javelina Creek, ca. 800-1000 ft. N of Dry Creek Rd. (Lost Canyon Rd.) from a point 4.0 roadmiles E of its jct. with St. Rt. 55 at Barksdale, elev. ca. 1650 ft., W shoreline of pond, 3 Oct 1998, *Carr 17771* (TEX). **Val Verde Co.:** Pecos River at Highway 90, S of the high bridge of Hwy 90, along the E bank of the Pecos, locally abundant, 9 Nov 1999, *Henrickson 22624* (TEX).

Representative documentation for **Florida. Collier Co.:** Vic. of Naples, S of town, common in marshy ditch, 9 Oct 1962, *Cooley 9028* (USF). **Dade Co.:** Perrine, empty, oolitic lot, 19 Sep 1973, *Kral 51893* (VDB). **Lake Co.:** Eustis-Trout Lake Nature Center, 1 Oct 1991, *Daubenmire s.n.* (USF). **Monroe Co.:** Big Pine Key, Sands subdivision, 8 Sep 1981, *Brumbach 9729* (BRIT, USF-2 sheets); Marathon Key, near intersection of Hwy 1 with 37th Street, roadside fill, 11 Nov 1983, *Sundberg 2327* (TEX) and *2328* (TEX); Key Largo, 0.2 m S of Tavernier Creek along Hwy 1, roadside fill, 11 Nov 1983, *Sundberg 2329* (TEX). **Okaloosa Co.:** Eglin Air Force Base, grassy area around pond just S of Eglin Blvd, along 7th St., 21 Nov 1983, *Wilhelm 11929* (USF).

Symphyotrichum expansum is recognized by its relatively small heads distally clustered in a corymbiform to thyrsiform arrangement and short (but still coiling at maturity), whitish to pinkish or light blue ray florets about as long or slightly shorter (in coiled form) than the pappus. Among the annual taxa, it is the most geographically widespread and elevationally diverse. In the western U.S.A. and Mexico, typical *S. expansum* occurs at 100–1650(–1950) meters; from Central America to Florida, it rarely grows at more than 10 meters.

The range of *Symphyotrichum expansum* apparently slightly overlaps that of *S. divaricatum* in southeastern New Mexico, western Texas, and adjacent Mexico. For the most part, the two are clearly distinct, and attempts by Sundberg (1986) to cross these two diploid taxa produced 0–3% plump achenes, almost all of which were inviable. In a yet unpublished floristic study in the Texas panhandle region (Hutchinson Co.), typical *S. expansum* has been observed in close proximity, without intermediacy, to typical *S. divaricatum*: the latter is an abundant colonizer in the sandy clay at many sites of the fluctuating shoreline of Lake Meredith (e.g., *Nesom & O'Kennon 689*, as cited above), while *S. expansum* was observed in the muck of a wet ditch and marsh margin at only one area immediately below the dam (*Nesom & O'Kennon 853*, BRIT). In Presidio Co., Texas (Big Bend Ranch State Natural Area), the two taxa have been observed and collected in close proximity, without evidence of intergradation: *S. divaricatum* (*Worthington 22636*, TEX, UTEP) and *S. expansum* (*Worthington 22637*, TEX, UTEP). Worthington noted by annotation that he observed two species of 'aster' in BBRSNA. Pringle apparently observed two co-occurring entities in Chihuahua, on the "wet banks of the Sacramento River [vicinity of Cd. Chihuahua], 13 Sep 1886": *Pringle 751* (LL) is *S. divaricatum* while *Pringle 750* (LL) is *S. expansum*.

Even though it appears that some degree of reproductive isolation exists between *Symphyotrichum divaricatum* and *S. expansum*, Sundberg (2004, p. 906) noted that "Populations intermediate in ligule length and width occur in trans-Pecos Texas, parts of New Mexico (including the type of *Aster neomexicanus*, collected in Chaves Co.), Arizona, and Chihuahua, Mexico." My observations corroborate the existence of plants with longer and slightly wider rays, which also are blue to purple, in contrast to the smaller, white to pink rays of *S. expansum*. Most of these occur where the two species are sympatric and apparently are relatively uncommon, compared to the parents. Such putative intermediates are similar to *S. expansum* in their small heads (inner phyllaries mostly 4–4.5 mm long) all strongly distally disposed on wiry peduncles. Because of its relatively large ray corollas, the Chaves Co. collection is identified and mapped here as typical *S. divaricatum*,, although in habit it resembles *S. expansum*.

Collections examined (*Symphyotrichum divaricatum<?>expansum*). **U.S.A. Texas. Brewster Co.:** 3.5 S of Marathon, infrequent in mud at Pena Blanca spring, 21 Oct 1946, *Warnock 46587* (SMU, TEX). **Jeff Davis Co.:** gravel and sand bars of Limpia Creek near Ft. Davis, 8 Oct 1926, *Palmer 23123* (TEX). **Pecos Co.:** roadside along irrigation ditch near Farm Road 1053, 1/2 mi N of Imperial, chromosome number *n*=5, 20 Aug 1967, *Watson 147* (TEX); ca. 5 mi W of Fort Stockton along IH-10, moist ditch along frontage road S of freeway, chromosome number *n*=5, 26 Aug 1983, *Sundberg 2160* (TEX). **Presidio Co.:** infrequent at spring near Rex Ivy's Lodge above La Jitas, 2200 ft, 24 Sep 1961, *Warnock 18163* (TEX). **Reeves Co.:** Hwy 285, S of Pecos, 20 Aug 1941, *Strandtman s.n.* (TEX). **Mexico. Chihuahua:** Delicias, along ditch, 10 Oct 1957, *Knobloch 631* (SMU).

The broad distributions and distinct morphology of *Symphyotrichum divaricatum* and *S. expansum*, their overlap and co-occurrence in a relatively small zone of sympatry, and the relatively few putative intermediates are taken here as rationale for treating both of them at specific rank.

Symphyotrichum squamatum (Spreng.) Nesom, Phytologia 77:292. 1994. *Conyza squamata* Spreng., Syst. Veg. 3:515. 1826. *Aster squamatus* (Spreng.) Hieron., Bot. Jahrb. Syst. 29:19. 1901. *Conyzanthus squamatus* (Spreng.) Tamamsch., Fl. U.R.S.S. 25:186. 1959. *Symphyotrichum subulatum* var. *squamatum* (Spreng.) Sundberg, Sida 21:908. 2004. Type: URUGUAY. Montevideo.

Erigeron semiamplexicaule Meyen, Reise 1:311. 1834. Type: ?. Synonymy fide Cabrera (1978).

Baccharis asteroides Colla, Mem. Reale Accad. Sci. Torino 38:14, pl. 25. 1835. *Aster asteroides* (Colla) Rusby, Mem. Torrey Bot. Club 4:213. 1895. Type: CHILE: Synonymy fide Sundberg (1986).

Conyza berteroana Phil., Linnaea 28:737. 1836. Type: CHILE: Synonymy fide Sundberg (1986).

Tripolium conspicuum Lindley ex DC., Prodr. 5:254. 1836. *Aster bangii* Rusby [nom. nov.], Mem. Torrey Bot. Club 4:213. 1895. Type: CHILE. Synonymy fide Sundberg (1986).

Aster linifolius Griseb., Abhand. Königl. Gesellsch. Wissens. Göttingen 24:178. 1879. Type: ? Synonymy fide Cabrera (1978).

Aster subtropicos Morong, Ann. New York Acad. Sci. 7:139. 1893. Type: PARAGUAY: Synonymy fide Sundberg (1986).

Tripolium moelleri Phil., Anal. Univ. Chile 87:403. 1894. *Aster moelleri* (Phil.) Reiche, Anal. Univ. Chile 109:338. 1901. Type: CHILE. Synonymy fide Cabrera (1978).

Tripolium oliganthum Phil., Anal. Univ. Chile 87:403. 1894. Type: CHILE: Synonymy fide Cabrera (1978).

Erigeron depilis Phil., Anal. Univ. Chile 87:417. 1894. Type: CHILE: Synonymy fide Cabrera (1978).

Aster barcinonensis Sennen, Bull. Acad. Int. Geogr. Bot. 23:242. 1914. Type: SPAIN: Synonymy fide Sundberg (1986).

$2n = 20$. Self-compatible. Native to South America and apparently widely distributed there; rare in California and the southeastern U.S.A. (Alabama, Florida, Louisiana, Texas), apparently mostly as a waif, usually on or near beaches and ballast dumps. Naturalized in Australia(!), Japan(!), Iraq(!), Africa(!), France(!), and probably other regions of the world. Noted by Britton (1914) to occur on Ireland Island and Boaz Island, Bermuda.

Documentation for U.S.A. occurrences. **Alabama. Mobile Co.:** sandy W end of Dauphin Island, 18 Oct 1973, *Tayor and Taylor 15382* (BRIT); Dauphin Island, Itasca Pl. near Iberville Dr., roadside near dunes, 9 Aug 1965, *Deramus D752* (VDB); Battleship Park, by Mobile-Baldwin Co. causeway, abundant on moist brackish sands, 22 Oct 1969, *Kral 38282* (NLU). **California. Kern Co.:** S of Greenfield, intersection of Cottonwood Rd and Buena Vista Rd, along roadside ditch, 16 Apr 1983, *Sundberg 2093*, "this population $n = 10$ pairs" (TEX). **Florida. [Escambia Co.]:** Pensacola, waste ground, 27 Jul 1899, *Curtiss 6497* (GH [fide Shinners 1953], USF); **Franklin Co.:** Apalachicola, ballast weed, Jul 1897, *Chapman s.n.* (MO [fide Shinners 1953], SMU). **Louisiana Orleans Par.:** weedy areas along streets N of New Orleans Convention Center from Howard Street W to elevated hwy in New Orleans, 10 Nov 1991, *Thomas 126,773* (NLU). **Texas. [Galveston Co.]:** "Galveston, sandy beaches, damp sands along the streets, 8 Aug 1902, *J. Reverchon 3319*" (MO, US-2 sheets); the MO collection was cited by Shinners (1953) as *Aster subulatus* var. *australis*; it was identified as *Symphyotrichum squamatum* by Sundberg (1986) and Nesom (1994).

Symphyotrichum squamatum is recognized by its corymbiform to thyrsiform arrangement of heads (borne primarily on bracteate distal branches and distally clustered), inner phyllaries 5–5.5 mm long, with sharply delimited apical green zones, and ray florets numerous (21–28(–38)) with filiform, erect (noncoiling) corollas shorter (1.3–2 mm long) than the mature pappus. It is the only one of the taxa treated here that is not a North American native; its evolutionary relationship to the others may be correspondingly distant. Natural hybridization has not been reported between *S. squamatum* and any other taxon.

KEY TO THE ANNUAL TAXA

1. Heads usually dense in an elongate, pyramidal-paniculate arrangement; inner phyllaries 6–7 mm long, phyllary apices linear-acuminate, distal margins often inrolled/involute, green zone of phyllaries narrowly lanceolate, usually extending the entire length of the phyllary, chartaceous bases short or absent; pappus accrescent, 4–5.5 mm long at maturity and usually longer than coiled ray corollas; habitats wet, saline ____ **Symphyotrichum subulatum**

1. Heads corymbiform to thyrsiform, diffusely paniculate, or secund to subsecund and paniculiform arrangements or at the tips of long, bracteate branches; inner phyllaries 4–6.5 mm long, phyllary apices acute to acuminate, distal margins inrolled/involute or not, green zone of phyllaries lanceolate to elliptic, chartaceous bases usually conspicuous; pappus not accrescent, 3.5–4(–5) mm long at maturity, longer or shorter than ray corollas; habitats moist to wet, rarely saline.
    2. Phyllary tips appressed, acute, flat, inner phyllaries with broadly lanceolate, distinctly demarcated, apical green zone, proximal 1/2–1/3 white-chartaceous; ray floret laminae erect, often involute along the edges (curling inward lengthwise), rarely coiling back distally (if so, then only ca. 1/2 coil), usually shorter than mature pappus; disc florets (3–)7–14 ____ **Symphyotrichum squamatum**
    2. Phyllary tips loose, linear-acuminate, distal margins often inrolled/involute, inner phyllaries with narrowly lanceolate, often weakly demarcated apical green zone, white-chartaceous bases short, ca. 1/3–1/2 the length of the phyllaries; ray floret laminae not involute along edges, usually coiling back distally in 1–4 or more coils, usually as long or longer than mature pappus; disc florets (6–)8–15, 11–23, or (20–)33–45(–50).
        3. Heads usually corymbiform to thyrsiform in arrangement (borne primarily on

distal branches, distally clustered); inner phyllaries 4–5.5(–6) mm long, phyllary apices acute to abruptly short-acuminate or long-acuminate, distal margins inrolled/involute or not; ray florets in 1(–2) series, corollas 2–3 mm long, laminae 0.1–0.3 mm wide (dried), white to light pinkish or slightly blue, coiling back in 1–2 coils or less commonly remaining straight; disc florets (6–) 8–15 ____________________________________ **Symphyotrichum expansum**

3. Head arrangements diffusely paniculiform to pyramidal-paniculiform to corymbiform or secund to subsecund and paniculiform; inner phyllaries 5–6.5 mm long; phyllary apices long-acuminate, distal margins usually inrolled/involute; ray florets in 1–3 series, corollas 2–7 mm long, laminae 0.2–0.8 mm wide (dry), white to blue or puple, coiling back in 2–4 or more coils; disc florets 11–23 or (20–)33–45(–50).
    4. Heads often at ends of long, bracteate branches, axillary heads usually maturing on elongate lateral branches, the whole arrangement often diffusely paniculiform to pyramidal-paniculiform, or heads more distally disposed and the arrangement corymbiform to thyrsiform; ray florets in 1 series, corollas mostly 4–7 mm long, laminae 0.4–0.8 mm wide (dry), blue to white, coiling back 3–4 or more times; disc florets (20–)33–45(–50); south-central U.S.A., extreme northwestern Mexico ____________ **Symphyotrichum divaricatum**
    4. Heads at first at ends of long, bracteate branches, then produced and maturing as axillary and nearly sessile or on very short lateral branches, commonly on one side of the main stem and appearing secund to subsecund, in paniculiform arrangements; ray florets in 2–3 series, corollas mostly 2–3.5(–4) mm long, laminae 0.2–0.4 mm wide (dry), blue to purple, coiling back in 2–3 coils; disc florets 11–23; Florida, coastal Georgia, Bahamas ____________________________________ **Symphyotrichum bahamense**

Perennial taxa—*Symphyotrichum tenuifolium* sensu lato

Symphyotrichum tenuifolium sensu stricto and *S. bracei* (*S. tenuifolium* var. *aphyllum*) are diploid, rhizomatous perennials endemic to coastal and near-coastal habitats. The former occurs mostly in marshes of western Cuba, the Bahamas, and the west coast of southern and central Florida; *S. tenuifolium* occurs in marshes along the Gulf coast from Texas to panhandle Florida and then along the Atlantic coast from northeastern Florida northward as far as Rhode Island, New Hampshire, and Maine. The key by Sundberg (2004) separates the two perennial taxa in a number of features. Each of them has been treated at specific rank by regional botanists (Cronquist 1980; Wunderlin 1982, 1998; Wunderlin & Hansen 2004), but Long (1970), Long and Lakela (1971), and Sundberg (1986, 2004) have regarded *S. bracei* as a variety within a more broadly conceived species. In the initial description of var. *aphyllum*, Long (1970, p. 41) noted that it is "connected by intermediate forms" to var. *tenuifolium* and is "a West Indian-Florida population segregate of the more northern [*S. tenuifolium*]." Sundberg (1986, 2004) observed that the two taxa intergrade where their ranges overlap along the Gulf Coast of northern and central peninsular Florida, from Taylor to Pinellas counties, where "almost all specimens are intermediate," suggesting that parental forms apparently are absent or rare and that gene flow is continuous. In contrast, I find that typical *S. bracei* occurs northward well into the range of typical *S. tenuifolium* (e.g., Hernando Co., *S. bracei*, *Sundberg 2305*, TEX; Citrus Co., *S. bracei*, *Schmid A-6*, USF; Taylor Co., *S. bracei*, *Godfrey 61659*, BRIT). Sundberg (2004) scored *Godfrey 61659* (FSU) as typical of *S. bracei* except for root structure, which is lacking on the BRIT duplicate.

Species-rank concepts of Cronquist, Wunderlin and Hansen, and the present study emphasize the distinctive morphologies of the two taxa, their mostly allopatric ranges, and the apparent hybridization and intermediacy that occurs within only a relatively small area of overlap. Long and Sundberg have emphasized the zone of intermediacy as rationale for treating these two taxa as geographic segments of a single species. Whichever point of view is adopted, treatment of these at specific rank may be more subjective than for the annual taxa, where reproductive isolation apparently is stronger.

Symphyotrichum tenuifolium (L.) Nesom, Phytologia 77:293. 1994 (1995). *Aster tenuifolius* L., Sp. Pl. 2:873. 1753. Type: U.S.A. "in America septentrionale."

Symphyotrichum bracei (Britton ex Small) Nesom, Phytologia 77:276. 1994. *Aster bracei* Britton ex Small, Fl. Miami 190, 200. 1913. Type: BAHAMAS. New Providence.

Aster tenuifolius var. *aphyllus* R.W. Long, Rhodora 72:40. 1970. *Symphyotrichum tenuifolium* (L.) Nesom var. *aphyllum* (R.W. Long) Sundberg, Sida 21:905. 2004. Type: U.S.A. Florida.

ACKNOWLEDGMENTS

Dick Wunderlin, Bruce Hansen, and Kanchi Gandhi made the critical interpretation, adopted here, of the validation and correct authority for *Aster subulatus* var. *elongatus*. Dick Wunderlin and John Semple made various helpful comments and observations. I also am grateful to the staff of TEX-LL for their help and to NLU, NMC, and USF for loans of specimens.

REFERENCES

Alain, H. 1962. Flora de Cuba (Compositae) 5:175–313.

Britton, N.L. 1914. Studies of West Indian plants–V. Bull. Torrey Bot. Club 41:1–24.

Cabrera, A.L. 1978. Flora de la Provincia de Jujuy, Republica Argentina. Coleccion Cientifica del INTA, Tomo XIII, Parte X: Compositae. Buenos Aires.

Clark, R.C., R.L. Jones, T. Weckman, R.L. Thompson, J.W. Thieret, Kentucky State Nature Preserves Commission, and K. Freeman. 2005. State records and other noteworthy collections for Kentucky. Sida 21:1909–1916.

Cronquist, A. 1980. Vascular flora of the southeastern United States, Vol. I. Asteraceae. Univ. of North Carolina Press, Chapel Hill.

Graustein, J.E. 1967. Thomas Nuttall, naturalist: Explorations in America, 1808–1841. Harvard Univ. Press, Cambridge, Mass.

Harden, G.J. (ed.). 1992. Flora of New South Wales. Vol. 3. New South Wales Univ. Press, Kensington, NSW, Australia.

Jones, A.G. 1984. Nomenclatural notes on *Aster* (Asteraceae)–III. The status of *A. sandwicensis*. Brittonia 36:463–466.

Jones, A. 1999. *Aster*, p. 266, in Wagner, W.L., D.R. Herbst, and S.H. Sohmer. Manual of the flowering plants of Hawai'i (rev. ed.), Volume 1. Univ. of Hawai'i Press and Bishop Museum Press, Honolulu, Hawaii.

Long, R.W. and O. Lakela. 1971. A flora of tropical Florida. Univ. of Miami Press, Coral Gables, Florida.

Long, R.W. 1970. Additions and nomenclatural changes in the flora of southern Florida–I. Rhodora 72:17–46.

Mapaura, A. and J. Timberlake (eds.). 2004. A checklist of Zimbabwean vascular plants. Southern African Botanical Diversity Network Report No. 33. SABONET, Pretoria and Harare.

Mohlenbrock, R.H. 2002. Vascular flora of Illinois. Southern Illinois Univ. Press, Carbondale and Edwardsville.

Nesom, G.L. 1994. Taxonomic overview of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. Phytologia 77:141–297.

Nesom, G.L. 2000. Noteworthy collections from herbarium NCU [Apiaceae, Asteraceae, Geraniaceae, Rhamnaceae]. Castanea 65:80–83.

Semple, J.C. 1992. A geographic summary of chromosome number reports for North American asters and goldenrods (Compositae: Astereae). Ann. Missouri Bot. Garden 79: 95–109.

Semple, J.C., S.B. Heard, and L. Brouillet. 2002. Cultivated and native asters of Ontario (Compositae: Astereae). Univ. Waterloo. Biol. Ser. 41:1–134.

Shinners, L.H. 1953. Notes on Texas Compositae–IX. Field & Lab. 21:155-162.

Smith, A.C. 1991. Flora Vitiensis nova: A new flora of Fiji (spermatophytes only). Vol. 5. Angiospermae: Dicotyledones, families 170–186. Pacific Tropical Botanical Garden, Lawai, Hawaii.

Soejima, A. and C.-I. Peng. 1998. *Aster* (Compositae). In: Huang, T.C., ed. Flora of Taiwan (ed. 2). Vol. 4, Angiosperms, Dicotyledons [Diapensiaceae–Compositae]. Editorial Committee of the Flora of Taiwan, National Taiwan Univ., Taipei. Pp. 848–868.

Sundberg, S.D. 1986. The systematics of *Aster* subgenus *Oxytripolium* (Compositae) and historically allied species. Ph.D. dissertation, Univ. of Texas, Austin.

Sundberg, S.D. 2004. New combinations in North American *Symphyotrichum* subgenus *Astropolium* (Asteraceeae: Astereae). Sida 21:903–910.

Sundberg, S.D. 2005. *Symphyotrichum* (in part). In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. Vol. 21. New York and Oxford.

Tamamschyan, S.G. 1959. *Conyzanthus*. In: B.K. Schischkin, ed. Flora of the USSR [translated from Russian, 1999]. Smithsonian Institution Libraries, Washington, D.C. Pp. 174–177 [originally 185–188].

Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters, and D.A. Webb. 1976. Flora Europaea, Vol. 4: Plantaginaceae to Compositae (and Rubiaceae). Cambridge Univ. Press, Cambridge.

Voss, E.G. 1996. Michigan flora. Part III: Dicots (Pyrolaceae–Compositae). Cranbrook Institute of Science Bull. 61 and Univ. Michigan Herbarium, Ann Arbor.

V Plants. 2005. V Plants: A virtual herbarium of the Chicago region. The Morton Arboretum, Field Museum of Natural History, and Chicago Botanic Garden. <http://www.vplants.org/> Accessed May 2005.

Walker, E.H. 1976. Flora of Okinawa and the southern Ryukyu Islands. Smithsonian Institution Press, Washington, D.C.

Wunderlin, R.P. 1982. Guide to the vascular plants of central Florida. Univ. Presses of Florida, Tampa.

Wunderlin, R.P. 1998. Guide to the vascular plants of Florida. Univ. Press of Florida, Gainesville.

Wunderlin R.P. and B.F. Hansen. 2004. Atlas of Florida vascular plants (internet). [S.M. Landry and K.N. Campbell (application development). Florida Center for Community Design and Research.] Institute for Systematic Botany, Univ. of South Florida, Tampa. <http://www.plantatlas.usf.edu/> Accessed April 2005.

PAPPUS VARIATION IN NORTH AMERICAN ASTERS. I. DOUBLE, TRIPLE AND QUADRUPLE PAPPUS IN *SYMPHYOTRICHUM* AND RELATED ASTER GENERA (ASTERACEAE: ASTEREAE)

John C. Semple and Jennifer L.A. Hood

Department of Biology
University of Waterloo
Waterloo, Ontario, CANADA N2L 3G1
jcsemple@sciborg.uwaterloo.ca

ABSTRACT

The pappus traits of 84 taxa of *Canadanthus*, *Ampelaster*, *Psilactis*, and *Symphyotrichum* (subtribe Symphyotrichinae) and 14 other species of asters were examined. Most species of Symphyotrichinae had a pappus consisting of three whorls; 1) a secondary inner whorl of a few bristles 40–85% the length of the inner primary whorl, 2) a primary outer whorl of many bristles with tapering ends about 90–95% the length of the inner primary whorl, and 3) a primary inner whorl of many bristles with very weakly to strongly clavate ends. In addition, a few species of *Symphyotrichum* have a vestigial secondary outer whorl of a single short bristle only about 10–30% the length of the primary inner whorl. In some species of *Symphyotrichum* the secondary inner whorl was difficult to distinguish from the primary outer whorl or possibly was absent. In a small sample of species of *Aster*, *Doellingeria*, *Eurybia*, *Eucephalus*, *Galatella*, *Herrickia*, *Ionactis*, *Oclemena*, and *Oreostemma*, the pappus was either triple or quadruple. The short secondary outer whorl was present in most species examined but was sometimes reduced to very few bristles or absent on some fruits. In some cases, the secondary inner whorl of mid length tapering bristles was present in some individuals in a species but not in others. The quadruple pappus with strongly clavate inner bristles appears to be plesiomorphic for the North American Clade of the tribe Astereae. In single species samples of *Crinitaria*, *Linosyris*, and *Felicia* the pappus differed from that of other species examined.

RESUMEN

Se examinaron las características de los vilanos de 84 taxa de *Canadanthus*, *Ampelaster*, *Psilactis*, y *Symphyotrichum* (subtribu Symphyotrichinae) y otras 14 especies de compuestas. La mayoría de las especies de Symphyotrichinae tienen un vilano de tres verticilos; 1) un verticilo secundario interno de pocas sedas con el 40–85% de la longitud del verticilo interno primario, 2) un verticilo externo primario con muchas sedas de extremos estrechados de aproximadamente el 90–95% de la longitud del verticilo interno primario, y 3) un verticilo interno primario de muchas sedas con extremos desde débilmente a fuertemente clavados. Además, algunas especies de *Symphyotrichum* tienen un verticilo secundario externo vestigial de una sola seda aproximadamente del 10–30% de la longitud del verticilo interno primario. En algunas especies de *Symphyotrichum* el verticilo secundario interno fue difícil de diferenciar del primario externo o posiblemente estaba ausente. En una pequeña muestra de especies de *Aster*, *Doellingeria*, *Eurybia*, *Eucephalus*, *Galatella*, *Herrickia*, *Ionactis*, *Oclemena*, y *Oreostemma*, el vilano era triple o cuádruple. El verticilo secundario externo corto estaba presente en la mayoría de las especies examinadas pero estaba reducido algunas veces a unas pocas sedas o ausente en algunos frutos. En algunos casos, el verticilo interno secundario de sedas de tamaño mediano estaba presente en algunos individuos de una especie pero no en otros. El vilano cuádruple con las sedas interiores fuertemente clavadas parece ser plesiomórfico para el clado Norte Americano de la tribu Astereae. En una sola muestra de especies de *Crinitaria*, *Linosyris*, y *Felicia* el vilano difería de las otras especies examinadas.

INTRODUCTION

The symphyotrichoid aster genera *Canadanthus* Nesom, *Ampelaster* Nesom, and *Symphyotrichum* Nees have long been reported to have a simple pappus with non-clavate bristles, either as species of *Aster* L. (e.g., Gray 1884; Fernald 1950; Cronquist 1955, 1968a, 1980, 1994) or recently as species of *Canadanthus*, *Ampelaster*, and *Symphyotrichum* (Nesom 1994, 2000; Semple et al. 2002). In contrast, some other North American asters historically treated at times in other genera or in *Aster* sensu lato have been reported to have a double (*Eucephalus* Nutt., *Sericocarpus* Nees; Gray 1884; Cronquist 1955) or a triple pappus (*Doellingeria* Nees; Cronquist 1968, 1980; Nesom 1994; Semple et al. 2002). The putatively double pappus consisted of a short whorl of outer bristles and a much longer whorl of inner bristles, while the putatively triple pappus had a short outer whorl and two long inner whorls, the outer slightly shorter and tapering and the inner bristles clavate. Species of *Solidago* L. historically were also considered to have a simple pappus (e.g., Gray 1884; Fernald 1950; Cronquist 1968b, 1980; Nesom 2000; Semple et al. 1999). However, Hood and Semple (2003) demonstrated that nearly all species of goldenrods had a double pappus with two primary whorls of long bristles (the outer shorter and tapering, the inner clavate) and at least some species had an additional secondary outer whorl of a few very short bristles. That is, a genus thought to have a simple pappus in fact had a triple pappus like that reported for *Doellingeria* (synonym: Aster sect. *Triplopappus* Torr. & A. Gray; Torrey and Gray 1841; Semple et al. 2002). Our discovery that goldenrods had a double (or rarely triple) pappus raised the possibility that other genera of Astereae thought to have a simple pappus might also be double or triple. This paper on pappus variation is one in a series being prepared by the first author's lab to report the findings of investigations of cypselae traits, including pappus variation in the North American Clade of the Asteraeae (sensu Noyes & Rieseberg 1999). The pappus whorl terminology proposed by Hood and Semple (2003; secondary outer whorl, primary outer whorl, and primary inner whorl) is used throughout this paper with the addition of new label for a fourth whorl not seen in *Solidago*, the secondary inner whorl of tapered mid length bristles.

MATERIALS AND METHODS

A preliminary survey was undertaken to examine under the dissecting microscope the pappus bristles of one or two specimens of representative species of the sections and subsections of *Symphyotrichum*. Subsequently, a more rigorous survey was conducted involving 80 taxa and one hybrid of *Symphyotrichum* and 4 species of other genera in the subtribe Symphyotrichinae Nesom and 14 species of other North American and Eurasian aster genera listed in Table 1. Observations were made using a dissecting scope (10–70×) or a compound light microscope (20–400×). The degree of the clavateness of bristle tips was determined using the 0–4 rankings described in detail in Hood and Semple (2003). At least five different fruits from each species were observed under the dissecting microscope at a maximum of 70×; most observations were made at 30–40×. For the most part, observations were made on specimens in the WAT Herbarium, but additional material on loan from BRIT, CAN, GH, and NY (Holmgren et al. 1990) was also examined to expand the number of taxa. In addition to several methods used in evaluating pappus features listed by Hood and Semple (2003), assessment of the presence or absence of any short secondary outer whorl linear to scaly bristles and other pappus features were also systematically undertaken. Thus, Table 1 has five columns of observational data plus a column for additional comments, while only four columns were included by Hood and Semple (2003).

Observations on the compound microscope were made from slides prepared as follows. For each species, two ray floret and two disc floret cypselae (with corollas or without corollas still attached) were mounted in Cytoseal™ 60 (low viscosity) mounting medium under a cover slip. Observations at 100–400× on the compound microscope were made similarly to the observations under the dissecting scope at 30–70×. Observations made on the two kinds of scopes were compared and any discrepancies were resolved by re-examining specimens.

Digital photomicrographs were taken using a Nikon CoolPix 990 camera manually held against the ocular lens of either the dissecting or compound microscope. Pictures were taken of specimens under the compound light microscope with either below stage or above stage lighting. Final digital illustrations were made using CorelDraw 12® from digital images edited with Corel PhotoPaint12® (Corel Corp.).

RESULTS AND DISCUSSION

The pappus of the majority of species of the Symphyotrichinae consists of three whorls (Figs. 1–4): 1) a secondary inner whorl of a few intermediate length, fine, tapering bristles usually about 50–70% of the length of the primary inner whorl, 2) a primary outer whorl of tapering, non-clavate bristles that were generally 5–10% shorter than the inner whorl, and 3) a primary inner whorl of very weakly to strongly clavate tipped bristles. The phylogenetically more basal taxa of the Symphyotrichinae *Canadanthus modestus* (Lindl.) Nesom (Figs. 1A–G), *Ampelaster carolinanus* (Walt.) Nesom (Figs. 1H–K), and *Almutaster pauciflorus* (Nutt.) Löve & Löve (Figs. 2A–E) are all diploids ($2n = 18$) with $x = 9$ chromosomal base number (Brouillet et al. 2001a, b; Semple et al. 2002). These have a triple pappus with no secondary outer whorl of short bristles or scales observed.

Table 1. Pappus variation in subtribe Symphyotrichinae: *Symphyotrichum* and related genera. **Clv**, degree of clavateness of inner bristles (0 = not clavate to 4 = strongly clavate); **Clv-Tap**, clavate alternating with tapered bristles (primary inner and outer whorls, y = yes, – not obviously so); **Lgth**, primary outer bristles shorter than primary inner bristles; **Ovrlp,** degree of overlapping of bristles at base (0= not observed; 1=slight overlap; 2= definite overlap); **2nd-Out**, evidence for a secondary outer whorl of very short scaly-bristles.

Taxon	Clv	Clv-Tap	Lgth	Ovrlp	2nd-Out	Comments
SYMPHYOTRICHINAE Nesom						
Canadanthus Nesom (*x* = 9)						
C. modestus	1	y	y	2	n	2nd inner bristles 60% of 1° inner
Ampelaster Nesom (*x* = 9)						
A. carolinianus	2	y	y	0	n	2nd inner, few, 50% of 1° inner
Almutaster Löve (*x* = 9)						
A. pauciflorus	1	y	y	0	n	2nd inner 50–60% of 1° inner
Psilactis A. Gray (*x* = 9, 4, 3)						
P. tenuis (*x* = 4)	1	y	y	0	n	heterocarpic, ray fruit epappose; 2nd inner bristle 40–60% of 1° inner
Symphyotrichum Nees						
subg. ***Chapmaniani*** (Semple) Semple (*x* = 7)						
S. chapmanii	2	y	y	2	y	2nd inner, few, 50–60% of 1° inner; possible 2nd outer whorl bristle, one seen, fine, 30% of 1° inner
subg. ***Symphyotrichum*** sect. *Symphyotrichum* (*x* = 8) subsect. *Symphyotrichum*						
series *Symphyotrichum*						
S. novi-belgii	0	–	y	0	n	2nd inner, very few, 70% of 1° inner
S. retroflexum	4	y	y	2	y	2nd inner bristles, few , 70–8% of 1° inner; possible 2nd outer bristle, 30% of 1° inner, only seen on one fruit
S. robynsianum	0	–	y	0	n	2nd inner, few, 70–80% of 1° inner
						series *Punicei* (House) Semple
S. elliottii	2	y	y	1	n	2nd inner, few, 70–80% of 1° inner

Taxon	Clv	Clv-Tap	Lgth	Ovrlp	2nd-Out	Comments
S. prenanthoides	0	–	y	0	n	2nd inner, few, 60–80% of 1° inner
S. puniceum	0	–	y	2	n	2nd inner bristles, few, 40–70% of 1°
subg. ***Symphyotrichum*** sect. *Symphyotrichum* ($x = 8$) subsect. *Occidentales* (Rydb.) Nesom (*Foliacei*)						
S. chilense	3	y	y	1	n	2nd inner, few, 75–80% of 1° inner
S. eatonii	2	y	y	0	n	2nd inner, few, 75–80% of 1° inner
S. foliaceum	3	y	y	0	n	2nd inner, very few, 80% of 1° inner
S. jessicae	2	y	y	0	n	2nd inner, very few, 70–80% of 1°
S. spathulatum	3	y	y	0	n	2nd inner, very few, 70–80% of 1°
S. subspicatum	3	y	y	0	n	2nd inner bristles not seen
subg. ***Symphyotrichum*** sect. *Symphyotrichum* ($x = 8$) subsect. *Heterophylli* (Nees) Semple series *Cordifolii* (G. Don in Loudon) Semple						
S. anomalum	1	y	y	1	n	2nd inner bristles, few, 80% of 1°
S. ciliolatum	0	y	y	0	n	2nd inner bristles, few, 70–80% of 1°
S. cordifolium	1	y	y	0	n	2nd inner bristles, few, 70% of 1°
S. drummondii	1	y	y	0	n	2nd inner bristles, few, 70% of 1°
S. shortii	1	y	y	1	n	2nd inner bristles, few, 70% of 1°
S. texanum	1	y	y	0	n	2nd inner bristles, few, 70–80% of 1°
S. undulatum	2	y	y	0	n	2nd inner bristles, few, 80% of 1°
S. urophyllum	0	y	y	0	n	variable bristle lengths; 2nd inner bristles, few, 60–70% of 1°; 1° outer 85–90% of 1° inner
series *Concinni* (Nees) Semple						
S. laeve	2	y	y	0	n	2nd inner bristles, few, 70–80% of 1°
S. oolentangiense	3	y	y	2	n	2nd inner bristles, few, 70–80% of 1°
S. attenuatum	0	–	y	0	n	2nd inner bristles 60–70% of inner
subg. ***Symphyotrichum*** sect. *Symphyotrichum* ($x = 8$) subsect. *Dumosi* (Torr. & A. Gray) Nesom						
S. boreale	0	–	y	0	n	2nd inner bristles, few, 60–70% of 1°
S. dumosum						
var. *dumosum*	1	y	y	0	n	2nd inner, 0–few, 70–80% of 1° inner
var. *strictior*	2	y	y	0	n	2nd inner, very few, 70% of 1° inner

Table 1. (continued)

Taxon	Clv	Clv-Tap	Lgth	Ovrlp	2nd-Out	Comments
subg. ***Symphyotrichum*** sect. *Symphyotrichum* (*x* = 8) subsect. *Dumosi* (Torr. & A. Gray) Nesom (continued)						
S. eulae	3	y	y	0	n	2nd inner bristles not seen
S. lanceolatum						
subsp. *hesperium*	1	y	y	0	y	2nd inner bristles, few, 50–60% of 1°; 2nd out bristle, one seen, 10% of 1° subsp. *lanceolatum*
var. *hirsuticaule*	1	y	y	0	n	2nd inner bristles, few, 70 of 1°
var *interior*	2	y	y	1	n	2nd inner bristles, few, 70% of 1°
var. *lanceolatum*	2	y	y	1	n	2nd inner bristles, few, 80% of 1°
var. *latifolium*	2	y	y	0	n	2nd inner bristles, few, 80% of 1°
S. lateriflorum						
var .*lateriflorum*	2	y	y	0	n	2nd inner bristles, few, 80% of 1°
var. *angustiflolium*	1	y	y	0	n	2nd inner bristles, few, 80% of 1°
S. nahanniense	1	y	y	1	n	2nd inner bristles 50–70% of 1° inner
S. praealtum						
var. *angustior*	2	y	y	2	n	2nd inner bristles, very few, 70–80% of 1° inner
var. *praealtum*	2	y	y	0	n	2nd inner bristles, few, 80% of 1°
S. ontarione						
var. *ontarione*	2	y	y	1	n	2nd inner bristles, few, 40–80% of 1°
S. racemosum	1	y	y	0	n	2nd inner bristles not seen; small fruit
S. simmondsii	1	y	y	1	n	2nd inner bristles, few, 70% of 1°
S. tradescanti	1	y	y	0	n	2nd inner bristles, few, 80% of 1°
S. welshii	1	y	y	1	n	2nd inner bristles 50–70% of 1° inner
subg. ***Symphyotrichum*** sect. *Symphyotrichum* (*x* = 8) subsect. *Porteriani* (Rydb.) Nesom						
S. depauperatum	0	–	y	0	n	2nd inner bristles, 0–few, 80% of 1°
S. parviceps	0	–	y	0	n	2nd inner bristles, few, 60–70% of 1°
S. porteri	2	y	y	0	n	2nd inner, 0–few, 60–70 % of 1° inner

Taxon	Clv	Clv-Tap	Lgth	Ovrlp	2nd-Out	Comments
S. pilosum						
var. *pilosum*	2	y	y	1	n	2nd inner, 0–few, 50–60% of 1°
var. *pringlei*	2	y	y	0	n	2nd inner bristles, 0–few, 80% of 1°
S. priceae	2	y	y	0	n	2nd inner, very few, 80% of 1° inner
sect. Conyzopsis (Torr. & Gray) Nesom ($x = 7$)						
S. frondosum	0	–	y	0	n	2nd inner not obvious; 1° bristles fine and of slightly different lengths
S. ciliatum	0	–	y	0	n	2nd inner not obvious; 1° bristles fine and of slightly different lengths
S. laurentianum	1	y	y	0	n	2nd inner not obvious; 1° bristles fine and of slightly different lengths
sect. *Turbinelli* (Rydb.) Semple ($x = 48$ derived from $x=8$)						
S. turbinellum	1	y	y	0	n	2nd inner, 1–few, 70–80% of 1° inner
subg. ***Ascendentes*** (Rydb.) Semple ($x = 13, 21$)						
S. ascendens	3	y	y	0	n	2nd inner bristles, few, 60–70% of 1°
S. defoliatum	1	y	y	0	n	2nd inner, very few, 80% of 1° inner
subg. ***Virgulus*** (Raf.) Nesom ($x = 5, 4$) sect. *Concolores* (Torr. & A. Gray) Nesom						
S. sericeum	1	y	y	2	y	2nd inner bristles, few, 60–70% of 1° inner; 2nd outer bristle, one seen on one fruit, 25% of ° inner
S. pratense	1	y	y	2	n	2nd inner bristles 40–80% of 1° inner
S. concolor						
var. *concolor*	1	y	y	0	n	2nd inner bristles, few, 50–60% of 1°
var. *divestitum*	1	y	y	0	n	2nd inner bristles, few, 60–80% of 1°
S. plumosum	1	y	y	1	n	2nd inner bristles 50–80% of 1° inner
subg. ***Virgulus*** (Raf.) Nesom ($x = 5, 4$) sect. *Grandiflori* (Torr. & A. Gray) Nesom						
subsect. *Grandiflori* (Torr. & A. Gray) Nesom						
S. campestre	3	y	y	1	n	2nd inner bristles, few, 40–70% of 1°
S. fendleri	2	y–	y	1	n	2nd inner bristles, few, 50–60% of 1°

Table 1. (continued)

Taxon	Clv	Clv-Tap	Lgth	Ovrlp	2nd-Out	Comments
subsect. *Grandiflori* (Torr. & A. Gray) Nesom (continued)						
S. grandiflorum	2	y	y	1	n	2nd inner bristles, few, 60–70% of 1°
S. oblongifolium	2	y	y	0	n	2nd inner bristles, few, 60–80% of 1°
S. yukonense	2	y	y	1	y	single short 2nd outer bristle seen; 2nd inner bristles 40–60%, fine; lower barbs of 1° bristles anthocyanotic
subsect. Mexicanae Nesom						
S. moranense	3	y	y	2	n	2nd inner bristles, few, 50–70% of 1°
S. trilineatum	2	y	y	2	n	2nd inner bristles, few, 60–70% of 1°
subg. ***Virgulus*** (Raf.) Nesom (*x* = 5, 4) sect. *Patentes* (Torr. & A. Gray) Nesom						
subsect. Patentes (Torr. & A. Gray) Nesom						
S. patens						
var. *patens*	3	y	y	1	n	2nd inner bristles, few, 60–80% of 1°
var. *patentissimum*	3	y	y	2	n	2nd inner bristles, few, 70–80% of 1°
S. phlogifolium	1	y	y	1	n	2nd inner bristles, few, 50–70% of 1°
S. georgianum	3	y	y	2	n	2nd inner bristles, few , 70% of 1°
subsect. *Brachyphylli* (Torr. & A. Gray) Nesom						
S. adnatum	2	y	y	0	n	2nd inner bristles, few, 50–70% of 1°
S. walteri	1	y	y	1	n	2nd inner bristles, few, 50–80% of 1°
subg. ***Virgulus*** (Raf.) Nesom (*x* = 5, 4) sect. *Polyliguli* (Semple & Brouillet) Semple						
S. novae-angliae	0	–	y	2	n	2nd inner bristles, few ,50–70% of 1°
S. ×*amethystinum*	0	–	y	0	n	2nd inner bristles, few, 50–80% of 1°
subg. ***Virgulus*** (Raf.) Nesom (*x* = 5, 4) sect. *Ericoidei* (Torr. & A. Gray) Nesom						
S. ericoides						
subsp. *ericoides*	2	y	y	1	n	2nd inner bristles, few, 70–80% of 1°
subsp. *pansum*	1	y	y	1	n	2nd inner bristles, few, 70–80% of 1°
S. falcatum	2	y	y	0	n	2nd inner bristles, few, 70–80% of 1°

Table 1. (continued)

Taxon	Clv	Clv-Tap	Lgth	Ovrlp	2nd-Out	Comments
subg. **Astropolium** (Nutt.) Semple (*x* = 5)						
S. subulatum						
var. *subulatum*	0	y	y	0	n	not clearly in three whorls; 2nd inner bristles, very few, 70–80% of 1°
S. tenuifolium						
var. *tenuifolium*	1	y	y	0	n	2nd inner bristles nearly as long as 1° outer bristles, or not present
EXAMPLES OF OTHER ASTER GENERA OF THE NORTH AMERICAN CLADE						
Doellingeria umbellata						
var. *umbellata*	3	y	y	2	y	2nd outer bristles, many, 10–15% of 1° inner bristles
Eucephalus engelmannii	4	y	y	2	y	2nd outer bristles, few, linear, 10–20% of 1° inner bristles; some individuals have a 2nd inner whorl of bristles 35–75% of 1° inner whorl
Eurybia macrophylla	3	y	y	2	y	2nd outer bristles, very few, 10–15% of inner bristles; some individuals have a 2nd inner whorl of bristles 50–60% of 1° inner whorl
Herrickia glauca	2	y	y	2	y	2nd outer bristles, very few 10–25%; 2nd inner bristles, few, 50–80% of 1° inner
Ionactis linariifolia	3	y	y	2	y	2nd outer bristles, many, 10–20% of 1° inner bristles; some individuals have a 2nd inner whorl of bristles 35–75% of 1° inner bristles
Oclemena reticulata	3	y	y	2	y	2nd outer bristles, few, 10–20% of inner bristles; 2nd inner bristles few, 40–60% of 1° inner

Table 1. (continued)

Taxon	Clv	Clv-Tap	Lgth	Ovrlp	2^{nd}-Out	Comments
EXAMPLES OF OTHER ASTER GENERA OF THE NORTH AMERICAN CLADE (continued)						
Oreostemma alpigenus ssp. *haydeni*	3	y	y	2	y	2^{nd} outer bristles, few, 10–15% of inner bristles; 2^{nd} inner bristles 40–60% of 1° inner bristles
EXAMPLES OF BASAL GRADE ASTERS						
Aster amellus	2	y	y	2	y	2^{nd} outer bristles very few, 10–30% of 1° inner; 2^{nd} inner bristles few,50–80% of 1° inner
Aster ageratoides subsp. *leiophyllus*	1–2	y	y	2	y	2^{nd} outer bristles very few, 20–25% of 1° inner; 2^{nd} inner bristles few, 50–60% of 1° inner
Aster scaber	3	y	y	2	y	2^{nd} outer bristles, few, 15–35% of 1° inner; 2^{nd} inner bristles, few, 40–70% of 1° inner
Galatella punctata	2	y	y	2	y	2^{nd} outer bristles very few; ca. 30% of 1° inner; 2^{nd} inner bristles few, 50–60% of 1° inner
Crinitaria linosyris	1	y	y	2	y	whorls grade outer to inner and not clearly discontinuous; 2^{nd} outer bristles very few, 30–40% of 1° inner; 2^{nd} inner bristles, 50–60% of 1° inner
Linosyris villosa	1?	?	?	2	y	numerous bristle, 70 plus; whorls grade outer to inner, shortest outer bristles 15% the length of the longest inner; inner most bristles only weakly clavate
Felicia amelloides	0–1	?	?	0	n	possibly two whorls, some bristles narrowly clavate, some variation in length, no short to mid length bristles

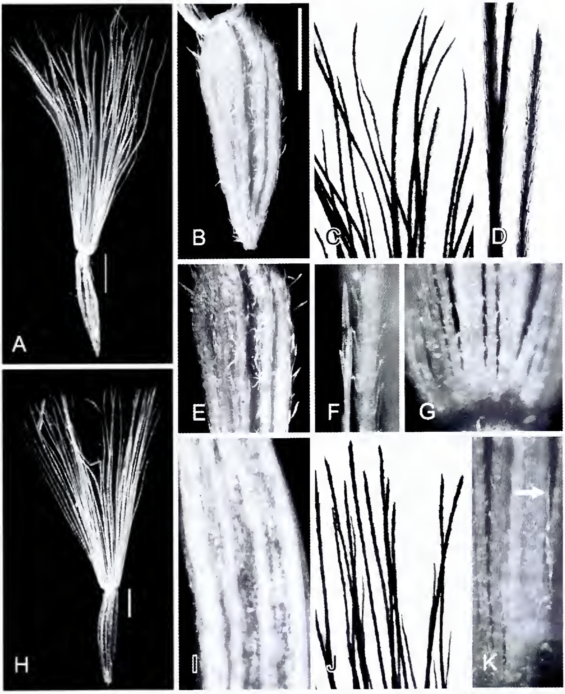


Fig. 1. Cypselae traits in *Canadanthus* and *Ampelaster*, disc fruits; scale bars = 1 mm. **A–G.** *Canadanthus modestus* (*Semple & Brouillet 7008* WAT). **A.** Immature fruit. **B.** Fruit body. **C.** Silhouette of tips of primary outer bristles (short, tapering) and primary inner bristles (longer, clavate). **D.** Clavate tip of primary inner whorl bristle. **E.** Mature fruit body detail. **F.** Tip of primary outer whorl bristle. **G.** Base of primary pappus whorls. **H–K.** *Ampelaster carolinianus* (*Semple 5393* WAT). **H.** Mature fruit. **I.** Detail of cypsela body. **J.** Silhouette of tips of primary outer bristles (short, tapering) and primary inner bristles (longer, clavate). **K.** Base of primary pappus whorls and single secondary pappus whorl bristle (arrow).

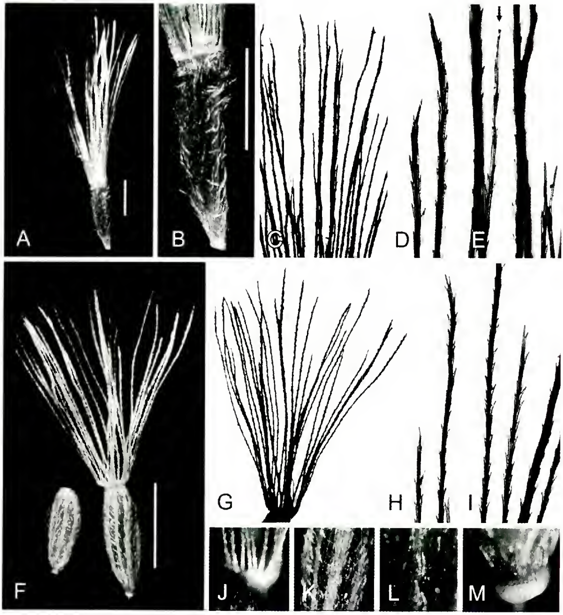


Fig. 2. Pappus traits in *Almutaster* and *Psilactis*; scale bars = 1 mm. **A–E.** Disc fruit, *Almutaster pauciflorus* (*Semple & Semple 5763* WAT). **A.** Mature fruit. **B.** Fruit body. **C.** Silhouette of pappus bristle tips. **D.** Clavate tips of primary inner whorl bristles. **E.** Tip of primary outer whorl bristle (arrow); the two shorter bristles on the right are possible long secondary outer bristles. **F–M.** *Psilactis tenuis (Semple & Heard 8201* WAT). **E.** Heterocarpic ray (epappose) and disc fruit. **G–M.** Disc fruit. **G.** Silhouette of pappus. **H.** Tips of primary whorl bristles. **I.** Tip of long secondary outer whorl bristle. **J.** Base of pappus whorls. **K.** Surface of fruit body. **L.** Detail of ridge of fruit body. **M.** Swollen base of fruit.

The much more derived, heterocarpic *Psilactis tenuis* (Figs. 2F–M) with $2n = 8$ had ray fruits without a pappus and disc fruits with what we interpret as a triple pappus. The mid length secondary inner bristles are obvious (Fig. 1G), but there was little difference in the primary outer and inner whorl bristles except length (Figs. 2G–I).

Within the large genus *Symphyotrichum*, with $x = 8, 7, 6, 5$ and 4 and diploid to duodecaploid taxa, there was some correlation between infrageneric group and degree of clavateness, but there was also considerable variation even between closely related species within the same subsection or even series. For example in *S.* series *Symphyotrichum*, *S. retroflexum* (Lindl.) Nesom (Figs. 4A–F) with $2n = 48$ had the most strongly clavate inner bristles in the genus and a few secondary inner whorl bristles, while *S. novi-belgii* (L.) Nesom with $2n = 48$ had non-clavate inner bristles and the secondary inner bristles were difficult to detect. All members of *S.* subsect. *Occidentales* had inner primary whorl bristles with well developed clavate tips. Most members of *S.* subsect. *Heterophylli* had non-clavate to weakly clavate inner primary bristles, while in the closely related subsect. *Dumosi*, species ranged from having non-clavate to strongly clavate primary inner bristles. Secondary inner bristles were generally few in number and 70–80% the length of the primary inner bristles. In subsect. *Porteriani*, the small fruits had relatively few bristles and very few secondary inner bristles. All these taxa have $x = 8$ and are members of subg. *Symphyotrichum*. This range in variation was also present in *S.* subg. *Virgulus* with $x = 5$, but the secondary inner whorl was more easily recognized as present, more variable in length, and with more and shorter bristles (40–80%).

The most distinct pappus in *Symphyotrichum* occurred in the three members of sect. *Conyzopsis*, which have $x = 7$ (Houle & Brouillet 1985). These have been treated as members of the separate genus *Brachyactis* Ledeb. (Jones 1989) but are likely derived from, or are sister group to, the western North American $x = 8$ *Foliacei* group (subsect. Occidentales; Semple et al. 2002 and earlier cited references). Conyzopsoid asters have a pappus with numerous fine bristles that are not clavate (Figs. 4I–L). The primary outer whorl is variable in length and shorter than the primary inner bristles. We saw no clear evidence of a secondary outer whorl. In short, in addition to having a derived chromosomal base number, being taprooted annuals rather than perennials like all other species in the genus, and being in other ways atypical members of the genus, the conyzopsoid asters also have a derived pappus that is apparently reduced to double, not triple or clavate, and they are the only species within *Symphyotrichum* with accrescent bristles (Nesom 1994).

Within *Symphyotrichum* it is sometimes difficult to distinguish between the whorls of bristles. As in *Solidago* (Hood & Semple 2003), the smaller cypselae with fewer bristles show less evidence for a multiple-whorled pappus. This was more often the case in sect. *Symphyotrichum*.

While most species of *Symphyotrichum* have a triple pappus, a few species also possess a vestigial secondary outer whorl. Only one short bristle was observed on one fruit in each case. These occurred in three different subgenera: subg. *Chapmanii*, *S. chapmanii*; subg. *Symphyotrichum*, *S. lanceolatum* subsp. *hesperium* and *S. retroflexum*; and subg. *Virgulus*, *S. sericeum* and *S. yukonense* (Fig. 3M). The same situation was observed in *Solidago* (Hood & Semple 2003), although for this report greater effort was made to detect the often difficult to

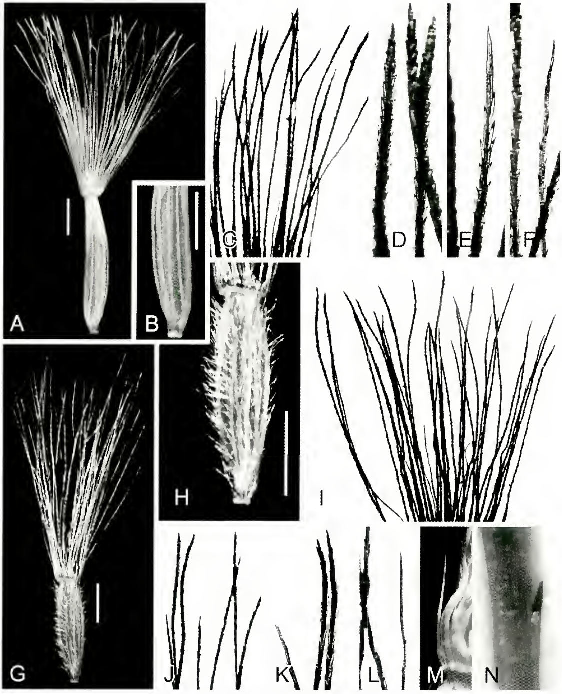


Fig. 3. Fruit traits in *Symphyotrichum*, disc fruits; scale bars = 1 mm. **A–F.** Subg. *Chapmaniani*, *S. chapmanii* (*Canne 2277* WAT). **A.** mature fruit. **B.** Fruit body detail. **C.** Silhouette of upper portion of pappus. **D.** Tips of primary inner whorl bristles. **E.** Tip of primary outer whorl bristle. **F.** Tip of secondary outer whorl bristle. **G–M.** Subg. *Virgulus*, *S. yukonense* (*Semple & Semple 10624* WAT). **G.** Mature fruit. **H.** Fruit body. **I.** Silhouette of upper portion of pappus. **J.** Tips of primary whorl bristles. **K.** Tips of primary inner whorl bristles (lower magnification than D–F). **L.** Tip of secondary outer whorl bristle. **M.** Single secondary outer whorl bristle. **N.** Anthocyanotic barb of primary whorl bristle near base; diffuse pigment also present in shaft.

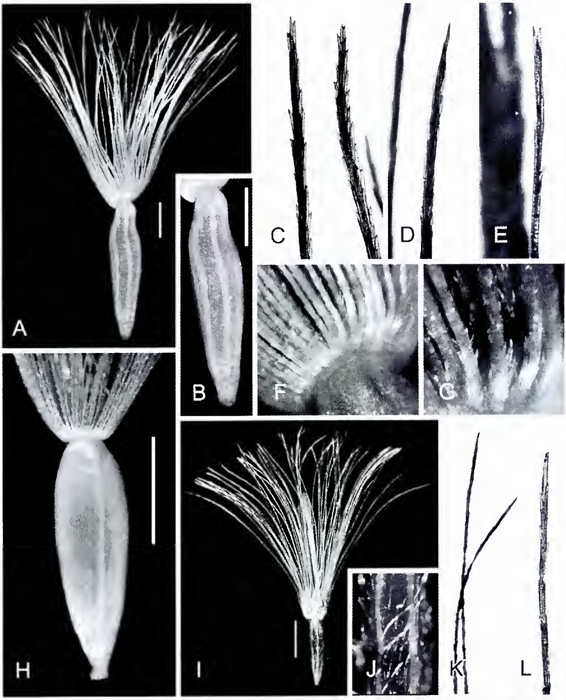


Fig. 4. Fruit traits in *Symphyotrichum* subg. *Symphyotrichum*, disc fruits I; scale bars = 1 mm. **A–F.** Sect./subsect. *Symphyotrichum*, *S. retroflexum* (*Semple & Chmielewski 6217* WAT). **A.** mature fruit. **B.** Fruit body detail. **C.** Tips of primary inner whorl bristles. **D.** Tip of primary outer whorl bristle. **E.** Tip of secondary outer whorl bristle. **F–G.** Base of pappus showing overlapping of bristles. **H.** Subsect. *Heterophylli*, *S. oolentangiense* (*Semple 2477* WAT) fruit body. **I–L.** Sect. *Conyzopsis*, *S. ciliatum* (*Houle & Legault 53* WAT). **I.** Mature fruit. **J.** Fruit body detail. **K.** Upper portion of primary whorl bristles. **K.** Tips of primary inner whorl bristles. **L.** Tip of primary inner whorl bristle show in **K.**

see, fine, secondary outer bristles. In all cases in *Symphyotrichum*, such bristles were clearly situated on the outer rim of the pappus. It seems likely that other species also rarely produce a bristle or two of the vestigial secondary outer whorl; finding such bristles was rather serendipitous. Documenting how frequently such rare bristles occur will take considerable time-consuming effort.

In other North American genera examined, species had either a quadruple or triple pappus, with both occurring within *Eucephalus*, *Doellingeria*, and *Ionactis* (Table 1). Historically, the short secondary outer whorl of bristles has been noted in all three genera, which were assumed to have a double pappus. The long inner "whorl" is in fact composed of usually three distinct whorls; a secondary inner whorl with tapering bristles 50–80% the length of the primary inner whorl; a primary outer whorl with tapering bristles 90–95% the length of the primary inner whorl; and a primary inner whorl of bristles with weakly to very strongly clavate bristles. Although species of *Doellingeria* have been treated as members of *Aster* sect. *Triplopappus*, their inner primary bristles are not as strongly clavate as those of some species of *Eucephalus*, which had not been reported to have two distinct whorls of longer inner bristles. These strongly clavate bristles were given a maximum score of 4 in Table 1, but they were more distinctly clavate than any *Solidago* and deserve a score of 5 on the 0–4 scale developed for goldenrods (Hood & Semple 2003).

The cypselae of at least some individuals of some species of *Eurybia* also have a quadruple pappus. Species in the related genus *Herrickia* also rarely had the short secondary outer whorl. The JCS laboratory is currently examining pappus traits in each of these $x = 9$ genera in detail and will report the results in a future paper.

Within the North American Clade some clades have lost one or more whorls of bristles, but not always the same whorl. In the Symphyotrichinae, the three longer whorls of bristles have generally been retained, but the short secondary outer whorl is absent or rarely vestigially present. In the Chrysopsidinae, the $x = 9$ genera have retained all four whorls to varying degrees, while the lower base number taxa have progressively lost the secondary inner and the secondary outer whorls (Semple, accepted). In the Solidagininae, some genera have retained the secondary outer whorl but lost the secondary inner whorl (e.g. *Sericocarpus*) while other genera have retained only the inner two primary whorls and usually lack the secondary outer whorl or possess it in a vestigial state (Hood & Semple 2003). Additional studies of all other subtribes and clades are needed to determine how many whorls of pappus bristles are really present. We note that several species that have been included in *Haplopappus* sensu Hall (1928) have been found to have either a double or triple pappus; this will be reported on in more detail in a future paper.

A few species of Eurasian and African asters were also examined to ascertain whether or not a quadruple pappus occurred in "Basal Group/Southern

Hemisphere Grade taxa" (Noyes & Rieseberg 1999) of Astereae. Four whorls were observed in species of *Aster* (one European, two eastern Asian species) and *Galatella* (Table 1); there were very few short outer bristles and only a few mid length bristles. In the *Crinitaria-Linosyris* group, which is more basal in the tribal phylogeny then *Aster* (Semple et al. 2002), the two species examined (Table 1) had numerous bristles that might be interpreted as four whorls or as a single series grading from very short outer bristles to long inner ones that were very weakly clavate. In both cases the pappus was different from that of North American basal genera. The pappus of the one species of *Felicia* examined lacked short and mid length bristles. The long bristles were slightly varied in length and some possibly were very narrowly clavate. The pappus was more like the most derived ones seen in some North American species, themselves known to be derived. The JCS laboratory has started a large systematic study of pappus variation in the Basal Grade genera of the Astereae and will report on the results in a future paper. At this point, however, it is clear that a quadruple pappus occurs in both the North American Clade and the some genera of Basal Grade of Astereae. A quadruple pappus is a plesiomorphic trait for the North American Clade; loss of whorls to three, two or one are derived states.

SYSTEMATICS IMPLICATIONS

Although *Symphyotrichum* has a triple pappus, for practical purposes, such as preparing keys to genera, it may be most convenient to treat the genus as having an "appearing simple" pappus (i.e., evidently having a single whorl of bristles), except possibly for sect. *Conyzopsis*, which has a distinctive pappus due to its numerous bristles in two similar whorls. In phylogenetic studies, the genus must be recognized as having a triple pappus with a vestigial fourth whorl in at least some species. The low number of secondary inner bristles and their apparent absence in some species reduces the value of this feature for purposes of identification. As well, for most species the low degree of clavateness of the primary inner bristles makes the condition not immediately obvious, as is clearly demonstrated by the fact that no one reported this before. Had we not begun with *Solidago*, we also might not have recognized the triple/quadruple pappus nature of the Symphyotrichinae genera of asters. In some cases, the triple nature of the pappus is only revealed by the small differences in average lengths of the three longer whorls. In Semple et al. (2002), the cypselae of 25 species of *Symphyotrichum* were illustrated in technical line drawing. Only a few of these can be interpreted now as showing differences in the lengths of the primary outer and inner whorl bristles, e.g. *S. praealtum* (Poir.) Nesom var. *praealtum*, and none illustrate the presence of the few-bristled shorter secondary inner whorl. Likewise, only three of the four whorls of pappus bristles of *Doellingeria umbellata* were illustrated; again the secondary inner whorl is missing. This is noted here to emphasize that differences between the secondary inner, the primary outer, and the inner pappus series in the North American Clade of the tribe Astereae are at times minor and difficult to see, but are nonetheless real.

ACKNOWLEDGMENTS

This research was supported by a Natural Sciences and Engineering Research Council of Canada Discovery Grant to JCS. The assistance of Troina Shea during preliminary work on this study is gratefully acknowledged.

REFERENCES

Brouillet, L., G. Allen, J.C. Semple, and M. Ito. 2001a. ITS phylogeny of North American asters (Asteraceae: Astereae): basal grade to North American lineages and distinct from Eurasian ones. http://www.sci.ouc.bc.ca/biol/CBA/abstract.html

Brouillet, L., G.A. Allen, J.C. Semple, and M. Ito. 2001b. ITS phylogeny of North American asters (Asteraceae : Astereae). Botany 2001 [ASPT/BSA/IOPB joint meeting] Albuquerque, New Mexico 12–16 August 2001. http://www.botany2001.org/section12/abstracts/63.shtml

Cronquist, A. 1955. Vascular plants of the Pacific Northwest. Part 5: Compositae. University of Washington Press. Seattle.

Cronquist, A. 1968a. *Aster* L. In: H.A. Gleason, ed. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. HafnerPub. Co., New York. Pp. 440–468.

Cronquist, A. 1968b. *Solidago* L. In: H.A. Gleason, ed. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. Hafner Pub. Co., New York. Pp. 413–438.

Cronquist, A. 1980. Vascular flora of the southeastern United States – Vol. 1 Asteraceae. The University of North Carolina Press, Chapel Hill.

Cronquist, A. 1994. Intermountain flora vascular plants of the Intermountain West, U.S.A: Volume 5 Asterales. The New York Botanical Garden, Bronx.

Fernald, M.L. 1950. Gray's manual of botany 8th Ed. D. Van Nostrand Company, New York.

Gray, A. 1884. Synoptical flora of North America. Vol. 1, part. 2. Ivison, Blakemean, Taylor & Co., New York.

Hall, H.M. 1928. The genus *Haplopappus*, a phylogenetic study in the Compositae. Publ. Carnegie Inst. Wash. 389:1–391.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett. 1990. Index herbariorum. Part I. The herbaria of the world, ed. 8. Regnum Veg. 120:1–693.

Hood, J.L.A. and J.C. Semple. 2003. Pappus variation in *Solidago* (Asteraceae: Astereae). Sida 20:1617–1630.

Jones, A.G. 1989. *Aster* and *Brachyactis* (Asteraceae) in Illinois. Illinois Nat. Hist. Survey Bull. 34:139–194.

Nesom, G.L. 1994. Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. Phytologia 77:141–297.

Nesom, G.L. 2000. Generic conspectus of the tribe Astereae (Asteraceae) in North America, Central America, the Antilles and Hawaii. Sida, Bot. Misc. 20.

Noyes, R.D. and L.H. Rieseberg. 1999. ITS sequence data support a single origin of North American Astereae (Asteraceae) and reflect deep geographic divisions in *Aster* s.l. Amer. J. Bot. 86:398–412.

Semple, J.C. 2006. Pappus variation in goldenaster Subtribe Chrysopsidinae (Asteraceae: Astereae). Sida (in Press).

Semple, J.C., S.B. Heard, and L. Brouillet. 2002. Cultivated and native asters of Ontario (Compositae: Astereae): *Aster* L. (including *Asteromoea* Blume, *Diplactis* Raf. and *Kalimeris* (Cass.) Cass.), *Callistephus* Cass., *Galatella* Cass., *Doellingeria* Nees, *Oclemena* E.L. Greene, *Eurybia* (Cass.) S.F. Gray, *Canadanthus* Nesom, and *Symphyotrichum* Nees (including *Virgulus* Raf.). Univ. Waterloo Biol. Ser. 41:1–134.

Semple, J.C., G.S. Ringius, and J.J. Zhang. 1999. The goldenrods of Ontario: *Solidago* L. and *Euthamia* Nutt. 3rd Ed. Univ. Waterloo Biol. Ser. 36:1–90.

Torrey, J. and A. Gray. 1841. Flora of North America. Vol. 2. Wiley & Putnam, New York.

BOOKS RECEIVED

BARBARA A. CELLARIUS. 2004. **In the Land of Orpheus: Rural Livelihoods and Nature Conservation in Postsocialist Bulgaria.** (ISBN 0-299-20150-3, hbk.). The University of Wisconsin Press, 1930, Monroe Street, Madison, WI 53711, U.S.A. (**Orders:** www.wisc.edu/wisconsinpress/, 608-263-1110, 608-263-1120 fax, E-mail: uwiscpress@uwpress.wisc.edu, orders from the Chicago Distribution Center, 773-702-7000, 800-621-8476 fax, or 773-702-7212). $45.00, 331 pp., tables, b/w figures, 6" × 9".

Table of Contents.—Introduction, **1)** Bulgarian Environmental NGOs and Nature Conservation. A Historical View; **2)** Landscape, Community, and Economic History in the Central Rhodope; **3)** Postsocialist Strategies of Mountain Agriculture; **4)** Making Ends Meet; **5)** Conserving the Natural Heritage of the Rhodope; **6)** A Civil Balkan Village? Cavers and Collective Action; Conclusion, Notes, Bibliography, and Index.

ELIZABETH RIPPEY and BARBARA ROWLAND. 2004. **Coastal Plants: Perth and the South-West Region, Second Edition.** (ISBN 1-920694-05-6, pbk.). University of Western Australia Press, Crawley, Western Australia 6009, www.uwapress.uwa.edu.au (**Orders:** International Specialized Book Services, Inc., 920 NE 58th Avenue, Suite 300, Portland, OR 97213-3786, U.S.A.). $26.95, 276 pp., b/w line drawings, color plates, 6 1.2" × 9 1/2".

From the Preface.—"Originally published in 1995 as *Plants of the Perth Coast and Islands*, this revised edition is more concise, but covers a wider area: the south-west coastline from Dongara to Dunsborough."

Descriptions for over 130 plant species are provided in a very nice layout. Each plant discussed includes: description, distribution (map), flowering period, clean b/w line drawings useful in identification, notes, and a color plate (water color painting by Elizabeth Rippey) on verso page. No keys are provided but otherwise this is a very nice book.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

DAHLIA SUBLIGNOSA (ASTERACEAE): A SPECIES IN ITS OWN RIGHT

Dayle E. Saar[1]
Department of Biological Sciences
Murray State University
Murray, Kentucky 42071, U.S.A.

Paul D. Sørensen
Department of Biological Sciences
Northern Illinois University
DeKalb, Illinois 60115, U.S.A.

ABSTRACT

Dahlia dissecta var. *sublignosa* was recognized in 1969 based on available herbarium specimens. Here we present molecular evidence to demonstrate that var. *sublignosa* is not the sister taxon to *D. dissecta* var. *dissecta*, nor is it conspecific with either of its two closest allies, *D. linearis* and *D. foeniculifolia*. Therefore, we elevate *Dahlia dissecta* var. *sublignosa* to the rank of species, as **D. sublignosa** (P.D. Sørensen) D.E. Saar & P.D. Sørensen comb. & stat. nov.

RESUMEN

Dahlia dissecta var. *sublignosa* se reconoció en 1969 basándose en los especimenes de herbario disponibles. Presentamos aquí una prueba molecular para demostrar que var. *sublignosa* no es el taxon hermano de *D. dissecta* var. *dissecta*, ni es conspecífico con ninguno de sus dos semejantes más próximos, *D. linearis* y *D. foeniculifolia*. Por ello, elevamos *Dahlia dissecta* var. *sublignosa* al rango de especie, así como **D. sublignosa** (P.D. Sørensen) D.E. Saar & P.D. Sørensen comb. & stat. nov.

INTRODUCTION

Dahlia dissecta S. Watson presently has two recognized intraspecific taxa: *D. dissecta* var. *dissecta* and *D. dissecta* var. *sublignosa* P.D. Sørensen. *Dahlia dissecta* is in sect. *Entemophyllon*, which includes five other species. *Dahlia dissecta* var. *dissecta* is known from rocky slopes and ledges in the Mexican states of Hidalgo and San Luis Potosí, at elevations of 1900–2500 m. While not common, plants are not difficult to find in these areas. Variety *sublignosa* is known only from the type locality and a nearby location in western Tamaulipas, Mexico, at elevations of 2100–2500 m. The ranges for these two varieties are separated by about 137 km at their closest point, and var. *sublignosa* is not sympatric with any other taxa in sect. *Entemophyllon*.

Dahlia dissecta var. *dissecta* was conservatively described based on limited herbarium specimens known at the time (Sørensen 1969). Morphologically, the two taxa are very similar, at least superficially. Both have ultimate leaf segments that closely resemble each other in shape. All of the species in sect. *Entemophyllon* described at the time had substantial perennating stems except *D. dissecta*, which is wholly herbaceous. Variety *sublignosa* is minimally woody at the base of the canes.

---

[1] Author for correspondence; e-mail: dayle.saar@murraystate.edu

SIDA 21(4): 2161–2167. 2005

The varieties differ in that *D. dissecta* var. *sublignosa* tends to be larger, reaching heights of 7–9 dm compared to 3–7.6 dm for var. *dissecta*. Stems of the current year's growth arise directly from a crown of tubers or rootstock on var. *dissecta*, whereas stems of var. *sublignosa* frequently arise from short (5–15 cm) ligneous portions of the previous year's growth. The leaves of var. *sublignosa* can be a little longer (11–19 vs. 10–15 cm), with sometimes smaller ultimate segments (0.5–5.5 vs. 2–9 mm). Outer involucral bracts are 2.5–5.5 mm in width for var. *sublignosa* and 1.8–4 mm for var. *dissecta* (Sørensen 1969). Perhaps the most distinctive feature of difference is the squarish, cusp-tipped leaf segments of var. *sublignosa*, as compared to more rounded leaf segments on var. *dissecta*, which may or may not have a smaller cusp (see Fig. 1a–b).

Observations made with recently collected live material suggested more differences between the varieties than can be seen with herbarium specimens alone. Therefore, a molecular analysis was conducted to clarify the relationship of these two presumed intraspecific taxa.

MATERIALS AND METHODS

Live plant material was obtained from Plant Delights Nursery, Inc., Raleigh, NC, which originated as seed from Yucca Do Nursery, Hempstead, TX, accession number D07-615, collected in the Cerro Peña Nevada Mountains, in the vicinity of the type locality. *D.E. Saar 3521, 3522* (MUR).

Plants of *Dahlia dissecta* var. *sublignosa* flowered in an outdoor plot, which provided material for chromosome counts from pollen mother cells in developing capitula. Heads of appropriate size were fixed in modified Carnoy's solution (4:3:1 v/v of chloroform: absolute or 95% ethanol: glacial acetic acid), transferred to 70% alcohol, and stored at 4°C until the chromosomes were counted. The staining procedure is summarized in Saar (1999).

Leaf material was collected from two greenhouse plants of *Dahlia dissecta* var. *sublignosa* and one plant of *Dahlia foeniculifolia* Sherff at Murray State University. DNA was extracted using a DNeasy® Plant Mini Kit (Qiagen no. 69104). The internal transcribed spacer regions (ITS) of nuclear ribosomal DNA were amplified using forward primer ITS5m (Sang et al. 1995) to prevent accidental amplification of endophytic fungi, if present (Saar et al. 2001), and reverse primer ITS4 (White et al. 1990). Reactions were in 50µL volumes and contained 2 units of *Taq* polymerase (Promega, Madison, WI), 0.2mM of each dNTP, 0.1uM of each primer, and 75ng of template. Amplification was carried out on an MJ Research thermal cycler PTC-200 using the following protocol: one cycle of 2 min 30 sec at 95°C, 30 sec at 50°C, and one min at 72°C.; followed by 30 cycles of 30 sec at 95°C, one min at 50°C, and one min at 72°C; and finished with 6 min at 72°C. Amplified products were run on 1.0% agarose gels using 0.5 × TBE and detected with ethidium-bromide fluorescence on a UV transilluminator. Products were cleaned for sequencing using Microcon® Centrifugal Filter

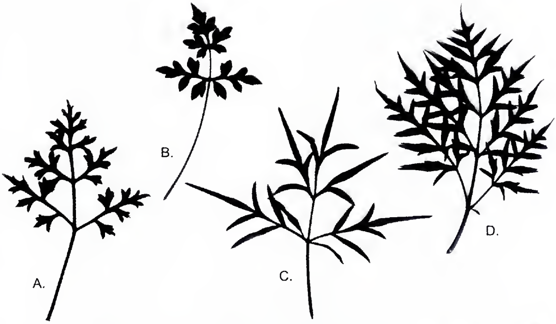


Fig. 1. Comparative leaf shapes from greenhouse-grown plants: **A.** *Dahlia sublignosa* (formerly *D. dissecta* var. *sublignosa*); **B.** *Dahlia dissecta* (var. *dissecta*); **C.** *Dahlia linearis*; **D.** *Dahlia foeniculifolia*. Leaves from these greenhouse plants are representative of wild-grown plants in general shape but are smaller in size and not proportional to each other as suggested here. See text for leaf dimensions of wild-collected plants.

Devices (YM-100) from Millipore (Bedford, MA). Sequencing was on a Beckman-Coulter capillary sequencer. This procedure was performed twice for var. *sublignosa*, beginning with the DNA extraction from fresh leaves. Our sequence for *D. dissecta* var. *dissecta* (Saar et al. 2003) is congruent with the sequence of var. *dissecta* obtained by Gatt et al. (2000), so repeating the procedure for this taxon was deemed unnecessary.

ITS sequences from three species in sect. *Entemophyllon* were downloaded from GenBank (Saar et al. 2003). Material from the remaining species in the section, *Dahlia congestifolia* P.D. Sørensen, was not available, as it is known only from the type specimen. During field work in 1995, we twice searched the W-facing slopes of the somewhat isolated, small limestone mountain of Cerro Chulco near Apan in extreme southern Hidalgo, the type locality of *D. congestifolia*, but failed to relocate this species. Two other unsuccessful searches were made subsequent to the collection of the type but prior to its formal recognition (Sørensen 1987). *Dahlia merckii* Lehm. was used as the outgroup taxon based on Saar et al. (2003) and its sequence was also obtained from GenBank (Table 1).

Sequences were aligned with Clustal W software (alignment available on request). No gaps were needed to align the ingroup taxa; three one-base gaps were required to align the ingroup with the outgroup taxon. They were ignored in the analysis. Single base polymorphisms are limited to one (r) in *Dahlia*

Table 1. GenBank Accession Numbers.

Species	GenBank Accession No.	Source
Dahlia dissecta S. Watson	AY117465	Saar et al. 2003
Dahlia foeniculifolia Sherff	AY117466	Saar et al. 2003
Dahlia linearis Sherff	AY117467	Saar et al. 2003
Dahlia merckii Lehm.	AY117471	Saar et al. 2003
Dahlia rupicola P.D. Sørensen	AY117468	Saar et al. 2003
Dahlia scapigeroides Sherff	AY117469	Saar et al. 2003
Dahlia sublignosa (P.D. Sørensen) Saar & P.D. Sørensen	DQ198259	this study

linearis Sherff and two (y, s) in *D. scapigeroides* Sherff, which were included in the matrix format symbols for analysis. A branch-and-bound search was performed using PAUP* 4.0v8 (Swofford 1998) on a Macintosh G5 computer. Bootstrap analysis (Felsenstein 1985) was performed using 1000 replicates. Pairwise distances [uncorrected ("p") distance matrix] were calculated with PAUP.

RESULTS

The ITS sequences for both plants of *Dahlia dissecta var. sublignosa* are identical, so only one sequence was submitted to GenBank. The new sequence obtained for *D. foeniculifolia* is consistent with that of Saar et al. (2003) but is of better quality (no unknowns or polymorphisms), presumably due to the availability of better leaf material from the same plant (GenBank sequence updated).

The phylogenetic analysis produced two trees of a shortest length of 70 steps (CI 0.971, RI 0.917, RC 0.890, HI 0.029). A total of 671 base pairs were aligned and analyzed: 251 bp in ITS-1, 220 bp in ITS-2, and the remaining bp from flanking regions of coding nrDNA.

Results show that the sister taxon to *Dahlia dissecta* var. *sublignosa* is not var. *dissecta* but either *D. linearis* or *D. foeniculifolia*. The tree shown in Figure 2, based on a strict consensus, results in a polytomy between *D. linearis*, *D. foeniculifolia*, and the two samples of var. *sublignosa*.

A distance matrix of sect. *Entemophyllon* has an average of 1.54% ($\delta = 0.0066$) sequence divergence among the six taxa. *Dahlia dissecta* var. *sublignosa* differs from *D. linearis* by 0.91% and from *D. foeniculifolia* by 1.21%.

The chromosome number is $n=17$.

DISCUSSION

The phylogenetic analysis shows that *Dahlia dissecta* var. *dissecta* and var. *sublignosa* are not conspecific. Leaf and flower morphology and ITS sequences also do not suggest that it is a variety of the next closest taxa, *D. linearis* or *D. foeniculifolia* (Fig. 1). The sequence divergences between var. *sublignosa* and *D.*

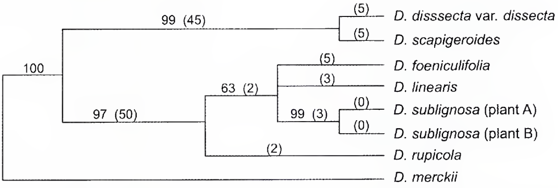


Fig. 2. Phylogenetic anaylsis of *Dahlia* sect. *Entemophyllon* using ITS sequences. Outgroup is *D. merckii* (not in sect. *Entemophyllon*). Numbers above branches represent bootstrap values; numbers in parenthesis indicate number of changes.

linearis and between var. *sublignosa* and *D. foeniculifolia* (0.91 and 1.21%, respectively) are consistent with the other species in the section and other clades in the genus. By comparison, the "variable root clade" (Saar et al. 2003) averages 0.97% (δ = 0.0087) divergence for 10 taxa and the "core *Dahlia* clade" (Saar et al. 2003) averages 0.87% (δ = 0.0096) over 15 taxa. Therefore, it is concluded that *D. dissecta* var. *sublignosa* should be elevated to the rank of species, coordinate with the other taxa of the section:

Dahlia sublignosa (P.D. Sørensen) D.E. Saar & P.D. Sørensen, comb. & stat. nov. (**Fig. 3**). TYPE: MEXICO. TAMAULIPAS: 4.8 km N of Miquihuana in forest dominated by *Pinus* (99°47'N Lat; 23°36'W Long), elev. ca. 2100 m, 14 Jul 1949, *Stanford, Taylor, & Lauber 2436* (HOLOTYPE: NY; ISOTYPES: GH, MICH, TEX, UC, US-2, WTU).

Dahlia sublignosa is readily distinguished from either *D. linearis* or *D. foeniculifolia* by its shorter ultimate leaf segments (0.5–5.5 mm vs. 9–23 for *D. linearis* and 30–55 mm for *D. foeniculifolia*). The chromosome number of n=17 is consistent with five of the other species in the section; the number is not known for the sixth species, *Dahlia congestifolia*.

The elevation of *Dahlia sublignosa* to rank of species brings the number of "wild" species in the genus to 36, but does not include the cultivated forms often called *D. variabilis* Desf. or occasionally *D. pinnata* Cav., but see Hansen and Hjerting (1996) for clarification of the latter binomial.

ACKNOWLEDGMENTS

We thank Courtney A. Thomason for preparing the line drawing of *Dahlia sublignosa*. We are grateful to the folks at Plant Delights Nursery, Raleigh, NC, for generously supplying us with living material of *Dahlia sublignosa*. Guy Nesom and Richard Noyes provided helpful comments for an earlier version of the manuscript.

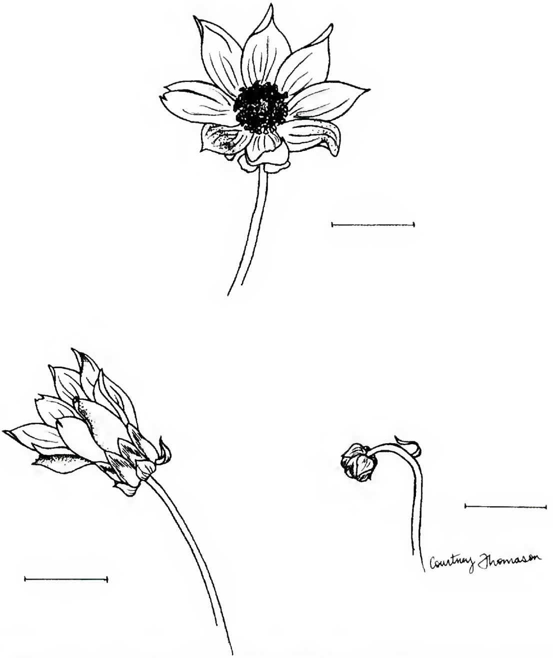


Fig. 3. Flower head of *Dahlia sublignosa*. Scale bar represents 1 cm.

REFERENCES

FELSENSTEIN, J. 1985. Confidence limits on phylogenies: an approach using bootstrap. Evolution 39:783–791.

GATT, M., K.R.W. HAMMETT, and B.G. MURRAY. 2000. Molecular phylogeny of the genus *Dahlia* Cav. (Asteraceae, Heliantheae-Coreopsidinae) using sequences derived from the internal transcribed spacers of nuclear ribosomal DNA. Bot. J. Linn. Soc. 133:229-239.

HANSEN, V.H. and J.P. HJERTING. 1996. Observations on chromosome numbers and biosystematics in the genus *Dahlia* (Asteraceae, Heliantheae) with an account on the identity of *D. pinnata, D. rosea*, and *D. coccinea*. Nordic J. Bot. 16:445–455.

Sang, T., D.J. Crawford, and T.F. Stuessy. 1995 . Documentation of reticulate evolution in peonies (*Paeonia*) using internal transcribed spacer regions of nuclear ribosomal DNA: implications for biogeography and concerted evolution. Proc. National Acad. Sci. 92:6813–6817.

Saar, D.E., 1999. A phylogenetic analysis of the genus *Dahlia* (Asteraceae): an interdisciplinary study. Ph.D. dissertation, Northern Illinois University, DeKalb.

Saar, D.E., N.O. Polans, P.D. Sørensen, and M.R. Duvall. 2001. Angiosperm contamination by endophytic fungi: detection and methods of avoidance. Pl. Mol. Biol. Rep. 19:249-260.

Saar, D.E., N.O. Polans, and P.D. Sørensen. 2003. A phylogenetic analysis of the genus *Dahlia* (Asteraceae) based on internal and external transcribed spacer regions of nuclear ribosomal DNA. Syst. Bot. 28:627–639.

Sørensen, P.D. 1969. Revision of the genus *Dahlia* (Compositae, Heliantheae-Coreopsidinae). Rhodora 71:309–365, 367–416.

Sørensen, P.D. 1987. *Dahlia congestifolia*, Section *Entemophyllon* (Asteraceae: Heliantheae, Coreopsidinae), new from Hidalgo, Mexico. Rhodora 89:197–203.

Swofford, D.L. 1998. PAUP* 4.0: Phylogenetic analysis using parsimony. Macintosh Beta Version 8 (with Beta 10 Updateers). Distributed by Sinauer Associates, Inc., Sunderland, MA.

White, T.J., T. Burns, S. Lee, and J. Taylor. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: M.A. Innis, D.H. Gelfand, J.J. Sninsky and T.J. White, eds. PCR protocols: a guide to methods and applications, eds. San Diego, CA: Academic Press, Inc. Pp. 315–322.

BOOK NOTICE

Sabeeha Merchant, Winslow R. Briggs, and Vicki L. Chandler (eds). 2005. **Annual Review of Plant Biology: Volume 56, 2005.** (ISBN 0-8243-0656-2, hbk; ISSN 1040-2519). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $189.00 (U.S.A.), $194.00 (Int'l.), 575 pp., 7 1/2" × 9".

Contents of Volume 56 of *Annual Review of Plant Biology*:

Fifty Good Years, Peter Starlinger

Phytoremediation, Elizabeth Pilon-Smits

Calcium Oxalate in Plants: Formation and Function, Vincent R. Franceschi, Paul A. Nakata

Starch Degradation, Alison M. Smith, Samuel C. Zeeman, Steven M. Smith

CO2 Concentrating Mechanisms in Algae: Mechanisms, Environmental modulation and Evolution, Mario Giordano, John Beardall, John A. Raven

Solute Transporters of the Plastid Envelope Membrane, Andreas Weber, Rainer Schwacke, Ulf-Ingo Flugge

Abscisic Acid Biosynthesis and Catabolism, Eiji Nambara, Annie Marion-Poll

Redox Regulation: A Broadening Horizon, Bob B. Buchanan, Yves Balmer

Endocytotic Cycling of PM Proteins, Angus S. Murphy, Anindita Bandyopadhyay, Susanne E. Holstein, Wendy A. Peer

Molecular Physiology of Legume Seed Development, Hans Weber, Ljudmilla Borisjuk, Ulrich Wobus

Cytokinesis in Higher Plants, Gerd Juergens

Evolution of Flavors and Scents, David R. Gang

Biology of Chromatin Dynamics, Tzung-Fu Hsieh, Robert Fischer

Shoot Branching, Paula C. McSteen, Ottoline Leyser

Protein Splicing Elements and Plants: From Transgene Containment to Protein Purification, Thomas C. Evans, Jr., Ming-Qun Xu, Sriharsa Pradhan

Molecular Genetic Analyses of Microsporogenesis and Microgametogenesis in Flowering Plants, Hong Ma

Plant-Specific Calmodulin-Binding Proteins, Nicolas Bouche, Ayelet Yellin, Wayne A. Snedden, Hillel Fromm

Self-Incompatibility in Plants, Seiji Takayama, Akira Isogai

Remembering Winter: Toward a Molecular Understanding of Vernalization, Sibum Sung, Richard M. Amasino

New Insights to the Function of Phytopathogenic Bacterial Type III Effectors in Plants, Mary Beth Mudgett

Indexes: Subject Index; Cumulative Index of Contributing Authors, Volumes 46–56; Cummulative Index of Chapter Titles, volumes 46–66.

CORRECTION TO THE TYPE CITATION OF *SARRACENIA ALABAMENSIS* AND VALIDATION OF THE NAME *SARRACENIA ALABAMENSIS* SUBSP. *WHERRYI* (SARRACENIACEAE)

F.W. Case, Jr.

7275 Thornapple Lane
Saginaw, Michigan 48609, U.S.A.

Case and Case (1974) described a new species of *Sarracenia, S. alabamensis* F.W. Case & R.B. Case, from the Fall Line Sand Hills of Chilton, Autauga, and Elmore counties, Alabama. The "type plant" (as cited) was collected June 1971 in Elmore Co., Alabama, from a plant in the railroad ditch approximately halfway between the towns of Elmore and Speigner, but the type specimen was prepared at a later date from a cultivated division of the same plant grown in our personal greenhouse. As cited, the type consisted of a flowering portion (1 May 1972–US 02797766), with the sigmoid spring leaves and flowers, and a summer portion (27 July 1972–US 02797767 and US 02797768) with the large and distinctive summer leaves. For valid publication, however, Article 8.2 of the International Code of Botanical Nomenclature (Greuter et al. 2000) requires that the type be a single gathering made at one time. To correct the error, validation of this name requires designation of a single type, as follows:

Sarracenia alabamensis F.W. Case & R.B. Case, sp. nov. TYPE: ALABAMA. ELMORE CO.: between Elmore and Speigner, gravelly, peaty springhead in thicket of *Rhododendron, Alnus, Magnolia virgini[c]a, Rhus vernix,* and *Arundinaria tecta,* [field collection Jun 1971; greenhouse grown], 1 May 1972, *F. Case & R. Case S500* (HOLOTYPE: US 02797766; ISOTYPE: MICH). Latin description: Rhodora 76:653–655. 1974.

In addition, an infraspecific name is not validly published unless the name of the species to which it is assigned is validly published either simultaneously or previously (ICBN Article 43.1, Greuter et al. 2000). Thus, *Sarracenia alabamensis* subsp. *wherryi* (Case & Case 1976) was not validly published and is reprised here:

Sarracenia alabamensis subsp. **wherryi** F.W. Case & R.B. Case, subsp. nov. TYPE: ALABAMA. WASHINGTON CO.: swampy trough in pine woods about a half-mile E of Chatom, growing with *Sarracenia leucophylla,* [field collection Jul 1972; greenhouse grown], Sep 1974, *F. Case & R. Case S573* (HOLOTYPE: US 02797749). Latin description: Rhodora 78:315. 1976.

ACKNOWLEDGMENTS

I wish to thank Rob Naczi and A.A. Reznicek for bringing this error to my attention and for helping me to correct it. Guy Nesom kindly reviewed the paper and offered additional comments.

REFERENCES

Case, F.W. and R.B. Case. 1974. *Sarracenia alabamensis*, a newly recognized species from central Alabama. Rhodora 76:650–665.

Case, F.W. and R.B. Case. 1976. The *Sarracenia rubra* complex. Rhodora 78: 270–325.

Greuter, W., J. McNeill, F.R. Barrie, H.M. Burdet, V. Demoulin, T.S. Filgueiras, D.H. Nicolson, P.C. Silva, J.E. Skog, P. Trehane, N.J. Turland, and D.L. Hawksworth (eds.). 2000. International code of botanical nomenclature (St. Louis Code) adopted by the Sixteenth International Botanical Congress, St. Louis, Missouri, July-August 1999. Koeltz, Konigstein. [Regnum Veg. 138.]

A CASE OF DISPUTED ORTHOGRAPHY: IS IT *ECHINOCHLOA COLONA*; OR IS IT *ECHINOCHLOA COLONUM* (GRAMINEAE)?

Daniel B. Ward

Department of Botany
University of Florida
Gainesville, Florida 32607, U.S.A.

ABSTRACT

Within the genus *Echinochloa* (Gramineae) the epithet of the grass familiarly known as Jungle Rice has been spelled either "*colona*" or "*colonum*." Linnaeus, in his original recognition of the species as a member of the neuter genus *Panicum*, chose "*colonum*" as the epithet. This word, from the Latin "*colonus*," is a noun. As such, under the International Code of Botanical Nomenclature it must retain its original spelling whatever the gender of the genus to which it may be assigned. The grass is thus correctly known as *Echinochloa colonum* (L.) Link.

RESUMEN

Dentro del género *Echinochloa* (Gramineae), el epíteto de la especie conocida comúnmente como Arroz Salvaje ha sido escrito tanto "*colona*" como "*colonum*." Linnaeus, en su reconocimiento original de la especie como miembro del género neutro *Panicum*, escogió "*colonum*" como epíteto. Esta palabra, del latín "*colonus*," es un sustantivo. En sí, bajo el Código Internacional de Nomenclatura Botánica, debe conservar su ortografía original, cualquiera que sea el género (masculino, femenino, o neutro) del género al que sea asignado. Así pues, el nombre correcto de la especie es *Echinochloa colonum* (L.) Link.

INTRODUCTION

The Old World grass known as Jungle Rice, a member of the genus *Echinochloa* (Gramineae), is now found in tropical and temperate areas throughout the world. Though in ancient times and into the early 20th century it served as an edible grain, it is now best known as a secondary forage for cattle or as a troublesome weed of wet soils. It was given scientific recognition in the mid-18th century, first as a species of *Panicum*, then as a member of the newly formed genus *Echinochloa*. In these two genera it has borne only a single specific epithet. Yet over the decades different authors, with about equal frequency, have given this epithet two spellings—*colona* and *colonum*. But few have attempted to explain their chosen spelling. And none have provided adequate justification of which spelling is correct.

HISTORY

Jungle Rice—a common name of relatively recent origin—has been known from ancient times. The grains have been found in the intestines of mummies of early Egypt, where their amount and purity make it "most probable that the plant was cultivated as a cereal" (Tackholm & Drar 1941). Its use as a foodstuff in India continued to be documented into the 20th century (Gamble 1928; Bor 1968). The plant was recorded and illustrated by at least three pre-Linnaean authors: Plukenet (1692), Sloane (1696, 1707), and Ehret (1748).

When Linnaeus (1759) published *Panicum colonum* he transcribed the epithet wholly in lower case. His diagnosis of the new species read: *P. spiculis alternis secundis muticis ovatis scabris, rachi teretiuscula*. He referred to the illustrations of both Sloane (1707) and Ehret (1748). His basis may have been a specimen (LINN 80.23; Savage 1945) now in the Linnaean Herbarium obtained from the Irish physician, Patrick Browne, who returned to England in 1756 after a stay in Jamaica (Stafleu 1971); the sheet bears a "Br" in Linnaeus' hand. He may also have seen material in the Jamaica collections of Sir Hans Sloane whom he visited in 1736 (Stearn 1957:110), and was certainly familiar with the plate in Sloane's (1707) book. The plant's relatively distinct morphology, which matches the Sloane and Ehret plates, has made a secure linkage with Linnaeus' diagnosis and name; no later author has questioned the accuracy of their application to the grass known as Jungle Rice.

Panicum is a genus of great size, recently estimated (Mabberley 1996) to contain more than 500 species. It would be even larger if certain groups of species had not been removed as deserving of independent generic rank. *Echinochloa* was among the first of these distinctive groups to be given generic standing, by Beauvois (1812), to contain the familiar Barnyard-grass, *E. crusgalli* (L.) Beauv. Beauvois at the same time formed a second generic segregate, *Oplismenus*. Kunth (1816) then made a transfer of *Panicum colonum*, to form *Oplismenus colonus* (L.) HBK.; and Link (1833) published the now-universally accepted combination (if not spelling), *Echinochloa colona* (L.) Link.

Floristic botanists were slow to accept the new combinations. Influential writers throughout the 19th century—Hooker (1897) and Cooke (1908) in India; Grisebach (1864) in the West Indies; Nash (in Britton & Brown 1898), Chapman (1897), and Mohr (1901) in North America—continued to employ *Panicum colonum*. [Nash (1898), under Britton's editorial edict that all species must have common names, is the apparent originator of the now widely used "Jungle Rice."] Perhaps Merrill (1923) was the last important author to retain Linnaeus' *P. colonum*.

Other than its initial formation, the first significant use of Linnaeus' epithet in the segregate genus *Echinochloa* appears to have been by Nash (in Small's "Flora of the Southeastern United States" 1903), who chose to follow Link (1833) in forming the epithet as "*colona*." Nash seized a second opportunity to promote this spelling by his authorship of the grasses in Britton and Brown (1913), expanding the usage into northeastern North America. The practice received further approbation by Hitchcock (1909) in Cuba; by Stapf (in Prain 1920) and Hutchinson and Dalziel (1936) in Africa; by Gamble (1928) in India; by Hitchcock (in Small's "Manual of the Southeastern Flora" 1933); and by Rozhevits and Shishkin (1934) in Russia.

But opposition began to arise to the burgeoning use of *colona*. Hitchcock (who in his earlier works had employed *colona*) noted (1913): "Dr. E.L. Greene called attention to the fact that the specific name is not an adjective, and suggested that it is probably a genitive plural. The word appears to be contracted from *colonorum*, genitive plural of *colonus*, a husbandman or a *colonist*. Dr. J.A. Nieuwland has kindly searched Latin authorities and verifies this conclusion, though there appears to be no direct authority for the word *colonum*."

Wiegand (1921)—other than Hitchcock, the only author expressing an opinion who had devoted significant time to the taxonomy of *Echinochloa*—observed: "Hitchcock, following Greene, has called attention to the fact that the name *colonum* is not an adjective and hence should not be declined." And Bor (1960), perhaps irritated by the use of *colona* without explanation by other authors addressing the flora of India, brusquely commented: "The correct form of the specific epithet is *colonum*, a contraction of *colonorum*, and not *colona*."

Argument in defense of *colona* was slow to appear. Clayton (in Hepper 1968) may have been the first: "The declension of the epithet depends on whether it is regarded as a noun or an adjective. Lexicographers differ, but the adjectival use was acceptable to those of Linnaeus' own time." This explanation was expanded by Cope (in Nasir & Ali 1982): "The epithet is sometimes treated as the irregular genitive plural of a noun ('of the farmers') and spelt *colonum*. However, there seems no reason to depart from the adjectival form familiar to botanists; though not in the purest classical tradition, its use was sanctioned by lexicographers of Linnaeus' own time." Though citing as his authority an author who had taken the contrary view, Michael (2003) justified *colona*: "Hitchcock (1913) considered that '*colonum*' was a non-declining contraction, but dictionaries of Linnaeus' time treated it as a declining adjective. Because Linnaeus was the first to name the species (as '*Panicum colonum*'), it seems best to follow the practice considered correct in his day; hence '*E. colona*'."

Only these six authors have been found who expressed a justification for their use of either *Echinochloa colona* or *E. colonum*. The many others either held no opinion or gave none in their floristic writings. The three most detailed North American studies—Hitchcock 1920; Wiegand 1921; Gould et al. 1972—all used *colonum*, though only Hitchcock and Wiegand provided justification of the spelling. Two world-scale compilations of plant names (Uphof 1968; Mabberley 1996) pointed in opposite directions. Two comprehensive listings of plant names for temperate North America (Shetler & Skog 1978; Kartesz 1994) similarly differed in their spelling of the epithet. A recent and influential inventory of plants of economic importance worldwide (Wiersema & Leon 1999) chose *colona*.

A cursory survey of floristic authors addressing *Echinochloa* has shown that in the 20th century (and into the 21st) there is rough equivalence to the two positions; 36 have used *E. colona*, while 43 have used *E. colonum*.

Authors who have employed *Echinochloa colona*: Acevedo-Rodriguez (1996), Allen (1992), Balick, Nee and Atha (2000), Britton and Brown (1913), Clayton and Renvoize (1982, 1986), Clewell (1985), Dassanayake et al. (1994), Diggs et al. (1999), Duncan and Kartesz (1981), Gamble (1928), Gibbs Russell et al. (1991), Gould (1975), Green (1985), Hepper (1968), Hitchcock (1909), Howard (1979), Hutchinson and Dalziel (1936), Jones et al. (1997), Maire (1952), Michael (2003), Nasir and Ali (1982), Prain (1920), Robinson and Fernald (1908), Rozhevits and Shishkin (1934), Small (1903, 1933), Stace (1997), Stevens et al. (2001), Thulin (1995), Turner et al. (2003), Wagner et al. (1990), Watson and Dallwitz (1992), Wofford and Kral (1993), Wunderlin (1998), Zuloaga et al. (2003).

Authors who have employed *Echinochloa colonum*: Adams (1972), Backer (1968), Blomquist (1948), Bor (1960, 1968), Britton and Millspaugh (1920), Correll and Correll (1982), Correll and Johnston (1970), Davis (1985), Fernald (1950), Gleason (1952), Gleason and Cronquist (1963), Godfrey and Wooten (1979), Hall (1978), Hatch et al. (1990), Hitchcock (1913, 1920, 1931, 1935, 1936), Hitchcock and Chase (1917, 1951), Hodge (1954), Li et al. (1978), Maheshwari (1967), Proctor (1984), Pulle (1966), Radford et al. (1968), Rechinger (1964, 1971), Robyns and Tournay (1955), Saldanha and Nicolson (1976), Shouliang (1990), Srivastava (1976), Standley (1937), Steyermark (1963), Swallen (1955), Tackholm and Drar (1941), Terrell (1977), Tutin et al. (1980), Walker (1976), Wiggins (1980), Zangheri (1976).

But correct orthography, as in other more obvious niches of plant taxonomy, is not governed by popular vote, but by conformation to codified rules. Though rules are difficult to understand, sometimes treacherous to follow, they are the only path to consistent usage.

DISCUSSION

Orthography is "the art of spelling words according to accepted usage" (Random House 1979). In taxonomic parlance, "accepted usage" is defined by the rules of the International Code of Botanical Nomenclature (Greuter et al. 2000). In the present instance, the determination of whether *colona* or *colonum* is correct is decided by interpretation and application of Article 23, the Names of Species. It is critical to determine whether the word was first used as an adjective, or as a noun. Resolution of these alternatives requires that there be understanding of the origin of the word and its use in the naming of Jungle Rice.

Colonus was a term used in the late Roman Empire for a worker who was bonded to the farmland of a wealthy landowner; though technically not a slave, the worker was not free to seek employment elsewhere. (This practice later became the coerced labor of the middle-age feudal system.) The word *colonus* is a second declension Latin noun; it is masculine. It is often translated as "freeborn serf," or at times as "husbandman," a now-obsolete term surviving only as "animal husbandry," the care and raising of agricultural animals. Occasionally it is read as "farmer" or as "*colonist*," in recognition of the modern inapplicability of the original meaning.

Latin is a highly inflected language (Stearn 1983), that is, the ending of each word indicates the case, number, and gender. *Colonus* is the nominative singular, *colonum* the accusative singular, *coloni* the genitive singular, *colonorum* the genitive plural, etc. Were a Roman to observe, "The *colonus* kicks the horse" (or equus, also a second declension noun), he would say, "*Colonus equum calcitat.*" Were the horse to do the kicking, the expression would be, "*Equus colonum calcitat.*" If the horse kicks more than one person, "*Equus colonos calcitat.*"

In common practice the word *colonus* had no feminine ending, that is, there appears to have been no widely used *colona* in the Latin language (Lewis & Short 1879). That spelling appears to be recorded only twice in the ancient writings (by Ovid). Just as in "horse" (where "mare" indicates the female), the feminine gender most often would have been expressed by a separate word or disregarded entirely. Similarly, there cannot be a neuter *colonum* in the nominative; the structure of the language may appear to permit it, but the concept of a "neuter" worker would be without meaning.

Moreover, there is no adjective *colonus* (or *colona* or *colonum*) in the Latin language. It seems most improbable that "dictionaries of Linnaeus' time treated it as a declining adjective" (Michael 2003). Indeed, were *colonus* treated as an adjective, the word would be unintelligible when translated into English ("free-born serfish"?).

The statements by the six authors who gave reasons for their use either of *colona* or *colonum* need examination. All were brief, some cryptic, and some misleading or erroneous. The three who spoke for continued use of *colonum* (Hitchcock 1913; Wiegand 1921; Bor 1960) clearly understood the word to be a noun (the wording of Hitchcock and of Wiegand: "not an adjective"). They erred, perhaps, in that each seemed to assume his readers would properly interpret this fact to require retention of the original spelling. Two spoke of the word *colonum* being a contraction of *colonorum*; this remark is unneeded in that, while *colonorum* is available (the genitive plural of *colonus*), *colonum* is itself a perfectly good form (the accusative singular), thus requiring no "contraction."

Nieuwland, as quoted by Hitchcock (1913), raised a further detail, that "there appears to be no direct authority for the word *colonum*." There indeed seems to be no documented *colonum* in classical Latin (Lewis & Short 1879). Nieuwland's point may be that he believed proper taxonomic style calls for use only of Latin words known to be recorded in surviving Latin writings. Yet, once recognized as a second declension noun, the word *colonus* implies appropriate spellings in other number and case.

The three authors who spoke for changing the spelling to *colona* (Clayton 1968; Cope 1982; Michael 2003) are more difficult to understand. The claim that lexicographers "of Linnaeus' own time" accepted *colona* (Clayton, paraphrased by Cope and Michael) is made without documentation, and no such lexicographic treatment has been seen (the usage by Ovid perhaps excepted). Most significantly, all three state or indicate that they believe the word *colonus* may be treated as an adjective and thus altered in spelling to agree with the associated genus, perhaps without comprehending that such action must carry them outside the parameters of acceptable Latin.

Linnaeus did not employ the epithet elsewhere than in 1759. The word *colonus*, however spelled, appears to be found in post-Linnaean technical botanical literature only in application to the grass described by Linnaeus (Google, Nov 2003). There are thus no guiding examples of its use with other genera by other authors.

The pathway is indirect by which Linnaeus probably came to use this word for his epithet. The references he cited lack the word: *colonum* does not appear in the phrase-names accompanying the plates of Sloane (1707) nor Ehret (1748), nor in Sloane's (1696) more extensive text. But Sloane (1696)—though this publication was not cited by Linnaeus—referred to a still-earlier publication: Plukenet (1692). There, under a drawing that may be the first illustration of Jungle Rice, and accompanied by a phrase name (*Gramen paniceum minus, spica divulsa*) cited by Sloane, Plukenet noted his plant to be "*Pestis Coloni*," or "plague of the farmer." Plukenet's work was well known to Linnaeus, and it is most probable that this phrase (*Coloni*, here, in the genitive singular) was the inspiration for his selection of "*colonum*."

APPLICATION TO BOTANY

Classical Latin, of course, is not the same as botanical Latin (Stearn 1983). The use of Latin as an international language, a practice of the past 250 years, is relatively rigid, with many words given precise meanings unknown to the Roman writer or scholar. These meanings may originate, not with their classical use, but with the application to a botanical situation, as determined by the Recent author who needs a special term for a special structure.

If the term is employed, not just for descriptive purposes, but for a botanical name, the author's latitude is without limit. It is generally recognized that good style encourages an author to use a term or combination of terms, from Latin or Greek, that closely track classic usage. But, encouragement aside, there is no requirement in the Code (Greuter et al. 2000) that the word (or words) used in forming a name be appropriate, or that it be spelled correctly, or that it have any meaning whatsoever.

A provision of the Code (Art. 23.1; Greuter et al. 2000) would appear to restrict this latitude: "The name of a species is a binary combination consisting of the name of the genus followed by a single specific epithet in the form of an adjective, a noun in the genitive, or a word in apposition..." *Colonum*, though accusative, is used in apposition. But the near-simultaneous permission (Art. 23.2) that an epithet "may even be formed arbitrarily" does allow, by modern rules, deviation from strict nominative structure for a word used in apposition.

Thus Linnaeus, though writing far in advance of the modern rules, still falls within their parameters.

It was common practice for Linnaeus (1753, et seq.) to select as the epithet for his new name a word pre-existing in the medieval botanical literature. Many of these words, perhaps most, were adjectives. But others were nouns—known as substantives—and are carried over unchanged into modern botanical usage. Until the mid 20th century many authors indicated the substantive origin of epithets by retaining a capital letter at the beginning of each epithet so formed. Now, though capitalization of substantives is still permitted, the majority of authors de-capitalize epithets, giving uniformity to the structure of names, but obscuring the history and the original usage of the epithet.

Nouns used for epithets are treated differently from adjectives. Adjectives must agree (in case, number, and gender) with the genus to which they are attached, and this agreement is indicated by the requisite change in spelling. In contrast, the Code (Art. 23.5; Greuter et al. 2000) mandates that a noun retains its own gender and ending irrespective of the gender of the generic name.

An example lies near at hand, of a noun used as an epithet and transferred, without change in spelling, to a genus of another gender. Linnaeus (1753) also described and named the plant now commonly known as Barnyard-grass; he termed it *Panicum Crusgalli*. ("Crusgalli" is literally translated as "chicken's leg," but is usually interpreted to mean "cock's-spur.") When transferred to *Echinochloa* by Beauvois, it became *E. crusgalli* (in modern, preferred usage). Though Linnaeus did not indicate the source of this epithet, his use of a capital initial letter designated it as a substantive. No subsequent author has attempted to treat it as an adjective and adjust the original spelling so as to agree with the gender of the new genus.

Linnaeus' *Panicum colonum* was received differently. In the masculine genus *Oplismenus*, Kunth (1816) recorded it as *O. colonus*. In the feminine genus *Echinochloa*, Link (1833) stated it to be *E. colona*. The arguments so weakly presented for treating *colonum* as an adjective would perhaps have been strengthened had their proponents noted that the originators of these segregate genera had done so also. Had Clayton (1968) referred to botanists rather than lexicographers, he would have been accurate in his observation that "adjectival use was acceptable to those of Linnaeus' own time."

The judgments of Kunth and of Link, however, are still just judgments of later authors, no different from those of the many still later authors who chose *E. colona*. Only the action by the original author, Linnaeus, could potentially carry decisive weight.

It is unknown why Linnaeus (1759) chose "*colonum*" as the spelling of the epithet for his new species. He was, of course, assigning the new entity to the genus *Panicum*, a genus he had formed earlier (1753) and which he had treated as neuter (as indicated both by the ending of the word (*-um*) and by the ending of adjectival epithets he placed thereunder). Since Linnaeus both wrote and spoke Latin (Stafleu 1971:83), he cannot be thought of as making a beginner's error, that is, he would have known full well that the nominative was *colonus* and that the word, carried into botanical usage, would normally retain its nominative spelling unchanged. Too, if he obtained his epithet from the brief usage by Plukenet (1692), he knew the word to be a noun. Yet his use of lower case for the initial letter of *colonum* indicates he thought of the word as formed differently from other substantives.

Two alternatives are offered. Perhaps Linnaeus did understand the word to be a noun and chose the accusative, or *colonum*, for reasons of euphony, for smooth combination with its assigned genus *Panicum*. Or perhaps Linnaeus chose to disregard its meaning as a noun and saw it only as a sequence of letters which could be treated as an adjective and declined to agree with its genus.

CONCLUSION

The second of these possibilities is untenable. One cannot break away from the certainty that Linnaeus would have recognized the word was a noun and must have intentionally chosen the accusative, *colonum*, so that it would follow smoothly his genus *Panicum*. His choice of *colonum* is within the practices of the 18th century and the language of the modern Code. His preference for the harmonious *colonum* rather than the discordant *colonus* in no way negates its status as a noun. His decapitalization of the initial letter is stylistic and immaterial. No argument seems convincing that Linnaeus thought of the word as an adjective. Though Linnaeus, by creating the new name, had the option of selecting for its epithet whatever word he wished, his choice of a word that is a noun removes the power of later authors to treat it as an adjective. As a noun whose spelling is unchanged in whatever genus it may be placed, the name formed by Link in 1833 must be read as *Echinochloa colonum*.

ACKNOWLEDGMENTS

I thank J. Richard Abbott (FLAS), Mary Barkworth (UTC), William J. Dress (BH), Mark A. Garland (PIHG), Walter S. Judd (FLAS), and Dan H. Nicolson (US) for their useful and important comments and suggestions, Christine M. Housel (ABT) for the Hispanicized abstract, and Emily W. Wood and colleagues (GH) for access to critical pre-Linnaean publications.

REFERENCES

Acevedo-Rodríguez, P. 1996. Flora of St. John, U.S. Virgin Islands. New York Botanical Garden, New York. [522–*E. colona*]

Adams, C.D. 1972. Flowering plants of Jamaica. Univ. of the West Indies, Mona. [186–*E. colonum*]

ALLEN, C.M. 1992. Grasses of Louisiana, 2nd ed. Cajun Prairie Habitat Pres. Soc., Eunice. [98: *E. colona*]

BACKER, C.A. 1968. Flora of Java. Groningen, Netherlands. [3:556–*E. colonum*]

BALICK, M.J., M.H. NEE, and D.E. ATHA. 2000. Checklist of the vascular plants of Belize. New York Botanical Garden Press, New York. [187–*E. colona*]

BEAUVOIS, P. 1812. Essai d'une Nouvelle Agrostographie 53, 161.

BLOMQUIST, H.L. 1948. The grasses of North Carolina. Duke Univ. Press, Durham. [185–*E. colonum*]

BOR, N.L. 1960. Grasses of India, Burma and Ceylon. Pergamon Press, London. [308–*E. colonum*]

BOR, N.L. 1968. Flora of Iraq. Ministry of Agric., Baghdad. [9:479–*E. colonum*]

BRITTON, N.L. and A. BROWN. 1898. Illustrated flora of the northern United States, Canada and the British Possessions, 1st ed. Grasses: G.V. Nash. New York Botanical Garden, New York. [3:496–*Panicum colonum*]

BRITTON, N.L. and A. BROWN. 1913. Illustrated flora of the northern United States, Canada and the British Possessions, 2nd ed. Grasses: G. V. Nash. New York Botanical Garden, New York. [1:134–*E. colona*]

BRITTON, N.L. and C.F. MILLSPAUGH. 1920. The Bahama flora. New York. [26–*E. colonum*]

CHAPMAN, A.W. 1897. Flora of the southern United States, 3rd ed. Cambridge Botanical Supply, Cambridge, Mass. [587–*Panicum colonum*]

CLAYTON, W.D. and S.A. RENVOIZE. 1982. Flora of tropical East Africa: Gramineae. Royal Botanical Garden, Kew. [557–559–*E. colona*]

CLAYTON, W.D. and S.A. RENVOIZE. 1986. Genera graminum: Grasses of the World. Royal Botanical Garden, Kew. [289–*E. colona*]

CLEWELL, A.F. 1985. Guide to the vascular plants of the Florida panhandle. Florida State Univ. Press, Tallahassee. [139–*E. colona*]

COOKE, T. 1908. Flora of the Presidency of Bombay. Taylor and Francis, London. [931–*Panicum colonum*]

CORRELL, D.S. and H.B. CORRELL. 1982. Flora of the Bahama Archipelago. Cramer, Vaduz, Germany. [132–*E. colonum*]

CORRELL, D.S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner. [183–*E. colonum*]

DASSANAYAKE, M.D., F.R. FOSBERG, and W.D. CLAYTON. 1994. Flora of Ceylon. Amerind Publ. Co., New Delhi. [8:181–*E. colona*]

DAVIS, P.A. 1985. Flora of Turkey. Univ. Press, Edinburg. [9:145–*E. colonum*]

DIGGS, G.M., B.L. LIPSCOMB, and R.J. O'KENNON. 1999. Shinners & Mahler's illustrated flora of north central Texas. Botanical Research Inst. of Texas, Fort Worth. [1266–*E. colona*]

DUNCAN, W.H. and J.T. KARTESZ. 1981. Vascular flora of Georgia. Univ. of Georgia Press, Athens. [15–*E. colona*]

EHRET, G.D. 1748. Plantae et Papiliones Rariones. Heidelberg, Germany. [t. 3, f. 3]

FERNALD, M.L. 1950. Gray's Manual of Botany, 8th ed. American Book Co., New York. [223–*E. colonum*]

GAMBLE, J.S. 1928. Flora of the Presidency of Madras. Adlard and Son, London. [3:1776–*E. colona*]

GIBBS RUSSELL, G.E., L. WATSON, M. KOEKEMOER, L. SMOOK, N.P. BARKER, H.M. ANDERSON, and M.J. DALLWITZ. 1991. Grasses of southern Africa. National Botanic Garden, Pretoria. [119–*E. colona*]

GLEASON, H.A. 1952. Illustrated flora of the northeastern United States and Canada. Lancaster Press, Lancaster, Pennsylvania. [1:233–*E. colonum*]

GLEASON, H.A. and A. CRONQUIST. 1963. Manual of vascular plants of northeastern United States and adjacent Canada. Van Nostrand Co., Princeton, New Jersey. [114–*E. colonum*]

GODFREY, R.K. and J.W. WOOTEN. 1979. Aquatic and wetland plants of the southeastern United States. Univ. of Georgia Press, Athens. [1:155–*E. colonum*]

GOULD, F.W. 1975. The grasses of Texas. Texas A. & M. Univ. Press, College Station. [538–*E. colona*]

GOULD, F.W., M.A. ALI, and D.E. FAIRBROTHERS. 1972. A revision of *Echinochloa* in the United States. Amer. Midland Naturalist 87:36–59. [56–*E. colonum*]

GREEN, J.W. 1985. Census of the vascular plants of western Australia, 2nd ed. Dept. of Agric., Perth. [32–*E. colona*]

GREUTER, W., J. MCNEILL, F.R. BARRIE, H.M. BURDET, V. DEMOULIN, T.S. FILIGUIERAS, D.H. NICOLSON, P.C. SILVA, J.E. SCOG, P. TREHANE, and N.J. TURLAND. 2000. International code of botanical nomenclature. Saint Louis Code. Koeltz, Germany.

GRISEBACH, A.H.R. 1864. Flora of the British West Indian Islands. Reeve & Co., London. [545–*Panicum colonum*]

HALL, D.W. 1978. The grasses of Florida. Univ. of Florida, Ph. D. diss. Gainesville. [338–*E. colonum*]

HATCH, S.L., K.N. GANDHI, and L.E. BROWN. 1990. Checklist of the vascular plants of Texas. Texas Agric. Experiment Station, College Station. [183–*E. colonum*]

HEPPER, F.N. 1968. Flora of West Tropical Africa, 2nd ed. Grasses: W.D. Clayton. Crown Agents, London. [3:439–440–*E. colona*]

HITCHCOCK, A.S. 1909. Catalogue of the grasses of Cuba. Contr. U. S. Nat. Herb. 12:183–258. [213–*E. colona*]

HITCHCOCK, A.S. 1913. Mexican grasses in the United States National Herbarium. Contr. U. S. Nat. Herb. 17:181–389. [256–257–*E. colonum*]

HITCHCOCK, A.S. 1920. The North American species of *Echinochloa*. Contr. U. S. Nat. Herb. 22:133–153. [150–*E. colonum*]

HITCHCOCK, A.S. 1931. North American Flora. New York Botanical Garden, New York. [17(4):311–*E. colonum*]

HITCHCOCK, A.S. 1935. Manual of the grasses of the United States, 1st ed. U. S. Dept. Agric., Washington. [692–*E. colonum*]

HITCHCOCK, A.S. 1936. The genera of the grasses of the United States. U. S. Dept. Agric. Bull. 772. [247–*E. colonum*]

HITCHCOCK, A.S. and A. CHASE. 1917. Grasses of the West Indies. Contr. U. S. Nat. Herb. 18:261–471. [345–*E. colonum*]

Hitchcock, A.S. and A. Chase. 1951. Manual of the grasses of the United States, 2nd ed. U. S. Dept. Agric., Washington. [711–*E. colonum*]

Hodge, W.H. 1954. Flora of Dominica, B.W.I. Lloydia 17:1–238. [1:131–*E. colonum*]

Hooker, J.D. 1897. Flora of British India. Reeve & Co., London. [7:32–*Panicum colonum*]

Howard, R.A. 1979. Flora of the Lesser Antilles. Grasses: F. W. Gould. Arnold Arboretum, Jamaica Plain, Mass. [3:125–*E. colona*]

Hutchinson, J. and J.M. Dalziel. 1936. Flora of West Tropical Africa, 1st ed. Crown Agents, London. [2:558–*E. colona*]

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas. Univ. of Texas Press, Austin. [243–*E. colona*]

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora, 2nd ed. Timber Press, Portland, Oregon. [438–*E. colona*]

Kunth, C.S. 1816. Nova genera et species plantarum. [1:108–*Oplismenus colonus*]

Lewis, C.T. and C. Short. 1879. A Latin dictionary. Clarendon Press, Oxford.

Li, H., T. Liu, T. Huang, T. Koyama, and C.E. DeVol. 1978. Flora of Taiwan. Grasses: C. Hsu. Epoch Publ. Co., Taipei. [5:552–*E. colonum*]

Link, J.H.F. 1833. Hortus Regius Botanicus Berolinensis. Berlin. [2:209–*E. colona*]

Linnaeus, C. 1753. Species plantarum. Stockholm.

Linnaeus, C. 1759. Systema naturae, 10th ed. Stockholm. [2:870–*Panicum colonum*]

Mabberley, D.J. 1996. The plant–book, 2nd ed. Cambridge. [248–*E. colona*]

Maheshwari, P. 1967. The flora of Delhi. Gossain & Co., Calcutta. [393–*E. colonum*]

Maire, D.R. 1952. Flore de l'Afrique du Nord. Lechevalier, Paris. [1:311–*E. colona*]

Merrill, E.D. 1923. Enumeration of Philippine plants. Dept. of Agriculture and Natural Resources, Manila. [1:62–*Panicum colonum*]

Michael, P.W. 2003. Flora of North America. Oxford Univ. Press, New York. [25:398–400–*E. colona*]

Mohr, C. 1901. Plant life of Alabama. U. S. Dept. Agric., Washington. [358–*Panicum colonum*]

Nasir, E. and S.I. Ali. 1982. Flora of Pakistan, no. 143. Grasses: T. A. Cope. Islamabad. [196–197–*E. colona*].

Plukenet, L. 1692. Phytographia. Londini. [tab. 189, fig. 5]

Prain, D. 1920. Flora of tropical Africa. Grasses: O. Stapf. Reeve & Co., London. [9:607–*E. colona*]

Proctor, G.R. 1984. Flora of the Cayman Islands. Royal Botanic Garden, Kew. [190–191–*E. colonum*].

Pulle, A. 1966. Flora of Surinam. Netherlands. [1(1):409–*E. colonum*]

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. Grasses: A. E. Radford. Univ. of North Carolina Press, Chapel Hill. [132–*E. colonum*]

Rechinger, K.H. 1964. Flora of lowland Iraq. Grasses: N. L. Bor. Cramer, Weinheim, Germany. [51–*E. colonum*]

Rechinger, K.H. 1971. Flora Iranica. Grasses: N. L. Bor. Akademische Druck, Graz, Austria. [70:479–*E. colonum*]

Robinson, B.L. and M.L. Fernald. 1908. Gray's New Manual of Botany, a handbook of the flowering plants and ferns, 7th ed. Grasses: A. S. Hitchcock. American Book Co., New York. [118–*E. colona*]

ROBYNS, W. and R. TOURNAY. 1955. Flore des Spermatophytes du Parc National Albert. Institut des Parcs Nationaux du Congo Belge, Bruxelles. [3:92–*E. colonum*]

ROZHEVITS, R.Y. and B.K. SHISHKIN. 1934. Flora of the U.S.S.R. National Science Foundation, Washington. [2:33–*E. colona*]

SALDANHA, C.J. and D.H. NICOLSON. 1976. Flora of Hassan District, Karnataka, India. Amerind Publ. Co., New Delhi. [726–*E. colonum*]

SAVAGE, S. 1945. A catalogue of the Linnaean Herbarium. London.

SHETLER, S.G. and L.E. SKOG. 1978. A provisional checklist of species for Flora North America (revised). Missouri Botanical Garden, St. Louis. [163–*E. colonum*]

SHOULIANG, C. 1990. Flora Republicae Popularic Sinicae. Science Press. [10(1):252–*E. colonum*]

SLOANE, H. 1696. Catalogus plantarum quae in Insula Jamaica. Londini. [p. 30]

SLOANE, H. 1707. A voyage to the Islands Madera, Barbados, Nieves, S. Christophers and Jamaica. London. [t. 64, f. 3]

SMALL, J.K. 1903. Flora of the southeastern United States, 1st ed. Grasses: G. V. Nash. New York. [84–*E. colona*]

SMALL, J.K. 1933. Manual of the southeastern flora. Grasses: A. S. Hitchcock. New York. [83–*E. colona*]

SRIVASTAVA, T.N. 1976. Flora of Gorakhpurensis. Today and Tomorrow, New Delhi. [363–*E. colonum*]

STACE, C. 1997. New flora of the British Isles, 2nd ed. Cambridge Univ. Press, Cambridge. [911–*E. colona*]

STAFLEU, F.A. 1971. Linnaeus and the Linnaeans. Utrecht, Netherlands.

STANDLEY, P.C. 1937. Flora of Costa Rica. Field Museum of Natural History, Chicago. [18:75–*E. colonum*]

STEARN, W.T. 1957. An introduction to the Species Plantarum and cognate botanical works of Carl Linnaeus. Bartholomew Press, Great Britain.

STEARN, W.T. 1983. Botanical Latin, 3rd ed. David & Charles, London.

STEVENS, W.D., C. ULLOA, and A. MONTEIL. 2001. Grasses: R.W. Pohl and G. Davidse. Flora of Nicaragua. Missouri Botanical Garden Press, St. Louis. [3:2034–*E. colona*]

STEYERMARK, J.A. 1963. Flora of Missouri. Iowa State Univ. Press, Ames. [233–*E. colonum*]

SWALLEN, J.R. 1955. Flora of Guatemala. Field Museum of Natural History, Chicago. [2:112–*E. colonum*]

TACKHOLM, V. and M. DRAR. 1941. Flora of Egypt. Fouad Univ., Cairo. [1:446–*E. colonum*]

Terrell, E.E. 1977. A checklist of names for 3,000 vascular plants of economic importance. U. S. Dept. Agric. handbook 505. Washington. [47–*E. colonum*]

THULIN, M. 1995. Flora of Somalia. Grasses: T. A. Cope. Royal Botanic Gardens, Kew. [4:223–*E. colona*]

TURNER, B.L., H. NICHOLS, G. DENNY, and O. DORON. 2003. Atlas of the vascular plants of Texas. Botanical Research Inst. of Texas, Fort Worth. [805–*E. colona*]

Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.V. Valentine, S.M. Walters, and D.A. Webb. 1980. Flora Europaea. Cambridge Univ. Press, Cambridge. [5:262–*E. colonum*]

Uphof, J.C.T. 1968. Dictionary of economic plants, 2nd ed. Cramer, New York. [193–*E. colonum*]

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawaii. Grasses: P. J. O'Connor. Univ. of Hawaii Press, Oahu. [2:1535–*E. colona*]

Walker, E.H. 1976. Flora of Okinawa and the Southern Ryuku Islands. Smithsonian Institution Press, Washington. [211–*E. colonum*]

Watson, L. and M.J. Dallwitz. 1992. The grass genera of the world. C. A. B. International, Cambridge. [341–*E. colona*]

Wiegand, K.M. 1921. The genus *Echinochloa* in North America. Rhodora 23:49–65. [53–*E. colonum*]

Wiersema, J.H. and B. Leon. 1999. World economic plants: A standard reference. CRC Press, Boca Raton, Florida. [195–*E. colona*]

Wiggins, I.L. 1980. Flora of Baja California. Stanford Univ. Press, Stanford. [942–*E. colonum*]

Wofford, B.E. and R. Kral. 1993. Checklist of the vascular plants of Tennessee. Botanical Research Inst. of Texas, Fort Worth. [19–*E. colona*]

Wunderlin, R.P. 1998. Guide to the vascular plants of Florida. Univ. Press of Florida, Gainesville. [106–*E. colona*]

Zangheri, P. 1976. Flora Italica. Grasses: A. B. Cattarini. Padova, Milan. [1:910–*E. colonum*]

Zuloaga, F.O., O. Morrone, G. Davidse, T.S. Filgueiras, P.M. Peterson, R.J. Soreng, and E. Judziewicz. 2003. Catalogue of New World grasses. Smithsonian Inst., Washington. [3:215–*E. colona*]

BOOK NOTICE

Neal K. van Alfen, George Bruening, and William O. Dawson (eds). 2005. **Annual Review of Phytopathology: Volume 43, 2005.** (ISBN 0-8243-1343-7, hbk; ISSN 0066-4286). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $183.00 (U.S.A.), $188.00 (Int'l.), 694 pp., 7 1/2" × 9".

Contents of Volume 43 of *Annual Review of Phytopathology*:

ICBN CLARIFICATION NEEDED: USE OF RANKS

Guy L. Nesom and Barney Lipscomb

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.

ABSTRACT

The current (2000) International Code of Botanical Nomenclature is open to divergent interpretation regarding the use of ranks. Article 4.1 outlines secondary ranks to be used between the principal ranks of family and species and below species. Article 4.2 states that ranks prefixed by "sub-" (termed here as "tertiary" rank, immediately subsidiary in sequence and relative order to principal or secondary ranks) are used to increase the number of ranks to a "greater number" than formed in 4.1. Some taxonomists, in contrast, apparently interpret these Articles such that tertiary ranks may be used without reference to secondary ranks (e.g., subgenus in a genus without sections or series; subspecies in species without varieties or forms). Alternate formulations are offered for Articles 4 and 5 that may more clearly express the intent of the Code: Formulation 1 if the intent is to mandate that tertiary ranks between family and species, and below species, be used only in conjunction with secondary ranks; Formulation 2 if the intent is that tertiary ranks may be used without reference to secondary ranks.

RESUMEN

El actual Código Internacional de Nomenclatura Botanica (2000) está abierto a interpretaciones diversas respecto al uso de los rangos. El Artículo 4.1 esboza los rangos secundarios para usar entre los rangos principales de familia y especie, y especie e inferiores. El Artículo 4.2 establece que los rangos con el prefijo "sub-" (llamados aquí rango "terciario", inmediatamente siguientes en secuencia y orden relativo a los rangos principales o secundarios) se usan para incrementar el número de rangos a un "numero más grande" que los formados en 4.1. Algunos taxónomos, por el contrario, interpretan aparentemente estos Artículos de modo que los rangos terciarios pueden usarse sin referencia a los rangos secundarios (ej. subgénero en un género sin secciones o series; subespecies en especies sin variedades o formas). Se ofrecen formulaciones alternativas para los Artículos 4 y 5 que pueden expresar más claramente la intención del Código: Formulación 1 si la intención es de exigir que los rangos terciarios entre familia y especie, y por debajo de especie, se usen sólo en conjunción con rangos secundarios; Formulación 2 si la intención es que los rangos terciarios puedan usarse sin referencia a los rangos secundarios.

The Articles of the International Code of Botanical Nomenclature (Greuter et al. 2000, the "Saint Louis Code") are "mandatory" rules (Preface, p. vii), and they are generally carefully and rigorously followed by taxonomic botanists. Such nomenclatural prescriptions are intended to provide a stable method of naming and to avoid creation of superfluous names. Valid publication must be in accordance with the Articles.

The 2000 Code is open to divergent interpretation regarding the use of ranks and associated implications for valid nomenclatural practice. As Articles 4.1 and 4.2 are written, ranks in 4.2 (i.e., ranks in addition to those in 3.1 and 4.1) are used in a classification after associated ranks in 3.1 and 4.1 are used, i.e., rank subgenus is used in a genus after there are named sections and/or series in the classification; similarly, rank subspecies is used in a species in which varieties and/or forms already are in use. Current practice, however, is inconsistent regarding which ranks must be used and which ranks are optional. We place the following observations and suggestions on record with the hope that they may lead to clarification of this part of the Code.

Rules pertaining to sequence and relative order of ranks are found primarily in Articles 3, 4, and 5. A closely related pair of these rules—Articles 4.1 and 4.2—is the focal point of apparent ambiguity.

Article 4.1. "*The secondary ranks of taxa in descending sequence are tribe (tribus) between family and genus, section (sectio) and series (series) between genus and species, and variety (varietas) and form (forma) below species.*"

Article 4.2. "*If a greater number of ranks of taxa is desired, the terms for these are made by adding the prefix sub- to the terms denoting the principal or secondary ranks. A plant may thus be assigned to taxa of the following ranks (in descending sequence): regnum,* **sub***regnum, divisio or phylum,* **sub***divisio or* **sub***phylum, classis,* **sub***classis, ordo,* **sub***ordo, familia,* **sub***familia, tribus,* **sub***tribus, genus,* **sub***genus, sectio,* **sub***sectio, series,* **sub***series, species,* **sub***species, varietas,* **sub***varietas, forma,* **sub***forma.*" [bold added]

Article 4.1 outlines secondary ranks to be used below principal ranks. Article 4.2 states that ranks prefixed by "sub" and immediately subsidiary in sequence to principal or secondary ranks are used to increase the number of ranks (presumably for a "greater number" than formed in 4.1).

Recommendation 26A.2 appears to be consistent with the intent of the ICBN in using the "sub" ranks in conjunction with ranks provided in 3.1 and 4.1:

Recommendation 26A.2 "*A subspecies not including the type of the correct name of the species should, where there is no obstacle under the rules, be given a name with the same final epithet and type as a name of one of its subordinate varieties.*"

Article 3 specifies the principal ranks "in descending sequence" as kingdom, division or phylum, class, order, family, genus, and species. Articles 4.1 and 4.2 deal with secondary ranks (4.1) and "tertiary ranks" (4.2—those prefixed by "sub;" although the phrase "tertiary rank" is not used by the ICBN, it is a useful one and apparently consistent with the intent of the Code). Article 5.1 emphatically fixes the relative order of ranks.

Article 5.1. "*The relative order of the ranks specified in Art. 3 and 4 must not be altered (see Art. 33.7 and 33.8).*"

Examples in clarification in 33.7 indicate that

1) principal ranks must be assigned in relative order (e.g., species may not contain genera);

2) secondary ranks must be used within the principal rank to which they are subsidiary (e.g., section must be used within the rank of genus); and
3) a secondary rank can be subsidiary only to a secondary rank earlier in relative order (e.g., forms cannot be divided into varieties).

Based on the 4.2 sequence and relative order of ranks, although not explicitly given in example by the Code, varieties cannot be divided into subspecies. Varieties can be clustered within subspecies rank.

Changes instituted in the 1994 Code
The structure of Articles 4.1 and 4.2 in the 2000 (Saint Louis) Code was first instituted in the 1994 ("Tokyo") Code (Greuter et al. 1994), which divided Article 4.1 of the 1988 Code (Greuter et al. 1988) into two parts (4.1 and 4.2). The newly structured Articles 4.1 and 4.2 remained unchanged in the 2000 Code and were not suggested for modification by the Vienna botanical congress for the forthcoming 2006 Code (Fred Barrie, pers. comm.). The 1988 Code has the following:

Article 3.1. "The principal ranks of taxa in ascending sequence are: species (*species*), genus (*genus*), family (*familia*), order (*ordo*), class (*classis*), division (*divisio*), and kingdom (*regnum*). Thus, except for some fossil plants (see Art. 3.2), each species is assignable to a genus, each genus to a family, etc."

Article 4.1. "If a greater number of ranks of taxa is required, the terms for these are made either by adding the prefix *sub-* to the terms denoting the ranks or by the introduction of supplementary terms. A plant may thus by assigned to taxa of the following ranks (in descending sequence): *regnum, subregnum, divisio, subdivisio, classis, subclassis, ordo, subordo, familia, subfamilia, tribus, subtribus, genus, subgenus, sectio, subsectio, series, subseries, species, subspecies, varietas, subvarietas, forma, subforma*."

No distinction in the 1988 Code was made among ranks below principal ranks. The phrase "secondary ranks" (referred to in the 1988 Code as "supplementary terms") was first introduced in the 1994 Code. The two proposals for change relating to 1988 Article 4.1 (Silva 1993; Greuter & McNeill 1993) were rejected by general vote (McNeill 1993) but were referred to the Editorial Committee, which adopted them in slightly modified form (Greuter, McNeill, & Barrie 1993).

In the original proposal by Silva for modification of Article 4.1 (1993, p. 186), identification of secondary ranks was done with the intention, at least in part, that "proliferation of ranks by use of a prefix should be restricted to ... principal and secondary ranks." In discussion of the proposals at the nomenclature sessions (prior to the Editorial Committee meeting), Rapporteur-général Greuter noted the following, regarding what was to become Article 4.2: "What Silva had attempted, and perhaps partly achieved, was to bring a coherent logic into the hierarchy of ranks—where hierarchy meant, not the taxonomic hierarchy but a classification of ranks by their importance" (Greuter et al. 1993, p. 40).

Difference in Interpretation of the 2000 Code

The wording of Articles 4.1 and 4.2 in the 2000 Code directly implies that tertiary ranks are used between family and genus, between genus and species, and below species (secondary ranks are available in each area) only after use of an immediately preceding secondary rank (in descending sequence). Between kingdom and family (where secondary ranks do not exist), tertiary ranks immediately follow principal ranks. None of the Code notes or examples pertinent to 4.1, 4.2, or 5.1 (and 33.7 or 33.8, as pointed to by 5.1), however, provides explicit clarification regarding this. In alternative interpretation and in practice, and apparently contrary to the 2000 Code, subfamilies are used in a classification without use of tribes, subgenera without sections, and subspecies without varieties.

This difference in interpretation may exist because of a disparity between Articles 4.1 and 4.2: **tertiary ranks precede the secondary ranks in "relative order" and "descending sequence" but because tertiary ranks are used to increase the number of ranks beyond those provided by secondary ranks, secondary ranks precede tertiary ranks in order of use**. If the Code does not intend to mandate this order of use in ranks, then the separation of 4.1 from 4.2, coupled with the wording of 4.2 ("If a greater number of ranks of taxa is desired"), is stated incorrectly or at least is misleading.

Alternate formulations for clarification

In clarification of the problem discussed here, modifications of the 2000 (Saint Louis) Code are suggested. Two alternate formulations provide a contrast between what appear to be different interpretations of the Code. Article 3.1 (unmodified from the 2000 code) is included within both alternatives.

If modifications are necessary for the 2012 ICBN in regard to points considered here, a formal proposal in Taxon will be required. Because of the expanse of time between now and the next Code version, because we are not taking a position of advocacy, and because what the Editorial Committee intended in 1993 is not clear to us, we offer this commentary as a beginning point of discussion.

FORMULATION 1

If the intent of Articles 4 and 5 is to mandate that tertiary ranks be used only in conjunction with secondary ranks between family and genus, between genus and species, and below species, then we suggest that the following better express the intent of the Code.

Article 3.1 (unmodified from 2000 code). The principal ranks of taxa in descending sequence are: kingdom (regnum), division or phylum (divisio, phylum), class (classis), order (ordo), family (familia), genus (genus), and species (species). Thus, each species is assignable to a genus, each genus to a family, etc.

Article 4.1. A plant may be assigned to taxa of the following ranks (in descending sequence): regnum, subregnum, divisio or phylum, subdivisio or subphylum, classis, subclassis, ordo, subordo, familia, subfamilia, tribus, subtribus, genus, subgenus, sectio, subsectio, series, subseries, species, subspecies, varietas, subvarietas, forma, subforma.

Article 4.2. Secondary ranks of taxa are tribe (tribus) between family and genus, section (sectio) and series (series) between genus and species, and variety (varietas) and form (forma) below species. Terms for tertiary ranks of taxa are made by adding the prefix "sub-" to the terms denoting the principal and/or secondary ranks. Tertiary ranks are added if a greater number of ranks of taxa (beyond secondary ranks) is desired.

Article 4.3. Further ranks may also be intercalated or added if a greater number of ranks of taxa (beyond tertiary ranks) is desired, provided that confusion or error is not thereby introduced.

Article 5.1. The relative order of the ranks specified in Arts. 3 and 4 must not be altered (see Art. 33.7 [*the examples following 33.7 would be better placed here*] and 33.8). The sequence of use of ranks between the principal ranks family and species and below species is secondary (in descending sequence), then tertiary. Tertiary ranks follow the principal and/or secondary ranks from which they are derived. Any of the tertiary ranks may be omitted without altering the relative order; the secondary ranks series and forma may be omitted without altering the relative order.

Note a.—Use of the rank of tribe precedes use of subfamily; use of the rank of section precedes use of subgenus or series; use of the rank of variety precedes use of subspecies or form.

Note b.—A genus may be included in a family without reference to a tribe or to a subfamily (omission of one or both of the ranks between genus and family does not affect the relative order of ranks).

If Formulation 1 were adopted, a date might be set beyond which the rules would apply—in order to avoid chaotic invalidity of names at tertiary rank. Or, proposal of a name at tertiary rank prior to an appropriate name at secondary rank might be set to automatically establish the secondary rank.

Formulation 2

If the intent of Articles 4 and 5 is that tertiary ranks may be used without reference to secondary ranks, then we suggest that the following better express the intent of the Code. This formulation returns to the less restrictive nature of the 1988 Code, in which no distinction in use was made between secondary and tertiary ranks (as they are termed here). Here, there is no problem with subspecies as sole infraspecific rank within a classification or with subgenus as sole subdivision of a genus.

Article 3.1 (unmodified from 2000 code). The principal ranks of taxa in descending sequence are: kingdom (regnum), division or phylum (divisio, phylum), class (classis), order (ordo), family (familia), genus (genus), and species (species). Thus, each species is assignable to a genus, each genus to a family, etc.

Article 4.1 (same as in FORMULATION 1). A plant may be assigned to taxa of the following ranks (in descending sequence): regnum, subregnum, divisio or phylum, subdivisio or subphylum, classis, subclassis, ordo, subordo, familia, subfamilia, tribus, subtribus, genus, subgenus, sectio, subsectio, series, subseries, species, subspecies, varietas, subvarietas, forma, subforma.

Article 4.2. Secondary ranks of taxa are tribe (tribus) between family and genus, section (sectio) and series (series) between genus and species, and variety (varietas) and form (forma) below species. Terms for tertiary ranks of taxa are made by adding the prefix "sub-" to the terms denoting the principal and/or secondary ranks.

Article 4.3 (same as in FORMULATION 1). Further ranks may also be intercalated or added if a greater number of ranks of taxa (beyond tertiary ranks) is desired, provided that confusion or error is not thereby introduced.

Article 5.1. The relative order of the ranks specified in Art. 3 and 4 must not be altered (see Art. 33.7 [*the examples following 33.7 would be better placed here*] and 33.8). Any of the secondary or tertiary ranks may be omitted without altering the relative order, but use of tertiary ranks must follow the principal or secondary ranks from which they are derived.

Note a.—A genus may be included in a family without reference to a tribe or to a subfamily (omission of one or both of the ranks between genus and family does not affect the relative order of ranks); then rank of subgenus may be used within a genus without reference to sections; the rank of subspecies may be used within a species without reference to varieties.

Ranks of Taxa in Relation to Biology

The rank of subspecies sometimes is said to apply to a taxon more "species-like" than a variety and for this reason should precede "variety" in relative order of rank. Infraspecific population systems, however, like species themselves, vary continuously in degree of differentiation and reproductive isolation, and if varieties and subspecies both are treated as morpho-geographic taxa, then a biological distinction between the two ranks is arbitrary. We agree with Fred Barrie (pers. comm.) that the ICBN "legislates the names and relative order of ranks, not the taxonomic concepts attached to a given rank nor the [biological] conditions under which it is appropriate to use one over another." The discussion here of the ICBN structure and intent are detached from considerations of the importance or biological significance of ranks.

ACKNOWLEDGMENTS

Preparation of this discussion was precipitated by Ken Chambers, who brought to our attention another Code issue (included in an early version of the manuscript)—that issue is less complex and apparently will be resolved by the ICBN Editorial Committee before publication of the Vienna Code. We appreciate the comments of Tom Lammers, Gerry Moore, Rich Rabeler, Dick Wunderlin, and especially those of Fred Barrie (early manuscript version) and John Strother, which considerably sharpened the clarity of concepts and presentation.

REFERENCES

Greuter, W. et al. (eds.). 1988. International code of botanical nomenclature. Regnum Veg. 118. Koeltz Scientific Books, Königstein, Germany.

Greuter, W. et al. (eds.). 1994. International code of botanical nomenclature (Tokyo Code). Regnum Veg. 131. Koeltz Scientific Books, Königstein, Germany.

Greuter, W. et al. (eds.). 2000. International code of botanical nomenclature (Saint Louis Code). Regnum Veg. 138. Koeltz Scientific Books, Königstein, Germany.

Greuter, W. and J. McNeill. 1993. Synopsis of proposals on botanical nomenclature—Tokyo 1993. A review of the proposals concerning the International Code of Botanical Nomenclature submitted to the XV International Botanical Congress. Taxon 42: 191–271.

Greuter, W., J. McNeill, and F.R. Barrie. 1993. Report on botanical nomenclature—Yokohama 1993. Englera 14:1–265.

McNeill, J. 1993. Preliminary mail vote and report of Congress action on nomenclatural proposals. Taxon 42:907–922.

Silva, P.C. 1993. (290–320) Thirty-one proposals mainly concerning editorial matters. Taxon 42:185–190.

BOOK NOTICES

Elizabeth Losos and Egbert Giles Leigh, Jr. (eds.). 2004. **Tropical Forest Diversity and Dynamism: Findings from a Large-Scale Plot Network.** (ISBN 0-226-49346-6, pbk.). The University of Chicago Press, 1427 E. 60th Street, Chicago, IL 60637, U.S.A. (**Orders:** 1-800-621-2736, 773-660-2235 fax, www.press.uchicago.edu). $38.00, 645 pp., b/w figures, graphs, 6" × 9".

The book, *Tropical Forest Diversity and Dynamism*, is divided into seven major parts: **1)** Introduction; **2)** The Whole is Greater Than the Sum of the Plots; **3)** Habitat Specialization and Species Rarity in Forest Dynamics Plots; **4)** Local Variation in Canopy Disturbance and Soil Structure; **5)** The Diversity of Tropical Trees: Background; **6)** The Diversity of Tropical Trees: The Role of Pest Pressure; **7)** Forest Dynamics Plots.

"This book grew out of a symposium organized by the Center for Tropical Forest Science (CTFS) and held in August 1998 at the Smithsonian Institution in Washington, DC."

Patrick B. Durst, Chris Brown, Henrylito D. Tacio, and Miyuki Ishikawa. 2005. **In Search of Excellence: Exemplary Forest Management in Asia and the Pacific.** (ISBN 974-7946-68-8, pbk.). Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific and Regional Community Forestry Training Center for Asia and the Pacific, Bangkok, Thailand. (**Orders:** Patrick B. Durst, Senior Forestry Officer, FAO Regional Office for Asia and the Pacific, 39 Phra Atit Road, Bangkok 10200, Thailand; 66-2-697-4000, 66-2-697-4445 fax, email Patrick.Durst@fao.org). Price not given, 404 pp., color photos, graphs, maps, 7" × 10".

"The publication highlights a diversity of management approaches that have proven particularly innovative and successful in meeting challenges. Thus, it reaches out to foresters, policy-makers, planners and anyone interested in the future of forestry in Asia and the Pacific."

HERBARIUM ACRONYM CORRECTION FOR *IPOMOEA SEAANIA* (CONVOLVULACEAE) HOLOTYPE: SIDA 21(3). 2005

Richard Felger

Drylands Institute
PMB 405, 2509 N. Campbell Ave.
Tucson, Arizona 85719, U.S.A.

Daniel F. Austin

Arizona-Sonora Desert Museum
2021 N. Kinney Road
Tucson, Arizona 85743, U.S.A.

In a recent paper we described *Ipomoea seaania* as a new arborescent morning glory endemic to southern Sonora (Felger and Austin 2005). On page 1296 we list the location of the holotype as "UA," the informal local Tucson "acronym" for the University of Arizona. The correct herbarium designation is ARIZ; that is where the holotype is deposited. The line should read: "*Felger with Robert S. Devine 85-301* (HOLOTYPE: ARIZ."

REFERENCE

FELGER, R.S. and D.F. AUSTIN. 2005. *Ipomoea seaania*, a new species of Convolvulaceae from Sonora, Mexico. Sida 21:1293–1303.

BOOK NOTICES

University of California Press

James Lazell. 2005. **Island: Fact and Theory in Nature.** (ISBN 0-520-23277-1, hbk.). University of California Press, Berkeley, CA 94704, U.S.A (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax; www.ucpress.edu). $49.95, 382 pp., 40 color plates, b/w figures, 7" × 10".

From the dustcover.—"He presents compelling evidence that high levels of natural biodiversity underpin ecosystem resilience and stability, especially with respect to high-level consumers such as humans."

Island: Fact and Theory in Nature is broken up into six chapters: **1)** Ways of Looking at Diversity; **2)** How to Count Snakes—and Other Things; **3)** Putting Things Together; **4)** Great Guania and the Isles of Yesteryear; **5)** The Cast; **6)** Nature and Man. The author notes in the introduction that two major themes run through the book. "They are effectively its muscle and its blood. First, *diversity makes for stability, and that is good for us*....Second, *beware of ecological theories rendered as formulas*."

Philip W. Rundel and Robert Gustafson. 2005. **Introduction to the Plant Life of Southern California: Coast to Foothills.** (ISBN 0-520-23616-5, pbk.). University of California Press, Berkeley, CA 94704, U.S.A (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax; www.ucpress.edu). $18.95, 316 pp., 311 color photos, 4 1/2" × 7 1/4".

Highlights from the back cover.—"**Features** 327 color photographs vividly illustrating the major plant communities; **Describes** more than 300 plant species; **Covers** the counties of Santa Barbara, Ventura, Los Angeles, Orange, San Diego, western Riverside, and San Bernardino, as well as the Channel Islands; **Includes** a list of parks and other public areas for viewing southern California's plant communities."

Common and Latin names are provided for all plants. Excellent color photographs illustrate the plant communities discussed as well as species of plants that dominate the communities.

MISCELLANEOUS CHROMOSOME NUMBER REPORTS FOR *POA* (POACEAE) IN NORTH AMERICA

Robert J. Soreng

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.
sorengr@si.edu

ABSTRACT

The following 66 chromosome numbers and vouchers for 24 species of *Poa* L. are reported from Canada, México, and the U.S.A.: *P. abbreviata* subsp. *pattersonii*, $2n = 42$, $2n = 42$, $2n = 42$; *P. alpina*, $2n = 28+\mathrm{II}$, $2n = 32+\mathrm{I}$ (2×), $2n = 40+\mathrm{I}$, $2n = 42$, $2n = 56$; *P. arctica* subsp. *aperta*, $2n = 98+\mathrm{I}$; subsp. *arctica*, $2n = 56$; subsp. *arctica* (longipila form), $2n = 56–59$, $2n = 80$, $2n = 88$; *P. atropurpurea*, $2n = 28$; *P. bigelovii*, $2n = 28+\mathrm{I}$; *P. cusickii* subsp. *pallida*, $2n = 56+\mathrm{II}$, *P. fendleriana* subsp. *albescens*, $2n = 28+\mathrm{II}$, $2n = 56$; subsp. *fendleriana*, $2n = 56$ (4×), $2n = 59$, $2n = 58–60$, $2n = 58–64$, subsp. *longiligula*, $2n = 56$, $2n$ ca. 56; *P. glauca* subsp. *glauca*, $2n = 56$, $2n = 56–58$; subsp. *rupicola*, $2n = 48$, $2n = 48–50$, $2n = 54–56$, $2n$ ca. 100; *P. interior*, $2n = 42$; *P. laxa* subsp. *banffiana*, $2n = 84$; *P. leptocoma* $2n = 42$ (2×); *P. lettermanii*, $2n = 14$, *P. napensis*, $2n = 42$; *P. nervosa*, $2n = 28$; *P. occidentalis*, $2n = 14$ (2×), $2n = 28$; *P. paucispicula*, $2n = 42$; *P. piperi*, $2n = 28$; *P. pratensis* subsp. *alpigena*, $2n = 56+\mathrm{III}$; *P. reflexa*, $2n = 28$ (4×); *P. secunda* subsp. *juncifolia*, $2n = 63$; subsp. *secunda*, $2n = 84–88+\mathrm{II}$; *P. sierrae*, $2n$ ca. 58; *P. strictiramea*, $2n = 28–29$, $2n = 29+\mathrm{II}$; *P. supina* c.v. SUPERNOVA, $2n = 14$, *P. tracyi*, $2n = 28$ (5×), $2n = 28+\mathrm{I}$; *P. unilateralis* subsp. *pachypholis*, $2n = 42$; and *P. unilateralis* subsp. *unilateralis*, $2n = 84$.

RESUMEN

Se citan 66 números cromosomáticos y testigos de 24 especies de *Poa* L. de Canadá, México, y E.E.U.U.: *P. abbreviata* subsp. *pattersonii*, $2n = 42$, *P. alpina*, $2n = 28+\mathrm{II}$, $2n = 32+\mathrm{I}$ (2×), $2n = 40+\mathrm{I}$, $2n = 42$, $2n = 56$; *P. arctica* subsp. *aperta*, $2n = 98+\mathrm{I}$; subsp. *arctica*, $2n = 56$, subsp. *arctica* (forma longipila), $2n = 56–59$, $2n = 80$, $2n = 88$; *P. atropurpurea*, $2n = 28$; *P. bigelovii*, $2n = 28+\mathrm{I}$, *P. cusickii* subsp. *pallida*, $2n = 56+\mathrm{II}$; *P. fendleriana* subsp. *albescens*, $2n = 28+\mathrm{II}$, $2n = 56$; subsp. *fendleriana*, $2n = 56$ (4×), $2n = 59$, $2n = 58–60$, $2n = 58–64$; subsp. *longiligula*, $2n = 56$, $2n$ ca. 56; *P. glauca* subsp *glauca*, $2n = 56$, $2n = 56–58$; subsp *rupicola*, $2n = 48$, $2n = 48–50$, $2n = 54–56$, $2n$ ca 100; *P. interior*, $2n = 42$; *P. laxa* subsp. *banffiana*, $2n = 84$; *P. leptocoma* $2n = 42$ (2×); *P. lettermanii*, $2n = 14$; *P. napensis*, $2n = 42$; *P. nervosa*, $2n = 28$; *P. occidentalis*, $2n = 14$ (2×); *P. paucispicula*, $2n = 42$; *P. piperi*, $2n = 28$; *P. pratensis* subsp. *alpigena*, $2n = 56+\mathrm{III}$; *P. reflexa*, $2n = 28$ (4×); *P. secunda* subsp. *juncifolia*, $2n = 63$; subsp. *secunda*, $2n = 84–88+\mathrm{II}$; *P. sierrae*, $2n$ ca. 58; *P. strictiramea*, $2n = 28–29$, $2n = 29+\mathrm{II}$; *P. supina* c.v. SUPERNOVA, $2n = 14$; *P. tracyi*, $2n = 28$ (5×), $2n = 28+\mathrm{I}$; *P. unilateralis* subsp. *pachypholis*, $2n = 42$; y *P. unilateralis* subsp. *unilateralis*, $2n = 84$.

The Flora of North America North of México (Morin et al. 1993) editorial policy requires that chromosome numbers be independently published prior to being reported in the treatments. Therefore, I am reporting a series of chromosome counts here for *Poa* that are unreported or only mentioned with partial voucher

SIDA 21(4): 2195 – 2203. 2005

Table 1. Voucher information for chromosome counts in the genus *Poa* that are new or mentioned with no or only partial voucher information in Soreng (1985, 1990, 1991a, 1991b, 1993, 1998) and Soreng and Hatch (1983). *RJS* = *R.J. Soreng*, *RWS* = *R. W. Spellenberg.*

Taxon	**County & State**	**Specific location, date, collection no. & herbarium**	**Chromosome no. (2*n*), and notes**
Poa abbreviata subsp. *pattersonii* (Vasey) A. Löve, D. Löve & B.M. Kapoor	U.S.A. Colorado:	Clear Cr. Co.: Rocky Mts., Mt. Evens top, SSE of Georgetown ca. 13 km, 3 Aug 1984, *RJS, R. Bayer, M. Dunford & G.L. Stebbins 2555* (US)	**42** (Soreng 1991b, with partial voucher) information
	Colorado:	Summit/Park Co. boundary, Rocky Mts., Tenmile Range, North Star Mt., Hoosier Ridge W of Hoosier Pass, 2 Aug 1984, *RJS, R. Bayer, M. Dunford & G.L. Stebbins 2548* (US)	**42** (Soreng 1991b, with partial voucher information)
	Montana:	Deer Lodge Co.: Anaconda-Pintlar Wilderness, Mt. Tiny, above Storm Lk., 6 Aug 1980, *RJS & RWS 1165-2* (US)	*n* = **21,** from pollen division (Soreng 1991b, with partial voucher information)
Poa alpina L.	CANADA. Alberta:	Banff N.P., ca. 100 km N of Banff on hwy 93, E slopes of Mt. Peyto, S of Peyto Lk., N of Bow Lk., 28 Jul 1980, *RJS & RWS 1018* (US)	**42** (new)
	Alberta:	Plateau Mt., between Mt. Livingston and Mt. Burke, ca. 67 km due N of Colman, 2 Aug 1980, *RJS & RWS 1105* (US)	**56** (new)
	U.S.A. Colorado:	Sagauche Co.: San Luis Mts., N slope of Baldy Chato, off Big Meadow Rd. FR 790, 17 Aug 1980, *RJS & RWS 1406-a* (US)	**28+II** (new)
	Colorado:	Sagauche Co.: San Luis Mts., N slope of Baldy Chato, off Big Meadow Rd. FR 790, 17 Aug 1980, RJS *& RWS 1406-b* (US)	**32+I** (new)
	Wyoming:	Park Co.: Beartooth Pass, E summit, 8 Aug 1980, *RJS & RWS 1213-5* (US)	**40+I** (new)
	Wyoming:	Sublett Co.: Little Sheep Mt., NW of N end of Green Lakes ca. 6 km, 10 Aug 1980, *RJS & RWS 1290* (US)	**32+I** (new)
Poa arctica subsp. *aperta* (Scribn. & Merr.) Soreng	U.S.A. Colorado:	Sagauche Co.: San Luis Mts., N slope of Baldy Chato, off Big Meadow Rd., FR 790, 17 Aug 1980, *RJS & RWS 1412-a* (US)	**99** (Soreng 1985, without voucher)

TABLE 1. (continued)

Taxon	**County & State**	**Specific location, date, collection no. & herbarium**	**Chromosome no. (2*n*), and notes**
Poa arctica R.Br. subsp. *arctica*	CANADA. Alberta:	Kananaskis Prov.P., at Kananaskis Summit (Highwood Pass), near Mt. Arethusa ca. 67 km S of Seebe and Hwy 1, on Hwy 40, on W side, 31 Jul 1980, *RJS & RWS 1094* (US)	**56** (new)
	U.S.A. Colorado:	Pitkin Co. (W of Lake Co. line?), Rocky Mts., Sawatch Range, Independence Pass, 15 Aug 1980, *RJS & RWS 1391* (US)	**88** (new)
	Montana:	Deer Lodge Co.: Anaconda-Pintlar Wilderness, Mt. Tiny, above Storm Lk., 6 Aug 1980, *RJS & RWS 1180* (US)	**80** (new)
	Montana:	Glacier Co.: Glacier N.P., Pigan Pass, 4 Aug 1980, *RJS & RWS 1142* (US)	**56–59** (new)
Poa atropurpurea Scribn.	U.S.A. California:	San Bernardino Co.: Baldwin Lake, 1985, *RJS 2632* (US)	**28** (Soreng 1993, without voucher)
Poa bigelovii Vasey & Scribn.	U.S.A. New Mexico:	Lincoln Co.: White Mts., NE of Sierra Blanca, below Monjeau L.O., 16 Jun 1981, *RJS 1584t* (US)	**28+I** (Soreng 1985, without voucher)
Poa cusickii subsp. *pallida* Soreng	U.S.A. Montana:	Park Co.: NE of Gardner 10 km, E of Jardine, Jun 08 1984, *RJS 2453-a* (US)	**56+II** (Soreng 1991a, with voucher, but location incomplete and number erroneously reported as *RJS 2456*)
Poa fendleriana subsp. *albescens* (Hitchc.) Soreng	MEXICO. Chihuahua:	Sierra Madre Occidental, Creel, near air strip, 15 Apr 1984, *RJS & RWS 2309* (US)	**56** (new)
	Sonora:	5 km NW of Cananea on microondas road N from road to Sonora, 19 Mar 1982, *RJS & RWS 1780-5* (US)	**28+II,** with inversion bridge & fragments (Soreng 1985, without voucher)
Poa fendleriana (Steud.) Vasey subsp. *fendleriana*	U.S.A. New Mexico:	Catron Co.: Sheridan Gulch, 21 May 1983, *RJS & D. Ward 2125* (US)	**56,** with multivalents (new)
	Mexico:	Dona Ana Co.: Organ Mts., W side, below and E of Baylor Pk., 10 Feb 1984, *RJS & R. Neilson 2190-b* (US)	**56** (new)

TABLE 1. (continued)

Taxon	County & State	Specific location, date, collection no. & herbarium	Chromosome no. (2*n*), and notes
	Mexico:	Grant Co.: Black Range, 19 km NW of Mimbres, *D. Ward 81-04* (NMC)	**58–64** (new)
	Mexico:	Lincoln Co.: White Mts., Montgomery Biological Research Station, 8 km N of Ruidoso, 18 Apr 1981, *RJS 1580* (US)	**56** (new)
	Mexico:	Sandoval Co.: Sandia Mts., W base, Juan Tabo Picnic Area, NE of Albuquerque, 6 Jun 1983, *RJS & RWS 2172* (US)	**58–60** (new)
	Mexico:	Socorro Co.: San Mateo Mts., 21 Mar 1984, *RJS 2303* [no voucher]	**56** (new)
	MEXICO. Chihuahua:	Sierra Madre Occidental, 7 km E of Tomachic, 14 Apr 1984, *RJS 2306* (US)	*n* = **28+I,** mitotic, pistillate plant (new)
Poa fendleriana subsp. *longiligula* (Scribn. & T.A. Williams) Soreng	U.S.A. Arizona:	Apache Co.: Chuska Mts., 6.7 km NE of Lukachukai, on BIA-13, 9 Jun 1983, *RJS & RWS 2177* (US)	**56** (new)
	Wyoming:	Park Co.: Mammoth Hot Springs, 08 Jun 1984, *RJS 2454* (US)	*n* ca. **28,** mitotic (new)
Poa glauca Vahl subsp. *glauca*	CANADA. Alberta:	Plateau Mt., between Mt. Livingston and Mt. Burke, 67 km due N of Colman, 1 Aug 1980, *RJS & RWS 1098-3* (US)	56–58, meiosis irregular (new)
	U.S.A. New Mexico:	Taos Co.: Wheeler Peak, ridge 3.3 km N of peak, 0.4 km S of Frazer Mt., 19 Aug 1980, *RJS & RWS 1454-1* (US)	**56,** multivalents and laggers common (new)
Poa glauca subsp. *rupicola* (Nash) W.A. Weber	U.S.A. Colorado:	Pitkin Co.: Rocky Mts., Sawatch Range, Independence Pass, 15 Aug 1980, *RJS & RWS 1372-18* (US)	Ca. **100** (new)
	Wyoming:	Park Co.: Clay Butte Look-Out., ca. 2 km W of Beartooth Lk., 8 Aug 1980, *RJS & RWS 1221-2* (US)	**54–56,** multivalents (new)
	Wyoming:	dito, *RJS & RWS 1221-5* (US)	**48–50,** multivalents (new)
	Wyoming:	Sublett Co.: Top of Little Sheep Mt., NW of N end of Green Lakes ca. 6.25 km, 10 Aug 1980, *RJS & RWS 1299-6* (US)	**48** (new)
Poa interior Rydb.	U.S.A. Colorado:	Sagauche Co.: San Luis Mts., N slope of Baldy Chato, off Big Meadow Rd. FR 790, 17 Aug 1980, *RJS & RWS 1422-a-3* (US)	**42** (new)

TABLE 1. (continued)

Taxon	**County & State**	**Specific location, date, collection no. & herbarium**	**Chromosome no. (2*n*), and notes**
Poa laxa Haenke subsp. *banffiana* Soreng	U.S.A. Montana:	Glacier Co.: Glacier N.P., Pigan Pass, 4 Aug 1980, *RJS & RWS 1137* (US)	**84** (Soreng 1991b, with partial voucher information)
Poa leptocoma Trin.	U.S.A. Montana:	Glacier Co.: Glacier N. P., Pigan Pass, 4 Aug 1980, *RJS & RWS 1148-4* (US)	**42** (Soreng & Hatch 1983)
	Utah:	Summit Co.: Mt. Murdock E of Bald Mt. Pass, Hwy 150, 12 Aug 1980, *RJS & RWS 1347-2* (US)	**42** (new)
Poa lettermanii Vasey	CANADA or U.S.A.:		**14** (A. Löve, pers. com., letter ca. 1982, reported by, Soreng 1991a, voucher unknown)
Poa napensis Beetle	U.S.A. California:	Napa Co.: Calistoga, S end of landing strip W of Lincoln Ave., 27 May 1986, *RJS 2926* (US)	**42** (Soreng 1991a, with partial voucher and location)
Poa nervosa (Hook.) Vasey s.str. (excluding *Poa wheeleri* Vasey)	U.S.A. Oregon:	Marion Co.: Silver Cr. Falls S.P., Winter Falls, 6 Jun 1986, *RJS 2960* (US)	**28** (new)
Poa occidentalis Vasey	U.S.A. New Mexico:	Rio Ariba Co.: SW of Coyote, Puerco C.G., ca. 33 km NW of Los Alamos, 15 Aug 1978, *RJS & S.L. Hatch 48* (US)	**14** (Soreng & Hatch 1983)
	New Mexico:	Otero Co.: Sacramento Mts., ca. 8.3 km ENE of Cloudcroft S of NM-244 on CR-7, Dec early 1978, *RJS 123b* (US)	**28** (Soreng & Hatch 1983)
	New Mexico:	Otero Co.: Cloudcroft, *S.L. Hatch-2222* (TAES)	**14** (Soreng & Hatch 1983, count by S.L. Hatch)
Poa paucispicula Scribn. & .Merr	CANADA. Alberta:	Banff N.P., ca. 100 km N of Banff on hwy 93, E slopes of Mt. Peyto, S of Peyto Lk., N of Bow Lk., 28 Jul 1980, *RJS & RWS 1016* (US)	**42** (Soreng & Hatch 1983, reported as *Poa leptocoma*)
Poa piperi Hitchc.	U.S.A. California:	Del Norte Co.: Off hwy 199 0.6 km on Patrick Cr. Rd above the Middle Fork of the Smith Rv., 2 Jun 1986, *RJS 2950* (US)	**28** (Soreng 1990, 1993, without voucher)
Poa pratensis L. subsp. *alpigena* (Lindm.) Hiitonen	U.S.A. Alaska:	Nome, Jul 1983, *G.L. Stebbins A-3107!* (US)	**56+III,** original det. as *Poa arctica (new)*

Table 1. (continued)

Taxon	**County & State**	**Specific location, date, collection no. & herbarium**	**Chromosome no. (2*n*), and notes**
Poa reflexa Vasey & Scribn.	U.S.A. New Mexico:	Taos Co.: Wheeler Pk. La Cal Basin, ca. 1.7 km NNW of peak, 19 Aug 1980, *RJS & RWS 1478-4* (US)	**28** (Soreng & Hatch 1983)
	Utah:	Summit Co.: Mt. Murdock E of Bald Mt. Pass, Hwy 150, 11 Aug 1980, *RJS & RWS 1336* (US)	**28** (Soreng & Hatch 1983)
	Wyoming:	Park Co.: Clay Butte Look Out., ca. 2 km W of Beartooth Lk.,8 Aug 1980, *RJS & RWS 1227* (US)	**28** (new)
	Wyoming:	Sublett Co.: S side of Little Sheep Mt., NW of Green Lakes ca. 5 km, 10 Aug 1980, *RJS & RWS 1260-3* (US)	**28** (Soreng & Hatch 1983)
Poa secunda subsp. *juncifolia* (Scribn.) Soreng	U.S.A. Nevada:	Lander Co.: Toiyabe Range, E of Austin ca. 13 km on Hwy 50, 1 Jul 1980, *RJS 821* (US)	**63** (Soreng 1991b, with partial voucher information)
Poa secunda J. Presl subsp. *secunda*	U.S.A. Montana:	Glacier Co.: Glacier N.P., Siyeh Pass Trail, 4 Aug 1980, *RJS & RWS 1135* (US)	**84–88+II** (Soreng 1991b, with partial voucher information)
Poa sierrae T. Howell	U.S.A. California:	Eldorado Co.: Deep Canyon, N. Fork of American River, E of Colfax off hwy 80 ca. 2 m, ca. 0.8 km NE of river crossing of Iowa Hill-ColfaxRd., 30 May 1986, *RJS & G.L. Stebbins 2931* (US)	ca. **58** (new)
Poa strictiramea Hitchc.	MEXICO. Chihuahua:	Sierra Madre Occidental, W of San Jose Babicora, C. El Diablo Pass, 2 km W on road to Madera, 13 Apr 1984, *RJS & RWS 2304-a* (US)	*n* = **14+I,** mitosis (Soreng 1991a, with voucher and partial location)
	Chihuahua:	dito, *RJS & RWS 2304-b* (US)	*n* = **14–15+II,** mitosis (new)
Poa supina Schrad. cv. SUPERNOVA	U.S.A. Maryland:	Cultivated from commercial seed, 2000, *RJS & J. Cayouette 5950-b* (US)	*n* = **7,** mitosis (J. Cayouette, unreported)
Poa tracyi Vasey	U.S.A. New Mexico:	Bernalillo Co.: Sandia Crest, rim N of Tram, 16 Jul 1981, *RJS & K. Gadzia 1642* (US)	**28** (Soreng & Hatch 1983)
	New Mexico:	Colfax Co.: WNW of Raton, Raton City Park, 16 Aug 1978, *RJS & S.L. Hatch 64* (US)	**28** (Soreng & Hatch 1983)

TABLE 1. (continued)

Taxon	**County & State**	**Specific location, date, collection no. & herbarium**	**Chromosome no. (2*n*), and notes**
	New Mexico:	Colfax Co.: NW of Raton, Raton City Park, 31 May 1979, *RJS 266* (US)	**28** (Soreng & Hatch 1983)
	New Mexico:	Colfax Co.: N of Raton, John Mayer's Ranch, down canyon from Raton Pass on side of Bartlet Mesa, E side of US-25, 31 May 1979, *RJS 267* (US)	**28** (Soreng & Hatch 1983)
	New Mexico:	Colfax Co.: Raton Ranch, NW of Raton ca. 7.5 km, 3 Jun 1979, *RJS 272* (US)	**28** (Soreng & Hatch 1983)
	New Mexico:	Colfax Co.: Raton Ranch, NW of Raton ca. 12 km, 3 Jun 1979, *RJS 274* (US)	**28** (Soreng & Hatch 1983)
	New Mexico:	Lincoln Co. Sierra Blanca, circ below the Peak, 10 Jul 1982, *RJS & RWS 2007* (US)	**28+I** (new)
Poa unilateralis subsp. *pachypholis* (Piper) Soreng	U.S.A. Washington:	Pacific Co.: Ilwaco, *RWS & D. Southerland 1522A* (NMC)	**42,** R.W. Spellenberg count (Soreng 1998, with partial voucher information)
Poa unilateralis Scribn. subsp. *unilateralis*	U.S.A. Oregon:	Curry Co.: 3.3 km S of Gold Beach on serpentine road cut, Buena Vista Waysides, 300 ft above the ocean, 22 Jun 1949, *J. Clausen 2151* (CAS)	**84,** as *Poa unilateralis*, J. Clausen unpublished (Soreng 1991a, with voucher but no location)

information in Soreng (1985, 1990, 1991a, 1991b, 1993, 1998) and Soreng and Hatch (1983). Table 1 includes full specimen citations and herbaria (acronyms following Holmgren et al. 1990) where the vouchers are deposited for all of my previous and new reports. My own counts were done between 1978 and 1988. Methods for the chromosome preparations were given in Soreng and Hatch (1983).

In addition, vouchers and/or notes of a few counts done by other botanists/authors that have not been reported previously are included. Jacques Cayouette provided his new chromosome count of *P. supina* from the recently introduced (in North America) cultivar SUPERNOVA. The count reported in Soreng (1991a) for *P. lettermanii* was mentioned to me in a letter by A. Löve, ca. 1982. This report is interesting as it raises to three the number of diploid species in the New World (the others are *P. occidentalis* and *P. pseudoabbreviata*). Verification of the count for *P. lettermanii* is needed since I only have the correspondence record. I found an unpublished report for *P. unilateralis* subsp. *unilateralis* of $2n = 84$ on a herbarium specimen at CAS, the count likely done by the collector of the specimen, geneticist Jens Clausen. Myers (1947) reported a count by Stebbins of $2n = 42$, presumably for the typical subspecies (as *P. unilateralis* subsp. *pachypholis* is rather local, more recently published, and restricted to the coast of NW Oregon and adjacent Washington). Richard W. Spellenberg made a count of $2n = 42$ for *P. unilateralis* subsp. *pachypholis*.

Although emphasis has switched away from cytogenetic comparisons of species to DNA analyses in *Poa* (Gillespie & Soreng 2005; Soreng 1990), it is important to have an understanding of the cytogenetic history of taxa in order to interpret results of other analyses, and to be able to locate vouchers and know where they were collected. Of the 66 counts listed in Table 1, 34 are unreported elsewhere. The base chromosome number in the genus *Poa* is $x = 7$, and the counts reported here generally correspond to multiples of seven, but unbalanced sets of chromosomes were frequently encountered. Roman numerals given after numbers (i.e.; $2n = 28+\text{II}$) represent unpaired chromosomes in the metaphase or anaphase of meiosis, or unbalanced numbers in mitosis or later stages of meiosis. Although supernumary or B chromosomes have been reported frequently in *Poa*, no attempt was made to distinguish unbalanced chromotin of this type from fragments resulting from irregular meiosis, etc. Most of the counts reported here conform to numbers reported by other authors for the same taxa. *Poa sierrae* ($2n = 28$) is the only taxon reported here for the first time. In taxa with previously reported counts, other than my own, and disregarding the extra chromotin, the only the previously unrecorded numbers in any taxon reported here are; $2n = 56$ in *P. fendleriana* subsp. *albescens*, and $2n = 48$, 48–50, 54–56, and ca. 100 in *P. glauca* subsp. *rupicola*. This work continues to show the pattern in *Poa* of few diploid taxa, numerous taxa with low, fairly stable tetra- and hexaploid numbers, other taxa with higher eupolyploid series, and taxa with eupolyploid peaks connected by dysploid series of numbers (Hiesey & Nobs 1982; Stebbins 1950).

ACKNOWLEDGMENTS

Most of these chromosome counts were done durning my Masters degree research under Stephen L. Hatch and then Kelly W. Allred, and PhD reseach under Richard W. Spellenberg, at New Mexico State University. My appreciation is extended to these advisors, to Gerrit Davidse and Lynn J. Gillespie for their helpful reviews of the manuscript, and to Jacques Cayouette for allowing me to report his new chromosome count.

REFERENCES

GILLESPIE, L.J. and R.J. SORENG. 2005. A phylogenetic analysis of the bluegrass genus *Poa* based on cpDNA restriction sited data. Syst. Bot. 30:84–105.

HIESEY, W.M. and M.A. NOBS. 1982. Experimental studies on the nature of species VI: Interspecific hybrid derivatives between facultatively apomictic species of bluegrasses and their responses to contrasting environments. Publications of the Carnegie Institute of Washingon. Vol. 636.

HOLMGREN, P.K., N.H. HOLMGREN, and L.C. BARNETT. 1990. Index herbariorum. Part I.: the herbaria of the world. New York Botanical Garden, Bronx.

MORIN, N.R. et al. (eds.). 1993 forward. Flora of North America north of Mexico. Oxford University Press, New York.

MYERS, W.M. 1947. Cytology and genetics of forage grasses. Bot. Rev. 13:319–421.

SORENG, R.J. 1985. *Poa* L. in New Mexico, with a key to middle and southern Rocky Mountain species (Poaceae). Great Basin Naturalist 45:395–422.

SORENG, R.J. 1990. Chloroplast DNA phylogenetics and biogeography in a reticulating group: study in *Poa* (Poaceae). Amer. J. Bot. 77:1383–1400.

SORENG, R.J. 1991a. Systematics of the *Poa* L., group "Epiles" (Poaceae). Syst. Bot. 16:507–528.

SORENG, R.J. 1991b. Notes on new subspecific taxa and hybrids in North American *Poa* (Poaceae). Phytologia 71:390–413.

SORENG, R.J. 1993. *Poa* L. In: J.C. Hickman, ed. The Jepson manual: higher plants of California. University of California Press, Berkeley. Pp. 1284–1291.

SORENG, R.J. 1998. An infrageneric classification for *Poa* in North America, and other notes on sections, species, and subspecies of *Poa*, *Puccinellia*, and *Dissanthelium* (Poaceae: Poeae). Novon 8:187–202.

SORENG, R.J. and S.L. HATCH. 1983. A comparison of *Poa tracyi* and *Poa occidentalis*. Sida 10: 123–141.

STEBBINS, G.L. 1950. Variation and evoluton in plants. Columbia Univeristy Press, New York.

BOOK NOTICES

University of California Press

GARY GRIGGS, KIKI PATSCH, and LAURET SAVOY. 2005. **Living with the Changing California Coast.** (ISBN 0-520-24447-8, pbk.). University of California Press, Berkeley, CA 94704, U.S.A (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax; www.ucpress.edu). $24.95, 540 pp., b/w photographs, 6" × 9".

The first edition of this book titled *Living with the California Coast*, was published in 1985. In the author's words, the first part of the book provides the reader "with some basic background on how the shoreline works, the processes and hazards that occur here, things to consider before buying or building, options in hazardous locations, and how policies and legislation influence our response." In the second part of the book, "the authors and coastal geologists familiar with specific regions describe these individual areas [coastline areas from the Oregon border to Mexico], including what we know about their geology, hazards, and histories."

NORMAN MYERS and JENNIFER KENT (eds.). Foreword by EDWARD O. WILSON. 2005. **The New Atlas of Planet Management.** (ISBN 0-520-23879-6, pbk.). University of California Press, Berkeley, CA 94704, U.S.A (**Orders:** California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax; www.ucpress.edu). $39.95, 304 pp., color photos, graphs, drawings, 9 1/4" × 12 1/2".

Authors' comments about this book.—"This is no ordinary atlas. It maps and analyses a living planet at a critical point in its history—as one species, own, threatens to disrupt and exhaust its life-support systems. It charts the growing division in the human family. And it proposes that we have the chance to redirect our course, and become caretakers of our future.

The New Atlas of Planet Management is a first approach to this challenging task. It organizes the mass of available environmental data, statistical predictions, and other conflicting opinions and solutions into a simple, coherent structure. It is divided into seven sections: Land, Oceans, Elements, Evolution, Humankind, Civilization, and Management; each of these is considered from three perspectives: Potential resources, Crises, and Management alternatives.

This structure enables us to examine any critical area of concern and to weigh up: first, what it has to offer; second, where, how, and why things are obviously going wrong; and third, how we might set about putting things right, by applying a range of alternative strategies.

More than a structure for a book, this analytical formula offers one possible approach to planet management. We hope it will spur the rising global debate on our future prospects."—*Norman Myers and Jennifer Kent.*

This book is extremely well-illustrated with extensive captions describing the issues, the resources, the crises or even possible solutions

RELATIONSHIPS BETWEEN PLANT FOLKLORE AND ANTITUMOR ACTIVITY: AN HISTORICAL REVIEW[1]

Richard W. Spjut[2]

World Botanical Associates
P.O. Box 81145
Bakersfield, California 93380-1145, U.S.A.
www.Worldbotanical.com

ABSTRACT

The National Cancer Institute's (NCI) record of plants that have shown significant inhibitory effect in experimental tumor systems (active plants), 1960–1974, was compared with species and genera in references on medicinal folklore, including poisonous plants, to determine whether their percentages of active plants were significantly greater than those screened at random (10.4%). The percent active species in medicinal and/or poisonous references in general were found to be 1.4 to 2.6 times greater, while the number and different kinds of medicinal uses appear related to geographical data of species that also indicate medicinal plants were screened more thoroughly because of their widespread occurrence. The best correlation is seen with poisonous plants, including medicinal plants that suggest a moderate to strong therapeutic effect; their percentages of active species were nearly three (29.3%, anthelmintics) to four times (45.7%, arrow and homicidal poisons) greater than plants screened at random. Selection of plants based strictly on use in folk medicine would probably benefit new (start-up) screening programs, whereas in the long-term, it appears more cost effective to systematically screen the broadest diversity of plants readily available since the common medicinal species would be collected irregardless. A systematic collection strategy could give emphasis to genera that have not been exhaustively studied, especially to species with medicinal uses that indicate toxicity or are considered poisonous.

RESUMEN

El registro de plantas del National Cancer Institute (NCI) 1960–1974, que han mostrado un efecto inhibidor significativo en sistemas tumorales experimentales (plantas activas), se compararon con géneros y especies que aparecen en referencias de medicina popular, incluyendo plantas venenosas, para determinar en que medida los porcentajes de plantas activas eran significativamente más altas que las investigadas al azar (10.4%). El porcentaje de especies activas referenciadas como medicinales y/o venenosas en general se encontró que era de 1.4 a 2.6 veces mayor, mientras que el número y diferentes tipos de usos medicinales parecen relacionados con datos geográficos de especies que también indican que las plantas medicinales fueron investigadas más minuciosamente debido a su amplia distribución. La mejor correlación se aprecia con las plantas venenosas, incluyendo las plantas

---

[1] A summary of the data in this paper was presented at the Society for Economic Botany Symposium on Plants And Cancer held in Baltimore, August 1975. An alternate paper was published in Cancer Treatment Reports in August 1976 (Spjut & Perdue, Vol. 50, 8:979–985). Left out were all data and discussion on Quisumbing's (1951) Medicinal Plants of The Philippines, reviews on genera with geographically disjunct uses of medicinal species, and activity according to the tumor systems employed.

[2] USDA Agricultural Research Service, Medicinal Plant Resources Laboratory, Beltsville, MD 20705. The NCI terminated their agreement with the ARS in Oct 1982. Spjut left the USDA in March 1997. World Botanical Associates, Bakersfield, CA 93380-1145.

SIDA 21(4): 2205 – 2241. 2005

medicinales que parecen tener un efecto terapéutico de moderado a fuerte; los porcentajes de especies activas fue de cerca de tres (29.3%, antihelmínticos) a cuatro veces (45.7%, venenos para flechas y homicidios) mayor que las plantas investigadas al azar. La selección de plantas basada estrictamente en el uso en medicina popular probablemente sería beneficiosa para los nuevos programas de investigación, mientras que a largo término, parece tener un costo efectivo mayor la investigación sistemática de una diversidad de plantas fácilmente disponibles ya que las especies medicinales comunes pueden colectarse en cualquier parte. Una estrategia de colecta sistemática pondría énfasis en géneros que no hayan sido estudiados exhaustivamente, y especialmente en especies con usos medicinales que indiquen toxicidad o que se consideren venenosas.

INTRODUCTION

The USDA Agricultural Research Service (ARS) was a major supplier of plant samples for the National Cancer Institute (NCI) Cancer Chemotherapy Screening Program from 1960–1982. The objective of this program was to identify novel chemical structures produced by plants that would be useful in treatment of cancer. Two major discoveries of novel anticancer drugs from this period were taxol (Wani et al. 1971), isolated from stem-bark of *Taxus brevifolia* Nutt. (Taxaceae), initially collected in Washington, August 1962, followed discovery of confirmed antitumor activity in KB Cell Culture (KB), July 1964 (NCI CPAM, 1977), and camptothecin (Wall et al. 1966), isolated from *Camptotheca acuminata* Decne. (Nyssaceae), based on fruit samples collected in September 1961 from a USDA Plant Introduction Station in Chico, California, and reported to have confirmed antitumor activity in L-1210 Leukemia (LE), July 1962 (NCI CPAM 1977). Semi-synthetic derivatives of compounds from both species are currently employed to treat various cancers (Cragg et al. 1996). The commercial development of these anticancer drugs, however, did not occur until the 1990s. In 1986, the NCI re-developed its biodiversity screening program of natural products (Boyd 1992; Cragg et al. 1996; Newman et al. 2003); however, the acquisition of plant samples for the NCI screen was suspended in 2004.

In August 1975, a symposium on "Plants and Cancer" was held in Baltimore, MD at the Annual Meeting of the Society for Economic Botany. The contributors included many scientists actively involved in the NCI search of new anticancer drugs from plant products who had agreed, in advance, to providing a research contribution. My assigned study was "Plant Folklore: A Tool for Predicting Sources of Antitumor Activity? Other contributed papers were "Procurement of Plant Materials for Antitumor Screening" (Perdue 1976), "Preparation of Plant Extracts for Antitumor Screening" (Statz & Coon 1976), "Bioassay of Plant Extracts for Anticancer Activity" (Abbott 1976), "Isolation and Chemical Characterization of Antitumor Agents from Plants" (Wall et al. 1976), "Types of Anticancer Agents Isolated from Plants" (Hartwell 1976), "Distribution of Anticancer Activity in Higher Plants" (Barclay & Perdue 1976), "Novel Plant-Derived Tumor Inhibitors and Their Mechanisms of Action" (Kupchan 1976), "Pharmacology of Antitumor Agents from Higher Plants" (Sieber et al. 1976), and "Plant Products in Cancer Chemotherapy" (Carter 1976). These and others were published collectively in Cancer Treatment Reports, edited by Robert E. Perdue, Jr., and Jonathan L. Hartwell (Vol. 60, No. 8, 1976).

Upon investigating the relationships between antitumor activity and plant folklore, I felt that plants used in folklore were not going to lead to discovery of novel compounds any more than a systematic sampling of the world's plant diversity based on taxonomy, the approach that had been in practice 14 years. Therefore, in order to show this, the most common medicinal uses of plants, and also poisonous plants, would need to be investigated. During the course of the study, the results on the NCI active species found in literature on medicinal and poisonous plants, in comparisons to those screened at random, raised more questions than could be answered, including the one originally proposed. The Spjut and Perdue (1976) paper excluded much data in another manuscript that had been completed and peer reviewed.

After nearly 30 years, the unpublished data still seem relevant to present day studies in ethnobotany and pharmacology, particularly the relationship between antitumor activity and folklore indicating plant toxicity; therefore, this paper will focus on that relationship, including also data from Spjut and Perdue (1976). Another important relationship involves the multiple uses for a large number of widely distributed species; their impact on the apparent correlation between antitumor activity and medicinal folklore will be discussed. Additionally, Spjut (1985) reviewed the random screen methodology in detail with reference to unpublished data on The Philippine medicinal plants; these data will be presented in this publication.

MATERIALS AND METHODS

Literature Surveys.—This paper deals with data compiled from literature and the NCI plant screening program prior to 1977. Folklore and plants in this study were limited to literary sources for evaluating medicinal uses and poisonous effects of higher plants in man and animals. Included are plants believed to have medicinal or poisonous properties, and the scientific literature dealing with active chemical agents in confirmed poisonous and medicinal plants. Botanical data and the references cited, including the nomenclature of plants, are not updated since this paper was prepared and last reviewed in July 1976; however, in regard to pharmacological data on compounds that were isolated, more recent references are provided.

Eight compendia on medicinal and poisonous plants were employed to identify which of their genera and species were active in the NCI program: Hardin & Arena (1974), Hartwell (1967–1971), Kingsbury (1964), Krochmal & Krochmal (1973), Quisumbing (1951), Train et al. (1957), Webb (1948), and Weiner (1972). One of these, Quisumbing (1951), was further utilized to determine whether a specific medicinal use was more closely correlated with antitumor activity. Because antitumor activity appeared to correlate with a wide variety of medicinal uses, additional data from Quisumbing (1951) were compiled and analyzed in regard to multiple uses of plants as related to their geographical distribution. Additionally, we (Spjut & Perdue 1976) prepared our own compilation on plants used as (1) anthelmintics, (2) fish poisons, and (3) arrow, ordeal and homicidal poisons to determine whether there was a correlation between antitumor activity and plant toxicity in contrast to medicinal plants in general.

Active species.—An active species is defined as one represented by one or more extracts having shown a significant inhibitory effect in any tumor system used in the NCI preliminary screen; these were primarily KB Cell Culture (human epidermoid carcinoma of the nasopharynx, KB, 1960–1982), P-388 Leukemia (PS, 1968–82), Lewis Lung Carcinoma (LL, 1962–66), Walker Carcinoma 256 (WA, 1966–69), Sarcoma 180 (SA, 1956–62), Adenocarcinoma 755 (CA, 1956–62) and L-1210 Leukemia (LE, 1956–71) (Abbott 1976; Geran et al. 1972; Hartwell 1976; Suffness & Douros 1979). The NCI provided a print-out of their active species for this study; additionally, another printout indicating tumor systems for the confirmed active species was consulted (NCI CPAM 1977).

Active agents have included a broad spectrum of compounds (Hartwell 1976), some of which were precluded from further screening (e.g., tannins, phytosterols) by changes made in the extraction procedure and tumor assays (Hartwell 1976); thus, the NCI screen evolved to become more selective in identifying active candidates for drug development by eliminating classes of compounds not considered useful for treating cancer (Hartwell & Abbott 1969). During the 1960s, tannins—in aqueous extracts from a wide variety of plants—were frequently active in WA, but also in CA, LL and SA tumors; a total of 164 species, representing 7.7% of all active species (2,127) in this study were tannin actives (Barclay & Perdue1976; Hartwell 1976). Later, tannins were extracted out before testing, while tumors insensitive to tannins were subsequently employed (Hartwell 1976). Consequently, many variables are represented in the definition of an active species, such as differences in extraction procedures, quantity and kind of tumor systems employed, parameters that define activity from testing extracts, and whether specific plant parts screened correspond to those employed in folklore. Nevertheless, it is felt that all plants regarded active by the NCI from 1960–1976 are valid for making comparisons with folk uses of plants.

Comparisons between the NCI active species and those in the literature considered taxonomic synonyms and closely related species when known. For instance, the NCI active species, *Thalictrum polycarpum* (Torr.) S. Wats., based on a sample collected and identified by A.S. Barclay from southern California in 1962, was not found in the literature reviewed to have medicinal or poisonous reports; however, this species could be interpreted as a synonym of *T. fendleri* Engelm. (Munz 1959), one that was reportedly used in medicine by the Indian

Tribes of Nevada (Train et al. 1957). Based on taxonomy, *T. polycarpum* is considered a medicinal plant.

Active genus. Comparisons were also made at the genus level; however, the size of the genus varies—from just one species (e.g., *Camptotheca*) to more than 1,000 species (e.g., *Euphorbia*); Willis (1922) had determined that 47% of all genera are monotypic, 17% have two species, 8% have three species, and the remaining 28% have four or more species. An active genus is one with one or more active species. Because most genera have more than one species (53%), the percentages of active genera will be higher than active species. Also, when more than one species in an active genus is reportedly used medicinally and/or poisonous, the relationship between antitumor activity and folklore will appear closer, or lie between the percentages of active genera and active species.

Random Screen. The rationale of the NCI screen has been to regard any species as a potential source for novel anticancer drugs; thus, screening of plants has been considered random. In practice, however, collecting was not purely random. One reason is that it is not possible to collect every plant species encountered in the field, because the quantity of dry weight needed may not be practical to obtain. Another is that geographic sampling has not been uniform for political and economic reasons.

The number of genera and species screened and active in the NCI program was determined by A.S. Barclay for the symposium on "Plants and Cancer" at the Society for Economic Botany meeting in Baltimore, August 1975. His data accounted for all species and genera screened by the NCI—up to the end of 1974, taking into consideration synonyms and samples that the NCI acquired not only from the USDA, but from all contractors. His tabular summary is reproduced here, Table 1 (Barclay & Perdue 1976).

The percentages for active genera, 26.0, and species, 10.4, are the bases for making comparisons to those in folklore references; however, it must be kept in mind that the numbers for active species and genera are cumulative; i.e., they do not represent the actual frequency at which activity occurs. This is because some species have been screened more than once, or have included more plant parts than others, thus, have had more opportunity to show activity—also keeping in mind that the NCI screen has become more selective over time.

GENERAL SURVEYS

The NCI computer record of active plant species was compared with species and genera cited in indices or texts of eight compendia to determine which have shown antitumor activity (Table 2). With two exceptions, active species were 1.4 to 2.6 times more frequent in references on medicinal and/or poisonous plants than in plants screened at random, while results with active genera were more consistent—at nearly double that of the random screen.

The greater variation at the species level for medicinal plants is partly due

TABLE 1. NCI overall screening data for vascular plants (1960–1974).

	Number Screened	Number Active	% Active
Genera	4,716	1,225	26.0
Species	20,535	2,127	10.4

to many species not screened, in contrast to higher percentages of genera screened. For one reference, Quisumbing (1951), it was determined that 626 of the 855 species were tested; thus, instead of the 16.4% active of those recorded (855), 22.4% of those species actually screened (626) were active—nearly double that of the random screen.

In regard to the wide ranging values seen for poisonous plants, the lower percentage of 9.2% active species in Webb (1948) seems related to many species that are suspected to cause poisoning of livestock. When data from the same reference was restricted to species that were reported to be poisonous *and* also used medicinally, the percent active species was notably higher, 18.9%. These data suggest that plants, both poisonous *and* used medicinally, are more likely to show antitumor activity than those strictly used medicinally. Also, data from other references (Kingsbury 1964; Hardin & Arena 1974) had more plants confirmed to be poisonous, which in Hardin and Arena (1974) were restricted to those taken internally (Spjut & Perdue 1976). The higher percentages of active species (21.5%, 41.1%) and genera (56.4%, 66.4%) in these references on poisonous plants indicate that toxicity is a factor in the apparent correlation between antitumor activity and plants generally used in medicinal folklore.

ACTIVE PLANTS ACCORDING TO NUMBER AND KINDS OF MEDICINAL USES

Quisumbing (1951), in his *Medicinal Plants of the Philippines*, provided species indices for 116 different categories of therapeutic uses and for 111 different kinds of specific diseases, a total of 227 different medicinal applications from which 90 were selected on the basis of 19 or more species being listed to determine whether antitumor activity was more closely correlated with a particular therapeutic effect (Appendix I, 62 medicinal applications) or specific disease (Appendix II, 28 medicinal applications). What we found, however, was a broad correlation with all medicinal applications (Appendix I, II). This broad correlation appears related to a large number of widely distributed species for which many have probably been screened more than once by the NCI, while a correlation between antitumor activity and toxicity is also evident. These relationships will be made apparent in the data and discussion that follow.

Quisumbing (1951), in reporting on 855 species in 580 genera and 143 families of vascular plants in The Philippines, did not limit his review to medicinal uses within The Philippines. He also drew on literary sources outside The Philippines.

TABLE 2. Number and percent of active genera and active species for medicinal and poisonous plants in eight selected references.

Reference	Genera Listed	Genera active	% Genera active	Species Listed	Species active	% Species active
Medicinal Plants						
Krochmal (1973)	207	131	63.3	251	67	26.7
Quisumbing (1951)	580	271	46.7	855	140	16.4
Train et al. (1957)	142	77	54.2	214	32	15.0
Webb (1948)	398	228	57.3	529	87	16.5
Weiner (1972)	285	156	54.7	388	73	18.8
Poisonous Plants						
Hardin & Arena (1974)	113	75	66.4	141	58	41.1
Kingsbury (1964)	282	159	56.4	488	105	21.5
Webb (1948)	433	211	48.7	760	70	9.2
Poisonous Plants used Medicinally						
Webb (1948)	229	153	66.8	196	37	18.9
Plants Used Against Cancer						
Hartwell (1967–1971)	1,201 (1,033 tested)	480	46.5 (tested)	2,725 (1,815 tested)	314	17.3 (tested)

Thus, many plants not known to be used medicinally in The Philippines were included so long as the plant occurred there, a practice not uncommonly employed by many ethnobotanists in other geographic studies of medicinal plants. Nevertheless, the result is that there are many widespread species represented. This is evident in part by finding that 8% of all species in Quisumbing (1951) are endemic to The Philippines, based on geographical data he also provided; thus, 92% of the species in Quisumbing (1951) extend beyond The Philippines.

The distribution of endemic species according to the number of uses is shown in Figure 1. Among 110 species in Quisumbing (1951) listed for only one medicinal application, 25% were found to be endemic to The Philippines, followed by a sharp decline for those reported under multiple applications—15% for plants listed under two medicinal applications, 8% for three medicinal application—to none found under nine or more medicinal applications. It is certainly not surprising to find that narrower geographically distributed species have fewer medicinal reports.

However, the extent to which medicinal species are reported for many different uses is perhaps not fully realized by many ethnobotanists. The 808 species listed, among the 90 medicinal applications selected from Quisumbing (1951), accounted for a whopping, 5,843 species entries (meaning that many of the 808 species are used for more than one application), the distribution of which is shown in Figure 2. As an average, 50% of the species reported under any one

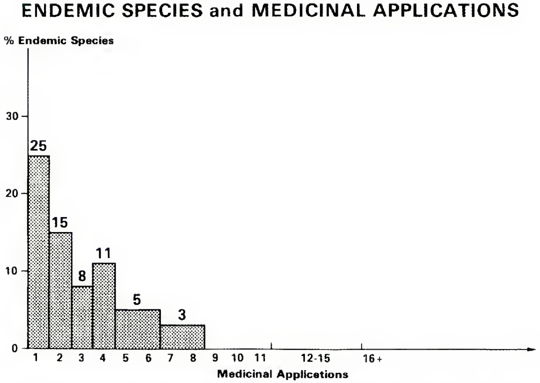


Fig. 1. Percent endemic species to The Philippines according to number of different medicinal applications based on 90 of 227 medicinal applications in Quisumbing (1951). The number of medicinal species for each number of uses is shown in Fig. 2. Of 110 species reportedly used for only one medicinal application, 25% were endemic to The Philippines; for species with two medicinal applications, 15% were endemic, etc., to no endemics for species reported to have nine or more medicinal applications. Geographical data are based on Quisumbing (1951).

medicinal application were also found under 11 or more other medicinal applications.

The extent of the widespread occurrence for many of the medicinal plants reported by Quisumbing (1951) is further evident by percent species screened according to the number of uses recorded, Figure 3, and the fact that relatively few species were actually collected from The Philippines. Some of the medicinal applications in the higher multiple use categories were combined to obtain a more equitable number of species for each category. The results show, as one might expect, a definite correlation between the number of uses and percent species screened, increasing from 45% for species with only one medicinal application, to 99% for those with 16 or more medicinal applications. Plants were procured largely from the United States, Australia, New Zealand, Fiji, Taiwan, India, Turkey, Ethiopia, Kenya, Tanzania, South Africa, Ghana, Mexico, Panama, Colombia, Brazil, and Peru. Small numbers of collections were also obtained from other countries; see also procurement map in Perdue (1976).

For the 90 selected medicinal applications from Quisumbing (1851), 626 species in 531 genera were found to have been screened of which 140 species

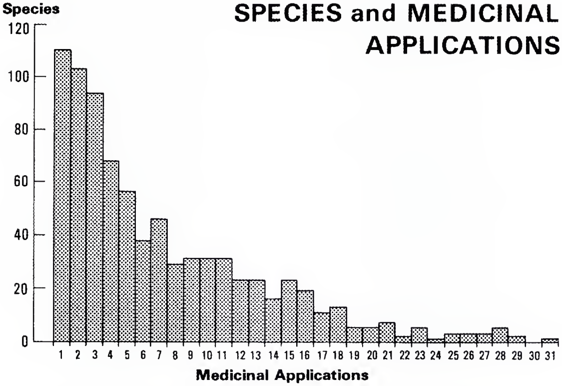


Fig. 2. A numerical distribution of species according to number of medicinal applications for a total of 90 different kinds of medicinal applications that included 808 species in Quisumbing (1951). The number of species for each number of medicinal applications decreases from 110 species used for just one purpose, to one species, *Artemisia vulgaris* L., cited under 31 different medicinal applications.

(22.4%) in 265 genera (49.7%) were active (Appendix III); additionally, 40% of the 140 active species were found to have 12 or more medicinal applications. One medicinal application with notably high percentages of active species and genera was plants used against hemorrhoids, 35.3% (24) of the 68 species and 72.1% of the 61 genera.

Are plants used for treatment of hemorrhoids more closely correlated with antitumor active plants than plants used for other purposes? Statistically, the distribution of active genera and species for the medicinal applications in Quisumbing (1951) might be expected to follow a bell-shaped curve distribution in which there will be higher than average as well as lower than average percentages of active species (and genera). The categories with higher percentages of active species would also be expected to have more widely distributed species based on data presented in Figures 1–3 and the absence of plant collections from The Philippines as already indicated. Indeed, among 68 species listed by Quisumbing (1951) for plants used against hemorrhoids, 75% (51) were reported for 11 or more other medicinal applications, which included 23 of the 24 active species. Therefore, it cannot be concluded that plants used for a particular remedy such as hemorrhoids are more likely to show antitumor activity than plants used for other purposes.

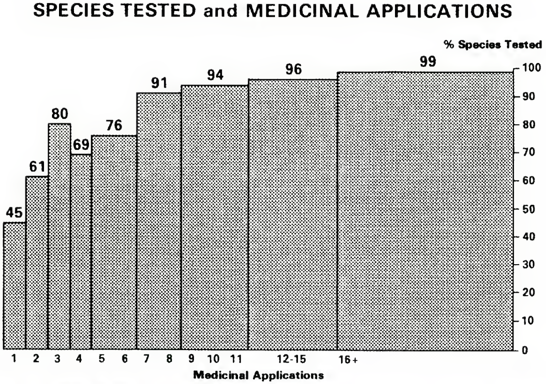


FIG. 3. Percent of species screened by the NCI for antitumor activity according to number of medicinal applications for 808 species listed in 90 of 227 different medicinal applications by Quisumbing (1951). The percent screened for each numerical category of medicinal uses of plants is shown to increase from 45% for species reported to have just one medicinal use to 99% screened for those reported for 16 or more different medicinal applications.

On the other hand, one might argue that the use of plants for many medicinal remedies by one or more cultures should constitute strong evidence for discovering biological activity. At the species level, however, cultural diffusion might exaggerate and multiply reports (Watson 1983), whereas medicinal reports based on disjunct occurrences of closely related species in genera may appear more valid, depending, however, on the size of the genus and number of medicinal species reported. The following six cases exemplify how folklore may appear in one case to have strong validity, while in other instances appears inconclusive.

1) *Brucea* (Simaroubaceae) is a small paleotropical genus of 6 species with *B. antidysenterica* in Africa and *B. javanica* (L.) Merr. in southeast Asia that have reportedly been used for treating skin diseases, dysentery, tapeworm, and cancer (Burkhill 1935; Chopra et al. 1956; Dalziel 1937; Hartwell 1967–1971; Quisumbing 1951; Watt & Breyer-Brandwijk 1962; Webb 1948). Anticancer activity has been identified in both species and one other, *B. guineensis* G. Don, found only in west tropical Africa without any reported use. The anticancer compound, bruceantin (Kupchan et al. 1973), isolated from *B. antidysenterica*, has undergone preclinical studies as a potential drug for cancer chemotherapy. It was found to be toxic in human application; however, derivatives of related compounds are still being investigated for cancer chemotherapy (Cuendet & Pezzuto 2004; Mata-Greenwood et al. 2001).

2) *Colubrina* (Rhamnaceae) includes one widespread species, *C. asiatica* (L.) Brongn., eight species of spotty distribution in the Old World, one in India, three in Indonesia and four in Madagascar, plus about 22 species distributed in tropical and subtropical America (Johnston 1971). *Colubrina asiatica* has been used as an abortifacient and for treating skin diseases (Quisumbing 1951). Species of *Colubrina* in the West Indies and Mexico have been used as an anthelmintic and for treating dysentery and skin diseases (Standley 1922–1926). Anticancer activity has been identified in six New World species, but not in *C. asiatica*. An ansamacrolid, colubrinol (Wani et al. 1973), isolated from *C. texensis* (Torr. & Gray) A. Gray, is related to maytansine, which has undergone clinical studies for cancer chemotherapy as discussed below. *Colubrina californica*, a closely related species to *C. texensis*, has also shown similar activity, but no medicinal reports could be found for these species.

3) *Maytenus* (Celastraceae) is a large pantropical genus of 150 or more species with relatively few species reported for medicinal purposes. One species in South America, *Maytenus ilicifolia* Mart. Ex Reiss., has been employed for treating a variety of ailments such as peptic ulcers, dyspepsia, gastralgia, enteritis, cystitis, insomnia, nervousness, acne, hemorrhoids, dysentery, and cancer (Hartwell 1967–1971; Morton 1968). In Mexico, *M. phyllanthoides* Benth. has been employed as a remedy for scurvy and toothache (Standley 1922–1926), and *M. pseudocasearia* Reiss. has been used to treat dysentery (von Reis Altschul 1973). In East and South Africa, four or five species have been used medicinally as remedies for amoebic dysentery, diarrhea, colic, malaria, epilepsy, “madness,” colds and cancer (Harington 1969; Watt & Breyer-Brandwijk 1962). Anticancer activity has been identified in 21 of 31 *Maytenus* species screened. An ansamacrolid, maytansine (Kupchan et al. 1972), isolated from several African species, underwent clinical trials for cancer chemotherapy. This was discontinued because of toxicity; however, there is renewed interest in derivatives of maytansinoids, which are less toxic (Bander et al. 2003; Larson et al. 1999).

4) *Ficus* (Moraceae) is a very large pantropical genus, ˜800 species (Airy Shaw 1973), and many *Ficus* species are employed medicinally for a variety of purposes throughout the tropics. Seventeen species had shown antitumor activity; yet, none have yielded compounds for clinical studies.

5) *Fritillaria* (Liliaceae) has about 85 species distributed in temperate regions of the northern hemisphere (Airy Shaw 1973). In China, species of *Fritillaria* are used for a wide variety of ailments that include cancer (Hartwell 1967–1971; Steinmetz 1962). In Europe and the Himalayas of India, several species have been used against asthma and tuberculosis (Steinmetz 1962). The NCI has screened species from Southeast Asia, Europe, and the United States; none have shown activity.

6) *Thamnosma* (Rutaceae) is a small genus of ~8 species with a spotty distribution: southern Africa, Arabia, Socotra and the southwestern United States (Airy Shaw 1973). Africans have smoked plants of *T. africana* Engl. to relieve chest conditions (Watt & Breyer-Brandwijk 1962). A decoction of the stems of *T. montana* Torr. & Frem. has been used by Native American tribes of Nevada for colds and as a tonic (Train et al. 1957). Both species have been screened by the NCI; neither was active.

It is apparent from these six cases that an objective analysis is difficult. Subjectively, one might weigh small genera (*Brucea*) more than large genera (*Ficus*), similar medicinal uses as opposed to different uses—among different cultures, spotty distribution as seen for species of *Brucea* and *Thamnosma*, over continuous distribution as in the case of *Ficus*, and to the kinds of medicinal applications, especially cancer (e.g., *Brucea, Fritillaria, Maytenus*) as opposed to treating colds (e.g., *Thamnosma*). In *Ficus* it might appear significant that many species are used medicinally in folklore; however, of 174 species of *Ficus* screened by the NCI, only 9.8% were active, which is slightly less than that of the random screen (10.4%). In the case of *Fritillaria*, however, there is no correlation evident due to lack of activity.

PLANTS USED AGAINST CANCER

Hartwell (1967–1971) compiled a record of more than 3,000 species of plants reported in folklore for treating cancer and other symptomatic conditions such as warts and tumors. The vascular plants included 2,725 species representing 1,201 genera and 185 families. An estimated two-thirds of the species and 86% of the genera were screened for antitumor activity based on sampling of four families (Fabaceae, Liliaceae, Rubiaceae, Rutaceae; Spjut & Perdue 1976); it was not practical to compare all 2,725 species in Hartwell against the record of 20, 225 species screened, as was done for the NCI record of 2,127 active species of which 314 active species were found in Hartwell (1967–1971). Thus, an extrapolated result is provided, indicating 17.3% active species and 46.5% active genera for those screened and used against cancer (Table 2).

The percentages of active species and active genera found in Hartwell's (1967–1971) record of plants used against cancer are comparable to that seen in the general references on medicinal plants (Table 2). It should be realized that the greater the number of species included in a study like that of Hartwell (1967–1971), the greater the number of species that will be represented with relatively narrower ranges in geographical distribution; thus, the impact of the more thoroughly screened, widely distributed species, will be less. The 1.7 fold increase in active species and the 1.8 fold increase in active genera over the random screen in Hartwell's (1967–1971) plants used against cancer is perhaps a more realistic assessment of the relationship between plants used in medicinal folklore and those that have shown antitumor activity in the NCI screen.

RELATIONSHIPS BETWEEN ANTITUMOR ACTIVITY AND MEDICINAL PLANTS, TOXIC PLANTS, AND POISONOUS PLANTS

General Surveys.—The percentages of active species in the general surveys (Table 2) indicated that poisonous plants, including those with medicinal uses, appear more likely to show antitumor activity than medicinal plants in general.

Antitumor activity among the different therapeutic uses (Appendix I) were also evaluated for evidence of a correlation with plant toxicity; for example, a plant used as an emetic will likely induce a stronger physiological reaction, which could also be more harmful if taken in excess, than a plant taken as a stimulant. In a further review of the 62 medicinal applications in Quisumbing (1951, Appendix I), ten were selected as representative of two therapeutic use categories: (1) five that represent a weak-to-moderate effect—stimulant, alterative, diaphoretic, aperient, and laxative—and (2) five that appear to exert a moderate-to strong physiological effect—purgative, cathartic, abortifacient, anthelmintic, and emetic. A comparison of the percentages of the active species in the two categories (Table 3) show that the percentages of active species are all higher in the moderate-to-strong category, suggesting, therefore, that plants with medicinal uses associated with possible toxic side affects are more likely to show antitumor activity than medicinal plants in general.

Plants Used as Anthelmintics.—Plants used as anthelmintics—those taken internally by humans for helminth infestations such as tapeworm, roundworm, guinea worm, elephantiasis and shistosomiasis—are included in Table 3 as an example of a medicinal application where one may expect a moderate to strong reaction in using a plant product that results in the expulsion or destruction of parasitic worms. Thus, from this perspective, the 30% active species of the 150 species listed in Quisumbing (1951) would appear to have a closer correlation with antitumor activity when compared to the 22.4% active species for all medicinal plants in that same reference, besides the less frequent active species among those therapeutic uses that imply a weaker physiological effect (Table 2, 3, Appendix I).

Nevertheless, an independent review of the literature was conducted to determine which species are reported as anthelmintics—because of Perdue's observation on such plants in Ethiopia that were also active in the NCI screen (Spjut & Perdue 1976). Recorded were 668 species in 457 genera and 128 families of which 482 species in 433 genera were screened. The active species, and the bioassay(s) in which they were active, are indicated in Appendix IV; a complete list of plants used as anthelmintics for this study with references to each species is available at www.worldbotanical.com. Of those tested, 29.3% of the species and 52.2% of the genera were active.

The 29.3% active for anthelmintic species is nearly three times that of the

Table 3. Antitumor activity as related to potency of therapeutic effect: selected medicinal applications from Quisumbing (1951).

	Therapeutic Use	Percent Active Species
Weak to Moderate in Effect		
	Stimulant	14.8
	Alterative	23.4
	Diaphoretic	23.1
	Aperient	22.5
	Laxative	20.6
Moderate-To-Strong In Effect		
	Purgative	25.7
	Cathartic	25.9
	Abortifacient	27.9
	Anthelmintic	30.0
	Emetic	32.1

random screen, and is clearly higher than that seen in general references on medicinal plants (Table 1), in particular the 22.4% found for all Medicinal Plants of the Philippines (Quisumbing 1951). These data support the finding that medicinal plants with indication of toxic side effects, such as the case with anthelmintics, are more likely to show biological activity, than medicinal plants in general.

Plants Used as Fish and Arrow Poisons.—As with anthelmintics, we compiled separate lists for plants used as fish and arrow poisons that also included ordeal and homicidal poisons (Spjut & Perdue 1976). These data can be found at www.worldbotanical.com; in this publication, only the active species with reference to the tumor assay are listed, Appendix V, VI.

The results, presented in Table 4, show that the percent active species among those tested was 38.6% for plants used as fish poisons and 45.7% for plants used as arrow, homicidal and/or ordeal poisons.

Plants used as poisons are obviously more toxic than those generally used for medicinal purposes, which are not employed for lethal purposes, but still can be deadly if taken in excess. One might also expect fish poisons to be somewhat less harmful than arrow poisons, because fish poisons are used to capture fish for consumption in which the fish are often only stunned, whereas arrow poisons are intended to kill. Data on antitumor activity that correlates with these differences (Table 4) are seen as another example of a correlation between plant toxicity and antitumor activity.

The correlation that is evident between poisonous plants and antitumor activity led to further evaluation in regard to the type of tumor activity, because activity in poisonous plants was suspected as largely occurring in the KB Cell Culture, a bioassay that is sensitive to cytotoxic agents (Hartwell 1976).

Table 4. Antitumor activity in poisonous plants.

Poisons	Genera tested	%Genera active	Species tested	%Species tested active
Fish	158	65.8	145	38.6
Arrow, Ordeal, & Homicidal	60	75.0	70	45.7

Data in Appendix III, IV, V, and VI, which indicate tumor system of activity with their percentages of active species and genera, confirmed this. These data are summarized in Table 5. The percentages of KB active species were found to be 6.7% for medicinal plants in The Philippines (Quisumbing 1951), 11.4% for anthelmintics, 20.7% for fish poisons, and 30.0% for arrow poisons, in contrast, for example, to activity in the WA assay that was 8.5%, 8.3%, 8.3%, and 7.1%, respectively. Clearly, there is correlation between antitumor activity and plant toxicity based on the KB assay and folklore data.

DISCUSSION AND CONCLUSIONS

Selective approaches to screening plants for antitumor activity have been conducted previously by taxonomy (Belkin & Fitzgerald 1953b), by taxonomy and medicinal use such as anti-malarial plants in the Amaryllidaceae (Fitzgerald et al.1958), and by specific medicinal or poisonous applications such as plants used as cathartics, diuretics and pesticides (Belkin et al.1952a; Belkin & Fitzgerald 1952b, 1953c). These and other similar experimental studies were limited to screening against Sarcoma 37. It is interesting to note that in the case with plants used as cathartics, nearly half of the species tested were active. This might be compared to another study by the same authors using the same bioassay in screening "miscellaneous plants" in which they found only 14% active (Belkin & Fitzgerald 1953a); a comparison that is analogous to the "random screen" in the present study.

One important discovery relating to these investigations came from the medicinal use of a root extract of May-apple, *Podophyllum peltatum* L. (Berberidaceae), known as "podophyllin." Hartwell (1960, 1976) indicated he had investigated podophyllin and samples of May-apple because of their use against cancer by practitioners in the United States and by the Penobscot Indians of Maine. Records for such use were found to date back to 1849; additionally, in Louisiana May-apple was used to treat venereal warts or as an "escharotic," dating back to 1845 (Hartwell 1960). Podophyllotoxin and two peltatins were isolated and found to be highly active in Sarcoma 37 (Hartwell & Shear 1947). Hartwell (1976) commented that the development of podophyllotoxin as a potential drug was complicated by toxicity, but also indicated "there is reason to hope that chemical derivatives may be developed which with will eliminate this disadvantage." "Etoposide" and "teniposide" are semi-synthetic derivatives

TABLE 5. Comparison of general and specific folk uses of plants with percentages of active species according to antitumor assay.

Folklore Use	KB	PS	WA	LL	SA
Medicinal Uses in General (Quisumbing 1951)	6.7	8.2	8.5	1.1	3.5
Anthelmintics	11.4	9.5	8.3	2.1	5.6
Fish Poisons	20.7	9.7	8.3	4.1	8.9
Arrow & Homicidal Poisons	30.0	18.6	7.1	1.4	1.4

currently in use as drugs to treat small-cell lung cancers, testicular cancer, carcinoma, and lymphomas (Moraes et al. 2002). Their development, known also as "VM-26" and "VP-213," came from 4'demethylpodophyllotoxin that was found in a Himalayan species, *Podophyllum hexandrum* Royle (Hartwell 1976).

Advocates of promoting folklore as the tool for discovery of biologically active compounds must recognize that there are a large number of widely distributed species that are frequently reported for use in medicines, and have already been chemically investigated. Examples of these, which have shown antitumor activity, are candlenut (*Aleurites molucanna* [L.] Willd.), custard apples (*Annona reticulata* L., *A. squamosa* L.), star fruit (*Averrhoa carambola* L.), cabbage (*Brassica olearacea*), paradise-flower (*Caesalpinia pulcherrima* [L.] Sw.), Indian laurel (*Calophyllum inophyllum* L.), safflower (*Carthamus tinctoris* L.), Madagascar periwinkle (*Catharanthus roseus* [L.] G. Don), coconut (*Cocos nucifera* L.), coffee (*Coffea arabica* L.), taro (*Colocasia esculenta* [L.] Schott), sunflower (*Helianthus annuus* L.), Indian heliotrope (*Heliotropium indicum* L.), beach morning glory (*Ipomoea pes capre* [L.] R. Br.), mango (*Mangifera indica* L.), China-berry (*Melia azedarach* L.), oleander (*Nerium oleander* L.), avocado (*Persea americana* Mill.), peach (*Prunus persica* L.), pomegranate (*Punica granatum* L.), bracken fern (*Pteridium aquilinum* [L.] Kuhn), mangrove (*Rhizophora mangle* L.), castor bean (*Ricinus communis* L.), nightshade (*Solanum nigrum* L.), teak (*Tectona grandis* L. f.), yellow oleander (*Thevetia peruviana* [Pers.] K. Schum.) (Tables 1 and 2 in Spjut 1985; Buckingham 1993–2005; USDA 1980), and most other species in Quisumbing (1951) that were found to be active in the NCI screen (Appendix III).

Uses for many of these active species date back to the early domestication of plants (Zohary & Spiegel-Roy 1975), a time when there was lack of concern for intellectual property rights or ownership that, for the most part, has evolved only since the last decade (Lesser 1997). Hartwell (1960) noted that cancer remedies can be found as early as 1500 B.C. in the Ebers papyrus of Egypt, that "plant remedies for cancer are described in ancient Chinese and Hindu medical writings," that "the record continues unabated through the Graeco-Roman period and the Christian and Arabian-Middle Ages to modern times," and that "the roster of the hundreds of medical, pharmacological and botanical works recommending herbal treatments for cancer reads like a summary of the great names in the history of medicine." I have further suggested that the various uses for many of the widespread species (e.g., Appendix III) are the result of cultural diffusion; thus, any indigenous ownership claim(s) for a particular use for a particular plant remedy cannot be easily substantiated. Cultural diffusion may also explain many medicinal uses for a species within a relatively narrow geographic area, as evident with plants used by Indian Tribes of Nevada (Train et al. 1957).

Although the occurrence of anticancer activity among plants used as folklore remedies, when compared with that for plants tested at random, suggests that folklore could be a useful tool for predicting sources of anticancer activity, there are also costs that have to be taken into consideration in trying to selectively pursue such plants (Hartwell 1976). A field team can randomly collect as many as 60 (-100) samples in a day from 10–30 species (Perdue & Hartwell 1969), whereas a more selective approach, as I have experienced with recollections of active plants, would yield only 1–2 samples per day. Thus, a random field collection could generate 1–3 new active leads each day, whereas it would require 2–3 days to obtain a similar result in a selective approach. It might be added that this folklore study was based on reports in literature. Obtaining such information directly in the field would cost even more. On the other hand, it is also evident from the data presented in this study that many of the alleged medicinal species would be collected in a random (biodiversity prospecting) screening program—because of their widespread occurrence. Furthermore, a biodiversity (random) type of approach undertaken systematically is not only less expensive, but will also yield novel compounds from plants not reported in folk literature (e.g., camptothecin from *Camptotheca acuminata*, Perdue et al. 1970), and provide a scientific foundation for identifying chemotaxonomic, ecological and other relationships of pharmacological value. Random collections can also include medicinal and/or poisonous plants in the collection strategy, the focus of which might be on genera that are clearly indigenous or endemic to a collection area, and would likely yield novel compounds.

The NCI screen involves more than just identifying leads such as the 2,127 active species reviewed in this study; other steps in drug development include isolating and identifying the active compounds, pharmacological evaluation of the active compounds, and clinical evaluation for treating cancer in three phases (Goldin et al. 1974). Criteria for clinical consideration during the 1970s had included activity in a panel of tumor systems such as the L-1210 Leukemia, KB Cell Culture, P-388 Leukemia, new Lewis Lung tumor, and B16 Melanoma (Goldin et al. 1974; Hartwell 1976). Compounds from only ~1% of the 2,127 active species had reached clinical evaluation—Table 1 in Hartwell (1976). Seventeen of 21 genera in Hartwell (1976, Table 1) were identified as having less of a taxonomic relationship to each other among the compounds of clinical interest (*Acer, Brucea, Camptotheca, Caesalpinia, Cephaelis, Cephalotaxus, Colchicum, Fagara, Heliotropium, Holacantha, Maytenus, Ochrosia, Stereospermum, Taxus, Thalictrum, Tripterygium, Tylophora*). With exception to *Camptotheca* and *Holacantha*, these genera were found to have species reported in the literature as poisonous. *Holacantha*, a genus of two species, has a very limited distribution in southwestern North America, thus, the lack of medicinal reports for this genus is not unexpected, although a closely related genus, *Castela*, includes species used in folk medicine (Standley 1922–1926). Similarly, *Camptotheca*, a monotypic genus of limited distribution in China, lacks reports on medicinal use except for one general reference on a herbarium specimen "drug plant" *F. A. McClure* 6546 at AA (Perdue et al. 1970). Of the remaining genera, all except *Cephalotaxus, Ochrosia, Tripterygium* and *Tylophora* have species reportedly used against cancer or cancer like symptoms (Hartwell 1967–1971).

It might be noted that nearly all active compounds in these plants were discovered from screening in the KB Cell Culture (Hartwell 1976). The correlation between anticancer activity and plant use indicative of toxicity might indicate that future screening of plant extracts could place more emphasis on bioassays that can detect cytotoxicity, such as the KB assay (Perdue 1982; Spjut & Perdue 1976); however, KB activity alone will not lead to development of a new anticancer drug, as evident for plants used as arrow poisons, in which 21% of the active species are strictly KB actives. Many of these plant poisons belong to genera in the Apocynaceae and Asclepiadaceae whose activity is largely due to cardenolides, steroid lactones that have not demonstrated much in vivo activity (Hartwell 1976, Table 15). Poisonous plants in two other families, Cucurbitaceae and Datiscaceae, have yielded only cucurbitacins, triterpenes that are toxic without in vivo activity (Hartwell 1976, Table 10; Cassady & Suffness 1980). Additionally, many other species of poisonous plants are in the Euphorbiaceae in which P-388 Leukemia activity was more frequent, but the compounds were largely phorbol esters (Suffness & Douros 1979). Such compounds are known to be tumor-promoting (Farnsworth et al. 1976), while also inactive in other antitumor assays (Suffness & Douros 1979; Cassady & Suffness 1980); however, one non-tumor promoting phorbol ester was found to have potential for treating AIDS (Gustafson et al. 1992).

Nevertheless, the extent to which plant genera include species reported in folklore to be poisonous, and also used in medicine, especially against cancer, certainly deserve further study. The potential for discovery of novel chemotherapeutic agents would appear greater when geographical evidence indicates similar uses in different cultures as earlier described for *Brucea* and *Maytenus*, while Hartwell (1967–1971) also mentioned that *Heliotropium indicum* and other species of this genus have been reported in folklore for treating cancer in scattered regions of the world. Thus, the relationship between anticancer activity and folklore appears more meaningful and less coincidental when there is this kind of support from taxonomic and geographic data. Future screening might focus on genera that have yet to show activity. A good example is *Fritillaria*, a genus reportedly rich in alkaloids with highly toxic species that are used for medicinal purposes, including cancer (Steinmetz 1962).

One of the most useful drugs in the chemotherapy of acute childhood leukemia (and other cancers), is vincristine from the periwinkle, *Catharanthus roseus* (L.) G. Don., one of the many widely distributed species used in folk medicine. This discovery resulted not from a search for antitumor activity, but was incidental to a search for compounds with hypoglycemic activity. The plant was under investigation in two different laboratories because of its folk use as a remedy for diabetes (Carter 1976). These facts, and the apparent correlation in this paper between various uses of medicinal plants and antitumor activity, suggest that antitumor activity should be looked upon as just one kind of biological activity that probably correlates well with a broad spectrum of other kinds of biological activity.

There is a growing interest in natural products as food additives and as alternative medicines, partly promoted by an awareness and need for biodegradable natural products to replace synthetic chemical compounds that increasingly contaminate our environment (Jacobson 1989). Where new kinds of biological activity are sought, such screening programs can benefit not only by taking into consideration folkloric uses of plants, but also the massive amount of data generated by the NCI random screen, such as the many novel antitumor agents that have been reported. Therefore, one would hope that the NCI continue screening of natural products. The byproducts of this program are invaluable as many compounds, undoubtedly, will find use in other therapies if they cannot be used to treat cancer. A case in point is recollections of antitumor active plants from which small amounts were funneled to Martin Jacobson at another ARS laboratory in Beltsville, MD who apparently found good insecticidal activity in many of the NCI active plants, e.g., *Arnica chamissonis* Less. ssp. *foliosa* (Nutt.) Maquire (USDA ARS Medicinal Plant Resources correspondence; data recorded for requests of recollections by active species and geographical location; www.worldbotanical.com; see also Jacobson 1989).

Finally, there is one aspect of the folk medicine that cannot be compared with the NCI's random method of searching for potential anticancer drugs. In folk medicine, prescriptions may include a combination of two or more plants, and/or other substances. This is especially common in Chinese medicine (American Herbal Pharmacology Delegation 1975). The separate ingredients of a prescription may not show activity, but one may speculate on whether there is a synergistic effect with combined materials as often seen in drug combination therapies.

APPENDIX I.
ANTITUMOR ACTIVITY IN QUISUMBING (1951) PLANTS ACCORDING TO THERAPEUTIC PROPERTIES

Therapeutic Property	Number of Species Listed	Number of Species Active	% of Species Active	Number of Genera Listed	Number of Genera Active	% of Genera Active
Abortifacient	61	17	27.2	58	63	74.1
Alexipharmic	20	8	40.0	20	16	80.0
Alterative	47	11	23.4	45	27	60.0
Anthelmintic	150	45	30.0	132	88	66.6
Antiarthritic	25	5	20.0	22	16	72.7
Antiasthmatic	83	22	26.5	74	49	66.2
Antibechic	121	22	18.2	99	57	57.6
Antibilious	27	8	29.6	25	14	56.0
Antiblennorrhagic	110	28	25.5	98	53	53.5
Anticatarrhal	36	8	22.2	34	20	58.8
Anticephalagic	96	23	24.0	89	50	56.2
Anticolic	71	18	25.4	69	46	66.6
Antidiabetic	35	8	22.9	31	22	71.0
Antidiarrhoetic	156	39	25.0	136	85	62.5
Antidyspeptic	60	15	25.0	54	34	63.0
Antidysenteric	177	43	24.3	150	86	57.3
Antiherpetic	26	9	34.6	25	13	52.0
Antimalarial	50	13	32.5	37	25	67.6
Antinephritic	23	3	13.0	22	7	31.8
Antineuralgic	22	5	22.7	21	12	57.1
Antiodontalgic	56	15	26.8	51	33	64.7
Antipyrotic	29	5	17.2	29	18	62.1
Antirheumatic	167	40	24.0	140	80	57.1
Antiscabious	77	17	22.1	67	43	64.2
Antiscorbutic	38	10	26.3	35	19	54.3
Antiseptic	42	10	23.8	39	25	64.1
Antispasmodic	49	15	30.6	46	30	65.2
Antisyphilitic	37	10	27.0	34	18	52.9
Antivenomous	50	9	18.0	46	22	47.8
Aperient	40	9	22.5	38	19	50.0
Aperitive	27	7	25.9	25	14	56.0
Aphrodisiac	48	9	18.8	47	27	57.4
Astringent	174	42	24.1	156	94	60.3
Carminative	92	11	12.0	80	44	55.0
Cathartic	27	7	25.9	24	18	75.0
Demulcent	64	11	17.2	59	33	55.9
Depurative	39	10	25.6	36	21	58.3
Diaphoretic	91	21	23.1	85	50	58.8
Digestive	27	8	29.6	25	16	64.0
Diuretic	220	53	24.1	181	107	59.1
Emetic	78	25	32.1	74	52	70.3

APPENDIX I. (CONTINUED)

Therapeutic Property	Number of Species Listed	Number of Species Active	% of Species Active	Number of Genera Listed	Number of Genera Active	% of Genera Active
Emmenagogue	132	34	25.8	119	72	60.5
Emollient	77	22	28.6	69	42	60.9
Expectorant	54	11	20.4	50	32	64.0
Febrifuge	222	53	23.9	191	112	58.6
Galactagogue	26	7	26.9	23	14	60.9
Hemostatic	36	8	22.2	35	19	54.3
Laxative	63	13	20.6	62	36	58.1
Lithotriptic	27	4	14.8	27	15	55.6
Narcotic	24	6	25.0	20	13	65.6
Pectoral	40	14	35.0	39	27	69.2
Poultice	218	41	18.8	178	85	47.8
Purgative	105	27	25.7	85	59	69.4
Refrigerant	53	6	11.3	48	29	60.4
Rubefacient	38	13	34.2	35	24	68.6
Sedative	31	5	16.1	27	13	48.1
Stimulant	108	16	14.8	89	50	56.2
Stomachic	145	34	23.4	125	76	60.8
Tonic	176	32	18.2	155	84	54.2
Tonics (bitter)	34	10	29.4	33	23	69.7
Vesicant	22	5	22.7	19	13	68.4
Vulerary	82	13	15.9	76	35	46.1

APPENDIX II.
ANTICANCER ACTIVITY IN QUISUMBING (1951) PLANTS ACCORDING TO SPECIFIC DISEASES

Medicinal Use	Number of Species Listed	Number of Species Active	% of Species Active	Number of Genera Listed	Number of Genera Active	% of Genera Active
Abscess	22	7	31.8	22	17	77.3
Alopecia	26	5	19.2	26	13	50.0
Amenorrhoea	29	5	17.2	27	18	66.7
Anasarca	57	17	29.8	54	37	68.5
Aphthae	57	17	29.8	54	37	68.5
Bronchitis	39	8	20.5	36	22	61.1
Cholera	29	6	20.7	27	16	59.3
Constipation	30	10	33.3	28	19	67.9
Ears, Affections of	36	8	22.2	32	19	59.4
Eczema	24	10	41.7	22	16	72.7
Eyes, Affections of	40	9	22.5	39	22	56.4
Furuncles	65	16	24.6	63	37	58.7
Gingivitis	19	6	31.6	19	14	73.7

APPENDIX II. (CONTINUED)

Medicinal Use	Number of Species Listed	Number of Species Active	% of Species Active	Number of Genera Listed	Number of Genera Active	% of Genera Active
Hemoptysis	26	3	11.9	26	11	42.3
Hemorrhoids	68	24	35.3	61	44	72.1
Indigestion	20	4	20.0	19	13	68.4
Jaundice	32	10	31.3	31	18	58.1
Leprosy	34	9	26.5	34	18	52.9
Liver Diseases	43	10	23.3	39	21	53.8
Menorrhagia	23	4	17.4	22	17	77.3
Nervous Diseases	50	16	32.0	48	34	70.8
Ophthalmia	21	9	42.9	21	15	71.4
Skin Diseases	123	29	23.6	105	55	52.4
Throat Diseases	57	16	28.1	49	34	69.4
Tinea	37	12	32.4	30	19	63.3
Tuberculosis	47	10	21.3	44	25	56.8
Ulcers	120	26	21.7	113	65	57.5
Wounds	128	26	20.3	111	69	62.2

APPENDIX III.

ANTITUMOR ACTIVE SPECIES IN QUISUMBING (1951) MEDICINAL PLANTS OF THE PHILIPPINES

Species	Tumors						
	KB	PS	WA	LL	SA	CA	Other
Abrus precatorius L.	1	1					
Albizia procera (Roxb.) Benth.			1				
Aleurites molucanna (L.) Willd.		1					
Allamanda cathartica L.	1						
Alstonia scholaris (L.) R. Br.		1					
Amorphophallus paenoiifolius (Dennst.) Nicolson			1				
Anacardium occidentale L.			1				
Anamirta cocculus Wight & Arn.		1					
Anaxagorea luzonensis A. Gray		1					
Annona muricata L.	1						
Annona reticulata L.	1	1					
Annona squamosa L.	1						
Antiaris toxicaria (Rumph. ex Pers.) Lesch.	1	1					
Arcangelisia flava (L.) Merr.		1					
Argemone mexicana L.	1						
Asclepias curassavica L.	1			1			
Averrhoa bilimbi L.		1					
Averrhoa carambola L.			1				

APPENDIX III. (CONTINUED)

Species	Tumors						
	KB	PS	WA	LL	SA	CA	Other
Bacopa monniera (L.) Wettst.	1		1				
Barringtonia asiatica (L.) Kurz					1		
Bauhinia malabarica Roxb.			1				
Boerhavia diffusa L.			1	1			
Brassica olearacea L.			1				
Bryophyllum pinnatum Kurz	1						
Caesalpinia pulcherrima (L.) Sw.			1		1		D1
Calotropis gigantea (L.) Dryander ex Aiton f.	1		1				
Calophyllum inophyllum L.		1			1		
Canna indica L.		1					
Capsicum frutescens L.					1		
Cardiospermum halicababum L.			1				
Carthamus tinctorius L.		1				1	
Cassia alata L.					1		
Cassia occidentalis L.			1				
Cassia siamea Lam.		1					
Casuarina equisetifolia L.	1						
Catharanthus roseus (L.) G. Don		1					
Ceiba pentandra (L.) Gaertner				1	1		
Celastrus paniculata Willd.	1						
Celosia argentea L.			1		1		
Centella asiatica (L.) Urban			1				
Cerbera manghas L.	1						
Cestrum nocturnum L.	1						
Clausena excavate Burm. f.		1					
Clerodenrdon fragans R. Br.			1				
Cocos nucifera L.					1		
Coffea arabica L.			1				
Coix lachryma-jobi		1					
Coleus blumei Benth.		1					
Colocasia esculenta (L.) Schott.			1				
Corchorus olitorius L.	1						
Cordia dichotoma Forst.			1				
Crateva religiosa Forst. f.			1				
Crescentia cujete L. (Roxb.) R. Br. ex Lindley			1				
Cryptostegia grandiflora	1						
Cyperus rotundus L.					1		
Datura metel L.			1				
Derris trifoliate Lour.	1						
Diospyros discolor Willd.		1	1				
Dodonaea viscose (L.) Jacq.					1		
Dregea volubilis (L.f.) Benth. ex Hook. f.			1				
Duranta repens L.		1					

APPENDIX III. (CONTINUED)

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Elephantopus scaber L.			1		1		
Elephantopus mollis Kunth	1	1					
Entada phaseoloides (L.) Merr.			1				
Erythrina variegata L.		1	1				
Erythroxylum coca Lam.		1					
Flagellaria indica L.			1				
Gloriosa superba L.			1				
Grangea maderaspatana Poir.			1				
Graptophyllum pictum Griff.			1				
Hedychium coronarium Koenig.		1					
Helianthus annuus L.		1					
Hernandia ovigera L.	1						
Homonoia riparia Lour.			1				
Hyptis suaveolens (L.) Poit.	1	1					
Ipomoea pes-capre L.		1	1				
Ixora coccinea L.		1					
Jatropha curcas L.		1					
Jatropha gossypifolia L.		1			1		
Jussiaea erecta L.	1						
Justicia procumbens L.		1					
Kalanchoe laciniata (L.) DC.	1						
Lagerstroemia indica L.					1		
Lansium domesticum Correa			1				
Lantana camara L.			1				
Leucaena glauca L.		1					
Lonicera japonicum Thunb.					1		
Lunasia amara Blanco	1						
Mallotus philippensis (Lam.) Muell.-Arg.					1		
Mangifera indica L.					1		
Manilkara zapota (L.) D. Royle	1						
Melia azederach L.	1		1	1			
Melia dubia Cav.	1						
Merremia umbellata (L.) Hall. f.		1					
Mimusops elengi L.			1				
Mirabilis jalapa L.			1	1	1		
Morus nigra L.			1				
Muntingia calabina L.	1						
Nerium indicum Mill.	1		1		1	1	
Nopalea cochinellifera (L.) Salm-Dyck		1					
Oldenlandia corymbosa L.					1		
Paspalum scrobiculatum L.		1					
Passiflora foetida L.		1					
Pedilanthus tithymaloides (L.) Poit.	1						

APPENDIX III. (CONTINUED)

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Persea americana Mill.		1					
Phragmites australis (Cav.) Trin. ex Steudel			1				
Physalis peruviana L.	1	1					
Pilea microphylla (L.) Liebm.		1					
Piper umbellatum L.	1						
Pithecellobium saman (Jacq.) Benth.		1					
Punica granatum L.	1						
Quassia amara L.	1	1					
Quisqualis indica L.			1				
Rhinacanthus nasutus Kurz	1						
Ricinus communis L.	1	1	1				
Rubia cordifolia L.			1				
Securinega virosa (Roxb. ex Willd.) Baillon			1				
Semecarpus cuneiformis Blanco	1		1	1			LE
Senecio scandens Buch. Ham.		1					
Setaria palmifolia (Koenig) Stapf		1					
Sida cordifolia L.		1					
Solanum nigrum L.			1	1	1		
Solanum verbascifolium L.					1		
Sonneratia acida L. f.			1				
Sphaeranthus africanus L.	1						
Streblus asper Lour.	1	1	1				
Tabernaemontana pandacaqui Lam.		1					
Tamarindus indicus L.			1				
Tectona grandis L.		1					
Tephrosia purpurea (L.) Pers.			1				
Terminalia catappa L.	1						
Theobroma cacao L.					1	1	
Thevetia peruviana (Pers.) Schumann	1	1					
Toddalia asiatica (L.) Lam.	1						
Toona calantas Merr. & Rolfe	1						
Trema orientalis (L.) Blume			1				
Trianthema portulacastrum L.			1				
Vernonia cinerea (L.) Less.			1				
Voacanga globosa (Blanco) Merr.		1					
Waltheria americana L.		1					
Total # Active: 140 Screened: 626	42	51	53	7	22	3	
Percent Active: 22.4%	**6.71%**	**8.15%**	**8.47%**	**1.12%**	**3.51%**	**0.48%**	

APPENDIX IV.
PLANTS USED AS ANTHELMINTICS THAT HAVE SHOWN ANTITUMOR ACTIVITY

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Abrus precatorius L.	1	1					
Acacia sieberiana DC.		1					
Acokanthera oblongifolia (Hochst.) L. E. Codd	1						
Acokanthera oppositifolia (Lam.) L. E. Codd	1						
Afrormosia latiflora (Benth. Ex Baker) Harms		1					
Agrostemma githago L.			1				
Ailanthus altissima (Mill.) Swingle	1						
Alangium salviifolium (L. f.) Wangerin	1	1				1	
Aleurites molucanna (L.) Willd.		1					
Alstonia scholaris (L.) R. Br.		1					
Ambrosia artemisiifolia L.	1						
Anacardium occidentale L.			1				
Annona glabra L.	1						
Annona muricata L.	1						
Annona reticulata L.	1	1					
Annona senegalensis Pers.	1						
Annona squamosa L.	1						
Apocynum androsaemifolium L.	1						
Apocynum cannabinum L.	1		1				
Apodytes dimidiata R. Meyer ex Arn.		1					
Arcangelisia flava (L.) Merr.		1					
Aristolochia indica L.						1	
Argemone mexicana L.	1						
Asclepias curassavica L.	1			1			
Averrhoa carambola L.			1				
Azadirachta indica A. Juss.	1						
Barringtonia asiatica (L.) Kurz					1		
Bauhinia variegate L.			1				
Bersama abyssinica Fresen.	1	1	1	1			
Bocconia arborea S. Wats.	1						
Boerhavia diffusa L.			1	1			
Brassica olearacea L.			1				
Bridelia micrantha	1	1	1				
Brucea antidysenterica (Hochst.) Baillon	1	1					
Brucea javanica (L.) Merr.		1					
Calocarpum sapota (Jacq.) Merr.	1						

APPENDIX IV. (CONTINUED)

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Calophyllum inophyllum L.		1			1		
Calotropis gigantean (L.) Dryander ex Aiton f.	1	1					
Calotropis procera (Aiton) Dryander ex Aiton f.	1						
Canavalia cathartica Thouars		1					
Capparis deciduas (Florsk.) Edgew.			1				
Carissa edulis Vahl		1					
Cassia alata L.					1		
Cassia auriculata L.	1						
Cassia occidentalis L.			1				
Catharanthus roseus (L.) G. Don		1					
Celosia argentea L.			1		1		
Citrullus lanatus (Thunb.) Masf.	1						
Clausena anisata (Willd.) Hook. f. ex Benth.		1					
Clausena excavata Burm. f.		1					
Clerodendrum indicum (L.) O. Kuntze					1		
Clerodendrum phlomoides L. f.			1				
Cocos nucifera L.					1		
Coix lachryma-jobi L.		1					
Cordia dichotoma Forst.			1				
Cornus florida L.					1		
Croton macrostachyus Hutch. ex Del.		1		1	1		
Croton megalocarpus Hutch.		1					
Cyperus rotundus L.					1		
Cryptostegia grandiflora (Roxb.) R. Br. ex Lindley	1						
Cypripedium calceolus L.					1		
Datura metel L.			1				
Dichroa febrifuga Lour.	1						
Dicranopteris linearis (Burm. f.) Underw.			1				
Dodonaea viscosa Jacq.					1		
Dryopteris filix-mas (L.) Schott					1		
Ekebergia capensis Sparrm.	1						
Elephantopus scaber L.			1		1		
Embilia schimperi Vatke					1		
Entada phaseoloides (L.) Merr.			1				
Erythrina variegata L.		1	1				
Erythrophleum suaveolens (Guill. & Perr.) Brenan	1						

APPENDIX IV. (CONTINUED)

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Ficus sterrocarpa Diels			1				
Gloriosa superba L.			1				
Helenium autumnale L.	1	1					
Helenium hoopesii A. Gray			1				
Hippomane mancinella		1					
Holarrhena pubescens (Buch.-Ham.) Wall.	1	1					
Jatropha curcas L.		1					
Juglans nigra L.					1		
Juniperus communis L.	1	1					
Jussiaea suffruticosa L.	1						
Lansium domesticum Correa			1				
Liriodendron tulipifera L.	1						
Luffa echinata Roxb.			1				
Maesa lanceolata Forsk.	1			1			
Mallotus philippensis (Lam.) Muell.-Arg.					1		
Mangifera indica L.					1		
Maprounea africana Muell.-Arg.		1					
Maytenus senegalensis (Lam.) Exell	1	1					
Melia azederach L.	1		1	1			
Melia dubia Cav.	1						
Morus nigra L.			1				
Myrica cerifera L.			1				
Myrsine africana L.					1		
Nauclea latifolia Sm.		1					
Nicotiana glauca Grah.	1						
Pergularia daemia (Forsk.) Chiov.	1	1					
Persea americana L.		1					
Physalis peruviana L.	1	1					
Phytolacca americana L.			1				
Pilostigma thonningii (Schumach.) Milne-Redh.	1				1		
Pinus palustris Mill.			1		1		
Pinus taeda L.					1		
Piper umbellatum L.	1						
Plectranthus blumei (Bent.) Launert		1					
Plumeria rubra L.		1					
Podophyllum peltatum L.	1						
Prunus persica (L.) Batsch.			1				FV
Prunus virginiana L.		1					
Pteridium aquilinum (L.) Kuhn.					1		

APPENDIX IV. (CONTINUED)

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Punica granatum L.	1						
Quassia amara L.	1	1					
Quisqualis indica L.			1				
Rapanea pulchra Gilg & Schellenb.		1	1				
Rhizophora mangle L.					1		
Rhus typhina L.	1			1			
Salvia officinalis L.					1		
Securidaca longipedunculata Fresen.		1					
Semecarpus anacardium L.	1		1	1			LE
Solanum nigrum L.			1	1	1		
Sphaeranthus africanus L.	1						
Sphaeranthus indicus L.			1				
Strychnos henningsii Gilg		1					
Tagetes minuta L.				1			
Tamarindus indicus L.					1		
Tanacetum vulgare L.	1	1					
Tectona grandis L.		1					
Tephrosia purpurea (L.) Pers.			1				
Tephrosia vogelii Hook. f.	1						
Terminalia cattapa L.	1						
Thuja occidentalis L.	1						
Toddalia asiatica (L.) Lam.	1						
Trema orientalis (L.) Blume			1				
Trichilia emetica Vahl	1						
Typha domingensis Pers.		1					
Urtica dioica L.					1		
Vernonia amygdalina Del.			1				
Vernonia cinerea (L.) Less.			1				
Vernonia colorata (Willd.) Drake		1					
Ximenia caffra Sond.		1					
Total # Active: 141	55	46	40	10	27	2	
Screened: 482							
Percent Active: 29.3%	**11.41%**	**9.54%**	**8.30%**	**2.07%**	**5.60%**	**0.41%**	

APPENDIX V.
ANTITUMOR ACTIVE PLANTS USED AS FISH POISONS

Species	Tumors						
	KB	PS	WA	LL	SA	CA	Other
Acacia albida Del.			1				
Acacia melanoxylon R. Br.	1				1		
Acacia pulchella R. Br.			1				
Acokanthera oppositifolia (Lam.) L.E. Codd	1						
Adenium obesum Balf. f.	1						
Aegiceras corniculatum (L.) Blanco			1				
Aesculus californica (Spach) Nutt.					1		
Agave americana L.	1			1	1		MS
Albizia procera (Roxb.) Benth.	1		1				
Anagallis arvensis L.					1		
Anamirta cocculus Wight. & Arn.		1					
Annona muricata L.	1						
Annona squamosa L.	1						
Asclepias curassavica	1			1			
Barringtonia asiatica (L.) Kurz					1		
Caesalpinia pulcherrima (L.) Sw.			1		1		D1
Calophyllum inophyllum L.		1			1		
Cassia alata L.					1		
Cerbera manghas L.	1						
Chlorogalum pomeridianum (DC.) Kunth.			1				
Cleistanthus collinus Benth.	1						
Croton sylvaticus L.	1	1					
Cucumis ficifolius A. Rich.	1						
Datisca glomerata (Presl.) Baillon	1						
Datura metel L.			1				
Derris trifoliata Lour.	1						
Diospyros maritima Blume		1					
Dodonaea viscosa Jacq.					1		
Eremocarpus setigerus (Hook.) Benth.		1					
Euphorbia esula L.		1			1		
Euphorbia hyberna L.				1			
Fagara macrophylla (Oliv.) Engl.	1						
Fluggea leucopyrus Willd.			1				
Gnidia kraussiana Meisn.		1					
Helenium autumnale L.	1	1					
Jatropha curcas L.		1					
Leucaena leucocephala (Lam.) Dewit.	1		1	1			

APPENDIX V. (CONTINUED)

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Lonchocarpus urucu Killip & Smith	1						
Mallotus philippensis (Lam.) Muell.-Arg.					1		
Melia azederach L.	1		1	1			
Millettia ferruginea (Hochst.) Bak.	1						
Mundulea sericea (Willd.) A. Chev.	1						
Pergularia daemia (Forsk.) Chiov.	1	1					
Persea americana Mill.		1					
Phyllanthus brasiliensis Muell.-Arg.		1					
Piscidia erythrina L.	1						
Pleiogynium solandri Engl.	1						
Sapindus saponaria L.	1						
Stephania abyssinica (Dillon & A. Rich.) Walp.	1			1			
Taxus baccata L.	1						
Tephrosia candida DC.	1						
Tephrosia purpurea (L.) Pers.			1				
Tephrosia vogelii Hook. f.	1						
Thevetia peruviana (Pers.) Schum.	1	1					
Verbascum phlomoides L.			1		1		
Voacanga globosa (Blanco) Merr.		1					
Total: 56 Active Species Screened: 145	30	14	12	6	12	0	2
Percent active: 38.6%	**20.69%**	**9.66%**	**8.28%**	**4.14%**	**8.28%**	**0.00%**	**1.38%**

APPENDIX VI.
ANTITUMOR ACTIVE PLANTS USED AS ARROW, HOMICIDAL, AND/OR ORDEAL POISONS

Species	**Tumors**						
	KB	**PS**	**WA**	**LL**	**SA**	**CA**	**Other**
Abrus precatorius L.	1	1					
Acokanthera longifolia Stapf	1	1					
Acokanthera oblongifolia (Hochst.) L.E.Codd	1						
Acokanthera oppositifolia (Lam.) L.E.Codd	1						
Acokanthera schimperi (A. DC.) Schweinf.	1						
Adenium obesum Balf. f.	1						
Amorphophallus campanulatus (Dennst.) Nicolson			1				
Antiaris toxicaria (Rumph. ex Pers.) Lesch.	1						
Boophone disticha Herb.		1					
Calophyllum inophyllum L		1			1		
Calotropis procera (Aiton) Dryander ex Aiton f.	1						
Canthium comprosoides F. Muell.			1	1			
Cassine crocea (Thunb.) Kuntze	1	1					
Cerbera mangas L.	1						
Cheiranthus cheri L.		1					
Derris trifoliata Lour.	1	1					
Erythrophleum africanum (Benth.) Harms	1		1				
Euphorbia candelabrum Tremaut ex Kotschy	1	1					
Fagara macrophylla (Oliv.) Engl.	1						
Gloriosa superba L.			1				
Hippomane mancinella L.		1					
Jatropha curcas L.		1					
Lansium domesticum Correa			1				
Lophopetalum javanicum (Thunb.) Kuntze		1					
Lunasia amara Blanco	1						
Parkia filicoidea Welw. ex Oliv.	1						
Rauvolfia mombasiana Stapf	1						
Securidaca longipenduculata Fresen.		1					
Strophanthus courmontii Franch.	1						
Strophanthus hispidus DC.	1						
Tephrosia vogelii Hook. f.	1						
Thevetia peruviana (Pers.)Schum.	1	1					
Total: 32 Active Species	21	13	5	1	1		
Screened: 70							
Percent active: 45.7%	**30.00%**		**18.57%**		**7.14%**	**1.43%**	**1.43%**

ACKNOWLEDGMENTS

I thank Gordon Cragg and three anonymous reviewers for their critical review and comments and Susan Spjut for her editorial suggestions.

REFERENCES

Airy Shaw, H.K. 1973. J.C. Willlis' dictionary of flowering plants and ferns (ed. 8), Cambridge Univ. Press, London.

Abbott, B.J. 1976. Bioassay of plant extracts for anticancer activity. Cancer Treat. Rep. 60:1007–1110.

American Herbal Pharmacology Delegation. 1975. Herbal pharmacology in the People's Republic of China. National Academy of Sciences, Washington, DC.

Bander, N.H., D.M. Nanus, M.I. Milosky, L. Kostakoglu, S. Vallabahajoslua, and S.J. Goldsmith. 2003. Targeted systematic therapy of prostrate cancer with a monoclonal antibody to prostrate-specific membrane antigen. Semin Oncol 30:667–677.

Barclay, A.S. and R.E. Perdue, Jr. 1976. The distribution of anticancer activity in higher plants. Cancer Treat. Rep. 60:1081–1113.

Belkin, M., D.B. Fitzgerald and N. Felix. 1952a. Tumor-damaging capacity of plant materials. II. Plants used as diuretics. J. Nat. Cancer Inst. 13:741–744.

Belkin, M. and D.B. Fitzgerald. 1952b. Tumor-damaging capacity of plant materials. I. Plants used as cathartics. J. Natl. Cancer Inst. 13:139–155.

Belkin, M. and D.B. Fitzgerald. 1953a. Tumor-damaging capacity of plant materials. V. Miscellaneous Plants. J. Natl. Cancer Inst. 14:607–625.

Belkin, M. and D.B. Fitzgerald. 1953b. Tumor-damaging capacity of plant materials. IV. Conifers. J. Natl. Cancer Inst. 13:895–903.

Belkin, M. and D.B. Fitzgerald. 1953c. Tumor-damaging capacity of plant materials. III. Plants used as pesticides. J. Natl. Cancer Inst. 13:889–893.

Boyd, M.R. The future of new drug development. In J.E. Neiderhuber, ed. Current Therapy in Oncology, B.C. Decker, Inc., Philadelphia. Pp. 11–22.

Buckingham, J. 1993–2005. Dictionary of natural products. Chapman and Hall/CRC Press, 1993 and hardbound supplements, 1994–1997, and CD ROM supplements, published at 6 month intervals.

Burkhill, I.H. 1935. A dictionary of the economic products of the Malay Peninsula. 2 Vols., London.

Cassady, J.M. and M. Suffness. 1980. Terpenoid antitumor agents. In J. Cassady and J. Douros, eds. Anticancer agents based on natural product models, Academic Press, New York. Pp. 201–269.

Carter, S.E. and R.L. Livingston. 1976. Clinical evaluation of drugs from plants. Cancer Treat. Rep. 60:1141–1156.

Chopra, R.N., S.L. Nayar, and I.C. Chopra. 1956. Glossary of Indian medicinal plants. Council of Scientific and Industrial Research, New Delhi.

Cragg, G.M., J.E. Simon, J.G. Jato, and K.M Snader. 1996. Drug discovery and development at the National Cancer Institute: Potential for new pharmaceutical crops. In: J. Janick, ed. Progress in New Crops, ASHS Press, Arlington, VA. Pp. 554–560.

Cuendet, M. and J.M. Pezzuto. 2004. Antitumor activity of bruceantin: an old drug with new promise. J. Nat. Prod. 67:269-272.

Dalziel, J.M. 1937. The useful plants of West Tropical Africa. Crown Agents for the Colonies, London.

Farnsworth, N.R., A.S. Bingel, H.H. S. Fong, A.A. Saleh, G.M. Christenson, and S.M. Saufferer. 1976. Oncogenic and tumor-promoting spermatophytes and pteridophytes and their active principles. Cancer Treat. Rep. 60:1171–1214.

Fitzgerald, D.B., J.L. Hartwell and J. Leiter. 1958. Tumor-damaging activity in plant families showing antimalarial activity. Amaryllidaceae. J. Natl. Cancer Inst. 20:763–774.

Geran, R.E., N.H. Greenberg, N.M. Macdonald, A.M. Schumacher, and B.J. Abbott. 1972. Protocols for screening chemical agents and natural products against animal tumors and other biological systems. Third ed. Cancer Chemotherapy Rep., Part 3(3):1–103.

Goldin, A., S. Carter and N. Mantel. 1974. Evaluation of antineoplastic activity: requirements of test systems. In O. Eichier, A. Farah, H. Herken, and A.D. Welch, eds. Handbook of experimental pharmacology, new series, Springer Verlag, Berlin and New York. Pp. 12–32.

Gustafson, K.R., J.H. Cardellina II, J.D. McMahon, R.J. Gulakowski, J. Ishitoya, Z. Szallasi, N.E. Lewin, P.M. Blumberg, O.S. Weislow, J.A. Beutler, R.W. Buckheit, Jr., G.M. Cragg, P.A. Cox, J.P. Bader, and M.R. Boyd. 1992. A nonpromoting phorbol from the Samoan medicinal plant *Homalanthus nutans* inhibits cell killing by HIV-1. J. Med. Chem. 35:1978–1986.

Hardin, J.W. and J.M. Arena. 1974. Human poisoning from native and cultivated plants. Second ed., Duke Univ. Press, Durham, NC.

Harington, J.S. 1969. Herbal Davis remedy, mixture—*Maytenus heterophylla, Sanseviera* sp. and *Scutia myrtina*, a written comm. to J. Hartwell at the NCI from the Head of The Cancer Research Unit of the National Cancer Association of South Africa, South African Institute for Medical Research.

Hartwell, J.L. 1960. Plant remedies for cancer. Cancer Chemother. Rep. 7:19–24.

Hartwell, J.L. 1967–1971. Plants used against Cancer. A survey. Lloydia 30:379–436, 1967 and ten additional installments ending with 34(4):286–437, 1971.

Hartwell, J.L. 1976. Types of anticancer agents isolated from plants. Cancer Treat. Rep. 60:1031-1067.

Hartwell, J.L. and M.J. Shear. 1947. Chemotherapy of cancer: Classes of compounds under investigation and active components of podophyllin. Cancer Res. 7:716.

Hartwell, J.L. and B.J. Abbott. 1969. Antineoplastic principles in plants: Recent developments in the field. In S. Garattini, A. Goldin, F. Hawking and L.J. Kopin, eds. Advances in Pharmacology and Chemotherapy, Vol. 7, Academic Press, New York and London. Pp. 117–209.

Jacobson, M. 1989. Focus on phytochemical pesticides. Vol. I, The neem tree. CRC Press, Inc., Florida.

Johnston, M.C. 1971. Revision of *Colubrina*. (Rhamnaceae). Brittonia 23:2–53.

Kingsbury, J.M. 1964. Poisonous plants of the United States and Canada. Prentice Hall, Englewood Cliffs, NJ.

Krochmal, A.C. 1973. A guide to the medicinal plants of the United States. Quadrangle, the New York Times Book Co, New York.

Kupchan, S.M., Y. Komoda, W.A. Court, G.J. Thomas, R.M. Smith, A. Karim, C.J. Kilmore, R. C. Haltiwanger, and R.F. Bryan. 1972. Maytansine, a novel antileukemic ansa macrolide from Maytenus ovatus. J. Amer. Chem. Soc. 94:1354–1356.

Kupchan, S.M, R.W. Britton, M.F. Siegler, and.M.F. Siegel. 1973. Bruceantin, a new potent antileukemic simaroubolide from Brucea antidysenterica. J. Org. Chem. 38:178–179.

Kupchan, S.M. 1976. Novel plant-derived tumor inhibitors and their mechanisms of action. Cancer Treat. Rep. 60(8):1115–1126.

Larson, G.M., B.T. Shanebergt and T. Sneden. 1999. Two new maytansinoids from *Maytenus buchananii*. J. Nat. Prod. 62:361–363.

Lesser, W.H. 1997. International treaties and other legal and economic issues relating to the ownership and use of genetic resources. In: K.E. Hoagland and A.Y. Rossman, eds. Global genetic resources: access, ownership, and intellectual property rights. Association of Systematics Collections, Washington, DC. Pp. 31–50.

Mata-Greenwood, E., J.F. Daeuble, P.A. Grieco, J. Dou, J.D. McChesney, J.R. Mehta, A.D. Kinghorn, and J.M. Pezzuto. 2001. Novel esters of glaucarubolone as inducers of terminal differentiation of promyelocytic HL-60 Cells and inhibitors of 7,12-dimethylbenz[a]anthracene-induced preneoplastic lesion formation in mouse mammary organ culture. J. Nat. Prod. 64:1509–1513.

Moraes, R.M., H. Lata, E. Bedir, M. Maqbool, and K. Cushman. 2002. The American mayapple and its potential for podophyllotoxin production. In: J. Janick and A. Whipkey, eds. Trends in New Crops and New Uses. ASHS Press, Alexandria, VA. Pp. 527–532.

Morton, J. 1968. A survey of medicinal plants of Curacao. Econ. Bot. 22:87–102.

Morton, J. 1974. Folk Remedies of the Low Country. E. A. Seemann Publ. Co., Miami.

Munz, P.A. 1959. A California Flora. Univ. California Press, Berkeley and Los Angeles (3rd Printing).

National Cancer Institute (NCI). 1977. Confirmed Plant and Animal Materials (CPAM) Reports. A Computer Printout, Drug Evaluation Branch (unpublished), Developmental Therapeutic Program, Division of Cancer Treatment, dated 30 September 1977, plant materials, 606 p.; animal materials, ~100p.

Newman, D., G.M. Cragg, and K.M. Snader. 2003. Natural products as sources of new drugs over the period 1981–2002. J. Nat. Prod., 66 (7), 1022–1037.

Perdue, R.E., Jr. 1976. Procurement of plant materials for antitumor screening. Cancer Treat. Rep. 60:987–998.

Perdue, R.E., Jr. 1982. KB Cell Culture: I. Role in discovery of antitumor agents from higher plants. J. Nat. Prod. 45:418–426.

Perdue, R.E., Jr. and J.L. Hartwell. 1969. The search for plant sources of anticancer drugs. Morris Arbor. Bull. 20(3):35–53.

Perdue, R.E., Jr., R.L. Smith, M.E. Wall, J. Hartwell, and B. Abbott. 1970. *Camptotheca acuminata* Decaisne [Nyssaceae] Source of Camptothecin, an Antileukemia Alkaloid, USDA Tech. Bull. 1415.

Quisumbing, E. 1951. Medicinal plants of the Philippines. Tech. Bull. 16, Philadelphia, Dept. Agric. and Nat. Res., Manila.

Reis Altschul von, S. 1973. Drugs and foods from little-known plants. Harvard Univ. Press, Cambridge, MA.

Sieber, S.M., J.A.R. Mead, and R.H. Adamson. 1976. Pharmacology of antitumor agents from higher plants. Cancer Treat. Rep. 50:1127–1139.

Spjut, R.W. and R.E. Perdue, Jr. 1976. Plant folklore: A tool for predicting sources of antitumor activity? Cancer Treat. Rep. 60:979–985.

Spjut, R.W. 1985. Limitations of a random screen: Search for new anticancer drugs in higher plants. Econ. Bot. 39:266–288.

Standley, P.C. 1922–1926. Tress and shrubs of Mexico. Contr. U.S. Natl. Herb., Washington Govt. Printing Office, Vol. 23.

Statz, D. and F.B. Coon. 1976. Preparation of plant extracts for antitumor screening. Cancer Treat. Rep. 60:999–1005.

Suffness M. and J. Douros. 1979. Drugs of plant origin. In V.T. DeVita and H. Busch, eds. Methods of Cancer Research Vol. 16:73–126.

Steinmetz, E.F. 1962. An effective anticancer drug? *Fritillaria cormus* and its possibilities for the cure of other stubborn diseases. Quarterly J. Crude Drug Res. 2:285–298.

Train, P., J.R. Henrichs and W.A.. Archer. 1957. Medicinal uses of plants by Indian Tribes of Nevada. Contributions toward a flora of Nevada, No. 45. Revised ed. with summary of pharmacological research by W.A. Archer. A series prepared through the cooperative of the National Arboretum and the Plant Introduction Section, USDA, ARS, Beltsville, MD.

United States Department of Agriculture (USDA). 1980. Combined list of genera extensively screened or completed (GESOC) and materials collected 6 or more times. Revised Feb. 14 (unpublished, available at www.worldbotanical.com).

Wall, M.E., M.C. Wani, C.E. Cook, and K.H. Palmer. 1966. Plant antitumor agents. I. The isolation and structure of camptothecin, a novel alkaloidal leukemia and tumor inhibitor from *Camptotheca acuminata*. J. Amer. Chem. Soc. 88:3888–3890.

Wall, M.E., M.C. Wani, and. H. Taylor. 1976. Isolation and chemical characterization of antitumor agents from plants." Cancer Treat. Rep. 60:1011–1030.

Wani, M.C., H.L. Taylor, M.E. Wall, P. Coggon, and A.T. McPhail. 1971. Plant antitumor agents. VI. The isolation and structure of taxol, a novel antileukemic and antitumor agent from *Taxus brevifolia*. J. Amer. Chem. Soc. 93:2325–2327.

Wani, M.C., H.L. Taylor, and M.E. Wall. 1973. Plant antitumor agents: colubrinol acetate and colubrinol, antileukaemic ansa macrolides from *Colubrina texensis*. Chem. Commun. P. 390.

Watson, A.M. 1983. Agricultural innovation in the early Islamic world. The diffusion of crops and farming techniques, 700-1100. Cambridge Univ. Press.

WATT, J.M. and M. BREYER-BRANWIJK. 1962. The medicinal and poisonous plants of southern and eastern Africa (2nd ed). E and S Livingstone, Ltd., Edinburgh and London.

WEBB, L.J. 1948. Guide to the medicinal and poisonous plants of Queensland. Bull. No. 232, CSIRO, J. J. Gourley, Govt. Printer, Melbourne, Australia.

WEINER, M.A. 1972. Earth medicine-earth foods (plant remedies, drugs, and natural foods of the North American Indians). MacMillan Publ. Co.

WILLIS, J.C. 1922. Age and area. Cambridge Univ. Press.

ZOHARY, D. and P. SPIEGEL-ROY. 1975. Beginnings of fruit growing in the Old World. Science 187:319–327.

BOOK NOTICES

Timber Press

JAMES CULLEN (text) with photographs by DEBBIE WHITE and FRIEDA CHRISTIE. 2005. **Hardy Rhododendron Species: A guide to Identification.** (ISBN 0-88192-723-6, hbk.). Published in association with the Royal Botanic Garden Edinburgh and Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $49.95, 496 pp., color photos, 7" × 9".

Publisher's comments.—"For the enthusiastic amateur or experienced rhododendron grower, this landmark reference provides the keys to the accurate identification of the nearly 300 rhododendron species widely in cultivation. An extensive introduction places the work in context as it examines the history of *Rhododendron* classification and gives a full survey of plant structures throughout the many species. Species are listed in systematic order, so that similar species occur close to each other in the text. These are fully described, including complete citations of previous references and notes on the occurrence of wild-origin specimens in cultivation. Beautiful photographs include close-up shots of flower and leaf, microscope images of leaf surfaces, and easy-to-use diagnostic keys, making this the indisputable volume for plant identification. A milestone in the identification of rhododendrons, this will become an essential reference for botanists, nurserymen, and enthusiasts.

Each taxonomic entry includes a description of one or more of the following: Synonymy, Illustration, Habit, Leaves, Vegetative Buds, Inflorescence Buds, Calyx, Corolla, Nectary, Stamens, Pollen, Ovary, Style, Stigma, Fruit, Seeds, Distribution, Flowering, Hardiness Zone, and additional notes.

Taxonomic keys are provided for subgenera, sections, and subsections.

PIET OUDOLF and NOEL KINGSBURY. 2005. **Timber Press Pocket Guide to Bulbs.** (ISBN 0-88192-740-6, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 175 pp., color photos, 9 1/2" × 11 1/2".

Publisher comments.—"This is a must-have book for designers, urban planners, landscape architects, and avid gardeners. The authors offer a planting philosophy as well as concrete advice; for instance, questions of scale and movement such as positioning entrances and paths, creating connective layouts, using plants as barriers and as conduits, and maintaining the designed space as plants grow."

ETHNOBOTANICAL REPORT FROM MANGROVES OF PICHAVARAM, TAMIL NADU STATE, INDIA

K. Venkatesan

Department of Botany
Annamalai University
Annamalainagar – 608 002
INDIA

V. Balakrishnan

Department of Botany
Annamalai University
Annamalainagar – 608 002
INDIA

K.C. Ravindran

Department of Botany
Annamalai University
Annamalainagar – 608 002
INDIA

V. Devanathan[1]

CAS in Botany
University of Madras
Guindy Campus
Chennai – 600 005, INDIA

ABSTRACT

Ethnobotany deals with the study of the natural and traditional interrelationships between man and plants. Mangroves are one of the primary features of coastal areas and play a significant role in coastal development. Mangrove areas are economically exploited, especially for timber and fishery products. A comprehensive knowledge about other aspects, such as active substances obtained from mangroves, is less freely available. This paper reviews the utilization of the mangroves as source of medicinal products for the Pichavaram coastal people. A floristic survey was undertaken and 11 ethnomedicinal plant species belonging to 8 families were recorded from the Pichavaram mangroves. A list of plant species along with the plant part/s used and their mode of application reported to be efficacious for different ailments is provided

RESUMEN

La Etnobotánica trata del estudio de las interrelaciones naturales y tradicionales entre el hombre y las plantas. Los manglares son una de las características primarias de las áreas costeras y juegan un papel importante en el desarrollo costero. Las áreas de manglar son explotadas económicamente, especialmente para madera y productos pesqueros. Un conocimiento exhaustivo de otros aspectos, tales como principios activos que se obtienen de los manglares, está menos disponible. Este artículo revisa el uso de los manglares como fuente de productos medicinales por los habitantes costeros de Pichavaram. Se realizó un estudio florístico y se encontraron 11 especies vegetales etnomedicinales de 8 familias en los manglares de Pichavaram. Se aporta una lista de especies vegetales junto con la parte o partes usadas y su modo de uso para que sean eficaces en diferentes enfermedades.

INTRODUCTION

Mangroves are assemblages of trees and shrubs that grow in the intertidal region of tropical and subtropical coastlines, in areas where river water mixes with sea water. Mangroves have two components, mangrove forests and their

---

[1] Corresponding author: venkat0503@rediffmail.com, CAS in Botany, Guindy Campus, University of Madras, Chennai 600 005, India.

SIDA 21(4): 2243 – 2248. 2005

associated water bodies. A group of woody trees and shrub that can grow well in saline water and logged condition constitute the forest component (Selvam & Karunakaran 2004). Pichavaram is in the North-East coastal part of Tamil Nadu State and lies between Lat.11° 27' N; Long. 79° 47' E.

The Pichavaram mangrove wetland is located in the northern extremity of the Cauvery delta, near the mouth of the Coleroon River. Its total area is about 1,350 ha, with its many small islands being colonized by thirteen true mangrove species. Remote sensing data indicates that nearly 54% of the mangrove forest of Pichavaram (total forested area 700 ha, excluding water bodies, sand dunes etc.) was in a degraded state in 1986. Analysis of the remote sensing data of 1996 showed that the mangrove forest cover has increased by about 60 ha compared to the area in 1987, which is mainly due to the restoration efforts being undertaken collaboratively by the Tamil Nadu Forest Department and M.S. Swaminathan Research Foundation along with the participation of the local communities. Pichavaram mangrove receives fresh water mostly during the northeast monsoon season from October to November. It is reported that 13 species are present in the mangrove wetlands, Tamilnadu; these include two species of *Rhizophora* in Pichavaram, which are regarded as endangered species, a fact that underlines the importance of the Pichavaram mangrove from a biodiversity stand point.

Currently there is an increasing desire to unravel the centuries old secrets of traditional medicines. In India, ethnobotanical studies with a good scientific base have appeared in last 1–5 decades (Chopra et al. 1956; Jain 1963, 1965; Jain & Borthakur 1980; Bhargara 1981; Yadav & Patil 2001).

MATERIALS AND METHODS

An ethnobotanical survey of the forest people of Pichavaram mangrove was undertaken during the 2001–2002. Through repeated interactions and participatory rural appraisal (PRA), details on the ethnobotany of the plants used by the folk population were gathered with villagers using the methods described by Jain (1983). According to Jain (1987) samples of plants were collected, identified and voucher specimens were deposited in the Department of Botany, Faculty of Science, Annamalai University, Annamalainagar, Tamilnadu. The collected plants were identified using the flora of the Presidency of Madras (Gamble & Fischer 1915–1935) This paper describes the most important medicinally used plants.

RESULTS

The traditional knowledge system in Tamilnadu State is fast eroding. There is an urgent need to record all ethnobotanical information among the diverse ethnic communities before the traditional culture is completely lost. As of result of the present study the ethnobotanical use of 11 plant species belonging to 8 families have been reported from the Pichavaram mangrove area. A range of preparations are used to treat diseases. The most popular medicinal preparations are plant extract, decoction, paste and juice. Information on botanical name, herbarium number, local name, family, diseases cured/uses, parts used and mode of application are given in the Table 1.

DISCUSSION AND CONCLUSION

There is an increasing demand for the production of healthcare medicines and cosmetic items from plant origin based on the ancient knowledge in folk remedies. Plant sources are being identified for further investigation for their pharmacological properties and efforts are also being made to investigate the activities of isolated individual constituents.

Eleven species of mangroves were identified as medicinally important for the treatment of snakebite, skin diseases, dysentery, urinary disorders as well as for birth control and as blood purifiers.

Communities (Irulars and Meenavars) living close to and interacting with the Pichavaram mangrove wetlands have gained a unique cognitive understanding of the medicinal values of the plants within the mangroves. Experience has led to a rich knowledge system that is reflected in the native classifications of mangrove wetlands.

The role of ethnobotanical studies is of crucial importance as some miraculous medicines for incurable diseases are known to the local communities. As knowledge acquired through the ages is usually passed on from generation to generation, it is necessary to popularize the identity and utility of these medicinal plants.

Management systems are losing their value because of various factors. Any assistance to protect these traditional systems will win the confidence of the local people; this in turn will be the first step toward the success of community-based mangrove conservation and management. The collection and documentation of traditional knowledge on ethnomedicines is important for finding new, effective safe drugs for a range of ailments. However, to give more support to the above findings, further investigation is needed for the isolation of the active principles and for the pharmacological evaluation of different medicinal plant species.

The estimation of the number of endangered medicinal plants is rising day by day (Jain 1992). Medicinal plants are threatened due to over exploitation, shifting cultivation, deformation and environmental pollution (Karuppusamy et al. 2002). The conservation of medicinal plants not only saves local lives but also improves the socio economic condition of the people where the plants exist. The following strategies have been suggested for the conservation of medicinal plants.

Table 1. Ethnobotanical report from mangroves of Pichavaram, Tamil Nadu State, India.

Latin Name/Family (Voucher Specimen)	**Local Name**	**Disease Cured/Uses**	**Parts Used**	**Mode of Application**
Acanthus ilicifolius L., Acanthaceae (*AUB 102*)	Kazhimulli	Snakebite	Fruits	Crushed fruits are made into a dressing and applied as a dressing to the snake bite.
		Kidney stones	Whole plant	The whole plant is boiled in water and the patient drinks the final solution, half of a glass each time until the signs and symptoms of the kidney stones disappear.
		Skin diseases, small pox, health promotion, detoxification and ulcer	Whole plant	A whole plant paste is applied to the affected body for skin diseases. The juice is orally given for other diseases.
Avicennia alba Blume, Avicenniaceae (*AUB 108*)	Vellaikandal	Birth control	Resin	Resinous substances are mixed with water and given orally.
Avicennia officinalis L., Avicenniaceae (*AUB 110*)	Narikandal	Bone pain, urinary disorders, bronchial asthma, stomach disorders and detoxification	Leaves	The leaves are boiled in water and the extract is given orally
Bruguiera cylindrica (L.) Blume, Rhizophoraceae (*AUB 532*)	Pannukkuchi	Tumor inhibitors, constipation	Leaves	Leaves contain alkaloids. A leaf paste is applied to the tumor.
			Whole plant	The whole plant is boiled in water and the solution is drunk twice daily after meals
Clerodendron inerme Gaertn., Verbenaceae (*AUB 428*)	Peenarisangu	Pain, jaundice,	Leaves	A leaf paste is used.
		washing dishes	Sap of leaves	Leaf sap is used
		malaria, infected wounds, anti-inflammation and itching skin	Leaf extract	Leaf extract and paste is used.

TABLE 1. (continued)

Latin Name/Family (Voucher Specimen)	**Local Name**	**Disease Cured/Uses**	**Parts Used**	**Mode of Application**
Excoecaria agallocha L., Euphorbiaceae (*AUB 483*)	Thillai	Toothache	Latex	A latex extracted from leaves and bark is applied to the tooth.
		Anti-inflammation	Roots	Fresh root material is used.
Ipomoea pes-caprae (L.) Sweet, Convolvulaceae (*AUB 325*)	Adappankodi or Kuthiraikulambu	Wandering and swelling	Whole plant	A whole plant extract is used.
		Skin diseases	Leaves	A leaf paste is used.
		Fatigue	Seeds	Crushed seeds are used.
Rhizophora mucronata Lam., Rhizophoraceae (*AUB 372*)	Kanthal	Diarrhea, nausea and vomiting	Bark	A bark extract is given orally.
Rhizophora apiculata Blume, Rhizophoraceae (*AUB 333*)	Kandal	Diarrhea, vomiting, ameobiasis and stop bleeding	Bark	A bark extract is given orally.
Salicornia brachiata Roxb., Chenopodiaceae (*AUB 238*)	Kozhikali or Seethavavazham	Itches	Whole plant ash	The plant ash is applied to the skin.
Xylocarpus granatum K.D. Koenig Meliaceae (*AUB 267*)	Somundri	Dysentery	Bark	A bark extract is used.
		Illumination of hair	Oil	Oil extracted from the seeds is applied to the hair.
		Diarrhea and cholera	Bark	A bark decoction is given orally.

a) Control over exploitation

b) Establishment of mangroves

c) Cultivation of rare and endangered medicinal species

d) Awareness creation of the utility and conservation of medicinal plants to local communities

ACKNOWLEDGMENT

The authors wish to express their gratitude to K.P. Chellappan, Dean, Faculty of Science (retired) and R. Panneerselvam, Professor and Head, Dept. of Botany, Annamalai University, for their encouragement and help in various ways. Two anonymous reviewers greatly improved the manuscript.

REFERENCES

Bhargava, N. 1983. Ethnobotanical studies of the tribes of Andaman and Nicobar islands, India. Onge. Econ. Bot. 37:1101–119.

Chopra, R.N., S.L. Nayar, and I.C. Chopra. 1956. Glossary of Indian medicinal plants. Council of Scientific and Industrial Research, New Delhi, India.

Gamble, J.S. and C.F.C. Fischer. 1915-1935. Flora of the Presidency of Madras. London (issued in II parts: 1–7 by Gamble, 8-11 by C.E.C. Fischer), vols. (1–3) Calcutta.

Jain, S.K. 1963. Studies in Indian ethnobotany-less known uses of fifty common plants from tribal areas of Madhya Pradesh. Bull. Surv. India 5:223–226.

Jain, S.K. 1965. Medicinal plant lose of the tribals of Bastar. Econ. Bot. 19:236–250.

Jain, S.K. 1983. Ethnobotany in India – An overview. BSI, Howrah, India. Pp. 1–37.

Jain, S.K. 1987. A manual of ethnobotany, Oxford Publishers, Jodhpur, India.

Jain, S.K. 1992. Ethnobotanical aspects of Indian tropical ecosystems. In: K.P. Singh and J.S. Singh, eds. Tropical ecosystem, ecology and management. Wiley Eastern Ltd., New Delhi, India. Pp. 507–511.

Jain, S.K. and S.K. Borthakur. 1980. Ethnobotany of the mikirs of India. Econ. Bot. 34:264–272.

Karuppusamy, S., K.M. Rajasekaran, and N. Karmegam. 2002. Medicinal plant resources of Dindigul district of Tamil Nadu. J. Natcon 14(1):151–158.

Selvam, V. and V.M. Karunakaran. 2004. Ecology and biology of mangroves. M.S. Swaminathan Research Foundation, Taramani, Chennai: 7.

Yadav, S.S. and H.S. Patil. 2001. Traditional medicines and healthcare system of tribals of Satpuda Region, Maharashtra State. Plant Archives 1(1&2):111–118.

PINGUICULA VULGARIS (LENTIBULARIACEAE) AND ITS USES IN NORWAY

Torbjørn Alm

Department of Botany
Tromsø Museum
University of Tromsø
N-9037 Tromsø, NORWAY

ABSTRACT

Pinguicula vulgaris is a common species in Norway, and well known in folk tradition, not least for its reputed use to curdle milk. Most vernacular names recorded so far, e.g. the widespread *tettegras* or *tettegress* ("rennet grass" or "thickening grass") reflect this use. The fat leaves have also found some uses in folk medicine, e.g. to treat wounds and ringworms, and in folk veterinary medicine, mainly to treat sore teat. There are also a few records of *P. vulgaris* being used as an apotropaic, in magic, and in children's games.

NORWEGIAN SUMMARY/NORSK SAMMENDRAG

Pinguicula vulgaris er vanlig i Norge, og godt kjent i folketradisjonen, ikke minst for sin virkning som tette i melk. De fleste folkelige navn på arten gjenspeiler denne egenskapen, f.eks. det vidt utbredte *tettegras* eller *tettegress*. Bladene har også funnet en viss anvendelse i folkemedisinen, bl.a. til å behandle sår og ringorm, og i folkelig veterinærmedisin, særlig som en kur for såre spener. I noen få tilfeller har *P. vulgaris* også tjent som verneråd, i magi og i barnelek.

INTRODUCTION

Of the three *Pinguicula* species found in Norway, *P. vulgaris* L. is by far the most widespread. It is found almost throughout the country, and in many different environments, from near sea level to 1570 m a.s.l. in interior southern Norway (Elven 1994:559). *P. alpina* L. is more demanding in terms of habitats, preferring calcareous substrates, and the tiny *P. villosa* L. is restricted to *Sphagnum* hummocks on oligotrophic mires in interior SE Norway and northeastern North Norway (Alm 2000).

All three species share the typical characteristics of the genus *Pinguicula*: a rosette of insect-trapping leaves, secreting a viscous, enzymatic fluid in the presence of small insects or other prey (Casper 1966; Heide 1912; Heslop-Harrison & Heslop-Harrison 1980, 1981; Heslop-Harrison & Knox 1971; Legendre 2000; Warming 1886). *P. vulgaris* belongs to the subgenus *Pinguicula* (Casper 1966; Legendre 2000; cf. Jobson et al. 2003). Christen (1961) studied the species from a pharmacological point of view.

In Scandinavian folk tradition, the leaves of *Pinguicula vulgaris* have been used as *tettegress*, "thickening grass" or "rennet grass," to treat or preserve milk, but how this was done, the characteristics of the product, and the mechanism

SIDA 21(4): 2249 – 2274. 2005

behind are disputed (Brøndegaard 1971). The use for dairy products in particular has attracted the attention of numerous authors, e.g. Bergsåker (1982), Brøndegaard (1951, 1971), Evjen (1986), Forsén (1966), Gisler (1749), Gunnerus (1774), Jæger-Lejrvik (1959), Olsen-Sopp (1912), Ränk (1960, 1971), and Weisæth (1990). Høeg (1974) provides much information on the ethnobotany of *P. vulgaris* in Norway. Larsson (1988) carried out an extensive survey of vernacular names in the Nordic countries (see also comments in Hansson 1990). Wix (1995, 1996) provided some notes on traditional uses in Scandinavia, but the language barrier kept him from checking more than a few references.

SCOPE AND SOURCES

This paper aims at a comprehensive review of ethnobotanical traditions related to *Pinguicula vulgaris* in Norway. It should be noted that *P. alpina* may also have served as *tettegress*, although all sources that identify the species (and not only the genus) mention only *P. vulgaris* (e.g. Bergsåker 1982; Bjørndal 1949; Brøndegaard 1971; Gunnerus 1774; Høeg 1974; Kirkevoll 1940; Sortdal 1981; Tonning 1773), or note that the plant used had blue flowers (e.g. Klonteig 2000 and seven letters in NFS Manum). Several voucher specimens confirm the identification as *P. vulgaris*, e.g. in the18th century herbarium of J.E. Gunnerus (in TRH), the 1837-39 herbarium of the linguist Ivar Aasen (Lid 1941), and some vouchers in TROM.

Throughout Norway, *P. vulgaris* or *tettegras/tettegress* is well known in folk tradition. Numerous authors mention its use in milk. Much useful information is found in the vast collection of Norwegian ethnobotanical data assembled by Ove Arbo Høeg in the period 1925 to 1973. However, his large volume (Høeg 1974) makes little use of previous publications.

In addition to data from about seventy publications providing data on Norwegian traditions, some archival data have been incorporated here, mainly from NEG (Norsk etnologisk gransking/Norwegian ethnological survey), NFS (Norsk folkeminnesamling/Norwegian folklore collection) and NOS (Norsk ordbok, seddelarkivet/Norwegian dictionary, card archive). Furthermore, some data have been excerpted from my own ethnobotanical records, mainly from North Norway; these are referred to as EBATA + year and record number. Informants are not identified here; transcripts and some recordings of the original interviews are stored at the Department of Botany, Tromsø Museum (TROM). Unless otherwise stated, all citations have been translated from Norwegian.

Vernacular names

No record of any Norse name for *Pinguicula vulgaris* seems to exist; the species is not mentioned by Heizmann (1993). The oldest surviving record, *Marie sko* ("Mary's shoe"), was made at Bergen in 1599, and is found in the diary of Sivert Grubbe (Rørdam 1873). It is an unusual name (see Table 1), although a couple of other vernacular names referring to the Virgin Mary are known. They are obviously younger than the Christianization of Norway, and must have been coined after AD 1000.

Most Norwegian vernacular names for *Pinguicula vulgaris* reflect its use for making *tettemelk* or "thickened milk" (Fig. 1). *Tette* may be translated as "rennet" (otherwise known as *kjæse* or *løpe* in Norwegian), but the etymological meaning or root is "(make) thick, thight, compact" (Bjorvand & Lindeman 2000; Torp 1919). A straightforward *tettegras* or *tettegress* ("rennet grass" or "thickening grass"), with some dialectal variations, predominates over large areas (Table 1). Exceptionally, it may also occur in place-names, e.g. *Tettgrasmyra* in Trysil (Kvernbekk 1979:64). *Kjæsegras/gress* ("rennet grass") reflects similar use. Several names on *melk-, mjelk- and mjælk-* ("milk") refer to the use in dairy products. Other vernacular names refer to the fat and/or slimy appearance of the leaves, e.g. *feitgras*, "fat grass" (Tonning 1773:4), *sleipgras*, "slippery grass" (Høeg 1974:473), *slimgras*, "slime-grass" (Tonning 1773:4), *såpeblomme*, "soap flower" (Halvorsen 1988:188), and the North Sámi *vuodjalasta* ("butter leaf").

Melkekors ("milk cross") and other names containing *kors* or *kross* ("cross") obviously refer to the leaf rosette. According to Brøndegaard (1971), it may have reminded people of the cross-shaped lower end of traditional churning sticks, but available records would rather suggest that people thought that the leaf rosette looked like a cross or star.

Pinguicula vulgaris in pastures

Pinguicula vulgaris is hardly a very frequent pasture-grass for cattle or sheep. In some areas, the plant was considered harmful, by adversely affecting milk. People believed that milk would become thick if the cows consumed *P. vulgaris*, as recorded at Tolga, Trysil and Åsnes in Hedmark (Furuset 1980:126; Reichborn-Kjennerud 1922:87; NFS Manum), Øyer in Oppland (NEG 69:15278), Tjøme in Vestfold (NEG 69:14491), Marnadal in Vest-Agder (NEG 69:15544), Jølster in Sogn og Fjordane (NEG 69:14404), and other stations in southern Norway (Høeg 1974:491). In Gausdal (Oppland), Vestad (1984:60) was told that "the milk could become thick if the cows ate much of this grass." At Trysil in Hedmark, people had noted that milk products could become thick and sour during the summer. In such cases, they believed that the cows had grazed *tettgubbe* ("thickening old man"), according to Furuset (1980:126) either *P. vulgaris* or *Drosera* spp. In Troms, N Norway, people claimed that such effects of *Pinguicula vulgaris* occurred mainly in the autumn (Alm 1983:393).

Some believed *P. vulgaris* to be poisonous, as reflected in the vernacular name *sprenggras* ("burst grass") in Central Norway (Høeg 1974:492). It was said to be harmful for horses, sometimes for cattle or sheep. Strøm (1762:112) noted that "a few" people at Sunnmøre in W Norway considered *P. vulgaris* as harmful to sheep, though he does not specify in which way. A similar belief is reported

Fig. 1. In Norwegian folk tradition, *Pinguicula vulgaris* has been much used to make thickened milk. A commercial product based on a *P. vulgaris* culture, "Tjukkmjølk," made by Rørosmeieriet, is now on sale nationwide. It was also the first food product in Norway with a "controlled origin" label. In accordance with folk tradition, it is more viscous than ordinary (rennet-based) thickened milk. Photograph by Jorunn Marie Rødli and Mari Karlstad.

from Telemark by Wille (1786), but people there also claimed that sheep avoided the plant. Farmers in Valdres, interior SE Norway, believed that it caused a liver disease in sheep (Kirkevoll 1940:174). At Singsås in Sør-Trøndelag, Central Norway, *P. vulgaris* was believed to cause colic in cattle (Høeg 1974:492). In other areas, no such negative effects on grazing animals were known. In his topographical description of Gudbrandsdalen in SE Norway, Hiorthøy (1785) noted that "Whether this herb is harmful to the sheep, as stated by Mr. Strøm, is not known here."

Folk medicine

In Norwegian folk tradition, *Pinguicula* has found some, but restricted use for medicinal purposes. It was mostly used externally. A decoction of the leaves in water could be used to remove lice from children, and to promote the growth of fair hair: "When the leaves are boiled in water, and the children's heads are washed with it, lice are purged, and the hair grows, and also gets a yellow colour" (Tonning 1773:5). Mohr (1786:152) noted similar use.

In Hallingdal (Buskerud, SE Norway), an ointment was made by boiling

Table 1. Alphabetical list of Norwegian vernacular names for *Pinguicula vulgaris* (original spelling, if different from present-day Norwegian, is indicated). Municipalities (communes) are given is possible. "Numedal area" and similar records indicate vernacular names that may derive from several municipalities within the given area.

Norwegian	**English translation**	**Area and source**
Adam og Eva	Adam and Eve	Troms: Kvænangen (EBATA 2004:7)
Blåstjern	Blue star	Nord-Trøndelag: Nordli (Høeg 1974:493)
Feitegras	Fat grass	Norway, unspecified (Reichborn-Kjennerud 1922:87)
Feitgras	Fat grass	Norway, unspecified (Tonning 1773:4, as Feit-Gras)
Feitgress	Fat grass	Norway, unspecified (Viborg 1793:15, as Feitgræs; Hornemann 1806:20, as Feitgræs)
Feittstjerna	Fat star	Troms: Sørreisa (Høeg 1974:493)
Flogfangar	Fly-catcher	Nordland: Vefsn (Lundestad 1992:35; Øksendal 1977:99, 1993:110)
Geitablom	Goat flower	Hordaland: Kvinnherad (Høeg 1974:493)
Geitmjølk	Goat milk	Sør-Trøndelag: Selbu (Høeg 1974:493)
Giftgras	Poison grass	Sør-Trøndelag: Røros (NFS O.A. Høeg)
Gjeitfettblomster	Goat-fat-flowers	Sør-Trøndelag: Bjugn: Stjørna (Høeg 1974:493)
Gjetslek	Goat's lick	Hedmark: Tolga (Høeg 1974:493)
Gjøketunge	Cucoo's tongue	Hedmark: Elverum (Høeg 1974:493)
Istegras	Curdle grass	Buskerud: Sigdal (NEG 69:14517)
Kinnekross	Butter bucket cross	Hordaland: Fusa; Sund: Hamre; Masfjorden; Sogn og Fjordane: Aurland; Balestrand (Høeg 1974:493); Nordland: Steigen (Høeg 1974:493)
Kjæsegras	Rennet grass	Norway, unspecified (Reichborn-Kjennerud 1922:87); Telemark: Notodden: Bolkesjø (Djupedal 1959:65), Seljord (Ross 1895:397), Tinn (Klonteig 2000:83)
Kjæsegress	Rennet grass	Telemark (Wille 1786:122, as Kjæse-Græs)
Kjerringkjeft	Old woman's mouth	Telemark: Vinje (Høeg 1974:493)
Kjokkmjølkgras	Thick-milk-grass	Sør-Trøndelag: Soknedal (Høeg 1974:493)
Korstroll	Cross-troll	Sør-Trøndelag: Holtålen: Ålen (Høeg 1974:493)
Kukors	Cow cross	Hordaland: Fusa: Hålandsdal (Høeg 1974:493)
Maria tåregress	Mary's tear grass	Nordland: Rana (unpublished note by A. Blytt 1870, as Mariæ Taaregræs)
Marie sko	Mary's shoe	Hordaland: Bergen (Rørdam 1873:405, diary note by Sivert Grubbe, July 6, 1599)
Maritetta	Mary's rennet	Hordaland: Ulvik (Høeg 1974:492)

Table 1. (continued)

Norwegian	English translation	Area and source
Melkekors	Milk cross	Norway, unspecified (Viborg 1793:15; Hornemann 1806:20); Sogn og Fjordane: Vågsøy: Nordre Vågsøy (Høeg 1974:493); Møre og Romsdal: Sunnmøre area (Strøm 1756:fol. 66a, as Melcke-Kaarset; Strøm 1762:111, as Mælke-Kors)
Melkekross	Milk cross	Sogn og Fjordane: Lærdal (NFS Manum)
Mjelkekors	Milk cross	Sogn og Fjordane: Førde, Naustdal (Høeg 1974:493), Jølster (NEG 69:14362); Møre og Romsdal: Sunnmøre (Aasen 1860:10)
Mjelkgras	Milk grass	Hordaland: Sund (Høeg 1974:493)
Mjelkgress	Milk grass	Nordland: Grane (Høeg 1974:493)
Mjelkkross	Milk cross	Hordaland: Sunnhordland area (Høeg 1974:493)
Mjeltekors	Milk cross	Norway, unspecified (Schübeler 1888:184); Møre og Romsdal: Ørsta: Vartdal (Høeg 1974:493)
Mjølkegras	Milk grass	Hedmark: Eidskog, Os (Høeg 1974:493)
Mjølkekors	Milk cross	Hedmark: Eidskog (Fjellstad 1966:171); Vest-Agder: Farsund: Lista; Hordaland: Fusa, Kvam, Strandbarm, Stord, Tysnes; Sogn og Fjordane: Balestrand, Bremanger, Høyanger: Lavik, Leikanger, Lærdal, Sogndal, Vik; Møre og Romsdal: Herøy (Høeg 1974:493)
Mjølkekross	Milk cross	Sogn og Fjordane: Høyanger (NFS Manum); Møre og Romsdal: Sunnmøre area (Aasen 1860:10)
Mjølkrot	Milk root	Sør-Trøndelag: Selbu (Høeg 1974:493)
Mjøltekross	Milk cross	Norway, unspecified (Schübeler 1888:184)
Myrbukk	Mire buck	Sogn og Fjordane: Jølster (Høeg 1974:493)
Myrstjerne	Mire star	Nordland: Hadsel, Tjeldsund (NFS O.A. Høeg); Troms: Berg (NEG 69:14465); Finnmark: Alta (NEG 69:14465).
Orm(e)gras	Worm grass	Telemark: Nissedal; Møre og Romsdal: Halsa (Høeg 1974:493)
Ringormblomst	Ringworm- flower	Nordland: Sortland (Høeg 1974:493); Troms: Tromsø (NFS O.A. Høeg)
Ringormgras	Ringworm-grass	Oppland: Lillehammer: Fåberg (Høeg 1974:493); Telemark: Nissedal (NFS O.A. Høeg); Nordland: Steigen, Sortland (Høeg 1974:492-493); Troms: Skånland, Sørreisa (Høeg 1974:493)

Table 1. (continued)

Norwegian	**English translation**	**Area and source**
Ringormgress	Ringworm grass	North Norway, unspecified (NFS Gade-Grøn 49, as ringormgræs)
Såpeblomme	Soap flower	Telemark: Vinje (Halvorsen 1988:198)
Sinagras	*Sina* grass	Rogaland: Sandnes: Hetland (Høeg 1974:493)
Skåleblom	Cup flower	Aust-Agder: Bykle (Høeg 1974:493)
Sleipgras	Slippery grass	Nordland: Brønnøy: Velfjord (Høeg 1974:493)
Slimgras	Slime-grass	Norway, unspecified (Tonning 1773:4, as Sliim Gras)
Slimgress	Slime-grass	Norway, unspecified (Viborg 1793:15, as Sliimgræs; Hornemann 1806:20, as Sliimgræs—both probably based on Tonning 1773)
Smørkross	Butter cross	Sogn og Fjordane: Aurland, Luster: Hafslo (Høeg 1974:493)
Snigleblom	Snail flower	Møre og Romsdal: Vågsøy: Nordre Vågsøy (Høeg 1974:493)
Sniglegras	Snail grass	Møre og Romsdal: Vågsøy: Nordre Vågsøy (Høeg 1974:493)
Sprenggras	Burst grass	Hedmark: Tolga (Reichborn-Kjennerud 1922:87); Sør-Trøndelag: Holtålen: Haltdal, Ålen, Melhus, Midtre Gauldal: Singsås, Tydal (Høeg 1974:493)
Tætgras	Thickening grass	Nordland: Hattfjelldal (unpublished note by H. Christiansen)
Tættegras	Thickening grass	Nordland: Rana (Heltzen 1834/1981:63); Troms: Tromsø (Solvang 1924:28)
Tættegras	Thickening grass	Nordland: Rana (Heltzen 1834/1981:63); Troms: Tromsø (Solvang 1924:28)
Tættegress	Thickening grass	Troms: Tromsø or Lyngen: Ullsfjord (NEG 69:17443); Finnmark: Sør-Varanger (NFS O.A. Høeg 90)
Tættgras	Thickening grass	Nordland: Vega (Engen 1975)
Tetegras	Thickening grass	Oppland: Østre Toten (Høeg 1974:492)
Tetta	"Rennet"	Hordaland: Ulvik (Høeg 1974:492)
Tettagras	Thickening grass	Østlandet (Høeg 1974:472); Rogaland: Finnøy: Sjernarøy (NEG 69:14326), Karmøy: Torvastad (NEG 69:14655), Suldal (Sandvik 1991:283)
Tette	"Rennet"	(Høeg 1974:492)
Tetteblad	Thickening leaf	Hordaland: Hardanger area (NFS Manum)
Tetteblomst	Thickening flower	Hedmark: Folldal (NFS Manum), Stange (NFS Manum); Oppland: Lillehammer (NFS Manum); Akershus: Skedsmo (NFS Manum); Hordaland: Hardanger (NFS Manum); Troms: Tromsø (EBATA 2001:7)

TABLE 1. (continued)

Norwegian	English translation	Area and source
Tettegras	Thickening grass	Norway, unspecified (Aasen 1860:10; Ramus 1715:270); Hedmark: Eidskog (Fjellstad 1966:171), Elverum (NEG 69:14267), Folldal (NEG 69:14554), Grue (NFS Manum), Tynset (NEG 69:14262), Åsnes: Hoff (NEG 69:14372); Oppland: Begndal (Hagen 1950:281), Fron (Jenshus 1986:181), Gausdal (Vestad 1984:60; NEG 69:15596), Lillehammer (NFS Manum); Sør-Aurdal (NFS Manum), Sør-Fron (NFS Manum), Vestre Slidre (NOS, note by G. Kirkevoll), Valdres area (Kirkevoll 1940:174; Lineikro 1975:53; NOS, note by O. Hegge), Øyer (NEG 69:15278); Østfold: Spydeberg (NEG 69:14290); Buskerud: Hemsedal (NEG 69:14904), Hol (NOS, note by G. Sollien), Nore og Uvdal (NEG 69:14398), Numedal area (Flatin 1918:56), Ringerike (NFS Manum); Vestfold: Andebu (NOS, note by O. Bråvoll & O. Berg), Telemark: Kragerø (NFS Manum), Porsgrunn: Brunlanes (NEG 69:14363), Tinn (Klonteig 2000:78); Aust-Agder: Birkenes: Herefoss (NEG 69:14380), Risør: Sønderled (NEG 69:14279); Valle (NEG 69:14307), Åmli: Gjøvdal (NEG 69:14289); Vest-Agder: Kvinesdal (NEG 69:14375), Vennesla (NEG 69:14370); Rogaland: Forsand (NEG 69:14391), Gjesdal (NEG 69:20503), Hjelmeland: Fister (NEG 69:14344), Hå: Nærbø, Sandnes: Høgsfjord (NOS, note by T. Hannaas), Time (NEG 69:14366), Vindafjord: Imsland (NEG 69:15141); Hordaland: Askøy: Lavik (NOS, note by T. Hannaas), Bømlo (NEG 69:14392), Etne (NEG 69:15226), Lindås (NEG 69:14477), Os (NOS, note by T. Hannaas), Ullensvang (Skre & Skre 1974:53), Voss (NEG 69:14284); Sogn og Fjordane: Askvoll (NOS, note by T. Hannaas), Jølster (NEG 69:14404), Stryn (NOS); Møre og Romsdal: Averøy: Kvernes (NEG 69:14320), Fræna (NEG 69:14259), Hareid (Bjørndal 1949:121), Sunndal: Øksendal (NEG 69:14954), Vanylven (NEG 69:14885, 19514), Volda (NEG 69:14302), Ålesund: Borgund (NEG 69:15171); Sør-Trøndelag: Agdenes (NEG 69:14294), Hemne (NEG 69:14387, 14400), Holtålen: Haltdalen (NEG 69:14282), Midtre Gauldal: Singsås, Soknedal and Støren (NEG 69:14508, 14300, 14281), Selbu (Evjen 1986:63), Snillfjord (NEG 69:17287); Nord-Trøndelag: Levanger: Skogn (NEG 69:14579), Lierne: Nordli

TABLE 1. (continued)

Norwegian	English translation	Area and source
		(NEG 69:14345), Steinkjer: Sparbu (NEG 69:14330), Verdal (NEG 69:14384); Nordland: unspecified (NEG 69:14356), Bindal (NEG 69:14368), Grane (NEG 69:14274), Hattfjelldal (NEG 69:14312; NOS, note by Hallfrid Christiansen), Brønnøy: Velfjord (Strompdal 1938:73), Vefsn (NEG 69:16462), Meløy (NEG 69:14468), Beiarn (NEG 69:14621), Skjerstad (NEG 69:21821), Bodø: Kjerringøy (NEG 69:14468), Lofoten area (Blix 1971:218-219), Vestvågøy (NOS, note by Hallfrid Christiansen); Troms: Harstad (Alm 1983:393), Berg (Høeg 1974:492)
Tettegres	Thickening grass	Telemark: Skien (NFS Manum)
Tettegress	Thickening grass	Norway, unspecified (Gunnerus 1772:20, as Tætte-Græss; Hornemann 1806:20, as Tættegræs; Schübeler 1888:184, as Tettegræs; Tonning 1773:4, as Tætte-Græs; Viborg 1793:15, as Tættegræs); Oppland: Gudbrandsdalen area (Hiorthøy 1785, as Tette-Græs), Vestre Toten (NFS Manum); Buskerud: Kongsberg (G.T. Holm in a 1750's manuscript, printed in Høeg 1940:95, as Tætegræss); Sogn og Fjordane: Sunnfjord area (Arentz 1802:87, as Tette-Græs); Møre og Romsdal: Nordfjord area (Krogh 1813:289, as Tættegræs), Sunnmøre area (Strøm 1756:fol. 66a, as Tette-Græsset, 1762:111, as Tette-Græs); Sør-Trøndelag: Meldal (NFS Manum), Selbu (NEG 69:21925), Nord-Trøndelag: Grong (NEG 69:14263), Verdal (Gunnerus 1768:81, as Tætte-Græs); Nordland: Hattfjelldal (NFS Manum), Beiarn (NEG 69:14359), Hamarøy (EBATA 2005:70), Andøy (EBATA 2005:52); Troms: Harstad (Alm 1983:393; NEG 69:14547), Dyrøy (NEG 69:22808), Torsken (EBATA 1984:6), Balsfjord (NEG 69:20627), Tromsø (EBATA 2005:44, 50), Lyngen or Tromsø: Ullsfjord (NEG 69:17443), Storfjord (Nilsson & Johansen 1994:49), Kåfjord (NEG 69:16667), Skjervøy (EBATA 2005:45), Kvænangen (NEG 69:20974); Finnmark: Hammerfest (EBATA 2001:1, 2005:2), Kvalsund (EBATA 2005:13), Måsøy (EBATA 1994:1), Lebesby (NEG 69:22155), Sør-Varanger (annotated voucher specimen by A.B. Wessel in TROM)
Tettegubbe	Thickening old man	Akershus: Skedsmo (NFS Manum); Troms: Tromsø (EBATA 2005:43)
Tettemjølkgras	Thickened-milk grass	Nord-Trøndelag: Meråker (Høeg 1974:493)

Table 1. (continued)

Norwegian	English translation	Area and source
Tetteplante	Thickening plant	Vestfold: Tjøme (NEG 69:14491); Telemark: Drangedal (NFS Manum); Troms: Lenvik (EBATA 2004:23)
Tettgras	Thickening grass	Hedmark, widespread (Høeg 1974:492), Elverum (Øvrebø 1939:4), Åsnes (NFS Manum); Oppland, widespread (Høeg 1974:492), Dovre (Solberg 1937:229); Møre og Romsdal: Tingvoll (Sortdal 1981:22; NEG 69:14381); Sør-Trøndelag: Oppdal (Rise 1947:51); Nord-Trøndelag: Nærøy: Foldereid (NEG 69:14309)
Tettgubbe	Thickening old man	Hedmark: Elverum (Høeg 1974:492; NFS Manum); Trysil (Furuset 1980:126, name also used for *Drosera* spp.); Akershus: Skedsmo: Lillestrøm (Høeg 1974:492); Sør-Trøndelag: Orkdal: Geitastrand (Høeg 1974:492); Troms: Bardu (Høeg 1974:492)
Tettmelkplante	Thickened-milk plant	Nord-Trøndelag: Steinkjer (NFS Manum)
Tettplante	Thickening plant	Hedmark: Rena (NFS Manum)
Tettskjørgull	Thickening fragile gold	Sør-Trøndelag: Meldal (Høeg 1974:493)
Tittagras	Thickening grass	Østlandet, unspecified (Høeg 1974:492); Rogaland: Hå: Nærbø (NEG 69:14367)
Titte	"Rennet"	Norway, "rare" (Høeg 1974:492)
Tittegras	Thickening grass	Hordaland: Odda (NEG 69:22415)
Tittegubbe	Thickening old man	Sør-Trøndelag: Selbu (Høeg 1974:492; NFS Manum)
Tjettblad	Thickening leaf	Sør-Trøndelag (Weisæth 1990:84)
Tjettgras	Thickening grass	Nord-Trøndelag (Høeg 1974:492), Steinkjer: Beitstad (NEG 69:15202) and Egge (NEG 69:14295)
Tjettgras	Thickening grass	Sør-Trøndelag (Weisæth 1990:84)
Tjettgress	Thickening grass	Nord-Trøndelag (Høeg 1974:492), Grong: Hauan (NEG 69:14280)
Tussebetgras	Gnome-bite grass	Buskerud: Hallingdal (Mehlum 1891:397; Reichborn-Kjennerud 1922:87)
Vassfiol	Water violet	Telemark: Vinje: Mosli (Høeg 1974:493)
Vibefeit	Lapwing fat	Nordland: Beiarn (NEG 69:14261)
Ystegras	Curdle grass	Buskerud: Krødsherad (Mørch 1976:993)

the plant, and used to treat what people considered to be *tussebitt* ("gnome bites"), usually infected wounds (Mehlum 1891:397; Reichborn-Kjennerud 1922:87). Høeg (1974:492) noted that the leaves were used for wounds, e.g. in Modalen (Hordaland, W Norway) and Rana (Nordland, N Norway). A slightly more frequent medicinal use was to cure ringworms, recorded at Lillehammer (Hedmark, SE Norway), Sortland (Nordland), Sørreisa, Berg, and perhaps Tromsø (Troms), the four latter all in N Norway (Høeg 1974:492; Reichborn-Kjennerud 1922:87, 1941:56; NFS Gade-Grøn 49). The mode of use was simple: "The root [rosette] leaves were used for ringworms. They rubbed the leaves around the sick part." (NFS O.A. Høeg). In Fåberg, SE Norway and Rana, N Norway, the leaves were used to treat warts. They have also served as a cure for eczema in Troms (Høeg 1974:492) and in Porsanger, Finnmark (EBATA 2005:84), N Norway.

Folk veterinary medicine

Locally, *Pinguicula vulgaris* has found some use in folk veterinary medicine, again mainly as an external ointment. Some used it to treat wounds (Høeg 1974:492; Kirkevoll 1940:174). According to the latter author, it was mixed with linseed oil in Valdres (Oppland, SE Norway). *P. vulgaris* was also used as a cure for sore teat. Sámi herdsmen used the leaves of *Pinguicula* to treat sore teat in reindeer (Gunnerus 1772; Tonning 1773:5), and Norwegian farmers used it for cows in Lærdal and Vik (Sogn og Fjordane, W Norway), and for cows and goats in central Norway (Høeg 1974:492; Weisæth 1990:84). The record from Lærdal is instructive:

(...) this is *Melkekrossen* ["the milk cross"]. It grows on wet rocks and in damp places. At home, we used to boil it with some kind of fat. It was used to anoint the teat of cows when they were sore or cracked. This was a good, old advice which we used when I was at the summer farm at home in Sværefjorden. Perhaps it is still used." (NFS Manum, letter dated 28 September 1958).

In Etnedal (Oppland) and Hægeland (Aust-Agder), Høeg (1974:492) recorded local use of *P. vulgaris* to calm down cows who had already mated. According to Storaker (1928:63), it was also used to cure some kind of "bone disease" in cattle.

Calendar

A wide range of plants have served as calendar marks in Norway, e.g. to indicate when the harvest could start. *Pinguicula vulgaris* is not an important one, but has found at least local use, a tradition first noted by Hans Strøm in his 1756 diary:

"When *Tette-Græsset* or *Melcke-Kaarset* has sprouted, one uses this as a sign, that the cattle are fed [will find sufficient pasture] and may, without danger, be let out to feed on the grass." (Strøm 1756:fol. 66a, cited from Standal *et al.* 1997:143).

Høeg (1974:492) noted a similar tradition, i.e. that the cows could survive outdoors when the rosettes of *P. vulgaris* appeared, at some stations in Western Norway. In a few cases, flowering is suggested as the marker, but this gives an unlikely, late date.

Apotropaic and magical uses

In parts of western Norway, *P. vulgaris* is known as *mjølkekross* ("milk cross") and similar names. The plant was placed in the milk bucket the first time the cows were milked outdoors in spring (Høeg 1974:491-492); the same tradition applied to *Potentilla erecta* (L.) Räuschel. In both cases, the practice served mainly as an apotropaic, based on a kind of similarity magic: putting the "fat" leaves of *Pinguicula vulgaris* or the yellow flowers of *Potentilla erecta* into the milk bucket should ensure a good yield of fat and yellow butter. A fine account is available from Høyanger in Sogn og Fjordane, W Norway:

"I know this plant well. (...) It was called *mjølkekross*. In spring, during the first evening the cows were milked outdoors, we had to burn *bueld* ["farm or cattle fire"]. That is, we collected wood and juniper (*sprake*) to make a fire. While it was burning, the cows should be milked, and in the milk bucket, there had to be a fine *mjølkekross*. This should ensure a good yield of milk during the summer. I was told so by an old dairy maid when I accompanied her while she was milking the cows." (NFS Manum, undated [1958] letter).

The observation had been made some 45 years earlier, i.e. about 1913, when the female informant had visited the neighbouring farm and repeatedly participated in the "bueld" ritual. Her great-grandmother had done the same thing, but kept it secret—as is often the case with such magic rites (additional letter from the same female informant in NFS Manum).

Exceptionally, *P. vulgaris* has also served other magical purposes. At Ringerike (Ådal) in SE Norway, people believed that if the plant was laid under the pillow for the night, the girls would dream of their coming husband (NFS Manum). Children in Dalsfjord (Volda, W Norway) believed that finding much *P. vulgaris* meant they would recover all their sheep when the pasture season was over in the autumn (Høeg 1974:492).

Children's games

Pinguicula vulgaris is hardly an attractive plant for children, though it may at least arouse their curiosity. The only record of any use in children's games derive from the island of Seiland in Finnmark, N Norway: "As children we used the rosette as soap. It was somewhat slippery and slimy and felt like handling soap." (EBATA 2005:2).

Use in dairy products

According to widespread lore in Norway, the leaves of *P. vulgaris* were used to treat milk, which although turning sour, would still retain a better taste than if left untreated, and also gain a desired "thick" quality. (Bergsåker 1982; Grude 1945:106; Hovdhaugen 1971:34; Sandvik 1991; Schübeler 1888:185; records in NEG, NFS, and NOS). Høeg (1974:490) collected information on such use from 83 municipalities in Norway. However, descriptions of the actual process of preparing such milk differ widely in folk tradition, as do the ascribed qualities or characteristics of the product. Several aspects need to be clarified: how "tettemelk" was made, the product and its characteristics, why it was made, and, finally, geographical distribution and time-line.

Preparation

"Thickened" milk could be made in several different ways. Most frequently, it was made by adding a small amount of *tette* or rennet, often just a spoonful, as a starter culture. This *tette* could, however, derive from various sources. At least in the 19th and 20th century, rennet from the belly of slaughtered calves was the most frequently used source of rennet in Norwegian peasant societies. It contains a proteolytic enzyme and various milk bacteria, and its ability to produce curdled milk is well documented (cf. Wix 1995, 1996).

Contrary to this, the effect of *tette* made from *Pinguicula vulgaris* is disputed. Ramus (1715:270), Gunnerus (1772), Tonning (1773) and other 18th century authors found no reason to doubt that *tettegress* could be used to prepare thickened milk. An early account is found in the 1756 diary of Hans Strøm, in a section detailing the plant lore of Kvamsøya in Sande, Møre og Romsdal, W Norway:

"This herb is also placed in the milk which by this shall gain a fine taste, or perhaps become thicker." (Strøm 1756:fol. 66a, cited from Standal et al. 1997:143).

In his *Flora norvegica*, also a rich source of plant-lore, Gunnerus (1772:20) included only a very short note on the ethnobotany of *P. vulgaris*: "Norv. *Tætte-Græss* (qvia adhibetur lacti hyperboreo parando)." A much more detailed account of the way *tettemelk* was prepared is found in his 1774 treatise on dairy products in Norway:

"Thick sour milk is much used for food in Norway, and when prepared for this purpose, one mostly uses *Tætte*" (...) "to make it thick, by which it acquires a better taste. For *Tætte* is used the well-known, so-called *Tætte-Græs* (*Pingvicula vulgaris*), of which the leaves are put in a dish of fresh milk, which thereafter thickens and becomes so sticky, that it may be drawn out in long threads. Subsequently, this *Tætte* will pass its quality on to other milk, into which a spoonful is mixed, just as has already been noted by Mr. von Linné in his *Flora lapponica n. XI. p. 10. litt. 3. de lacte compacto hyperboreo*; and this thick milk, which in this way passes on to further milk, into which it is mixed, the same character, has from this property acquired the name: *Tætte-Melk*." (Gunnerus 1774:142-143).

Tonning (1773) added some interesting details, including observations on the time of year for such practice, and the supposed economic benefits:

"In some places in Norway, when the summer is at its warmest, and the milk will not easily curdle, but rather usually becomes sour too quickly, the peasant wives places the fat and slimy leaves of this herb in the sieve, through which the fresh milk is passed, which in two or three days gives the so-called Tæt-Melk (*Lac hyperboreum*). This kind of milk, which thereby becomes so thick and viscous, that it may be drawn out in long strings, is very economic in numerous rural households, since it may be mixed either with fresh milk, or with water, and thereby greatly increased [in quantity]." ... "Such *Tæt-Melk* is not known to be used in other places than in Norway and Sweden." (Tonning 1773:4-5).

At Gudbrandsdalen in SE Norway, Hiorthøy (1785) recorded the following procedure:

"This grass is collected and placed in the milk vessels, so that the milk should more rapidly curdle and become thick. A spoonful of such milk is subsequently used for other milk vessels, since it has the same effect as the grass itself" [i.e., served as a starter culture] (Hiorthøy 1785:99).

Klonteig (2000) provides a detailed account of the procedure used at Tinn in Telemark, SE Norway. He also noted that *P. vulgaris* had to be collected in spring, while it was growing.

"They rubbed clean wooden cups, troughs or buckets with this leaf rosette [of *P. vulgaris*]. Then they poured fresh milk into the cup. It is left standing until the milk thickens and gets suitably sour. It should not be left standing for so long that the milk could be drawn out as long threads. The *tette* fungus [sic] prevented the milk from getting mouldy or rotten, so that it stayed fresh for a long time." (Klonteig 2000:43; further comment on the time of year p. 78).

Related procedures, i.e. sieving fresh milk through *Pinguicula* leaves, or pouring milk into a container with such leaves, are frequently mentioned in folkloristic and ethnobotanical literature. Evjen (1986:63) claimed that at least locally in Trøndelag, the plant part used was the crushed roots, not the leaves. A record from Jølster in Sogn og Fjordane, W Norway, confirms that the roots were sometimes included, and provides some additional details on the collection of plant material:

"They put their fingers down at the plant [base], below the root, and then extracted both the root and the plant, washed it and put it at the bottom of the container." (NEG 69:14362)

In most cases, only the leaves were used. Some specify that they had to be thoroughly cleaned, others that washing the plant should be avoided, as recorded in Kvænangen, Troms (N Norway):

"At Valan, two old females told me that one had used *tettegres* (...) to make rennet. When using the plant, it should not be washed. The root was cut off and insects stuck in the slime were removed; the rennet was in the slime." (NEG 69:20974)

It should be noted that almost all ethnobotanical traditions included here apply to the Norwegian majority population, living in what was traditionally a faring society. Sørensen & Olsen (1981:28-29) mention similar use of *P. vulgaris* as a substitute rennet among the Finnish ethnic minority of SE Norway, also with an agriculture-based way of living. Contrary to this, *Pinguicula* plays a minor role in Sámi ethnobotany. Those that were involved in traditional reindeer herding would have little use for it (except to treat sore teat in reindeer); the fat reindeer milk hardly needs rennet to become thick, although *Angelica archangelica* L. was often added, according to some authors (e.g. Kuoljok 1971:58) as a kind of rennet. A single example of Sámi use of *Pinguicula vulgaris* as a rennet substitute may be quoted, from Seiland at the coast of Finnmark, N Norway, where people based their living on fisheries and small-scale agriculture. Referring to the 1950's or later, its use was described as follows:

"We collected these stars [the leaves], washed them, and poured warm, fresh milk over them. It was left standing for a day or so, and then it became thickened milk." "It was like a pudding in the bowl. When you took a spoonful, the hole remained." Only fresh milk was considered suitable: "When they ceased having cows, they tried with milk they had bought. But it did not work, (...) it did not turn into true thickened milk." (EBATA 2001:1)

A frequently used, alternative source of rennet in Norwegian folk tradition was terrestrial snails, e.g. the large, black *Arion ater* L., and, according to the descriptions given, several other species as well. Accordingly, such snails were known as *tettegubbe* ("thickening old man") or similar terms (numerous records in NEG 79); identical names have been recorded for *Pinguicula vulgaris* (Table 1). Høeg (1974:490) commented on this tradition, but expressed some doubt if snails had really been used in milk. Such use is, however, well documented from the western, central and northerns parts of Norway (Alm 1983:393, 1985:41-42; Bjørndal 1949:121; Blix 1971; Evjen 1986; Fjellstad 1966:171; Hovdhaugen 1971:34; Weisæth 1990; NFS Gade-Grøn 150; numerous records in NEG). At least in the north, this tradition survived well into the 20th century. In Troms, I have repeatedly been told the names of persons who had used snails for this purpose (e.g. EBATA 1978:26, 2005:45). My own mother had been served *tettemelk* in her youth, but did not like it, in particular because one—according to local lore—could get an unpleasant surprise when the bottom of the bucket became visible. Leaves of *Pinguicula* were not objected to by anyone, but snails certainly were. In some cases, snails may have been more commonly used than *Pinguicula*, leading to a folk belief that the effect of the latter was due to snails having rested on the leaves, depositing slime (Alm 1983:393). In Møre og Romsdal, W Norway, snails were considered the "very best" source of *tette* (Bjørndal 1949:121). A few records also show that such use was known, at least locally, by the Finnish and Sámi ethnic minorities, e.g. at Porsanger in Finnmark, N Norway (EBATA 1992:11).

The note of Bjørndal (1949) is interesting in specifying that three different kinds of rennet were used at Hareid in Møre og Romsdal (W Norway)—and that an apotropaic precaution was added when preparing the milk:

"(...) to get thickened milk, they either used rennet from previously prepared thickened milk, or *tettegras (Pinguicula vulgaris)*, or, the very best: an ordinary black snail. The rennet should be applied to the bottom of the bucket with the fingers, not with a spoon or other utensils, and always in the shape of a cross. If snails were used, they were first wrapped in linen towels and then placed two by two as a cross. This was done to ward off evil." (Bjørndal 1949:121).

The product and its characteristics

Pinguicula-based thickened milk was usually made from fresh milk, without heating or boiling it. When *tette* had been added to the milk, the mixture was stored in a modestly warm place, often on a special shelf. It should not be too warm, in which case the product would turn sour, nor too cold. The final product, i.e. fine *tettemelk* (thickened milk), should be fresh, not very sour, taste well, and be so viscous that it formed a rope from the spoon when retrieved from the container (Jæger-Leirvik 1959). Though descriptions of *tettemelk* vary, most (e.g. Sørensen & Olsen1981:29; Sortdal 1981; NFS Manum) agree that it was more viscous or ropy than milk made from ordinary rennet.

As to the rennet or *tette* itself, whether derived from calves or from *Pinguicula*, people knew that it could be stored for long periods. Weisæth (1990:78) noted that people at a farm in Trøndelag had kept the same culture for more than 40 years. His experiments also showed that tette made from *P. vulgaris* was robust, and could be stored in frozen condition. More frequently, *tette* was stored in a desiccated form (Lorås 1978:8), e.g. by letting it dry in a glazed cup (Jæger-Leirvik 1959:46), in a towel (Støren 1919), in a wooden container (Weisæth 1990:76), or on a piece of wood, which was put in a bag and placed in the food stores (Ambjørgrud *et al.* 1965). When needed again, it was soaked in fresh milk or in a mixture of warm water and fresh milk (Weisæth 1990:76).

Why was it made?

In the old Norwegian society, milk often formed a large part of the diet. It could be the major constituent of several daily meals, especially in inland areas, less so at the coast (Grøn 1942:82). In addition to the culinary aspects noted above, there were two main reasons for preparing *tettemelk*—related to economy and storage.

In the past, fresh or sweet milk was little used in Norway (Grøn 1942:83; Opedal 1940:55). Cream was usually removed to make butter, most of which was sold to allow some cash income. *Tettemelk* could be prepared from both full and skimmed milk. In both cases, the milk sugars (lactose) were transformed to milk acid (Weisæth 1990:83). Due to its thick character, *tettemelk* had a greater ability to make people feel well fed (Lorås 1978:7). It could also be mixed with water and consumed as a drink to quench thirst.

In the past subsistence economy, cattle were frequently inadequately fed during the winter, especially towards spring as fodder stores ran out. As a result, cows would only produce milk for a restricted period of year, mainly in summer (Jæger-Leirvik 1959:46). Preparing curdled milk was important in terms of allowing milk products to be stored. The various "thickened" milk products (bearing a wide variety of vernacular names in Norwegian) could easily be stored for a long time, depending on storage conditions and the time of year. Storing for weeks, months or half a year or more is frequently mentioned in the NEG records. Jæger-Leirvik (1959:47) made a much more modest claim, that *tettemelk* could be stored for about one week.

Rennet was also used to prepare *kjellermelk*, i.e. "cellar milk," which could be stored for several months in summer (Grøn 1942:84). Freshly sieved, warm milk was mixed and boiled with 1/3 of water, cooled to body temperature, and transferred to a barrel with rennet. This procedure was repeated daily until the barrel was full. The mixture was stirred frequently, until turning sour. Only skimmed milk was used (Støren 1919). Contrary to *tettemelk*, "cellar milk" was boiled before transfer to the buckets where it was stored (Weisæth 1990:78). The product could be stored for about one year (Grøn 1942:84; Olsen-Sopp 1912). In parts of Norway, large containers of milk prepared in this way were stored for winter use, e.g. in wooden buckets holding up to 300 litres at Målselv in Troms, N Norway (Sæter 1926:234).

Geographical distribution and time-line

Utilization of *Pinguicula vulgaris* as a rennet substitute—and vernacular names that suggest such use (Table 1)—are known from most of Norway, including Østlandet/SE Norway (Fjellstad 1966:171; Flatin 1918:56; Hagen 1950:281; Halvorsen 1988:198; Kirkevoll 1940:174; NFS Manum), Vestlandet/W Norway (Aasen 1860:10; Arentz 1802:87; Bjørndal 1949:121; Lundberg 1998:253-254; Skre & Skre 1974:53; Strøm 1762:111-112; NFS Manum), Trøndelag (Evjen 1986:63; Weisæth 1990:84; NFS Manum) and North Norway (Alm 1983:393; Blix 1971:218-219; Jenssen 1982:44; Solvang 1924:28; Strompdal 1938:73; NFS Manum); numerous records in Høeg 1974 and NEG may be added to this list.

Preparation of *tettemelk* with *P. vulgaris* seems to have survived longer in the central and northern parts of Norway than in the south. In the latter area, such use may have been uncommon already in the 19th century. In his large Norwegian dictionary, the linguist Ivar Aasen explained *tettegras* as "A herb, which was previously used to make 'Tette'" (Aasen 1873; cf. Grøn 1942:83). Contrary to this, some of those who contributed to the NEG records, mostly in 1959–1960, had first-hand experience of such use. In fact, *tettemelk* may still be used in parts of Norway. According to Weisæth (1990:78) it was in daily use at some farms in Trøndelag, Central Norway in the late 1980's. Thickened milk based on *P. vulgaris* is now marketed as a commercial product by a dairy at Røros in

Sør-Trøndelag, Central Norway (Ola Arvid Feragen, pers. comm. 2005), available throughout Norway.

Although common, the practice of using *Pinguicula vulgaris* as a substitute rennet was not universally known. From Telemark in SE Norway, Wille (1786:122) noted that it was "used here only very rarely instead of rennet." At Krødsherad in Buskerud, SE Norway, Mørch (1976:993) noted that "*Ystegras (tettegras)* is not known to have been used for making thickened milk."

As an alternative to *Pinguicula vulgaris*, a few sources mention similar use of *Drosera* leaves, e.g. in Rogaland (NOS) and Trøndelag (Weisæth 1990). Høeg (1974) does not mention such use of *Drosera* species, but he recorded some vernacular names, similar to the most frequent ones for *Pinguicula vulgaris*, that would suggest it.

The effect on milk: folk belief or reality?

In the early 20th century, Olsen-Sopp (1912) carried out an experimental study of *tettemelk* and how it could be made. According to him, *Pinguicula*-based cultures failed to produce true thickened milk. The product did have a ropy character, but an evil smell. Nilsson (1950), who carried out a microbiological study in Sweden, came to similar conclusions. Experiments at a dairy laboratory in Rogaland (SW Norway) in the 1970s also failed to produce a satisfying product (Bergsåker 1982). Ambjørgrud *et al.* (1965) considered the effect of *Pinguicula* to be little more than mere superstition. Lorås (1978), in her thesis on dairy products, carried out new experiments with *Pinguicula vulgaris* as a source of rennet, but concluded that it was useless.

On the other hand, it is easily proven that sieving milk through *Pinguicula* leaves gives it a ropy character, instantly yielding at least a small amount of a highly viscous, jelly-like product. According to my own experiments, this works even with pasteurised milk, but yields only a small amount, whereas Weisæth (1990:80) succeeded only with fresh milk. Several informants cited in Høeg (1974) noted that one should use fresh, still warm milk directly from the cow.

Even in ethnobotanical literature, the effect of *P. vulgaris* on milk is disputed. Høeg (1974:490) suggested that it was nothing but an example of the doctrine of signatures, i.e. that people inferred the alleged ability to make milk "thick" from the fat leaves of *Pinguicula*. This was refuted by Weisæth (1990), based both on his own experiments and 20th century tradition in his home district of Trøndelag, Central Norway. According to him, *Pinguicula* could indeed be used to make thickened milk. In his experiment, 10-15 fresh leaves of *Pinguicula* sufficed to turn one litre of sweet milk into "a fine and good, thick *tettemelk*" (Weisæth 1990:76). In Sweden, Larsson (1988) claimed to have succeeded in using a *Pinguicula*-based culture, but no details are given on the procedure; some data are provided by Alm and Larsson (1983).

Until recently, however, documentation in terms of milk characteristics, chemistry and the bacteria involved has been weak. A recent study by Haug (1996) succeeded in producing thickened milk using *Pinguicula vulgaris*. An excellent culture was derived from plant material collected at Tromsø. And old rennet culture from Røros in Central Norway, supposedly originally from *Pinguicula vulgaris*, also yielded a satisfying product. Both these cultures contained strains of *Lactococcus lactis* subsp. *cremoris* and *Leuconostoc mesenteroides* subsp. *dextranicum*. However, plant material (*Pinguicula* leaves) from three other Norwegian sites failed to yield thickened milk. Haug (1996) suggested that the leaves had been collected too late in the season, since some ethnobotanical records cited by Høeg (1974) indicated that plants should preferably be collected early in the season, while they were growing. This is partly contradicted by the success of the Tromsø material, which was collected in late summer (August). At present, knowledge of bacteria present on *Pinguicula* leaves is limited, and it is certainly possible that only some plants house species and strains suitable for rennet. This would explain some of the past confusion as to whether *Pinguicula* works or not—and the wide range of results obtained, from complete failures to excellent cultures.

Comparison with the use of *Pinguicula vulgaris* in other areas

Pinguicula vulgaris is widely distributed in the northern hemisphere, including Europe and the northern parts of North America, but absent in most of Asia (Hultén & Fries 1986). Despite this, it plays a much more prominent role in folk tradition in the Old than the New World. Vernacular names reflecting its fat, slimy leaves are widely distributed in Europe, e.g. in Italy, the Netherlands, and in the German-speaking countries (Brøndegaard 1951:958; Marzell 1977:762-763; Schübeler 1888:185), and in much of NW Europe. Very little information on any use of *Pinguicula* species is available from North America. For *P. vulgaris*, Moerman (1998:403) only notes that the Owekeeno of Canada kept dried roots as a good luck charm. Such use is also known from Europe. In Scotland, the plant had some reputation as an apotropaic, protecting cows and milk from witches and other evil influences (Darwin 1996:128; Grigson 1955:312; Milliken & Bridgewater 2004:163-164; Vickery 1995:56).

Just as in Norway, the leaves of *P. vulgaris* have been used to cure wounds in other parts of Europe, e.g. in Germany and Great Britain; other *Pinguicula* species were used for the same purpose in Spain (Brøndegaard 1961:959; Grigson 1955:312-313).

As noted above, the main use of *P. vulgaris* in folk veterinary medicine in Norway was to treat sore teat. This cure is also known from the Great Britain (Allen & Hatfield 2004; Grigson 1955) and the Alps, where Bauhinus (1650-51) noted that herdsmen used it for the same purpose. The belief that *P. vulgaris* could cause harm to livestock, known from parts of Norway, was widespread in Sweden (Larsson 1988, map 26), and is also known from France (Brøndegaard

1951:958) and Great Britain (Grigson 1955:312). In Scotland, it was considered to make the milk of grazing cows disagreeable and stringy, and was reputed to cause disease, e.g. liver fluke infestation, in sheep (Milliken & Bridgewater 2004:66, 122, 248).

Thickened milk has been much used in Eurasia, especially in alpine areas where summer farms or transhumance prevailed (Ränk 1971). Before the advent of refrigerators and other modern technology, it was an important way of storing milk. Vernacular names and other traditions suggesting the use of *P. vulgaris* as a rennet substitute are widely distributed in Europe, especially in the NW, including Norway, Sweden (Larsson 1988), and Great Britain (Grigson 1955:312). Numerous Swedish sources mention such use, including Linnaeus (1737:10), who provided a detailed description of its use among Swedish settlers in the country's northern part. Vernacular names suggesting use in dairy products are also known from the Faroes (Brøndegaard 1971:80; Svabo 1959:156) and in Iceland (Brøndegaard 1971:80; Hjaltalín 1839; Mohr 1786; Nilsson 1988:155; Olsson 1961:118-119; Schübeler 1888:185), both areas largely settled by people of Norwegian ethnic origin. Some vernacular names recorded in Scotland, e.g. on Orkney and the Shetland islands, may derive from Norse settlers, but other Scots and Gaelic names suggest that the tradition was known to the Scots as well. *P. vulgaris* was used as rennet for cheese in Lanarkshire (Darwin 1996:128; Milliken & Bridgewater 2004:65; Vickery 1995:56). A few names of similar origin are known in the German, French and Finnish languages (Brøndegaard 1971:80, Ränk 1960:60). Marzell (1977:766) mentioned the use of *Pinguicula* as a rennet substitute from Kärnten in Austria.

In summary, numerous authors have carried out experiments with *Pinguicula vulgaris* in milk, with widely different results. Experiments and folk tradition agree that the leaves (or their proteolytic enzymes) do have some effect on milk; i.e. by making it stringy. Most laboratory (e.g. Lorås 1978; Nilsson 1950; Nilsson & Nilsson 1958; Olsen-Sopp 1912) experiments with *Pinguicula* have failed to produce thickened milk, at least of a quality suitable for food and storage, and Ränk (1960) suggested the folk use of—or belief in—*Pinguicula vulgaris* as a substitute for rennet was an example of similarity magic, based on a comparison of the viscous, thickened milk and the slimy leaves of the plant. The recent study of Haug (1996) convincingly demonstrated that *P. vulgaris* may be used to make thickened milk, but also that some *Pinguicula*-based cultures failed to do so. This may explain some of the past confusion as to whether *Pinguicula* works or not.

ACKNOWLEDGMENTS

Anne-Marie Wiersholm provided access to and help with the archives at NFS/Norsk folkeminnesamling. Ola Arvid Feragen at Rørosmeieriet supplied information on their use of a *Pinguicula* culture for thickened milk. The referees provided many useful comments. Laurent Legendre, University of Western Australia, helped with some literature.

REFERENCES

AASEN, I. 1860. Norske Plantenavne. Budstikken 2:9–37.

AASEN, I. 1873. Norsk Ordbog. Ed. 2. Mallings Boghandel, Christiania.

ALLEN, D. E. and G. HATFIELD. 2004. Medicinal plants in folk tradition. An ethnobotany of Britain & Ireland. Timber Press, Portland, Oregon.

ALM, L. and I. LARSSON. 1983. Från forntid till framtid. Den nordiske tätmjölken—en produkt med gamla anor. Nordisk mejeriindustri 1983(6):396–399.

ALM, T. 1983. Trollbær og tortengress. Folkeminne fra Klatran og Sørvikmark. Om planter og plantenavn. Håløygminne 16:373–396.

ALM, T. 1985. Kongro og kokkelur. Folkeminne fra Klatran og Sørvikmark. Om dyr og dyrenavn. Håløygminne 17:40–60.

ALM, T. 2000. Flora of North Norway: *Pinguicula villosa* L. (Lentibulariaceae). Polarflokken 24:191–205.

AMBJØRGRUD, O., I. BØRKE, J. JANSEN, and E. MOE. 1965. Tette. In: Norsk mat. Cappelen, Oslo. Pp. 69–72.

ARENTZ, H. 1802. Fortsættelse af: Beskrivelse over Søndfjord i det nordre Bergenhusiske Amt. Topogr. J. Norge 8(29):1–144.

BAUHINUS, J. 1650–1651. Historia plantarum universalis. Yverdun.

BERGSÅKER, J. 1982. Tettegras og andre plantar i gamalt mjølkestell. Meieriposten 1982(18):482, 484, 490.

BJORVAND, H. and F.O. LINDEMAN. 2000. Våre arveord. Etymologisk ordbok. Novus, Oslo.

BJØRNDAL, M. 1949. Segn og tru. Folkeminne frå Møre. Norsk Folkeminnelags Skr. 64:1–199.

BLIX, D. 1971. Nordnorsk mat. Håløygminne 13:215–223.

BRØNDEGAARD, V.J. 1951. Primitiv løbe. Mælkeritidende 1951:178–181.

BRØNDEGAARD, V.J. 1961. Vibefedt (*Pinguicula*) i folkemedicinen. Farm. Tid. 71(51):957–962.

BRØNDEGAARD, V.J. 1971. Primitiv løbe. Svenska Landsmål och Svenskt Folkliv 94:75–90.

CASPER, S.J. 1966. Monographie der Gattung *Pinguicula* L. Bibl. Bot. 127–128:1–209 + 16 pl.

CHRISTEN, K. 1961. Beitrag zur Pharmakochemie und Pharmakologie des gemeinen Fettkrautes (*Pinguicula vulgaris* L.). Die Pharmazie 16:92–102.

CHRISTEN, K. and T. GORDONOFF. 1960. The active principle of *Pinguicula vulgaris*. Arzneimittelforschung 10:560–561.

DARWIN, T. 1996. The Scots herbal. Plant lore of Scotland. Mercat Press, Edinburgh.

DJUPEDAL, R. 1959. Brev til Ivar Aasen om norske plantenamn. Blyttia 17:61–66.

ELVEN, R. (ed.) 1994. Johannes Lid & Dagny Tande Lid: Norsk flora. Ed. 6. Det norske samlaget, Oslo.

ENGEN, B. 1975. Vegamålet. Eit oversyn med hovudvekt på kvantitet og klusilar. Ei synkronisk og diakronisk gransking. Thesis, University of Oslo.

EVJEN, G. 1986. Tettemelk/tjukkmelk. Årb. Sparbu Historielag 1986:63–64.

Fjellstad, L.M. 1966. I grendom. Folkeminne frå Eidskog III. Norsk Folkeminnelags Skr. 98: 1–171.

Flatin, T. 1918. Gamalt fraa Numedal III. (Tilleggsbok til Norsk folkekultur 4). Erik Gunleikson, Risør.

Forsén, R. 1966. Die Langmilch (Pitkäpiimä). Meijeritieteellinen Aikakauskirja 26(1).

Furuset, O. 1980. Jordbrukstradisjonar frå Bjørsetgrenda. Årb. Glåmdalen 39:115–130.

Gisler, N. 1749. Beskrifning om Tätmjölkens tillagning. Kongl. Svensk. Vetensk.-Acad. Handl. 10:11–14.

Grigson, G. 1955. The Englishman's flora. Phoenix House, London.

Grøn, F. 1942. Om kostholdet i Norge fra omkring 1500-tallet og opp til vår tid. Skr. Norske Vidensk. Akad. Oslo. II. Hist.-Fil. Kl. 1942(4):1–264.

Grude, D. 1945. Mat- og kjøkenstell. Fram husmorskule, Oslo.

Gunnerus, J.E. 1772. Flora norvegica. Pars posterior. Hafniæ (Copenhagen).

Gunnerus, J.E. 1768. Om nogle Norske Planter. Kongel. Norske Videnskabers Selsk. Skr. 4: 81–86.

Gunnerus, J.E. 1774. Oeconomisk Afhandling om alle de Maader, hvorpaa Melken nyttes i Norge. Kongel. Norske Vidensk. Selsk. Skr. 5:26–152.

Hagen, A. 1950. Mer omkring gamle plantenavn fra Valdres. 2. Tidsskr. Valdres Historielag 6:272–283.

Halvorsen, R. 1988. En del av kulturarven. Plantenavn i Vinje-dialekten. Blyttia 46:195–198.

Hansson, Å. 1990. Om tätmjölk, tätgräs, surmjölk och skyr. Svenska Landsmål och Svensk Folkliv 1989:88–103.

Haug, I. 1996. Bakteriologiske og teknologiske aspekter vedrørende produksjon av tettemelk. Thesis, Norwegian Agricultural University.

Heide, F. 1912. [The structure and biology of arctic flowering plants.] Lentibulariaceae (*Pinguicula*). Medd. Grønland 36:441–481.

Heizmann, W. 1993. Wörterbuch der Pflanzennamen in Altwestnordischen. (Reallexikon der germanischen Altertumskunde, Ergänzungsbände, Band 7). Walter de Gruyter, Berlin - New York.

Heltzen, I.A. 1834/1981. Ranens beskrivelse. Manuscript, printed as: Ranens Beskrivelse 1834 by Rana museums- og historielag/Lofotboka.

Heslop-Harrison, Y. and J. Heslop-Harrison. 1980. Chloride ion movement and enzyme secretion from the digestive glands of *Pinguicula*. Ann. Bot. 45:729–731.

Heslop-Harrison, Y. and J. Heslop-Harrison. 1981. The digestive glands of *Pinguicula*: structure and cytochemistry. Ann. Bot. 47:293–319.

Heslop-Harrison, Y. and R.B. Knox. 1971. A cyto-chemical study of the leaf-gland enzymes of insectivorous plants of the genus *Pinguicula*. Planta 96:183–211.

Hiorthøy, H.F. 1785. Physisk og Ekonomisk Beskrivelse over Gulbransdalen Provstie i Aggershus Stift i Norge. Første del. Kiøbenhavn.

Hjaltalín, O.J. 1830. Íslenzk grasafræði. København.

Høeg, O.A. 1940. G.T. Holms liste over plantenavn fra Numedal og Sandsvær i 1750-årene. Nytt Mag. Naturv. 80:89–107.

Høeg, O.A. 1974. Planter og tradisjon. Floraen i levende tale og tradisjon i Norge 1925–1973. Universitetsforlaget, Oslo - Bergen - Tromsø.

Hornemann, J.W. 1806. Forsøg til en dansk oeconomisk Plantelære. Et Priisskrivt. Andet Oplag, forøget med norske og holstenske Planter. København.

Hovdhaugen, E. 1971. Dei gode henders gjerning. Bondekvinnenes liv og lagnad i dei siste hundre åra. Landbruksforlaget, Oslo.

Hultén, E. and M. Fries. 1986. Atlas of North European vascular plants north of the Tropic of Cancer. Koeltz Scientific Books, Koenigstein.

Jæger-Leirvik, P. 1959. Tettmelk og settmelk i ytre Namdal. Norsk Folkemus. Årb. 13:43–50.

Jenshus, G. 1986. Fronsmålet. Fron historielag, Vinstra.

Jenssen, Ø. 1982. Leirfjord bygdebok. Særbind I. Helgelandsmålet i Leirfjord. Språk og språkkultur der Vefsn og Rana møter Øyan. Leirfjord bygdeboknemnd.

Jobson, R.W., J. Playford, K.M. Cameron, and V.A. Albert. 2003. Molecular phylogenetics of Lentibulariaceae inferred from plastid *rps*16 intron and *trn*L-F DNA sequences: Implications for character evolution and biogeography. Syst. Bot. 28:157–171.

Kirkevoll, G. 1940. Plantor og plantenamn frå Valdres, serleg frå Vestre Slidre. Tidsskr. Valdres Historielag 4:165–176.

Klonteig, O. 2000. Fjellbygder i attersyn. Frå det gamle Tinn i Telemark. Forlaget Grenland, Porsgrunn.

Krogh, J.A. 1813. Efterretninger om Provstiet Nordfjord i Bergens Stift i Norge. Topogr.-Stat. Saml. Kongel. Selsk. Norges Vel 2(1):1– 291.

Kuoljok, K.E. 1971. Föda och nödföda. Hur människan använde vildmarkens tillgånger. LTs förlag, Stockholm.

Kvernbekk, P.G. 1979. Navnekulturen i Trysil. Årb. Trysil 1:57–66.

Lagerberg, T., J. Holmboe. and R. Nordhagen. 1957. Våre ville planter, vol. 6(1). Johan Grundt Tanum, Oslo.

Larsson, I. 1988. Tätmjölk, tätgräs, surmjölk och skyr. En datorstödd ordgeografisk studie över nordiska ord rörande äldre tiders mjölkhushållning. Stockholm Studies in Scandinavian Philology. New Series 18:1–236.

Legendre, L. 2000. The genus *Pinguicula* L. (Lentibulariaceae): an overview. Acta Bot. Gall.147(1):77–98.

Lid, J. 1941. Ivar Aasens herbarium. Nytt Mag. Naturvitensk. 82:57–80.

Lineikro, U. 1975. Utnyttinga av naturen i det gamle bygdesamfunnet. Tidsskr. Valdres Historielag. Årb. 1975:51–54.

Linnaeus, C. 1737. Flora Lapponica. Salomo Schouten, Amsterdam.

Lorås, B.1978. Dyrkingsbetingelsene og lagringstidens betydning for kvaliteten av tettemelk. Thesis, Norwegian Agricultural University.

Lundberg, A. 1998. Karmøys flora. Fagbokforlaget, Bergen.

Lundestad, H. 1992: Ordsamling frå Vefsn. Småskr. Vefsn Mus. 5:1–197.

Marzell, H. 1977. Wörterbuch der deutschen Pflanzennamen. Vol. 3. S. Hirzel Verlag, Stuttgart - Franz Steiner Verlag, Wiesbaden.

Mehlum, A. 1891. Hallingdal og Hallingen. Lyche, Drammen.

Milliken, W. and S. Bridgewater. 2004. Flora Celtica. Plants and people in Scotland. Birlinn, Edinburgh.

Moerman, D. 1998. Native American ethnobotany. Timber Press, Portland, Oregon.

Mohr, N. 1786. Forsøg til en Islandsk Naturhistorie. Kjøbenhavn.

Mørch, A. 1976. Krødsherad. Bind III. Bygdehistorie. Krødsherad kommune, Noresund.

Nilsson, A.B. and L. Johansen. 1994. Mattradisjoner i Skibotn. Menneske og miljo i nord-Troms. Årb. 1994:44–49.

Nilsson, G. 1950. Något om bakteriefloran i den svenska tätmjölken. Svensk. Mejeritidn. 1950:411–416.

Nilsson, G. and R. Nilsson. 1958. Studies concerning Swedish ropy milk. The antibiotic qualities of ropy milk. Arch. Mikrobiol. 31:191–197.

Øksendal, H. 1993. [Lokale namn på plantar]. Flog-fangar. Far etter fedrane. Årb. Vefsn, Grane og Hattfjelldal 1994:110.

Øksendal, K. 1977. Plantenamn frå Vefsn. Årb. Helgeland 1977:94–102.

Olsen-Sopp, O.J. 1912. Tätte, die urnordische Dauermilch und verwandte Milchsorten, sowie ihre Bedeutung für die Volksernährung. Erste Serie. Centr. Bakteriol. Parasitenkunde Abt. II 33:1–54.

Olsson, A. 1961. Koagulerad mjölk i äldre tiders hushållning. Rig:113–122.

Opedal, H. 1940. Makter og menneske. Folkeminne frå Hardanger IV. Norsk Folkeminnelags Skr. 46:1–192.

Øvrebø, L. 1939. Gamle plantenavn i Elverum. Østlendingen 39(7):4.

Ramus, J. 1715. Norriges Beskrivelse. Kiøbenhavn.

Rank, G. 1960. Vilken roll har tätörten spelat i mjölkhusshållningen? Folktro kontra vetande. Folk-Liv 24–25:65–75.

Rank, G. 1971. Verbreitungsverhältnisse einiger Milchprodukte im eurasischen Raum. Ethnol. Scand. 1971:120–126.

Reichborn-Kjennerud, I. 1922. Våre folkemedisinske lægeurter. Kristiania.

Reichborn-Kjennerud, I. 1941. Vår gamle trolldomsmedisin. III. Vidensk.-Akad. Oslo. II. Hist.-fil. Kl. Skr. 1940(1):1–221.

Reichborn-Kjennerud, I. 1944. Vår gamle trolldomsmedisin. IV. Vidensk.-Akad. Oslo. II. Hist.-fil. Kl. Skr. 1943(2):1–263.

Rise, O.J. 1947. Oppdalsboka. Historie og folkeminne. I. Johan Grundt Tanum, Oslo.

Rørdam, H.F. 1873. Sivert Grubbes dagbog. Danske Mag. 4. Rk. 2:361–406.

Ross, H. 1895. Norsk ordbog. Tillæg til "Norsk Ordbog" af Ivar Aasen. Cammermeyer, Christiania.

Sandvik, S. 1991. Suldalsmålet. Mållæra, ord og vendingar. Norsk bokreidingslag, Bergen.

Sæter, I. 1926. Maalselvdalen, Maalselv og Øverbygd herreder. Oslo.

Schubeler, F.C. 1888. Viridarium norvegicum. Norges Væxtrige. Vol. 2. Universitetsprogram, Christiania.

Skre, B. and I. Skre (eds.) 1974. Hordaland og Bergen i manns minne. Daglegliv ved hundreårsskiftet. Det norske samlaget, Oslo.

SOLBERG, R. 1937. Is-gud: dikt på Dovremål. Aschehoug, Oslo.

SOLVANG, J. 1924. Gamal tru og skikk i bygda. Håløygminne 1:23–32.

SØRENSEN, R. and J.B. OLSEN. 1981. Finnskogene. Gyldendal norsk forlag, Oslo.

SORTDAL, K.K. 1981. Lækjeråder. Tingvoll, Nordmøre. Talatrosten 1981:22–23.

STANDAL, R., K. AALBERG, K., and T. AARSET. 1997. Hans Strøm: Annotations Boog over de Merkværdigheder som udi Syndmørs Fogderie forefindes indrette[t] Anno 1756. Skr. Haram Kulturhistoriske Lag 41:I–XXXI, 1–311.

STORAKER, J.T. 1928. Naturrigerne i den norske Folketro. (Storakers samlinger IV). Norsk Folkeminnelags Skr. 18:1–292.

STØREN, K. 1919. Melkebruket. In: Ødegaard, N., ed.: Landbruksboken. Vol. 2. Aschehoug, Kristiania. Pp. 891–896.

STRØM, H. 1756. Annotations Boog over de Merkværdigheder som udi Syndmørs Fogderie forefindes indrette Anno 1756. [Handwritten manuscript (128 double folio pages), printed and annotated in Standal et al. 1997]

STRØM, H. 1762. Physisk og Oekonomisk Beskrivelse over Fogderiet Søndmør, beliggende i Bergens Stift i Norge. Første part. Sorøe.

STROMPDAL, K. 1938. Gamalt frå Helgeland II. Norsk Folkeminnelags Skr. 40:1–112.

SVABO, J.C. 1959. Innberetninger fra en Reise i Færøe 1781 og 1782. Selskabet til Udgivelse af færøske Kildeskrifter og Studier, København.

TONNING, H. 1773. Norsk medicinsk og oeconomisk Flora. I. Kiøbenhavn.

TORP, A. 1919. Nynorsk etymologisk ordbok. Aschehoug, Kristiania.

VESTAD, J.P. 1984. Gausdalsmålet. Gausdal.

VIBORG, E. 1793. Forsøg til systematiske danske Navne af indenlandske Planter forfattet til Brug for Lærlingerne ved den Kongelige Veterinærskole. Kiøbenhavn.

VICKERY, R. 1995. Dictionary of plant-lore. Oxford University Press, Oxford—New York,

WARMING, E. 1886. Om nogle arktiske væxters biologi. Bihang, Kongl. Svensk. Vetensk.-Akad. Handl. 12, Afd. III(2):1–40.

WEISÆTH, G. 1990. Nytt og gammelt om tettegras, tette og tettemelk. Våre Nyttevekster 85:76–87.

WILLE, H.J. 1786. Beskrivelse over Sillejords Præstegield i Øvre-Tellemarken i Norge tilligemed et geographisk Chart over samme. Gyldendals forlag, København.

WILSE, N. 1779. Physisk, oeconomisk og statistisk Beskrivelse over Spydebergs Præstegjeld og Egn i Aggerhuus-Stift udi Norge. Christiania.

WIX, L. 1995. The traditional uses of *Pinguicula* in food. Part 1. Uses and geographical distribution. Intern. Pinguicula Study Group Newsl. 6:11–15.

WIX, L. 1996. The traditional uses of *Pinguicula* in food. Part 2. The use of *Pinguicula vulgaris* in the preparation of tätmjölk. Intern. Pinguicula Study Group Newsl. 7:16–20.

ARCHIVAL SOURCES

EBATA: my own ethnobotanical records, with year and running number (e.g. EBATA 2004:7), mostly from interviews; original material at Dept. of Botany, Tromsø Museum.

NEG (Norsk etnologisk gransking / Norwegian ethnological survey). Answers to questionnaire No. 69, on milk and milk products, distributed 1959.

NFS (Norsk folkeminnesamling / Norwegian folklore collection): (a) NFS Gade-Grøn, questionaires on Norwegian folk medicine, distributed 1911; (b) NFS O.A. Høeg: original material of O.A. Høeg; (c) NFS Manum: answers to a 1958 query by S. Manum in "Magasinet for alle" about vernacular names and uses of *Pinguicula vulgaris*.

NOS (Norsk ordbok, seddelarkivet / Norwegian dictionary, card archive).

NOTES ON LOUISIANA BOTANY AND BOTANISTS, 1718–1975

Joseph A. Ewan

Edited by Steven P. Darwin
Department of Ecology and Evolutionary Biology
Tulane University
New Orleans, Louisiana 70118-5698, U.S.A.

Editor's note.—The present paper was written ca. 1992 while the author, formerly at Tulane University, was Research Associate at the Missouri Botanical Garden, St. Louis. It was intended for a volume of essays honoring botanical artist Margaret Stones, but the collection was never published and the manuscript was abandoned. Before the intended submission, Ewan asked me to make corrections and suggest modifications, which I did. With those few and minor changes made, Ewan's notes on Louisiana's botanical history seemed to me well worthy of publication as a stand-alone contribution. For Joseph A. Ewan (1909–1999) see A.S. Bradburn, *Sida* 19:219–222 (2000); L.J. Dorr, *Taxon* 49:107–111 (2000); C. Wolf, *Plant Sci. Bull.* 46:14 (2000). For Ewan bibliography, see L.J. Dorr and D. Holland, *Arch. Natl. Hist.* 27:307–334 (2000). I thank A.S. Bradburn, L.J. Dorr, E.G. Sundell, and J.W. Thieret for reviewing the manuscript and offering valuable suggestions.

> A concern for history has always been regarded as a mark of a civilized man.He who knows only his own generation remains always a child.
>
> — These two maxima, the first from historian Louis B. Wright, the second from college president George Norlin, read from sides of the same coin: perception comes from perspective and from the wide-angled lens of history.

We review the lives and botany of a select few of Louisiana's naturalists-artists-collectors who have left records, sometimes only sketchily, in books, letters, and dried plant specimens from 1718 to 1975. This essay is only an introduction to the history of botanical exploration in the state. Well-known figures are mentioned, but barely remembered persons will be particularly noticed on the premise that search warrants may be posted. My annotated *Bibliography of Louisiana botany*, listing 384 entries to the year 1950, is the base of this review.[1] A supplement to the bibliography by Eric Sundell brought the coverage to 1975 with an additional 433 titles, chiefly of recent taxonomic revisions.

The first naturalist to visit Louisiana was Antoine Simon Le Page du Pratz, who as a traveling architect and engineer observed the flora and fauna.[2] He arrived 25 August 1718 reporting that New Orleans existed "only in name." Though du Pratz died in 1775, in a real sense I met him through the enthusiasm of Stanley Clisby Arthur and his bookseller, Joseph Harmanson, by the publication of a composite altered English translation of du Pratz's *History of Louisiana* based on the London edition. This New Orleans imprint of 1947, important for its annotations and a topical index, had a press run of only 600 copies. Du Pratz had gathered notes of plant and animal names and uses from his early contacts with his slave girl of the Chitimache tribe, purchased soon after his arrival. Louisiana natural history began when she whacked an alligator on the snout as it approached his campfire. From crocodiles to cockroaches, which he remarked are relished by house cats, his narrative is interesting. Five chapters report on forest trees and other botanical subjects. Although he mentions about fifty trees, no specimens collected by him are known. He noticed mangroves as he entered the delta,[3] stating that they were "very common all over America." If you believe you know our flora, try identifying every tree in du Pratz's forest.

Benjamin Smith Barton, Philadelphia naturalist-physician, loaned his copy of du Pratz's "Louisiana" to Meriwether Lewis in 1803. Lewis returned the book four years later after its trip to Oregon.[4] Du Pratz stayed in Louisiana sixteen years, sometime on the Bayou St. John, at an Indian village above New Orleans, and at Natchez. His *Histoire* was written from memory after his return to France. Opinions differ: biohistorian Elliot Coues, though he edited Lewis and Clark's travels and others, did not produce an annotated edition. Coues concluded du Pratz's "matter is very wild and of no account."[5] I suggest his is a clue book, to be verified.

Perhaps the best known of early French travelers on the Mississippi River was Pierre Charlevoix (1682–1761),[6] Jesuit missionary-historian whose visit in 1720 was first published in 1744, but not Englished until John Shea published its six volumes between 1866 and 1872. Charlevoix cited black vomit, *Ilex vomitoria*, cassina,[7] then known by the Indian name apalachina, which altered into Apalachicola, the present Florida river and town. Understandably it was plants then used by Man, black vomit, sweet gum, and wax myrtle, that entered Charlevoix's text.[8]

Before plants were collected and kept in cabinets, they were more or less carefully observed. From this description what do you suggest was Bossu's plant: "a tree that grows in Louisiana that bears a fruit similar to a banana that the natives call *hasseminier*. Savages cover their cabins with the bark and also use it to make little boxes called *cassot*, in which to put fruits."[9] Bossu also says the bark was used to make a trumpet. What tree was it? *Asimina*? Jean-Bernard Bossu (1720–1792), son of a surgeon, was in wars in Italy, moved to the marines, left for Louisiana in 1750 but then was assigned to Illinois country. He lived with the Akancas or Quapaw Indians near the mouth of the Arkansas River, staying there for seven years. Bossu returned to Louisiana in 1758, then for a third time as a private citizen, 1770–1771.

The early travels of Bossu were first translated into English by a German, Johann Reinhold Forster,[10] who later would ship with Capt. Cook on his Second Voyage. Samuel Derris Dickinson in 1982 provided a fully annotated rendition of Bossu's *New Travels* of 1770–1771.[11] As had Charlevoix, Bossu mentions the plants related to man's use, but with more detail: cassine, *Ilex*; candleberry, *Myrica cerifera*; ginseng, *Panax quinquefolius*; red laurel, *Persea borbonia*; white laurel, *Magnolia virginiana* (?); sassafras, *Sassafras albidum*; sweet gum or copala, *Liquidambar styraciflua*; palmetto, *Sabal minor*; "American tea," *Ceanothus americanus*; and yucca, *Yucca* sp.

Scarcely noticed in the history of our plant introductions is *Gaillardia*, known in the South as blanket-flower. In 1786 a six-page paper was published by the Paris Academy of Sciences, the first scientific paper devoted solely to a Louisiana genus. Fougeroux de Bondaroy described *Gaillardia pulchella* as cultivated from Louisiana seed in France by one d'Essales.[12] Whether a cultivated voucher was preserved I do not know. *Gaillardia* was a sensation when it flowered in Europe. Three botanists, Lamarck, Buc'hoz, and l'Héritier raced its description into print in 1788. With the happy exception of Philip Miller's Chelsea gatherings, garden-grown specimens are dubiously labeled or lost.[13] The intense competition among nurserymen to seize the market was not peculiar to France; it will inevitably complicate the effort to fix types of such discoveries as *Gaillardia*. The effort to improve the wild plant and the resulting cultivars further add to the botanical bouillabaisse. Where was that *Gaillardia* seed collected? I suggest on the Opelousas prairies.

We know William Bartram's oak-leaf hydrangea hereabouts. The description of his Florida experiences with bellowing alligators at the Alachua savannah, dramatically sketched in action, are classic. These drawings and important albums of plant specimens, preserved in the Natural History Museum, London, were reported with annotations in 1968.[14] That Bartram suffered great pain from an injury and eye infection meant that his "plan of peregrinations" through Louisiana had to be curtailed, and he collected no specimens. Nevertheless he had pressed westward to the Pearl River country, stayed four or five weeks at the seat of an Englishman named Rumsey on what Bartram called "Pearl Island," which was wiped away by hurricane years ago. He recuperated under the roof of "friendly" Rumsey whose fruit trees had reached "the utmost degree of perfection." His eyes "having sufficient strength to endure the open daylight" he set off from Pearl Island westward in a "handsome large boat with three negroes to navigate her." Using today's maps we trace Bartram's route through the Rigolet's, along Lake Pontchartrain's north shore, across the mouth of the Tangipahoa River through Pass Manchac to Lake Mauripas, to Amite River and an outpost on the Mississippi River. Turning north on the river he lodged at the plantation of William Dunbar,[15] a Scottish gentle-man naturalist whose other plantation near Natchez is better known. He traveled in a "neat cypress boat with three oars" to Pointe Coupee on the west side of the river, then on as far as Port Hudson, admiring the White Cliffs. He finally reached White Plains, an isolated prairie, by horseback, 27 October 1775. Bartram was impressed by sassafras with straight trunks up to 40 or 50 feet. There he saw "great and beautiful whooping cranes." He then retraced his route in Louisiana, his eyes still painful, and returned to Carolina. If you would follow his journey through the southern states, pick up the "naturalist's edition" of *Travels* by Bartram's Boswell, Francis Harper.[16]

Although Claude Robin was a student of Jussieu, and the author of the first description of the Louisiana flora, it is Rafinesque who translated and revised Robin's work, publishing it as *Florula Ludoviciana*. Claude César Robin[17] visited Martinique and Santo Domingo en route to Louisiana. Details of his travels in Louisiana are vague, but he wrote long detailed plant descriptions, noted folk names and uses which amounted to 238 pages of his *Voyage* (Paris, 1807). *Gaillardia* is described but without comment on its dramatic introduction twenty years earlier. Robin's text deserves critical study. A three-column table comparing Robin's, Rafinesque's, and what we think their sometimes cryptic phrases mean, would be welcome indeed.[18] Though we have yet to discover any herbarium records of Robin's, we value his contribution. Incidentally, our black locust, *Robinia*, commemorates Jean Robin, a 16th century French botanist, not Claude Robin.

An actor in the widescreen drama of Audubon's life, though he is barely mentioned in Audubon's writings, was the young artist Joseph Robert Mason.[19] Mason is unnoticed in botanical history for his plant backgrounds. He was born in Cincinnati in 1807 and was a pupil at thirteen in Audubon's drawing class in Cincinnati in the spring of 1820. The instructor must have been impressed with the lad's talents for he took him with him on the flatboat trip to New Orleans. "As the cumbersome ark drifted downstream," to borrow Marshall Davidson's words, Audubon was busy shooting birds and sketching for his planned *Birds of America*. Meanwhile Mason was collecting samples of the plants he would incorporate with the bird drawings, often later added to Audubon's originals. They arrived at Bayou Sara, West Feliciana Parish, in January 1821. Eight days later they were in New Orleans where Audubon added bird drawings to his portfolio, meanwhile making portraits of townspeople to meet his expenses. But when Audubon received an offer from a wealthy plantation owner's wife, Lucretia Pirrie, to teach her daughter drawing, he accepted and they set off for Oakley Plantation near St. Francisville. It was there that Joseph Mason would make most of his Louisiana drawings. For example, Mason drew loblolly pine, *Pinus taeda*, and Audubon signed the drawing "James Pirrie's plantation, Louisiana, July 10, 1821. Plant J.R. Mason."[20] To my knowledge this was the only instance when Audubon recorded Mason's part in his work. Mason drew *Magnolia grandiflora* in fruit on 5 October 1821, but Audubon did not indicate on the drawing that it was Mason's art. I like Mason's jessamine, *Gelsemium sempervirens*. His red-flowered *Iris fulva* is no match for Margaret Stones', but it is an interesting record for the species about twenty years after it was first collected by Aloysius Enslen who was then gathering for Prince Lichtenstein.[21] Audubon wrote to his wife Lucy in 1822, carefully distinguishing Mason's talent from his own, that Joseph Mason "draws flowers better than any man probably in America." Understandably Mason chafed under Audubon's unwillingness to recognize his artistic talents in what was already Audubon's grand plan. On 23 August 1822, Mason left Audubon's employ at Natchez and returned to Cincinnati. Whether it was Mason who later worked in Philadelphia for William P.C. Barton has not been confirmed.[22]

Joseph Mason deserves a study and a census of his Louisiana drawings that will, however, be nettled with confusion, partly on dates, but perennially on attribution. The 1966 American Heritage edition of Audubon's watercolors with Marshall Davidson's introduction, and assistance from the late Harold W. Rickett of New York Botanical Garden, will be your best source for the investigation.[23]

A familiar spring umbellifer about New Orleans is chervil, as the genus *Chaerophyllum* is known in Europe; ours is *C. tainturieri* described by William Jackson Hooker in 1835 from Louis Tainturier's specimen.[24] I found some hints about the Tainturier family in New Orleans' St. Louis cemetery no. 1, aisle 3, that suggest they came from Santo Domingo; no one has put all the dates and doubts into a believable account. S.W. Geiser suggests that Tainturier was professor of mathematics at the College d'Orleans, located at the corner of Hospital and St. Claude streets in New Orleans. Eight letters survive in the Hooker correspondence, the last, 18 April 1836, informs of the dispatch of some plants collected "at 60 miles above New Orleans and which, in great part, are different from those which were sent twelve years ago." This Tainturier essay-in-the-waiting would assist the systematic botanist, and gratify the historian: botanists do not live alone. The College d'Orleans, founded in 1811, represented French influence as Louisiana's first institution of higher learning. One commentator, however, remarked that the Creole cared little for schooling, and so the college "sank in a sea of troubles" and was closed in 1826.[25]

The natural sciences have always flourished with the hand of what Mark Catesby called "encouragers" or the patrons. Little known are the agents who forwarded the collections, held the mail, the true confreres. Joseph Barabino, who kept a small apothecary shop at 144 Old Levee Street, was the agent for Lesueur and Say.[26] The French historian of natural history E.T. Hamy left us an account of Barabino:

> a zealous naturalist who was especially interested in entomology, but whose equipment was quite incomplete. Lesueur helped his new friend with advice, furnished him with pins, cork sheets, etc., etc. The Barrabino [sic] drugstore was the gathering place of several devotees of natural history. It was near the leading market, and everything that was strange in the vicinity of the city was brought there. Lesueur dreamed of making it the center of a society similar to that of Philadelphia. Barrabino spoke several languages and correspondence with foreign countries could be carried on with ease.[27]

Barabino collected *naturalia* for Bory de Saint-Vincent and for the Lyceum of Natural History in New York from the year 1825.[28] When the paleontologist of Philadelphia's Academy, Samuel George Morton, named the Cretaceous fossil

Inoceramus barabini he remarked "I name this species in memory of the many favors I have received from my friend Joseph Barabino, Esq., of New Orleans."[29] Lesueur's portrait of Barabino in the archives of New Harmony bears a note by Robert J. Usher, librarian of the old Howard Memorial Library at Lee Circle: "he died while quite young from fever contracted in the swamps in which he was searching for ferns." The year was 1834.

At Oxford University's Botany Department I was shown the portrait of Charles Giles Bridle Daubeny (1795–1867),[30] who kept a pair of organ-grinder's monkeys at the gate to the Botanic Garden next door to where he lived, in the Gatehouse. These lively guards set off an alarm at unwanted visitors. Daubeny, the son of a rector at Stratton in Gloucestershire, a graduate of Winchester and Magdalen College, was intended for a medical career, but his classes at Edinburgh aroused his interest in geology, especially in volcanology. After travels on the continent he began, when twenty seven, to teach chemistry at Oxford, and two years later was made Professor of Botany in 1834. He visited Canada and the United States, touring Louisiana 5–28 March 1838. His *Journal of a tour* (1842) in an edition of 100 copies "for private circulation," accounts for why so few know Daubeny's American sojourn. New Orleans, Opelousas, "Lake Chicou" come into his narrative but it was a lingering winter that year, and so his plant notes are fewer than for other states he visited. In Daubeny's *Popular geography of plants* (1855) he comments that magnolias "must be seen in America before we can form any conception of their splendour. A petted Magnolia nailed up against a south wall in an English garden, gives a very poor idea of the magnificent trees to be seen there, sometimes 90 feet in height . . . whilst the profusion of their large white blossoms, just delicately tinted, is beautifully contrasted by the background of shining dark green leaves."[31] In a letter to W.J. Hooker, Daubeny wrote "I am distracted by too many objects," and that Hooker would find scant botanical notices in his book.[32] Daubeny's *Journal* deserves, indeed invites with its honest commentary, a rebirth by some publisher, though some of us may not agree when on leaving New Orleans he said "I never left a large city with less regret."

Thomas Drummond wrote his patron William Jackson Hooker at Glasgow from New Orleans on the 5th of January 1832 "I take this opportunity of a vessel going direct for the Clyde to forward what collections I have made during the past season."[33] Born in Perthshire, Scotland, Drummond fell into the orbit of William Jackson Hooker, then Professor of Botany at Glasgow. Perhaps lowly mosses had encapsulated their friendship. Though Professor Hooker reported on Drummond's field work in America in the pages of the *Journal of Botany* soon after his letters arrived, to read the eleven closely packed letters of Drummond, now preserved at Kew, is to sense the high tide of botanical exploration. Drummond was collecting plants (and other *naturalia*) for subscribers whom Professor Hooker had contacted on his behalf. On the 20th of May 1832

Drummond wrote "I have been extremely busy" and asked Hooker to negotiate only eight or ten specimens for each species. To keep up anticipations, however, Drummond often mentioned plants he had collected, for example, *Acacia, Allium, Crinum,* and *Zizania*. Drummond told Hooker, "you frequently find a single specimen & probably don't find it again so that it is impossible to have all the collections [of a single number] full." [34]

At the close of his 1832 season in Louisiana, Drummond hoped he would be able to proceed north from Covington to Natchez through the pine woods north of Lake Pontchartrain where he found what he called "a few pretty plants," namely two species of *Rhexia* and two of *Sabatia*. The extreme barrenness of this country, however, disappointed him. He mentioned that he had found *Drosera brevifolia* and *Pinguicula lutea*.

Before Louisiana, Drummond had been with Sir John Franklin in the Canadian Arctic, and then in the Canadian Rockies collecting both mosses and flowering plants. Yes, this was the "Drummond" of Drummond's phlox, named by Hooker.[35] His phlox was collected in southeastern Texas, grown from seed, the flowers described by Hooker as "brilliant rose-red or purple varying exceedingly on different individuals in intensity." Drummond, however, did not live to admire his introduction. Hooker regretted that although the phlox "bids fair to be a great ornament to the gardens of our country [it must] serve as a frequent memento of its unfortunate discoverer." Drummond's plan after exploring Florida had been to sample the exciting Cuban flora, but his last days in the spring of 1835 will never be known. The British consul at Havana sent Drummond's death certificate to Professor Hooker. Geiser wrote "had [Drummond] made Texas his permanent home the history of Texas botany would have been written very differently," and that he was a man of "tremendous physical energy, of persistence . . . forgetful of self . . . it seems an unnecessarily cruel fate that kept [Drummond] from bringing to completion his work in Texas." [36]

An international enterprise founded by a physician and a professor-parson of the German town of Essingen related to a botanist of Louisiana. A Natural History Traveling Society, or the *Unio Itineraria* of Württemberg, was founded by Dr. Ernst Steudel and Professor Christian Hochstetter, both of Essingen. The *Unio Itineraria* collected specimens from correspondents: William Darlington of West Chester, Pennsylvania, and the French naturalist Jean Louis Berlandier, who collected in Texas, were among the members. By exchange-sale, specimens were distributed to cabinets especially in Europe. Dr. Joseph C. Frank,[37] born in Rastadt, who had published a local flora of his native town in 1830, was deputed by the Society to travel and collect in the United States. According to Stuckey, Dr. Frank botanized in southwestern Ohio and the *Unio Itineraria* distributed sets of his plants, 100 sheets for 11 florins each. These were an important source of information on 19th Century Ohio flora. The Kentucky botanist

Dr. Charles Short says the Grand Duke of Baden commissioned Frank to collect and investigate the flora of the southern states, but his Louisiana stay was brief.[38] He and his wife were stricken with yellow fever, and Frank died two months later in New Orleans in November 1835. He was fifty three. His wife returned to Germany with his collections, and they were distributed in 1836 by *Unio Itineraria*.

Josiah Hale, born in Virginia and a private pupil of Rafinesque, graduated at Transylvania with a medical degree in 1822.[39] He then moved to Port Gibson, Mississippi, an important shipping center where he practiced medicine and collected the local flora. He took off two years for poor health to botanize in Louisiana until 1825 when, as a physician in residence, he moved to Josiah Johnson's plantation twenty miles from Alexandria and continued to collect plants. Hale's first letter to John Torrey in 1838 began his association with Torrey and Gray.[40] They proposed the genus *Halea* in 1842, but forty years later Gray decided it was indeed a species of *Tetragonotheca*. Occasionally a Hale label would catch Gray's eye, for example, "*Ulmus crassifolia* Nuttall. Grows in swamps, subject to inundation, Red River - flowers late in Sept. and ripens fruit in Oct. It will be seen by the present sp[ecimen] that the expression 'ramis teretibus' does not universally apply." [41] Hale's plants were not numbered, and so after Charles Short and others had divided the original specimens and exchanged a portion, the origin "Louisiana" was often all that accompanied the specimen.

The keen interest in botanical exchanges of this era may be seen, for example, as when Hale wrote to Torrey, "at the request of my friend Dr. Leavenworth, I have put up & shipped on the brig Mary Ann, Capt. Wade, a box of specimens of plants growing in the neighborhood of Alexandria." [42] On another occasion Hale wrote to George Engelmann from Canton, Mississippi, "some weeks ago I put on board the steamer Woodruff, at New Orleans, for St. Louis, a small box of specimens of plants for Dr. Mead of Augusta, Ill., directed to your care, by his instructions." [43] Hale took early retirement, married, and invested in local enterprises. When his fortune of 100,000 dollars plunged to 10,000 dollars, he moved to New Orleans to begin private practice again. During these six years in New Orleans he joined Riddell and others to found the New Orleans Academy of Sciences on 1 April 1853, and was elected the first president. Heart trouble set in in January 1856, and Hale died 21 July. In the Academy's Minute Book is written, Dr. Hale "has, perhaps done more to make known the peculiarities of the flora of Louisiana than all others taken together." [44] Hale's particular interests were grasses and sedges, two groups not enamored of by his friend Riddell.

Elsewhere I have taken the historical heights reached by two American botanists for whom two 14,000-foot peaks in Colorado have been named, Gray's and Torrey's, for they dominated nineteenth century systematics. [45] In the middle decades so many novelties were being discovered in the Great West that they nearly ran out of names of botanists to commemorate. William Marbury Carpenter[46] did not collect in Colorado or California, but the stunning genus *Carpenteria*, of which there is but a single species, named by Torrey, commemorates an endemic saxifragaceous shrub of the southern Sierra Nevada. Carpenter was born in West Feliciana Parish 25 June 1811, about twelve miles from St. Francisville. The Carpenters had lived in Louisiana since 1773, and on his mother's side, the Marburys since 1795. At eighteen Carpenter was admitted at West Point as a cadet, but with a rheumatic heart he returned home just before graduation. Soon after leaving West Point he accepted a professorship of Natural Science at Centenary College, Jackson, Louisiana, then called College of Louisiana, teaching botany, geology, "and some other things." He botanized widely in Louisiana on vacations, occasionally with students. In 1832, for example, he collected around Opelousas.

Carpenter wrote to John Torrey, "You will perhaps find some of my statements respecting the size of plants in the south, as inclining to extravagance. If, however, you have traveled in our delta, you will at once know that it is not exaggeration. For example, in vol. 1. p. 260 *Fl[ora] N[orth] A[merica]* you state as follows of the *Berchemia volubilia* ["supple-jack" of the bayous, *Berchemia scandens*] climbing to the height of 12 or 15 ft. In Louisiana, trees exceeding 100 ft in height are sometimes completely covered by it," and "I believe that vines of it are common here which would measure more than 200 ft, and would have a circumference near the root, of 6 to 9 inches."[47]

It is not recorded when Carpenter collected his M.D. degree, but he practiced about Jackson and from 1842 taught materia medica at the Medical School of Louisiana in New Orleans. Charles Lyell, British geologist, visited New Orleans, and we have his story: "Dr. William Carpenter, although in full practice as a physician, kindly offered to accompany me [to examine the geology around Balize, in the Mississippi delta] and his knowledge of botany and geology, as well as his amiable manners, made him a most useful and agreeable companion."[48] They had carried Charlevoix's maps of the passes, published in 1743, and had found them remarkably accurate.

Before his death at thirty-seven years Dr. Carpenter published on geology in Silliman's *Journal*. Perhaps biographical details are buried in Benjamin Silliman's papers at Yale. Fewer than one hundred Carpenter specimens now survive in the Tulane University herbarium. They were once part of the New Orleans Academy of Sciences collection assembled by the physician-botanists Riddell and Hale.

Who was the leading botanist of Louisiana in the Nineteenth Century, who engaged the important collectors Josiah Hale and William Carpenter to cooperate with him in what might have become the first synopsis of the state flora? John Leonard Riddell. Riddell will remain a riddle. More writers have discussed Riddell than any other figure in our story, yet no full biography of this man with details of his various enterprises has ever appeared, though Karlem Riess came close.[49] Perhaps the very incubus of records—twenty eight manuscript diaries at Tulane—have hampered the effort. "At the time of his death, 1865, [Riddell] was considered by many to be the foremost American scientist."[50]

After botanical instruction from Amos Eaton, whom we must admit was one of the most colorful figures in our history of science,[51] Riddell was actively botanizing in Ohio, and trying to sell his bound book-like herbaria to citizens as well as to teachers in female academies. He advertised in the Marietta newspaper that he was willing to collect plants for sale: dried specimens for conversation pieces! In 1833 he began corresponding with John Torrey and sent him herbarium specimens. His 116-page *Synopsis of the flora of the western states* published in Cincinnati in 1835—no small synopsis—was the basis for his botanical activities in Louisiana after his arrival in New Orleans in 1836 to teach chemistry officially, and natural history actually at the Medical College of Louisiana. In many ways we are reminded of Rafinesque. Besides Riddell's catalogue of plants growing spontaneously in Franklin County, Ohio, his six-page "Geological ramble ... near Cleveland," and his abstract on *Oscillatoria* structure, by 1847 he was also lecturing at the People's Lyceum of New Orleans on "Orrin Lindsay's plan of aerial navigation with a narrative of his explorations in the higher regions of the atmosphere and his wonderful voyage around the moon." Riddell's lecture was printed, and it has been suggested that he anticipated H.G. Wells by some half-century. Remember that Riddell's invention of the first practical binocular microscope was noticed in the eleventh edition of the *Encyclopaedia Britannica.*

Riddell served as Federal postmaster of New Orleans during Jefferson Davis's Confederate years. When the Confederate postal system was started 1 June 1861, prepayment of all postage in cash was demanded. It was then that Riddell circumvented Confederate action by issuing "provisional stamps" and "fractional currency" in denominations of one cent to five dollars—all to facilitate the Federal cause.[52] Riddell was undoubtedly a spy for the Union. Small question but that Riddell's botanical work had to be set aside. And where is the largest collection of Riddell's specimens to be consulted? Not in the United States, but at the Natural History Museum, London. Through A.H.G. Alston's efforts it had acquired from a provincial museum in the Midlands a set of 320 specimens, mostly of Louisiana plants (although the bound volume is titled "Ohio"!). Paris had 290 Riddell sheets, acquired with the Durand herbarium,[53] from which Riddell specimens were distributed.[54] The Fielding Herbarium at Oxford University contains about 70 specimens, possibly acquired by Prof. Daubeny.[55] On 27 March 1838 Daubeny met Riddell on his American tour, and though he recorded his New Orleans visit in his *Journal*, strangely he does not mention Riddell.

In this country Tulane University probably has the largest series, roughly

125 sheets, these surviving from the old New Orleans Academy of Sciences herbarium.[56] Gray Herbarium, Torrey Herbarium, Philadelphia Academy, Darlington Herbarium at West Chester, Missouri Botanical Garden, and Smithsonian Institution, all have Riddell specimens. His conflict with Gray, the leading figure in American botany at the time and the only botanist to win a head in the Hall of Fame in New York City, made history. In 1851 Riddell completed a synoptical account of the plants of Louisiana which he submitted to the Smithsonian Institution for publication. Joseph Henry sent the manuscript to Asa Gray for consideration, a customary practice. Though no correspondence relative to Gray's rejection has ever been located, the evidence is found in the Gray Herbarium. Gray scissored and inserted pages from Riddell's manuscript into the copy of *Synopsis of the flora of the western states* which Riddell had presented to him. There will also be found neatly folded manuscript pages in packets on herbarium sheets of the respective species described in Riddell's manuscripts.[57]

Handicapped by residence in a city which Lyell characterized as gripped by cultural paralysis, plagued by two attacks of yellow fever in 1837 and 1853, weakened by the animosities of his colleagues, bound by high costs of local printing and by protracted delays in mail deliveries with his botanical correspondents, Riddell labored under impressive difficulties. Yet, as James Cassedy expressed it, "he combined luck, native talent, and audacity to achieve considerable scientific success in antebellum United States."[58] Granted, his native talents were less than those of an Engelmann or a Chapman, two practicing physicians who achieved more substantial botanical successes. For all its imperfections Riddell's *Flora* would have stabilized the knowledge of Louisiana botany in the mid-nineteenth century.

"The scientific man is always on the road, never at journey's end," as T.D.A. Cockerell wrote, "we necessarily work with incomplete materials and more or less inadequate tools. We have to build on foundations often poorly established, and no matter how clever or industrious we may be, posterity will have to revise and correct much of what we have done. So true is this, that it is easy to become discouraged, and many do fall away and give up the quest."[59]

Americus Featherman collected plants in Louisiana from 1858 until 1875. He was born in 1822 in Oettingen, a county in Germany, and came to the United States when seventeen years of age. According to John Hendley Barnhart he studied medicine at Paris, practiced medicine in Missouri and studied and practiced law.[60] He published three reports on agricultural botany while teaching in the Louisiana State University between 1869 and 1872. For some reason he returned to Europe in 1875 and lived in Paris. Over one hundred of his plant specimens are reported to be in the Paris herbarium. Asa Gray disposed of twelve proposed new species described from Louisiana by Featherman. One, *Sabatia oligophylla*, Featherman illustrated in water color.[61]

The New Orleans World's Industrial and Cotton Centennial Exposition of 1884 brought together botanists with their exhibits. John Gill Lemmon and his wife Sara Allen Plummer Lemmon exhibited Pacific Coast conifers, pressed ferns, and wild flowers.[62] George Vasey submitted grasses, and Joseph Finley Joor, who had lived in Texas for a decade, exhibited the woods of Texas. Joor, born on the Comite River, Parish of East Baton Rouge, graduated from the New Orleans School of Medicine, served as Quarantine Surgeon at Ship Island Station, and practiced at Thibodaux.[63] Facing poor health he moved to the prairies of Texas, first at Harrisburg, then at Birdston. While at Birdston he wrote to George Engelmann for some plant identifications: "I have now on hand specimens of 100 doubtful plants, including several Cruciferae, a Claytonia, a Callirrhoe."[64] He listed a dozen genera, all evidence of his botanical acuity. Joor was appointed Assistant Commissioner for Texas to prepare exhibits of woods and Texas plants for the Exposition.

It was Paul Tulane's gift of $10,000 to establish a natural history collection, shortly after his million dollar educational endowment in 1884, that brought Joor to the Tulane University of Louisiana. He began his assistant curatorship by arranging the 120 mounted birds, small-case habitat groups of chimpanzee, platypus, Kodiak bear, etc., and salvaging the herbarium including collections of Hale, Riddell, and Carpenter which had suffered from neglect in the New Orleans Academy of Sciences. He was appointed Professor of Botany in 1889 though without teaching duties. Tulane President Johnson urged Joor to go to Avery Island when a new shaft in the salt mines was exposing fossils and artifacts. Joor reported that the McIlhennys "most agreeably and hospitably received me."[65] Fossils collected there were divided between Tulane and Mr. Edward Avery McIlhenny; among them were two mastodon teeth, bones of equus, and of a giant sloth. For five years Professor Joor, no longer practicing medicine, cared for the Tulane Museum, continuing to collect plants mostly on his limited free time, and corresponded with botanists, among them George Vasey, A.W. Chapman, and William Trelease of the Missouri Botanical Garden. The early Joor specimens from the New Orleans Academy of Sciences were not among those purchased by the Garden in 1897.[66] Joor died at the age of forty-four. His daughter, Harriett, who taught art at Newcomb College and who retired to Lafayette, Louisiana, asked if I would accept her father's letters on behalf of Tulane. Gladly I did. Those 103 pieces, including a postcard from Asa Gray, now in Tulane archives, relive Joseph Joor's enthusiasm for plant study.

Perhaps the best known Louisiana botanist of the 1890's was the clergyman Abbé Augustus Barthélemy Langlois, born in Charanay, Loire, France, 24 April 1832. He attended the "Grand Seminary" of Lyons, and after 1855 the Seminary of Cincinnati, Ohio, and was ordained in 1857. He was appointed rector of Plaquemines Parish, which extended 110 miles along the Mississippi River. On his arrival at his new home he found the bloody cassock of his predecessor who had been murdered when called out during the night. Pastor Langlois served thirty years at Pointe à la Hache, amassing a reference library and comprehensive collections—his large herbarium went to Catholic University of America, but was later dispersed to several other institutions.[67] In 1887 Langlois moved to St. Martinville in the Teche country. That year he published what he called his provisional *Catalogue* of the Mississippi Delta flora.[68] In it he enumerated nearly 1200 seed plants, 650 fungi, 96 mosses, and 29 hepatics. Lichens were not listed, but over 200 numbers of them had been collected by the time of his death in 1900.

Langlois' fourteen letters to E.L. Greene from 1894 to 1897 tell of his "very happy voyage to Europe" in 1896 when he examined the herbaria at Geneva. "I only discovered at Boissier's Herb. my Louisiana lichens partly determined by John Mueller of Argau before his death."[69] He had also seen the "famous bryologists" Capt. Ferdinand Renauld and Jules Cardot. Langlois' nephew, rector at Breaux Bridge, Louisiana, wrote after his father's death that Langlois' library of "at least 300 volumes" included the thirty-six volumes of Job Bicknell Ellis's *North American fungi*.[70] According to Saccardo's *Sylloge fungorum* there are only 50 sets of Ellis in the world. Shirley Tucker has published a gazetteer of Langlois' collection sites and a bibliography.[71]

What's in a name? How about Bush? How about a "country storekeeper and botanist" as the New York Times headlined its story.[72] When Benjamin Franklin Bush, born in Columbus, Ohio, 21 December 1858, was seven, his mother moved him to Independence, Missouri.[73] The Missouri Pacific Railroad had just been opened from St. Louis to Kansas City, and so Benjamin and his mother rode the first train. Passenger pigeons were in the woods, Carolina parakeets ("paroquets" could be caught with a coat or hat), and prairie chickens were abundant. The Bushes moved to Courtney, sixteen miles east of Kansas City in the early 1890s. In Courtney he sold shoes, overalls, plugs of tobacco, and groceries. Yet Bush was able to prepare herbarium specimens. Thousands of sheets are in leading herbaria—*Index Herbariorum* lists twenty-seven herbaria: the Gray Herbarium has 3400, and the National Herbarium over 5000. His early contacts with Asa Gray and George Engelmann launched his traveling career, and William Trelease's contacts were critical. In 1899 Bush began a decade of exploration for the Arnold Arboretum with Professor Sargent relying on his field knowledge to ferret out the hawthorns then under pursuit. Ernest Jesse Palmer, who wrote a portrait of Bush, met him in 1900. Both botanists had collected in Louisiana. It is Bush's article in Sargent's *Garden and Forest* in 1897 about his search for corkwood, a shrub or small tree to thirty feet, that still challenges.[74] Corkwood, *Leitneria floridana*, discovered in swamps in southeast Missouri, was described by the Apalachicola botanist A.W. Chapman, friend of Asa Gray and John Torrey. Before Bush's discovery *Leitneria* had been known only from its first collection in Florida, and a dubious Drummond specimen from southeast

Texas. Trelease sent Bush to search Bayou Goula, White Lake, Louisiana, but though he "examined thoroughly" the cypress swamps he failed to find any *Leitneria*. He considered the "largest development" of *Leitneria* to be in the "big Lake, in se. Mo. and ne. Arkansas," where shrubs were "about twelve feet in height with stems nearly four inches in diameter." Who will find the first *Leitneria* in Louisiana?

Reginald Wodehouse Somers Cocks took his M.A. at Trinity College, Cambridge, with first honors in classics.[75] He must have been influenced especially by Kew-trained curator at the Cambridge Botanic Garden, Richard Irwin Lynch, indeed a linchpin. Lynch had raised the garden's collection almost to that of Kew for its "botanicks."[76] Cocks first arrived in Canada in 1890, but soon came to Louisiana. There are specimens at Tulane dated "Feliciana, March 1892," and by 1898 he was active in the Louisiana Society of Naturalists. By May 1906 he was corresponding with E.L. Greene, then at the Smithsonian, inquiring about Langlois' localities, and by December he had sent a "small package of plants" for Greene's attention. "I was very often able to get help from Dr. Mohr and Father Langlois" Cocks wrote, "but since their death there has been no botanical investigator anywhere in these parts."[77]

The year 1908 was a flowering for Professor Cocks, for two reasons: he met Harvard dendrologist Charles Sprague Sargent, and after one year at Louisiana State University he accepted the Ida Richardson Chair of Botany at Tulane. This chair had been created by the wife of the Dean of the Medical School, Tobias Gibson Richardson.[78] Cocks was already familiar with the Tulane herbarium, citing records in his paper in the Society of Naturalists' *Proceedings* as early as 1900.[79] It is the Sargent-Cocks circulation that was so significant to our botany, the systole and diastole that kept specimens in motion and diagnosed. I was instructed in Louisiana botany by the over 300 letters written by Charles Sargent to Professor Cocks, "my companion in annual journeys of exploration through the forests of Louisiana,"[80] from 1908 until 1926 when their lives and letters ceased. These letters are alive with the pursuit of hawthorns, oaks, and hickories, which Sargent conjectured he had missed in the first edition of his *Manual* (1905). For example, Sargent wrote Cocks, "in August 1901 Bush collected at Minden a sterile branch of a distinct-looking" species of *Crataegus* subgenus *Crus-galli*, adding a tease: "Is not Minden a place to explore?"[81]

Sometimes the "Cock's spur" is not always on the hawthorn. Sargent: "Britton says the . . . Nutmeg Hickory is called Bitter Walnut in Louisiana. This must be a fake story for in the first place the kernal [sic] is not bitter, and secondly is so rare in Louisiana that it cannot have secured a popular name."[82] Sargent wrote: "Thank you again for all your kindness to me during my visit to Louisiana. I never had a better week or saw finer or more interesting trees, and we must make another trip together before long."[83] After that 1910 letter they had many trips together. Some of you may know the house at the corner of Carrollton and

Freret streets built in 1849 by Nathaniel Wilkinson in Gothic cruciform design, the house snuggled behind a curtain of trees and shrubs. When Charles Low lived there Professor Sargent was house guest on his visits to New Orleans.

When I came to New Orleans in 1947, Percy Viosca was a local watchword. He had supplied teaching materials for biology classes, was with the State Department of Conservation, Curator of Reptiles, etc., in the State Museum, New Orleans, and was a President of the Louisiana Academy of Sciences. "Louisiana's first major herpetologist probably was Percy Viosca, 1892-1961."[84] He published a benchmark paper in the journal *Ecology* on "Louisiana wetlands and the value of their wildlife and fisheries resources."[85] He had given a radio talk sponsored by the Smithsonian Institution, this published in *Scientific Monthly*.[86] Viosca trumpeted Louisiana in 1933 in "a handy reference for tourists . . . and nature lovers generally," published in New Orleans.[87] This is still a very "handy" guide for tracing names now hushed by progress, and the folding map of landform-vegetation by L.E. Boesch is useful.

But it was Viosca's careful study of Louisiana irises that calls our wider attention. Edgar Anderson, that zealous researcher at the Missouri Botanical Garden, gave Viosca front-page recognition in his book *Introgressive hybridization* published in 1949.[88] Introgressive hybridization was a botanical topic that in a decade translated the genetics of hundreds of American plants into printer's ink. Viosca's study of Louisiana irises had soberly reduced the panoply of described "species" proposed by J.K. Small and E.J. Alexander into what Viosca interpreted as but a few freely interbreeding species. There were ninety-five taxa in Small's *Manual* of 1933. Edgar Anderson had known irises in the field while collecting and researching the genus *Tradescantia* with Robert Woodson. Paul Percy Viosca was a field naturalist who knew the sound of frogs, of birds in fleeting migration, and the non-migratory snakes we met in the bayous. I recall my visit to his bedside when he imprinted a thought: "When I have so much knowledge of the fauna and flora, why should this cancer snuff out my life?" He was seventy-two when he died a few weeks later.[89]

Versatile Clair Alan Brown, associated with Louisiana State University from 1926 for forty-two of his seventy-nine years, was first a forester and a mycologist studying wood-rotting fungi.[90] Later he wrote on Louisiana's fossil pollen record, her paleogeologic history, revegetation after flood waters, what plants grow on Indian mounds and the extent of middens, weeds in rice fields, and mushroom poisoning among cattle. He contributed nine chatty essays to *Louisiana Conversation Review*. His *Louisiana trees and shrubs* introduced our woody plants to hundreds of young biologists and vacationers.[91] He liked ferns and found their soil requirements interesting, co-authoring with Donovan Correll a book on ferns of the state.[92] Their attractively illustrated guide, published in an edition of only 500 copies, considers where and why ferns grow in a region we often think of as fern-poor.

Clair was a smiling botanist, optimistic, and thoroughly social. When he married Clara Douglas, serials librarian at the University in 1963, his interest in petrified wood joined her enthusiasm for lapidary handicraft. Clair knew this state. I remember how he warned me on a field trip along Thompson Creek to watch for quicksands. His handy manual *Wild flowers of Louisiana*, illustrated with his own full-color photographs, will be a record of our flora of 1972 a hundred years from now.[93]

> The life so short, the craft so long to learn,
> Th' assay so hard, so sharp the conquering ...
>
> Chaucer, Parlement of Foules, ca. 1382

ACKNOWLEDGMENTS

My thanks to so many librarians, archivists, and biologists who have aided my efforts in tracing our history. If this review is rewarding, thank my wife, Nesta,[94] my companion in zealous research.

NOTES

1. Joseph Ewan,"A bibliography of Louisiana botany," *SouthW. Louisiana J.* 8 (1967 [1968]) 2–83 (hereinafter cited as Ewan, *Bibliog.*) Eric Sundell,"Supplement 1951–1975," *Tulane Stud. Zool. Bot.* 21 (1979) 3–66. *Naturalists of the Old South,* planned on the model of *Rocky Mountain naturalists* (Denver, 1950) but never published, amounts to seven pamphlet boxes of 5×8 cards, recording quotations from correspondence, notes from archives, museum records, holographs from S.W. Geiser, etc. (hereinafter cited as *Old South*)."Historical sketch of Louisiana botany" by R.S. Cocks, *Proc. Louisiana Soc. Naturalists* (1897–1899) 69-84 (cited as Cocks, *Sketch*)."Some notes on the botanical history of Louisiana" by R.J. Usher, *Home Gardening* 1 (6)(1941) 12–13, 20–21; (7) 12–13, 19–20, and (8) 12–13. *Ferns and fern allies of Louisiana* (Baton Rouge, 1942) by C.A. Brown and D.S. Correll (cited as Brown and Correll, *Ferns*). John Francis McDermott published two symposia with relevant chapters: J. Ewan, "Scientist on the frontier," *Research opportunities in American cultural history* (Lexington, 1961) 81–101, and "French naturalists in the Mississippi Valley," *French in the Mississippi Valley* (Urbana, 1965) 159–174 (cited as Ewan, *French naturalists*). Roster of 70 persons in J. Ewan, "Letters from Charles Sprague Sargent to Reginald Somers Cocks, 1908–1926," *J. Arnold Arbor.* 46 (1965) 1–44, 122–159, 324–361, 411–444 (cited as *Sargent-Cocks letters*). J. Ewan, "Historical problems for the working taxonomist," *Taxon* 18 (1969) 194–203 (cited as Ewan, *Problems*).
2. Antoine Simon Le Page du Pratz, *History of Louisiana,* Joseph G. Tregle, ed. (Baton Rouge, 1975). *Dictionary of Louisiana biography,* Glenn R. Conrad, ed. (Lafayette, 1988) (cited as *DLB*). Cocks, *Sketch* 69-80. Ewan, *Bibliog.* 8. Ewan, *French naturalists* 164.
3. T. Becket, London, 1774 ed. (New Orleans [1947]) 223. Black mangrove, formerly *Avicennia nitida* Jacq., now *A. germinans* (L.) L. See E.L. Little Jr., *U.S.D.A. Agric. Handb.* 541 (1979) 59.

4. P.R. Cutright, "Lewis and Clark and Du Pratz," *Bull. Missouri Hist. Soc.* 21 (1964) 31–35. *Quarter of a millenium*, Edwin Wolf II and Marie Elena Korey, eds. (Philadelphia, 1981) fig. 90. p. 111. The copy now in the Library Company, Philadelphia. For B.S. Barton see J. Ewan and N. Ewan, *Benjamin Smith Barton, keystone naturalist and physician in Jeffersonian America* (Missouri Bot. Garden Press, St. Louis, 2005, in press).
5. Elliot Coues, *Birds of the Colorado Valley* (Washington, 1878) 582.
6. Charles E. O'Neill, *Charlevoix's Louisiana, selections from the History and the Journal* (Baton Rouge, 1977). Useful documented account of Pierre F.X. de Charlevoix, 1682–1761, in B. Boivin, "La flore du Canada en 1708," *Provancheria* 9 (1977) 223–297. D.P. Penhallow, *Trans. Roy. Soc. Canada* 5 sect. 4 (1888) 51–52. Ewan, *Bibliog.* 8.
7. A.H.G. Alston and R.E. Schultes, "Studies of early specimens and aspects of *Ilex vomitoria*," *Rhodora* 53 (1951) 273–280.
8. Economics of wax myrtle awaits study. Ewan, *French naturalists* 166. Ewan, *Bibliog.* 76.
9. Samuel Dorris Dickinson, *New travels in North America by Jean-Bernard Bossu, 1770–1791* (Natchitoches, La., 1982) 117.
10. Johann Reinhold Forster, transl. *Travels through that part of North America formerly called Louisiana, by M. Bossu* (London, 1771) 2 vols. Plant identifications by Forster, 1:347–355, to which is added Forster's "Catalogue of the known plants, shrubs, and trees in North America" as they relate to works of Catesby, Kalm, and Gronovius. Ewan, *Bibliog.* 9.
11. See note 9 for Dickinson, *Bossu*. For synopsis of Bossu editions see Ewan, *Science* 139 (1963) 478–479.
12. Auguste Denis Fougeroux de Bondaroy, *Hist. Acad. Roy. Sci. Mém. Math. Phys. (Paris)* 1786 (1788) 5. Ewan, *Bibliog.* 10.
13. Hazel le Rougetel, *Chelsea gardener, Philip Miller 1691–1771* (Portland, Ore., 1990) 182.
14. J. Ewan, *William Bartram, botanical and zoological drawings, 1756–1788* (Philadelphia, 1968) 154–167.
15. William Dunbar, 1749–1810, "Scottish-born scientist and Mississippi planter," took up his plantation near Natchez in 1792. Dunbar befriended Bartram's friend, Alexander Wilson. See Clark Hunter, *Life and letters of Alexander Wilson* (Philadelphia, 1983) 101, 373, and Wilson's letter, 358.
16. Francis Harper, *Travels of William Bartram, naturalist's edition* (New Haven, 1958). From this Harper classic, a paper-bound edition with background essay by Robert McC. Peck (Peregrine Smith, Salt Lake City, 1980) is reliable for maintaining original pagination of the 1791 edition.
17. For Claude César Robin, 1750-post 1807, see F. Monaghan, *French travelers in the United States, 1765–1932* (New York, 1961) 81.
18. C.S. Rafinesque, *Florula Ludoviciana* (New York, 1817) is an abridged and augmented translation of Robin's "Flore Louisianaise" in his *Voyage dans l'intérieur de la Louisiane, de la Floride occidentales … 1802 [to] 1806* (Paris, 1807) 3:325–538. See J. Ewan, editor's introduction, reprint Rafinesque, *Florula Ludoviciana* (New York, 1967) i–xl.
19. Essential reference: Stanley Clisby Arthur, *Audubon, an intimate life of the American*

woodsman (New Orleans, 1937) 273, the basis of Irving T. Richards, "Audubon, Joseph R. Mason, and John Neal," *Amer. Lit.* 6 (1934) 122–140, by correspondence with Arthur. Current study: Lois Elmer Bannon and Taylor Clark, *Handbook of Audubon prints* (Gretna, La., 1991) 57, Mason's backgrounds, 91–108. Francis Herrick, *Audubon the naturalist* (New York, 1917) 2:69 refers to Thomas Sully's report of Mason working in Philadelphia. The "Joseph R. Mason, 1808–1842" in George C. Groce and David H. Wallace, *Dictionary of artists in America, 1564–1860* (New Haven, 1957) 428, singularly makes no reference to Mason's association with Audubon!

20. Marshall B. Davidson, Introduction, *Original water-color paintings of John James Audubon for the Birds of America* (New York, 1966) plate 211, but Mason's drawing of *Hydrangea quercifolia*, plate 83, as usual makes no record of his participation.
21. Aloysius Enslen, Austrian gardener whom Frederick Pursh had known in Europe. He collected for Prince Lichtenstein as far south as New Orleans, where he first found the copper-colored *Iris* "on the banks of the Mississippi River near New Orleans," but the records in Vienna evidently lost. Enslen's discoveries, including the iris, were circulated in the Philadelphia coterie. John Lyon listed the "sp. nova. copper coloured flowers," then undescribed, on his broadside of garden novelties from America (*Trans. Amer. Philos. Soc.* 53 (pt. 2) (1963) 57). The latest account on Enslen is J. Ewan, editor's introduction, reprint, F. Pursh, *Flora Americae Septentrionalis* (Cramer, Vaduz, Germany, 1979) 15–16. See also J. Ewan, "From Calcutta and New Orleans, or, tales from Barton's greenhouse," *Proc. Amer. Philos. Soc.* 127 (1983) 125–134. The type specimen of *Iris fulva* Ker. was destroyed in the bombing of World War II. See also Margaret Stones, *Flora of Louisiana ... with botanical descriptions by Lowell Urbatsch* (Louisiana State Univ. Press, Baton Rouge, 1991).
22. William Paul Crillon Barton, 1786-1856, M.D. and Prof. of Botany, University of Pennsylvania, drew 49 native species, colored the plates himself, for his *Vegetable materia medica of the United States* (Philadelphia, 1817–18) but it would have been Barton's ambitious three-volume *Flora of North America* (Philadelphia, 1821-23) that possibly involved Joseph Mason. Barton's wife, Esther Sergeant, assisted with the drawings of both works. See J. Ewan, "History of Philadelphia horticulture: chronology, dramatis personae," *From seed to flower, Philadelphia 1681–1876* (Penn. Hort. Soc., 1976) 59, 65.
23. See note 20. Davidson introduction, xi–xxix. Color reproductions from the Audubon collection at the New York Historical Society.
24. Louis Francois Tainturier, fl. 1825-1840, market-gardener (?), correspondent of W.J. Hooker, whose eight letters, 1824–1836, are preserved at Kew, lived at 47 Burgundy St., acc. *Gibson's guide and directory, 1838,* and *Michel's New Orleans directory, 1840.* The scattered references to Tainturier in Torrey and Gray, *Flora* 1:15, the collections in the Philadelphia Academy, and in T. Nuttall, *Sylva* 1:194, represent correspondence with Hooker and not the unlikely correspondence of Tainturier with American botanists. Ewan, *Old South*. W.J. Hooker, Nov. 21, 1825, to John Richardson, in part, "I am even keeping in view our projected Flora of British N. America and am extending my correspondence to all parts of that Continent, in order that our portion of it may in due

time, be the better illustrated. I have an excellent correspondent even at New Orleans, who sent me large collections from that neighbourhood & some way up the banks of the Mississippi." Hooker-Richardson letters, Kew.

25. For College of Orleans see Joseph A. Breaux, *Publ. Louisiana Hist. Soc.* 7 (1915) 136–142. Ewan, *Old South*. Ewan, *French naturalists* 173. Could there be a connection between the "herbarium of 8000 plants well dried and well preserved" and Tainturier? Joseph Lakanal announced at the College of Orleans in 1822. See John Charles Dawson, *Lakanal, the regicide* (University, Ala., 1948) 133.
26. S.H. Scudder, *Psyche* 8 (1899) 306–308. Harry B. Weiss and Grace M. Ziegler, *Thomas Say, early American naturalist* (Springfield, Ill., 1931) cites six Barabino references.
27. E.T. Hamy, *Travels of the naturalist Charles A. Lesueur in North America, 1815–1837*, Milton Haber, transl. (Kent, Ohio, 1968) 66.
28. Ewan, *Bibliog.* 38, 52, 56. For more on Lesueur and Bory see M. Ly-Tio-Fane, *Le géographe et le naturaliste à l'Ile-de-France, 1801, 1803* (Port Louis, Mauritius, 2003).
29. S.G. Morton, *Synopsis of the organic remains of the Cretaceous group of the United States* (Philadelphia, 1834) 63. Though Morton did not botanize, Asa Gray memorialized him in the celastraceous genus *Mortonia*, in *Plantae Wrightianae* 1 (1852) 34, "to that most eminent American naturalist, the late Samuel George Morton, author of *Crania americana*." For sidelights on the "American Golgotha," see Frank Spencer, *Trans. Stud. Coll. Physicians Philadelphia* ser. 5, 5 (1983) 321–338, and W.J. Bell, Jr. in C.C. Gilespie, ed., *Dictionary of scientific biography* 9 (1974) 540—541.
30. Daubeny, son of an Anglican cleric, is identified by Arnold Thackray as a chemist and geologist, not as a botanist (in C.C. Gilespie, ed., *Dictionary of scientific biography* 3 (1971) 585–586. At the Oxford meeting of the British Association for the Advancement of Science when the Bishop of Oxford hoped to conclude the sessions by "smashing Darwin," Daubeny supported the *Origin*. See Leonard Huxley, *Life and letters of Joseph Dalton Hooker* (London, 1918) 1:521. The Catalogue of the archives of the Oxford Botany Department, now deposited in the Bodleian Library, lists 135 Daubeny titles. Ewan, *Old South*.
31. *Popular geography of plants; or a botanical excursion round the world* (L. Reeve, London, 1855) 113. The work was edited by Daubeny, with the author given as "E.M.C." A ms record equated this with Emily M. Cox, but the National Union Catalog ascribes the authorship to Maria E. Catlow, author of popular works on insects and shells.
32. C.G.B. Daubeny, Oxford, 4 March 1843, to W.J. Hooker, Hooker correspondence, Kew.
33. Thomas Drummond's Louisiana and Texas herbarium records were the first widely distributed among the world's botanical centers. Some of the best narrative in the field of botanical exploration, Samuel W. Geiser, *Naturalists of the frontier* (Dallas, 1948) ed. 2. 55–78, provided a background.
34. T. Drummond, New Orleans, 20 May 1832, to W.J. Hooker, Hooker correspondence, Kew.
35. *Bot. Mag.*, plate 3441. 1835. Geiser provides a map of Drummond's collecting localities.
36. Ibid. 1948, 78.

37. The collections of Joseph C. Frank, 1782–1835, M.D., in the Missouri Botanical Garden herbarium were acquired with the Bernhardi Herbarium. George Engelmann, St. Louis, 17 Feb. 1842, to Asa Gray, comments on Frank's botanizing in western Pennsylvania (Asa Gray correspondence, Harvard). Ronald L. Stuckey, *Castanea* 39 (1974) 263–272, on Frank's Ohio collections. Agnes Chase, *Contrib. U.S. Natl. Herb.* 28 (1929) 32, reported the type specimen of *Paspalum frankii* Steud., labeled "New Orleans, 1837," is in the Drake Herbarium, Paris.
38. See R.L. Stuckey, *Scientific publications of Charles Wilkins Short* (New York, 1978) i–v. Ewan, *Problems* 200. Ewan, *Bibliog.* 20.
39. J. Ewan, "Josiah Hale, M.D., Louisiana botanist, Rafinesque's pupil," *J. Soc. Bibliogr. Nat. Hist.* 8 (1977) 235–243.
40. Ibid. 237. Ewan, *Bibliog.* 25. *Sargent-Cocks letters*, numbers 140, 192, 246.
41. Specimen simply annotated by Asa Gray "Louisiana, Hale" Gray Herbarium, Harvard.
42. Ibid. 238. J. Hale, New Orleans, 6 June 1838, to John Torrey, Torrey correspondence, N.Y. Botanical Garden.
43. J. Hale, Canton, Mississippi, 7 Nov. 1855, to G. Engelmann. Engelmann correspondence, Missouri Botanical Garden. For Samuel Barnum Mead, 1799-1880, M.D., see the overlooked privately printed Alice L. Kibbe, *Afield with plant lovers and collectors* (Carthage, Ill., 1953) 5–42.
44. New Orleans Academy of Sciences archives now preserved at Howard-Tilton Memorial Library, Tulane.
45. J. Ewan. "Only ten feet less." In James E. Guncke, ed., *Current topics in plant science* (New York, 1969) 155–166.
46. R.S. Cocks, "William Marbury Carpenter, a pioneer scientist of Louisiana," *Tulane Graduates' Mag.* 3 (1914) 122–127. Also John Duffy, ed., *Rudolph Matas history of medicine in Louisiana* (Baton Rouge, 1962) passim.
47. W.M. Carpenter, Jackson, La., 15 June 1839, to John Torrey, Torrey correspondence, N.Y. Botanical Garden, courtesy of Susan Fraser, archivist.
48. Charles Lyell, *Second visit to the United States of North America* (New York, 1850) 2:111. Carpenter accompanied Lyell in March, 1846, about New Orleans, 2:106-107, and his observations around Port Hudson, 2:138–139, and the hydrography of the Mississippi River, 2:188–189, were reported by Lyell.
49. J. Karlem Riess, "John Leonard Riddell," *Tulane Stud. Geol. Paleontol.* 13 (1977) 1–110. John Duffy, ed., *Rudolph Matas history of medicine in Louisiana* (Baton Rouge, 1962) 2:85–86, passim. Ralph W. Dexter, "Early career of John L. Riddell as a science lecturer in the nineteenth century," *Ohio. J. Sci.* 88 (1988) 184–188. Ewan, *Problems* 200. *DLB.*
50. Otto Juettner, *Daniel Drake and his followers* (Cincinnati, 1909) 202–203. J.L. Riddell, to Amos Eaton, quoted by Wm. M. Smallwood, *New York History* 18 (1937) 183.
51. "Prior to Agassiz, no other individual contributed nearly so much to American culture through the actual study of natural history as did Amos Eaton" Wm. M. and Mabel S.C. Smallwood, *Natural history and the American mind* (New York, 1941) 283, in a

notable chapter, 249–284. When publication of Eaton, *Manual of botany* (Albany, 1817) was rejected, 63 Williams College students underwrote its printing (262).

52. Hubert C. Skinner, "The remarkable Dr. John Riddell," *Linn's Weekly Stamp News* (Sidney, Ohio) 40 (1967) 23.
53. Agnes Chase, "Durand Herbarium," *Bartonia* 17 (1935) 40–45.
54. Laurence J. Dorr, "Identity of *Riddellia* Raf.," *Taxon* 41 (1992) 80–83, see 81.
55. Hermia N. Clokie, *Account of the herbaria of the Department of Botany in the University of Oxford* (Oxford, 1964) 154 and 232.
56. Ewan, *Problems* 199-200, for figures of Riddell herbarium labels.
57. J. Ewan, "Riddell's place in the phytography of Louisiana." *Amer. J. Bot.* 50 (1963) 631, abstract.
58. *J. Hist. Med. Allied Sci.* 28 (1973) 102.
59. J. Ewan, *Rocky Mountain naturalists* (Denver, 1950).
60. John H. Barnhart, *Biographical notes upon botanists* (Boston, 1965) 3 vols. Ewan, *Bibliog.* 29.
61. A. Gray, "Report on the botanical report of A. Featherman," *Amer. J. Sci.* ser. 3. 2 (1871) 374–375. Ewan, *Bibliog.* 29-30. R.L. Wilbur, *Rhodora* 57 (1955) 101.
62. J. Ewan, "Roots of the California Botanical Society," *Madroño* 24 (1987) 1–17. Photograph of the Lemmons' exhibit at the New Orleans Cotton Exposition, fig. 2, refs. 16.
63. J.B.S. Norton, "Joseph F. Joor," *Bot. Gaz.* 23 (1898) 271–274. portr. Copy of obituary in *SouthW. Presbyterian* for August 25, 1892, in *Tulane University Scrap-book*, vol. 2, Jan. 1, 1889–July 31, 1893, pp. 110–111, Howard-Tilton Memorial Library.
64. Engelmann letters, Missouri Botanical Garden archives.
65. Joor papers, 1868–1893, Tulane Univ., Howard-Tilton Memorial Library, Special Colls.
66. Verified by Anne S. Bradburn, Tulane Univ. Herbarium, October, 1978.

67 For the Langlois herbarium (said to amount to 20,000 specimens) see A.O. Tucker, M.E. Poston, and H.H. Iltis, *Taxon* 38 (1989) 196–203.

68 A.B. Langlois, *Catalogue provisoire de plantes phanérogames et cryptogames de la Basse-Louisiane* (St. Etienne, France, 1887).

69. A.B. Langlois, St. Martin's Church, St. Martinville, La., 6 Oct. 1896, to E.L. Greene, Notre Dame Univ. archives.
70. J.M. Langlois, Breaux Bridge, La., 4 Dec. 1900, to E.L. Greene, Notre Dame Univ. archives.
71. Shirley C. Tucker, "Langlois's collection sites of Louisiana lichens," *Bryologist* 73 (1970) 137–142. See also Eric Sundell, *Tulane Stud. Zool. Bot.* 21 (1979) 43.
72. *New York Times* for Feb. 7, 1934.
73. Ernest J. Palmer, "Benjamin Franklin Bush," *Amer. Midl. Naturalist* 18 (1937) ii–vi. portr., bibliog. of his writings. For the field collecting of Ernest Jesse Palmer, 1875–1962, in Louisiana on behalf of the Arnold Arboretum and the Missouri Botanical Garden, see *Sargent-Cocks letters*, passim.
74. B.F. Bush, "Notes on the botany of some southern swamps," *Gard. & Forest* 10 (1897) 514–516. *Leitneria* is known today from Brazoria and Chambers counties, Texas, where

Drummond first discovered it. For comprehensive report on *Leitneria* see R.B. Channell and C.E. Wood, Jr., *J. Arnold Arbor.* 43 (1962) 435–438. Useful early account by William Trelease, *Missouri Bot. Gard. Annual Rep.* 6 (1895) 65–90. frontis., plates 30-44.

75. *Sargent-Cocks letters* 2-6, portr. Ewan, *Bibliog.* 35–43.
76. S.M. Walters, *Shaping of Cambridge botany* (Cambridge, 1981) 75–82.
77. R.S. Cocks, New Orleans, 20 May 1906, to E.L. Greene, Notre Dame Univ. archives.
78. For Ida Ann Slocum Richardson, d. 1910, second wife of Tobias Gibson Richardson, 1827–1892, M.D., see Mary Gehman, *Women and New Orleans, a history* (New Orleans, 1988) 115, 127; and Charlotte Seidenberg, *New Orleans garden* (New Orleans, 1990) 457–458.
79. R.S. Cocks, "Grasses of Louisiana," *Proc. Louisiana Soc. Naturalists* [1900] 125–131.
80. C.S. Sargent, *Bot. Gaz.* 66 (1918) 437.
81. *Sargent-Cocks letters* 94.
82. Ibid. 98.
83. Ibid. 7.
84. Harold A. Dundee and Douglas A. Rossman, *Amphibians and reptiles of Louisiana* (Baton Rouge, 1989) 4.
85. *Ecology* 9 (1928) 216–229.
86. *Sci. Monthly* 26 (1928) 19–27.
87. *Louisiana out-of-doors* (New Orleans, 1933). 190 pp., 110 illus. One dollar.
88. Edgar Anderson, *Introgressive hybridization* (New York, 1949). P. Viosca, "Irises of southeastern Louisiana," *Bull. Amer. Iris Soc.* 57 (1935) 3–55.
89. *New Orleans States-Item* for 28 Aug. 1961, portr. Memorial number, *Tulane Stud. Zool.* 9 (1962) no. 5.
90. Clair Alan Brown, Ph. D. thesis: "*Odontia*, an epixylous fungus of family Hydnaceae." See *Bot. Gaz.* 96 (1935) 640-675.
91. *Louisiana trees and shrubs* (Baton Rouge, 1945). Ewan, *Bibliog.* 62.
92. C.A. Brown and Donovan S. Correll, *Ferns and fern allies of Louisiana* (Baton Rouge, 1942). Ewan, *Bibliog.* 59.
93. C.A. Brown, *Wild flowers of Louisiana* (Baton Rouge, 1972). See Eric Sundell, *Tulane Stud. Zool. Bot.* 21 (1979) 46.
94. For Ada Nesta Dunn Ewan (1908–2000) see L.J. Dorr and Alan T. Whittemore, *Taxon* 49 (2000) 817–818.

ADDITIONS AND EMENDATIONS TO *THE WILD ORCHIDS OF NORTH AMERICA, NORTH OF MEXICO*

Paul Martin Brown[1]

Research Associate
University of Florida Herbarium (FLAS)
Florida Museum of Natural History
379 Dickinson Hall, PO Box 110575
Gainesville, Florida 32611-0575, U.S.A.

ABSTRACT

The Wild Orchids of North America, North of Mexico (Paul Martin Brown and Stan Folsom, University Press of Florida, 2003 ISBN 0-8130-2572-9) has served as an illustrated and annotated checklist of the orchids of that region. In the few years since research was completed for that work many new taxa have been described, other pertinent facts have been published, and six corrections of fact need to be added to the original manuscript. Those additions and corrections, including literature references and photographs, are presented here to enable the reader to update this volume to the close of 2005.

RESUMEN

The Wild Orchids of North America, North of Mexico (Paul Martin Brown y Stan Folsom, University Press of Florida, 2003 ISBN 0-8130-2572-9) ha servido como catálogo anotado e ilustrado de las orquídeas de esa región. En los pocos años desde que se finalizó la investigación del trabajo se han descrito muchos taxa nuevos, se han publicado otros hechos importantes, y se han hecho seis correcciones que necesitan añadirse al manuscrito original. Estas adiciones y correcciones, que incluyen referencias bibliográficas y fotografías, se presentan aquí para posibilitar al lector poner al día en 2005 este volumen.

Since the compilation and publication of *The Wild Orchids of North America, North of Mexico* in April 2003 (research completed in May 2002), six errors have been noted, several older forms revived, numerous new taxa described, new combinations published, range extensions noted, 'lost' species rediscovered, and significant publications presented. Whether one embraces all of the subspecific taxa is not the point of this publication. These taxa have been described and are present in living material, and therefore they deserve some recognition. Recent reassessments of older generic concepts (i.e., *Gymnadeniopsis*) and ongoing molecular work (i.e., *Piperia/Platanthera*) have resulted in several transfers and new combinations. Whereas this is not intended in any way to be a revised or second edition of *The Wild Orchids of North America, North of Mexico*, those combinations and transfers (although in some cases a more accurate assessment of the individual taxon) are usually listed as synonyms, with literature

---

[1] Address for correspondence: 10896 SW 90th Terrace, Ocala, Florida 34481, U.S.A. naorchid@aol.com

references, under the appropriate species. Additions and corrections are arranged in original page order of *The Wild Orchids of North America, North of Mexico*.

Page

2

Amerorchis rotundifolia (Banks *ex* Pursh) Hultén

small round-leaf orchis

emend:

forma *angustifolia* (Rousseau) P.M. Brown—narrow-leafed form

Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, p. 284.

add:

forma *rosea* P.M. Brown—pink-flowered form

Brown, P.M. 2004 *North American Native Orchid Journal* 10: 34.

forma *wardii* P.M. Brown—bicolored form

Brown, P.M. 2004. *North American Native Orchid Journal* 10: 34.

7

Calopogon barbatus (Walter) Ames

bearded grass-pink

add:

forma *lilacinus* P.M. Brown—lilac-flowered form

forma *albiflorus* P.M. Brown—white-flowered form

Brown, P.M. 2003. *North American Native Orchid Journal* 9: 33.

Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, pp. 26–27.

Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 40–41.

8

Calopogon multiflorus Lindley

many-flowered grass-pink

add:

forma *albiflorus* P.M. Brown—white-flowered form

Brown, P.M. 2004. *North American Native Orchid Journal* 10: 21.

Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 42–43.

Calopogon oklahomensis D.H. Goldman

Oklahoma grass-pink

add:

forma *albiflorus* P.M. Brown—white-flowered form

Brown, 2003. *North America Native Orchid Journal* 9: 33–34.
Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, pp. 30–31.

10
Calypso bulbosa (Linnaeus) Oakes var. *americana* (R. Brown) Luer
eastern fairy-slipper
add:
    forma *biflora* P.M. Brown—two-flowered form
Brown, 2004. *North American Native Orchid Journal* 10: 35.
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, pp. 32–33.

13
add:
Cleistes ×*ochlockoneensis* P.M. Brown
Ochlockonee hybrid rosebud orchid
(*C. divaricata* × *C. bifaria*)
Brown, P.M. 2004. *North American Native Orchid Journal* 10: 22.
Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, p. 53.

16
add:
Corallorhiza maculata (Rafinesque) Rafinesque var. *ozettensis* Tisch
Ozette coralroot
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Pacific Northwest and Canadian Rockies*, pp. 40–41.
Tisch, E. 2001. *Madrono* 48: 40–42.

18
Corallorhiza striata Lindley var. *vreelandii* (Rydberg) L.O. Williams
Vreeland's striped coralroot
correct spelling to: Todsen

19
Corallorhiza trifida Chatelain
early coralroot
add:
    forma *verna* (Nuttall) P.M. Brown—yellow-stemmed/white-lipped form
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, p. 284.

Corallorhiza wisteriana Conrad

Wister's coralroot
add:
forma *cooperi* P.M. Brown—cranberry-pink colored form
Brown, P.M. 2004. *North American Native Orchid Journal* 10: 22.
Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 62–63.

20
Cranichis muscosa Swartz
moss-loving cranichis
emend:
rediscovered in Collier County, Florida in 2004
Clusman, R. 2004. *Native Orchid Conference Journal* 1(2): 26–28.

21
Cypripedium acaule Aiton
pink lady's-slipper, moccasin flower
add:
forma *lancifolium* House—narrow-leaved form
House, H. 1924. *New York State Museum Bulletin* 254: 236.

23
Cypripedium fasciculatum Kellogg *ex* S. Watson
clustered lady's-slipper
add:
forma *purpureum* P.M. Brown—mahogany-flowered form
forma *viride* P.M. Brown—green-flowered form
Brown, P.M. 2004. *North American Native Orchid Journal* 10: 36.
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Pacific Northwest and Canadian Rockies*, pp. 56–57.

24
Cypripedium guttatum Swartz
spotted lady's-slipper
add:
forma *albiflorum* Lee—white-flowered form
Lee, Y.N. 1996. *Flora of Korea*: 1164.

Cypripedium kentuckiense C.F. Reed
ivory-lipped lady's-slipper
add:
forma *summersii* P.M. Brown—concolorous yellow-flowered form
Brown, P.M. 2002. *North American Native Orchid Journal* 8: 30–31.

Calopogon multiflorus
forma *albiflorus* p. 8

Calypso bulbosa var. *americana*
forma *biflora* p. 10

Corallorhiza maculata var. *ozettensis* p. 16

Corallorhiza wisteriana forma *cooperi* p. 19

27

Cypripedium passerinum Richmond

sparrow's-egg lady's-slipper, Franklin's lady's-slipper

add:

forma *minganense* (Victorin) P.M. Brown—dwarf form

Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, p. 284.

28

add:

Cypripedium ×*herae* Ewacha & Sheviak

Queen Hera's hybrid lady's-slipper

(*C. parviflorum* var. *pubescens* × *C. reginae*)

Sheviak, C.S. 2004. *Orchids* 73(4): 296–299.

29

Cyrtopodium punctatum (Linnaeus) Lindley

cowhorn orchid

photograph is incorrect (is *C. macrobulbon*), see new photograph

add:

Cyrtopodium macrobulbon (La Llave & Lexara) G.A. Romero-González & G. Carnevali Fernández-Concha

giant cowhorn orchid

southwestern Florida; Mexico

photographed (1999) in Monroe County, Florida; introduced?

Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, p. 73.

30

Dactylorhiza aristata (Fischer *ex* Lindley) Soó var. *aristata*

Fischer's orchid

add:

forma *albomaculata* P.M. Brown—white/pink spotted lip form

Brown, P.M. 2004. *North American Native Orchid Journal* 10: 37.

Dactylorhiza aristata (Fischer *ex* Lindley) Soó var. *kodiakensis* Luer & Luer *f.*

Kodiak orchid

add:

forma *alba* P.M. Brown—white-flowered form

Brown, P.M. 2004. *North American Native Orchid Journal* 10: 37.

32

Deiregyne confusa Garay

Hildago ladies'-tresses

Funkiella confusa (Garay) Szlachetko, Rutkowski, & Mytnik

emend:

discovered at Big Bend National Park in 2004

photo in Luer (and on p. 32) taken in Durango, Mexico and does not appear to exhibit pubescent sepals of *D. confusa* and may be *D. durangensis*; see new photograph

Coleman, R. 2006. *Native Orchid Conference Journal* 3: in press.

Szlachetko, D.L., P. Rutkowski, and J. Mytnik. 2005. *Contributions to the taxonomic revision of the subtribes Spiranthinae, Stenorrhynchidinae and Cyclopogoninae (Orchidaceae) in Mesoamerica and the Antilles.* Polish Botanical Studies 20: 229.

45

Insert the following and remove from the indicated pages in *Platanthera*.

Gymnadeniopsis clavellata (Michaux) Rydberg var. *clavellata*

Platanthera clavellata (Michaux) Luer var. *clavellata* (details see p. 78)

little club-spur orchis

Gymnadeniopsis clavellata (Michaux) Rydberg var. *ophioglossoides* (Fernald) W.J. Schrenk

Platanthera clavellata (Michaux) Rydberg var. *ophioglossoides* (Fernald) P.M. Brown (details see p. 79)

northern club-spur orchis

Gymnadeniopsis integra (Nuttall) Rydberg

Platanthera integra (Nuttall) Lindley (details see p. 84)

yellow fringeless orchis

Gymnadeniopsis nivea (Nuttall) Rydberg

Platanthera nivea (Nuttall) Lindley (details see p. 87)

snowy orchis

Rydberg, P.A. 1901. in Britton, *Manual of the Flora of the Northeastern United States*, p. 293.

Brown, P.M. 2002. *North American Native Orchid Journal* 8: 32–40.

Gymnadeniopsis clavellata (Michaux) Rydberg var. *clavellata*

little club-spur orchis

add:

forma *wrightii* (Olive) P.M. Brown—spurless form

Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, p. 284.

Olive, L. 1951. *Bulletin of the Torrey Botanical Club* 78(4): 289-291. 1951.

Cyrtopodium macrobulbon p.29

Cyrtopodium puncatum p. 29

Deiregyne confusa p. 32

49

emend:
Hexalectris revoluta Correll var. *revoluta*
recurved crested coralroot
Texas; Mexico
Catling, P.M. 2004. *Native Orchid Conference Journal* 1(2): 14–16.
rare and local in the mountains of southern Texas
[photograph and drawing are *H. revoluta* var. *colemanii*]

add:
Hexalectris revoluta var. *colemanii* P.M. Catling
Coleman's crested coralroot
se Arizona
Coleman, R.A. 1999. *North American Native Orchid Journal* 5(1): 312–15.
Catling, P.M. 2004. *Native Orchid Conference Journal* 1(2): 14–16.
this new variety was recently described from southeastern Arizona

50

Hexalectris spicata (Walter) Barnhardt var. *spicata*
crested coralroot
correct: forma *albolabia* to white-lipped form
add:
    forma *wilderi* P.M. Brown—albino form
    forma *lutea* P.M. Brown—yellow-flowered form
P.M. Brown. 2004. *North American Native Orchid Journal* 10: 23.
Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 134–135.

51

Hexalectris warnockii Ames & Correll
Texas purple-spike
add:
    forma *lutea* P.M. Catling—yellow-flowered form
Catling, P.M. 2004. *Native Orchid Conference Journal* 1(2): 24.

57

insert correct name:
Listera banksiana Lindley
    Listera caurina Piper
northwestern twayblade
Brown, P.M. 2004. *North American Native Orchid Journal* 10: 2–12.
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Pacific Northwest and Canadian Rockies*, pp. 260.
Lindley, J. 1840. *Genera and Species of Orchidaceous Plants* p. 455.

the rule of priority dictates that *Listera banksiana* (1840) must be used over *L. caurina* (1898)

58
Listera cordata (Linnaeus) R. Brown var. *cordata*
heart-leaved twayblade
add:
 forma *tetraphylla* Lavoie—four-leaved form
Lavoie, G. 1984 *Provancheria* 7: 92.

63
emend:
Malaxis paludosa (Linnaeus) Swartz
bog adder's-mouth
incorrect photograph (is *Platanthera sparsiflora*!); replace with new photograph

64
Malaxis spicata Swartz
Florida adder's-mouth
add:
 forma *trifoliata* P.M. Brown—three-leaved form
Brown, P.M. 2003. *North American Native Orchid Journal* 9: 34.
Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, pp. 126–27.
Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 154–55.

68
Pelexia adnata (Swartz) Sprengel
glandular ladies'-tresses
emend:
discovered in Collier County, Florida in 2004
Brown, P.M. and S. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 172–73.

69
Piperia candida Morgan & Ackerman
 (*Platanthera candida* (Morgan & Ackerman) R.M. Bateman: homonym)
slender white piperia
Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

70
Piperia colemanii Morgan & Glicenstein
 Platanthera colemanii (Morgan & Glicenstein) R.M. Bateman

Hexalectris revoluta var. *revoluta* p. 49

Hexalectris spicata var. *spicata* forma *lutea* p. 50

Hexalectris revoluta var. *colemanii* p. 49

Malaxis paludosa p. 63

Coleman's piperia

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

Piperia cooperi S. Watson

Platanthera cooperi (S. Watson) R.M. Bateman

Cooper's stoutspire orchid

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

71

Piperia elegans Lindley

Platanthera elegans Lindley

Platanthera elegans Lindley subsp. *maritima* (Rydberg) R.M. Bateman

elegant piperia

Lindley, J. 1835. *Genera and Species of Orchidaceous Plants*, p. 285.

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

Piperia elegans Lindley subsp. *decurtata* Morgan & Glicenstein

Platanthera elegans Lindley subsp. *decurtata* (Morgan & Glicenstein) R.M. Bateman

Point Reyes piperia

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

72

Piperia elongata Rydberg

Platanthera elongata (Rydberg) R.M. Bateman

long-spurred piperia

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

Piperia leptopetala Rydberg

Platanthera leptopetala (Rydberg) R.M. Bateman

lace orchid

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

73

Piperia michaelii Greene

Platanthera michaelii (Greene) R.M. Bateman

Michael's piperia

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

Piperia transversa Suksdorf

Platanthera transversa (Suksdorf) R.M. Bateman

flat-spurred piperia

Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

74

Piperia unalascensis (Sprengel) Rydberg

Alaskan piperia

add:

forma *olympica* P.M. Brown—dwarf montane form
Brown, P.M. 2004. *North American Native Orchid Journal* 10: 37.

Piperia yadonii Morgan & Ackerman
Platanthera yadonii (Morgan & Ackerman) R.M. Bateman
Yadon's piperia
Bateman, R.M. 2003. *Botanical Journal of the Linnaean Society* 142(1): 21.

75
Platanthera blephariglottis Lindley [delete var. *blephariglottis*]
northern white fringed orchis

76
emend and insert with text on p. 79:
Platanthera conspicua (Nash) P.M. Brown
Platanthera blephariglottis Lindley var. *conspicua* (Nash) Luer
southern white fringed orchis
Brown, P.M. 2002. *North American Native Orchid Journal*: 8: 3–14.

79/94
add:
Platanthera convallariifolia (Fischer) Lindley
lily-leaved rein orchis
rare on Alaskan islands; eastern Asia
Sheviak, C.J. 2002. in *Flora of North America*, vol. 26 pp. 559–60.
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Pacific Northwest and Canadian Rockies*, pp. 132–33.
[note corrected spelling to *convallariifolia*]

80
Platanthera dilatata (Pursh) Lindley var. *albiflora* (Chamisso) Ledebour
bog candles
range extension: east to southwestern South Dakota

81
Platanthera flava (Linnaeus) Lindley var. *flava*
southern tubercled orchis
range extension: east to southern New Jersey

83
Platanthera hookeri (Torrey) Lindley
Hooker's orchis
add:
forma *oblongifolia* (J.A. Paine) P.M. Brown—narrow-leaved form
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, p. 284.

emend:
Platanthera huronensis (Nuttall) Lindley
green bog orchis
incorrect line art; replace with new figure

88
correct spelling to:
blunt-leafed rein orchis
few-flowered blunt-leafed rein orchis

89
Platanthera orbiculata (Pursh) Lindley
pad-leaved orchis
add:
 forma *longifolia* (Clute) P.M. Brown—narrow-leaved form
 forma *pauciflora* (Jennings) P.M. Brown—few-flowered form
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, p. 284.

90
Platanthera peramoena (A. Gray) A. Gray
purple fringeless orchis
add:
 forma *doddsiae* P.M. Brown—white-flowered form
Brown, P.M. 2002. *North American Native Orchid Journal* 8: 30–31.
Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, pp. 26–27

Platanthera praeclara Sheviak & Bowles
 Fimbriella praeclara (Sheviak & Bowles) Szlachetko & Rutkowski
western prairie fringed orchis
Szlachetko, D. and P. Rutkowski 2000. *Acta Botanica Fennica* 169: 380.

91
Platanthera psycodes (Linnaeus) Lindley
small purple fringed orchis
add:
 forma *fernaldii* (Rousseau & Rouleau) P.M. Brown—dwarf form
Victorin, M. 1957. *Bulletin de Jardin Botanique de l'État* 27: 370.
Brown, P.M. and S.N. Folsom. 2006. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region*, p. 284.

92
emend:
Platanthera sparsiflora (S. Watson) Schlecter [delete var. *sparsiflora*]
few-flowered rein orchis

Platanthera stricta Lindley
slender bog orchis
range extension: east to southwestern South Dakota

94
add the following hybrids:
Platanthera ×apalachicola P.M. Brown & S. Stewart
Apalachicola hybrid fringed orchis
(*P. chapmanii* × *P. cristata*)
Brown, P.M. 2003. *North American Native Orchid Journal* 9: 35.
Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States* p. 163.

Platanthera ×beckneri P.M. Brown
Beckner's hybrid fringed orchis
(*P. conspicua* × *P. cristata*)
Brown, P.M. 2002. *North American Native Orchid Journal*: 8: 3–14.
Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, p. 164.

Platanthera ×lueri P.M. Brown
Luer's hybrid fringed orchis
(*P. conspicua* × *P. ciliaris*)
Brown, P.M. 2002. *North American Native Orchid Journal*: 8: 3–14.
Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, p. 166.

Platanthera ×osceola P.M. Brown & S. Stewart
Osceola hybrid fringed orchis
(*P. chapmanii* × *P. ciliaris*)
Brown, P.M. 2003. *North American Native Orchid Journal* 9: 35.
Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, p. 167.

Platanthera ×vossii
Voss' hybrid rein orchis
New nothogenus and combination:
emend to:
×Platanthopsis vossii (Case) P.M. Brown
Brown, P.M. 2002. *North American Native Orchid Journal* 8: 32–40.

Piperia unalascensis forma *olympica* p. 74

Platanthera huronensis p. 83

Platanthera x*lueri* p. 94

Platanthera convallariifolia pp. 79/94

97

Ponthieva brittoniae Ames

Mrs. Britton's shadow-witch

emend:

rediscovered in Miami-Dade County, Florida in 2004

Larocque, M. 2004. *Native Orchid Conference Journal* 1(2): 33–34.

Sadel, J.L. 2005. *Orchids* 74(5): 380–82.

Sadel, J.L., S.W. Woodmansee, G.D. Gann, and T. V. Armentano. 2005. *Sida* 21(3): 1917–1920.

101

Pteroglossaspis ecristata (Fernald) Rolfe

crestless plume orchid

add:

forma *purpurea* P.M. Brown—dusky purple-flowered form

Brown, P.M. 2003. *North American Native Orchid Journal* 9: 35.

Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, pp. 184–85.

Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 228–29.

104

Spiranthes brevilabris Lindley

short-lipped ladies'-tresses

emend:

now extant from two areas in central Florida

106

Spiranthes cernua (Linnaeus) L.C. Richard

nodding ladies'-tresses

range extension: south to northern Florida

Brown, P.M. and S.N. Folsom. 2004. *Wild Orchids of the Southeastern United States*, pp. 194–95.

Brown, P.M. and S.N. Folsom. 2005. *Wild Orchids of Florida*: updated and expanded edition, pp. 244–45.

108

Spiranthes floridana (Wherry) Cory *emend.* P.M. Brown

Florida ladies'-tresses

emend:

currently known from three very small extant sites in central Florida

Spiranthes infernalis Sheviak
Ash Meadows ladies'-tresses
emend:
not listed as federally threatened, but is considered a species of concern

116
Spiranthes sylvatica P.M. Brown
woodland ladies'-tresses
range extension: northeastern Texas, southeastern Oklahoma, and southern Arkansas

169
Insert in Key 9: *Cyrtopodium* after couplet 2
emend to read:
1b flowers heavily spotted or mottled...2

2a plants epiphytic, flowers yellow with heavy spotting.....*C. punctatum*
2b plants terrestrial or nearly so; flowers orange yellow with mottled spotting.....*C. macrobulbon*

172
Insert in Key 16: *Hexalectris* after couplet 5
emend to read:
5b petals and sepals otherwise...6

6a central lobe of the lip more or less squared at the tip; petals 15–17 mm long; recurved; western Texas.....*H. revoluta* var. *revoluta*
6b central lobe of the lip pointed; petals 19–22 mm long, strongly recurved; southeastern Arizona.....*H. revoluta* var. *colemanii*

181
Insert in Key 28: *Spiranthes* after couplets 11 and 19
emend to read:
11i plants with small (ca. 5 mm), cream-colored flowers; late August/September flowering...11ii

11iia plants with fully opened, although not wide-spreading, flowers.....*S. casei* var. *casei*
11iib plants with nearly closed flowers; restricted to southern Nova Scotia.....*S. casei* var. *novaescotiae*

19i plants with small, cream-colored flowers; late August/September flowering...19ii

19iia plants with fully opened, although not wide-spreading, flowers.....*S. casei* var. *casei*

19iib plants with nearly closed flowers; restricted to southern Nova Scotia.....*S. casei* var. *novaescotiae*

Spiranthes casei differs from *Spiranthes vernalis* and *S. laciniata* in range and drier habitat and from *S. cernua* and *S. ochroleuca* in (usually) single-ranked inflorescence and smaller, ca. 5 mm, flowers with the perianth not as widespreading.

185
Excluded species
add:
Triphora hassleriana (Cogniaux) Schlecter
Photograph from Miami-Dade County in Florida in Bransilver, 2004. p. 115 was labeled as *T. gentianoides* but subsequently identified as *T. hassleriana*. Plants were of horticultural origin and are not reproducing.

190
add:
Cyrtopodium macrobulbon
Cleistes ×*ochlockoneensis*
Platanthera ×*apalachicola*
Platanthera ×*beckneri* [photo on p. 143 as *P.* ×*canbyi*]
Platanthera ×*lueri* [photo on p. 141 as *P.* ×*bicolor*]
Platanthera ×*osceola*

195
add:
Hexalectris revoluta var. *colemanii*
Platanthera convallariifolia
Cleistes ×*ochlockoneensis*
Platanthera ×*apalachicola*
Platanthera ×*beckneri* [photo on p. 188 as *P.* ×*canbyi*]
Platanthera ×*lueri* [photo on p. 185 as *P.* ×*bicolor*]
Platanthera ×*osceola*

Glossary
199 correct definition to:
peduncle: stalk bearing an inflorescence or solitary flower

Bibliography
201 correct spelling to Buswell
202 correct spelling to Liggio

additions:

Ames, D., P.B. Acheson, L. Heshka, B. Joyce, J. Neufeld, R. Reeves, E. Reimer, and I. Ward. *Orchids of Manitoba.* Native Orchid Conservation Inc. Winnipeg, Man., 2005.

Bransilver, C. *Wild Love Affair: Essence of Florida's Native Orchids.* Westcliff Publishers. Englewood, Colorado, 2004.

Brown, P.M. Revalidation of *Platanthera conspicua. North American Native Orchid Journal* 8(2002): 3–14.

________. Resurrection of the genus *Gymnadeniopsis* Rydberg. *North American Native Orchid Journal* 8(2002): 32–40.

Brown, P.M. and S.N. Folsom. *Wild Orchids of the Southeastern United States, North of Peninsular Florida.* Gainesville, Fla.: University Press of Florida, 2004.

________. *Wild Orchids of Florida, with References to the Atlantic and Gulf Coastal Plains:* updated and expanded edition. Gainesville, Fla.: University Press of Florida, 2005.

________. *Wild Orchids of the Canadian Maritimes and Northern Great Lakes Region.* Gainesville, Fla.: University Press of Florida, 2006.

________. *Wild Orchids of the Pacific Northwest and Canadian Rockies.* Gainesville, Fla.: University Press of Florida, 2006.

Burrage, A. *Notes on Native New England Orchids.* Privately published, 1921.

Cotterill, P. *Orchids of Lakeland* (Provincial Park). Alberta Environmental Protection, 1998.

Cutter, Jr., V.M. *New Hampshire Orchids.* Unpublished manuscript, ca. 1940.

Deane, W. The Native Orchids of New England. *The American Gardener* 12(1891): 152–157.

Dueck, L. *Wild Orchids in South Carolina: the Story.* Aiken, South Carolina: Savannah River Ecology Laboratory, 2003.

Fitzpatrick, T.J. and M.F.L. Fitzpatrick. The Orchidaceae of Iowa. *Proceedings of the Iowa Academy of Sciences.* 7 (1900): 187–196.

Fowler, J.A. *Wild Orchids of South Carolina: a popular natural history.* Columbia: University of South Carolina Press, 2005.

Henderson, J. *A Taxonomic Treatment of the Genus Habenaria in Eleven Midwestern States.* MS Thesis. University of Missouri-Kansas City, 1977.

Irwin, F.G. and P. Reeder. Wild Orchids of Illinois. *Outdoor Illinois.* 4, no.10 (1965): 4–14.

Johnson, G. An Annotated Checklist of the Orchids of Arkansas. *Claytonia* 23 no. 4(2004): 5–6.

Johnsson, R. G. *The Orchids of Isle Royale National Park.* Houghton, Mich.: Wolf's Eye Press, 1963.

Kravig, M.L. Orchids of the Black Hills. *Proceeding of the South Dakota Academy of Sciences* 48 (1969.): 119–131.

Magrath, L.W. Native Orchids of Kansas. *Transactions of the Kansas Academy of Science* 74 (1971): 287–309.

________. *Orchids of the Prairies and Plains Regions of North America.* Ph.D. Dissertation. University of Kansas, Lawrence, 1973.

________. 2001. Native Orchids of Oklahoma. *Crosstimbers* Spring 2001: 18–25.

Rydberg, P.A. *Gymnadeniopsis* Rydberg in Britton, *Manual of the Flora of the Northeastern United States*, p. 293, 1901.

Scott, P.J. Orchids in Newfoundland. *Canadian Orchid Journal* 1, no. 2 (1981): 22–26.

________. The orchids of Newfoundland and Labrador. *Osprey* 1, no. 2 (1985): 183–198.

Sweet, Cheryl. Wild Orchids. *Arizona Highways* 80(2): 16–19. 2004.

Titford, W. and J. Titford. *A Traveller's Guide to Wild Flowers of Newfoundland, Canada*. St. John's, Newfoundland: Flora Frames, 1995.

Voitk, A. and M. Voitk. *Orchids on the Rock-the Wild Orchids of Newfoundland*. Corner Brook, Newfoundland. Gros Morne Cooperating Association. 2006 (expected date May 2006)

Photo Credits

205

correct photo credit for *Basiphyllaea corallicola* to Chuck L. McCartney, Jr.
emend Ron Coleman: *Hexalectris revoluta* to *Hexalectris revoluta* var. *colemanii*

206

new photo credits (in this publication): Aaron Kennedy: *Hexalectris revoluta* var. *colemanii*
Allison Leavitt, National Park Service: *Deiregyne confusa*, *Hexalectris revoluta* var. *revoluta*

Personal Checklist

230–236

add (or delete as indicated) the following:

Amerorchis rotundifolia
small round-leaf orchis
  forma *rosea*
  forma *wardii*

Calopogon barbatus
crested grass-pink
  forma *lilacinus*
  forma *albiflorus*

Calopogon multiflorus
many-flowered grass-pink
  forma *albiflorus*

Calopogon oklahomensis
Oklahoma grass-pink
  forma *albiflorus*

Calypso bulbosa var. *americana*
eastern fairy-slipper
  forma *biflora*

Cleistes ×*ochlockoneensis*
Ochlockonee hybrid rosebud orchid

Corallorhiza maculata var. *ozettensis*
Ozette coralroot

Corallorhiza trifida
early coralroot
  forma *verna*

Corallorhiza wisteriana
Wister's coralroot
  forma *cooperi*

Cypripedium acaule
pink lady's-slipper, moccasin flower
  forma *lancifolium*

Cypripedium fasciculatum
clustered lady's-slipper
  forma *purpureum*
  forma *viride*

Cypripedium guttatum
spotted lady's-slipper
forma *albiflorum*

Cypripedium kentuckiense
ivory-lipped lady's-slipper
forma *summersii*

Cypripedium passerinum
sparrow's-egg lady's-slipper,
Franklin's lady's-slipper
forma *minganense*

Cypripedium ×herae
Queen Hera's hybrid lady's-slipper

Cyrtopodium macrobulbon
giant cowhorn orchid

Dactylorhiza aristata var. *aristata*
Fischer's orchid
forma *albomaculata*

Dactylorhiza aristata var. *kodiakensis*
Kodiak orchid
forma *alba*

Gymnadeniopsis clavellata var. *clavellata*
little club-spur orchis
forma *wrightii*

Hexalectris revoluta var. *colemanii*
Coleman's coralroot

Hexalectris warnockii
Texas purplespike
forma *lutea*

Hexalectris spicata var. *spicata*
crested coralroot
forma *wilderi*
forma *lutea*

Malaxis spicata
Florida adder's-mouth
forma *trifoliata*

Listera cordata var. *cordata*
heart-leaved twayblade
forma *tetraphylla*

Piperia unalascensis
Alaskan piperia
forma *olympica*

Delete: *Platanthera blephariglottis* var. *conspicua*
add:
Platanthera conspicua
southern white fringed orchis

Platanthera hookeri
Hooker's orchis
forma *oblongifolia*

Platanthera orbiculata
pad-leaved orchis
forma *longifolia*
forma *pauciflora*

Platanthera peramoena
purple fringeless orchis
forma *doddiae*

Platanthera psycodes
small purple fringed orchis
forma *fernaldii*

Platanthera ×apalachicola
Apalachicola hybrid fringed orchis
(*P. chapmanii* × *P. cristata*)

Platanthera ×beckneri
Beckner's hybrid fringed orchis
(*P. conspicua* × *P. cristata*)

Platanthera ×lueri
Luer's hybrid fringed orchis
(*P. conspicua* × *P. ciliaris*)

Platanthera ×osceola
Osceola hybrid fringed orchis
(*P. chapmanii* × *P. ciliaris*)

Delete: *Platanthera* ×*vossii*
add:
×*Platanthopsis vossii*
Voss' hybrid rein orchis

Pteroglossaspis ecristata
crestless plume orchid
forma *purpurea*

add to page **229**:
Gymnadeniopsis clavellata var. *clavellata*
little club-spur orchis
Gymnadeniopsis clavellata var. *ophioglossoides*
northern club-spur orchis
Gymnadeniopsis integra
yellow fringeless orchis
Gymnadeniopsis nivea
snowy orchis

Delete from page **232**:
Platanthera clavellata var. *clavellata*
Platanthera clavellata var. *ophioglossoides*
Platanthera integra
Platanthera nivea

ACKNOWLEDGMENTS

I am grateful to Stan Folsom his line drawings and watercolor of *Corallorhiza maculata* var. *ozettensis* based upon the original description by Ed Tisch, Ron Coleman for additional information on *Deiregyne confusa*, Scott Stewart, Ann Malmquist, and Helen Jeude for reviewers' comments and Chuck Sheviak and Philip Kauth for additional comments. Barney Lipscomb, editor of *Sida*, has been especially helpful in facilitating the layout of this information.

Note.—A limited number of reprints designed for insertion into *The Wild Orchids of North America, North of Mexico* are available from the author. Copies of the book are also available from your bookseller, the University Press of Florida (*www.upf.com*), or the author (*naorchid@aol.com*).

BOOK NOTICES

Timber Press

MARK C. TEBBITT. 2005. **Begonias: Cultivation, Identification, and Natural History.** (ISBN 0-88192-733-3, hbk.). Published in association with the Brooklyn Botanic Garden and Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 272 pp., 212 color photos and water color paintings, b/w line drawings, 7" × 9".

Aside from the chapters on introduction, general cultivation techniques and five appendices, there is a good deal of useful taxonomic information provided. There is a key to the sections of *Begonia* represented in cultivation as well as keys to species within sections. Each species has a very nice botanical description. Appendix E (New Combinations and Synonymy) includes four new combinations: *Begonia conchifolia* Dietrich f. *rubrimaculata* (J. Golding) M.C. Tebbitt, **comb. nov.**; *Begonia modestiflora* Léveillé var. *hypoleuca* (L.A. Lauener) M.C. Tebbitt, **comb. nov.**; *Begonia modestiflora* Léveillé var. *sootepensis* (Craib) M.C. Tebbitt, **comb. nov.**; *Begonia modestifolora* Léveillé var *thorelii* (Gagnepain) M.C. Tebbitt, **comb. nov.**

This will be a useful book to *Begonia* gardeners and botanists alike.

MARY E. GERRITSEN and RON PARSONS. 2005. **Masdevallias: Gems of the Orchid World.** (ISBN 0-88192-737-6, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $45.95, 299 pp., color photos, b/w line drawings, 7 1/2" × 10".

Masdevallias are fascinating and beautiful plants. This book could easily serve as a coffee table book to "wow" friends. A key to the subgenera and sections of *Masdevallia* is included.

Contents—Introduction, The History of the Genus *Masdevallia*, *Masdevallia* Form and Function, Growing Masdevallias, *Masdevallia* Propagation: Hybridization, What Is in a Name?, Showing Masdevallias, Genera related to *Masdevallia*, Subclassification of *Masdevallia*, Featured *Masdevallia* Species, *Masdevallia* Hybrids, Appendix I (Registered *Masdevallia* Hybrids), Appendix II (Species and Culture), Glossary, Nurseries and Flasking Services, Further Reading, and Index.

NEW RECORDS OF PTERIDOPHYTES FOR THE FLORA OF PERU

Alan R. Smith

University Herbarium, University of California
1001 Valley Life Sciences Bldg. # 2465
Berkeley, California, 94720-2465, U.S.A.
arsmith@berkeley.edu

Blanca León

Plant Resources Center
University of Texas at Austin
Austin, Texas 78712, U.S.A.

Hanna Tuomisto

Department of Biology
University of Turku
FI-20014 Turku, FINLAND

Henk van der Werff

Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri, 63199-0299, U.S.A.

Robbin C. Moran

New York Botanical Garden
Bronx, New York 10458, U.S.A.

Marcus Lehnert and Michael Kessler

Albrecht-von-Haller-Institut für Pflanzenwissenschaften
Abteilung für Systematische Botanik
Karspüle 2, D-37073, Göttingen, GERMANY

ABSTRACT

We document 137 species of pteridophytes new to the flora of Peru since the publication of the previous flora by Tryon and Stolze, in 1994. Some of these are recently described species (but no new species are described herein), while many are range extensions of known species from adjacent countries; a few are species that have been elevated in status from lesser rank, or species that have a new name, not mentioned by Tryon and Stolze. Most of these additions are the result of new collections, unknown at the time of the previous flora, and most are from montane rain forests and cloud forests, on the eastern slope of the Andes, from Dept. Amazonas to Dept. Cuzco. This area is known to be the richest for ferns, in Peru. These additions bring the known total of pteridophyte species for Peru to about 1200, making it one of the richest countries in the world for ferns and lycophytes.

RESUMEN

Se registra 137 especies de pteridofitas nuevas para la flora del Perú desde la publicación previa en 1994 del trabajo de Tryon y Stolze. Algunas son especies recientemente descritas, mientras que la mayoría son registros de extensión de distribución desde paises vecinos y unas pocas han sido elevadas en categoría desde rangos menores o tienen un nombre nuevo no mencionado por Tryon y Stolze. La mayoría de estas adiciones son el resultado de recolectas nuevas, desconocidas entonces para la flora previa. Estas adiciones incrementan a cerca de 1200 el total de especies conocidas para el Perú, haciendo de éste uno de los paises más ricos en el mundo en helechos y licofitas.

INTRODUCTION

It is almost an axiom in floristic work, especially in the tropics, that a flora is outdated by the time it is published. Ten years following the completion of the six-fascicle publication of the "Pteridophyta of Peru," by Tryon and Stolze (1989a, 1989b, 1991, 1992, 1993, 1994), approximately 137 additional species of ferns and

SIDA 21(4): 2321 – 2342. 2005

allies have been added to the flora. Thirty-five of these have been recently described in other publications, while the majority (80 spp.) are range extensions of species known previously only from adjacent countries; still others are species that were synonymized (we believe inappropriately; 19 spp.) or now go under a name not mentioned by Tryon and Stolze (2 spp.), or were treated at lesser (varietal) rank (1 sp.). Most of these species additions are the result of new collections, unknown at the time of completion and publication of the Tryon and Stolze flora. These additions, and two corrections (species erroneously reported from Peru), bring the previous (Tryon & Stolze 1994) total of 1060 up to 1195 species. The number will continue to grow, as new species are described and as taxonomic revisions of especially difficult and poorly studied groups (e.g., *Elaphoglossum*) are completed. As a conservative estimate, there may be as many as 100 species already collected but still undescribed, so that the total number of pteridophytes from Peru is likely to eventually approach, if not exceed, 1300 species.

In Peru, the most species-rich areas for ferns appear to be along the eastern slope of the Andes, in montane rain forests and cloud forests (León & Young 1996; Young 1992; Young & León 1999). Tryon and Stolze (1994) reported more than 390 pteridophyte species for each department in this zone, from Amazonas to Cuzco, and our new records increase these numbers further (Table 1). The four departments for which we report more than twenty new species are either in this zone (Amazonas, San Martín, and Pasco) or in lowland Amazonia (Loreto). Proportionally, the increase in the number of known species is highest in Loreto (12%) and Amazonas (11%). In both departments, intensive collecting has recently taken place in preparation for a local florula (in Amazonas, by Rodolfo Vásquez/Henk van der Werff) or in connection with ecological studies (in Loreto, by Hanna Tuomisto). A further indication of the incomplete, but improving knowledge of Peruvian ferns derives from recent collections by Henk van der Werff. In a 2004 shipment of ca. 255 sheets collected from Peru, all from Pasco, Prov. Oxapampa, about 40 species were first records for Dept. Pasco (of which ca. seven were new for Peru), and another four were putatively undescribed (no doubt more, but monographic study is needed). Numbers like this suggest that, ultimately, all of the departments on the eastern slope of the Andes will be found to contain ca. 500–600 species of pteridophytes. Obviously, southwestern Peruvian departments containing substantial dry areas (Arequipa, for instance) will always have low numbers of ferns, regardless how much collecting is done. For fern diversity, it is usually true that wetter is better, especially in the mountains; habitat diversity, both climatic and edaphic, can substantially add to this diversity.

We are reluctant to extrapolate or generalize from the pteridophyte data to other groups of plants or animals, because different taxonomic groups may vary in general biogeographic patterns, ecological requirements, and the state of

TABLE 1. Number of pteridophyte species in the different departments of Peru. The numbers of **known spp.** are taken from Tryon and Stolze (1994); the numbers of **new spp.** are from the present paper or publications cited in this paper. Many additional departmental records are known for species previously reported from Peru by Tryon and Stolze (1989a, 1989b, 1991, 1992, 1993, 1994), but these are not the subject of this paper (Smith, unpubl. data).

Department	Known spp	New spp	% New spp	Total spp
Amazonas	398	42	11	440
Loreto	252	31	12	283
Pasco	393	24	6	417
San Martín	490	24	5	514
Cajamarca	225	17	8	242
Cuzco	559	16	3	575
Madre de Dios	169	11	7	180
Huánuco	541	11	2	552
Junín	457	7	2	464
Puno	188	4	2	192
Ucayali	105	3	3	108
Ayacucho	145	2	1	147
Tumbes	20	1	5	21
Piura	38	1	3	39
Lambayeque	51	1	2	52
Lima	72	1	1	73
Ancash	86	1	1	87
La Libertad	128	1	1	129
Apurimac	57	0	0	57
Arequipa	32	0	0	32
Huancavelica	73	0	0	73
Ica	1	0	0	1
Mocegua	4	0	0	4
Tacna	1	0	0	1

current knowledge. However, we expect that many groups of organisms will converge on the pattern that the highest numbers of new species records will be found from areas with wet climate, high habitat heterogeneity, and low exploration-density, especially the remote areas of the eastern Andes and western Amazonia.

Our ignorance of the Peruvian fern flora can be seen in statistics for *Elaphoglossum*. Mickel (in Tryon & Stolze 1991) recognized 124 species of *Elaphoglossum* (including *Peltapteris*); of these, 50 were newly described in the flora or in papers immediately preceding the flora. However, *Elaphoglossum* can not necessarily be taken as representative for the ferns, inasmuch as it is one of the largest (and consequently most complex and understudied) genera in the Andes.

Recent estimates for the number of pteridophyte species in tropical and subtropical Latin American countries include 1008 species for Mexico (Mickel

& Smith 2004), 1358 species for Mesoamerica (Davidse et al. 1995), and 1204 species for Venezuela (Smith 2005a). The lack of reliable estimates for Colombia, Ecuador, Bolivia, or Brazil make meaningful comparisons of diversity and species richness with those countries impossible, but we predict that all four will be found to contain in excess of 1200 species of pteridophytes, and the total may well approach 1500 species in Colombia.

The goal of this paper is to put on record, in a single place, as many as possible of the recent species additions to Peru, similar to the efforts for flowering plants done by Ulloa et al. (2004). We generally do not address in this paper differences in taxonomic opinion from the previous Tryon/Stolze treatment, except when those differences result in recognition of additional taxa at species rank. As an example of the kind of information not included in this paper, there is now evidence suggesting that *Notholaena nivea* (Poir.) Desv. (Tryon & Stolze 1989b) be placed in *Argyrochosma* (as *A. nivea* (Poir.) Windham) (Windham 1987). In fact, many of the infraspecific taxa treated by Tryon and Stolze (e.g., the three varieties of *Notholaena nivea*) have been or will be accorded species rank in floristic treatments of other neotropical countries (e.g., for Mexico, Mesoamerica, Venezuelan Guayana, Ecuador, and Bolivia; Mickel & Smith 2004; Davidse et al. 1995; Smith in Steyermark et al. 1995; Jørgensen & León-Yánez 1999; Kessler & Smith, in prep.). Other examples illustrating these differing opinions might include *Asplenium radicans* L. var. *cirrhatum* (Rich. ex Willd.) Rosenst. and *A. radicans* var. *partitum* (Klotzsch) Hieron., both of which many authors (Adams in Davidse et al. 1995; Mickel & Smith 2004) elevate to species rank (as *Asplenium cirrhatum* Rich ex Willd. and *A. flabellulatum* Kunze, respectively). These matters are largely a matter of taxonomic opinion, and the overall number of taxa recognized will not change. However, comparisons of taxon numbers at a given rank between countries need to take into account such subjective disagreements.

In this paper, we publish no new taxa or combinations, these are better left to monographers or those doing more detailed floristic work, and require the examination of types and perhaps further field and herbarium studies, both within and outside Peru. Ongoing floristic projects in adjacent areas, especially Bolivia (by Kessler and Smith) and Ecuador (by Øllgaard and collaborators), as well as the production of local florulas within Peru (Río Cenepa area, Dept. Amazonas, by Vásquez et al., in prep.; Cordillera de Yanachaga in Dept. Pasco) can be expected to shed light on many additional taxonomic problems and result in additional species descriptions.

Many of the species accepted and treated by Tryon and Stolze now are known from one or more additional departments within Peru. We do not mention these in the list below, or in Table 1, but specimens can be found in various herbaria, especially the Missouri Botanical Garden (MO) and the herbarium of the University of California, Berkeley (UC), as well as herbaria in Peru (CUZ, HAO, HUT, USM). Some of these additions can also be found in the TROPICOS database: http://mobot.mobot.org/W3T/Search/vast.html

The following species are additions to the Peruvian flora since the completion of the Peruvian pteridophyte flora by Tryon and Stolze (1994). None of these species were recognized at species rank by Tryon and Stolze, and most of the names were not mentioned at any rank. A few names (e.g., *Adiantum villosissimum* Mett. ex Kuhn) were discussed as problematic species or possible synonyms of highly variable recognized species, or treated as synonyms. Further work on the Peruvian fern flora must await description of undescribed species, preferably in a monographic context or at least considering closely related species. An updated fern flora of the country is needed but probably attainable only in the distant future.

Adiantum argutum Splitg. (Pteridaceae)

PERU. Madre de Dios. Prov. Manu: close to village of Diamante, S side of Río Alto Madre de Dios, 12°21'S, 70°57'W, 400 m, *Tuomisto 13368, et al.* (CUZ, USM, TUR, UC). **Prov. Tambopata:** Santuario Nacional Pampas del Heath, Río Heath, Pto. San Antonio, 12°57'12"S, 68°52'60"W, 210 m, *Aguilar & Castro 1055* (MO not seen, UC); Explorer's Inn, near confluence of Río Tambopata and Río La Torre, 39 km SW of Puerto Maldonado, 12°50'S, 69°20'W, *Smith 1363, et al.* (UC); 10 km NW from the mouth of Río Pariamanu, on the E bank of Río de las Piedras, 12°22'S, 69°14'W, 200 m, *Tuomisto 13683, et al.* (CUZ, TUR, USM).

Adiantum decoratum Maxon (Pteridaceae)

PERU. Madre de Dios. Prov. Manu: close to Cocha Cashu biological station on the S side of Río Manu, 11°54'S, 71°24'W, 400 m, *Tuomisto 13106, et al.* (CUZ, TUR, USM); 5 km E from Cocha Cashu biological station, 11°53'S, 71°21'W, 400 m, *Tuomisto 13150, et al.* (CUZ, TUR, USM); close to village of Altos de Maizal, N side of Río Manu, 11°49'S, 71°28'W, 400 m, *Tuomisto 13207, et al.* (CUZ, TUR, UC, USM); N side of Río Manu, 12°8'S, 71°3'W, 400 m, *Tuomisto 13351, et al.* (CUZ, TUR, USM).

Adiantum diogoanum Glaz. ex Baker (Pteridaceae)

PERU. Cajamarca. Prov. San Ignacio: Nambealle, entre La Vega del Toro y Las Abejas, 4°58'46"S, 79°05'01"W, 800–1000 m, *Campos 4730, et al.* (MO, UC); Namballe, Caserio Las Abejas, camino hacia el Río Canchis (La Guayusa), 5°00'S, 79°04'W, 870–950 m, *Rodríguez R. 1642* (MO, UC, USM).

Adiantum dolosum Kunze (Pteridaceae)

PERU. Madre de Dios. Prov. Manu Pakitza, N side of Río Manu, 11°56'S, 71°17'W, 400 m, *Tuomisto 13308, et al.* (CUZ, TUR, USM); 10 km E from mouth of Río Manu, 3 km N from N bank of Río Madre de Dios, 12°16'S, 70°49'W, 300–400 m, *Tuomisto 13520, et al.* (CUZ, TUR, UC, USM); close to village of Diamante, S side of Río Alto Madre de Dios, 12°21'S, 70°57'W, 400 m, *Tuomisto 13379, et al.* (CUZ, TUR, UC, USM); W bank of Río de los Amigos, 3 km upriver from its mouth, 12°34'S, 70°6'W, 200–300 m, *Tuomisto 13649, et al.* (CUZ, TUR, USM). **Prov. Tambopata:** 5 km E downriver from mouth of Río de los Amigos on N bank of Río Madre de Dios, 12°35'S, 70°02'W, 200–300 m, *Tuomisto 13668, et al.* (CUZ, TUR, UC, USM); 10 km NW from the mouth of Río Pariamanu, 12°23'S, 69°22'W, 200 m, *Tuomisto 13690, et al.* (CUZ, TUR, USM).

Adiantum fuliginosum Fée (Pteridaceae)

PERU. Loreto. Prov. Mariscal Ramon Castilla: 3 km S of the village of Huanta, 3°17'S, 71°51'W, 100–150 m, *Tuomisto 5225, et al.* (TUR, USM, Z); 4–8.5 km NW from the village of Puerto Izango, Río Yaguasyacu, 3°16'S, 72°2'W, 100–150 m, *Tuomisto 11317* (AMAZ, TUR, USM). **Prov. Maynas:** Explorama/ACEER reserve, 5–15 km E of the mouth of Quebrada Sucusari at lower Napo, 3°15'S, 72°50'W, 100–

200 m, *Tuomisto 7772, et al.* (AMAZ, TUR). **Prov. Requena:** 3 km E from Requena, 5°4'S, 73°48'W, 150–200 m, *Tuomisto 12746, et al.* (AMAZ, TUR, USM); 10 km E from Jenaro Herrera, 4°55'S, 73°35'W, 150–200 m, *Tuomisto 13009, et al.* (AMAZ, TUR, USM). **Madre de Dios. Prov. Manu:** from mouth of Río Azul ca. 10 km down to Río Madre de Dios, 12°33'S, 70°31'W, 300 m, *Tuomisto 13567, et al.* (CUZ, TUR, UC, USM); 5 km W from the mouth of Río de los Amigos, N bank of Río Madre de Dios, 12°33'S, 70°10'W, 200–300 m, *Tuomisto 13636, et al.* (CUZ, TUR, USM).

Adiantum glaucescens Klotzsch (Pteridaceae)

PERU. Amazonas. Prov. Bagua: Distrito Imaza, Yamayakat. Nororiental del Marañón RENOM, alrededor de la quebrada de Kusut, 04°55'S, 78°19'W, 330–380 m, *Quipuscoa S. 230* (MO, UC, USM).

Adiantum humile Kunze (Pteridaceae)

PERU. Loreto. Prov. Maynas: near Brilla Nueva, Borro [Bora] Indian village on upper Río Yaguasyacu, *Gentry & Revilla 20455* (MO not seen, UC, USM); Río Pastaza, Kapawari, 2°20'S, 76°20'W, 190 m, *Lewis et al. 12569* (MO not seen, USM). **Prov. Mariscal Ramon Castilla:** 3 km S of the village of Huanta, 3°17'S, 71°51'W, 100–150 m, *Tuomisto 5262, et al.* (AAU, AMAZ, TUR, U, USM); between roads Ex Petroleros and Bello Horizonte, Km 38–40 on Iquitos-Nauta road, 4°04'S, 73°28'W, 100–200 m, *Tuomisto 6678, et al.* (AMAZ, TUR, UC); Upper Río Itaya, ca. 2 km SSE of village Carbajal, 4°17'S, 73°35'W, 100–200 m, *Tuomisto 9685, et al.* (AMAZ, TUR, UC); Dist. Sargento Lores, Constancia Norte, Shapajillal, 4°07'19"S, 72°55'25"W, 116 m, *Vásquez 22995, et al.* (MO not seen, UC). **Madre de Dios. Prov. Manu:** S side of Río Manu, close to Cocha Cashu biological station, 11°55'S, 71°19'W, 400 m, *Tuomisto 13298, et al.* (CUZ, TUR, USM); 15 km E from the mouth of Río Manu, N bank of Río Madre de Dios, 12°17'S, 70°46'W, 300–400 m, *Tuomisto 13528, et al.* (CUZ, TUR, USM). **Pasco. Prov. Oxapampa:** Paujil, near Puerto Bermudez, *León 299* (USM). **Ucayali. Prov. Coronel Portillo:** Bosque Nacional von Humboldt, 230–260 m, *Narita 8* (USM).This species was initially listed for Peru by Tryon (1964) and later included as a synonym of *A. latifolium* (Tryon & Stolze 1989: 66).

Adiantum paraense Hieron. (Pteridaceae)

PERU. Loreto. Prov. Loreto: 1.5 km E of the road to Iquitos at km 10 from Nauta, 4°28'S, 73°34'W, 100–150 m, *Tuomisto 4414, et al.* (AMAZ, TUR, U). **Prov. Maynas:** 7 km E of the oil palm plantation at Río Maniti, 3°38'S, 72°56'W, 100–150 m, *Tuomisto 4781, et al.* (TUR, USM); Upper Río Itaya, ca. 10 km SW of village Carbajal, 4°18'S, 73°40'W, 100–200 m, *Tuomisto 10166, et al.* (AMAZ, TUR, UC).

Adiantum villosissimum Mett. ex Kuhn (Pteridaceae)

PERU. Huánuco. Prov. Huánuco: Exito, Balsa Playa, 1100 m, *Vargas C. 5317* (UC). **Junín:** Chanchamayo, 1500 m, *Schunke s.n.* (UC).

Alsophila minervae M. Lehnert (Cyatheaceae)

PERU. Pasco. Prov. Oxapampa: trail to summit of Cordillera Yanachaga via Río San Daniel, 10°23'S, 78°27'W, 2500 m, *Smith & Boetger 7817* (USM) (Lehnert 2003:171).

Alsophila mostellaria M. Lehnert (Cyatheaceae)

PERU. Amazonas. Prov. Bongará: road Pedro Ruiz-Florida, 5°51.7'S, 77°58.4'W, 2200 m, *Lehnert 243* (HOLOTYPE: USM; ISOTYPES: GOET, UC). **Cajamarca. Prov. Santa Cruz:** Dist. Catache, upper Río Zaña valley, ca. 5 km above Monte Seco, ca. 1800 m, Dillon et al. 4883 (HUT). **Pasco. Prov. Oxapampa:** road La Merced-Oxapampa, ca. 23 km from Oxapampa, 10°44.4'S, 75°21.2' W, 1500 m, *Lehnert 242, 321* (GOET, UC, USM). Additional collections cited by Lehnert (2003:172) from Depts. Cajamarca and Pasco.

Alsophila salvinii Hook., vel aff. (Cyatheaceae)

PERU. San Martín. Prov. Rioja: along road Rioja-Pedro Ruiz, El Mirador, 5°40'29"S, 77°46'25"W, 1850 m, *van der Werff 15666, et al.* (MO, UC).

Arachniodes macrostegia (Hook.) R.M. Tryon & D.S. Conant (Dryopteridaceae)
PERU. Loreto. Prov. Maynas: *Moran 3763* (USM); *Revilla 2749* (UC); *Rimachi 8285* (USM); 2 km S of the village of Mishana at Río Nanay, 3°52'S, 73°24'W, 100–150 m, *Tuomisto 2370, et al.* (TUR, USM); Puerto Almendras along Río Nanay, 3°51'S, 73°22'W, 100–200 m, *Tuomisto 6434*, with Ruokolainen (AMAZ, NY, TUR, USM). **Prov. Requena:** 4 km SE from Requena, 5°5'S, 73°49'W, 150–200 m, *Tuomisto 12767, et al.* (AMAZ, TUR, USM); 4 km E from Jenaro Herrera, 4°54'S, 73°38'W, 150–200 m, *Tuomisto 13028, et al.* (AMAZ, TUR, USM). **Pasco: Prov. Oxapampa:** Villa América, Quebrada Castillo, *Arana 18* (USM).

Asplenium eutecnum A.R. Sm. (Aspleniaceae)
PERU. Amazonas: Prov. Condorcanqui: Dist. El Cenepa, Comunidad de Tutino, Pumpu-entsa, 340 m, *Vásquez 24244, et al.* (HOLOTYPE: HUT; ISOTYPES: MO, NY, UC). Also known from Loreto (Smith 2005b).

Asplenium incurvatum Fée (Aspleniaceae)
PERU. Cajamarca: Prov. San Ignacio: Tabaconas, Santuario Nacional Tabaconas Namballe, 5°17'30"S, 79°16'W, 2190–2200 m; *Campos & Tenorio 5708* (MO, UC, USM). **Prov. San Marcos:** 6 km above San Marcos on road to Cajamarca, 2600–2700 m, *Weigend et al. 97/328* (USM). **San Martín: Prov. Rioja:** Aguas Verdes, 5°40'S, 77°40'W, 800 m, on limestone, *van der Werff 16616, et al.* (MO not seen, UC, USM). This species is segregated from *A. serra* Langsd & Fisch. and appears to be restricted to limestone and sandstone outcrops).

Asplenium monodon Liebm. (Aspleniaceae)
PERU. Cajamarca: Prov. San Ignacio: Santo Tomas Bosque Primario, 4°55'S, 78°50'W, 2070 m, *Vásquez 20521, et al.* (MO not seen, UC).

Asplenium palmeri Maxon (Aspleniaceae)
PERU. San Martín: Prov. Rioja: Aguas Verdes, 5°40'S, 77°40'W, 800 m, on limestone, *van der Werff 16612, et al.* (MO not seen, UC, USM).

Asplenium polyphyllum Bertol. (Aspleniaceae)
PERU. Cuzco: Prov. Urubamba: Dist. Ollantaytambo, Huaytampo, 13°10'47"S, 72°21'10"W, 3650 m, *Calatayud 1025, et al.* (UC). Reported by Adams (in Davidse et al. 1995) from Peru, but without citation of specimen.

Asplenium pseuderectum Hieron. (Aspleniaceae)
PERU. Madre de Dios: Prov. Manu: Cocha Cashu Biological Station, along path 12, 11°52'S, 71°24'W, 400 m, *Tuomisto 13074, et al.* (CUZ, TUR, UC, USM); close to Cocha Cashu biological station, 11°53'S, 71°24'W, 400 m, *Tuomisto 13159* et al. (CUZ, TUR).

Blechnum gracile Kaulf. (Blechnaceae)
PERU. Amazonas: Prov. Bagua: valley of Río Marañón above Cascadas de Mayasi near Campamento STte Montenegro (Kms 276–280 of Marañón road), 450 m, *Wurdack 1822* (UC, US not seen, USM). **Prov. Luya:** Camporredondo, Jaipe, 6°09'07"S, 78°21'05"W, 2050 m, *Campos 3646, et al.* (MO not seen, UC, USM). **Cajamarca: Prov. San Ignacio:** La Coipa, La Lima, 5°26'S, 78°55'W, 1800 m, *Campos 4009*, with García (MO not seen, UC). **Huánuco: Prov. Leoncio Prado:** 60 km E of Tingo María, Divisoria Pass, 1500 m, *Tryon & Tryon 5271* (USM). **Junín: Prov. Chanchamayo:** Chanchamayo, 2000 m, *Esposto 636* (USM). **Pasco: Prov. Oxapampa:** Dist. Villa Rica, bosque de Protección San Matias-San Carlos, 1355 m, *Perea & Mateo 083* (MO not seen, UC). **San Martín: Prov. Huallaga:** Abajo de La Morada, 6°57'S, 77°32'W, 2000–2200 m, *Quipuscoa S. 1016*, with Bardalaes (F not seen, UC). Subsumed under *B. fraxineum* Willd. by Tryon and Stolze (1993:59); some of the specimens they cited under that name are *B. meridense* Klotzsch.

Blechnum lechleri Mett. (Blechnaceae)

PERU. Pasco: Prov. Oxapampa: Parque Nacional Yanachaga-Chemillen, Abra Yanachaga, 10°22'S, 75°27'W, *Vásquez 28423, et al.* (MO not seen, UC). One of the syntypes, "Peruvia, Tatanara," is also from Peru. Mentioned, but not accepted, by Tryon and Stolze (1993:68); a synonym is *B. violaceum* (Fée) Hieron. Widely distributed from the Lesser Antilles to Bolivia, and distinguished from *B. cordatum* (Desv.) Hieron. by the pronounced, dark, peglike aerophores at the pinna bases and the dark, atropurpureous rachises.

Callipteris andina Pacheco & R.C. Moran (Athyriaceae)

PERU. Amazonas (Pacheco & Moran 1999:353). It is doubtful whether *Callipteris* is separable from *Diplazium*, but no combination is available in the latter genus.

Campyloneurum amazonense B. León (as *C. amazonensis*) (Polypodiaceae)

PERU. Amazonas: ca. 12–18 km trail E of La Peca in Serrania de Bagua, 1800–1950 m, *Gentry et al. 22930* (HOLOTYPE: USM; ISOTYPES AMAZ, F, MO, UC) (León 2005).

Campyloneurum cochense (Hieron.) Ching (Polypodiaceae)

PERU. Amazonas: Prov. Chachapoyas: Dist. Leymebamba, Alrededor de la Laguna de Los Cóndores, 6°51.102'S, 77°41.415'W, 2500–2700 m, *Quipuscoa S. 1270, et al.* (F not seen, UC). **San Martín: Prov. Mariscal Cáceres:** Parque Nacional del Rio Abiseo, valle de Chochos, 3300 m, *León & Young 2041* (USM).

Ceradenia kalbreyeri (Baker) L.E. Bishop (Grammitidaceae)

PERU. Pasco: Prov. Oxapampa: Chacos, 10°37'S, 75°17'W, 2500 m, *van der Werff 17678, et al.* (MO not seen, UC).

Ceradenia cf. kookenamae (Jenman) L.E. Bishop (Grammitidaceae)

PERU. Cajamarca: Prov. San Ignacio: San José de Lourdes, Picorana, 4°58'S, 78°53'W, 2470–2560 m, *Campos 5593, et al.* (MO not seen, UC, USM).

Ceradenia spixiana (Mart. ex Mett.) L.E. Bishop (Grammitidaceae)

PERU. San Martín: Prov. Rioja: along road Yorongos-Uquihua, *van der Werff 16584* (MO not seen, UC).

Ceradenia tryonorum B. León & A.R. Sm. (Grammitidaceae)

PERU. San Martín: Prov. Mariscal Cáceres: Parque Nacional Río Abiseo, near El Tingo, 7°58'S, 77°18'W, 2800 m, *Léon & Young 3840* (HOLOTYPE: USM; ISOTYPES: TEX, UC). (León & Smith 2003:81).

Cochlidium linearifolium (Desv.) Maxon ex C. Chr. (Grammitidaceae)

PERU. Amazonas: Prov. Bagua: Comunidad de Yamayakat, Bosque primario, 05°03'24"S, 78°20'17"W, 600 m, *Vásquez 23793, et al.* (MO).

Cyathea amazonica R.C. Moran (Cyatheaceae)

PERU. Loreto: Prov. Maynas: Quebrada Tamshiyacu, Caseria Alianza, 4°05'S, 72°58'W, 130 m, *Gentry et al. 29231* (MO); San Miguel, 2 km below Indiana, 3°30'S, 73°02'W, 130 m, *Gentry 65689, et al.* (MO); ca. 5 km NW from village of Gen Gen at Río Mormón, 3°37'S, 73°17' W, *Tuomisto 3034* (AMAZ, TUR) (three additional collections cited by Moran 1995, all from Prov. Maynas).

Cyathea boliviana R. M. Tryon (Cyatheaceae)

PERU. Cuzco: Prov. Paucartambo: carretera a Pilcopata, 2650 m, *León 2204* (USM).

Cyathea brevistipes R.C. Moran (Cyatheaceae)

PERU. Pasco: Prov. Oxapampa: *Foster et al. 10532* (F not seen, USM) (Moran 1991).

Cyathea caroli-henrici M. Lehnert (Cyatheaceae)

PERU. Cuzco: Prov. Urubamba: 2050 m, *Bonino 1127* (CUZ) (Lehnert 2003:180).

Cyathea concordia B. León & R.C. Moran (Cyatheaceae)

PERU. Amazonas: Cordillera del Condor, 1950–2050 m, 3°52'48"S 78°26'00"W, *Beltrán & Foster 1183* (F, USM), type and only known collection (León & Moran 1996).

Cyathea herzogii Rosenst. (Cyatheaceae)

PERU. Cuzco: Prov. La Convención: Cordillera Vilcabamba, 12°38'S, 73°38'W, 1760 m, *Dudley 10588* (NA not seen, USM). **Junín: Prov. Satipo:** Northern Cordillera Vilcabamba, E slope, upper Río Puyeni watershed, 11°33'35"S, 73°38'W, 2090 m, *Boyle et al. 4749* (USM). Distinct at species rank from *Cyathea caracasana* (Klotzsch) Domin, where it was included by Tryon (1976: 77).

Cyathea palaciosii R.C. Moran (Cyatheaceae)

PERU. Amazonas: Prov. San Martín: 5°41'S, 77°48'W, 1950 m, *van der Werff 16721, et al.* (MO not seen, UC) (Moran 1995).

Cyathea thelypteroides A.R. Sm. (Cyatheaceae)

PERU. Amazonas: Bagua Distr., upper slopes and summit of Cerro Tayu, 05°15'56"S, 78°22'07"W, 1030 m, *van der Werff 16323, et al.* (HOLOTYPE: USM; ISOTYPES: MO, UC) (Smith 2005b).

Cyathea tortuosa R.C. Moran (Cyatheaceae)

PERU. Amazonas: Prov. Bagua: Dist. Imaza, Yamayakat, 5°03'20"S, 78°20'23"W, 400 m, *Vásquez 21790, et al.* (MO not seen, UC). **Madre de Dios:** Prov. Manu: Cerro de Pantiacolla, Río Palotoa 10–15 km NNW of Shintuya, 12°35'S, 71°18'W, 650–700 m, *Foster 10703* (F, UC); **San Martín:** along Yorongos–La Florida road near Rioja, 1000 m, *van der Werff 16542, et al.* (MO not seen, UC, USM). Also Depts. Pasco and Loreto (Moran 1991:100).

Cyathea werffii R.C. Moran (Cyatheaceae)

PERU. Amazonas: Puerto Nazareth, 540 m, *Ellenberg 3489* (UC), a paratype (Moran 1991:94).

Cyathea windischiana A.R. Sm. (Cyatheaceae)

PERU. Amazonas: Bagua Distr., Cerro Tayu, ca. 1 hour from Chiriaco, 05°15'56"S, 78°22'07"W, 800 m, *van der Werff 16207, et al.* (HOLOTYPE: UC; ISOTYPE: MO) (Smith 2005b).

Cyathea xenoxyla M. Lehnert (Cyatheaceae)

PERU. Amazonas. Prov. Condorcanqui: Cordillera del Condor, Puerto de la Vigilancia Alfonso Ugarte (PV 3), cabeceras del Río Comainas, tributaria al oeste del Río Cenepa, 3°55.0'S, 78°25.4'W, 1000–1300 m, *Beltran & Foster 1083* (USM). **Prov. Chachapoyas:** road Chachapoyas–Mendoza, 52 km from Chachapoyas, ca. 10 km behind Molinopampa, 6°14.2'S, 77°35.9'W, 2400 m, *Lehnert 229* (GOET, UC, USM). **Cuzco. Prov. La Convención:** Dist. Echaraté, Llactahuaman, N del Rio Apurimac, NE del Pueblo Libre, S de la Cordillera de Vilcabamba, 12°51'55.5"S, 73°30'40"W, 1650 m, *Baldeon et al. 3077* (USM). **Pasco. Prov. Oxapampa:** trail to summit of Cordillera Yanachaga via Río San Daniel, 10°23'S, 75°27' W, 2500 m, *Smith & Boetger 7846* (USM). **San Martín. Prov. Rioja:** road Moyobamba–Pedro Ruíz, Km 395, *Lehnert 216* (GOET, UC, USM). **Ucayali. Prov. Coronel Portell:** Dobson (?), *Ferreyra s.n.* (USM). (Lehnert 2003:177).

Danaea acuminata Tuomisto & R.C. Moran (Marattiaceae)

PERU. Specimens from Depts. Loreto and Madre de Dios cited by Tuomisto and Moran (2001:28), e.g., **Madre de Dios: Prov. Manu:** 4 km S of village of Boca Colorado, 12°38'S, 70°25'W, 300 m, *Tuomisto 13589, et al.* (CUZ, TUR, U, UC, USM).

Danaea bipinnata Tuomisto (Marattiaceae)

PERU. Specimens from Dept. Loreto cited by Tuomisto and Moran (2001:33), e.g., **Loreto**: Mariscal

Ramon Castilla, 20.5–26 km NW from village of Puerto Izango, Río Yaguasyacu, 3°12'S, 72°10'W, 100–150 m, *Tuomisto 11387, et al.* (AMAZ, TUR, UC, USM).

Danaea leprieurii Kunze (Marattiaceae)
PERU. Specimens from Depts. Loreto and Madre de Dios cited by Tuomisto and Moran (2001:50), e.g., **Loreto:** Maynas, Upper Río Itaya, ca. 5 km SSE of village Carbajal, 4°19'S, 73°35'W, 100–200 m, *Tuomisto 10116, et al.* (AMAZ, TUR, UC, US). **Madre de Dios: Prov. Manu:** 4 km S from village of Boca Colorado, 12°38'S, 70°25'W, 300 m, *Tuomisto 13592, et al.* (CUZ, TUR, UC, USM).

Dennstaedtia arcuata Maxon (Dennstaedtiaceae)
All Peruvian specimens treated as *D. werckleı* (H. Christ) R. M. Tryon by Tryon and Stolze (1989b) are referred to *D. arcuata*, by Navarrete and Øllgaard (2000); this name was not mentioned by Tryon and Stolze.

Dennstaedtia auriculata H. Navarrete & B. Øllg. (Dennstaedtiaceae)
PERU. Cuzco: Prov. Convención: Amaibamba, 1700 m, *Vargas 9805* (UC). This specimen cited as *D. arborescens* (Willd.) Maxon, by Tryon and Stolze (1989b:100), a species restricted to the Antilles by Navarrete and Øllgaard (2000).

Dennstaedtia cornuta (Kaulf.) Mett. (Dennstaedtiaceae)
PERU. Amazonas: 12 km E of La Peca, 1700 m, *Barbour 2498* (MO not seen, UC). **Pasco: Prov. Oxapampa:** Palcazu, 10 km N of Oxapampa, 10°32'S, 75°23'W, 2100 m, *D. Smith 8479* (MO not seen UC); along road Chatarra-Cacazu, 10°32'S, 75°04'W, 890 m, *van der Werff 18292, et al.* (MO not seen, UC). This name not mentioned by Tryon and Stolze (1989b), but probably some of the specimens they cited as *D. dissecta* are *D. cornuta*; the former is considered to be restricted to the Antilles, s Mexico, and nw South America. See Navarrete and Øllgaard (2000).

Dennstaedtia coronata (Sodiro) C. Chr. (Dennstaedtiaceae)
PERU. San Martín: Prov. Huallaga: abajo de La Morada, cerca al Río Guabayacu, 6°57'S, 77°32'W, 1900–2000 m, *Quipuscoa & Bardales 962* (UC). Name not mentioned by Tryon and Stolze (1989b). See Navarrete and Øllgaard (2000).

Dennstaedtia mathewsii (Hook.) C. Chr. (Dennstaedtiaceae)
PERU. Cajamarca: Prov. San Ignacio: La Coipa, Vista Florida (camino a la Laguna), 5° 26'10"S, 78° 56'00"W, 1900–2000 m, *Campos 4048*, with García (MO not seen, UC); Huarango, El. Progresso, 5° 19'15"S, 78° 40'00"W, 1300–1450 m, *Campos 6276, et al.* (MO not seen, UC). **Pasco: Prov. Oxapampa:** Parque Nacional Yanachaga, El Huampal, 10°11'S, 75°34'W, 1200 m, *van der Werff 17908, et al.* (MO not seen, UC). Name treated as synonymous with *D. arborescens* (Willd) Maxon by Tryon and Stolze (1989b). See Navarrete and Øllgaard (2000), who considered *D. arborescens* to be restricted to the Antilles.

Dennstaedtia obtusifolia (Willd.) T. Moore (Dennstaedtiaceae)
Specimens cited as *D. dissecta* (Sw.) T. Moore by Tryon and Stolze (1989b) are mostly to be referred to *D. obtusifolia*. According to Navarrete and Øllgaard (2000), *D. dissecta* is restricted to the Antilles, Mesoamerica, and nw S. America, and is not known from Peru.

Diplazium grandifolium (Sw.) Sw. (Athyriaceae)
PERU. Amazonas: Prov. Bongará: Shillac, N by trail from Pedro Ruiz, 5°49'S, 78°01'W, 2300 m, *D. Smith & Vásquez S. 4908* (MO not seen, UC); Dist. Sipabamba, Shilla, ca. 1900 m, *Young & Eisenberg 355* (MO not seen, UC). Tryon and Stolze (1991:83) cited many specimens of this species from Peru, but all as var. *andicola* Stolze. We believe that this variety is a good species and that the correct name at species rank is *Diplazium ballivianı* Rosenst., type from Bolivia. The true *D. grandifolium*, type from

the West Indies, does indeed occur in Peru, but apparently no specimens were seen by Tryon and Stolze. We note that the two Peruvian specimens of *D. grandifolium* cited are from 1900 and 2300 m, while 16 of 18 specimens seen of *D. balliviani* from the southern Andes are from low elevation, 100–400 m; two others, both from Bolivia, extend to 1100 m.

Diplazium immensum Stolze (Athyriaceae)

PERU. San Martín: *Knapp & Alcorn 7749* (F, MO, neither seen). Cited by Tryon and Stolze (1991:77), under *D. macrophyllum* Desv., and as *D. immensum* by Stolze et al. (1994:41).

Diplazium lilloi (Hicken) R. M. Tryon & A. F. Tryon (Athyriaceae)

PERU. Cuzco: Prov. Urubamba: Dist. Ollantaytambo, Huaytampo, 13°09'02"S, 72°30'28"W, 2300 m, *Calatayud & Farfán 1072* (MO not seen, UC).

Diplazium longisorum (Baker) C. Chr. (Athyriaceae)

PERU. San Martín: Prov. Rioja: carretera Rioja–Pedro Ruíz, 1450 m, *van der Werff 15558* (MO not seen, UC).

Diplazium paucipinnum Stolze (Athyriaceae)

PERU. San Martín: along Rioja–Pedro Ruíz, about bridge Serranoyacu, 1170 m, *van der Werff 16777, et al.* (UC) (Stolze et al. 1994:72).

Diplazium tabalosense Hieron. (Athyriaceae)

PERU. Amazonas: Prov. Bagua: Río Urubamba [Utcubamba], on Cerro Tapur above Hda. Misqui, ca. 40 km S of Bagua Grande, 1200 m, *Hutchison 1483* (UC, USM). **Loreto: [Prov. Alto Amazonas]:** above Pongo de Manseriche, mouth of Río Santiago, 200 m, *Mexia 6129* (UC). **Madre de Dios: Prov. Manu:** Río Manu close to Cocha Cashu Biological Station, 11°53'S, 71°24'W, 400 m, *Tuomisto 13177, et al.* (CUZ, TUR, UC, USM); Parque Nacional del Manú, Cocha Cashu Biological Station, *Foster P-84-57, P-84-86* (UC). Several of the specimens cited by Tryon and Stolze (1991:79) as *D. striatum* (L.) C. Presl are *D. tabalosense*, which differs from *D. striatum* by the glabrous costae, costules, and tissue between veins abaxially, less incised pinnae (blades never 2-pinnate, even at the base), and narrower indusia ca. 0.1–0.2(0.3) mm wide. Known from Venezuela, Ecuador, Peru, and Bolivia.

Diplazium wolfii Hieron. (Athyriaceae)

PERU. Junín: Prov. Satipo: Gran Pajonal, Mapari, ca. 12 km SW of Chequitavo, 74°23'W, 10°45'S, 1300 m, *D. Smith 6789* (MO not seen, UC, USM) (see Stolze et al. 1994:22).

Elaphoglossum ambiguum (Mett. ex H. Christ) Alston (Dryopteridaceae)

PERU. Cajamarca: Prov. San Ignacio: Chirinos, localidad de Pacasmayo, 5°15'00"S, 78°55'00"W, 1750 m, *Campos & Garcia 4504* (MO not seen, UC, USM).

Elaphoglossum exsertipes Mickel (Dryopteridaceae)

PERU. Amazonas: near border with Dept. San Martín, 5°41'S, 77°48'W, 2000 m, *van der Werff 16650, et al.* (MO not seen, UC). **San Martín:** along road Rioja–Pedro Ruíz, El Mirador, 5°40'29"S, 77°46'25"W, 1850 m, *van der Werff 15659* (MO not seen, UC).

Elaphoglossum palmarum M. Kessler & Mickel (Dryopteridaceae)

PERU. San Martín: Prov. Rioja: Pedro Ruíz–Moyobamba road, Km 390, Venceremos, 5°50'S, 77°45', 1800–1900 m, *D. Smith 4503* (MO not seen, UC). Previously cited by Mickel (in Tryon & Stolze 1991:143) as *E. litanum* (Sodiro) C. Chr., which is now known only from Ecuador.

Elaphoglossum tovarense (Mett. ex Kuhn) T. Moore ex C. Chr., vel aff. (Dryopteridaceae)

PERU. Amazonas: Prov. Bagua: Yamayakat, 04°55'S, 78°19'W, 320 m, *Jaramillo 1189, et al.* (MO).

Enterosora trichosora (Hook.) L.E. Bishop (Grammitidaceae)

PERU. Amazonas: near border with Dept. San Martín, 5°41'S, 77°48'W, 2000 m, *van der Werff 16667, et al.* (MO not seen, UC).

Equisetum myriochaetum Schltdl. & Cham. (Equisetaceae)

PERU. Amazonas: Prov. Bagua: 25 km E of La Peca, 5900 ft, *Barbour 2880* (MO). **Cajamarca:** Huarango, Nuevo Mundo, 1600–1700 m, *Campos & Núñez 4623* (MO). Synonymized under *E. giganteum* by Tryon and Stolze (1994:15), but well characterized by Hauke (1963).

Eriosorus hirtus (Kunth) Copel. (Pteridaceae)

PERU. Piura: Prov. Ayabaca: Cerro de Aypate, Comunidad Campesina de Tacalpo, anexo Yanchalá, 4°42', 82"S, 79°34'150'W, 2800–2880 m, *Quipuscoa S. 643, et al.* (F not seen, UC).

Eriosorus novogranatensis A. F. Tryon (Pteridaceae)

PERU. Amazonas: San Martín, 5°41'S, 79°48'W, 1940 m, *van der Werff 16729* (MO not seen, UC, USM), *16747, et al.* (MO not seen, UC).

Huperzia dichotoma (Jacq.) Trevis. (Lycopodiaceae)

PERU. Pasco: Prov. Oxapampa: along road Chatarra–Pto. Bermudez, 10°30'S, 75°03'W, 700 m, *van der Werff 18161, et al.* (MO not seen, UC).

Huperzia firma (Mett.) Holub, vel aff. (Lycopodiaceae)

PERU. Amazonas: Prov. Leymebamba: Dist. Leymebamba, ruta Laguna de Los Cóndores, La Atalyaya, alrededores de La Fila, 6°49.056'S, 77°44.134'W, 3000–3500 m, *Quipuscoa S. 1206, et al.* (F not seen, UC).

Hymenophyllum dendritis Rosenst. (Hymenophyllaceae)

PERU. Huanuco: [Prov. Leoncio Prado]: alrededores de Maria, 800 m, *Aguilar 304* (UC). Perhaps most of the specimens cited by Tryon and Stolze (1989a:59) as *H. apiculatum* Mett. ex Kuhn from Peru are better referred to *H. dendritis*, a low-elevation, smaller species (fronds mostly 3–5 cm long) with ovate, rather than obovate involucres, included, shorter receptacles (generally < 1 mm long vs. often slightly exserted receptacles ca. 2 mm long in *H. apiculatum*), and smaller sporangia (ca. 0.3 mm long vs. 0.5 mm long).

Hymenophyllum platylobum Bosch (Hymenophyllaceae)

PERU. Puno: [Prov. Carabaya]: San Gabán, *Lechler 2489* (HOLOTYPE: P, photo US; ISOTYPE: F). Treated by Morton (1947) and by Tryon and Stolze (1989a:68) as a synonym of *H. valvatum* Hook. & Grev., but we believe the two are specifically distinct.

Jamesonia verticalis Kunze (Pteridaceae)

PERU. San Martin: Dto. Huallaga, Saposoa, entre El Tambo y Jalca de El Rayo, camino a Leymebamba, 2800–3200 m, *Quipuscoa S. 2484, et al.* (F not seen, UC).

Lellingeria aff. suspensa (L.) A.R. Sm. & R.C. Moran (Grammitidaceae)

PERU. Amazonas: near border with Dept. San Martín, 5°41'S, 77°48'W, 2000 m, *van der Werff 16686, et al.* (MO not seen, UC).

Lindsaea bolivarensis V. Marcano (Lindsaeaceae)

PERU. Loreto: Prov. Maynas: ca. 7 km E of oil palm plantation at Río Manití, 3°38'S, 72°56'W, 100–150 m, *Tuomisto 4721, et al.* (TUR, UC, USM); trail from the village of Panguana towards Río Manití, about 8 km from Río Amazonas, 3°53'S, 73°5'W, 100–200 m, *Tuomisto 6124, et al.* (TUR, UC, USM); Explorama/ ACEER reserve, 5–15 km E of the mouth of Quebrada Sucusari at lower Napo, 3°15'S, 72°50'W, 100–200 m, *Tuomisto 7755, et al.* (AMAZ, KSP, TUR); 2 km SE of the village Santa Ana at lower Río Tahuayo, 4°6'S, 73°7'W, 100–200 m, *Tuomisto 8863*, with Oré (AMAZ, TUR, USM) (Marcano 1989:254).

Lindsaea coarctata K.U. Kramer (Lindsaeaceae)

PERU. Loreto: Prov. Maynas: close to the village Nina Rumi at lower Río Nanay, 20 km SW of Iquitos, 3°51'S, 73°23'W, 100–200 m, *Tuomisto 5863* (AMAZ, TUR, USM). **Prov. Mariscal Ramon Castilla:** 3–4 km W from village of Puerto Izango, Río Yaguasyacu, 3°18'S, 72°01'W, 100–150 m, *Tuomisto 11227, et al.* (AMAZ, TUR, UC, USM). **Prov. Requena:** 3 km E from Requena, 5°04'S, 73°48'W, 150–200 m, *Tuomisto 12764, et al.* (AMAZ, TUR, USM); 4 km SE from Requena, 5°05'S, 73°49'W, 150–200 m, *Tuomisto 12778, et al.* (AMAZ, TUR, USM).

Lindsaea hemiptera K.U. Kramer (Lindsaeaceae)

PERU. Loreto: Prov. Maynas: 14 km NW from the carretera to Nauta at km 40, 3°56'S, 73°30'W, 100–150 m, *Tuomisto 3557, et al.* (AAU, AMAZ, TUR, USM, Z); Experimental station 'El Dorado' of INIA, Km 25 along road Iquitos-Nauta, 3°57'S, 73°25'W, 100–200 m, *Tuomisto 13049*, with Ruokolainen (AMAZ, TUR, UC, USM).

Lindsaea javitensis Humb. & Bonpl. ex Willd. (Lindsaeaceae)

PERU. Loreto: Prov. Maynas: Experimental station 'El Dorado' of INIA, Km 25 along road Iquitos-Nauta, 3°57'S, 73°25'W, 100–200 m, *Tuomisto 13051*, with Ruokolainen (AMAZ, TUR, UC, USM).

Lindsaea tetraptera K.U. Kramer (Lindsaeaceae)

PERU. Loreto: Prov. Maynas: Experimental station of UNAP at Puerto Almendras along Río Nanay, 20 km air distance from Iquitos, 3°51'S, 73°22'W, 100–200 m, *Tuomisto 6439*, with Ruokolainen (AMAZ, TUR, USM); close to the experimental station of UNAP at San Gerardo, km 13 of the road Iquitos-Nauta, 3°55'S, 73°22'W, 100–200 m, *Tuomisto 7217*, with Ruokolainen (AMAZ, TUR, USM); Experimental station 'El Dorado' of INIA, Km 25 along road Iquitos-Nauta, 3°57'S, 73°25'W, 100–200 m, *Tuomisto 13048*, with Ruokolainen (AMAZ, TUR, UC, USM).

Lomariopsis prieuriana Fée (Dryopteridaceae)

PERU. Loreto: Prov. Maynas: C. Nueva Paleta, Río Napo, 3°01'S, 73°21'W, Flores 348, 353, 363 (AAU). **San Martín: Prov. Rioja:** road Rioja-Pedro Ruiz, 1450 m, *van der Werff 15554* (UC). Additional collections from Loreto cited by Moran (2000:93).

Megalastrum mollis A.R. Sm. (Dryopteridaceae)

PERU. Amazonas: Bagua Distr., along road from Chiriaco towards Bagua, 5°16'57"S, 78°23'10'W, 750 m, *van der Werff 16300, et al.* (HOLOTYPE: UC; ISOTYPE: MO) (Smith. 2005b).

Melpomene assurgens (Maxon) A.R. Sm. & R.C. Moran (Grammitidaceae)

PERU. Cajamarca: Prov. San Ignacio: Tabaconas, Santuario Nacional Tabaconas-Namballe, 5°15'00"S, 79°19'00"W, 2300–2400 m, *Campos 5691, et al.* (MO not seen, UC, USM). Discussed under *Grammitis moniliformis* (Lag. ex Sw.) Proctor by Tryon and Stolze (1993:99).

Melpomene peruviana (Desv.) A.R. Sm. & R.C. Moran (Grammitidaceae)

PERU. Ancash: Prov. Huaras: N of Laguna Llanganuco, 9°03.1'S, 77°36.2' W, 4400, *Lehnert 273* (UC). **Ayacucho: Prov. Huamanga:** Ayacucho-Andahuaylas, above Ocros, 13°23.5'S, 73°57.3'W, 4200 m, *Lehnert 339* (UC, USM); Ayacucho-Andahuaylas, behind furcation to Vilcas Huamán, 13°22'S, 73°58'W, 4200 m, *Lehnert 333* (UC, USM). Synonymized under *Grammitis flabelliformis* (Poir.) C. V. Morton by Tryon and Stolze (1993:102).

Metaxya lanosa A.R. Sm. & Tuomisto (Metaxyaceae)

Cited by Smith et al. (2001) from Loreto. Several additional collections are now known: **PERU. Loreto: Prov. Maynas:** Distr. Iquitos, El Dorado-INIA, Varillal Alto Húmedo, *McDaniel & Rimachi 27814* (IBE not seen, USM); *Moran 3630* (USM); *Rimachi 7526* (USM).

Microgramma acatallela Alston (Polypodiaceae)

PERU. [Loreto]: Prov. Maynas: Iquitos, Estación Biológica, Allpahuayo-IIAPBosque primario, 03°53'S, 73°25'W, 130 m, *Jaramillo & Marcos 703* (MO not seen, UC). **Pasco**: Dist. Pozuzo, Parque Nacional Yanachaga Chemillén, 10°11'S 75°34'W, 1225 m, *Monteagudo 4846, et al.* (MO not seen, UC); El Huampal, *van der Werff 17930A, et al.* (MO not seen, UC). Most likely, specimens identified as *M. piloselloides*, as defined by Tryon and Stolze (1993:152), are *M. acatallela*; the former is generally considered to be restricted to the Antilles, s Mexico, and Guatemala (e.g., Mickel & Smith 2004:398).

Microgramma fosteri B. León & H. Beltrán (Polypodiaceae)

–**PERU. Ucayali: Prov. Padre Abad:** Cordillera Azul del Biabo, cabaceras del Río Pisqui, 8°28'45.6"S, 75°43'5.21"W, 1220 m, *Beltrán 3643, et al.* (HOLOTYPE: USM) (León & Beltran 2002).

Micropolypodium caucanum (Hieron.) A.R. Sm., vel aff. (Grammitidaceae)

PERU. Pasco: Prov. Oxapampa: road to Chacos, near top of ridge, 10°35'S, 75°06'W, 2400–2700 m, *van der Werff 18539, 18573, et al.* (MO not seen, UC); Chacos, 10°37'S, 75°17'W, 2500 m, *van der Werff 17697, et al.* (MO); Parque Nacional Yanachaga-Chemillen, Abra Yanachaga, 10°22'S, 75°27'W, 2900 m, *Vásquez 28455, et al.* (MO not seen, UC).

Pecluma robusta (Fée) M. Kessler & A.R. Sm. (Polypodiaceae)

PERU. San Martín: Prov. Huallaga: Dist. Saposoa, Arriba de Zarumilla, al NO del pueblo, 6°34'55"S, 77°23'06"W, 1350 m, *Quipuscoa S. 2096, et al.* (F not seen, UC) (Kessler & Smith 2005).

Pleopeltis disjuncta M. Kessler & A.R. Sm. (Polypodiaceae)

PERU. Cuzco: *Cook & Gilbert 1510* (US), as cited by Kessler and Smith (2005). See also Tryon and Stolze (1993:137), under *Polypodium furfuraceum* Schltdl. & Cham.

Pleopeltis stolzei A.R. Sm. (Polypodiaceae)

PERU. Amazonas: see Tryon and Stolze (1993:143), Kessler and Smith (2005). A synonym is *Pleopeltis macrocarpa* (Bory ex Willd.) Kaulf. var. *laciniata* Stolze.

Polybotrya sessilisora R.C. Moran (Dryopteridaceae)

PERU. Loreto: Prov. Loreto: 1.5 km E of road to Iquitos at Km 10 from Nauta, 4°28'S, 73°34'W, 100–150 m, *Tuomisto 4435, et al.* (AAU, AMAZ, TUR, U, USM); Río Tigre, 2 km E of the village Paraíso, 3°57'S, 74°17'W, *Tuomisto 13977, et al.* (AMAZ, USM, TUR); Río Tigre, 7 km NW of the village Paicheplaya, 3°00'S, 75°22'W, *Tuomisto 14560, et al.* (AMAZ, TUR, UC, USM). **Prov. Maynas:** Explorama/ACEER Reserve, 15–23 km E of mouth of Quebrada Sucusari at lower Napo, 3°15'S, 72°45'W, 100–200 m, *Tuomisto 7853, et al.* (AMAZ, KSP, TUR, UC); Upper Río Itaya, about 5 km SSE of the village Carbajal, 4°19'S, 73°35'W, 100–200 m, *Tuomisto 10120, et al.* (AMAZ, TUR, US).

Polypodium appressum Copel. (Polypodiaceae)

PERU. Amazonas: Izuchaca, 6°19'40"S, 77°31'05"W, *van der Werff 16936, et al.* (MO not seen, UC). **Junín: Prov. Tarma:** Agua Dulce, 1900 m, *Woytkowski 35479* (UC). The species was subsumed under the much more common *P. fraxinifolium* Jacq. by Tryon and Stolze (1993:132).

Polypodium attenuatum Humb. & Bonpl. ex Willd. (Polypodiaceae)

PERU. Tumbes Hwy to "El Caucho," 400 m, *Coronado 230* (UC). Misdetermined as *P. aureum* by Tryon, in 1957.

Polypodium (Pleopeltis) fayorum R.C. Moran & B. Øllg. (Polypodiaceae)

PERU. Cajamarca: Prov. Santa Cruz: 1800 m, *Sagastegui & Leiva 14092* (UC) (Moran & Øllgaard 1998:437).

Polypodium funckii Mett. (Polypodiaceae)

PERU. Amazonas: Prov. Chachapoyas: Chachapoyas-Mendoza, Km 52, *Lehnert 232* (UC). **Huánuco:** Carpish, 2800 m, *Coronado 70* (UC).

Polypodium giganteum Desv. (Polypodiaceae)
PERU. Pasco: Prov. Oxapampa: along road Chatarra-Cacazu, 10°32S, 75°04'W, *van der Werff 18272, et al.* (MO not seen, UC).

Polypodium gilliesii C. Chr. (Polypodiaceae)
Stork et al. 9283 (UC), *Stork & Vargas 9338* (UC), *Tryon & Tryon 5418* (BM, UC), from Dept. Lima, *Sagastegui 12956, et al.* (UC), from Dept. La Libertad, as well as other specimens seen from Dept. Lima and Dept. Lambayeque from low elevations are this species, and not *P. lasiopus* Klotzsch, as cited Tryon and Stolze (1993:130). *Polypodium gilliesii* differs from *P. lasiopus*, where it was synonymized by both Hensen (1990) and Tryon and Stolze (1993), by having abaxially glabrous or nearly glabrous blades (lacking long, septate hairs) and generally longer, narrower, somewhat diverging, and darker rhizome scales (most prominently seen in Venezuelan specimens, the type locality); in addition, *P. lasiopus* grows at elevations above 1700 m in Peru, while *P. gillliesii* is recorded from 400–800(–1300) m, primarily on lomas.

Polypodium intricatum M. Kessler & A.R. Sm. (Polypodiaceae)
PERU. Amazonas: Prov. Luya: Dist. Camporredondo, Tullanya, Pascana, La Palma, 6°04'35"S, 78°21'45"W, 2710 m, *Vásquez 22033, et al.* (MO not seen, UC, USM). **Cajamarca:** *Campos & Nuñez 4647* (UC). **San Martín: Prov. Rioja:** Pedro Ruíz–Moyobamba road, Km 390, 77°45'W, 05°50'S, 1800 m, *Smith 4414* (MO not seen, UC, USM). See also Tryon and Stolze (1993:130), most specimens cited under *P. loriceum* L.

Polypodium kunzeanum C. Chr. (Polypodiaceae)
PERU. Amazonas: Prov. Bongará: Shillac, north by trail from Pedro Ruíz, 5°49'S, 78°01'W, 2300 m, *D. Smith 4945*, with Vásquez S. (MO not seen, UC). **Huánuco:** between Chinchao and Puente Durand, 2000 m, *Coronado 85* (UC). Cited by Tryon and Stolze (1993) as a synonym of *P. sessilifolium* Desv., which we believe is not closely related. *Polypodium kunzeanum* has much less regular venation, sometimes with two included and themselves anastomosing veins within an areole, cordate-based, nonadnate pinnae (the basalmost with lobes overlapping the rachis), and non-clathrate rhizome scales. Both collections seen from Peru, neither cited by Tryon and Stolze (although *Smith 4945* was annotated as *P. triseriale* vel aff.), are indicated as growing terrestrially.

Polypodium loriciforme Rosenst. (Polypodiaceae)
PERU. Pasco: Prov. Oxapampa: Dist. Chontabamba, carretera a la Suiza, 10°39'S, 75°27'W, 2130–2210 m, *Monteagudo 4539, et al.* (MO not seen, UC).

Polypodium maritimum Hieron. (Polypodiaceae)
PERU. Cajamarca: Prov. San Ignacio: San José de Lourdes, 4°59'22"S, 78°53'03"W, 2020 m, *Vásquez 26336, et al.* (MO not seen, UC); San José de Lourdes, camino al Cerro Picorana, 5°01'40"S, 78°54'30"W, 2100–2200 m, *Campos 5507, et al.* (MO not seen, UC).

Polypodium polystichum Link (Polypodiaceae)
PERU. Huánuco: Prov. Huánuco: Dist. Churubamba, Hacienda Mercedes, Cotirarda, 1560 m, *Mexia 8216a* (UC); Dist. Churubamba, Hacienda Exito, bank of Río Ysabel, 1100 m, *Mexia 8163* (UC). **Pasco: Prov. Oxapampa:** Gran Pajonal, vicinity of Chequitavo, 10°45'S, 74°23'W, 1250 m, *D. Smith 5161* (MO not seen, UC). Related to *P. fraxinifolium* Jacq. but with spreading, long-acuminate scales.

Polypodium (Pleopeltis) tweedianum Hook. (Polypodiaceae)
PERU. Cajamarca: Prov. Contumazá, entrada al Bosque Cachil, 2500 m, *Sagástegui 15107, et al.* (F not seen, UC). Related to *P. pycnocarpum* C. Chr., but with sharply bicolored rhizome scales with a sclerotic mid-stripe.

Polystichum cochleatum (Klotzsch) Hieron. (Dryopteridaceae)

PERU. See Tryon and Stolze (1991:54), under *P. pycnolepis* (Klotzsch) T. Moore; the name accepted by Tryon and Stolze for this species is, in our opinion, a synonym of their *P. orbiculatum* (Desv.) J. Rémy & Fée

Polystichum rufum M. Kessler & A.R. Sm. (Dryopteridaceae)

PERU. San Martín: Prov. Lamas: Dist. Lamas, below English Evangelical Mission, Lamas, *Belshaw 3428* (UC; GH, US not seen). Specimen previously cited as *P. montevidense* (Spreng.) Rosenst. by Tryon and Stolze (1991:52).

Polystichum stuebelii Hieron. (Dryopteridaceae)

PERU. Cuzco: Prov. Urubamba: Dist. Ollantaytambo, Huaytampo, 13°09'02"S, 72°30' 28"W, 2400 m, *Calatayud 1109, et al.* (MO not seen, UC). **Pasco: Prov. Oxapampa:** Dist. Oxapampa, Parque Nacional Yanachaga Chemillén, cercanías del Refugio el Cedro, 10°32'S, 75°21'W, 2420 m, *Monteagudo 3814, et al.* (MO not seen, UC). Probably included within *P. montevidense* (Spreng.) Hieron. by Tryon and Stolze (1991), but the name *P. stuebelii* not mentioned by them.

Polytaenium brasilianum (Desv.) Benedict (Vittariaceae)

PERU. Cuzco: Prov. Convención: Tupitari, 2000 m, *Vargas C. 3440* (UC). This species was recognized as distinct by Tryon (1964), and the Vargas specimen cited as representative, but *Antrophyum brasilianum* (Desv.) C. Chr. was synonymized by Tryon and Stolze (1989b:87) under *A. cajenense* (Desv.) Spreng. [= *Polytaenium cajenense* (Desv.) Benedict]. The latter differs in having oblanceolate (vs. elliptic) blades and darkened (vs. stramineous) midribs abaxially towards the base of the blades.

Pteris consanguinea Mett. ex Kuhn (Pteridaceae)

PERU. Amazonas: Prov. Bagua: 12 km E of La Peca, 1700 m, *Barbour 2497* (MO not seen, UC). **Cajamarca: Prov. San Ignacio:** San José de Lourdes, 5°01'00"S, 78°57'00"W, 1500–1600 m, *Campos 3890, et al.* (MO not seen, UC); San José de Lourdes, 4°59'22"S, 78°53'03"W, 2020 m, *Vásquez 26293, et al.* (MO not seen, UC). **San Martín: Prov. Huallaga:** Dist. Saposoa, al sur de Añazco Pueblo, 2000 m, *Quipuscoa S. 2328, et al.* (F not seen, UC). Specimens placed here would key to *P. decurrens* C. Presl in Tryon and Stolze (1989b:77), but that species differs in a number of respects (see Prado & Windisch 2000).

Pteris muricatopedata Arbeláez (Pteridaceae)

PERU. Huánuco: Prov. Leoncio Prado: Dtto. Emileo Baldizan, Tingo María-Pucallpa La Divisora road, 1600 m, *Rimbach 4993* (NY not seen). **Pasco: Prov. Oxapampa:** 4–5 km N of Mallampampa, 2400 m, *Smith & Canne 5786* (NY not seen). Additional collection from Pasco cited by Arbeláez (1995:177).

Saccoloma membranaceum Mickel (Dennstaedtiaceae, temporarily)

PERU. Amazonas: Dist. Bagua, Imaza, Quebrada Almendro, 5°18'S, 78°20'W, 400 m, *Vásquez 26106, et al.* (MO not seen, UC); Dist. Bagua, along road Imaza-Chiriaco, 5°03'24"S, 78°20'17"W, 400 m, *van der Werff 16182, et al.* (MO not seen, UC); Dist. Imaza, Tayu Mujaji. Comunidad de Wawas, 5°15'56"S, 78°22'07"W, 900 m, *Vásquez 24644, et al.* (MO not seen, UC). **Pasco: Prov. Oxapampa:** along road Chatarra-Cacazu, 10°32'S, 75°04'W, 890 m, *van der Werff 18249* (MO not seen, UC).

Salpichlaena hookeriana (Kuntze) Alston (Blechnaceae)

PERU. Loreto: Prov. Maynas: ca. 10 km SW of Iquitos at zoological park, *Moran 3672* (UC); 7 km E of the oil palm plantation at Río Manití, 3°38'S, 72°56'W, 100–150 m, *Tuomisto 4771, et al.* (AAU, AMAZ, TUR, U, USM); Explorama/ACEER reserve, 23–31 km E of the mouth of Quebrada Sucusari at lower Napo, 3°14'S, 72°39'W, 100–200 m, *Tuomisto 7880, et al.* (AMAZ, KSP, TUR, US); Upper Río Itaya, about 6 km SSE of the village Carbajal, 4°20'S, 73°35'W, 100–200 m, *Tuomisto 10083, et al.* (AMAZ, NY, TUR). **Prov. Mariscal Ramón Castilla:** 2–5 km SW from village of Puerto Izango, Río Yaguasyacu, 3°18'S, 72°01'W, 100–150 m, *Tuomisto 11252, et al.* (AMAZ, TUR, UC, USM). **Prov. Requena:** 2 km N from the biological station of Jenaro Herrera, 4°52'S, 73°39'W, 150–200 m, *Tuomisto 12785, et al.* (AMAZ, TUR, USM). **Prov. Loreto:** 5 km upriver from mouth of Río Pucacuro, 3°17'S, 74°59'W, *Tuomisto 14123, et al.* (AMAZ, TUR, USM). **Madre de Dios: Prov. Manu:** 4 km S from the village of Boca Colorado, 12°38'S, 70°25'W, 300 m, *Tuomisto 13588, et al.* (CUZ, TUR, USM). Subsumed by Tryon and Stolze (1993:70) under *S. volubile* (Kaulf.) J. Sm., but easily distinguished by the serrate sterile pinnule apices, strongly dimorphic, elaminate fertile pinnules ca. 1–2 mm wide and the buds in the axils of sterile pinnae. Tryon and Stolze also cited two specimens from Loreto (not seen) that are most likely this species.

Schizaea fluminensis Miers ex J. Sturm (Schizaeaceae)

PERU. Loreto: *Maas 6336, et al.* (AMAZ, USM); *Mejía s.n.* (USM). Cited by Vásquez (1997) for Loreto; see also León et al. (in press).

Selaginella arthritica Alston (Selaginellaceae)

PERU. Huánuco: Prov. Leoncio Prado: along road from Tingo Maria to Pucalpa, less than 1 km N of Sortilegio, 9°13'16"S, 75°50'15"W, 1310 m, *Croat 81744*, & Sizemore (MO not seen, UC, USM).

Selaginella fragilis A. Braun (Selaginellaceae)

PERU. Loreto: Prov. Requena: 140 m, *van der Werff 1010, et al.* (MO not seen, UC). Subsumed by Tryon and Stolze (1994:84) under *S. parkeri* (Hook. & Grev.) Spring, but this specimen, at least, seems specifically distinct, with much narrower penultimate divisions and long-flagelliform branch apices.

Selaginella leucoloma Alston ex Crabbe & Jermy (Selaginellaceae)

PERU. Puno: trail from Aricoma Pass to Santo Domingo, 5800 ft, *McCarroll 126*, pro parte (MICH). Cited by Valdespino (1995:366).

Selaginella macilenta Baker (Selaginellaceae)

PERU. Junín: Chanchamayo, 750 m, *Kunkel 347* (S). Cited by Valdespino (1995:322).

Selaginella moritziana Spring (Selaginellaceae)

PERU. Pasco: Prov. Oxapampa: San Alberto, 10°32'S, 75°21'W, 2400 m, *van der Werff 18597, et al.* (MO not seen, UC). *Selaginella pearcei* Baker, type from Peru, was subsumed under *S. novae-hollandiae* (Sw.) Spring by Tryon and Stolze (1994:77), but it is referred to *S. moritziana* var. *pearcei* (Baker) Valdespino, ined., by Valdespino (1995).

Selaginella palmiformis Alston ex Crabbe & Jermy (Selaginellaceae)

PERU. Loreto: Prov. Mariscal Ramón Castilla: ca. 3 km S of Huanta, 3°17'S, 72°51'W, 100–150 m, *Tuomisto 5231, et al.* (AAU, AMAZ, TUR, UC, USM). **Prov. Maynas:** surroundings of tourist lodge of Explorama Tours at Río Sucusari, 3°10'S, 72°52'W, 100–150 m, *Tuomisto 5818, et al.* (AAU, AMAZ, TUR, UC, USM); Maynas, trail from village of Panguana towards Río Manití, ca. 8 km from Río Amazonas, 3°53'S, 73°05'W, 100–200 m, *Tuomisto 6101, et al.* (AMAZ, TUR, UC, US); Explorama/ACEER Reserve, 1.6–3.3 km E of mouth of Quebrada Sucusari at lower Napo, 3°15'S, 72°53'W, 100–200 m, *Tuomisto 7712, et al.* (AMAZ, KSP, TUR, UC, US). **Prov. Mariscal Ramón Castilla:** 3–4 km W from village of Puerto Izango, Río Yaguasyacu, 3°18'S, 72°01'W, 100–150 m, *Tuomisto 11232, et al.* (AMAZ, TUR, UC, USM).

Selaginella tomentosa Spring (Selaginellaceae)

PERU. Amazonas: Río Cenepa, second ridge E of Huampami, 900–1000', *Berlin 633* (MO, UC). This species was synonymized under *S. geniculata* (C. Presl) Spring by Tryon and Stolze (1994), but *S. tomentosa* is easily distinguished by the decidedly short-hairy stems. It has been recognized by nearly all other pteridologists, e.g., by Alston et al. (1981:306).

Sticherus aurantiacus Østergaard & B. Øllg. (Gleicheniaceae)

PERU. San Martín: [Prov. San Martín]: Tarapoto, 750 m, *Williams 5972* (US); between Moyobamba and Huallaga, *Stübel 1103* (B).

Sticherus boliviensis (Maxon & C. V. Morton) J. Gonzales, comb. ined. (Gleicheniaceae)

PERU. Puno: Prov. Sandia: Limbani, 3200–3450 m, *Metcalf 30539* (GH, MO, US).

Sticherus decurrens (Raddi) J. Gonzales, comb. ined. (Gleicheniaceae)

PERU. Amazonas: Prov. Bagua: between Aramango and Montenegro, 275 m, *López 4163* (GH). **Cuzco:** Asunción, 1200 m, *Vargas 7908* (GH); Quispicanchis, between Inambari and Quincemil, 500–650 m, *Vargas C. 16487* (H). **Huánuco: Prov. Leoncio Prado:** Tingo Maria, 710 m, *Tryon & Tryon 5263* (GH, USM). **JUNÍN: Prov. Chanchamayo:** La Merced, *Kunkel 652* (GH). **Loreto: [Prov. Alto Amazonas]:** Pumayacu, between Balsapuerto and Moyobamba, 600–1200 m, *Krug 3242* (MO, NY). **San Martín:** road Tarapoto-Yurimaguas, Km 12–15, 2250 m, *Hickok 646* (GH). See Gonzales (2003).

Sticherus ferrugineus (Raddi) J. Gonzales, comb. ined (Gleicheniaceae)

PERU. Cuzco: Prov. Convención: Río Apurimac, above Hacienda Luisiana, *Wade 1333* (GH). **Loreto:** Río Marañón Valley, between mts. of Río Pastaya and Río Huallaga, San Lorenzo, 150 m, *Killip 29219* (NY, US). See Gonzales (2003).

Sticherus lanosus (H. Christ) J. Gonzales, comb. ined. (Gleicheniaceae)

PERU. Cuzco: 5 km N of Aguas Calientes, 2000 m, *Solomon 3172* (MO); Urubamba, Machu Pichu, 2000 m, *Saunders 1232* (GH). **Huánuco:** Cerros del Sira, 9°25'S, 74°44'W, 1560 m, *Dudley 13193* (GH). **Puno:** Carabaya, Ollachea-San Gabán road, Chacaneque, *Boeke 3139* (MO, NY); Valle de Marcapata, 2000 m, *Herrera 1592* (US). See Gonzales (2003).

Sticherus lanuginosus (Fée) Nakai (Gleicheniaceae)

Previously often called *S. penniger* (Mart.) Copel. [= *Gleichenia pennigera* (Mart.) T. Moore, in Tryon & Stolze 1989a], which is considered a synonym of *S. pruinosus* (Mart.) Ching, by Gonzales (2003).

Sticherus melanoblastus Østergaard & B. Øllg. (Gleicheniaceae)

PERU. Pasco: Prov. Oxapampa: La Suiza Nueva, 10°38'S, 75°27'W, 2240 m, *van der Werff 17622, et al.* (MO not seen, UC). Mentioned as possibly in Peru by Østergaard Anderson and Øllgaard (2001).

Sticherus velatus (Kunze) Copel. (Gleicheniaceae)

PERU. Huánuco: Pampayacu, Jul 1829, *Poeppig s.n.* (HOLOTYPE: W, the fragment of *Poeppig s.n.* at US annotated as isotype of *S. velatus* is in fact *S. lanosus*). **Cuzco:** La Convención, Valle Santa Ana, 1000–1500 m, *Herrera 2637* (US); Cuchero, *Poeppig 1117* (W). See Gonzales (2003). This species synonymized under *Gleichenia tomentosa* (Cav. ex Sw.) Spreng. by Tryon and Stolze (1989a:42).

Tectaria microsora A.R. Sm. (Dryopteridaceae)

PERU. Amazonas: Prov. Bagua: Distr. Imaza, Comunidad Aguaruna de Putuim, 4° 55'S, 78° 19'W, 680 m, *Rodríguez R. 967, et al.* (HOLOTYPE: HUT; ISOTYPES: MO not seen, UC, USM); Distr. Imaza, region del Marañón, comunidad de Yamayakat, Quebrada Kusu-Chapi, Río Marañon, 04° 55'S, 78° 19'W, 550 m, *Vásquez 19644* (MO, UC); same locality, 600 m, *Rodríguez R. 288* (MO, UC, USM); Dist. Bagua, along road from Chiriaco towards Bagua, 05° 16'57"S, 78° 23', 10"W, 800 m, *van der Werff 16260* (MO, UC). **Prov. Condorcanqui:** Distr. El Cenepa, región Nororiental del Marañón, Río Cenepa, comunidad Tutino, 04° 33'S, 78° 10'W, 350 m, *Vásquez 18404, et al.* (MO, UC); see Smith (2005b).

Tectaria pilosa (Fée) R.C. Moran (Dryopteridaceae)

PERU. Amazonas: Prov. Bagua: Dtto. Imaza, Comunidad de Yamayakat, 05°03'24"S, 78°20'17W, 450 m, *Rojas 567, et al.* (MO not seen, UC). **Prov. Condorcanqui:** Dtto. El Cenepa, Comunidad Aguaruna Pagki-Suwa, Río Cenepa, quebrada Tayo, 04°31'35"S, 78°10'34"W, 289 m, *Vásquez 22151, et al.* (MO not seen, UC, USM). **Ayacucho: Prov. La Mar:** between Santa Rosa and Hacienda Luisiana, 640 m, *Wasshausen & Encarnación 630* (US not seen, USM). **Loreto: [Prov. Alto Amazonas]:** above Pongo de

Manseriche, bank of Río Santiago, 200 m, *Mexia 6354* (UC). **Prov. Maynas:** Explor Napo Camp at Río Sucusari, 03°20'S, 72°55'W, 120 m, *van der Werff 12926, et al.* (MO not seen, UC). Treated by Tryon and Stolze (1991:25) as a variant of *T. incisa*, but we think *T. pilosa* is adequately distinct, at species rank. They also cited specimens from Depts. Cajamarca, Huánuco, Madre de Dios, and Pasco that may be this species.

Tectaria pubens R.C. Moran (Dryopteridaceae)

PERU. Loreto: Prov. Maynas: ca. 50 km downriver from Iquitos, Explorama Lodge, ca. 120 m, *Moran 3647* (HOLOTYPE: MO; ISOTYPE: UC); additional collections from the same general locality cited by Moran (1992:138).

Terpsichore chrysleri (Copel.) A.R. Sm. (Grammitidaceae)

PERU. Amazonas: [Prov. Bongara]: Laguna de Pomacochas, 2550 m, *van der Werff 15809, et al.* (MO not seen, UC). **Cajamarca: Prov. San Ignacio:** Tabaconas, El Pajonal, camino al Páramo y al Cerro Coyona, 5°17'30"S, 79°16'02"W, 2250 m, *Campos 5728, et al.* (MO not seen, UC); San José de Lourdes, 5°00'S, 78°54'W, 1800 m, *Vásquez 26157, et al.* (MO not seen, UC). Subsumed under *Grammitis asplenifolia* (L.) Proctor by Tryon and Stolze (1993:104), but easily distinguished; some (probably most) of the specimens cited by them as *G. asplenifolia* are, in fact, *Terpsichore chrysleri*, specifically *van der Werff 8608* (UC) and *Woytkowski 35485* (UC), but *Terpsichore asplenifolia* (L.) A.R. Sm. s. str. also occurs in Peru.

Terpsichore mollissima (Fée) A.R. Sm. (Grammitidaceae)

PERU. Pasco: Prov. Oxapampa: Parque Nacional Yanachaga, El Huampal, 10°11'S, 75°34'W, 1200 m, *van der Werff 17846, et al.* (MO not seen, UC). **San Martín: Prov. Rioja:** Moyobamba-Pedro Ruíz, Km 383, 5°50'S, 77°30'W, ca. 2000 m, *Lehnert 221* (UC, USM).

Terpsichore subtilis (Kunze ex Klotzsch) A.R. Sm. (Grammitidaceae)

PERU. Amazonas: near border with San Martín, 5°41'S 77°48'W, 2000 m, *van der Werff 16675, et al.* (MO).

Terpsichore youngii B. León & A.R. Sm. (Grammitidaceae)

PERU. Cuzco: near San Lorenzo, 2300–2500 m, *León & Young 4487* (HOLOTYPE: USM; ISOTYPE: UC) (León & Smith 2003:84).

Thelypteris cinerea (Sodiro) A.R. Sm. (Thelypteridaceae)

PERU. Amazonas: road Chachapoyas-Mendoza, a little past Molinopampa, 6°14'11"S, 77°35'49"W, 2400 m, *van der Werff 15095, et al.* (MO not seen, UC).

Thelypteris steyermarkii A.R. Sm. (Thelypteridaceae)

PERU. Cuzco: Prov. Paucartambo: Kosñipata Valley, Km 150, San Pedro, Río Unión and Río Kosñipata junction, 1800 m, in sandy beach-river, *Núñez 11958* (MO).

Trichomanes accedens Hook. (Hymenophyllaceae)

PERU. Amazonas: Quebrado El Almendro, 5°14'40"S, 78°21'24"W, 430 m, *van der Werff 14560, et al.* (MO not seen, UC). **Loreto: Prov. Requena:** 140 m, *van der Werff 10112, et al.* (MO not seen, UC). **Prov. Maynas:** Mishana, along Río Nanay, 140 m, *van der Werff 10193* (MO not seen, UC); Experimental station of UNAP at Puerto Almendras along Río Nanay, 20 km air distance from Iquitos, 3°51'S, 73°22'W, 100–200 m, *Tuomisto 6429*, with Ruokolainen (TUR, US, USM). Discussed and considered probably synonymous with *T. cristatum* Kaulf. by Tryon and Stolze (1989a:98).

Trichomanes dactylites Sodiro (Hymenophyllaceae)

PERU. Cajamarca: Prov. San Ignacio: San José de Lourdes, laderas del Cerro Picorana, 4°58'00"S, 78°53'01"W, 2500–2540 m, *Campos 5933, et al.* (MO not seen, UC).

Trichomanes pilosum Raddi (Hymenophyllaceae)
PERU. Amazonas: Prov. Bagua: Dist. Imaza, Quebrada Almendra, 5°14'40"S, 78°21'34"W, 400 m, *van der Werff 16124, et al.* (MO not seen, UC).

Trichomanes spruceanum Hook. (Hymenophyllaceae)
PERU. Loreto: Prov. Maynas: Dist. Iquitos, Puerto Almendras, 130 m, on white sand, *van der Werff 9845, et al.* (MO not seen, UC).

DELETIONS FROM THE FLORA

Elaphoglossum peruvianum (L. D. Gómez) Mickel (Dryopteridaceae)
Treated by Mickel (in Tryon & Stolze 1991:170, under *Peltapteris*), but now regarded as a heterotypic synonym of *Elaphoglossum moorei* (E. Britton) H. Christ, according to Moran and Mickel (unpublished ms.); we also subsume *Peltapteris* in *Elaphoglossum*.

Megalastrum yungense (H. Christ & Rosenst.) A.R. Sm. & R.C. Moran (Dryopteridaceae)
The specimen of *M. yungense* cited in Fl. Peru (Tryon & Stolze 1991:14), *D. Smith 4424* (MO not seen, NY, UC), is actually *M. biseriale* (Baker) A.R. Sm. & R.C. Moran, so *M. yungense* is not yet known from Peru.

ACKNOWLEDGMENTS

We thank Jasivia Gonzales for information regarding species of *Sticherus* in Peru, an unpublished part of her dissertation. We also thank curators of herbaria at HUT and MO for loan of specimens and for sending digital images, and two reviewers for helpful comments and suggestions on this manuscript.

REFERENCES

Arbeláez, A.L. 1995. Two new species and new records for *Pteris* (Pteridaceae) from Colombia. Brittonia 47:175–181.

Davidse, G., M. Sousa S., and S. Knapp (gen. eds.). 1995. Flora Mesoamericana, Vol. 1. Psilotaceae a Salviniaceae. R.C. Moran and R. Riba (pteridophyte eds.). Universidad Nacional Autónoma de México, Ciudad Universitaria, México, D.F.

Gonzales, J. 2003. A taxonomic revision of the genus *Sticherus* (Gleicheniaceae–Pteridophyta) in the Neotropics. Ph.D. Dissertation, Univ. Göttingen, Germany, 172 pp.

Hauke, R.L. 1963. A taxonomic monograph of the genus *Equisetum* subgenus *Hippochaete*. Beih. Nova Hedwigia 8:1–123, tables 1–9, graphs 1–3, plates 1–22.

Jørgensen, P.M. and S. León-Yánez (eds.). 1999. Catalogue of the vascular plants of Ecuador = Catalogo de las plantas vasculares del Ecuador. Monogr. Syst. Bot. Missouri Bot. Gard. 75:1–1181 + vii.

Kessler, M. and A.R. Smith. 2005. Seven new species, 13 new combinations, and one new name of Polypodiaceae from Bolivia. Candollea 60:271–288.

Lehnert, M. 2003. Six new species of tree ferns from the Andes. Amer. Fern J. 93:169–183.

León, B. 2004 [2005]. A new species of *Campyloneurum* (Polypodiaceae) from northern Peru. Revista Peruana de Biología 11:135–137.

León, B. and H. Beltrán. 2002. A new *Microgramma* subgenus *Solanopteris* (Polypodiaceae) from Peru and a new combination in the subgenus. Novon 12:481–485.

León, B., H. Beltrán, and P. Fine. 2005. Sobre el género *Schizaea* (Schizaeceae) en el Peru. Revista Peruana de Biologia (ms submitted).

León, B. and R.C. Moran. 1996 [1997]. *Cyathea concordia* (Cyatheaceae), a new pinnate-pinnatifid tree fern from the Peruvian/Ecuadorian border. Brittonia 48:511–513.

León, B. and A.R. Smith. 2003. New species and new combinations of Grammitidaceae from Peru. Amer. Fern J. 93:81–89.

León, B. and K.R. Young. 1996. Distribution of pteridophyte diversity and endemism in Peru. In: J.M. Camus et al., eds. Pteridology in perspective, pp. 77–91. Royal Botanic Gardens, Kew.

Marcano, V. 1989. Novedades pteridofitica neotropicales: 2. Lindsaeaceae de Venezuela. Bol. Soc. Venez. Ci. Nat. 43(146):241–270.

Mickel, J.T. and A.R. Smith. 2004. The pteridophytes of Mexico. Mem. New York Bot. Gard. 88:1–1055 + xxiv.

Moran, R.C. 1991. Eight new species of tree ferns (*Cyathea*, Cyatheaceae) from the American tropics and three new combinations. Novon 1:88–104.

Moran, R.C. 1992. Five new species of ferns from the American tropics. Novon 2:132–138.

Moran, R.C. 1995. Five new species and two new combinations of ferns (Polypodiopsida) from Ecuador. Nordic J. Bot. 15:49–58.

Moran, R.C. 2000. Monograph of the neotropical species of *Lomariopsis* (Lomariopsidaceae). Brittonia 52:55–111.

Moran, R.C. and B. Øllgaard. 1998. New species of ferns (Polypodiopsida) from Ecuador. Nordic J. Bot. 18:431–439.

Morton, C.V. 1947. The American species of *Hymenophyllum* section *Sphaerocionium*. Contr. U.S. Natl. Herb. 29:139–201.

Navarrete, H. and B. Øllgaard. 2000. The fern genus *Dennstaedtia* (Dennstaedtiaceae) in Ecuador – new characters, new species and a new combination. Nordic J. Bot. 20: 319–346.

Østergaard Anderson, E. and B. Øllgaard. 2001. 10. Gleicheniaceae. In: G. Harling and L. Andersson, eds. Flora of Ecuador 66:105–173.

Pacheco, L. and R.C. Moran. 1999. Monograph of the neotropical species of *Callipteris* with anastomosing veins (Woodsiaceae). Brittonia 51:343–388.

Prado, J. and P.G. Windisch. 2000. The genus *Pteris* L. (Pteridaceae) in Brazil. Bol. Inst. Bot. (São Paulo) 13:103–199.

Smith, A.R. 2005a. Floristics in the 21st century: balancing user-needs and phylogenetic information. Brit. Fern Gaz. 17:105–137.

Smith, A.R. 2005b. New species of ferns from the area of Cenepa, Peru. Novon (ms.).

Smith, A.R., H. Tuomisto, K. Pryer, J. Hunt, and P.G. Wolf. 2001. *Metaxya lanosa*, a second species in the genus and fern family Metaxyaceae. Syst. Bot. 26:480–486.

Steyermark, J.A., P.E. Berry, and B.K. Holst (eds.). 1995. Flora of the Venezuelan Guayana. Vol. 2. Pteridophytes, Spermatophytes: Acanthaceae–Araceae. Timber Press, Portland.

Stolze, R.G., L. Pacheco, and B. Øllgaard. 1994. 14(5B). Polypodiaceae-Dryopteridoideae-Physematieae. In G. Harling and L. Andersson (eds.), Flora of Ecuador 49:1–108.

Tryon, R.M. 1976. A revision of the genus *Cyathea*. Contr. Gray Herb. 206:19–98.

Tryon, R.M. and R.G. Stolze. 1989a. Pteridophyta of Peru. Part. I. 1. Ophioglossaceae - 12. Cyatheaceae. Fieldiana, Bot., n.s., 20:1–145.

Tryon, R.M. and R.G. Stolze. 1989b. Pteridophyta of Peru. Part. II. 13. Pteridaceae - 15. Dennstaedtiaceae. Fieldiana, Bot., n.s., 22:1–128.

Tryon, R.M. and R.G. Stolze. 1991. Pteridophyta of Peru. Part. IV. 17. Dryopteridaceae. Fieldiana, Bot., n.s., 27:1–176.

Tryon, R.M. and R.G. Stolze. 1992. Pteridophyta of Peru. Part. III. 16. Thelypteridaceae. Fieldiana, Bot., n.s., 29:1–80.

Tryon, R.M. and R.G. Stolze. 1993. Pteridophyta of Peru. Part. V. 18. Aspleniaceae - 21. Polypodiaceae. Fieldiana, Bot., n.s., 32:1–190.

Tryon, R.M. and R.G. Stolze. 1994. Pteridophyta of Peru. Part. VI. 22. Marsileaceae - 28. Isoëtaceae. Fieldiana, Bot., n.s., 34:1–123.

Tuomisto, H., and R.C. Moran. 2001. Marattiaceae. In: G. Harling and L. Andersson, eds. Flora of Ecuador 66:21–68.

Ulloa Ulloa, C., J. Zarucchi, and B. León. 2004. Diez años de adiciones a la flora del Perú: 1993–2003. Arnaldoa (Número especial Noviembre 2004):1–242.

Valdespino, I. 1995. A monographic revision of *Selaginella* P. Beauv. subgenus *Heterostachys* Baker in Central and South America. Ph.D. thesis, City University of New York.

Vásquez M., R. 1997. Flórula de las Reservas Biológicas de Iquitos, Perú. Allpahuayo-Mishana, Explornapo Camp, Explorama Lodge. Monogr. Missouri Bot. Gard. 63:54–55.

Windham, M.D. 1987. *Argyrochosma*, a new genus of cheilanthoid ferns. Amer. Fern J. 77: 37–41.

Young, K.R. 1992. Biogeography of the montane forest zone of the eastern slopes of Peru. In: K.R. Young and N. Valencia, eds. Biogeografía, ecología y conservación del bosque montano en el Perú. Mem. Mus. Hist. Nat. "Javier Prado" 21:119–140.

Young, K.R. and B. León. 1999. Peru's humid eastern montane forests: An overview of their physical settings, biological diversity, human use and settlement, and conservation needs. DIVA, Technical Report no. 5:1–97. http://diva.dmu.dk/1_viden/2_miljoe-tilstand/3_natur/diva/diva_rep.htm

THE VASCULAR FLORA OF GILES COUNTY, TENNESSEE

Dwayne Estes

University of Tennessee Herbarium (TENN)
Department of Ecology & Evolutionary Biology
University of Tennessee
Knoxville, Tennessee 37996-1100, U.S.A.
tnplants@yahoo.com

ABSTRACT

A survey of the vascular flora of Giles County, Tennessee was conducted between July 1998 and September 2004. A total of 1208 species and infraspecific taxa, representing 138 families and 553 genera, were documented from 30 qualitatively defined habitats, resulting in 912 county records. Several rare taxa were discovered, including two federally threatened species: *Apios priceana* and *Helianthus eggertii*. Other noteworthy rare species found were *Cimicifuga rubifolia, Perideridia americana, Stellaria fontinalis*, and *Xyris laxifolia* var. *iridifolia*. *Arenaria lanuginosa*, a Tennessee endangered species thought extirpated from the state, was rediscovered after not having been collected since 1948. In addition, three state records, *Achyranthes japonica, Euonymus kiautschovicus*, and *Eupatorium × pinnatifidum*, were found. Other noteworthy collections include *Baccharis halimifolia* and *Amaranthus powellii*, each representing second reports from Tennessee.

RESUMEN

Se realizó un estudio de la flora vascular de Giles County, Tennessee entre Julio de 1998 y Septiembre de 2004. Se documentaron un total de 1208 especies y taxa infraspecíficos, que representan 138 familias y 553 géneros, procedentes de 30 hábitats definidos cualitativamente, que aportaron 912 citas para el condado. Se descubrieron varios taxa raros, incluyendo dos especies amenazadas federalmente: *Apios priceana* y *Helianthus eggertii*. Otras especies notables raras encontradas fueron *Cimicifuga rubifolia, Perideridia americana, Stellaria fontinalis*, y *Xyris laxifolia* var. *iridifolia*. *Arenaria lanuginosa*, una especie amenazada de Tennessee que se creía eliminada del estado, se redescubrió después de no haber sido colectada desde 1948. Además, se encontraron tres citas para el estado *Achyranthes japonica, Euonymus kiautschovicus*, y *Eupatorium _ pinnatifidum*. Otras colecciones notables incluyen *Baccharis halimifolia* y *Amaranthus powellii*, ambas representan segundas citas para Tennessee.

INTRODUCTION

Giles County is in a portion of Tennessee that has received very little botanical attention. In 1998, the county's known flora consisted of 263 species and infraspecific taxa (Chester et al. 1993, 1997). In order to increase the knowledge of the flora of Giles County and of southern Middle Tennessee, a study of the county's flora was completed. The objectives of this study were to (1) compile an annotated list of the vascular flora of the county; (2) locate and document state and federally listed plants of conservation concern; and (3) qualitatively describe the county's plant communities.

SIDA 21(4): 2343 – 2388. 2005

Study Area

Giles County is in southern Middle Tennessee (35°23'N, 87°03'W) near the center of the southern border of the state (Fig. 1). The county is ca. 50 km long (north to south) and 36 km wide (east to west) with a total area of 158,248 ha. It is entirely within the Interior Low Plateau Physiographic Province delimited by Fenneman (1938), and lies within two physiographic sections: the Highland Rim and the Central (Nashville) Basin (Quarterman & Powell 1978). The Highland Rim (HR) of Giles County is comprised of two subsections: the Eastern Highland Rim (EHR) and the Western Highland Rim (WHR). The portion of the Rim that occupies the extreme southeastern corner of the county is part of the EHR. The WHR is mostly confined to the western half of the county although portions extend to northeastern and east-central sections in the form of outlying knobs and ridges. Generally, elevations of the HR range from ca. 335 m in the northern portion of the county to 259 m in southern sections. Much of the Rim is rugged and dissected by numerous stream valleys, but in a few areas broad flat uplands occur. Strata of the Mississippian-aged Fort Payne Formation underlie most of the HR. Cherty limestone and chert are the main surface rocks and Chattanooga black shale is exposed on some slopes while on broader ridgetops a thin layer of loess is present (True et al. 1968).

Central and southeastern portions of Giles County lying along the valleys of the Elk River and Richland Creek are part of the Outer Central Basin (OCB) Subsection of the Central Basin Section. The Outer Basin of Giles County is separated from the main Central Basin region to the NNE by the Elk Ridge, a line of west-east trending, shale-capped hills that are technically part of the HR (DeSelm 1959). The OCB is below the level of the surrounding HR, beginning generally on the middle and lower slopes of the hills and extending downward into the valleys of the numerous streams that dissect the county (True et al. 1968). The elevation of the OCB ranges from 183 m to ca. 290 m. The topography varies from level to rolling in larger stream valleys to hilly near the HR. Strata of Ordovician-aged non-cherty phosphatic limestone underlie the OCB (True et al. 1968). Along the Elk River and in the lower section of the Richland Creek Valley, Quaternary-aged alluvial deposits exist. These deposits occur as nearly level to gently sloping terraces and bottomlands that are underlain by nonphosphatic limestone (True et al. 1968).

Five soil associations occur in the study area (True et al. 1968). The Mountview-Fullerton-Pickwick (MFP) association consists of acidic brown silty soils and reddish cherty clay soils that occur on the highest elevated areas of the HR. The topography varies from level to gently rolling. This association makes up about 8% of the county's soils. The Bodine-Mountview-Fullerton (BMF) association is acidic and is comprised of cherty soils, silty soils, and cherty clay soils on broken hills and in deep narrow hollows of the WHR. Although this association is restricted to the western half of the county it makes up 23%

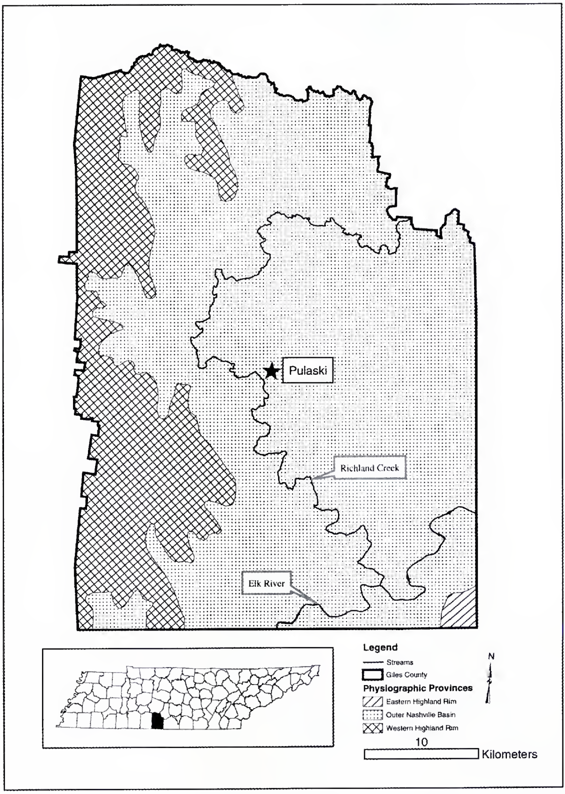


FIG. 1. Map of Giles County, Tennessee showing location of the Western Highland Rim, Eastern Highland Rim, Outer Central (Nashville) Basin, major streams, and the county seat (adapted from Griffith et al. 1998).

of the county's soils. On high winding ridges in east-central and northeastern Giles County, on outliers of the WHR, cherty acidic soils of the Bodine-Fullerton-Dellrose (BFD) association occur, occupying 10% of the county. The Dellrose-Bodine-Mimosa association (DBM) is a cherty and rocky soil found on steep slopes, ridgetops, low-lying knobs, and deep hollows. These soils vary from slightly to strongly acid and make up 27% of the county's soils. In the OCB in valleys of the Elk River, Richland Creek, and their larger tributaries, in bottomlands, on terraces, and on adjacent uplands, soils of the Staser-Armour-Maury (SAM) association occur. These soils are often phosphatic and are neutral to acidic; 32% of the county's soils are of this association (True et al. 1968).

Giles County lies within the Tennessee River drainage system. One of the Tennessee River's major tributaries, the Elk River, crosses the southeastern quarter of the county. The main tributary of the Elk River is Richland Creek. This large creek enters Giles County from the northeast, flows south through the central portion of the county, and empties into the Elk River in the south-central section. Both the Elk River and Richland Creek are medium-sized streams lined mostly by agricultural fields and wooded slopes. Limestone bluffs are frequent along the Elk River and the lower section of Richland Creek. Both streams are characterized by having a shallow channel, a slow to moderate flow, a rocky or gravelly substrate, and numerous gravel bars and shoals. Other important streams in the county include Big, Bradshaw, Buchanan, Indian, Shoal, Sugar, and Weakley creeks. These streams occur in the smaller valleys and are lined mostly by small fields and wooded slopes. They, like the Elk River and Richland Creek, have a rocky or gravelly substrate and frequent gravel bars, shoals, and riffles. While most of the streams in the county are like those described above, Piney Creek on the EHR of extreme southeastern Giles County is a slow-flowing stream that resembles streams of the southeastern Coastal Plain. It has a muddy substrate and is bordered mostly by wet flatwoods.

The study area is located in Köppen's Cfa climatic type and is characterized by a mild rainy climate with hot summers and lacks a distinct dry season (Ackermann 1941). The average growing season is 190 days and extends from April 13 to October 20. The mean annual temperature is 15°C. July is typically the hottest month with an average temperature of 32°C, while January is the coldest with an average temperature of −0.4°C. Annual precipitation totals 139.04 cm with snow accounting for about 12.19 cm. February and March are the wettest months and September and October the driest (True et al. 1968).

Giles County is within the eastern portion of Braun's (1950) Western Mesophytic Forest Region approximately 80-90 km west of the Mixed Mesophytic Forest Region. The Western Mesophytic Forest is transitional to surrounding forest regions and lacks a combination of characterizing dominants. Local climate, topography, and soil conditions influence vegetational characteristics of a particular area (Braun 1950, Chester 1995). Most of the county's forests clearly fit into Braun's Western Mesophytic Forest Region but in the eastern portion of the county, on sheltered north slopes and in ravines, forests with qualities of Braun's (1950) Mixed Mesophytic Forest Region occur.

METHODS

Specimens were collected between July 1998 and September 2004. Thirty plant communities, including all types known to occur within the county, were sampled during the study. Collecting sites were located by driving throughout the county, and by consulting county road, topographic, and county soil survey maps. Specimens were identified using standard field manuals: Small (1933), Fernald (1950), Radford et al. (1968), Cronquist (1980), Isely (1990), Gleason and Cronquist (1991), and Yatskievych (1999). In addition to native taxa, many non-native species were collected or observed during the survey. Non-native taxa listed in the annotated checklist include only those taxa that appeared to be naturalized or persistent. Most voucher specimens have been deposited in the herbarium at the University of Tennessee (TENN). Some specimens have been deposited in the herbaria of Austin Peay State University (APSC), Middle Tennessee State University (MTSU), or the Vanderbilt (VDB) collection at the Botanical Research Institute of Texas. Furthermore, the herbaria at MTSU, TENN, and VDB were consulted for species not collected during this study. All such specimens encountered were checked for accuracy and each was annotated. The status of federal and state listed rare species was taken from the Tennessee Natural Heritage Program (2003). All information concerning the location, habitat, and population status of rare species discovered during the inventory was provided to the Tennessee Natural Heritage Program to aid in their protection. Lastly, the plant communities of the county were qualitatively described according to their physiographic location, soil association, topographic position, and species composition.

RESULTS AND DISCUSSION

Floristic Summary

Of ca. 2000 voucher specimens, 1186 species and infraspecific taxa were collected, resulting in 912 county records. An additional 22 taxa were observed during the study for which vouchers were not collected. Therefore, the total flora of Giles County included 1208 species and infraspecific taxa representing 138 families and 553 genera distributed among 36 pteridophytes, 5 gymnosperms, 28 monocots, and 883 dicots. Asteraceae was the largest family with 151 taxa, followed by Poaceae (109), Cyperaceae (75), Fabaceae (63), Rosaceae (53), Lamiaceae (34), Liliaceae (33), Brassicaceae (31), Ranunculaceae (30), and Scrophulariaceae (30). The woody flora of the county was quite large with 254 taxa. The largest woody genera were *Quercus* (18 taxa, including one hybrid), *Prunus* (10), *Rubus* (9), *Carya* (8), *Crataegus* (7), *Acer* (6), and *Salix* (6). *Cornus*, *Euonymus*, *Hypericum*, *Ulmus*, and *Vaccinium* each had five taxa. *Aesculus* (including one hybrid), *Ilex*, *Lonicera*, *Pinus*, *Rhus*, *Smilax*, and *Vitis* each had four taxa. Woody genera represented by three taxa included *Celtis*, *Clematis*, *Fraxinus*, *Hydrangea*, *Magnolia*, *Rhododendron*, *Rosa*, and *Viburnum*. The largest herbaceous genera were *Carex* (47), *Juncus* (14), *Solidago* (14), *Polygonum* (13), *Eupatorium* (12), *Symphyotrichum* (12), *Viola* (12), *Desmodium* (11), *Dichanthelium* (11), *Asclepias* (10), *Cyperus* (10), *Helianthus* (10), and *Ranunculus* (10). Seventy-nine percent of the flora (955 taxa) consisted of native species while introduced taxa accounted for 237 taxa (20%) (Wofford and Kral 1993). An additional eight species (<1%) were native to portions of Tennessee but did not appear to be native to Giles County. A complete summary of the flora of Giles County is provided in Table 1.

Rare/Protected Plants

In Giles County, 17 taxa are considered rare and are tracked by the Tennessee Division of Natural Heritage (Table 2). Of these, two are federally threatened (LT), two are state endangered (E), five species are listed as state threatened (T), one is listed as special concern-proposed threatened (S-PT), three species are listed as special concern (S), and the remaining four taxa are threatened or of special concern due to commercial exploitation (T-CE, S-CE) (Tennessee Natural Heritage Program 2003).

Prior to this survey, seven rare species had been reported from the county. However, one previously reported rare taxon, *Galium asprellum* Michx. (*R. Kral 64888*, VDB), was based on a misidentified specimen of *Galium mollugo*, a non-native species. Another, *Allium tricoccum*, was reported from the county based on a Kral collection (*R. Kral 54907*, VDB). Upon closer inspection, it was determined that the specimen best corresponds with *A. tricoccum* var. *burdickii* instead of the more eastern *A. tricoccum* var. *tricoccum*. Two additional taxa, *Leavenworthia exigua* var. *exigua* and *Schoenolirion croceum*, were reported from the county based on collections made in the 1950s; unfortunately the populations were not relocated during the study and these taxa are presumed extirpated from the county. A fifth species, *Arenaria lanuginosa*, was collected for the first time in Tennessee from Giles County in 1948 along bluffs of the Elk River (*A.J. Sharp, S. Fairchild, & E. Clebsch 9840*, TENN). As of 1999, the species was listed as endangered and possibly extirpated from the state (Tennessee Natural Heritage Program 1999). In the summer of 2000, *A. lanuginosa* was rediscovered along two bluffs of the Elk River after not having been observed for over 50 years (Estes & Chester 2001). A third Giles County population was found in 2001 (Estes 2004).

As a result of this study, 11 rare taxa were discovered that represent new county records. The most significant were *Apios priceana* and *Helianthus eggertii* (United States Fish and Wildlife Service 1993, 1999), both listed as federally

TABLE 1. Summary of the vascular flora known from Giles County, Tennessee.

Group	Families	Genera	Species and Infraspecific Taxa Native	Non-native	Total
Pteridophytes	14	25	36	0	36
Gymnosperms	2	2	2	3	5
Angiosperms					
Monocots	19	101	231	53	284
Dicots	103	425	686	197	883
Total	**138**	**553**	**955**	**253**	**1208**

TABLE 2. The rare vascular plant species known from Giles County, Tennessee.

Scientific Name	Federal Status	State Status
Apios priceana	LT[1]	E[2]
Helianthus eggertii	LT	T[3]
**Arenaria lanuginosa*		E
Perideridia americana		E
Cimicifuga rubifolia		T
Juglans cinerea		T
**Lesquerella densipila*		T
**Schoenolirion croceum*		T
Stellaria fontinalis		T
Xyris laxifolia var. *iridifolia*		S-PT[4]
Castanea dentata		S[5]
**Leavenworthia exigua* var. *exigua*		S
**Phemeranthus calcaricus*		S
**Allium tricoccum* var. *burdickii*		T-CE[6]
Lilium michiganense		T-CE
Hydrastis canadensis		S-CE[7]
Panax quinquefolius		S-CE

* Rare taxon known from Giles County prior to this study

[1] Taxon listed as threatened in the United States

[2] Taxon listed as endangered in Tennessee

[3] Taxon listed as threatened in Tennessee

[4] Taxon currently listed as special concerned-proposed threatened in Tennessee

[5] Taxon listed as special concern in Tennessee

[6] Taxon listed as threatened in Tennessee due to commercial exploitation

[7] Taxon listed as special concern in Tennessee due to commercial exploitation

threatened by the United States Fish and Wildlife Service. Estes (2004) provided a more detailed discussion of the significance of these and other notable rare or uncommon plants of Giles County.

Additional Noteworthy Collections

A large established population of the Asiatic species *Achyranthes japonica* var. *hachijoensis* was discovered in extreme southern Giles County on a wooded floodplain of the Elk River at the base of a limestone bluff ca. 3 river miles upstream from Limestone County, Alabama. Medley et al. (1985) first reported this species as new to North America based on material collected from northeastern Kentucky and adjacent West Virginia. This species also has been reported from Ohio (Flora of North America Editorial Committee 2003). The discovery of *A. japonica* var. *hachijoensis* in Giles County represents a state record, a range extension of ca. 500–600 km to the southwest, and the first report of the species from the Tennessee River watershed.

Euonymus kiautschovicus, an introduced shrub native to China, was collected from two localities in Giles County, one along a roadside embankment at the edge of disturbed woods and the other from a weedy bank between a stream and roadside. This species has not previously been reported from Tennessee. At both sites, only one or two plants were found and did not seem to exhibit strong invasive potential.

Eupatorium × *pinnatifidum*, a hybrid species originating from a cross between *E. capillifolium* and *E. perfoliatum*, was collected for the first time in Tennessee from flat uplands on the EHR at the edge of a clearing adjacent to wet flatwoods dominated by *Acer rubrum*, *Pinus taeda*, *Quercus nigra*, and *Q. phellos*. Both *E. capillifolium* and *E. perfoliatum* were growing within 10 m of the *E.* × *pinnatifidum* plants.

At the site where *E.* × *pinnatifidum* occurred, several individuals of *Baccharis halimifolia*, a species formerly restricted to the southeastern Coastal Plain were observed. The shrubs were approximately 1-2 m tall. One month prior to the discovery of *B. halimifolia* in Giles County, one individual was discovered ca. 87 km to the NNE in Rutherford County, Tennessee (Estes 2004). This is the second report for *B. halimifolia* from the state. *Baccharis halimifolia* should be considered an exotic species in Tennessee and is to be expected in disturbed areas across the southern half of the state.

A third species found in Giles County that deserves special mention is *Amaranthus powellii*. This species was discovered in August 2003 on a roadside next to a cornfield in association with *Amaranthus palmeri*, *A. spinosus*, *Eragrostis pectinacea*, and *Senna obtusifolia*. At that time, it had not been previously documented from the state; but shortly thereafter, during the preparation of this manuscript, the Flora of North America Editorial Committee (2003) reported *A. powellii* from Tennessee. This is apparently the second report for the species from the state.

Plant Communities

Thirty qualitatively defined plant communities were sampled in the county.

These were divided into four sections, those that occurred on the HR, those of the OCB, aquatic or riverine communities, and anthropogenically altered or maintained habitats. The 20 communities included for the HR and OCB and the three habitats listed for the Streams and Riverine Communities section were generally natural communities, although most have sustained some type of human-related disturbance. The seven types of Disturbed Sites sampled included areas that generally lacked natural qualities, appeared recently affected by anthropogenic disturbances, or were maintained as unnatural communities by human activities.

Highland Rim

1. Oak-Hickory Forests (OH).—The oak-hickory community was the dominant upland forest type on dry to submesic sites on the HR, occupying broad upland flats, ridge-tops, and upper slopes of south and west-facing hillsides. This community was mostly associated with the Mountview, Bodine, and Dickson series of the MFP, BMF, and BFD soil associations. The canopy contained several species of oak including *Quercus alba*, *Q. coccinea*, *Q. montana*, *Q. stellata*, and *Q. velutina* as well as a few hickory species, including *Carya alba*, *C. glabra*, and *C. ovata* var. *ovata*. Less dominant but common species were *Acer rubrum*, *Nyssa sylvatica*, *Oxydendrum arboreum*, and *Sassafras albidum*. In the subcanopy and understory *Amelanchier arborea*, *Cornus florida*, *Kalmia latifolia*, *Rhododendron canescens*, *Styrax grandifolia*, *Vaccinium arboreum*, and *V. stamineum* were occasional to common constituents. Woody vines common to this community included *Smilax glauca*, *S. rotundifolia*, *Toxicodendron radicans*, *Vitis aestivalis* var. *aestivalis*, and *V. rotundifolia*. Subshrubs and low shrubs were *Chimaphila maculata*, *Hypericum hypericoides* subsp. *multicaule*, and *Vaccinium pallidum*. The herbaceous layer was sparsely vegetated when compared to more mesic forests, but included *Carex picta*, *Coreopsis major*, *Cunila origanoides*, *Danthonia spicata*, *Desmodium rotundifolium*, *Dichanthelium dichotomum* var. *dichotomum*, *Eurybia hemispherica*, *Solidago erecta*, *S. hispida*, *S. ulmifolia*, and *Viola hirsutula*.

2. Rich Forests (RF).—Rich mesophytic forests were primarily found on lower to middle north and east facing slopes, in ravines, and in narrow stream valleys. Such sites were associated mostly with soils of the Bodine and Dellrose series of the BMF soil association. The canopy often contained *Acer nigrum*, *A. saccharum*, *Aesculus flava* (mostly EHR), *Carya cordiformis*, *Fagus grandifolia*, *Fraxinus americana*, *Quercus alba*, *Q. rubra*, *Tilia americana*, *T. heterophylla*, and *Ulmus rubra*. Woody vines of this community included *Menispermum canadense*, *Parthenocissus quinquefolia*, and *Smilax tamnoides*. Common understory shrubs or small trees were *Asimina triloba*, *Carpinus caroliniana*, *Dirca palustris*, *Hydrangea cinerea*, *Lindera benzoin*, and *Staphylea trifolia*. In the herbaceous layer *Actaea pachypoda*, *Adiantum pedatum*, *Anemone acutiloba*, *Botrychium virginianum, Cardamine concatenata, Carex cumberlandensis, C. albursina, C. kraliana, Diplazium pycnocarpon, Erythronium americanum* subsp. *harperi, Hydrophyllum appendiculatum, Jeffersonia diphylla, Oxalis illinoensis, Pachysandra procumbens, Phacelia bipinnatifida, Phlox divaricata, Polemonium reptans, Trillium cuneatum, T. flexipes, T. stamineum, Valeriana pauciflora*, and *Viola pubescens* var. *scabriuscula* were present, in addition to many others.

3. Flatwoods (FW).—This community occurred only in extreme southeastern Giles County on the EHR along Piney Creek in association with soils of the Guthrie and Taft series of the MFP soil association. The site was level and the soil saturated, often for much of the year. *Acer rubrum, Nyssa biflora, N. sylvatica, Quercus nigra*, and *Q. phellos* dominated the canopy while *Q. lyrata* and *Pinus taeda* were occasional associates. Common small trees and shrubs were *Arundinaria gigantea, Cornus foemina, Crataegus marshallii, Hypericum crux-andreae, H. hypericoides* subsp. *hypericoides, Ilex verticillata, Photinia pyrifolia, Rhododendron canescens, Styrax americana, Vaccinium fuscatum, Viburnum dentatum* var. *lucidum*, and *V. nudum* var. *nudum*. Noteworthy herbaceous species of this community included *Arisaema triphyllum* subsp. *pusillum, Carex flaccosperma, C. gigantea, C. intumescens, C. joorii, Chasmanthium laxum, Galium obtusum, Gratiola neglecta, G. virginiana, Isotria verticillata, Osmunda cinnamomea, O. regalis, Platanthera flava* var. *flava*, and *Triadenum virginicum*. Clearings and wet meadows within the flatwoods community supported a number of herbaceous species that were not found elsewhere in the county. Some of these species are more common on the southeastern Coastal Plain. Examples include *Agalinis purpurea, Eryngium prostratum, Gratiola pilosa, Ludwigia linearis, Mikania scandens, Mitreola petiolata, Rhexia mariana* var. *interior, R. mariana* var. *mariana, R. virginica*, and *Spiranthes vernalis*.

4. Bluffs and Rock Outcrops (RO).—Outcroppings of limestone and less frequently shale generally were located on the slopes of hills or often in narrow ravines or along watercourses, mostly in the strongly dissected portion of the HR. Such outcrops were mostly associated with Rockland of the BMF soil association. The rock outcrops were almost exclusively located in or closely surrounded by forested areas. In some places, sizeable bluffs also occurred. Two types of bluff or rock outcrop communities of the HR were identified: those that were relatively moist and those that were dry to xeric. The more mesic bluffs and rock outcrops were located mostly on north or east facing exposures while the drier ones were typically associated with south or west facing aspects. Shrubs or woody vines associated with moist sites included *Decumaria barbara, Hydrangea cinerea*, and *Philadelphus hirsutus*. Herbaceous species common to moist bluffs were *Aquilegia canadensis, Arabis laevigata, Asplenium rhizophyllum, Cystopteris bulbifera, C. tennesseensis, Galium triflorum, Heuchera villosa, Parietaria pensylvanica, Saxifraga virginiensis, Sedum ternatum, Solidago caesia*, and *Thalictrum dioicum*. On drier sites, some of the above species also were present but notable additions included *Andropogon gerardii*, *Asclepias verticillata*, *Cheilanthes lanosa*, *Oxalis violacea*, *Packera obovata*, *Pellaea atropurpurea*, *Pleopeltis polypodioides* subsp. *michauxiana*, *Polymnia canadensis*, *Sedum pulchellum*, *Solidago sphacelata*, and *Woodsia obtusa*.

5. Barrens (RB).—Portions of western Giles County lie within the Barrens of the southwestern Highland Rim described by Shanks (1958). Barrens were mostly encountered on soils of the Mountview and Dickson series of the MFP and BMF soil associations. The county's highest quality barrens were found on the undissected portion of the HR in the southwestern quarter of the county but other good examples occurred on thin ridges and even in some valleys throughout the western edge of the county. They occurred mostly at the margins of oak-hickory forest, often along roadsides, and were apparently principally maintained as open areas by periodic mowing. Without periodic disturbance the barrens likely would be succeeded by oak-hickory forest. Although the barrens themselves lacked trees for the most part, species that occasionally intruded from surrounding oak-hickory forest included *Oxydendrum arboreum*, *Pinus taeda*, *Quercus coccinea*, *Q. marilandica*, *Q. stellata*, and *Sassafras albidum*. Small trees and shrubs of the barrens were *Ceanothus americanus*, *Malus angustifolia*, *Rhus copallinum*, *Rubus flagellaris*, *Salix humilis* var. *humilis*, *Vaccinium arboreum*, and *V. stamineum*. Perennial grasses and members of the Asteraceae and Fabaceae dominated the barrens. The most important grasses were *Andropogon gerardii*, *A. gyrans*, *A. virginicus*, *Dichanthelium* spp., *Panicum anceps*, *Saccharum alopecuroidum*, *Schizachyrium scoparium* var. *divergens*, *S. scoparium* var. *scoparium*, and *Tridens flavus* var. *flavus*. Other herbaceous species were *Ambrosia bidentata*, *Angelica venenosa*, *Asclepias amplexicaulis*, *Aureolaria pectinata*, *Chamaecrista fasciculata*, *C. nictitans*, *Conyza canadensis* var. *pusilla*, *Coreopsis tripteris*, *Desmodium* spp., *Eupatorium* spp., *Euphorbia corollata*, *Eurybia hemispherica*, *Galium pilosum*, *Helianthus* spp. (including *H. eggertii*), *Hypericum drummondii*, *H. gentianoides*, *Lespedeza* spp., *Liatris spicata*, *L. squarrulosa*, *Parthenium integrifolium*, *Pteridium aquilinum* var. *latiusculum*, *Silphium mohrii*, *Solidago* spp., *Spiranthes lacera* var. *gracilis*, *Symphyotrichum* spp., *Veronicastrum virginicum*, and *Viola sagittata*.

6. Marshes (RM).—Marshes were more or less open wetland areas with standing water and were dominated by herbaceous vegetation and shrubs. Those surveyed occurred at the headwaters of small streams and in natural upland depressions. This community was restricted to soils of the Guthrie, Taft, and Lee series of the MFP soil association. Some were created by beaver activity; others were created by human actions such as stream damming and road construction. Trees and large shrubs were mostly restricted to their margins. Important large tree species were *Acer rubrum*, *Liquidambar styraciflua*, *Nyssa sylvatica*, *Quercus phellos*, *Salix nigra*, and rarely *Betula nigra*. Shrubs included *Cephalanthus occidentalis*, *Itea virginica*, *Photinia pyrifolia*, *Rhododendron* *canescens*, *Vaccinium corymbosum*, *V. fuscatum*, and *Viburnum nudum* var. *nudum*. Noteworthy emergent or marginal herbaceous species were *Carex crinita* var. *brevicrinis*, *C. joorii*, *C. lupuliformis*, *Hibiscus moscheutos* subsp. *moscheutos*, *Juncus effusus*, *J. repens*, *Osmunda cinnamomea*, *O. regalis*, *Panicum rigidulum* var. *pubescens*, *Platanthera ciliaris*, *Proserpinaca palustris*, *Rhexia mariana* var. *interior*, *Rhynchospora glomerata*, *Saccharum baldwinii*, *Scirpus cyperinus*, *Sparganium americanum*, *Typha latifolia*, and *Viola* × *primulifolia*. Few floating or submerged aquatics were observed; the most abundant were *Lemna minor*, *Potomogeton diversifolius*, and *Spirodela polyrrhiza*.

7. Wet Meadows (WM).—Wet meadows were frequently encountered in valleys along small streams or in upland swales. They occurred on soils of the Lobelville, Lee, and Lynnville series associated with the MFP, BMF, and BFD soil associations. These sites appeared to be maintained as open areas by periodic grazing or mowing thereby preventing the establishment of large shrubs and trees. The most common shrubs found in the wet meadows included *Alnus serrulata*, *Amorpha fruticosa*, *Cephalanthus occidentalis*, *Cornus amomum*, and *Salix sericea*. Common herbaceous taxa were *Acorus calamus*, *Alisma subcordatum*, *Apios americana*, *Asclepias incarnata* subsp. *incarnata*, *Bidens aristosa*, *B. cernua*, *Boehmeria cylindrica*, *Carex frankii*, *C. vulpinoidea*, *Commelina virginica*, *Dichanthelium dichotomum* var. *ramulosum*, *D. scoparium*, *Eupatorium fistulosum*, *E. perfoliatum*, *Hibiscus moscheutos* subsp. *moscheutos*, *Hymenocallis occidentalis*, *Impatiens capensis*, *Juncus coriaceus*, *Lobelia cardinalis*, *L. siphilitica*, *Ludwigia alternifolia*, *Mentha* × *piperita*, *Mimulus alatus*, *Panicum rigidulum* var. *rigidulum*, *Polygonum hydropiperoides*, *P. sagittatum*, *Rhexia virginica*, and *Solidago gigantea*. At one site on an outlier of the HR in northeastern Giles County, a wet meadow was found that contained three species that are uncommon in Middle Tennessee: *Panicum verrucosum*, *Paspalum fluitans*, and *Trachelospermum difforme*.

8. Acidic Seeps (AS).—This community type was restricted to forested ravine bottoms in extreme northwestern Giles County in the upper sections of small HR streams. The soils of acidic seeps are part of the Lee series, a member of the BMF soil association. The surrounding forest type was predominantly oak-hickory. Some species common to the oak-hickory community were present among the seeps but were mostly restricted to dry hummocks. Such taxa included *Acer rubrum*, *Liquidambar styraciflua*, *Nyssa sylvatica*, *Oxydendrum arboreum*, and *Quercus alba*. Shrubs common to this community were *Alnus serrulata*, *Cephalanthus occidentalis*, *Euonymus americana*, *Itea virginica*, *Photinia pyrifolia*, *Rhododendron alabamense*, *R. canescens*, and *Vaccinium fuscatum*. Important herbaceous taxa were *Bartonia virginica*, *Carex atlantica* subsp. *capillacea*, *C. intumescens*, *Osmunda cinnamomea*, *O. regalis*, *Phlox glaberrima*, *Platanthera clavellata*, and *Thelypteris novaboracensis*. An unidentified species of *Sphagnum*, a non-vascular plant, was one of the dominant ground cover species in this community.

9. Calcareous Seeps (CS).—This type of wetland community occurred along the western edge of Giles County on lower slopes of ravines and hollows along small streams, by waterfalls, or above wet bluffs. The seeps occurred over limestone, had a thin, gravelly, continuously waterlogged substrate, and were level to slightly sloping. This community was restricted to soils of the BMF association, specifically the Rockland type or Lynnville and Lobelville soil series. Most were found among forests but the seeps themselves usually lacked large trees. Shrubs commonly associated with the seeps were *Alnus serrulata* and *Lindera benzoin*. The woody vine *Decumaria barbara* was often associated with the seeps in the southwestern corner of the county. Herbaceous species found were *Cardamine pensylvanica, Carex leptalea, Chelone glabra, Cuscuta compacta, Dichanthelium dichotomum* var. *ramulosum, Dryopteris celsa, Equisetum hyemale* var. *affine, Glyceria striata, Impatiens capensis, Juncus coriaceus, Lobelia cardinalis, Oxypolis rigidior, Samolus valerandi* subsp. *parviflorus*, and *Solidago patula*.

10. Riparian Areas (RIP).—This community included those areas that were located along riparian zones in the HR and was found in conjunction with a variety of series belonging to the BMF soil association. Many species were found in this broad community type although few species were restricted to it. Trees included a few species of *Quercus* and *Acer* as well as *Carpinus caroliniana, Juglans cinerea* (rarely), *J. nigra, Liquidambar styraciflua, Morus rubra*, and *Platanus occidentalis*. Smaller trees and large shrubs were *Alnus serrulata, Arundinaria gigantea, Cornus amomum, Corylus americana, Crataegus calpodendron, Hamamelis virginiana, Lindera benzoin, Salix caroliniana*, and *S. sericea*. Many species of wildflowers inhabited this community, including most of the species listed for the wet meadow community above. Additional noteworthy herbaceous taxa were *Elymus macgregorii, Equisetum hyemale* var. *affine*, and *Mertensia virginica*.

OUTER CENTRAL BASIN

1. Rich Forests (BRF).—In the OCB, rich woodlands occurred most often on middle to upper, north and east facing slopes, along river bluffs, or in sheltered hollows associated with soils of the Bodine, Dellrose, and Culleoka series of the MFP, BMF, and BFD soil associations. Unfortunately, much of this forest community was heavily logged or grazed in the past. The dominant canopy species of the Basin's rich woodlands included *Acer nigrum, A. saccharum, Aesculus flava, Carya cordiformis, Carya ovata* var. *ovata, Fagus grandifolia, Fraxinus americana, Juglans nigra, Liriodendron tulipifera, Quercus muehlenbergii, Q. rubra, Prunus serotina, Tilia americana* var. *americana*, and *T. americana* var. *heterophylla*. A rare component of some of the forests was *Juglans cinerea*.

Smaller woody species that were sometimes present included *Aesculus pavia, Asimina triloba, Carpinus caroliniana, Gleditsea triacanthos, Morus rubra,* and *Ulmus rubra. Euonymus atropurpurea, E. americana, Hydrangea cinerea, Lindera benzoin,* and *Staphylea trifolia* were frequent shrubs. Notable herbaceous taxa were *Actaea pachypoda, Arisaema triphyllum* subsp. *triphyllum, Botrychium virginianum, Carex blanda, C. kraliana, Claytonia virginica, Cynoglossum virginianum, Delphinium tricorne, Impatiens pallida, Jeffersonia diphylla, Osmorhiza claytonii, Panax quinquefolius, Phacelia bipinnatifida, Podophyllum peltatum, Sanguinaria canadensis, Thalictrum thalictroides,* and *Trillium cuneatum.*

2. Dry Forests (BDF).—Dry forests occurred along ridge-tops and on middle to upper, south or west facing and occasionally east facing slopes. This community was most frequently associated with Rockland soils of the DBM and SAM soil associations. These forests, like the remainder of forested land in the county, have been heavily logged and grazed. They contained *Acer saccharum, Aesculus glabra, Carya glabra, C. ovata* var. *ovata, Celtis laevigata, Fraxinus americana, F. quadrangulata, Juniperus virginiana, Quercus alba, Q. muehlenbergii, Q. shumardii, Robinia pseudoacacia, Ulmus alata,* and *U. serotina.* Common small trees and shrubs were *Cornus florida, Crataegus crus-galli, C. intricata, Forestiera ligustrina, Frangula caroliniana, Ostrya virginiana, Prunus americana, Rhus aromatica, Rosa setigera, Symphoricarpos orbiculatus,* and *Viburnum rufidulum.* Frequent woody vines included *Bignonia capreolata, Cocculus carolinus,* and *Smilax bona-nox. Agrimonia pubescens, Anemone virginiana, Asplenium platyneuron, Camassia scilloides, Carex albicans* var. *albicans, C. cephalophora, Chasmanthium sessiliflorum, Elymus villosus, Heliotropium tuberosum, Lobelia inflata, Melica mutica, Nothoscordum bivalve, Scutellaria ovata,* and *Viola palmata* were the common herbaceous species.

3. Limestone Karst Woods (LKW).—This community type was restricted to a small area in the central portion of the county. These forests occurred on small rocky knobs over Ordovician-aged Lebanon or Ridley limestone where soil was sufficiently deep to support forests. Limestone karst woods were associated with Rockland soils of the SAM soil association. The rock outcrops in these communities were often massive (1–4 m tall) and covered several ha. Common tree species of the karst woods included *Celtis laevigata, Diospyros virginiana, Fraxinus americana, F. quadrangulata, Juniperus virginiana, Quercus muehlenbergii, Q. shumardii, Tilia heterophylla, Ulmus alata,* and *U. serotina.* In the subcanopy and shrub layer, *Callicarpa americana, Cercis canadensis, Forestiera ligustrina, Frangula caroliniensis, Rhamnus lanceolata, Rhus aromatica, Sideroxylon lycioides, Staphylea trifolia, Symphoricarpos orbiculatus,* and *Viburnum rufidulum* were found. Frequent herbs were *Cynoglossum virginianum, Delphinium tricorne, Erythronium albidum, Frasera caroliniensis, Nemophila aphylla, Osmorhiza claytonii, Packera obovata, Polygonatum biflorum, Trillium* *cuneatum*, *T. sessile*, and *Vicia minutiflora*. On the rock outcrops in the forest, species such as *Aquilegia canadensis*, *Arabis laevigata*, *Asplenium resiliens*, *A. rhizophyllum*, *A. ruta-muraria*, *Cystopteris bulbifera*, *Heuchera villosa*, *Pellaea atropurpurea*, *Perideridia americana*, *Pleopeltis polypodioides* subsp. *michauxiana*, *Polymnia canadensis*, *Ranunculus micranthus*, *Saxifraga virginiensis*, and *Woodsia obtusa* were present.

4. Cedar Barrens (CB).—This community type was represented by only a few degraded examples that were restricted to the slopes of small knobs over Ordovician limestone in central Giles County. Cedar barrens were found on Rockland soils of the SAM association. They occurred on open slopes surrounded by rocky limestone karst woods within close proximity to cedar glades. *Juniperus virginiana* was abundant near the margins of the barrens and as isolated individuals among them. Most of the woody species were the same as those listed for the glades with a few exceptions such as *Quercus stellata* and *Vaccinium arboreum*. They were dominated by a variety of perennial grasses and herbs. Noteworthy herbaceous taxa were *Allium canadense* var. *canadense*, *Andropogon virginicus*, *Aristida oligantha*, *Asclepias viridiflora*, *Carex cherokeensis*, *Chasmanthium sessiliflorum*, *Croton capitatus*, *Cuphea viscosissima*, *Daucus carota*, *Dichanthelium malacophyllum*, *Eupatorium altissimum*, *E. hyssopifolium*, *Euphorbia corollata*, *Festuca arundinacea*, *Geranium carolinianum*, *Lespedeza procumbens*, *Lobelia spicata*, *Onosmodium molle* subsp. *molle*, *Panicum flexile*, *Potentilla recta*, *P. simplex* (plants in this community may be referable to the variety *argyrisma* Fern.), *Rudbeckia triloba*, *Sabatia angularis*, *Silphium trifoliatum* var. *latifolium*, *Sporobolus clandestinus*, and *Tridens flavus* var. *flavus*.

5. Cedar Glades (CG).—The limestone glades of Giles County were distributed mostly along a 16 km stretch of a 32 km section of a fault line that runs diagonally from NW to SE across the southern half of the county. Along this line, they were mostly along the western edge and to the west of Richland Creek. Like most other glades of Middle Tennessee, these were associated with Ordovician-aged Lebanon and Ridley limestone of the Stones River Group (Miller et al. 1966). They occurred on level to slightly sloping sites with shallow gravelly soil or exposed limestone. Cedar glades were mostly associated with soils of the Rockland type, part of the SAM association. Such sites often were wet in the winter and spring and were dry during summer and autumn. The woody species commonly associated with glade margins included *Celtis laevigata*, *Carya ovata* var. *australis*, *Forestiera ligustrina*, *Frangula caroliniana*, *Juniperus virginiana*, *Quercus muehlenbergii*, *Rhus aromatica*, *Rosa carolina*, *R. setigera*, and *Sideroxylon lycioides*. In the open portion of the glades, common herbaceous species included *Amphiachyris dracunculoides*, *Astranthium integrifolium*, *Carex cherokeensis*, *Cyperus squarrosus*, *Dichanthelium malacophyllum*, *Erigeron strigosus* var. *calcicola*, *Geranium molle*, *Glandularia* *canadensis, Grindelia lanceolata, Heliotropium tenellum, Houstonia purpurea* var. *calycosa, Hypericum sphaerocarpum, Hypoxis hirsuta, Isanthus brachiatus, Leavenworthia torulosa, Malvastrum hispidum, Manfreda virginica, Minuartia patula, Nothoscordum bivalve, Oenothera triloba, Onosmodium molle* subsp. *molle, Oxalis priceae* subsp. *priceae, Opuntia humifusa, Packera anonyma, Panicum flexile, Penstemon tenuiflorus, Phemeranthus calcaricus, Ranunculus fascicularis, Rudbeckia triloba, Ruellia humilus, Salvia lyrata, Scutellaria parvula, Sedum pulchellum, Sisyrinchium albidum, Symphyotrichum priceae, Verbena simplex,* and *Viola egglestonii.*

6. Bluffs and Outcrops (BO).—Other than cedar glades and man-made road-cut bluffs, rock outcrops and bluffs were generally uncommon in the OCB. Some small bluffs were located near caves or springs. Larger bluffs were mostly confined to watercourses, particularly the larger streams such as the Elk River and lower section of Richland Creek. The soils of this community are part of the Rockland type of the DBM and SAM soil associations. Woody species associated with bluffs included *Fraxinus quadrangulata, Hypericum frondosum, Juniperus virginiana, Quercus muehlenbergii,* and *Philadelphus pubescens* var. *pubescens.* Common herbaceous taxa encountered were *Asplenium resiliens, Cheilanthes alabamensis, C. lanosa, Cystopteris bulbifera, Heuchera villosa, Matelea gonocarpos, Pellaea atropurpurea,* and *Sedum pulchellum.*

7. Marshes (BM).—Marshes were rare in the OCB, mostly restricted to the flood plains of large streams. This community was restricted to soils of the Lynnville and Newark series of the SAM soil association. All of those sampled were formed either by man or by beaver activity. Common trees included *Fraxinus pennsylvanica, Platanus occidentalis,* and *Salix nigra* with *Cephalanthus occidentalis* the common shrub. Emergent aquatics were represented by *Leersia oryzoides, Scirpus cyperinus,* and *Typha latifolia.* Floating and submerged aquatics included *Heteranthera reniformis, Lemna minor, Potomogeton diversifolius, P. foliosus, Spirodela polyrrhiza,* and rarely *Azolla caroliniana.*

8. Wet Meadows (BWM).—Wet meadows occurred mostly in the flood plains of larger streams and were associated with the Newark, Lynnville, and Armour series of the DBM and SAM soil associations. This community type was dominated by various herbaceous wetland species. Representative taxa of this community included *Alopecurus carolinianus, Ammannia coccinea, Asclepias incarnata* subsp. *incarnata, Bidens cernua, B. frondosa, Carex frankii, C. vulpinoidea, Cyperus strigosus, Echinochloa muricata, Gratiola neglecta, Iva annua, Juncus acuminatus, J. effusus, Leersia oryzoides, Lobelia siphilitica, Ludwigia glandulosa, L. palustris, Lycopus rubellus, L. virginicus, Panicum dichotomiflorum, Polygonum hydropiperoides, Rorippa sessiliflora, Rotala ramosior, Rumex altissimus,* and *Sagittaria australis.*

9. Limestone Wet Meadows (LWM).—This community type was found in low areas within or near limestone cedar glades or along roadside ditches through gladey areas where the ground was thoroughly saturated for lengthy periods in spring. The soils of this community are part of the Talbott and Roellen series of the SAM soil association. Some are also associated with the Rockland type. The major difference between the Limestone Wet Meadow Community and other wet meadows of the OCB is that the limestone wet meadows are thin-soiled depressions over limestone bedrock. Characteristic species of this plant community included *Carex festucacea, C. granularis, Cuphea viscosissima, Eleocharis bifida, E. obtusa, Hypericum sphaerocarpum, Isoetes butleri, Juncus filipendulus, Leavenworthia torulosa, Mecardonia acuminata, Nothoscordum bivalve, Scirpus atrovirens,* and *S. lineatus.*

10. Riparian Areas (BRIP).—This community type occurred along the flood plains of medium to large streams in association with soil of the Staser, Lynnville, and Armour series of the SAM soil association. Tree species common to this community were *Acer negundo, A. saccharinum, Celtis laevigata, Fraxinus pennsylvanica, Gleditsea triacanthos, Populus deltoides, Quercus shumardii, Salix nigra, Ulmus americana,* and rarely *Betula nigra. Asimina triloba, Cornus drummondii,* and *Staphylea trifolia* were occasional to common understory species. At several sites, *Arundinaria gigantea* was the dominant understory species. *Aristolochia tomentosa,* a high-climbing woody vine, was restricted to this community type. Herbaceous species found in this community included *Ageratina altissima, Alliaria petiolata, Chasmanthium latifolium, Elymus macgregorii, E. virginicus, Laportea canadensis, Microstegium vimineum, Phlox paniculata, Silphium perfoliatum,* and *Verbesina alternifolia.*

STREAMS AND RIVERINE COMMUNITIES

1. Small Streams and Springs (ST).—Small streams and springs were common throughout Giles County. Species commonly found in this community included *Lemna minor, Mentha × piperita, Rorippa nasturtium-aquaticum, Spirodela polyrrhiza,* and *Veronica anagallis-aquatica.*

2. Large Streams and Rivers (RIV).—The two largest streams in Giles County are the Elk River and Richland Creek. These two streams are approximately 25-75 m wide in most places and are characterized by having a slow to moderate current with more or less shallow waters. The substrate is mostly composed of large rocks, gravel, and silt. Aquatic species were generally rare and were confined to the shallow and often swift-flowing riffles or slow-moving backwater areas. Representative taxa found in this community included *Heteranthera dubia, Justicia americana, Podostenum ceratophyllum,* and *Potomogeton nodosus.*

3. Gravel Bars (GB).—Large gravel bars were frequent along the Elk River and Richland Creek. Large woody species generally were not abundant due to perioidic flooding. Woody species that were common in this community included saplings of *Betula nigra, Platanus occidentalis, Populus deltoides, Salix caroliniana,* and *S. nigra.* The common herbaceous taxa were *Cuscuta* sp., *Diodia* *virginiana*, *Dysphania ambrosioides*, *Eclipta prostrata*, *Justicia americana*, *Polygonum* spp., and *Samolus valerandi* subsp. *parviflorus*.

Disturbed Habitats

A number of anthropogenically modified or maintained communities were sampled during the survey. These areas were found in all three physiographic sections and often were surrounded by some of the more natural habitats discussed above. The most common of the disturbed sites sampled included farm ponds and man-made lakes **(FP)**; lawns, old homesites, cemeteries, etc. **(LAW)**; pastures and fields **(PAS)**; crop fields **(CRP)**; roadsides and railroad tracks **(RD)**; abandoned lots and bare ground **(DIS)**; and urban thickets **(UT)**. These sites appeared to receive higher amounts of disturbance than other communities and contained higher numbers of non-native and weedy species compared to more natural communities.

ANNOTATED CHECKLIST

Nomenclature follows the PLANTS database (USDA NRCS 2000) except for the genus *Crataegus*, which follows Wofford and Chester (2002); newly described species (Campbell 2000, Allison & Stevens 2001, Smith 2001); and those plants covered in published volumes of *Flora of North America* (1993, 1997, 2000, 2002a, 2002b, 2003), with the exception of *Carya glabra* and *C. ovalis* and infraspecific taxa within *Lindera*. *Juncus biflorus* and *J. marginatus* are maintained here as distinct species following Radford et al. (1968). The arrangement of the checklist follows that of Wofford and Kral (1993), whereby the taxa are divided into three major groups: PTERIDOPHYTES, GYMNOSPERMS, and ANGIOSPERMS (MONOCOTS, DICOTS). Families and genera are arranged alphabetically within the three major divisions.

An asterisk (*) precedes the scientific name of each taxon not native to Tennesseee (sensu Wofford & Kral 1993). Two asterisks (**) signify taxa that are native to portions of Tennessee but not to Giles County. Entries denoted by the symbol "@" represent recently described taxa (for recently described taxa, a literature citation is provided in brackets following all other information). A cross (†) indicates taxa collected from Giles County prior to this study (mostly based on Chester et al. 1993, 1997); those without a cross represent county records. Taxa preceded by "Δ" were observed but not collected. Rare taxa are listed in **bold** type and are enumerated in Table 2.

Following the scientific name and authority, an abbreviation is listed for the relative abundance of each taxon within the county. An abbreviation for the physiographic area(s) where the taxon was collected or observed and an abbreviation for the habitat are listed next. The abbreviations used in the checklist to represent relative abundance, physiographic province, and habitat types are listed in Table 3.

TABLE 3. Abbreviations used in the checklist of vascular plants known from Giles County, Tennessee.

Symbols Used in the Checklist

***** = Non-native species
@ = Recently described taxon
Δ = Taxon observed but not collected

Relative Abundance

V = Very rare
R = Rare
S = Scarce
I = Infrequent
O = Occasional
F = Frequent
C = Common
X = Extirpated

Physiographic Area

OCB = Central Basin
HR = Highland Rim (both EHR & WHR)
EHR = Eastern Highland Rim
WHR = Western Highland Rim

Plant Communities

AS = Acidic Seep
BDF = Central Basin Dry Forest
BRF = Central Basin Rich Forest
BM = Central Basin Marsh
BO = Central Basin Bluff/Outcrop
BRIP = Central Basin Riparian Area
BWM = Central Basin Wet Meadow
CB = Cedar Barren
CG = Cedar Glade
CRP = Crop Field
CS = Calcareous Seep
DIS = Disturbed Area
FW = Flatwood
FP = Farm Pond/Lake
GB = Riverine Gravel Bar
LAW = Old Homesite/Lawn
LKW = Limestone Karst Wood
LWM = Limestone Wet Meadow
OH = Oak-Hickory Forest
PAS = Pasture/Field
RB = Highland Rim Barren
RD = Roadside/Railroad
RIV = River/Large Stream
RM = Highland Rim Marsh
RO = Highland Rim Bluff/Outcrop
RIP = Highland Rim Riparian Area
RF = Highland Rim Rich Forest
WM = Highland Rim Wet Meadow
ST = Small Stream/Spring
UT = Urban Thicket

The classification used to categorize the relative abundance of each taxon follows that of Murrell and Wofford (1987) and is as follows: very rare, found in a single locale with few individuals; rare, one or two localities, generally small populations; scarce, several localities, or scattered small populations; infrequent, scattered localities throughout; occasional, well distributed but not abundant anywhere; frequent, generally encountered; and common, characteristic and dominant. Taxa not observed over the last 20 years are listed as extirpated.

When taxa were found in all three physiographic areas (Outer Central Basin, Eastern Highland Rim, Western Highland Rim) the word ALL is listed. For taxa collected from both the Eastern and Western Highland Rims the designation HR is given, otherwise each physiographic area is listed separately. Additional habitat information is listed where necessary. For each entry, the physiographic and habitat designations are listed in their order of abundance, starting with the most abundant.

After the information concerning relative abundance, physiographic province, and habitat, the author's collection number is given in parenthesis. For specimens collected by the author housed at TENN only the author's collection number is given (e.g. 01077); however, for specimens housed in herbaria other than TENN, both the author's collection number and herbarium acronym where the specimen is deposited are given (e.g. 01349, VDB). For taxa listed in the checklist that were collected by others, the collector's name, collection number, and the herbarium acronym where the specimen is housed are included (e.g. R. Kral 39577, VDB).

PTERIDOPHYTES

ASPLENIACEAE

†*Asplenium platyneuron* (L.) B. S. P.—F; ALL; BDF, BRF, FW, LKW, OH, RF; (02686).

†*Asplenium resiliens* Kunze—O; OCB, WHR; LKW, BO, RO; (00339).

†*Asplenium rhizophyllum* L.—O; ALL; BO, RO, LKW, RF, BRF; (02825).

†*Asplenium ruta-muraria* L.—R; OCB; LKW, BO; (04452).

AZOLLACEAE

Azolla caroliniana Willd.—R; OCB; BM; (03521).

BLECHNACEAE

Woodwardia areolata (L.) T. Moore—R; HR; FW, AS; (00031).

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underwood ex Heller—O; HR; RB, OH; (02142).

DRYOPTERIDACEAE

†*Athyrium filix-femina* (L.) Mertens var. *asplenioides* (Michx.) Farw.—O; HR; RF; (00914).

†*Cystopteris bulbifera* (L.) Bernh.—O; ALL; LKW, BO, RO; (06784).

†*Cystopteris protrusa* (Weatherby) Blasdell—I; OCB, WHR; BRF, RF; (02190).

†*Cystopteris tennesseensis* Shaver—S; WHR, OCB; RO, BO; (J. Shaver 10220, TENN).

Δ *Deparia acrostichoides* (Swartz) M. Kato—V; WHR; RF.

Diplazium pycnocarpon (Spreng.) M. Broun—I; WHR, OCB; RF, BRF; (01537).

Dryopteris celsa (W. Palmer) Knowlt., Palmer, & Pollard—V; WHR; CS, WM; (02127).

Dryopteris marginalis (L.) Gray—V; WHR; RF; (00984).

†*Onoclea sensibilis* L.—S; HR; CS, FW; (03763).

†*Polystichum acrostichoides* (Michx.) Schott—C; ALL; RF, BRF, FW; (00970).

†*Woodsia obtusa* (Spreng.) Torr. subsp. *obtusa*—O; OCB, WHR; LKW, BDF, CG, BO, RO; (00666).

EQUISETACEAE

Equisetum hyemale L. var. *affine* (Engelm.) Calder & R. L. Tayor—R; WHR; CS, RIP; (00129).

ISOETACEAE

Isoetes butleri Engelm.—V; OCB; LWM; (03043).

LYCOPODIACEAE

Diphasiastrum digitatum (Dillenius ex A. Braun) Holub—R; WHR; OH, RD; (01607).

OPHIOGLOSSACEAE

Botrychium biternatum (Sav.) Underwood—S; HR; FW, RB; (05030).

Botrychium dissectum Spreng.—R; WHR; RF; (06783).

†*Botrychium virginianum* (L.) Sw.—F; ALL; RF, BRF, LKW; (01936).

†*Ophioglossum engelmannii* Prantl—R; OCB; CG; (01954).

Ophioglossum vulgatum L.—R; EHR, OCB; FW, LKW; (00605).

OSMUNDACEAE

†*Osmunda cinnamomea* L.—I; HR; RM, FW, AS, ST; (01905).

†*Osmunda regalis* L. var. *spectabilis* (Willd.) Gray—I; HR; RM, FW, AS, ST; (00588).

POLYPODIACEAE

†*Pleopeltis polypodioides* (L.) Andrews & Windham subsp. *michauxiana* (Weatherby) Andrews & Windham—O; OCB, WHR; LKW, BDF, BO, RO, on trees and rocks; (01783).

PTERIDACEAE

†*Adiantum pedatum* L.—I; ALL; RF, BRF; (02187).

†*Cheilanthes alabamensis* (Buckl.) Kunze—S; OCB; BO, LKW; (00652).

Cheilanthes lanosa (Michx.) D. C. Eat.—R; OCB, WHR; BO, RO; (02757).

†*Pellaea atropurpurea* (L.) Link—O; OCB, WHR; LKW, BO, RO, CG; (00663).

SELAGINELLACEAE

†*Selaginella apoda* (L.) Spring—V; WHR; RM; (A. J. Sharp, E. Clebsch, & A. Clebsch 9814, TENN).

THELYPTERIDACEAE

†*Phegopteris hexagonaptera* (Michx.) Fée—I; ALL; RF, BRF; (04931).

†*Thelypteris noveboracensis* (L.) Nieuwl.—S; HR; AS, FW; (00916).

GYMNOSPERMS

CUPRESSACEAE

Juniperus virginiana L. var. *virginiana*—F; ALL; CG, CB, LKW, BDF, RDF, RB, RD, PAS, BO, RO; (01616).

PINACEAE

***Pinus echinata* P. Mill.—R; WHR, OCB (probably planted); OH, RB, RD, few if any native stands; (03150).

***Pinus strobus* L.—V; WHR, tree plantation with seedlings; (02140).

Pinus taeda L.—S; ALL; FW, OH, RB, native only in extreme southern part of county; (00367).

***Pinus virginiana* P. Mill.—R; WHR; RD, no native stands observed; (01631).

ANGIOSPERMS: MONOCOTS

ACORACEAE

**Acorus calamus* L.—R; WHR, OCB; WM, BWM; (03772).

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose—S; OCB; CG, CB, BO; (00821).

***Yucca filamentosa* L.—R; OCB; RD, LAW, doubtfully native to county; (04954).

ALISMATACEAE

Alisma subcordatum Raf.—S; HR; WM, FW; (00831).

Sagittaria australis (J. G. Smith) Small—R; WHR, OCB; AS, BWM; (05426).

Sagittaria montevidensis Chamisso & Schlechtendal subsp. *calycina* (Engelm.) Bogin—S; WHR; FP, WM; (01333).

ARACEAE

Arisaema dracontium (L.) Schott—R; OCB; LKW; (02115).

Arisaema triphyllum (L.) Schott subsp. *pusillum* (Peck) Huttleston—R; EHR; FW; (00553).

†*Arisaema triphyllum* (L.) Schott subsp. *triphyllum*—F; ALL; RF, BRF, LKW; (01743).

COMMELINACEAE

**Commelina communis* L.—O; ALL; BRIP, BWM, CRP, GB, RD, RIP; (03745).

**Commelina diffusa* Burm. f.—R; OCB; LWM, RD; (02715).

Commelina erecta L. var. *erecta*—R; OCB; CG, BO; (06427).

†*Commelina virginica* L.—S; ALL; WM, BWM; (03864).

†*Tradescantia subaspera* Ker Gawler—S; WHR, OCB; RF, BRF, BRIP, BO; (00980).

Tradescantia virginiana L.—S; WHR; RF, OH; (01920).

CYPERACEAE

Bulbostylis capillaris (L.) C. B. Clarke ex J. D. Hooker—V; WHR; RB, wet ruts; (05289).

†*Carex albicans* Willd. ex Spreng. var. *albicans*—O; ALL; RF, BRF, LKW, OH; (04399).

Carex albolutescens Schwein.—R; WHR; RM, WM; (03276).

Carex albursina E. Sheldon—R; HR; RF; (04401).

†*Carex amphibola* Steud.—I; OCB, WHR; BRF, RF; (05914).

Carex atlantica Bailey subsp. *capillacea* (Bailey) Rezn.—R; WHR; AS; (00424 VDB).

Carex aureolensis Steudel.—V; OCB; BM; (03522).

Carex baileyi Britt.—V; WHR; RM; (00036 VDB).

Carex basiantha Steudel—R; OCB; LKW; (05899).

Carex blanda Dewey—S; OCB; BDF, BRF, PAS, CG; (04446).

Carex cephalophora Willd. ex Willd.—S; WHR; RF; (00614).

Carex cherokeensis Schwein.—S; OCB; CG, CB, LKW; (02039).

Carex complanata Torr. & Hook.—R; WHR; RB; (04905).

Carex crinita Lam. var. *brevicrinis* Fern.—R; WHR, RM; (02353).

Carex cumberlandensis Naczi, Kral, & Bryson.—I; WHR; RF; (05910).

Carex debilis Michx. var. *debilis*—S; HR; AS, FW; (00428 VDB).

Carex digitalis Willd.—R; WHR; AS; (02265).

Carex festucacea Schkuhr ex Willd.—I; OCB, WHR, BWM, LWM, RM; (03243).

Carex flaccosperma Dewey—R; EHR; FW; (02053).

†*Carex frankii* Kunth—O; ALL; BWM, RM, BM, RM; (00668).

†*Carex gigantea* Rudge—V; EHR; FW; (05019).

Carex granularis Muhl. ex Willd.—R; OCB; LWM; (03249).

†*Carex intumescens* Rudge—S; HR; AS, WM, FW; (00967).

Carex jamesii Schweinitz—R; OCB; BRF; (05834).

Carex joorii Bailey—S; HR; FW, WM, RM; (01322 VDB).

Carex kraliana Naczi & Bryson—R; OCB; BDF; (00654).

†*Carex laevivaginata* (Kukenth.) Mackenzie—R; WHR; CS; (02086).

Carex leavenworthii Dewey—S; OCB; BDF; (00649).

Carex leptalea Wahlenb.—R; WHR; CS; (02261).

Carex lupuliformis Sartwell ex Dewey—R; WHR; RM; (00786).

Carex lupulina Willd.—S; HR; WM, FW; (04206).

Carex lurida Wahlenb.—S; HR; AS, FW; (00953).

Carex muehlenbergii Schkuhr ex Willd. var. *enervis* Boott—R; OCB; PAS, CG; (05896).

Carex normalis Mackenzie—R; EHR; WM; (02346).

Carex picta Steud.—I; WHR; OH; (01613).

Carex planispicata Naczi—R; WHR; RF; (05972).

Carex prasina Wahlenb.—R; WHR; AS, RF; (00614).

Carex radiata (Wahlenb.) Small.—R; WHR; RF; (05971).

Carex rosea Schkuhr ex Willd.—I; WHR, OCB; RF, BRF, AS; (03680).

†*Carex scoparia* Schkuhr ex Willd.—X; WHR, OCB; WM, BWM; (K. Rogers 34914, TENN).

†*Carex stipata* Muhl. ex Willd.—R; WHR, OCB; WM, BWM; (K. Rogers 34913, TENN).

Carex stricta Lam.—R; WHR; AS; (02260).

Carex styloflexa Buckl.—R; WHR; AS; (00427 VDB).

Carex swanii (Fern.) Mackenzie—V; WHR; WM; (03278).

Carex texensis (Torr. ex L.H. Bailey) L.H. Bailey—R; EHR; RF, OH; (04400).

Carex tribuloides Wahlenb.—V; WHR; RF; (04913).

Carex virescens Muhl. ex Willd.—V; WHR; RF, OH?; (H. R. DeSelm s.n., TENN).

†*Carex vulpinoidea* Michx.—I; OCB, WHR; BWM, WM, LWM; (03242).

Cyperus acuminatus Torr. & Hook.—V; WHR; DIS; (06790).

†*Cyperus echinatus* (L.) Wood—I; OCB, WHR; PAS, BWM, LWM, WM, RB; (01257).

Cyperus flavescens L.—R; WHR; RD, wet ditch; (02836).

Cyperus lancastriensis Porter ex Gray—S; OCB; PAS; (01199).

Cyperus odoratus L.—S; OCB; PAS; (01205)

†*Cyperus pseudovegetus* Steud.—R; EHR; WM; (05028).

Cyperus refractus Engelm. ex Boeckl.—R; OCB; LWM; (03644).

**Cyperus rotundus* L.—V; OCB; CG; (04100).

Cyperus squarrosus L.—S; OCB; CG, LWM; (04105).

†*Cyperus strigosus* L.—O; ALL; WM, BWM; (04177).

@†*Eleocharis bifida* S. G. Smith—R; OCB; CG, CB, LWM; (03267); [Smith 2001].

Eleocharis engelmannii Steud.—R; EHR; WM; (02352).

Eleocharis microcarpa Torr. var. *filiculmis* Torr.—V; EHR; FW; (05390).

Eleocharis obtusa (Willd.) J. A. Schultes—O; ALL; WM, BWM, LWM; RM, BM; (06288).

Eleocharis cf. *tenuis* (Willd.) Schultes—V; EHR; WM; (06297).

Fimbristylis autumnalis (L.) Roemer & Schultes—R; WHR; WM, FP; (01331).

Isolepis carinata Hook. & Arn. ex Torr.—V; EHR; WM; (02347).

†*Rhynchospora capitellata* (Michx.) Vahl—S; HR; WM, RM; (06306).

Rhynchospora corniculata (Lam.) Gray—R; HR; WM; (02780).

Rhynchospora glomerata (L.) Vahl—S; HR; WM, RM, FW; (03780).

†*Rhynchospora recognita* (Gale) Kral—X; OCB; BO; (A. J. Sharp, S. Fairchild, & E. Clebsch 9892, TENN).

†*Scirpus atrovirens* Willd.—I; ALL; WM, BWM, LWM; (00998).

†*Scirpus cyperinus* (L.) Kunth—S; WHR; RM; (01323).

Scirpus pendulus Muhl.—V; OCB; LWM; (04903).

Scleria pauciflora Muhl. ex Willd. var. *pauciflora*—V; WHR; RB; (05288).

Scleria oligantha Michx.—S; WHR; OH, RO; (05154).

Scleria triglomerata Michx.—S; HR; FW, OH; (05026).

DIOSCOREACEAE

**Dioscorea polystachya* Turczaninow—O; OCB, WHR; BRIP, RIP; (05311).

Dioscorea villosa L.—O; ALL; BRF, RF; (00608).

IRIDACEAE

**Belamcanda chinensis* (L.) DC.—S; OCB, WHR; CG, PAS, LAW; (01474).

Iris cristata Sol. ex Ait.—I; HR; RF; (01849).

**Iris germanica* L.—R; EHR; RD; (04376).

†*Sisyrinchium albidum* Raf.—I; OCB, WHR; CG, CB, LKW, BDF, BDF, BO, RO; (01952).

†*Sisyrinchium angustifolium* Mill.—I; ALL; BWM, WM, PAS, BRIP, RIP; (02200).

JUNCACEAE

†*Juncus acuminatus* Michx.—S; EHR, WHR; FW, WM, BM, BWM; (01012 VDB).

Juncus biflorus Ell.—R; EHR; WM; (06296).

†*Juncus coriaceus* Mackenzie—I; ALL; WM, BWM, CS, AS; (05164).

Juncus debilis Gray—R; EHR; WM; (02339).

†*Juncus diffusissimus* Buckl.—R; WHR, OCB; RM, BWM; (05291).

Juncus effusus L.—I; ALL; RM, WM, BM, BWM; (02844).

Juncus filipendulus Buckl.—R; OCB; LWM, CG; (03246).

Juncus interior Wieg.—R; WHR; RB, DIS; (05304).

Juncus marginatus Rostk.—R; EHR; WM; (02356).

Juncus repens Michx.—R; WHR; RM; (01324).

Juncus scirpoides Lam.—R; EHR; WM; (02777).

Juncus secundus Beauv. ex Poir.—R; WHR, OCB; RB, CG; (05287).

Juncus tenuis Willd.—O; ALL; PAS, BWM, WM, BM; (03862).

Juncus torreyi Coville—V; OCB; BWM; (03690).

Luzula acuminata Raf. var. *carolinae* (S. Wats.) Fern.—R; WHR; RF; (02139).

†*Luzula echinata* (Small) Hermann—I; ALL; RF, BRF; (02136).

LEMNACEAE

Lemna minor L.—O; ALL; FP, ST; (01473).

Spirodela polyrrhiza (L.) Schleid.—S; WHR; FP; (03682).

LILIACEAE

Allium canadense L. var. *canadense*—I; ALL; RB, PAS, CB, CG, RD; (02321).

Allium cernuum Roth—V; OCB; BO; (00835).

*†*Allium sativum* L.—X; OCB; RD; (A. J. Sharp, A. Clebsch, E. Clebsch 40, TENN).

†***Allium tricoccum*** Sol. var. ***burdickii*** Hanes—R; WHR, OCB; RF, BRF; (00406).

**Allium vineale* L.—I; OCB, WHR; RD, PAS, LAW; (02317).

Amianthium muscitoxicum (Walt.) Gray—R; WHR; RF, OH; (02117).

**Asparagus officinalis* L.—S; OCB, WHR; RD, PAS; (04919).

Camassia scilloides (Raf.) Cory—S; OCB; BRF, BDF; (01793).

Chamaelirium luteum (L.) Gray—R; WHR; OH; (03297).

Erythronium albidum Nutt.—S; OCB; BRF, LKW; (01662).

Erythronium americanum Ker-Gawl subsp. *americanum*—R; WHR; RF; (05908).

Erythronium americanum Ker-Gawl subsp. *harperi* (W. Wolf) Parks and Hardin—O; ALL; RF, BRF; (04398).

**Hemerocallis fulva* (L.) L.—I; ALL; RD, WM, ST, LAW; (02357).

**Hyacinthoides nonscripta* (L.) Chouard—V; WHR; RD; (01740).

†*Hymenocallis occidentalis* (J. Le Conte) Kunth—I; WHR; WM, RF; (01334).

†*Hypoxis hirsuta* (L.) Coville—S; OCB, WHR; CG, OH; (01950).

Δ ***Lilium michiganense*** Farw.—V; WHR; RF.

Maianthemum racemosum (L.) Link subsp. *racemosum*—O; ALL; RF, BRF, LKW; (02029).

**Muscari neglectum* Guss. ex Ten.—I; OCB; CG, PAS; (00338).

**Narcissus poeticus* L.—R; WHR; LAW; (00421).

*Δ *Narcissus pseudonarcissus* L.—O; ALL; LAW, RD, PAS.

†*Nothoscordum bivalve* (L.) Britt.—S; OCB; CG, CB, LWM, LKW, BO; (01653).

**Ornithogalum umbellatum* L.—S; OCB; LAW, PAS, CG; (01942).

Polygonatum biflorum (Walt.) Ell.—O; ALL; RF, BRF, LKW; (01916).

Prosartes lanuginosa (Michx.) D. Don—V; WHR; RF; (02034).

†***Schoenolirion croceum*** (Michx.) Wood.—X; OCB; CG, LWM; (E. Quarterman 5218, specimen formerly at VDB, now apparently lost).

†*Trillium cuneatum* Raf.—C; ALL; RF, BRF, LKW; (01934).

Trillium flexipes Raf.—R; WHR; RF; (01733).

Trillium sessile L.—I; OCB; LKW, BDF, BRF; (01916).

†*Trillium stamineum* Harbison—I; ALL; RF, BRF; (01805).

Uvularia grandiflora Sm.—I; WHR; RF; (01666).

Uvularia perfoliata L.—R; WHR; RF; (H. R. DeSelm s.n., TENN).

Uvularia sessilifolia L.—R; EHR; FW (06293).

ORCHIDACEAE

Cypripedium parviflorum Salisb. var. *pubescens* (Willd.) Knight—V; WHR; RF; (02030).

Goodyera pubescens Willd. R. Br. ex Ait. f.—R; WHR; OH, RF; (01485).

Isotria verticillata Raf.—V; EHR; FW; (02800).

Platanthera ciliaris (L.) Lindl.—V; WHR; RM and associated wet woods; (02745).

Platanthera clavellata (Michx.) Luer—R; WHR; AS, RM; (00957).

Platanthera flava (L.) Lindl. var. *flava*—V; EHR; FW; (06283).

Platanthera peramoena (Gray) Gray—V; OCB; BWM; (03868).

Spiranthes cernua (L.) Rich.—R; WHR; PAS, RD; (06880).

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer—S; OCB, WHR; CB, RB; (02880).

Spiranthes vernalis Engelm. & Gray—V; EHR; WM; (04943).

Tipularia discolor (Pursh) Nutt.—I; ALL; RF, BRF; (02801).

POACEAE

**Agrostis gigantea* Roth—R; OCB; WM; (06276).

Agrostis hyemalis (Walt.) B. S. P.—R; EHR; WM; (02348).

Agrostis perennens (Walt.) Tuckerman—I; ALL; OH, FW, BDF; (03669).

Alopecurus carolinianus Walt.—R; OCB; BWM; (02206).

Andropogon gerardii Vitman—S; WHR; RB, RO; (03684).

Andropogon gyrans Ashe—R; WHR; RB, RM; (05677).

Andropogon ternarius Michx.—R; WHR; RB; (05676).

Andropogon virginicus L.—C; ALL; PAS, RB, RD; (06884).

Aristida longespica Poir.—R; WHR; DIS; (06799).

Aristida oligantha Michx.—R; OCB, WHR; CB, RB; (02890).

**Arthraxon hispidus* (Thunb.) Makino—R; EHR; WM, FW; (04195).

†*Arundinaria gigantea* (Walt.) Chapm.—O; ALL; BRIP, RIP, BRF, RF, FW; (00250).

Brachyelytrum erectum (Schreb. ex Spreng.) Beauv.—I; WHR; RF; (02848).

**Bromus commutatus* Schrad.—I; OCB, WHR; PAS, RD; (02207).

Bromus pubescens Muhl. ex Willd.—I; WHR; RF; (06413).

**Bromus racemosus* L.—V; OCB, EHR; (01943).

**Bromus sterilis* L.—V; OCB; CG, PAS; (02044).

**Bromus tectorum* L.—I; OCB; RD, PAS, CG; (04457).

Chasmanthium latifolium (Michx.) Yates—I; WHR, OCB; RF, RIP, BRIP, LKW; (01482).

Chasmanthium laxum (L.) Yates—R; EHR; FW, WM; (02776).

Chasmanthium sessiliflorum (Poir.) Yates—I; OCB, WHR; LKW, OH; (00787).

Cinna arundinacea L.—S; WHR; RF; (01532).

**Cynodon dactylon* (L.) Pers.—O; ALL; PAS, LAW, RD, DIS; (05397).

**Dactylis glomerata* L.—O; ALL; PAS, RD; (02096).

Danthonia spicata (L.) Beauv. ex Roemer & J. A. Schultes—I; HR; OH, (02257).

Dichanthelium acuminatum (Sw.) Gould & C. A. Clark var. *acuminatum*—R; OCB; BWM; (02210).

Dichanthelium acuminatum (Sw.) Gould & C. A. Clark var. *lindheimeri* (Nash) Beetle—S; WHR; RB; (03663).

Dichanthelium boscii (Poir.) Gould & C. A. Clark—I; HR; OH, RF; (03759).

†*Dichanthelium commutatum* (J. A. Schultes) Gould—I; ALL; BRF, RF; (H. R. DeSelm 1654, TENN).

Dichanthelium depauperatum (Muhl.) Gould—S; WHR; RB, OH; (02318).

Dichanthelium dichotomum (L.) Gould—O; HR; OH, FW; (05276).

Dichanthelium laxiflorum (Lam.) Gould—O; ALL; BDF, LKW, BRF, RF; (00762 VDB).

Dichanthelium malacophyllum (Nash) Gould—I; OCB; CG, CB, BDF; (00646 VDB).

Dichanthelium microcarpon (Muhl. ex Ell.) Mohlenbrock—I; ALL; WM, RM, BWM, FW; (00788 VDB).

Dichanthelium sphaerocarpon (Ell.) Gould var. *isophyllum* (Scribn.) Gould & C. A. Clark—S; WHR; RB; (03654).

Dichanthelium scoparium (Lam.) Gould—S; HR; WM, RM, FW; (04183).

***Digitaria ciliaris* (Retz.) Koel.—I; OCB, WHR; DIS, CRP, LAW, RD, GB, CG; (02729 VDB).

**Digitaria sanguinalis* (L.) Scop.—I; OCB; PAS, RD; (05264).

**Digitaria violascens* Link—V; WHR; DIS; (06798).

**Echinochloa colona* (L.) Link—I; OCB; BWM, LWM; (04081).

**Echinochloa crusgalli* (L.) Beauv.—S; WHR; GB, DIS; (02730).

†*Echinochloa muricata* (Beauv.) Fern. var. *muricata*—I; ALL; WM, BWM, BM, RM; (04077).

**Eleusine indica* (L.) Gaertn.—I; OCB; DIS, CRP, RD; (04176).

†*Elymus glabriflorus* (Vasey ex L.H. Dewey) Scribn. & Ball—R; WHR; RD; (05313).

Elymus hystrix L.—O; OCB, WHR; BDF, BRF, BRIP, LKW, RF, RIP; (00947).

@*Elymus macgregorii* R. Brooks & J.J.N. Campbell—I; WHR, OCB; RIP, BRIP; (02320); [Campbell 2000].

†*Elymus riparius* Wieg.—I; WHR, OCB; RF, BRIP; (00946).

†*Elymus villosus* Muhl. ex Willd.—O; OCB, WHR; BDF, BO, LKW, RO; (00651).

Elymus virginicus L.—I; WHR, OCB; RIP, BRIP, RF, RD, PAS; (05298).

**Eragrostis cilianensis* (All.) Vign ex Janchen—S; OCB; DIS, CRP, RD; (04177).

**Eragrostis curvula* (Schrad.) Nees—S; OCB; RD; (06271).

Eragrostis frankii C.A. Mey ex Steud.—R; OCB; CG; (04104).

Eragrostis pectinacea (Michx.) Nees ex Steud.—I; OCB; PAS, CRP, RD; (05267).

Eragrostis spectabilis (Pursh.) Steud.—S; HR; RB; (04188).

**Festuca arundinacea* Schreb.—C; ALL; PAS, DIS, LAW, RD; (02211).

†*Festuca subverticillata* (Pers.) Alexeev.—I; WHR; RF; (02185).

Glyceria striata (Lam.) A.S. Hitchcock—I; WHR; CS, AS, ST, WM; (02024).

**Hordeum pusillum* Nutt.—I; ALL; DIS, RD, PAS; (02143).

*†*Hordeum vulgare* L.—V; OCB; RD; (R. Kral 64891, VDB).

Leersia oryzoides (L.) Sw.—I; ALL; BM, BWM, RM, WM, FW; (03527).

†*Leersia virginica* Willd.—O; ALL; BRIP, RIP, GB, ST; BWM, WM; (02978).

**Lolium perenne* L. subsp. *multiflorum* (Lam.) Husnot.—I; ALL; DIS, RD, PAS; (02197).

Melica mutica Walt.—O; ALL; BRF, BDF, RF, BO, RO; (00610).

**Microstegium vimineum* (Trin.) A. Camus—F; ALL; RF, BRF, BDF, DIS, RD, ST, BM, BWM, FW; (05468).

**Miscanthus sinensis* Anderss.—R; WHR; PAS; (06327).

Muhlenbergia schreberi J. F. Gmel.—I; WHR, OCB; OH, RO, CG, PAS; (05646).

Muhlenbergia sobolifera (Muhl.) Trin.—R; WHR; RF; (02847).

Muhlenbergia sylvatica Torr. ex Gray—S; WHR; RF; (05148).

Panicum anceps Michx.—O; ALL; RB, PAS; (03655).

Δ *Panicum capillare* L.—S; OCB; CRP.

Panicum dichotomiflorum Michx.—I; ALL; BWM, WM, BM, RM, GB, DIS; (04186).

Panicum flexile (Gattinger) Scribn.—I; OCB; CG, CB, BO, PAS; (04101).

Panicum philadelphicum Bernh. subsp. *gattingeri* (Nash) Freckmann & Lelong—I; OCB; CG, CB, BO, RD; (05652).

Panicum rigidulum Bosc. ex Nees var. *pubescens* (Vasey) Lelong—V; WHR; RM; (02748).

Panicum rigidulum Bosc. ex Nees var. *rigidulum*—I; OCB, WHR; BWM, WM, (03856).

Panicum verrucosum Muhl.—R; HR; WM; (04073).

Panicum virgatum L.—R; OCB; RD, DIS; (06272).

**Paspalum dilatatum* Poir.—O; ALL; DIS, PAS, LAW; (04174).

†*Paspalum distichum* L.—X; OCB; river bottom; (L.S. Treanor Jr. s.n., TENN).

Paspalum fluitans (Ell.) Kunth.—V; WHR; WM, RM; (04086).

Paspalum laeve Michx. var. *pilosum* Scribn.—R; EHR, OCB; WM, LWM; (05021).

**Paspalum urvillei* Steud.—V; WHR; RD; (06774).

**Phleum pratense* L.—S; OCB; PAS, RD; (05411).

**Poa annua* L.—O; ALL; DIS, PAS, LAW, RD; (04403).

Poa autumnalis Muhl. ex Ell.—I; HR; RF; (02085 VDB).

**Poa compressa* L.—R; OCB; PAS; (04953).

**Poa pratensis* L.—O; ALL; DIS, PAS, LAW, RD; (04450).

Poa sylvestris Gray—I; HR; RF, RO; (01930).

**Poa trivialis* L.—V; WHR; CS; (02095 VDB).

Saccharum alopecuroidum (L.) Nutt.—O; ALL; PAS, RB, RD; (04109).

Saccharum baldwinii Spreng.—V; WHR; RM; (01326).

Saccharum giganteum (Walt.) Pers.—R; EHR; WM, RB; (04197).

Schizachyrium scoparium (Michx.) Nash var. *divergens* (Hack) Gould—R; WHR; RB; (02864).

Schizachyrium scoparium (Michx.) Nash var. *scoparium*—I; HR; RB, OH, RO; (03649).

*†*Secale cereale* L.—S; OCB; CG, RD; (02209).

**Setaria faberi* Herrm.—O; OCB; CRP, DIS, PAS, RD; (05413).

Setaria parviflora (Poir.) Kerguelen—O; ALL; BWM, WM, PAS, RD, RB; (02733 VDB).

*†*Setaria viridis* (L.) Beauv. var. *major* (Gaudin) Pospichal—R; OCB; CRP; (H.R. DeSelm 1652, TENN).

**Setaria viridis* (L.) Beauv. var. *viridis*—I; OCB; CRP, DIS, PAS, RD; (05266).

Sorghastrum nutans (L.) Nash—R; WHR; RB; (02916).

**Sorghum halapense* (L.) Pers.—F; ALL; DIS, PAS, CRP, RD; (00776).

Sphenopholis intermedia (Rydb.) Rydb.—R; EHR; FW; (02101).

Sphenopholis nitida (Biehler) Scribn.—I; ALL; BRF, LKW, RF; (03251).

Sporobolus clandestinus (Biehler) A. S. Hitchc.—S; OCB; CG, CB; (05649).

Sporobolus compositus (Poir.) Merr. var. *compositus*—R; OCB; CG; (05487).

Sporobolus vaginiflorus (Torr. ex Gray) Wood—I; OCB; CG, CB; (04103).

Tridens flavus (L.) A. S. Hitchc. var. *flavus*—O; ALL; RB, PAS, LWM, RD; (04169).

**Vulpia myuros* (L.) K. C. Gmel.—R; WHR; RB; (4920).

Vulpia octoflora (Walt.) Rydb. var. *glauca* (Nutt.) Fern.—R; WHR; RB; (00587).

PONTEDERIACEAE

*Δ *Eichhornia crassipes* (Mart.) Solms—R; OCB, WHR; FP, observed in two separate ponds over the course of two or three years but plants were not seen in either pond in 2004.

Heteranthera dubia (Jacq.) MacM.—R; OCB; RIV, swift shallows; (03517).

Heteranthera reniformis Ruiz & Pavon—V; OCB; BM; (03528).

POTOMOGETONACEAE

Potomogeton diversifolius Raf.—R; WHR; RM; (02752).

Potomogeton foliosus Raf. subsp. *foliosus*—R; OCB; BM; (03523).

Potomogeton nodosus Poir.—V; OCB; RIV, swift shallows; (03520).

SMILACACEAE

†*Smilax bona-nox* L.—F; OCB, WHR; BDF, LKW, CG, BRIP, RIP, BO, RO; (00208).

Smilax glauca Walt.—I; ALL; OH, RB, FW, BDF; (00022).

Smilax hugeri (Small) J. B. Norton ex Pennell—S; WHR, OCB; RF, LKW; (00604).

Smilax lasioneura Hook.—S; WHR, OCB; OH, RF, BDF, PAS; (01472).

Smilax rotundifolia L.—O; ALL; OH, FW, BDF; (00200).

†*Smilax tamnoides* L.—I; WHR, OCB; RF, BRF, RIP, BRIP; (00162).

SPARGANIACEAE

Sparganium americanum Nutt.—R; WHR; RM; (03782).

TYPHACEAE

Typha angustifolia L.—V; WHR; RD, roadside ditch; (00995).

Typha latifolia L.—I; ALL; RM, BM, BWM, FP; (03693).

XYRIDACEAE

Xyris laxifolia Mart. var. ***iridifolia*** (Chapman) Kral.—V; EHR; WM; (06298).

ANGIOSPERMS: DICOTS

ACANTHACEAE

Justicia americana (L.) Vahl—I; OCB; RIV, GB; (03519).

Ruellia caroliniensis (J. F. Gmel.) Steud.—I; WHR; RB, RD; (00992).

Ruellia humilis Nutt.—S; OCB; CG, CB; (00784).

Ruellia strepens L.—S; OCB; LKW, BDF, CG; (04091).

ACERACEAE

Acer barbatum Michx.—S; WHR; RF; (05277).

Acer negundo L.—I; ALL; BRIP, RIP, FW; (00142 MTSU).

Acer nigrum Michx. f.—I; WHR, OCB; RF, BRF; (01922).

Acer rubrum L. var. *trilobum* Torr. & Gray ex K. Koch—O; ALL; OH, FW, RM, RD; (00826).

Acer saccharinum L.—O; OCB; BRIP, BM; (05319).

†*Acer saccharum* Marsh.—C; ALL; RF, BRF; (04499); [including both var. *saccharum* and var. *schneckii* Rehd.].

AMARANTHACEAE

**Achyranthes japonica* (Miq.) Nakai var. *hachijoensis* Honda—R; OCB; BRIP; (06419).

Amaranthus hybridus L.—I; OCB; CRP, DIS, RD; (03746).

**Amaranthus palmeri* S. Wats.—S; OCB; CRP, DIS, RD; (04175).

**Amaranthus powellii* S. Wats.—R; OCB; CRP; (05273).

**Amaranthus spinosus* L.—O; ALL; PAS, DIS; (02714).

ANACARDIACEAE

†*Rhus aromatica* Ait.—I; OCB; LKW, CG, CB, BO, BDF; (01970).

Rhus copallinum L. var. *latifolia* Engl.—O; ALL; RB, OH, BDF, PAS, RD; (03664).

†*Rhus glabra* L.—O; ALL; PAS, RD; (03672).

Rhus hirta (L.) Sudworth—S; OCB, WHR; BRF, PAS, RD; (03983).

Toxicodendron radicans (L.) Kuntze—C; ALL; OH, BDF, RF, BRF, FW, BRIP, RIP; (03675).

ANNONACEAE

Asimina triloba (L.) Dunal—F; ALL; RF, BRF, BRIP, RIP; (00401).

APIACEAE

Angelica venenosa (Greenway) Fern.—I; WHR; RB; (00976).

*†*Carum carvi* L.—V; OCB; RD; (R. Kral 64893, VDB).

†*Chaerophyllum procumbens* (L.) Crantz.—I; OCB; BRF, RF; (05839).

†*Chaerophyllum tainturieri* Hook—O; ALL; PAS, RD, DIS; (02316).

Cicuta maculata L.—R; OCB; BWM; (02835).

**Conium maculatum* L.—I; OCB; DIS, PAS, CRP, BWM, BRIP; (04501).

Cryptotaenia canadensis (L.) DC.—I; ALL; RF, BRF; (00943).

**Daucus carota* L.—F; ALL; PAS, DIS, RD, RB; (03656).

Erigenia bulbosa (Michx.) Nutt.—S; WHR; RF; (01634).

Eryngium prostratum Nutt. ex DC.—V; EHR; WM; (02791).

†*Eryngium yuccifolium* Michx.—V; WHR; RB; (R. Carter & T. Smith 3133, VDB).

Osmorhiza claytonii (Michx.) C. B. Clarke—I; ALL; RF, BRF, LKW; (00436).

Osmorhiza longistylis (Torr.) DC.—S; WHR, OCB; RF, LKW; (04911).

Oxypolis rigidior (L.) Raf.—S; WHR, OCB; AS, CS, ST, WM, BWM; (01184).

*†*Pastinaca sativa* L.—R; OCB; PAS, RD; (04942).

Perideridia americana (Nutt. ex DC.) Reichenb.—V; OCB; LKW; (02112).

†*Ptilimnium capillaceum* (Michx.) Raf.—S; EHR, OCB; WM, BM; (02774).

Sanicula canadensis L. var. *canadensis*—O; ALL; RF, BRF, BDF; (00945).

Sanicula odorata (Raf.) K. M. Pryer & L. R. Phillippe—I; WHR; RF; (00934).

Sanicula smallii Bickn.—R; WHR; OH; (02849).

Sanicula trifoliata Bickn.—S; WHR, OCB; RF, BRF; (02728).

†*Thaspium trifoliatum* (L.) Gray var. *aureum* Britt.—O; WHR; RF, RO; (02684).

**Torilis arvensis* (Huds.) Link—S; OCB; DIS, PAS, CG; (03704).

†*Zizia aurea* (L.) W. D. J. Koch—S; WHR; RIP; (02130).

APOCYNACEAE

Amsonia tabernaemontana Walt. var. *tabernaemontana*—V; WHR; RF; (04912).

Apocynum cannabinum L.—I; ALL; WM, BWM, RD; (00983).

Trachelospermum difforme (Walt.) Gray—V; WHR; WM; (04000).

**Vinca major* L.—R; OCB; RD, BDF; (01788).

**Vinca minor* L.—S; OCB, WHR; LAW, LAW; (01632).

AQUIFOLIACEAE

†*Ilex decidua* Walt.—S; OCB; BDF, RD; (06793).

Ilex longipes Chapman ex Trel.—R; WHR, OCB; OH, LKW; (02871).

Ilex opaca Ait.—S; WHR, OCB; OH, BDF; (00282).

Ilex verticillata (L.) Gray—R; EHR; FW; (00555).

ARALIACEAE

Aralia racemosa L.—V; WHR; RF; (01269).

Aralia spinosa L.—I; ALL; RF, BRF, OH; (00961).

*Δ *Hedera helix* L.—R; OCB; LAW, UT.

Panax quinquefolius L.—S; ALL; RF, BRF, LKW; (00933).

ARISTOLOCHIACEAE

Aristolochia serpentaria L.—I; WHR; RF; (02824).

†*Aristolochia tomentosa* Sims—I; OCB; BRIP; (03184).

Asarum canadense L.—O; ALL; RF, BRF; (01736).

ASCLEPIADACEAE

Asclepias amplexicaulis Sm.—R; WHR; RB; (03661).

Asclepias exaltata L.—V; WHR; RF; (02268).

Asclepias incarnata L. subsp. _incarnata_—I; ALL; WM, BWM, RM, BM; (03859).

Asclepias quadrifolia Jacq.—R; WHR; RF; (02129).

Asclepias syriaca L.—O; OCB; PAS, BRIP, RD; (03671).

Asclepias tuberosa L. subsp. _interior_ Woods.—O; ALL; PAS, RD, RB; (04918).

Asclepias variegata L.—S; WHR; RB, OH; (02249).

Asclepias verticillata L.—V; WHR; RO; (05158).

Asclepias viridiflora Raf.—R; OCB; CG, CB; (03715).

Asclepias viridis Walt.—R; OCB; CG, PAS; (02108).

Cynanchum laeve (Michx.) Pers.—I; OCB, WHR; DIS, BRIP, RD; (03514).

Matelea caroliniensis (Jacq.) Woods.—I; WHR; RF, RO; (02323).

†_Matelea gonocarpos_ (Walt.) Shinners—I; OCB, WHR; LKW, BDF, BO, RO; (00657).

ASTERACEAE

Achillea millefolium L.—O; ALL; PAS, DIS, RB, RD; (02138).

†_Ageratina altissima_ (L.) King & H. E. Robins.—I; OCB, WHR; RF, BRF, BDF, DIS, RD; (04066).

Ambrosia artemisiifolia L.—F; ALL; DIS, RB, CG, PAS, CRP, RD; (04068).

Ambrosia bidentata Michx.—R; WHR; RB; (02739).

Ambrosia trifida L.—O; OCB, WHR; BRIP, RIP, DIS, RD, PAS; (04067).

Amphiachyris dracunculoides (DC.) Nutt.—S; OCB, CG, CB, PAS; (04099).

†_Antennaria plantaginifolia_ (L.) Richards.—O; ALL; OH, BDF, LKW; (01715 APSC).

Antennaria solitaria Rydb.—S; WHR; OH; (01874).

*Anthemis cotula _L.—R; OCB, PAS; (04952)._

*_Arctium minus_ Bernh.—S; OCB; DIS, PAS; (06432).

Arnoglossum atriplicifolium (L.) H. E. Robins.—I; WHR; RF, RIP; (03872).

†_Arnoglossum muehlenbergii_ (Schultz-Bip.) H. E. Robins.—R; WHR; RF; (00950).

*_Artemisia annua_ L.—O; OCB; DIS, RD, PAS, CG; (04093).

†_Astranthium integrifolium_ (Michx.) Nutt. subsp. _integrifolium_—S; OCB; CG, CB, LKW; (01773).

*_Baccharis halimifolia_ L.—V; EHR; FW, DIS; (04202).

Bidens aristosa (Michx.) Britt.—I; WHR; WM, RM; (01517).

Bidens bipinnata L.—I; OCB; CG, LKW, BDF, DIS; (02887).

†_Bidens cernua_ L.—S; OCB; BWM; (04088).

Bidens frondosa L.—S; OCB; BWM, DIS; (05467).

Boltonia asteroides (L.) L'Hér—R; EHR; WM; (04190).

Brickellia eupatorioides (L.) Shinners—V; OCB; CG, CB; (04097).

*_Carduus nutans_ L.—F; ALL; DIS, PAS, RD, CG; (02041).

*_Centaurea biebersteinii_ DC.—R; OCB; RD; (D. Sunbrink CENMA-I-65MM5-5/21/98, TENN).

*_Centaurea cyanus_ L.—R; OCB; CRP, PAS; (02047).

Chrysopsis mariana (L.) Ell.—S; WHR; OH; (02898).

Chrysopsis pilosa Nutt.—R; WHR; RB; (02842).

*_Cichorium intybus_ L.—I; OCB; RD, PAS, DIS; (06438).

†_Cirsium altissimum_ (L.) Hill—I; WHR; RIP, RF; (01250).

Cirsium discolor (Muhl. ex Willd.) Spreng.—O; OCB, WHR; PAS, RB, RD; (05402).

Cirsium muticum Michx.—V; WHR; RB; (01301).

*†_Cnicus benedictus_ L.—X; OCB; alfalfa field; (T. T. Jackson 20432, TENN).

Conoclinium coelestinum (L.) DC.—O; ALL; WM, BWM, PAS, RD; (03857).

Conyza canadensis (L.) Cronq. var. _canadensis_—I; ALL; DIS, PAS, RD; (01191).

Conyza canadensis (L.) Cronq. var. _pusilla_ (Nutt.) Cronq.—R; WHR; RB; (02858).

Coreopsis lanceolata L.—V; OCB; highway roadcut; (02208 EKU).

Coreopsis major Walt.—O; WHR; OH, RB; (00033).

Coreopsis tinctoria Nutt.—R; WHR, OCB; RD, PAS; (00931).

Coreopsis tripteris L.—I; WHR; RB; (01183).

*_Crepis pulchra_ L.—R; OCB; CG; (03240).

Doellingeria infirma (Michx.) Greene—R; WHR; OH; (02905).

Doellingeria umbellata (P. Mill.) Nees var. _umbellata_—R; WHR; RM, WM; (02747).

*_Eclipta prostrata_ (L.) L.—I; ALL; BWM, WM, GB; (02761).

Elephantopus carolinianus Raeusch.—I; ALL; BDF, OH, PAS, RD; (01258 VDB).

Elephantopus tomentosus L.—S; WHR; OH; (02746).

Erechtites hieraciifolia (L.) Raf. ex DC.—I; ALL; RB, OH, DIS, RD; (04205).

Erigeron annuus (L.) Pers.—I; OCB, WHR; PAS, RD; (02453).

Erigeron philadelphicus L.—O; WHR, OCB; PAS, RD; (01811).

†_Erigeron pulchellus_ Michx.—S; WHR; OH, RF, RO; (00119).

@†*Erigeron strigosus* Muhl. ex Willd. var. *calcicola* J. Allison—S; OCB; CG; (03647) [Allison and Stevens 2001].

Erigeron strigosus Muhl. ex Willd. var. *strigosus*—O; ALL; PAS, RB, RD; (00783).

Eupatorium album L. var. *album*—R; WHR; RB; (02828).

Eupatorium altissimum L.—R; OCB; CG, CB; (04098).

Eupatorium capillifolium (Lam.) Small—I; ALL; PAS, RD, DIS; (04200).

†*Eupatorium fistulosum* Barratt—I; WHR, OCB; WM, BWM; (02837).

Eupatorium hyssopifolium L.—I; WHR, OCB; RB, CB; (02891).

Eupatorium perfoliatum L.—I; ALL; WM, BWM, RM, BM; (03853).

Eupatorium pilosum Walt.—R; EHR; FW; (05029).

Eupatorium × *pinnatifidum* Ell.—V; EHR; WM, FW; (04199).

Eupatorium purpureum L.—S; WHR; RF; (00948).

Eupatorium rotundifolium L. var. *ovatum* (Bigelow) Torr.—O; HR; RB, OH, WM; (03737).

Eupatorium serotinum Michx.—I; OCB, WHR; PAS, DIS; (01316).

Eupatorium sessilifolium L.—S; WHR; OH, RF; (01094).

Eurybia hemispherica (Alexander) Nesom—I; WHR; RB, OH; (01137).

Fleischmannia incarnata (Walt.) King & H. E. Robins.—I; OCB; BDF, LKW; (04170).

**Galinsoga quadriradiata* Cav.—R; OCB; RD; (00647).

Gamochaeta purpurea (L.) Cabrera—I; ALL; PAS, RB, OH, BDF, RD; (02066).

Grindelia lanceolata Nutt. var. *lanceolata*—R; OCB; CG, CB; (02687).

Helenium amarum (Raf.) H. Rock—O; ALL; PAS, CG, RD; (03706).

†*Helenium autumnale* L.—S; OCB, EHR; LWM, WM; (04193).

Helenium flexuosum Raf.—S; HR; WM; (00001).

Helianthus angustifolius L.—S; EHR; WM; (04198).

**Helianthus annuus* L.—V; OCB; RD; (05420).

Helianthus atrorubens L.—I; WHR; RB, OH; (01389).

Helianthus decapetalus L.—R; WHR; RF; (01093a,b).

Helianthus eggertii Small—R; WHR; RB; (02851).

Helianthus hirsutus Raf.—I; WHR; RB, OH; (01139).

Helianthus microcephalus Torr. & Gray—I; WHR; RB, OH; (01305).

Helianthus silphioides Nutt.—R; WHR; RB; (03755)

Helianthus strumosus L.—V; WHR; RF, RD; (03871).

†*Helianthus tuberosus* L.—O; OCB, WHR; BRIP, RIP; (01034).

Heliopsis helianthoides (L.) Sweet—I; WHR; RF; (04933).

Hieracium gronovii L.—I; WHR; OH, RB; (02903).

**Hypochaeris radicata* L.—R; WHR; PAS; (03756).

**Iva annua* L.—S; OCB; BWM; (05462).

†*Krigia biflora* (Walt.) Blake—O; WHR; OH; (00289).

†*Krigia caespitosa* (Raf.) Chambers—I; ALL; CRP, DIS, BWM, GB, WM, CG; (02214).

Krigia dandelion (L.) Nutt.—R; EHR; WM; (02056).

†*Lactuca canadensis* L.—O; ALL; PAS, RB, RD; (03665).

Lactuca floridana (L.) Gaertn.—I; WHR; RF, RIP, RD; (02917).

**Lactuca saligna* L.—R; OCB; RD; (06280).

**Lactuca serriola* L.—I; OCB; RD, PAS, DIS; (03674).

**Leucanthemum vulgare* Lam.—O; ALL; PAS, RD, CG, CB, DIS; (01772).

Liatris spicata (L.) Willd. var. *spicata*—S; WHR; RB; (02841).

Liatris squarrulosa Michx.—S; WHR; RB; (01522).

**Matricaria discoidea* DC.—V; OCB; CRP; (01670 VDB).

Mikania scandens (L.) Willd.—R; EHR, FW, WM; (04187).

Packera anonyma (Wood) W. A. Weber & A. Löve—O; ALL; RB, CG, CB, PAS; (02065).

†*Packera glabella* (Poir) C. Jeffrey—I; ALL; BWM, WM, CS, CRP, RD; (02097).

Packera obovata (Muhl. ex Willd.) W. A. Weber & A. Löve—I; WHR, OCB; OH, RO, LKW, BO; (00456).

Parthenium integrifolium L. var. *integrifolium*—I; WHR; RB; (02315).

Pluchea camphorata (L.) DC.—S; ALL; WM, BWM; (04082).

†*Polymnia canadensis* L.—I; OCB, WHR; LKW, BDF, BO, RF, RO; (02713).

Prenanthes altissima L.—I; WHR; RF; (01479).

Pseudognaphalium obtusifolium (L.) Hilliard & Burtt—S; WHR; RB; (01182).

Pyrrhopappus carolinianus (Walt.) DC.—I; ALL; BWM, WM, PAS, RB; (05163).

Ratibida pinnata (Vent.) Barnh.—R; OCB; rocky PAS; (04898).

Rudbeckia fulgida Ait. var. *fulgida*—R; WHR; RB; (01048).

†*Rudbeckia fulgida* Ait. var. *umbrosa* (C. L. Boynton & Beadle) Cronq.—R; WHR; CS, ST; (06787).

Rudbeckia hirta L. var. *hirta*—O; ALL; RB, OH, RD, PAS; (00982 VDB).

Rudbeckia hirta L. var. *pulcherrima* Farw.—I; OCB; PAS, RD; (00210).

Rudbeckia laciniata L. var. *laciniata*—I; WHR; RF, CS; (01053).

†*Rudbeckia triloba* L.—O; OCB; CG, CB, BDF, PAS, RD; (00779).

Sericocarpus linifolius (L.) B. S. P.—S; WHR; RB, OH; (01390).

Silphium asteriscus L. var. *asteriscus*—I; WHR; OH, RB, RF; (03752).

†*Silphium mohrii* Small—S; WHR; RB; (00922).

Silphium perfoliatum L.—S; OCB; BRIP, PAS, RD; (01342).

Silphium trifoliatum L. var. *latifolium* Gray—R; OCB; CG, CB; (01046).

Smallanthus uvedalius (L.) Mackenzie ex Small—I; HR; RF, RD; (05423).

Solidago arguta Ait. var. *caroliniana* Gray—I; WHR; RB, OH; (03681).

Solidago caesia L.—I; ALL; RF, BRF, BO, RO; (06794).

†*Solidago canadensis* L var. *scabra* Torr. & Gray—F; ALL; RB, PAS, RD; (04111).

Solidago erecta Pursh—I; WHR; OH; (02900).

Solidago flexicaulis L.—R; WHR; RF; (02726).

Solidago gigantea Ait.—I; ALL; WM, BWM; (01129).

Solidago hispida Muhl. ex Willd. var. *hispida*—I; WHR; OH; (02902).

Solidago missouriensis Nutt. var. *fasciculata* Holz.—R; WHR; RB; (01047).

Solidago nemoralis Ait.—O; WHR; RB, PAS; (01521).

Solidago odora Ait. var. *odora*—I; WHR; RB; (02869).

Solidago patula Muhl. ex Willd.—R; WHR; CS; (06379).

Solidago rugosa P. Mill. ssp. *aspera* (Ait.) Cronq.—I; HR; OH, RB, WM, FW; (06781).

Solidago sphacelata Raf.—R; WHR; RO; (02846).

Solidago ulmifolia Muhl. ex Willd.—I; WHR; OH; (05274).

**Sonchus asper* (L.) Hill—I; EHR, PAS; (02340).

Symphyotrichum cordifolium (L.) Nesom—I; WHR; RF; (01481).

Symphyotrichum drummondii (Lindl.) Nesom—S; OCB, WHR; BDF, RO; (05638).

Symphyotrichum dumosum (L.) Nesom—I; WHR; RB; (02868).

Symphyotrichum lanceolatum (Willd.) Nesom—S; WHR, OCB; WM, BWM; (05465).

Symphyotrichum lateriflorum (L.) A. & D. Löve—O; ALL; RF, BRF, PAS, RD; (01349 VDB).

Symphyotrichum ontarione (Wieg.) Nesom—R; OCB; PAS, LWM, BWM; (05645).

Symphyotrichum patens (Ait.) Nesom—I; WHR; RB, OH; (02972).

Symphyotrichum pilosum (Willd.) Nesom—F; ALL; PAS, RD, DIS; (01471).

Symphyotrichum priceae (Britt.) Nesom—R; OCB; CG; (06789).

Symphyotrichum shortii (Lindl.) Nesom—O; ALL; BDF, BO, RO, OH; (01382).

Symphyotrichum undulatum (L.) Nesom—R; WHR; RB, OH; (02974).

Symphyotrichum urophyllum (Lindl.) Nesom—O; WHR, OCB; RF, BRF, RO; (01536 VDB).

**Taraxacum laevigatum* (Willd.) DC.—R; OCB; RD; (01974).

**Taraxacum officinale* G. H. Weber ex Wiggers—F; ALL; PAS, RD, DIS, CRP; (06441).

Verbesina alternifolia (L.) Britt. ex Kearney—O; WHR, OCB; RIP, RF, BRIP, WM, BWM; (01261).

Verbesina virginica L.—O; WHR, OCB; RIP, BRIP, CG, CB, PAS; (01131).

†*Vernonia gigantea* (Walt.) Trel. ex Bran. & Cov.—F; ALL; PAS, RB, WM, BWM; (03860).

**Xanthium strumarium* L.—I; ALL; PAS, DIS; (04095).

BALSAMINACEAE

Impatiens capensis Meerb.—O; ALL; RF, BRF, WM, BWM, CS, AS; (01032).

Impatiens pallida Nutt.—R; WHR, OCB; RF, BRF; (01128).

BERBERIDACEAE

**Berberis bealei* Fortune—V; WHR; PAS; (05915).

*Δ *Berberis thunbergii* DC.—V; OCB; PAS.

†*Caulophyllum thalictroides* (L.) Michx.—R; WHR; RF; (02727).

Jeffersonia diphylla (L.) Pers.—S; WHR, OCB; RF, BRF; (00385).

*Δ *Nandina domestica* Thunb.—V; OCB; highway roadcut.

†*Podophyllum peltatum* L.—C; ALL; BRF, RF, BDF; (01746).

BETULACEAE

Alnus serrulata (Ait.) Willd.—O; HR; RIP, CS, AS, FW; (00316).

Betula nigra L.—S; ALL; RM, FW, BRIP; (01142).

Carpinus caroliniana Walt.—F; ALL; RF, BRF, RIP, BRIP; (02857).

Corylus americana Walt.—I; WHR; OH, RF; (00962).

†*Ostrya virginiana* (Mill.) K. Koch—O; ALL; BDF, LKW, OH, RF, BRF, BO, RO; (05278).

BIGNONIACEAE

†*Bignonia capreolata* L.—O; ALL; RF, BRF, BDF, LKW; (02046).

†*Campsis radicans* (L.) Seem ex Bureau—O; ALL; RF, BRF, BDF, RD; (02709).

**Catalpa bignonioides* Walt.—R; OCB; BRIP; (02189).

**Δ *Catalpa speciosa* (Warder) Warder ex Engelm.—S; OCB; BRIP.

BORAGINACEAE

*†*Buglossoides arvensis* (L.) I. M. Johnston—S; OCB; CG, RD, DIS; (01660).

Cynoglossum virginianum L.—I; ALL; BRF, BDF, LKW, RF; (01953).

*Δ *Heliotropium indicum* L.—R; EHR; FW.

Heliotropium tenellum (Nutt.) Torr.—R; OCB; CG, CB; (02690).

†*Lithospermum canescens* (Michx.) Lehm.—V; OCB; CG; (E. Quarterman 5268, VDB).

Lithospermum tuberosum Rugel ex DC.—I; WHR, OCB; OH, RF, BDF, LKW, RB; (02882).

Mertensia virginica (L.) Pers. ex Link—I; WHR, OCB; RIP, BRIP; (00127).

†*Myosotis macrosperma* Engelm.—O; ALL; RF, BRF, BDF, LKW; (01958).

†*Onosmodium molle* Michx. subsp. *molle*—S; OCB; CG, CB, PAS; (04849).

BRASSICACEAE

**Alliaria petiolata* (Bieb.) Cavara & Grande—S; OCB; BRF; (03182).

*†*Arabidopsis thaliana* (L.) Heynh.—R; EHR; CRP; (04394).

†*Arabis laevigata* (Muhl. ex Willd.) Poir. var. *laevigata*—O; ALL; RF, RO, BRF, BO, LKW; (01737).

*†*Barbarea verna* (P. Mill.) Aschers.—S; WHR; RD, RIP; (02134).

*†*Barbarea vulgaris* Ait. f.—O; ALL; PAS, RD; (00435).

*†*Brassica rapa* L.—O; ALL; CRP, PAS, RD, DIS; (00328).

*†*Capsella bursa-pastoris* (L.) Medik.—I; OCB; CRP, RD, DIS; (01748).

†*Cardamine angustata* O. E. Schulz—I; WHR; RF; (03039).

†*Cardamine bulbosa* (Schreb. ex Muhl.) B. S. P.—I; WHR; CS; (01727).

†*Cardamine concatenata* (Michx.) Sw.—F; ALL; BRF, RF; (01701).

Cardamine diphylla (Michx.) Wood.—R; OCB; BRF; (05832).

**Cardamine hirsuta* L.—C; ALL; CRP, DIS, BRF, BDF, RF, LKW; (01774).

†*Cardamine parviflora* L.—R; OCB, WHR; LKW, RO; (A. J. Sharp, C. J. Felix, & W. Adams 10930, TENN).

Cardamine pensylvanica Muhl. ex Willd.—S; WHR, OCB; CS, BWM; (04453).

†*Descurainia pinnata* (Walt.) Britt. subsp. *brachycarpa* (Richards) Detling—X; OCB; CG; (E. Quarterman, J. Baskin, & S. Oakland 64-52, VDB).

*†*Descurainia sophia* (L.) Webb ex Prantl—V; OCB; RD; (R. Kral 64884, VDB).

Draba brachycarpa Nutt. ex Torr. & Gray—R; EHR, OCB; CRP, CG; (04395).

**Draba verna* L.—I; OCB; CG, RD, DIS; (01661).

*†*Erysimum repandum* L.—R; OCB; CRP, RD; (03077).

Iodanthus pinnatifidus (Michx.) Steud.—S; WHR; RF; (02186).

†***Leavenworthia exigua*** Rollins var. ***exigua***—X; OCB; CG; (E. Quarterman, J. Baskin & S. Oakland 64-61, VDB).

†*Leavenworthia torulosa* Gray—S; OCB; CG, LWM; (01603).

*†*Lepidium campestre* (L.) Ait. f.—R; OCB; CG; (01964).

*†*Lepidium densiflorum* Schrad.—V; OCB; RD; (R. Kral 64894, 2 May 1980, VDB).

†*Lepidium virginicum* L.—I; OCB; CG, CB, PAS, RD, DIS; (03272).

†***Lesquerella densipila*** Rollins—R; OCB; CRP; (01672).

**Rorippa nasturtium-aquaticum* (L.) Hayek.—O; ALL; ST; (01768).

Rorippa sessiliflora (Nutt.) A.S. Hitchc.—R; OCB; BWM; (04396).

Sibara virginica (L.) Rollins—S; OCB, WHR; CRP; (01671).

*†*Sisymbrium officinale* (L.) Scop.—S; OCB; CG, RD; (01969).

**Thlaspi arvense* L.—R; OCB; RD; (01790).

BUXACEAE

Pachysandra procumbens Michx.—I; WHR; RF; (04910).

CACTACEAE

Opuntia humifusa (Raf.) Raf. var. *humifusa*—I; OCB; CG, CB, BO, PAS; (01626).

CALLITRICHACEAE

Callitriche heterophylla Pursh subsp. *heterophylla*—S; WHR; RM; (02203).

CAMPANULACEAE

†*Campanulastrum americanum* (L.) Small—I; WHR, OCB; RF, BRF; (00655).

Lobelia cardinalis L.—I; WHR; WM, RM, RIP, ST; (01134).

Lobelia inflata L.—I; WHR; RD; (02702).

Lobelia puberula Michx. var. *puberula*—I; WHR; RB; (01300).

†*Lobelia siphilitica* L.—O; ALL; BWM, WM; (05418).

Δ *Lobelia spicata* Lam.—V; OCB; CB.

†*Triodanis perfoliata* (L.) Nieuwl. var. *perfoliata*—I; WHR, OCB; DIS, RD; PAS; (02313).

CAPPARACEAE

**Cleome hassleriana* Chod.—V; WHR; GB; (02732).

CAPRIFOLIACEAE

**Lonicera fragrantissima* Lindl. & Paxton—R; WHR, OCB; RD, UT; (03038).

**Lonicera japonica* Thunb.—C, ALL; BRF, BDF, BWM, RF, WM, BRIP, RIP, PAS, RD; (02256).

**Lonicera maackii* (Rupr.) Herder—R; OCB; RD, UT; (05670).

†*Lonicera sempervirens* L.—I; WHR; OH, RO; (02081).

Sambucus nigra L. subsp. *canadensis* (L.) R. Bolli—O; ALL; BWM, BM, WM, RM, FW, BRIP, RIP, CS; (02826).

†*Symphoricarpos orbiculatus* Moench—C; ALL; BDF, LKW, OH, BRF, RF, BO, RD; (05644).

Viburnum dentatum L. var. *lucidum* Ait.—R; EHR; FW; (02790 EKU).

Viburnum nudum L. var. *nudum*—R; HR; FW, RM; (05013).

†*Viburnum rufidulum* Raf.—O; ALL; BDF, LKW, BRF, RF; (01973).

CARYOPHYLLACEAE

†***Arenaria lanuginosa*** (Michx.) Rohrb.—R; OCB, WHR; BO, RO; (02755).

*†*Arenaria serpyllifolia* L.—R; OCB; RD; (02194).

*†*Cerastium brachypetalum* Desportes ex Pers.—S; OCB; CG, RD; (01784).

Cerastium brachypodum (Engelm. ex Gray) B. L. Robins.—R; WHR; OH; (05906).

*†*Cerastium fontanum* Baumg. subsp. *vulgare* (Hartman) Greuter & Burdet—S; OCB; RD; (A. J. Sharp, C. J. Felix, & B. Adams 10957, TENN).

**Cerastium glomeratum* Thuill.—S; WHR; LAW; (02092 VDB).

†*Cerastium nutans* Raf.—S; WHR; RO, RF; (01924 VDB).

**Dianthus armeria* L.—I; OCB; RD, PAS; (02196).

**Holosteum umbellatum* L.—S; OCB; CRP, CG; (01674).

†*Minuartia patula* (Michx.) Mattf.—I; OCB; CG, CB, BO; (00363).

**Myosoton aquaticum* (L.) Moench—R; WHR; CS, ST; (02090 VDB).

**Saponaria officinalis* L.—I; OCB, WHR; RD, PAS; (01077).

**Silene latifolia* Poir. subsp. *alba* (P. Mill.) Greuter & Burdet—R; WHR; RD; (02723).

Silene stellata (L.) Ait. f.—S; WHR; RF; (01045).

†*Silene virginica* L.—O; ALL; RF, OH, RO, BRF, BDF; (00595).

Stellaria fontinalis (Short & Peter) B.L.Robins.—R, OCB; LWM; (03250).

**Stellaria media* (L.) Vill. subsp. *media*—C; ALL; RF, BRF, LKW, LAW, PAS, RD; (01867).

Stellaria pubera Michx.—I; HR; RF; (01810).

CELASTRACEAE

Celastrus scandens L.—V; WHR; RIP; (01529).

**Euonymus alata* (Thunb.) Sieb.—R; EHR; FW, OH; (02049).

†*Euonymus americana* L.—F; ALL; RF, BRF, LKW; (02122).

†*Euonymus atropurpurea* Jacq. var. *atropurpurea*—S; OCB; LKW, BDF, BRF; (02889).

**Euonymus fortunei* (Turcz.) Hand.-Maz.—R; OCB; UT, LKW; (05902).

**Euonymus kiautschovicus* Loesener.—R; OCB; BDF, RD, BRIP, UT; (05674).

CHENOPODIACEAE

**Chenopodium album* L.—O; ALL; DIS, RD, PAS, GB, CRP; (04172).

Chenopodium standleyanum Aellen—V; WHR; RF; (03981).

**Dysphania ambrosioides* (L.) Mosyakin & Clemants—I; OCB; PAS, GB, DIS; (01198).

CISTACEAE

Lechea minor L.—V; WHR; RB (05309).

†*Lechea mucronata* Raf.—S; WHR; RB; (02843).

CLUSIACEAE

Hypericum acutifolium Ell.—R; WHR; RB; (06776).

Hypericum crux-andreae (L.) Crantz—R; EHR; FW, WM: (02797).

Hypericum drummondii (Grev. & Hook.) Torr. & Gray—I; WHR; PAS, RB; (01189).

Hypericum frondosum Michx.—S; OCB; BO, BDF; (00985).

Hypericum gentianoides (L.) B. S. P.—R; WHR; RB; (02854).

Hypericum hypericoides (L.) Crantz subsp. *hypericoides*—S; HR; FW, OH, AS, WM; (02703).

†*Hypericum hypericoides* (L.) Crantz subsp. *multicaule* (Michx. ex Willd.) Robson—I; ALL; OH, BDF; (00023).

†*Hypericum mutilum* L.—I; ALL; WM, RM, BWM, BM; (01147).

**Hypericum perforatum* L.—R; OCB; RD; (04917).

Hypericum prolificum L.—R; OCB; BDF; (00774).

Hypericum punctatum Lam.—I; ALL; RB, PAS, OH, BDF; (01318).

Hypericum sphaerocarpum Michx.—I; OCB; CG, LWM, CB; (02688).

Triadenum virginicum (L.) Raf.—R; EHR; FW; (04189).

Triadenum walteri (J.G.Gmel.) Gleason—VR; WHR; CS; (06380).

CONVOLVULACEAE

Calystegia catesbiana Pursh—R; WHR; RB; (2078 VDB).

Calystegia silvatica (Kit.) Griseb. subsp. *fraterniflorus* (Mackenzie & Bush) Brummitt—F; OCB, WHR; BRIP, RIP, BWM, WM, RD; (03754).

**Dichondra caroliniensis* Michx. —R; OCB; LAW; (06440).

**Ipomoea coccinea* L.—R; OCB; RD; (01340).

**Ipomoea hederacea* Jacq.—S; OCB; CRP, DIS, RD; (05412).

†*Ipomoea lacunosa* L.—R; OCB; CRP; (01336).

†*Ipomoea pandurata* (L.) G. F. W. Mey.—I; WHR; OH, RB; (00991).

**Ipomoea purpurea* (L.) Roth—S; OCB; RD, CRP; (06881).

CORNACEAE

Cornus alternifolia L. f.—V; WHR; RF; (01757).

†*Cornus amomum* P. Mill.—I; ALL; WM, RM; ST, AS, CS, BWM; (01528).

†*Cornus drummondii* C. A. Mey.—I; OCB; BDF, LKW, BRIP, BO, CG, CB; (04108).

†*Cornus florida* L.—F; ALL; RF, BRF, BDF, OH; (01809).

Cornus foemina P. Mill.—R; EHR; FW; (02341).

Nyssa biflora Walt.—R; HR; RM, FW; (02793).

†*Nyssa sylvatica* Marsh.—O; ALL; OH, BDF, BRF, FW, RM; (02925).

CRASSULACEAE

†*Penthorum sedoides* L.—I; ALL; WM, BWM, RM, BM; (02725).

†*Sedum pulchellum* Michx.—I; OCB; CG, BO, LKW; (00455).

**Sedum sarmentosum* Bunge—R; WHR; RO; (02088).

Δ *Sedum ternatum* Michx.—S; WHR; RF, RO.

CUCURBITACEAE

**Citrullus vulgaris* (Thunb.) Matsumura & Nakai—V; WHR; DIS; (05302).

**Cucurbita pepo* L.—R; OCB; PAS, RD; (01194).

†*Melothria pendula* L.—R; EHR; FW; (04185).

Sicyos angulatus L.—I; OCB; BRIP; (04090).

CUSCUTACEAE

Cuscuta compacta Juss. ex Choisy—S; WHR; CS, ST, RIP; (01299).

Cuscuta gronovii Willd. ex J. A. Schultes—R; EHR; WM; (04203).

Cuscuta pentagona Engelm.—I; OCB, WHR; PAS, RD; (05429).

DIPSACACEAE

**Dipsacus fullonum* L.—R; OCB; PAS, RD; (05173).

EBENACEAE

Diospyros virginiana L.—F; ALL; PAS, BDF; (01908 MTSU).

ELAEAGNACEAE

**Elaeagnus umbellata* Thunb.—R; WHR, OCB; OH, RD, PAS; (03148).

ERICACEAE

Gaylussacia baccata (Wangenh.) K. Koch—V; EHR; FW; (02803).

†*Kalmia latifolia* L.—I; HR; OH, RO; (02894).

†*Oxydendrum arboreum* (L.) DC.—O; ALL; OH, BDF; (03658).

Rhododendron alabamense Rehd.—R; WHR; AS, OH; (01852).

Rhododendron canescens (Michx.) Sweet—I; HR; OH, FW, RM, AS, RB; (01872).

Rhododendron periclymenoides (Michx.) Shinners—R; HR; OH, AS; (01802).

†*Vaccinium arboreum* Marsh.—I; ALL; OH, RB, CB; (02888).

Vaccinium corymbosum L.—R; EHR; FW; (00038).

Vaccinium fuscatum Ait.—I; HR; OH, AS, FW, RM; (03026).

†*Vaccinium pallidum* Ait.—I; WHR; OH, RB; (00423).

Vaccinium stamineum L.—I; HR; OH, RB; (01758).

EUPHORBIACEAE

Acalypha gracilens Gray—R; WHR; RB; (02861).

Acalypha ostryifolia Riddell—I; OCB; CRP, PAS, RD; (04089).

†*Acalypha rhomboidea* Raf.—X; OCB; BO; (A. J. Sharp, S. Fairchild, & E. Clebsch 9859, TENN).

Acalypha virginica L.—O; ALL; RD, DIS, CRP, LWM, CG, GB; (05174).

**Chamaesyce maculata* (L.) Small—I; OCB; PAS, RD, DIS; (05392).

Chamaesyce nutans (Lag.) Small—I; ALL; PAS, RB, RD, CG, CB; (04125).

**Chamaesyce prostrata* (Ait.) Small—R; OCB; CRP, RD; (05320).

Croton capitatus Michx.—S; OCB; CG, CB; (05484).

†*Croton monanthogynus* Michx.—I; OCB; CG, CB, BO, RD; (05617).

Euphorbia corollata L.—I; WHR; RB, OH, RD; (01051).

**Euphorbia cyparissias* L.—R; OCB; RD, LAW; (01652).

Euphorbia dentata Michx.—I; OCB; BO, CG, CB; (00648).

Euphorbia mercurialina Michx.—R; OCB; BRF; (03185).

Phyllanthus caroliniensis Walt.—I; ALL; WM, BWM; (04118).

Tragia cordata Michx.—V; WHR; RO; (05159).

FABACEAE

**Albizia julibrissin* Durazz.—I; ALL; DIS, BRF, RF, RD; (00159).

†*Amorpha fruticosa* L.—S; WHR, OCB; WM, CG; (01130 APSC).

Amorpha nitens Boynt.—R; OCB; CG; (00780).

†*Amphicarpaea bracteata* (L.) Fern.—I; ALL; RF, BRF; (01599).

†*Apios americana* Medik.—I; ALL; WM, BWM, ST; (02855).

Apios priceana B. L. Robins.—R; WHR; RF, RO; (02710).

Astragalus canadensis L.—R; OCB; BO; (06275).

†*Cercis canadensis* L.—F; BDF, LKW, OH, RF, PAS; (01718).

Chamaecrista fasciculata (Michx.) Greene—I; ALL; PAS, RB, RD; (01317).

Chamaecrista nictitans (L.) Moench—S; WHR; RB; (02823).

Clitoria mariana L.—I; WHR; RB; (00233).

**Coronilla varia* L.—I; ALL; RD; (02181).

Crotalaria sagittalis L.—R; WHR; RB; (02852).

Desmanthus illinoensis (Michx.) MacM. ex B. L. Robins. & Fern.—R; OCB; BWM, PAS; (04126).

Desmodium ciliare (Muhl. ex Willd.) DC. var *ciliare*—S; WHR; RB; (02740).

Desmodium cuspidatum (Muhl. ex Willd.) DC. ex Loud.—R; WHR; RF; (01256).

Desmodium glutinosum (Muhl. ex Willd.) Wood—S; WHR; RF; (00994).

Desmodium laevigatum (Nutt.) DC.—R; WHR; RD; (06786).

Desmodium nudiflorum (L.) DC.—I; WHR; OH, RF; (03750).

Desmodium nuttallii (Schindl.) Schub.—I; OCB, WHR; PAS, RD, RB; (01319).

Desmodium paniculatum (L.) DC.—I; ALL; PAS, OH, FW; (04120).

†*Desmodium pauciflorum* (Nutt.) DC.—I; HR; RF; (00245).

Desmodium perplexum Schub.—R; WHR; RF; (01530).

Desmodium rotundifolium DC.—I; WHR; OH, RB; (02901).

Desmodium viridiflorum (L.) DC.—S; WHR; RB; (02856).

Galactia volubilis (L.) Britt.—I; WHR, OCB; RB, OH, CG, CB; (03705).

Gleditsia triacanthos L.—O; OCB; PAS, BRF, BRIP; (05400).

**Kummerowia stipulacea* (Maxim.) Makino—R; WHR; RD; (02706).

**Kummerowia striata* (Thunb.) Schindl.—F; ALL; PAS, LAW, RD; (05399).

**Lathyrus hirsutus* L.—R; EHR; WM, PAS; (02358).

Lathyrus latifolius L.—R; WHR; RD; (03740).

**Lespedeza bicolor* Turcz.—S; WHR; RD, PAS, RB; (03668).

**Lespedeza cuneata* (Dum.-Cours.) G. Don—C; ALL; PAS, RD, RB; (04071).

Lespedeza frutescens (L.) Hornem.—S; WHR; RB; (02878).

Lespedeza hirta (L.) Hornem. subsp. *hirta*—I; WHR; OH, RB; (02904).

Lespedeza procumbens Michx.—I; WHR, OCB; RB, OH, CB; (02862).

Lespedeza repens (L.) W. Bart.—S; WHR; RB; (03739).

Lespedeza violacea (L.) Pers.—R; OCB; CG; (05488).

Lespedeza virginica (L.) Britt.—I; WHR; RB; (01141).

**Medicago lupulina* L.—F; ALL; PAS, RD; (01786).

**Melilotus albus* Medik.—F; ALL; PAS, RD, DIS; (00755).

**Melilotus officinalis* (L.) Lam.—I; WHR; RD; (02079).

Mimosa microphylla Dry.—S; WHR; RB; (02314).

Orbexilum pedunculatum (P. Mill.) Rydb. var. *pedunculatum*—R; WHR; RB, OH; (02077).

Pediomelum subacaule (Torr. & Gray) Rydb.—V, possibly X; OCB; CG, moist soil; (D. McGavock 32, MTSU).

Phaseolus polystachios (L.) B. S. P.—R; WHR; RB; (01091).

*†*Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida—S; OCB, WHR; DIS, RD; (03670).

***Robinia hispida* L. var. *hispida*—R; WHR; LAW, RD; (01185).

Robinia pseudoacacia L.—O; ALL; BDF, BRF, RF, PAS; (05286).

Senna marilandica (L.) Link—R; OCB, WHR; CG, PAS, RF; (06433).

**Senna obtusifolia* (L.) Irwin & Barneby—I; OCB, WHR; CRP; (05269).

Strophostyles umbellata (Muhl. ex Willd.) Britt.—I; WHR; RB; (02701).

Stylosanthes biflora (L.) B. S. P.—I; WHR; RB; (02700).

Tephrosia virginiana (L.) Pers.—I; WHR; RB; (02182).

*†*Trifolium campestre* Schreb.—O; ALL; PAS, RD; (00600).

**Trifolium incarnatum* L.—R; OCB; CB; (01962).

**Trifolium pratense* L.—F; ALL; PAS, RD; (00770).

**Trifolium repens* L.—C; ALL; LAW, PAS, RD, CG; (03271).

†*Vicia caroliniana* Walt.—I; WHR; RF, OH; (01722).

**Vicia grandiflora* Scop.—R; OCB; PAS, RD; (01770).

†*Vicia minutiflora* F. G. Dietr.—I; OCB, WHR; LKW, BDF, RF; (00448).

**Vicia sativa* L. subsp. *nigra* (L.) Ehrh.—I; OCB; PAS, RD; (01769).

**Vicia villosa* Roth subsp. *varia* (Host) Corb.—S; WHR; RD; (01005).

FAGACEAE

Castanea dentata (Marsh.) Borkh.—S; WHR, OCB; OH, BDF; (00973).

**Castanea mollissima* Blume—R; OCB; RD, LAW; (00141).

†*Fagus grandifolia* Ehrh.—F; ALL; BRF, RF, FW; (00135).

Quercus alba L.—F; ALL: OH, BDF, RF, BRF; (02924).

Quercus bicolor Willd.—V; OCB; BWM; (00988).

Quercus coccinea Munchh.—I; HR; OH; (05314).

Quercus falcata Michx.—O; HR; OH; (01311).

Quercus × *filialis* Little—V; WHR; RM, WM; (02909).

†*Quercus imbricaria* Michx.—S; OCB, WHR; BDF, OH; (04107).

Quercus lyrata Walt.—R; HR; RM, WM, FW; (02907).

Quercus marilandica Munchh.—S; HR; OH, RB; (02926).

Quercus michauxii Nutt.—R; OCB; BRIP; (02922).

Quercus montana Willd.—O; ALL; OH, BDF; (05904).

†*Quercus muehlenbergii* Engelm.—C; ALL; LKW, BDF, BO, BRF, RF, RO; (04094).

Quercus nigra L.—S; EHR; FW; (04113).

†*Quercus pagoda* Raf.—S; OCB; BDF, BRIP; (00007).

†*Quercus phellos* L.—I; HR; FW, RM, WM, OH; (02910).

Quercus rubra L.—O; ALL; RF, BRF, LKW; (01476).

†*Quercus shumardii* Buckl.—C; ALL; BDF, BRF, LKW, BO, RF; (05422).

Quercus stellata Wangenh.—O; ALL; OH, BDF; (04112).

Quercus velutina Lam.—O; ALL; OH, BDF; (00960).

FUMARIACEAE

†*Corydalis flavula* (Raf.) DC.—I; OCB, WHR; BRF, BDF, RF, LKW; (03139).

Dicentra cucullaria (L.) Bernh.—R; WHR; RF; (01698).

GENTIANACEAE

Bartonia paniculata (Michx.) Muhl.—V; EHR; FW; (05388).

Bartonia virginica (L.) B. S. P.—V; WHR; AS; (01310).

Frasera caroliniensis Walt.—I; WHR, OCB; RF, OH, BDF, LKW; (00963).

Obolaria virginica L.—R; WHR; OH; (03140).

Sabatia angularis (L.) Pursh—I; WHR, OCB; RB, CG; (03712).

Sabatia brachiata Ell.—R; WHR; RB; (03651).

GERANIACEAE

Geranium carolinianum L. var. *carolinianum*—I; ALL; PAS, RD, CG; (01951).

**Geranium dissectum* L.—S; OCB; CRP, LAW, PAS; (01946).

Geranium maculatum L.—I; HR; RF; (01762).

**Geranium molle* L.—S; OCB; LKW, CG, CB; (01775).

GROSSULARIACEAE

Itea virginica L.—S; HR; AS, RM, WM, FW; (00549).

HALORAGACEAE

**Myriophyllum aquaticum* (Vell.) Verdc.—R; OCB; FP, BWM; (05280).

Proserpinaca palustris L.—R; HR; RM, FW, ST; (00561).

HAMAMELIDACEAE

Hamamelis virginiana L.—I; HR; RF; (01050).

Liquidambar styraciflua L.—O; ALL; FW, OH, BDF, RM; (00790).

HIPPOCASTANACEAE

Aesculus flava Ait.—I; ALL; BRF, RF; (05838).

†*Aesculus glabra* Willd.—I; OCB; BDF, PAS; (00818).

Aesculus × *hybrida* DC.—V; WHR; RF; (00408 VDB).

Aesculus pavia *L.—O; ALL; BRF, BDF, RF; (01798).*

HYDRANGEACEAE

†*Decumaria barbara* L.—R; WHR; RF, RIP; CS; (03757).

Hydrangea arborescens L.—R; OCB; BRF; (03515).

†*Hydrangea cinerea* Small—F; ALL; RF, BRF, RO, BO; (02452).

Hydrangea quercifolia Bartr.—R; WHR; OH; (02100).

Philadelphus hirsutus Nutt.—S; WHR; RF, RO; (02188).

†*Philadelphus pubescens* Loisel. var. *pubescens*—S; OCB; BO, BDF; (A. J. Sharp, S. Fairchild, & E. Clebsch 9864, TENN).

HYDROPHYLLACEAE

Hydrophyllum appendiculatum Michx.—I; OCB, WHR; BRF, RF; (01932).

Hydrophyllum macrophyllum Nutt.—R; WHR; RF; (02145).

†*Nemophila aphylla* (L.) Brummitt—O; OCB; LKW, BDF, BRF; (01717).

†*Phacelia bipinnatfida* Michx.—O; ALL; RF, BRF; (00402).

Phacelia dubia (L.) Trel. var. *interior* Fern.—V; OCB; CG; (01782).

†*Phacelia purshii* Buckl.—O; OCB; PAS, CG, RD; (03264).

JUGLANDACEAE

†*Carya cordiformis* (Wangenh.) K. Koch—O; ALL; RF, BRF; (05421).

Carya glabra (Mill.) Sweet—O; ALL; OH, RF, BDF, BRF; (00028).

Carya ovalis (Wang.) Sarg.—O; OCB, WHR; RF, BDF, BRF; (00057).

***Carya illinoinensis* (Wangenh.) K. Koch—R; OCB; RD; (02923).

Carya laciniosa (F. Michx.) Loudon—R; OCB; BRF, BDF; (05387).

†*Carya ovata* (P. Mill.) K. Koch var. *australis* (Ashe) Little—I; OCB; BDF, LKW, BO, CG, CB; (00611).

Carya ovata (P. Mill.) K. Koch var. *ovata*—F; ALL; BDF, OH, BRF, RF, LKW; (05406).

Carya tomentosa (Poir.) Nutt.—O; ALL; OH, BDF; (00139).

Juglans cinerea L.—S; ALL; RF, BRF, RIP; (00249).

Juglans nigra L.—F; ALL; BRIP, RIP, BRF, RF; (05285).

LAMIACEAE

†*Agastache nepetoides* (L.) Kuntze—S; WHR; RF, RIP; (R. Kral 36930, TENN).

*Δ *Ajuga reptans* L.—R; OCB; LAW.

Blephilia ciliata (L.) Benth.—I; OCB, WHR; CG, LKW, RF; (03273).

Blephilia hirsuta (Pursh.) Benth.—R; WHR, OCB; RF, BRIP; (03741).

*†*Calamintha nepeta* (L.) Savi—V; OCB; BDF, BO; (01003 VDB).

Collinsonia canadensis L.—I; WHR; RF; (01533).

Cunila origanoides (L.) Britt.—R; WHR; OH; (02973).

**Glechoma hederacea* L.—O; ALL; PAS, LAW, RD, RF, BRF; (01702).

Hedeoma hispida Pursh—R; OCB; PAS; (04895).

Isanthus brachiatus (L.) B. S. P.—I; OCB; CG; (05650).

*†*Lamium amplexicaule* L.—F; ALL; PAS, LAW, RD; (01619).

**Lamium purpureum* L.—F; ALL; PAS, LAW, RD; (00360).

Lycopus americanus Muhl. ex W. Bart.—S; OCB, EHR; LWM, FW; (06788).

Lycopus rubellus Moench—I; WHR, OCB; CS, BWM; (01267).

Lycopus virginicus L.—I; OCB; BWM, BM; (05250).

*†*Marrubium vulgare* L.—X; OCB; thin limestone soil; (A. J. Sharp, C. J. Felix, & B. Adams 10968, TENN).

**Mentha × piperita* L.—O; WHR, OCB; WM, BWM, BM; (01038).

†*Monarda bradburiana* Beck—S; WHR; OH, RB, RF; (02076).

Monarda fistulosa L.—I; WHR; RB; (00964).

*†*Perilla frutescens* (L.) Britt.—F; ALL; PAS, DIS, RD, GB; (04069).

**Prunella vulgaris* L.—O; ALL; PAS, BWM, RD; (00940).

†*Pycnanthemum loomisii* Nutt.—O; WHR; RB, RD, PAS, OH; (02845).

Pycnanthemum muticum (Michx.) Pers.—R; EHR; WM; (06303).

Pycnanthemum tenuifolium Schrad.—I; WHR; RB; (03650).

†*Salvia lyrata* L.—O; ALL; PAS, RD, OH, BDF, LKW, CG, CB; (00609).

Salvia urticifolia L.—R; WHR; OH, RB; (02252).

Scutellaria elliptica Muhl. ex Spreng. var. *hirsuta* (Short & Peter) Fern.—I; WHR; RF; (05151).

Scutellaria incana Biehler var. *incana*—R; WHR; WM; (00581).

Scutellaria integrifolia L.—R; EHR; WM; (02338).

Scutellaria lateriflora L.—I; WHR, OCB; WM, BWM; (01265).

Scutellaria ovata Hill—R; OCB; BDF; (00656).

†*Scutellaria parvula* Michx. var. *parvula*—S; OCB; CG, CB; (01785).

†*Teucrium canadense* L.—I; OCB; BWM, BM, PAS; (03491).

Trichostema dichotomum L.—V; WHR; RB; (02860).

LAURACEAE

†*Lindera benzoin* (L.) Blume var. *benzoin*—O; ALL; RF, BRF, RIP, BRIP; (02977).

Lindera benzoin (L.) Blume var. *pubescens* (Palmer & Steyermark) Rehd. —R; OCB; BM; (03886).

†*Sassafras albidum* (Nutt.) Nees—O; ALL; OH, BDF, PAS, RB; (03657).

LINACEAE

Linum medium (Planch.) Britt. var. *texanum* (Planch.) Fern.—R; WHR; RB; (02741).

Linum striatum Walt.—I; HR; WM; (02795).

†*Linum virginianum* L.—R; WHR; RD, RB; (03686).

LOGANIACEAE

Mitreola petiolata (J.F.Gmel.) Torr. & Gray—R; EHR; FW; (02792).

Spigelia marilandica (L.) L.—O; ALL; RF, BRF, BDF, BO, RO; (00993).

LYTHRACEAE

Ammannia coccinea Rottb.—R; OCB; BWM; (05414).

Cuphea viscosissima Jacq.—S; OCB; LWM, CG, CB, BO; (02875).

Rotala ramosior (L.) Koehne—I; ALL; WM, BWM, RM, FP; (04079).

MAGNOLIACEAE

Liriodendron tulipifera L.—C; ALL; RF, BRF; (00136).

Magnolia acuminata (L.) L.—R; WHR; RF; (01755 VDB).

**Magnolia grandiflora* L.—R; OCB; LAW, RD; (06268).

†*Magnolia macrophylla* Michx.—R; HR; RF; (02121).

MALVACEAE

†*Hibiscus moscheutos* L. subsp. *moscheutos*—I; ALL; WM, RM, FW, BWM, BM; (01133).

**Hibiscus syriacus* L.—S; WHR, OCB; RF, RD, LAW; (06444).

**Hibiscus trionum* L.—V; OCB; CRP; (01339).

Malvastrum hispidum (Pursh.) Hochr.—R; OCB; CG; (05631).

*†*Sida spinosa* L.—O; ALL; PAS, DIS, RD, CG; (05482).

MELASTOMATACEAE

Rhexia mariana L. var. *interior* (Pennell) Kral & Bostick—R; HR; RM, FW; (02796 VDB).

Rhexia mariana L. var. *mariana*—S; EHR; WM; (02769).

Rhexia virginica L.—S; HR; WM, FW; (02704).

MENISPERMIACEAE

Calycocarpum lyonii (Pursh) Gray—S; OCB, WHR; BRIP, RF; (03734).

Cocculus carolinus (L.) DC.—O; OCB, WHR; BDF, BRF, RO, LKW, CG, RD; (01470).

†*Menispermum canadense* L.—I; WHR, OCB; RF, BRF; (03694).

MOLLUGINACEAE

Mollugo verticillata L.—I; OCB; CRP; (01177).

MONOTROPACEAE

Monotropa uniflora L.—V; WHR; RF; (02830).

MORACEAE

**Broussonetia papyrifera* (L.) L'Hér. ex Vent.—S; OCB; UT, BDF, RD, LAW; (05315).

**Maclura pomifera* (Raf.) Schneid.—O; OCB; PAS, BDF, LAW; (04106).

**Morus alba* L.—R; EHR, OCB; UT; (05016).

Morus rubra L.—O; ALL; BRF, BDF, BRIP, RIP, RF; (03875).

OLEACEAE

Chionanthus virginicus L.—S; WHR; OH, FW; (02794).

†*Forestiera ligustrina* (Michx.) Poir.—I; OCB; LKW, CG, CB, BDF, BO; (02873).

**Forsythia viridissima* Lindl.—R; OCB; LAW; (03033).

Fraxinus americana L.—F; ALL; RF, BRF, BDF, (05279).

†*Fraxinus pennsylvanica* Marsh.—O; ALL; BRIP, RIP, BM, RM, BWM, WM, FW; (00154).

†*Fraxinus quadrangulata* Michx.—I; OCB; LKW, CG, BDF, BO, BRF; (00653).

**Jasminum nudiflorum* Lindl.—R; OCB; RD; (01604).

**Ligustrum sinense* Lour.—C; ALL; BRIP, RIP, BRF, RF, BDF, LAW, LKW; (02198).

ONAGRACEAE

†*Circaea lutetiana* L. subsp. *canadensis* (L.) Aschers & Magnus—I; HR; RF; (00949).

†*Epilobium coloratum* Biehler—S; OCB, WHR; BWM, WM; (R. Kral 36940, VDB).

Ludwigia alternifolia L.—I; ALL; WM, RM, BWM, BM, AS; (02705).

Ludwigia decurrens Walt.—S; WHR, OCB; WM, BWM, FP, GB; (01330).

Ludwigia glandulosa Walt.—R; OCB; BWM; (05427).

Ludwigia linearis Walt.—V; EHR; WM; (02778).

Ludwigia palustris (L.) Ell.—O; ALL; RM, BM, WM, BWM, ST, FP; (01146).

**Ludwigia uruguayensis* (Camb.) H. Hara—V; WHR; ST; (06266).

Oenothera biennis L.—O; ALL; PAS, RD; (02919).

†*Oenothera laciniata* Hill—S; OCB; CG, DIS, RD, CRP; (01966).

**Oenothera speciosa* Nutt.—S; EHR, OCB; RD; (00558).

Oenothera triloba Nutt.—S; OCB; CG; (01779).

OROBANCHACEAE

Conopholis americana (L.) Wallr. f.—S; WHR, OCB; RF, BRF, LKW; (01787).

†*Epifagus virginiana* (L.) W. Bart.—S; WHR; RF; (01534).

OXALIDACEAE

Oxalis illinoensis Schwegm.—R; WHR; RF; (01929).

†*Oxalis priceae* Small subsp. *priceae*—S; OCB; CG; (01949).

Oxalis stricta L.—F; ALL; PAS, DIS, RD, LAW, RB, OH, BDF, GB; (02067).

†*Oxalis violacea* L.—I; OCB, WHR; CG, LKW, BO, RO; (01721).

PAPAVERACEAE

*Δ *Papaver dubium* L.—R; OCB; RD.

†*Sanguinaria canadensis* L.—O; ALL; RF, BRF; (01664).

Stylophorum diphyllum (Michx.) Nutt.—R; HR; RF; (01803).

PASSIFLORACEAE

†*Passiflora incarnata* L.—F; PAS, RD; (03747).

Passiflora lutea L.—S; WHR; RF; (01251).

PHYTOLACCACEAE

Phytolacca americana L. var. *americana*—F; ALL; PAS, RD; (00763).

PLANTAGINACEAE

Plantago aristata Michx.—R; WHR; PAS, RB; (01192).

**Plantago lanceolata* L.—F; ALL; PAS, LAW, RD; (00938).

Plantago rugelii Dcne.—F; ALL; PAS, LAW, RD; (00951).

Plantago virginica L.—I; WHR, OCB; RD, CG; (01901).

PLATANACEAE

Platanus occidentalis L.—C; ALL; BRIP, RIP, BM, BWM, RM, WM, FW; (04930).

PODOSTEMACEAE

Podostemum ceratophyllum Michx.—R; OCB; RIV, swift shallows; (03488).

POLEMONIACEAE

†*Phlox amoena* Sims—R; WHR; RB; (00351).

†*Phlox divaricata* L. subsp. *divaricata*—O; HR; RF, RIP; (01723).

†*Phlox glaberrima* L.—R; WHR; AS; (00956).
Phlox paniculata L.—R; WHR, OCB; RIP, RF, BRIP, RD; (03532).
Polemonium reptans L.—O; ALL; RF, BRF, RIP; (01734).

POLYGALACEAE

Polygala ambigua Nutt.—R; WHR; RB; (02742).
Polygala cruciata L.—V; EHR; WM; (06301).
Polygala incarnata L.—R; WHR; RB; (02853).
Polygala sanguinea L.—S; HR; WM, RM; (01148).

POLYGONACEAE

**Polygonum aviculare* L.—S; ALL; RD, GB; (02354).
*†*Polygonum caespitosum* Blume var. *longisetum* (de Bruyn) A. N. Steward—O; ALL; GB, ST, BRIP, RIP, RF, BRF, DIS, (03699).
**Polygonum cuspidatum* Seib. & Zucc.—R; OCB; UT; (06436).
*†*Polygonum hydropiper* L.—X; WHR; RM; (A. J. Sharp, E. Clebsch, & A. Clebsch 9822, TENN).
Polygonum hydropiperoides Michx.—I; ALL; WM, RM, BWM, BM, FW; (02760).
Polygonum lapathifolium L.—S; ALL; WM, BWM; (05162).
†*Polygonum pensylvanicum* L.—O; WHR, OCB; WM, BWM; (05463).
**Polygonum persicaria* L.—I; OCB; BWM, RD, DIS; (05168).
†*Polygonum punctatum* Ell.—I; EHR, OCB; WM, BWM; (03858).
Polygonum sagittatum L.—S; HR; WM; (01381).
†*Polygonum scandens* L.—S; WHR; RO; (06328).
Polygonum setaceum Baldw.—R; WHR; GB, ST; (01253).
†*Polygonum virginianum* L.—O; ALL; RF, BRF, BDF, LKW; (01127).
**Rumex acetosella* L.—I; ALL; PAS, RD; (01854).
Rumex altissimus Wood—I; ALL; BWM, BM, WM, RM; (02062).
**Rumex conglomeratus* Murr.—V; OCB; BWM; (06442).
**Rumex crispus* L. subsp. *crispus*—F; ALL; PAS, DIS, RD; (02204).
**Rumex obtusifolius* L.—R; WHR; RD; (02829).

PORTULACACEAE

†*Claytonia virginica* L.—O; ALL; RF, BRF, BDF; (01699).
†***Phemeranthus calcaricus*** (S. Ware) Kiger—R; OCB; CG; (03703).
**Portulaca oleracea* L.—I; OCB; CG, CRP, RD; (04102).

PRIMULACEAE

Dodecatheon meadia L.—R; WHR; RF; (03134 MTSU).
Lysimachia ciliata L.—R; WHR; RIP; (05294).
**Lysimachia nummularia* L.—S; OCB; BWM, BRIP; (02201).
Lysimachia quadrifolia L.—R; WHR; RF; (03679).
†*Samolus valerandi* L. subsp. *parviflorus* (Raf.) Hultén—S; WHR, OCB; CS, ST, GB; (03761).

PYROLACEAE

Chimaphila maculata (L.) Pursh—F; ALL; OH, BDF; (00231).

RANUNCULACEAE

†*Actaea pachypoda* Elliott—I; ALL; RF, BRF; (01807 APSC).
†*Anemone acutiloba* (DC.) G. Lawson—O; HR; RF; (00317).
Anemone americana (DC.) H. Hara—R; WHR; OH; (01633).
Anemone quinquefolia L. var. *quinquefolia*—R; WHR; RF; (03137).
†*Anemone virginiana* L.—I; WHR, OCB; RB, CG, CB, BDF; (01049).
†*Aquilegia canadensis* L.—I; ALL; BO, RO, LKW, CG; (00342).
Cimicifuga rubifolia Kearney—R; WHR; RF; (02912).
†*Clematis catesbyana* Pursh—R; OCB; CG, CB, BDF; (03252).
**Clematis terniflora* DC.—R; OCB; RD; (01341).
†*Clematis versicolor* Small ex Rydb.—R; OCB; BO, BDF; (06423).
Clematis viorna L.—R; WHR; RF; (04914).
Clematis virginiana L.—O; OCB, WHR; BRIP, RIP, RD; (01260).
**Consolida ajacis* (L.) Schur—V; OCB; LKW; (03645).
†*Delphinium tricorne* Michx.—I; OCB, WHR; BRF, RF, LKW; (01794).
Enemion biternatum Raf.—R; WHR; RF; (01696).
Hydrastis canadensis L.—S; WHR, OCB; RF, BRF; (01266).
†*Myosurus minimus* L.—R; OCB; PAS, CRP, RD; (E. Quarterman 5261, VDB).
†*Ranunculus abortivus* L.—O; ALL; BRIP, RIP, LAW, RD, PAS, FW, BRF, RF; (01669).
**Ranunculus bulbosus* L.—S; OCB; RD; (05837).

†*Ranunculus fascicularis* Muhl. ex Bigelow—S; OCB; CG, CB, LKW; (00343).

Ranunculus hispidus Michx. var. *hispidus*—I; WHR; RF, OH; (01865).

Ranunculus hispidus Michx. var. *nitidus* (Chapman) T. Duncan—S; EHR, OCB; WM, FW, BWM; (01668).

†*Ranunculus micranthus* Nutt.—S; OCB; LKW, BO; (01778).

*†*Ranunculus parviflorus* L.—V; OCB; RD; (R. Kral 64879, 2 May 1980, VDB).

Ranunculus pusillus Poir.—S; ALL; WM, BWM; (02054).

†*Ranunculus recurvatus* Poir.—I; HR; RF; (00602).

**Ranunculus sardous* Crantz—C; ALL; PAS, RD, LWM, CG; (00939 VDB).

†*Thalictrum dioicum* L.—R; WHR; RF, RO; (01868).

Thalictrum revolutum DC.—S; WHR, OCB; WM, BWM; (03865).

†*Thalictrum thalictroides* (L.) Eames & B. Boivin—F; ALL; RF, BRF, LKW; (01667).

RHAMNACEAE

Berchemia scandens (Hill) K. Koch—S; OCB, WHR; BRF, RF; (02128).

Ceanothus americanus L.—S; WHR; RB; (00232).

Frangula caroliniana (Walt.) Gray—O; ALL; BRF, BDF, LKW, RF, PAS, RD; (03646).

Rhamnus lanceolata Pursh.—R; OCB; LKW, CG; (02885).

ROSACEAE

Agrimonia parviflora Ait.—S; WHR, OCB; WM, BWM; (01132).

Agrimonia pubescens Wallr.—S; OCB; BDF; (01178).

†*Agrimonia rostellata* Wallr.—I; WHR; RF; (01262).

Amelanchier arborea (Michx. f.) Fern.—O; HR; OH, RB, FW; (00128).

Amelanchier canadensis (L.) Medik.—R; WHR; RB, OH: (02141).

**Chaenomales speciosa* (Sweet) Nakai—V; OCB; BDF (06273).

Crataegus calpodendron (Ehrh.) Medik.—S; WHR, OCB; RF, BRF; (01915).

Crataegus collina Chapm.—R; OCB, WHR; PAS; (03771).

Crataegus crus-galli L.—S; OCB, WHR; PAS, BDF, OH, RB; (03854).

Crataegus intricata Lange—O; ALL; PAS, RF, BRF, BDF; (02137).

Crataegus marshallii Egglest.—R; EHR; FW; (00552).

Crataegus pruinosa (Wendl. f.) K. Koch—R; OCB, WHR; PAS, BDF; (00226).

Crataegus spathulata Michx.—V; OCB; BDF; (s.n.).

**Duchesnea indica* (Andr.) Focke—F; ALL; PAS, RD, LAW; (05967).

Fragaria virginiana Duchesne—R; OCB; CG; (04458).

†*Geum canadense* Jacq.—I; WHR, OCB; RF, BRF, LKW; (00944).

†*Geum vernum* (Raf.) Torr. & Gray—R; OCB; BRF; (01975).

†*Geum virginianum* L.—X; OCB, WHR; densely wooded slopes; (H. K. Svenson 8811, TENN).

Malus angustifolia (Ait.) Michx.—S; HR; RB, OH, PAS; (01754).

**Malus pumila* P. Mill.—R; OCB; PAS, LAW; (00252).

Photinia melanocarpa (Michx.) Robertson & Phipps—R; HR; FW, RB; (03186).

Photinia pyrifolia (Lam.) Robertson & Phipps—I; HR; AS, RM, WM, FW; (01847).

Physocarpus opulifolius (L.) Maxim.—V; OCB; BO; (00836 APSC).

Porteranthus stipulatus (Muhl. ex Willd.) Britt.—S; WHR; OH, RB; (02251).

**Potentilla recta* L.—I; OCB; RD, PAS, CG, CB; (02099).

†*Potentilla simplex* Michx.—I; WHR; OH, RB; (01857); [Plants of cedar glades and cedar barrens in the county may belong to the variety *argyrisma* Fern. while plants from other habitats seem to belong to the typical variety].

Prunus americana Marsh.—O; ALL; BDF, BRF, RF, PAS, RD, CG; (01795).

†*Prunus angustifolia* Marsh.—O; OCB; PAS, RD, CG; (01320).

**Prunus caroliniana* Ait.—V; OCB; UT, RD; (00352).

**Prunus cerasifera* Ehrh.—R; OCB; PAS; (05409).

Prunus hortulana Bailey—R; OCB; RD; (01745).

*Δ *Prunus mahaleb* L.—R; OCB; BDF, LAW.

†*Prunus mexicana* S. Wats.—S; OCB; BDF, PAS; (00260 VDB).

Prunus munsoniana W. Wight & Hedrick—R; WHR; RD; (00248).

**Prunus persica* (L.) Batsch—I; ALL: RD, PAS, LAW; (06446).

Prunus serotina Ehrh.—F; ALL; BRF, RF, BDF, OH, PAS; (01791).

**Pyracantha fortuneana* (Maxim.) Li—V; OCB; PAS; (05632).

**Pyrus calleryana* Decne.—R; EHR; RD; (05424).

**Pyrus communis* L.—S; OCB; PAS, LAW; (05968).

Rosa carolina L.—S; OCB, WHR; CG, CB, RB; (02109).

**Rosa multiflora* Thunb. ex Murr.—F; ALL; PAS, BDF, BRF, RF, BRIP, RIP, RD; (05293).

Rosa setigera Michx.—O; OCB, WHR; BDF, PAS, RD, BWM; (03890).

Rubus alumnus Bailey—R; WHR; OH; (00032).

Rubus argutus Link—C; ALL; PAS, RD; (05410).

*Δ *Rubus bifrons* Vest ex Tratt—R; OCB; PAS, RD.

**Rubus discolor* Weihe & Nees—R; EHR; RD; (05425).

Rubus flagellaris Willd.—I; HR; RB, OH, PAS; (00398).

Rubus occidentalis L.—I; ALL: BRF, RF, BDF; (06445).

Rubus pensilvanicus Poir.—R; EHR; RF; (05405).

*Δ *Rubus phoenicolasius* Maxim.—V; OCB; BRF.

Rubus trivialis Michx.—R; OCB; RD; (01789).

**Spiraea prunifolia* Seib. & Zucc.—S; WHR, OCB; RD, LAW; (01700).

**Spiraea thunbergii* Seib.—R; OCB; CG, LAW: (01615).

RUBIACEAE

†*Cephalanthus occidentalis* L.—I; ALL; WM, RM, BWM, BM, FW, FP; (00764).

**Cruciata pedemontana* (Bellardi) Ehrend.—R; OCB; RD; (02195).

Diodia teres Walt.—O; ALL; PAS, RB, CB, CG, RD; (01190).

†*Diodia virginiana* L.—I; OCB, WHR; BWM, WM, PAS; (01143).

†*Galium aparine* L.—F; ALL; BRF, RF, LKW, PAS, RD, BRIP, RIP; (01961).

Galium circaezans Michx.—I; ALL; RF, BRF, LKW; (05147).

*†*Galium mollugo* L.—V; OCB; PAS; (R. Kral 64888, VDB).

Galium obtusum Bigelow—R; EHR; FW; (00554).

**Galium parisiense* L.—R; OCB; RD; (06439).

†*Galium pilosum* Ait.—I; WHR; RB, PAS; (00761).

Galium tinctorium L.—I; ALL; WM, BWM; (02833).

Galium triflorum Michx.—O; ALL; RF, BRF, LKW, RO, BO; (02451).

Houstonia caerulea L.—I; HR; OH; (00429).

Houstonia purpurea L. var. *calycosa* Gray—S; OCB; CG, CB; (03274).

Houstonia purpurea L. var. *purpurea*—I; ALL; RF, OH, BRF, BDF; (02126).

Houstonia pusilla Schoepf—S; OCB, WHR; PAS, CRP; (01635).

†*Mitchella repens* L.—S; HR; FW, OH; (05394).

*†*Sherardia arvensis* L.—I; OCB; PAS, LAW; (01939).

RUTACEAE

**Poncirus trifoliata* (L.) Raf.—S; OCB; PAS, BDF; (05835).

Ptelea trifoliata L.—R; OCB; BDF, BRIP; (03742).

SALICACEAE

**Populus alba* L.—S; WHR; RD, LAW; (03873).

*Δ *Populus* × *canescens* (Ait.) Sm.—V; OCB; PAS.

Populus deltoides Bartr. ex Marsh.—I; OCB; BRIP, BWM, BM, DIS; (01971).

*Δ *Populus nigra* L.—V; WHR; PAS.

Salix caroliniana Michx.—I; WHR, OCB; RIP, GB; (03749).

Salix humilis Marsh. var. *humilis*—R; WHR; RB; (01910).

Salix interior Rowlee.—I; OCB; BWM, BM, BRIP, GB, RD; (01948).

Salix nigra Marsh.—F; ALL; BRIP, RIP, BM, RM, BWM, WM, FP; (00160).

**Salix* × *sepulcralis* Simonkai—R; OCB; RD, BRIP; (05969).

Salix sericea Marsh.—R; WHR; WM, ST; (00066).

SAPINDACEAE

**Cardiospermum halicacabum* L.—S; OCB; BWM, PAS; (01201).

SAPOTACEAE

†*Sideroxylon lycioides* L.—I; OCB; BDF, LKW, CG, CB; (05633).

SAURURACEAE

Saururus cernuus L.—R; OCB, EHR; BM, BWM, FW; (03887).

SAXIFRAGACEAE

†*Heuchera americana* L. var. *americana*—S; WHR; RF; (02133).

†*Heuchera villosa* Michx.—O; ALL; RO, BO, LKW; (06281); [Giles County material is referable to var. *macrorhiza* (Small) Rosl, But. & Lak.].

Mitella diphylla L.—R; WHR; CS, RF; (01766).

†*Saxifraga virginiensis* Michx.—O; ALL; RO, BO, LKW, RF, BRF; (01622).

Tiarella cordifolia L. var. *collina* Wherry—O; HR; RF; (03135).

SCROPHULARIACEAE

Agalinis gattingeri (Small) Small—S; WHR; RB, OH; (02914).

Agalinis purpurea (L.) Pennell—R; EHR; WM, FW; (04184).

Aureolaria flava (L.) Farw.—I; WHR; OH; (02897).

Aureolaria pectinata (Nutt.) Pennell—S; WHR; RB, OH; (03683).

†*Aureolaria virginica* (L.) Pennell—R; EHR; FW, OH; (02798).

†*Chelone glabra* L.—I; WHR, OCB; WM, BWM, CS, AS, ST; (01302).

Dasistoma macrophylla (Nutt.) Raf.—S; WHR, OCB; RF, RD, BDF; (00935).

†*Gratiola neglecta* Torr.—S; EHR, OCB; WM, FW, BWM; (02059).

Gratiola pilosa Michx.—R; EHR; WM; (05020).

Gratiola virginiana L.—S; HR; FW, AS; (03190).

Leucospora multifida (Michx.) Nutt.—R; OCB; CRP; (05318).

Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperrider—V; WHR; RB, DIS; (06791).

Lindernia dubia (L.) Pennell var. *dubia*—S; EHR, OCB; WM, BWM; (05014).

Mecardonia acuminata (Walt.) Small var. *acuminata*—R; OCB; LWM, CG; (02893).

†*Mimulus alatus* Ait.—I; HR; WM; (05022).

**Paulownia tomentosa* (Thunb.) Sieb. & Zucc. ex Steud.—O; ALL; BRF, RF, RD; (05404).

Pedicularis canadensis L.—S; WHR; RF; (02131).

†*Penstemon calycosus* Small—I; OCB, WHR; PAS, RD, BRIP, BO; (02098).

†*Penstemon tenuiflorus* Pennell—R; OCB; CG, CB; (03269).

Scrophularia marilandica L.—R; OCB, WHR; BRF, RF; (05155).

**Verbascum blattaria* L.—I; OCB, PAS, CG, RD; (03639).

**Verbascum thapsus* L.—F; ALL; PAS, RD; (00965).

*†*Veronica agrestis* L.—R; OCB; CRP, RD; (00321).

Δ *Veronica anagallis-aquatica* L.—R; OCB; ST.

*†*Veronica arvensis* L.—I; ALL; RD, DIS, BDF; (01759).

**Veronica hederifolia* L.—R; WHR; RO; (01720).

**Veronica peregrina* L. subsp. *peregrina*—I; OCB, WHR; CRP, RD, DIS; (02093 APSC).

**Veronica persica* Poir.—R; OCB; RD, LAW; (04351).

**Veronica polita* Fries.—R; WHR; RD; (00122 VDB).

Veronicastrum virginicum (L.) Farw.—R; WHR; RB; (02707).

SIMAROUBACEAE

**Ailanthus altissima* (P. Mill.) Swingle—O; ALL; BRF, BDF, RF, RD; (05312).

SOLANACEAE

**Datura stramonium* L.—I; ALL: PAS, RD, DIS; (04128).

*Δ *Nicandra physalodes* (L.) Gaertn.—R; OCB; CRP.

Physalis angulata L.—I; OCB, WHR; CRP, DIS, RD; (01335).

Physalis heterophylla Nees—S; OCB; CG; (04921).

†*Physalis longifolia* Nutt. var. *subglabrata* (Mackenzie & Bush) Cronq.—I; OCB; RD, PAS; (01206).

Physalis virginiana Mill. var. *virginiana*—R; WHR; OH, RB; (02250).

Solanum carolinense L. var. *carolinense*—O; ALL; PAS, RD, DIS; (02312).

Solanum ptychanthum Dunal—S; WHR; RF, RB; (05290).

STAPHYLEACEAE

†*Staphylea trifolia* L.—F; ALL; RF, BRF, BRIP, RIP, LKW; (01526).

STYRACACEAE

Styrax americanus Lam.—R; EHR; FW; (02071).

Styrax grandifolius Ait.—S; WHR; OH; (02082).

THYMELAEACEAE

†*Dirca palustris* L.—I; WHR, OCB; RF, BRF; (02976).

TILIACEAE

†*Tilia americana* L. var. *americana*—I; ALL: RF, BRF; (03874).

†*Tilia americana* L. var. *heterophylla* (Vent.) Loud.—F; ALL; RF, BRF; (04900).

ULMACEAE

†*Celtis laevigata* Willd.—F; ALL; BDF, LKW, PAS, BRIP, RIP; (03709).

Celtis occidentalis L.—R; WHR; RIP; (02920).

Celtis tenuifolia Nutt.—R; OCB, WHR; LKW, CG, RB; (01388 VDB).

Ulmus alata Michx.—O; ALL; LKW, BDF, PAS, OH; (01618).

†*Ulmus americana* L.—I; ALL; BRIP, RIP, BDF; (00082).

*Δ *Ulmus pumila* L.—R; OCB; PAS, RD, LAW.

Ulmus rubra Muhl.—O; ALL; RF, BRF; (03765).

Ulmus serotina Sarg.—I; OCB, WHR; BRF, BDF, RF, PAS; (02921).

URTICACEAE

Boehmeria cylindrica (L.) Sw.—I; ALL: WM, RM, BWM, BM; (00942).

Laportea canadensis (L.) Weddell—I; ALL; RF, BRF, RIP, BRIP; (00941).

†*Parietaria pensylvanica* Muhl. ex Willd.—S; WHR; RF, RO; (04915).

†*Pilea pumila* (L.) Gray—I; ALL; RF, BRF, ST; (05167).

†*Urtica chamaedryoides* Pursh.—I; ALL; RF, BRF; (01799).

VALERIANACEAE

Valeriana pauciflora Michx.—R; WHR; RF; (01913).

*†*Valerianella locusta* (L.) Lat.—I; OCB; PAS, DIS; (04456).

†*Valerianella radiata* (L.) Dufr.—O; WHR, OCB; PAS, RD, RF; (02125 APSC).

†*Valerianella umbilicata* (Sullivant) Wood—I; OCB; CRP, RD, PAS, LWM; (04455).

VERBENACEAE

†*Callicarpa americana* L.—I; OCB; BDF, LKW; (03648).

Glandularia canadensis (L.) Nutt.—R; OCB; CG; (01704).

Phryma leptostachya L.—I; ALL; RF, BRF, BDF; (00667).

†*Phyla lanceolata* (Michx.) Greene—I; ALL; WM, BWM; (02832).

**Verbena brasiliensis* Vell.—R; OCB; PAS, BRIP; (03489).

Verbena hastata L.—R; WHR; WM, RM; (03753).

Verbena simplex Lehm.—O; OCB, WHR; CG, CB, PAS, BO, RD, RB; (02043).

Verbena urticifolia L.—I; OCB, WHR; PAS, RD; (00778).

VIOLACEAE

Hybanthus concolor (T. F. Forst) Spreng.—I; WHR; RF; (01763).

†*Viola bicolor* Pursh—O; ALL; RD, PAS, CRP; (00362).

Viola cucullata Ait.—I; WHR, OCB; CS, ST, WM, BWM; (00378).

Viola egglestonii Brainerd—R; OCB; CG; (01624).

Viola hirsutula Brainerd—S; WHR; OH; (03142).

†*Viola palmata* L.—I; ALL; BDF, RF, BRF, LKW; (02132).

Viola × *primulifolia* L.—R; WHR; RM; (00464).

†*Viola pubescens* Ait. var. *scabriuscula* Schwein. ex Torr. & Gray—O; ALL; BRF, RF; (00404 APSC).

Viola sagittata Ait.—R; WHR; RB; (03147).

†*Viola sororia* Willd.—O; RF, BRF, PAS, LAW, BRIP, RIP; (01695).

†*Viola striata* Ait.—I; ALL; RF, BRF, RIP, BRIP; (01797).

Viola tripartita Ell.—S; WHR; RF, OH; (02031); [Giles County material is referable to variety *glaberimma* (DC.) Harper].

Viola walteri House—R; OCB, WHR; BRF, RF; (03061).

VISCACEAE

Phoradendron leucarpum (Raf.) Reveal & M.C. Johnston—I; OCB; epiphytic on trees; (05675).

VITACEAE

***Ampelopsis arborea* (L.) Koehne—R; OCB; BWM; (05317).

†*Ampelopsis cordata* Michx.—I; OCB; BRIP; (05316).

Parthenocissus quinquefolia (L.) Planch.—F; ALL; RF, BRF, RIP, BRIP, LKW; (05305).

Vitis aestivalis Michx. var. *aestivalis*—O; ALL; OH, BDF; (02267).

Vitis cinerea (Engelm.) Millard var. *baileyana* (Munson) Comeaux—S; WHR; RF, RIP; (02266).

Vitis rotundifolia Michx.—O; ALL; OH, BDF; (00191).

†*Vitis vulpina* L.—F; OCB, WHR; BRIP, RIP, BWM; (05419).

ACKNOWLEDGMENTS

I would like to thank the following individuals for their assistance during this project. Eugene Wofford, curator of the University of Tennessee Herbarium, and Edward Chester, professor of biology at Austin Peay State University, served as mentors and offered helpful advice throughout the project. Claude Bailey, Roger McCoy, and David Lincicome of the Tennessee Natural Heritage Program deserve thanks for providing information concerning several rare species. Robert

Kral, curator of the Vanderbilt Herbarium at the Botanical Research Institute of Texas kindly verified several problematic specimens and loaned material for study, and Ed Schilling, professor of botany at the University of Tennessee, assisted with the identification of some specimens of *Helianthus*. Chris Fleming prepared the figure. Lastly, Eugene Wofford, Hal DeSelm, Edward Chester, Robert Kral, Joey Shaw, and two anonymous reviewers provided many helpful comments that improved the manuscript.

REFERENCES

Ackerman, E.A. 1941. The Köppen classification of climates in North America. Geogr. Rev. 31:105–111.

Allison, J.R. and T.E. Stevens. 2001. Vascular flora of Ketona dolomite outcrops in Bibb County, Alabama. Castanea 66:154–205.

Braun, E.L. 1950. Deciduous forests of eastern North America. The Blakiston Company, Philadelphia, Pennsylvania.

Campbell, J.J.N. 2000. Notes on North American *Elymus* species with paired spikelets I: *E. macgregorii* sp. nov. and *E. glaucus* ssp. *mackenzii* comb. nov. J. Kentucky Acad. Sci. 61: 88–98.

Chester, E.W. 1995. An overview of forest diversity in the Interior Low Plateaus: Physiographic Province. Pp. 109–115 in: Landis, T.D.; Cregg, B., tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. PNW-GTR-365. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Chester, E.W., B.E. Wofford, R. Kral, H.R. DeSelm, and A.M. Evans. 1993. Atlas of Tennessee vascular plants. Volume 1. Pteridophytes, gymnosperms, angiosperms: monocots. Misc. Publ. No. 9. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee.

Chester, E.W., B.E. Wofford, and R. Kral. 1997. Atlas of Tennessee vascular plants. Volume 2. Angiosperms: dicots. Misc. Publ. No. 13. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee.

Cronquist, A. 1980. Vascular flora of the southeastern United States. Volume 1. Asteraceae. The University of North Carolina Press, Chapel Hill, North Carolina.

DeSelm, H.R. 1959. A new map of the Central Basin of Tennessee. J. Tennessee Acad. Sci. 34:66–72.

Estes, D. 2004. Noteworthy collections: Middle Tennessee. Castanea 69:69–74.

Estes, D. and E.W. Chester. 2001. *Arenaria lanuginosa* rediscovered and a new county record for *Apios priceana* in Tennessee. J. Tennessee Acad. Sci. 76:16. (Abstract).

Fenneman, N.M. 1938. Physiography of eastern United States. McGraw Hill Book Company, New York, New York.

Fernald, M.L. 1950. Gray's manual of botany. Eighth edition. American Book Company, New York, New York.

Flora of North America Editorial Committee (eds.). 1993. Flora of North America north of

Mexico. Volume 2. Pteridophytes and gymnosperms. Oxford University Press, New York, New York.

Flora of North America Editorial Committee (eds.). 1997. Flora of North America north of Mexico. Volume 3. Magnoliophyta: Magnoliidae and Hamamelidae. Oxford University Press, New York, New York.

Flora of North America Editorial Committee (eds.). 2000. Flora of North America north of Mexico. Volume 22. Magnoliophyta: Alismatidae, Arecidae, Commelinidae (in part), and Zingiberidae. Oxford University Press, New York, New York.

Flora of North America Editorial Committee (eds.). 2002a. Flora of North America north of Mexico. Volume 23. Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York, New York.

Flora of North America Editorial Committee (eds.). 2002b. Flora of North America north of Mexico. Volume 26. Magnoliophyta: Liliidae: Liliales and Orchidales. Oxford University Press, New York, New York.

Flora of North America Editorial Committee (eds.). 2003. Flora of North America north of Mexico. Volume 4. Caryophyllidae, Part 1. Oxford University Press, New York, New York.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. Second edition. The New York Botanical Garden, Bronx, New York.

Griffith, G.E., J.M. Omernik, and S. Azevedo. 1998. Ecoregions of Tennessee. 1: 940 000. Albers equal area projection. U.S. Geological Survey, Reston, Virginia.

Isely, D. 1990. Vascular flora of the southeastern United States. Volume 3, Part 2. Leguminosae (Fabaceae). The University of North Carolina Press, Chapel Hill, North Carolina.

Medley, M.E., H. Bryan, J. MacGregor, and J.W. Thieret. 1985. *Achyranthes japonica* (Miq.) Nakai (Amaranthaceae) in Kentucky and West Virginia: New to North America. Sida 11: 92–95.

Miller, R.A., W.D. Hardeman, D.S. Fullerton, C.R. Sykes, and R.K. Garman (eds.). 1966. Geologic map of Tennessee. West-Central Sheet. Tennessee Department of Conservation, Division of Geology, Nashville, Tennessee.

Murrell, Z.E. and B.E. Wofford. 1987. Floristics and phytogeography of Big Frog Mountain, Polk County, Tennessee. Castanea 52:262–290.

Quarterman, E. and R.L. Powell. 1978. Potential ecological/geological natural landmarks on the Interior Low Plateaus. United States Department of the Interior, Washington, District of Columbia.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The University of North Carolina Press, Chapel Hill, North Carolina.

Shanks, R.E. 1958. Floristic regions of Tennessee. J. Tennessee Acad. Sci. 33:195–210.

Small, J.K. 1933. Manual of the southeastern flora. The University of North Carolina Press, Chapel Hill, North Carolina.

Smith, S.G. 2001. Taxonomic innovations in North American *Eleocharis* (Cyperaceae). Novon 11:241–257.

Tennessee Natural Heritage Program. 1999. Tennessee rare plant list. Division of Natural Heritage, Tennessee Department of Environment and Conservation, Nashville, Tennessee.

Tennessee Natural Heritage Program. 2003. Tennessee rare plant list. Division of Natural Heritage, Tennessee Department of Environment and Conservation, Nashville, Tennessee.

True, J.C., J.F. Campbell, and E.P. Davis. 1968. Soil survey of Giles County, Tennessee. United States Department of Agriculture Soil Conservation Service, Washington, District of Columbia.

United States Fish and Wildlife Service. 1993. Recovery plan for Price's Potato-Bean (*Apios priceana*). Jackson, Mississippi.

United States Fish and Wildlife Service. 1999. Recovery plan for *Helianthus eggertii* (Eggert's Sunflower). Atlanta, Georgia.

USDA (United States Department of Agriculture). 2000. Natural Resources Conservation Service. The PLANTS database (http://plants.usda.gov/plants/). National Plant Data Center, Baton Rouge, Louisiana [as accessed December 29, 2003].

Wofford, B.E. and E.W. Chester. 2002. Guide to the trees, shrubs, and woody vines of Tennessee. The University of Tennessee Press, Knoxville, Tennessee.

Wofford, B.E. and R. Kral. 1993. Checklist of the Tennessee vascular plants. Sida, Bot. Misc. 10. Botanical Research Institute of Texas, Fort Worth, Texas.

Yatskievych, G. 1999. Steyermark's flora of Missouri. Volume 1. Revised edition. The Missouri Botanical Garden Press, St. Louis, Missouri.

THE VASCULAR FLORA OF MONTGOMERY COUNTY, ARKANSAS

Travis D. Marsico[1]

University of Arkansas Herbarium (UARK)
Biomass Research Center 141
Fayetteville, Arkansas 72701, U.S.A.

ABSTRACT

A floristic inventory in Montgomery County, Arkansas, documented 1,110 vascular plant taxa. Fifty-nine taxa (5% of county total) in Montgomery County are considered to be of conservation concern and are tracked by the Arkansas Natural Heritage Commission. One hundred and thirty-four taxa (12% of county total) were introduced, 21 (2% of county total) of which are considered invasive. The families with the most taxa represented in the flora are Asteraceae (144), Poaceae (120), Cyperaceae (82), Fabaceae (75), and Rosaceae (38). *Elatine triandra* Schkuhr represents a species never before collected in Arkansas. A single federally endangered species, *Ptilimnium nodosum* (Rose) Mathias, was noted. *Hydrilla verticillata* (L.f.) Royle, a federally listed noxious weed was collected. Montgomery County has one of the highest proportions of sensitive species in Arkansas, but has fewer than 20% of the State's known alien species, probably due to its high diversity of rare habitats and a relatively intact landscape. With 1,110 taxa, Montgomery County is the sixth best-collected county in Arkansas. However, since most Arkansas counties have fewer than 800 documented taxa, there is a clear need for increased floristic work if the species that grow in Arkansas are to be known.

RESUMEN

Se llevó a cabo un inventario florístico en el condado de Montgomery, Arkansas, que proporcionó una lista de 1.110 taxa de plantas vasculares. Cincuenta y nueve taxa (5% del total) del condado de Montgomery son considerados raros y están siendo monitoreados por la Comisión Herencia Natural de Arkansas (Arkansas Natural Heritage Commission). Ciento treinta y cuatro taxa (12% del total del condado) son introducidos y 21 (2% del total del condado) son considerados especies invasoras. Las familias con un mayor número de taxa representados en la flora son Asteraceae (144), Poaceae (120), Cyperaceae (82), Fabaceae (75), y Rosaceae (38). *Elatine triandra* Schkuhr es una especie que fue colectada por primera vez en Arkansas. Fue encontrada una sola especie federal en peligro, *Ptilimnium nodosum* (Rose) Mathias. Se colectó *Hydrilla verticillata* (L. f.) Royle, una especie nociva federal mencionada. El condado de Montgomery tiene una de las más elevadas proporciones de especies sensibles de Arkansas, pero tiene menos del 20% de las especies introducidas en el estado, probablemente debido al gran número de hábitats raros y un paisaje relativamente intacto. Con 1.110 taxa, el condado de Montgomery es el sexto condado muestreado de Arkansas. Sin embargo, puesto que la mayoría de los condados de Arkansas tienen menos de 800 taxa documentados, hay una necesidad de más estudios florísticos con el fin de conocer las especies que crecen en Arkansas.

---

[1] Present Address: Department of Biological Sciences, Galvin Life Science 107, University of Notre Dame, Notre Dame, Indiana 46556, U.S.A, tmarsico@nd.edu

SIDA 21(4): 2389 – 2423. 2005

INTRODUCTION

Floristic studies have long provided botanists with baseline knowledge of plant species distribution and habitat preference, so proportionately more is known from locations that have had extensive inventories (Duncan 1953). Descriptive studies are needed before subsequent ecological endeavors can be conducted. No systematic inventory of the Ouachita Mountains' flora has been conducted to date with the exception of Hot Springs National Park (Palmer 1926; Scully 1937, 1941, 1942). In addition, certain areas of botanical interest in the Ouachitas (e.g., Rich Mountain, Mount Magazine, and Albert Pike) have received much attention by botanists, but very frequently for their charismatic plant species, and a comprehensive flora accompanied by vouchered specimens is lacking. This study is the first one of its scale in the physiographic region of the Ouachita Mountains of Arkansas.

Geography, Geology, and Soils

Montgomery County is located in west central Arkansas in the Central Ouachita Mountains (Fig. 1). The county covers 2,023 km^2 (781 mi^2), and is characterized by east-west trending ranges of the Ouachita Mountains, including the Fourche, Caddo, and Cossatot mountains. The Fourche Mountains are located in the northern part of the county. The central portion of the county consists of a large basin that contains the Ouachita and Caddo rivers. The Caddo Mountains are south of the basin, and southwest of the Caddo Mountains are the Cossatot Mountains. Elevation in Montgomery County ranges from a low of 149 m in the very southeast corner of the county along Sugarloaf Creek to a high of 673 m at Slatington Mountain in the southwest (490 to 2209 ft).

Geologically the area is old and the exposed rock and soils are varied. The oldest rock in the state, which dates from the Cambrian and lower Ordovician periods, is Collier Shale, which is partially exposed in Montgomery County (Braden 1999). The east-west geology of the Ouachita Mountains displays the rock in decreasing age both north and south of the center due to anticline folding during the Pennsylvanian Period.

All the sedimentary rocks in the Ouachita Mountains were deposited before the tectonic events of the late Pennsylvanian. Each rock type was deposited in a horizontal stratum, but was subsequently twisted and folded into its present shape (Palmer 1926). Thrust faulting and folding due to continental collision gave the Ouachita Mountains their compressed anticline/syncline deformation (Snider 1982). The Ouachita fold belt extends from southwest Alabama north through Arkansas, and southwest through Oklahoma, Texas, and into Mexico. The 2,100 km course of the Ouachitas is only exposed for 500 km (Flawn 1959). The rocks are shale, sandstone, quartzite, conglomerate, and novaculite (Palmer 1926). Novaculite, the slightly metamorphosed product of chert (Guccione 1993), is mined for high-quality whetstone in the area, and is interesting both geologically and

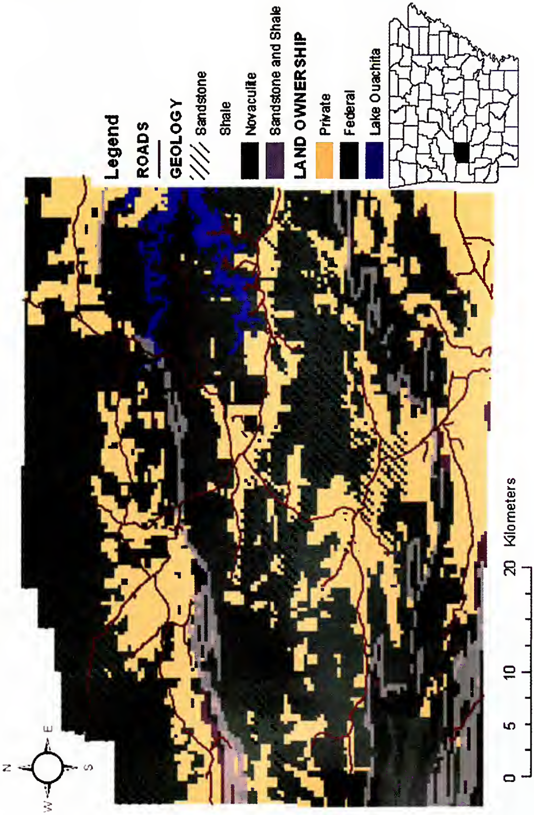


Fig. 1. Geology and land ownership in Montgomery County, Arkansas.

botanically. Additionally, novaculite glades are habitats unique to the Ouachita Mountains. Substantially due to its geology, Montgomery County is rich in regional endemics of both plants and animals. The area has a great diversity of habitats in close proximity to one another (Braun 1950) due to its rough and varied topography.

Soil orders in the region are Entisols and Ultisols. Entisols are young soils with little or no evidence of developed soil horizons. In the Ouachita Mountains they form in the vicinity of stream courses where erosion is extreme and equals or exceeds soil formation. Ultisols are old soils that form in warm, humid climates with a seasonal dry period under forest vegetation. Ultisols are the dominant soils in Montgomery County (Soil Survey Staff 1998, 1999). Soils in the area are commonly thin and in many places, including steep slopes and glades, the parent geologic material has far greater influence than that of the soil.

Climate

The climate of Montgomery County and the central Ouachita Mountains is broadly described as humid sub-tropical (Bailey 1995). The climate of the state of Arkansas is influenced by its latitude between 33 and 37 degrees north, the prevailing westerlies, polar fronts from the continent, and Gulf of Mexico moisture (Baldwin 1984). The following climate data were compiled from the National Oceanic and Atmospheric Administration (NOAA) observations collected in Mount Ida, Arkansas, in central Montgomery County, from 1931 through 2000, but represent 66 years of observation due to missing values from 1948, 1949, 1950, and 1954. The average annual high temperature is 23°C (73°F), the average annual low temperature is 8°C (47°F), and the overall average annual temperature is 15°C (60°F). Temperatures have ranged from an all-time high of 47°C (116°F) on August 10, 1936, to a low of -29°C (-21°F) on February 2, 1951. Even though extremes in precipitation or temperature occur, they are rare. The average hottest day for a given year is 39°C (103°F), but the most common value in the 66 years of data collection was 38°C (100°F). The average coldest temperature for a year is -15°C (5°F), and the most common value was -13°C (8°F). The average period without a freeze (growing-season) is typically between 200 and 240 days in the Ouachita Mountains province (USDA 1981).

The area receives some of the highest rainfall in Arkansas (Reinhold 1969) with an annual average of 141 cm (55 in.). The range of annual rainfall, however, is incredibly varied, with a maximum of 213 cm (84 in.) recorded in 1945 and a minimum of 83 cm (33 in.) recorded in 1936. The Ouachita Mountains are high enough to draw more rainfall from passing storm systems than other natural regions of Arkansas. Precipitation is seasonal with the spring months of March, April, and May commonly being wettest and typical dry times in July through September. Snow is limited in the region, and one out of every five years lacked snow entirely. The average annual snowfall for the area is 12 cm (5 in).

The greatest yearly snowfall recorded was 47 cm (19 in) in 1988. Ice storms are uncommon, but may be severe. In December 2000, an ice storm struck the region and dramatically opened the forest canopy. There were long-term changes in vegetation structure due to the severity of that storm.

Anthropogenic Influence

Montgomery County and the greater Ouachita Mountain region were occupied by early Americans in the Dalton cultural period in the early Holocene for hunting grounds and short-term settlements. There is evidence that even in rugged areas of the Cossatot Mountains by the late Caddo period (15th Century), hunting and gathering was supplemented by small plots of maize, beans, and squash (Early 2000). Although First Nations peoples mined and farmed small plots, their impact to the landscape in the area appears small compared to that after European settlement.

European descendants typically from Mississippi, Alabama, and Georgia settled in the Ouachita Mountains in the 19th Century. They were predominately of English or Scotch-Irish heritage, and lived subsistence lives with only small farms, often surrounded by virgin woodland (Smith 1986). When mechanized logging arrived in the Ouachitas around 1900, the vegetation began to change rapidly as large tracts of shortleaf pine timber were logged. Virtually no virgin timber remained by 1950. The Arkansas National Forest was set aside in 1907 (changed to the Ouachita National Forest in 1926). Sustained yield forestry began to replace "cut out and get out" practices in the 1920s, but as a valuable timber resource the areas within the Ouachita National Forest experienced heavy logging. In the 1970s Weyerhaeuser Company began intensively managing its stands as monocultures of loblolly pine. The Ouachita National Forest began to use even-age management as well (Smith 1986). Such management regimes are now unacceptable on public lands. It is important to note that although none of the land is in its pre-settlement state, and all of it is managed, the majority of Montgomery County retains the landscape's original character, and allows for a great number of native species to persist or thrive. The Ouachita National Forest and Montgomery County will likely keep their semi-natural character long into the future.

Ever since the warming and drying after the most recent ice age, plant communities in the region have experienced human induced fires. Though Euro-American settlers in the South were casual in their feelings toward fire, national policy prevented fire in an effort to prevent damage to property. However, U.S. Forest Service policy in the South had always contained provisions for allowing fire, and interest in using fire as a management tool increased (Pyne 1982). Currently, the Ouachita National Forest prescribes burns to limit potential for catastrophic fire and improve wildlife habitat (http://www.fs.fed.us/r8/ouachita/fire/fire_management%20.shtml).

Although ecosystem degradation by land management practices is always a concern, most of Montgomery County is in federal land holding, and ecosystem destruction from development is of little concern. A potential problem, now, and the second most important cause for the decline of imperiled species is the introduction of non-native, invasive species (Stein et al. 2000). Common exotic invasive species in Montgomery County include *Elaeagnus umbellata*, *Lespedeza cuneata*, *Ligustrum sinense*, *Lonicera japonica*, and *Microstegium vimineum*.

Ecological Systems

The Ecological Systems Database (NatureServe 2003) was used as a framework for classifying ten plant communities in Montgomery County. The communities are defined on a meso-scale, allowing for patterns of ecological variability while remaining recognizable to guide conservation and land managers' needs (Comer et al. 2003). NatureServe lacked anthropogenically managed or created communities that did not fall under the categories of "natural" or "semi-natural." These include easily recognizable areas such as pastures, roadsides, and abandoned pits or quarries. A distinct community dominated by *Pinus taeda* was not included for the Ouachita Mountains. The only natural community that was lacking from the published list was the Shale Glade Ecological System. Shale glades are important botanically in Montgomery County because they are areas where unique plant assemblages form and include species found nowhere else in the county.

(PIN) Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland.—The Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland covers the largest land area in Montgomery County. It is classified as a natural or semi-natural, vegetated, and upland matrix. The thread that ties this variable system together is the presence and often dominance of *Pinus echinata*. The hardwood components, dominated by various *Quercus* species, vary with slope, aspect, and moisture conditions (Dale & Ware 1999). There are other hardwood canopy species in the system such as *Carya* spp. and *Prunus serotina*, but they are less abundant than oaks. The canopy ranges from completely closed to more commonly open with as little as 40% canopy cover. The system covers a wide range of topography from level to steep slopes, most aspects, and is not tied to a specific topographic feature (e.g., streams) or geology. Understory species include *Vaccinium* spp., *Solidago* spp., *Monarda* spp., and *Schizachyrium scoparium* as dominants.

(LOB) Ouachita Mountain Planted Loblolly Pine Forest.—This ecological system is not listed by NatureServe (2003) for Montgomery County probably because *Pinus taeda* is thought to be exotic to the Ouachita Mountains. The loblolly pine system is similar to the shortleaf pine system in the Ouachitas except that it is dominated by *Pinus taeda* rather than *Pinus echinata*. The com-

munity is located only in the southeastern portion of the county where the topography is less rugged and slopes are less steep than in other areas. Common herbaceous species include *Asclepias variegata*, *Lactuca canadensis*, *Pseudognaphalium helleri*, *Clitoria mariana*, and *Rhexia mariana*. Except for its location in the Ouachita Mountains, the community matches closely the *Pinus taeda* forest alliance of the West Gulf Coastal Plain Pine-Hardwood Forest (NatureServe 2003). Sites in Montgomery County range from obvious plantations with trees in straight rows to a more natural system managed by fire. Although all sites may represent plantings in this area, the system (at least non-plantation sites) can follow the semi-natural classification of the Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland with a different dominant canopy species, or the West Gulf Coastal Plain Pine-Hardwood Forest in a more northern location.

(MES) Ozark-Ouachita Mesic Hardwood Forest.—The Ozark-Ouachita Mesic Hardwood Forest is classified as a natural or semi-natural vegetated upland small patch system. This community may be found on low, north-facing slopes and along river terraces in areas that are not distinctly riparian. *Quercus alba* and *Q. rubra* are common oak dominants, but the classic mesic species are *Fagus grandifolia* and *Acer barbatum*. *Tilia americana* is another canopy species, and *Asimina triloba* and *Magnolia tripetala* may be found in the understory. In the Crystal Campground area, the mesic forest includes a population of *Pinus strobus*, planted for timber in 1910, but subsequently naturalized, and it is the only reproducing population known in Arkansas. The herbaceous layer of this community contains a wide range of spring ephemeral species such as *Trillium recurvatum*, *Cypripedium kentuckiensis*, and *Podophyllum peltatum*. Mesic forest habitat provides greater moisture to vegetation thus supporting different species than the shortleaf pine-oak forest and woodland system.

(RIP) Ozark-Ouachita Riparian.—The Ozark-Ouachita Riparian community is variable in vegetation, but has one main topographic feature that ties the system together—streams. The system is classified as natural or semi-natural, vegetated, and upland. The spatial pattern is linear. Canopy species may vary, but typically include *Liquidambar styraciflua* and *Platanus occidentalis* as canopy dominants. *Acer* spp. and various *Quercus* spp. are also canopy species in the riparian ecosystem. *Betula nigra* occurs infrequently. The understory and shrub layers often consist of *Lindera benzoin*, *Alnus serrulata*, *Hamamelis vernalis*, *Carpinus caroliniana*, and *Ostrya virginiana*. The herbaceous layer is diverse and commonly consists of *Festuca subverticillata*, *Osmorhiza longistylis*, *Galium aparine*, *Viola pubescens*, and *Elymus virginicus*. Certain riparian sites also include the Ouachita Mountain endemic, *Hydrophyllum brownei*. The riparian system does not often include *Fagus grandifolia* in its canopy. The riparian zone in Montgomery County is typically found from the immediate riverbank through a system of periodically flash flooded terraces. The size of

the stream dictates the distance away from the stream that the riparian community is encountered. The substrate consists of soils that are rich and well-drained and often with abundant gravel.

(SEE) Ouachita Mountain Forested Seep.—The Ouachita Mountain Forested Seep community is characterized as a natural, small patch, vegetated wetland. All seepage areas have water coming from below the ground surface. Seeps may occur at the headwaters of streams or along riparian areas. They are saturated or very moist throughout the year. The canopy may be dominated by *Liquidambar styraciflua*, *Quercus alba*, *Acer rubrum*, and *Magnolia tripetala*, which is also common in the understory. The coverage of the canopy is variable from fully covered to quite open. However, due to the soft substrate, which allowed for easy uprooting, much of the canopy in many seeps in Montgomery County was dramatically opened by an ice storm in December 2000. Subcanopy species commonly encountered are *Magnolia tripetala*, *Ilex opaca*, *Carpinus caroliniana*, and *Corylus americana*. Aside from the saturated soil, the herbaceous layer provides a distinctive sign of a forested seep. Ferns are abundant and diverse and include *Osmunda cinnamomea*, *Osmunda regalis*, *Athyrium filix-femina*, *Onoclea sensibilis*, and others.

(NOV) Ouachita Novaculite Glade and Woodland.—The Ouachita Novaculite Glade and Woodland system is defined as a small patch of natural occurrence that is vegetated and upland. The diagnostic feature for the community is novaculite geology. The system is found from 450–640 m (1476–2100 ft.) in elevation and is a mosaic of open glades, outcrops, and woodlands. Dominant species include *Quercus stellata*, *Quercus marilandica*, *Quercus rubra*, and *Carya texana*. The endemic *Quercus acerifolia* is found only in this and the Ouachita Montane Oak Forest system. A common and often distinctive member in the subcanopy is *Ptelea trifoliata*. The herbaceous layer is dense with grass species including *Bromus* spp., *Danthonia spicata*, *Dichanthelium* spp., and *Schizachyrium scoparium*. *Ambrosia artemisiifolia*, *Helianthus divaricatus*, and *Helianthus hirsutus* are other common associates. Trees are often stunted and gnarly due to drought, fire, wind, and ice, all of which are thought to play important roles in the maintenance of this system.

The Ouachita Montane Oak Forest is a similar community to the Novaculite Glade system except that it lacks novaculite substrate. The inclusion of this system under the Novaculite heading is appropriate here because the montane oak forest has a limited extent in Montgomery County. It is only found in high-elevation areas in the northwest part of the county. Although the geology differs, vegetation is remarkably similar in both high-elevation communities, and does not warrant a separate community designation in Montgomery County.

(SHA) Ouachita Mountain Shale Glade.—The Ouachita Mountain Shale Glade community is characterized as a small to large patch, natural or semi-

natural vegetated, upland system. The soil is very thin and shale (the dominant substrate) is often exposed at the surface. This ecosystem is found on level or slightly sloped topography in the basin regions of the Ouachita Mountains. There is often no tree canopy associated with this system, but *Juniperus virginiana* and *Carya texana* have become common canopy species. There is little shrub layer, as the system is dominated by a diverse array of herbs and grasses. The shale substrate acts as a fragipan, creating very wet surface conditions in the early spring that dry throughout the summer, when the system appears nearly barren. This hydro-xeric phenomenon characterizes the shale glade. Herbaceous species include *Talinum calycinum* and *Dodecatheon meadia*, as well as many members of the Asteraceae including *Coreopsis grandiflora*, *Silphium laciniatum*, and *Solidago* spp.

(ROA) Ouachita Mountain Upland Herbaceous with Regular Interval Human-Induced Disturbance.—This community includes those habitats that are managed by, at minimum, yearly grazing or mowing: roadsides, roadside ditches, pastures, and cemeteries. These are linear, small patch, or large patch, anthropogenic upland vegetated systems. They are typically without a tree or shrub layer and consist mostly of grasses and other herbaceous species such as *Daucus carota*, *Bidens* spp., *Trifolium campestre*, *Paspalum* spp., *Lolium* spp., and *Tridens flavus*. The species growing in these habitats are adapted to full sun and a range of moisture conditions. Although not considered by NatureServe, this system is important to the categorization of the plant species in the Ouachita Mountains. Pastures and roadsides favor grass species, which tolerate mowing/grazing, serve as entry points and corridors for invasive species, represent novel habitat for natives, and make up a large land area.

(WEE) Ouachita Mountain Upland Herbaceous-Shrubby with Single Major Human-Induced Disturbance.—This community is common along abandoned Forest Service roadways, but also is used for any land not actively managed, such as abandoned lots, pits, or mines. It is a linear or small patch vegetated, upland anthropogenic system. Though much less important in terms of land area covered than Regular Interval Disturbance system, it is distinct from it. The main difference between the ecosystems is type of disturbance. The Regular Interval Disturbance system has regular, at least annual mechanical disturbance, whereas this weedy community begins with a single major disturbance only. After this usually vegetation-voiding initial event, colonization and succession occur undisturbed, unless aided by plantings to reduce erosion. This system is characterized by weedy or early successional herbaceous and shrub species and represents an ever-changing continuum from unvegetated bare ground to late successional stages. These habitats are abundant with non-native species such as *Ligustrum sinense* and *Lespedeza cuneata*. Other abundant early colonizers include *Ambrosia* spp. and *Acalypha virginica*.

(WET) Ouachita Mountain Human Created/Maintained Still Water Wetland and Gravel Bar.—This system is a variable system that includes anthropogenic lakes and ponds (none of which are natural in the Ouachita Mountain landscape), a beaver created upland marsh, and natural gravel bars of rivers and streams. These are wetland systems that can often be described as early successional. Regulated lakes and ponds in the region have a fluctuating shoreline allowing for wetland plant growth and colonization that follows the water level. Stream gravel bars, though natural, mimic this pattern due to rapid water level changes in streams and rivers. Gravel bars also experience vegetation-voiding disturbance during flash floods. These systems are dominated by a mix of wetland herbaceous and shrub species and weedy early successional plants. True aquatic species include *Nymphaea odorata*, *Potamogeton* spp., and *Utricularia gibba*. Examples of emergent or terrestrial species in this system are *Justicia americana*, *Xanthium strumarium*, and *Cleome hassleriana*. Richardson Bottoms, a beaver created upland marsh, though a unique community in the Ouachita Mountains, fits under this category for ecological system description.

METHODS

Voucher collections were made from August 2001 through October 2003. Several primary collecting sites were established by conducting pilot searches early in the study, reviewing topographic maps, and consulting Ouachita National Forest and Arkansas Natural Heritage Commission unpublished document accounts (Orzell 1985; Bates 1993; Robison & Marsh undated). The primary sites are representative of the diversity of habitats found within the political boundary of Montgomery County. At primary sites, collections were made in each phase (spring, summer, fall) of the growing season. Auxiliary sites were visited only once or twice throughout the study period.

Vouchers were collected according to standard collecting methodology, and material was compared to UARK specimens and keyed with pertinent floras (e.g., Radford et al. 1968; Smith 1994a; Diggs et al. 1999; Yatskievych 1999) for the majority of the identifications. A representative voucher specimen for each taxon was deposited at the University of Arkansas Herbarium (UARK). Specimens were assigned a community type from which they were collected in order to provide a high resolution of species distribution within Montgomery County.

After all collections were identified, Smith (1988) by way of the Texas A&M Bioinformatics Working Group website (http://www.csdl.tamu.edu/FLORA/cgi/kartesz_ar_ page_click?county=Montgomery) was consulted for species collected from Montgomery County by previous investigators. Taxa that were found on Smith's list that were not collected in the current field study (2001–2003) were noted. Subsequently, a search was conducted for the listed specimens. Identifications of specimens found at UARK were verified, and those at other herbaria were accepted as correctly identified without review. Collections made by E.L. Hardcastle, C.S. Reid, D.X Williams, and C.T. Witsell in Montgomery County since 1988 were also reviewed.

RESULTS

Plant collections resulted in 1,013 taxa at and below the species level, 474 genera, and 139 families. Further investigation led to the discovery of additional species collected by others for Montgomery County. These additions bring the total known taxa for Montgomery County to 1,110 species and subspecific assignations, 506 genera, and 143 families. The plant families with the greatest number of taxa are as follows: Asteraceae (144), Poaceae (120), Cyperaceae (82), Fabaceae (75), and Rosaceae (38). Forty-three taxa that had previously been reported from Montgomery County could not be supported by voucher specimens, and have subsequently been excluded from the flora. The specimens either never existed (a verbal report only), could not be found, or have been annotated as some other taxon.

Fieldwork resulted in the addition of one species not previously known to occur in Arkansas: *Elatine triandra* Schkuhr. *Elatine triandra* is native to the United States and the collection represents a range expansion from its known distribution. This wetland species was collected on the muddy shores of a recently constructed lake southwest of Mount Ida.

Fifty-nine of the 1,110 taxa in Montgomery County are tracked by the Arkansas Natural Heritage Commission. Species of special concern, therefore, make up 5% of the flora in Montgomery County. One population of the listed, federally endangered species *Ptilimnium nodosum* (Rose) Mathias was located. The voucher is a photograph (*T.D. Marsico 3247*, UARK), since a permit to collect endangered species was not obtained. The location of the population had been studied by Hardcastle and Williams (2000), and as stated in their report, thousands of individuals were observed.

Non-native species have recently gained the attention of land managers. One hundred and thirty-four (12%) taxa of the 1,110 of the Montgomery County flora are represented by species categorized as non-native. Of those, 21 are considered invasive. Montgomery County also contains a native invasive, *Baccharis halimifolia* L. Invasive status follows the working list from the Rare and Invasive Plants of Arkansas Conference (RIPAC) in October 2003 (Arkansas Native Plant Society 2003). One of the taxa collected is a federally listed noxious weed, *Hydrilla verticillata* (L.f.) Royle.

Collections made during the course of the study revealed that the riparian and roadside communities are home to the greatest number of species, whereas the planted loblolly pine forest, forested seeps, and shale glades had the fewest species. Also of note is the three communities with the greatest percentage of introduced taxa are those that are human created and/or dominated (Table 1).

TABLE 1. Summary of plant collections by community type in Montgomery County. Because only Marsico collections were assigned to a community, 1013 taxa are used in "total" calculations. Community codes are lob—Planted loblolly pine forest, mes—Mesic hardwood forest, nov—Novaculite glade and woodland and montane oak forest, pin—Shortleaf pine-oak forest and woodland, rip—Riparian, roa—Roadside, roadside ditch, pasture, and cemetery, see—Forested seep, sha—Shale glade, wee—Weedy areas such as abandoned ONF roadways, abandoned lots, pits, or mines, wet—Wetlands including lakes, ponds, mudflats, gravel bars, and a marsh.

	Number of Native Taxa (N)	**Number of Introduced Taxa (I)**	**Total Taxa (N+I)=T**	**Percent of County Total Marsico Collections (T/1013)*100**	**Percent in Habitat Introduced (I/T)*100**
LOB	91	4	95	9%	4%
MES	283	14	297	29%	5%
NOV	196	15	211	21%	8%
PIN	289	14	303	30%	5%
RIP	418	36	454	45%	9%
ROA	355	68	423	42%	19%
SEE	167	4	171	17%	2%
SHA	145	13	158	16%	9%
WEE	149	53	202	20%	36%
WET	330	46	376	37%	14%

DISCUSSION

The 1,110 taxa documented for Montgomery County places it sixth among the best collected counties of the state. While it is important to remember that botanical diversity relates to land area, topographic diversity, and land use practice, many places in the state of Arkansas are still not well known botanically. The best collected county is Washington with 1,355 taxa, and the worst is Woodruff with 347 (Smith 1994b). The top five best collected counties, except for Pulaski, are in the Ozark Plateaus Natural Division. All counties in Arkansas that have had systematic botanical inventories conducted have over 900 known taxa; therefore, it is probable that all counties in the state have this potential. Still, 65% of Arkansas counties have fewer than 800 documented taxa. This underscores the need for increased floristic work if the flora of Arkansas is to be fully understood.

With 59 species of special concern, Montgomery County has one of the highest proportions of sensitive plant species in Arkansas. When combined with animals, the Ouachita Mountains have a high level of endemism (Robison & Allen 1995). Contributing to the diversity, Montgomery County contains disjunct species from the Ozark Plateaus and the nearby Gulf Coastal Plain. Also, shale and novaculite glades, forested seeps, and mesic and riparian communities are hot-spots for rare species. The high number of rare habitats provides adequate conditions for the plants that are specific for those habitats.

After habitat destruction, alien or introduced species are the second-greatest threat to imperiled species (Stein et al. 2000). Montgomery County has fewer than 20% of the known alien species in Arkansas, but over one-third of the total native species known to occur in the state. While the flora of Arkansas is comprised of about 24% non-native taxa (Arkansas Vascular Flora Committee, pers. comm.), Montgomery County has only half that (12%). One possible reason for this difference is the relatively intact landscape of Montgomery County. Even though anthropogenic influence has been pronounced, human activities have not prevented the landscape from retaining many of its original qualities. For example, where there was once pine-dominated forest, this system remains today. Human population remains low, and agriculture is not a prominent force. In contrast, the state of Missouri has seen its numbers of introduced taxa increase by 35% from the early 1960s through the late 1990s. This is at least partially attributable to unprecedented environmental changes including a highly and continually disturbed landscape, favoring the predominate annual and biennial habit of introduced taxa (Yatskievych 1999). Therefore, it is not surprising that the vast majority of introduced species in Montgomery County are found in the three main human created or dominated landscapes of roadsides, wet areas, and abandoned roadways or lots. Over one-third of the introduced taxa collected in this study were gathered from the community classified as "weedy areas," which by definition would include a high number of weeds.

Overall, roadside and riparian habitats include the highest diversity of species in Montgomery County. This is due primarily to the widespread nature of each of these communities in a linear system. While roadsides and streamsides do not amount to a majority of the Montgomery County landscape, they cut through all other communities, allowing for high numbers of species exclusive to those communities alongside species that spill out from other communities. The planted loblolly pine forest, novaculite and shale glades, and forested seeps have the lowest overall diversity simply due to the very low amount of land area each covers in the county.

ANNOTATED CHECKLIST OF VASCULAR PLANT TAXA

Taxa below all represent vouchers from Montgomery County, Arkansas. They are listed alphabetically by family, then alphabetically by genus, specfic epithet, and subspecific designation where appropriate. For all vouchers collected by T.D. Marsico, following the Latin name is a collection number corresponding to a specimen deposited at UARK, the habitat codes for where the taxa were collected, whether the taxa are native (N) or introduced (I), and any other special designation such as a species of special concern (SC) or invasive (**I***). Taxa listed that were not collected by the author have the Latin name followed by the collector of the voucher, his/her collection number, the herbarium in which the voucher is located, and its status as native or introduced. Habitat codes are as follows: **lob**—Planted loblolly pine forest, **mes**—Mesic hardwood forest, **nov**—Novaculite glade and woodland and montane oak forest, **pin**—Shortleaf pine-oak forest and woodland, **rip**—Riparian, **roa**—Roadside, roadside ditch, pasture, and cemetery, **see**—Forested seep, **sha**—Shale glade, **wee**—Weedy areas such as abandoned ONF roadways, abandoned lots, pits, or mines, **wet**—Wetlands including lakes, ponds, mudflats, gravel bars, and a marsh. All nomenclature follows The PLANTS Database (USDA, NRCS 2004).

ACANTHACEAE

Dicliptera brachiata (Pursh) Spreng., 4626, rip, N
Justicia americana (L.) Vahl, 3138, pin, rip, roa, wet, N
Ruellia humilis Nutt., 2642, nov, roa, sha, N
Ruellia pedunculata Torr. ex Gray ssp. *pedunculata*, 2405, pin, wet, N
Ruellia strepens L., 4250, rip, see, N

ACERACEAE

Acer barbatum Michx., 834, mes, N
Acer leucoderme Small, 2754, nov, N, SC
Acer negundo L., 3261, rip, roa, wee, N
Acer rubrum L. var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg., 4955, pin, rip, wet, N
Acer rubrum L. var. *rubrum*, 5053, lob, mes, pin, rip, roa, see, wet, N
Acer saccharinum L., 3135, rip, wet, N
Acer saccharum Marsh. var. *saccharum*, 5692, nov, rip, N

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose, 3742, nov, roa, sha, N
Yucca arkansana Trel., 4994, pin, roa, N

Alismataceae

Alisma subcordatum Raf., 5539, roa, wet, N
Echinodorus cordifolius (L.) Griseb., 3295, wet, N
Sagittaria graminea Michx. var. *graminea*, 5485, rip, wet, N
Sagittaria latifolia Willd., 4027, roa, N
Sagittaria platyphylla (Engelm.) J.G. Sm., 5771, wet, N

Amaranthaceae

Amaranthus retroflexus L., R. D. Thomas, 131846, NLU, I
Amaranthus spinosus L., 4414, wet, N
Iresine rhizomatosa Standl., 3877, rip, wee, N

Anacardiaceae

Rhus aromatica Ait. var. *aromatica*, 3947, nov, pin, roa, sha, N
Rhus copallinum L., 5997, nov, pin, roa, wee, N
Rhus glabra L., 5534, pin, roa, wee, N
Toxicodendron pubescens P. Mill., 5061, pin, N
Toxicodendron radicans (L.) Kuntze, 2651, lob, mes, nov, pin, rip, roa, see, N

Annonaceae

Asimina triloba (L.) Dunal, 5447, mes, nov, rip, N

Apiaceae

Chaerophyllum procumbens (L.) Crantz var. *procumbens*, 4727, mes, nov, rip, roa, wee, wet, N
Chaerophyllum tainturieri Hook. var. *tainturieri*, 4699, mes, roa, N
Cicuta maculata L., 2308, rip, roa, N
Cryptotaenia canadensis (L.) DC., 5456, mes, pin, rip, see, wet, N
Daucus carota L., 5105, roa, wee, wet, I
Erigenia bulbosa (Michx.) Nutt., 540, rip, N
Eryngium prostratum Nutt. ex DC., 5473, lob, rip, roa, wet, N
Eryngium yuccifolium Michx., 3580, rip, roa, N
Hydrocotyle prolifera Kellogg, 4068, rip, wet, N
Hydrocotyle verticillata Thunb. var. *verticillata*, 3890, rip, N
Osmorhiza longistylis (Torr.) DC., 1626, mes, nov, rip, see, N
Oxypolis rigidior (L.) Raf., 3572, mes, pin, rip, N
Ptilimnium capillaceum (Michx.) Raf., 5478, wet, N
Ptilimnium nodosum (Rose) Mathias, 3247, wet, N, SC, Federally Endangered
Ptilimnium nuttallii (DC.) Britt., 2562, pin, sha, wee, wet, N
Sanicula canadensis L., 5503, lob, mes, nov, pin, rip, see, sha, wet, N
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, 1718, mes, rip, N
Sanicula smallii Bickn., 1603, mes, N, SC
Spermolepis inermis (Nutt. ex DC.) Mathias & Constance, 2601, wee, N

Taenidia integerrima (L.) Drude, 1744, mes, rip, N
Thaspium barbinode (Michx.) Nutt., 3436, mes, rip, N
Thaspium trifoliatum (L.) Gray, 2514, mes, rip, see, N
Torilis arvensis (Huds.) Link, 2590, pin, wee, I
Trepocarpus aethusae Nutt. ex DC., 5452, pin, rip, wee, wet, N
Zizia aurea (L.) W.D.J. Koch, 4984, pin, rip, roa, wet, N

Apocynaceae

Amsonia ciliata Walt. var. *ciliata*, E. Sundell, 11139, UAM, N
Amsonia hubrichtii Woods., 3153, rip, sha, wet, N, SC
Amsonia tabernaemontana Walt., 4861, mes, nov, N
Apocynum cannabinum L., 5533, roa, N
Trachelospermum difforme (Walt.) Gray, 5521, lob, pin, rip, roa, sha, wee, wet, N
Vinca major L., 4762, pin, roa, I*

Aquifoliaceae

Ilex ambigua (Michx.) Torr., 3485, mes, N
Ilex decidua Walt., 3041, rip, roa, N
Ilex longipes Chapman ex Trel., 3484, mes, rip, N, SC
Ilex opaca Ait. var. *opaca*, 5467.5, mes, rip, see, N
Ilex vomitoria Ait., 5733, lob, mes, nov, pin, N

Araceae

Arisaema dracontium (L.) Schott, 5506, rip, wet, N
Arisaema triphyllum (L.) Schott, 1831, mes, rip, see, N

Araliaceae

Aralia spinosa L., 4197, mes, wee, N

Aristolochiaceae

Aristolochia serpentaria L., 3350, mes, pin, N
Aristolochia tomentosa Sims, 5597, rip, N
Asarum canadense L., 1495, rip, N

Asclepiadaceae

Asclepias longifolia Michx., 2392, sha, N
Asclepias quadrifolia Jacq., 1602, mes, pin, see, N
Asclepias tuberosa L. ssp. *interior* Woods., 2248, nov, roa, sha, N
Asclepias variegata L., 5492, lob, mes, pin, roa, see, N
Asclepias verticillata L., 3188, nov, roa, N
Matelea baldwyniana (Sweet) Woods., 2748, nov, rip, roa, sha, N
Matelea decipiens (Alexander) Woods., 334, mes, N
Matelea gonocarpos (Walt.) Shinners, 2360, rip, N

Aspleniaceae

Asplenium platyneuron (L.) B.S.P., 5509, lob, mes, nov, pin, rip, roa, sha, wee, N
Asplenium bradleyi D.C. Eat., R. D. Thomas, 100549, UARK, N
Asplenium trichomanes L., J. L. Roberts, 254, UARK, N

Asteraceae

Achillea millefolium L., 2394, roa, sha, N
Ageratina altissima (L.) King & H.E. Robins. var. *altissima*, 4534, mes, nov, pin, rip, N
Ambrosia artemisiifolia L., 4109, nov, pin, roa, wee, N
Ambrosia bidentata Michx., 4287, roa, wee, N
Ambrosia trifida L., 4161, rip, roa, wee, N
Antennaria parlinii Fern. ssp. *fallax* (Greene) Bayer & Stebbins, 984, pin, N
Antennaria parlinii Fern. ssp. *parlinii*, 717, mes, N
Antennaria plantaginifolia (L.) Richards., 4670, mes, nov, pin, rip, sha, N
Arnoglossum plantagineum Raf., 2395, pin, roa, sha, N
Astranthium integrifolium (Michx.) Nutt., 1544, rip, roa, wee, N
Baccharis halimifolia L., 5130, mes, roa, wet, N*
Bidens aristosa (Michx.) Britt., 4081, nov, pin, rip, roa, wee, wet, N
Bidens bipinnata L., J. E. Moore, 3347, UCAC, N
Bidens discoidea (Torr. & Gray) Britt., 6044, roa, N
Bidens frondosa L., 4604, roa, wet, N
Boltonia diffusa Ell., 3868, see, rip, wet, N
Brickellia eupatorioides (L.) Shinners, 4510, pin, N
Carduus nutans L., 5089, roa, I*
Centaurea cyanus L., J. Hauser, 255, APCR, I
Chrysopsis pilosa Nutt., 4028, roa, wee, wet, N
Cirsium altissimum (L.) Hill, 3970, mes, pin, rip, roa, wet, N
Cirsium carolinianum (Walt.) Fern. & Schub., 1856, mes, pin, rip, roa, N
Cirsium discolor (Muhl. ex Willd.) Spreng., 6002, lob, roa, N
Cirsium horridulum Michx., 4943, see, N
Conoclinium coelestinum (L.) DC., 4001, mes, rip, roa, wet, N
Conyza canadensis (L.) Cronq. var. *canadensis*, 4091, mes, nov, pin, N

Conyza canadensis (L.) Cronq. var. *pusilla* (Nutt.) Cronq., 4286, roa, wee, N

Coreopsis grandiflora Hogg ex Sweet var. *grandiflora*, 2101, mes, pin, sha, N

Coreopsis grandiflora Hogg ex Sweet var. *harveyana* (Gray) Sherff, 2286, lob, nov, pin, sha, wee, N

Coreopsis lanceolata L., 1742, pin, rip, roa, wee, N

Coreopsis palmata Nutt., 2003, pin, N

Coreopsis tinctoria Nutt. var. *tinctoria*, 2199, sha, wee, N

Coreopsis tripteris L., 3708, lob, rip, roa, see, N

Croptilon divaricatum (Nutt.) Raf., D. M. Moore, 410229, UARK, N

Doellingeria sericocarpoides Small, 4011, see, wee, N

Echinacea pallida (Nutt.) Nutt., 2380, pin, roa, sha, N

Echinacea pupurea (L.) Moench, 2414, mes, nov, pin, rip, roa, wet, N

Eclipta prostrata (L.) L., 5737, wet, N

Elephantopus carolinianus Raeusch., 3883, mes, rip, see, wet, N

Elephantopus tomentosus L., 3373, lob, mes, see, wet, N

Erechtites hieraciifolia (L.) Raf. ex DC. var. *hieraciifolia*, 3509, pin, roa, sha, wet, N

Erigeron annuus (L.) Pers., 2489, mes, pin, rip, roa, wet, N

Erigeron philadelphicus L., 791, rip, N

Erigeron pulchellus Michx., 880, mes, N

Erigeron strigosus Muhl. ex Willd., 1562, mes, nov, rip, roa, sha, wee, wet, N

Eupatorium altissimum L., 320, nov, N

Eupatorium fistulosum Barratt, 3824, see, N

Eupatorium perfoliatum L. var. *perfoliatum*, 4365, roa, wet, N

Eupatorium purpureum L., 3762, mes, pin, N

Eupatorium rotundifolium L., 4325, lob, pin, N

Eupatorium serotinum Michx., 6007, lob, pin, rip, roa, wee, wet, N

Eurybia hemishperica (Alexander) Nesom, 3800, lob, nov, pin, roa, sha, wet, N

Gamochaeta purpurea (L.) Cabrera, 2118, nov, roa, N

Grindelia lanceolata Nutt, 3895, rip, N

Helenium amarum (Raf.) H. Rock, 3778, rip, roa, wet, N

Helenium flexuosum Raf., 5176, pin, rip, roa, wet, N

Helianthus angustifolius L., 4488, rip, wet, N

Helianthus divaricatus L., 5524, lob, mes, nov, pin, rip, roa, sha, wee, wet, N

Helianthus hirsutus Raf., 3951, nov, pin, rip, roa, N

Helianthus mollis Lam., R. D. Thomas, 128892A, NLU, N

Helianthus occidentalis Riddell ssp. *plantagineus* (Torr. & Gray) Shinners, 3886, rip, N, SC

Helianthus silphioides Nutt., 4274, mes, roa, N

Helianthus simulans E.E. Wats., 477, roa, N

Heliopsis helianthoides (L.) Sweet, 1720, mes, rip, N

Hieracium gronovii L., 2004, nov, pin, rip, roa, see, N

Ionactis linariifolius (L.) Greene, 4589, pin, N

Krigia biflora (Walt.) Blake var. *biflora*, 5041, mes, rip, see, wet, N

Krigia caespitosa (Raf.) Chambers, 4696, rip, N

Krigia dandelion (L.) Nutt., 4807, rip, wet, N

Krigia virginica (L.) Willd., 4899, roa, N

Lactuca canadensis L., 3175, lob, mes, nov, pin, roa, sha, N

Lactuca floridana (L.) Gaertn., 6001, mes, roa, wee, wet, N

Lactuca serriola L., 3208, rip, wee, I

Lapsana communis L., Pias, 959, NLU, I

Leucanthemum vulgare Lam., 2283, roa, sha, wee, I

Liatris aspera Michx., 3627, nov, N

Liatris elegans (Walt.) Michx., 4348, roa, N

Liatris pycnostachya Michx., 3713, lob, rip, roa, N

Liatris squarrosa (L.) Michx. var. *compacta* Torr. & Gray, 2648, nov, N, SC

Liatris squarrosa (L.) Michx. var. *squarrosa*, 3400, roa, N

Liatris squarrulosa Michx., 3944, nov, pin, roa, N

Marshallia caespitosa Nutt. ex DC. var. *caespitosa*, 1759, sha, N, SC

Packera aurea (L.) A. & D. Love, 4766, mes, pin, rip, see, N

Packera glabella (Poir.) C. Jeffrey, Hawkins, 18, APCR, N

Packera obovata (Muhl. ex Willd.) W.A. Weber & A. Love, 1075, mes, rip, wet, N

Packera tomentosa (Michx.) C. Jeffrey, 4698, roa, N

Parthenium integrifolium L. var. *integrifolium*, 3037, roa, N

Pityopsis graminifolia (Michx.) Nutt., 4587, nov, pin, N

Pluchea camphorata (L.) DC., 4225, pin, see, wee, N

Polymnia cossatotensis A.B. Pittman & V. Bates, 3675, mes, N, SC

Prenanthes altissima L., 4351, pin, rip, see, N

Pseudognaphalium helleri (Britt.) A. Anderb. ssp. *helleri*, 4620, lob, pin, sha, N

Pseudognaphalium obtusifolium (L.) Hilliard & Burtt ssp. *obtusifolium*, 4238, mes, rip, wee, N

Pyrrhopappus carolinianus (Walt.) DC., 2345, roa, wee, wet, N

Rudbeckia fulgida Ait. var. *umbrosa* (C.L. Boynt. & Beadle) Cronq., 4044, wet, N

Rudbeckia grandiflora (D. Don) J.F. Gmel. ex DC. var. *grandiflora*, 5633, pin, roa, sha, N

Rudbeckia hirta L., 5507, lob, mes, pin, rip, roa, sha, wee, wet, N

Rudbeckia laciniata L. var. *laciniata*, 3341, mes, rip, see, N

Rudbeckia subtomentosa Pursh, 3577, rip, N

Rudbeckia triloba L. var. *triloba*, 3422, pin, rip, roa, wet, N

Silphium asteriscus L. var. *asteriscus*, 3570, mes, rip, roa, N

Silphium integrifolium Michx., 3582, mes, pin, rip, roa, N

Silphium laciniatum L., 3232, roa, sha, N

Silphium perfoliatum L. var. *perfoliatum*, 3872, rip, roa, N

Silphium radula Nutt., Mrs. J. Miller, 176, UARK, N

Smallanthus uvedalius (L.) Mackenzie ex Small, 3264, rip, wee, N

Solidago arguta Ait. var. *bootii* (Hook.) Palmer & Steyermark, D. Demaree, 56954, BRIT, N

Solidago auriculata Shuttlw. ex Blake, 335, mes, N, SC

Solidago caesia L. var. *caesia*, 4428, mes, pin, rip, wee, N

Solidago canadensis L., 6024, lob, mes, nov, roa, wet, N

Solidago hispida Muhl. ex Willd., 4586, mes, pin, rip, roa, see, N

Solidago nemoralis Ait., 4022, lob, nov, pin, rip, roa, sha, wee, N

Solidago odora Ait., 4332, nov, pin, rip, sha, N

Solidago ouachitensis C. & J. Taylor, 4214, mes, rip, N, SC

Solidago petiolaris Ait., 4406, nov, pin, rip, sha, wet, N

Solidago radula Nutt., 4393, nov, pin, N

Solidago rugosa P. Mill., 6006, lob, N

Solidago ulmifolia Muhl. ex Willd. var. *microphylla* Gray, 4171, mes, pin, rip, roa, wet, N, SC

Solidago ulmifolia Muhl. ex Willd. var. *palmeri* Cronq., 4336, mes, nov, pin, rip, roa, sha, wee, wet, N

Solidago ulmifolia Muhl. ex Willd. var. *ulmifolia*, 3630, nov, N

Sonchus oleraceus L., 3200, wee, I

Symphyotrichum anomalum (Engelm.) Nesom, 4330, mes, nov, pin, roa, N

Symphyotrichum drummondii (Lindl.) Nesom var. *texanum* (Burgess) Nesom, 4492, nov, rip, sha, N

Symphyotrichum dumosum (L.) Nesom, 4478, wet, N

Symphyotrichum lateriflorum (L.) A. & D. Love, 6026, pin, roa, see, N

Symphyotrichum oblongifolium (Nutt.) Nesom, J. Logan, 155, UCAC, N

Symphyotrichum ontarione (Wieg.) Nesom, 4623, rip, N

Symphyotrichum oolentangiense (Riddell) Nesom var. *oolentangiense*, 4622, nov, pin, sha, N

Symphyotrichum patens (Ait.) Nesom var. *patens*, 4089, nov, pin, roa, wet, N

Symphyotrichum pilosum (Willd.) Nesom, 6023, pin, rip, roa, wee, wet, N

Symphyotrichum racemosum (Ell.) Nesom, 4594, pin, N

Symphyotrichum turbinellum (Lindl.) Nesom, 4593, pin, rip, N

Symphyotricum lanceolatum (Willd.) Nesom, 4631, mes, rip, see, sha, N

Taraxacum officinale G.H. Weber ex Wiggers, 4816, roa, wee, wet, N & I

Thelesperma filifolium (Hook.) Gray, D. M. Moore, 54-112, UARK, N

Verbesina alternifolia (L.) Britt. ex Kearney, 4163, rip, N

Verbesina helianthoides Michx., 5470, mes, pin, rip, roa, sha, N

Verbesina virginica L. var. *virginica*, 4222, rip, roa, wee, wet, N

Vernonia baldwinii Torr. ssp. *baldwinii*, 3549, nov, pin, rip, roa, sha, wee, N

Vernonia baldwinii Torr. ssp. *interior* (Small) Faust, 5666, pin, roa, N

Vernonia fasciculata Michx. ssp. *fasciculata*, 3611, rip, N, SC

Vernonia lettermannii Engelm. ex Gray, D. M. Moore, 55-290, UARK, N, SC
Vernonia missurica Raf., 3711, lob, pin, see, wet, N
Xanthium strumarium L., 4421, rip, wet, N

Azollaceae

Azolla mexicana Schlecht. & Cham. ex K. Presl, J. Peck, 94511, LRU, N

Balsaminaceae

Impatiens capensis Meerb., 5458, rip, see, wet, N

Berberidaceae

Nandina domestica Thunb., 4797, mes, **I***
Podophyllum peltatum L., 5515, mes, nov, rip, see, wet, N

Betulaceae

Alnus serrulata (Ait.) Willd., 2326, mes, rip, see, wet, N
Betula nigra L., 6038, rip, wet, N
Carpinus caroliniana Walt., 5437, rip, see, wet, N
Corylus americana Walt., 5445, mes, rip, see, N
Ostrya virginiana (P. Mill.) K. Koch, 5467, mes, nov, pin, rip, roa, N

Bignoniaceae

Bignonia capreolata L., 1011, rip, N
Campsis radicans (L.) Seem. ex Bureau, 6000, lob, rip, roa, wee, wet, N
Catalpa bignonioides Walt., 1680, wet, N

Blechnaceae

Woodwardia areolata (L.) T. Moore, 3550, pin, see, wet, N

Boraginaceae

Cynoglossum amabile Stapf & Drummond, Mrs. J. Miller, 179, UARK, I
Cynoglossum virginianum L., 1694, mes, see, N
Hackelia virginiana (L.) I.M. Johnston, D.M. Moore, 430153, UARK, N
Heliotropium indicum L., 4070, rip, wet, I
Lithospermum latifolium Michx., 4942, rip, N
Myosotis verna Nutt., 5038, mes, rip, see, wet, N
Onosmodium molle Michx. ssp. *subsetosum* (Mackenzie & Bush) Cochrane, 4401, nov, N

Brassicaceae

Arabis canadensis L., 2361, sha, N
Arabis laevigata (Muhl. ex Willd.) Poir. var. *laevigata*, 1812, rip, N
Arabis missouriensis Greene, 1657, mes, nov, pin, rip, roa, wet, N
Barbarea verna (P. Mill.) Aschers., 1295, pin, rip, roa, I
Brassica rapa L., 769, roa, I
Cardamine angustata O.E. Schultz, 576, rip, see, N, SC
Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., W. Butler, 28, UCAC, N
Cardamine concatenata (Michx.) Sw., 619, mes, pin, rip, see, sha, N
Cardamine hirsuta L., 688, mes, rip, roa, see, sha, wet, I
Cardamine parviflora L. var. *arenicola* (Britt.) O.E. Schultz, M. C. Black, 44, UARK, N
Cardamine pensylvanica Muhl. ex Willd., 4713, wet, N
Draba aprica Beadle, E. Sundell, 11143, UAM, N, SC
Lepidium virginicum L. var. *medium* (Greene) C.L. Hitchc., 2179, roa, wee, N
Lepidium virginicum L. var. *virginicum*, 2570, rip, roa, wee, wet, N
Rorippa nasturtium-aquaticum (L.) Hayek, C. Reid, 1961, UARK, N
Rorippa palustris (L.) Bess. ssp. *fernaldiana* (Butters & Abbe) Jonsell, 4819, roa, wet, N
Selenia aurea Nutt., 696, sha, wet, N
Streptanthus maculatus Nutt ssp. *obtusifolius* (Hook.) Rollins, 5699, nov, N, SC

Buddlejaceae

Polypremum procumbens L., 3297, wet, N

Cabombaceae

Brasenia schreberi J.F. Gmel., 5021, wet, N

Cactaceae

Opuntia humifusa (Raf.) Raf. var. *humifusa*, 2362, nov, roa, sha, N

Callitrichaceae

Callitriche heterophylla Pursh ssp. *heterophylla*, 5031, mes, pin, roa, sha, wet, N

Campanulaceae

Campanulastrum americanum (L.) Small, 3643, mes, nov, rip, N
Lobelia appendiculata A. DC., 5069, lob, pin, roa, N
Lobelia cardinalis L., 4264, rip, roa, see, wet, N
Lobelia inflata L., 3454, mes, rip, wee, N
Lobelia puberula Michx., 6028, lob, mes, pin, roa, wee, wet, N
Lobelia siphilitica L., 4467, roa, N
Lobelia spicata Lam., 2374, lob, pin, rip, sha, N
Triodanis lamprosperma McVaugh, 1903, nov, pin, roa, sha, wee, wet, N

Triodanis leptocarpa (Nutt.) Nieuwl., 1760, sha, N
Triodanis perfoliata (L.) Nieuwl. var. *biflora* (Ruiz & Pavon) Bradley, 2220, roa, wet, N
Triodanis perfoliata (L.) Nieuwl. var. *perfoliata*, 2011, nov, pin, rip, roa, wet, N

Capparaceae

Cleome hassleriana Chod., 3866, wet, I
Polanisia dodecandra (L.) DC., G. E. Tucker, 5297, APCR, N

Caprifoliaceae

Lonicera flava Sims, Mrs. J. Miller, 63, UARK, N
Lonicera japonica Thunb., 1673, mes, rip, see, wee, wet, **I***
Lonicera sempervirens L., 993, lob, mes, nov, rip, roa, sha, N
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, 5525, mes, rip, roa, wee, wet, N
Symphoricarpos orbiculatus Moench, 3637, nov, pin, rip, roa, N
Viburnum nudum L., 2446, see, N
Viburnum prunifolium L., 1134, pin, N
Viburnum rafinesquianum J.A. Schultes, 1026, mes, N
Viburnum rufidulum Raf., 2010, mes, nov, pin, roa, N

Caryophyllaceae

Arenaria serpyllifolia L., 4781, wee, I
Cerastium glomeratum Thuill., 759, mes, rip, roa, wee, wet, I
Dianthus armeria L., 5490, nov, roa, sha, wee, I
Minuartia muscorum (Fassett) Rabeler, 2331, rip, roa, sha, N
Paronychia fastigiata (Raf.) Fern. var. *fastigiata*, J. E. Moore, 3088, UCAC, N
Saponaria officinalis L., 3440, wet, I
Silene stellata (L.) Ait.f., 3259, nov, pin, rip, roa, see, N
Silene virginica L., 1282, mes, nov, pin, rip, roa, N
Stellaria media (L.) Vill. ssp. *media*, 881, mes, nov, pin, rip, wee, wet, I
Stellaria media (L.) Vill. ssp. *pallida* (Dumort.) Aschers. & Graebn., 686, roa, wet, I

Celastraceae

Euonymus americana L., 1792, mes, rip, N

Ceratophyllaceae

Ceratophyllum demersum L., 5486, wet, N

Chenopodiaceae

Chenopodium ambrosioides L., 4416, rip, wet, I
Chenopodium standleyanum Aellen, 4404, nov, N

Cistaceae

Lechea mucronata Raf., 3677, lob, N
Lechea tenuifolia Michx., 1296, roa, sha, wee, wet, N

Clusiaceae

Hypericum drummondii (Grev. & Hook.) Torr. & Gray, 3554, pin, roa, sha, wee, wet, N
Hypericum gentianoides (L.) B.S.P., 3617, nov, pin, roa, N
Hypericum gymnanthum Engelm. & Gray, 3242, roa, N
Hypericum hypericoides (L.) Crantz, 3748, nov, pin, rip, roa, wee, wet, N
Hypericum lobocarpum Gattinger, 3285, rip, N
Hypericum mutilum L., 5736, rip, roa, see, wet, N
Hypericum prolificum L., 3185, mes, pin, rip, roa, sha, wet, N
Hypericum pseudomaculatum Bush, 2267, nov, sha, wee, wet, N
Hypericum punctatum Lam., 3284, mes, nov, rip, roa, wee, wet, N
Triadenum walteri (J.G. Gmel.) Gleason, 4305, wet, N

Commelinaceae

Commelina communis L. var. *communis*, 2587, mes, rip, wee, wet, I
Commelina diffusa Burm. f., 4611, wet, N
Commelina erecta L. 3559, rip, wee, wet, N
Commelina virginica L., 5738, rip, see, wet, N
Murdannia keisak (Hassk.) Hand.-Mazz., 4408, wet, **I***
Tradescantia bracteata Small ex Britt., 2415, pin, N
Tradescantia ernestiana E.S., Anderson & Woods., 998, mes, rip, roa, wet, N
Tradescantia hirsuticaulis Small, 4809, nov, pin, roa, wet, N
Tradescantia hirsutiflora Bush, 2586, nov, wee, N
Tradescantia longipes E.S. Anderson & Woods., 694, sha, N, SC
Tradescantia occidentalis (Britt.) Smyth, 2679, lob, mes, wet, N
Tradescantia ohiensis Raf., 5052, mes, nov, rip, roa, wee, wet, N
Tradescantia ozarkana E.S. Anderson & Woods., R. Kirkwood, K-26, UCAC, N, SC

Convolvulaceae

Ipomoea hederacea Jacq., 4630, rip, I

Ipomoea lacunosa L., 3855, rip, wee, wet, N
Ipomoea pandurata (L.) G.F.W. Mey., 3147, mes, rip, roa, wet, N

Cornaceae

Cornus drummondii C.A. Mey., 1575, rip, N
Cornus florida L., 2230, mes, nov, pin, rip, roa, see, N
Cornus foemina P. Mill., 5763, rip, wet, N
Cornus obliqua Raf., 2089, mes, pin, rip, roa, N

Crassulaceae

Penthorum sedoides L., 5767, lob, see, wet, N
Sedum nuttallianum Raf., J. L. Roberts, 277, UARK, N
Sedum pulchellum Michx., 1757, sha, N
Sedum ternatum Michx., 778, mes, rip, N, SC

Cucurbitaceae

Melothria pendula L., 3590, rip, roa, N
Sicyos angulatus L., 4115, roa, wee, N

Cupressaceae

Juniperus virginiana L. var. *virginiana*, 5504, nov, pin, roa, sha, wet, N

Cuscutaceae

Cuscuta compacta Juss. ex Choisy, 4005, rip, roa, see, wet, N
Cuscuta cuspidata Engelm., E. B. Smith, 3370, UARK, N
Cuscuta gronovii Willd. ex J.A. Schultes, 6020, roa, wee, N
Cuscuta indecora Choisy, 4226, wee, N
Cuscuta pentagona Engelm., 6022, rip, sha, roa, wet, N
Cuscuta polygonorum Engelm., 3642, nov, N

Cyperaceae

Bulbosytlis capillaris (L.) Kunth ex C.B. Clarke, 220, sha, N, SC
Carex albicans Willd. ex Spreng. var. *albicans*, 770, rip, N
Carex albolutescens Schwein., 2393, sha, N
Carex amphibola Steud., 1588, mes, rip, see, N
Carex blanda Dewey, 1476, mes, rip, wet, N
Carex bushii Mackenzie, 2372, roa, sha, N
Carex caroliniana Schwein., 5179, wet, N
Carex cephalophora Muhl. ex Willd., 2098, mes, nov, pin, rip, roa, see, N
Carex cherokeensis Schwein., 4714, mes, rip, wet, N
Carex complanata Torr. & Hook., 2160, lob, pin, rip, wet, N
Carex crinita Lam., 4967, mes, rip, see, wet, N
Carex davisii Schwein. & Torr., 1632, mes, N, SC
Carex debilis Michx. var. *debilis*, 1652, mes, N
Carex digitalis Willd., C. T. Bryson, 4344, UARK, N
Carex festucacea Schkuhr ex Willd., 2542, rip, see, wet, N
Carex flaccosperma Dewey, 5469, pin, rip, roa, wet, N
Carex frankii Kunth, 5481, mes, pin, rip, roa, see, wee, wet, N
Carex glaucodea Tuckerman ex Olney, 5087, pin, roa, wet, N
Carex granularis Muhl. ex Willd. var. *granularis*, 5111, roa, N
Carex grayi Carey, 3603, rip, N
Carex hirsutella Mackenzie, 2100, mes, nov, pin, roa, sha, wet, N
Carex intumescens Rudge, 4958, rip, wet, N
Carex jamesii Schwein., P. E. Hyatt, 6937, UARK, N
Carex joorii Bailey, 3898, rip, N
Carex laevivaginata (Kukenth.) Mackenzie, J. H. Rettig, 540, UARK, N, SC
Carex latebracteata Waterfall, 5002, pin, sha, N, SC
Carex laxiculmis Schwein., P. E. Hyatt, 7329, UARK, N, SC
Carex laxiflora Lam., J. H. Rettig, 560, BRIT, N, SC
Carex leavenworthii Dewey, 1548, rip, roa, N
Carex leptalea Wahlenb., 2444, see, N
Carex lupulina Muhl. ex Willd., 4959, rip, wet, N
Carex lurida Wahlenb., 5460, mes, pin, rip, roa, see, wet, N
Carex muehlenbergii Schkuhr ex Willd., 3089, mes, nov, pin, roa, sha, N
Carex nigromarginata Schwein., 762, mes, pin, roa, N
Carex oklahomensis Mackenzie, 2384, rip, roa, sha, N
Carex oligocarpa Schkuhr ex Willd., 1435, rip, N
Carex ouachitana Kral, Manhart & Bryson, 2791, mes, N
Carex oxylepis Torr. & Hook. var. *oxylepis*, 2417, mes, pin, roa, N
Carex oxylepis Torr. & Hook. var. *pubescens* J.K. Underwood, 1076, mes, see, N, SC
Carex retroflexa Muhl. ex Willd., 1513, mes, rip, see, N
Carex rosea Schkuhr ex Willd., 2437, mes, rip, see, N
Carex squarrosa L., 5172, pin, N
Carex stricta Lam., E. B. Smith, 3801, BRIT, N, SC

Carex swanii (Fern.) Mackenzie, 2739, nov, N, SC
Carex texensis (Torr.) Bailey, 1499, rip, N
Carex torta Boott ex Tuckerman, 1097, mes, rip, see, N, SC
Carex tribuloides Wahlenb., 5494, wet, N
Carex vulpinoidea Michx., 5475, lob, mes, nov, pin, rip, roa, see, wet, N
Cyperus aristatus Rottb., E. Sundell, 10606, UARK, N
Cyperus echinatus (L.) Wood, 2066, pin, wee, N
Cyperus erythrorhizos Muhl., 4482, wet, N
Cyperus esculentus L., 436, wee, wet, N
Cyperus flavescens L., D. M. Moore, 32971, UARK, N
Cyperus iria L., 4549, wee, wet, I
Cyperus lupulinus (Spreng.) Marcks, 3725, nov, wee, N
Cyperus polystachyos Rottb. var. *texensis* (Torr.) Fern., 4560, wet, N
Cyperus pseudovegetus Steud., 5747, wet, N
Cyperus retroflexus Buckl., 3729, nov, wee, N
Cyperus squarrosus L., 382, wet, N
Cyperus strigosus L., 3324, roa, see, sha, wet, N
Dulichium arundinaceum (L.) Britt., 3257, wet, N, SC
Eleocharis acicularis (L.) Roemer & J.A. Schultes, 3300, wet, N
Eleocharis engelmannii Steud., 2304, rip, sha, wet, N
Eleocharis lanceolata Fern., 5553, roa, N
Eleocharis obtusa (Willd.) J.A. Schultes, 2724, mes, rip, roa, sha, wee, wet, N
Eleocharis quadrangulata (Michx.) Roemer & J.A. Schultes, 5131, wet, N
Fimbristylis annua (All.) Roemer & J.A. Schultes, 180, sha, N
Fimbristylis autumnalis (L.) Roemer & J.A. Schultes, 4235, wee, wet, N
Fimbristylis vahlii (Lam.) Link, 396, wet, N
Kyllinga pumila Michx., 4419, wee, wet, N
Rhynchospora caduca Ell., 3178, roa, N, SC
Rhynchospora corniculata (Lam.) Gray, 5751, rip, wet, N
Rhynchospora globularis (Chapman) Small, 5611, roa, N
Rhynchospora glomerata (L.) Vahl, 3568, rip, N
Rhynchospora recognita (Gale) Kral, 2687, lob, rip, roa, N
Schoenoplectus pungens (Vahl) Palla var. *pungens*, 3849, wet, N
Scirpus atrovirens Willd., 5578, roa, wet, N
Scirpus cyperinus (L.) Kunth, 5731, lob, wet, N
Scirpus georgianus Harper, 2310, mes, rip, N
Scirpus pendulus Muhl., 5128, roa, N
Scleria oligantha Michx., 2229, lob, nov, pin, roa, sha, N
Scleria triglomerata Michx., 2497, pin, N

Dennstaedtiaceae

Dennstaedtia punctilobula (Michx.) T. Moore, G. Oleson, 87-017, UARK, N, SC
Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underwood ex Heller, 2151, mes, pin, roa, N
Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) Heller, 5510, roa, N

Dioscoreaceae

Dioscorea oppositifolia L., 3587, rip, I
Dioscorea villosa L., 5442, mes, pin, rip, N

Dryopteridaceae

Athyrium filix-femina (L.) Roth ssp. *asplenioides* (Michx.) Hulten, 5491, lob, mes, rip, see, N
Cystopteris protrusa (Weatherby) Blasdell, 3413, rip, N
Cystopteris tennesseensis Shaver, 2770, mes, rip, N
Dryopteris celsa (Wm. Palmer) Knowlt., Palmer & Pollard ex Small, 2536, see, N, SC
Dryopteris marginalis (L.) Gray, 2430, mes, pin, see, N
Onoclea sensibilis L., 1687, see, N
Polystichum acrostichoides (Michx.) Schott, 5479, mes, pin, rip, see, wet, N
Woodsia obtusa (Spreng.) Torr. ssp. *obtusa*, 3663, mes, nov, pin, N
Woodsia obtusa (Spreng.) Torr. ssp. *occidentalis* Windham, 3330, rip, sha, wee, N

Ebenaceae

Diospyros virginiana L., 5500, nov, rip, roa, wet, N

Elaeagnaceae

Elaeagnus umbellata Thunb., 3592, pin, rip, roa, wet, **I***

Elatinaceae

Elatine triandra Schkuhr, 4041, wet, N

Equisetaceae

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eat., 4457, roa, N

Ericaceae

Gaylussacia baccata (Wangenh.) K. Koch, V. Bates, 10455, UARK, N, SC

Lyonia ligustrina (L.) DC., 5529, mes, rip, see, wet, N
Rhododendron prinophyllum (Small) Millais, 289, rip, see, N
Rhododendron viscosum (L.) Torr., 2309, mes, pin, rip, see, wee, N
Vaccinium arboreum Marsh., 2657, nov, pin, rip, sha, wet, N
Vaccinium fuscatum Ait., 2483, see, N
Vaccinium pallidum Ait., 1898, mes, nov, pin, see, N
Vaccinium stamineum L., 1129, mes, nov, pin, rip, N
Vaccinium virgatum Ait., 5040, lob, pin, rip, see, wet, N

Euphorbiaceae

Acalypha gracilens Gray, 3088, nov, pin, N
Acalypha monococca (Engelm. ex Gray) L. Mill. & Gandhi, 3733, nov, pin, sha, wet, N
Acalypha rhomboidea Raf., 4132, roa, N
Acalypha virginica L., 3136, roa, wee, wet, N
Chamaesyce humistrata (Engelm.) Small, 3853, wee, wet, N
Chamaesyce maculata (L.) Small, 4157, rip, roa, N
Chamaesyce nutans (Lag.) Small, 3854, nov, rip, roa, wee, wet, N
Croton capitatus Michx., 4424, roa, N
Croton glandulosus L. var. *septentrionalis* Muell.-Arg., 3164, wee, wet, N
Croton monanthogynus Michx., 3224, nov, roa, sha, wee, wet, N
Croton willdenowii G.L. Webster, 3331, nov, sha, wet, N
Euphorbia corollata L., 5519, mes, nov, pin, roa, see, sha, N
Euphorbia cyathophora Murr., 3332, mes, nov, sha, N
Euphorbia dentata Michx., 6004, rip, roa, wet, N
Euphorbia spathulata Lam., 6004, roa, N
Leptopus phyllanthoides (Nutt.) G.L. Webster, 5000, pin, N
Phyllanthus caroliniensis Walt., 3852, roa, see, wet, N
Tragia cordata Michx., 3340, mes, sha, N
Tragia urticifolia Michx., R. D. Thomas, 128945, NLU, N

Fabaceae

Albizia julibrissin Durazz., 3119, pin, rip, wee, **I***
Amorpha fruticosa L., 4961, lob, rip, roa, N
Amorpha nitens Boynt., D. M. Moore, 55-289, UARK, N
Amorpha ouachitensis Wilbur, T. Huffman, sn, UARK, N
Amphicarpaea bracteata (L.) Fern. var. *bracteata*, 3749, pin, rip, see, N
Amphicarpaea bracteata (L.) Fern. var. *comosa* (L.) Fern., 4130, rip, N
Apios americana Medik., 5543, pin, rip, roa, see, wet, N
Astragalus canadensis L., 3548, nov, pin, N
Astragalus crassicarpus Nutt. var. *trichocalyx* (Nutt.) Barneby, L. A. Bariola, 85, UARK, N, SC
Astragalus distortus Torr. & Gray var. *distortus*, J. W. Gibbons, 33, UARK, N
Astragalus distortus Torr. & Gray var. *engelmannii* (Sheldon) M.E. Jones, 4794, sha, N
Baptisia alba (L.) Vent. var. *macrophylla* (Larisey) Isely, 4945, roa, N
Baptisia bracteata Muhl. ex Ell. var. *leucophaea* (Nutt.) Kartesz & Gandhi, 1981, nov, pin, rip, roa, wet, N
Baptisia nuttalliana Small, 2086, roa, N
Baptisia sphaerocarpa Nutt., 4946, roa, N
Cercis canadensis L. var. *canadensis*, 5444, mes, pin, rip, roa, sha, N
Chamaecrista fasciculata (Michx.) Greene, 3959, nov, sha, wee, N
Chamaecrista nictitans (L.) Moench ssp. *nictitans*, 2563, nov, sha, wee, wet, N
Clitoria mariana L., 3118, lob, nov, pin, rip, roa, N
Crotalaria sagittalis L., 3833, wet, N
Desmodium canescens (L.) DC., E. B. Smith, 3773, UARK, N
Desmodium cuspidatum (Muhl. ex Willd.) DC. ex Loud. var. *cuspidatum*, 6021, roa, see, N
Desmodium glutinosum (Muhl. ex Willd.) Wood, 3933, mes, N
Desmodium laevigatum (Nutt.) DC., 4388, lob, N
Desmodium marilandicum (L.) DC., 4087, pin, N
Desmodium nudiflorum (L.) DC., 3476, lob, mes, pin, N
Desmodium nuttallii (Schindl.) Schub., 3404, rip, N
Desmodium obtusum (Muhl. ex Willd.) DC., 6009, lob, pin, rip, N
Desmodium paniculatum (L.) DC. var. *paniculatum*, 4266, mes, nov, pin, roa, see, N
Desmodium pauciflorum (Nutt.) DC., 3366, mes, pin, rip, see, N

Desmodium perplexum Schub., 3997, mes, pin, rip, see, wet, N
Desmodium rotundifolium DC., 4577, mes, N
Galactia regularis (L.) B.S.P., 3731, lob, nov, N
Galactia volubilis (L.) Britt., 3401, roa, sha, N
Gleditsia triacanthos L., 2215, nov, rip, roa, wet, N
Kummerowia stipulacea (Maxim.) Makino, 237, roa, I
Kummerowia striata (Thunb.) Schindl., 3312, lob, nov, roa, wet, I
Lathyrus hirsutus L., 1936, pin, I
Lathyrus latifolius L., 2532, roa, I
Lathyrus venosus Muhl. ex Willd., 1064, mes, nov, pin, N
Lespedeza cuneata (Dum.-Cours.) G. Don, 3288, nov, rip, roa, wee, wet, **I***
Lespedeza hirta (L.) Hornem., 3932, lob, nov, pin, roa, N
Lespedeza procumbens Michx., 4591, pin, roa, N
Lespedeza repens (L.) W. Bart., 4387, lob, pin, roa, wee, wet, N
Lespedeza violacea (L.) Pers., 3652, rip, wee, wet, N
Lespedeza virginica (L.) Britt., 4021, pin, roa, N
Medicago lupulina L., 3207, wee, I
Orbexilum pedunculatum (P. Mill.) Rydb. var. *pedunculatum*, 4818, mes, wet, N
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida, 4310, wee, **I***
Rhynchosia latifolia Nutt. ex Torr. & Gray, 5563, pin, N
Robinia hispida L., 5088, roa, N
Robinia pseudoacacia L., 3143, mes, nov, pin, rip, wee, wet, N
Robinia viscosa Vent., 1666, roa, N
Senna marilandica (L.) Link, 3620, nov, pin, rip, N
Strophostyles helvula (L.) Ell., 3148, roa, wet, N
Strophostyles umbellata (Muhl. ex Willd.) Britt., 5758, lob, pin, roa, wet, N
Stylosanthes biflora (L.) B.S.P., 4272, pin, roa, sha, N
Tephrosia onobrychoides Nutt., G. Barber, 2201, UARK, N
Tephrosia virginiana (L.) Pers., 2499, nov, pin, roa, N
Trifolium arevense L., 5210, roa, I
Trifolium campestre Schreb., 1341, roa, I
Trifolium dubium Sibthorp, C. Reid, 1949, UARK, I
Trifolium incarnatum L., 4854, nov, roa, wee, I
Trifolium pratense L., 1150, pin, rip, roa, wee, wet, I
Trifolium reflexum L., 1315, roa, N
Trifolium repens L., 1149, mes, pin, roa, wee, I
Trifolium vesiculosum Savi, 2604, wee, wet, I
Vicia caroliniana Walt., 1119, pin, wee, wet, N
Vicia minutiflora F.G. Dietr., 4723, wet, N
Vicia sativa L., 4703, nov, rip, roa, wee, wet, I
Vicia tetrasperma (L.) Schreb., 5108, roa, I
Vicia villosa Roth ssp. *varia* (Host) Corb., 2069, nov, roa, wee, I
Vicia villosa Roth ssp. *villosa*, 2713, wet, I
Wisteria floribunda (Willd.) DC., 4300, wet, **I***
Wisteria sinensis (Sims) DC., 3369, roa, **I***

Fagaceae

Castanea pumila (L.) P. Mill. var. *ozarkensis* (Ashe) Tucker, 5630, mes, nov, pin, see, N, SC
Castanea pumila (L.) P. Mill. var. *pumila*, 195, see, N
Fagus grandifolia Ehrh., 1637, mes, rip, see, N
Quercus acerifolia (Palmer) Stoynoff & Hess, 3615, nov, N, SC
Quercus alba L., 5472, mes, pin, rip, roa, see, wee, N
Quercus falcata Michx., 5153, lob, mes, nov, pin, N
Quercus marilandica Muenchh., 2633, nov, pin, N
Quercus muehlenbergii Engelm., 4395, mes, nov, pin, rip, roa, sha, N
Quercus nigra L., 4674, rip, wet, N
Quercus pagoda Raf., 1518, rip, N
Quercus palustris Muenchh., 4964, wet, N
Quercus phellos L., 2329, lob, pin, rip, roa, wet, N
Quercus rubra L., 4391, mes, nov, N
Quercus shumardii Buckl. var. *shumardii*, 1739, rip, N
Quercus stellata Wangenh., 4507, nov, pin, wee, N
Quercus velutina Lam., 5620, nov, pin, N

Fumariaceae

Corydalis crystallina Engelm., W. Butler, 57, UCAC, N
Corydalis flavula (Raf.) DC., 4683, rip, N
Corydalis micrantha (Engelm. ex Gray) Gray ssp. *australis* (Chapman) G.B. Ownbey, 774, rip, N

Gentianaceae

Bartonia paniculata (Michx.) Muhl. ssp., *paniculata*, 4007, see, N
Frasera caroliniensis Walt., 1750, rip, N
Sabatia angularis (L.) Pursh, 3371, roa, sha, wee, N

Sabatia campestris Nutt., D.M. Eggers Ware, 5483, UARK, N

Geraniaceae

Geranium carolinianum L., 1152, mes, roa, wet, N
Geranium dissectum L., 1563, roa, I
Geranium maculatum L., 1247, rip, N

Grossulariaceae

Itea virginica L., 3267, rip, see, N
Ribes curvatum Small, J. L. Roberts, 617, UARK, N, SC

Haloragaceae

Myriophyllum heterophyllum Michx., 5549, wet, N
Myriophyllum spicatum L., 5161, wet, **I***
Proserpinaca palustris L., 5750, wet, N

Hamamelidaceae

Hamamelis vernalis Sarg., 1000, mes, pin, rip, wet, N
Hamamelis virginiana L., 442, mes, nov, pin, rip, see, N
Liquidambar styraciflua L., 3875, pin, rip, see, wee, wet, N

Hippocastanaceae

Aesculus glabra Willd., 4859, mes, nov, rip, see, N
Aesculus pavia L., 1058, mes, N

Hydrangeaceae

Hydrangea arborescens L., 5448, mes, rip, see, N

Hydrocharitaceae

Hydrilla verticillata (L.f.) Royle, 5168, wet, I

Hydrophyllaceae

Hydrolea ovata Nutt. ex Choisy, 5724, wet, N
Hydrophyllum brownei Kral & Bates, 1712, mes, rip, see, N, SC
Nemophila phacelioides Nutt., 4938, rip, roa, wet, N
Phacelia hirsuta Nutt., 1148, mes, roa, wet, N
Phacelia ranunculacea (Nutt.) Constance, 4690, mes, rip, N

Hymenophyllaceae

Trichomanes petersii Gray, J. Peck, 82457, LRU, N, SC

Iridaceae

Belamcanda chinensis (L.) DC., J. E. Moore, sn, UARK, I
Iris cristata Ait., 2095, mes, nov, pin, rip, see, N
Iris pseudacorus L., 4924, wet, I
Iris verna L., D. M. Moore, 510023, UARK, N, SC
Iris virginica L., 4965, wet, N
Sisyrinchium angustifolium P. Mill., 5028, mes, rip, roa, sha, wet, N
Sisyrinchium campestre Bickn., 4795, roa, N
Sisyrinchium langloisii Greene, M. C. Black, 81, UARK, N

Isoetaceae

Isoetes melanopoda Gay & Durieu ex Durieu, 852, see, sha, N

Juglandaceae

Carya alba (L.) Nutt. ex Ell., 5502, lob, mes, nov, pin, roa, wee, wet, N
Carya cordiformis (Wangenh.) K. Koch, 5438, mes, nov, rip, N
Carya texana Buckl., 3645, mes, nov, pin, sha, N
Juglans nigra L., 3463, lob, mes, N

Juncaceae

Juncus acuminatus Michx., 4969, mes, rip, roa, wet, N
Juncus brachycarpus Engelm., 5610, roa, N
Juncus coriaceus Mackenzie, 5732, lob, mes, pin, rip, roa, see, wee, wet, N
Juncus debilis Gray, 4301, wet, N
Juncus dichotomus Ell., 2301, rip, N
Juncus diffusissimus Buckl., 5554, rip, roa, wee, N
Juncus effusus L., 5547, mes, roa, wet, N
Juncus interior Wieg., 5557, roa, N
Juncus marginatus Rostk., 5555, lob, roa, wee, wet, N
Juncus secundus Beauv. ex Poir., 3384, roa, sha, wet, N
Juncus tenuis Willd., 2083, pin, rip, roa, see, sha, wee, wet, N
Juncus torreyi Coville, 3684, lob, wet, N
Juncus validus Coville, 3535, roa, N
Luzula acuminata Raf. var. *acuminata*, 2786, mes, N
Luzula acuminata Raf. var. *carolinae* (S. Wats.) Fern., 613, rip, N, SC
Luzula bulbosa (Wood) Smyth & Smyth, 4791, mes, roa, sha, N
Luzula echinata (Small) F.J. Herm., 647, mes, pin, rip, roa, see, N

Lamiaceae

Ajuga reptans L., 763, roa, I
Clinopodium arkansanum (Nutt.) House, 5573, roa, N
Cunila origanoides (L.) Britt., 4106, mes, pin, rip, see, wee, N

Hedeoma hispida Pursh, 5199, sha, wet, N
Hedeoma pulegioides (L.) Pers., Simpson, sn, UARK, N
Isanthus brachiatus (L.) B.S.P., E. B. Smith, 3767, UARK, N
Lamium amplexicaule L., 676, rip, roa, N
Lamium purpureum L., 677, rip, roa, wet, N
Lycopus rubellus Moench, 4207, mes, rip, see, wet, N
Lycopus virginicus L., 4655, see, N
Mentha spicata L., Simpson, sn, UARK, I
Monarda fistulosa L. ssp. *fistulosa* var. *stipitatoglandulosa* (Waterfall) Scora, comb. nov. ined., 2571, nov, pin, roa, sha, wee, wet, N
Monarda punctata L., D. Demaree, 57040, APCR, N
Monarda russeliana Nutt. ex Sims, 2045, mes, pin, rip, N
Perilla frutescens (L.) Britt., 4146, mes, pin, rip, I
Physostegia angustifolia Fern., 5605, roa, N
Prunella vulgaris L., 4953, lob, mes, pin, rip, roa, wee, wet, N
Pycnanthemum albescens Torr. & Gray, 3176, lob, roa, wet, N
Pycnanthemum muticum (Michx.) Pers., 3253, rip, N
Pycnanthemum tenuifolium Schrad., 5497, lob, pin, roa, sha, wet, N
Salvia azurea Michx. ex Lam., D. Demaree, 62848, NLU, N
Salvia lyrata L., 904, mes, rip, roa, wet, N
Scutellaria elliptica Muhl. ex Spreng. var. *elliptica*, 5043, mes, rip, wet, N
Scutellaria lateriflora L., 4049, wet, N
Scutellaria ovata Hill, 2409, mes, nov, pin, wet, N
Stachys eplingii J. Nelson, 3461, mes, pin, N, SC
Stachys tenuifolia Willd., 3594, mes, rip, N
Teucrium canadense L. var. *canadense*, 3420, rip, N
Trichostema dichotomum L., Simpson, sn, UARK, N

Lauraceae

Lindera benzoin (L.) Blume, 1619, mes, rip, see, N
Sassafras albidum (Nutt.) Nees, 5511, mes, nov, pin, see, wet, N

Lemnaceae

Lemna aequinoctialis Welw., 4030, wet, N
Spirodela punctata (G.F.W. Mey.) C.H. Thompson, 5026, wet, N

Lentibulariaceae

Urticularia gibba L., 4303, wet, N

Liliaceae

Allium canadense L. var. *canadense*, 1234, pin, rip, roa, wet, N
Allium canadense L. var. *mobilense* (Regel) Owenby, 2242, sha, N
Allium vineale L., 2191, wee, I
Amianthium muscitoxicum (Walt.) Gray, 2459, mes, see, N
Camassia scilloides (Raf.) Cory, 4849, nov, N
Erythronium albidum Nutt., 544, rip, N
Erythronium rostratum W. Wolf, 604, nov, rip, see, N
Hemerocallis fulva (L.) L., 1920, nov, I
Lilium michiganense Farw., Mrs. J. Miller, 166, UARK, N
Maianthemum racemosum (L.) Link, 1307, mes, pin, rip, roa, see, N
Melanthium virginicum L., 5483, lob, pin, roa, see, N
Melanthium woodii (J.W. Robbins ex Wood) Bodkin, R. Davis, 1967, APCR, N, SC
Muscari botryoides (L.) P. Mill., 682, roa, I
Nothoscordum bivalve (L.) Britt., 1091, mes, nov, rip, roa, sha, wet, N
Ornithogalum umbellatum L., 957, rip, I
Polygonatum biflorum (Walt.) Ell., 1702, rip, see, N
Stenanthium gramineum (Ker-Gawl.) Morong var. *gramineum*, G. E. Tucker, 15000, APCR, N, SC
Trillium pusillum Michx. var. *ozarkanum* (Palmer & Steyermark) Steyermark, 609, rip, N, SC
Trillium recurvatum Beck, 4941, mes, rip, N
Trillium viridescens Nutt., 1256, rip, wet, N
Uvularia grandiflora Sm., 2412, pin, N
Uvularia perfoliata L., 701, mes, N, SC
Uvularia sessilifolia L., 5044, wet, N

Linaceae

Linum medium (Planch.) Britt. var. *texanum* (Planch.) Fern., 3513, roa, wet, N
Linum striatum Walt., 3280, pin, rip, roa, N

Loganiaceae

Spigelia marilandica (L.) L., 1439, mes, pin, rip, roa, N

Lycopodiaceae

Lycopodium digitatum Dill. ex A. Braun, 1117, pin, N

Lythraceae

Ammannia coccinea Rottb., 400, wet, N
Didiplis diandra (Nutt. ex DC.) Wood, 5725, wet, N, SC
Rotala ramosior (L.) Koehne, 6042, wee, wet, N

Magnoliaceae

Magnolia acuminata (L.) L., 4575, mes, N
Magnolia grandiflora L., 2147, pin, see, N
Magnolia tripetala (L.) L., 1622, mes, rip, see, N

Malvaceae

Abutilon theophrasti Medik., D. X Williams, ARF0078, UARK, I
Callirhoe pedata (Nutt. ex Hook.) Gray, 1753, sha, N
Hibiscus laevis Allioni, 3847, wet, N
Malva neglecta Wallr., Simpson, sn, UARK, I
Sida spinosa L., 3843, roa, wet, N

Marsileaceae

Pilularia americana A. Braun, 5201, sha, N, SC

Melastomataceae

Rhexia mariana L. var. *interior* (Pennell) Kral & Bostick, 3282, rip, roa, sha, N
Rhexia mariana L. var. *mariana*, 2700, lob, wet, N
Rhexia virginica L., 5723, wet, N

Menispermaceae

Calycocarpum lyonii (Pursh) Gray, 2581, rip, see, wee, N
Cocculus carolinus (L.) DC., 2732, nov, pin, rip, roa, wee, wet, N
Menispermum canadense L., 1353, rip, N

Mollugaceae

Mollugo verticillata L., 402, wet, N

Monotropaceae

Monotropa uniflora L., 4579, pin, N

Moraceae

Maclura pomifera (Raf.) Schneid., 1723, rip, wet, N
Morus rubra L., 5538, rip, roa, see, wet, N

Najadaceae

Najas guadalupensis (Spreng.) Magnus, 4281, wet, N

Nyctaginaceae

Mirabilis albida (Walt.) Heimerl, 2600, roa, wee, N

Nymphaeaceae

Nuphar lutea (L.) Sm., 5019, wet, N
Nymphaea odorata Ait., 5018, wet, N

Nyssaceae

Nyssa sylvatica Marsh., 4966, mes, nov, pin, rip, roa, wet, N

Oleaceae

Fraxinus americana L., 5493, lob, mes, pin, rip, N
Fraxinus pennsylvanica Marsh., T. Huffman, sn, UARK, N
Ligustrum sinense Lour., 4466, lob, mes, rip, roa, see, wee, **I***

Onagraceae

Gaura demareei Raven & Gregory, 250, roa, N
Gaura longiflora Spach, 3840, roa, wee, N
Ludwigia alternifolia L., 5459, lob, mes, pin, roa, see, wet, N
Ludwigia decurrens Walt., 3885, lob, wet, N
Ludwigia glandulosa Walt., 3389, wet, N
Ludwigia palustris (L.) Ell., 5097, roa, wet, N
Oenothera fruticosa L., 5010, mes, pin, N
Oenothera laciniata Hill, 2580, roa, wee, N
Oenothera linifolia Nutt., 4978, pin, roa, sha, N
Oenothera villosa Thunb., 4140, rip, roa, N

Ophioglossaceae

Botrychium biternatum (Sav.) Underwood, 4628, pin, rip, see, N
Botrychium dissectum Spreng., J. E. Moore, sn, UARK, N
Botrychium virginianum (L.) Sw., 1069, mes, rip, see, N
Ophioglossum crotalophorioides Walt., C. Reid, 3393.5, UARK, N
Ophioglossum vulgatum L., 2363, sha, N

Orchidaceae

Cypripedium kentuckiense C.F. Reed, 841, mes, rip, N, SC
Goodyera pubescens (Willd.) R. Br. ex Ait. f., J. E. Moore, 3081, UCAC, N
Isotria verticillata Raf., 5661, see, N
Platanthera ciliaris (L.) Lindl., 192, rip, see, N
Platanthera clavellata (Michx.) Luer, 3787, see, N
Platanthera lacera (Michx.) G. Don, 5100, roa, N
Spiranthes cernua (L.) L. C. Rich., 4483, roa, wet, N
Spiranthes tuberosa Raf., 208, sha, N
Spiranthes vernalis Engelm. & Gray, 2706, roa, wet, N

Orobanchaceae

Epifagus virginiana (L.) W. Bart., 3407, rip, N
Orobanche uniflora L., C. Hunter, 70, UARK, N

Osmundaceae

Osmunda cinnamomea L., 986, rip, see, N
Osmunda regalis L., 5753, mes, pin, see, wet, N

Oxalidaceae

Oxalis corniculata L., 675, roa, N
Oxalis stricta L., 5034, lob, mes, pin, rip, roa, wee, wet, N
Oxalis violacea L., 884, mes, pin, rip, roa, see, sha, N

Papaveraceae

Sanguinaria canadensis L., 610, rip, roa, see, N

Passifloraceae

Passiflora incarnata L., 5523, rip, roa, wee, N
Passiflora lutea L., 5518, nov, pin, rip, roa, wee, wet, N

Phytolaccaceae

Phytolacca americana L., 5526, nov, pin, rip, roa, wee, wet, N

Pinaceae

Pinus echinata P. Mill., 3086, pin, rip, N
Pinus strobus L., 4574, mes, N
Pinus taeda L., 5761, lob, nov, wet, N

Plantaginaceae

Plantago aristata Michx., 2578, roa, sha, wee, N
Plantago heterophylla Nutt., Hardin, 606, APCR, N
Plantago lanceolata L., 2124, roa, wee, I
Plantago rugelii Dcne., 2540, rip, roa, see, N
Plantago virginica L., 4774, rip, roa, wee, N

Platanaceae

Platanus occidentalis L., 1813, rip, N

Poaceae

Agrostis gigantea Roth, 4544, pin, rip, I
Agrostis hyemalis (Walt.) B.S.P., 5078, rip, roa, wet, N
Agrostis perennans (Walt.) Tuckerman, E.B. Smith, 3753, UARK, N
Aira caryophyllea L., 1163, roa, I
Aira elegans Willd. ex Kunth, D.M. Moore, 55- 291, UARK, I
Alopecurus carolinianus Walt., 910, roa, N
Andropogon gerardii Vitman, 3546, lob, nov, pin, rip, roa, sha, N
Andropogon ternarius Michx., 4505, rip, N
Andropogon virginicus L. var. *virginicus*, 6025, roa, N
Anthoxanthum aristatum Boiss., 5149, roa, I
Anthoxanthum odoratum L., 878, mes, I
Aristida dichotoma Michx., 218, roa, sha, N
Aristida oligantha Michx., 4312, wee, N
Arthraxon hispidus (Thunb.) Makino, 4254, roa, wet, I
Arundinaria gigantea (Walt.) Muhl., 5480, mes, rip, see, N
Axonopus furcatus (Fluegge) A.S. Hitchc., 4613, wet, N
Brachyelytrum erectum (Schreb. ex Spreng.) Beauv., 3356, mes, nov, pin, rip, see, N
Bromus catharticus Vahl, 4895, roa, I
Bromus commutatus Schrad., 1682, wet, I
Bromus hordeaceus L., 1030, wee, I
Bromus japonicus Thunb. ex Murr., 2072, nov, wee, I
Bromus pubescens Muhl. ex Willd., 1809, mes, nov, pin, rip, roa, sha, N
Bromus racemosus L., 1569, roa, wee, I
Bromus secalinus L., 2749, nov, rip, roa, I
Chasmanthium latifolium (Michx.) Yates, 2250, mes, pin, rip, roa, sha, N
Chasmanthium laxum (L.) Yates, 3489, lob, mes, see, N
Chasmanthium sessiliflorum (Poir.) Yates, 3480, mes, pin, roa, wet, N
Cynodon dactylon (L.) Pers., 4474, roa, wee, wet, **I***
Dactylis glomerata L., 5601, nov, pin, roa, sha, wee, I
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes, 1925, nov, pin, roa, sha, wee, N
Diarrhena americana Beauv., 3676, mes, nov, N
Diarrhena obovata (Gleason) Brandenburg, 3873, rip, sha, N
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*, 5436, pin, rip, roa, sha, wee, wet, N
Dichanthelium boscii (Poir.) Gould & C.A. Clark, 2022, mes, nov, pin, rip, N
Dichanthelium clandestinum (L.) Gould, 3493, mes, N
Dichanthelium commutatum (J.A. Schultes) Gould, 1354, mes, nov, pin, rip, roa, see, N
Dichanthelium depauperatum (Muhl.) Gould, 1327, pin, roa, N
Dichanthelium dichotomum (L.) Gould, 2346, mes, pin, rip, roa, see, wet, N
Dichanthelium laxiflorum (Lam.) Gould, 2062, roa, wee, wet, N
Dichanthelium linearifolium (Scribn. ex Nash) Gould, 4982, mes, nov, pin, sha, N

Dichanthelium oligosanthes (J.A. Schultes) Gould, 1370, wee, N

Dichanthelium ravenelii (Scribn. & Merr.) Gould, 5062, pin, N

Dichanthelium scoparium (Lam.) Gould, 3240, pin, roa, sha, wet, N

Dichanthelium sphaerocarpon (Ell.) Gould var. *isophyllum* (Scribn.) Gould & C.A. Clark, 5463, lob, mes, pin, rip, roa, sha, wet, N

Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon*, 2693, lob, mes, pin, sha, N

Digitaria ciliaris (Retz.) Koel., 3162, roa, wee, wet, N

Digitaria ischaemum (Schreb.) Schreb. ex Muhl., 4232, mes, roa, wee, wet, I

Digitaria sanguinalis (L.) Scop., 3775, pin, rip, wet, N

Digitaria violascens Link, 213, sha, I

Echinochloa colona (L.) Link, 4609, wet, I

Echinochloa muricata (Beauv.) Fern., 5721, rip, roa, wee, wet, I

Eleusine indica (L.) Gaertn., 4409, wee, wet, I

Elymus canadensis L., 2592, wee, N

Elymus hystrix L., 5579, nov, rip, N

Elymus villosus Muhl. ex Willd., 2583, nov, wee, N

Elymus virginicus L. var. *virginicus*, 5474, pin, rip, roa, see, wee, wet, N

Eragrostis capillaris (L.) Nees, 3714, nov, N

Eragrostis curvula (Schrad.) Nees, 3456, mes, roa, wee, I

Eragrostis hirsuta (Michx.) Nees, 4309, wee, N

Eragrostis hypnoides (Lam.) B.S.P., 5994, roa, wet, N

Festuca paradoxa Desv., 1961, lob, pin, N

Festuca subverticillata (Pers.) Alexeev, 1621, mes, pin, rip, see, wee, N

Glyceria striata (Lam.) A.S. Hitchc., 2325, mes, pin, rip, see, sha, N

Holcus lanatus L., 5151, roa, **I***

Hordeum pusillum Nutt., 1558, roa, wet, N

Leersia oryzoides (L.) Sw., 4377, roa, wet, N

Leersia virginica Willd., 4514, lob, mes, pin, rip, see, N

Lolium arundinaceum (Schreb.) S.J. Darbyshire, 2187, mes, roa, sha, wee, **I***

Lolium perenne L. ssp. *multiflorum* (Lam.) Husnot, 2200, roa, sha, wee, I

Lolium perenne L. ssp. *perenne*, 1794, nov, rip, roa, sha, wet, I

Melica mutica Walt., 5047, mes, rip, roa, wet, N

Melica nitens (Scribn.) Nutt. ex Piper, 2750, nov, N

Microstegium vimineum (Trin.) A. Camus, 441, mes, pin, rip, roa, wee, wet, **I***

Muhlenbergia schreberi J.F. Gmel., D. M. Moore, 420407, UARK, N

Muhlenbergia sobolifera (Muhl. ex Willd.) Trin., 3957, mes, nov, N

Muhlenbergia sylvatica Torr. ex Gray, 4219, mes, wee, N

Muhlenbergia tenuiflora (Willd.) B.S.P., No collector listed, sn, UAM, N

Oplismenus hirtellus (L.) Beauv., D. M. Moore, 410404, UARK, N

Panicum anceps Michx., 3827, lob, nov, pin, rip, roa, see, wet, N

Panicum capillare L., 3736, nov, roa, N

Panicum dichotomiflorum Michx., 4616, nov, pin, wet, N

Panicum flexile (Gattinger) Scribn., 4308, wee, N

Panicum philadelphicum Bernh. ex Trin., 217, sha, N

Panicum rigidulum Bosc ex Nees, 4138, rip, roa, wet, N

Panicum virgatum L., 3865, lob, nov, pin, rip, roa, wee, wet, N

Paspalum dilatatum Poir., 3537, roa, wee, wet, I

Paspalum dissectum (L.) L., 378, wet, N

Paspalum floridanum Michx., 4267, roa, N

Paspalum laeve Michx., 3202, wee, wet, N

Paspalum notatum Fluegge var. *saurae* Parodi, 3654, lob, roa, wee, I

Paspalum setaceum Michx., 3524, roa, wet, N

Paspalum urvillei Steud., 4278, wet, I

Pennisetum glaucum (L.) R. Br., 3777, pin, rip, wee, wet, I

Phleum pratense L., 4719, sha, wet, I

Piptochaetium avenaceum (L.) Parodi, 1330, mes, pin, roa, N

Poa annua L., 4709, rip, roa, wet, I

Poa autumnalis Muhl. ex Ell., 895, mes, see, N

Poa bulbosa L., 4910, roa, I

Poa pratensis L., 4912, roa, N

Poa sylvestris Gray, 1114, mes, rip, N

Saccharum alopecuroidum (L.) Nutt., 4211, roa, N

Saccharum brevibarbe (Michx.) Pers. var. *contortum* (Ell.) R. Webster, 3553, rip, roa, wee, N

Sacciolepis striata (L.) Nash, 4497, rip, N, SC

Schizachyrium scoparium (Michx.) Nash, 4355, nov, pin, roa, sha, N

Secale cereale L., 1342, roa, sha, wee, I
Setaria parviflora (Poir.) Kerguelen, 2386, roa, sha, wee, wet, N
Sorghastrum nutans (L.) Nash, 4018, roa, N
Sorghum halepense (L.) Pers., 3612, rip, roa, wee, wet, **I***
Sphenopholis nitida (Biehler) Scribn., 2008, nov, N
Sphenopholis obtusata (Michx.) Scribn., 1322, rip, roa, N
Sporobolus clandestinus (Biehler) A.S. Hitchc., R. L. McGregor, 38721, UARK, N
Sporobolus compositus (Poir.) Merr. var. *compositus*, 219, sha, N
Sporobolus vaginiflorus (Torr. ex Gray) Wood, 4320, wee, N
Steinchisma hians (Ell.) Nash, 2176, rip, roa, sha, wee, wet, N
Stenotaphrum secundatum (Walt.) Kuntze, 4060, roa, N
Tridens flavus (L.) A.S.Hitchc. var. *flavus*, 3235, mes, nov, pin, roa, sha, N
Tridens strictus (Nutt.) Nash, 3923, roa, wet, N
Tripsacum dactyloides (L.) L., 3530, roa, N
Vulpia myuros (L.) K.C. Gmel., 2231, roa, sha, wee, I
Vulpia octoflora (Walt.) Rydb., 1288, pin, wet, N

Podostemaceae

Podostemum ceratophyllum Michx., J. E. Moore, sn, UARK, N, SC

Polemoniaceae

Phlox divaricata L. ssp. *laphamii* (Wood) Wherry, 1464, rip, wee, N
Phlox paniculata L., 3588, rip, roa, N
Phlox pilosa L. ssp. *ozarkana* (Wherry) Wherry, 4985, pin, N
Phlox pilosa L. ssp. *pilosa*, 902, mes, nov, pin, rip, roa, N
Polemonium reptans L., 1589, rip, N

Polygalaceae

Polygala ambigua Nutt., 2185, nov, pin, sha, wee, N
Polygala polygama Walt., D.M. Moore, 4176, UARK, N
Polygala sanguinea L., 5075, roa, sha, N

Polygonaceae

Eriogonum longifolium Nutt., 4651, sha, N
Polygonella americana (Fisch. & C.A. Mey.) Small, 3633, nov, N
Polygonum aviculare L., 492, wee, I
Polygonum caespitosum Blume var. *longisetum* (de Bruyn) A.N. Stewart, 3995, mes, rip, see, wee, N
Polygonum convolvulus L., 1921, nov, I
Polygonum hydropiperoides Michx., 6041, lob, rip, roa, sha, wet, N
Polygonum lapathifolium L., 4554, wet, N
Polygonum pensylvanicum L., 4149, rip, roa, wet, N
Polygonum punctatum Ell., 3994, rip, see, wee, wet, N
Polygonum sagittatum L., 266, rip, see, N
Polygonum scandens L., 325, mes, nov, rip, N
Polygonum setaceum Baldw., 3528, roa, N
Polygonum tenue Michx., 4397, nov, sha, N
Polygonum virginianum L., 3839, mes, rip, see, N
Rumex acetosella L., 1553, rip, roa, sha, I
Rumex altissimus Wood, 1477, wet, N
Rumex conglomeratus Murr., H. H. Iltis, 5110, UARK, I
Rumex crispus L., 3206, nov, roa, wee, wet, I
Rumex hastatulus Baldw., 5175, wee, wet, N
Rumex obtusifolius L., 1707, rip, roa, I
Rumex pulcher L., 2602, wee, I

Polypodiaceae

Pleopeltis polypodioides (L.) Andrews & Windham ssp. *michauxianum* (Weatherby) Andrews & Windham, 1111, mes, nov, pin, rip, see, sha, N

Pontederiaceae

Heteranthera limosa (Sw.) Willd., 4031, wet, N

Portulacaceae

Claytonia virginica L., 1050, lob, mes, nov, pin, rip, roa, see, wet, N
Talinum calycinum Engelm., 2644, nov, sha, N

Potemogetonaceae

Potamogeton diversifolius Raf., 6029, wet, N
Potamogeton nodosus Poir., 3887, wet, N
Potamogeton pulcher Tuckerman, 5015, wet, N
Potamogeton pusillus L., 5024, wet, N

Primulaceae

Dodecatheon meadia L., 4782, sha, N
Lysimachia lanceolata Walt., 2339, mes, rip, N
Lysimachia quadriflora Sims, 4948, roa, N
Samolus valerandi L. ssp. *parviflorus* (Raf.) Hulten, 3181, mes, roa, see, wee, N

Pteridaceae

Adiantum capillus-veneris L., Mayo, 275, HEND, N

Adiantum pedatum L., 4576, mes, N
Cheilanthes lanosa (Michx.) D.C. Eat., 2731, nov, pin, N
Cheilanthes tomentosa Link, W. C. Taylor, 918, UARK, N

Ranunculaceae

Actaea pachypoda Ell., 2785, mes, N
Anemone virginiana L., 6008, lob, rip, see, N
Clematis reticulata Walt., 2589, wee, N
Delphinium carolinianum Walt. ssp. *carolinianum*, 1752, mes, pin, sha, N
Delphinium newtonianum Moore, E. Hardcastle, AR13, UARK, N, SC
Delphinium tricorne Michx., 1010, mes, rip, N
Enemion biternatum Raf., C. Hunter, 58, UARK, N
Hepatica nobilis Schreb. var. *obtusa* (Pursh) Steyermark, 611, mes, rip, N
Ranunculus abortivus L., 4747, rip, wet, N
Ranunculus bulbosus L., 4684, rip, I
Ranunculus fascicularis Muhl. ex Bigelow, 4783, sha, N
Ranunculus harveyi (Gray) Britt., 4784, mes, rip, roa, sha, N
Ranunculus hispidus Michx. var. *nitidus* (Chapman) T. Duncan, M. C. Black, 39, UARK, N
Ranunculus laxicaulis (Torr. & Gray) Darby, 4957, wet, N
Ranunculus micranthus Nutt., 4687, nov, rip, roa, wet, N
Ranunculus pusillus Poir., 5508, roa, see, wet, N
Ranunculus recurvatus Poir., 1505, mes, rip, see, N
Ranunculus sardous Crantz, 2186, roa, wee, wet, I
Thalictrum dasycarpum Fisch. & Ave-Lall., 1778, rip, N
Thalictrum revolutum DC., 3602, rip, N
Thalictrum thalictroides Eames & Boivin, 706, mes, nov, pin, rip, see, wet, N

Rhamnaceae

Berchemia scandens (Hill) K. Koch, 5742, mes, rip, roa, see, wet, N
Ceanothus americanus L., 5003, pin, N
Ceanothus herbaceus Raf., J. C. Baker, 60, UAM, N
Frangula caroliniana (Walt.) Gray, 5537, mes, nov, pin, rip, sha, wee, wet, N

Rosaceae

Agrimonia parviflora Ait., 4256, roa, N
Agrimonia rostellata Wallr., 5740, lob, mes, pin, rip, see, N
Amelanchier arborea (Michx. f.) Fern., 5749, lob, mes, pin, rip, sha, N
Chaenomeles speciosa (Sweet) Nakai, 744, see, I
Crataegus berberifolia Torr. & Gray, 2201, rip, roa, wet, N
Crataegus crus-galli L., 2629, nov, N
Crataegus intricata Lange, D. M. Moore, 56-55, UARK, N
Crataegus marshallii Egglest., 5532, mes, nov, pin, rip, wet, N
Crataegus spathulata Michx., 5450, pin, rip, roa, wet, N
Crataegus uniflora Muenchh., 4508, pin, N
Crataegus viridis L. var. *viridis*, 1023, roa, N
Duchesnea indica (Andr.) Focke, 1523, rip, I
Fragaria virginiana Duchesne, 1309, rip, roa, N
Geum canadense Jacq., 5454, mes, nov, rip, see, N
Photinia pyrifolia (Lam.) Robertson & Phipps, 2447, see, N
Physocarpus opulifolius (L.) Maxim., 2330, mes, rip, wet, N
Porteranthus stipulatus (Muhl. ex Willd.) Britt, 3638, lob, nov, roa, wee, N
Potentilla recta L., 2282, nov, rip, roa, sha, I
Potentilla simplex Michx., 1115, nov, pin, rip, roa, wee, N
Prunus americana Marsh., 3920, nov, pin, rip, roa, N
Prunus mexicana S. Wats., 5505, nov, pin, wet, N
Prunus persica (L.) Batsch, 2617, wee, I
Prunus serotina Ehrh., 5522, lob, nov, pin, roa, wee, wet, N
Prunus umbellata Ell., 4856, nov, N
Pyrus calleryana Dcne., 571, roa, **I***
Pyrus communis L., 2616, wee, I
Rosa carolina L., 2040, lob, mes, nov, pin, rip, roa, N
Rosa chinensis Jacq., 5139, roa, I
Rosa multiflora Thunb. ex Murr., 1345, roa, **I***
Rosa setigera Michx., 5462, pin, rip, roa, see, wee, N
Rubus argutus Link, 5032, lob, rip, see, wet, N
Rubus bushii Bailey, 1126, pin, N
Rubus discolor Weihe & Nees, 5091, roa, I
Rubus flagellaris Willd., 1908, mes, nov, pin, roa, wee, N
Rubus ostryifolius Rydb., 1997, pin, N
Rubus pensilvanicus Poir., 2726, mes, nov, N
Rubus trivialis Michx., 2131, roa, wee, wet, N

Spiraea xbilliardii Herincq. (pro sp.) [*douglasii* x *salicifolia*], 2797, roa, N

Rubiaceae

Cephalanthus occidentalis L., 3301, rip, roa, wet, N
Cruciata pedemontana (Bellardi) Ehrend., 5101, roa, I
Diodia teres Walt., 388, nov, roa, wee, wet, N
Diodia virginiana L., 5760, rip, wee, wet, N
Galium aparine L., 1444, mes, nov, rip, roa, see, N
Galium arkansanum Gray, 1999, mes, nov, pin, see, N
Galium circaezans Michx., 3700, lob, mes, pin, rip, N
Galium obtusum Bigel. ssp. *obtusum*, 4956, sha, wet, N
Galium pilosum Ait., 5528, lob, rip, wee, wet, N
Galium tinctorium L., 2712, roa, wet, N
Galium triflorum Michx., 2433, rip, see, N
Hedyotis nigricans (Lam.) Fosberg, 3896, rip, sha, N
Houstonia caerulea L., 4804, roa, sha, wet, N
Houstonia longifolia Gaertn., 4980, pin, N
Houstonia micrantha (Shinners) Terrell, 679, roa, N
Houstonia ouachitana (E.B. Sm.) Terrell, 1107, mes, nov, pin, rip, N, SC
Houstonia purpurea L., 5451, mes, pin, rip, see, N
Houstonia pusilla Schoepf, 716, mes, pin, rip, roa, sha, wet, N
Mitchella repens L., 1398, lob, mes, pin, rip, see, N
Sherardia arvensis L., 4734, rip, roa, wee, I

Rutaceae

Poncirus trifoliata (L.) Raf., 1401, rip, roa, wet, **I***
Ptelea trifoliata L., 2741, nov, N
Zanthoxylum clava-herculis L., 4003, roa, N

Salicaceae

Populus alba L., 3557, wee, I
Populus deltoides Bartr. ex Marsh. ssp. *deltoides*, R. Avra, sn, UCAC, N
Salix caroliniana Michx., 1089, mes, rip, roa, see, wet, N
Salix nigra Marsh., 4975, roa, wet, N

Sapindaceae

Cardiospermum halicacabum L., 4119, rip, N

Sapotaceae

Sideroxylon lanuginosum Michx., 2751, nov, pin, rip, wet, N

Saxifragaceae

Heuchera americana L. var. *americana*, 2763, mes, nov, pin, N
Heuchera americana L. var. *hirsuticaulis* (Wheelock) Rosendahl, Butters & Lakela, 4835, nov, N
Saxifraga palmeri Bush, 600, rip, N

Scrophulariaceae

Agalinis fasciculata (Ell.) Raf., 4386, lob, wet, N
Agalinis tenuifolia (Vahl) Raf., 4501, pin, rip, N
Aureolaria grandiflora (Benth.) Pennell, 439, pin, rip, roa, wet, N
Aureolaria pectinata (Nutt.) Pennell, M. Stewart, 87-529, UAM, N
Gratiola brevifolia Raf., 3269, rip, N
Gratiola neglecta Torr., 5033, wet, N
Gratiola pilosa Michx., 3382, wet, N
Lindernia dubia (L.) Pennell, 5476, rip, wee, wet, N
Mecardonia acuminata (Walt.) Small, 4384, lob, N
Mimulus alatus Ait., 3278, mes, rip, see, wet, N
Nuttallanthus canadensis (L.) D.A. Sutton, 1147, roa, N
Pedicularis canadensis L., 4725, mes, rip, N
Penstemon arkansanus Pennell, 4989, pin, rip, roa, N
Penstemon digitalis Nutt. ex Sims, 1726, mes, rip, roa, sha, N
Penstemon tubiflorus Nutt., 1834, mes, N
Scrophularia marilandica L., 3961, mes, rip, N
Verbascum blattaria L., 5208, roa, wee, wet, I
Verbascum thapsus L., 3746, wee, I
Veronica arvensis L., 4722, rip, roa, wet, I
Veronica peregrina L., 4710, wet, N
Veronica persica Poir., 566, roa, I
Veronicastrum virginicum (L.) Farw., 3764, pin, N

Selaginellaceae

Selaginella apoda (L.) Spring, D.M. Moore, 430154, UARK, N

Smilacaceae

Smilax bona-nox L., 5046, lob, mes, nov, pin, rip, roa, see, wee, wet, N
Smilax glauca Walt., 5045, mes, rip, see, wee, wet, N
Smilax herbacea L., 3632, nov, N
Smilax lasioneura Hook., 1593, mes, N
Smilax laurifolia L., 451, see, N
Smilax rotundifolia L., 4962, lob, mes, pin, rip, see, sha, wee, wet, N
Smilax tamnoides L., 3425, rip, wet, N

Solanaceae

Datura stramonium L., Simpson, sn, UARK, I
Physalis angulata L., 3867, wet, N
Physalis heterophylla Nees, 3518, rip, roa, N
Physalis pubescens L., 4556, mes, wet, N
Solanum carolinense L., 5030, rip, roa, wee, wet, N
Solanum ptychanthum Dunal, 4118, mes, nov, pin, rip, wee, wet, N

Sparganiaceae

Sparganium androcladum (Engelm.) Morong, 5772, wet, N

Staphyleaceae

Staphylea trifolia L., 5455, rip, N

Styracaceae

Halesia tetraptera Ellis var. *monticola* (Rehd.) Reveal & Seldin, D. M. Moore, 69007, UARK, N
Styrax grandifolius Ait., 5471, mes, rip, N

Thelypteridaceae

Phegopteris hexagonoptera (Michx.) Fee, 4341, mes, pin, rip, N
Thelypteris noveboracensis (L.) Nieuwl., 4245, rip, N, SC

Thymelaeaceae

Dirca palustris L., 708, mes, N

Tiliaceae

Tilia americana L. var. *americana*, 5443, mes, nov, pin, rip, N
Tilia americana L. var. *caroliniana* (P. Mill.) Castigl., 2105, pin, rip, N

Typhaceae

Typha angustifolia L., 5516, wet, I
Typha latifolia L., 5545, roa, wet, N

Ulmaceae

Celtis laevigata Willd., 6014, lob, nov, rip, sha, wet, N
Celtis occidentalis L., R. D. Thomas, 128988, NLU, N
Celtis tenuifolia Nutt., 1899, nov, pin, rip, sha, N
Ulmus alata Michx., 5051, pin, rip, roa, wet, N
Ulmus americana L., 6005, nov, rip, see, wet, N
Ulmus pumila L., 4597, roa, I
Ulmus rubra Muhl., 1943, pin, rip, see, N

Urticaceae

Boehmeria cylindrica (L.) Sw., 3250, mes, rip, roa, see, N
Laportea canadensis (L.) Weddell, 4444, rip, N
Pilea pumila (L.) Gray, 3879, mes, rip, see, N
Urtica chamaedryoides Pursh, M. C. Black, 43, UARK, N

Valerianaceae

Valerianella longiflora (Torr. & Gray) Walp., T. Witsell, 01-0251, UARK, N
Valerianella nuttallii (Torr. & Gray) Walp., E. Sundell, 2304, UAM, N, SC
Valerianella palmeri Dyal, 4678, rip, N, SC
Valerianella radiata (L.) Dufr., 1320, mes, pin, rip, roa, sha, wee, wet, N

Verbenaceae

Callicarpa americana L., 5513, nov, pin, rip, wet, N
Glandularia canadensis (L.) Nutt., 661, mes, roa, sha, N
Phryma leptostachya L., 5449, mes, nov, pin, rip, N
Verbena brasiliensis Vell., 4559, rip, wet, I
Verbena stricta Vent., Simpson, sn, UARK, N
Verbena urticifolia L., 3999, mes, rip, wee, N

Violaceae

Hybanthus concolor (T.F. Forst.) Spreng., 3670, mes, N
Viola affinis Le Conte, 4887, mes, pin, rip, see, N
Viola bicolor Pursh, 652, nov, roa, sha, wet, N
Viola lanceolata L., 4728, rip, N
Viola palmata L., 4812, pin, wet, N
Viola pedata L., 587, mes, nov, pin, rip, roa, sha, wee, wet, N
Viola pubescens Ait., 790, rip, see, N
Viola sagittata Ait., 653, lob, pin, rip, roa, sha, wet, N
Viola sororia Willd., 732, mes, rip, see, N
Viola striata Ait., 954, rip, see, N
Viola villosa Walt., 779, rip, N

Vitaceae

Ampelopsis arborea (L.) Koehne, 4114, rip, roa, N
Ampelopsis cordata Michx., 3472, mes, roa, N
Parthenocissus quinquefolia (L.) Planch., 5446, mes, nov, pin, rip, roa, see, sha, N
Vitis aestivalis Michx., 3596, mes, pin, nov, rip, N
Vitis cinerea (Engelm.) Millard var. *cinerea*, 5517, pin, rip, roa, wee, wet, N
Vitis palmata Vahl, 4048, wet, N
Vitis rotundifolia Michx. var. *rotundifolia*, 5050, nov, pin, rip, roa, see, wet, N
Vitis rupestris Scheele, V. Bates, 10447, UARK, N
Vitis vulpina L., 5744, mes, pin, rip, wee, wet, N

Xyridaceae

Xyris jupicai L.C. Rich., 3889, rip, N

ACKNOWLEDGMENTS

I gratefully acknowledge the University of Arkansas Herbarium (UARK) for its continuous support of this research effort in the form of funds and resources as well as people who proved to be an invaluable resource and support system. Funding for the project was provided by UARK, the Ouachita National Forest (ONF), and the Arkansas Native Plant Society. The Ouachita Mountains Biological Station provided an excellent place to stay and work while I was in the field. I thank Johnnie Gentry for discussions on the directions the project should take and about the manuscript. Cindy Sagers and David Krementz also provided ideas and assistance. Susan Hooks (ONF) was instrumental in providing information that allowed me to choose primary collection sites. Johnnie Gentry, George Johnson, Sarah Nunn, Jim Peck, Chris Reid, and Eric Sundell helped in identifications. I thank Rob Doster, Johnnie Gentry, Edie Hardcastle, Terry McKay (ONF), Sarah Nunn, Matt Nutt, Chris Reid, John Shadwick, and Theo Witsell (ANHC) for their company and assistance in the field. Johnnie Gentry, Cindy Sagers, David Krementz, Leesia Marshall-Rosenberger, Sarah Nunn, Krista Clements Peppers, and Staria Vanderpool, as well as three anonymous reviewers commented on the manuscript. I especially thank my wife, Katie Marsico, who not only assisted in the field and reviewed the manuscript, but supported me with her love through it all.

REFERENCES

Arkansas Native Plant Society. 2003. Invasive plants in Arkansas' natural areas. Presented at the Rare and Invasive Plants of Arkansas Conference, 23–24 October 2003, Fayetteville, AR.

Bailey, R.G. 1995. Description of the ecoregions of the United States. 2nd ed. rev. and expanded (1st ed. 1980). Misc. Publ. No. 1391 (rev.), USDA Forest Service Washington, DC.

Baldwin, J.R. 1984. Arkansas tornado distribution, recurrence probability and intensity: 1950–1982. M.A. Thesis, University of Arkansas, Fayetteville.

Bates, V. 1993. Ouachita National Forest, Volume I: Overview of plant communities and an inventory of natural areas. Unpublished Internal Report.

Braden, A. 1999. Geologic map of Arkansas. Arkansas Geologic Commission, William V. Bush, State Geologist, Vardelle Parham Geology Center, Little Rock, Arkansas.

Braun, E.L. 1950. Deciduous forests of eastern North America. Hafner Publishing Company, Inc., NY.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, VA.

Dale, E.E. and S. Ware. 1999. Analysis of oak-hickory-pine forests of Hot Springs National Park in the Ouachita Mountains, Arkansas. Castanea 64:163–174.

Diggs, G.M., Jr., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners & Mahler's illustrated flora of north central Texas. Botanical Research Institute of Texas, Ft. Worth.

Duncan, W.H. 1953. Taxonomic collections of vascular plants in the southeastern States—their abundance and relation to production of floras. Rhodora 55:353–358.

Early, A.M. 2000. Results of the winding stair project. In: Forest farmsteads: a millennium of human occupation at winding stair in the Ouachita Mountains. A.M. Early, ed. Arkansas Archeological Survey, Fayetteville, AR.

Flawn, P.T. 1959. The Ouachita structural belt. In: The geology of the Ouachita Mountains: A Symposium. L.M. Cline, W.J. Hilseweck, and D.E. Feray, eds. Dallas Geological Society and Ardmore Geological Society, Dallas, TX.

Guccione, M.J. 1993. Geologic history of Arkansas through Time and Space. M. J. Guccione (self published), Fayetteville, AR.

Hardcastle, E. and D.X Williams. 2000. *Ptilimnium nodosum*: Arkansas Status Report 2000. Unpublished document.

NatureServe. 2003. Ecological Systems Database, version 1.01. NatureServe, Arlington, VA.

Orzell, S.L. 1985. Selected acid seep forests in the Ouachita National Forest—Preliminary Botanical Assessment. Unpublished Report for the Arkansas Natural Heritage Commission.

Palmer, E.J. 1926. The ligneous flora of Hot Springs National Park and vicinity. Journal of the Arnold Arboretum 7:104–135.

Pyne, S. J. 1982. Fire in America: A cultural history of wildland and rural fire. Princeton University Press, Princeton, NJ.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The University of North Carolina Press, Chapel Hill, NC.

Reinhold, R.O. 1969. Climates of the states: Arkansas. Climatography of the United States No. 60-3. U.S. Department of Commerce, Environmental Science Services Administration, Washington, D.C.

Robison, H.W. and D.L. Marsh. Undated. Biodiversity of seeps and springs on the Caddo Ranger District, Ouachita National Forest, Arkansas. Final Report of Part I to USDA Forest Service, Ouachita National Forest, Caddo Ranger District.

Robison, H.W. and R.T. Allen. 1995. Only in Arkansas: A study of the endemic plants and animals of the State. University of Arkansas Press, Fayetteville.

Scully, E.J. 1937. Ferns of Hot Springs National Park. Amer. Fern J. 27:50–62.

Scully, E.J. 1941. The mosses of Hot Springs National Park and vicinity. Bryologist 44:125–128.

Scully, E.J. 1942. Grasses of Hot Springs National Park and vicinity. Rhodora 44:70–71.

Smith, E.B. 1988. An atlas and annotated list of the vascular plants of Arkansas. 2nd Edition. Edwin B. Smith (self published).

Smith, E.B. 1994a. Keys to the flora of Arkansas. The University of Arkansas Press, Fayetteville.

Smith, E.B. 1994b. Plant taxonomy booklet: Materials for BOTY 4104 Lecture and Laboratory. P.A. No. 410. Printing Services Professor's Assistance Program, University of Arkansas, Fayetteville.

Smith, K.L. 1986. Sawmill: the story of cutting the last great virgin forest east of the Rockies. The University of Arkansas Press, Fayetteville.

Snider, L.V. 1982. Integrated multidisciplinary lineament analysis of the Ouachita Mountains of Arkansas and Oklahoma. Master's thesis. University of Arkansas, Fayetteville.

Soil Survey Staff. 1998. Dominant soil orders and suborders. Soil taxonomy. 1998. Maps and Soil Photographs, USDA, NRCS. National Soil Survey Center, Lincoln, NE.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys, 2nd edition. USDA, NRCS.

Stein, B.A., L.S. Kutner, and J.S. Adams (eds.). 2000. Precious heritage: the status of biodiversity in the United States. Oxford University Press, New York, NY.

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874–4490 USA.

USDA Soil Conservation Service Handbook 296. 1981. Land resource regions and major land resource areas of the United States. USDA.

Yatskievych, G. 1999. Steyermark's flora of Missouri—Revised Edition. Missouri Botanical Garden, St. Louis.

BOOK NOTICES

Timber Press

JIM JERMYN (text) with photographs by WILHELM and DIETER SCHACHT. 2005. **Alpine Plants of Europe: A Gardener's Guide.** (ISBN 0-88192-734-1, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 320 pp., color photos, 8 b/w figures, 7 1/2" × 10 1/2".

The photographs are truly exquisite and the photographers are to be congratulated. I found it hard to close the book once I opened it. Nine chapters from the history of European alpine plants to alpine gardening, fill in the space between the stunning photos.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

JOHN E. BRYAN. 2005. **Timber Press Pocket Guide to Bulbs.** (ISBN 0-88192-752-2, flexibind). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $19.95, 227 pp., 300 color photos, 5 3/4" × 8 1/4".

As noted in the Preface, this book "is intended to give gardeners a greater appreciation of bulbs." The bulbous plants referenced in the *Guide to Bulbs* are arranged alphabetical from *Achimenes longiflora* to *Zantedschia elliotiana*. The *Guide to Bulbs* gives information to more than 700 species, cultivars, and hybrids. Everyday helpful information on such things as cultivation, maintenance, and pests and diseases is also found in the *Guide*.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

MIKANIA BUCHTIENII (ASTERACEAE: EUPATORIEAE) NEW TO ARGENTINA

María M. Cerana

Facultad de Ciencias Agropecuarias
Universidad Nacional de Córdoba
Casilla de Correo 509
5000 Córdoba, Argentina
macerana@agro.uncor.edu

Luis Ariza-Espinar

Instituto Multidisciplinario de Biología Vegetal (IMBIV)
CONICET- Universidad Nacional de Córdoba
Casilla de Correo 495
5000 Córdoba, Argentina
arizaesp@imbiv.unc.edu.ar

ABSTRACT

Mikania buchtienii B.L. Rob. (Asteraceae, Eupatorieae) is first reported as occurring in Argentina, where it has been collected in the Yungas region of the northwestern part of the country (Salta and Jujuy provinces). The species, which was known only from Bolivia, is described and illustrated and a key shows the differences between *M. buchtienii* and *M. euryanthela*, a closely related species.

RESUMEN

Mikania buchtienii B.L. Rob. (Asteraceae, Eupatorieae) se cita por primera vez para Argentina, donde ha sido colectada en las Yungas de la región noroccidental del país (provincias de Salta y Jujuy). La especie, que vive en Bolivia, es descripta e ilustrada, y una clave muestra las diferencias entre *M. buchtienii* y *M. euryanthela*, una especie muy afín.

During an extensive taxonomic study of the genus *Mikania* in Argentina (Cerana 1997a, b), two specimens from the northwestern Argentina (Yungas region) came to our attention. After a literature review and comparison with similar species, we concluded that it was necessary to relocate and collect the species in its natural habitat in order to determine its identity. In July 1997, February and November 1998, three trips were made to Las Capillas in Jujuy Province to search for the species, but without success. In October 2000, field studies were conducted in San Pedrito, Salta Province, located about 45 km from Estación Vespucio. One flowering specimen, which also had fruits from the previous year, was collected. Other plants present were in the vegetative stage.

In addition to the field studies, specimens from the following herbaria were examined: BAB, CORD, CTES, JUA, LIL, LP, LPB, SI. Our research has shown that the collection and herbarium specimens represent the first records of *Mikania buchtienii* B.L. Rob. for Argentina. This is also the first known occurrence of the species from outside of Bolivia. A specimen was sent to W.C. Holmes of Baylor University in Waco, Texas, who confirmed our determination.

Mikania buchtienii B.L. Rob., Contr. Gray Herb. n. s. 64:7. 1922. (**Fig. 1**).
Twining lianas; stems terete, striate, glabrate. Leaves simple, coriaceous, opposite, petiolate, inconspicuously stipulate; petioles 10–30 mm long; blades from

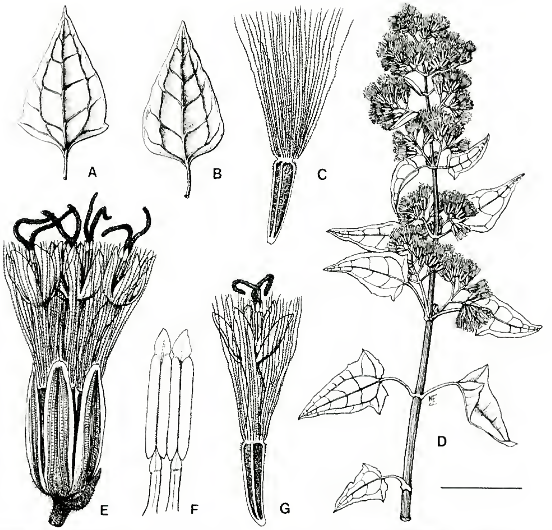


Fig. 1. ***Mikania buchtienii*** **B.L. Rob. A. Leaf with deltate-hastate shape. B. Leaf with deltate-ovate shape. C. Achene. D. Flowering branch. E. Head. F. Stamens. G. Floret. (A, B: *Cerana 1740*, CORD; C-G: *Schulz 5482*, LIL). Scale bar = 30 mm (A, B, D), 3 mm (C, E, G), 1 mm (F).**

deltate-hastate to deltate-ovate or ovate, 30–90 × 20–60 mm, margins entire to slightly serrate, bases subcordate to rounded, apices acute; upper surfaces glabrescent, lower surfaces glabrate or slightly pilose. Capitulescence paniculate to cylindrical, dense, branches terete, terminal or axillary disposed; heads ca. 10 mm long, peduncles pubescent; subinvolucral bracts lanceolate, abaxially pubescent, 2.5–3.5 × 0.7 mm, located at the base of the peduncle or beneath the head; phyllaries 5–6.7 × 1.2–1.8 mm, apex obtuse or rounded, the outer bracts oblong, lanceolate or oblanceolate, abaxially pubescent, the inner ones, lanceolate, glabrate, apex ciliate. Corolla white, 5–6.5 mm long, tube 2.8–3.5 mm long, limb widely campanulate to campanulate 2–3 mm long, divided into lanceolate corolla lobes extending almost to the base (2.3–2.6 mm long); style glabrous. Achenes 3.5–4 mm long, more densely pubescent apically, ribs serrulate;

pappus yellowish white with 45–60 barbellate bristles, 5.5–7 mm long.

Phenology.—Flowering specimens were collected from August to October, but it is assumed that flowering and fruiting occur from August to March.

Habitat and distribution.—The original description and previous additional reports of *M. buchtienii* have been based on specimens collected in upland forests, riverine woodlands and mattoral areas in the Yungas region of Bolivia, at 1100–3500 m (Robinson 1922a, b). The new records extend the known range to the forests and borders of woods in the Yungas region of Salta and Jujuy, Argentina, at 1000–1200 m. This biogeographical province has a wet and humid climate with over 2500 mm of rain annually and temperatures between 14° and 26° C (Cabrera 1971).

Specimens examined. **ARGENTINA. Jujuy:** Capital, Las Capillas, 22 Sep 1981, *Ahumada y Rotman 4321* (JUA, SI). **Salta:** General José de San Martín, San Pedrito (Pozos de la Standard), 25 Aug 1944, *Schulz 5482* (LIL, BAB, CTES); General José de San Martín, San Pedrito, Empresa Panamerican Energy, a ±200 m de la Histórica Escuela, 19 Oct 2000, *Cerana 1740* (CORD, BAYLU).

BOLIVIA. La Paz: Nor Yungas, Yolosa hacia Chuspipata, pasando Sacramento Bajo y el derrumbe grande, antiguo (16° 16' S, 67° 47' W), 19 Sep 1995, *Beck 22468* (LPB); Inquisivi, "Río Churu", following the Río Churu from 200 m W of Aguilani to 1 km above the main fork up river, 3 km SE of the ruins of Choquecamiri, 17 km N of Choquetanga (16° 42' S, 67° 20' W), 12 Sep 1991, *Lewis 40208* (LPB); Inquisivi, "Aguas Calientes de Calachaca", in the area of the thermal springs of the Río Calachaca Jahuira, 9 km NW of Choquetanga (16° 48' S, 67° 19' W), 9 Mar 1991, *Lewis 38244* (LPB).

Mikania buchtienii is closely related to *Mikania euryanthela* (Malme) W.C. Holmes, which is widespread in Paraguay, southern Brazil (State of Parana) and the provinces of Corrientes, Chaco, Formosa and Misiones in Argentina (Barroso 1959; Holmes & McDaniel 1996; Cerana 1997a, b). Both species are similar in leaf blade shape, corolla shape and very long corolla lobes. The main differences between them are summarized in the following key:

KEY TO DISTINGUISH *MIKANIA BUCHTIENII* AND *M. EURYANTHELA*

1. Leaf blades membranaceous, deltate-ovate, bases subcordate to truncate, glabrate; capitulescence paniculate, scattered; subinvolucral bracts slightly pubescent, with a prominent middle nerve; corolla glabrate, limb 2–2.3 mm long divided into corolla lobes 1.5–1.7 mm long; achenes glabrous ________ **Mikania euryanthela**
1. Leaf blades coriaceous, deltate-hastate, deltate-ovate, or ovate, bases subcordate or rounded, upper surfaces glabrescent, lower surfaces glabrate or slightly pilose; capitulescence paniculate to cylindrical, dense; subinvolucral bracts pubescent, with an inconspicuous middle nerve; corolla pubescent, limb 2–3 mm long divided into corolla lobes 2.3–2.6 mm long; achenes pubescent ________ **Mikania buchtienii**

ACKNOWLEDGMENTS

We are grateful to curators of the herbaria BAB, CORD, CTES, JUA, LIL, LP, LPB, SI, and St. Beck, director of the herbaria LPB for their loan of specimens. We appreciate M. Nee (NY) for sending us digital images. We thank W.C. Holmes of Baylor University, Waco, Texas, for assistance in confirming the identity of our plant. Guy Nesom and an anonymous reviewer offered helpful improvements. We thank managers of Panamerican Energy for providing access to the property and transportation while on-site. We thank A.P. de Pereyra (F.C.A., Universidad Nacional de Córdoba, Argentina) for assistance with the English version of the manuscript. Financial support for the research was provided by Agencia Córdoba Ciencia and Fondo para la Investigación Científica y Tecnológica (FONCyT). Thanks are also due to N. de Flury and L. Ribulgo for drawing the excellent illustration.

REFERENCES

Barroso, G.M. 1959. *Mikaniae* do Brasil. Arq. Jard. Bot. Rio de Janeiro 16:38–333.

Cabrera, A.L. 1971. Fitogeografía de la República Argentina. Bol. Soc. Argent. Bot. 14:1–42.

Cerana, M.M. 1997a. El género *Mikania* (Asteraceae) en la República Argentina. Aspectos taxonómicos y morfológicos. Tesis Doctoral. Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Argentina. Pp. 1–257.

Cerana, M.M. 1997b. *Mikania.* In: A.T. Hunziker, ed., Tribu Eupatorieae, Fl. Fanerog. Argent. 47:54–76.

Holmes, W.C. and S. McDaniel. 1996. *Mikania*. In: Spichiger y Ramella, eds., Flora del Paraguay 25:208–271.

Robinson, B.L. 1922a. Records preliminary to a general treatment of the Eupatorieae, - I. Contr. Gray Herb. n.s. 64:1–21.

Robinson, B.L. 1922b. The Mikanias of northern and western South America. Contr. Gray Herb. n.s. 64:21–116.

RANUNCULUS FICARIA (RANUNCULACEAE), NEW TO NORTH CAROLINA AND AN UPDATED KEY TO CAROLINA CONGENERS

Alexander Krings

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

Alan S. Weakley

Herbarium
University of North Carolina
North Carolina Botanical Garden
Chapel Hill, North Carolina 27599-3280
weakley@unc.edu

Joseph C. Neal

Department of Horticultural Science
North Carolina State University
Raleigh, North Carolina 27695-7609, U.S.A.
Joe_Neal@ncsu.edu

Edward C. Swab

Herbarium, Department of Botany
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.

ABSTRACT

Populations of the expanding exotic *Ranunculus ficaria* L. (Ranunculaceae) are reported escaped in North Carolina. Voucher specimens are cited and an updated key to *Ranunculus* L. in the Carolinas is presented.

RESUMEN

Poblaciones de la exótica en expansión *Ranunculus ficaria* L. (Ranunculaceae), se citan escapadas en Carolina del Norte. Se citan los especímenes y se presenta una clave actualizada de *Ranunculus* L. en las Carolinas.

Populations of the exotic *Ranunculus ficaria* L. (lesser celandine) are known outside of cultivation from the northeastern United States, Oregon, and Washington (Gleason & Cronquist 1991; USDA, NRCS 2005), but the species has been previously collected in the Southeast only in Kentucky, Tennessee, Virginia, and Maryland (Whittemore 1997). *Ranunculus ficaria* is native to much of Europe (Tutin 1976; Taylor & Markham 1978). The species was reported in New York State as early as 1890 (Hollick & Britton 1891). By the mid 1940s, it was known from several northeastern coastal states, as well as Virginia (*Sargent s.n.*, NCSC), but had not yet reached West Virginia (Bell 1945). The taxon was not previously reported for North Carolina by Radford et al. (1968), Pittillo et al. (1969), Pittillo et al. (1972), Kral (1981), Pittillo and Brown (1988), or Whittemore (1997). However, a population of the species was recently encountered in Raleigh (Wake Co., North Carolina). Twenty-nine clumps were observed, of which seventeen were either in flower or fruit at the time of collection. Individuals were observed

SIDA 21(4): 2429 – 2437. 2005

only in areas receiving partial shade for a significant portion of the day. They were absent from portions of the lawn receiving full sunlight.

Voucher collection **U.S.A. North Carolina. Wake Co.:** Raleigh, backyard lawn of residential home on Van Dyke Avenue, in partial shade, absent from portions of lawn receiving full sun, 11 Apr 2005, *Krings 1271* (AUA, F, FLAS, GA, LSU, MISS, NCSC, NCU, TEX, UNA, US, USF, USCH, VDB).

The species has also been observed on a private property in Chatham Co., where it had apparently been planted in the past, but is now escaping short distances into nearby natural areas. Due to summer senescence, vouchers of this population have not been taken this year.

Several attempts have been made to morphologically distinguish diploid from polyploid plants of *R. ficaria* (Marsden-Jones 1935; Marsden-Jones & Turrill 1952; Lawalrée 1955). Unfortunately, most of these have proven unreliable (Heywood & Walker 1961; Jones 1966; Taylor & Markham 1978). Arguing that too great a reliance had been placed on chromosome counts, Sell (1994) recognized five subspecies (Table 1), with the caution that these taxa could be recognized with ease only if cultivated or examined at intervals through their flowering and fruiting periods. If only seen once in the field or from a single specimen, certain identification would remain difficult. The following key was provided by Sell (1994) to facilitate identification:

1\. Leaf blades to 8 × 9 cm; petioles to 28 cm; flowers to 60 mm diam; achenes to 5.0 × 3.5 mm
  2\. Stems rather robust, but straggling; bulbils present in leaf axils after flowering ____ subsp. **ficariiformis**
  2\. Stems robust and erect; without bulbils in leaf axils after flowering ____ subsp. **chrysocephalus**
1\. Leaf blades to 4 × 4 cm; petioles to 15 cm; flowers to 40 mm diam; achenes to 3.5 × 2.2 mm
  3\. Leaves crowded at base with few on short stems ____ subsp. **calthifolius**
  3\. Leaves less crowded at base and more numerous on the elongate stems
    4\. Bulbils not present in leaf axils after flowering; achenes well-developed ____ subsp. **ficaria**
    4\. Bulbils present in leaf axils after flowering; achenes poorly developed ____ subsp. **bulbilifer**

USDA, NRCS (2005) reported only *R. ficaria* var. *bulbifera* Marsden-Jones for the United States. Sell (1994) pointed out that this name is illegitimate, being a later homonym of *R. ficaria* var. *bulbifer* Albert, which Sell treated in synonymy under subsp. *bulbilifer* Lambinon. Based on Whittemore's (1997) description of the species, the flower sizes of individuals of subsp. *bulbilifer* in the United States would be on the upper end compared with European individuals as recognized by Sell (1994) (Table 1).

Following Sell (1994), the individuals of the Wake Co., North Carolina population are tentatively referable to subsp. *ficariiformis* (F.W. Schwartz) Rouy & Fouc, previously not reported for the United States. Though there are some more

Table 1. The five subspecies of *Ranunculus ficaria* L. recognized by Sell (1994). Fls=flowers; ptio=petioles; ptls=petals.

subsp. *bulbilifer* Lambinon	**subsp. *calthifolius* (Reichenb.) Arcangeli**	**subsp. *chrysocephalus* P.D. Sell**	**subsp. *ficariiformis* (F.W. Schultz) Rouy & Fouc.**	**subsp. *ficaria***
Tetraploid Ptio ≤ 15 cm long Axillary bulbils globular	Diploid Ptio ≤ 7 cm long Axillary bulbils absent	Tetraploid Ptio ≤ 21 cm long Axillary bulbils absent	Tetraploid Ptio ≤ 28 cm long Axillary bulbils ovoid or globular	Diploid Ptio ≤ 15 cm long Axillary bulbils absent
Fls ≤ 25 mm diam Ptls 6–11 × 2–5 mm, not contiguous	Fls ≤ 30 mm diam Ptls 10–15 × 2.5–6 mm, not contiguous	Fls ≤ 60 mm diam Ptls 18–25 × 9–15(–18)mm, contiguous or overlapping	Fls ≤ 50 mm diam Ptls 17–26 × 4–12 mm, contiguous or overlapping	Fls 20–40 mm diam Ptls 10–20 × 4–9 mm, often contiguous
Occurs throughout most range of the species, although rare in Mediterranean region	Restricted to east-central and south-eastern Europe	Occurs in the eastern Mediterranean region	Occurs in the central and western Mediterranean Region	Restricted to western Europe

diminutive plants in the population, a number of individuals bear leaves > 4 cm diam and petals ≥ 17 × 6 mm, that are contiguous to overlapping (see Table 1 for a comparison of characters among subspecies). On some plants, ellipsoid axillary bulbils are evident. However, subspecific taxa of *R. ficaria* are not uniformly accepted. Citing extensive intergradation in form, Whittemore (1997) did not recognize any subspecific taxa in his treatment of *Ranunculus* L. for the *Flora of North America*. To help address the continuing disparity in taxonomic treatments, detailed studies are needed to examine the distribution of haplotypes and potential morphological correlations. Such an approach has been useful for other expanding exotic plants (e.g., Saltonstall 2002, 2003a–c; Saltonstall et al. 2004). Further investigation is also needed to determine more precisely the timing and mode of introduction, as well as the rate of spread of the species. Survey of herbarium collections may shed more light on this matter. Pertinent studies regarding the life history, pollination biology, and ecology have been published by Marsden-Jones (1935, 1936) and Taylor and Markham (1978).

To improve collections, Sell (1994) suggested that specimens should be taken late when fruit and bulbils are developed. However, at this stage any flowers remaining open are typically late ones, which are generally smaller than

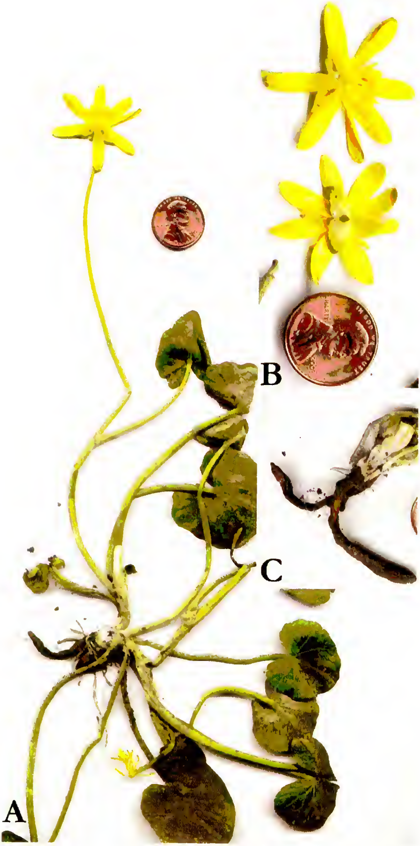


FIG. 1. *Ranunculus ficaria* L. **A.** Habit; **B.** Flowers; **C.** Tuberous roots. Based on *Krings 1271*.

those when the plant first came into flower. To improve our understaning of the distribution and ecology of subspecies, botanists should note flower sizes on an initial visit to populations and then check the bulbils and fruits at a later date (Sell 1994).

Ranunculus ficaria (Fig. 1) can be distinguished from its Carolina congeners by the combination of unlobed, reniform to suborbicular leaves, tuberous roots, typically three sepals, yellow petals ≥ 10 mm long (sometimes partially fading to white with age), and pubescent, beakless achenes. An updated key to Carolina congeners, largely adapted from Whittemore (1997), is provided below. Following arguments presented by Nesom (1993), we diverge from Whittemore (1997) in treating *R. carolinianus* DC. as a species, rather than as a variety of *R. hispidus* Michx. Distribution, habitat, and frequency information follows Weakley (2005) (Mt = Mountains; Pd = Piedmont; Cp = Coastal Plain). Unless otherwise indicated, provincial distributions and comments apply equally to North Carolina (NC) and South Carolina (SC). Asterisks indicate exotic species.

KEY TO *RANUNCULUS* IN THE CAROLINAS

1. All leaves unlobed
    2. Leaf blades reniform to suborbicular or orbicular, bases shallowly to deeply cordate.
        3. Roots tuberous; petals ≥ 10 mm long; achenes pubescent, beaks absent ________ ***R. ficaria*** L. [Pd (NC); disturbed rich forests and bottomlands, mesic suburban forests, lawns, naturalized locally from horticultural plantings; rare]
        3. Roots filiform; petals ≤ 3.5 mm long; achenes glabrous, beaks subulate, curved ________ **R. abortivus** L. [Mt, Pd, Cp; low fields, disturbed areas, bottomlands, lawns, roadsides; uncommon]
    2. Leaf blades ovate to lanceolate, bases truncate, rounded-obtuse to cuneate (sometimes cordate in *R. laxicaulis*, then petals 2–6 mm long).
        4. Petals 1–3, 1.5–2 mm long ________ **R. pusillus** Poir. [Mt (NC), Pd, Cp; marshes, ditches, other wet habitats; common (uncommon in Mt)]
        4. Petals 4–6, 5–8 mm long
            5. Proximal cauline leaf blades 5.9–12.2 cm long; petals 5; achenes to 1.8 mm long ________ **R. ambigens** S. Wats. [Pd (NC), Cp (NC); marshes; rare]
            5. Proximal cauline leaf blades to 5.7 cm long; petals 4–6; achenes 0.8–1 mm long ________ **R. laxicaulis** (Torr. & A. Gray) Darby [Cp; marshes; rare]
1. All or some leaves lobed or compound.
    6. Leafy stems creeping and rooting at the nodes, or floating in water (then rootless).
        7. Leaves 3-foliolate.
            8. Achene margins 0.4–1.2 mm wide ________ **R. carolinianus** DC. [Mt, Pd, Cp; swamp forests, wet woodlands, open marshy wetlands; uncommon]

8. Achene margins 0.1–0.2 mm wide ____ ***R. repens** L. [Mt (NC), Pd (NC), Cp; low meadows, disturbed areas; uncommon]

7. Leaves simple, lobed, parted, or dissected.
   9. Leaves ≤ 1 cm long; floral receptacles glabrous; petals white; achenes ≤ 1.6 mm long ____ **R. hederaceus** L. [Cp; coastal brackish marshes, other circumneutral soils; rare]
   9. Leaves ≥ 1.2 cm long; floral receptacles sparsely hispid; petals yellow; achenes ≥ 1.8 mm long ____ **R. flabellaris** Raf. [Cp (NC); pools in floodplains of small stream swamps, other stagnant or slow moving waters; rare]

6. Leafy stems erect or if decumbent rooting only at the base (rarely rooting at the nodes in *R. sceleratus*), never floating.
   10. Style absent; achene margins thick and corky, emergent aquatic or on wet soil ____ **R. sceleratus** L. [Pd (NC), Cp; marshes, ditches, and stream margins; uncommon]
   10. Style present; achene margins not corky; various habitats, but not aquatic.
       11. Basal leaves variously unlobed to deeply divided; achenes thick-lenticular or asymmetrically thick-lenticular to compressed-globose, 1.2–2 times as wide as thick.
           12. Stems villous ____ **R. micranthus** Nutt. [Pd (NC); rich forests; rare]
           12. Stems glabrous.
               13. Sepals glabrous; achene beaks 0.1–0.2 mm long ____ **R. abortivus** L. [Mt, Pd, Cp; low fields, disturbed areas, bottomlands, lawns, roadsides; uncommon]
               13. Sepals hispid; achene beaks 0.6–1 mm long ____ **R. alleghaniensis** Britton [Mt (NC, SC?); cove forests, rich forested slopes; uncommon]
       11. Basal leaves always deeply lobed or compound; achenes strongly compressed, at least 3–15 times as wide as thick.
           14. Achenes spinose or papillose (sometimes smooth in *R. sardous*).
               15. Petals 1–2 mm long; receptacles glabrous; achenes finely papillate, each with a hooked bristle.
                   16. Flowers pedicellate; sepals 5 ____ ***R. parviflorus** L. [Mt, Pd, Cp; disturbed areas; common (rare in Mt)]
                   16. Flowers sessile; sepals 3 ____ ***R. platensis** Spreng. [Pd (NC); lawns and ditches; rare]
               15. Petals 4–10 mm long; receptacles pilose or hispid; achenes coarsely papillate (but not terminating in hooked bristles), spinose, or tuberculate.
                   17. Sepals spreading; achenes 5–9, borne in a single whorl, long-spinose ____ ***R. arvensis** L. [Mt (NC), Pd; fields, disturbed areas; rare]
                   17. Sepals reflexed; achenes 13–60, borne in ovoid or globose heads, papillose to spinose.
                       18. Basal leaves simple; achene beaks 2–2.5 mm long ____ ***R. muricatus** L. [Pd (SC), Cp (SC); ditches and marshes; rare]
                       18. Basal leaves compound; achene beaks to 0.7 mm long.

19. Petals 7–10 mm long; achenes sparsely papillate or sometimes smooth ____________ ***R. sardous** Crantz [Pd, Cp; low fields, disturbed areas; uncommon]
19. Petals 4–5 mm long; achenes densely tuberculate ____________ ***R. trilobus** Desf. [Cp (SC); fields, roadsides, ditches; rare]

14. Achenes smooth, glabrous or pubescent.
  20. Petals 3–5 mm long; achene beaks markedly recurved ____________ **R. recurvatus** Poir. [Mt, Pd, Cp; bottomland forests, cove forests, swamps, mesic slope forests; common]
  20. Petals ≥ 7 mm long; achene beaks more or less straight, not markedly recurved.
    21. Sepals reflexed along a defined fold 1–3 mm above base.
      22. Stem bases bulbous, corm-like; petals 9–13 mm × 8–11 mm ____________ ***R. bulbosus** L. [Mt, Pd, Cp; fields, roadsides, disturbed areas; common (rare in South Carolina)]
      22. Stem bases not bulbous; petals 7–10 × 4–8 mm ____________ ***R. sardous** Crantz [Pd, Cp; low fields, disturbed areas; uncommon]
    21. Sepals spreading (sometimes reflexed from base with age).
      23. Basal leaf blades 3–5-parted, pentagonal in outline ____________ ***R. acris** L. [Mt (NC), Pd (NC), Cp; pastures, fields, roadsides, disturbed areas; common (uncommon in Pd, rare in Cp)]
      23. Basal leaf blades 3–5-foliolate, ovate to deltate in outline.
        24. Tuberous roots absent ____________ **R. hispidus** Michx. [Mt, Pd; rich moist forests, creek banks, mesic to dry woodlands and forests, bottomlands; common]
        24. Tuberous roots present ____________ **R. fascicularis** Muhl. ex Bigelow [Mt (NC), Pd; wet flats with prairie affinities, rocky barrens and glades over mafic rocks, ultramafic outcrop barrens, limestone barrens; rare]

ACKNOWLEDGMENTS

We are grateful to Charles W. Averre (Prof. Emeritus, Dept. Plant Pathology, NCSU) for bringing the plant to our attention and the thoughtful reviews of a previous version of the manuscript by Michael Denslow, Carl Keener, and an anonymous reviewer.

REFERENCES

Bell, F.H. 1945. The genus *Ranunculus* in West Virginia. Amer. Midland Nat. 34:735–743.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd ed. New York Botanical Garden, New York.

Heywood, V.H. and S. Walker. 1961. Morphological separation of cytological races in *Ranunculus ficaria* L. Nature (London) 189:604.

Hollick, A. and N.L. Britton. 1891. Flora of Richmond Co., N.Y.–Additions and new localities, 1890. Bull. Torrey Bot. Club 18:213–214.

Jones, B.M.G. 1966. Variation in *Ranunculus ficaria*. Proc. Bot. Soc. British Isles 6:275.

Kral, R. 1981. Some distributional reports of weedy or naturalized foreign species of vascular plants for the southern states, particularly Alabama and middle Tennessee. Castanea 46:334–339.

Lawalrée, A. 1955. Flore Générale du Belgique. Vol. 2. Bruxelles.

Marsden-Jones, E.M. 1935. *Ranunculus ficaria* Linn.: Life-history and pollination. J. Linn. Soc. London (Bot.) 50:39–55.

Marsden-Jones, E.M. 1937. Pollination of *Ranunculus ficaria* L. by insects. J. Bot. (London) 75:133–141.

Marsden-Jones, E.M. and W.B. Turrill. 1952. Studies on *Ranunculus ficaria*. J. Genetics 50: 522–534.

Nesom, G.L. 1993. *Ranunculus* (Ranunculaceae) in Nuevo León, with comments on the *R. petiolaris* group. Phytologia 75:391–398.

Pittillo, J.D., J.H. Horton, and K.W. Greenlee. 1969. Additions to the vascular flora of the Carolinas. I. J. Elisha Mitchell Sci. Soc. 85:18–22.

Pittillo, J.D., J.H. Horton, and K.E. Herman. 1972. Additions to the vascular flora of the Carolinas. II. J. Elisha Mitchell Sci. Soc. 88:144–152

Pittillo, J.D. and A.E. Brown. 1988. Additions to the vascular flora of the Carolinas. III. J. Elisha Mitchell Sci. Soc. 104:1–18.

Pogan, E. and H. Wcisslo. 1986. Studies in *Ranunculus ficaria* L. VII. Additions to chromosome numbers. Acta Biologica Cracoviensia, Series Botanica 28:87–92.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The University of North Carolina Press, Chapel Hill.

Saltonstall, K. 2002. Cryptic invasion of a non-native genotype of the common reed, *Phragmites australis*, into North America. Proc. Natl. Acad. Sci. USA 99:2445–2449.

Saltonstall, K. 2003a. Microsatellite variation within and among North American lineages of *Phragmites australis*. Molec. Ecology 12:1689–1702.

Saltonstall, K. 2003b. Genetic variation among North American populations of *Phragmites australis*: implications for management. Estuaries 26(2B):445–452.

Saltonstall, K. 2003c. A rapid method for identifying the origin of North American *Phragmites* populations using RFLP analysis. Wetlands 23:1043–1047.

Saltonstall, K., P.M. Peterson, and R. Soreng. 2004. Recognition of *Phragmites australis* subsp. *americanus* (Poaceae: Arundinoideae) in North America: evidence from morphological and genetic analyses. Sida 21:683–692.

Sell, P.D. 1994. *Ranunculus ficaria* L. sensu lato. Watsonia 20:41–50.

Taylor, K. and B. Markham. 1978. Biological flora of the British Isles *Ranunculus ficaria* L. (*Ficaria verna* Huds.; *F. ranunculoides* Moench). J. Ecology 66:1011–1031.

TUTIN, T.G. 1964. *Ranunculus* L. In: T.G. TUTIN et al., eds. Flora Europaea, Vol.1 Cambridge University Press, Cambridge. Pp. 223–237.

USDA, NRCS. 2005. *The PLANTS Database*, Version 3.5 (http://plants.usda.gov). Data compiled from various sources by Mark W. Skinner. National Plant Data Center, Baton Rouge.

WEAKLEY, A.S. 2005. Flora of the Carolinas, Virginia, and Georgia: Working draft, 10 June 2005. University of North Carolina Herbarium, Chapel Hill.

WHITTEMORE, A.T. 1997. *Ranunculus*. In: Flora North America Editorial Committee (eds.), Flora North America, Vol. 3. Oxford University Press, New York. Pp. 88–135.

BOOK NOTICE

CHARLES BOEWE (ed.). **A C.S. Rafinesque Anthology.** 2005. (ISBN 0-7864-2147-9, pbk.). McFarland & Company, Inc., Box 611, Jefferson, NC 28640, U.S.A. (**Orders:** www.mcfarlandpub.com, 800-253-2187). $45.00, 271 pp., 17 b/w figures, 7" × 10".

From the back cover.—"Among American naturalists, C.S. Rafinesque (1783–1840) is second only to Audubon in the popular interest he sustains. This interests is due in part to his colorful life and provocative personality, but he is also remembered for devising Latin scientific names for more plants than any other naturalists who ever lived—and a great number in the animal kingdom, as well. This passion for nomenclature has kept his name memorable (some would say notorious) among naturalists. Yet his taxonomic writings made up only a part of his extensive oeuvre."

There are at least six previous books on Rafinesque also edited by Charles Boewe. Rafinesque's essays covered in this volume are **1)** Antiquities, **2)** Linguistics, **3)** Society, **4)** Education, **5)** Public Lectures, **6)** Popular Science, **7)** Phytogeography, **8)** Natural Science, and **9)** Metaphysics.

A great fan of Rafinesque was the Canadian born botanist, Lloyd H. Shinners (SMU). Ruth Ginsburg, in her 2002 biography, *Lloyd Herbert Shinners: By Himself*, discusses Shinners' admiration for Rafinesque. The following excerpt gives some insight into the life of Rafinesque and his influence on at least one botanist:

"Constantin Samuel Rafinesque was a naturalist, traveler, and writer. Born in Constantinople, he spent much of his youth in Italy and came to the United States in 1815. He was not trained in botany, but he read widely in several languages and became deeply interested in natural history, making important contributions to ichthyology as well as botany. Shinners admired his wide knowledge, his voracious appetite for discovery and publication, and especially his courage in defending unpopular positions. Lack of diplomacy, organization, and understanding of their limitations were other characteristics that they shared."

If you enjoy reading about great naturalists then you will definitely enjoy Boewe's *A C.S. Rafinesque Anthology.—Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

THE OCCURRENCE OF *CERASTIUM PUMILUM* (CARYOPHYLLACEAE) IN OKLAHOMA

Bruce W. Hoagland

Oklahoma Biological Survey
and Department of Geography
University of Oklahoma
Norman, Oklahoma 73019, U.S.A.
e-mail: bhoagland@ou.edu

Amy Buthod

Oklahoma Biological Survey
University of Oklahoma
Norman, Oklahoma 73019, U.S.A.

Gloria Caddell

Department of Biology
University of Central Oklahoma
Edmond, Oklahoma 73034, U.S.A.

ABSTRACT

Cerastium pumilum (Caryophyllaceae) was recently reported for Oklahoma without documentation. This paper documents the occurrence of *Cerastium pumilum* W. Curtis in Oklahoma. The first collection from Oklahoma was made in 1981 from Hughes County but no additional collections were made until 2003. Since that time, *C. pumilum* has been documented in eight additional counties. Thus, *C. pumilum* is currently known from a total of 11 Oklahoma counties.

RESUMEN

Cerastium pumilum (Caryophyllaceae) se citó recientemente de Oklahoma sin documentación. Este artículo documenta la presencia de *Cerastium pumilum* W. Curtis en Oklahoma. La primera colección de Oklahoma se hizo en 1981 en Hughes County pero no se hicieron colecciones adicionales hasta 2003. Desde entonces, *C. pumilum* se ha documentado en otros ocho condados. Así pues, *C. pumilum* se conoce actualmente de un total de 11 condados de Oklahoma..

Cerastium pumilum W. Curtis (Caryophyllaceae) is an annual plant species native to Europe and southwest Asia (Diggs et al. 1999). It has been reported from the adjacent states of Arkansas, Kansas, Missouri, and Texas, but not Colorado (USDA-NRCS 2005). Morton (2005) mapped *C. pumilum* in Oklahoma but did not provide voucher documentation. The Oklahoma distribution record in Morton (2005) is based on a 1981 collection by Steve Stephens.

Voucher collection: **OKLAHOMA. Hughes Co.:** 3.5 mi W of Calvin, roadside shoulder, red sandy soils, few plants, 7 Apr 1981, *Steve Stephens 90325* (KANU).

However, *C. pumilum* is not listed in Taylor and Taylor (1994) and a search of Hoagland et al. (2005) revealed that no collections had been deposited in Oklahoma herbaria prior to 2003, when the authors collected it from three counties. Since then, it was collected from five additional counties in 2004 and three in 2005. All specimens reported below are deposited in the Robert Bebb Herbarium at the University of Oklahoma (OKL), with the exception of Caddell and Rice

(*GMC 1039*) which is deposited at the University of Central Oklahoma (CSU). Since these specimens represent locales covering a broad geographic extent, additional county records are no doubt forthcoming.

Additional voucher specimens: **OKLAHOMA. Beckham Co.:** 1.1 mi E of I-40 from jct. with Hwy 34, T11N, R22W, sec 35, disturbed area, 3 Apr 2003, *Buthod and Hoagland, AB3649.* **Cleveland Co.:** Norman, T9N R2W sec 32, disturbed area, 7 May 2005, *Amy Buthod, AB6762.* **Kay Co.:** Blackwell city park, T27N, R1W, sec 23, disturbed area, 29 May 2003, *Buthod, Hoagland, and Fagin, AB3822.* **Lincoln Co.:** Turner Turnpike (I-44) at exit 171, T15N, R5E, sec 32, disturbed grassland, 6 May 2004, *Buthod and Hoagland, AB6155.* **Major Co.:** ca. 3 mi W of Bouse Junction on Hwy 412, T22N, R16W, sec 6, grazed pasture, 22 Apr 2004, *Buthod and Shannon, AB4563.* **Oklahoma Co.:** Forest Park in Oklahoma City, T12N, R3W, sec 13, disturbed grassland, 27 Apr 2004, *Buthod, Hoagland, and Fagin, AB4609.* **Oklahoma Co.:** Lake Arcadia, T14N, R2W, sec 34, disturbed area, 3 Mar 2005, *Amy Buthod* and *Lacy Brookshire*, AB6251. **Ottawa Co.:** Approximately 7.2 mi NE of Grove, T26N, R23E, sec 33, disturbed area, 22 Apr 2004, *Buthod, Hoagland, and Brookshire, AB4544.* **Pawnee Co.:** 5 mi W of Cleveland on Hwy 64, T21N, R7E, sec 15, disturbed area, 1 Apr 2004, *Buthod and Hoagland, AB4521.* **Stephens Co.:** 1.6 mi SW of Bray at Clear Lake, T2N, R6W, sec 29, disturbed area, 13 Mar 2003, *Hoagland and Buthod, AB3421.* **Woodward Co.:** Alabaster Caverns State Park, T26N, R18W, sec 28, disturbed area along roadside near Canyon Campground, 7 May 2005, *Caddell and Rice, GMC 1039.*

ACKNOWLEDGMENTS

We thank Richard Rabeler for reviewing the paper and for bringing the Stephens specimen to our attention and Craig Freeman for providing the label data from that specimen.

REFERENCE

Diggs, G.M, B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners & Mahler's illustrated flora of north central Texas. Botanical Research Institute of Texas (Fort Worth) and Austin College (Sherman, TX).

Hoagland, B., A. Buthod, I. Butler, P. Callahan-Crawford, W. Elisens, A. Udasi, and R. Tyrl. 2005. Oklahoma vascular plants database. [online]. Available: http://www.biosurvey.ou.edu. (Accessed on 1 March 2005).

Morton, J.K. 2005. *Cerastium* Linnaeus. In: Flora of North America Editorial Committee (eds), Flora of North America north of Mexico, vol. 5 Magnoliophyta: Caryophyllidae, part 2. New York (NY): Oxford Press.

Taylor R. J. and C.S. Taylor. 1994. An annotated list of the ferns, fern allies, gymnosperms, and flowering plants of Oklahoma. Southeastern Oklahoma State University, Durant.

USDA-NRCS 2005. The PLANTS database [online]. Available: http://plants.usda.gov/plants. National Plant Data Center, Baton Rouge, LA. (Accessed on 1 March 2005).

FIRST RECORD OF *NYMPHOIDES INDICA* (MENYANTHACEAE) IN TEXAS

Ken Saunders

Freshwater Resources Program
Inland Fisheries Division
Texas Parks and Wildlife Department
San Marcos, Texas 78666, U.S.A.

ABSTRACT

The first Texas record of *Nymphoides indica* (L.) Kuntze (Menyanthaceae) is reported new for Texas.

RESUMEN

Se cita por primera vez para Texas *Nymphoides indica* (L.) Kuntze (Menyanthaceae).

Nymphoides specimens were collected from Soldier Springs, Uvalde County, Texas in April 2002 and subsequently planted in small water gardens upon return to the laboratory. Specimens from this locale had previously been cursorily identified as *N. aquatica* (Bill Carr, The Nature Conservancy of Texas, pers. comm.). However, upon inspection of flowers from reared specimens, it was determined that the species was instead *N. indica* (independent species verification by David Lemke, Texas State University Biology Department), which represents a new species record in Texas.

Voucher specimen: **U.S.A. Texas. Uvalde Co.:** Soldier Springs, ca 2 km S. of the U.S. Hwy 90 bridge and a short distance upstream of County Road 202 (Tom Nunn crossing), floating in water with *Trichocoronis rivularis* and other species, from the banks out into mid pool, 18 Apr 2002, *Saunders & Lemke s.n.* (SWT).

It has since been observed in at least one other spring system upstream of Soldier Springs, also within the Nueces River basin (Chad Norris, Texas Parks and Wildlife Department, pers. comm.).

Two native *Nymphoides* species are known to occur in the southeastern United States (Wood 1983; Jacono 2002), namely *N. cordata* (Ell.)Fern and *N. aquatica*) (J.F. Gmel.) Kuntze. *Nymphoides indica* (L.) Kuntze (water snowflake) is native to both New and Old World tropical regions, but like many other introduced aquatic macrophytes, has been brought to the United States for ornamental uses. Ornduff (1969) did not find consistent morphological difference between New World plants known as *N. humboldtiana* (H.B.K.) Kuntze, and Old World plants known as *N. indica* (L.) Kuntze. Ornduff thus concluded the two must be conspecific and since the name *N. indica* has priority both Old and New World specimens should be referred to by this name. Occurrence of wild populations of *N. indica*, until now has been documented only in two

SIDA 21(4): 2441 – 2443. 2005

southwestern counties in Florida (Wunderlin & Hansen 2004) where it is spreading rapidly (Jacono 2002).

Nymphoides indica is a floating perennial with tuberous and adventitious, spur-like roots; it can propagate through rhizomes. Within its native range, it occurs in shallow ponds and stream pools at elevations below 1500 m (Ornduff 1969; Sivarajan & Joseph 1993). Flowers are produced in cymose, umbel-like clusters, which occur on the petiole on the same node as the spur-like roots. Flowers have four to eight petals covered with copious marginal hairs producing a furry appearance, hence the common name water snowflake (Wood 1983). The flowers are fairly small and slender (1.7–2.7 cm wide), white with a center area of light yellow (Ornduff 1969; Jacono 2002). Anthers are often black and seeds range from 1.0–1.7 mm in length (Ornduff 1969).

The springs and pool at Soldier Springs lie entirely within the flood plain of the Nueces River but during normal flows are separated from the main course by a point of land. The pool flows into the river at the downstream end of the point along the eastern edge of the channel. Spring flows emanate from gravel and cobble substrates within a short spring run at the head of the pool. The pool has depths in excess of 1.3 m (Bill Carr, *op cit*), is up to 30 m wide, and measures a few hundred meters in length. Brune (1981) classified the springs as moderately large, meaning they have a mean discharge between 0.79 and 7.93 m^3/s.

At the time of the *Nymphoides indica* collection, the spring run and pool were densely vegetated with various aquatic macrophyte species. Among the most prolific was *Trichocoronis rivularis*, a species with restricted global distribution and found only in a few southwestern Texas and northern Mexico spring systems and cienegas (Bill Carr, *op cit*). *Trichocoronis rivularis* together with *N. indica* formed areas of very dense vegetation extending from the banks out into mid pool. Both species were distributed throughout the pool but were most dense from the mouth of the spring run downstream to about the middle of the pool. Other common macrophytes included *Justicia americana*, *Ludwigia* sp., *Myriophyllum* sp., *Nasturtium officinale*, and *Potamogeton illinoensis*.

ACKNOWLEDGMENTS

Thanks to Bill Carr, The Nature Conservancy of Texas, for providing background information, and to David Lemke, Texas State University, Biology Department for verification of specimen identification. Nicholas Tippery and Guy L. Nesom provided helpful review comments.

REFERENCES

Brune G. 1981. Springs of Texas Vol. 1. Branch-Smith, Inc., Fort Worth, Texas.

Jacono, C. 2002. Florida's floating-hearts – know *Nymphoides*. Aquaphyte 22(1):insert.

ORNDUFF, R. 1969. Neotropical *Nymphoides* (Menyanthaceae): Meso-American and West Indian species. Brittonia 21:346–352.

SIVARAJAN, V.V. and K.T. JOSEPH. 1993. The genus *Nymphoides* Séguier (Menyanthaceae) in India. Aquatic Bot. 45:145–170.

WOOD, C.E. 1983. The genera of Menyanthaceae in the southeastern United States. J. Arnold Arbor. 64:431–445.

WUNDERLIN, R.P. and B.F. HANSEN. 2004. Atlas of Florida vascular plants [S.M. Landry and K.N. Campbell (application development), Florida Center for Community Design and Research.]. Institute for Systematic Botany, University of South Florida, Tampa.

BOOK NOTICES

MIROSLAV M. GRANDTNER (compiler). 2005. **Elsevier's Dictionary of Trees. Volume 1: North America with Names in Latin, English, French, Spanish and other Languages.** (ISBN 0-444-51784-7, hbk.). Elsevier B.V. Radarweg 29, P.O. Box 211, 1000 AE Amsterdam, THE NETHERLANDS. (**Orders:** www.elsevier.com). $199.00, 1489 pp., 6 1/2" × 9 1/2".

The general compiler, Miroslav M. Grandtner, had numerous scientific collaborators to help with this incredible index. Each entry (genus and species) is numbered and the names bolded for easy reference and includes author of the name, family (with distribution), synonym(s), and common names (sometimes with specific country noted). The list tallies up some 8,778 entries which includes genera. "Indexes" include **1)** List of Synonyms of Latin Names; **2)** English Names; **3)** Noms Français; **4)** Nombres Españoles, **4)** Other Names [languages]; and concludes with **5)** Trade Names.

Texas A&M University Press

JOHN WATSON, CAROLE PETERSON, and DEANNA PAYNE. 2005. **In Our Backyards: Public and Private Gardens of the Texas Coastal Bend.** (ISBN 0-9766235-0-1, hbk.). Botanical and Nature Institute of South Texas, Inc. d.b.a. the Corpus Christi Botanical Gardens & Nature Center. (**Orders:** Texas A&M University Press, 4354 TAMU, College Station, TX 77843-4354, U.S.A. (979-458-3982, 979-847-8752 fax). $39.95, 120 pp., color photos, 11" × 8 1/4".

Publisher comments.—"This wonderful new book showcases efforts of area gardeners to beautify our region, discusses environmental issues facing the Coastal Bend, and links these topics by showing how gardeners and landscapers effectively can address environmental issues which concern us all."

And to help showcase these gardens are beautiful and crisp color photographs.

TIMOTHY BRUSH. 2005. **Nesting Birds of a Tropical Frontier: The Lower Rio Grande Valley of Texas.** (ISBN 0-58544-490-1, pbk.). Texas A&M University Press, 4354 TAMU, College Station, TX 77843-4354, U.S.A. (**Orders:** 979-458-3982, 979-847-8752 fax). $24.95, 245 pp., color photos, 4 maps, 6 1/4" × 9 1/4".

Contents.—Preface, Introduction, The Lower Rio Grande Valley of Texas, Ecological Diversity and history, Habitats and Birds of the Valley, The Spectacular, Annual Cycle, Breeding Birds of the Valley, Species, Accounts and Summaries, Concluding Remarks, References, and Index.

MUSCARI COMOSUM (LILIACEAE) NEW TO TEXAS

Lee M. Luckeydoo

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060, U.S.A.
LLuckeydoo@BRIT.org

ABSTRACT

Muscari comosum (L.) Mill. (Liliaceae) is reported as a non-cultivated persisting population in Parker County, Weatherford, Texas. This species, non-cultivated, is a new record for the state of Texas.

RESUMEN

Muscari comosum (L.) Mill. (Liliaceae) se cita como una población persistente no cultivada en Parker County, Weatherford, Texas. Esta especie, no cultivada, es una nueva cita para el estado de Texas.

Muscari comosum (L.) Mill. (tassel grape-hyacinth, feather hyacinth) has not been reported for Texas by Correll and Johnson (1970), Hatch et al. (1990), Jones et al. (1997), Diggs et al. (1999), or Flora of North America (2002). This species has been reported for several other states in the U.S.: South Carolina (Haldeman 2001), Oregon, Missouri, Illinois, Ohio, Pennsylvania, Tennessee, Virginia, North Carolina, Georgia (Kartesz 1999), and Kentucky (Kartesz 1999; Jones 2005).

A Texas collection of *Muscari comosum* is in the Tracy (TAES) Herbarium, Texas A&M University (Brazos Co. *Ness s.n.*, 10 Apr 1899). The label information states that this was a "single specimen found on campus" (Kruse pers. comm. 2005). No further information was available as to this specimen having been cultivated or existing as a persisting population.

The Texas collection reported here was submitted to the Botanical Research Institute of Texas by a homeowner in Weatherford, Texas (Parker County). The species had not been planted in the yard since the owner's family moved into the home in 1948. The plants were first noted in the yard approximately "20 years ago." This is a non-cultivated persisting population that is currently growing in two groups. The homeowner has observed a gradual increase in the number of plants of *M. comosum* over time. The plants thus appear to be spreading slowly.

Muscari comosum (Fig. 1) is a perennial that regenerates from a bulb and is native to the Mediterranean region (Lopez Alonso & Pascual Reguera 1989). This species has a distinctive flowering scape (raceme), which has fertile, dark purple, urn-shaped flowers that are spaced along the top half of the axis and a tassel of infertile purple flowers at the tip of the axis. Synonyms for this plant include *Hyacinthus comosus* L.

FIG. 1. *Muscari comosum*. Illustration by Pierre-Joseph Redouté (1759–1840) (Mallary & Mallary 1986).

Voucher specimen: **TEXAS: Parker Co.:** Weatherford, owner's family have lived in home since 1948, these plants were not seen until 1980/1990- occurring in 2 clumps (15 and 9 scapes); flowers deep purple with tassel at top of stalk, fragrant, *Spear s.n.* 15 Apr 2005. A photograph, dated 1992, of *M. comosum* in homeowner's yard accompanies this specimen.

ACKNOWLEDGMENT

Thanks to Barney Lipscomb of BRIT for providing assistance with identification, Monique Reed for her valuable comments, and Dale Kruse of the Tracy Herbarium for providing collection data.

REFERENCES

CORRELL, D.S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

DIGGS, G.M., B.L. LIPSCOMB, and R.J. O'KENNON. 1999. Shinners & Mahler's illustrated flora of North Central Texas. Sida, Bot. Misc. 16.

FLORA OF NORTH AMERICA EDITORIAL COMMITTEE (eds.) 2002. Flora of North America north of Mexico. New York and Oxford. 26:317.

HALDEMAN, J.H. 2001. Noteworthy collection, South Carolina. Castanea 66:308.

HATCH, S.L., K.N. GANDHI, and L.E. BROWN. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Bull. MP-1655.

JONES, S.D., J.K. WIPFF, and P.M. MONTGOMERY. 1997. Vascular plants of Texas: a comprehensive checklist including synonymy, bibliography, and index. Univ. of Texas Press, Austin.

JONES, R.L. 2005. Plant life of Kentucky: An illustrated guide to the vascular flora. Univ. Press of Kentucky, Lexington.

KARTESZ, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T. and C.A. Meacham. Synthesis of the North America flora, version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

KRUSE, D. 3 May 2005. Personal communication. Tracy Herbarium. Texas A&M University, College Station.

LOPEZ ALONSO, D. and L. PASCUAL REGUERA. 1989. Population structure and pattern of geographic variation in *Muscari comosum* along its range of distribution. Genetica 78: 39–49.

MALLARY, P and F. MALLARY. 1986. A Redouté treasury, 468 watercolors from Les Liliacees of Pierre-Joseph Redouté. Plate 153. Vendome Press, New York.

ANNOUNCEMENT

Digital Atlas of the Virginia Flora Is Online

The *Digital Atlas the Virginia Flora*, a significantly augmented and somewhat revised version of edition III of the *Atlas of the Virginia Flora* (hardcopy 1992), is now available on the Virginia Tech website at http://www.biol.vt.edu/digital×atlas. The Atlas project for the Virginia flora was initiated by Alton M. Harvill, Jr., of Longwood College, Farmville, Virginia, in the mid 1970s. With assistance from a group of other Virginia botanists who were also collecting extensively in the state, Harvill produced three hardcopy editions of the *Atlas* (1977/1981, 1986, and 1992). Following Dr. Harvill's retirement, this group [which he had named and incorporated as the Virginia Botanical Associates (VBA)] continued his work by accumulating new records from their own and others' more recent field work (e.g. records from the Virginia Division of Natural Heritage). The group also targeted numerous taxonomic issues needing resolution.

Ultimately, the VBA set the goal of making available on-line a modified and updated version of *Atlas III* and began developing a checklist. Thomas F. Wieboldt compiled and maintained the developing checklist at the Massey Herbarium at Virginia Tech, and he also modified family circumscriptions to follow (largely) the Angiosperm Phylogeny Group (APG2). The initial database was populated with records from the 1992 hardcopy edition; then VBA members added new records to the database.

The Digital Atlas of the Virginia Flora is very much a work in progress. This is especially true in regard to mapping of infraspecific taxa that are currently "buried" in species maps because the specimens on which these maps were based had been identified only to species level.

Users of the web-site are invited to correspond with the VBA regarding the *Digital Atlas of the Virginia Flora*. Please direct questions, comments, and/or any new data to *Thomas F. Wieboldt, Massey Herbarium, Virginia Tech, Blacksburg, VA 24061; phone (540) 231-5746; e-mail: wieboldt@vt.edu.*

SIDA 21(4): 2448. 2005

HYDROCOTYLE SIBTHORPIOIDES (APIACEAE) NEW FOR TEXAS AND NOTES ON INTRODUCED SPECIES

Barney L. Lipscomb

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102, U.S.A.
barney@brit.org

George M. Diggs, Jr.

Department of Biology
Austin College
Sherman, Texas 75090, U.S.A.
and
Botanical Research Institute of Texas
gdiggs@austincollege.edu

ABSTRACT

Hydrocotyle sibthorpioides (Apiaceae) is reported as new to the Texas flora. Introduced species in the East Texas flora, as well as noxious plants and invasive exotics (including four particularly problematic species (*Cuscuta japonica*, *Orobanche ramosa*, *Solanum viarum*, and *Triadica sebifera*) are discussed.

RESUMEN

Hydrocotyle sibthorpioides (Apiaceae) se cita como nueva para la flora de Texas. Se discuten especies introducidas en la flora del Este de Texas, así como plantas nocivas y exóticas invasoras (incluyendo cuatro especies particularmente problemáticas (*Cuscuta japonica*, *Orobanche ramosa*, *Solanum viarum*, y *Triadica sebifera*).

Hydrocotyle is a cosmopolitan genus of approximately 130 species of creeping perennial herbs, including a number grown as ornamental ground covers (Mabberley 1997) or cultivated in water gardens or other aquatic habitats. *Hydrocotyle sibthorpioides* Lam., lawn marsh-pennywort or lawn water-pennywort, is a native of Asia (Mabberley 1987, 1997) but is widely cultivated. The species, usually described as a lawn weed, is naturalized in a number of localities in the eastern United States (Arkansas, Florida, Delaware, Georgia, Indiana, Louisiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia) and in California and Hawaii (Gleason & Cronquist 1963; Strausbaugh & Core 1978; Constance 1993; Kartesz 1999; USDA PLANTS Database 2005). It was not reported from Oklahoma (Taylor & Taylor 1994); however, it is reported from both Arkansas and Louisiana (USDA PLANTS Database 2005). Despite this proximity, the species has not been previously reported from Texas (Correll & Johnston 1970; Stanford 1976; Hatch et al. 1990; Jones et al. 1997; Diggs et al. 1999).

A collection made in 2001 in Dallas is apparently the first documented occurrence of this species for Texas.

Voucher specimen: **TEXAS. Dallas Co.:** spreading in landscape, 3511 Overbrook, Dallas, 5 Jun 2001, *B. Lipscomb 3502* (BRIT).

SIDA 21(4): 2449 – 2456. 2005

Since originally observed at the collection locality, the species has persisted and spread in the lawn. Because this plant is low-growing and inconspicuous, particularly when growing with taller grasses, we suspect that it is more widespread in Texas yards and has simply escaped notice. It has likely been intentionally planted into other localities as a ground cover or accidentally introduced with soil, compost, or cultivated plants.

Hydrocotyle sibthorpioides can be recognized by the following description (modified from Gleason & Cronquist 1963, 1991; Radford et al. 1968; Strausbaugh & Core 1978; and Constance 1993). Delicate, glabrous, perennial, terrestrial herb; stems creeping; leaves petiolate, the petioles 0.5–2+ cm long; leaf blades reniform to suborbicular, shallowly 5–7-lobed, 3–12+ mm wide, minutely crenate; umbels simple, capitate, with 3–10 sessile flowers, peduncled, the peduncles 5–15 mm long; flowers sessile, whitish; fruits round, 1–1.5 mm wide. Mar–Sep. Kartesz (1999) listed *H. rotundifolia* Roxb. as a nomenclatural synonym. An illustration (Fig. 1), reprinted from Hiroe and Constance (1958), and a photograph (Fig. 2) are provided.

The five species of *Hydrocotyle* known to occur in Texas can be distinguished using the following key modified from those in Gleason and Cronquist (1963), Radford et al. (1968), Constance (1993), and Diggs et al. (1999):

1. Leaves peltate (= petiole attached to middle of lower surface of leaf blade).
   2. Flowers in a simple umbel (= all flowers in inflorescence attached at the same point) **H. umbellata** L.
   2. Flowers in a branched umbel or in whorls along an inflorescence axis (definitely not all attached at the same point)
      3. Flowers in a branched umbel, with more than 2 branches **H. bonariensis** Lam.
      3. Flowers in whorls along an unbranched inflorescence axis, forming an interrupted spike or spike-like raceme or the axis with only 2 branches **H. verticillata** Thunb.
1. Leaves not peltate, the petiole attached at base of a notch.
   2. Plants aquatic; stems and petioles fleshy; individual flowers and fruits with short but distinct pedicels **H. ranunculoides** L.f.
   2. Plants terrestrial; stems and petioles thread-like; individual flowers and fruits sessile **H. sibthorpioides** Lam.

Hydrocotyle sibthorpioides is yet another introduced species (considered here as those originating outside the United States) added in recent years to the flora of Texas. Such non-native species are variously referred to as alien, exotic, or foreign. Their effects on the Texas flora have been commented upon a number of times in recent years (e.g., Diggs et al. 1999; O'Kennon et al. 1999; see Diggs et al. 2006, in press, for a detailed discussion), and there is growing concern in the state about their potential impacts. Recently (2003), a bill authorizing the Texas Department of Agriculture to publish a list of noxious plants was passed (Hibbs 2003; Texas Parks & Wildlife 2003), and that list is now available on-line (Texas Administrative Code 2005). However, Texas still has no single authority in

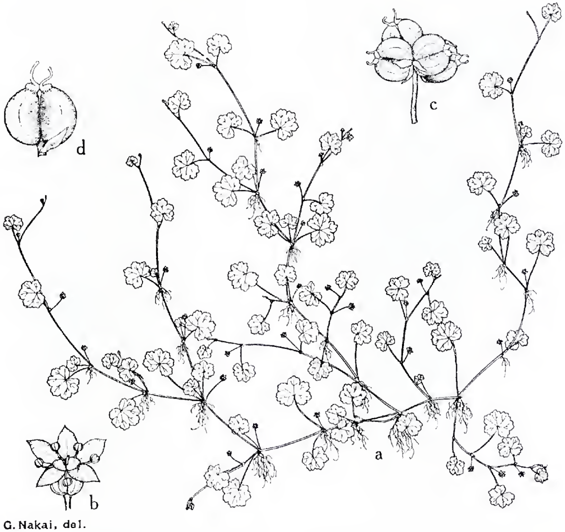


FIG. 1. Habit of *Hydrocotyle sibthorpioides* (reprinted from Hiroe & Constance 1958, fig. 4).

charge of addressing invasive species issues, and detailed policies for effective and coordinated control efforts are still lacking. This deficiency could prove costly to the state in the future, both economically and ecologically. Fortunately, significant attention is now focused on the problem, and a major collaborative conference addressing the issue, the state-wide Texas Invasive Plant Conference (The Pulling Together Initiative), was held in November of this year (TexasInvasives.org 2005).

Data recently obtained for volume one of the *Illustrated Flora of East Texas* (Diggs et al. 2006, in press) indicate that of the 3,402 total species known for East Texas, 619 species or 18% of the East Texas flora are introduced. Unfortunately, very little is known regarding the percentage of Texas' land area covered primarily by such exotics or the percent biomass represented by alien species in a variety of Texas habitats. Certainly vast areas of grazing land and roadsides are vegetated almost exclusively by exotics such as King Ranch

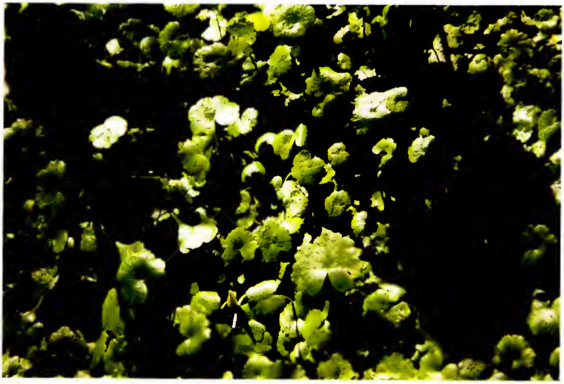


Fig. 2. Photograph of *Hydrocotyle sibthorpioides* (photo by B.L. Lipscomb).

bluestem (*Bothriochloa ischaemum* (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celerier & Harlan), Johnson grass (*Sorghum halepense* (L.) Pers.), Bermuda grass (*Cynodon dactylon* (L.) Pers.), and tall fescue (*Festuca arundinacea* Schreb.). Casual observation and anecdotal evidence would suggest that many other habitats are seriously affected as well. A particularly troubling example is the eastern Asian *Triadica sebifera* (L.) Small [*Sapium sebiferum* (L.) Roxb.], usually known as Chinese tallow tree or as popcorn tree, which has been widely used in landscaping in East Texas, in part because of its brilliant fall color. However, this species is now widely recognized as one of the most serious invasive exotics in East Texas and in the adjacent Gulf Prairies and Marshes (e.g., Barrilleaux & Grace 2000; Keay et al. 2000; Loos 2002). It is particularly problematic in invading and destroying native Coastal Prairie habitats and is showing a rapid increase in sapling populations in some floodplain forests of the Big Thicket National Preserve (Harcombe et al. 1998; Keay et al. 2000). In fact, in areas that had previously been primarily native forest, one can now find large numbers of young individuals of *Triadica sebifera*, sometimes being swarmed over by yet another invader, Japanese climbing fern (*Lygodium japonicum* (Thunb. ex Murray) Sw.).

A table in the *Illustrated Flora of East Texas* (Diggs et al. 2006, in press) lists 41 species recently (since 1997) introduced into East Texas (and new to the state). This listing is almost certainly incomplete, in part because of species discovered since the book went to press. While many of these exotics, such as *Hydrocotyle sibthorpioides*, may be innocuous and present little danger of becoming invasive or otherwise of concern, a number pose serious conservation or economic threats. A weed with the potential to be economically devastating, *Orobanche ramosa* L. (hemp broom-rape or branched broom-rape), is now spreading in the west central part of East Texas and has been reported from at least 22 counties (Texas Cooperative Extension 2003). Recently (2004), it was discovered as far north as Dallas County (J. Quayle, pers. comm.). It is apparently being spread widely by highway mowing equipment. This chlorophyll-less native of southern and central Europe is a well known root parasite of agricultural crops, including bean, cabbage, celery, eggplant, pepper, potato, and sunflower and has the potential to have a significant economic impact in Texas. In heavily infested areas in other parts of the world, hemp broom-rape has been known to cause total crop failure (USDA undated). It is classified as a federal noxious weed (USDA Natural Resources Conservation Service 2002). *Cuscuta japonica* Choisy, Japanese dodder, is another federal noxious weed. Though currently reported in Texas only from Houston (Harris County), there is concern about its possible spread (Camilli 2002; Huber 2002). It is an aggressive parasitic vine which attacks a variety of woody plants and has the potential to have serious ecological and economic consequences if not eradicated. *Solanum viarum* Dunal, tropical soda apple, is yet another federal noxious weed recently reported from Texas (Reed et al. 2004). This perennial, prickly shrub native to Brazil and Argentina is an alternate host to several viral diseases and pathogens that attack other members of the Solanaceae. It is thus a threat to a number of vegetable crops including tomatoes, potatoes, eggplants, and peppers (Byrd et al. 2004). A final well known example is *Salvinia molesta* Mitchell, giant salvinia, a federal noxious weed that in recent years has been found in abundance at Toledo Bend Reservoir on the Texas-Louisiana border (Jacono 1999b) and at numerous other localities in the state. This South American native (Forno & Harley; Forno 1983; U.S. Geologic Survey 2000) is a serious threat to aquatic habitats in Texas (Diggs et al. 2006, in press). Considered "one of the world's worst weeds" (Jacono 1999b), it has been introduced by humans to fresh waters of Africa, Asia, Australia, s Europe, New Zealand, North America, and the South Pacific and has resulted in severe economic and environmental problems (Jacono 1999a, 1999b; Garbari et al. 2000). The plants can grow rapidly, cover the surface of lakes and streams, and form floating mats that shade and crowd out native plants. Additionally, the mats (sometimes to a meter thick) reduce oxygen content, degrade water quality, and can cause physical problems including hindering boats, clogging irrigation and drainage canals, and blocking water intakes (Thomas & Room 1986; Jacono 1999a, 1999b, 1999c; Wood et al. 2001; Moran 2004).

The four species just discussed are among the 29 species currently on the Texas Noxious Plant List (Texas Administrative Code 2005). Unfortunately, among the 619 introduced species documented for East Texas, there are numerous other detrimental exotics that could certainly join them on the list. Further, without major emphasis on prevention, there will almost certainly be additional problematic introduced species added to the Texas flora in the years to come.

ACKNOWLEDGMENTS

We would like to thank Robert George for locating and scanning the illustration and for obtaining a number of references and Guy Nesom and Monique Reed for reviewing the manuscript. We also thank Lorine Gibson for her assistance

REFERENCES

BARRILLEAUX, T.C. and J.B. GRACE. 2000. Growth and invasive potential of *Sapium sebiferum* (Euphorbiaceae) within the coastal prairie region: The effects of soil and moisture regime. Amer. J. Bot. 87:1099–1106.

BYRD, J.D., JR., C.T. BRYSON, and R.G. WESTBROOKS. 2004. Tropical soda apple (*Solanum viarum* Dunal): Identification and control. http://www.ceris.purdue.edu/napis/pests/tsa/tsa2004-fs.pdf. Accessed Oct 2005.

CAMILLI, K. 2002. Giant Asian Dodder: A new invasive plant detected in Texas. http://www.invasive.org/eastern/other/texas.html. Accessed Oct. 2005.

CORRELL, D.S. and M.C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

CONSTANCE, L. 1993. Apiaceae. In: J.C. Hickman, ed. The Jepson manual: Higher plants of California. Pp. 136–166. Univ. of California Press, Berkeley.

DIGGS, G.M. JR., B.L. LIPSCOMB, and R.J. O'KENNON. 1999. Shinners & Mahler's illustrated flora of North Central Texas. Sida, Bot. Misc. 16.

DIGGS, G.M. JR., B.L. LIPSCOMB, M.D. REED, and R.J. O'KENNON. 2006 (in press). Illustrated flora of East Texas, Vol. 1. Sida, Bot. Misc. 26.

FORNO, I.W. 1983. Native distribution of the *Salvinia auriculata* complex and keys to species identification. Aquatic Bot. 17:71–83.

FORNO, I.W. and K.L.S. HARLEY. 1979. The occurrence of *Salvinia molesta* in Brazil. Aquatic Bot. 6:185–187.

GARBARI, F., A. GIOVANNINI, and D. MARCHETTI. 2000. *Salvinia molesta* D.S. Mitchell (Salviniaceae) nuova per la flora d'Italia. Arch. Geobot. 6:73–78.

GLEASON, H.A. and A. CRONQUIST. 1963. Manual of the vascular plants of northeastern United States and adjacent Canada. Van Nostrand Reinhold Company, New York.

GLEASON, H.A. and A. CRONQUIST. 1991. Manual of the vascular plants of northeastern United States and adjacent Canada, 2nd ed. Van Nostrand Reinhold Company, New York.

HATCH, S.L., K.N. GANDHI, and L.E. BROWN. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Misc. Publ. No. 1655.

HARCOMBE, P.A., R.B.W. HALL, J.S. GLITZENSTEIN, and D.R. STRENG. 1998. Sensitivity of Gulf Coast forests to climate change. In: G.R. Guntenspergen and B.A. Vairin, eds. Vulnerability of coastal wetlands in the southeastern United States: Climate change research results, 1992–97. Biological Science Rep. USGS/BR/BSR–1998-002. U.S. Dept. of the Interior, U.S. Geol. Survey, National Wetlands Research Center, Lafayette, LA.

Hibbs, D.A. 2003. Title 4. Agriculture. http://www.sos.state.tx.us/texreg/archive/October172003/PROPOSED/4.AGRICULTURE.html#18. Accessed Feb 2004.

Hiroe, M. and L. Constance. 1958. Umbelliferae of Japan. Univ. California Publ. Bot. 30:1–144.

Huber, K. 2002. Stranglehold: Giant dodder threatens urban landscape. Houston Chronicle 18 May 2002, page 8D.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas: A comprehensive checklist including synonymy, bibliography, and index. Univ. of Texas Press, Austin.

Jacono, C. 1999a. Have you seen this plant? Texas Parks and Wildlife information sheet. Texas Parks and Wildlife, Austin.

Jacono, C. 1999b. *Salvinia molesta* (Salviniaceae), new to Texas and Louisiana. Sida 18:927–928.

Jacono, C. 1999c. *Salvinia molesta* (D.S. Mitchell) invades the United States! Aquatics 21:4–9.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland, 1st ed. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American Flora, CD format, Version 1.0. North Carolina Botanical Garden, Chapel Hill.

Keay, J., W.E. Rogers, R. Lankau, and E. Siemann. 2000. The role of allelopathy in the invasion of the Chinese tallow tree (*Sapium sebiferum*). Texas J. Sci. 52(4) Suppl.:57–64.

Loos, P.M. 2002. An alien among us. Newsletter Native Plant Soc. Texas 20:6.

Mabberley, D.J. 1987. The plant book, a portable dictionary of the higher plants. Reprinted with corrections in 1989. Cambridge Univ. Press, Cambridge, England, U.K.

Mabberley, D.J. 1997. The plant book, a portable dictionary of the higher plants, 2nd ed. Cambridge Univ. Press, Cambridge, England, U.K.

Moran, R.C. 1992. The story of the molesting *Salvinia*. Fiddlehead Forum 19:26–28.

O'Kennon, R J., T.M. Barkley, G. M. Diggs, Jr., and B.L. Lipscomb. 1999. *Lapsana communis* (Asteraceae) new for Texas and notes on invasive exotics. Sida 18:1277-1283.

Quayle, J. (Jeff). Personal communication, 2004. Plant collector, discoverer of the recently described *Senecio quaylii* (Asteraceae), naturalist, and botanical consultant of Fort Worth, TX.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The Univ. of North Carolina Press, Chapel Hill.

Reed, M.D., M. Ketchersid, and R.L. Thompson. 2004. *Solanum viarum* (Solanaceae) —tropical soda-apple—confirmed from Texas. Sida 21:1171–1174.

Stanford, J.W. 1976. Keys to the vascular plants of the Texas Edwards Plateau and adjacent areas. Published by the author, Brownwood, TX.

Strausbaugh, P.D. and E.L. Core. 1978. Flora of West Virginia, 2nd ed. Seneca Books, Inc., Grantsville, West Virginia.

Taylor, R.J. and C.E.S. Taylor. 1994. An annotated list of the ferns, fern allies, gymnosperms and flowering plants of Oklahoma, 3rd ed. Southeastern Oklahoma State Univ., Durant.

Texas Administrative Code. 2005. Quarantines and Noxious Plants, Chapter 19. State of Texas.

http://info.sos.state.tx.us/pls/pubreadtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=4&pt=1&ch=19&rl=300. Accessed Oct 2005.

Texas Cooperative Extension. 2003. Keep watch for branched broomrape (*Orobanche ramosa*): A major threat to U.S. crops. http://www-aes.tamu.edu/mary/brmrape/brmrape.htm 2002. Accessed Jan 2003.

TexasInvasives.org. 2005. http://www.texasinvasives.org/. Accessed Oct 2005.

Texas Parks and Wildlife. 2003c. Recent legislation affects Texas fish and wildlife. http://www.tpwd.state.tx.us/news/news/030626a.phtml. Accessed Feb 2004.

Thomas, P.A. and P.M. Room. 1986. Taxonomy and control of *Salvinia molesta*. Nature 320: 581–584.

USDA (U.S. Department of Agriculture). Undated. Keep watch for branched broomrape (*Orobanche ramosa*). http://www-aes.tamu.edu/mary/brmrape/brmrape.htm. Accessed Oct 2005.

USDA Natural Resources Conservation Service. 2002. Federal noxious weeds. http://plants.usda.gov/cgi_bin/topics.cgi?earl=noxious.cgi. Accessed Dec 2002.

USDA PLANTS Database. 2005. PLANTS profile for *Hydrocotyle sibthorpioides* Lam. http://plants.usda.gov/cgi_bin/topics.cgi?earl=plant_profile.cgi&symbol=HYSI. Accessed Oct 2005.

U.S. Geologic Survey. 2000. *Salvinia molesta*, giant salvinia. http://nas.er.usgs.gov/ferns/. Accessed 2000.

Wood, M., B. Hardin, and J. García. 2001. Attack on giant salvinia. U.S.D.A. Agric. Res. 49:4–6; also on-line at: http://www.ars.usda.gov/is/AR/archive/nov01/giant1101.htm. Accessed Aug 2004.

ANNOUNCEMENT

2005 Delzie Demaree Travel Award Recipients

The 17th Annual Delzie Demaree Travel Award was presented at the 52nd Annual Systematics Symposium (7–11 Oct 2005) at the Missouri Botanical Garden. Three students were presented the Travel Award: **Mario Blanco**, University of Florida; **Pedro Fiaschi**, Virginia Commonwealth University; and **Lina S. Juswara**, Ohio State University.

The 2005 Travel Awards were underwritten by **1)** Delzie Demaree Travel Award Endowment, **2)** Members of the Delzie Demaree Travel Award Committee, and **3)** John Clayton Chapter of the Virginia Native Plant Society.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

2006 Applications for the Delzie Demaree Travel Award

Applications for the 2006 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2006 are 13–14 October.

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M and Arkansas State University at Jonesboro where in retired as professor emeritus in 1953. On of the things he enjoyed most as a botanist was assisting students with their field botany research.

BOOK REVIEWS

MARY PRATT. 2005. **Practical Science for Gardeners.** (ISBN 88192-718-X, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 175 pp., b/w drawings, conversion chart, appendices, glossary, index, 6" × 9".

In *Practical Science for Gardeners*, Mary Pratt gives the reader some of the science behind common and successful gardening practices. This book will be especially interesting for gardening enthusiasts that may not have any botanical background. The book is written in a very conversational style with clever chapter titles such as "Nature arms race and how to negotiate a peace deal," for the chapter discussing weeds, pests and methods of control. This relaxed little science book can be thought of as horticulture "lite," offering the reader a simplified scientific rationale for why some common practices are effective and others are not. Pratt also includes quite a bit of personal charm and relates some her personal gardening strategies.

Chapters include information on basic cellular building blocks, plant anatomy, plant hormonal chemistry, soil science, pest control, biodiversity, basic genetics, genetically modified plants, plant classification and plant species naming. After reading the information within these chapters, readers will understand the answers to many important gardening questions including: which nutrients do what in a plant, the benefits of different fertilizer nutrient ratios, why light and placement are so important to plants, what happens when plants are water stressed, processes that occur in a seed during germination, ways to determine plant nutrient deficiencies, the importance of biodiversity in the garden, what soil pH is, and how to correct improper soil pH, what are some integrated pest management and biocontrol strategies, and what does genetically modified mean.

Chapters are presented in a way to help readers apply the scientific information discussed to practical garden uses. Each chapter includes a number of boxes that provide gardening suggestions related to scientific or research information just presented. These suggestions include some practical information for solving or preventing garden problems. For instance, after reading the information on hormones and their functions in the plant, a gardening suggestions box includes information on how to ripen tomatoes, and the effects of pruning plants. Pratt also suggests books for further reading on topics presented in each chapter. Important words within each chapter are bolded, and many of these bolded words are defined in a glossary found at the end of the text.

This book will be of particular important for British gardeners. Although the information presented in the chapter on biodiversity is applicable to many environments, the examples and suggested species given are specific for the UK. One theory of succession, climax theory, is presented and the development of woodland, grasslands and wetlands gardening habitats are discussed. A variety of gardening strategies for success and suggested species are included in the discussion on each of these gardening habitats. Readers outside of the UK be cautious in using the species suggested, what does well in one area, may be an aggressive invasive in another (Eurasian Milfoil, *Myriophyllum spicatum*, for example).

Practical Science for Gardeners is an easy and enjoyable read, and can be a useful book for gardeners interested in learning the science behind successful gardening practices. Practical Science for Gardeners presents a cursory overview of plant and horticultural science behind gardening that should encourage readers to learn more of the science on topics of interest to them; the author has thoughtfully included suggestions for more advance reading by chapter topic. The information is presented in a way that encourages the reader think about why garden practices may or not be valid.

Pick up a copy of Mary Pratt's *Practical Science for Gardeners*; reading it will be like enjoying a conversation over the fence with well-informed gardening neighbor.—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

BEN-ERIK VAN WYK. 2005. **Food Plants of the World.** (ISBN 0-88192-743-0, hbk.). Timber Press Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (**Orders:** www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 480 pp., many color photos, 6 1/2" × 9 1/2".

Have you ever looked at unfamiliar produce, beans, grains, or spices in the groceries and asked yourself—What is that, where does it originate from, and more importantly, what parts can you eat and what preparation is needed? Author Ben-Erik van Wyk has provided the answers to such questions in his book, *Food Plants of the World*. van Wyk, has constructed a food plant encyclopedia, listing information on 354 food plants and their close relatives, complete with fantastic color photographs. *Food Plants of the World* would be a great resource for food scientists and epicures alike.

The first section of the book lists primary crops by regions: i.e. central Asia, Africa, etc. This is followed by major food categories, such as cereals, pulses, fruits, vegetables, herb, sugars, beverage plants, spices and flavors. Descriptions of the major food categories include information on general anatomy, basics on processing and cooking, and other interesting facts. Within each food category, are lists of the "main" plants by common names, followed by the scientific names. This list of primary foods in the category is important as a quick reference to determine the scientific name of common foods, although common names are also found in the index. The author has included some intriguing color photographs of foods within a category with common names in the captions, for instance for cereals, the photograph shows lines of different grains. Note that the author admittedly uses the labels of fruit and vegetable in the "grocery," not in the botanical sense.

The bulk of the text is the food plant "encyclopedia" in alphabetical order by specific epithet. Each food entry contains vibrant color images of the plant, as well as the edible portions. Following the food photographs, are descriptions including the plant description, origin and history, parts consumed, cultivation and harvesting, uses, nutritional value, assorted notes, common names in various languages and the family to which the species belongs. The descriptions are very thorough and the common names in multiple languages can be very helpful when shopping in different groceries or markets for foods and spices.

The author has included handy references after the food encyclopedia. The first is a section discussing the structure and function of nutrient compounds. The chemical structures of various sugars, starches, fats, proteins, vitamins and minerals are included in the discussion. The descriptions of the different structures describe a small portion of the chemistry of how the body processes such molecules and compounds, and often, the author has provided a little information on the food sources that many of the various compounds are derived from. The second reference included is a quick guide to commercialized food plants, with common name, edible portions, country of origin, and base nutritional values. The remaining items include a glossary, further reading section, and index.

Food Plants of the World by Ben-Erik van Wyk is highly recommended for those in food sciences or anyone with a general interest in learning more about the foods consumed around the world. The text is thorough and sharp, and the color photographs are fantastic in helping to visualize the plant in the field and the edible portions. This could be a wonderful reference book or gift for cooks, horticultural students or "foodies" in general. Definitely a book worth a look!—*Lee Luckeydoo, Herbarium, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

Jan Wrede. 2005. **Trees, Shrubs, and Vines of the Texas Hill Country.** (ISBN 1-58544-426-X, pbk.). Louise Lindsey Merick Natural Environment series; no. 39. Texas A&M University Press, John H. Lindsey Bldg., Lewis St. 4354 TAMU, College Station, TX 77843-4354, U.S.A. (**Orders:** wlawrence@tamu.edu, http://www.tamu.edu/upress, 800-826-8911). $23.00 hbk., 246 pp., color photos, index, 5 3/4" × 8 1/2".

Each of 126 species is illustrated by at least one color photograph. A short morphological description is provided for each species with a brief commentary on aspects of its biology, growth characteristics, and uses (for landscape and for wildlife forage and habitat). Within gymnosperms, dicots, and monocots the species are arranged alphabetically by family, genus, and species, one species per page. The first one-fifth of the book includes nicely written sections on red cedar management, healthy streams, benefits of native species, landscaping with woody plants, and invasive species. At the end are appendices with information on native plant nurseries and demonstration gardens and other resources for native plants. A multi-page chart gives "color or aroma," "season," "potential height," "site preference," and "wildlife uses" for 117 native species. The book surely will quickly be in the hands of many residents of central Texas and will be much used and valued. It potentially provides a great service toward Hill Country conservation.

For identification of woody plants, Wrede's book is the successor of Daniel Lynch's *Native & Naturalized Woody Plants of Austin & the Hill Country* (1981) and could have supplanted it. Surprisingly, though, the newer book does not include a large set of Hill Country species treated and illustrated in the earlier one: *Ageratina (Eupatorium) havanensis, Ampelopsis arborea, Ampelopsis cordata, Andrachne phyllanthoides, Berchemia scandens, Bernardia myricifolia, Buddleja racemosa, Castela texana, Catalpa speciosa, Ephedra antisyphyllitica, Ficus carica, Fraxinus pennsylvanica, Galphimia (Thryallis) angustifolia, Juglans nigra, Ligustrum sinense, Mimosa biuncifera, Nicotiana glauca, Pavonia lasiopetala, Populus alba, Prunus caroliniana, Prunus mexicana, Quercus macrocarpa, Quercus sinuata, Rosa bracteata, Sesbania drummondii, Symphoricarpos orbiculatus, Thamnosma texana, Ulmus americana.*

Among further Hill Country omissions, more conspicuous and interesting are these. *Amorpha roemeriana, Convolvulus arvensis, Condalia viridis, Croton texensis var. alabamensis, Dalea formosa, Diospyros virginiana, Forestiera reticulata, Juglans major, Ligustrum lucidum, Ligustrum quihoui, Matelea edwardsensis, Mimosa texana, Parthenocissus heptaphylla, Passiflora incarnata, Rubus bifrons, Salix exigua, Salvia ballotiflora.* Also not included are *Opuntia engelmannii* (the most common Hill Country species of prickly pear, the Texas state plant), *O. imbricata, O. davisii, O. macrorhiza*, and *O. phaeacantha*. Hawthorns are treated as "*Crataegus* sp.," acceding to the myth that "The taxonomy of the Hill Country *Crataegus* is uncertain," and continuing "and there may be several species that are very hard to separate, so all can be conveniently treated as one." *Crataegus crus-galli, C. greggiana, C. reverchonii, C. tracyi, C. turnerorum, C. uvaldensis*, and *C. viridis* are Hill Country species and are no more difficult to identify than the *Prunus* species. The smaller photo (p. 148) shows *C. crus-galli*, the larger *C. tracyi*. Finally, in view of the lengthy and useful discussion of cedar management (all presumably assumed to be *Juniperus ashei*), at least a mention of *J. pinchotii* and *J. virginiana* would have been appropriate, although neither is abundant in the Hill Country.—*Guy Nesom and Bob O'Kennon, Botanical Research Institute of Texas, Fort Worth, TX, 76012-4060, U.S.A.*

Dariusz L. Szlachetko, Piotr Rutkowski, and Joanna Mytnik. 2005. **Contributions to the Taxonomic Revision of the Subtribes *Spiranthinae*, *Stenorrhynchidinae* and *Cyclopogoninae* (Orchidaceae) in Mesoamerica and the Antilles.** (ISBN 83-89648-18-0, pbk.; ISSN 0867-0730). Polish Botanical Studies 20. IB Publisher, Polish Academy of Sciences, W. Szafer Institute of Botany, Lubicz 46, PL-31-512 Krakow, POLAND. (**Orders:** ed-office@ib-pan.krakow.pl). Euro 90,00; ca. USD $105.46, 387 pp. 646 figures (including maps, types, line drawings, and color plates), 17 × 24 cm.

This long-awaited publication by Szlachetko and his associates is a major contribution to the taxonomy and distribution of these three Spiranthoid subtribes. Treating 170 species in 35 genera, it is copiously illustrated with not only maps for each species but diagnostic morphological line drawings, photographs of type specimens, and a sprinkling of color plates and is an excellent reference for those interested in this particular group of orchids. Covering Mexico, Central America, and the Antilles many species are also found in the United States in Florida, southwestern Texas, southern New Mexico, and southeastern Arizona. Each genus is heavily referenced and although several newer genera and new combinations are used ten pages of cross-referenced synonyms are given.

The are two negative aspects of the volume. The lack of a general index, although the aforementioned synonyms are helpful in locating current treatments, requires going back and forth from the Table of Contents to the synonyms; the arrangements of genera and species is by subtribes and not alphabetical. Following what unfortunately appears to be a trend in publications on this region, when species are also found in the adjacent United States the information on them is either lacking or erroneous, primarily because it is based up work done more than 25 years ago. For some reason distributional work presented in several recent major North American publications works was not consulted.

Significant corrections that should be made concerning US distribution would include:

Pages 14–17: *Mesadenus polyanthus* (Reichenbach f.) Schlecter listed for USA and is not found here, whereas *M. lucayanus* (Britton) Schlecter is not listed for the USA and is present in Florida.

Pages 146–153: The treatment of *Sacoila squamulosa* at any rank or synonym is curiously missing. Szlachetko has treated in other publications as *S. lanceolata* var. *squamulosa*. It is present throughout much of the range of the work as well as in central Florida.

Pages 209–210: *Schiedeella fauci-sanguinea* (Dod) Burns-Balogh is listed erroneously for USA and figure 351 is *Schiedeella arizonica* P.M. Brown photographed by C. Luer in Arizona and known from the USA in southwestern Arizona and western Texas.

Page 229: *Funkiella confusa* (Garay) Szlachetko, Rutkowski, and Mytnik (syn. *Deiregyne confusa* Garay) omits USA (Texas) from the range whereas *F. durangensis* (Ames & C. Schweinfurth) Szlachetko on page 232 is listed for USA but does not occur there.

Page 299: *Cyclopogon elatus* (Swartz) Schlecter omits USA (Florida) from the range.

Page 302: *Cyclopogon cranichoides* (Grisebach) Schlecter omits USA (Florida) from the range.

Page 313: *Pelexia adnata* (Swartz) Poiteau ex Richard omits USA (Florida) from the range.

Supporting documentation for all of the above may be found in the appropriate generic treatments within the Orchidaceae, *Flora of North America*, volume 26.—*Paul Martin Brown, Ocala, FL 34481 U.S.A., naorchid@aol.com*

MARGARET MEE. 2004. **Margaret Mee's Amazon: Diaries of an Artist Explorer.** (ISBN 1-85149-454-5, hbk.). Antique Collectors' Club in association with The Royal Botanic Gardens, Kew, Sandy Lane, Old Martlesham, Woodbridge, Suffolk, IP12 4SD, UK. (**Orders:** www.antiquecollectorsclub.com, 01394-389950, 01394-389999 fax, email info@antique-acc.com). $59.50, 319 pp., water color paintings, 9 1/2" × 11 1/2".

Some books are a slow read, this was one. Not because it was boring...hardly! Encounters with snakes, armed poachers, malaria, electric eels, and storms, read as high adventure, to say the least. What made the book a slow read was that the book is also an art book, filled with full-page botanical paintings of Margaret Mee, the writer/artist/adventurer who journeyed to the Amazon to paint the rare and unknown flowers indigenous to the region. The reader is faced with the choice, at every turn of the page; do I read the wild story or do I gaze at the magnificent art? It is impossible to do both. The complex, otherworldly plants of the Amazon are executed in such exacting detail, you must pause and stare, thus forgetting about the story you were reading. Yet the adventure the artist recounts of hunting plants via dugout canoe, is so compelling, you dare not slow down to study the life-like paintings.

Margaret Mee's Amazon Diaries of an Artist Explorer is a hefty book bursting with big reproductions of her finished watercolors, intimate small sketches, studies done quickly 'in situ,' and photographs documenting the people met and the places visited. She recorded triumphs large and small, "I swam in the black water of the river, fearful of the currents, and went collecting in a dugout canoe with two young Indian boys. Gilberto climbed high in a tree, and from a rotting branch, which I feared would fall upon him, threw down a strange bromeliad which I had seen from afar the plant was not in flower, but I had no doubt that this was a new species."

Mee did not begin her travels deep into the fertile rainforests until the age of forty-seven. She continued until seventy-six. So focused was she on her mission to document the flora of the vanishing Amazon, that she would often return to a distant outpost, where a rare plant had been spotted months earlier, just for the opportunity to record it in bloom.

Ever focused on her mission to paint rare and unknown species, she brushed off the misery of mosquitoes, hunger, humidity and drenching rains. The artist writes in her diary of finding *Acacallis cyanea*—the blue orchid. "I walked until I was exhausted, wading through streams and then, with soaking canvas shoes, ploughed through black, swampy ground. But I was delighted with the results of my journey, for I had material for many paintings."

Margaret Mee when conditions favored such, set up an easel and painted, she also painted seated in the bottom of a rocking canoe, and when approaching dusk made either method of painting difficult, plants were piled into the bottom of the boat and painted later. She rendered the most complex of plants with a deft hand, explaining away the unfavorable conditions matter-of-factly, "the flowers fell in golden showers as I unraveled the tendrils. I painted the plant seated in the boat as we moved upstream, for vine flowers are delicate and ephemeral."

Her work combines the rare ability to commit to paper, the strictest botanical detail of a plant, while at the same time, imbuing it with artistry. Her will and determination triumphed in a series of paintings of the Moonflower, which blooms briefly and only at night. She set up an all night vigil to witness the opening of the night bloomer. As it unfurled she painting furiously, by torchlight...until daybreak, at which time the ephemeral flower withered and was no more. The resulting body of work represents the only known images of the nocturnal beauty.

Place this book at your nightstand. Read the wild adventure of this tireless explorer or gaze at the magnificent paintings of a brilliant botanical artist ...or do both. You will be lured back to it nightly, like a moth to a Moonflower.

Cynthia Padilla, National instructor of botanical arts and naturalist illustration is sought out for research projects, reviews, commissioned plant portraits, workshops, and as a travel leader on sketching tours. http://www.botanicalart.50megs.com/ Join other botanical arts and natural science enthusiasts at: http://groups.yahoo.com/group/botanicalart

---

DAVID R. FOSTER and JOHN D. ABER. 2004. **Forests in Time: The Environmental Consequences of 1,000 years of change in New England.** (ISBN 0-300-09235-0, hbk.). Yale University Press, 302 Temple Street, P.O. Box 209040, New Haven CT 06520-9040, U.S.A. (**Orders:** www.yale.edu/yup, 203-432-0960, 203-432-0948 fax). $45.00, 447 pp., b/w figures, tables, index, bibliography, contributors, bibliographic essay, 6" × 9 1/4".

The book, *Forests in Time*, is composed of essays by multiple authors that discusses the history of a New England forest. Harvard University acquired nearly 3,000 acres to establish the Harvard Forest, a study site located in Petersham, Massachusetts, as an area to conduct ecological research. The authors stated that in order to understand current environmental issues, one must understand the history of a particular area. This book was easy to read, and provided graphs and tables to help the reader understand the ecological changes of a forest, although some of these graphs were harder to interpret than others. The authors use of detailed pictures throughout the book helps the reader develop a better perspective of how this forest changed through time. The book is divided into five main sections: background to ecological studies, regional history, modern forest landscape, understanding forest ecosystems, and lessons learned from this study.

The **first section** introduces readers to the ecological studies, conducted in the forest study site, and the reasons for Long Term Ecological Research (LTER). The text helps readers understand that landscape change occurs in response to environmental, anthropogenic, and biological factors. The landscape changes are studied at four spatial scales: site, landscape, sub-region, and region. Each of these spatial scales are affected by hydrology, humans, vegetation, and the biogeochemistry of the ecosystems. Because trees have long generation times, long-term studies must be conducted in order to understand any changes that occur.

The **second section** describes historical changes of the forest. The Harvard Forest landscape has seen a variety of changes in time: from being a tundra, boreal forest, and temperate forest at some point in its life. These changes occurred through natural (wind, pests, and fire), as well as anthropogenic (Native American) disturbances.

The **third section** explains how historical land use can affect species richness (number of species present) and species composition both directly and indirectly. The influence of several historical and modern factors were tested at the Montague Plain and Prospect Hill including prior land uses that can alter the soil organic matter and nutrient storage availability of the soil. The authors used several graphs to support the change in abundance of specific plants at each site and the effects of land-use history. These graphs showed a strong correlation between the carbon to nitrogen ratio and nitrification in forest soils with different land-use histories. Studies on the long term influences between the forest and atmosphere were performed. The forest removes more ozone than the atmosphere, and appeared to have a more considerable influence than urban areas or ecosystems composed of smaller vegetation. All of these changes have worked in creating the present forest ecosystem.

The **fourth section** discusses research conducted to understand forest ecosystems through long-term studies. Scientists conducted several research experiments designed to simulate hurricane affects on forest ecosystems, the process of nitrogen saturation, soil warming, and litter and root influences on soil This research allows for long term study of these various effects. There were several controls used throughout the experiments: nutrient fluctuation, "ecophysiological performance, population dynamics, vegetation structure, and ecosystem productivity."

The **fifth section** and conclusion reviewed lessons learned from research done in the forest. This research is leading to a better understanding of forest systems and ideas to improve land conservation. The land and forest are constantly changing, and people that manage this land need to "find ways to incorporate landscape change into long term planning". This constant change proves that in natural systems, such as the forest, long term studies must be conducted because they help to develop better conservation objectives.

This book was very interesting, and will help readers understand the importance of long term ecological research. This book was written in a way that it is easy for those new to science and ecology to understand. It is recommended to persons interested in New England terrestrial ecology, disturbance effects on forest structure, and long-term research locations.—*Keri McNew, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

DOUGLAS E. SOLTIS, PAMELA S. SOLTIS, PETER K. ENDRESS, and MARK W. CHASE. 2005. **Phylogeny and Evolution of Angiosperms.** (ISBN 0-87893-817-6, pbk.) Sinauer Associates, 23 Plumtree Rd, Sunderland, MA 01375-0407, U.S.A., (**Orders:** 413-549-1118 fax; orders@sinauer.com; www.sinauer.com). $59.95, 370 pp., numerous b&w figures, 8 1/2" × 11".

Rare is the book that has you cursing its basic tenets and thesis, yet draws you to explore it often. This is such a book. In many ways, it is already a classic. So you might as well buy a copy and place it within easy reach next to Cronquist's *Integrated System*.

In essence, *Phylogeny and Evolution of Angiosperms* is the magnum opus of the Angiosperm Phylogeny Group (APG). Although the authors' style is somewhat detached, as if to explain the actions of the APG as a third party, they are actually movers and shakers of the APG. They know its workings and conclusions from the ground up. Although leaders in the field of angiosperm molecular systematics, they are all classically trained, mostly in the 1970s and are well versed in plant morphology. This fact is evident in the text, and that is the reason for my oxymoronic relationship with this book.

Organization of the chapters is such that they fall into three natural sections. Chapters 1 and 2 provide general background and concepts. Chapters 3 to 9 are detailed accounts of molecular support and morphological characteristics of the major segments of the APG classification (sequentially, the basal angiosperms, monocots, basal eudicots, peripheral core eudicots, caryophyllids, rosids, and asterids. Chapters 10–13 examine the application of the APG classification to problems and concepts of evolutionary diversification across the angiosperms.

Why I love this book:

It is a readable and elaborated explanation of the current APG classification. Besides incorporating new publications to update APG II, the authors present new analyses to answer questions raised during the composition of the book itself.

Not only do the authors put the APG cladogram into words, but they also characterize the morphology of the taxa (especially orders) recognized in the APG classification. In particular, they report any synapomorphies that corroborate the molecularly defined clades. This is especially helpful in cases with morphologically divergent taxa that are united on molecular grounds. The authors are to be commended for a writing style that keeps this material from becoming tedious.

- The book is a gold mine of data and references, citing both recent molecular and morphological studies. Combined with Cronquist's *Integrated System*, it provides a commanding window into the comparative literature on angiosperms.
- It summarizes many new insights into genomics, morphogenetics, and the regulation of gene expression. In short, it is a great resource for keeping up-to-date.

Why I hate loving *Phylogeny and Evolution of Angiosperms*:

- I thoroughly disagree with the philosophical basis of the authors' conclusions. This philosophy is: "DNA sequence similarity is the ace that trumps all." The last section of each characterized taxonomic group is devoted to a discussion of "Character Evolution." Likewise, the last four chapters examine general trends across angiosperms. In these discussions, every morphological character that is discussed is evaluated for homology by its distribution on the molecular cladogram—no exceptions. Am I uneducated or simply prudent enough not to jump on this latest bandwagon? Is one to believe that a sample of three genes (two of which are plastid metabolic genes) adequately sample the genome of angiosperms? Even for the subclades based on as many as seven genes, is that an adequate sample? Given how little is known about gene regulation, expression of phenotype, and interaction of the genome with the proteonome (especially that carried through the egg cell), such sweeping conclusions are premature, at best, and potentially disruptive and destabilizing to systematics. Indeed, the DNA is information that contains messages in much the same way that language composed of symbols does. Is not the basing of our classification on the comparisons of nucleotide matches much the same as saying we have translated a message by simply analyzing the occurrence frequency of letters in the message?

So what should a classically trained botanist do with this book? Obtain a copy; use it to keep up-to-date with this bandwagon and perhaps launch your own research projects. Refer to it often as you read molecular or other systematic papers. Use it to memorize the APG classification to be conversant with molecular systematists.

I can imagine that others may hate to love this book for other reasons. What if you are a molecular biologist with limited background in morphology? Obtain a copy, smugly agreeing with the APG classification. Then, force yourself to learn the morphology so skillfully introduced in the book.

Could it be that the authors, too, will come to hate to love their own book? On page 19 they say, "A new paradigm is needed to promote further progress in seed plant relationships in general and angiosperm origins in particular. Given the direction that the molecular and genetic data are taking us, this new paradigm may be much more radical than even the authors suppose.

Why will you hate loving *Phylogeny and Evolution of Angiosperms*?—*Roger W. Sanders, Research Associate, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., rsanders@brit.org.*

BIENNIAL REPORT AND UPDATE 2004–2005

SIDA, CONTRIBUTIONS TO BOTANY
Source of current research in classical and modern
systematic botany for readers throughout the world
...bringing out the best in botanical science for plant conservation and education

To all authors, we thank you for choosing *Sida, Contributions to Botany* as your forum to disseminate information and knowledge gained by scientific inquiry. Volume 21 is the largest volume of SIDA ever published. SIDA is published twice a year. Volume 21 has 2511 pages, 290 authors, 224 published contributions, and includes 237 new names and new combinations. Published papers are available online in Adobe Acrobat format (PDF files); the PDF files are true representations of the hard copy of SIDA <*http://www.brit.org/sida/SCBCurIssue.htm*>.

A word of thanks to the 298 individuals acknowledged on pages 2469–2470, who generously supported SIDA through their time and expertise in reviewing 227 manuscripts submitted for volume 21. All manuscript submissions are peer-reviewed by distinguished reviewers; your support is deeply appreciated. If by chance you reviewed a manuscript and your name was left out, the error rests solely on the shoulders of this editor and I truly apologize. Please bring any omissions to my attention.

Below are the dates of publication for each of the four issues of volume 21, subscriptions for calendar year 2006, and distribution of SIDA. We also bring to your attention (see page 2468) the *Mary M. Hennen Scientific Publications Endowment,* established to provide support to the future of BRIT's scientific publication program (*Sida, Contributions to Botany* and *Sida, Botanical Miscellany*). The index to volume 21 (2004–2005 follows and the issue concludes with a printed copy of the current guidelines to contributors. The online version is at *http://www.brit.org/sida/SubmitPaper.htm*.

We thank all authors, reviewers, subscribers (individuals, institutions, organizations), and readers for your continued interest and support. It is our plan to continue bringing you the best sources of current research in classical and modern systematics with your continued support. Wishing you the best in 2006 and beyond.—**Barney Lipscomb** (BRIT), Editor; **John W. Thieret** (NKU), Associate Editor; and **Félix Llamas** (LEB), Contributing Spanish Editor.

Dates of publication

21(1), pp. 1–510: 20 August 2004
21(2), pp. 511–1248: 28 December 2004
21(3), pp. 1249–1954: 5 August 2005
21(4), pp. 1955–2511: 21 December 2005

Subscriptions and distribution.—Sida is distributed in over 90 countries. There are 860 subscriptions, 345 domestic and 515 foreign. Brazil has the most subscribers (38) outside of the U.S.A. Sida is available through paid subscription or scholarly exchange. Online information is available at *http://www.brit.org/sida/subscriptions.htm*.

Annual subscription rates for Sida, Contributions to Botany for 2006.

Domestic (USA only)

1) Subscribing institutions (universities, libraries, and other institutes including agents)	**$75.00**
2) Individual personal subscriptions	**$39.00**

Outside the USA

1) Subscribing institutions (universities, libraries, and other institutes including agents)	**$85.00**
2) Individual personal subscriptions	**$39.00**

Mary M. Hennen Scientific Publications Endowment Established.—In honor of his wife, **Mary**, BRIT research associate, professor emeritus of botany at Purdue University, the world's pre-eminent authority on the systematics and biogeography of the rust fungi, **Joe Hennen** has established the *Mary M. Hennen Scientific Publications Endowment* to provide support to the future of BRIT's scientific publication program (*Sida, Contributions to Botany* and *Sida, Botanical Miscellany*). Joe and Mary (life-science librarian at Purdue University) have long recognized that publication of scientific botanical information is an integral part of conserving our natural heritage.

Every gift to the endowment will make a difference for the future of *Sida* and *Sida, Bot. Misc.* There are many different ways to make a gift; use a credit card, give a check, stock, pledge, bequest, trust, memorials, employer/employee matching contributions, installments, etc. The BRIT Press seeks your support to ensure innovation and excellence in preparation, manufacture, and distribution of botanical research and scientific discoveries for the twenty-first century. For more information about the BRIT Press or anyone interested in making a contribution to the *Mary M. Hennen Scientific Publications Endowment*—which supports *Sida* and *Sida, Bot. Misc.*—contact **Barney Lipscomb** at the Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, Texas 76102-4060, U.S.A.; 817-332-7432; barney@brit.org; sida@brit.org.

SIDA 21(4): 2468. 2005

REVIEWERS: VOLUME 21 (2004–2005)

298 reviewers: several individuals reviewed more than one manuscript
Thank you for supporting *Sida, Contributions to Botany.*

Acedo, Carmen
Aiken, Susan
Alexander, J.C.M.
Allred, Kelly W.
Anderson, Loran C.
Andreas, Barbara K.
Arnold, A. Elizabeth
Arriagada, Jorge E.
Austin, Daniel F.
Ayala-Silva, Tomas
Ayers, Tina J.

Bailey, Jr., Claude J.
Baird, Gary I.
Baldwin, Bruce G.
Ball, Peter W.
Ballard, Jr., Harvey E.
Ballenger, Julie
Barber, Susan C.
Barkworth, Mary E.
Barlow-Irick, Patricia
Barrie, Fred R.
Baskin, Carol C.
Baskin, Jerry M.
Baum, Bernard R.
Bean, Travis
Beck, James
Beidleman, Richard
Benz, Bruce F.
Beutler, John A.
Blanco, Mario A.
Block, Timothy A.
Bohs, Lynn A.
Borchsenius, Finn
Brenner, David
Brouillet, Luc
Brown, Larry E.
Brunell, Mark S.
Buck, William R.
Burnham, Robyn
Burns, Jean

Campbell, Julian
Cardellina, John
Carlquist, Sherwin
Carlsward, Barbara S.
Carranza, Eleazar
Carstens, Kenneth C.
Carter, Richard
Chambers, Kenton L.
Chinnappa, C.C.
Christensen, Knud Ib
Church, Sheri A.
Clark, Lynn G.
Columbus, J. Travis
Consaul, Laurie L.
Cornejo Valverde,
Fernando H.
Costea, Mihai
Cragg, Gordon
Craven, Lyn A.
Cruden, Robert W.

Das, A.P.
Davidse, Gerrit
Davila, Patricia D.
Delprete, Piero G.
Denslow, Michael W.
Dorr, L.J.
Dowling, R.M.
Duvall, James

Eggli, Urs
Elisens, Wayne J.
Endress, Peter K.
Essig, Frederick B.
Evans, Dan K.
Ezcurra, Cecilia

Fantz, Paul R.
Farmer, Susan B.
Ferguson, Carolyn J.
Fernández-Concha,
Germán Carnevali
Fishbein, Mark
Ford, Bruce A.
Freeman, Craig C.
Freire, Susana Edith
Freire-Fierro, Alina
Frye, Christopher
Fryxell, Paul A.

Galloway, Cynthia M.
Gandhi, Kanchi N.
Garland, Mark A.
George, Robert
Germán Ramírez,
María T.
Ghafoor, Abdul
Gillespie, Lynn J.
Goldblatt, Peter
Gómez-Sánchez,
Maricela
González-Elizondo, M.
Socorro
Graff, Pamela
Grant, Verne

Hall, David W.
Hallgren, Steven
Hansen, Bruce F.
Harriman, Neil A.
Hartman, Ronald L.
Hatch, Stephan L.
Haynes, Robert R.
Hennen, Joe
Henrickson, James
Herrera Arrieta,
Yolanda
Hess, Bill
Hill, Steven R.
Hoch, Peter
Hoggard, Gloria
Hoggard, Ronald K.
Holmes, Walter C.
Holst, Bruce K.
Horne, Francis R.
Howcroft, N.H.S.
Humber, Richard A.
Hyatt, Philip

Janovec, John
Jarvis, Charlie
Jeude, Helen
Johns, Bob
Johnson, Dale E.
Johnson, George P.
Jones, Thomas H.
Judd, Walter S.
Judziewicz, Emmet J.

Kaul, Robert B.
Kawasaki, Lucia
Keeley, Sterling C.
Keener, Carl S.
Keil, David J.
Keith, Eric L.
Kennedy, Robin C.
Kephart, Susan R.
Khan, Zaheer
Kirkbride, Jr., Joseph H.
Knapp, Sandra
Kral, Robert
Krapovickas, Antonio
Kumar, Muktesh

Lammers, Thomas G.
Lamont, Eric
Lance, Ron
Landrum, Leslie R.
Lee, Linda
Lemke, David E.
Lewis, David
Liggio, Joe
Liogier, Alain
Lipkin, Robert
Liston, Aaron
Livshultz, Tatyana
Llamas, Félix
Lohmann, Lucia G.
Lonard, Robert I.
Lowry II, Porter P.

MacDougal, John
Macklin, James A.
Magill, Robert E.
Magrath, Lawrence K.
Malmquist, Ann
Marcondes-Ferreira,
Washington
Martin, David L.
Martínez Díaz,
Mahinda

SIDA 21(4): 2469. 2005

McDonald, J.A.
McDowell, Tim
McKenzie, Paul
McMullen, Conley K.
McNeill, John
Mejía, Teresa
Mellichamp, T. Lawrence
Middelton, David
Mill, Robert
Molpus, Jane
Moore, Gerry
Morefield, James D.
Moreno, Nancy P.
Mueller, Jochen
Murray, David F.
Murrell, Zack

Naczi, Robert F.C.
Nasir, Syed Mahmood
Nee, Michael
Neill, Amanda
Nelson, Allan D.
Nelson, John
Nepokroeff, Molly
Nesom, Guy
Nevling, Lorin I.
Nicolson, Dan H.
Nordman, Carl
Norris, Dan
Noyes, Richard D.

Oberlies, Nicholas H.
Olmstead, Richard G.
Orzell, Steve L.

Palmer, Michael W.
Paratley, Robert
Peck, James H.
Peet, Robert
Pennington, T.D.
Pérez García, Blanca
Perkins, Kent
Peterson, Paul M.
Pfister, Donald H.
Phillips, Sylvia
Plunkett, Gregory M.
Pöll, Elfriede
Poole, Jackie
Porter-Utley, Kristen E.
Powell, A. Michael
Pratt, Donald B.
Pringle, James S.
Pruski, John F.
Pyne, Milo

Rabeler, Richard
Reed, Monique D.
Rettig, Jeff H.
Reveal, James L.
Rhoads, Ann F.
Riskind, David
Roberts, Roland P.
Robertson, Kenneth R.
Rock, Janet H.
Rohrer, Joseph R.
Rossman, Amy
Rumely, John H.
Rutishauser, R.
Ryburn, Adam K.

Saar, Dayle E.
Salazar, Jackeline
Sanchez del Pino, Ivonne
Sanchez, Carlos
Sanders, Roger
Schilling, Edward E.
Schultz, Joanna L.
Schuyler, Alfred Ernest
Semple, John C.
Shaw, Joey
Sheviak, Charles J.
Shulkina, Tatyana
Siddiqi, Akmal
Simpson, Beryl B.
Singhurst, Jason
Skinner, Mark
Smith, Don
Smith, Latimore
Smith, S. Galen
Soltis, Douglas E.
Spence, John
Stannard, B.L.
Steury, Brent
Stevens, G.N.
Stewart, Scott
Stoynoff, Nick A.
Strother, John L.
Stuckey, Ronald L.
Sundell, Eric
Sutter, Robert D.
Syring, John

Taylor, Charlotte M.
Taylor, David D.
Tejero, Daniel
Telfair II, Ray C.
Thiede, Joachim
Thieret, John W.
Thomas, R. Dale
Tippery, Nicholas
Tucker, Gary
Tye, Alan

Umber, Ray

Van Horn, Gene S.
Vanderpool, Staria S.

Wagner, Warren L.
Wallnöfer, Bruno
Ware, Stewart
Weakley, Alan S.
Webster, Grady
Weigend, Maximilian
Wilken, Dieter H.
Williams, Justin
Williams, Norris H.
Wilson, Barbara L.
Wilson, Carol A.
Windler, Donald R.
Wipff, Joseph K.
Witsell, Theo
Wunderlin, Richard P.

Yang, T.Y. Aleck
Yatskievych, George A.
Yin-Long Qiu
Yokota, Masatsugu

Zamudio, Sergio
Zarucchi, James L.
Zmarzty, Sue
Zona, Scott A.

Index to 224 titles with 293 Authors: Volume 21 (2004-2005)

We know you have a choice. Thank you for choosing and supporting *Sida, Contributions to Botany.*

SIDA 21(4): 2471. 2005

SIDA 21(4): 2472. 2005

INDEX OF 290 AUTHORS: VOLUME 21 (2004-2005)

Thank you for choosing *Sida, Contributions to Botany.*

BOTANICAL NAMES AND SUBJECT INDEX: VOLUME 21 (2004-2005)

New names (236) in **bold face**

SIDA 21(4): 2488. 2005

236 NEW NAMES AND NEW COMBINATIONS: VOLUME 21 (2004–2005)

SIDA 21(4): 2501. 2005

Chrysothamnus scopulorum (M.E. Jones) Urbatsch, R.P. Roberts & Neubig, comb. nov.—**21(3):**1626

Chrysothamnus scopulorum var. **canonis** (S.L. Welch) Urbatsch, R.P. Roberts & Neubig, comb. nov.—**21(3):**1627

Chrysothamnus stylosus (Eastwood) Urbatsch, R.P. Roberts & Neubig, comb. nov.—**21(3):**1627

Cirsium arizonicum var. **bipinnatum** (Eastw.) D.J. Keil, comb. nov.—**21(1):**209

Cirsium arizonicum var. **chellyense** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov.—**21(1):**209

Cirsium arizonicum var. **rothrockii** (A. Gray) D.J. Keil, comb. et stat. nov.—**21(1):**210

Cirsium arizonicum var. **tenuisectum** D.J. Keil, var. nov.—**21(1):**210

Cirsium clavatum var. **americanum** (A. Gray) D.J. Keil, comb. nov.—**21(1):**211

Cirsium clavatum var. **osterhoutii** (Rydb.) D.J. Keil, comb. et stat. nov.—**21(1):**212

Cirsium cymosum var. **canovirens** (Rydb.) D.J. Keil, comb. et stat. nov.—**21(1):**212

Cirsium eatonii var. **clokeyi** (S.F. Blake) D.J. Keil, comb. et stat. nov.—**21(1):**212

Cirsium eatonii var. **eriocephalum** (A. Nelson) D.J. Keil, comb. nov.—**21(1):**212; **21(3):**1645

Cirsium eatonii var. **hesperium** (Eastw.) D.J. Keil, comb. et stat. nov.—**21(1):**212

Cirsium eatonii var. **peckii** (L.F. Hend.) D.J. Keil, comb. et stat. nov.—**21(1):**212

Cirsium eatonii var. **viperinum** D.J. Keil, var. nov.—**21(1):**212

Cirsium edule var. **macounii** (Greene) D.J. Keil, comb. et stat. nov.—**21(1):**213

Cirsium edule var. **wenatchense** D.J. Keil, var. nov.—**21(1):**213

Cirsium horridulum var. **megacanthum** (Nutt.) D.J. Keil, comb. et stat. nov.—**21(1):**214

Cirsium inamoenum (Greene) D.J. Keil, comb. nov.—**21(1):**214

Cirsium inamoenum var. **davisii** (Cronquist) D.J. Keil, comb. et stat. nov.—**21(1):**214

Cirsium occidentale var. **lucianum** D.J. Keil, var. nov.—**21(1):**214

Cirsium ochrocentrum var. **martinii** (P. Barlow-Irick) D.J. Keil, comb. et stat. nov.—**21(1):**215

Cirsium pulcherrimum var. **aridum** (R.D. Dorn) D.J. Keil, comb. et stat. nov.—**21(1):**215

Cirsium scariosum var. **americanum** (A. Gray) D.J. Keil, comb. nov.—**21(1):**215

Cirsium scariosum var. **citrinum** (Petrak) D.J. Keil, comb. nov.—**21(1):**215

Cirsium scariosum var. **coloradense** (Rydb.) D.J. Keil, comb. et stat. nov.—**21(1):**215

Cirsium scariosum var. **congdonii** (R.J. Moore & Frankton) D.J. Keil, comb. et stat. nov.—**21(1):**215

Cirsium scariosum var. **robustum** D.J. Keil, var. nov.—**21(1):**215

Cirsium scariosum var. **toiyabense** D.J. Keil, var. nov.—**21(1):**216

Citharexylum danirae León de la Luz & Chiang, sp. nov.—**21(2):**548

Clibadium arriagadae Pruski, sp. nov.—**21(4):**2029

Conoclinium betonicifolium var. **integrifolium** (A. Gray) T.F. Patterson, comb. nov.—**21(3):**1641

Conyza popayanensis (Hieron.) Pruski, comb. nov.—**21(4):**2032

Crataegus chrysocarpa var. **vernonensis**

Urbatsch & J. Anderson sp. nov.—**21(3):**1558

Ericameria linearis (Rydberg) R.P. Roberts & Urbatsch, comb. nov.—**21(3):**1560

Ericameria winwardii (R.D. Dorn & C.H. Delmatier) R.P. Roberts & Urbatsch, stat. nov.—**21(3):**1562

Erigeron clokeyi var. **pinzliae** Nesom, var. nov.—**21(1):**28

Erigeron davisii (Cronq.) Nesom, comb. et stat. nov.—**21(1):**22

Erigeron glacialis var. **hirsutus** (Cronq.) Nesom, comb. nov.—**21(2):**671

Erigeron greenei Nesom, nom. nov.—**21(1):**28

Erigeron klamathensis (Nesom) Nesom, comb. et stat. nov.—**21(1):**20

Erigeron maniopotamicus G.L. Nesom & T.W. Nelson, sp. nov.—**21(2):**673

Erigeron poliospermus var. **disciformis** (Cronq.) Nesom, comb. et stat. nov.—**21(1):**24

Erigeron porsildii Nesom & Murray, nom. nov.—**21(1):**44

Erigeron robustior (Cronq.) Nesom, comb. et stat. nov.—**21(1):**21

Eriocaulon anshiense Punekar, Malpure & Lakshmin., sp. nov.—**21(2):**626

Eriocaulon kanarense Punekar, Watve & Lakshmin., sp. nov.—**21(2):**628

Eriocaulon konkanense Punekar, Malpure & Lakshmin., sp. nov.—**21(2):**630

Eriophorum ×**medium** subsp. **album** J. Cayouette, subsp. nov.—**21(2):**807

Eugenia inversa Sobral, sp. nov.—**21(3):**1465

Eutrochium dubium (Willd. ex Poiret) E.E. Lamont, comb. nov.—**21(2):**901

Eutrochium fistulosum (Barratt) E.E. Lamont, comb. nov.—**21(2):**901

Eutrochium maculatum (L.) E.E. Lamont, comb. nov.—**21(2):**902

Eutrochium maculatum var. **bruneri** (A. Gray) E.E. Lamont, comb. nov.—**21(2):**902

Eutrochium maculatum var. **foliosum** (Fernald) E.E. Lamont, comb. nov.—**21(2):**902

Eutrochium purpureum (L.) E.E. Lamont, comb. nov.—**21(2):**902

Eutrochium purpureum var. **holzingeri** (Rydberg) E.E. Lamont, comb. nov.—**21(2):**902

Eutrochium steelei (E.E. Lamont) E.E. Lamont, comb. nov.—**21(2):**902

Festuca californica subsp. **hitchcockiana** (E.B. Alexeev) S.J. Darbyshire, comb. et stat. nov.—**21(3):**1461

Festuca californica subsp. **parishii** (Piper) S.J. Darbyshire, comb. nov.—**21(3):**1461

Fevillea subgenus **Anisosperma** (Silva Manso) G. Robinson & Wunderlin, comb. et stat. nov.—**21(4):**1993

Fevillea bahiensis G. Robinson & Wunderlin, sp. nov.—**21(4):**1977

Galactophora angustifolia J.F. Morales, sp. nov.—**21(4):**2060

Gamochaeta argyrinea Nesom, sp. nov.—**21(2):**718

Gamochaeta chionesthes Nesom, sp. nov.—**21(2):**725

Gentianopsis detonsa subsp. **nesophila** (Holm) J.S. Pringle, comb. nov.—**21(2):**527

Gentianopsis virgata subsp. **macounii** (Holm) J.S. Pringle, comb. nov.—**21(2):**529

Gilia castellanosii (J.M. Porter) V.E. Grant, comb. nov.—**21(2):**539

SIDA GUIDELINES FOR CONTRIBUTORS

Sida home page: *http://www.brit.org/sida/*
Guidelines: http://www.brit.org/Sida/SubmitPaper.htm

Sida, Contributions to Botany (ISSN 0036-1488) is an international journal of systematic botany containing primary research papers sensu lato, including anatomy, biogeography, chemotaxonomy, cladistics, ecology, floristics, genetics & evolution, numerical taxonomy, paleobotany, and palynology. *Sida* is open to all authors anywhere; coverage is not restricted to any geographical area.

All manuscripts submitted to *Sida* are considered by at least two reviewers. Manuscripts may be submitted in English or Spanish. Page costs are $35 per page but may be waived or reduced under certain circumstances. Please contact the editor and make arrangements before publication. Manuscripts are not rejected due to lack of financial support. Submit manuscripts and editorial questions to Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TEXAS 76102-4060, U.S.A. Phones: 1-817-332-4441 voice; 1-817-332-4112 fax. Our electronic mail address is sida@brit.org. Access *Sida* home page at *www/brit.org/sida.*

Submissions: Please submit manuscripts in electronic format as an email attachment. If you wish submissions are also accepted by USPS mail with a single hard copy and on computer disk. Figures/illustrations may be submitted in low-resolution format (**jpgs**) as email attachments for review purposes only. Upon acceptance for publication, the manuscript may be submitted as an email attachment or returned in the mail with a single hard copy and an electronic copy. If you have figures/illustrations in electronic format they should be submitted in **tif** format, scanned at the absolute best quality possible. Digital figures may have to be submitted on a CD-ROM disk if they are too large for email. Typically b/w line drawings should be scanned at 600 dpi or higher and b/w half tones and color photos at 300 dpi. If you need your figures/illustrations digitized, the editorial staff at *Sida* will be happy handle any electronic digitization needs you have; all original material can be returned if requested. Color digitization works best from color transparencies (slides).

Consult the latest issue of *Sida* for format of articles and notes regarding title, author, and address. Ranges of numbers are separated by double hyphens (6--8) OR use an en dash (–). Footnotes, figure legends, appendices, and tables should be on separate pages and inserted at end of manuscript following references. Authors are encouraged to use the APG families, nearly all of which are on / APweb/ which can be accessed through the Missouri Botanical Garden research site (Angiosperm phylogeny).

Abstract

Every paper should include both an English and Spanish, or another major language abstract.

Specimen Citations

Label information should be followed for specimen citations in whatever language. Follow whatever unit if measure is provided on the label (metric or English). Use the collector's last name (or full name) and number or (s.n) and *italicize*. Abbreviate the months of the year by the first three letters of the month without a period. Example: Texas. Jeff Davis Co.: 1 mi W of Fort Davis, 3 Jan 1972, *Smith 118* (BRIT). Example: **BRAZIL. Bahia:** Serra da Agua de Rega, 23 km N of Seabra, road to Agua de Rega, ca. 1000 m, 24 Feb 1971 (fr), *Irwin et al. 30894* (HB, MBM, MO, NY).

Author Citations

Use the author abbreviations as given in the *Author Abbreviations* compiled at the Herbarium, Royal Botanic Gardens, Kew (1992). Use et or the ampersand (&) between two authors; for more than two authors, restrict to the first one followed by et al. Do not *italicize* or underline in the manuscript the terms et, et al., ex, or in.

Plant names in the text should include authorship or clearly state the botanical nomenclature being followed.

Latin Descriptions or Diagnoses; English Descriptions

Please provide a Latin diagnosis for each new taxon. After the Latin diagnosis, an English or Spanish version is recommended highlighting the diagnostic characters. Write plant descriptions as incomplete sentences with phrases separated by semicolons.

Figures

Please present ALL figures (maps included) as a unified, single sequence of figures. A scale should be in or on the illustration or photograph; reduction will automatically reduce the scale and subject proportionately. In halftones, sharp glossy photographs with good contrast are necessary for good reproduction. Please mount illustrative material (halftones, line drawings, etc.) on flexible paper so that may be mounted and on a high-speed drum scanner if need. You may also submit graphic materials in electronic format. Typically b/w line drawings should be scanned at 600 dpi or higher and b/w half tones and color photos at 300 dpi. Please consult the editor for additional information if need. Color figures can be used and an additional cost maybe charged. Color digitization works best from color transparencies (slides). Please submit color prints for reviewing purposes.

References

This includes all of the literature cited in the text and may include other article citations the author may deem desirable. Normal text references should be cited as follows: 'Ricketson and Pipoly (1997) stated...' or 'the latest revision (Ricketson & Pipoly 1997)' when reference is used as authority for a statement. When there are three or more authors use only the name of the first author followed by et al.. 'Barrie et al. (1992a) stated'. References at the end of the article are arranged alphabetically and chronologically making use of a,b, etc. if an author had more than one publication in a given year. Author's names are printed in Cap/small caps, NOT ALL CAPS, please type author names in Cap/small cap or in Cap/lower case except for initial capitals. Only the first letter of the initial word, proper nouns, and proper adjectives of titles should be capitalized. Please note there is no space between initials of authors. For journal abbreviations, use *Botanico-Periodicum-Huntianum*. Reference examples:

Barrie, F.R., C.E. Jarvis, and J.L. Reveal. 1992a. The need to change Article 8.3 of the Code. Taxon 41:508—512.

Ricketson, J. and J. Pipoly. 1997. A synopsis of the genus *Gentlea* (Myrsinaceae) and a key to the genera of Myrsinaceae in Mesoamerica. Sida 17:697—707. [author's names in cap/lower case]

Crawford, D.J. 1983. Phylogenetic and systematic inferences from electrophoretic studies. In: S.D. Tanksley and T.J. Orton, eds. Isozymes in plant genetics and breeding, Part A. Elsevier, Amsterdam. Pp. 257—287. [author's names in cap/small cap]

Sivinski, R.C. and K. Lightfoot (eds.). 1995. Inventory of rare and endangered plants of New Mexico. New Mexico Forestry and Resources Conservation Division. Energy, Minerals and Natural Resources Department. Misc. Pub. No. 4.

SIDA 21(4): 2510. 2005

Abbreviations

When the following abbreviations are used the period is omitted. Distance: mm, dm, cm, m, km, ft, mi; directions (in caps): S, N, E, W, months: first 3 letters only, Jan, Feb, etc. Example: Potter Co.: 2 km W of Dot, 5 Jun 1971, *Smith 118* (SMU).

Documented Plant Chromosome Numbers

Refer to **Sida** 21(3):1663. 2005.

Acknowledgments

Recommendation: Consider acknowledging the herbaria consulted for any data in your paper as this acknowledgment might help herbaria and institutions justify their existence and support either from their own institution or from granting agencies. In a time where herbaria are merging and even dying, let's not take them for granted.

Floristic Papers

Floristic papers are important, but they need to be more than a list of plants, they need added value, they need meat and context added. Such papers should emphasize the uniqueness of the floristic study area, physical characteristics, cultural and historical information, land use history, climate, major vegetational habitats, rare/endangered/special concern taxa, new county records, state records, disjuncts, invasives, etc. Lists in and of themselves are not that useful. Annotate your list as much as possible. The more annotations you can add to the checklist the more value it will have. A list that provides ecological notes on rare and endangered taxa or other noteworthy taxa, State and Federal status on any rare and endangered species, and highlights and notes any endemics, disjuncts, or significant geographic distribution records, etc., is so much more valuable and useful. Conservation issues are also important and any information and discussion on such would add considerable value to the paper.

Also note which and how many species are state-listed by the Heritage Program if they exist. Summarize how many taxa occur in various classes of county numbers, which is informative for conservation of the state's flora.

Range Extensions

Range extension papers will ONLY be considered for publication when the taxon being reported represents a new state record, significant disjunct, documented exotic/invasive, rare and/or endangered or is a rare endemic.

Questions: Email the editor (Barney Lipscomb, barney@brit.org).

This photographic guide to the Wild Flowers of Mombacho is color-coded and arranged by Family within the color sections. It covers flowering plants found on the whole of the Volcano; which includes both tropical cloud forest and dry, deciduous forest, at lower altitudes.

The book covers 200 plants, each of which has two or three photographs and a short description in both English and Spanish giving common name(s); a short description of the plant; height; flowering period; habitat and any known use of the plant. The vast majority of plants are likely to be found in similar habitats throughout tropical America and nearly one third are pan tropical, making this book of interest to a wide audience throughout the tropics.

Sida, Bot. Misc. No 28, 2006
issn 0823-1475
isbn 1-889878-14-6
6.5" x 8.5", x + 217pp.
over 500 photographs
$15 + p&p*
*USA $3
*International: $7
Texas residents add $1.24 sales tax

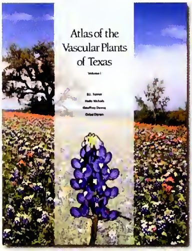
WILD FLOWERS OF MOMBACHO
NICARAGUA
FLORES SILVESTRES DEL MOMBACHO
BY HELEN PICKERING

BRIT
PRESS

The Atlas of Texas covers about 6000 taxa. This is the result of 54 years of herbarium and fieldwork by B.L. Turner, beginning in 1948 at Sul Ross State University, Alpine, Texas. In short, the senior author has examined personally, touched, or "pored over" an estimated several hundred thousand sheets in the preparation of the forthcoming Atlas volumes. Contents include an introduction, atlas of Texas plants arranged alphabetically by family, by genus, by species, and an index.

Available from
Botanical Research Institute of Texas Press
509 Pecan Street
Fort Worth, TX 76102-4060, USA
E-mail: sida@brit.org • Fax 1-817-332-4112
www.brit.org/Sida/Sida/24.htm

Sida, Bot. Misc. No. 24, 2003, issn 0833-1475,
isbn (vol. 1) 1-889878-08-1 • isbn (vol. 2) 1-889878-09-X • 7 1/2" × 10"
Vol. 1 approx. 630 pp. • Vol. 2 approx. 275 pp.
Vol. 1 $50 + p&h* • Vol. 2 $40 + p&h* • Set $80 + p&h*
*USA: $10 (vol. 1); $9.50 (vol. 2); $12 (set)
*International: $12.50 (vol. 1) • $11.50 (vol. 2); $25 (set)
Texas residents add sales tax: $4.13 (vol. 1) • $3.30 (vol. 2) • $7.43 (set)



Atlas of the
Vascular Plants of Texas

By
B.L. Turner,
Holly Nichols, Geoffrey Denny,
Oded Doron

BRIT
PRESS

UISIANA TEXAS GEORGIA NORTH AMERICA ARKANSAS FLORIDA IOWA MIS

ANSAS OKLAHOMA VIRGINIA OREGON NEBRASKA ALABAMA NEW MEXICO CALIF

Poaceae NORTH CAROLINA SOUTH CAROLINA MONTANA VERMONT IND

IO MICHIGAN UNITED STATES ILLINOIS TENNESSEE ALASKA KENTUCKY NEW YORK M

NNSYLVANIA NEW JERSEY MASSACHUSETTS *Asteraceae* I

YOMING ARIZONA HAWAII NEVADA UTAH WASHINGTON SOUTH DAKOTA NO

AKOTA *Cactaceae* RHODE ISLAND COLORADO DELAWARE MISSOURI

RGINIA MINNESOTA CANADA ONTARIO ALBERTA BRITISH COLUMBIA SASKATCHEWAN YU

RRITORY NORTHWEST TERRITORIES NOVA SCOTIA MANITOBA NEWFOUNDLAND MANATOBA QU

W BRUNSWICK PRINCE EDWARD ISLAND SOUTH AMERICA PERU CHILE B

Myrsinaceae AMAZONIA ARGENTINA ECUADOR BELIZE COLO

ENCH GUIANA URUGUAY SURINAME PARAGUAY VENEZUELA BOLIVIA GUATEMALA SAN SALV

ONDURAS GUYANA CENTRAL AMERICA NICARAGUA PANAMA COSTA

UBA PUERTO RICO DOMINICAN REPUBLIC HAITI BAHAMAS JAMAICA NORTH & SO

OREA ASIA TAIWAN JAPAN *Orchidaceae* VIETNAM CHINA

DIA BURMA BANGLADESH MALAYSIA IRELAND FRANCE GERMANY ITALY NORWAY SW

EUROPE UNITED KINGDOM PHILIPPINES FINLAND AUSTRALIA HUN

WITZERLAND CZECHOSLOVAKIA POLAND YUGOSLAVIA RUSSIA GREECE PAKISTAN SYRIA

AN MADAGASCAR INDIA PAPUA NEW GUINEA NEPAL SYRIA SRI L

W SOUTH WALES QUEENSLAND VICTORIA WESTERN AUSTRALIA NORTHERN TERRITORY S

Fabaceae AUSTRALIA TASMANIA NEW ZEALAND MALAYSIA SUMATRA

HAYANA ISRAEL MOROCCO SOUTH AFRICA AFRICA EGYPT NIGERIA ETHIOPIA SOM

BYA JORDON KENYA CONGO SUDAN ZIMBABWE MOZAMBIQUE ZAMBIA SAUDI A

RACRUZ MEXICO NUEVO LEON CHIHUAHUA MONTEREY MICHOACAN OA

DALGO GUADALAJARA *Liliaceae* COAHUILA YUCATAN SIN

ISSN 0036-1488