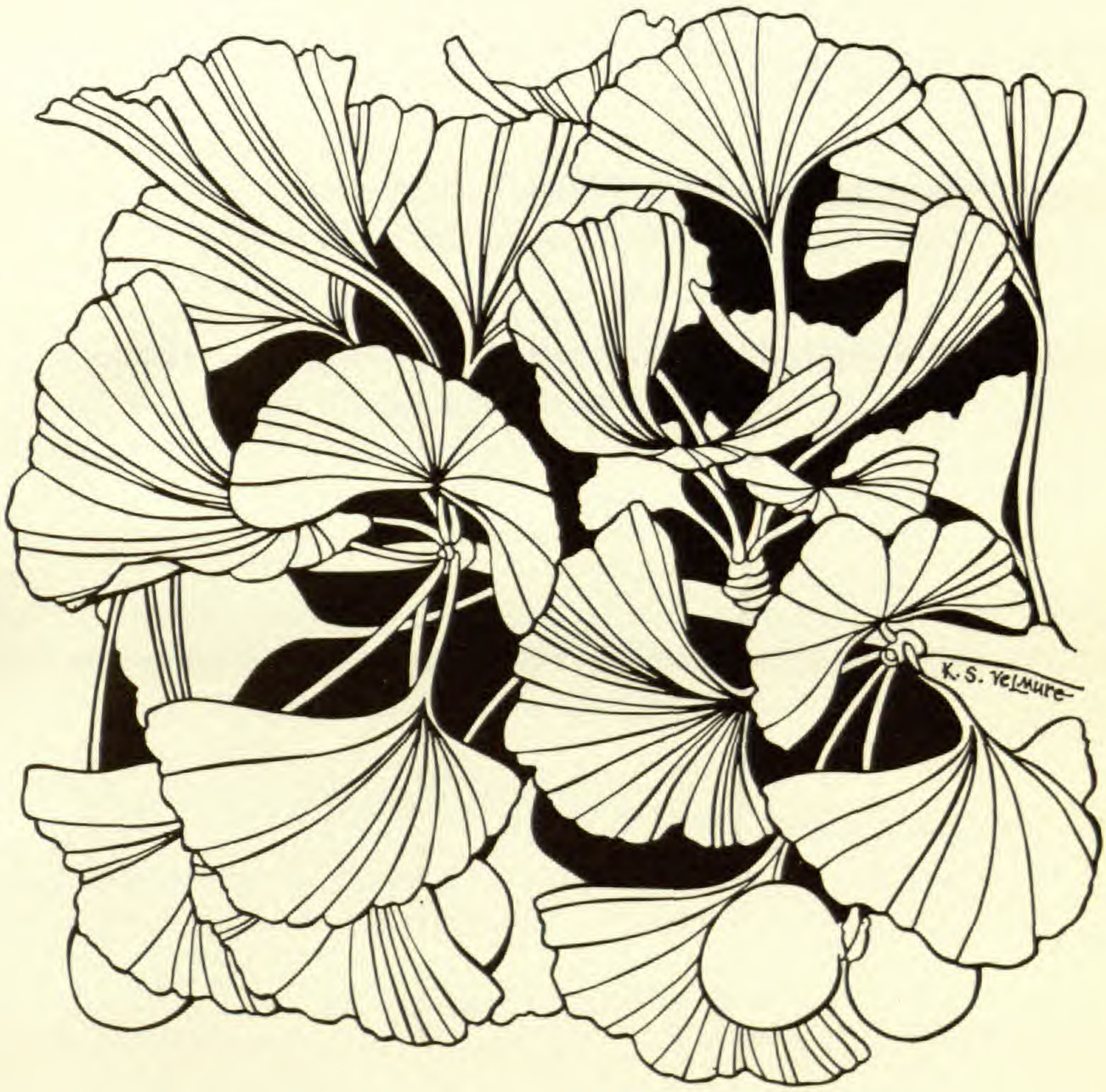
QK1
.J765

JOURNAL OF THE ARNOLD ARBORETUM



Volume 54 HARVARD UNIVERSITY 1973

MISSOURI BOTANICAL
GARDEN LIBRARY

Dates of Issue

No. 1 (pp. 1–122) issued 9 February, 1973
No. 2 (pp. 123–330) issued 26 April, 1973
No. 3 (pp. 331–418) issued 16 July, 1973
No. 4 (pp. 419–493) issued 14 November, 1973

Contents of Volume 54 *1973*

Studies of Pacific Island Plants, XXV.
The Myrsinaceae of the Fijian Region.
ALBERT C. SMITH 1
The Genera of Lactuceae (Compositae)
in the Southeastern United States.
BERYL SIMPSON VUILLEUMIER 42
New Taxa from Brazil and Guyana in the Genus
Hymenaea (Leguminosae, Caesalpinioideae).
YIN-TSE LEE and JEAN H. LANGENHEIM 94
The Genus Cyrtandra in the Ryukyu
and Caroline Islands.
GEORGE W. GILLETT 105
The Wood of Amentotaxus.
HOWARD J. MILLER 111
Dioecism in Citharexylum
(Verbenaceae): An Addendum.
P. B. TOMLINSON 120
Lazella Harenberg Schwarten [notice] 121
Statement of Ownership 122
Lateglacial Plants and Plant Communities
in Northwestern New York State.
NORTON G. MILLER 123
A Provisional Key and Enumeration of Species of Syzygium
(Myrtaceae) from Papuasia.
T. G. HARTLEY and L. M. PERRY 160
Studies of Pacific Island Plants, XXV. The
Myrsinaceae of the Fijian Region — (concluded).
ALBERT C. SMITH 228
Present Status and Problems of Bamboo
Classification.
D. GROSSER and W. LIESE 293
Notes on West Indian Myrtaceae.
ROGERS MCVAUGH 309
Three New Species of Picramnia (Simaroubaceae)
from Central America.
DUNCAN M. PORTER 315
The Krameriaceae in the Southeastern United States.
KENNETH R. ROBERTSON 322
XII International Botanical Congress [notice].
A. TAKHTAJAN 329
Succession
WILLIAM H. DRURY and IAN C. T. NISBET 331
Chromosome Counts in Cultivated Junipers.
MARION T. HALL, APARNA MUKHERJEE, and
WEBSTER R. CROWLEY 369

Notes on the Piperaceae of the Lesser Antilles.
RICHARD A. HOWARD 377
Cytology of West Himalayan Betulaceae and Salicaceae.
P. N. MEHRA and T. S. SAREEN 412
Lazella Harenberg Schwarten, 1900–1973.
RICHARD A. HOWARD 419
Chromosome Numbers of Tree Species of a Lowland Tropical Community.
K. S. BAWA 422
The Enumeratio and Selectarum of Nicolaus von Jacquin.
RICHARD A. HOWARD 435
Revision of Kentrothamnus (Rhamnaceae).
MARSHALL C. JOHNSTON 471
Index 474
Karl Sax [notice] 493

QH1
.H32

JOURNAL OF THE ARNOLD ARBORETUM

Volume 54 HARVARD UNIVERSITY Number 1

MISSOURI BOTANICAL

FEB 19 1973

GARDEN LIBRARY

Journal of the Arnold Arboretum

Published quarterly in January, April, July, and October by the Arnold Arboretum, Harvard University.

Subscription price $16.00 per year, beginning January, 1972.

Subscriptions and remittances should be sent to Ms. Ellen Bernstein, Arnold Arboretum, 22 Divinity Avenue, Cambridge, Massachusetts 02138, U.S.A.

Volumes I–XLV, reprinted, and some back numbers of volumes 46–50 are available from the Kraus Reprint Corporation, 16 East 46th Street, New York, New York 10017, U.S.A.

EDITORIAL STAFF
B. G. Schubert, Editor
C. E. Wood, Jr.
S. A. Spongberg

CIRCULATION
E. Bernstein

Printed at the Harvard University Printing Office, Boston, Massachusetts

---

COVER: *Ginkgo biloba* L., the maidenhair tree, so-called from the fancied resemblance of its leaves to those of the maidenhair fern. In China it has also been called the silver apricot, from the hard inner seed coat which is silvery when cleaned and vaguely resembles an apricot pit, and the duck-foot tree, from the resemblance of the leaves to the webbed feet of ducks.

The drawing for the cover and the devices for the back cover and reprints were planned and drawn by Karen Stoutsenberger Velmure from specimens taken from a tree cultivated in the Arnold Arboretum of Harvard University.

We want to assure the purists among our readers that our *Ginkgo* does not have leaves with open parallel venation. We think, however, that an exact reproduction of the dense dichotomous veins would have produced a much less dramatic design.

Second-class postage paid at Boston, Massachusetts

JOURNAL
OF THE
ARNOLD ARBORETUM

VOL. 54 JANUARY 1973 NUMBER 1

STUDIES OF PACIFIC ISLAND PLANTS, XXV. THE MYRSINACEAE OF THE FIJIAN REGION [1]

ALBERT C. SMITH

IN ORDER TO OBTAIN an adequate understanding of the Fijian species of many angiosperm families, it is obviously necessary to extend studies into adjacent island-groups. Ideally such studies should be extended westward at least as far as Malesia. It is not feasible in floristic work to revise large families throughout their entire Malesian-Pacific range, but a practicable geographic compromise in the present instance exists in the boundaries of the "Fijian Region." As defined by Takhtajan (1969: 250, *fig. 32*), the Fijian Region includes the Santa Cruz, Banks, and New Hebrides Islands, Fiji, Rotuma, the Horne and Wallis Islands, Samoa, Tonga, and Niue. Earlier phytogeographic analyses have implied the integrity of this area as a "Southwestern Pacific Subprovince" (van Balgooy, 1960) or a "Fijian Province" (Thorne, 1964). Although the outlines and rank of such areas are necessarily somewhat subjective, current studies indicate that a separate Fijian Region merits recognition on the basis of its phytogeographic cohesion and peripheral discontinuities. It would be a more satisfactory and logical area for a floristic revision than a single archipelago like Fiji, but the present writer cannot hope to cover it. Nevertheless, studies of a limited number of families in the entire Fijian Region are feasible while a new Flora of Fiji is being compiled.

One of the many large angiosperm families that requires a new, worldwide review is the Myrsinaceae, of which the treatment by Mez (1902) remains the only comprehensive revision. For its period, and in view of the material then available, Mez's work seems highly meritorious, even after 70 years. Modern taxonomists who criticize this monograph and many other Pflanzenreich treatments should feel challenged to update them. Certainly different conclusions as to relationships would come to light by the application of modern techniques and the careful examination of perhaps ten times as many collections as were available to Mez. Un-

[1] No. XXIV of this series was published in Brittonia, vol. 23(4). (1971). The present paper is based on research partially supported by a grant from the National Science Foundation. The dated parenthetical references in the text refer to literature, which will be cited in the final part of this paper.

fortunately, it is easier to depreciate such works and the meticulous scholarship of their authors than it is to improve upon them.

For the Myrsinaceae there fortunately do exist some supplementary regional revisions that are very useful (e.g. Walker, 1940, 1959; Backer & Bakhuizen van den Brink, 1965; and studies of some American genera). In the Fijian Region, especially in Fiji itself, the family is a frequent component of the forest vegetation, although usually occurring as shrubs and small trees of the undergrowth, or sometimes as lianas. It is represented in our area by six genera and 43 indigenous species, including six here described as new; two new combinations are proposed.

Pertinent herbarium collections in the following institutions are here cited: Arnold Arboretum of Harvard University (A); Bernice P. Bishop Museum (BISH); British Museum (Natural History) (BM); University of California, Davis (DAV); Gray Herbarium of Harvard University (GH); Royal Botanic Gardens, Kew (K); Department of Botany, University of Massachusetts (MASS); New York Botanical Garden (NY); Muséum National d'Histoire Naturelle, Paris (P); Departments of Agriculture and Forestry, Suva, Fiji (SUVA); University of California, Berkeley (UC); and U.S. National Herbarium (US). The collaboration of administrators in making such material available is greatly appreciated.

KEY TO GENERA

Ovary semisuperior, the ovules in our species bi- to several-seriate; pedicels with a pair of persistent distal bracteoles (prophylls); fruit essentially inferior, many-seeded, the seeds angled-obovoid, convex at apex, the style and calyx persistent. ..... 1. *Maesa.*

Ovary superior; pedicels without prophylls; fruit superior and eventually falling from the calyx, one-seeded, the seed more or less subglobose.

Ovules mostly several-seriate but in our species 6–10 and irregularly uniseriate; style elongate, very slender and subulate to a minutely punctiform stigma; inflorescences in our species compact, irregularly fasciculiform or short-racemose or rarely short-paniculate, the rachis rarely more than 3 mm. long at anthesis. ..... 2. *Ardisia.*

Ovules uniseriate, in our species 2–5; style sometimes cylindric and slender but not subulate, the stigma discoid or subcapitate or peltate or (in no. 6) diverse.

Inflorescences paniculate, usually obviously pedunculate, often freely branched, in our species rarely less than 20 mm. long at anthesis and usually much longer.

Corolla sympetalous, the lobes obviously dextrorsely contorted in bud; flowers in our species hermaphrodite.

Anthers dorsifixed, the filaments distally free and ligulate; pedicels sometimes swollen distally into a clavate or cupuliform calyx-tube, but sometimes as in *Discocalyx*; style as long as or longer than the ovary, in our species 0.6–5 mm. long at anthesis. ..... 3. *Tapeinosperma.*

Anthers broadly basifixed, the filament-tube adnate to the corolla-tube for its entire length and not distally divided into free parts; pedicels slenderly terete, the calyx subrotate from base; style often

shorter than the ovary, in our species (0.1–) 0.2–0.7 mm. long at anthesis. ..... 4. *Discocalyx.*
Corolla in our species choripetalous, the petals narrowly imbricate in bud; flowers functionally unisexual. ..... 5. *Embelia.*
Inflorescences glomerulate or verruciform, essentially epedunculate, the axis in our species not exceeding 7 mm. long. ..... 6. *Rapanea.*

1. **Maesa** Forsk. Fl. Aegypt.-Arab. 66. Oct. 1775; Seem. Fl. Vit. 147. 1866; Mez in Pflanzenr. 9(IV. 236): 15. 1902; St. John in Naturaliste Canad. **98**: 571, 573. 1971.

Baeobotrys J. R. & G. Forst. Char. Gen. Pl. 11. Nov. or Dec. 1775, ed. 2. 21. 1776.

Mez's statement in his monograph to the effect that *Maesa* is a "Genus vastum, difficillime systematice ordinandum, . . ." is not likely to be disputed. Even in so limited a region as that now under consideration, species as satisfactory morphological groupings appear non-existent. In his key Mez utilized such characters as whether the prophylls are laterally free from one another or whether they are connate to form a cymbiform receptacle under the calyx; the presence or absence of lineolate glands in the calyx-lobes; the margins of the prophylls and calyx-lobes, whether entire, crenulate, or ciliolate; the apical shape of the calyx- and corolla-lobes; and the proportionate lengths of filaments and anthers. Among the Pacific species these characters seem of limited value in demarcating populations. One is, therefore, required to assign exaggerated value to characters of indument (distribution and length of hairs as well as persistence of minute scales), to leaf size and shape, to the abundance or sparseness of secretory canals in the leaf-blades, to inflorescence-type (whether paniculate or merely simply racemose), and to pedicel-length. None of these characters are satisfactory either, but by utilizing them with caution one can delimit populations that have a certain cohesion as well as a reasonable distribution. I have chosen this course rather than the alternative, of which we have recently seen some startling examples in various families, of distending infra-generic groupings in favor of muddled and geographically meaningless comprehensive taxa.

Although Mez indicates that the flowers of *Maesa* are functionally unisexual, the species of our region appear to have hermaphrodite flowers. An ovuliferous ovary and seemingly polliniferous anthers are present; if incipient dioecism occurs, which is likely, it is not obvious. The species of our area are normally 5-merous, although 4- or 6-merous flowers may occasionally be found; all of our taxa have the calyx- and corolla-lobes with quincuncial aestivation; the corolla is submembranous and campanulate; the stamens are affixed near the middle of the corolla-tube; the ovary is about half-inferior at anthesis; the placenta is essentially subglobose or ovoid; the fruits have a thin pericarp 0.2–0.4 mm. thick including a carnose, glandular-lineolate mesocarp and a spongy or brittle endocarp; the prophylls, sepals, and style persist in fruit; the seeds are numerous (indi-

cating that most ovules develop), angled-obovoid, when mature castaneous or blackish, shining, and approximately 1–1.2 mm. long and 1–1.5 mm. broad on the convex apex. These characters, being essentially uniform, are omitted from the following descriptions of species.

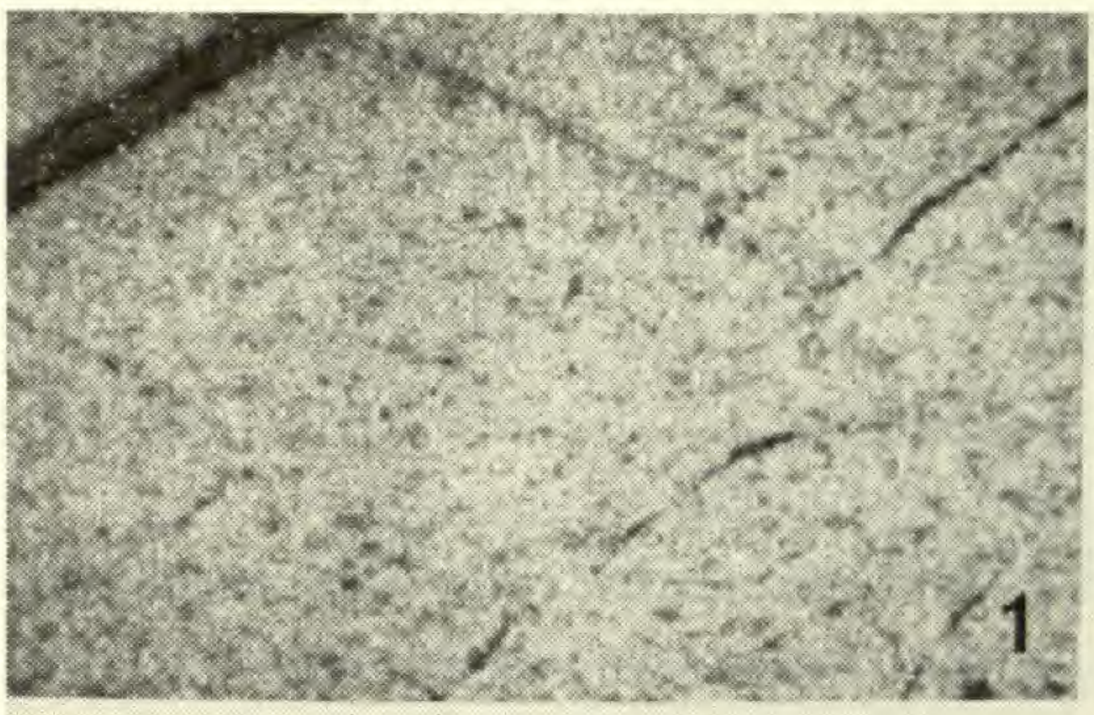
The presence of secretory canals in the leaf-mesophyll of Myrsinaceae (Metcalfe & Chalk, 1950: 865) has often been noted in taxonomic discussions. These canals contain tannin and other materials and are frequently described as "resiniferous lines" or "nervilliform lines" (Mez, 1902). In *Maesa*, in particular, their putative presence or absence has been utilized to differentiate species. As a taxonomic character in *Maesa*, the secretory canals are undeniably useful, but considerable caution must accompany statements that they are present or absent.

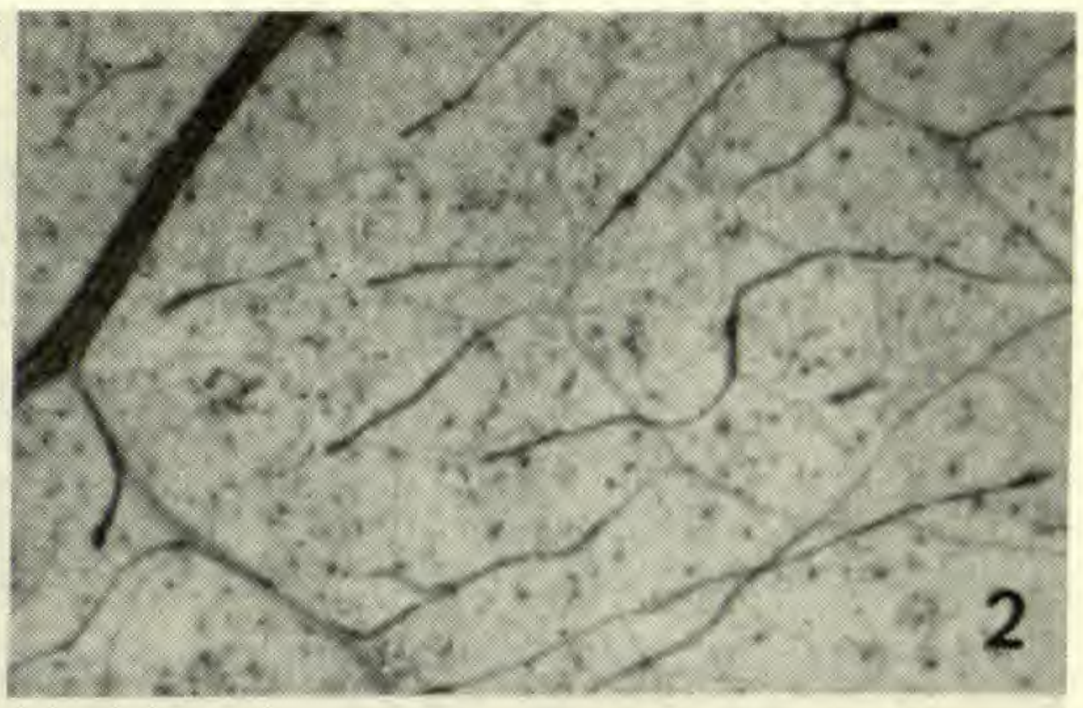
As examples, in herbarium specimens of *M. tabacifolia* secretory canals are inconspicuous or not apparent, but in cleared leaves [2] (FIGURE 10) they are seen to be copiously immersed in the mesophyll at right angles to tertiary nerves. Leaf-indument, if present as in this species, shows well in cleared leaves. To separate such paired species as *M. insularis* and *M. samoana* it is convenient to suggest that in dried leaves secretory canals are comparatively inconspicuous in the former (FIGURE 1) and obvious in the latter (FIGURE 3). In fact, canals are present in both species as seen in cleared leaves, but less copiously so in *M. insularis* (FIGURE 2) than in *M. samoana* (FIGURE 4). Another pair of related species consists of *M. persicifolia*, in which dried leaves (FIGURE 5) seem nearly or quite to lack canals, and *M. vitiensis* (FIGURES 7, 9), leaves of which are usually copiously marked on the lower surface by sinuously parallel "resinferous lines." In cleared leaves, confluent areas of secretory cells become obvious in *M. persicifolia* (FIGURE 6), while in *M. vitiensis* (FIGURE 8) the canals nearly disappear with clearing.

It is evident, then, that in different species or individuals of *Maesa*, at least as represented by herbarium material, the secretory canals have different degrees of superficiality, abundance, form, and soluble content. A detailed study of these bodies in *Maesa*, and in other genera of Myrsinaceae, would doubtless be taxonomically illuminating. But in the meantime, with these few cautionary examples, I continue to mention the

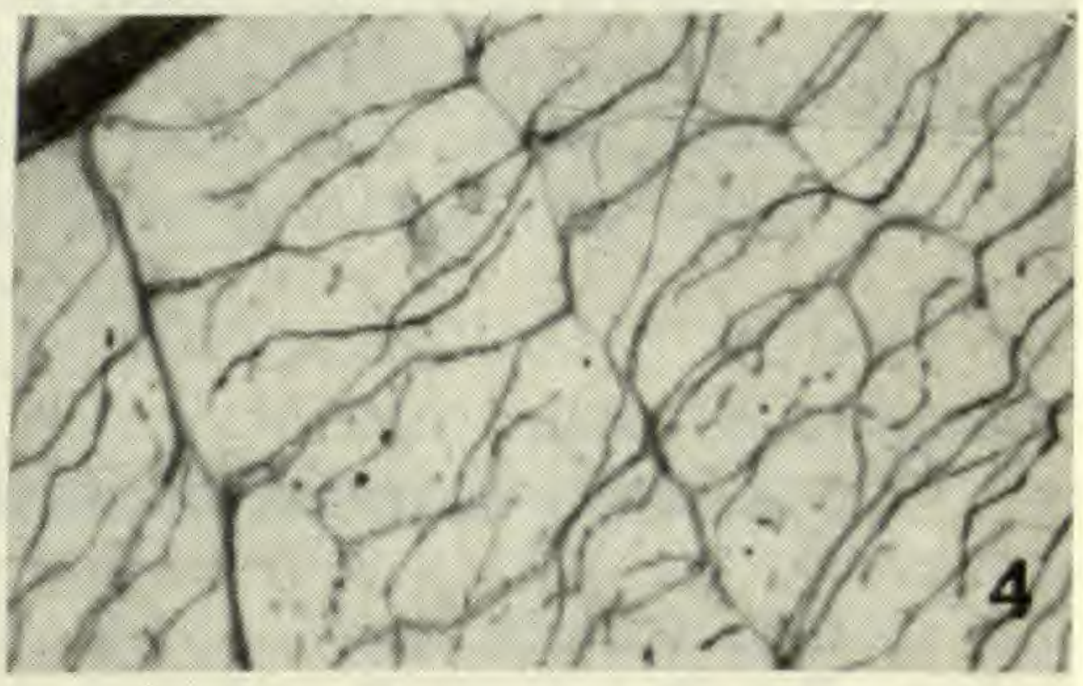
[2] Dr. David W. Bierhorst has kindly aided in the technique of preparing leaves from herbarium specimens as follows: leaves are cleared in 3–4% NaOH followed by saturated aq. chloral hydrate, then stained with 1% safranin in absolute ethyl alcohol, and finally cleared in xylene and mounted in synthetic resin.

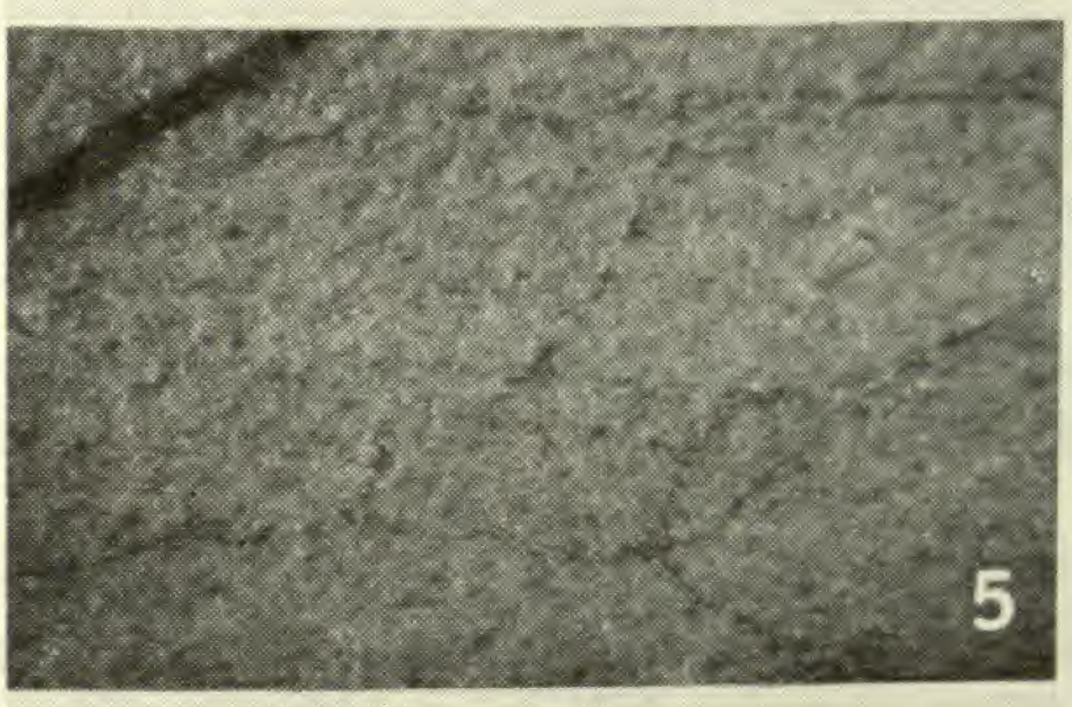
FIGURES 1–10. Leaf-blades of *Maesa* spp., showing the lower surfaces (left figures) of blades from dried herbarium specimens, and cleared portions (right figures), all × 10. FIGURES 1 and 2. *M. insularis*: 1 from *Fiji Dept. Agr. 11577*, 2 from *Gillespie 3479*. FIGURES 3 and 4. *M. samoana*: 3 from *Christophersen 384*, 4 from *Reinecke 262*. FIGURES 5 and 6. *M. persicifolia*: 5 from *Degener 15004*, 6 from *Fiji Dept. Agr. 14895*. FIGURES 7–9. *M. vitiensis*: 7 and 8 from *Gillespie 2390*, 9 from *Gillespie 3287*. FIGURE 10. *M. tabacifolia*: from *Seemann 286*.

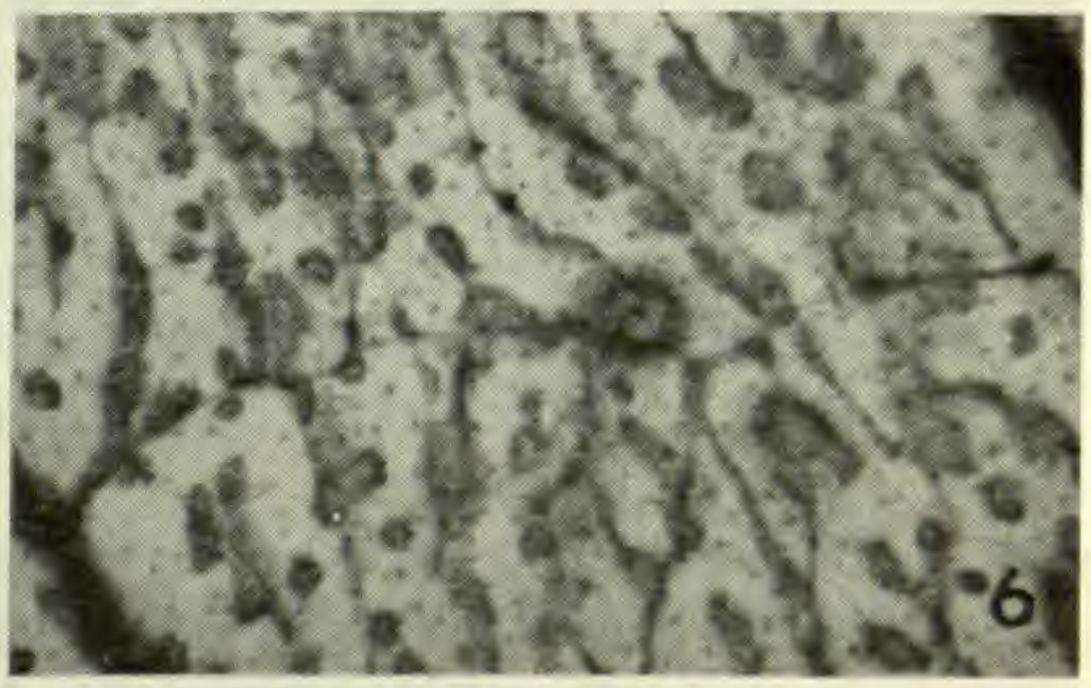

1


2

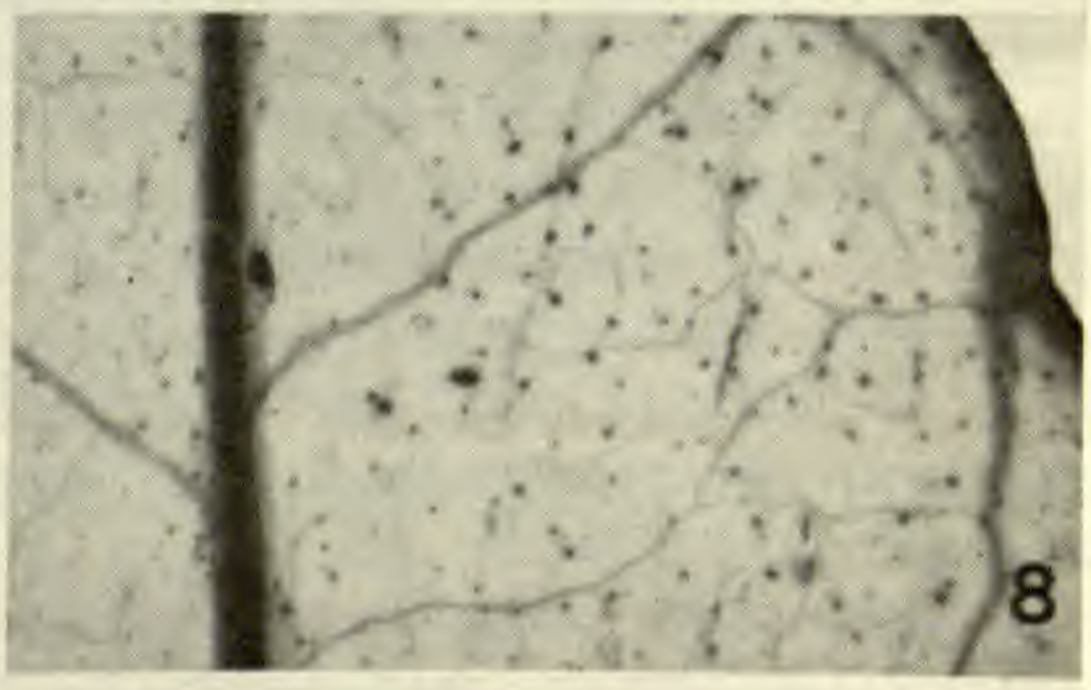
3


4


5


6

7


8

9

10

secretory canals in keys and descriptions in such a genus as *Maesa*, where satisfactory taxonomic characters are at a premium.

Maesa is an abundant and complex genus in many parts of its range, which extends from Africa and Madagascar eastward through southeastern Asia to Japan, Queensland, and Malesia into the Pacific as far as Samoa and Tonga. In the region here covered 23 species have been proposed, but with several reductions I now recognize 15 species.

St. John (1971) has provided a valuable commentary on the overlooked 1775 edition of the Forsters' "Characteres Generum Plantarum," indicating that *Maesa* Forsk. has priority over *Baeobotrys* J. R. & G. Forst., although both were published in 1775.

KEY TO SPECIES

Indument (of young parts, branchlets, petioles, and at least the proximal parts of leaf-costas) composed of spreading simple hairs as well as of minute scales, the hairs usually obvious but sometimes inconspicuous, rarely as short as 0.1 mm.

Spreading hairs usually obvious on some inflorescence-parts, occasionally limited to calyx-lobes.

Leaf-blades prevailingly ovate to suborbicular and about twice as long as broad (or broader), usually 6–13 × 3.5–9.5 cm., persistently soft-pilose at least on the lower surface, cordate to rounded at base, infrequently merely broadly obtuse, the secondary nerves usually 5–8 per side; inflorescences prevailingly paniculate, only rarely simply racemose.

Prophylls comparatively inconspicuous, oblong-deltoid, 0.4–0.7 × 0.2–0.5 mm.; leaf-blades usually conspicuously crenulate-dentate at margin, without apparent secretory canals; Fiji. .. 1. *M. corylifolia.*

Prophylls comparatively conspicuous, ovate, 1–1.2 mm. long and broad; leaf-blades inconspicuously crenulate at margin; New Hebrides.

Petioles about 15 mm. long; leaf-blades cordate at base, without obvious secretory canals; inflorescences compact, about 2 cm. long at anthesis. ..... 2. *M. bennettii.*

Petioles 25–35 mm. long; leaf-blades rounded at base, with obvious secretory canals near lower surfaces; inflorescences 5–7 cm. long at anthesis. ..... 3. *M. aneiteensis.*

Leaf-blades prevailingly lanceolate or oblong-lanceolate and about 3 times as long as broad, usually 6–13.5 × 2–4.5 cm., usually glabrous on both surfaces except for scattered hairs on the principal venation, but sometimes copiously pilose beneath, prevailingly acute to obtuse at base, infrequently narrowly subcordate, usually subentire or undulate at margin but occasionally obviously crenulate, the secondary nerves usually 6–11; inflorescences simply racemose, only rarely paniculate with as many as 10 branches; Fiji. ..... 4. *M. pickeringii.*

Spreading hairs lacking on inflorescence-parts, these merely furfuraceous; leaf-blades glabrous beneath except for sparse indument on proximal parts of costa and secondaries (or occasionally soft-pilose on the lower surface in no. 5).

Leaf-blades prevailingly obovate-elliptic to ovate, usually 8–26 × 5–15 cm.,

comparatively broad, usually about twice as long as broad; petioles 15–45 mm. long.

Inflorescence-parts (rachis, bracts, pedicels, and calyx) copiously furfuraceous, the scales at anthesis usually congested, contiguous or overlapping, fimbriate-margined; prophylls inconspicuous, lanceolate- or ovate-deltoid, 0.5–1 mm. long and broad; calyx-lobes deltoid, 0.7–1 × 0.7–1.2 mm.; leaf-blades with comparatively inconspicuous secretory canals, these usually not apparent; Fiji to Samoa. ..... 5. *M. tabacifolia.*

Inflorescence-parts (rachis, bracts, pedicels, and calyx) with comparatively few and scattered scales, these not contiguous at anthesis nor obviously fimbriate; prophylls comparatively conspicuous, ovate, usually 1–1.4 mm. long and broad; calyx-lobes ovate, 0.8–1.2 × 1–1.5 mm.; leaf-blades with obvious secretory canals near lower surfaces; New Hebrides.

Leaf-blades rounded at base, rounded or broadly obtuse at apex. ..... 6. *M. eramangensis.*

Leaf-blades broadly obtuse at base, obtusely cuspidate at apex. ..... 7. *M. aubertii.*

Leaf-blades prevailingly lanceolate to oblong-elliptic, usually 4–13 × 1.5–5 cm., comparatively narrow, usually about 3 times as long as broad; petioles 5–27 mm. long. ..... 14. *M. persicifolia.*

Indument composed of minute scales only, without hairs (or, if hairs rarely present and visible on branchlets, then forming an obscure puberulence and less than 0.1 mm. long).

Leaf-blades usually 5–23 × 3–13 cm., comparatively broad, often about twice as long as broad, or if proportionately longer then rarely less than 4 cm. broad; petioles 10–45 mm. long.

Petioles narrowly winged in the distal half; leaf-blades obovate or lanceolate-elliptic, 8–17 × 4–9 cm., attenuate to obtuse at base and long-decurrent on the petiole; inflorescences appearing simply racemose and fasciculate but actually short-paniculate, composed of 2–5 elongate branches arising from a short, irregular rachis; Santa Cruz Islands and New Hebrides. ..... 8. *M. banksiana.*

Petioles not conspicuously winged, the leaf-blades usually short-decurrent on the petiole; inflorescences paniculate, with branches spreading from an elongate rachis, or simply racemose.

Inflorescences prevailingly paniculate but infrequently simply racemose; leaf-blades elliptic to ovate, not suborbicular, the marginal crenations often comparatively inconspicuous.

Secretory canals comparatively inconspicuous on lower leaf-surfaces.

Leaf-blades elliptic to ovate- or obovate-elliptic, obtuse at base, obtuse to obtusely short-acuminate at apex; inflorescences soon glabrate; New Hebrides.

Pedicels at anthesis and in fruit not exceeding 1 mm. in length, the prophylls conspicuous, 1–1.5 × 1–2 mm.; leaf-blades usually 12–17 × 8–13 cm., the basal margin conspicuously thickened. ..... 9. *M. nemoralis.*

Pedicels 1.5–2 mm. long at anthesis, 2–4 mm. long in fruit, the prophylls less conspicuous, 0.7–1 × 1–1.5 mm.; leaf-blades usually 6–14 × 3–8 cm., the basal margin less obviously thickened. ..... 10. *M. ambrymensis.*

Leaf-blades ovate-oblong to elliptic-lanceolate, usually acute to attenuate at base and gradually acuminate to cuspidate at apex, usually 8–23 × 3.5–9.5 cm.; inflorescences often persistently furfuraceous; pedicels to 2 mm. long, the prophylls comparatively inconspicuous, 0.4–1 mm. long and broad; Fiji. ..... 11. *M. insularis.*

Secretory canals sinuously copious and conspicuous near lower leaf-surfaces; leaf-blades ovate-elliptic to ovate-lanceolate, more than twice as long as broad, usually 9–21 × 4–9 cm., rounded to attenuate at base, cuspidate or short-acuminate at apex; Samoa. ..... 12. *M. samoana.*

Inflorescences often simply racemose but sometimes paniculate, the pedicels 1–4 mm. long; leaf-blades ovate to suborbicular, sometimes broadly elliptic, usually 5–14 × 4.5–11.5 cm., rounded to broadly obtuse at base, rounded (less often broadly obtuse or obtusely cuspidate) at apex, conspicuously crenulate at margin, with copious and conspicuous secretory canals near lower surfaces; eastern Fiji, Tonga, and eastern Samoa. ..... 13. *M. tongensis.*

Leaf-blades usually 4–13 × 1.5–5 cm., comparatively narrow, usually about 3 times as long as broad; petioles 5–35 mm. long; Fiji.

Indument-scales often subpersistent on inflorescence-parts; petioles narrowly winged distally; leaf-blades usually rounded to obtuse at base and abruptly short-decurrent on the petiole, the secondary nerves spreading, the lower surfaces without visible secretory canals or these immersed and not apparent, rarely faintly discernible; inflorescences usually paniculate, sometimes bipinnately so, with spreading branches, infrequently simply racemose, the pedicels often negligible but sometimes to 2.5 mm. long at anthesis and to 3 mm. long in fruit, the corolla-lobes inconspicuously glandular-lineolate. ..... 14. *M. persicifolia.*

Indument-scales evanescent, rarely persistent to anthesis on inflorescence-parts; petioles narrowly winged or cartilaginous-angled often nearly to base; leaf-blades attenuate to obtuse at base and long-decurrent on the petiole, the secondary nerves curved-ascending, the lower surfaces usually with conspicuous secretory canals but these sometimes immersed and not obvious; inflorescences often simply racemose but frequently paniculate and then usually with comparatively short and ascending branches, the pedicels obvious, usually 1.5–2.5 mm. (but sometimes only 0.5 mm.) long at anthesis and often to 3.5 mm. long in fruit, the corolla-lobes obviously and conspicuously glandular-lineolate. ..... 15. *M. vitiensis.*

1. **Maesa corylifolia** A. Gray in Proc. Amer. Acad. Arts **5**: 330. 1862; Seem. Viti, 438. 1862, Fl. Vit. 148. 1866; Horne, A Year in Fiji, 264. 1881; Mez in Pflanzenr. 9(IV. 236): 37. 1902; Gibbs in Jour. Linn. Soc. Bot. **39**: 155, p. p. 1909; J. W. Parham, Pl. Fiji Isl. 156. 1964. FIGURE 11.

Maesa macrophylla sensu Seem. in Bonplandia **9**: 257. 1861; non Wall.
Maesa corylifolia var. n. Horne, A Year in Fiji, 264. 1881.

Liana or scandent shrub to 5 m. high, with indument of two types: (1)

diaphanous, ferruginous, irregular scales about 0.1 mm. in diameter, and (2) spreading, translucent, ferruginous hairs 0.3–1 mm. long; branchlets slender, furfuraceous and persistently pilose, copiously lenticellate; petioles (7–) 10–30 mm. long, slender, shallowly canaliculate distally, copiously pilose; leaf-blades chartaceous, drying dark brown, ovate, (5–) 6–13 cm. long, (2.5–) 3.5–8.5 cm. broad, cordate at base or infrequently merely rounded and rarely broadly obtuse, cuspidate or short-acuminate and callose-mucronulate at apex, usually conspicuously crenulate-dentate at margin (crenations 2–4 per centimeter, callose-tipped), copiously and persistently soft-pilose on both surfaces or rarely eventually glabrate above except on nerves, the costa prominent beneath, the secondary nerves 5–7 per side, spreading, raised on both surfaces, the veinlet-reticulation immersed or prominulous beneath, the secretory canals not apparent; inflorescences axillary, solitary, broadly paniculate, often bipinnately so, only sporadically simply racemose, usually 4–15 cm. long and broad and with 5–15 spreading lateral branches, the rachis, branches, bracts, pedicels, prophylls, and calyx copiously pilose; peduncle to 2 cm. long, slender like the rachis, the branch-subtending bracts oblong, 1–2 mm. long, obtuse or rounded, glabrous within, the flower-subtending bracts similar, 0.5–1 mm. long; pedicels slender, 0.3–1.5 mm. long, the prophylls inconspicuous, oblong-deltoid, 0.4–0.7 mm. long, 0.2–0.5 mm. broad, obtuse, glabrous within; calyx-lobes deltoid, 0.6–0.8 mm. long and broad, acute, obscurely erosulous at margin, glabrous within; corolla 1.2–1.8 mm. long and 2–3 mm. in apical diameter, the tube shorter than the lobes, the lobes ovate-oblong, 0.8–1.2 mm. long and broad, rounded and strongly reflexed at apex, minutely erosulous at margin, inconspicuously glandular-lineolate; filaments and anthers each to 0.4 mm. long; ovary flattened-conical, the style minute, to 0.3 mm. long, inconspicuously lobed, the ovules usually 15–18, 2-seriate; fruits ovoid or subglobose, 2–3 mm. in diameter at maturity, often copiously furfuraceous, pilose at least distally and on the persistent calyx-lobes.

TYPE LOCALITY: Mathuata Province, Vanua Levu, Fiji; the type is a U.S. Exploring Expedition specimen, cited in the sequence below.

DISTRIBUTION: Endemic to Fiji, but thus far known only from the two large islands, Viti Levu and Vanua Levu, and also from Ovalau and Ngau. It is sometimes locally abundant, occurring at elevations from near sea-level to 1,150 m. in various types of forest and also in grassland thickets or on open hillsides. Individuals are often lianas but sometimes scrambling or scandent shrubs to 5 m. high. Corollas are noted as white to pale greenish yellow, often brown-lineolate; the filaments are pale greenish yellow and the anthers yellow; the ovary is orange-red, with a green stigma; and the fruits at maturity are dull waxy white.

LOCAL NAMES: The only dependable names, often generic in connotation, are *kutumirase* (on Viti Levu) and *kolo ni mbeka* (on Vanua Levu).

Other recorded names are *wa vatu* (Mba), *wa sinu* (Nandronga & Navosa), *ngingi* (Namosi), *vere* (Mathuata), and *kala mbu ndi wawa* (Thakaundrove).

Fiji. VITI LEVU: MBA: Mountains near Lautoka, *Greenwood 46* (K), *403* (K), *896* (A, K, NY, UC, US); between Nandala and Nukunuku Creeks, west of Nandarivatu, *Smith 6175* (A, BISH, K, US); Savundamatau Creek, west of Nandarivatu, *Webster & Hildreth 14252* (DAV, MASS); vicinity of Nandarivatu, *Gibbs 557* (BM, K), *Gillespie 3185* (BISH, UC), *Parks 20722* (BISH, SUVA, UC, US), *Tothill 344* (K), *Greenwood 846* (A, K), *Smith 6031* (A, BISH, K, NY, US); Mt. Nanggaranambuluta, *Gillespie 3679* (BISH, K, NY, UC), *Smith 4893* (A, BISH, K, US), *Fiji Dept. Agr. 13543* (BISH, SUVA); Mt. Tomanivi, *Smith 5219* (A, BISH, K, US). NANDRONGA & NAVOSA: Northern portion of Rairaimatuku Plateau, *Smith 5428* (A, BISH, K, NY, US), *5478* (A, BISH, K, US), *5587* (A, BISH, K, US). NAMOSI: Mt. Voma, *Fiji Dept. Agr. 945* (A, BISH, K, SUVA); vicinity of Namuamua, *Gillespie 2959* (BISH). REWA: Suva and vicinity, *Yeoward 6* (K), *Tothill 555* (BISH, K), *H. B. R. Parham 66* (BM). VITI LEVU, without further locality: *Graeffe 57* (BM). OVALAU: *Milne 263* (K); Mt. Koronimoko, *Smith 8073* (BISH, GH, K, SUVA, UC, US); north of Levuka, *Gillespie 3474* (BISH, UC). NGAU: *Milne 222* (K). VANUA LEVU: MATHUATA: *U. S. Expl. Exped.* (US 73887 holotype; isotypes at GH, K), *Seemann 288* (BM, GH, K); Seanggangga Plateau, *Smith 6638* (A, BISH, K, US), *Fiji Dept. Agr. 10486* (BISH, SUVA), *15199* (K, MASS, SUVA); vicinity of Lambasa, *Greenwood 519* (K); Mt. Numbuiloa, *Smith 6347* (A, BISH, K, US). THAKAUNDROVE: South of Nakula Valley, *Smith 349* (BISH, GH, K, NY, UC, US); between Urata and Valethi, *Degener & Ordonez 13824* (A, BISH, K, NY, UC, US). FIJI, without further locality: *Horne 167* (GH, K), *822* (GH, K).

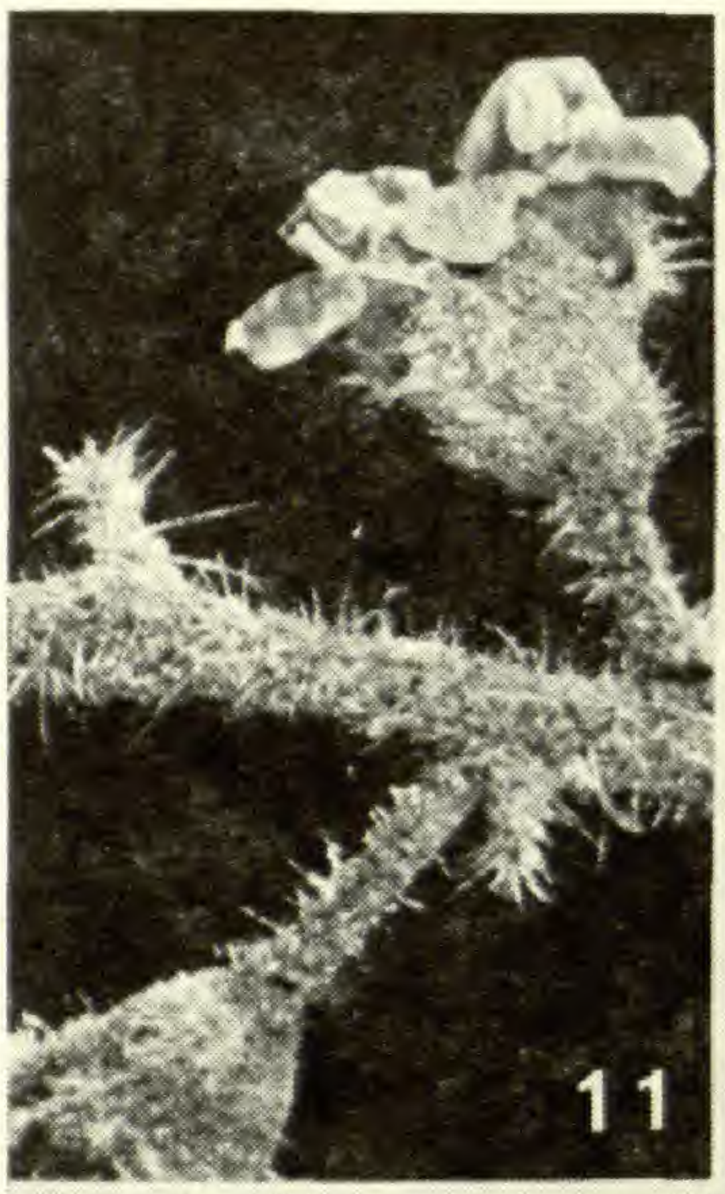
Although typically a distinct and unmistakable taxon, *M. corylifolia*, if reasonably interpreted, is seen to vary peripherally and to merge with other taxa. Among species with which it may occasionally be inter-fertile are *M. pickeringii* and *M. tabacifolia*; comments on such relationships are noted under those species.

2. **Maesa bennettii** Mez in Pflanzenr. 9(IV. 236): 53. 1902; Guillaumin in Bull. Soc. Bot. France 74: 700, as *M. bennetii*. 1927.

Shrub or small tree (?), with indument of simple spreading hairs and doubtless also of minute scales; branchlets thick, short-tomentose, the lenticels small and dense on older parts; petioles about 15 mm. long, the leaf-blades oval, about 9 cm. long and 6 cm. broad, cordate at base, broadly rounded at apex, entire (?) at margin, above eventually subglabrate, beneath shortly soft-tomentose and minutely ferruginous-punctate, without apparent secretory canals, the costa prominulous above and prominent beneath; inflorescences axillary, few-flowered, sparsely 2–4-branched, not

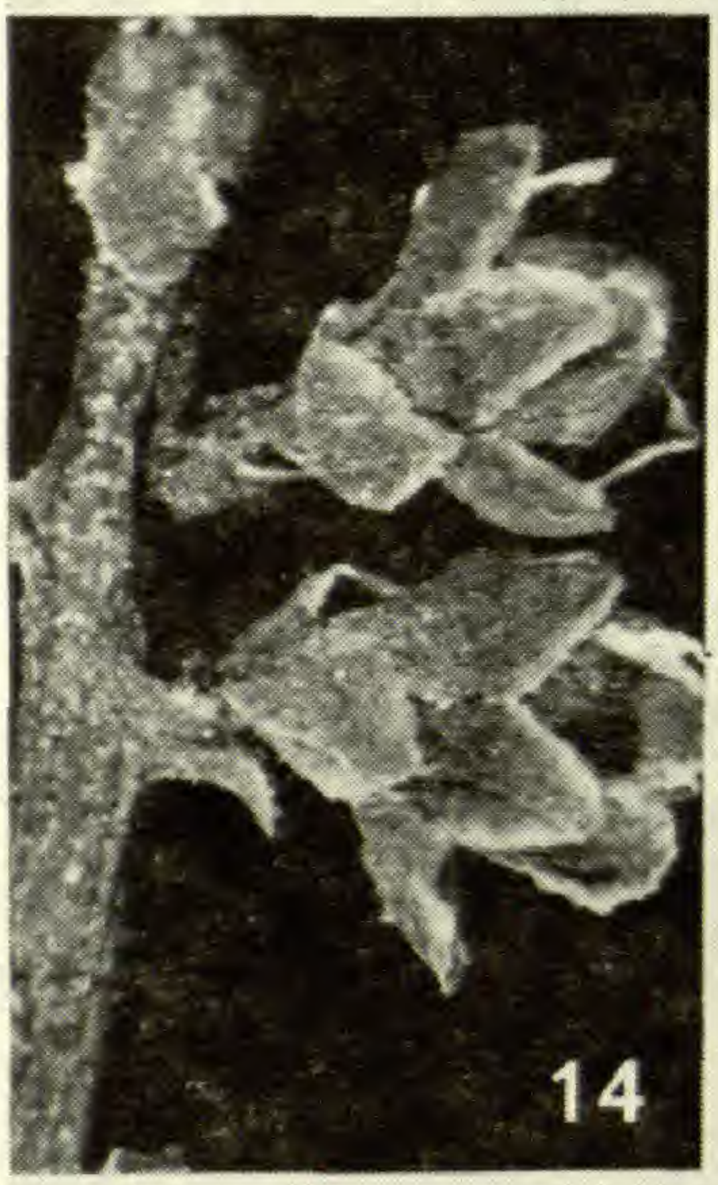
---

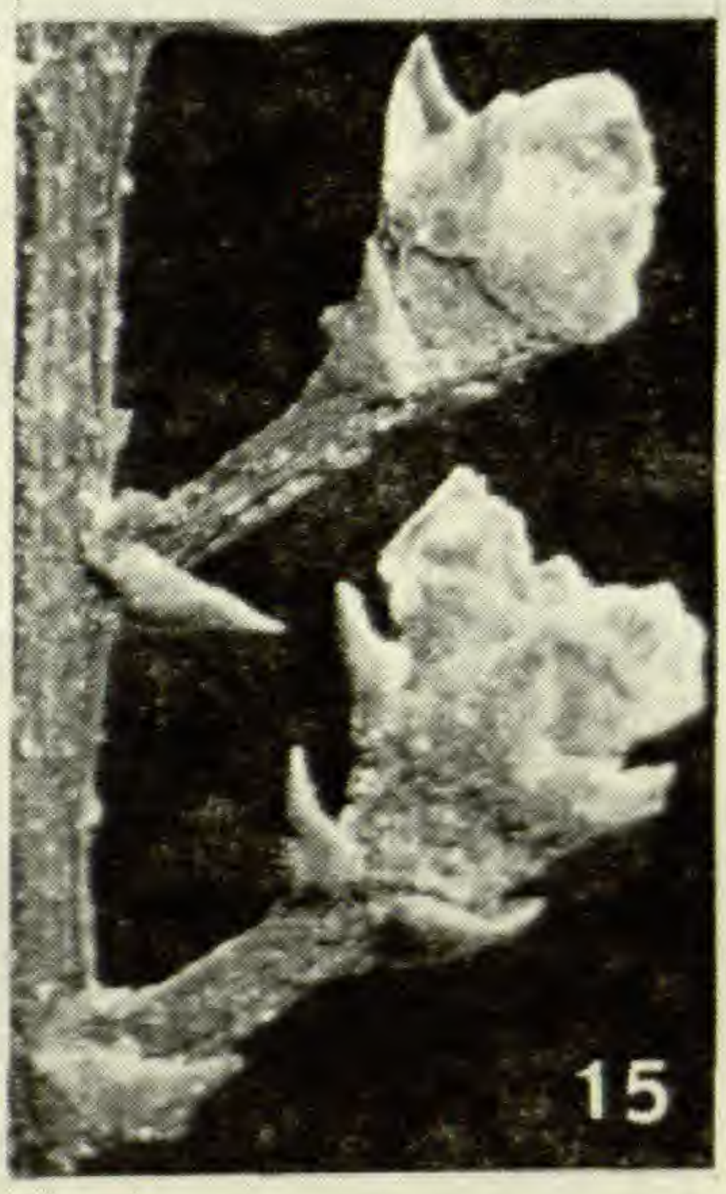
FIGURES 11–19. Flowers of *Maesa* spp., showing a portion of a rachis or inflorescence-branch, flower-subtending bracts, pedicels, and prophylls, all × 10. FIGURE 11. *M. corylifolia*: from *Smith 349*. FIGURE 12. *M. pickeringii*: from *Fiji Dept. Agr. 14763*. FIGURE 13. *M. tabacifolia*: from *Smith 8773*. FIGURE 14. *M. nemoralis*: from *Stone 2212*. FIGURE 15. *M. ambrymensis*: from *Aubert de la Rüe*, Aug. 1934. FIGURE 16. *M. insularis*: from *Smith 9060*. FIGURE 17. *M. tongensis*: from *Setchell & Parks 15630*. FIGURE 18. *M. persicifolia*: from *Degener 15037*. FIGURE 19. *M. vitiensis*: from *Webster & Hildreth 14093*.


11

12

13


14


15

16

17

18

19

much longer than the petioles, the branches tomentose; pedicels stout, about 0.5 mm. long, the prophylls large, forming a cymbiform or cupuliform receptacle below the calyx; flowers glabrous, about 3 mm. long, the calyx-lobes broadly ovate, round or subacute, without conspicuous glands, the corolla-tube subequal to lobes, these narrowly rounded, without obvious glandular lines; filaments and anthers subequal in length, the anthers dorsifixed, scarcely emarginate; style short, the stigma obtuse.

TYPE LOCALITY: Eromanga, New Hebrides; the type, collected by Bennett, was deposited in the Berlin herbarium and presumably has been destroyed. No isotypes or other collections were designated by Mez.

No material has been seen that might be referred to *M. bennettii*, which, on the basis of Mez's description and key, seems to be a reasonably distinct species; the above description is modified from the original treatment. Among New Hebridean species it seems closest to *M. aneiteensis*. From the Fijian *M. corylifolia* it would appear amply distinct in its rounded leaf-apex, compact inflorescences, large prophylls, and glabrous flowers.

3. **Maesa aneiteensis** Mez in Pflanzenr. 9(IV. 236): 52. *fig. 7, A–F.* 1902; Guillaumin in Bull. Soc. Bot. France 74: 700, as *M. aneitensis.* 1927.

Shrub or small tree, the young parts copiously lepidote-furfuraceous and also tomentose with spreading hairs 0.2–0.5 mm. long, the indument persistent on branchlets, leaves, and inflorescence-parts; branchlets slender, obviously lenticellate on older parts; petioles 25–35 mm. long, canaliculate; leaf-blades chartaceous, broadly ovate or suborbicular, 7–12.5 cm. long, 5–9.5 cm. broad, rounded at base and abruptly short-decurrent on the petiole, rounded or broadly obtuse and callose-tipped at apex, subentire or inconspicuously crenulate at margins (crenations 1 or 2 per centimeter, callose-tipped), glabrous or spreading-pilose on principal nerves above, uniformly soft-tomentose beneath or at least on principal nerves and otherwise sparsely pilose, the costa prominent beneath, the secondary nerves 6–8 per side, spreading, prominulous above, strongly elevated beneath, the veinlet-reticulation lax, inconspicuous, the secretory canals obvious on lower surface; inflorescences axillary, paniculate with several branches, 5–7 cm. long, the rachis, bracts, and pedicels copiously or sparsely tomentose; peduncle 4–12 mm. long, the branch-subtending bracts deltoid-lanceolate, 1.5–2 mm. long, acute, dorsally tomentose, the flower-subtending bracts similar, 1–1.5 mm. long; pedicels 1–1.5 mm. long, the prophylls conspicuous, ovate, 1–1.2 mm. long and broad, acute or obtuse, dorsally sparsely pilose; calyx-lobes broadly ovate, about 1 mm. long, slightly narrower, obtuse, obscurely erosulous at margin, dorsally pilose or glabrate, obviously glandular-lineolate; corolla 2–2.6 mm. long and about 2 mm. in apical diameter, the tube slightly shorter than the lobes, these ovate, 1.3–1.5 mm. long, 0.8–1.3 mm. broad, rounded at apex,

subentire or minutely erosulous at margin, glandular-lineolate; filaments 0.3–0.5 mm. long, the anthers 0.5–0.7 mm. long and broad; style short, obscurely lobed, the ovules 20–40, 3- or 4-seriate; fruits ovoid, 2–3 mm. long (immature?), with often pilose calyx-lobes.

TYPE LOCALITY: Aneityum, New Hebrides; the type is *Bennett 15*, the only collection cited by Mez, said to be deposited in the Geneva and Vienna herbaria.

DISTRIBUTION: Endemic to the New Hebrides and perhaps to the island of Aneityum. No adequate field-notes are at hand, but the M'Gillivray specimen is noted as a "small tree."

New Hebrides. ANEITYUM: *M'Gillivray 15* (BM, K).

The M'Gillivray material, with flowers and fruits, permits a slight amplification of Mez's description. The closest relationship of *M. aneiteensis* seems to be with *M. bennettii*, from which it differs in its longer petioles, its leaf-blades being merely rounded rather than cordate at base and with obvious secretory canals, and its more ample inflorescences. Future collections in the New Hebrides may well suggest that the two species do not merit maintenance.

4. **Maesa pickeringii** A. Gray in Proc. Amer. Acad. Arts **5**: 329. 1862; Seem. Viti, 438. 1862, Fl. Vit. 148. 1866; Horne, A Year in Fiji, 264. 1881; Mez in Pflanzenr. 9(IV. 236): 37. 1902; J. W. Parham, Pl. Fiji Isl. 158. 1964. FIGURE 12.

Maesa corylifolia sensu Gibbs in Jour. Linn. Soc. Bot. **39**: 155, p. p. 1909; non A. Gray.

Shrub or small tree or liana, the indument consisting of minute ferruginous scales and also of spreading hairs 0.2–0.6 mm. long; branchlets furfuraceous or also copiously pilose, often glabrate, abundantly lenticellate; petioles 7–25 mm. long, canaliculate, copiously or sparsely pilose or glabrate; leaf-blades chartaceous, often thick, lanceolate to oblong- or ovate-lanceolate, (5–) 6–13.5 cm. long, 2–4.5 (–5.5) cm. broad, broadly obtuse (rarely very narrowly subcordate) to acute at base and abruptly decurrent on the petiole, obtuse to obtusely acuminate at apex, subentire or undulate or crenulate at margin, glabrous on both surfaces or with a few hairs persisting on principal nerves or occasionally copiously pilose beneath, the costa plane or slightly raised above, prominent beneath, the secondary nerves 6–11 per side, curved-ascending, sharply elevated beneath, the veinlet-reticulation usually immersed, the secretory canals obscure or not apparent; inflorescences axillary, solitary or sometimes paired, 2–8 cm. long, simply racemose or with 2 or 3 lateral branches, infrequently truly paniculate but rarely with as many as 4–10 branches, the peduncle (to 1 cm. long), rachis, bracts, pedicels, and prophylls scattered-furfuraceous and sparsely or copiously pilose, the flower-subtending bracts

oblong-deltoid, subacute, 0.7–1.2 mm. long, glabrous within, the branch-subtending bracts similar but lanceolate and to 2.5 mm. long; pedicels slender, 0.5–2 mm. long, the prophylls inconspicuous, oblong-deltoid, 0.5–1 mm. long, about 0.5 mm. broad, acute; calyx usually spreading-pilose at least on lobes, rarely subglabrate, the lobes deltoid, 0.5–1 mm. long and broad, acute, obscurely erosulous at margin, inconspicuously glandular-lineolate; corolla 1.3–1.5 mm. long and 1.5–2 mm. in apical diameter, the tube subequal to the lobes, these oblong, about 0.7 × 0.6 mm., obtuse and reflexed at apex, obscurely erosulous at margin, inconspicuously glandular-lineolate; filaments and anthers each to 0.4 mm. long; ovary conical, the style to 0.3 mm. long, obscurely lobed, the ovules 15–20, usually 3-seriate; fruits ellipsoid, to 4.5 × 4 mm. at maturity, subpersistently furfuraceous and also sparsely pilose at least on the calyx-lobes.

TYPE LOCALITY: Viti Levu, Fiji; the type is a U.S. Exploring Expedition specimen, cited below. The US specimen (no. 49420) is a mixture, of which the left-hand portion precisely matches Gray's description and is to be taken as the holotype. The right-hand portion represents *M. persicifolia* A. Gray but apparently is not a part of the type material of that species.

DISTRIBUTION: Endemic to Fiji, but known only from Viti Levu and some of the smaller islands of the Lomaiviti group. It is recorded from near sea-level to about 850 m., in various types of forest or thickets or on open hillsides, as a shrub or small tree to 10 m. high or as a scrambling liana, with a white corolla.

Fiji. VITI LEVU: MBA: Mountains and hills near Lautoka, *Greenwood 901* (A, K), *1071* (A, BISH, K, NY, UC); Sambeto Range, *Vaughan 3208* (BM, K); Navoli, *Fiji Dept. Agr. 10889* (BISH, SUVA); Naloto Range, *Fiji Dept. Agr. 14763* (BISH, SUVA); vicinity of Nandarivatu, *Gibbs 556* (BM, K), *Parks 20507* (BISH, SUVA, UC, US), *20515* (BISH, UC, US), *Degener & Ordonez 13558* (A, BISH, K, NY, UC, US), *Fiji Dept. Agr. 8519* (BISH, MASS, SUVA); Mt. Nanggaranambuluta, *Fiji Dept. Agr. 2336* (A, SUVA). NANDRONGA & NAVOSA: Rairaimatuku Plateau, between Nandrau and Nanga, *Smith 5587a* (A, US). RA: Yanggara, *Greenwood 767A* (K); Ndombuilevu, *Fiji Dept. Agr. 1225* (A, BISH, SUVA). VITI LEVU, without further locality: *U. S. Expl. Exped.* (US 49420 p. p. holotype; isotypes at GH, K, NY). MAKONGAI: *Tothill 363* (K). WAKAYA: *Tothill 357* (BISH, K). FIJI, without further locality: *Fiji Dept. Agr. 3929* (BISH, SUVA).

In the sense of its nomenclatural type, *M. pickeringii* clearly differs from *M. corylifolia* in the less copious indument of both vegetative and inflorescence parts, the somewhat shorter petioles, the narrower leaf-blades that are prevailingly lanceolate rather than ovate, obtuse or acute rather than cordate at base, less obviously crenulate at margin, and with more numerous secondary nerves, and in having its inflorescences simply racemose rather than broadly paniculate. However, with the availability of abundant material of this complex from northwestern Viti Levu, where the interior forests give way to grassland and scrub thickets, it becomes

apparent that the two taxa intergrade in many respects. Occasional individuals with the typical leaf-shape and simply racemose inflorescences of *M. pickeringii* are found to have the soft-pilose leaf-blades usually associated with *M. corylifolia*. Populations occur in the vicinity of Nandarivatu that combine the typical indument and paniculate inflorescences of *M. corylifolia* with the narrower and obtuse based leaf-blades of *M. pickeringii*. I have cited collections as one or the other species; the strictly intermediate forms are comparatively few and need not obscure the generally satisfactory nature of the two taxa recognized by Gray.

5. **Maesa tabacifolia** Mez in Pflanzenr. 9(IV. 236): 51. 1902; Rechinger in Denkschr. Akad. Wiss. Wien **85**: 326. 1910; J. W. Parham, Pl. Fiji Isl. 158. 1964. FIGURES 10, 13.

Maesa indica sensu Seem. in Bonplandia **9**: 257. 1861; A. Gray in Bonplandia **10**: 36. 1862; non auctt.

Maesa nemoralis sensu Seem. Viti, 438, 1862, in Jour. Bot. **2**: 72. 1864, Fl. Vit. 148. 1866, 430. 1873; Horne, A Year in Fiji, 264. 1881; non A. DC.

Maesa grandis Gillespie in Bishop Mus. Bull. **74**: 5. *fig. 2*. 1930.

Maesa samoana sensu St. John & A. C. Sm. in Pacific Sci. **25**: 336. 1971; non Mez.

Shrub or small tree or liana, the indument composed of copious, ferruginous, minute, fimbriate-margined, irregular scales and also of pale spreading hairs 0.1–0.4 mm. long, the latter persistent but often inconspicuous on young branchlets, petioles, and proximal parts of the costa and secondaries of both surfaces of leaf-blades; branchlets slender, terete, abundantly but not conspicuously lenticellate; petioles 15–45 mm. long, canaliculate, often semiterete proximally; leaf-blades chartaceous, elliptic or ovate to obovate-elliptic, (7–) 8–26 cm. long, (3.5–) 5–15 cm. broad, rounded (or shallowly subcordate) to obtuse at base and abruptly decurrent on the petiole, obtuse to obtusely short-acuminate at apex and callose-apiculate, conspicuously or obscurely crenulate at margin (crenulations 1–3 per centimeter, callose-tipped), persistently (but often inconspicuously) pilose on the proximal parts of the costa and secondaries and infrequently soft-pilose on the lower surface, the costa flattened or slightly elevated above, prominent beneath, the secondary nerves 6–11 per side, spreading or subascending, sharply elevated beneath, the veinlet-reticulation often immersed, sometimes prominulous beneath and sparsely pilose, the secretory canals inconspicuous or not apparent; inflorescences axillary, solitary, usually 4–11 cm. long and paniculate with 3–12 spreading branches, rarely simply racemose, branched from base or with a slender peduncle to 1.5 cm. long, the rachis, bracts, pedicels, prophylls, and calyx copiously furfuraceous with congested scales, the rachis and branches rarely also minutely pilosulous; flower-subtending bracts oblong-deltoid, obtuse or acute, 0.5–1.5 mm. long, the branch-subtending bracts slightly larger or sometimes subfoliaceous; pedicels 0.5–2 mm. long, the prophylls inconspicuous, lanceolate- or ovate-deltoid, 0.5–1 mm. long and broad,

acute; calyx-lobes deltoid, 0.7–1 mm. long and slightly broader, acute, obscurely erosulous at margin, without obvious lineolate glands; corolla 1.5–1.8 mm. long and to 2.5 mm. in apical diameter, the tube subequal to the lobes, these ovate-oblong, 0.7–1.1 mm. long and 1–1.2 mm. broad, rounded and reflexed at apex, minutely erosulous, with usually obscure lineolate glands; filaments scarcely 0.2 mm. long, the anthers oblong-deltoid, about 0.3 mm. long; ovary conical, the style sometimes stout, to 0.4 mm. long, the stigma obscurely lobed, the ovules 10–15, 2- or 3-seriate; fruits ovoid or subglobose, about 4 mm. in diameter at maturity.

TYPE LOCALITY: Mez's citation was: "Viti Lewu und Matuku (Harvey, Horne, Moseley, Seemann n. 286)." He did not mention places of deposit, but all these annotated specimens are available. The Harvey collection is from Viwa Island, Tailevu Province, Viti Levu. The Horne specimens, unnumbered, are from "Rewa," by which Horne probably referred to the village of that name on Viti Levu. Moseley's specimen is from the island of Matuku. *Seemann 286*, the best of the collections, bears labels indicating "Viti Levu, July 1860" and "Somosomo, May 1860, at the waterfall." (As was then customary, Seemann's specimens were collated and numbered after the collection was returned to England, and therefore there are mixed localities and, unfortunately, occasional mixed taxa.) Nevertheless, I designate as the lectotype the two sheets of *Seemann 286* deposited at Kew; the locality must remain uncertain, as southeastern Viti Levu (where Seemann was in July 1860) and/or the vicinity of Somosomo, Taveuni. The K and GH sheets of *Seemann 286* also bear fragmentary portions of *M. persicifolia*, which Gray (in Proc. Amer. Acad. Arts **5**: 330. 1862) took to represent *M. nemoralis*.

Maesa grandis is typified by *Gillespie 2503*, from Namosi Province, Viti Levu, Fiji, as cited below.

DISTRIBUTION: Fiji (several islands), the Horne and Wallis Islands, and Samoa (at least Upolu and Apolima, reported from the latter island by Rechinger). It has been reported from altitudes of sea-level to 600 m., and from forest, thickets, or open hillsides. Usually recorded as a shrub or slender tree 1–7 m. high, the species also occurs as a liana; the corolla is noted as white to pale yellow, with faint purplish linear glands; the filaments are white and the anthers yellow; the gynoecium is noted as dull pink, and the mature fruit as dull white.

LOCAL NAMES AND USES: Recorded local names (most of which are perhaps not reliable) are: Fiji: *ngginggi* (Namosi), *ndawandawa i rakalavo* (Naitasiri), *matameranggginggi* (Tailevu), *kolo ni mbeka* (Thakaundrove), *vini* (Taveuni); Horne Islands: *uali*; Samoa (Upolu): *vi vao, vine, vine vao, laufia, masame*. It has been noted in Tailevu, Viti Levu, and on Futuna that the leaves are used medicinally.

Fiji. VITI LEVU: NAMOSI: Mt. Voma, trail from Namosi, *Gillespie 2503*, September 3, 1927 (BISH holotype of *M. grandis*; isotypes at BISH, K, NY, UC); Wainambua Creek, south of Mt. Naitarandamu, *Smith 8773* (BISH, GH, K, SUVA, UC, US). NAITASIRI: Waimano Creek, Wainimala Valley, *St. John 18180* (BISH,

K, SUVA, US). TAILEVU: Viwa Island, *Harvey*, Nov. 1855 (BM, GH); Navuloa, *Fiji Dept. Agr. 2717* (BISH, SUVA). REWA: Rewa Village (?), *Horne* (GH, K). VITI LEVU, without further locality: *Milne 14* (K). VITI LEVU and/or TAVEUNI: *Seemann 286*, p. p. (K lectotype; isolectotypes at BM, GH). KANDAVU: *Tothill 348* (BISH, K), *366* (K); Lutumatavoro, *Fiji Dept. Agr. 14928* (BISH, MASS, SUVA). NAIRAI: *Milne 184* (K), *Tothill 364* (K). VANUA LEVU: MATHUATA: Ndreketi Plantation, *Fiji Dept. Agr. 16965* (BISH, MASS, SUVA). THAKAUNDROVE: West of Mbutha Bay, Natewa Peninsula, *Smith 812* (BISH, GH, K, NY, UC, US). TAVEUNI: Vicinity of Waiyevo, *Gillespie 4632* (BISH, K, NY, UC, US); vicinity of Wairiki, *Gillespie 4664* (BISH); Mt. Manuka, east of Wairiki, *Smith 8181* (BISH, GH, K, SUVA, UC, US). MOALA: *Milne 129* (K). MATUKU: *Moseley* (K), *Bryan 240* (A, BISH, K, US), *250* (A, BISH, UC, US).

Horne Islands. FUTUNA: Vilo Malia, *Yen 412* (BISH). ALOFI: *Yen X20* (BISH).

Wallis Islands: *Védel*, in 1847 (P). UVEA: *Graeffe 29* (BM); Lac Lanutavake, *McKee 19899* (BISH, P).

Samoa. UPOLU: Lefaga, Tafagamanu, *Bristol 1956* (BISH); Lefaga, Savaia, *Bristol 2106* (BISH, K); Lefaga, Mata'utu, *Bristol 2399* (BISH); near Safata, *Rechinger 469* (BM, US). SAMOA, without further locality: *Whitmee* (BM, GH), *7* (K), *11* (K).

In describing *M. grandis*, Gillespie did not contrast it with any other species, and he erroneously indicated it as "glabrous." In fact, however, the type specimen is copiously but minutely pilose on its branchlets, petioles, and leaf-costa precisely as in typical *M. tabacifolia*. Gillespie's specimen has the leaf-blades rounded to shallowly subcordate at base, but it is well within the normal variation of *M. tabacifolia*.

Eastward of Fiji, *M. tabacifolia* has often been confused with the quite different *M. samoana*, which is now seen to be absent from the Horne and Wallis Islands. The occurrence of the former species in Samoa had been noted by Rechinger, but as a rule Samoan herbarium material has been indiscriminately placed with *M. samoana*.

The cited collections from most parts of Fiji, as well as those from Samoa and the Horne and Wallis Islands, are quite typical of *M. tabacifolia* in the sense of the specimens cited by Mez. However, material from Taveuni and the Natewa Peninsula of Vanua Levu represents a form with more abundant indument, the spreading hairs being sometimes copious on the lower surfaces of leaf-blades. These individuals suggest *M. corylifolia* in their indument, which may also extend sparsely to the rachis and branches of the inflorescence, although not to the calyx as characteristically in *M. corylifolia*. Additionally, these copiously pilose specimens of *M. tabacifolia* differ from *M. corylifolia* in having long-petiolate, larger leaf-blades with less obvious marginal crenations and with the base obtuse, or at least not obviously cordate as is characteristic for *M. corylifolia*.

6. **Maesa eramangensis** Mez in Pflanzenr. 9(IV. 236): 52. 1902; Guillaumin in Bull. Soc. Bot. France 74: 700, as *M. eromangensis*. 1927.

Shrub or small tree (?), the indument consisting of minute, ferruginous scales and also of pale, spreading hairs 0.2–0.4 mm. long, the latter subpersistent on young branchlets, petioles, and proximal parts of the costa

and secondaries of both surfaces of leaf-blades; branchlets at first subangular, becoming terete, copiously lenticellate; petioles 22–30 mm. long, shallowly canaliculate; leaf-blades submembranous, elliptic, 9–11 cm. long, 5.5–7.5 cm. broad, rounded at base and abruptly decurrent on the petiole, rounded or broadly obtuse and sometimes inconspicuously emarginate at apex, subentire or obscurely crenulate at margin, the costa slightly elevated above, prominent beneath, the secondary nerves 6–8 per side, spreading, curved, plane or prominulous above, sharply elevated beneath, the veinlet-reticulation plane or immersed above, prominulous beneath, the secretory canals obvious beneath; inflorescences axillary, solitary, paniculate, sometimes bipinnately so, 5–7 cm. long, with 2–4 (or more?) spreading branches, the slender rachis and peduncle (usually 1–1.5 cm. long) with scattered scales, the branch- and flower-subtending bracts oblong-deltoid, 1–1.8 mm. long, acute; pedicels 1–2 mm. long, like the prophylls and calyx dispersed-lepidote, the prophylls ovate, 1–1.3 mm. long, 0.8–1.2 mm. broad, acute, sparsely glandular-lineolate, obscurely ciliolate at margin; calyx-lobes ovate, 0.8–1.2 × 1–1.5 mm., acute or obtuse, obscurely erosulous at margin, glandular-lineolate; corolla about 2 mm. long and 2–2.5 mm. in apical diameter, the tube subequal to the lobes, these ovate-oblong, 1–1.3 mm. long, rounded (or subacute?), obscurely erosulous at margin, conspicuously glandular-lineolate; filaments about 0.3 mm. long, the anthers oblong, 0.4–0.5 mm. long; style slender, 0.2–0.4 mm. long, the stigma obscurely lobed, the ovules 25–30, 4- or 5-seriate.

TYPE LOCALITY: Eromanga, New Hebrides; the type and only material cited by Mez is an unnumbered Bennett collection, said to be deposited in the Geneva and Vienna herbaria.

DISTRIBUTION: Endemic to the New Hebrides and perhaps to the island of Eromanga. No descriptive field-notes are available; the excellent flowering specimen cited below was collected in May 1896.

New Hebrides. EROMANGA: Dillon Bay, *Morrison* (K).

The Morrison specimen agrees well with Mez's description and permits a slight broadening of it. From the allied *M. tabacifolia*, *M. eramangensis* differs in having its leaf-blades rounded or very broadly obtuse at apex and with obvious secretory canals near the lower surface, its inflorescence-parts with widely dispersed rather than contiguous scales, its prophylls comparatively conspicuous, its calyx-lobes proportionately broader, its corolla with more conspicuous glandular lines, and, on the basis of the material examined, its ovules more numerous.

7. **Maesa aubertii** Guillaumin in Bull. Soc. Bot. France **82**: 350. 1935.

Shrub or small tree (?), the indument consisting of minute, irregular, ferruginous scales about 0.1 mm. in diameter and also of spreading, simple hairs 0.1–0.2 mm. long, the latter profusely persistent on young branchlets, petioles, and proximal parts of leaf-costas; branchlets slender, subterete,

copiously pale-lenticellate; petioles 30–40 mm. long, slender, canaliculate; leaf-blades chartaceous, broadly ovate, 10–13.5 cm. long, 6–9 cm. broad, broadly obtuse and thick-margined at base and abruptly decurrent on the petiole, obtusely cuspidate at apex, inconspicuously crenulate at margin, the costa sharply raised above, prominent beneath, tardily subglabrate, the secondary nerves 5–8 per side, subspreading, slightly prominulous on both sides or plane above, sometimes proximally pilose beneath, the veinlet-reticulation lax, immersed above, prominulous beneath, the secretory canals obvious beneath; inflorescences axillary, solitary, paniculate, 3–8 cm. long, with few, ascending branches and many flowers, the slender rachis, peduncle (1–1.5 cm. long), bracts, pedicels, prophylls, and calyx dispersed-lepidote, the branch- and flower-subtending bracts oblong-deltoid, 0.8–2 mm. long, acute; pedicels 1–1.5 mm. long, the prophylls ovate, 1–1.4 mm. long and broad, acute, minutely erosulous and sparsely glandular at margin; calyx-lobes ovate, 1–1.2 mm. long and broad, obtuse, minutely erosulous at margin, glandular-lineolate; corolla about 1.6 mm. long and 2 mm. in apical diameter, the lobes oblong, about 1 × 1 mm., rounded and recurved at apex, minutely erosulous at margin, conspicuously glandular-lineolate; filaments about 0.2 mm. long, the anthers deltoid, about 0.4 mm. long; style about 0.5 mm. long, the stigma rounded, the ovules about 30, 4-seriate; fruits subglobose, about 3 mm. in diameter, inconspicuously dispersed-lepidote.

TYPE LOCALITY: From Guillaumin's citation it is not clear that he was aware that two collections of M. & Mme. Aubert de la Rüe were included among the three sheets available at Paris. One of these was obtained on Ambrim in August 1934, the other two on Sakau Island in the Maskelyne Islands, just southeast of Malekula Island, also in August 1934. Although the latter collection is better, the first bears an excellent drawing and, except for the final word "Sakau," is the specimen described in Guillaumin's citation. Therefore I designate as the lectotype the Aubert de la Rüe specimen from Ambrim.

DISTRIBUTION: Endemic to the New Hebrides and thus far known only from the collections mentioned above, from Ambrim and the Maskelyne Islands. The former was obtained on volcanic cinders near an active volcano, at an altitude of 600–700 m.; the latter lacks field data.

New Hebrides. AMBRIM: Near the active volcano, *Aubert de la Rüe*, August 1934 (P lectotype). MASKELYNE ISLANDS: Sakau Island, *Aubert de la Rüe* (P).

Maesa eramangensis and *M. aubertii* are keyed together by Guillaumin (in Bull. Soc. Bot. France 82: 351. 1935), being separated by the former having erect and subacute corolla-lobes, and the latter reflexed and rounded corolla-lobes. Mez also indicates in his key that *M. eramangensis* has "petala acutiuscula," but in my observation the corolla-lobes in *Maesa* in our area are never really acute, and this character would appear undependable. On the basis of the available material I retain *M.*

aubertii as distinct because of its slightly longer petioles, obtuse rather than rounded leaf-base, and conspicuously cuspidate rather than usually rounded leaf-apex. These are certainly very questionable characters, but the two taxa have discrete distributions, and the material of *Maesa* from the New Hebrides is so sparse that I refrain from combining concepts without very positive evidence.

8. **Maesa banksiana** Guillaumin in Jour. Arnold Arb. **14**: 58. 1933.

Maesa pentecostes Guillaumin in Bull. Mus. Hist. Nat. Paris II. **9**: 293. 1937.

Small tree, to 10 m. high, the young parts copiously furfuraceous with minute, irregular, ferruginous scales about 0.1 mm. in diameter, these subpersistent on some inflorescence parts; branchlets slender, slightly angled distally, soon subterete and glabrate, copiously lenticellate; petioles 10–25 mm. long, semiterete or shallowly canaliculate, narrowly winged in the distal half; leaf-blades chartaceous, obovate or lanceolate-elliptic, 8–17 cm. long, 4–9 cm. broad, attenuate to obtuse at base and long-decurrent on the petiole, obtuse to obtusely short-acuminate at apex, inconspicuously crenulate at margin (crenations 1 or 2 per centimeter, callose-tipped), the costa elevated above, prominent beneath, the secondary nerves 5–7 per side, subascending, raised on both surfaces, the veinlet-reticulation copious, prominulous or immersed on both surfaces, the secretory canals usually obvious; inflorescences axillary or lateral above leaf-scars, short-paniculate, the branches 2–5, slender, spreading or ascending, 2–7 cm. long, congested on a very short, irregular rachis 1–5 mm. long, this copiously furfuraceous, the branch-subtending bracts thick, oblong, to 1.5 mm. long, copiously furfuraceous, rounded at apex, the flower-subtending bracts ovate-deltoid, 0.5–0.7 mm. long, acute, glabrate; pedicels 0.5–1.5 mm. long, the prophylls ovate-deltoid, 0.5–1 mm. long and broad, acute, minutely erosulous and sparsely glandular at margin; calyx dispersed-lepidote, the lobes ovate-deltoid, 0.8–1 mm. long and broad, rounded or obtuse, obscurely erosulous at margin, sparsely or obviously glandular-lineolate; corolla 1.5–2 mm. long at anthesis, the tube subequal to lobes, these ovate, 0.8–1 mm. long, rounded, obscurely erosulous at margin, inconspicuously glandular-punctate or short-lineolate; filaments 0.4–0.5 mm. long, the anthers oblong, subequal to filaments in length; free part of ovary conical, the style stout, 0.2–0.5 mm. long, the stigma obscurely lobed, the ovules 8–12, 2- or 3-seriate.

TYPE LOCALITY: Vanua Lava, Banks Islands, New Hebrides; the type is *Kajewski 456*. The type of *M. pentecostes* was collected by M. and Mme. Aubert de la Rüe on Pentecost Island, New Hebrides, in 1935.

DISTRIBUTION: Endemic to the Santa Cruz Islands and the New Hebrides and thus far known only from three islands between Vanikoro and Pentecost. It has been collected in rain-forest or in secondary forest from near sea-level to 510 m.; Kajewski notes it as a common small tree 8–10 m. high on Vanikoro and Vanua Lava, with a white corolla.

LOCAL NAME AND USE: The de la Rüe specimen records the local name *matpuas*, and indicates that flowers are placed on the crowns of coconut trees to insure an abundant harvest.

Santa Cruz Islands. VANIKORO: *Kajewski 552* (A, BISH, K, UC, US)
New Hebrides. VANUA LAVA, Banks Group: *Kajewski 456*, July 12, 1928 (A holotype; isotypes at A, BISH, K, P, US). PENTECOST: Axial zone of island between Taaling and Lalak, December 6, 1935 (P holotype of *M. pentecostes*).

Maesa banksiana is amply distinguished from the other species of our area by having its inflorescences with a very short rachis and elongate branches, suggesting a fasciculate cluster of simple racemes; however, they seem better described as short-paniculate. The leaf-blades are long-decurrent on the petiole, which is narrowly but obviously winged in the distal half. A comparison of the two type collections discloses no consequential differences. That of *M. pentecostes* has the more mature inflorescences, while the type of *M. banksiana* has slightly longer petioles and a more conspicuously attenuate leaf-base.

9. **Maesa nemoralis** (J. R. & G. Forst.) A. DC. in Trans. Linn. Soc. **17**: 134. 1834, in DC. Prodr. **8**: 79. 1844; Mez in Pflanzenr. 9(IV. 236): 53. 1902; St. John in Naturaliste Canad. **98**: 573. 1971.
FIGURE 14.

Baeobotrys nemoralis J. R. & G. Forst. Char. Gen. Pl. 11. *t. 11.* 1775, ed. 2. 22. *t. 11.* 1776; Forst. f. Fl. Ins. Austr. Prodr. 16. 1786; Vahl, Symb. Bot. **1**: 19, as *Baeobothrys n.* 1790; Spreng. Syst. Veg. **1**: 760. 1824.
Maesa baeobotrys R. & S. Syst. Veg. **5**: 226, as *Maasa b.* 1819 (1820?).
Maesa efatensis Guillaumin in Bull. Soc. Bot. France **66**: 272. 1920, in op. cit. **74**: 700. 1927, in Jour. Arnold Arb. **13**: 12. 1932.
Maesa tabacifolia sensu Guillaumin in Bull. Soc. Bot. France **74**: 700. 1927; non Mez.
Maesa aubertii sensu Guillaumin in Jour. Linn. Soc. Bot. **51**: 556. 1938; non sensu typi.

Shrub or tree to 20 m. high, the young parts copiously but minutely furfuraceous with irregular scales less than 0.1 mm. in diameter, the indument persisting for a time on some inflorescence parts but in general fugacious; branchlets slender, soon terete, obviously or inconspicuously lenticellate; petioles 15–45 mm. long, often robust, shallowly canaliculate; leaf-blades chartaceous, becoming thick, elliptic to ovate- or obovate-elliptic, (6–) 12–17 cm. long, (4–) 8–13 cm. broad, obtuse at base and abruptly short-decurrent on the petiole, conspicuously thickened on the basal margin, obtuse or obtusely cuspidate at apex, narrowly recurved and thickened and inconspicuously crenulate at margin (crenations 1–3 per centimeter, callose-thickened), often copiously but minutely glandular beneath and with inconspicuous secretory canals, the costa plane or slightly raised above, prominent beneath, the secondary nerves 6–8 per side, ascending or subspreading, inconspicuous or impressed above, sharply raised

beneath, the veinlet-reticulation irregular, immersed above, plane or prominulous beneath; inflorescences axillary or lateral above leaf-scars, solitary, paniculate, 3–9 cm. long and broad, with (1–) 3–8 ascending lateral branches (very rarely simply racemose), many-flowered, the peduncle (to 1.2 cm. long), rachis, branches, bracts, pedicels, and prophylls copiously or sparsely furfuraceous at anthesis, at length glabrate; rachis slightly flattened or angled, the branch-subtending bracts oblong- or lanceolate-deltoid, 1.5–4 mm. long, acute, the flower-subtending bracts 1–1.5 mm. long; pedicels often stout, 0.3–1 mm. long, the prophylls conspicuous, broadly ovate, 1–1.5 mm. long, 1–2 mm. broad, acute or obtuse, obscurely erosulous at margin, inconspicuously glandular-lineolate or punctate; calyx-lobes ovate-deltoid, 1–1.2 mm. long and broad, obtuse, entire or obscurely erosulous at margin, sparsely glandular-lineolate; corolla about 2 mm. long and 2–3 mm. in apical diameter, the tube short, the lobes ovate or oblong, 1–1.5 mm. long and broad, rounded and recurved, minutely erosulous at margin, obviously glandular-lineolate; filaments 0.3–0.4 mm. long, the anthers oblong, about 0.5 mm. long; free part of ovary ovoid, the style stout, 0.2–0.4 mm. long, the stigma obtuse-rounded, the ovules 25–30, 3–5-seriate; fruits ellipsoid or subglobose, about 4 mm. in diameter at maturity.

TYPE LOCALITY: Tana, New Hebrides. Three Forster specimens are available in the herbarium of the British Museum; the best of these, probably from the Banksian herbarium, bears the inscription "Tanna," and I have indicated this sheet as the lectotype. A second sheet, from G. Forster's herbarium, and a third, from the Pallas herbarium, bear detached leaves and portions of inflorescences. A fourth sheet (BM), indicated as collected by W. Anderson on Tana in 1774, is probably part of the original material. There is also available at Kew a Forster sheet obtained from the Liverpool Botanic Garden. The type of *M. efatensis* is a David Levat specimen collected at Vila, Efate, New Hebrides, in December 1883.

DISTRIBUTION: Endemic to the New Hebrides and now known from several islands. It has been noted at elevations from sea-level to 300 m. in coastal thickets or rain-forest, as a shrub or tree to 20 m. high; the corolla is indicated as yellow and the fruit as pink to cream-colored at maturity.

LOCAL NAMES: The following names have been recorded once each: *nadherak* (on Espiritu Santo); *na damami* (on Nguna, just north of Efate); and *naamam* (on Efate, by Levat).

New Hebrides. ESPIRITU SANTO: Hog Harbour, *I. & Z. Baker 333* (BM). NGUNA: Near summit of Mt. Mawasi, *Stone 2212* (BISH, US). EFATE: Undine Bay, *Morrison*, Aug. 18, 1896 (K); Vila, *Levat*, December 1883 (P holotype of *M. efatensis*). TANA: *J. R. & G. Forster* (BM lectotype; isolectotypes at BM, K), *Anderson*, in 1774 (BM), *Schmid 3260* (P); Lenakel, *Kajewski 9* (A, K, NY, P). ANEITYUM: Anelgauhat Bay, *Kajewski 792* (A, BISH, K, NY, P, US).

Maesa nemoralis, the only species of the Forsters' genus *Baeobotrys*, is

well characterized by its lack of a pilose indument, its large leaf-blades conspicuously thickened at the basal margins and short-decurrent on usually long and stout petioles, and its short pedicels with conspicuous prophylls. In his monograph, Mez unaccountably keyed and described *M. nemoralis* as having terminal, bipinnately paniculate inflorescences, although in fact these are always axillary and simply paniculate (even rarely racemose). Probably this treatment led Guillaumin to redescribe as *M. efatensis* what is clearly the same taxon, as suggested by remarks in his original protologue and also by his key in Bull. Soc. Bot. France **82**: 351. 1935.

10. **Maesa ambrymensis** Guillaumin in Bull. Soc. Bot. France **82**: 350. 1935, in Bull. Mus. Hist. Nat. Paris II. **9**: 292. 1937, in Jour. Linn. Soc. Bot. **51**: 556. 1938. FIGURE 15.

Shrub or small tree, the young parts copiously furfuraceous with minute, irregular, ferruginous scales, these subpersistent on some inflorescence parts but the plant soon glabrate throughout; branchlets subterete, copiously pale-lenticellate; petioles slender, canaliculate, 13–40 mm. long; leaf-blades chartaceous, elliptic-ovate, (4.5–) 6–14 cm. long, (2.5–) 3–8 cm. broad, broadly obtuse to subacute at base and abruptly decurrent on the petiole, obtusely cuspidate or short-acuminate at apex, crenulate at margin, often conspicuously so (crenations 1–3 per centimeter, callose-apiculate), dispersed-glandular beneath and with inconspicuous secretory canals, the costa plane above or proximally slightly elevated, prominent beneath, the secondary nerves 5–8 per side, subascending, plane above, prominulous beneath, the veinlet-reticulation lax, immersed above, plane or prominulous beneath; inflorescences axillary, solitary, 3–11 cm. long and broad, usually paniculate with 2–7 spreading branches, rarely simply racemose, very rarely partially bipinnately paniculate, many-flowered, the peduncle (to 2.5 cm. long) and slender rachis and branches essentially glabrous at anthesis, the branch-subtending bracts oblong-deltoid, 1–2.5 mm. long, acute, sparsely and minutely glandular at margin, the flower-subtending bracts similar but 0.5–1 mm. long; pedicels slender, 1.5–2 mm. long at anthesis and 2–4 mm. long in fruit, the prophylls ovate-deltoid, 0.7–1 mm. long, 0.7–1.5 mm. broad, acute, obscurely erosulous and sparsely or copiously glandular at margin; calyx-lobes ovate-deltoid, 0.8–1 mm. long and broad, subacute, obscurely erosulous and glandular at margin, glandular-lineolate; corolla about 1.5 mm. long and 2.5 mm. in apical diameter, the tube short, the lobes oblong, 0.8–1.2 mm. long and broad, rounded, minutely erosulous at margin, glandular-lineolate; filaments about 0.2 mm. long, the anthers deltoid, about 0.3 mm. long; free part of ovary ovoid, the style slender, about 0.5 mm. long, the stigma obscurely lobed, the ovules about 20, 3- or 4-seriate; fruits ovoid or subglobose, about 4 × 3.5 mm. at maturity.

TYPE LOCALITY: Ambrim, New Hebrides; the type was obtained by M. & Mme. Aubert de la Rüe in August 1934. There are three sheets of this

collection at Paris, all with the same label data and all annotated by Guillaumin, one with a drawing. None of these is very ample, and I believe that they should be taken collectively as the holotype.

DISTRIBUTION: Endemic to the New Hebrides and known from three of the islands. The species is noted as a shrub or small tree occurring at elevations of 300–1,525 m., in mossy forest (on Espiritu Santo), on volcanic cinders near an active volcano (on Ambrim), or in cliff-thickets (on Tana); the corolla and fruit have been recorded as white.

New Hebrides. ESPIRITU SANTO: Mt. Tabwemasana, *I. & Z. Baker 32* (BM). AMBRIM: Near the active volcano, *Aubert de la Rüe*, August 1934 (P *holotype*); Mont Toüo, *Aubert de la Rüe*, Jan. 5, 1936 (P); on a plateau, *Aubert de la Rüe*, Jan. 8–11, 1936 (P). TANA: Near center, *Schmid 3261* (P).

Maesa ambrymensis is a close relative of *M. nemoralis*, differing in having its leaf-blades averaging considerably smaller and lacking conspicuous marginal thickenings at the base; its pedicels are more slender and longer than those of *M. nemoralis* and bear smaller and less conspicuous prophylls. Additionally, on the basis of the available material, the bracts, prophylls, and calyx-lobes of *M. ambrymensis* bear inconspicuous marginal glands, its flowers are smaller, and its ovules are fewer. While none of these differences are very striking, I believe that the two species may be maintained as distinct, even though both occur at least on Espiritu Santo and Tana. Field notes suggest that *M. nemoralis* is a low elevation, often littoral plant, while *M. ambrymensis* occurs only in uplands away from the coasts.

11. **Maesa insularis** Gillespie in Bishop Mus. Bull. **74:** 6. *fig. 3.* 1930. FIGURES 1, 2, 16.

Maesa samoana sensu A. C. Sm. in Bishop Mus. Bull. **141:** 120. 1936; J. W. Parham, Pl. Fiji Isl. 158. 1964; non Mez.

Liana or shrub or slender tree to 10 m. high, then often with scandent branches, the young parts copiously ferruginous-furfuraceous with irregular scales about 0.1 mm. in diameter, these usually long-persistent on inflorescence parts, the vegetative parts usually soon glabrate; branchlets slender, subterete, sparsely or copiously pale-lenticellate; petioles 12–40 mm. long, slender, canaliculate, conspicuously so and narrowly winged distally; leaf-blades chartaceous, often becoming subcoriaceous, elliptic- or ovate-lanceolate or ovate-oblong, 8–23 cm. long, 3.5–9.5 (–13) cm. broad, usually acute to attenuate at base, sometimes obtuse, rarely rounded or shallowly subcordate, decurrent on the petiole, gradually acuminate or cuspidate (with an acumen 1–2 cm. long and callose-apiculate) at apex, rarely obtuse, inconspicuously undulate-crenulate at margin, the costa plane above or proximally slightly raised, prominent beneath, the secondary nerves 5–11 per side, curved, spreading or subascending, slightly elevated above and sharply so beneath, the veinlet-reticulation immersed or plane, sometimes prominulous beneath, the secretory canals inconspicuous

or not apparent, only rarely obvious beneath; inflorescences axillary, solitary, paniculate, often copiously and occasionally bipinnately so, 4–13 cm. long, 4–8 cm. broad, with 5–15 (–20) spreading branches, many-flowered, branched near base or with a peduncle to 2.5 cm. long, the rachis, branches, bracts, pedicels, prophylls, and calyx copiously furfuraceous, tardily subglabrate; branch-subtending bracts deltoid or lanceolate, obtuse or acute, 0.6–2 mm. long, the flower-subtending bracts similar but smaller; pedicels 0.3–2 mm. long in flower and fruit, the prophylls inconspicuous, deltoid to lanceolate, 0.4–1 mm. long and broad, acute, minutely erosulous and sparsely glandular at margin; calyx-lobes lanceolate-deltoid, 0.5–1 mm. long and broad, acute, minutely erosulous at margin, often obscurely glandular-lineolate; corolla 1.2–1.5 mm. long, 1.5–2 mm. in apical diameter, the lobes oblong-ovate, 0.6–1.2 mm. long and broad, rounded and reflexed, obscurely erosulous at margin, copiously glandular-lineolate; filaments 0.2–0.3 mm. long, the anthers oblong, to 0.4 mm. long; free part of ovary conical, tapering into a stout obtuse style about 0.2 mm. long, the ovules about 20, 3- or 4-seriate; fruits subglobose and about 3 mm. in diameter at maturity.

TYPE LOCALITY: Vicinity of Nasinu, Naitasiri Province, Viti Levu, Fiji; the type is *Gillespie 3479*, cited in the sequence below.

DISTRIBUTION: Endemic to Fiji but locally abundant on several of the islands, at elevations from near sea-level to 1,000 m. Habitats recorded include forest from lowlands to high ridges, thickets along beaches or in grassland, etc. The species is usually noted as a liana but sometimes as a shrub or slender tree to 10 m. high, and then often with subscandent branches; the corolla is white to greenish yellow, with pink or purple to brownish glandular lines; the filaments are white and the anthers yellow; the ovary is deep red to rich pink; and the fruits become white at maturity.

LOCAL NAMES: *Kutumirase* (in Mba) and *kolo ni mbeka* (in Mathuata) have been noted, but these are apt to be generic in those areas; a name recorded on Kandavu is *vorovorokuro*.

Fiji. VITI LEVU: MBA: Nggaliwana Creek, near Navai, *Smith 5343* (A, BISH, K, NY, US); vicinity of Tumbenasolo, *Smith 4614* (A, BISH, K, US). NAMOSI: Mt. Naitarandamu, *Gillespie 3116* (BISH, UC, US); between Mt. Naitarandamu and Korombasambasanga Range, *Smith 8476* (BISH, GH, K, SUVA, UC, US); vicinity of Namosi, *Gillespie 2832* (BISH); near Namuamua, *Smith 9060* (BISH, GH, K, SUVA, UC, US); Wairoro Creek and vicinity of Mau, *Fiji Dept. Agr. 3827* (BISH, K, MASS, SUVA), *12903* (BISH, MASS, SUVA). SERUA: Between Navua River and Wainiyavu Creek, *Smith 9016* (BISH, GH, K, UC, US); between Ngaloa and Korovou, *Smith 9250* (US). NAITASIRI: Rairaimatuku Plateau, between Mt. Tomanivi and Nasonggo, *Smith 6101* (A, BISH, K, NY, US); Viria, *Meebold 16517* (BISH); Navuso, *Fiji Dept. Agr. 12600* (BISH, SUVA); Tholo-i-suva, *Fiji Dept. Agr. 11577* (BISH, SUVA), *Fiji Dept. For. 439* (*Bola 134*) (K, SUVA); Tamavua-Sawani Road, *Setchell & Parks 15084* (BM, UC); vicinity of Tamavua, *Gillespie 2150* (BISH, UC); Central Road, *MacDaniels 1136* (K); vicinity of Nasinu, Oct. 23, 1927, *Gillespie 3479* (BISH holotype; isotypes at BISH, NY, UC), *3531* (BISH, K, UC).

KANDAVU: Hills above Namalata and Ngaloa Bays, *Smith 57*, *69*, *80*, *118* (all BISH, GH, K, NY, UC, US); Onoriki, *Fiji Dept. Agr. 14953* (SUVA, UC). OVALAU: West of Levuka, *Gillespie 4434* (BISH, UC). VANUA LEVU: MATHUATA: Near Mbatiri, *Fiji Dept. Agr. 13092*, p. p. (BISH, SUVA); Vuniwambua, *Fiji Dept. Agr. 12929* (BISH, K, SUVA); vicinity of Natua, *Smith 6688* (A, BISH, K, US); Mathuata coast, *Greenwood 588* (K), *588A* (K); Mt. Numbuiloa, *Smith 6448*, *6556* (both A, BISH, K, US). THAKAUNDROVE: Yanawai River basin, *Degener & Ordonez 14102* (A, BISH, K, US); Mt. Nasorolevu, *Fiji Dept. Agr. 17155* (BISH, SUVA); Savundrondro, *Fiji Dept. Agr. 13166* (BISH, K, SUVA); vicinity of Korotasere, *Fiji Dept. Agr. 15488* (MASS, SUVA). VANUA LEVU, without further locality: *H. B. R. Parham*, in 1932 (BM). TAVEUNI: Summit ridge east of Somosomo, *Gillespie 4823* (A, BISH, UC, US). NAITAMBA: *Tothill 351* (K). FIJI, without further locality: *Horne 84* (GH, K), *97* (K), *Fiji Dept. Agr. 3911* (BISH, SUVA).

Upon reconsideration of extensive suites of specimens, I believe that *M. insularis* should not be combined with *M. samoana*, a course I suggested in 1936. The most obvious separating character, the conspicuous secretory canals of the leaf-blades in *M. samoana* and their obscurity in *M. insularis*, is only partially dependable. Additionally, *M. samoana* has its inflorescences somewhat less complex, occasionally simply racemose, and with the furfuraceous indument comparatively evanescent; *M. insularis* has its inflorescences always paniculate, sometimes very conspicuously so, and with the indument usually persistent and often abundant. The prophylls and calyx-lobes of *M. samoana* are comparatively conspicuous, broadly deltoid, broader than long, and obtuse; those of *M. insularis* are often lanceolate-deltoid, longer than broad, and acute. The corollas of *M. samoana* are somewhat the larger, 1.8–2.5 mm. long and with lobes usually 1–1.5 mm. long and broad; those of *M. insularis* are 1.2–1.5 mm. long and with lobes 0.6–1.2 mm. long and broad. To be sure, both taxa are highly variable, but in view of the generally unsatisfactory nature of specific lines in *Maesa*, they are as distinct as many other species pairs.

Some of the variations noted in *M. insularis* suggest *M. tabacifolia* and are separable primarily in the lack of a pilose indument. *Maesa insularis* is also suggestive of the New Hebridean *M. ambrymensis*, differing in its less obviously crenulate leaf-blades, its characteristically shorter pedicels, and its somewhat smaller prophylls. Some of the specimens here referred have unusually narrow leaf-blades, occasionally 3.5 cm. broad or, on depauperate specimens, even less. If sought among the species keyed as having such comparatively narrow leaves, these unusual specimens of *M. insularis* are readily distinguished from *M. persicifolia* in having their leaf-blades attenuate at base and decurrent on the petiole in hard, cartilaginous angles, and in having their leaf-apices comparatively long-acuminate. Such specimens of *M. insularis* can hardly be confused with *M. vitiensis*, a small-leaved species with a similar leaf-base but usually with conspicuous secretory canals, comparatively short leaf-blades, and essentially glabrous inflorescences with usually long pedicels.

12. **Maesa samoana** Mez in Pflanzenr. 9(IV. 236): 53. 1902; Lauterb. in Bot. Jahrb. 41: 232. 1908; Rechinger in Denkschr. Akad. Wiss.

Wien **85**: 326. 1910; Christophersen in Bishop Mus. Bull. **128**: 166, p. p. 1935. FIGURES 3, 4.

Maesa nemoralis sensu Reinecke in Bot. Jahrb. **25**: 665. 1898; non A. DC.

Shrub or small tree to 5 m. high, the young parts copiously castaneous-furfuraceous with suborbicular scales 0.1–0.2 mm. in diameter, these subpersistent on some vegetative parts, the young branchlets, petioles, and leaf-costa rarely minutely puberulent with pale hairs less than 0.02 mm. long; branchlets flattened in distal internodes, becoming terete, copiously pale-lenticellate; petioles (15–) 20–45 mm. long, canaliculate; leaf-blades chartaceous, ovate-elliptic to ovate-lanceolate, (8–) 9–21 cm. long, (2.5–) 4–9 cm. broad, rounded to attenuate at base and abruptly decurrent on the petiole, obtusely cuspidate or short-acuminate at apex, inconspicuously crenulate at margin, conspicuously marked with sinuous secretory canals beneath and sometimes above, the costa stout, flattened or slightly raised above, prominent beneath, the secondary nerves 6–10 per side, curved, subspreading, slightly raised or plane above, strongly elevated beneath, the veinlet-reticulation lax, immersed or inconspicuously prominulous above, usually obvious beneath; inflorescences axillary, solitary or rarely paired, paniculate with 1–10 spreading branches or occasionally simply racemose, 3–8 cm. long, usually many-flowered, branched near base or with a peduncle to 1 cm. long, the rachis and branches sparsely furfuraceous, soon glabrate; branch-subtending bracts ovate-deltoid, glabrous, 0.7–1.5 mm. long, the flower-subtending bracts similar but smaller; pedicels 0.3–1.3 mm. long in flower and fruit, rarely elongating to 4 mm. in fruit, the prophylls conspicuous, broadly ovate-deltoid, 0.7–1 mm. long, 1–1.5 mm. broad, obtuse, minutely erosulous and sometimes sparsely glandular-ciliolate at margins, sparsely glandular-lineolate; calyx-lobes broadly deltoid, 0.7–1 mm. long, 0.8–1.3 mm. broad, obtuse, similar to prophylls in margin and texture; corolla 1.8–2.5 mm. long and about 2.5 mm. in apical diameter, the tube shorter than lobes, the lobes oblong-ovate, 0.8–1.5 mm. long and broad, rounded, obscurely erosulous at margin, copiously glandular-lineolate; filaments 0.2–0.3 mm. long, the anthers oblong-deltoid, about 0.4 mm. long; free part of ovary broadly conical, the style stout, 0.3–0.6 mm. long, 2- or 3-lobed, the ovules 20–25, 3- or 4-seriate; fruits ellipsoid or subglobose and 3.5–4 mm. in diameter at maturity.

TYPE LOCALITY: In describing *M. samoana*, Mez cited several specimens from Upolu and Savaii ("Graeffe n. 1577, 1597, Reinecke n. 262, 262a, Whitmee") without indicating either a holotype or places of deposit. No lectotypification seems to have been suggested by subsequent students of Samoan plants, most of whom have followed Mez in ascribing to Samoa only one species of *Maesa*. Since it now seems that there are other taxa of the genus in Samoa, it is essential to designate a lectotype for *M. samoana* from among the specimens seen by Mez. Some of these may have been deposited in the Berlin herbarium, in which case they have presumably been destroyed. But fortunately others so annotated by Mez are still available. Of the collections cited, *Graeffe 1577* (K) and *1597* (K), *Rein-*

ecke 262 (K, US), and at least one Whitmee collection (BM, GH) were annotated by Mez and represent the species in the sense of his description and key. Other Whitmee specimens belong to *M. tabacifolia*, and I have seen no material of *Reinecke 262a*. In order unequivocally to establish Mez's species, I here designate the Kew sheet of *Graeffe 1597* as the lectotype of *M. samoana*; it was collected on Mt. Tofua on Upolu.

DISTRIBUTION: Endemic to Samoa and, as here interpreted, occurring on Savaii and Upolu only, in montane forest at elevations of 400 to about 1,000 m. It has been noted as a shrub or small tree 3–5 m. high, with a white to yellow or sometimes pink-tinged corolla.

LOCAL NAME: The only name recorded seems to be *fie pua*, noted by Christophersen on Upolu.

Samoa. SAVAII: Maliolio, Mangaloa, *Vaupel 361* (BISH, K, NY, US); above Matavanu, *Christophersen & Hume 2001* (BISH, K, NY, UC, US), *2052* (BISH, K, NY, UC). SAVAII, without further locality: *Graeffe 1577* (K). UPOLU: Mt. Tofua, *Graeffe 1597* (K lectotype); vicinity of Mulifanua, *Reinecke 262* (K, US); vicinity of Lanutoo, *Rechinger 734* (BM, K, US); Mala'olelei-Lanutoo trail, *Christophersen 384* (A, BISH, K, NY, UC); near Mala'olelei, *Christophersen 163* (BISH, K, NY, US); above Utumapu, *Rechinger 945* (BM, US); "montane region," *Graeffe 1391* (GH). UPOLU, without further locality: *Graeffe* (NY). SAMOA, without further locality: *Whitmee* (BM, GH), *156* (K), *225* (K).

In describing *M. samoana* and *M. tongensis* in 1902, Mez placed them as adjacent species in his treatment, indicating that the first has its calyx-lobes rounded and its filaments longer than the anthers, the second having its calyx-lobes acuminate and its filaments equal to the anthers. While these particular characters seem undependable, a comparison of the specimens cited by Mez indicates two quite different taxa. *Maesa samoana* has its leaf-blades narrowly elliptic, nearly three times as long as broad and inconspicuously crenulate, its inflorescences prevailingly paniculate, and its flowers and fruits usually short-pedicellate. *Maesa tongensis* has its leaf-blades broadly ovate to suborbicular, nearly as broad as long and conspicuously crenulate, its inflorescences few-branched or simply racemose, and its flowers and fruits long-pedicellate. These contrasting features are reasonably dependable as to the available material from Upolu and Savaii (*M. samoana*) and from Tonga and southern Lau (*M. tongensis*). Christophersen in 1935 pointed out that specimens from Tutuila and the Manua Islands differ from typical *M. samoana* in their relatively broader, almost rounded leaves; in fact these collections from the eastern Samoan islands also have prevailingly simple inflorescences with long pedicels. Although practically every differentiating character between *M. samoana* and *M. tongensis* fails at some point in the population as a whole, the extremes seem worthy of specific recognition, and the collections from the eastern Samoan islands more closely resemble *M. tongensis* in the totality of their characters than *M. samoana*.

13. **Maesa tongensis** Mez in Pflanzenr. 9(IV. 236): 54. 1902; Yuncker in Bishop Mus. Bull. 220: 209. 1959. FIGURE 17.

Maesa nemoralis sensu A. Gray in Proc. Amer. Acad. Arts 5: 329. 1862; Hemsl. in Jour. Linn. Soc. Bot. 30: 183. 1894; Burkill in Jour. Linn. Soc. Bot. 35: 44. 1901; non A. DC.

Maesa vitiensis sensu Hemsl. in Jour. Linn. Soc. Bot. 30: 183. 1894; non Seem.

Maesa samoana sensu Setchelle in Carnegie Inst. Wash. Publ. 341: 60. 1924; Christophersen in Bishop Mus. Bull. 128: 166, p. p. 1935; Yuncker in Bishop Mus. Bull. 184: 56. 1945; non Mez.

Shrub or small tree to 4 m. high, the young parts copiously castaneous-furfuraceous with suborbicular scales 0.1–0.2 mm. in diameter, these usually evanescent; branchlets subterete, sparsely pale-lenticellate; petioles slender, 13–40 (–50, juvenile) mm. long, canaliculate, narrowly winged distally; leaf-blades chartaceous, ovate or suborbicular or broadly elliptic, (3–) 5–14 cm. long, (2–) 4.5–11.5 cm. broad, rounded or broadly obtuse at base and there marginally thickened and abruptly decurrent on the petiole, rounded and sometimes subretuse at apex, less often broadly obtuse or obtusely cuspidate, conspicuously crenulate at margin (crenations 1 or 2 per centimeter, callose-thickened), with scattered minute superficial glands beneath, the costa strongly elevated above, prominent beneath, the secondary nerves 4–7 per side, curved, spreading, slightly elevated on both sides or plane above, the veinlet-reticulation lax, inconspicuously prominulous on both sides or immersed above, the secretory canals sinuous and obvious on lower surface; inflorescences axillary, solitary, rarely appearing terminal on lateral branchlets, often simply racemose but sometimes paniculate with 1–4 (very rarely to 15) spreading branches, (1–) 2–11 cm. long, many-flowered, the peduncle (to 1.5 cm. long) and rachis slender, glabrous; branch-subtending bracts oblong-deltoid, obtuse, 0.8–2.5 mm. long, obscurely glandular at margin, the flower-subtending bracts similar, to 1.5 mm. long; pedicels 1–3 mm. long in flower and to 4 mm. in fruit, the prophylls often only subapical, ovate-deltoid, 0.6–1.2 mm. long and broad, obtuse, minutely erosulous at margin, conspicuously glandular-lineolate; calyx-lobes broadly deltoid, 0.7–1.2 mm. long and broad, obtuse or subacute, entire or obscurely erosulous at margin, copiously or sparsely glandular-lineolate; corolla 1.8–2.5 mm. long and about 2.5 mm. in apical diameter, the tube shorter than lobes, the lobes oblong-suborbicular, 0.9–1.8 mm. long and broad, rounded, subentire, copiously glandular-lineolate; filaments 0.2–0.4 mm. long, the anthers oblong, about 0.6 mm. long; free part of ovary broadly conical, the style 0.5–0.6 mm. long, the stigma conspicuously 2- or 3-lobed, the ovules 35–45, 4–6-seriate; fruits ellipsoid or subglobose, 3–4 mm. in diameter at maturity.

TYPE LOCALITY: Mez's type citation is: "Vavau: Crosby n. 228, Harvey, Lister. — Blüht im Juni (Herb. Asa Gray, Kew, Paris)." The three collections are definitely conspecific and all are excellent. Because it is perhaps the best specimen and has an unequivocal locality, I here designate

the Kew sheet of *Crosby 228* as the lectotype. It was collected on Vava'u in June 1891. The Harvey specimen bears the label "Vavau and Lifuka, Friendly Islands." Of the three Kew sheets of Lister, one bears a field label indicating that it was obtained on 'Eua in December 1889, but another is indicated as "Tutuila, Samoa," a Lister locality to be questioned.

DISTRIBUTION: Tonga; also southern Lau, Fiji, and the eastern Samoan islands. The species has been obtained from sea-level to an elevation of 500 m., in thickets or inland scrub-forest, but most often along beaches or on limestone cliffs. It is noted as a shrub or small tree 1–4 m. high, usually with scandent branches; the corolla is greenish white and perhaps pink-tinged, and the mature fruit is white.

LOCAL NAMES: *Yaro* (Fulanga, Fiji; a very questionable name for this taxon); *langakalialifa* (Vava'u); *valo valo* (Tongatapu); *puataukanave* ('Eua); *lala* (Ofu, Samoa).

Fiji. FULANGA: *Tothill 349* (BISH, K, NY); on limestone formation, *Smith 1160* (BISH, GH, K, NY, UC, US).

Tonga. VAVA'U: *Crosby 228* (K lectotype). "VAVAU and LIFUKA": *Harvey*, in 1855 (GH, K, NY). TONGATAPU: Kolovai, *Soakai 247* (K); Vahe, *Setchell & Parks 15434* (K, UC); terrace trail, Hufagalupe, *Setchell & Parks 15630* (BISH, K, UC, US); below Fua'amotu, *Yuncker 16244* (BISH, BM, US). 'EUA: *Lister*, Dec. 1889 (K), *Moore 454* (US); along trail to Lokupo, northeastern side of island, *Yuncker 15527* (BISH, BM, GH, US); summit of eastern ridge, *Yuncker 15686* (BISH, BM, US). TONGA, without further locality: *Anderson & Nelson* (Cook's Third Voyage), April–July 1777 (BM).

Samoa. TUTUILA: Between Pago Pago and Nuuuli, *Yuncker 9359* (A, BISH); near Fagatoga, *Setchell 581* (BISH, UC); vicinity of Pago Pago, *Diefenderfer 3* (BISH), *Seale*, May 26, 1929 (NY), *Wisner 154* (BISH); top of Pioa, *Christophersen 3522* (BISH). OFU: Vaoto, *Garber 1097* (BISH, NY). TAU: Luma-Faleasao trail, *Garber 686* (BISH, NY, UC); south of Siufaga, *Yuncker 9105* (BISH). SAMOA, without further locality: *U. S. Expl. Exped.* (GH, NY, US 73886), *Powell 8* (K).

Although *M. tongensis* has been considered endemic to Tonga, the specimens from Fulanga in Fiji agree excellently with those originally cited by Mez. The above-cited collections from the eastern Samoan islands are not quite so typical of *M. tongensis*, but they appear better placed here than in *M. samoana*, as discussed under that related species.

14. **Maesa persicifolia** A. Gray in Proc. Amer. Acad. Arts **5:** 330, as *M. persicaefolia*. 1862; Mez in Pflanzenr. 9(IV. 236): 48. 1902; J. W. Parham, Pl. Fiji Isl. 158. 1964. FIGURES 5, 6, 18.

Maesa nemoralis sensu A. Gray in Proc. Amer. Acad. Arts **5:** 330. 1862; non A. DC.

Maesa persicaefolia A. Gray ex Seem. Fl. Vit. 148. 1866, 430. 1873; Horne, A Year in Fiji, 264. 1881.

Maesa densiflora Gillespie in Bishop Mus. Bull. **74:** 5. *fig. 1*. 1930; J. W. Parham, Pl. Fiji Isl. 156. *fig. 59, B*. 1964.

Maesa parksii Gillespie in Bishop Mus. Bull. **74:** 8. *fig. 6.* 1930; J. W. Parham, Pl. Fiji Isl. 158. 1964.

Tree or shrub, often becoming scandent, or liana, the young parts copiously ferruginous-furfuraceous with irregular scales about 0.1 mm. in diameter, these often subpersistent, the young branchlets, petioles, and leaf-costas also sometimes obscurely puberulent or minutely pilose with hairs to 0.2 mm. long; branchlets often flattened in distal internodes, becoming terete, with copious, pale, often protuberant lenticels; petioles slender, 5–27 mm. long, canaliculate, often narrowly winged distally; leaf-blades chartaceous, sometimes becoming thick, ovate- or elliptic-lanceolate to narrowly oblong-elliptic, 4–13 cm. long, 1.5–5 (–5.5) cm. broad, rounded to obtuse or shallowly subcordate (rarely subacute) at base and abruptly short-decurrent on the petiole, narrowly rounded to obtuse or obtusely short-acuminate at apex, subentire or inconspicuously crenulate at margin (crenations 1–3 per centimeter), obscurely glandular-thickened, lacking obvious secretory canals or these immersed and inconspicuous on the lower surface, the costa plane or slightly elevated above, prominent beneath, the secondary nerves 6–12 per side, spreading or curved, immersed or slightly raised above, sharply raised or prominulous beneath, the veinlet-reticulation inconspicuous, immersed on both sides or prominulous beneath; inflorescences axillary, solitary, paniculate, sometimes bipinnately so, with 1–15 spreading branches, infrequently simply racemose, 2–11 cm. long, many-flowered, branched from base or with a peduncle to 2 cm. long, the rachis and branches copiously or sparsely furfuraceous at anthesis; branch-subtending bracts deltoid to ovate-lanceolate, acute to obtuse, 0.6–1.5 mm. long, furfuraceous without but often glabrate, minutely erosulous and often glandular-ciliolate at margin, the flower-subtending bracts somewhat smaller; pedicels essentially none or to 1.5 (rarely 2.5) mm. long at anthesis and to 3 mm. long in fruit, like the prophylls eventually glabrate, the prophylls inconspicuous, ovate- to lanceolate-deltoid, 0.5–1 mm. long and broad, acute to obtuse, obscurely erosulous and often ciliolate at margin, inconspicuously glandular-lineolate; calyx-tube copiously or sparsely furfuraceous but glabrate in fruit, the lobes deltoid, 0.4–1 mm. long and broad, acute or subacute, like the prophylls in margin and texture; corolla 1.2–1.8 mm. long, 1.5–2 mm. in apical diameter, the tube subequal to lobes or shorter, the lobes ovate-oblong, 0.7–1 mm. long and broad, rounded and reflexed at anthesis, subentire or minutely erosulous at margin, inconspicuously glandular-lineolate; filaments 0.2–0.5 mm. long, the anthers oblong-deltoid, to 0.5 mm. long; free part of ovary flattened-conical, the style 0.2–0.4 mm. long, the stigma obscurely or obviously 2–4-lobed, the ovules 10–30 (some often aborted), 2–4-seriate; fruits subglobose at maturity and 3–4 mm. in diameter.

TYPE LOCALITY: Mbua Bay, Mbua Province, Vanua Levu, Fiji. Gray's description is based entirely upon the U.S. Exploring Expedition collection listed below, but he also cited *Seemann 287* as "perhaps a form of this species," pointing out several differences. The latter specimen, which was

subsequently described by Seemann as *M. vitiensis*, does not enter into the typification of *M. persicifolia*. The type of *M. densiflora* is *Parks 20512*, from Nandarivatu, Mba Province, Viti Levu, and that of *M. parksii* is *Parks 20509*, from the same locality. Both of these types are cited and discussed below.

DISTRIBUTION: Endemic to Fiji and probably to be expected from several of the high islands, although it now seems abundant only on Viti Levu. It has been collected from near sea-level to an altitude of 1,200 m., in dense, dry, or open forest, or on open hillsides. It is often noted as a liana, but sometimes as a slender or compact shrub or tree 1–10 m. high, with frequently scandent branches; the corolla is white to cream-colored or pale yellow, with faint purple glandular lines; the filaments and anthers are pale yellow or cream-colored; and the mature fruit is dull or waxy white.

LOCAL NAMES AND USES: The following names seem probably correct: *mbutambuta* (Yasawas); *kutumirase* (Mba); *kutu* (Nandronga & Navosa); *mbumbu marasea* (Ra); *merikula* (Mbua); and *mbumbu* (Thakaundrove). J. W. Parham has also noted for *M. densiflora* the following names: *ndrau mbombosanga*, *ndrau ni makaka*, and *monitona*; but I have not been able to associate them with specific labels. The bark and leaves have been reported as having medicinal uses, mostly unspecified or vague.

Fiji. YASAWAS: YASAWA I.: Tethi, *Fiji Dept. Agr. 13657* (BISH, SUVA). WAYA I.: Ridge back of Yalombi, *St. John 18010* (BISH, SUVA, US); below Yalombi and Natawa, *Fiji Dept. Agr. 13672* (BISH, SUVA). VITI LEVU: MBA: North of Natalau, near Lautoka, *Degener 15004* (A, BISH, NY, UC, US); Mt. Evans Range, *Greenwood 379* (K), *Smith 4093*, *4130* (both A, BISH, K, US), *4189* (A, US); Nukunuku Creek, west of Nandarivatu, *Vaughan 3398* (BM, K); vicinity of Nandarivatu, *Parks 20509* (BISH holotype of *M. parksii*; isotypes at SUVA, UC, US), *20512* (BISH holotype of *M. densiflora*; isotypes at SUVA, UC, US); Mt. Nanggaranambuluta (Lomalangi), *Gillespie 3787* (BISH, UC), *Greenwood 874* (A, K), *Smith 4825* (A, BISH, K, US), *Fiji Dept. Agr. 12532* (BISH, SUVA); Sovutawambu, *Degener 14595* (A, BISH, K, NY, UC, US); Nandala, *Degener 14375* (A, BISH, K, NY, UC, US); Mt. Tomanivi (Victoria), *Fiji Dept. Agr. 13029* (BISH, SUVA), *13068* (BISH, K, MASS, SUVA), *O. & I. Degener 32074* (BISH). NANDRONGA & NAVOSA: Nausori Highlands, *Fiji Dept. Agr. 13845* (*Damanu 21*) (K, SUVA); Nausori Village, *Fiji Dept. Agr. 13333* (BISH, K, SUVA); vicinity of Kalavo, *H. B. R. Parham 215* (BM); vicinity of Singatoka, *Greenwood 15* (K), *Fiji Dept. Agr. 5995* (BISH, SUVA); near Sovi Bay, *Degener 15037* (A, BISH, K, NY, UC, US); "Nandronga District," *W. L. Parham 1* (K). SERUA: Hills near coast between Korovou and Wainiyambia, *Smith 9179*, *9217*, *9321*, *9351* (all BISH, GH, K, SUVA, US). RA: Vicinity of Penang, *Greenwood 767* (K); vicinity of Rewasa, near Vaileka, *Degener 15340* (A, BISH, K, NY, UC, US). NAITASIRI: Rairaimatuku Plateau, between Mt. Tomanivi and Nasonggo, *Smith 5786* (A, BISH, K, US). TAILEVU: Matavatathou, *Fiji Dept. Agr. 9234* (*McKee 2799*) (K, SUVA, US). REWA: Vicinity of Suva, *H. B. R. Parham 383* (BM). VITI LEVU or TAVEUNI: *Seemann 286*, p. p. (mounted with type material of *M. tabacifolia*, GH, K). VANUA LEVU: MBUA: Mbua Bay, *U. S. Expl. Exped.* (US 49408 holotype; isotype at GH); Koromba Forest, *Fiji Dept. Agr. 15117* (BISH, SUVA); Mt. Seatura, *Fiji Dept. Agr. 14895* (BISH, SUVA); vicinity of Nandi, *Milne* (K). THAKAUNDROVE: Mt.

Kasi, Yanawai River region, *Smith 1783* (BISH, GH, K, NY, US). FIJI, without further locality: *Harvey*, Nov. 1855 (BM, GH, K), *Tothill 367* (K), *Fiji Dept. Agr. 13002* (BISH, SUVA).

In proposing *M. densiflora* as a new species, Gillespie made no comparisons; his description indicates no points of differentiation from *M. persicifolia* and his type material, although from a dense-foliaged specimen with immature inflorescences, falls well within a normal range of variation. I have not been able to verify Gillespie's mention of the flowers as 5–7-merous. The stigma in his type is more deeply lobed than usual for *M. persicifolia*.

Maesa parksii was similarly described by Gillespie without mention of a related species. His type specimen is certainly not "glabrous in all parts," as described, but bears minute spreading hairs 0.1–0.2 mm. long on the young branches, petioles, and proximal parts of the costa on both leaf-surfaces. However, such hairs are lacking from the inflorescences, which are simply racemose or sparsely paniculate. No other characters seem to separate *M. parksii* from *M. persicifolia*, a logical interpretation of which seems to include a few specimens, among which is the type of *M. parksii*, with a sparse, obscure, short indument of spreading hairs on a few vegetative parts. Through these individuals *M. persicifolia* is seen to approach *M. pickeringii*, the two concepts being very distinct in their typical elements but separable, in borderline individuals, only by the absence of a pilose inflorescence-indument in the former and its presence in the latter.

The closest relative of *M. persicifolia* is *M. vitiensis*, and indeed these taxa were combined by Mez. However, as indicated in my key and in the discussion of the following species, they differ by characters as satisfactory as one can hope for in *Maesa*.

15. **Maesa vitiensis** Seem. Fl. Vit. 148. 1866; Horne, A Year in Fiji, 264. 1881. FIGURES 7–9, 19.

Maesa indica var. sensu Seem. in Bonplandia **9:** 257. 1861; A. Gray in Bonplandia **10:** 36. 1862; non auctt.
Maesa persicifolia sensu Seem. Viti, 438, 1862; non A. Gray.
Maesa lenticellata Gillespie in Bishop Mus. Bull. **74:** 6. *fig. 4.* 1930; J. W. Parham, Pl. Fiji Isl. 156. 1964.
Maesa neriifolia Gillespie in Bishop Mus. Bull. **74:** 7. *fig. 5.* 1930; J. W. Parham, Pl. Fiji Isl. 158. 1964.
Maesa stenophylla A. C. Sm. in Jour. Arnold Arb. **33:** 106. 1952; J. W. Parham, Pl. Fiji Isl. 158. 1964.

Small tree or shrub, or liana, the young parts copiously furfuraceous with ferruginous or dark brown irregular scales 0.1–0.2 mm. in diameter, these evanescent from most parts of the plant; branchlets subterete, with copious, pale, often protuberant lenticels; petioles slender, 5–35 mm. long, canaliculate, narrowly winged distally but conspicuously cartilaginous-angled nearly to base; leaf-blades chartaceous or subcoriaceous, narrowly elliptic to ovate-lanceolate or lanceolate, (4–) 5–13 cm. long, 1.5–5 (–6)

cm. broad, attenuate to acute or sometimes obtuse at base and long-decurrent on the petiole, obtuse to cuspidate or slenderly acuminate at apex and callose-apiculate, subentire or undulate or obscurely crenulate at margin, usually with sinuously parallel secretory canals conspicuous on the lower surface or these sometimes immersed, the costa plane or sharply elevated above, prominent beneath, the secondary nerves 4–8 per side, curved-ascending or sharply ascending, immersed to prominulous above, often sharply prominulous beneath, the veinlet-reticulation usually obscure and immersed on both surfaces; inflorescences axillary or occasionally terminal on short lateral branches, solitary, simply racemose or narrowly paniculate with 1–10 short ascending branches, 1.5–9 cm. long, with few to many flowers, the peduncle short, like the slender rachis, branches, and pedicels sparsely furfuraceous but soon glabrate; branch-subtending bracts lanceolate, 1–2.2 mm. long, acute, the flower-subtending bracts similar but 0.5–1.5 mm. long; pedicels (0.5–) 1.5–2.5 mm. long at anthesis and to 3.5 mm. long in fruit, the prophylls deltoid to lanceolate, 0.5–1 mm. long and usually narrower, acute to obtuse, obscurely erosulous and sometimes glandular-ciliolate at margin, obscurely or obviously glandular-lineolate; calyx-lobes deltoid, 0.4–1 mm. long and broad, subacute or obtuse, like the prophylls in margin and texture; corolla 1.3–1.5 mm. long, 1.5–2.5 mm. in apical diameter, the tube subequal to lobes or shorter, the lobes ovate-oblong, 0.6–1.5 mm. long and broad, rounded, minutely erosulous at margin, obviously and conspicuously glandular-lineolate; filaments 0.1–0.3 mm. long, the anthers deltoid-ovoid, 0.3–0.4 mm. long; free part of ovary broadly conical, the style 0.2–0.5 mm. long, the stigma obscurely 2- or 3-lobed, the ovules 12–20, 2–4-seriate; fruits subglobose at maturity and 3–3.5 mm. in diameter.

TYPE LOCALITY: In describing *M. vitiensis*, Seemann cited his own no. *287* and also a Harvey specimen. As the latter belongs to a different species, *M. persicifolia*, it is desirable to lectotypify *M. vitiensis* by *Seemann 287*, which obviously was the principal basis of his description; it was collected on Ovalau in October 1860. In combining the two species mentioned in 1902, Mez cited both the Seemann and Harvey specimens, indicating that his reduction was more influenced by the latter than the former; however, he did not lectotypify *M. vitiensis*. The three species now being reduced to *M. vitiensis* are typified as follows: *M. lenticellata* by *Gillespie 3149*, from Mt. Naitarandamu, Namosi Province, Viti Levu; *M. neriifolia* by *Gillespie 2390*, from Mt. Korombamba, Rewa Province, Viti Levu; and *M. stenophylla* by *Smith 6490*, from Mt. Numbuiloa, Mathuata Province, Vanua Levu. All four types involved are cited below in the geographic sequence.

DISTRIBUTION: Endemic to Fiji and known from several high islands. It occurs from near sea-level to an altitude of 1,150 m., in dense or open forest and in thickets of crests and hillsides. It has been noted as a liana or as a slender or compact tree or shrub 2–5 m. high; the corolla is white to

cream-colored or pale yellow, with brownish or salmon-pink glandular lines; the filaments are pale green and the anthers yellow; and presumably the fruit becomes white at maturity.

LOCAL NAMES: *Kolo ni mbeka* has been noted in Mathuata, *rongo* and *tui ni nduna* in Mbua.

Fiji. VITI LEVU: SERUA: Mt. Tikituru (Gordon), *Fiji Dept. Agr. 14498* (BISH, K, SUVA). NAMOSI: Mt. Naitarandamu, summit ridge, Sept. 28, 1927, *Gillespie 3149* (BISH holotype of *M. lenticellata*; isotypes at BISH, UC); Korombasambasanga Range, *Fiji Dept. Agr. 2209* (BISH, SUVA), *14575* (BISH, SUVA); Mt. Vakarongasiu, summit, *Gillespie 3287* (BISH, K, NY, UC), *Fiji Dept. Agr. 14600* (BISH, SUVA), *14703* (BISH, SUVA). NAITASIRI: Central Road, *Tothill 468* (A, K), *486* (BISH, K, NY), *552* (BISH, K), *578* (BISH, K). REWA: Mt. Korombamba, summit, Aug. 23, 1927, *Gillespie 2390* (BISH holotype of *M. neriifolia*; isotypes at BISH, K, NY, UC), *Meebold 17056* (BISH, K), *Webster & Hildreth 14093* (DAV, MASS). OVALAU: *Seemann 287*, October 1860 (K lectotype; isolectotypes at BM, GH). VANUA LEVU: MBUA: Rukuruku Bay, *H. B. R. Parham 6* (GH); Ndavoka, *H. B. R. Parham 458* (K). MATHUATA: Vicinity of Lambasa, *Greenwood 487* (K); northwestern slopes of Mt. Numbuiloa, east of Lambasa, Nov. 6, 1947, *Smith 6490* (A holotype of *M. stenophylla*; isotypes at BISH, K, US); Undu Point, *Tothill 350* (K), *356* (BISH, K), *358* (BISH, K). THAKAUNDROVE: Nandongo, inland from Malake, *Horne 674* (K); Maravu, near Salt Lake, *Degener & Ordonez 14153* (A, BISH, K, NY, US). TAVEUNI: Main ridge east of Somosomo, *Smith 8367* (BISH, GH, K, UC, US); Rairai Ndreketi, *Fiji Dept. Agr. 15890* (BISH, NY, SUVA); Mt. Manuka, east of Wairiki, *Smith 778* (BISH, GH, K, NY, US), *8223* (BISH, GH, K, US). FIJI, without further locality: *Fiji Dept. Agr. 1730* (BISH, SUVA).

In describing *M. neriifolia*, Gillespie compared it with *M. persicifolia* as understood by Mez, i.e. including *M. vitiensis*. Later, Gillespie realized that his species could not be separated from *M. vitiensis*; in a 1932 annotation on *Seemann 287* (K) he noted its distinctiveness from *M. persicifolia* and its identity with his own *M. neriifolia*. Indeed, the latter is precisely similar to the Seemann specimen except for its shorter pedicels, and it cannot be maintained.

Gillespie did not contrast his new species *M. lenticellata* with *M. neriifolia*, but a careful comparison of the two type collections indicates that the only consequential difference is the absence of obvious secretory canals from the leaf-blades of *M. lenticellata* and their copious presence in *M. neriifolia*. Taking *M. vitiensis* as a whole, it seems undesirable to exclude from it the type of *M. lenticellata* and a few other specimens from southern Viti Levu that have the secretory canals somewhat immersed in the leaf-tissue. Examination of cleared leaf-blades shows that canals are copiously present (although disappearing with prolonged clearing) in all material referable to the four taxa under consideration; but in the case of *M. lenticellata* they are sometimes so immersed in the leaf-tissue as to be indistinguishable on surface examination. In most other specimens of this complex, the secretory canals are fairly close to the lower leaf-surface and hence obvious.

In describing *M. stenophylla* I contrasted it with *M. persicifolia* in Mez's sense. Examination of the specimens now available indicates that *M. stenophylla* has all the basic characters associated with *M. vitiensis*: the cartilaginous-margined petioles, the leaf-blades with ascending nerves and gradually tapering base, the copious secretory canals near the lower leaf-surface, and the essentially glabrous inflorescences. The leaf-blades of *M. stenophylla* (with which I would associate *Horne 674* and *Greenwood 487*) are proportionately narrower than those of other available specimens of the complex, being four or five times as long as broad. However, specimens from Undu Point, Mathuata, have leaves approaching this extreme shape, and therefore I now believe *M. stenophylla* not nomenclaturally useful at any level.

As suggested in the preceding paragraphs, *M. vitiensis* is allied to *M. persicifolia* but seems worthy of specific recognition on the basis of its evanescent lepidote indument, its winged or sharply angled petioles, its leaf-blades usually attenuate at base and conspicuously marked beneath with sinuous secretory canals, its frequently simply racemose inflorescences with long pedicels, and the obvious glandular lines of its corollas. The two species have different, although not entirely mutually exclusive, distributions, *M. persicifolia* being frequent in the Yasawas, northern and western Viti Levu, and western Vanua Levu, while *M. vitiensis* generally replaces it in southeastern Viti Levu, eastern Vanua Levu, and Taveuni.

2. **Ardisia** Sw. Prodr. 3, 48. 1788; Seem. Fl. Vit. 149, p. p. 1866; Mez in Pflanzenr. 9(IV. 236): 57. 1902. *Nom. cons.*

The large genus *Ardisia*, as interpreted by Mez, has many species in tropical Asia and tropical America but is lacking in Africa. In the Pacific it extends eastward through Malesia to New Guinea, the Solomons, and Australia, with a single outlying endemic species in Fiji. The genus should have been included in my discussion (Smith, 1955) of genera with ranges terminating in Fiji. No indigenous occurrences of the genus have been noted from the New Hebrides or from elsewhere in the Fijian Region, but two species are here discussed as cultivated or naturalized.

Ardisia is well characterized by its conspicuous, slender, tapering style and its minute, punctiform stigma (FIGURE 22). In most species the ovules are several-seriate on the placenta, but in a few they are essentially uniseriate, this being the case in the Fijian species.

1. **Ardisia brackenridgei** (A. Gray) Mez in Pflanzenr. 9(IV. 236): 127. 1902; Turrill in Jour. Linn. Soc. Bot. **43**: 30. 1915; J. W. Parham, Pl. Fiji Isl. 155. 1964. FIGURES 20–23.

Ardisia sp. Seem. in Bonplandia **9**: 257. 1861; A. Gray in op. cit. **10**: 37. 1862; Seem. in op. cit. **10**: 296. 1862, Viti, 439. 1862.

Myrsine brackenridgei A. Gray in Proc. Amer. Acad. Arts **5**: 330. 1862; Seem. Viti, 438. 1862, Fl. Vit. 149. 1866; Horne, A Year in Fiji, 265. 1881.

Ardisia vitiensis Seem. Fl. Vit. 150. 1866; Horne, A Year in Fiji, 257. 1881.

Ardisia storckii Seem. Fl. Vit. 150. 1866; Horne, A Year in Fiji, 257. 1881; Mez in Pflanzenr. **9**(IV. 236): 126. 1902; J. W. Parham, Pl. Fiji Isl. 156. 1964.
Myrsine sp. n. Horne, A Year in Fiji, 265. 1881.
Tinus storckii Kuntze, Rev. Gen. Pl. **2**: 975. 1891.

Shrub or tree to 5 m. high, the young parts minutely but copiously furfuraceous with irregular scales less than 0.1 mm. in diameter, soon glabrous or the indument subpersistent on the rachis and pedicels; branchlets slender, slightly flattened but soon terete, 1–3 mm. in diameter distally, grayish and inconspicuously lenticellate; leaves alternate, the petioles slender, semiterete or shallowly canaliculate, narrowly winged to base, 3–12 mm. long, the blades chartaceous, drying brownish, black-glandular-punctate, elliptic to elliptic- or oblong-lanceolate, 4–13 cm. long, 1.5–3.5 (–4.7) cm. broad, acute to attenuate at base and long-decurrent on the petiole, obtuse to obtusely acuminate at apex, irregularly and inconspicuously crenate and narrowly recurved at margin, the costa shallowly canaliculate or plane above, sharply raised beneath, the secondary nerves 12–25 per side, interspersed with others less evident, spreading or subascending, sharply prominulous on both sides or at length subimmersed above, irregularly anastomosing toward margin, the veinlet-reticulation copious, prominulous or subimmersed; inflorescences axillary or lateral, irregularly fasciculiform or short-racemose (very rarely short-paniculate), one or several borne on an irregular persistent nodule or rarely from a slender peduncle, the rachis short and slender at anthesis (to 3 mm. long) but sometimes elongate to 15 mm. in fruit, the flowers 1–7, the fruits rarely more than 5 but sometimes the rachis with additional scars, the flower-subtending bracts oblong or lanceolate, to 1.5 mm. long, copiously glandular-punctate, obtuse, sparsely glandular-ciliolate, caducous; pedicels slender, slightly swollen distally, 4–11 mm. long at anthesis, sometimes elongating to 17 mm. or rarely to 25 mm. in fruit; flowers 5-merous, the calyx submembranous, cupuliform at anthesis and 2–3 mm. in apical diameter, becoming rotate and slightly accrescent in fruit, the lobes dextrorsely contorted, broadly ovate, 1–1.3 mm. long and broad at anthesis, sparsely pellucid-glandular-punctate, obtuse or rounded at apex, copiously glandular-ciliolate; corolla submembranous, ovoid and acute in bud, to 4.5 mm. long, the tube about 0.5 mm. long, the lobes dextrorsely contorted, elliptic-lanceolate, at anthesis 2.5–4 mm. long and 1.5–2 mm. broad, acute, sparsely or copiously glandular-punctate; filaments 0.5–1 mm. long at anthesis, connate into a minute tube proximally and adnate to corolla-tube, free and slenderly ligulate distally, the anthers dorsifixed near base, oblong-deltoid, 1.5–2.5 mm. long, subsagittate at base, acute at apex or with a slender mucro to 0.2 mm. long; ovary ovoid, the style slenderly subulate, 1.5–3.5 mm. long, the stigma minutely punctiform, the placenta obovoid, flattened at apex, the ovules 6–10, irregularly uniseriate; mature fruits subglobose or obovoid, obscurely multicostate in drying, up to 8 mm. in diameter or sometimes to 9 × 6 mm., copiously lineolate with immersed glands, the style caducous, leaving a small circu-

lar scar, the pericarp 0.5–1 mm. thick, the mesocarp carnose, the endocarp crustaceous, about 0.2 mm. thick.

TYPE LOCALITY: Three types, all Fijian, are involved in the synonymy; all are cited below in the appropriate sequence. The type of the oldest name, *Myrsine brackenridgei*, is a U.S. Exploring Expedition specimen collected in 1840 in the mountains of Ovalau, in fruit.

The type of *A. vitiensis* is *Seemann 291*, a fruiting specimen collected on Viti Levu in July 1860. During this month Seemann (1862: 82–133) visited several areas in the present Provinces of Tailevu, Rewa, Namosi, and Serua. The exact location of his no. *291* cannot be stated, other than coastal southeastern Viti Levu.

In describing *A. storckii* Seemann cites his no. *292* and *Storck 897*, the former a robust fruiting specimen and the latter an excellent flowering specimen. Although the name is herewith being reduced to *A. brackenridgei*, it seems desirable to lectotypify it; in view of the specific epithet and the excellence of the material, I designate *Storck 897* as the lectotype. The only cited localities are "Viti Levu & Ovalau." *Seemann 292* bears two field labels indicating: "Viti Levu, 1860" and "Port Kinnaird, July 1860." It is probable, therefore, that no. *292* contains elements from both localities, as Seemann was on both Viti Levu and Ovalau in July 1860. *Storck 897* bears no detailed locality and may have come from either island.

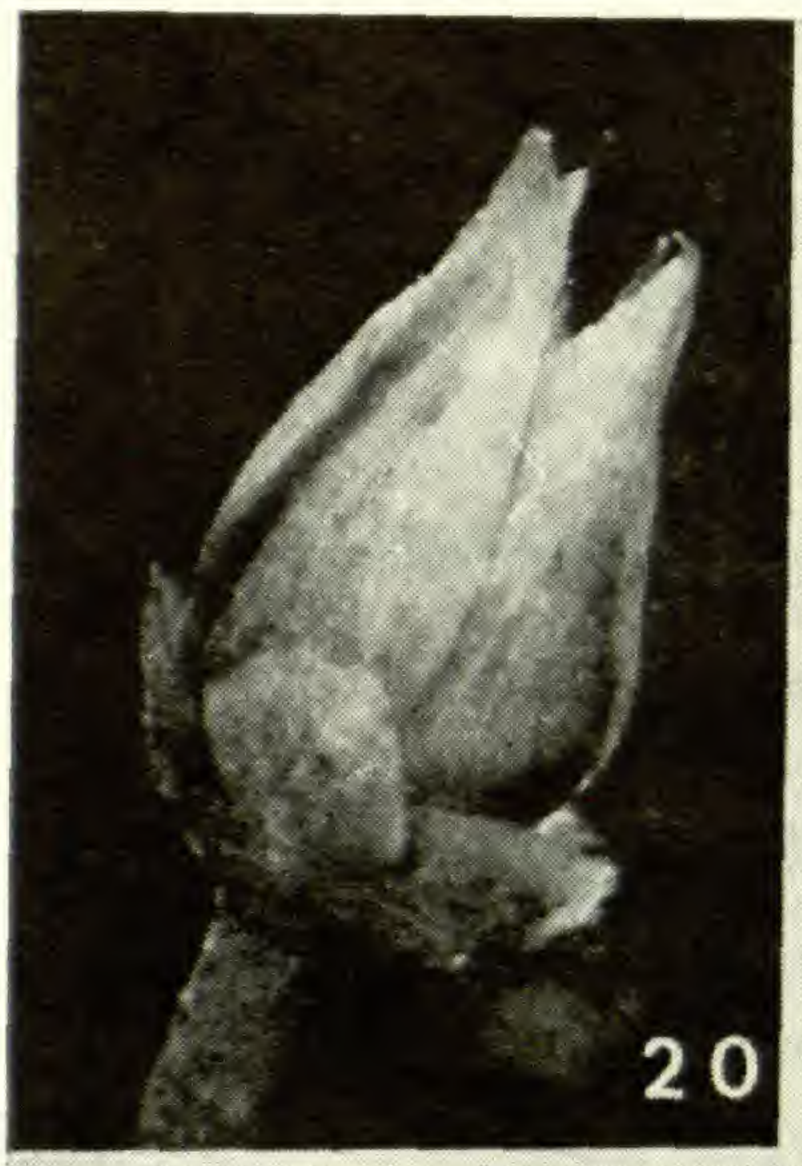
DISTRIBUTION: Endemic to Fiji and known from several islands at elevations between 150 and 915 m., occurring in sometimes dense forest, thickets, and in forest-grassland transitional areas. It has been noted as a shrub or small tree 0.5–5 m. high, with a slender trunk, sometimes simple-stemmed and often dense-foliaged. The petioles are sometimes reddish; the flower-buds are pale pink or red and the mature corolla pink; the fruits are at first dull white or purple-tinged, becoming pink and at length red.

LOCAL NAME: This plant of the undergrowth seems to have been neglected by Fijians, the only recorded name being *thondo*, noted on *Smith 551* from Vanua Levu.

Fiji. VITI LEVU: MBA: Mt. Evans Range, *Greenwood 447* (K); Mt. Mbatilamu, Vunda, *Fiji Dept. Agr. 14131* (BISH, K, MASS, SUVA); Nandrau Road, south of Nandarivatu, *im Thurn 282* (K); between Nggaliwana and Tumbeindreketi Creeks, east of Navai, *Smith 6017* (A, US). NANDRONGA & NAVOSA: Rairaimatuku Plateau, between Nandrau and Nanga, *Smith 5527* (A, BISH, K, US); between

---

FIGURES 20–23. *Ardisia brackenridgei*: 20 and 21 from *Storck 897*, 22 from *Smith 551*, 23 from *Smith 7537*. 20, flower, × 10; 21, two corolla-lobes and stamens, × 15; 22, gynoecium and two calyx-lobes, × 15; 23, young fruit, showing calyx and stylar scar, × 8. FIGURES 24–28. *Tapeinosperma capitatum*: 24–27 from *Smith 749*, 28 from *Smith 7589*. 24, flower, × 3; 25, two corolla-lobes and stamens, × 7; 26, stamens, dorsal (left) and ventral views, × 10; 27, gynoecium, × 8; 28, partial lateral view of putamen, × 2.5.


20

21

22

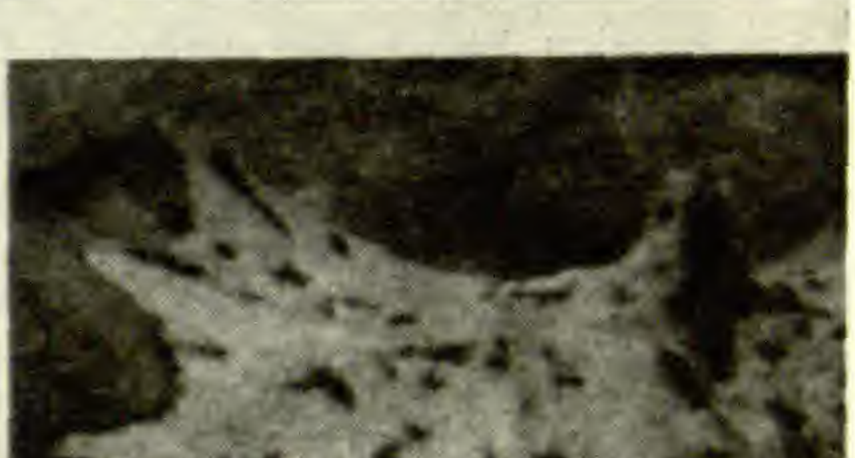
23

24

25

26

27


28

Koronayalewa and Vonolevu, *Fiji Dept. Agr. 1392* (SUVA). SERUA: Upper Navua River, *Fiji Dept. Agr. 15518* (K, SUVA). VITI LEVU, without further locality: *Seemann 291* (K holotype of *Ardisia vitiensis*; isotypes at BM, GH); *Graeffe 22* (BM). VITI LEVU or OVALAU: *Seemann 292* (BM, GH, K, P); *Storck 897* (K lectotype of *Ardisia storckii*; isolectotypes at BM, GH). OVALAU: Mt. Korotolutolu, west of Thawathi, *Smith 8031* (BISH, GH, K, SUVA, UC, US); south of Mt. Korolevu, west of Lovoni Valley, *Smith 7537* (BISH, GH, K, SUVA, UC, US); Wainisavulevu, Lovoni Valley, *Fiji Dept. Agr. 14507* (BISH, K, SUVA). OVALAU, without further locality: *U. S. Expl. Exped.* (US 63445 holotype; isotypes at GH, NY), *Horne 262* (GH, K), *291* (GH, K), *355* (GH, K). KORO: Eastern slope of main ridge, *Smith 977* (BISH, GH, K, NY, UC, US). VANUA LEVU: MBUA: Navotuvotu, summit of Mt. Seatura, *Smith 1656* (BISH, GH, K, NY, UC, US). MATHUATA-THAKAUNDROVE boundary: Crest of Korotini Range, *Smith 551* (BISH, GH, K, NY, UC, US). TAVEUNI: Mt. Manuka, western slope between Somosomo and Wairiki, *Smith 774* (BISH, GH, K, NY, UC, US). MOALA: Above Maloku, *Smith 1345* (BISH, GH, K, NY, UC, US). FIJI, without further locality: *Yeoward 25* (K).

Of the three basionyms here synonymized, Mez reduced *A. vitiensis* to *A. brackenridgei*, but he maintained *A. storckii* as distinct on the basis of its inflorescence having about 5 (rather than 2 or 3) flowers and its leaf-blades being more obscurely glandular-punctate. Among the cited specimens these differences seem inconsequential. Whether the leaf-punctations are obvious or obscure depends upon age and environmental conditions; and the number of flowers and fruits per inflorescence is highly variable. Even in the type of *A. brackenridgei* the fruits vary from 1 to 5 per inflorescence, while on the lectotype of *A. storckii* the flowers may be as many as 7 per inflorescence.

It should be noted that in the present species the ovules are uniseriate on the placenta, a character which in Mez's key and generic description would remove *A. brackenridgei* from *Ardisia*. However, some of his illustrations show an essentially uniseriate placenta with few ovules, and it is apparent that *Ardisia* must be interpreted to include such species. The Fijian taxa are placed by Mez in his subgenus *Tinus* (Burm.) Mez, among a few species with "placentae ovula subpauca (5–10) saepius spurie quasi 1-seriata gerentes." The closest relative of *A. brackenridgei* is noted in Mez's key as the Australian *A. pachyrhachis* F. v. Muell., but the relationship does not seem very close, that species having coriaceous leaf-blades, comparatively numerous flowers, and eciliolate calyx-lobes.

CULTIVATED OR NATURALIZED SPECIES

Ardisia crispa (Thunb.) A. DC. in Trans. Linn. Soc. 17: 124. 1834, in DC. Prodr. 8: 134. 1844; Mez in Pflanzenr. 9(IV. 236): 144. *fig. 22*. 1902.

Bladhia crispa Thunb. Fl. Japon. 97. 1784.

DISTRIBUTION: Eastern Asia, from Sikkim through upper India and China to Hainan, Formosa, and the Ryu Kyus to Japan, the Philippines,

Borneo, and Java; now widely cultivated (cf. Neal, In Gardens of Hawaii, 665. 1965). As introduced into Fiji as an ornamental, the plant is a shrub to 3 m. high occurring from near sea-level to about 200 m.; it seems to be known locally as *Australian holly* and "*crispa*." All the collections cited below are in the Fiji Department of Agriculture series of numbers.

Fiji. VITI LEVU: NAITASIRI: Nanduruloulou, *9811* (BISH, SUVA); Mbatiki (Arboretum), *11745* (BISH, SUVA). REWA: Suva, *16090* (SUVA); Vunikawai, *6065* (SUVA); Lami, *11570* (SUVA).

Ardisia humilis Vahl, Symb. Bot. 3: 40. 1794; Mez in Pflanzenr. 9(IV. 236): 127. *fig. 20, A–E.* 1902; Christophersen in Bishop Mus. Bull. 128: 166. 1935.

DISTRIBUTION: From the Maldive Islands and India eastward to southern China and Malesia to the Philippines and Celebes; frequently cultivated and sometimes naturalized. Its occurrence in Samoa is indicated by a single collection from an erect tree 7–8 m. high, doubtless originally cultivated but now naturalized in woods and open country at elevations of 50–150 m.

Samoa. UPOLU: Vicinity of Apia, *Wilder 79* (BISH).

[To be concluded]

THE GENERA OF LACTUCEAE (COMPOSITAE) IN THE SOUTHEASTERN UNITED STATES [1]

BERYL SIMPSON VUILLEUMIER

Tribe LACTUCEAE Cassini, Jour. Phys. Chim. Hist. Nat. Arts **88**: 151. 1819 [2]

Herbs [or sometimes low shrubs or, exceptionally, small trees], mostly with milky juice and alternate or radical leaves. Heads homogamous. Florets perfect. Corolla with a strap-shaped, 5-toothed limb (ligule). Anthers sagittate or auriculate at the base, usually with small terminal appendages. Style branches short to long, narrowing toward the tip or obtuse; pollen-collecting hairs short to long. Achenes smooth to ribbed and rugose or muricate, often narrowed at the base and terminally beaked; pappus usually of one or more rows of simple or plumose bristles, rarely of scales or lacking. (Tribe Cichorieae Dumortier, Anal. Fam. Pl. 30. 1829; subfam. Cichorioideae Kitamura, Mem. Coll. Sci. Kyoto Univ. B. **13**: 4. 1937, *ibid*. **22**: 77. 1955; subfam. Lactucoideae Solbrig, Taxon **12**: 230. 1963; subfam. Liguliflorae auct., nom. inval.).

About 60–65 genera in five to eight subtribes, the center of diversity in the Mediterranean basin. About 60 species in 17 genera occur in the southeastern United States. Of these, only half are indigenous; the remainder are weedy species introduced primarily from southern Europe.

[1] Prepared for a generic flora of the southeastern United States, a joint project of the Arnold Arboretum and the Gray Herbarium of Harvard University made possible through the support of the National Science Foundation (Grant GB-6459X, principal investigator Carroll E. Wood, Jr.). This treatment follows the format established in the first paper of the series (Jour. Arnold Arb. **39**: 296–346. 1958.) The area covered includes North and South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana. The descriptions are based primarily on species included in this area, with additional data from other taxa between brackets. References that the author has not seen are marked by an asterisk.

I want to particularly thank C. E. Wood, Jr., not only for his advice, but for many additions and for an immense amount of editing. His efforts are especially evident in genera 1–8. Mistakes that remain are to be attributed solely to the author. I am also very grateful to K. L. Chambers for reading and adding to the section on *Krigia*, A. S. Tomb for reviewing the treatment of *Lygodesmia*, and D. K. Northington for numerous suggestions concerning *Pyrrhopappus*. N. Dunkly aided in checking and typing the bibliography and J. E. Hanhisalo typed the remainder of the manuscript. The illustration of *Cichorium* was drawn by L–V. Trautz and that of *Krigia* by K. S. Velmure.

[2] The tribes of the Compositae in the southeastern United States have been treated by Solbrig (Jour. Arnold Arb. **44**: 436–461, 1963). The reader should consult this work for additional information not included here (e.g., familial and tribal descriptions, notes, and references).

The tribe Lactuceae, the most distinctive of the Compositae, has been recognized as a taxonomic unit since A. L. de Jussieu (Gen. Pl. 168. 1789), and many authors still treat it as a subfamily (correctly Cichorioideae Kitamura) of the Compositae. Members of the tribe are easily distinguished by their homogamous heads of perfect flowers with 5-toothed ligulate corollas. Most species are also laticiferous.

There has been little historical agreement about the relationships of genera within the tribe, and numerous subtribal arrangements, the best known of which are those of Bentham & Hooker, Hoffmann, and Stebbins, have been proposed. Bentham & Hooker and Hoffmann considered certain morphological characters, including habit, pappus type, involucre, and receptacular bracts, to be of particular significance in delimiting subtribes. In 1953, Stebbins culminated almost 30 years of work on the Lactuceae with a classification of the tribe based on a completely different conceptual framework from that of any of his predecessors. Instead of trying to find "key" characters, he considered each genus individually and placed it with the genus to which it appeared to be most closely related. By clustering together a greater and greater number of genera and then drawing boundaries where there seemed to be significant discontinuities, he concluded that eight subtribes should be recognized. Although these subtribal groups are for the most part biologically meaningful and represent evolutionary units, they are difficult to characterize and Stebbins himself made no attempt to provide a key to the subtribes because he thought that it would have been impossible.

Stebbins's studies emphasized the value of karyotype, pollen morphology, shape of the style arms, geographical distribution, and ecology, in addition to the more usual morphological criteria. In 1966, Jeffrey, in a modification of Stebbins's scheme, pointed out the value of the size and shape of the pollen-collecting hairs on the style and style-arms and the type of pubescence of the exterior of the corolla tube as additional morphological characters. He concluded that the ligulate Compositae fall into 5 groups comprising 11 subgroups and 23 series, but he did not apply formal taxonomic nomenclature to these because he thought that further work is first necessary and because of his uncertainty of what status — tribal or subfamilial — should be given to the ligulate Compositae within the family. The genera of Lactuceae are here arranged in accordance with Stebbins's subtribal classification, but any modifications in relationships suggested by Jeffrey are noted under each genus.

In considering the Lactuceae as a whole, Stebbins concluded that *Dubyaea* and *Soroseris* come closest to representing the primitive members of the tribe. Data from floral and wood anatomy indicate that these genera are particularly unspecialized anatomically (Stebbins, Carlquist). Both genera have numerous supernumerary bundles in the ovary, a platform of bundles at the base of the ovule, and a lack of fusion between the ovarian and perianth bundles. These characters led Stebbins to postulate that *Dubyaea* was not far removed from an ancestral type that had a superior ovary and a unilocular ovary with two parietal ovules. Similar un-

specialized features have been found in a few members of the Senecioneae and the Mutisieae, but the Lactuceae do not seem to be more closely related to either of these tribes than to any other in the Compositae, and, in fact, Stebbins was unable to ally the Lactuceae with any other tribe in the family.

A compilation of cytological data from 53 genera of the Lactuceae by Stebbins, Jenkins, & Walters indicated that nine is the base number in the tribe. Throughout the tribe, as in the genus *Crepis* (see below), there seems to have been an evolutionary trend in karyotype morphology from large to small chromosomes and from median to subterminal centromeres.

REFERENCES:

AHLES, H. E., C. R. BELL, & A. E. RADFORD. Species new to the flora of North or South Carolina. Rhodora **60:** 10–32. 1958. [*Crepis pulchra*, *Hypochoeris glabra*, *Lapsana communis*, *Leontodon Leysseri*, *Picris hieracioides*, & *Tragopogon dubius*.]

BABCOCK, E. B. The genus *Crepis*. Part I. The taxonomy, phylogeny, distribution, and evolution of *Crepis*. Univ. Calif. Publ. Bot. **21:** 1–198. 1947; Part II. Systematic treatment. *Ibid*. **22:** 199–1030. 1947. [Both a comprehensive treatment of *Crepis*, and a thoroughly documented study of evolutionary changes.]

——— & G. L. STEBBINS. Systematic studies in the Cichorieae. *Ibid*. **18:** 227–240. 1943.

———, ———, & J. A. JENKINS. Chromosomes and phylogeny in some genera of the Crepidinae. Cytologia Fijii Jubil. Vol. 188–210. 1937. [*Prenanthes*, *Dubyaea*, *Lactuca*, *Cephalorrhynchus*, *Youngia*, *Ixeris*.]

BENTHAM, G. Notes on the classification, history, and geographical distribution of Compositae. Jour. Linn. Soc. Bot. **13:** 335–582. *pls. 8–11*. 1873. [Cichoriaceae, 389, 390; 475–480.]

——— & J. D. HOOKER. Gen. Pl. **2:** 163–533. 1873. [Tribus Cichoriaceae, 168, 169; 219–223; 504–533; subtribal classification, 219–223; *Cichorium*, 506; *Krigia*, 507; *Pyrrhopappus*, 523; *Lygodesmia*, 530; *Tragopogon*, 530; *Hypochoeris*, 519; *Leontodon*, 520; *Picris*, 511; *Sonchus*, 528; *Hieracium*, 516; *Prenanthes*, 527; *Lactuca*, 524; *Lapsana*, 509; *Taraxacum*, 522; *Crepis*, 513 (including *Youngia*, 514).]

BOBROV, E. G., & N. N. TSVELEV. Compositae subfamily Cichorioideae. Fl. URSS. **29:** i–xxiv, 1–796. 1964. [All genera except *Hieracium*; cf. vol. **30.**]

BOLKHOVSKIKH, Z., V. GRIF, T. MATVEJEVA, & O. ZAKHARYEVA. Chromosome numbers of flowering plants. Ed. by A. D. FEDOROV. (Russian and English prefaces.) 926 pp. Leningrad. 1969. [Asteraceae, 60–148.]

CARLQUIST, S. Wood anatomy of Cichorieae (Compositae). Trop. Woods **112:** 65–91. *pls. 1–5*. 1960. [Confirms some of Babcock and Stebbins's theories concerning the least specialized members of the tribe.]

CASSINI, H. Ébauche de la synanthérologie. Huitième mémoire. Le tableau méthodique des genres de la tribu des Lactucées. Opusc. Phytol. **1:** 378–426. 1826. [Previously published in Dict. Sci. Nat. **25:** 59–89. 1822.]

CHATTERJEE, T., & K. SHARMA. Cytotaxonomy of Cichorieae. Genetica **40:** 577–590. 1969.

DON, D. An attempt at a new classification of the Cichoraceae, with some ob-

servations on the geographical distribution of this family. Edinburgh New Philos. Jour. **6:** 305–311. 1829.

FOURNIER, P. Le livre des plantes médicinales et vénéneuses de France. 3 vols. Paris. 1947–48. [Contains common names and folklore concerning many of our genera that are native to the Mediterranean area.]

GUSTAFSSON, Å. Apomixis in higher plants. Part I. The mechanism of apomixis. Acta Univ. Lund. II. Afd. 2. **42**(3): 1–68. 1946; Part II. The causal aspect of apomixis. *Ibid.* **43**(2): 69–180. 1947; Part III. Biotype and species formation. *Ibid.* **43**(12): 181–370. 1947.

HEGI, G. Dicotyledones (V. Teil). Sympetalae (Schluss der Compositae). Illus. Fl. Mittel-Europa **6:** 549–1008. *pls. 264–274.* 1928; 1009–1152 *pls. 275–277.* 1928; 1153–1351. *pls. 278–280.* 1929. [*Cichorium*, 992–1000; *Lapsana*, 1000–1002; *Hypochoeris*, 1008–1016; *Leontodon*, 1017–1035; *Picris*, 1035–1042; *Tragopogon*, 1042–1053; *Taraxacum*, 1078–1096; *Sonchus*, 1101–1110; *Lactuca*, 1113–1134; *Crepis*, 1134–1180; *Prenanthes*, 1180–1182; *Hieracium*, 1182–1351. A very thorough treatment of the taxonomy, nomenclature, anatomy, and ecology of many genera and species introduced from southern Europe into the United States.]

HOFFMANN, O. Compositae. Liguliflorae-Cichorieae. Nat. Pflanzenfam. IV. **5:** 350–368. 1893; 369–387. 1894. [*Cichorium*, 356; *Krigia*, 358 (*Serinia*, 357); *Pyrrhopappus* (as *Sitilias*), 373; *Lygodesmia*, 372; *Tragopogon*, 365; *Hypochoeris*, 361; *Leontodon*, 363; *Picris*, 364; *Sonchus*, 371; *Hieracium*, 375; *Prenanthes*, 375; *Lactuca*, 371; *Lapsana*, 357; *Taraxacum*, 370; *Crepis*, 373 (including *Youngia*, 374).]

HOPPER, W. E. R. Seed formation, germination, and post-germination development in certain Cichorieae. Trans. Illinois Acad. Sci. **34:** 70–72. 1941.*

JEFFREY, C. Notes on Compositae: I. The Cichorieae in East Tropical Africa. Kew Bull. **18:** 427–486. 1966. [Includes outline of a refined classification of Cichorieae.]

KNUTH, P. Compositae. Handbuch der Blüthenbiologie **3**(2): 213–237. 1905. [*Krigia*, 237; *Tragopogon*, 237; *Taraxacum*, 237.]

LEDIN, R. B. The Compositae of South Florida. Quart. Jour. Florida Acad. Sci. **14:** 51–207. 1951. [*Lygodesmia*, 173; *Hieracium*, 173; *Lactuca*, 174; *Sonchus*, 177.]

NYGREN, A. Apomixis in the Angiosperms. II. Bot. Rev. **20:** 577–649. 1954. [*Hieracium*, 583; *Taraxacum*, 586.]

RICKETT, H. W. Wild flowers of the United States. vol. 2. The southeastern states. Part 2. New York. 1966. [*Cichorium*, 636, *pl. 238*; *Krigia*, 642, *pl. 240*; *Pyrrhopappus*, 642, *pl. 239*; *Picris*, 645, *pl. 240*; *Sonchus*, 645, *pl. 239*; *Hieracium*, 642, *pl. 240*; *Prenanthes*, 636, *pl. 238*; *Lactuca*, 638, *pl. 239*; *Taraxacum*, 640, *pl. 239*; *Crepis*, 644.]

SCHULTZ BIPONTINUS, C. H. Tribe Cichorieae. *In*: P. B. WEBB & S. BERTHELOT, Hist. Nat. Isles Canaries **3**(pt. 2, sect. 2): 386–473. 1842–1850. [Includes several new subtribes and infrageneric categories.]

———. Beitrag zum Systeme der Cichoriaceen. Jahresb. Pollichia **22–24:** 296–322. 1866.

SOLBRIG, O. Subfamilial nomenclature of Compositae. Taxon **12:** 229–235. 1963.

STEBBINS, G. L., JR. A new classification of the tribe Cichorieae, family Compositae. Madroño **12:** 65–81. 1953.

———, J. A. JENKINS, & M. S. WALTERS. Chromosomes and phylogeny in the Compositae, tribe Cichorieae. Univ. Calif. Publ. Bot. **26:** 401–429. 1953.

WODEHOUSE, R. P. Pollen grains. xv & 574 pp. New York & London. 1935. [Cichorieae, 457–488. Describes the complex exines in the tribe. *Plate 11* illustrates pollen of several species.]

ZANDER, R. [i.e., F. H. W. R. ZANDER.] Die Milchsafthaare der Cichoriaceen. Eine anatomisch-physiologische Studie. Bibliot. Bot. **7**(Heft 37): 1–44. *2 pls*. 1896.

KEY TO THE GENERA OF LACTUCEAE IN THE SOUTHEASTERN UNITED STATES

A. Pappus of small scales, or of membranaceous scales and bristles, or absent.
  B. Pappus of numerous small truncate scales in one or two rows crowning the achenes; flowers sky blue (pink or white). ..... 1. *Cichorium*.
  B. Pappus of bristles and scales, or of a single row of pointed scales, or absent; flowers yellow to orange.
    C. Pappus of simple bristles and scales, or of a single row of pointed scales. ..... 2. *Krigia*.
    C. Pappus absent; annuals.
      D. Involucre of 2 series (8 erect bracts and a short outer series); leaves cauline with numerous heads paniculately arranged. ..... 15. *Lapsana*.
      D. Involucre of a single series of bracts, cuplike in fruit; stems reduced, heads on slender peduncles. ..... 2. *Krigia*.
A. Pappus of simple and/or plumose bristles in one or more series.
  E. Pappus of plumose bristles or of both plumose and simple bristles.
    F. Plants with a basal rosette of leaves, essentially scapose, leaves on flowering stems reduced; involucre of more than one series of bracts.
      G. Receptacle with a flat scale subtending each flower. ..... 6. *Hypochoeris*.
      G. Receptacle naked, without scales. ..... 7. *Leontodon*.
    F. Plants with leafy flowering stems.
      H. Leaves narrow, grass-like, the plant glabrous or with only floccose pubescence and glabrate with age; involucre of a single series of bracts; achenes slender-beaked. ..... 5. *Tragopogon*.
      H. Leaves broad, rough-hairy with coarse multicellular hairs, these either pointed or bifurcate-hooked at tip; involucre of more than one series of bracts; achenes beakless. ..... 8. *Picris*.
  E. Pappus of one or more series of simple setose and/or capillary hairs, never plumose.
    I. Achenes essentially cylindrical, columnar, fusiform, not strongly flattened.
      J. Leaves greatly reduced, usually to scales; stems stiff; heads with a slender involucre, 5–10-flowered; corolla rose-purple (rarely white); achenes long-tapering upward. ..... 4. *Lygodesmia*.
      J. Leaves evident, in a basal rosette or cauline.
        K. Involucral bracts in a single series of ± equal height, sometimes with a tiny basal ring of small bracts; achenes beakless; flowers yellow.
          L. Achenes ± compressed, but not strongly flattened, with unequal ribbing; inflorescence of numerous small heads. ..... 16. *Youngia*.
          L. Achenes ± cylindrical and equally ribbed; inflorescence of few to several medium-sized heads. ..... 17. *Crepis*.

K. Involucral bracts in two distinct series or in several overlapping series.
M. Achenes conspicuously beaked.
N. Achenes not muricate, 4- or 5-ribbed; leafy-stemmed plants or sometimes scapose; pappus with a minute villous ring below. ..... 3. *Pyrrhopappus*.
N. Achenes with 8 prominent ribs, strongly muricate above; scapose plants, the scapes 1-headed, hollow; pappus without a villous ring. ..... 14. *Taraxacum*.
M. Achenes truncate, not beaked.
O. Pappus white, composed of both straight bristles and soft, downlike ones; leaves glabrous, the margins with weak prickles; flowers yellow ..... 10. *Launaea*.
O. Pappus of numerous capillary filaments; leaves never with marginal prickles.
P. Inflorescence a branching raceme or panicle of drooping (rarely ascending) heads; involucre slender, cylindrical; flowers whitish, creamy, or pink; lower leaves often divided or deeply lobed. ..... 12. *Prenanthes*.
P. Inflorescence of 1 to many erect or ascending heads, mostly in corymbs or panicles; involucre campanulate; flowers yellow (orange-red in *H. aurantiacum*); leaves entire or only toothed. ..... 11. *Hieracium*.
I. Achenes flat or flattened, involucral bracts imbricated; stems mostly leafy.
Q. Achenes beakless; pappus white, composed of straight bristles and fine down-like hairs intermixed; flowers yellow ..... 9. *Sonchus*.
Q. Achenes beaked or short tapering at the apex; pappus white to tan; flowers yellow, purple, or blue. ..... 13. *Lactuca*.

Subtribe **Hyoseridinae** Lessing, Synopsis 127. 1832, "Hyoserideae."

1. **Cichorium** Linnaeus, Sp. Pl. 2: 813. 1753; Gen. Pl. ed. 5. 354. 1754.

Erect, caulescent perennial [biennial or annual] glabrous or pubescent herbs with petiolate, oblanceolate [lanceolate], parted or dentate [crisped] basal leaves, and alternate, lanceolate, dentate, clasping stem leaves becoming smaller and more entire upward along the stem. Heads homogamous, radiate, 1–3 in leaf axils, shortly pedunculate, or sessile, or terminal and solitary. Involucre of 2 series of bracts: the outer short, ovate to lanceolate, spreading; the inner much longer, lanceolate, rigid, upright, concave at the base where each clasps an achene; receptacle flat, naked. Corolla blue (pink or white), pubescent at top of corolla tube with slender hairs, except abaxially. Anthers with short basal auricles; pollen basically spherical and usually 3-pored and with an elaborate pattern of conical spines surmounting the structure (cf. Wodehouse, *plate 11, fig. 6*). Style branches long, thin, rounded at the apex. Achenes 5-angled, truncate at the apex, sometimes concave at the base, glabrous; pappus of one or two series of very short, flat, truncated scales forming a short crown atop the achene. LECTOTYPE SPECIES: *Cichorium Intybus*

L.; see Britton & Brown, Illus., Fl. No. U.S. ed. 2. 3: 305. 1913. (Origin of name disputed; according to Pliny from Egyptian and to Forsköl from Arabic, but according to Theophrastes and Dioscorides from Greek *kichorion*, of the fields, an appropriate derivation). — CHICORY.

A genus of some four to nine species usually considered to fall into two sections. Section CICHORIUM, including the majority of the species, all of which are native to Europe and the Mediterranean area, is distinguished by the many-floreted heads and glabrous plant bodies. Section ACANTHOPHYTON (Less.) DC. contains only a single species of middle Europe, Rhodes, and Cyprus, *C. spinosum L.*, which has spiny stems and heads with only six florets. Only the introduced *C. Intybus* L., chicory, chiccory, $2n = 18$, has become established in North America. This species, native to the mountains of northern Europe, now occurs in weedy habitats across southern Canada and in the United States from Maine to Washington state and south to California and Texas, in the west, and Georgia and Mississippi in the east.[3]

No serious attempt seems to have been made recently to analyze the extensive geographical variation present in *Chicorium Intybus*, and numerous infraspecific taxa have been recognized. Some polymorphic characters have been investigated and have been shown to be caused by the action of a single major gene (e.g., Rick has shown that the blue flower color is dominant over mauve (pink) in the Radichetta variety of chicory, and that long internodes are dominant to short).

Cichorium Intybus is most closely related to *C. Endivia* L., endive, $2n = 18$ (but some varieties with $2n = 36$). Bentham suggested that the two are conspecific, but recent biosystematic work has tended to confirm their more traditional treatment as distinct species. Rick found that the breeding systems of the two are different, *C. Intybus* being self-sterile and *C. Endiva* self-fertile. Nevertheless, natural hybrids are sometimes found and are easy to produce artificially. The close relationship of the two is shown by the complete bivalent pairing found in 209 out of 210 meiotic cells investigated from F_1 hybrids. Two cytogenetic differences were, however, discernible in the genomes of the parental varieties examined: one pair of chromosomes was unequal in length, indicating a deletion, and one pair formed bridges at meiosis in the hybrid, suggesting the presence of a translocation.

Because of its ready availability and ease of cultivation, *Cichorium Endivia* has been used as an experimental plant in numerous physiological studies. It is a winter annual and needs cold to stimulate maturation and flowering. Experiments have shown that only regular, frequent applications of gibberellin (but only at certain favorable temperatures) can duplicate the long-term effects of cold. Cold apparently stimulates the production of a substance similar to gibberellin.

[3] Small (p. 1490) lists this species as occurring in Florida, but I can find no specimen, nor a citation of one, from any locality south of Georgia and Mississippi, although Ledin includes it as a garden plant in southern Florida.

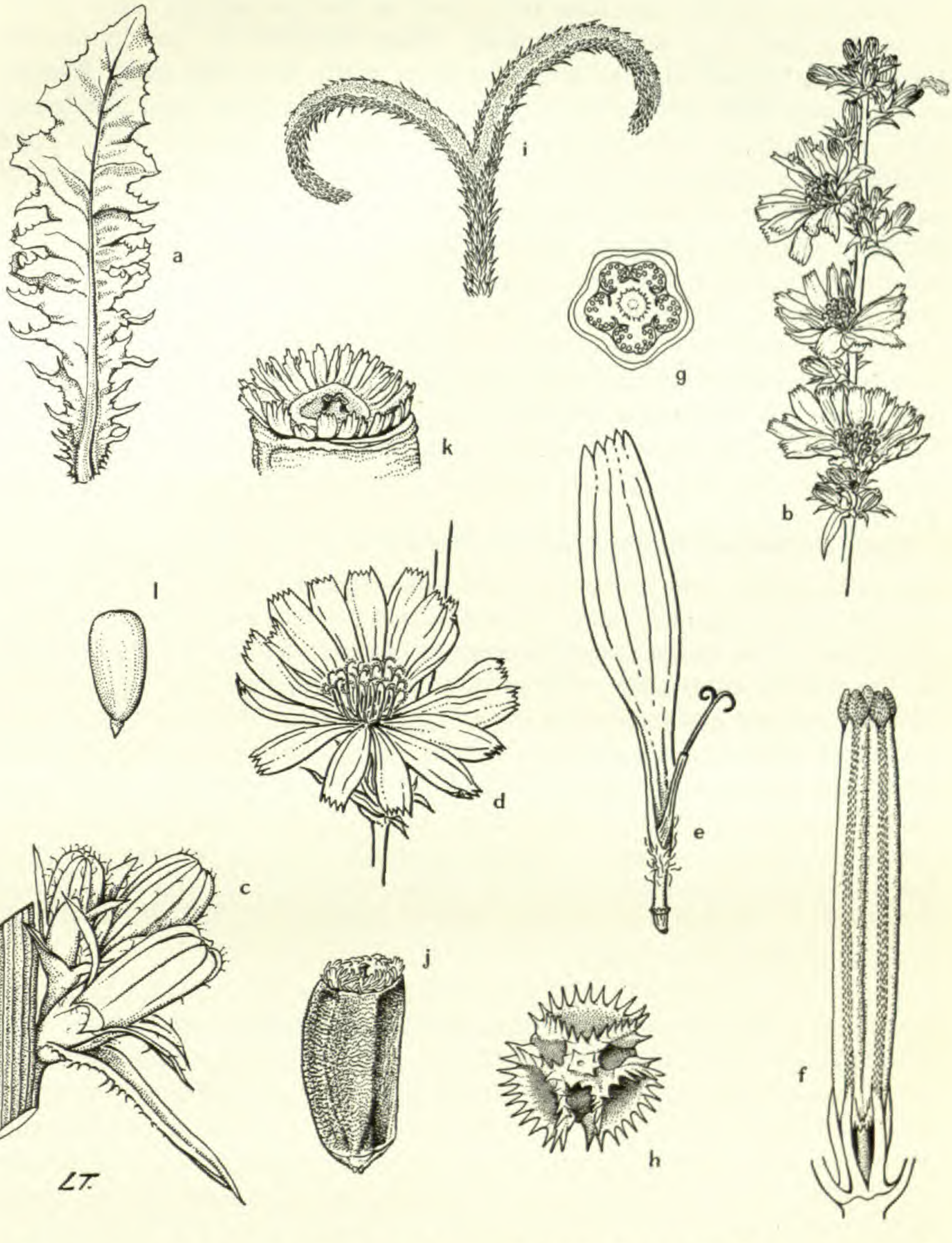


FIGURE 1. **Cichorium.** a–l, *C. Intybus*: a, basal leaf, × 1/4; b, upper part of flowering stem, × 1/2; c, glomerule of heads in axil of bract, lowermost head after anthesis, the corollas fallen — note two series of involucral bracts, × 2; d, head at anthesis, × 1; e, flower, × 4; f, androecium from bud just before anthesis, style not shown — note apical and basal appendages, × 8; g, cross section of flower bud just before anthesis, showing corolla, five coherent anthers (locules of adjacent anthers confluent), and style with pollen-collecting hairs, × 20; h, pollen grain in polar view, diameter ca. 40 μm. (after Wodehouse); i, upper part of style with stigmas, × 15; j, achene in lateral view, abaxial surface to left, × 12; k, detail of pappus of scales, from adaxial side of achene — note persistent style base, × 20; l, seed with papery seed coat, oriented as in achene, cotyledons of embryo parallel with page, × 8.

Cichorium Intybus has long been used in Europe and northern Africa as both a medicinal and food plant. Pliny recorded its use in ancient Egypt as a "friend of the liver." Extracts made from the roots, flowers, and achenes have been used as diuretics and laxatives, and the leaves have been applied externally to help heal infections. Recent studies have shown that a compound that has positive bacteriostatic effects is present in roasted or dried roots. The chemical, isolated by chromatography, effectively inhibits numerous microörganisms and is possibly responsible for the efficacy of extracts of chicory in treating gall-bladder and kidney and infections. Although not positively identified, comparative chemical reactions suggest that the principle may be a sesquiterpene.

Ground, roasted chicory root has been used for making a beverage since the late eighteenth century, and is today frequently substituted for, or mixed with, coffee to which it imparts a bitter taste. The stimulatory effects of chicory are probably due to the glucoside chicorin ($C_{32}H_{34}O_{10}$).

Both *Cichorium Intybus* and *C. Endivia* are cultivated as greens that are eaten either raw or cooked, and considerable confusion stems from popular names applied to the various forms of the two species. In Great Britain all forms of the two are known as *chicory* and *endive*, respectively; in the United States the wild naturalized *C. Intybus* and its root are *chicory*, but the blanched leafy form imported from Belgium (where it is known as *witloof, barbe-de-bouc, or chicorée de Bruxelles*) is *Belgian endive*; the curly-leaved form of *C. Endivia* is *chicory*, while the flat-leaved form is *endive* or *escarole*. In France, the wild plant and root of *C. Intybus* are *chicorée*, *chicorée sauvage*, or *barbe de capucin*; the blanched, leafy cultivated forms are *endive* or *endive de Belgique*; the curly-leaved forms of *C. Endivia* are *endive frisée*, and the flat-leaved forms are *escarole*, *scarole*, or *scariole*.

Generically, *Cichorium* is rather isolated within the subtribe Hyoseridinae Less., but on morphological grounds it appears to belong with *Hymenonema* Cass. and *Catananche* L. (cf. Cassini and Stebbins), two small genera also native to the Mediterranean area. Jeffrey also considered it isolated and treated it as the only member of his *Cichorium*-subgroup, of the *Cichorium*-group that includes, among others, *Dubyaea*, *Prenanthes*, *Crepis*, *Taraxacum*, *Chondrilla*, and *Launaea*. In his classification, *Hymenonema* and *Catananche* are members of the *Tolpis*-group.

REFERENCES:

Under tribal references see BENTHAM, BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, CASSINI, FOURNIER, JEFFREY, LEDIN, RICKETT, STEBBINS, and WODEHOUSE.

BAILEY, W. W. Chicory. Am. Bot. **13:** 54–66. 1907.

DOORENBOS, J., & P. C. RIEMENS. Effect of vernalization and daylength on number and shape of leaves in chicory and endive. Acta Bot. Neerl. **8:** 63–67. 1959.

GRIER, N. M. Notes on variation in chicory. Am. Midl. Nat. **6:** 148–149. 1919.

GRODZÍNSKA-ZACHWEIJA, A., W. KAHL, & W. PASEK. Bacteriostatic action of chicory (*Cichorium Intybus* L.). Bull. Acad. Polon. Sci. Biol. **10:** 513–517. 1962.

KNOBLOCH, I. W. Developmental anatomy of chicory — the root. Phytomorphology **4:** 47–54. 1954.

MONTAGNÉ, P. Larousse gastronomique. English ed. (Transl. by N. FROUD, P. GRAY, M. MURDOCK, & B. M. TAYLOR.) C. TURGEON & N. FROUD, eds. 1101 pp. New York. 1961. [cf. pp. 269, 400, 403.]

RAPPAPORT, L., & J. BONNER. Interactions of gibberellin, vernalization, photoperiod and temperature in the flowering of endive. Pl. Physiol. **35:** 90–102. 1960.

RICK, C. M. Chicory-endive hybridization. Calif. Agr. **7:** 7. 1953.

STOUT, A. B. Duplication and cohesion in the main axis in *Chicorium Intybus*. Brooklyn Bot. Gard. Mem. **1:** 480–485. *pl. 12. fig. 1.* 1918.

Subtribe **Microseridinae** Stebbins in Solbrig, Taxon **12:** 234. 1963.

2. **Krigia** Schreber, Linn. Gen. Pl. **2:** 532. 1791, nom. cons.

Low annual or perennial herbs, sometimes with a short perennial caudex or a small underground tuber. Leaves basal or alternate, petiolate, simple, entire, toothed, or pinnately to lyrately lobed; cauline leaves sometimes sessile. Flowering stems caulescent or scapose, monocephalous or branched with the heads on long peduncles. Involucre of 1 or 2 series of narrow equal-sized bracts reflexed at maturity or becoming somewhat thickened and standing upright to form a cup surrounding the achenes; receptacle flat to slightly convex, naked or fimbrillate. Florets perfect. Corolla ligulate, monochromatic, yellow to orange. Anthers with short terminal appendages and small, inconspicuous tails. Style branches obovate, short, flat. Achenes cylindrical or angled, truncate at apex and tapering at base, 10–15-ribbed, glabrous or pubescent; pappus double, the inner pappus capillary, the outer of short, flattened scales, or pappus of a few short scales, or reduced to a minute scaly crown, or altogether absent. (Including *Apogon* Ell., *Cymbia* (Torrey & Gray) Standley, *Cynthia* D. Don [nom. superfluum], *Serinia* Raf., *Troximon* Gaertner.) TYPE SPECIES: *K. virginica* (L.) Willd. (*Tragopogon virginicum* L.), typus cons. (Named for David Krieg, a German physician born in the 17th century, who was among the first plant collectors in Maryland.) — DWARF DANDELIONS.

A genus of seven species in two sections (Shinners) endemic to temperate North America, six of the species occurring in the southeastern United States. The species are rather sharply defined and often can be distinguished on the basis of the pappus alone. Numerous authors have assigned the species to two or three genera, but the inclusion of all in a single genus (cf. Stebbins, Shinners, Chambers) seems more meaningful biologically in view of the great similarity in structure of florets, achenes, involucre, and foliage.

Section KRIGIA (sect. *Eucynthia* (DC.) Shinners, sect. *Eukrigia* Torrey

& Gray, subg. *Cynthia* (D. Don) Gray; *Troximon* Gaertner; *Cynthia* D. Don, *Cynthia* sect. *Adopogon* DC.) includes four species, all with heads with 8–16 involucral bracts that are reflexed at maturity. *Krigia Dandelion* (L.) Nutt., $2n = 59$ (probably 60), derives its vernacular name, potato-dandelion, from the small ovoid to spherical tuber some 0.5–6 cm. underground from which the caudex of the season grows. Individual plants produce at or near the surface of the ground slender stolons that develop at their tips either rosettes of leaves or tubers (of two internodes; cf. Holm, 1891) that produce a leafy sprout the following season. The heads are solitary on naked scapes, and the pappus is composed of 25–45 unequal bristles 5–8 mm. long and 10 oblong-lanceolate scales. The plant is distributed mainly on the Coastal Plain from Florida to southeastern Texas, northward to New Jersey, Kentucky, Illinois, Missouri, and Kansas. Also perennial but lacking tubers and having more or less leafy stems, *K. montana* (Michx.) Nutt., $2n = 20$, occurs mostly on wet, open rocks in the mountains of western North Carolina, eastern Tennessee, and northern Georgia. The pappus is composed of 15–25 bristles 4.5–6 mm. long and 5 oblong-oval scales. A third perennial, *K. biflora* (Walter) Blake, $2n = 10, 20$, is widely distributed from North Carolina and Georgia to Arkansas, northward to Massachusetts and Minnesota, and has remarkable disjunct occurrences in Colorado, New Mexico, and Arizona. The stem leaves are few and reduced, the flowering peduncles come from the axils of reduced leafy bracts, and the pappus is composed of 20–40 unequal bristles 4.5–5.5 mm. long and of about 10 oblong-ovate or oblong-lanceolate scales. The annual *K. virginica*, $2n = 10$, is the most widely distributed of the species, occurring from Florida to Texas, north to Maine, Vermont, Ontario, Michigan, Wisconsin, and Iowa. The involucral bracts are much shorter than in the preceding species, and the reduced pappus is composed of five bristles 4.5–5 mm. long, alternating with five truncate scales.

The three annual species composing section CYMBIA Torrey & Gray (sect. *Bellidion* Scheele; *Apogon* Ell., *Cymbia* (Torrey & Gray) Standley, *Serinia* Raf.) have heads with 4–10 involucral bracts that remain upright, the involucre being more or less cuplike at maturity. It seems likely that the involucre of these plants may function like a splash-cup in the dispersal of the achenes, which either lack a pappus or have a greatly reduced one. In *Krigia occidentalis* Nutt. the pappus is composed of five bristles only 1.2–2 mm. long and five scales 0.4–0.6 mm. long, while in both *K. cespitosa* (Raf.) K. L. Chambers (*K. oppositifolia*, nom. invalidum),[4] $2n = 8$, and *K. gracilis* (DC.) Shinners the pappus is either com-

[4] **Krigia cespitosa** (Raf.) K. L. Chambers, comb. nov. *Serinia cespitosa* Raf. Florula Ludoviciana 149. 1817. *Krigia ? oppositifolia* Raf. *loc. cit.* 57, nomen invalidum.

On page 57 of his *Florula Ludoviciana* Rafinesque gave the name of this plant as *Krigia ? oppositifolia* Raf., but under "Additions" on page 149 of the same work he wrote, "Sp. 175. *Krigia oppositifolia*, must rather be called *Serinia cespitosa* Raf. The genus *Serinia* differs from *Krigia* by the naked seeds; the name means *small chicory*." Shinners (*Wrightia* **1**: 202. 1947) and Merrill (*Index Rafinesquianus*, 241. 1949) treated *Serinia cespitosa* as a substitute name (nomen novum) for *Krigia oppositifolia*, as

pletely lacking or is reduced to a minute scaly crown up to 0.2 mm. long. The involucres of *K. cespitosa* are only 3–4.3 mm. tall in flower, and the corollas are only 2–4 mm. long, while those of *K. gracilis* are 5.3–8.3 and 5–10 mm., respectively. *Krigia occidentalis* occurs from southeastern and eastern Texas westward to the plains region of Texas, northward to Oklahoma, Arkansas, and southwestern Missouri; *K. cespitosa* in spite of its lack of pappus, is widely distributed from Florida and Texas, northward to North Carolina, Tennessee, southern Illinois, Arkansas, Kansas, and Oklahoma; and *K. gracilis* is endemic to Texas, from the southern part of eastern Texas, westward to the plains region. Shinners notes that *K. cespitosa* often grows with either *K. occidentalis* or *K. gracilis* but intergrades do not seem to occur.

Plants of the annual *Krigia virginica* generally have two flowering forms. Plants in spring have the leaves crowded in a rosette, are almost scapose and largely unbranched. After flowering and fruiting, the plants tend to die back, losing most of the basal leaves, but later begin to grow and flower again, becoming more branched, taller, and often bushy in appearance, with slender, mostly entire leaves (cf. Holm, Shinners).

Chromosome numbers reported for three of the four species of sect. KRIGIA form a polyploid series, $2n = 10$, 20, and 60 (59). Both diploids and tetraploids have been found in *K. biflora* by Chambers, who reported that the tetraploids behave as autoploids and have reduced pollen fertility. *Krigia montana*, a tetraploid, has high pollen fertility. Chambers found near Asheville, N. C., a hexaploid population ($2n = 30$) that may have originated by allopolyploidy from hybrids between diploid *K. biflora*, $2n = 10$, and *K. montana*, $2n = 20$. The hexaploid shows somewhat irregular meiosis but greater pollen fertility than tetraploid *K. biflora*. Morphologically, the hexaploid is most likely to be confused with *K. montana* "which it resembles in the 'key' character of a leafy-bracted inflorescence," although in flower color and some details of the inflorescence and fruit it varies in the direction of *K. biflora*. In crossing attempts involving the two species and the hexaploid, seedlings were obtained from *K. montana* × *K. biflora* ($4x$) and from hexaploid × *K. biflora* ($4x$). No other hybrids, either artificial or natural, seem to have been reported.

In sect. CYMBIA, the chromosome number of *Krigia cespitosa* has been reported as $2n = 8(?)$. Other counts for this species, as well as for the others in the section, are needed before the significance of this number in relation to those found in sect. KRIGIA can be determined.

---

though page 57 of *Florula Ludoviciana* had priority over page 149 of the same book (all of which was published at the same time). Other authors, some of whom use the combination *Serinia oppositifolia* (Raf.) Kuntze for this species, have treated the two names in the same way. Page priority, however, is not recognized under the International Code of Botanical Nomenclature. Because of the correction made by Rafinesque on page 149, it is clear that *Krigia oppositifolia* Raf. was "not accepted by the author in the original publication" (ICBN, 1972, Art. 34) and was therefore not validly published. *Serinia cespitosa* Raf. is a validly published name and the basionym for the combination made here. I am grateful to Dr. Carroll Wood for his helpful advice on this nomenclatural problem. — K. L. CHAMBERS, Oregon State University, Corvallis, Oregon 97331.

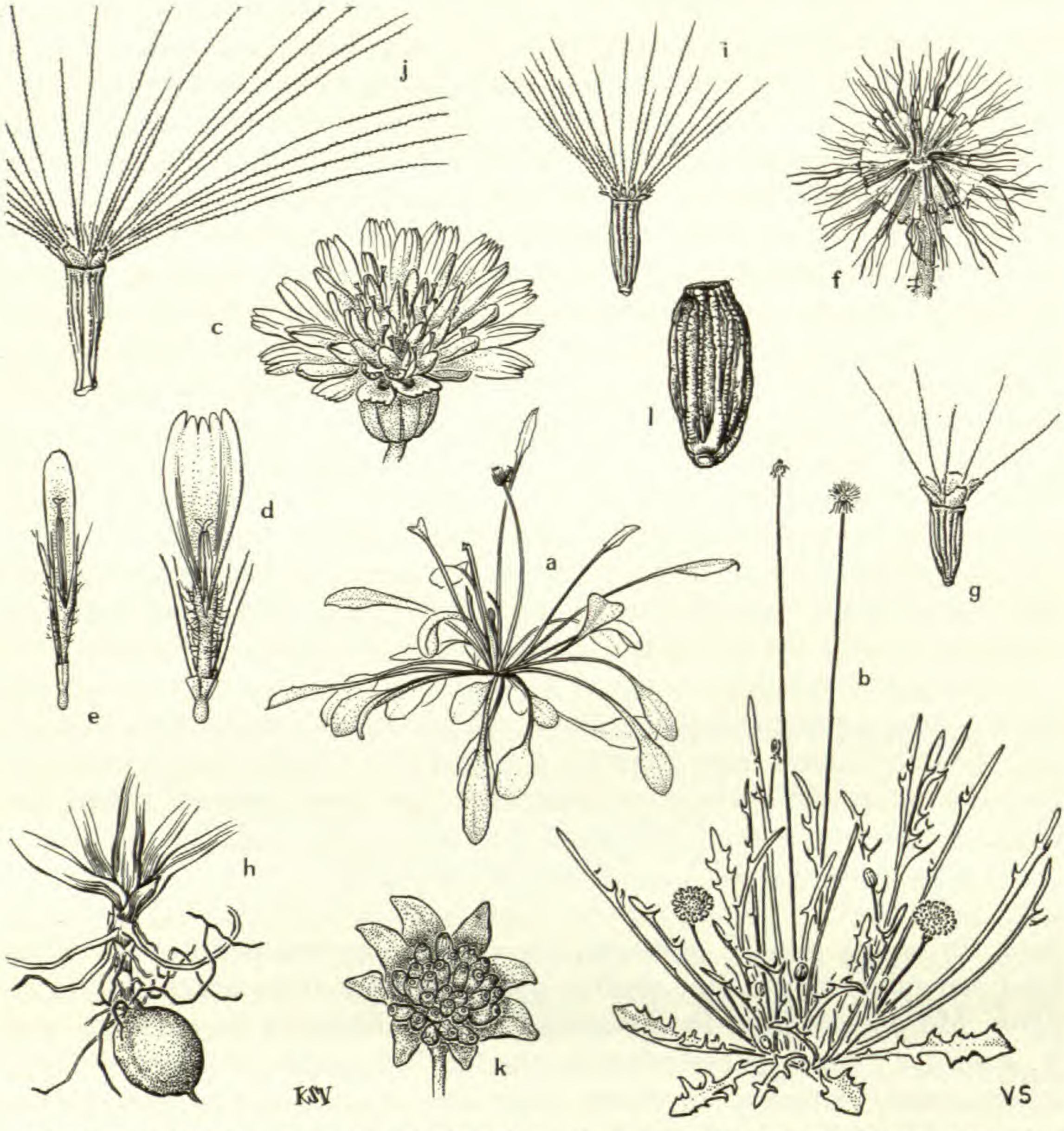


FIGURE 2. **Krigia.** a–g, *K. virginica*: a, plant in early spring phase, flowering about to begin, × 1/2; b, plant in later flowering phase, × 1/2; c, head of flowers, tips of involucral bracts not visible, × 3; d, flower from outer part of head, × 6; e, flower from center of head, × 6; f, head in fruit, only some flowers pollinated, to show spherical arrangement of achenes, the involucral bracts reflexed, not visible, × 3; g, achene — note pappus of five bristles and five scales, × 6. h, i, *K. Dandelion*: h, base of plant showing tuber, × 1; i, achene with pappus of scales and bristles, × 6. j, *K. biflora*: achene, with pappus of scales and long bristles, × 6. k, l, *K. cespitosa*: k, cuplike involucre with mature achenes, × 3; l, achene, × 12.

At least *K. virginica* and *K. cespitosa* seem to be self-compatible, and both set varying numbers of fruit in the absence of pollinators. The heads of flowers expand in the morning in sunlight, close in early afternoon. In both species an individual head opens for about three successive days (obs. C. E. Wood).

The anatomy of *Krigia Dandelion* was investigated by Holm, who found in the root, in addition to the usual articulated laticiferous ducts that occur in root, stem, and leaf, a series of endodermal oil ducts that cor-

respond to those found in some other Lactuceae but contain no oil. These ducts appear to be rare in the Compositae but have been found in *Scorzonera*, *Scolymus*, and *Tragopogon*, all members of the Lactuceae but none related to *Krigia*.

Bentham & Hooker assigned *Krigia* to subtribe Hyoseridinae, placing it in their classification between *Microseris* and *Phalacroseris*, but assigned *Serinia* (as *Apogon*), here included in *Krigia*, to subtribe Lapsaninae, along with *Hispidella* and *Lapsana*. Hoffmann maintained *Krigia* and *Serinia* as separate genera but assigned them to a rather heterogeneous subtribe Cichoriinae, which included 20 genera. In contrast, Stebbins assigned *Krigia* (including *Serinia*) to subtribe Microseridinae, which included *Pyrrhopappus*, to which he thought *Krigia* closely related, and Jeffrey also associated *Krigia* with *Pyrrhopappus*, *Picrosia*, and *Microseris* in the *Microseris*-series of his *Microseris*-subgroup, *Tolpis*-group. However, K. L. Chambers, who is studying the biosystematics of the group, comments that "*Krigia* is a very cohesive genus which is quite isolated taxonomically from the other genera that are placed with it in the subtribe Microseridinae" (Letter, Aug. 1972).

The genus has no economic importance, although several of the annual species are sometimes minor weeds in cultivated ground.

REFERENCES:

Under tribal references see BENTHAM & HOOKER, HOFFMANN, JEFFREY, KNUTH, RICKETT, and STEBBINS.

CHAMBERS, K. L. An allopolyploid *Krigia* from the southern Appalachians. (Abstr.) Am. Jour. Bot. **52:** 648. 1965.

FERNALD, M. L. New or recently restudied plants of eastern North America. [Part 5 in Contr. Gray Herb. 72.] Rhodora **26:** 122–127. 1924. [126, 127, *Troximon* Gaertner has priority over *Cynthia* D. Don when *Cynthia* is maintained as distinct from *Krigia*. Note, however, that under the present Code *Cynthia* is a superfluous name, since it included the type of *Troximon* (*T. virginicum* (L.) F. W. Schmidt = *K. biflora*).]

HOLM, T. Notes upon *Uvularia*, *Oakesia*, *Diclytra* and *Krigia*. Bull. Torrey Bot. Club **18:** 1–11. *pls. 111–113*. 1891. [Describes and figures tubers of *K. Dandelion*.]

———. Studies in the Compositae. I. *Krigia virginica* (L.) Willd. Am. Midl. Nat. **10:** 1–17. *figs. 1–15*. 1926.

SCHULTZ BIPONTINUS, C. H. Beitrag zum Systeme der Cichoriaceen. Pollichia **22–24:** 296–322. 1866. [Transfers *Apogon* to *Agoseris*; includes discussion of *Krigia* and *Troximon*, 299–305. Reprinted with changed pagination.]

SHINNERS, L. H. Revision of the genus *Krigia* Schreber. Wrightia **1:** 187–206. 1947.

STANDLEY, P. C. A revision of the cichoriaceous genera *Krigia*, *Cynthia*, and *Cymbia*. Contr. U.S. Natl. Herb. **13:** 351–357. 1911.

3. **Pyrrhopappus** A. P. de Candolle, Prodr. 7: 144. 1838, nom. cons.

Glabrous or pubescent annual or perennial herbs with subscapose or leafy stems arising from a taproot. Heads solitary to several on long pe-

duncles in an open raceme. Involucre campanulate, often with a white tomentum at the base, consisting of two rows of bracts, the outer in the form of a calyculus, the inner long, marginally scarious, abruptly keeled on the abaxial side near the tip (the keel up to 1 mm. high producing the appearance of a bifurcate apex) and becoming elongate and stiffened, spreading and finally reflexed as the achenes mature; receptacle slightly convex, naked. Corolla monochromatic yellow (sometimes dark on the underside of the ligule), rarely cream colored (and then pink streaked beneath). Anthers with small tails. Style branches short, obtuse, flattened. Achenes with a terete to fusiform body with broadly rounded ridges, with a long, slender, brittle beak, the beak often breaking just beneath the persistent pappus; pappus of numerous shining capillary hairs, tawny to purplish tan or orange-tan in color and subtended by a villous ring of minute hairs. (Including *Sitilias* Raf.) TYPE SPECIES: *P. carolinianus* (Walter) DC. (*Leontodon carolinianus* Walter), typus cons. (Name from Greek, *pyrros*, fire colored, and *pappos*, pappus.) — FALSE DANDELION.

A genus of five species (fide D. K. Northington) indigenous to the southern part of the United States and northern Mexico. *Pyrrhopappus carolinianus*, $2n = 12$, and *P. georgianus* Shinners represent the genus in the Southeast, and *P. grandiflorus* (*P. scaposus* DC.), *P. multicaulis* DC. (including *P. Geiseri* Shinners, fide Northington), $2n = 12$, and *P. Rothrockii* Gray, $2n = 12$, occur to the west of our region.

Pyrrhopappus carolinianus, an annual plant, occurs in open woods, fallow fields, roadsides, and prairies from Delaware and southeastern Virginia southward to Florida and west to Illinois, Kansas, Oklahoma, and Texas. The closely related *P. georgianus* has a more limited distribution on the Coastal Plain of South Carolina and Georgia to northern and central Florida. As delimited by Shinners, *P. georgianus* is apparently a perennial plant (the top of the woody tap root often with short branches, each with a rosette of leaves) 12–50 cm. tall, with 0–3 leaves and 1–5 reduced leafy bracts below the inflorescence, and the heads 30–100-flowered, the anthers 4–6 mm. long, and the achene body 5.5–7 mm. long with a beak 7–11 mm. long. *Pyrrhopappus carolinianus*, in contrast, is a mostly taller (15–120 cm.) annual, with 3–12 leaves below the inflorescence (the upper gradually smaller) and the heads 75–165 flowered, the anthers 2–4 mm. long, and the achene body 4–6 cm. long with a beak 7.5–10.5 mm. long.

Northington, who has recently studied the genus in detail, has concluded (letter) on the basis of chemosystematic, cytological, and populational morphological studies plus extensive field observations (data not yet published) that "this genus is an actively speciating group of taxa which are often morphologically very variable but with recognizable species."

Although Bentham & Hooker placed *Pyrrhopappus* in the subtribe Lactucinae D. Don ("Lactuceae") with *Lactuca*, *Sonchus*, and *Prenanthes*, it seems to belong more naturally with *Krigia* in the Microseridinae, as

suggested by Stebbins. The habit of these two genera is strikingly similar, and both have ovate, obtuse, flattened style branches and orange pollen (except for white-flowered plants of *Pyrrhopappus*). It is also noteworthy that one species of each genus, *K. Dandelion* (L.) Nutt. and *P. grandiflorus* Nutt., produces a small underground tuber. Jeffrey has also allied *Pyrrhopappus* with *Krigia, Serinia* (= *Krigia*), *Microseris*, and *Picrosia*, these genera constituting his *Microseris*-series, of the *Microseris*-subgroup of the *Tolpis*-group in the Lactuceae.

REFERENCES:

Under tribal references see BENTHAM & HOOKER, BOLKHOVSKIKH *et al.*, HOFFMANN, JEFFREY, RICKETT, and STEBBINS.

HARPER, R. M. A color phase of *Sitilias caroliniana* and some analogous variations in other genera. Torreya **33:** 143–146. 1933.

NORTHINGTON, D. K. The flavonoid chemistry of *Pyrrhopappus* (Cichorieae, Compositae). (Abstr.) Am. Jour. Bot. **59:** 672, 673. 1972. ["The flavonoid chemistry of the genus is characterized by a series of flavone glycosides based upon luteolin and apigenin skeletons."]

SHINNERS, L. H. Notes on Texas Compositae — VII. Field Lab. **19:** 74–82. 1951. [*P. Geiseri* Shinners, sp. nov., 81.]

———. Notes. *Pyrrhopappus georgianus* Shinners, sp. nov. *Ibid.* **21:** 93–94. 1953.

SMALL, J. K. *Sitilias multicaulis*. Addisonia **18:** 11, 12. *pl. 582.* 1933.

Subtribe **Stephanomeriinae** Stebbins in Solbrig, Taxon **12:** 235. 1963.

4. Lygodesmia D. Don, Edinburgh New Philos. Jour. 6: 311. 1829.

Glabrous perennial herbs with stiff, branching stems. Basal leaves linear, entire [or pinnatifid] or absent; stem leaves usually reduced to narrow bracts or small scales. Heads solitary, terminating the ultimate branches; involucre cylindrical or cylindroid, composed of 5(–9) subequal lanceolate interior bracts with scarious margins and more numerous very short exterior bracts; receptacle flat, naked. Corolla ligulate, 5-dentate at apex, pink or rose-colored to pale violet or purple (rarely white), never yellow. Anthers sagittate at base or with sharp auriculate or acuminate basal appendages; pollen echinolophate. Style branches slender and elongate. Achenes subterete, smooth on the abaxial surface, longitudinally ribbed on the adaxial surface, truncate at apex; pappus of numerous pale tan-colored capillary bristles. LECTOTYPE SPECIES: *L. juncea* (Pursh) Hooker; [5] see Britton & Brown, Illus. Fl. No. U.S. ed. 2. 3: 322. 1913. (Name from Greek, *lygos*, twig, and *desme*, bundle, in reference to the cluster of sticklike stems.) — SKELETON WEED, FLOWERING STRAW, RUSH-PINK.

[5] This combination traditionally has been attributed to David Don, the name cited as *Lygodesmia juncea* (Pursh) D. Don, but Don merely listed the species that he thought belonged to his new genus without making formal transfers. The combination was first made by Hooker in Fl. Boreali-Am. **1:** 295. 1834.

A well-defined genus of eight species, mostly of western North America, primarily in dry areas, prairie lands, and on the Plains. One species, isolated from its congeners, is restricted to our area, another enters it locally in Arkansas.

Lygodesmia aphylla (Nutt.) DC., rose-rush, rushweed, a distinctive species of the acid, sandy soils of open pinelands on the Coastal Plain of southern Georgia and Florida, is a sparsely branched plant from a slender, deep-seated rootstock. The stiffly ascending stems appear to be leafless since the stem leaves are reduced to small brown scales. The few very narrow, linear, entire basal leaves often have withered by the time flowering occurs. The involucre is usually 15–20 mm. tall, the heads are relatively large (3–5 cm. across when the corollas are expanded) with about 10 rose-pink to lavender (rarely white) flowers, and the achene is 10–15 mm. long. Its closest relative (fide Tomb) is *L. texana* (Torrey & Gray) Greene (*L. aphylla* var. *texana* Torrey & Gray), $2n = 18$, which occurs in rocky, calcareous soils in Oklahoma, Texas, New Mexico, Coahuila, and Chihuahua. The flowering heads are approximately the same size as those of *L. aphylla*, but the basal leaves and lower stem leaves, while almost linear, are wider and are pinnatifid, with short linear lobes.

The lower and much more branched *Lygodesmia juncea*, skeleton weed, in which all of the leaves are linear-subulate and bractlike, is widely distributed in dry areas, from British Colombia and Alberta to Manitoba and Minnesota, southward to northwestern Missouri, Oklahoma, Texas, New Mexico, and Nevada. It occurs locally in our area only in the region of Little Rock, Arkansas (fide Tomb). The involucre of this plant is usually 10–15 mm. high, the heads usually have five pink to pale violet (or rarely white) florets, and the achene is 6–10 mm. long. The plant has long been suspected of being poisonous to cattle, and Kingsbury lists it among 47 weedy species in which toxic concentrations of nitrates have been measured.

The reduction of leaf surface in most species presumably is an adaptation to the xeric or exposed habitats occupied by the members of the genus.

Stebbins allied *Lygodesmia* with ten genera (all North American except *Thamnoseris* Philippi, an endemic of San Felix and San Ambrosio islands off the coast of Chile) in the subtribe Stephanomeriinae, noting that *Stephanomeria, Lygodesmia, Chaetadelpha, Rafinesquia,* and *Thamnoseris* constitute one of two groups of genera within the subtribe. Jeffrey indicated similar relationships but removed *Thamnoseris* to a completely different alliance. Among these genera *Lygodesmia* apparently is distinctive in its unusually elongate style branches and echinolophate pollen. It appears to be most closely related to *Stephanomeria*, which was united with it by Shinners, who thought that the single distinguishing character (a capillary pappus in *Lygodesmia*, a plumose one in *Stephanomeria*) was not sufficient for maintaining them as separate genera. Stebbins maintained, however, that the two are "no closer to each other

in the sum total of their habital and floral characteristics than are many other pairs of generally recognized genera of the Cichorieae [Lactuceae]. In addition to the pappus, differences exist between most species of the two genera with respect to the character of the pollen grains, the length of the style branches, and the size and shape of the achenes." Tomb (1970b) has recently followed the same course, noting that *Lygodesmia* and *Stephanomeria* differ in base chromosome numbers ($x = 9$ *vs.* 8), pollen grains (echinolophate *vs.* echinate), achenes, and cotyledon morphology.

REFERENCES:

Under tribal references see JEFFREY, LEDIN, and STEBBINS.

BAKER, M. F. Florida wild flowers. xiv + 256 pp. *35 pls.* New York. 1926; Revised ed. xvi + 245 pp. *35 pls.* 1938. [Excellent photograph of open flower heads of *L. aphylla* opposite p. 238 (p. 231 in revised ed.).]

CORRELL, D. S., & M. C. JOHNSTON, & collaborators. Manual of the vascular plants of Texas. xv + 1881 pp. *Frontisp. + 1 map.* Texas Research Foundation, Renner, Texas. 1970. [*Lygodesmia* (incl. *Stephanomeria*), 1727, 1728; *Lygodesmia, Stephanomeria,* and *Prenanthella* maintained as distinct in synopsis of Texan taxa by A. S. Tomb, 1743; *L. juncea, L. rostrata, L. texana, S. exigua, S. pauciflora, S. Wrightii, P. exigua.*]

KINGSBURY, J. M. Poisonous plants of the United States and Canada. xiv + 626 pp. Englewood Cliffs, New Jersey. 1964. [References to *L. juncea,* 43.]

POWELL, A. M., & S. SIKES. Chromosome numbers of some Chihuahuan desert Compositae. Southwest. Nat. **15:** 175–186. 1970. [*L. ramosissima, L. texana,* $n = 9$; *L. pauciflora, L. tenuifolia,* $n = 8$; the last two species are to be referred to *Stephanomeria.*]

SPANN, L. Morphology and anatomy of *Lygodesmia juncea* (Pursh) D. Don. Univ. Kansas Sci. Bull. **21:** 421–438. *pls. 52–55.* 1933.*

TOMB, A. S. A cytotaxonomic study of the genus *Lygodesmia* (Compositae-Cichorieae). Ph. D. Diss., Univ. Texas, Austin. 1970a.*

———. Novelties in *Lygodesmia* and *Stephanomeria* (Compositae-Cichorieae). Sida **3:** 530–532. 1970b. [*L. arizonica,* sp. nov., $2n = 18$; *L. dianthopsis* (Eaton) Tomb, comb. nov.; *S. spinosa* (Nutt.) Tomb, comb. nov. (*L. spinosa* Nutt.).]

———. Populational karyotype analysis in the *Lygodesmia texana* complex (Compositae, Cichorieae). (Abstr.) Am. Jour. Bot. **57:** 748. 1970c. [Karyotype analysis is the most reliable method for documenting hybrids between *L. texana* and *L. ramosissima,* both of which have 9 pairs of chromosomes.]

———. Re-establishment of the genus *Prenanthella* Rydb. (Compositae: Cichorieae). Brittonia **24:** 223–228. 1972. [*P. exigua* (Gray) Rydb. (*Lygodesmia exigua* (Gray) Gray, $2n = 14$.]

———. Taxonomy of *Chaetadelpha* (Compositae: Cichorieae). Madroño **21:** 459–462. 1972. [*C. Wheeleri* Gray ex Watson, $2n = 18$; more closely related to *Lygodesmia* than to *Stephanomeria*; includes distinctions between the three genera.]

Subtribe **Scorzonerinae** Dumortier, Fl. Belg. Prodr. 1827, "Scorzonereae."

5. **Tragopogon** Linnaeus, Sp. Pl. 2: 789. 1753; Gen. Pl. ed. 5. 346. 1754.

Coarse biennial or perennial caulescent herbs with alternate, linear-lanceolate, leaves. Heads solitary at the ends of long stiff, erect peduncles. Involucre of one series of stiff, lanceolate bracts; receptacle flat or slightly convex, foveolate, with small scarious rims around the foveolae. Corolla purple or yellow, usually conspicuous, but sometimes hidden within the capitulum. Anthers sagittate or auriculate at base. Style branches thin, terete. Achenes slender, 5–10-ribbed, long beaked (sometimes the outer series short beaked), the surafce rugose or muricate [hispid]; pappus of numerous plumose bristles borne on a disc, the outer series sometimes expanded at the base. LECTOTYPE SPECIES: *T. pratensis* L.; see Britton & Brown, Illus. Fl. No. U.S. ed. 2. 3: 313. 1913. (Name from Greek *tragos*, goat, and *pogon*, beard, referring to the appearance of the pappus.) — GOAT'S BEARD.

A genus of 40–50 species indigenous to Europe, Africa, and temperate Asia. Three species are widely naturalized in North America. The three are quite distinct in their morphology, differing in habit; color, shape, crisping and curling of the leaves; color, number and shape of the involucral bracts; number of flowers in a head; relative lengths of the involucral bracts and corolla limb (ligule); shape and relative length of the beak and body of the fruit; and color of the fruit and pappus (Ownbey).

Tragopogon porrifolius L., salsify, oyster plant, $2n = 12$, characterized by pale to deep violet corollas shorter than the bracts (these usually 8), strongly inflated peduncles, and a brownish pappus, is widely escaped from cultivation and is naturalized from Maine to the Pacific coast, south to New Mexico and Georgia. *Tragopogon pratensis* L., $2n = 24$, has chrome-yellow corollas, those of the outer ones equalling the 8(–13) involucral bracts, leaves with crisped margins and recurved tips, peduncles that are scarcely inflated even in fruit, and a whitish pappus. It has been recorded as far west as Idaho and southward to Tennessee and Arizona. *Tragopogon dubius* Scop. (including *T. major* Jacq.), $2n = 12$, with pale lemon-yellow corollas all shorter than the bracts, strongly inflated peduncles, usually 13 bracts and over 100 flowers in each head, and a whitish pappus, occurs transcontinentally and extends southward to North Carolina, Tennessee, and New Mexico.

Natural hybrids between all three species have been found in both Europe and North America. The first recorded artificial hybrid was produced by Linnaeus between *T. pratensis* and *T. porrifolius*. Ownbey has demonstrated that two new species of *Tragopogon* have arisen by hybridization followed by doubling of the chromosome number and has provided not only the best-documented examples of this type of speciation within recent time, but has found evidence for polytopic origin of at least one species. The F_1 diploid hybrids are frequently encountered but are usually highly sterile; the morphology of the hybrids differs depending upon

which species is the carpellate parent. Doubling of the chromosome number simultaneously restores fertility and isolates the amphiploid reproductively from its diploid parents. *Tragopogon miscellus* Ownbey, $2n = 24$, the amphiploid (amphidiploid, allotetraploid) of *T. dubius* × *T. pratensis*, was described from two colonies about a mile apart near Moscow, Idaho; and *T. mirus* Ownbey, $2n = 24$, the amphiploid of *T. dubius* × *T. porrifolius*, was described from a colony in Pullman, Washington, and one at Palouse, about 15 miles away, the two apparently having originated independently. Both amphiploids are easily recognized by their "gigas" features. They "differ in none of their characters from the corresponding diploid hybrids, but they are much larger in every way. The stems and leaves are thicker, coarser, more massive and succulent. The heads are larger both in flower and in fruit, and the fruits larger and thicker. The mean volume of the spherical pollen grains is almost precisely the sum of the mean volumes of those of the parental species. The fertility averages between 52 and 66 per cent, although there is wide variation in individual plants beyond these limits. In all four colonies, the amphiploids occurred with both the parental species, and the diploid F_1 hybrid. In one patch, three species, three F_1 hybrids and one amphiploid species grew together" (Ownbey, 1950, p. 493). Recent studies of the flavonoid chemistry have further confirmed the amphiploid origin of both new species (Brehm & Ownbey). Brown & Schaack have recently found *T. miscellus* and *T. mirus* growing with the three parental species at Flagstaff, Coconino County, Arizona. These occurrences presumably represent further examples of the polytopic origin of the two amphiploid species.

The effects of light on germination of the dimorphic achenes of *Tragopogon dubius* and *T. porrifolius* have been investigated by Heilpern, who found that the outer, strongly curved, darker colored achenes germinate much faster in light, and slightly faster in darkness, than the inner, straight, paler achenes. Allard found that *T. dubius* seems to require long days for good growth and the initiation of flowering. Optimum reproduction occurs between 40° and 50° N. latitude, and Allard concluded that the southern distributional limit of the species would coincide with the latitude at which the day length is always too short to allow flowering.

In addition to the amphiploids, thirteen diploid species in the genus have been investigated cytologically. In eleven $2n = 12$, in one $2n = 12$ or 14, and in one $2n = 14$.

The cultivated salsify, *Tragopogon porrifolius*, is also called oyster plant because its carrot-shaped taproot (prepared in numerous ways like potato) is said to have a taste similar to that of oysters. In Europe, the shoots are sometimes eaten like asparagus, the leaves as salad greens, and the root is occasionally dried and ground as a substitute for chicory for blending with coffee. Extracts from the roots are used locally as a diuretic.

Both Stebbins and Jeffrey are in agreement that *Tragopogon* is allied to *Scorzonera* and *Tourneuxia*, but Stebbins treats the three as constituting a subtribe, Scorzonerinae, while in Jeffrey's classification they comprise the *Scorzonera*-subgroup of his *Hypochoeris*-group.

REFERENCES:

Under tribal references see AHLES *et al.*, BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, FOURNIER, HEGI, HOFFMANN, JEFFREY, KNUTH, STEBBINS, and STEBBINS *et al.*

ALLARD, H. A. *Tragopogon dubius*; its response to length of day. Ecology **23**: 53–58. *figs. 1, 2.* 1942.

BREHM, B. G., & M. OWNBEY. Variation in chromatographic patterns in the *Tragopogon dubius–pratensis–porrifolius* complex (Compositae). Am. Jour. Bot. **52**: 811–818. 1965.

——— & ———. Inheritance of C-glycosyl flavonoids in interspecific hybridizations of *Tragopogon.* (Abstr.) Am. Jour. Bot. **55**: 738. 1968.

BROWN, R. C., & C. G. SCHAACK. Two new species of *Tragopogon* for Arizona. Madroño **21**: 304. 1972. [*T. mirus* & *T. miscellus*.]

GUARD, A. T. Study of a natural hybrid population among three species of *Tragopogon.* (Abstr.) Proc. Indiana Acad. Sci. **67**: 286. 1958.

HEILPERN, E. VON. Keimungsphysiologische Untersuchungen. Österr. Bot. Zeitschr. **64**: 286–293. 1914.

NEITHAMMER, A. Beiträge zur Keimungsbiologie und physiologischen Anatomie der Fruchte von *Tragopogon pratensis* L. Beih. Bot. Centralbl. **47**: 282–290. 1930.

OWNBEY, M. Natural hybridization and amphiploidy in the genus *Tragopogon.* Am. Jour. Bot. **37**: 487–499. 1950. [The major work on the hybridization of *Tragopogon* spp. in North America and the amphiploid origin of two species.]

——— & G. D. MCCOLLUM. Cytoplasmic inheritance and reciprocal amphiploidy in *Tragopogon.* Am. Jour. Bot. **40**: 788–796. 1953.

——— & ———. The chromosomes of *Tragopogon.* Rhodora **56**: 7–21. 1954.

Subtribe **Hypochoeridinae** Lessing, Synopsis 130. 1832, "Hypochoerideae."
(Leontodontinae C. H. Schultz Bipontinus, 1850.)

6. **Hypochoeris** Linnaeus, Sp. Pl. 2: 810. 1753, "Hypochaeris"; Gen. Pl. ed. 5. 352. 1754.[6]

Annual or perennial herbs with scapose or paniculate flowering stems. Leaves basal, sometimes also alternate up the stem, oblanceolate in outline, entire or toothed [pinnatifid]. Involucre composed of several series of imbricate bracts with scarious margins and increasing in size toward the inside, the outer surface glabrous, lanate, or strigose; receptacle flat, with a scarious scale subtending each floret; both bracts and scales enlarging in fruit. Corolla yellow [white, or orange], sometimes with a tuft of hairs at the outside of the throat. Anthers sagittate at base. Style with a glandular base and thin, terete branches. Achenes glabrous, 10-ribbed

[6] In *Species Plantarum* Linnaeus used the spelling *Hypochaeris*, but in *Genera Plantarum*, ed. 5, he used *Hypochoeris*. In the preponderance of his later work he used the spelling with *ae*, rather than *oe* (as did his contemporaries), but he was inconsistent. In accordance with regulation 2 of Article 74 of the International Code of Botanical Nomenclature, 1972, the spelling with *oe*, which is more correct philologically, is used here. Most recent authors have also used this spelling.

and upwardly scabrous on the ribs, either monomorphic and beaked, or dimorphic, with the outermost achenes beakless, the inner ones beaked; pappus in one or two series, setose and/or plumose, white or tawny. LECTOTYPE SPECIES: *H. glabra* L.; see Bentham & Hooker, Gen. Pl. 2: 520. 1873, who treated this species as the only member of sect. EUPHYPOCHOERIS; see also Britton & Brown, Illus. Fl. No. U.S. ed. 2. 3: 309. 1913. (Name from Greek *hypochoiris*, used by Dioscorides for some plant, and also mentioned by Pliny as *hypochoeris*, the name perhaps derived from *hypo*, for, and *choiros*, pig, these animals being fond of its roots.) — CAT'S EARS.

A genus containing about 50 (Stebbins, *et al.*) to 100 (Cabrera) species in five or six sections (Hoffmann; Stebbins, *et al.*) with an unusual pattern of distribution. Most of the species are indigenous to extra-tropical South America, but about ten are European, and one is indigenous to Asia. Two European and two South American species are naturalized in North America; all four occur in the southeastern United States.

Both naturalized species of sect. HYPOCHOERIS, characterized by a pappus of an outer series of short bristles and an inner of much longer plumose ones, occur in the Southeast. *Hypochoeris glabra*, $2n = 10$, an annual, has been collected in scattered localities in the northeastern United States and is more extensively naturalized southward to Florida and Alabama, as well as in western North America from British Columbia to California. The perennial *Hypochoeris radicata* L., $2n = 8$, is widely naturalized from Newfoundland to Ontario, south to Missouri, Louisiana, Alabama, Georgia, and South Carolina, and from California to British Columbia. The two are easily distinguished by the uniformly beaked achenes of *H. radicata* versus the dimorphic ones of *H. glabra*. In the latter the outermost achenes are truncate (beakless) and have a pappus composed of short barbellate outer bristles and an inner series of much longer ones that are densely plumose in the lower third and remotely plumose and barbellate above, while all of the inner achenes are long beaked and with a pappus of shorter outer setose and barbellate series and an inner plumose and barbellate one. Almost completely sterile hybrids between the two species have been reported from Europe, but the cytology of these does not seem to have been investigated.

Section ACHYROPHORUS DC. in Lam. & DC., in which the pappus is composed entirely of plumose bristles, is represented in our area by the South American *Hypochoeris Tweedii* Hooker & Arn. (*H. brasiliensis* (Less.) Griseb. var. *Tweedii* (Hooker & Arn.) Baker), $2n = 8$, and by *H. microcephala* (Schultz Bip.) Cabrera var. *albiflora* (O. Kuntze) Cabrera, $2n = 8$, which is spreading rapidly in southeastern Texas (fide Tomb) and has been collected at Lake Charles in southwestern Louisiana (Thieret). *Hypochoeris Tweedii*, indigenous to Uruguay and northeastern Argentina but now distributed in disturbed habitats primarily on the Coastal Plain from North Carolina to Florida and Alabama, has been reported as both *H. brasiliensis*, with which it is perhaps conspecific (al-

though it is maintained as a distinct species by Cabrera), and *H. elata* (Wedd.) Griseb., a plant of the Andes at altitudes above 3500 meters. The campanulate involucre of *H. Tweedii*, 12–15 mm. tall by 6–8 mm. in diameter at anthesis with the exterior bracts linear, obtuse, and hispid, is characteristic. The involucre of *H. brasiliensis* differs in its linear, slightly obtuse and lightly lanuginose, exterior bracts. *Hypochoeris microcephala* var. *albiflora*, indigenous to Brazil, Uruguay, and northeastern Argentina, has white flowers and a narrowly cylindric involucre 10 mm. tall by 3–4 mm. in diameter at anthesis, with the outer bracts either glabrous or laxly lanuginose (Cabrera).

The flowers of *Hypochoeris radicata* are visited by a variety of insects, including bees, butterflies, flies, and small beetles, but can also be self-pollinated in at least three ways (Hagerup). The diurnal opening and closing of the head in response to light brings stigmas into contact with pollen on adjacent flowers; or self-pollination can occur through the agency of rain, the corollas of this species having on the outside of the throat a tuft of hairs that with those of the other flowers prevents water from penetrating between the flowers and traps water on the open head in a sort of pool on which the pollen can float into contact with the stigmas; or pollen can be carried from one flower to another by the movements of tiny insects of the genus *Thrips* that live in the flower heads, eating pollen and nectar and laying their eggs on the tips of the receptacular scales.

Diploid chromosome numbers reported for the genus are 6, 8, 10, 12, and 16. Stebbins has postulated that the base number of the Old World species, which he considers to be the most primitive, is five, but the wide variation in the genus is perhaps indicative that more than one base number is involved.

Hypochoeris is evidently related to *Leontodon* (q.v.) from which it differs conspicuously in the presence of bractlike receptacular scales. It is odd that both genera have species with dimorphic achenes.

The achenes of some European species are dried and extracted like those of *Arnica* for medicinal use (Fournier). The leaves are also eaten as a salad or cooked greens similar to those of *Taraxacum*, and Hooker & Arnott noted in the original description of *Hypochoeris Tweedii* that in Buenos Aires ". . . it is frequently employed as Endive."

REFERENCES:

Under tribal references see AHLES *et al.*, BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, FOURNIER, HEGI, HOFFMANN, JEFFREY, STEBBINS, and STEBBINS *et al.*

AHLES, H. E., & A. E. RADFORD. Species new to the flora of North Carolina. Jour. Elisha Mitchell Sci. Soc. **75**: 140–147. 1959. [*H. elata* = *H. Tweedii*.]

CABRERA, A. L. Flora de la Provincia de Buenos Aires. Parte VI. Compuestas. *Hypochoeris*, 393–407. 1963. [*Fig. 131*, p. 401, shows the morphological differences between the bracts of *H. Tweedii* and *H. brasiliensis*.]

HAGERUP, O. Thrips-pollination in *Hypochoeris radicata*. Nytt Mag. Bot. **3:** 55–58. 1954.

HOLMBERG, O. R. *Hypochoeris glabra L.* × *radicata* L., nova hybr. Bot. Not. **1930:** 413–416. 1930.

SAEZ, F. A. Estudio cytológico comparativo de algunas especies del género *Hypochaeris* (Compositae) de la America del Sur. Lilloa **19:** 97–104. *1 pl.* 1949.

SHINNERS, L. H. *Hypochoeris microphala* var. *albiflora* (Compositae) in southeastern Texas: new to North America. Sida **2:** 393, 394. 1966.

SZWABOWICZ, A. Embryological studies in *Hypochoeris uniflora* Vill. Acta Soc. Bot. Polon. **23:** 243–257. 1954. [$2n = 10$; Polygonum-type embryo sac; no evidence of apomixis found.]

THIERET, J. W. Twenty-five species of vascular plants new to Louisiana. Proc. Louisiana Acad. Sci. **32:** 78–82. 1969. [*H. microcephala* var. *albiflora* in Calcasieu Parish.]

7. **Leontodon** Linnaeus, Sp. Pl. *2*: 798. *1753*; Gen. Pl. ed. 5. 349. *1754*, nom. cons.

Perennial [or annual] scapose [or subscapose] herbs with simple [or sparingly branched] flowering stems. Basal rosette of lanceolate to lyrate, dentate, parted [or entire] leaves with forked or simple hairs [or glabrous]. Heads solitary, terminating naked scapes [or scapes bracteate, sparingly branched, each branch with a solitary head]. Involucre of an inner series of slightly imbricate lanceolate glabrous or pubescent bracts and an outer series of much shorter bracts; receptacle flat, naked, pitted, the pits often with toothed or ciliate margins. Corolla yellow. Anthers with sagittate, auriculate, or setose basal appendages; pollen spherical, spiny. Style branches thin, terete. Achenes ± cylindrical, the outermost truncate, beakless with a cuplike pappus of short scarious scales, the inner beakless or short beaked with a pappus of *2* rows of bristles, the inner plumose with dilated bases, the outer much shorter, simple and scabrid [or achenes all similar, beaked or beakless, with a pappus of two rows of hairs (plumose and simple) or with only a single row of plumose hairs dilated at base]. (*Virea* Adanson.) LECTOTYPE SPECIES: *L. hispidus* L., typus cons. (Name from Greek, *leon*, lion, and *odous, odontos*, tooth, from the coarsely toothed leaves.) — HAWKBIT.

A genus of 40 or fewer species in eight or nine sections native to Europe, Asia, northern Africa, and the Azores; three species adventive in North America, one of these sporadic in the southeastern United States.

The European *Leontodon taraxacoides* (Vill.) Mérat (*L. nudicaulis* auct., *L. nudicaulis* subsp. *taraxacoides* (Vill.) Schinz & Thell., *L. Leysseri* (Wallr.) G. Beck, *L. nudicaulis* f. *Leysseri* (Wallr.) Ascherson & Graebner), $2n = 8$, of sect. THRINCIA (Roth) Dumort., characterized by dimorphic achenes, the outermost beakless and curved, with a cuplike crown of short scales, the inner more or less beaked with a pappus of long plumose hairs and of shorter scabrid bristles, has been collected in our region in at least North Carolina and Alabama. It is of more frequent

occurrence in the Northeast (Massachusetts, Rhode Island, Connecticut, and New York) and has also been found in at least Pennsylvania, the District of Columbia, Illinois, and Texas, and from California northward to British Columbia, mostly near the coast. Its perennial habit (from a short, erect rootstock), leaves (at least beneath) with multicellular hairs bifurcate at the tip, bractless unbranched scapes, yellow flowers (the outermost gray-violet beneath), and dimorphic achenes are characteristic.

Leontodon autumnalis L., $2n = 12, 24$, of sect. OPORINIA (D. Don) W. D. Koch (all achenes similar, with a pappus of a single whorl of plumose hairs dilated at the base, and leaves with simple unforked hairs or glabrous), is widely naturalized to the north of our area in disturbed soils in Atlantic North America from Greenland and Newfoundland, south to Pennsylvania, and sporadically inland to Michigan, and in western North America from California to British Columbia. The pappus and the scaly-bracteate scapes are characteristic. *Leontodon hispidus* L. var. *glabratus* (W. D. Koch) Bischoff (*L. hastilis* L.), $2n = 14$, of sect. LEONTODON (all achenes similar, with a pappus of outer short, simple, scabrid bristles and inner, much longer plumose ones, and leaves [when pubescent] with hairs bifurcate at the tip), has been collected locally in Connecticut. Most of the range given for this plant and for *L. hastilis* var. *vulgaris* W. D. Koch (*L. hispidus* var. *hispidus*) in current manuals is based on misidentified specimens of *L. taraxacoides*. The rather large heads on ebracteate, unbranched scapes and the monomorphic achenes with a double pappus are characteristic. Only the glabrous form seems to be adventive in North America.

Chromosome numbers of $2n = 8, 10, 12, 14$, and 24 have been reported for species of *Leontodon*. Hybrids between various European taxa have been reported, but only that between *L. taraxacoides* (*L. Leysseri*), $2n = 8$, and *L. hispidus*, $2n = 14$, appears to have been studied cytologically. Six of the chromosomes of both parental taxa bear satellites, and four of the six have subterminal centromeres, while the remaining two have median centromeres. The hybrid ($2n = 11$) has, however, only four satellited chromosomes, all with subterminal centromeres, the two with median centromeres apparently having lost their satellites (Elliot).

Bergman found that in *Leontodon hispidus* the Polygonum-type embryo sac occurred in half of the ovaries examined, while the others had the Adoxa-type. He also found that somatic apospory occurred in some florets, and a statistical analysis of its occurrence indicated that it is a recessive genetically controlled character.

Studies by H. Becker (reported in Hegi) showed a difference in germination behavior between the inner and outer achenes of *Leontodon taraxacoides*. The inner ones will germinate in either light or dark, but the circumferential ones will germinate only if exposed to light.

Leontodon has been confused nomenclaturally with *Taraxacum* Wiggers, nom. cons., and *Leontodon Taraxacum* L., the lectotype effectively chosen by Adanson (1763), who removed all other species to a new genus, *Virea*, is *Taraxacum officinale* Wiggers, the type of the name *Taraxacum*.

Leontodon consequently has been conserved (provisionally; cf. ICBN. 1972) with a different type, *L. hispidus*, as suggested by Hitchcock & Green, to avoid the necessity of taking up *Virea* for all the species now known as *Leontodon*. (See Vuilleumier for discussion.)

Bentham (1873) suggested that *Leontodon* is related to *Taraxacum* and to *Hypochoeris*, but in Bentham & Hooker (1873) only the relationship to the latter is noted, although *Taraxacum* is placed in the same subtribe (Hypochoeridinae) with the two. Stebbins placed *Leontodon* in the subtribe Leontodontinae (= Hypochoeridinae) and *Taraxacum* in the Crepidinae, and Jeffrey suggested similar affinities for the two genera.

The genus has no economic importance, except for a few species that are lawn weeds in some areas.

REFERENCES:

Under tribal references see AHLES *et al.*, BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, HEGI, HOFFMANN, JEFFREY, and STEBBINS.

AHLES, H. E., C. R. BELL, & A. E. RADFORD. Species new to the flora of North or South Carolina. Rhodora **60:** 10–32. 1958. [*L. Leysseri*, 28.]

BERGMAN, B. Zytologische Studien über die Fortpflanzung bei den Gattungen *Leontodon* und *Picris*. Sv. Bot. Tidskr. **29:** 155–301. 1935.

ELLIOT, E. A new phase of amphiplasty in *Leontodon*. New Phytol. **49:** 344–349. 1950.

FERNALD, M. L. The "fall dandelions" of North America. Rhodora **3:** 293, 294. 1901. [See also Rhodora **4:** 39, 40. 1902.]

MACKENZIE, K. K. Proper use of the name *Leontodon*. Rhodora **27:** 47–49. 1925.

MAHESHWARI, P. An introduction to the embryology of Angiosperms. x + 453 pp. McGraw Hill Co., New York. 1950.

MEYER, K. Über die Entwicklung des Pollens bei *Leontodon autumnalis* L. Ber. Deutsch. Bot. Ges. **43:** 108–114. 1925.

TURESSON, G. Castration experiments in *Hieracium umbellatum* and *Leontodon autumnalis* L. Sv. Bot. Tidskr. **22:** 256–260. 1928. [None of the castrated heads produced achenes.]

VUILLEUMIER, B. Proposal for the conservation of the generic name (9574) *Leontodon* L. with *L. hispidus* L. as *typus conservandus* against *Virea* Adanson. Taxon **18:** 343–345. 1969.

WIDDER, F. J. Beiträge zur Kenntnis der Gattung *Leontodon*. I. *Leontodon croceus* Haenke und *Leontodon rilaensis* Hayek. Österr. Bot. Zeitschr. **76:** 272–305. 1927.

8. **Picris** Linnaeus, Sp. Pl. **2:** 792. 1753; Gen. Pl. ed. 5. 347. 1754.

Branched, perennial, hispid herbs with oblanceolate to spathulate basal (sometimes called cauline) leaves with entire, sinuate-dentate [or pinnately parted margins]. Heads long-pedunculate, arranged in a corymbose, determinate inflorescence. Involucre often swollen at base (especially after anthesis), composed of inner, imbricate, lanceolate bracts and several outer series progressively decreasing in size [or with a sharply dis-

tinct outer series of relatively large foliaceous bracts]; receptacle flat, naked or fimbrillate. Corolla yellow. Anthers with sagittate bases of acute auricles. Style branches thin. Achenes subterete or angled, frequently curved, 5–10-ribbed, all similar [or outermost distinct in some species], constricted at apex [or beaked], horizontally rugose, glabrous; pappus plumose, deciduous [with the beak]. LECTOTYPE SPECIES: *P. hieracioides* L.; typified by the removal of two of the four original species to *Helminthia* Juss. and of the third to *Hieracium*. (Name from Greek, *picros*, bitter, in reference to the taste of the plant). — OX-TONGUE, BITTER-WEED.

A genus of perhaps 35 (probably fewer) species indigenous to the Old World and assigned (on the basis of characters of the involucral bracts and achenes) to four sections (Hoffmann). *Picris hieracioides*, $2n = 10$, of sect. PICRIS, and *P. echioides* L., $2n = 10$, of sect. HELMINTHIA (Juss.) Hoffm., are adventive in northeastern North America, but only the former has been reported from our area, where it occurs in western North Carolina (cf. Ahles *et al.*). *Picris hieracioides* has leaves with stiff, pointed hairs and some hairs that are bifurcate at the tip with the divisions recurved, stems with similar bifurcate hairs, and the involucral bracts (the outer progressively smaller) pubescent and with bifurcate hairs. The achenes are beakless, and the pappus is deciduous. In *P. echioides* the pubescence includes hairs that are 3- or 4-furcate at the tip, with the divisions recurved in the manner of a grappling hook; the outermost involucral bracts are large and spiny; and the achenes are slender beaked. It has been recorded from scattered localities from eastern Canada south to the latitude of the District of Columbia.

Chromosome numbers of $2n = 10$ have been reported in all nine of the species of *Picris* that have been investigated, but *P. Sprengeriana* Poiret has been reported as having both $2n = 10$ and $2n = 8$. Bergman noted the occurrence of a few rare cases of ameiotic apospory that led to sterile embryo sacs in *P. hieracioides*.

Stebbins assigned *Picris* to subtribe Leontodontinae (properly Hypochoeridinae when used in his sense), along with *Hypochoeris*, *Leontodon*, *Urospermum*, *Hedypnois*, *Garhadiolus*, and *Rhagadiolus*; and Jeffrey retained the same alignment of genera in the *Hypochoeris*-series, of his *Hypochoeris*-subgroup, *Hypochoeris*-group.

REFERENCES:

Under tribal references see AHLES *et al.*, BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, HEGI, HOFFMANN, JEFFREY, RICKETT, and STEBBINS.

BERGMAN, B. Aposporie bei *Picris hieracioides* und *Leontodon hispidus*. Sv. Bot. Tidskr. **26:** 453–457. 1932.

———. Zytologische Studien über die Fortpflanzung bei den Gattungen *Leontodon* und *Picris*. *Ibid.* **29:** 155–301. 1935.

Subtribe **Crepidinae** Dumortier, Fl. Belg. Prodr. 74. 1827, "Crepideae."

9. **Sonchus** Linnaeus, Sp. Pl. 2: 793. 1753; Gen. Pl. ed. 5. 347. 1754.

Robust annual or perennial herbs with caulescent, branching, striate, often pubescent flowering stems arising from a taproot or creeping rhizome. Basal leaves absent or in a rosette; if present, lanceolate, spathulate, runcinate, or lyrate, serrate, dentate, or parted. Stem leaves similar, becoming more lanceolate and smaller up the stem, clasping, with acute or rounded auricles. Inflorescence a panicle of few to numerous heads. Involucre of several series of bracts; the inner lanceolate, subequal, slightly imbricate, sometimes marginally scarious, glabrous or pubescent; the outer much smaller, ovate; receptacle flat or concave, naked, becoming convex when the achenes are shed. Corolla yellow. Anthers sagittate at the base; pollen spherical, tricolporate, the surface with 15–20 lacunae surrounded by ridges surmounted by elaborate spines. Style branches thin, terete. Achenes monomorphic [dimorphic in some], flattened, narrowed at both ends, striated, sometimes rugose; pappus capillary, often composed of hairs and bristles (sensu Boulos), abundant, soft, white. LECTOTYPE SPECIES: *S. oleraceus* L.; see Britton & Brown, Illus. Fl. No. U.S. ed. 2. 3: 306. 1913. (Name from Greek, *sonchos*, a name used by Dioscorides, Theophrastes, and Pliny for a prickly plant.) — SOW-THISTLE.

A genus of some 70 species in three subgenera (Boulos) and indigenous to Europe, Asia, and northern Africa. The most primitive subgenus, ORIGOSONCHUS Boulos, found in tropical West Africa, is comprised of perennial species with few-headed inflorescences. Subgenus DENDROSONCHUS Webb ex Schultz Bip. is composed of a group of shrubby species with umbellate or cymose arrangements of heads. The woody habit of this subgenus is correlated with its adaptation to island life (see Carlquist, 1965, Chapter 8). Although a few of its species occur on the African mainland, the majority are restricted to Madeira and the Canary and Cape Verde islands. The most advanced subgenus, SONCHUS, is possibly derived from members of subg. DENDROSONCHUS (cf. Boulos), although many species have become annuals. The morphology of the species of subg. SONCHUS is variable, and numerous species, three of which are naturalized in the southeastern United States, have become cosmopolitan weeds.

Sonchus oleraceus L., sow-thistle, $2n = 16, 32$, is easily recognized by its annual habit (taproot), pinnately parted lyrate leaves with an arrow-shaped terminal segment, stem leaves with pointed auricles, and rugose achenes. This weedy plant now occurs across southern Canada, throughout the United States and in Mexico, the West Indies, and extratropical South America, as well as Australia.

Also naturalized all across the United States and southern Canada, in the West Indies, and in parts of South America, *Sonchus asper* (L.) Hill, $2n = 18$, is distinguished from the preceding species by its perennial habit, stiff, prickly leaves (more dentate than parted), round stem-leaf auricles, and smooth achenes. The third adventive species, the perennial sow-thistle, *S. arvensis* L. (including *S. arvensis* var. *glabrescens* Guenth.,

Grab. & Wimm. and *S. uliginosus* Bieb.), $2n = 18$, 36, 45, 54, and 64, is primarily a species of the northeastern United States and adjacent Canada, but has now been reported in North Carolina. This is actually a polyploid complex involving *S. arvensis*, $2n = 54$ and *S. uliginosus*, $2n = 36$. Boulos considers all of the morphological and chromosomal forms of this complex to belong to one biological species. There are innumerable intermediate specimens resulting from back-crossing, and there is a complete range of chromosome numbers from $2n = 36$ to 64 that would be impossible to assign to a given segregate taxon if it were recognized.

Natural hybridization, apparently without backcrossing and introgression, was reported between *Sonchus oleraceus* and *S. asper* by Barber. Recently, however, Hsieh *et al.* made all possible crosses between *S. oleraceus* ($2n = 36$), *S. arvensis* ($2n = 36$), and *S. asper* ($2n = 18$). Crosses between *S. arvensis* and *S. asper* produced pollen-sterile hybrids that had only partial meiotic pairing in the microsporocytes. The F_1 hybrids resulting from crosses between *S. oleraceus* and either *S. arvensis* or *S. asper* were also pollen-sterile, but, in addition, showed no pairing between parental chromosome complements during meiosis. During normal meiosis of the tetraploid *S. arvensis* and the diploid *S. asper*, bivalents were uniformly formed. In contrast, meiotic cells of the tetraploid *S. oleraceus* normally exhibited both bivalent and tetravalent pairing. Hsieh *et al.*, in contrast to Stebbins *et al.*, concluded that *S. arvensis* is an amphiploid with one chromosome complement from *S. asper* and that the race of *S. oleraceus* studied is an autotetraploid.

Although Bentham considered *Sonchus* closely related to *Lactuca* L., Babcock *et al.*, Stebbins, and Boulos all thought that it must be most closely allied to, and perhaps derived from, *Launaea* Cass., a genus of tropical Africa, Asia, and America. Recent pollen studies by Saad have reinforced this idea and have tended to confirm the subgeneric groupings outlined by Boulos. Jeffrey, in contrast, separates *Sonchus*, *Dendroseris* (sensu lato), and *Thamnoseris* as the *Sonchus*-group (subtribe?), while *Launaea*, *Aethiorrhiza*, and *Reichardia* constitute the *Launaea*-series, *Crepis*-subgroup, *Cichorium*-group.

Chromosome studies of other species in the genus have yielded numbers of $2n = 14$, 16, 32, 36, 45, 54, and 64.

The genus has no particular economic importance except as an annoying weed. In Eurasia *Sonchus* has been used locally as a medicinal plant, the juice being drunk to counteract asthma and stomach ulcers, and applied externally for the relief of earaches. In Asia proper, the sweetened juice of some species is considered to have a laxative effect (cf. Fournier).

REFERENCES:

Under tribal references see BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, FOURNIER, HEGI, HOFFMANN, JEFFREY, LEDIN, RICKETT, STEBBINS, and WODEHOUSE.

BARBER, H. N. Spontaneous hybrids between *Sonchus asper* and *S. oleraceus*. Ann. Bot. II. **5**: 375–377. 1941.

Boulos, L. Cytotaxonomic studies in the genus *Sonchus*. 1. *Sonchus gigas* Boulos nov. sp., a new tetraploid Egyptian species. Bot. Not. **112:** 363–368. 1959 2. The genus *Sonchus*, a general systematic treatment. *Ibid.* **113:** 400–420. 1960; 3. On the cytotaxonomy and distribution of *Sonchus arvensis* L. *Ibid.* **114:** 57–64. *maps.* 1961.

Carlquist, S. Island life; a natural history of the islands of the world. 451 pp. Natural History Press. New York. 1965.

Hsieh, T. S., A. B. Schooler, A. Bell, & J. D. Nalewaja. Cytotaxonomy of three *Sonchus* species. Am. Jour. Bot. **59:** 789–796. 1972. [*S. asper, S. oleraceus, S. arvensis.*]

Shumovich, W., & F. H. Montgomery. The perennial sowthistle in northeastern North America. Canad. Jour. Agr. Sci. **35:** 601–605. 1955.

Stebbins, G. L., Jr., J. A. Jenkins, & M. S. Walters. Chromosomes and phylogeny in the Compositae, tribe Cichorieae. Univ. Calif. Publ. Bot. **26:** 401–430. *55 figs.* 1953.

Syme, J. T. B., ed. English botany, ed. 3. Vol. 5. Compositae. 1866 (Reprint. 1873). [*Sonchus oleraceus, pl. 810; S. asper, pl. 811.*]

Turner, B. L., W. L. Ellison, & R. M. King. Chromosome numbers in the Compositae. IV. North American species with phyletic interpretation. Am. Jour. Bot. **48:** 216–223. 1961.

Walter, R., & E. Kuta. Cytological and embryological studies in *Sonchus* L. I. *Sonchus asper* (L.) Hill and *Sonchus oleraceus* L. Acta Biol. Cracov. Bot. **14:** 103–106. 1971.*

10. **Launaea** Cassini, Dict. Sci. Nat. **15:** 321. 1822.

Perennial [annual], glabrous herbs with a basal rosette and alternate, smaller stem leaves. Leaves pandurate [obovate to lanceolate], coarsely toothed [serrate to more or less entire]. Inflorescence a panicle of numerous [few] heads. Involucre composed of a few series of unequal, scarious [broadly scarious], lanceolate [ovate] bracts; receptacle flat, naked. Florets perfect. Corolla pale yellow. Anthers sagittate at the base. Style branches thin, short. Achenes dimorphic [monomorphic, polymorphic], the outer slightly flattened, with equal muricate ribs; the inner terete, glabrous, lightly but equally ribbed [if monomorphic, all slightly muricate, if polymorphic, gradually changing from one type to the other], beakless [or with a very short, stout beak]; pappus capillary, composed of thin, straight bristles and finer, downy, almost woolly hairs [only straight bristles with or without an outer ring of very short ones], copious, white. (Including *Brachyramphus* DC. and *Microrhynchus* Less.) Type species: *L. bellidifolia* Cass. (Named after French author Jean Claude Mien Mordant de Launay, d. 1816, librarian of the Jardin des Plantes, Paris, and a founder of *Herbier Générale de l'Amateur*, known for his popular writings on gardening and amateur botany.)

A genus of about 30 species in five sections (fide Hoffmann) distributed in Africa, Europe, Asia, southern North America, and the West Indies. Unfortunately, there has not been any modern published revision of *Launaea*, and the generic boundaries between it, *Lactuca*, and *Sonchus* remain obscure. This uncertainty of generic limits has caused our species, *Launaea intybacea* (Jacq.) Beauverd to be placed variously in *Lactuca*

(*L. intybacea* Jacq.), by Bentham & Hooker, by Adams in the *Flora of West Tropical Africa* (1963) and by Long & Lakela; in *Launaea*, by Hoffmann, by Jeffrey, and by Adams in *The Flowering Plants of Jamaica*; or in the segregate genus *Brachyrhamphus* (*B. intybaceus* (Jacq.) DC.), by De Candolle and Small. This species is native to the West Indies, but is now found in rocky areas and waste places in Mexico, northern South America, Florida, the Greater and Lesser Antilles, and subtropical Africa and India. It is the only species of *Launaea* indigenous to the New World. Despite a seemingly erratic geographical distribution, there is no doubt that *L. intybacea* is distinct from both the North American species of *Lactuca* (sect. MULGEDIUM) and the Old World species. It is easily recognized by the basal rosette of large yellow-green leaves and the much-branched inflorescence with pale-yellow-flowered heads.

Most of the species of *Lactuca* have beaked achenes, and all members have a monomorphic pappus and achenes. All members of *Launaea* have beakless achenes that are dimorphic or polymorphic (cf Boulos) and a dimorphic pappus. The presence of soft, white, down-like hairs among the straighter setae of the pappus and the difference between the outer and inner achenes readily distinguishes *L. intybacea* from all of our species of *Lactuca* and *Sonchus*. However, many species of *Sonchus*, like those of *Launaea* have dimorphic achenes and pappus, but the achenes of *Sonchus* are not so markedly dimorphic as those of *Launaea*. The most significant difference between these two genera, in Boulos's opinion, is the amount of fertility displayed by the achenial types within a capitulum. In species of *Sonchus*, all achenes are fertile but in *Launaea*, only one morphological type is fertile. Boulos, however, did not give any criterion for his assertion that achenes were fertile or nonfertile.

Babcock & Stebbins, Stebbins, and Boulos have all postulated that *Sonchus* was derived either from *Launaea* or from *Launaea*-like ancestors. This hypothesis is based on the observation that many features of *Launaea*, such as columnar achenes and the involucral bracts of varying sizes, are found in the most primitive species of *Sonchus*. Jeffrey, however, postulates quite different relationships (cf. *Sonchus*).

Although the chromosome number of *Launaea intybacea* has not been determined, numbers of $2n = 14$, 16, and 18 have been reported for species of the genus. The same numbers, plus higher ploidy levels of $2n = 36$, 45, 54, 60 and 64, have been found in *Sonchus*, further suggesting that it was derived from a *Launaea*-like stock.

The genus has no economic importance.

REFERENCES:

Under tribal references see BABCOCK & STEBBINS; BENTHAM & HOOKER; BOLKHOVSKIKH *et al.*; HOFFMANN; JEFFREY, pp. 430, 431, 472; and STEBBINS.

ADAMS, C. D. Compositae. *In*: HUTCHINSON, J. & J. M. DALZIEL. Flora of West Tropical Africa. ed. 2. F. N. HEPPNER, ed. **2**: 225–297. 1963. [*Lactuca intybacea*, 294.]

———. Flowering plants of Jamaica. 848 pp. Mona, Jamaica. 1972. [*Launaea intybacea*, 777.]

Boulos, L. Cytotaxonomic studies in the genus *Sonchus*. 2. The genus *Sonchus*, a general systematic treatment. Bot. Not. **113:** 400–420. 1960. [Discusses differences between *Lactuca*, *Launaea*, and *Sonchus* and mentions several characteristics of *Launaea* discussed in an unpublished Master's degree thesis.]

Ledin, R. B. The Compositae of South Florida. Quart. Jour. Florida Acad. Sci. **14:** 51–207. 1957. [*Lactuca intybacea*, 175.]

Long, R. & O. Lakela. A flora of tropical Florida. 962 pp. Miami. 1971. [*Lactuca intybacea*, 882.]

11. **Hieracium** Linnaeus, Sp. Pl. 2: 799. 1753; Gen. Pl. ed. 5. 350. 1754.

Perennial scapose or caulescent herbs, usually with a conspicuous indument (rarely glabrous). Leaves in a basal rosette and/or cauline, lanceolate, oblanceolate, entire, or dentate. Heads borne singly or in a panicle or cyme. Involucre of several (to two) series of herbaceous, imbricate bracts increasing in size toward the interior, often pilose with black hairs on the outer surface; receptacle flat to slightly convex, alveolate with membranaceous or ciliate margins, or naked. Corolla [sometimes subtubular] yellow, gold, or rarely orange-red in color, often with a tuft of hairs at the throat. Anthers with short sagittate auricles. Style branches thin, terete. Achenes terete, 4–10-ribbed, truncate at the apex, glabrous; pappus of simple setose bristles, white or brown. Lectotype species: *H. murorum* L.; see Britton & Brown, Illus. Fl. No. U.S. ed. 2. 3: 328. 1913. (Name from Greek *hierax*, hawk, because the Greeks believed that a similar plant, probably a species of *Crepis* [according to Zahn], was eaten by hawks to improve their eyesight.) — Hawk-weed.

A cosmopolitan genus of between 150 (Bentham & Hooker) and 450 (Zahn) species which are usually arranged in four subgenera, each with numerous sections. The presence of recognizable apomictic populations has led to excessive splitting of species and elaboration of formally described taxa. Fortunately, the indigenous North American taxa appear to be sexually reproducing and have been more conservatively treated. Seven native species of subg. Stenotheca (Monn.) Torrey & Gray, and at least four introduced species of subg. Pilosella (Schultz Bip.) Torrey & Gray occur in the southeastern United States.

The indigenous subg. Stenotheca includes nonstoloniferous species with biseriate involucres and achenes with a smooth ring at the apex. Several species of this section hybridize in overlapping parts of their ranges. *Hieracium paniculatum* L., $2n = 18$, with its large, open panicles of heads frequents deciduous woodlands from Nova Scotia and southern Quebec to Michigan, south to Georgia and Alabama. It hybridizes with *H. scabrum* Michx., $2n = 18$, a morphologically similar plant with stiff, corymbose inflorescences of flower heads. The two are sympatric

over the entire range of *H. paniculatum*, but *H. scabrum* occurs farther westward to Oklahoma. *Hieracium Trailii* Greene (*H. Greenii* Porter & Britton), an inland species distributed from the mountains of Pennsylvania south through Georgia and Alabama, may also hybridize with *H. scabrum* in West Virginia (cf. Myers).

Several species included by Small in his *Manual of the Southeastern Flora* are now considered either to be conspecific with *Hieracium venosum* L., $2n = 18$, or to be hybrids between this and related taxa. According to Gleason & Cronquist, *H. marianum* Willd. (*H. argyraeum* Small) is either a variant of *H. venosum* or a hybrid between it and either *H. scabrum* or *H. Gronovii* L. Plants formerly known as *H. Scribneri* Small are probably hybrids between *H. venosum* and *H. paniculatum*. If *H. venosum* is circumscribed in its broadest sense, it can be characterized by the conspicuously maroon-outlined veins on the rosette of basal leaves. The species occurs in acid soils in open woods and clearings from southern Maine to southern Ontario south to Florida and Louisiana.

Hieracium Gronovii, also a plant of dry, open woods from Massachusetts to Michigan, south to Florida and Texas, is distinguished by its dense pubescence of trichomes less than 1 cm. in length. *Hieracium longipilum* Torrey is very similar, but has hairs 1–2 cm. long, and is midwestern in distribution, with a range extending from southwestern Ontario and Michigan, west to Minnesota and Nebraska, and south to Kansas, Louisiana, and eastern Texas. *Heracium megacephalon* Nash, our only species with a white pappus, is endemic to the southeastern pinelands of South Carolina, Georgia, and Tennessee.

At least four European species of subg. PILOSELLA, characterized by the presence of lateral stolons, an involucre of several series of bracts, and a dentate ring at the apex of the achene are established in our area. *Hieracacium Pilosella* L., $2n = 36, 39, 45, 54, 63$, a low plant with solitary yellow-flowered heads, now occurs in dry areas from Newfoundland to Quebec, to Oregon, and southeastward to North Carolina. The most easily recognized species of the subgenus, *H. aurantiacum* L., $2n = 30, 45$, has brilliant red-orange florets. Introduced as an ornamental garden plant, it has become a common, and often pernicious, weed in pastures, open woods, and along roadsides from Newfoundland to Ontario, south to Ohio and in the mountains to North Carolina. Two other introduced species, the yellow-flowered *H. pratense* Tausch., $2n = 36$, and *H. florentinum* All., $2n = 36, 45$, are very similar morphologically, generally having been distinguished by the pubescent leaf surface of *H. pratense*, and the glabrous one of *H. florentinum*. Myers recently has suggested from studies in the United States that either the two are the extremes of one polymorphic species or that extensive hybridization has occurred between them. *Hieracium pratense* frequents dry, disturbed soils across southern Canada and the United States from Michigan southeast to Georgia, while *H. florentinum* prefers calcareous areas from Newfoundland to Quebec and south to Wisconsin and North Carolina.

Numerous studies, the earlier ones of which have been excellently

summarized by Gustafsson (1946, 1947), have been made on the reproductive biology of various species of *Hieracium*. Later work has been done by Bergman, Battaglia, and Turresson & Turresson. There is apparently some correlation between the type of reproduction, the chromosome number, and the subgenera recognized by Zahn (e.g., asexual reproduction by means of stolons occurs only in species of subg. PILOSELLA). In both subg. PILOSELLA and subg. HIERACIUM, there is great variation in chromosome numbers, $2n = 18, 27, 30, 36, 42, 45, 54, 63$, to 90, and apomixis is found in both these subgenera. The presence of three types of apomixis is of unusual interest. In the first, diplospory, the megagametophyte is produced from a true megaspore mother cell that undergoes meiosis. The two nuclei of the first division unite to form a restitution nucleus. In plants with a diploid number of 27, the two transient nuclei have unequal numbers of chromosomes (usually 1 and 26 or 13 and 14). After the nuclei reunite, the original number of 27 is restored. The second type of apomixis is the development of an embryo from a nonmeiotic egg cell, and the third type is apospory, the formation of a megagametophyte from a somatic cell, in this case a cell from the megasporangium (nucellus). Embryos produced from reduced and nonreduced egg cells have been found within the same ovule, but the ameiotic one usually crushes the former.

In the subg. STENOTHECA, regular meiosis and a diploid number of $2n = 18$ predominates. It should be noted, however, that apomixis found in other subgenera is facultative, and some outbreeding usually also occurs (e.g., Skalinska).

Muller (1969) lists *Hieracium* as a genus that exhibits autotoxicity. Plants tend to form "fairy rings" as they grow out from the central area in which metabolic products presumably accumulate.

Several species of *Hieracium* are used in Europe as diuretics and tonics (cf. Fournier). *Hieracium Pilosella* has been used to combat Maltese fever because the plants contain umbelliferene, a 7-hydroxycoumarine, known to have antibiotic properties (see Duquénois *et al.* and Haag-Berrurier).

REFERENCES:

Under tribal references see BENTHAM & HOOKER, BOLKHOVSKIKH *et al.*, FOURNIER, GUSTAFSSON, HEGI, HOFFMANN, JEFFREY, LEDIN, NYGREN, and RICKETT; under *Leontodon* see TURESSON.

BATTAGLIA, E. Development of angiosperm embryo sacs with non-haploid eggs. Am. Jour. Bot. **38:** 718–724. 1951.

BERGMAN, B. Zytologische Studien über sexuelles und asexuelles *Hieracium umbellatum*. Hereditas **20:** 47–64. 1935.

———. Studies on the embryo sac mother cell and its development in *Hieracium* subg. *Archieracium*. Sv. Bot. Tidskr. **35:** 1–42. 1941.

DAHLSTEDT, H. Bidrag till sydöstra Sveriges (Smålands, Östergötlands och Gotlands) *Hieracium*-flora. Sv. Vet-akad. Handl. **23**(15): 1–135. 1890; **25**(3): 1–201. 1893; **26**(3): 1–266. 1894.

DUQUÉNOIS, P., E. GRIEB, & M. HAAG. Développement et activité de l'*Hieracium Pilosella* L. au cours de sa végétation. Bull. Soc. Bot. France **103:** 426–429. 1956.

FAGERLIND, F. Die restitutions- und kontraktionskerne der *Hieracium*-mikrosporogenese. Sv. Bot. Tidskr. **41:** 247–263. 1947.

FERNALD, M. L. Notes on *Hieracium*. Rhodora **45:** 317–325. 1943. [Reprinted in Contr. Gray Herb. **148.**]

GUSTAFSON, A. H. Cytological studies in the genus *Hieracium*. Bot. Gaz. **94:** 512–533. *figs. 1–56.* 1933.

GUSTAFSSON, Å., & A. NYGREN. The temperature effect on pollen formation and meiosis in *Hieracium robustum*. Hereditas **32:** 1–14. 1946.

HAAG-BERRURIER, M. Mise en évidence d'une forme combinée de l'ombelliférone dans l'*Hieracium Pilosella* L., après stabilisation. Compt. Rend. Acad. Sci. Paris. **246:** 624–626. 1958.

KRUCKEBERG, A. A hybrid hawkweed from the Olympic Mountains of Washington. Madroño **19:** 126–129. 1967.

MULLER, C. H. Allelopathy as a factor in ecological process. Vegetatio **18:** 348–357. 1969.

MYERS, J. C. The genus *Hieracium* in West Virginia. Castanea **15:** 92–101. 1950.

SCHISCHKIN, B. K., & E. G. BOBROV. *Hieracium*. Fl. URSS. **30:** i–xxiv, 1–732. 1960. [785 spp.]

SKALINSKA, M. Experimental and embryological studies in *Hieracium aurantiacum* L. Acta Biol. Cracov. Bot. **14**(2): 139–152. 1971.*

TURESSON, G., & B. TURESSON. Experimental studies in *Hieracium Pilosella* L. I. Reproduction, chromosome number and distribution. Hereditas **46:** 717–736. 1960.

——— & ———. Observations on chromosome number and reproduction in some piloselloids. Bot. Not. **116:** 157–160. 1963.

WARD, L. F. The "king-devil". Bot. Gaz. **14:** 10–17. 1889. [*H. prealtum.*]

ZAHN, K. H. Hieracia domingensia. Bot. Jahrb. **52:** 272–276. 1915.

———. Compositae – *Hieracium*. Pflanzenreich IV. **280**(Hefte 75–77, 79, 82): 1–1705. 1921–1923.

12. **Prenanthes** Linnaeus, Sp. Pl. **2:** 797. 1753; Gen. Pl. ed. 5. 349. 1754, "*Prenantes.*"

Erect caulescent perennial herbs with alternate, petiolate or clasping, lanceolate, sagittate or cordate, entire, serrate, dentate, or deeply parted leaves. Inflorescence paniculate or racemose, the heads nodding or, in a few species, ascending. Involucre narrow, composed of few, tiny exterior bracts, and long, lanceolate, stiff, scarious inner bracts; receptacle flat, naked. Corolla white, purple, violet, or ochre. Anthers with acute basal appendages; pollen echinolophate. Style long with terete branches. Achenes narrow, oblong, subterete, more or less 4- or 5-angled, inconspicuously ribbed, slightly constricted at the apex; pappus abundant, setose, brownish, reddish or yellow in color. (Including *Nabalus* Cass.) LECTOTYPE SPECIES: *P. purpurea* L.; see Cassini, Dict. Sci. Nat. Paris **34:** 96. 1825. (Name from Greek, *prenes*, nodding, and *anthos*, flower.) — RATTLESNAKE ROOT.

A genus of some 25 species native to Europe, eastern Asia and the Himalayas, and North America, with a single climbing species, *P. subpeltata* Stebbins, in the Virunga Mountains of Central Africa. Species from the Canary Islands, Java, and Venezuela, have also been referred to this genus, but all of these apparently belong to other genera (cf. Babcock).

Unfortunately, there is no modern revision of the genus which discusses its evolutionary history or the relationships of the Old and New World species. The North American species are being investigated by Milstead, who recognizes 12 species in the New World. These, and a few species of northeastern Asia constitute the subg. NABALUS (Cass.) Gray (treated as the genus *Nabalus* Cass. in Small's *Manual of the Southeastern Flora*). Although primarily of woodlands of the North Temperate Zone, seven species of this subgenus occur in the southeastern United States. *Prenanthes racemosa* Michx. and *P. Boottii* occur to the north of our area, and *P. alata* (Hooker) D. Dietr. and *P. sagittata* (Gray) A. Nelson occur in northwestern North America.

Our two most distinctive species both have sessile cauline leaves and racemose inflorescences, but differ in that *Prenanthes aspera* Michx. (*Nabalus aspera* (Michx.) Torrey & Gray), $2n = 18$, has a pubescent inflorescence with ascending heads, whereas *P. autumnalis* Walter (*P. virgata* Michx., *Nabalus virgatus* (Michx.) DC.) has a glabrous inflorescence of nodding heads. The former occurs in dry areas from Pennsylvania to Minnesota and South Dakota, south to Missouri, Arkansas, Kansas, and Louisiana, and the latter from the pine barrens of New Jersey southward on the Coastal Plain to Georgia and Florida.

Most of our species are part of a complex, the members of which have distinctly petiolate, more or less triangular, stem leaves. *Prenanthes trifoliolata* (Cass.) Fern. (*Nabalus trifoliolata* Cass.), $2n = 16$, around which these species cluster, has a yellowish pappus, extremely variable leaves, and, supposedly, a glabrous involucre of deltoid to ovate bracts as long as the pappus (cf. Cronquist in Gleason, *The New Britton & Brown*). The species is distributed across southern Canada from Newfoundland to Quebec, southward in oak and pine woods to Tennessee and Georgia. *Prenanthes Serpentaria* Pursh (*Nabalus Serpentaria* (Pursh) Hooker; incl. *P. integrifolius* Small), $2n = 16$, is said to be distinguished from the preceding species by its pubescent bracts that are lanceolate and shorter than the pappus. Since this taxon occurs on the Coastal Plain from Massachusetts to Florida, Alabama, and Mississippi (as well as inland to Pennsylvania), it may be an eastern ecological race of *P. trifoliolata*. Another taxon that may be an isolated member of the *P. trifoliolata-serpentaria* complex is *P. roanensis* (Chickering) Chickering (*Nabalus roanensis* Chickering), which was thought to be restricted to the mountains at the border of Tennessee and North Carolina but has recently been found in nearby Grayson County, Virginia (Uttal & Mitchell). These populations differ from surrounding ones in the conspicuous black pubescence on the involucral bracts. The last member of this complex, *P. cylindrica* (Small) E. L. Braun (*Nabalus cylindricus*

Small), is separated from the other taxa by the presence of sparse pubescence on the involucre. A rather uncommon taxon, it occurs in the mountains from North Carolina to Kentucky.

Similar in gross morphology to the species clustered around *Prenanthes trifoliolata*, but readily distinguished by its reddish-brown pappus, *P. alba* L. (*Nabalus albus* (L.) Hooker), $2n = 32$, is a tetraploid plant of moist woodlands from Quebec to Saskatchewan, south to South Dakota, Missouri, and Georgia. *Prenanthes crepidinea* Michx. (*Nabalus crepidineus* (Michx.) DC.) can be recognized by its numerous 20–35-flowered heads arranged in a corymbose panicle. Also a woodland species, it is more southern in distribution than *P. alba*, occurring from New York to Minnesota, south to Tennessee and Missouri.

Prenanthes altissima L. (*Nabalus altissimus* (L.) Hooker), $2n = 16$, has heads with fewer flowers (usually 5 or 6, not more than 8) and primary involucral bracts (5) than any other of our species. It occurs from Prince Edward Island and Quebec, south to Missouri, Louisiana, and Georgia. Although Fernald recognized var. *cinnamomea* Fern. in the southwestern part of its range, Milstead considered formal recognition to be unnecessary, since the southern populations constitute the ends of a north-south cline in pappus color.

Studies by Babcock suggested that *Prenanthes* is a relatively primitive genus in the Crepidinae (although not as unspecialized as some species of *Crepis*). He also considered the genus to have had formerly an intercontinental range (across the Bering land bridge) which was later restricted and led to the present pattern of isolated groups in Europe, southeastern Asia, and North America. The New World species appear to be most closely related to the Japanese species of subg. NABALUS.

On the basis of cytological studies, Babcock speculated that the primitive *Prenanthes* arose from an amphidiploid of a hybrid between parents with chromosome numbers of $n = 5$ and $n = 4$. However, with the exception of two, all of the species for which numbers are now known have $2n = 16$ or 32. Babcock, Stebbins, & Jenkins later suggested that there are two base numbers, 8 and 9, in the genus; and Milstead notes that in subg. PRENANTHES $x = 9$, while in subg. NABALUS, $x = 8$.

Although species of *Prenanthes* have no real economic importance, *P. alba* was used by the American Indians to "cure" snake bite. Investigations of the properties of the species have not yielded a substance which would seem to be effective as an antivenin. Plant extracts have also been used as a general tonic (cf. Millspaugh).

REFERENCES:

Under tribal references see BABCOCK, BABCOCK *et al.*, BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, HEGI, HOFFMANN, JEFFREY, RICKETT, and STEBBINS.

CRONQUIST, A. Notes on the Compositae of the northeastern United States. VI. Cichorieae, Eupatorieae, and Astereae. Rhodora **50**: 28–35. 1948. [In-

cludes notes on *P. racemosa* and a new var. *multiflora* and on *Lactuca*.]
MILLSPAUGH, C. F. American medicinal plants. vol. 1. New York and Philadelphia. 1887. [*Nabalus*, **1**(94): [2 pp.] *pl. 94*.]
MILSTEAD, W. L. Migratory and phylogenetic trends in *Prenanthes*. (Abstr.) Proc. Indiana Acad. Sci. **72**: 257. 1963.
——— & G. L. WEBSTER. Variation patterns in eastern North American *Prenanthes*. (Abstr.) Am. Jour. Bot. **48**: 548. 1961.
——— & ———. Distribution patterns in *Prenanthes* (Compositae: Cichorieae). (Abstr.) Am. Jour. Bot. **49**: 677. 1962.
SIMS, J. *Prenanthes alba*. White-flowered *Prenanthes*. Bot. Mag. **27**: *pl. 1079*. 1808.
STEBBINS, G. L., JR. The scandent species of *Lactuca* and *Prenanthes* in Africa. Bull. Jard. Bot. Bruxelles **14**: 333–352. 1937.
UTTAL, L. J., & R. S. MITCHELL. Amendments to the Flora of Virginia – II. Castanea **37**: 96–118. 1972. [*P. roanensis* on Whitetop Mt., Grayson Co., Va.]

13. **Lactuca** Linnaeus, Sp. Pl. **2**: 795. 1753; Gen. Pl. ed. 5. 348. 1754.

Annual, biennial, or perennial glabrous or pubescent herbs with alternate cauline and/or basal leaves. Leaves entire, dentate, or pinnatifid. Inflorescence a panicle of numerous heads. Involucre composed of a few series of bracts increasing in size toward the inside and with scarious margins; receptacle flat, naked. Corolla yellow, blue, or white, the tube sometimes with a ring of long hairs at the summit. Anthers sagittate at the base, or with short setose-acuminate or acute auricles. Style branches, thin, short. Achenes flattened, ± 2-winged, beaked or beakless, but always terminated by a disc on which the pappus is borne, surface with a variable number of ribs; pappus setose or capillary (according to Stebbins, 1937, the bristles never more than four cells in thickness). (Including *Mulgedium* Cass., *Mycelis* Cass., and *Cicerbita* Wallr., in part.) LECTOTYPE SPECIES: *L. sativa* L.; see Britton & Brown, Illus. Fl. No. U.S. ed. 2. **2**: 317. 1917. (*Lactuca*, classical Latin for lettuce, *L. sativa*, the name derived from *lac*, milk, referring to the the milky juice.) — LETTUCE, WILD LETTUCE.

A genus of some 50–90 species native to the temperate areas of Europe, Asia, Africa, and North and South America, with major centers of diversity in the Himalayas and the Middle East. There is no modern revision of the genus, and various authors (Bentham & Hooker, Hoffmann, Fernald) have recognized different subgenera or sections. Following Fernald's treatment (supplemented by work of Stebbins), we have nine species in two subgenera. Two additional species of a third subgenus, MYCELIS (Cass.) Babcock *et al.*, are adventive to the north of our area.

Subgenus LACTUCA (sect. *Scariola* DC.), which comprises species that have long achenes with soft beaks, is represented by two introduced and four indigenous species in the flora of the southeastern United States. *Lactuca canadensis* L., $2n = 34$, a very variable species (Fernald recognized four varieties) grows in disturbed grounds from Prince Edward

Island to Saskatchewan, south to Texas and Florida. *Lactuca graminifolia* Michx., $2n = 34$, with linear cauline leaves, occurs in dry habitats from North Carolina (according to Fernald also in the New Jersey pine barrens) south to Florida, west to Wisconsin and Colorado. The densely pubescent *L. hirta* Muhl. also grows in dry areas and open woods but is distributed over a much larger area, from Prince Edward Island, east to Ontario, south to Texas, Louisiana, Mississippi, and West Virginia. The fourth indigenous species, *L. ludoviciana* (Nutt.) Riddell, $2n = 34$, is a plant of grasslands and prairies primarily in the western United States but extending as far east as Missouri, Louisiana, and possibly Georgia.

The introduced European weeds *L. saligna* L., $2n = 18$, and *L. Serriola* L. (*L. Scariola* L.[7]), $2n = 18$, both prefer moist disturbed ground or waste areas but are also found in openings in woods and along streams. The former occurs from southern Canada, south to Georgia and New Mexico, and the latter is widely scattered in the United States. The leaves of both species are quite variable in shape, but those of *L. Serriola* are distinguished by a row of sharp teeth on the underside of the midrib.

The common garden lettuce, *Lactuca sativa* L., $2n = 18, 36, 36 + B$, is apparently not known as a wild plant but has escaped from cultivation in various parts of the world. Many authors think that *L. sativa* was derived from *L. Serriola* and that the two species should be considered conspecific. Anderson quotes unpublished work of M. Ownbey showing extensive introgression from garden lettuces into *L. Serriola*, "previously largely unsuspected because the hybrids and hybrid derivative mongrels were superficially so similar to wild lettuce and so unlike garden lettuce." If the two are united, *L. sativa* is the correct name.

Four species of subg. MULGEDIUM (Cass.) Gray (*Mulgedium* Cass.), comprising species that have achenes with a short, stout beak or none at all, occur in the Southeast. *Lactuca floridana* (L.) Gaertner, $2n = 34$, characterized by its blackish achenes and bright white pappus, can be found in wet woods from New York to Iowa, south to Texas and Florida. *Lactuca biennis* (Moench.) Fern., $2n = 34$, differing in its olive-colored achene and dirty-white pappus, ranges through most of the northern United States, south to Colorado, Tennessee, and North Carolina. *Lactuca pulchella* (Pursh) DC. was placed in subg. LACUASTRUM Gray by Fernald because its achenial beak is intermediate between that of subg. LACTUCA and subg. MULGEDIUM. Stebbins, however, treated it as subsp. *pulchella* (Pursh) Stebbins of *L. tatarica* (L.) C. A. Meyer, an Old World

[7] Both *Lactuca Serriola* L. (Cent. II. Pl. [Linn. Diss. 63]. 29. 1756; republished in Amoen. Acad. **4:** 328, 1759.) and *L. Scariola* L. (Sp. Pl. ed. 2, 1119. 1763), are in use as the name of this plant. As Shinners pointed out (Field & Lab. **17:** 175. 1949), *L. Scariola* must be considered an illegitimate substitute name for the earlier *L. Serriola*. *Lactuca Serriola* was properly published and is both valid and legitimate. Since Linnaeus gave exactly the same specific diagnosis for *L. Scariola* (1763) as for *L. Serriola* (1756) and cited the same synonyms, *Scariola* is clearly a substitute epithet for *Serriola*. As such, the combination *L. Scariola* is illegitimate, and the correct name of this species is *L. Serriola*. — C. E. WOOD, JR.

plant that Babcock *et al.* (1937) had put in subg. MULGEDIUM. This large-headed taxon is found in North America in open areas from Quebec to Alaska, south to Missouri, New Mexico, and California.

In a study of some American species of *Lactuca*, Babcock *et al.* found a mosaic of relationships, with some species more closely related to Old World species than to other American ones. *Lactuca floridana*, $2n = 34$, seemed to be related to two species of Asia Minor (*L. Marshallii* Stebbins, $2n = 16$, and *L. Bourgaei* Irish & Taylor in L. H. Bailey, $2n = 16$), and *L. canadensis*, $2n = 34$, appeared to be closest to an eastern Asiatic species (*L. formosana* Maxim., $2n = 18$). The nearest relative of *L. graminifolia* was postulated by these authors to be a nonscandent African species, such as *L. capensis*. Whitaker & Thompson have conducted experiments which seem to contradict the relationships proposed by Babcock *et al.* Experimental crosses between *L. floridana* and *L. canadensis* yielded viable F_1 and F_2 generations. The success of these crosses prompted Whitaker & Thompson to postulate that the parental species were descended from a common amphidiploid ancestor.

Lindqvist studied the relationships of the members of subg. LACTUCA and concluded that *L. Serriola, L. sativa, L. saligna, L. altaica* Fischer & Meyer, $2n = 18$, and *L. virosa* L., $2n = 16, 18$, should all be considered conspecific. The morphological character often used to separate the taxa involved is the position of the involucral bracts at the time of achene maturity. In both *L. sativa* and *L. altaica* the involucral bracts remain rigid and upright, while in the other taxa of this complex, the bracts reflex as the achenes ripen. Genetic studies have clearly shown that bract position is under the control of a single gene and that the condition of reflexed bracts is dominant over upright bracts (Lindqvist).

Stebbins and his colleagues have placed *Lactuca* in the *Prenanthes-Ixeris* line of the subtribe Crepidinae because of the morphological similarities of *Lactuca, Cicerbita* Wallr., and *Prenanthes*. Jeffrey's treatment agrees with this placement.

All of the subgenera of *Lactuca* contain groups of species with chromosomal base numbers of both 8 and 9. The presence of these two distinct base numbers throughout the genus led Babcock *et al.* to speculate that *Lactuca* is polyphyletic in origin, although they made no comment as to the possible ancestral stocks. In Africa there is an isolated group of species which are scandent herbs, morphologically unlike, and apparently unrelated to, other species of *Lactuca*. Stebbins thought that these herbs were derived from scandent species of *Prenanthes*, rather than from African or Asian species of *Lactuca*.

Numerous pollination, embryological, and physiological studies have been made of *Lactuca sativa* because of its importance as an economic plant (lettuce). Although cultivated plants are almost exclusively self-pollinated, cross-pollination can, and undoubtedly does, occur. The megagametophyte of this species is of the Polygonum-type (Jones), and apomixis apparently does not occur.

A recent conference on lettuce recognized 130 "varieties" (cf. Huyskes

& Rodenberg), but three basic types are usually seen: the cos, with loose spathulate leaves (i.e., garden lettuce); the cabbage (iceberg); and the lanceolate or columnella (Romaine). Types similar to these three were known to the ancient Persians at least 500 B.C. (Sturtevant). Lindqvist's experiments have shown that several of the differences in leaf shape are controlled by a multiallelic system in which entire leaves are recessive to the various degrees of lobing.

The "Grand Rapids" variety of lettuce has also become famous because its seeds were used by Flint & McAlister and later by Borthwick *et al.* for experiments on the effects of light on germination. The reversible red – far-red system of light interactions exhibited by these seeds has helped to formulate the modern phytochrome theory.

In Europe *Lactuca virosa* is grown commercially as a source of latex, lactucarium, which is used as a cough sedative.

REFERENCES:

Under tribal references see BABCOCK *et al.*, BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, FOURNIER, HEGI, HOFFMANN, JEFFREY, LEDIN, RICKETT, STEBBINS, STEBBINS *et al.*, and WODEHOUSE.

ANDERSON, E. Introgressive hybridization. x + 109 pp. New York and London. 1949.

BORTHWICK, H. A., S. B. HENDRICKS, E. H. TOOLE, & V. K. TOOLE. Action of light on lettuce-seed germination. Bot. Gaz. **115:** 205–225. 1954.

FLINT, L. H., & E. D. MCALISTER. Wave lengths of radiation in the visible spectrum promoting the germination of light-sensitive lettuce seed. Smithson. Misc. Collect. **96**(2): 1–9. *pl. 1.* 1937.

GATES, R. R., & E. M. REES. A cytological study of pollen development in *Lactuca.* Ann. Bot. **35:** 365–398. *pls. 16–18.* 1921.

HUYSKES, J. A., & C. M. RODENBURG. International collaboration in the study of varieties of lettuce. Euphytica **6:** 94–95. 1957.

JONES, H. A. Pollination and life history studies of lettuce (*Lactuca sativa* L.). Hilgardia **2:** 425–479. 1927.

LINDQVIST, K. Reflexed and erect involucre in *Lactuca.* Hereditas **42:** 436–442. 1956.

———. Inheritance of lobed leaf form in *Lactuca. Ibid.* **44:** 347–377. 1958.

———. On the origin of cultivated lettuce. *Ibid.* **46:** 319–350. 1960.

STEBBINS, G. L., JR. Critical notes on *Lactuca* and related genera. Jour. Bot. **75:** 12–18. 1937.

———. Critical notes on the genus *Ixeris. Ibid.* 43–51.

———. The scandent species of *Prenanthes* and *Lactuca* in Africa. Bull. Jard. Bot. Bruxelles **14:** 333–352. 1937.

———. Notes on *Lactuca* in western North America. Madroño **5:** 123–126. 1939. [*L. virosa, L. Serriola, L. saligna, L. muralis, L. spicata, L. tatarica* subsp. *pulchella.*]

———. Notes on some Indian species of *Lactuca.* Indian Forest Rec. II. Bot. **1:** 237–245. *1 pl.* 1939.*

———. Studies in the Cichorieae: *Dubyaea* and *Soroseris,* endemics of the Sino-Himalayan region. Mem. Torrey Bot. Club **19:** 1–76. 1940.

STURTEVANT, E. L. A study of garden lettuce. Am. Nat. **20:** 230–233. 1886. [Reprint from Proc. 6th Meeting Soc. Promotion Agr. Sci., pp. 43, 44.*]
THOMPSON, R. C., T. W. WHITAKER, & W. F. KOSAR. Interspecific genetic relationships in *Lactuca*. Jour. Agr. Res. **63:** 91–107. 1941.
WHITAKER, T. W. The genetics of leaf form in cultivated lettuce. I. The inheritance of lobing. Proc. Am. Soc. Hort. Sci. **56:** 389–394. 1950.
———. The inheritance of certain characters in a cross of two American species of *Lactuca*. Bull. Torrey Bot. Club **71:** 347–355. 1944. [*L. canadensis*, *L. graminifolia*.]
——— & I. C. JAGGER. Cytogenetic observations in *Lactuca*. Jour. Agr. Res. **58:** 297–306. 1939.*
——— & G. D. MCCOLLUM. Shattering in lettuce — its inheritance and biological significance. Bull. Torrey Club **81:** 104–110. 1954.
——— & R. C. THOMPSON. Cytological studies in *Lactuca*. Bull. Torrey Bot. Club **68:** 388–394. 1941.

14. **Taraxacum** Wiggers, Prim. Fl. Hols. 56. 1780, nom. cons.

Perennial rosette herbs with scapose flowering stems arising from a straight or branched taproot. Basal leaves lanceolate to runcinate, entire, undulate, or doubly pinnatifid. Involucre of an inner series of connate, lanceolate bracts sometimes bifid at the apex, and an outer series of short, ovate bracts either appressed to the inner or reflexed; receptacle slightly convex, naked. Florets perfect (or functionally carpellate, the pollen abortive). Corolla yellow [violet, rose, or orange] with a dark band on the under side of the limb (ligule). Anthers sagittate at the base; pollen variable in shape (because of irregular meiosis), usually spherical, tricolporate, spinulose. Style branches thin, obtuse, variable in length. Achenes obconical, narrowing at the base, constricted at the apex, variously beaked, the beak terminating in a disc on which the pappus is borne; surface with 8 prominent ribs and up to 10 minor ribs, the upper half usually decorated with characteristic spines and knobs; pappus thin, soft, capillary, white. LECTOTYPE SPECIES: *T. officinale* Wiggers, typus cons. (Name probably of Arabic origin, applied by Theophrastus and Pliny to a yellow-flowered cichoriaceous plant, possibly a species of *Sonchus* L.) — DANDELION.

A now cosmopolitan genus indigenous to the North Temperate Zone. Estimates of the number of species vary from 6 (Bentham & Hooker) to over 1000 (Britton & Brown, ed. 2). This discrepancy in circumscription is caused by the predominance of asexual reproduction, which makes objective species delimitation almost impossible. Perhaps the most realistic treatment, and the one followed here, is that of Handel-Mazzetti (1907 & 1923) who recognized 63 species, which he ranked in 11 sections. European authors (e.g., Dahlstedt and van Soest) have since split the genus into numerous "species" and have erected sections that are difficult or impossible to correlate with those of Handel-Mazzetti. Although the geographical populations taxonomically treated as species by the

various authors are recognizable morphologically, it seems more meaningful biologically to group together those that appear to have very similar genomes and the possibility of interbreeding.

Sherff, in his treatment of the North American species of *Taraxacum*, followed the work of Handel-Mazzetti with the reduction of three species to synonymy and the addition of one neglected by the earlier author. Of the five species included in Sherff's study, two, both introduced, occur in the southeastern United States.

The common dandelion, *Taraxacum officinale*,[8] $2n = 16, 18, 22–26, 24, 33, 36, 37, 46–48$, of sect. TARAXACUM (sect. *Boreale* Handel-Mazzetti and in Sherff) is a native European weed now common all across southern Canada, Alaska, the United States, and in the uplands of Central and South America and the West Indies. Our second "species," the red-seeded dandelion, *T. laevigatum* (Willd.) DC.,[9] $2n = 16, 22, 24, 26, 32$, of sect. ERYTHROCARPUM Handel-Mazzetti, occurs in the southern part of Canada and in the United States from Maine to the Dakotas, south to Texas and Georgia. Although Fernald recognized 11 species in eastern North America, Gleason & Cronquist reduced the number to three, considering only *T. officinale*, *T. laevigatum*, and *T. ceratophorum* (Ledeb.) DC. as meaningful taxa.[10] The last occurs to the north and west of our area from New Hampshire and Massachusetts southwest to Mexico and California. The remaining species included in Sherff's treatment are found in northwestern North America, primarily in the Rocky Mountain area. Two additional segregate taxa, *T. lacistophyllum* (Dahlstedt) Dahlstedt and *T. disseminatum* Haglund have been identified by van Soest from specimens collected in Tennessee and Missouri respectively. *Taraxacum xanthostigma* Lindb., $2n = 24$, has been reported by Adams from Philadelphia, Pennsylvania.

The common dandelion, *Taraxacum officinale*, is easily distinguished from the red-seeded dandelion, *T. laevigatum*, by its greenish-brown achenes and, frequently, rather entire leaves. The achenes of *T. laevigatum* are red and the leaves are deeply lacerated. According to Berry, the red-seeded dandelion prefers sandier areas with little grass whereas the common one grows in more moist places, often with tall grass. Correll & Johnston, who recognize only *T. officinale*, comment, in *Manual of the Vascular Plants of Texas*, p. 1736, "The color of the achene varies from

[8] See Fernald (1948) for a clear explanation of why this is the correct name.

[9] There has been some debate as to whether the correct name for this species is *T. erythrospermum* Andrz. or *T. laevigatum*. Handel-Mazzetti, who examined the types of both names, considered them to be synonymous. Since *T. laevigatum* is the older name, it thus becomes the correct one. Shinners, however, decided that the American material did not agree with Willdenow's description of *T. laevigatum* and advocated the treatment of *T. erythrospermum* as a distinct species, a course previously followed in Britton & Brown, ed. 2 (*Illus. Fl. No. U.S.*), Fernald's *Gray's Manual*, and Small's *Manual*. In this article, as in Gleason & Cronquist (*The New Britton & Brown*), the circumscription of *T. laevigatum* is that of Handel-Mazzetti.

[10] See Cronquist in Gleason, New Britton & Brown Illus. Fl. Northeast. U.S. 3:532. 1952, for a discussion of the synonymy.

grayish or buffy to red-chestnut, but no other characters are correlated with this color and there seems to be no justification for recognition of *T. erythrospermum* as a separate entity."

Anatomical studies have been made primarily on the Asiatic *Taraxacum Kok-saghyz* Rodin, $2n = 16$, because of its use as a source of rubber during World War II. A review of the voluminous literature on this species can be found in Krotkov. The anatomy of *T. officinale* has been described by Gier & Burress, and that of *T. laevigatum* by Naylor. In both of these species a callus cylinder is formed outside the xylem if the crown of a plant is cut off. From this callus tissue, secondary vascular systems, which subsequently give rise to new rosettes, and ultimately, several independent plants, are initiated. (From this comes the frustration of gardeners who try to eliminate dandelions by cutting off the rosette of leaves.)

Apomixis has been reported for almost all species of *Taraxacum*, but most are still capable of some outbreeding, and this limited outbreeding may occasionally reintroduce new genetic material into apomictic populations. In the common dandelion, however, the amount of sexual reproduction during a given year seems to be almost negligible. Asexual seed production is possible from either an unreduced egg cell or one with a reconstituted diploid nucleus (cf. Nygren, Stork). Polyploidy has also been reported in both of our species and in numerous others of the genus. Diploid plants tend to have fairly constant pollen size and usually bloom for a short time early in the season. In contrast, polyploid plants have variably sized pollen grains, bloom early, and have a long flowering season (Fürnkranz). There seems to be no correlation within a species between the ploidy level and the geographic distribution, although plants with higher chromosome numbers are apt to grow in more disturbed areas.

The incompatibility system in sexually reproducing plants of *Taraxacum* is a four allele system with three of the alleles equal in the amount of expression ("strength") and all dominant to the fourth, as in *Crepis* L. and *Parthenium* L. (Okabe). The pollen incompatibility reaction is sporophytically controlled, with no incompatibility expressed in the style.

Part of the success of *Taraxacum officinale* as a ubiquitous weed is undoubtedly due to its germination system. Although some seeds germinate immediately, there is genetically controlled variation in germination time so that seedlings are produced continuously throughout the summer. Plants from achenes which germinate in the spring are robust by fall and flower the next spring; those from fall-germinated seeds are weak when winter sets in and frequently take up to three years to flower. Another reason for its success is undoubtedly its ability, because it reproduces by apomixis, to produce rapidly local, pure races well adapted to microhabitats within a heterogeneous habitat (Solbrig & Vuilleumier).

Although Bentham & Hooker considered *Taraxacum* to be related to *Leontodon* L., as had all previous authors, Stebbins placed them in separate subtribes, the former in the *Youngia-Ixeris* line of the Crepidinae, and the latter in the Leontodontinae.

Several species of *Taraxacum*, but primarily *T. officinale*, are used in European cookery. In some areas the unopened heads are pickled and used like capers. The ground, dried root is sometimes mixed with coffee. A wine is also made from macerated flower heads in a sugar solution inoculated with a fermentation culture. Dandelions are best known culinarily, however, for their leaves, which are eaten in salad or as a cooked vegetable.

Taraxacum is grown commercially in Europe for two additional purposes: the egg-shaped nectaries at the base of the style produce such an abundant amount of nectar (despite the presence of apomixis), that fields are planted near apiaries as a food source for the bees; and the taproots from several-year-old plants are dried and extracted for their content of inulin, which is used in the treatment of jaundice, constipation, and external sores.

REFERENCES:

Under tribal references see BENTHAM & HOOKER, BOLKHOVSKIKH *et al.*, FOURNIER, GUSTAFSSON, HEGI, HOFFMANN, JEFFREY, KNUTH, NYGREN, RICKETT, STEBBINS, and WODEHOUSE.

BERRY, J. A comparative study of the red-seeded and common dandelion. Proc. Iowa Acad. Sci. **29:** 313–315. 1922.

CHRISTIANSEN, M. P. New *Taraxacum* species in Denmark. (In Danish.) Bot. Tidsskr. **66**(1/2): 76–97. 1971.

COOPER, D. C., & R. A. BRINK. The endosperm-embryo relationships in an autonomous apomict, *Taraxacum officinale*. Bot. Gaz. **111:** 139–153. 1949.

CURTIS, W. M. The structure and development of some apomicts of *Taraxacum*. Bull. Misc. Inf. Roy. Bot. Gard. Kew **1940:** 1–29. 1940.

DAHLSTEDT, H. De svenska arterna av släktet *Taraxacum*. I. *Erythrosperma*. II. *Obliqua*. Acta Fl. Suec. **1:** 1–160. *pls. 1–11*. 1921; III. *Dissimilia*. IV. *Palustria*. V. *Ceratophora*. VI. *Arctica*. VII. *Glabra*. Sv. Vet-akad. Handl. III. **6**(3): 1–66. *pls. 1–8*. 1928; VIII. *Spectabilia*. *Ibid*. **9**(2): 1–99. *pls. 1–5, maps 1–6*. 1930.

FERNALD, M. L. The name *Taraxacum officinale*. Rhodora **50:** 216. 1948.

FÜRNKRANZ, D. Cytogenetische Untersuchungen an *Taraxacum* in Raume von Wien. Österr. Bot. Zeitschr. **107:** 310–350. 1960. II. Hybriden zwischen *T. officinale* und *T. palustre*. *Ibid*. **108:** 408–415. 1961; Untersuchungen an Populationen des *Taraxacum officinale* Complex im Kontaktgebiet der diploiden und polyploiden Biotypen. *Ibid*. **113:** 427–447. 1966.

GADGIL, M., & O. T. SOLBRIG. The concept of *r*- and *K*-selection: evidence from wild flowers and some theoretical considerations. Am. Nat. **106:** 14–31. 1972. [*T. officinale* & *Solidago* spp.]

GIER, L. J., & R. M. BURRESS. Anatomy of *Taraxacum officinale* 'Weber.' Trans. Kansas Acad. Sci. **45:** 94–97. 1942.

HANDEL-MAZZETTI, H. VON. Monographie der Gattung *Taraxacum*. xi + 175 pp. *pls. 1–5, 2 maps*. Leipzig. 1907.

———. Nachträge zur Monographie der Gattung *Taraxacum*. Österr. Bot. Zeitschr. **72:** 254–275. 1923.

HOFSTEN, C. G. VON. Studies on the genus *Taraxacum* Wigg. with special ref-

erence to the group *Vulgaria* Dt. in Scandinavia. (In Swedish; English summary.) 432 pp. Stockholm. 1954.

HOU-LIU, S. Y. The chromosome counts of some *Taraxacum* species. Acta Bot. Neerl. **12:** 76–83. 1963.

KAPPERT, H. Experimentelle Untersuchungen über die Variabilität eines Totalapomikten. Ber. Deut. Bot. Ges. **67:** 325–334. 1954.

KROTKOV, G. A review of literature on *Taraxacum Kok-saghyz* Rod. Bot. Rev. **11:** 417–461. 1945.

MALECKA, J. Processes of degeneration in anthers' tapetum of two male-sterile species of *Taraxacum*. Acta Biol. Cracov. Bot. **14**(1): 1–10. 1971.*

NAYLOR, E. The proliferation of dandelions from roots. Bull. Torrey Bot. Club **68:** 351–358. 1941.

NILSSEN, H. Totale Inventierung der Mikrotypen eines minimal Areals von *Taraxacum officinale*. (English summary.) Hereditas **33:** 119–142. 1947.

OKABE, S. On the nature of incompatibility alleles in *Taraxacum elatum* × *T. longe-appendiculatum* (Self-incompatibility studies in *Taraxacum* I.). Bot. Mag. Tokyo **69:** 592–597. 1956.

RICHARDS, A. J. The biosystematics of *Taraxacum*. Ph.D. Thesis, University of Durham, England. 1968.*

———. *In*: A. LÖVE, Ed., I. O. P. B. chromosome number reports, 23. Taxon **18:** 560–562. 1969. [88 "species," $2n = 16, 24, 32, 40, 48$.]

———. Eutriploid facultative agamospermy in *Taraxacum*. New Phytol. **69:** 761–774. 1970.

———. Hybridisation in *Taraxacum*. New Phytol. **69:** 1103–1121. 1970.

———. Observations on *Taraxacum* sect. *Erythrosperma* Dt. em. Lindb. f. in Slovakia. Acta Fac. Rerum Nat. Univ. Comen. Bratislav. Bot. **18:** 81–120. 1970.*

———. Taxonomic and nomenclatural notes on *Taraxacum* (Compositae). Jour. Linn. Soc. Bot. **65:** 37–45. *2 pls.* 1972.

———. The karyology of some *Taraxacum* species from alpine regions of Europe. Jour. Linn. Soc. Bot. **65:** 47–59. 1972.

———. The *Taraxacum* flora of the British Isles. Watsonia **9**(Suppl.): 1–141. 1972. [Includes 132 microspecies.]

SCHISCHKIN, B. K. *Taraxacum*. *In*: E. G. BOBROV & N. N. TSVELEV, Fl. URSS. **29:** 405–560. 1964. [202 spp.]

SHERFF, E. E. North American species of *Taraxacum*. Bot. Gaz. **70:** 329–359. *pls. 31–33.* 1920.

SHINNERS, L. H. Nomenclature of species of dandelion and goatsbeard (*Taraxacum* and *Tragopogon*) introduced into Texas. Field Lab. **17:** 13–19. 1949.

SOEST, J. L. VAN. New *Taraxaca* from the Netherlands. Acta Bot. Neerl. **5:** 94–101. 1956.

———. Nouvelle contribution pour la connaissance des *Taraxaca* du Portugal. Agron. Lusit. **18:** 94–97. 1956.

———. Les *Taraxacum* de Belgique. I. Bull. Jard. Bot. Bruxelles **26:** 211–235. 1956.

———. *Taraxacum* Sectio *Obliqua* Dt. en Sectio *Erythrosperma* Dt. em. Lb. in Nederland. (In Dutch.) Acta Bot. Neerl. **6:** 74–92. 1957.

———. The phytogeography of *Taraxacum*, with special reference to Europe. Blumea, Suppl. **4:** 60–67. *maps.* 1958.

———. *Taraxacum* sectio *Erythrosperma* Dahlstedt em. Lindberg f. in North America. Acta Bot. Neerl. **7:** 627, 628. 1958.

———. Alpine species of *Taraxacum*. Acta Bot. Neerl. **8**: 77–138. 1959.
———. *Taraxacum* species in India, Pakistan and neighbouring countries. Wentia **10**: 1–91. 1963.*
———. Die *Taraxacum*-Arten der Schweiz. Veröff. Geobot. Inst. Rübel Zürich **42**: 1–250. 1969.
———. New *Taraxacum* species from Azerbaijan. Acta Bot. Neerl. **21**: 192–196. 1972. [3 new spp. of sect. *Erythrosperma*.]
SOLBRIG, O. T. Genotypic variation within and between populations of the common dandelion, *Taraxacum officinale* Wigg. Isozyme Bull. **3**: 43, 44. 1970.
———. The population biology of dandelions. Am. Scientist **59**: 686–694. 1971.
——— & B. S. VUILLEUMIER. Components of regulation of a natural population of dandelions in Michigan. (In press.)
SÖRENSON, T., & T. GUNDJONSSON. Spontaneous chromosome aberrance in apomictic *Taraxaca*. Kong. Danske Videnskab. Selskab. Biol. Skrift. **4**(2): 1–48. 1946.
STORK, H. E. Studies in the genus *Taraxacum*. Bull. Torrey Bot. Club **47**: 199–210. *pls. 6, 7*. 1920.
SUKATSHEW, W. Einige experimentelle Untersuchungen über den Kampf ums dasein zwischen Biotypen derselben Art. Zeitschr. Induct. Abstamm. Vererbungslehre **47**: 54–74. 1928.
VALENTINE, D., & D. J. RICHARDS. Sexuality and apomixis in *Taraxacum*. Nature **214**: 114. 1967.

15. **Lapsana** Linnaeus, Sp. Pl. 2: 811. 1753; Gen. Pl. ed. 5. 353. 1754.

Delicate, branching, glabrous or pubescent annual herbs arising from a slender taproot. Basal leaves few, oblanceolate to ovate, dentate to lyrately parted; stem leaves oblanceolate, entire, dentate or parted. Inflorescence a panicle (often flat-topped in ours) of heads borne on long peduncles. Involucre of small, ovate outer bracts forming a calyculus and a few stiff lanceolate inner bracts becoming swollen as the achenes mature [in some species, the bracts reflexed and forming a "star" when the achenes are shed]; receptacle ± flat, naked. Corolla yellow, the limbs (ligules) twisting together as they dry and wither. Anthers with sagittate bases. Style branches long, slender, terete. Achenes more or less cylindrical, slightly bent, constricted at both ends, glabrous, the pappus lacking. LECTOTYPE SPECIES: *L. communis* L.; see Britton & Brown, Illus. Fl. No. U.S. ed. 2. **3**: 306. 1913. (Name from Greek, *lapsane* or *lampsane*, a name given by Dioscorides to a vegetable apparently a species of *Raphanus*.) — NIPPLEWORT.

A genus of 9 species native to the extratropical regions of Europe, Asia, and northern Africa. Two species have been introduced into North America: the Chinese *Lapsana apogonoides* Maxim., $2n = 44$, in California, and the European *L. communis* L., $2n = 12, 14, 16$, which has spread across southern Canada and the United States to Oregon, and as far south as Missouri, Virginia, and Haywood County, North Carolina.

The only truly weedy member of the genus, *L. communis* is also adventive in at least Africa, Polynesia, the West Indies, and South America.

Bentham & Hooker allied *Lapsana* with *Apogon* Ell. (now included in *Krigia* L.), but Stebbins considered *Lapsana* (because of its lack of a pappus) to be a specialized offshoot of the *Youngia-Ixeris* line of the Crepidinae. Jeffrey indicated a similar relationship.

The several chromosome numbers of $2n = 12$, 14, and 16 reported for *Lapsana communis* suggest that apomixis may be involved, but only out-crossing and self-pollination have as yet been reported. As evidence of cross-pollination, Hegi listed numerous insect visitors, and J. Small elaborated on the pollinator-adapted stamen irritability. When stamens of this species are touched, the filament nearest the stimulus contracts and the entire anther tube faces the visitor as the style pushes out the pollen toward it. Yet, both Müller and Knuth assert that self-pollination must occur, since after anthesis the style branches diverge greatly and the stigmas undoubtedly become covered with pollen from neighboring florets when the heads "open in the morning and close at night."

Although not really important economically, Fournier included *Lapsana communis* in his list of medical plants because the expressed juice of the plants is used as a soothing lotion on sores and sensitive skin, particularly on the nipples of nursing mothers (hence the common name nipplewort). The young leaves are also occasionally eaten as salad greens.

REFERENCES:

Under tribal references see AHLES, BELL, & RADFORD; BENTHAM & HOOKER; BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, FOURNIER, HEGI, HOFFMANN, JEFFREY, KNUTH, and STEBBINS.

MÜLLER, H. The fertilization of flowers. (Transl. by D. W. Thompson.) xii + 669 pp. London. 1883. [Compositae, 315–364; Cichoriaceae, 351–361.]

SMALL, J. The origin and development of the Compositae. New Phytol. Reprint **11:** 1–334. *pls. 1–6.* 1919. [Reprinted from a series of papers in New Phytol. **16–18.** 1917–1919. See chapter 3, Irritability of the pollen-presentation mechanism. New Phytol. **16:** 253–276. 1917.]

STEBBINS, G. L., JR. An anomalous new species of *Lapsana* from China. Madroño **4:** 154–157. *pl. 27.* 1938.

16. **Youngia** Cassini, Ann. Sci. Nat. **23:** 88. 1831.

Annual [biennial or perennial] herbs arising from a taproot [rhizome] and covered with scattered, multicellular trichomes. Leaves oblanceolate to lyrate, toothed or pinnatifid [entire]. Inflorescence of numerous small [to medium] [5–]10–20[–30]-flowered heads in a panicle [corymb]. Involucre of few, small outer bracts and 8 equal [6–12] longer, lanceolate inner bracts; receptacle slightly convex, naked. Corolla yellow. Anthers green, sagittate at the base. Style branches terete, yellow [in primitive species, branches flattened]. Achenes dorsiventrally compressed, unequally ribbed, with 3–5 ribs more prominent than others (in our species with

2–4 stronger), more or less spiny toward the apex, brown; pappus setose, white [to yellowish or cinereous], persistent. LECTOTYPE SPECIES: *Y. lyrata* Cass. = *Y. japonica* (L.) DC.; see E. B. Babcock & G. L. Stebbins, Carnegie Inst. Washington Publ. **484**: 5. 1937. (Name commemorating two Englishmen, one a poet, the other a physician, their identities not further revealed by Cassini.)

A genus of 28 species in six sections (cf. Babcock & Stebbins) native to Asia but with one weedy species, *Youngia japonica* (*Crepis japonica* (L.) Bentham), $2n = 16$, of sect. YOUNGIA (sect. *Euyoungia* Babcock & Stebbins), introduced and established in the United States in Maryland, North Carolina, Florida, and Louisiana. Indigenous from Japan and Korea to western China, northwestern India, the East Indies, New Guinea, and the Philippines, *Y. japonica* is widely naturalized in the tropics of the world. In the warmer parts of our area it seems to be spreading rapidly.

Although placed by most American authors (e.g., Small, Fernald, Rickett) in the genus *Crepis* L., Babcock & Stebbins assert that *Youngia japonica* belongs with a group of species in the phylogenetically distinct genus *Youngia*. Morphologically, the species of *Youngia* differ from those of *Crepis* in having numerous small heads, calyculate fewer-flowered involucres (i.e., with the small outer bracts mostly broad and closely imbricated), and compressed achenes with unequal ribbing (rather than columnar achenes with equal ribs as in *Crepis*). The similarities between some species of the two genera is, according to Babcock & Stebbins, the result of convergent evolution, not a reflection of close affinity. These authors also concluded that the two genera have distinct base chromosome numbers, 8 in *Youngia* and 5 in *Crepis*. Chromosome numbers of $2n =$ 10, 15, 16, 20, 24, and 32 have been reported for various species of *Youngia*, but it should be noted that the records of $2n = 15$ and 20 were from a species which also has individuals with $2n = 24$.

Data from morphology and anatomy have indicated that the closest relative of *Youngia* is *Ixeris* Cass. which has a similar type of calyculate involucre, pappus, corolla, anthers, and style branches (cf. Babcock & Stebbins).

In 1951, Babcock reported the occurrence of a new species of *Youngia*, *Y. americana* Babc., in Alaska. Hultén, however, in his recent *Flora of Alaska and Neighboring Territories* (1968) placed this species in the synonymy of *Crepis nana* Richardson var. *lyratifolia* (Turcz.) Hultén.

The genus appears to have no economic importance.

REFERENCES:

Under tribal references see BENTHAM & HOOKER, BOBROV & TSVELEV, BOLKHOVSKIKH *et al.*, HOFFMANN, JEFFREY, and STEBBINS.

BABCOCK, E. B. *Youngia americana*, a new species of phyletic significance. Madroño **11**: 1–6. 1951.

——— & G. L. STEBBINS. The genus *Youngia*. Carnegie Inst. Publ. **484.** 106 pp. 1939.

17. **Crepis** Linnaeus, Sp. Pl. **2:** 805. 1753; Gen. Pl. ed. 5. 305. 1754.

Perennial [annual] herbs with rhizomatous rootstocks [taproots]. Leaves in a basal rosette and cauline, elliptic, lanceolate or oblanceolate, entire, dentate, or lyrately parted. Heads in a cymose arrangement [or flowering stems monocephalous]. Involucre of one row of more or less equal-sized bracts sometimes thickened at the base; receptacle flat, naked [fimbrillate, paleaceous, or membraneous at the edges of the achenial attachment points]. Corolla yellow [white]. Anthers sagittate at the base; pollen with ridges topped with spines. Style branches thin, terete. Achenes columnar, truncate [slightly beaked], surface glabrous with ribs of equal size; pappus setose, white to yellow in color. LECTOTYPE SPECIES: *C. tectorum* L.; see Britton & Brown, Illus. Fl. No. U.S. ed. 2. **3:** 325. 1919. (Name from Greek, *krepis*, sandal, probably in reference to the shape of the achene.) — HAWK'S BEARD.

A genus of about 200 species in three subgenera and 27 sections (cf. Babcock). Most of the species are native to the Old World, but the ten species of sect. PSILOCHAENIA (Nutt.) Babc. and *Crepis nana* Richardson and *C. elegans* Hooker, both of sect. IXERODOPSIS Babc., are indigenous to North America. These native American species are concentrated in the northwestern part of North America, and only *Crepis runcinata* (James) Torrey & Gray, which reaches Minnesota, and *C. nana* which extends to Newfoundland, range into the East. None of the native American species occurs in the southeastern United States, but species introduced from Eurasia are now established within our area.

Although a number of species have been reported from the southeastern United States, only two (neither included in Small's *Manual of the Southeastern Flora*) appear to be persistent. *Crepis capillaris* (L.) Wallr., $2n = 6$, of sect. PHAECASIUM Cass., a pubescent herb with a woody caudex and a fine setose pappus, is now established in areas from eastern Canada to Michigan, south (mostly in the mountains) to Virginia, North Carolina, and Tennessee. *Crepis pulchra* L., of sect. PHYTODESIA Babc., is a slender, glabrous, plant without a woody caudex and with achenes with a coarse, setose pappus. It is now found primarily in weedy areas in Virginia, North and South Carolina, Georgia, Mississippi, and Kentucky.

The taxon listed by Small, Fernald, and Rickett as *C. japonica* (L.) Bentham, is assigned here to the genus *Youngia* (*q.v.*) as advocated by Babcock and Babcock & Stebbins.

Other species recorded from the eastern United States by various authors include *C. tectorum* L., $2n = 8$, of sect. CREPIS (sect. *Mesophyllon* Babc.); *C. setosa* Haller f., $2n = 8$, of sect. NAMAUCHENES (Cass.) Babc.; *C. foetida* L., $2n = 10$, of sect. HOSTIA Moench. ex Babc., said by Small to occur in northwestern Florida and Georgia; *C. nicaeënsis*

Balbis ex Pers., of sect. PHYTODESIA Babc.; *C. biennis* L., $2n = 40$, of sect. BERINIA (Brignol) Babc.; and *C. vesicaria* L. subsp. *taraxacifolia* (Thuiller) Thellung ex Schinz & Keller, of sect. LEPIDOSERIS (Reichenb.) DC. It is uncertain whether any of these is to be regarded as an established member of our flora.

As a consequence of the intensive investigations of Babcock and his associates (1920–1947), *Crepis* is one of the most thoroughly documented genera of angiosperms, and Babcock's monograph stands as a landmark. His cytological analyses were among the first to demonstrate that species that are similar morphologically are also (usually) the most similar in gross chromosome structure and genetic make-up. Hybrid plants were shown to have chromosome complements that are karyotypically and genetically "hybrid." Babcock also documented the phenomenon of speciation by geographical isolation by showing that the genetic differences between species of *Crepis* are of the same type as, but simply of greater magnitude than, differences between isolated subspecies of a single species.

Chromosomal changes, both increases and decreases in number, as well as in gross morphology, apparently occurred repeatedly in the evolution of *Crepis*. The least specialized species seem to have a diploid number of $2n = 10$ and chromosomes with metacentric centromeres. The more advanced species have $2n = 8$ or $2n = 6$, and small, paracentric chromosomes. Babcock was even able to show that the chromosome number of $n = 4$ was derived from one of $n = 5$ by means of a translocation and (presumed) loss of a centromere. In the North American sect. PSILOCHAENIA a different type of chromosomal evolution, polyploidy, occurred. The species of this group, which have numbers ranging from $2n = 22$ to $2n = 88$, were apparently derived from ancestors which doubled (and later redoubled) in chromosome number after the hybridization of progenitors with haploid numbers of $n = 7 + n = 4$ or $n = 5 + n = 6$. Although apospory is uncommon in the genus, Babcock & Jenkins found that the higher polyploids are apomictic, the embryo being formed from a sporophytic cell. No species, however, seems to be obligately apomictic.

The less specialized species of *Crepis* are leafy, coarse, rhizomatous, perennial herbs with few flowering stems, large heads, and monomorphic achenes. Advanced species are smaller, tending toward a scapose habit, taprooted, small headed, and frequently with dimorphic achenes.

Gross morphological data combined with cytological analyses led Babcock to conclude that the extant species of *Crepis* stemmed from three major lineages which diverged from a common ancestral stock of *Dubyaea*-like morphology. The evidence suggested that the ancestral forms were present in Central Asia. Within the subtribe Crepidinae, *Crepis* is most similar to the *Ixeris-Youngia* phyletic line and to the *Hieracium-Tolpis* line (cf. Babcock, 1947).

The genus is economically unimportant.

REFERENCES:

See all references under the tribe. Only a selection from the voluminous literature is included here. For a very extensive list see BABCOCK (1947, Pt. 1).

BABCOCK, E. B. Endemism in *Crepis*. Proc. Calif. Acad. Sci. IV. **25:** 269–290. 1944.

———. Cytogenetics and speciation in *Crepis*. *In*: DEMEREC, M., ed. Advances in genetics **1:** 69–93. Academic Press, New York. 1947.

———. The genus *Crepis*. Part one. The taxonomy, phylogeny, distribution, and evolution of *Crepis*. Univ. Calif. Publ. Bot. **21:** xii + 1–198. *frontis.* + *pl. 1.* 1947. Part two. Systematic treatment. *Ibid.* **22:** x + 199–1030. *pls. 2–36.*

———. Supplementary notes on *Crepis*. II. Phylogeny, distribution and Matthew's principle. Evolution **3:** 374–376. 1949; III. Taproot versus rhizome in phylogeny. *Ibid.* **4:** 358–359. 1950.

——— & J. A. JENKINS. Chromosomes and phylogeny of *Crepis*. III. The relationships of one hundred and thirteen species. Univ. Calif. Publ. Bot. **18:** 241–291. *figs. 1–24.* 1943.

——— & G. L. STEBBINS, JR. The American species of *Crepis*. Their interrelationships and distribution as affected by polyploidy and apomixis. Carnegie Inst. Publ. **504:** 1–100. *pls. 1–3.* 1938.

———, ———, & J. A. JENKINS. Genetic evolutionary processes in *Crepis*. Am. Nat. **76:** 337–363. 1942.

BISSELL, C. H. Newly introduced species of *Crepis* and *Leontodon*. Rhodora **4:** 249, 250. 1902.

CLAUSEN, J. Evolutionary patterns in the genus *Crepis*. Evolution **3:** 185–188. 1949. [Comments on Babcock's monograph.]

COLLINS, J. C. Inbreeding and cross-breeding in *Crepis capillaris* (L.) Wallr. Univ. Calif. Publ. Agr. Sta. **2:** 205–216. *pls. 39–41.* 1920.

FROST, S. A new mechanism for numerical increase of accessory chromosomes in *Crepis pannonica*. Heredity **47:** 497–503. 1960.

GROB, R. Zytotaxonomische Untersuchungen an *Crepis capillaris* und *Crepis nicaeënsis* und ihren F_1-Bastarden. (English summary.) Schweiz. Bot. Ges. Ber. **76:** 306–351. *pls. 1–8.* 1966.

LONG, B. Notes on the American occurrence of *Crepis biennis*. Rhodora **21:** 200–214. 1919. [See also *ibid.* **22:** 192, 193. 1921.]

STEBBINS, G. L., JR. Evolution in *Crepis*. Speciation, evolutionary trends and distributional patterns in *Crepis*. Evolution **3:** 188–193. 1949.

——— & E. B. BABCOCK. The effect of polyploidy and apomixis on the evolution of species in *Crepis*. Jour. Hered. **30:** 519–530. 1939.

——— & J. A. JENKINS. Aposporic development in the North American species of *Crepis*. Genetica **21:** 191–224. *pls. 1, 2.* 1939.

ARNOLD ARBORETUM,
HARVARD UNIVERSITY,
CAMBRIDGE, MASS. 02138

Present address:
DEPARTMENT OF BOTANY,
U. S. MUSEUM OF NATURAL HISTORY,
SMITHSONIAN INSTITUTION,
WASHINGTON, D.C. 20560

NEW TAXA FROM BRAZIL AND GUYANA IN THE GENUS HYMENAEA (LEGUMINOSAE, CAESALPINIOIDEAE)

YIN-TSE LEE AND JEAN H. LANGENHEIM

THE GENUS *Hymenaea* (Leguminosae, Caesalpinioideae, Detarieae *) is presently considered to have 16 species distributed from central Mexico, throughout Central America, the West Indies and all of the South American countries except Uruguay and Chile (Langenheim, Lee, & Martin, 1970, 1971; Langenheim, 1972). The Amazon Basin appears to be its center of distribution and its closest relative is the east African genus *Trachylobium* (Langenheim, 1972; Langenheim, Martin, & Lee, 1972).

The four taxa presented here occur in evergreen rainforest habitats in Brazil and Guyana (FIGURE 1). A previously undescribed species of *Hymenaea* and a new variety of *H. oblongifolia* Huber occur in the Atlantic coastal forests. Both of these taxa occur in southern Bahia, with the new variety having been collected also in more northerly sites in Pernambuco. *Hymenaea oblongifolia* previously has been known only from the heavy rainfall areas (over 2000 mm. annually) in the eastern and western portions of the Amazon Basin.

The other taxa to be discussed are *H. palustris* Ducke and *H. davisii* Sandwith, which are to be reduced to varieties of *H. oblongifolia*. *Hymenaea palustris* has a distribution very similar to that of *H. oblongifolia* in the Amazon Basin, but is locally isolated from it by a habitat difference. *Hymenaea oblongifolia* occurs primarily in the várzea (periodically inundated area), whereas *H. palustris* occurs principally in the continually wet igapó (swamp forest). *Hymenaea davisii* occurs along streams in the Wallaba (*Eperua*) forest in Guyana.

The relationship of the flora of the Amazonian rainforest ("hylaea") and the Brazilian Atlantic coastal rainforests, occurring from Pernambuco to the region around Rio de Janeiro, has aroused considerable interest for some time (Ducke, 1959; Andrade-Lima, 1953; Rizzini, 1963, 1967). Rizzini (1967) indicated that 277 genera occur both in the Amazonian and Atlantic rainforests. Usually a genus which is represented by one or a few species in the Atlantic forest is found to have several or many species in the Amazonian hylaea. The "Hylaea Bahiana," a region of forest occupying Tertiary plateaus in the south of Bahia and north of Espirito Santo, was once thought to be composed almost entirely of Amazonian species (Rizzini, 1963). More recent studies, however,

* In previous work (Langenheim, 1972), we have used the tribal designation of Cynometreae Bentham (1840) emend. Léonard (1957). Recently Heywood (1971) has presented de Candolle's (1825) name Detarieae which has priority over Bentham's name Cynometreae.

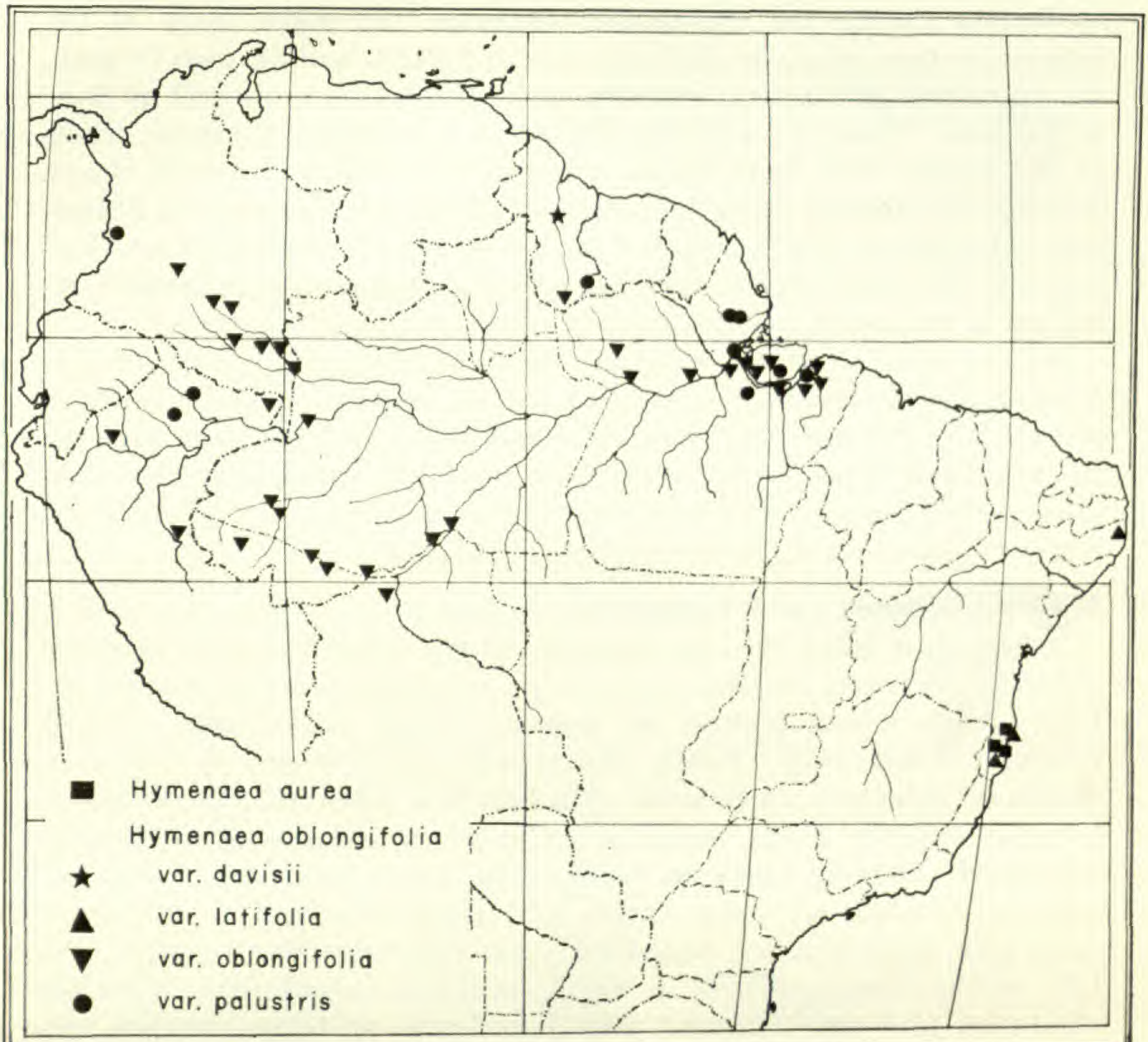


FIGURE 1. Map showing distribution of *Hymenaea aurea*, *H. oblongifolia* and its varieties.

have shown this area to have Amazonian, Atlantic, and endemic elements (Rizzini, 1967). Andrade-Lima (1953) also noted the high degree of similarity of this Bahian hylaea to that of the Amazonian terra firma and pointed to the role of high, annually well-distributed rainfall (2,000 mm. or more) in maintaining the two vegetation types. Vanzolini and Williams (1970) also have recorded the disjunct distribution in the Atlantic forest of "deep forest animals" from the Amazonian hylaea. The occurrence of Amazonian elements in these Atlantic forests, as well as in the central Brazilian cerrados and cerradãos and the northwestern caatinga, is a present-day indication of the previously more extensively distributed moist tropical vegetation and associated faunas that occurred as far south as central Patagonia in early Tertiary time (Menéndez, 1969; Simpson, 1969). During the Eocene epoch tropical rainforest vegetation probably reached its maximum development, extending to at least 50° north and attained almost double its present distribution (Wolfe, 1971, pers. comm., 1972). Progressive drying trends from Miocene to the present, with some

oscillations during the Pleistocene, restricted the major body of the Amazonian-type hylaea to the basins of the Amazon and the high Orinoco, the watersheds of Guyana, Surinam, and French Guiana as well as those of the lower Tocantins and Rio Pindaré in Maranhão. However, relicts of this hylaea flora occur locally throughout central and coastal Brazil. Marine transgressions along coastal Brazil during the Pliocene and Pleistocene (Harrington, 1962) probably further altered the coastal hylaea. Elements of the older tropical flora, particularly, appear to have found a refugium in the southern Bahia-northern Espirito Santo "tabuleiro."

Rizzini (1967) lists *H. courbaril*, the most widespread species of *Hymenaea*, as occurring in these Atlantic forests. We have found it in Bahia in both the evergreen rainforest and semideciduous forest. Its presence in both forest types is not unexpected since this species occupies evergreen, semideciduous, and deciduous forests, savannah, and thorn scrub essentially throughout the distribution of the genus.

Hymenaea aurea Lee & Langenheim, sp. nov. FIGURES 1 and 2.

Arbor usque ad 28 m. alta, diametro 90 cm. Rami juniores, alabastra, petioli ac folia tomento denso aureo-luteo, in senectute aureo-brunneo, obtecti. Rami vetusti brunnei fel argenteo-cinerei excorticantes. Petioli breves, 3–7 mm. longi. Foliola obovato-oblonga (5–9 cm. × 2–4 cm.), obtusa vel apiculata, supra nitida, pilis brevibus, subtus pilis densis aureo-brunneis obtecta. Costa superficiei inferioris prominens, dense hirsuto-tomentosa. Pedicelli usque ad 7 mm. longi, dense tomentosi. Tubus basalis calycis usque ad 9 mm. longus, lobi calycis obovati (15 × 9 mm.), extra pilis aureo-brunneis tomentosi, intus pilis aureo-luteis sericei. Petala cochleariformia (21 × 6 mm.), manifeste unguiculata. Ovarium stipitatum (3–6 mm. longum), pilis aureo-luteis, ad basem ovarium versus densioribus longissime obtectum. Fructus magni (9–15 cm. × 7–10 cm. × 2.5–3.0 cm.), complanati, pallide brunnei, ambitu porcis transversis summo rotundatis instructi, suturi haud perspicui. Semina 5 vel 8, vel plus.

HOLOTYPE. Una, Bahia, Brazil. Ca. 3 km. east of Fazenda São Raphael, Oct., 1969, *Jean H. Langenheim 5644* (UC **; isotype, UC). Feb., 1971, *Yin-Tse Lee 164* (paratype, UC).

Tree to 28 m. tall, the trunk to ca. 90 cm. in diameter, evergreen to facultatively deciduous. Young branches, leaf buds, petioles and leaves covered with golden-yellow tomentum, golden-brown upon aging. Older branches brown to silvery gray, with peeling epidermis. Leaves short-petiolate; petiole 3 to 7 mm. long. Stipules narrowly elliptic (15–20 mm. long, 5–8 mm. wide), obtuse, caducous. Leaflets oblique, sessile on one side and with petiolule ca. 3 mm. long on the other, coriaceous, obovate-oblong, 5–9 cm. long, 2–4 cm. wide, obtuse to apiculate; sparsely puberu-

** Upon completion of the systematic revision of the genus now in progress at the University of California, Santa Cruz, all specimens will be deposited in the herbarium of the University of California, Berkeley.

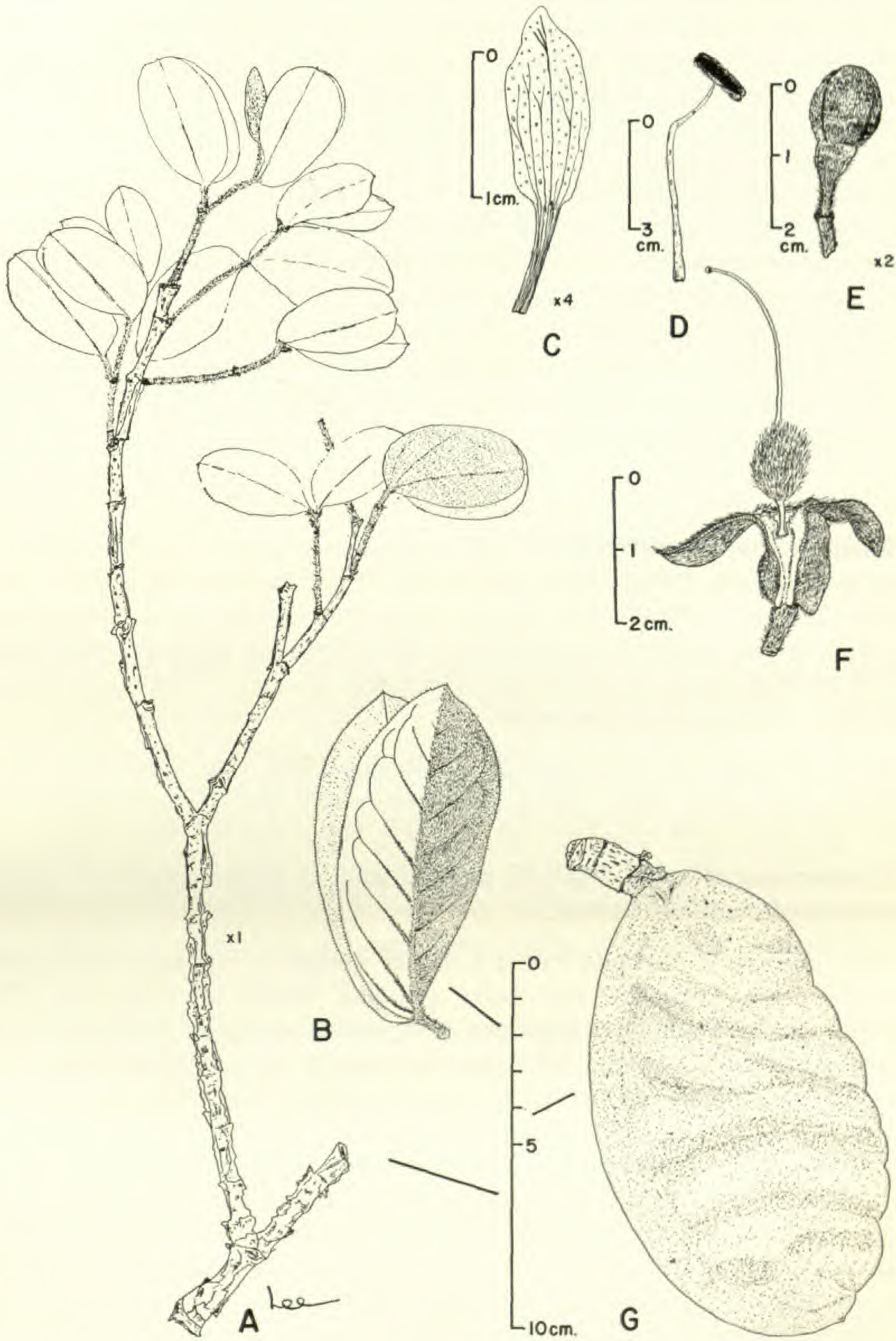


FIGURE 2. *Hymenaea aurea.* A, portion of a branch showing young leaves and tomentose branchlets; B, mature leaf; C, petal; D, stamen; E, mature flower bud; F, partly dissected flower showing position of stipe relative to hypanthium; G, slightly lateral view of fruit showing rounded ridges.

lent and shining above, densely pubescent beneath with golden-brown tomentum and prominent midrib which is densely hirsute-tomentose. Inflorescence a compound corymb; rachides short and robust, strongly flexuous. Bracts and bracteoles suborbicular, densely golden-brown tomentose dorsally, deep brown and glabrous within. Pedicels ca. 7 mm. long, densely tomentose. Flower medium in size for the genus. Calyx tube with stalk-like base (stalk ca. 9 mm. long); calyx lobes obovate (15 mm. long, 9 mm. wide), golden-brown tomentose dorsally, golden-yellow sericeous within. Petals creamy white, spatulate, 21 mm. long, 6 mm. wide, distinctly unguiculate (claws ca. 9 mm. long), caducous. Stamens ca. 30 mm. long; anthers elliptic, ca. 6 mm. long. Ovary with stipe 3 to 6 mm. long, oblique-oblong, heavily pubescent with golden-yellow woolly tomentum, the hairs longest at base; ovules 9 to 12; style ca. 25 mm. long, with minute capitate stigma. Fruit large and flat (9–15 cm. long, 7–10 cm. wide, 2.5–3.0 cm. thick), light brown, transversely ridged, suture not evident; seeds 5 to 8 or more.

HABITAT and DISTRIBUTION. This species is restricted to the Atlantic coastal evergreen forest. Although it was found in the same areas as *H. oblongifolia* var. *latifolia* (see below), along the eastern coast of southern Bahia, the two rarely occur together. It is frequent on clay-loam soils. The flowering season is from late December to early February. Fruits fall from November to December.

Brazil. SOUTHERN BAHIA: Fazenda São Raphael, Una, Oct., 1969, *J. H. Langenheim 5645, 5646, 5647*. Along the eastern coast from Una to Eunapolia, Feb., 1971, *Y. T. Lee 163, 177, 178, 180, 181, 182, 183, 184, 186*.

VERNACULAR NAMES. "Jatobá peloso" and "jatobá verdadeiro" (eastern coast of southern Bahia).

This species is characterized by dense, golden-yellow tomentose hairs on the young branches, leaf buds, petioles, leaves, and flowers. The specific epithet is derived from the prominence of these golden hairs on many parts of the plant. This species can be distinguished from *Hymenaea eriogyne* Benth. by (1) the ovary which is densely tomentose, but never hirsute at the base and (2) its unusually flat fruits. In addition, despite its close relationship to the Amazonian hylaea species, *H. eriogyne* is a low tree and presently is restricted to the caatinga areas in northeastern Brazil. *Hymenaea aurea* is distinguished from *H. oblongifolia* Huber, *H. parvifolia* Huber, and *H. torrei* Léon by its medium-sized flowers, corymbose inflorescence, and large fruits, and from the remainder of the species of *Hymenaea* by its densely tomentose ovary.

Hymenaea oblongifolia var. **latifolia** Lee & Langenheim, var. nov.
FIGURES 1 and 3.

Var. oblongifolio similis, foliola multo latiora (longitudo/latitudo ca. 2:1), obtusa vel retusa, interdum breviter acuminata, alabastris floriferis oblongioribus (18 × 6 mm.), lobis calycis anguste ovatis, leviter acutis

(9–12 mm. longis), petalis manifeste unguiculatis, unguibus usque ad 8 mm. longis, sub anthesi erectis discedit.

HOLOTYPE. Itabuna, Bahia, Brazil. Along road between the main entrance and the library on the grounds of CEPEC, Jan. 1971, *R. S. Pinheiro 1720* (CEPEC). Feb. 1972, *Yin-Tse Lee 162* (isotype, UC). Both specimens were collected from the same tree which is still living on the grounds of CEPEC. Village of Rio Branco, near Una, Bahia, Oct. 1969, *Jean H. Langenheim 5648* (paratype, UC).

Tree to 25 m. tall, the trunk to ca. 100 cm. in diameter, evergreen to facultatively deciduous. Leaves glabrous throughout; petioles rigid, 2–3 cm. long. Stipules narrowly-elliptic (15–20 mm. long, 5–8 mm. wide), obtuse, caducous. Leaflets oblique, sessile on one side and with petiolule ca. 6 mm. on the other, coriaceous, broadly oblong, 8–13 cm. long, 4.5–7.0 cm. wide (L/W ca. 2/1), obtuse to retuse or occasionally somewhat acuminate; midrib and secondary veins sharply prominent beneath. Inflorescence paniculate, the racemes ca. 18 cm. long; rachides golden-brown tomentose, ca. 5 cm. long at base of the inflorescence, slightly flexuous. Bracts and bracteoles suborbicular, 5 mm. long, caducous. Calyx tube broadly-obconic, with short stalk; calyx lobes narrowly ovate, 9 to 12 mm. long, slightly acute, about equally tomentose on the two sides. Petals creamy white, broadly spatulate (15 mm. long, 9 mm. wide), distinctly unguiculate (claws ca. 8 mm. long), erect during anthesis. Stamens ca. 25 mm. long; anthers elliptic, ca. 4 mm. long. Ovary with short stipe ca. 3 mm. long, compressed oblique-obovoid, densely hirsute, hairs longer at the base; style laterally attached, ca. 15 mm. long, glabrous, with minutely capitate stigma; ovules 3 to 4. Fruit ovoid to subcompressed obovoid (4.0–7.0 cm. long, 2.5–4.5 cm. wide, 2.5–3.5 cm. thick); suture not prominent; stalk ca. 12 mm. long; calyx occasionally remaining attached at base; seeds 1 to 3.

HABITAT and DISTRIBUTION. This variety is restricted to the Atlantic coastal evergreen forest which has been heavily cut for cultivation of cacao. It is most frequently found as isolated trees in cacao plantations (matta de cacau) or along rivers in the forest. It occurs particularly on sandy loam soils. The flowering season is from January to late February. Fruits fall around December.

Brazil. PERNAMBUCO: Rio Gurjaú, vicinity of Recife, Dec. 1951, *A. Ducke & D. Andrade-Lima 70* (IPEAN, R); Dec. 1952, *D. Andrade-Lima 52–1197* (IPA). Southern Bahia. Village of Rio Branco, near Una, Oct. 1969, *J. H. Langenheim 5649*. Along the eastern coast from Una to Prado, Feb. 1971, *Y. T. Lee 166, 167, 168, 169, 170, 171, 173, 175, 176, 179, 187*.

VERNACULAR NAMES. "Jatobá burundanga" and "jatobá farinheira" (eastern coast of southern Bahia).

The new taxon first came to our attention during a trip made by one of us (JHL) in 1969. The close affinity with the Amazonian species *H.*

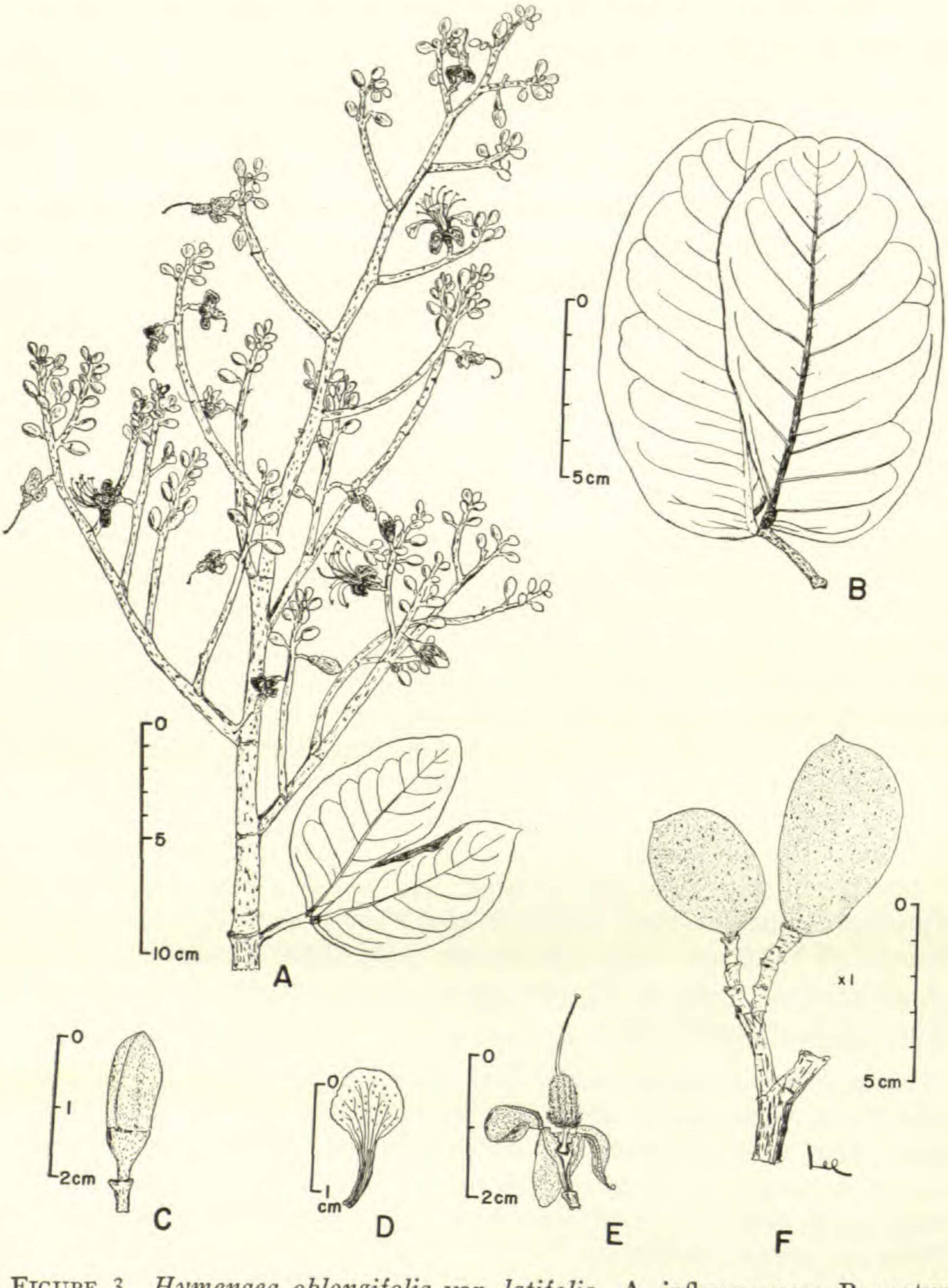


FIGURE 3. *Hymenaea oblongifolia* var. *latifolia*. A, inflorescence; B, mature leaf; C, mature flower bud; D, petal; E, partly dissected flower showing position of stipe relative to hypanthium; F, fruits.

oblongifolia Huber was immediately recognized, although the final determination was not made until flowers and the complete inflorescence were collected in 1971.

The epithet expresses the exceptional width of the leaflets. The name should not be confused with *H. latifolia* Hayne (Hayne, 1830), which has been appropriately transferred to the genus *Peltogyne* (Bentham, 1870).

In fact, the first two specimens of this variety were collected in the vicinity of Recife by the late Professor A. Ducke and Professor D. Andrade-Lima in the early fifties and were subsequently incorrectly identified by Ducke as *Hymenaea latifolia* Hayne.

The new variety is distinguished by the wide-oblong leaflets (the length-width ratio is about 2, as compared to 3 in var. *oblongifolia*), the distinctly unguiculate petals, and its habitat in the uplands of the Atlantic coastal evergreen forest.

Hymenaea oblongifolia var. **palustris** (Ducke) Lee & Langenheim, comb. et stat. nov. FIGURE 1.

H. palustris Ducke, Arch. Jard. Bot. Rio de Janeiro **1**: 24. 1915.

HOLOTYPE. In swamp forest (igapó) toward river margins. Utinga, near Belém, Pará, Brazil, Oct., 1914, *Adolpho Ducke* (MG) *15496* (MG, isotype, RB).

Tree to 30 m. tall, the trunk to ca. 85 cm. in diameter. Young branches sometimes rusty-tomentose. Petioles rigid, ca. 15 mm. long. Leaflets oblique, sessile on one side and with petiolule ca. 6 mm. long on the other, narrowly oblong (12–16 cm. long, 3.0–4.5 cm. wide), acute to obtuse, densely pubescent beneath with golden-brown tomentose hairs. Inflorescence paniculate, rachides rather long, slightly flexuous. Flowers smaller than in var. *oblongifolia* and var. *latifolia*. Pedicels ca. 2 mm. long. Calyx lobes ca. 7 mm. long, obtuse. About equally white-rusty sericeous on the two sides. Petals ca. 12 mm. long, subsessile. Stamens ca. 15 mm. long, anthers ca. 3 mm. long. Ovary short-stipitate, densely hirsute, hairs longer at base; ovules 3 to 4. Fruit ovoid to obovoid, subcompressed, suture not evident, short-stalked; seeds 1 to 3.

HABITAT and DISTRIBUTION. This variety is restricted to the swamp forest or igapó; it is from this habitat that it derives its name. It has essentially the same distribution as that of var. *oblongifolia*, occurring in the igapó, however, rather than the várzea. The flowering season is from September to October in Brazil and about a month later in Peru. Fruits fall around August.

VERNACULAR NAMES. "Jutaí" and "jutaí de igapó" (Pará and Terr. Amapá).

Brazil. Gurupú, Pará, Oct., 1916, *A. Ducke* (MG) *16567* (K, MG, R, US). Along Río Araguari, near Serro do Nevio, Terr. Amapá, Oct., 1961, *J. M. Pires, W. Rodrigues, & G. C. Irwin 51392* and *51393* (IPEAN, MG); *51438* (COL, IPEAN, MG, R, UB, VEN); Nov., 1971, *Y. T. Lee 67, 68, 69, 70* (UC). Ríos Pacaja and Muirapiranga, Pará, Oct., 1965, *T. D. Pennington & N. T. Silva 1660* (IPEAN, K, NY, US).

Colombia. Río Yurumanguí, Dept. de Valle, Jan.–Feb., 1944, *J. Cuatrecasas 15836* (COL, US).

Guyana. Upper New River, Dec., 1935, *T. G. Myers 5868* (K); *?Schoenbaugh* (K).

Peru. Río Itaya, Dept. Loreto, Sept., 1929, *L. Williams 3453* (US). Quebrada Valentin-Río Tahuayo, Dept. Loreto, Sept.–Oct., 1963, *A. A. Vargas 131* (NY, US).

As described by Ducke in 1915, *H. palustris* was distinguished from *H. oblongifolia* by small differences such as (1) hairs on the lower surface of the leaves, (2) narrower leaflets, (3) smaller flowers, and (4) much harder wood. These differences are sufficiently minor that Sandwith (1938) questioned whether or not *H. palustris* should be made a variety of *H. oblongifolia*. In the process of examining specimens for a systematic revision of the entire genus, we feel justified in reducing *H. palustris* to varietal status under *H. oblongifolia*.

Hymenaea oblongifolia var. **davisii** (Sandwith) Lee & Langenheim, comb. et stat. nov. FIGURE 1.

H. davisii Sandwith, Bull. Misc. Inf., Roy. Bot. Gard. Kew 1931: 366–367.

HOLOTYPE. In true Wallaba (*Eperua*) forest, along Warimia Creek, Essequibo River, Guyana, Jun., 1929, Forestry Department Record No. *943* (K).

Tree ca. 35 m. tall, the trunk ca. 60 cm. in diameter. Leaves glabrous throughout; petioles rigid, ca. 25 mm. long. Leaflets oblique, sessile on one side and with short petiolule ca. 5 mm. on the other, coriaceous, narrowly oblong, always distinctly falcate, 11 to 15 cm. long, 3.0 to 4.2 cm. wide, long acuminate. Inflorescence paniculate, to 15 cm. long; rachides pale brown tomentose, rather long and slightly flexuous. Pedicels 5–7 mm. long. Calyx tube obconical, with stalk-like base ca. 9 mm. long; calyx lobes elliptic-oblong, outside pale brown tomentose, inside dense, golden-brown sericeous. Petals oblong-lanceolate or lanceolate, 13–15 mm. long, 5–6 mm. wide, subsessile. Stamens 20–30 mm. long; anthers 4–5 mm. long. Ovary short-stipitate, densely hirsute, hairs longer at the base; style glabrous, 20–25 mm. long, with minute capitate stigma; ovules up to 6. Fruits ovoid (4.0–4.5 cm. long, 3.5 cm. wide), usually one-seeded.

HABITAT and DISTRIBUTION. This variety has been collected only twice along streams in the Wallaba forest, both times in the drainage of the Essequibo River, Guyana. Flowers in June.

VERNACULAR NAMES. Locust, simiri or courabarie, although the first two names also refer to the more common species, *H. courbaril*, in Guyana.

Guyana. Macouria River, Essequibo River, Mar., 1909, *C. W. Anderson 165* (K).

Hymenaea davisii was named by Sandwith in honor of Mr. T. A. W. Davis, then Assistant Conservator of Forests, British Guiana. Sandwith recognized its close affinity to *H. oblongifolia* but characterized *H. davisii* by (1) narrowly falcate and long acuminate leaflets, (2) long pedicels, (3) long stalk-like base of the calyx-tube and (4) usually one-seeded

fruits. After examining the type specimen and evaluating all the characters, the differences listed are considered as trends within a rather diverse species complex. Thus, it is appropriate to reduce *H. davisii* to a varietal status under *H. oblongifolia*. *Hymenaea oblongifolia*, therefore, is considered to be a polymorphic species with four varieties. A synoptic key to the varieties is presented to aid in identification:

1. Leaflets glabrous on the two sides.
   2. Leaflets narrowly falcate; petals lanceolate and subsessile; calyx-tube with long stalk-like base, ca. 9 mm. long. ..... var. *davisii*.
   2. Leaflets narrowly or wide-oblong; petals subunguiculate to distinctly unguiculate; calyx-tube with short stalk-like base, ca. 3 mm. long.
      3. Leaflets elongate-oblong (L/W ca. 3); petals subunguiculate to unguiculate. ..... var. *oblongifolia*.
      3. Leaflets wide-oblong (L/W ca. 2); petals distinctly unguiculate. .... var. *latifolia*.
1. Leaflets with dense, golden-brown tomentose hairs underneath. .... var. *palustris*.

ACKNOWLEDGMENTS

We wish to thank Dr. Paulo de T. Alvim, Director; Mr. Sérgio G. da Vinha, Mr. Maximo Hori, botanist and forester, of the Centro de Pesquisas do Cacau (CEPEC), Itabuna, Bahia, Brazil, for their generous support in providing assistance for the collection of the plants from Bahia. We are appreciative for the Latin descriptions done by Dr. Rimo Bacigalupi and criticism of the manuscript by Dr. Alva Whittingham. Also our gratitude is expressed to the curators of the herbaria, listed below with two exceptions by abbreviations of Lanjouw and Stafleu (1964), who kindly loaned or provided us facilities to examine specimens essential to this study; CEPEC, COL, IPA (Instituto de Pesquisas Agronômica, Recife, Pernambuco, Brazil), IPEAN, K, MG, NY, R, RB, UB, UC, US, and VEN. Grateful acknowledgment is made for funds to support this study from National Science Foundation grants GB–58161, GB–13659 and GB–29278.

LITERATURE CITED

ANDRADE-LIMA, D. Notas sôbre a dispersão de algunas especies vegetais no Brasil. An. Soc. Biol. Pernambuco **11**(1): 25–49. 1953.

BENTHAM, G. Hooker's Journal of Botany **2**: 74. 1840.

———. *In*: MARTIUS, Fl. Brasiliensis **15**(2): 232. 1870.

CANDOLLE, A. DE. Prodr. **2**: 94. 1825.

DUCKE, A. Estudos botânicos no Ceará. An. Acad. Brasil. Cien. **31**(2): 211–308. 1959.

HARRINGTON, H. J. Paleogeographic development of South America. Am. Assoc. Pet. Geol. Bull. **46**: 1773–1814. 1962.

HAYNE, F. G. Arzneikunde gebraüchlichen gewächse **11**: 7. Berlin. 1830.

HEYWOOD, V. H. The Leguminosae — a systematic purview. *In*: Chemotax-

onomy of the Leguminosae. EDS. J. B. HARBORNE, D. BOULTER & B. L. TURNER. Academic Press, New York. 1–29. 1971.

LANJOUW, J., & F. A. STAFLEU. Index herbariorum, 5th ed. Int. Bur. Pl. Tax. and Nomencl., Utrecht, Netherlands. Regnum vegetabile: **31.** 1964.

LANGENHEIM, J. H. Leguminous resin-producing trees in Africa and South America. *In*: Tropical Forest Ecosystems in Africa and South America: A Comparative Review. EDS. B. J. MEGGARS, E. S. AYENSU & W. D. DUCKWORTH. Smithsonian Press, Washington, D.C. 1972.

———, Y. T. LEE, & S. S. MARTIN. Amazonian species of the resin-producing genus *Hymenaea*. Am. Jour. Bot. **57**: 754. 1970.

———, ———, & ———. Brazilian species of the leguminous resin-producing genus *Hymenaea*. Am. Jour. Bot. **58**: 466. 1971.

———, S. S. MARTIN, & Y. T. LEE. Affinity of the African resin-producing genus *Trachylobium* with the neotropical genus *Hymenaea*. Brittonia **24**: 122. 1972.

LÉONARD, J. Genera des Cynometreae et des Amherstieae Africaines. Mem. Classe des Sciences de l'Academie Royale de Belgique **30**(2): 1–314. 1957.

MENÉNDEZ, C. A. Die Fossilen Floras Südamerikas. *In*: Biogeography and Ecology in South America, vol. 2. EDS. E. F. FITTKAU *et al.* Dr. W. Junk Publ. The Hague. 519–561. 1969.

RIZZINI, C. T. Notas prévia sôbre divisão fitogeográfica do Brasil. Revista Bras. Geol. **25**(1): 3–64. 1963.

———. Delimitacão e relacoēs da flora silvestre hileiana. *In*: Atas do Simpósio sôbre a Biota Amazônica, vol. 4 (Botânica). ED. H. LENT. Conselho Nacional de Pesquisas, Rio de Janeiro. 13–36. 1967.

SANDWITH, N. Y. New species and records from British Guiana. XV–Contributions to the flora of tropical America: XXX. Bull. Misc. Inf. Roy. Bot. Gard. Kew **1937**(2): 100–112. 1938.

SIMPSON, G. G. South American mammals. *In*: Biogeography and Ecology in South America, vol. 2. EDS. E. F. FITTKAU *et al.* Dr. W. Junk Publ. The Hague. 879–909. 1969.

VANZOLINI, P. E., & E. E. WILLIAMS. South American anoles. The geographic differentiation and evolution of the *Anolis crysolepis* species group (Sauria Iguanidae). Arq. Zool. São Paulo **19**(142): 1–124. 1970.

WOLFE, J. A. Tertiary climate fluctuations and methods of analysis of Tertiary floras. Paleogeography, Paleoclimatol., Paleoecol. **9**: 27–57. 1971.

DIVISION OF NATURAL SCIENCES
UNIVERSITY OF CALIFORNIA
SANTA CRUZ
CALIFORNIA 95060

THE GENUS CYRTANDRA IN THE RYUKYU AND CAROLINE ISLANDS

GEORGE W. GILLETT [1]

A RECENT MONOGRAPHIC STUDY of the genus *Cyrtandra* in the South Pacific, covering the territory from the New Hebrides to the Marquesas Islands, includes some 54 species of this very widely dispersed group. However, an additional five species occur north of the equator in the Ryukyu and Caroline Islands, a region with a measure of geographical coherence and some distance from the South Pacific territory of *Cyrtandra*. The purpose of this paper is to present the systematic relationships and expanded descriptions of these five species. A map showing the distribution of *Cyrtandra* and portraying the geographical relationships of the species may be consulted in volume **51** (page 242) of this Journal.

The five species considered here are probably from diverse origins. The most conservative speculation for the evolutionary history of *Cyrtandra yaeyamae* would include long-distance dispersal from northern Luzon. The most probable origins for *C. palawensis* and *C. todaiensis*, on the other hand, would be Mindanao or western New Guinea. These geographical relationships contrast with the eastern New Guinea–Solomon Islands source region for the lineages of *C. kusaimontana* and *C. urvillei*, and for the various lineages that extend across the South Pacific to the Marquesas Islands.

This small group of species includes some remarkable expressions of the genus, including the vining habit (*C. palawensis*), actinomorphic corolla (*C. palawensis* and *C. todaiensis*), valvate corolla lobes (*C. todaiensis*), and stamens numbering 4, 5, and 6 (as opposed to the usual pair of stamens) (*C. todaiensis*). The vining habit has been reported in some New Guinea species. Actinomorphic corollas with 4 or 5 stamens also occur in *Cyrtandra jonesii* of the Marquesas Islands, a species whose evolutionary lineage may be distinct from those of *C. palawensis* and *C. todaiensis* of the western Caroline Islands.

While not having had the advantage of field work in the Caroline and Ryukyu Islands, I have received excellent specimens, including spirit collections and field data, through the kind assistance of Mrs. Sheila Hardy, Mr. Demei Otobed, and Dr. Egbert Walker, to whom appreciation is extended. Thanks are also extended to the curators of the following herbaria who generously loaned specimens in their care:

[1] Supported by Grant GB–8608, National Science Foundation, and the Committee on Research, Academic Senate, University of California.

A Arnold Arboretum of Harvard University, Cambridge, Massachusetts.
BISH Bernice P. Bishop Museum, Honolulu.
E Royal Botanic Garden, Edinburgh.
K Royal Botanic Gardens, Kew.
P Muséum National d'Histoire Naturelle, Paris.
TAI National Taiwan University, Taipei.
UC University of California, Berkeley.
US Smithsonian Institution, Washington.

SYSTEMATIC TREATMENT

Cyrtandra J. R. & G. Forst. Char. Gen. 5. *pl. 3*. 1776.

A description of the genus and its geographical range is presented in Contr. U.S. Natl. Herb. **37**(4): 107–159.

KEY TO SPECIES

Corolla actinomorphic.
Stamens 2; shrubs climbing to 5–6 meters; corolla lobes imbricate; calyx persistent. ..... 1. *C. palawensis.*
Stamens 4, 5, or 6; erect shrubs 2–3 meters high; corolla lobes valvate; calyx deciduous. ..... 2. *C. todaiensis.*
Corolla bilabiate.
Inflorescence capitate to subcapitate, the pedicels concealed by the congested flowers and bracts. ..... 3. *C. yaeyamae.*
Inflorescence an open, branching cyme, not capitate or subcapitate, the pedicels visible, not obscured by the congested flowers and bracts.
Calyx 2.0–2.5 cm. long, pubescent on inner surface; corolla 3 cm. long. .... 4. *C. kusaimontana.*
Calyx 1.2–1.4 cm. long, glabrous on inner surface; corolla 1.5–2.0 cm. long. ..... 5. *C. urvillei.*

1. **Cyrtandra palawensis** Schltr. Bot. Jahrb. **56**: 577. 1921.

Climbing shrub ascending to 5–6 m., the young and mature parts densely to moderately pubescent with brown hairs 20–30 microns in diameter and 0.5–1.5 mm. long; leaves opposite, the petioles 3.5–8 cm. long, the blades elliptic, 4.5–9 cm. broad and 10–24 cm. long, primary veins 9–14 per side, blades equal to unequal and acute at bases, acute to acuminate at apices, entire to faintly serrate with about 1 shallow tooth per cm. at margins; inflorescences densely pubescent, of 3–10 flowers, the axillary peduncles 2 mm. long, terminated by deciduous, densely pubescent bracts 2 mm. broad and 5 mm. long; pedicels 2–5 mm. long; calyx persistent, cylindrical to inflated, pubescent on the outer surface with hairs 40–60 microns in diameter and 0.5–1.0 mm. long, glabrous on the inner surface, the calyx 9–12 mm. long, cleft 2–4 mm. into 5 nearly equal, acute lobes; corolla white, cylindrical, 14 mm. long, cleft 2–3 mm. into 5 equal, imbricate lobes, *the limb actinomorphic*, the outer surface of the corolla glabrous below, glabrate to pubescent above, with non-glandular hairs, the inner surface glabrous; stamens 2, the glabrous filaments 3 mm. long,

adnate to the corolla tube 4 mm. below the throat; staminodes 3, 0.25 mm. long, adnate to the tube 5 mm. below the throat, the center staminode 1 mm. above the laterals, the staminodes and stamens adnate opposite the 5 sinuses of the corolla; cupulate annular disc 1 mm. high, the margin entire; ovary glabrous, 6 mm. long; style glabrous, 7 mm. long; stigma cleft 1 mm. into two applanate lobes; fruit enveloped by the persistent calyx, the fruit 1.5 cm. long, ovoid, tapered at the apex into a beak 3–4 mm. long; seeds 0.5 mm. long, the coats sculptured by vertical striations.

TYPE LOCALITY: Babelthuap Island, Palau, Caroline Islands. Type collected by Ledermann (*Ledermann 14523*), not seen.

LOCAL NAME: "Melkii" (*Hardy & Otobed 83*).

DISTRIBUTION: Upland rain forest, Palau Archipelago. Confirmed localities limited to the island of Babelthuap.

Palau: without further locality, *Kanehira 274* (BISH), *1963* (K, P). **Babelthuap:** Aimiliki, *Hosokawa 7251* (BISH, TAI); Garmiscan, *Hosokawa 9139* (BISH, TAI); 2 mi. S. of Ngarekea Village, *Fehlman s.n.* (BISH); Ngetbelebel, Imelik, *Hardy & Otobed 83* (UCR).

This species has the distinction of an actinomorphic corolla, seen also in *C. todaiensis* Kanehira. It is different from the latter species in many characters, including imbricate corolla lobes, two stamens, and a persistent calyx. In the more than 90 species of Pacific *Cyrtandra* I have studied, none bears any close relationship to *C. palawensis*. The nearest relative is probably among the more than 200 species in New Guinea and the Philippines.

2. **Cyrtandra todaiensis** Kanehira, Bot. Mag. Tokyo **47**: 679. 1933.

Protocyrtandra todaiensis (Kanehira) Hosokawa, Trans. Nat. Hist. Soc. Formosa **24**(132): 202, 203. 1934.

Cyrtandra todaiensis is described and illustrated in vol. **51** (pages 241–246) of this Journal. Further discussion of this species has been advanced by Burtt in Notes Bot. Gard. Edinb. **30**(1): 1–10. 1970.

3. **Cyrtandra yaeyamae** Ohwi, Jour. Jap. Bot. **13**: 339, 340. 1937.

Cyrtandra iriomotensis Masam. Not. Syst. (Paris) **6**: 38, 39. 1937.

Shrub 2–4 m. high, the young foliage pubescent with indument of hairs 30 microns in diameter and 0.4–0.8 mm. long; stems square in cross-section, thick (2–4 cm.), light gray; leaves opposite, the petioles 3–7 cm. long, connate at bases; blades lanceolate to ovate, 7–17 cm. wide, 10–40 cm. long, tapering to an unequal, acute base and decurrent on the petiole, acute to acuminate at apex, shallowly undulate-dentate at margin, glabrous on both surfaces, much paler beneath, the primary veins about 16 on each side, curved-ascending, not uniting at margin; inflorescences axillary, many flowered, the congested fascicles with involucre-like bracts

at the summit of a peduncle, 5–20 mm. long, the bracts lanceolate to oblanceolate, 2–4 cm. long, entire or shallowly lacerate, glabrous, the inner bracts smaller; calyx about 6 mm. long, glabrous on the outer and inner surfaces, cleft to about 2 mm. from the base into 5 subequal lanceolate lobes; corolla funnelform to campanulate, creamy-white, about 2.5 cm. long, cleft into rounded lobes, glabrous outside, with inner pubescence of very short hairs; stamens 2, the filaments glabrous, 7–10 mm. long, adnate to the corolla tube about 1 cm. above the base, the anthers connate and borne slightly below the throat; staminodes 3, attached at the same level as the stamens, erect, straight, somewhat rigid, 3–4 mm. long, the middle staminode 1 mm. long and borne 1 mm. below the laterals, annular disc conspicuous 1.5–2 mm. high, with undulate margin; ovary 9 mm. long, glabrous; style 11 mm. long, densely pubescent with minute noncapitate hairs, bearing the bifid stigma below the anthers; fruit ellipsoidal, about 15 mm. long, tipped by 5 mm. of the persistent style base; seeds not seen.

TYPE LOCALITY: Iriomote Island, Ryukyu Islands. Type: *Sonohara s.n.* (KYO) not seen.

LOCAL NAME: "Yaeyama-iwa-tabako" (Yaeyama Rocky Tobacco).

DISTRIBUTION: Known only from Iriomote Island.

Iriomote Island: along the Nakara River, *Walker & Tawad 6882* (BISH, US), *ibid.*, *Hatusima 18732* (BISH, US).

This species is closely related to *Cyrtandra cumingii* which occurs in the Philippines and north to Botel Tobago, in the Batan Islands, off the southeast coast of Formosa. The similarity is so great that the latter name has been erroneously applied to the Iriomote collection of Hatusima.

4. **Cyrtandra kusaimontana** Hosokawa, Trans. Nat. Hist. Soc. Formosa **24**(132): 203. 1934.

Pubescent shrub almost 1 meter high, the stems, leaves, and inflorescences covered with a woolly to sparse indument of yellowish brown hairs 40–60 microns in diameter and 1.0 to 1.5 mm. long; leaves opposite, the petioles 7.5–13 cm. long, the blades elliptic-ovate, 14–17 cm. broad and 28–53 cm. long, the primary veins 8–9 per side, the blades unequal and attenuate at bases, acuminate at apices, irregularly and shallowly serrate at margins, woolly on the lower surface, the hairs scattered on the upper surface; inflorescences of 3–4 flowers, the cymes borne on axillary, woolly peducles 1–3 cm. long, terminated by 3–4 woolly pedicels 7–20 mm. long; bracts small; calyx tardily deciduous, densely pubescent on the outer and inner surfaces, cylindrical, 2.0–2.5 cm. long, cleft 10–20 mm. into 5 equal, lanceolate, acuminate lobes; corolla 3 cm. long, glabrous, the posterior lip scarcely apparent, the anterior lip trilobate; stamens 2, the filaments 7 mm. long, the anthers 2 mm. long; staminodes 3, 1–2 mm. long; cupulate annular disc 1.0 mm. high, entire at margin, persistent; ovary glabrous;

style sparsely pilose and shortly bilobed at apex; fruit ovoid, yellowish brown, 2.0–2.5 cm. long, tipped by 2.5 mm. of the style base; seeds 0.4 mm. long, ovoid, the coats coarsely reticulate.

TYPE LOCALITY: Kusaie, Eastern Caroline Islands. Type collected by Hosokawa, cited below.

DISTRIBUTION: Upland rain forest on the island of Kusaie.

Kusaie: "In the *Astronia* thicket situated upon the upper altitude of Mt. Buache (*T. Hosokawa* no. *6288 a*! July 29, 1933)." Type collection (not seen). Finkol, 500 ft., *Hosokawa 9389* (TAI).

The above description was prepared from a study of *Hosokawa 9389* and from a translation of Hosokawa's original publication. Some difficulties were encountered in the translation. Hosokawa apparently reversed the application of "anterior" and "posterior" as applied to the corolla. I have taken the liberty of using "posterior" to designate the bilobate upper lip and "anterior" for the trilobate lower lip, to be consistent with my usage of the terms. There is no doubt that *Hosokawa 9389* and the type specimen are of the same species, however. This species is strongly distinct from *C. urvillei*, which also occurs on Kusaie. *Cyrtandra kusaimontana* probably evolved from stock dispersed from New Guinea.

5. **Cyrtandra urvillei** C. B. Clarke, in DC. Monogr. Phan. **5**: 251, 252. 1883.

Cyrtandra ponapensis Kanehira, Bot. Mag. Tokyo **46**(548): 492, 493. 1932.

Shrub to small tree 1.5–5 m. high, the young parts pubescent with an indument of brown hairs 30–40 microns in diameter and 0.3–0.6 mm. long; leaves opposite, the petioles 2–10 cm. long, the blades ovate to elliptic, 4–17 cm. broad and 5–39 cm. long, the primary veins 5–8 per side, the blades equal to unequal and decurrent at bases, obtuse to acute at apices, entire to undulate to serrate with 1–3 teeth per cm. at margins; inflorescences pubescent, bearing 1–15 flowers, the axillary peduncles 1–2.5 cm. long, terminated by lanceolate bracts 5–10 mm. long, subtending 1–4 bracteolate, branched axes 5–8 mm. long; pedicels 5–10 mm. long; calyx 12–14 mm. long, cleft to within 1 mm. of base into 5 equal, linear-lanceolate lobes, pubescent on the outer surface with appressed hairs 30 microns in diameter and 0.2–0.3 mm. long, glabrous on the inner surface; corolla white, 16–19 mm. long, cleft 5–7 mm. into 5 unequal, rounded lobes; glabrous on the outer and inner surfaces except for an inner throat pubescence of capitate glandular hairs 30 microns in diameter and 0.1 mm. long; stamens 2, the glabrous filaments 3 mm. long, adnate to the corolla tube 3 mm. below the throat and opposite the sinuses of the anterior lobe, the anthers coherent at apices, held slightly below the throat; staminodes 3, 1 mm. long, adnate to the tube 3 mm. below the throat opposite the sinuses of the posterior lobes, the center staminode 0.5 mm. long and borne 1 mm. above the laterals; cupulate annular disc persistent,

1.5 mm. high, entire at margin; ovary glabrous, 5 mm. long; style glabrous, 5 mm. long; stigma cleft 0.5 mm. into two thick lobes; fruit ovoid 1.5 cm. long; seeds ovoid-fusiform, 0.4 mm. long, the coats sculptured with longitudinal striations.

TYPE LOCALITY: Kusaie Island, Caroline Islands. Type (not seen) collected by Dumont d'Urville.

DISTRIBUTION: Kusaie and Ponape Islands, eastern Caroline Islands, in upland rain forest, 100–700 m.

Kusaie: without further locality, *Kanehira 1381* (TAI), *Stone 1923* (BISH), Finkol, *Hosokawa 6416, 9416* (TAI), Utwa, *9374* (TAI), Mt. Buache, *6287* (TAI).
Ponape: Niinoani-zan, *Kanehira 831* (BISH, syntype of *Cyrtandra ponapensis* Kanehira); Tortom-zan, *Kanehira 1550* (K, TAI, syntypes of *C. ponapensis*); Naanaraut-zan, *Kanehira 1642* (P, syntype of *C. ponapensis*); Mt. Seletenreh, *Glassman 2743, Stone 5390* (BISH); Nanalant Mtn., *Takamatsu 1090* (BISH); Nawpil, *Hosokawa 8228* (TAI); Nipit, *Hosokawa 9502* (TAI); Kuporujo, *Takamatsu 660, 669, 671* (BISH); Troton, *Hosokawa 5749* (TAI); Nunioanii, *Hosokawa 5670* (BISH, TAI), *5687* (TAI), Ponape, without further locality, *Kanehira 1357* (P); *Ledermann 13682* (K).

In his "Die Gesneraceen von Mikronesien" (Bot. Jahrb. **56**: 576, 577. 1921) Schlechter circumscribed *Cyrtandra urvillei* to include both the Kusaie and the Ponape material, a judgment in which I concur. He cited d'Urville's type from Kusaie and *Ledermann 13682*, from Ponape, cited above. Kanehira published *C. ponapensis* 11 years later, in 1932, and illustrated both *C. urvillei* (Kusaie) and *C. ponapensis* (Ponape) in his "Flora Micronesica" in 1933. An examination of the specimens and of Kanehira's illustrations shows that these are one species, of the *Cyrtandra cymosa* (New Hebrides)–*C. tempestii* (Fiji)–*C samoensis* (Samoa)–*C. rarotongensis* (Rarotonga) lineage that is so well dispersed in the South Pacific. The occurrence of *C. urvillei* on both Ponape and Kusaie (300 miles southeast of Ponape) is consistent with the remarkably wide dispersal of this lineage. The related *C. samoensis* occurs on Niue Island, 300 miles southeast of its nearest locality in Samoa.

DEPARTMENT OF BIOLOGY
UNIVERSITY OF CALIFORNIA
RIVERSIDE, CALIFORNIA 92502

THE WOOD OF AMENTOTAXUS

HOWARD J. MILLER

CONTROVERSY OVER THE TAXONOMIC relationship of the Taxineae with the Coniferineae has created a new interest in the field of wood anatomy. This has been reflected by the flurry of investigations being conducted in families such as the Podocarpaceae.

The systematic position of *Amentotaxus* is somewhat uncertain (see Keng, 1969). While many authors place *Amentotaxus* in the Taxaceae, this genus has also been referred to the Cephalotaxaceae or even considered to represent a separate family, the Amentotaxaceae. When Kudo and Yamamoto (1931) described this last family, it was considered to be represented by only a single species, *Amentotaxus argotaenia* (Hance) Pilger. In his revision of *Amentotaxus* Li (1952) recognized four species. However, the description and publication of three new species of *Amentotaxus* based on leaf morphology would appear to have been overly optimistic and has not gone unchallenged. Hu (1964) recognized only three of the species, since she thought that *Amentotaxus cathayensis* Li could not be usefully upheld as distinct. Moreover, Chuang and Hu (1963) considered that *Amentotaxus formosana* Li was better referred to *Amentotaxus argotaenia* (Hance) Pilger. The divergence of opinion has increased the need to investigate any anatomical features that may be of taxonomic importance. In connection with this work it was thought an examination of the wood anatomy would be worthwhile, even though taxonomic evaluation at the subgeneric level is not often successful in this field. A comparative study of the wood anatomy within the genus *Amentotaxus* is considerably limited by the lack of availability of suitable material; most locations of *Amentotaxus* are in China. The scanty and now somewhat rare wood specimens were collected before 1935, with the exception of some from Taiwan.

PRIOR INVESTIGATIONS

Tang (1933) gave a short description of *Amentotaxus argotaenia*, based on two specimens from the province of Kwangtung in China. He noted rays 1–4 cells high in one specimen whereas in the other they were mostly 3–5 cells high. He also mentioned a slight difference in tracheid wall thickness between the early and late wood. A shorter description was made by Prince (1938). He stated in his introduction to the Taxineae that crassulae are clearly developed. Phillips' (1948) brief description mentioned that the horizontal walls of the ray cells are relatively thick and sparsely pitted; and that the parenchyma cells are wider than the tracheids and have nodular end walls.

The description given by Greguss (1955), based on wood from Taiwan, was much more detailed. According to Greguss the tracheid wall thickness in early wood is not significantly different from that of the late wood. He did not mention the presence of crassulae. Bordered pits are absent or rare on the tangential walls of tracheids, but on the radial wall they form one irregular row. Spiral thickenings are mostly paired. The pit aperture, which is rounded to slit-shaped, is very often enclosed by a pair of spirals and lies in the same direction as the spiral. Aperture direction was given as mostly 45° to the axis. There was no reference to ray wall thickness, but Greguss regarded the end wall as generally smooth. His more detailed description of the axial parenchyma is in agreement with Phillips'.

PRESENT DESCRIPTIONS

Amentotaxus argotaenia (Hance) Pilger (*A. formosana* Li). Uw 18635.

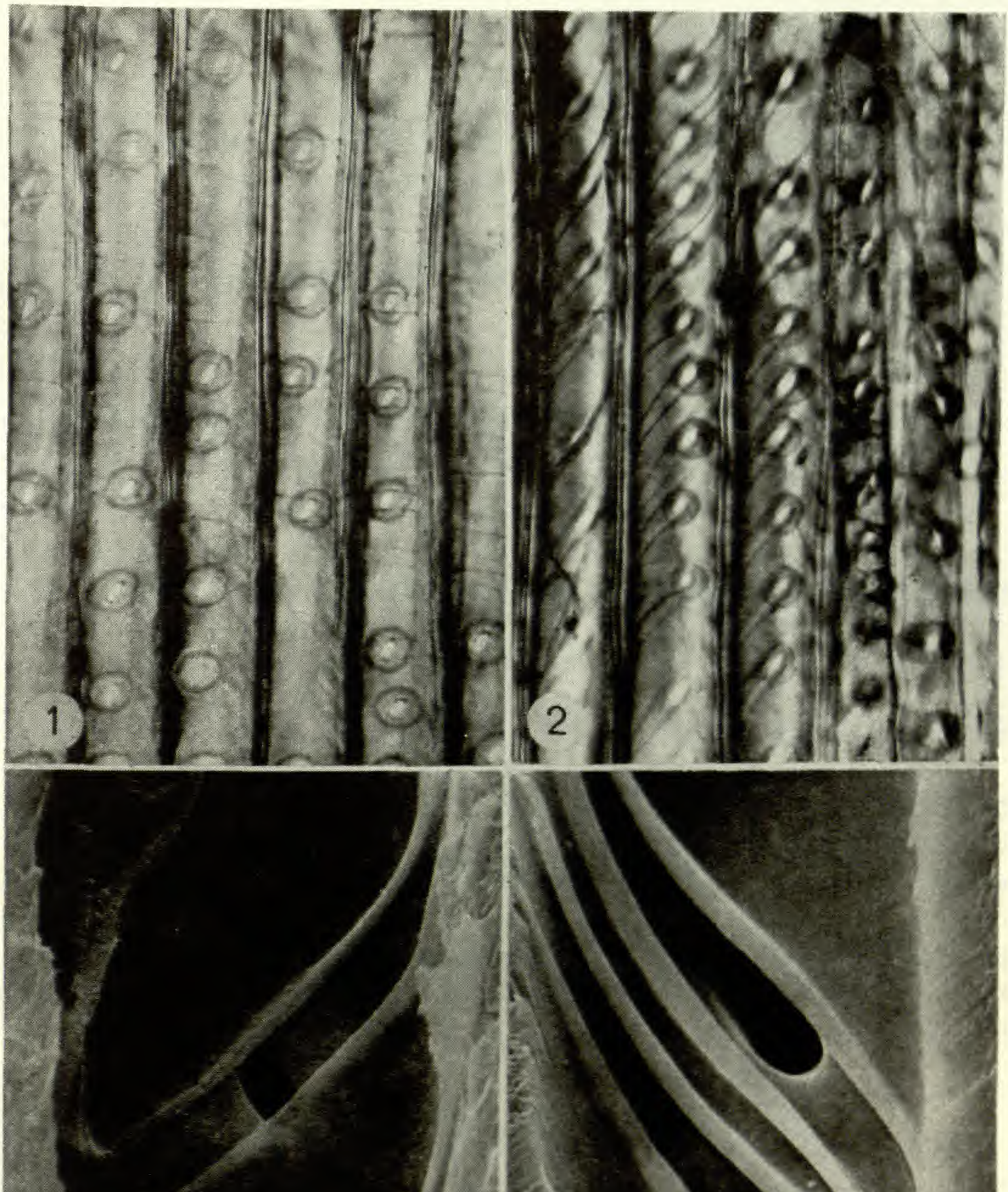
LOCATION: Taiwan (Formosa). Obtained from the Institute of Forest Botany, University of Tokyo, Japan. No.: TOFOw *5721.*

COLLECTOR: Dr. *Ryozo Kanehira.*

A smooth textured wood with a yellow-brown color. The growth rings although distinct are not so pronounced as in the Gymnosperms of the temperate zones. Their width varies from 40 to more than 90 cells. There is a gradual transition from early to late wood, and the late wood consists of only (2)4–5 rows of flattened tracheids.

The *tracheids* are rounded or angular in transverse section and display intercellular spaces. A few tracheids are present with a loosening of the secondary wall. Double spiral bands, 3–6 μ wide, appear to be characteristic of this wood. They vary in angle from almost horizontal (FIGURE 1), mostly in the early wood, to up to 60° (FIGURE 2), mostly in the late wood. Crassulae are present. The bordered pits are without torus and are rare on the tangential walls; on the radial walls they are arranged mostly in one irregular row but occasionally partially biseriate rows are found. Their size varies from 12–15 μ in the early wood, to 10–16 μ in the late wood. The pit apertures lie within the double spiral bands and are oval to lenticular, particularly in the late wood. In the early wood the aperture is oriented almost perpendicularly to the spiral bands (FIGURE 3) and mostly parallel to the bands (FIGURE 4) in the late tracheids. The aperture sizes vary from 2–5 $\mu \times$ 5–10 μ in the early wood to 2–4 $\mu \times$ 4–12 μ in the late wood. Pits are frequently accompanied by checking, which is more apparent in the late wood.

Tracheid measurements — in early wood: (17)25–30(40) μ radial and (17)28–32(40) μ tangential; in late wood: 10–14 μ radial, (15)25–28(35) μ tangential. Length: 800–3000 μ, average 2080 μ. The wall thickness is not significantly different in early and late wood and ranges from 2.5–5 μ.



FIGURES 1–4, *Amentotaxus argotaenia.* 1, Radial section showing horizontal spiral bands, × 280. 2, Radial section showing spiral bands up to 60°, × 280. 3, Radial section showing apertures perpendicular to spiral bands, × 1920. 4, Radial section showing apertures parallel to bands, × 2000. [FIGURES 3 and 4 S. E. M.]

The *wood rays* are uniseriate or occasionally partially two cells wide. This does not appear to represent a truly biseriate state, for occasionally in the transverse section, the end walls of ray cells are seen to meet diagonally. This point when viewed in the tangential section may give the impression of a biseriate ray. Rays are composed of parenchyma cells only with no ray tracheids, although thin-walled marginal ray parenchyma without cross-field pitting is frequently seen (FIGURE 5). Cupressoid cross-field pitting; 1–2 pits per cross-field, occasionally 3–4 pits, which, when found, are seen only in the outer row of pitted cells. In the early wood the largest pits are: 6–8 μ, aperture 5–6 μ; in the late wood: 7–10 μ and 5–8 μ respectively. The pits between ray and axial parenchyma are simple, 7–10 μ, though larger irregular pits up to 25 μ are present. There is occasional pitting in the horizontal walls and thin patches are also seen, probably from a fungal infection; mycelia were found throughout the specimen. Although the horizontal walls are generally smooth, they are very uneven in thickness. The end walls are thin and smooth, not nodular, and often join the horizontal walls obliquely. Indentures are present. Number of rays per mm.^{2} 50–60. Width of rays cells 12–18 μ, height 20–30 μ. The rays generally 1–3, maximum 11 cells high (275 μ). Distribution frequency — number of cells high and percent (in parentheses): 1 (21); 2 (43); 3 (23); 4 (8); 5 (3); 6+ (2).

Parenchyma is relatively abundant in the early wood, the distribution being diffuse but with a tendency to form small groups and short tangential bands (FIGURE 6). In the late wood it is scarce. The cells are mostly empty. The diameter of the cells varies from 20–50 μ but is generally 30–45 μ. The end walls are pitted and mostly nodular (FIGURE 7). The pits of the vertical walls are rounded or oval, 3–10 μ wide, although irregular pitting is common together with a tendency to form large irregular pits up to 25 μ wide.

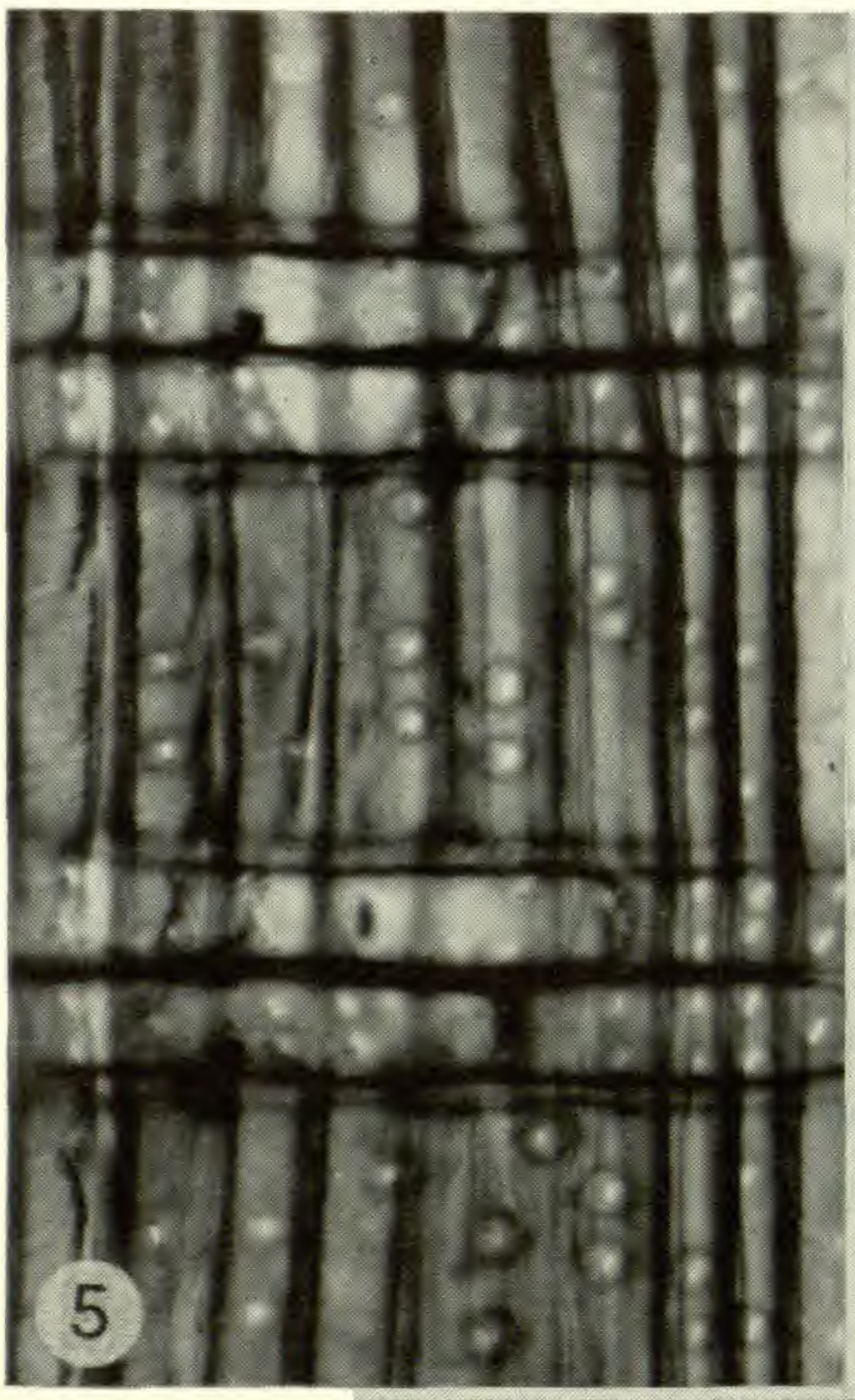
Amentotaxus argotaenia (Hance) Pilger (*A. formosana* Li). Uw 18638.

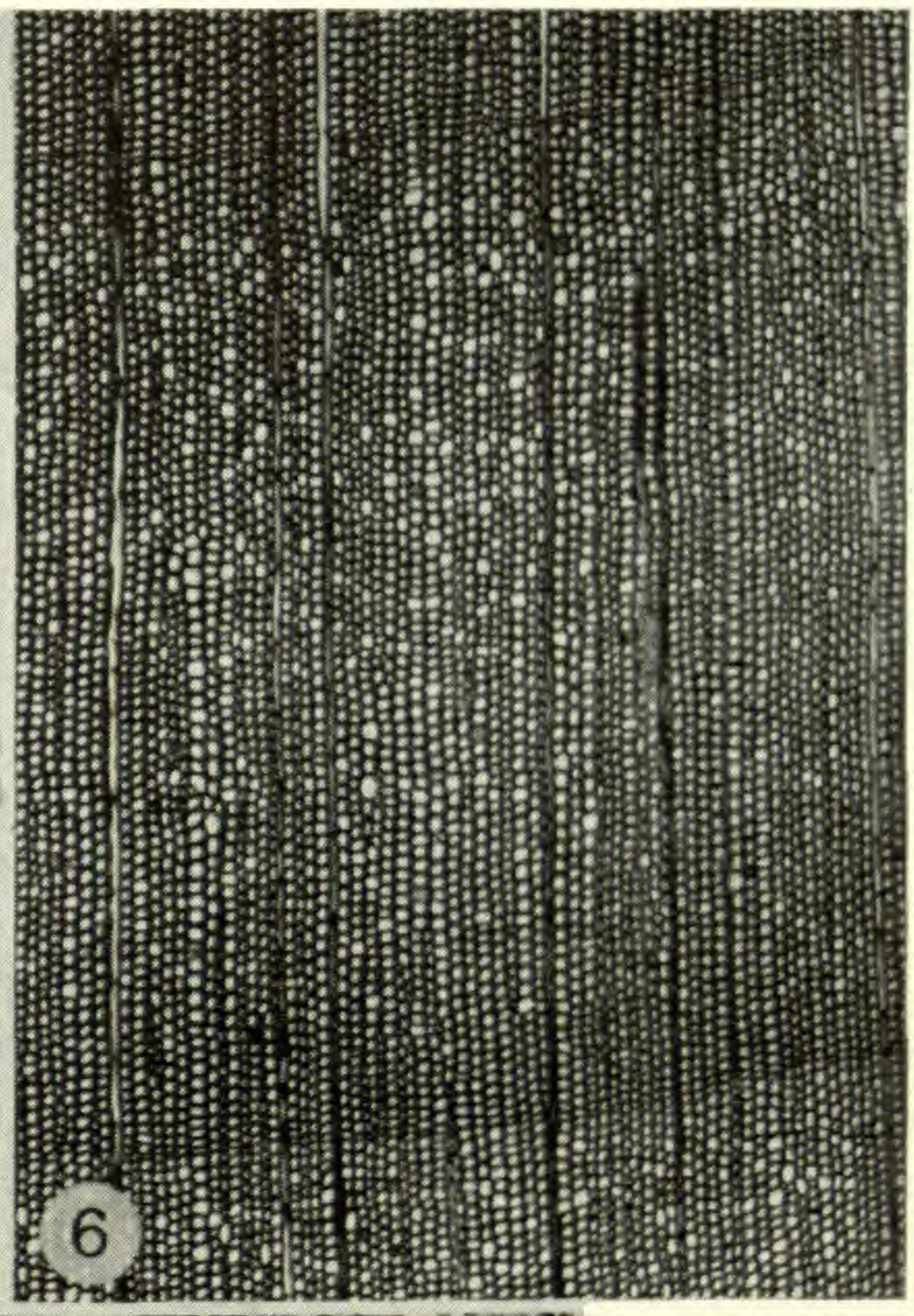
LOCATION: Taiwan (Formosa). Obtained from the U.S. Forest Products Laboratory, Madison, Wisc. No. *9369*. Originally from Dr. *Ryozo Kanehira*.

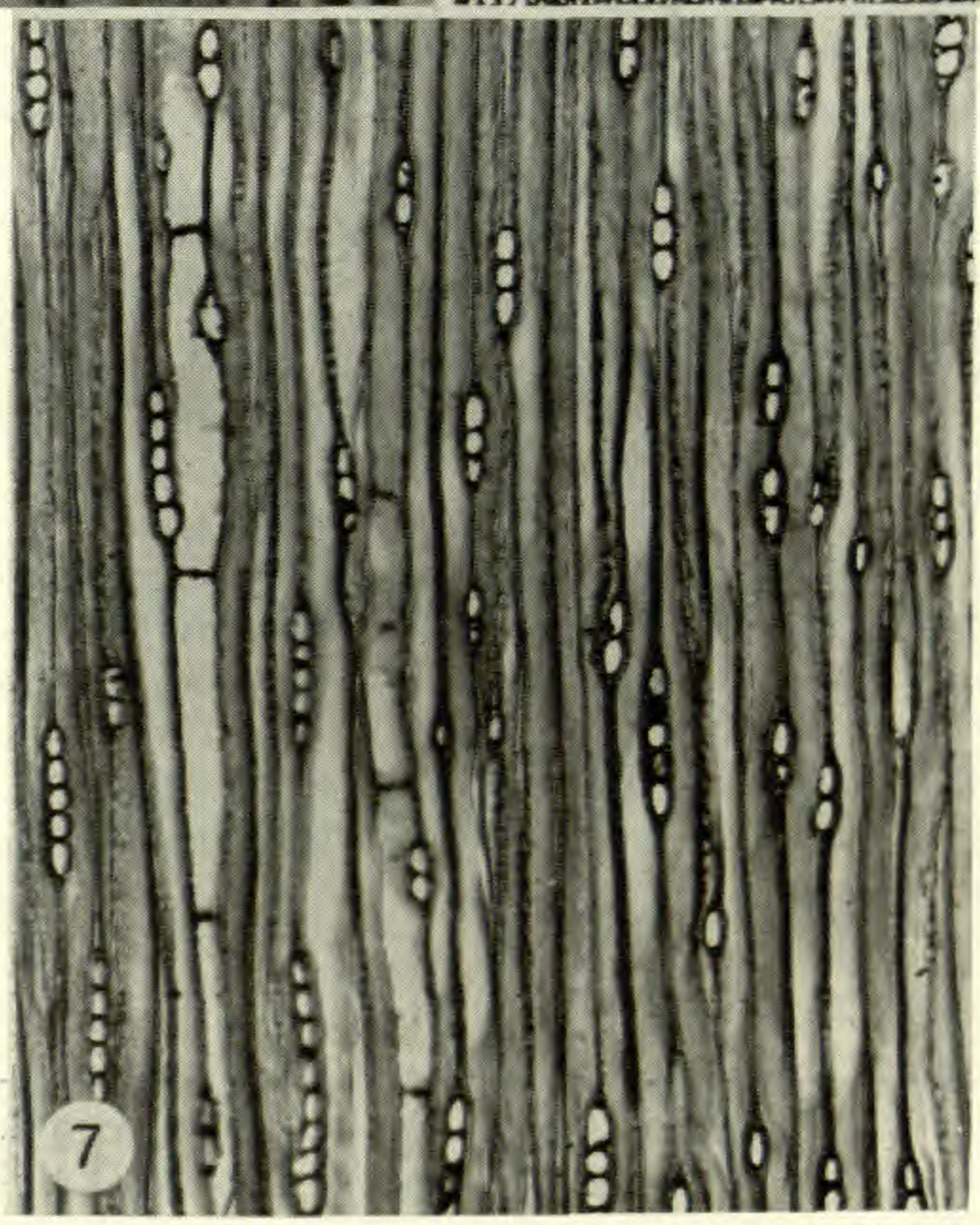
In this specimen the growth rings vary from 20–70 cells wide. The late wood consists of 2–4(5) flattened tracheids. The double spiral band is mostly horizontal, but occasionally up to 30°, 45° is rare. Tracheid lengths are 850–2650 μ with an average of 1900 μ. The rays are generally 1–4, maximum 12 cells high (275 μ). Distribution frequency — number of cells high and percent (in parentheses): 1 (26); 2 (42); 3 (11); 4 (14); 5 (4); 6+ (3). The parenchyma has a diameter of (15)25–40(50) μ, with pits of diameter 4–8 μ and irregular pits up to 30 μ wide

Amentotaxus argotaenia (Hance) Pilger, *sensu stricto*. Uw 18636.

LOCATION: listed as unknown, but believed to be Kwangtung. Obtained from the Institute of Forest Botany, University of Tokyo, Japan.







FIGURES 5–7. *Amentotaxus argotaenia*. 5, Radial section showing thin-walled marginal ray parenchyma, × 160. 6, Transverse section illustrating parenchyma in small groups and short tangential bands, × 30. 7, Tangential section showing general ray distribution and demonstrating axial ray parenchyma with nodular end walls, × 70.

No.: TOFOw *10848*. Collector unknown, but received from Dr. Y. Tang of China in 1935.

The description is comparable to that of Uw 18635, with the following modifications: the growth rings have a width of between 35–70 cells. The late wood consists of 2–3(4) rows of flattened tracheids. The angle of the double spiral bands ranges between 30° and 60°, but mostly 45°. Tracheid lengths vary from 1300–2600 μ, averaging 1890 μ. The parenchyma cells of the rays, although smooth, are slightly thicker, 0.5–1 μ, than in Uw 18635. Number of rays per mm.^{2} 30–40. Rays are generally 1–4, maximum 13 cells high (300 μ). Distribution frequency — number of cells high and percent (in parentheses): 1 (10); 2 (31); 3 (23); 4 (16); 5 (10); 6+ (10).

Parenchyma distribution is similar to Uw 18635, the diameter being (15)25–40(50) μ. The size of the pits is 4–10 μ with irregular pitting and a tendency to form large pits up to 30 μ wide.

Owing to the described variations and the limited number of wood specimens of *Amentotaxus* available, information was obtained from macerations prepared from twig material originating from herbarium specimens. See TABLE 1.

TABLE 1.

TAXA ACCORDING TO LI'S CLASSIFICATION	TRACHEID LENGTH μ	TYPE I* BANDS WITH PITS ORIENTED	TYPE II** BANDS PITS USUALLY PARALLEL	PROPORTION I TO II
1. A. ARGOTAENIA	900–1300	90°–45°	present	I > II
2. A. ARGOTAENIA	750–1050	Mostly 45°	present, more lenticular	I = II
3. A. CATHAYENSIS	600–1200	90°–45°	present, more lenticular	I » II
4. A. FORMOSANA	800–1100	Mostly 45°	present, more lenticular	I = II
5. *A. FORMOSANA	750–1400	More 45° than 90°	present	I < II
6. A. YUNNANENSIS	550–1200	90°–45° slightly lenticular	present, more lenticular	I < II
7. A. YUNNANENSIS	650–1500	90°–45° slightly lenticular	present, more lenticular	I < II

* Type I bands — those double spirals lying horizontal or nearly horizontal.
** Type II bands — those double spirals lying at approximately 45°, pit apertures usually being parallel.

In TABLE 1, **A. formosana* was 4 to 5 years old, and demonstrated the following characteristics: tracheids with bordered pits occurring on the tangential walls but rare; pits on the radial walls forming one row which

is more or less regular; the diameter of the pit borders as much as 25 μ in the early wood; crassulae present.

Rays are uniseriate and consist of parenchyma cells only. Marginal ray parenchyma is not apparent. The horizontal walls are slightly uneven in thickness with occasional pits. Indentures are present but rare. The end walls often join the horizontal walls obliquely. Mostly 2 pits per cross-field but 3–4 pits per cross-field are more frequent than in the wood specimens previously seen. Number of rays per mm.^{2} 100–200. Width of ray cells 8–16 μ, height 20–35 μ. The rays are generally 1–2, maximum 7 cells high (200 μ). Distribution frequency — number of cells high and percent (in parentheses): 1 (65); 2 (27); 3 (6); 4+ (2). The wood parenchyma is relatively abundant in the early wood. The pits are 5–10 μ wide, round and regular. There was no evidence of fungus in this specimen.

DISCUSSION

Obvious anatomical features such as the abundance and arrangement of the wood parenchyma and the double spirals of the tracheids enclosing the bordered pits are of importance at the generic level. Greguss went so far as to say that the arrangement and width of the parenchyma is so characteristic that this genus is immediately distinguishable from all other "conifers." Crassulae which occur in all specimens, including twig material, would appear to be a feature of importance at a higher taxonomic level (Prince, 1938).

The slight variations in tracheid wall thickness are not significant. Their diameter agrees closely with measurements made by Greguss. The tracheid lengths are slightly variable but there is an overlap between the three specimens. Their relative shortness in the twig specimens is in accordance with the first part of one of Sanio's Laws (1872), which states, "In the stem (and branches) the tracheids show an increase in size from within outwards, throughout a number of annual rings." The second part of the rule, ". . . until a certain size is reached, which remains constant in subsequent years," was in dispute; it has been discussed by many authors including Liang (1948) and was reviewed by Dinwoodie (1961). The orientation of the pit apertures within the double spiral might at first sight appear to be of some significance. Further investigations on the herbarium material show a complete range of variation without any apparent pattern. However, where bands lie at about 45°, the somewhat lenticular pits are mostly parallel to the axis of the band. On this point the present author is in agreement with Greguss.

The differences in the cell wall thickness of the rays is slight. Its true thickness is masked by a degree of irregularity, particularly marked in the stem woods. The marginal ray parenchyma described in Araucariaceae and Podocarpaceae (Greguss 1957), was not reported by Greguss (1955) for *Amentotaxus*. It was found in all the stem woods but was not apparent in the twig wood, indicating a later development. In specimen Uw

18636 there are only 30–40 rays per mm.^{2} compared to 50–60 rays per mm.^{2} in the other two. In this same specimen there is also a slight difference in the ray distribution frequency. Tang (1933) noted that one of his specimens had rays 1–4 cells high and the other 3–5 cells high. Differences of this nature would not appear to be of any systematic significance, since measurements on twig material show a marked increase in the number of rays (100–200 per mm.^{2}) and a concurrent decrease in the mean number of cells in each ray. These differences are probably related to factors of age, growth, environment, and other physiological factors.

The width of the axial parenchyma appears to be relatively constant. The only difference seen is in the wall where large irregular pits occur. In twig wood, only regular pits of normal size are found. The presence of a fungal infection could explain the irregularities, as the twig wood appears to be free from fungus. This could also account for the increased irregularity in the thickness in the horizontal walls of the ray parenchyma to be found in the stem wood.

CONCLUSIONS

Amentotaxus is unique at the generic level with the following characteristic features: abundance and distribution of wood parenchyma, nodular end walls; double spiral thickenings of tracheids mostly enclosing pit apertures; rays 1–4 cells high, horizontal walls of uneven thickness with end walls joining at an oblique angle. Some authors, e.g. Kudo and Yamamoto (1931), and Li (1963), have placed *Amentotaxus* in a separate family. On the basis of this investigation into the wood characteristics of *Amentotaxus*, it would be inadvisable for the present author to make any such taxonomic decisions until an adequate comparison has been made with the woods of related genera.

Significant differences are not apparent in the anatomical features of the material examined. It would therefore appear that a) taxonomic evaluation is not possible at the specific level, or b) *Amentotaxus* is monotypic. Should fresh material become available, however, complete with authenticated information about locality, environment, and age of specimen, reinvestigation might be advisable.

ACKNOWLEDGMENTS

My sincere thanks to Dr. David K. Ferguson of the University of Antwerp, coördinator of a project to research the Taxineae, for his help during this investigation. I am greatly indebted to Dr. Alberta M. W. Mennega for help and encouragement. I wish to thank Dr. Ken Alvin of the Imperial College of Science and Technology, London, for the scanning electron microscopic photographs. I am grateful to the curators of the wood collections at Tokyo (Inst. For. Bot.), and Madison (U.S. Forest Products Lab.) for providing the valuable wood specimens. Further

I wish to acknowledge the coöperation of Mr. A. Kuiper, Mr. A. Schipper and Mr. P. A. van den Berg.

MATERIAL STUDIED (in TABLE 1)

1. *Amentotaxus argotaenia* (Hance) Pilger. HONG KONG: *A. B. Westland s.n.* April 1885 (B).
2. *Amentotaxus argotaenia* (Hance) Pilger. Kwantung, CHINA: *Y. W. Taam 551* (A).
3. *Amentotaxus cathayensis* Li. Western Hupeh, CHINA: *E. H. Wilson 1894* (*K*).
4. *Amentotaxus formosana* Li. TAIWAN: *R. Kanehira & S. Sasaki s.n.* 19 Feb. 1925 (TI).
5. *Amentotaxus formosana* Li. TAIWAN: *R. Kanehira s.n.* 27 Dec. 1925 (A).
6. *Amentotaxus yunnanensis* Li. Yunnan, CHINA: *K. M. Feng 12792* (A).
7. *Amentotaxus yunnanensis* Li. Yunnan, CHINA: *H. T. Tsai 51887* (C, isotype).

REFERENCES

CHUANG, T.-I., & W. W. L. HU. 1963. Study of *Amentotaxus argotaenia* (Hance) Pilger. Bot. Bull. Acad. Sin. **4**(1): 10–14.

DINWOODIE, J. M. 1961. Tracheid and fibre length in timber. A Review of Literature. Forestry [Oxford]. **34**(2): 125–144.

GREGUSS, P. 1955. Xylotomische Bestimmung der heute lebenden Gymnospermen. Budapest.

———. 1957. Marginal ray parenchyma in Araucariaceae and Podocarpaceae. Acta Biol. N. S. **3**(Fasc. 1–2): 15–17. University of Szeged, Hungary.

HU, S.–Y. 1964. Notes on the Flora of China IV. Gymnospermae. Taiwania, **10**(1): 13–62.

KENG, H. 1969. Aspects of morphology of *Amentotaxus formosana* with a note on the taxonomic position of the genus. Jour. Arnold Arb. **50:** 432–445.

KUDO, Y., & Y. YAMAMOTO. 1931. Amentotaxaceae. IN: KUDO, Y., Materials for a flora of Formosa, IV. Jour. Soc. Trop. Agric. (Taihoku) 3(2): 110, 111.

LI, H.–L. 1952. The genus *Amentotaxus*. Jour. Arnold Arb. **33:** 192–198.

———. 1963. Woody Flora of Taiwan. Livingstone Publ. Co., Narberth, Pennsylvania. [Pp. 36, 37.]

LIANG, S.–C. 1948. The study of wood anatomy within the genus *Larix*, and the influence of internal and external factors thereon. [Ph.D. Thesis, University of Aberdeen]. Forestry [Oxford]. **22:** 222–237.

PHILLIPS, E. W. J. 1948. Identification of softwoods by their microscopic structure. Forest Products Res. Bull. **22:** 1–56. London.

PRINCE, J. B. 1938. Stem-wood in the Gymnosperms. [M.Sc. Thesis (For.), Univ. of New Brunswick]. 96 typewritten pages.

SANIO, K. 1872. Über die Grösse der Holzzellen bei der gemeinen Kiefer (*Pinus silvestris*). Jahrb. Wiss. Bot. **8:** 401–420.

TANG, Y. 1933. Anatomical studies and identification of Chinese softwoods. I. Bull. Fan Mem. Inst. Biol. **4**(7): 209–268.

INSTITUTE FOR SYSTEMATIC BOTANY
STATE UNIVERSITY, UTRECHT
NETHERLANDS

DIOECISM IN CITHAREXYLUM (VERBENACEAE): AN ADDENDUM

P. B. TOMLINSON

IN A RECENT ISSUE of this Journal (**53**: 386–389) dioecism in populations of *Citharexylum fruticosum* L. (Verbenaceae) native to South Florida was described (Tomlinson & Fawcett, 1972) with the implication that dioecism had not been recorded previously in the genus *Citharexylum* (= *Citharexylon*).

I am indebted to Dr. N. S. Troncoso, Instituto de Botánica Darwinion, San Isidro, Argentina, for drawing my attention to an earlier description of dioecism in this genus, in *C. montevidense* Spr. (= *C. barbinerve* Cham.) by Arechavaleta (1902). In this Argentinian-Uruguayan species, apart from the functional distinction whereby some plants set fruit and others do not, there are appreciable morphological differences between the inflorescences and flowers of male and female trees.

These observations supplement those made by Troncoso (1961a) on *Lippia* in which dioecism is recorded for several species. In the Verbenaceae, dioecism is now known for the genera *Aegiphila*, *Citharexylum*, and *Lippia* (Troncoso, 1961b).

LITERATURE CITED

ARECHAVALETA, J. 1902. *Citharexylon barbinerve* Cham. et Schlecht., tendencia hacia la unisexualidad de sus flores. Anal. Mus. Nac. Montevideo **4:** 149–152.

TOMLINSON, P. B. & FAWCETT, PRISCILLA. 1972. Dioecism in *Citharexylum* (Verbenaceae). Jour. Arnold Arb. **53:** 386–389.

TRONCOSO, NÉLIDA S. 1961a. Sobre dioecia en especies de *Lippia* (Verbenaceas). Bol. Soc. Argent. Bot. **9:** 181–185.

———. 1961b. Las "Lippia" (Verbenaceas) descritas del Paraguay por Robert Chodat y John Briquet. Darwiniana **12:** 256–292.

HARVARD UNIVERSITY
HARVARD FOREST
PETERSHAM, MASSACHUSETTS 01366

LAZELLA HARENBERG SCHWARTEN

New York, New York – December 8, 1900

Flemington, New Jersey – January 2, 1973

It is with great regret that we record the death of Mrs. Schwarten, Librarian of the Arnold Arboretum from 1944 to 1954 and of both the Arboretum and the Gray Herbarium from 1954 to 1967.

U. S. POSTAL SERVICE

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Act of August 12, 1970: Section 3685, Title 39, United States Code)

SEE INSTRUCTIONS ON PAGE 2 (REVERSE)

1. TITLE OF PUBLICATION
Journal of the Arnold Arboretum

2. DATE OF FILING
September 29, 1972

3. FREQUENCY OF ISSUE
Quarterly (January, April, July, October)

4. LOCATION OF KNOWN OFFICE OF PUBLICATION *(Street, city, county, state, ZIP code) (Not printers)*
22 Divinity ?Avenue, Cambridge, Massachusetts 02138

5. LOCATION OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS *(Not printers)*
22 Divinity Avenue, Cambridge, Massachusetts 02138

6. NAMES AND ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR

PUBLISHER *(Name and address)*
The Arnold Arboretum of Harvard University, 22 Divinity Avenue, Cambridge, Mass. 02138

EDITOR *(Name and address)*
Bernice G. Schubert, 22 Divinity Avenue, Cambridge, Massachusetts 02138

MANAGER EDITOR *(Name and address)*
Ellen Bernstein, 22 Divinity Avenue, Cambridge, Massachusetts 02138

7. OWNER *(If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given.)*

NAME	ADDRESS
The Arnold Arboretum of Harvard University	22 Divinity Ave., Cambridge, Mass. 02138

8. KNOWN BONDHOLDERS, MORTGAGEES, AND OTHER SECURITY HOLDERS OWNING OR HOLDING 1 PERCENT OR MORE OF TOTAL AMOUNT OF BONDS, MORTGAGES OR OTHER SECURITIES *(If there are none, so state)*

NAME	ADDRESS
The President and Fellows of Harvard University	Cambridge, Massachusetts 02138

9. FOR OPTIONAL COMPLETION BY PUBLISHERS MAILING AT THE REGULAR RATES (Section 132.121, Postal Service Manual)

39 U. S. C. 3626 provides in pertinent part: "No person who would have been entitled to mail matter under former section 4359 of this title shall mail such matter at the rates provided under this subsection unless he files annually with the Postal Service a written reques. for permission to mail matter at such rates."

In accordance with the provisions of this statute, I hereby request permission to mail the publication named in Item 1 at the reduced postage rates presently authorized by 39 U. S. C. 3626.

(Signature and title of editor, publisher, business manager, or owner)

10. FOR COMPLETION BY NONPROFIT ORGANIZATIONS AUTHORIZED TO MAIL AT SPECIAL RATES *(Section 132.122, Postal Manual)*

(Check one)

The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes

☒ Have not changed during preceding 12 months

☐ Have changed during preceding 12 months

(If changed, publisher must submit explanation of change with this statement.)

11. EXTENT AND NATURE OF CIRCULATION	AVERAGE NO. COPIES EACH ISSUE DURING PRECEDING 12 MONTHS	ACTUAL NUMBER OF COPIES OF SINGLE ISSUE PUBLISHED NEAREST TO FILING DATE
A. TOTAL NO. COPIES PRINTED *(Net Press Run)*	750	750
B. PAID CIRCULATION 1. SALES THROUGH DEALERS AND CARRIERS, STREET VENDORS AND COUNTER SALES	none	none
2. MAIL SUBSCRIPTIONS	463	492
C. TOTAL PAID CIRCULATION	620	629
D. FREE DISTRIBUTION BY MAIL, CARRIER OR OTHER MEANS 1. SAMPLES, COMPLIMENTARY, AND OTHER FREE COPIES	none	none
2. COPIES DISTRIBUTED TO NEWS AGENTS, BUT NOT SOLD	none	none
E. TOTAL DISTRIBUTION *(Sum of C and D)*	620	629
F. OFFICE USE, LEFT-OVER, UNACCOUNTED, SPOILED AFTER PRINTING	130	121
G. TOTAL *(Sum of E & F—should equal net press run shown in A)*	750	750

I certify that the statements made by me above are correct and complete.

(Signature of editor, publisher, business manager, or owner)

Bernice G. Schubert, Editor

PS Form 3526 July 1971

QK1
.H32

JOURNAL OF THE ARNOLD ARBORETUM

MAY 1 1973

GARDEN LIBRARY

Volume 54 HARVARD UNIVERSITY Number 2

S C3

Journal of the Arnold Arboretum

Published quarterly in January, April, July, and October by the Arnold Arboretum, Harvard University.

Subscription price $16.00 per year, beginning January, 1972.

Subscriptions and remittances should be sent to Ms. Ellen Bernstein, Arnold Arboretum, 22 Divinity Avenue, Cambridge, Massachusetts 02138, U.S.A.

Volumes I–XLV, reprinted, and some back numbers of volumes 46–50 are available from the Kraus Reprint Corporation, 16 East 46th Street, New York, New York 10017, U.S.A.

EDITORIAL STAFF

B. G. Schubert, Editor

C. E. Wood, Jr.

S. A. Spongberg

CIRCULATION

E. Bernstein

Printed at the Harvard University Printing Office, Boston, Massachusetts

---

COVER: *Ginkgo biloba* L., the maidenhair tree, so-called from the fancied resemblance of its leaves to those of the maidenhair fern. In China it has also been called the silver apricot, from the hard inner seed coat which is silvery when cleaned and vaguely resembles an apricot pit, and the duck-foot tree, from the resemblance of the leaves to the webbed feet of ducks.

The drawing for the cover and the devices for the back cover and reprints were planned and drawn by Karen Stoutsenberger Velmure from specimens taken from a tree cultivated in the Arnold Arboretum of Harvard University.

We want to assure the purists among our readers that our *Ginkgo* does not have leaves with open parallel venation. We think, however, that an exact reproduction of the dense dichotomous veins would have produced a much less dramatic design.

Second-class postage paid at Boston, Massachusetts

JOURNAL
OF THE
ARNOLD ARBORETUM

VOL. 54 APRIL 1973 NUMBER 2

LATEGLACIAL PLANTS AND PLANT COMMUNITIES IN NORTHWESTERN NEW YORK STATE[1]

NORTON G. MILLER

SOME OF THE MOST intriguing and best documented floras of former times are those which occurred in North Temperate regions just following disappearance of the Wisconsin ice sheet. In glaciated eastern and central North America plant communities that developed during the waning stages of glaciation are becoming increasingly better understood. At numerous sites in the southern portion of this region clear evidence of tundra vegetation is present in sediments deposited during and immediately following ice recession, and the fossil record shows that assemblages of tundra plants later gave way to forests rich in spruce. These developments occurred in what generally is termed lateglacial time which ends with the disappearance or decline of spruce, an event marked clearly in pollen diagrams from a wide area. Wright (1971) provides an up-to-date, regional review of the subject and of postglacial vegetation which replaced spruce and assemblages of other boreal plants.

Evidence for these changes has come mostly from pollen extracted from lake and bog sediments, although study of macroscopic plant remains, usually leaves, fruits, and seeds, has been employed to advantage also. Ideally the two methods should be combined when possible since data they

[1] This report grew from research originally summarized in a short chapter of a Ph.D. thesis submitted to Michigan State University. The remainder of the thesis is available elsewhere (Miller, 1973). Two of the pollen spectra were prepared at the Paleobotanical Laboratory of Harvard University, and I thank Dr. E. S. Barghoorn for permitting me to use this facility. I am grateful to Mr. Richard L. McCarthy, who first took me to the plant-bearing deposit, for much helpful information; to Dr. Howard Crum for assistance with certain bryophyte determinations and information on the North American ranges of some of the mosses treated here; to Dr. F. J. Hermann for determination of fruits of the Cyperaceae and Polygonaceae; to Mrs. Fay Kenoyer Daily for identifying oospores of members of the Charophyta; and to the USDA Forest Products Laboratory, Madison, Wisconsin, where the wood samples were identified. Miss Marion Seiler, Staff Artist and Photographer in the Department of Botany, University of North Carolina, Chapel Hill, expertly drew FIGURES 6h, 7a, 8, and 9, and inked my drawings of other mosses illustrated. The cost of publishing the figures has been met by a grant from the Smith Fund of the University of North Carolina at Chapel Hill and I am thankful for this support.

yield, while showing considerable agreement, may be supplemental as well. This is because more bulky parts of plants are usually not transported intact for great distances and thereby provide information on conditions at or close to the site of burial. In contrast pollen recovered from sediments may represent input from an area of substantial size and vegetational diversity.

In upstate New York lateglacial forest vegetation has been broadly characterized by Cox (1959) who studied pollen succession at many sites in the region. Detailed pollen diagrams also are available from several locations at the west end of the state (Miller, 1973), but megafossils have not been used to complement these studies. The present report describes the paleobotany and paleoecology of a lateglacial deposit in western New York. Included are pollen spectra and an account of abundant, well-preserved plant megafossils recovered from an organic bed. The megafossils comprise a fungus, oospores of four members of the Characeae, leafy gametophytes of thirty extant species of mosses, and represented by various kinds of remains, one vascular cryptogam, three conifers, and twenty-two flowering plants, nineteen of which have been identified to species. These data indicate the former presence of several distinct plant communities along the Lake Iroquois strand and suggest the likelihood of persistence of several of these plant assemblages at favorable sites in the region through postglacial time.

GEOLOGICAL SETTING AND HISTORY

The sediments described here are associated with Glacial Lake Iroquois which occupied the Lake Ontario basin (Karrow *et al.*, 1961) for about 2000 years between 12,600 and 10,500 years Before Present (B.P.). They are located in a gravel pit on the Leo S. Malloy property between Ewings Road and Eighteen Mile Creek, 4.5 miles north and a few degrees west of the center of the city of Lockport, Niagara County (43° 14′ 16″ N. Lat., 78° 42′ 30″ W. Long.). The organic bed originally was beneath about 3 meters of sand and gravel, but at the time samples were taken these sediments had been removed by quarrying. Richard L. McCarthy of Lockport, who made initial collections at the site, has obtained an age determination of 12,100 ± 100 B.P. (I-838, Buckley, *et al.*, 1968) on a piece of spruce wood from the bed.

I studied the pit three times between 1966 and 1969, and on my first visit (October 1966), the organic bed was just below the water table beneath about 5 cm. of clay and silt, the upper part of which was deposited out of a shallow pond that covers the bottom of the excavation during wet periods. The bed was sampled again in December, 1969, through the ice, and exploratory digging both times showed the organic deposit to be of limited extent. The principal constituent of the deposit is wood. Large fragments of branches, stems, and roots are intermingled with abundant smaller woody debris 1 cm. or less in length, and very

little inorganic sediment is intermixed. The larger pieces have rounded corners and show other evidence of water transport.

At 50 meters, N 20° W of the sampling point a residual "island" of sediment had been left in place when the surrounding sands and gravels were stripped away. According to McCarthy, sediments of similar lithology occurred above the organic bed. The section was measured (October 1966) as follows:

0– 15 cm.: soil, A zone;
15– 53 cm.: sandy loam, with cobbles, reddish;
53–100 cm.: sandy loam, yellowish;
100–104 cm.: pebble lens;
104–112 cm.: sandy loam, yellowish;
112–135 cm.: sand, fine to medium with dark stain;
135–174 cm.: sand, medium to coarse, carbonate cementation into stringers trending north-south;
174–198 cm.: gravel, with silt lenses, grading from light brown to reddish brown at base;
198–262 cm.: sand, fine to medium with pebbles and cobbles, yellow brown to olive;
262–277 cm.: sand, coarse, dark gray with yellow brown patches;
277–282 cm.: silty clay, pink;
282–295 cm.: sand, coarse, dark gray with yellow brown patches;
295–300 cm.: silty clay with coarse sand, pink;
300–306 cm.: sand, fine, dark gray;
306 cm.: water table;
306–311 cm.: silty clay;
311– cm.: sand, fine.
No organic layer was found at this point.

In April, 1968, a backhoe was being used to dig a small pit 350 meters north of the organic bed. The overlaying sand and gravels also had been removed from this new site. The excavation began in medium sand and proceeded downward through reddish brown, fine sand with silt and clay to a depth of 2.5 meters. A sample of the silty-clay sand, 1.8 meters below the surface, was collected for pollen analysis. The deposit of lacustrine sediment from which the sample was taken is probably the same as the fine sand beneath the organic bed.

It seems clear that the plant material was deposited after having been abraded in moving water, but how this relates to late Wisconsin geological history of the area is not precisely known. The age of the Lockport organic deposit corresponds closely to dated wood samples from Lake Iroquois sediments found at 340 feet Above Tide (A.T., i.e. elevation above sea level) near Lewiston in western Niagara County (see Karrow *et al.*, 1961). The Lockport deposit (FIGURE 1) is located 1.75 miles lakeward from the Iroquois beach, more or less equidistant between two strand extensions which course southward toward the city. The Iroquois beach is about 400 feet A.T. in this area and the deposit occurs 50 feet below this. In view of these facts, it is likely that the organic material was

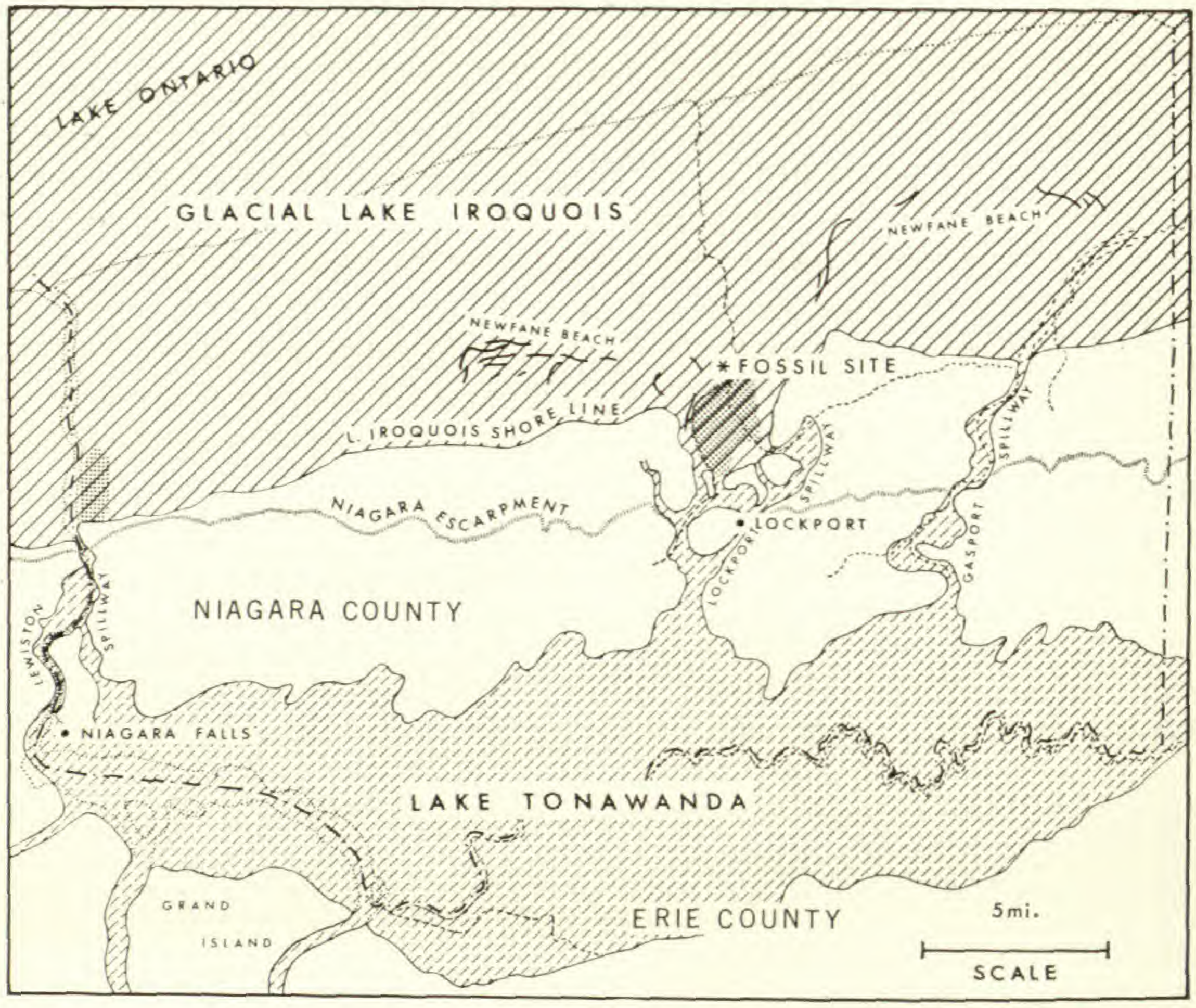


FIGURE 1. Northwestern New York during lateglacial time. Stippled areas north of Lewiston and Lockport spillways are deltas. (After Kindle & Taylor (1913) with modifications.)

deposited under comparable conditions at both sites. Events leading to the establishment of Glacial Lake Iroquois are fairly well known, and because of their importance to this study, they will be summarized briefly.

At the time of maximum southward extension of the Wisconsin ice sheet, the present basins of Lakes Erie and Ontario were deeply buried, but as the ice front retreated to the north, ice-dammed lakes of variable size and duration occupied first parts of the Erie basin, then the Ontario basin. While beach deposits record the presence of numerous lakes in the Erie basin, only one, Glacial Lake Iroquois, is prominently recorded in the Ontario basin. After establishment of glacial lakes Early Algonquin and Dana in the Erie basin (see Calkin, 1970), Lake Iroquois formed when waning Port Huron ice uncovered the Niagara escarpment thereby permitting separation of waters in the two basins. Further retreat was rapid and most of the Lake Ontario basin apparently was soon freed. However, because the St. Lawrence River valley remained clogged by ice, Lake Iroquois discharged near Rome, New York, via the Mohawk River valley to the Hudson River. It has been estimated (Karrow *et al.*, 1961) that Lake Ontario came into existence about 10,500 years ago

when ice withdrew to the north permitting final drainage of Glacial Lake Iroquois through the St. Lawrence Valley. Following initiation of Lake Iroquois, the continental ice sheet never again entered New York State.

During establishment of separate lakes in the Erie and Ontario basins, a shallow lake also formed in the broad basin between the Niagara and Onondaga escarpments. This body of water, Lake Tonawanda, as well as some of the Great Lakes, drained into Lake Iroquois through five spillways, three of which are shown in FIGURE 1. The two westernmost outlets, located near the present cities of Lockport and Lewiston, carried the most water and functioned the longest. The deposits treated in this report occur north of the Lockport spillway on the north edge of a delta formed during drainage of Lake Tonawanda.

A subaërial delta with shifting stream courses readily accounts for the burial of organic debris carried down the spillway or derived from near shore vegetation. It is likely that burial would have occurred in the early history of Lake Iroquois at a time when its shore was north of the main strand, perhaps building the weakly expressed Newfane beaches mapped by G. K. Gilbert and F. B. Taylor (in Kindle & Taylor, 1913). Subsequent isostatic uplift raised the lake surface to the level of the main beach, inundating and planing most of the delta and the Newfane beaches, both of which show evidence of this. It is also possible that the organic debris became buried along a shore line during adjustments in lake level, and that the gravel and sand above represent near-shore beach sediments. However, no evidence presently available indicates that early fluctuations in the level of Lake Iroquois were greatly separated in time from formation of the delta north of Lockport. Following either interpretation, the fine lacustrine sand collected north of the organic bed is somewhat older than the bed and sediment just beneath.

METHODS

The organic bed was sampled with a shovel, and two collections of plant material, totalling about 75 pounds wet weight, were obtained for laboratory analysis. As much as possible, the adhering silts and clays were cut from blocks of the organic layer before they were packed in plastic bags for carrying, and to avoid contamination all recent sediment was carefully removed. From the freshly broken face of a large block that included the organic bed and sediments beneath, two samples for pollen analysis were collected in December 1969. A sample of the bed is designated LS (Lockport site) 1, and a sample of gray, fine sand 2 centimeters beneath the bed is LS 2. A third sample analyzed for pollen came from the backhoe pit north of the organic bed. It was collected by a similar method and is LS 3.

After picking out all large pieces of wood, inorganic sediment was removed from chunks of the organic bed by washing it through an eight inch 1190 or 2000 μ mesh sieve into a bucket. The plant material retained by these sieves was stored in jars until studied microscopically. Small

seeds and fragments of plants that passed through the larger sieve or accidentally floated over its rim were concentrated by stirring the sediments and water in the bucket into a slurry, waiting a few seconds for some of the sand and silt to settle out, and pouring the watery mixture through a 177 or 210 μ mesh sieve. Small floating seeds and other fossils also became concentrated at the meniscus in the bucket of water from which they were easily removed.

Under a low magnification dissecting microscope, potentially identifiable megafossils were picked from the sieve residues and segregated into vials or jars by type. All mosses encountered were placed first in a common container, and later the entire collection was studied and identifications made. Comparisons with authenticated herbarium specimens were made routinely. Nearly all moss identifications were based on dissected fossil specimens, permanently mounted in Hoyer's solution (Anderson, 1954), and were checked against similarly prepared samples of recent collections. Line drawings were made using Wild dissecting or compound microscopes with drawing tubes or with an AO microprojector. Specimens of the plant fossils treated in this report are in the author's collection.

Pollen and spores in twenty-five to forty gram samples of sediment were concentrated following standard palynological procedures (Faegri & Iversen, 1964) involving treatments in 10 percent HCl, 72 percent HF, either $ZnCl_2$ or $ZnBr_2$ heavy liquid separation, 10 percent KOH, and acetolysis. A fine mesh screen was used to remove large organic debris from the sample of the organic bed. Residues were mounted in silicone oil from tertiary butyl alcohol (LS 3) or glycerine jelly (LS 1 and 2), and routine counting was done at a magnification of 250 diameters.

RESULTS

Pollen spectra. The three samples prepared for analysis had sufficient, well-preserved pollen to permit easy counting. The spectra are presented in FIGURE 2 in which the bars represent percentages calculated using the sum of arboreal (AP) and nonarboreal pollen (NAP), excluding that of aquatic species and spores of pteridophytes, as the percentage base. The AP + NAP total is greater than 325 in each of the three samples. Percentages of pollen types not included in FIGURE 2 are listed in TABLE 1. Pollen assemblages from comparable levels in the Houghton Bog (HB) and Protection Bog (PB) pollen profiles (Miller, 1973) have been included in FIGURE 2 and TABLE 1. These sites are about forty-five miles south of the Malloy gravel pit. A piece of wood from near the level of HB 2 has been radiocarbon dated at 11,880 $\pm$ 730 B.P. (I-3290), and thus compares well with the age of LS 1. At their respective sites HB and PB 2 are lower in the profile than HB and PB 1.

FIGURE 2. Pollen spectra from the Lockport site (LS), Houghton Bog (HB), and Protection Bog (PB). For pollen taxa in categories with asterisks, see TABLE 1.

POLLEN SPECTRA, w. NEW YORK STATE

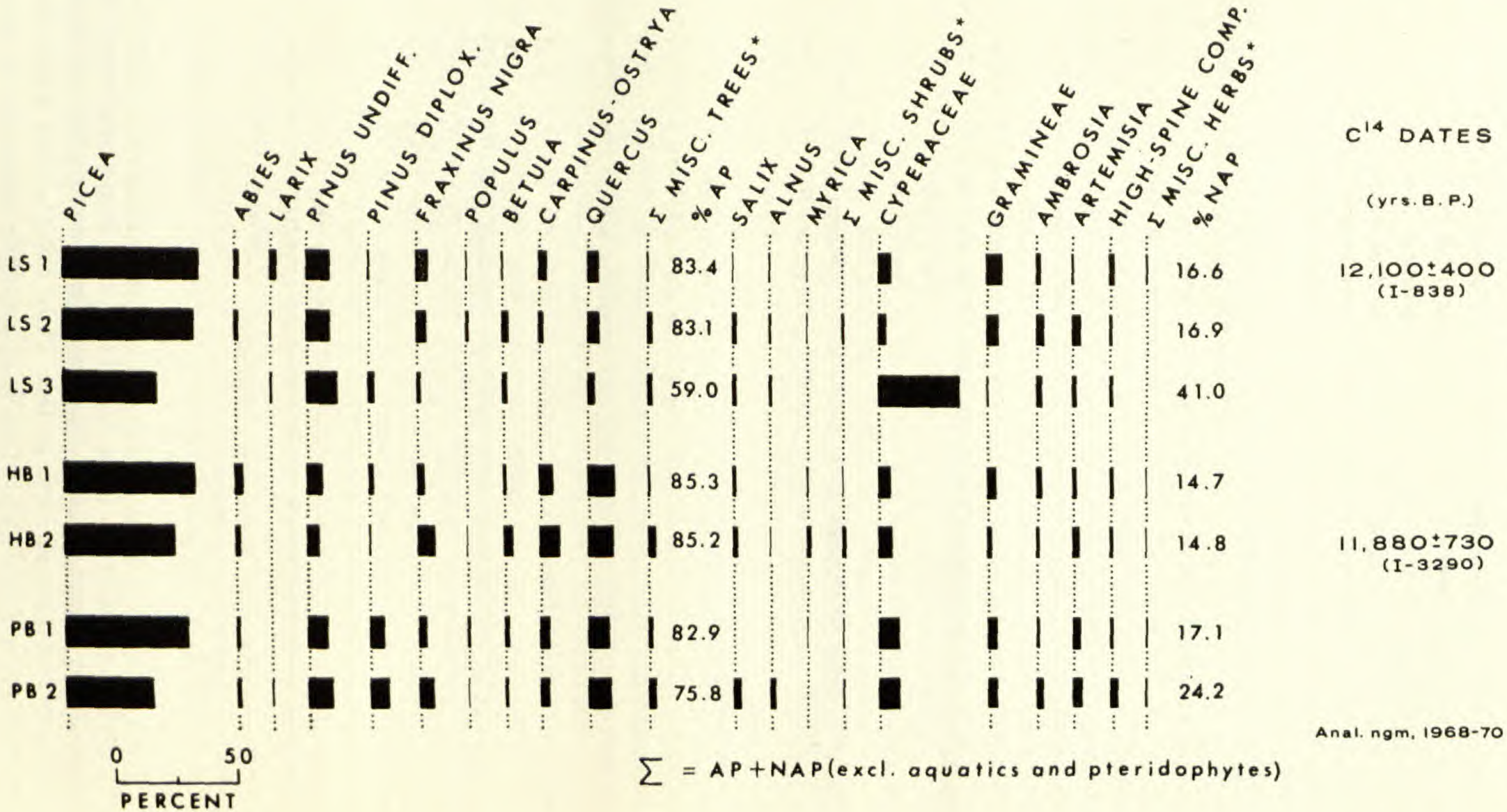


TABLE 1. **Percentages of pollen types not included in FIGURE 2.**

POLLEN TYPES INCLUDED IN SUM	LS 1	LS 2	LS 3	HB 1	HB 2	PB 1	PB 2
Pinus Strobus	—	—	—	—	—	—	0.8
Acer	—	—	0.3	0.2	0.6	—	0.9
Fagus	—	0.3	—	—	—	—	—
Tsuga	—	—	—	—	—	0.2	—
Ulmus	—	0.3	0.3	—	1.1	0.9	0.1
Platanus	—	—	—	—	—	0.2	—
Juglans	0.3	0.3	0.3	—	0.4	—	0.2
Carya	—	0.9	0.3	0.5	0.6	0.2	0.3
Corylus	0.3	0.6	—	0.2	1.1	0.2	0.4
Ericaceae	—	—	—	0.2	—	—	—
Nemopanthus	—	0.3	—	—	—	—	—
Thalictrum	—	—	—	—	—	0.2	0.1
Ranunculus	—	—	—	—	—	0.2	—
Urticaceae	0.3	—	—	—	—	—	—
Rumex	—	0.3	—	—	—	—	—
Cheno.-Am.	—	—	—	0.2	—	0.2	0.3
Caryophyllaceae	—	—	—	—	0.2	—	—
TYPES EXCLUDED FROM SUM							
Potamogeton	—	—	—	0.7	0.9	0.3	—
Typha	0.3	—	—	—	—	—	—
Sparganium	—	—	—	—	—	0.6	0.4
Myriophyllum	—	—	—	—	—	—	0.1
Utricularia	—	—	—	—	—	—	0.1
Polypodiaceae	0.8	1.6	1.5	0.7	0.9	0.4	1.4
Lycopodiaceae	0.3	0.3	—	0.2	—	0.3	0.1
Osmundaceae	—	—	—	0.1	—	—	—
Ophioglossaceae	—	—	—	—	—	0.1	0.2
Selaginella selaginoides	0.3	0.3	1.0	—	—	—	—
Sphagnum	—	—	0.3	—	—	—	0.1
Other bryophyte spores	1.1	—	—	—	—	—	0.2
Broken Abietineae	—	—	2.1	7.3	3.3	1.4	0.8
Unfamiliar*	0.8	0.5	—	0.8	0.7	—	0.2
Unknown**	3.6	9.6	6.0	5.2	6.1	1.4	4.8
Pediastrum	−***	−	+***	+	+	+	+
Pre-Pleistocene spores	+	+	+	−	−	−	+
Fungus spores	−	−	+	+	+	+	+

* Preservation good but identification not achieved.
** Preservation poor, identification impossible.
*** + = present, − = absent.

Pollen spectra from the Lockport site agree well among themselves and with pollen assemblages from Houghton and Protection bogs. All are dominated by spruce, contain significant amounts of pine, and have substantial percentages of herb pollen. Only LS 3 differs markedly from the usual amount of NAP, which in this sample comprises 41 percent of

the total, a difference due mainly to abundant sedge pollen. The presence of more temperate genera, such as oak (2.4, 4.2, and 4.8 percent in the Lockport samples, to 11 percent in HB 1), ash, and the ironwoods, may seem anomalous in an association dominated by spruce, but pollen of these types are regular components of lateglacial pollen assemblages in glaciated eastern North America. The variety of herb pollen in the spectra is fairly low and no tundra indicator types were found, although in each of the Lockport spectra, a few microspores of the predominantly boreal and subarctic *Selaginella selaginoides* are present.

Accepting 100 μ as the dividing point between the smaller pollen of black spruce and larger grains of white spruce, measurements of pollen length show that both *Picea glauca* and *P. mariana* occur in sediments at the Lockport site. Unfortunately their frequency could not be determined because too many broken and folded grains are present, although cones of both species were found in the organic bed and confirm the pollen data in a general way. Pine pollen encountered in the Lockport site samples was also scrutinized in an attempt to identify grains with a verrucose germinal furrow characteristic of *Pinus Strobus*. However, pollen with this morphology was not found, and in all intact, well-oriented grains examined more or less smooth furrows typical of *Pinus Banksiana* and *P. resinosa* (*Pinus* diplox. type in FIGURE 2) were seen. At sites in southwestern New York pollen of *P. Strobus* becomes abundant during the spruce decline.

Megafossils. The organic bed from which all plant fossils discussed in this section were isolated was of limited extent and variable thickness (1.5–15 cm.). Toward the edge of the deposit some sands and silts were intermixed with the organic debris, but mostly only reddish or brownish, unoxidized organic material was present, indicating that the water table had always been above the bed. Specimen preservation is good, although some material is abraded and some deformed due to compression by the overlying sands and gravels. In particular most of the larger pieces of wood were flattened to various degrees. However, compression was not great enough to make separation of the plant material difficult. In most cases, the fossils are not brittle or carbonized, and tissues are sufficiently firm to enable sections to be cut with ease. Specimens were stored and studied under water, or in 70 percent ethyl alcohol if fungi or bacteria appeared, because the fruits, seeds, and mosses in particular became extremely fragile upon drying.

FUNGI. Several isolated clusters of strongly branched, thick-walled hyphae bearing numerous brown, thicker-walled vesicles were found. The hyphae are sparsely septate, and incomplete internal constrictions block the interior of many filaments. In no instance were clusters embedded in or attached to plant tissues. The specimens are similar and possibly identical with what Rosendahl (1943) has named *Rhizophagites Butleri*. Vesicle size in specimens from the Lockport site is variable, but it falls

within the ranges given for *R. Butleri*, and clearly is larger than Rosendahl's second species, *R. minnesotensis*. Both are similar to extant mycorrhizal fungi of the genus *Rhizophagus* found in roots and root-like organs of a wide variety of cryptogamic and phanerogamic plants (Butler, 1939). Species of *Rhizophagus* are Zygomycetes. Specimens of *Rhizophagites* have been recovered from several Pleistocene deposits of different age in Minnesota and Alberta.

CHAROPHYTA. Brown or blackish charophyte oospores were fairly abundant in the organic bed. Many of these were isolated from among floating debris that accumulated at the meniscus, but some were also picked from the sieve residues. Specimens sent to Fay Kenoyer Daily were identified as the following four extant species: *Chara delicatula* Ag. emend A. Br., *C. sejuncta* A. Br., *Nitella flexilis* (L.) Ag., and *Tolypella glomerata* Desv. in Lois. (Daily, 1968; and *in litt.*, July 6, 1970). Germinated oospores of *Chara delicatula* showing primary rhizoids or slightly later stages are present; the other species are represented by oospores only.

Charophytes generally grow in shallow ponds, lakes, or sluggish streams with calcareous, sometimes brackish, waters. Except for species of *Nitella*, they rarely are found in acid waters. In New York State species of *Chara* occur infrequently at depths greater than 15 feet, although *Nitella* and *Tolypella* may grow deeper than this (Wood & Muenscher, 1956). Unless otherwise stated, the following comments are derived from Wood (1965). A highly tolerant species, *Chara delicatula* extends farther into high altitudes and polar latitudes than other Characeae. On the other hand, *C. sejuncta* is more southern in distribution, occurring from Massachusetts and the Great Lakes southward to Central America. It typically grows in aquatic habitats with mud or ooze bottoms (Daily, 1961). *Nitella flexilis* is the most common cold-tolerant species of the genus. Wood (1952) has reported on its presence in ponds with circumneutral to slightly acidic water near Woods Hole, Massachusetts. Of the four species at the Lockport site, the only one not recorded from New York State by Wood and Muenscher (1956), *Tolypella glomerata*, is now known to occur in North America from this state westward to Nebraska, Kansas, Arizona, and Saskatchewan. Because many charophytes are widely distributed and appear to have broad ecological tolerances, they have been little used in paleoecological studies.

MUSCI. About 250 ml. of thirty different mosses were obtained from the wet sieve residues. The completeness of specimens varied from stems with few leaves to plants equivalent to recently made herbarium collections. In spite of excellent preservation in nearly all cases, it is evident that some of the material had been abraded in moving water. Stems bearing torn or split leaves or leaf bases only indicate this, and in microscope preparations of some specimens, absent or thin outer walls of leaf cells show the effects of abrasion and perhaps bacterial decay at the cellular level. However, because mosses are fragile plants lacking the

abundant lignified tissues of tracheophytes, it is doubtful that they would remain intact through long distance water transport or if exposed to wave action for a lengthy period of time. Therefore, they are indicative of plant communities relatively close to the site of recovery.

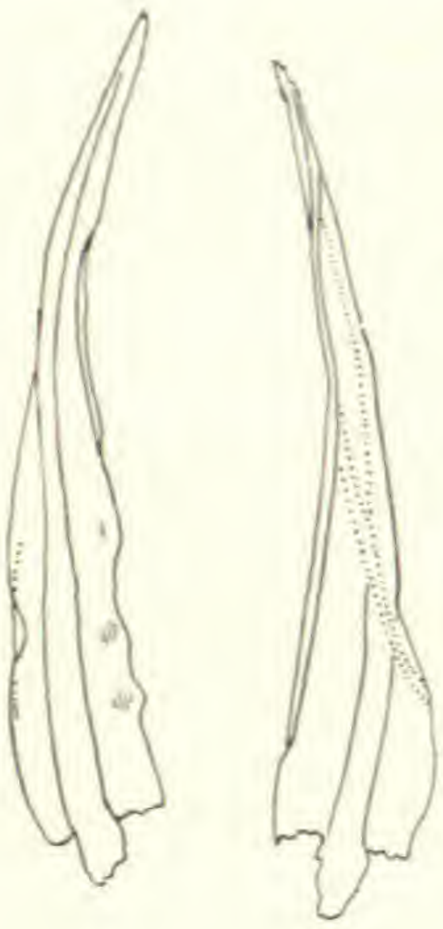
To determine the abundance of the various mosses represented in the organic bed, most of the collection was subdivided into units containing single species. Surprisingly, this was readily accomplished in spite of the small size of the fragments (average length ca. 1 cm.). Subtle differences in color (generally a shade of brown or blackish) or in texture helped in this task. The following terms, based on number of fragments identified, are used to indicate abundance of a particular species, RARE: five or less (actual number of specimens given); SPARSE: 6–10; RATHER ABUNDANT: 11–15; and ABUNDANT: 16 or greater. By this scale, twelve species were rare, three sparse, five rather abundant, and ten abundant.

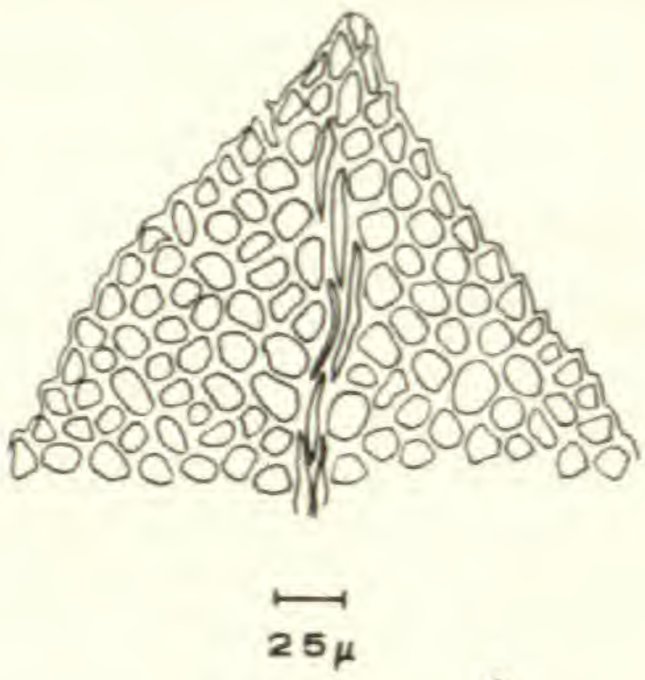
Sphagnum magellanicum Brid. — Rare; one short, leafy branch, probably from a capitulum. Cross sections of nearly dry leaves were made easily and showed included chlorophyllose cells characteristic of the species. A resorption furrow was also seen in some sections. In North America this is a widespread peat moss of acid habitats that extends across subarctic portions of the continent south to the Gulf of Mexico and California. Apparently no previous records from Pleistocene deposits in North America. FIGURE 3a.

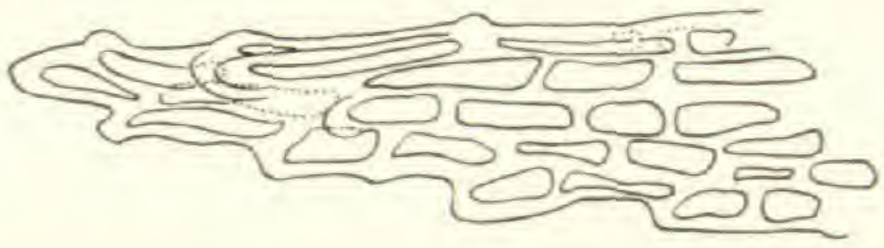
Fissidens osmundoides Hedw. — Rare; three fragments consisting of one isolated leaf and two nearly complete plants; critical leaf apices poorly preserved. This species was identified on the basis of the costa ending just below the apex of a leaf (FIGURES 3c, e). Its present range is circumboreal, and in North America it occurs from arctic (rare) and subarctic regions southward into the United States. No certain previous reports as a subfossil from North America. FIGURES 3b–e.

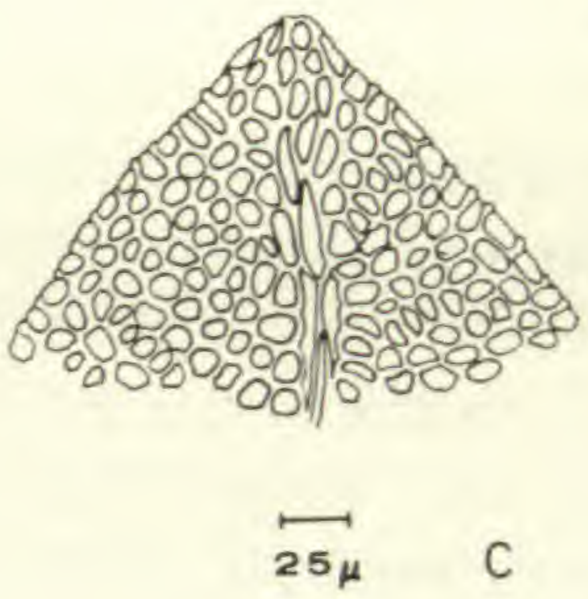
Ceratodon purpureus (Hedw.) Brid. — Abundant; blackish to dark brown, well-preserved leafy plants, one fragment with a cluster of archegonia. Leaves of subfossil specimens of this cosmopolitan, weedy species show the characteristic apical teeth (FIGURE 3g). Known otherwise in North America as a subfossil from a deposit of Pleistocene age in Minnesota (Rosendahl, 1948). FIGURES 3f, g.

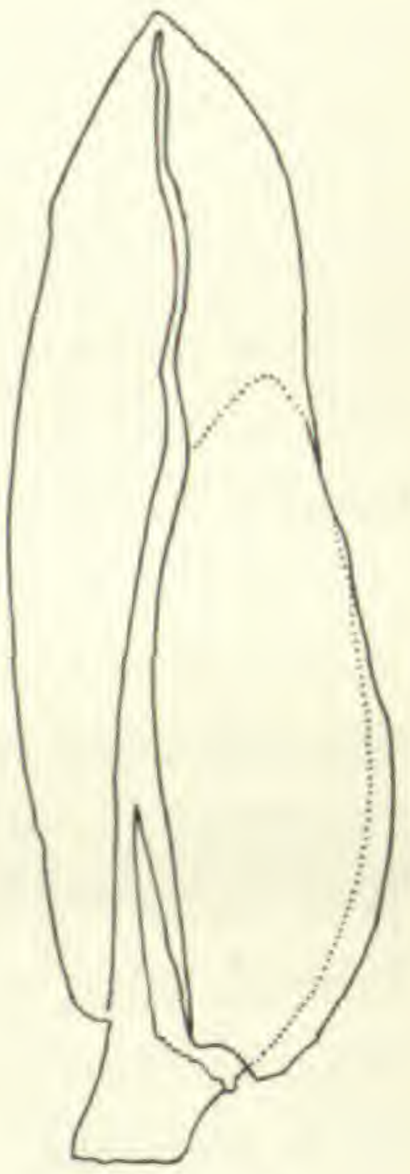
Distichium capillaceum (Hedw.) B.S.G. — Abundant; clumps of blackish, glossy plants held together by radicles and isolated, individual plants, one specimen with seta attached. Some of the material may be *D. inclinatum* (Hedw.) B.S.G., a species best distinguished from the former by the nature of the complete sporophyte, which is lacking in all specimens. Material from the Lockport site was named *D. capillaceum* on the basis of size and silkiness of the leafy plants. This is a widespread arctic-alpine species of calcareous habitats. It has been found in Pleisto-

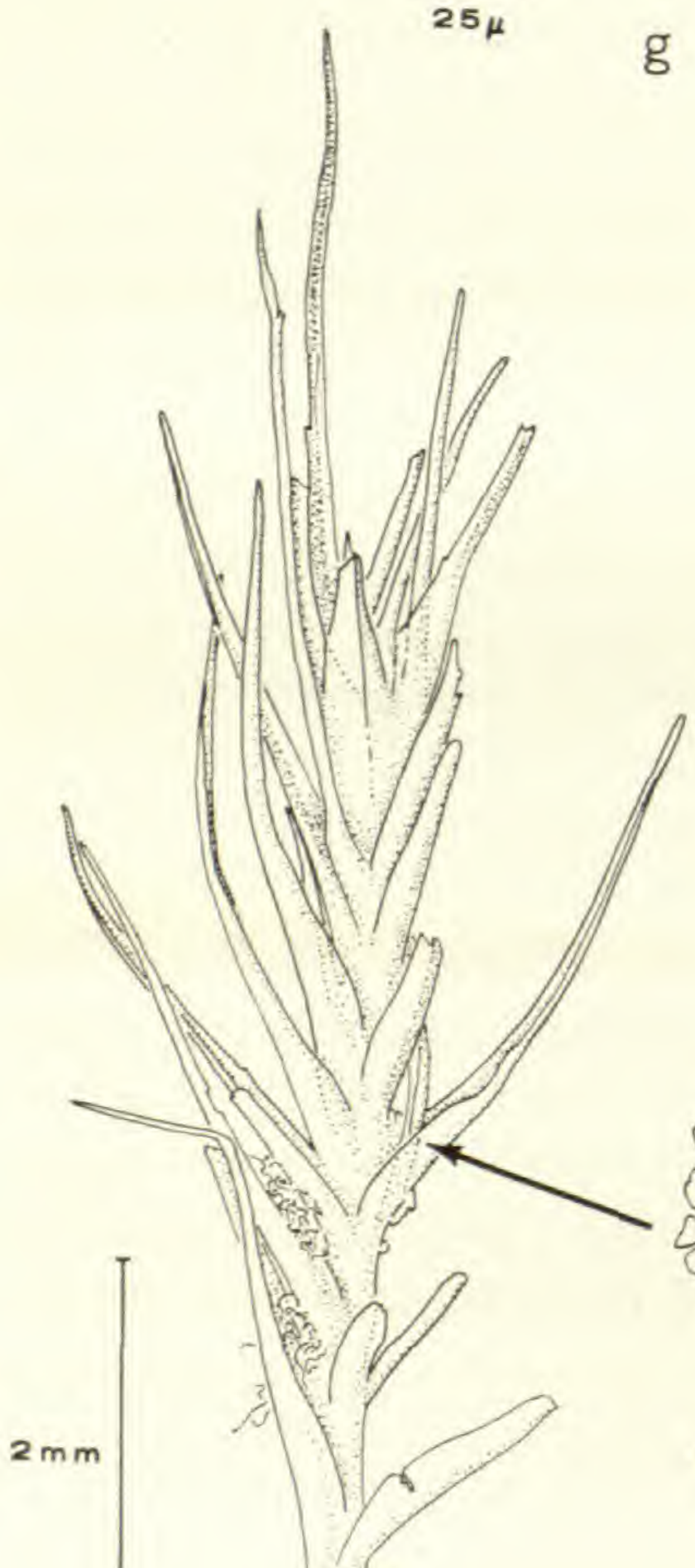












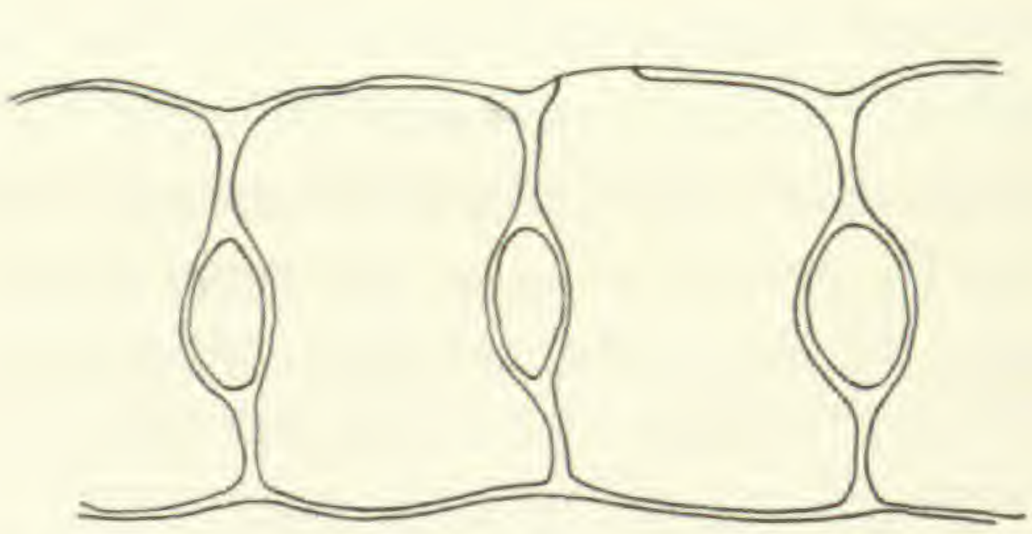


FIGURE 3. Subfossil mosses from Lockport site. a, Sphagnaceae, *Sphagnum magellanicum*; b–e, Fissidentaceae, *Fissidens osmundoides*, b, isolated leaf showing vaginant lamina, c, apex of leaf in b, d, portion of leafy gametophyte, e, apex of leaf at arrow in d; f–j, Ditrichaceae, f, g, *Ceratodon purpureus*, f, two

cene sediments in Ontario (Penhallow, 1896), Minnesota (Rosendahl, 1948), and possibly in Saskatchewan (as *Distichium* sp., De Vries & Bird, 1965). FIGURE 3h.

Ditrichum flexicaule (Schwaegr.) Hampe — Abundant; clumps and individual plants to 3 cm. tall. Steere (1947) considers this the most common of all alpine, arctic, and subarctic Bryophyta. In North America it is found across the northern portion of the continent south to New England, the Great Lakes area, and Colorado, but only recently reported from New York State (Orleans Co., Lyman & Coleman, 1966). As a subfossil, known from Michigan (Miller & Benninghoff, 1969), the Two Creeks forest bed in Wisconsin (Culberson, 1955), and Minnesota (Rosendahl, 1948). FIGURES 3i, j.

Dicranella Schreberiana (Hedw.) Schimp. — Sparse; represented by plants with strongly squarrose, toothed leaves that are sheathing at the base. This is an infrequent species found in North America at open places across southern Canada southward to the northern United States. Apparently unknown in North America as a subfossil. FIGURES 4a–c.

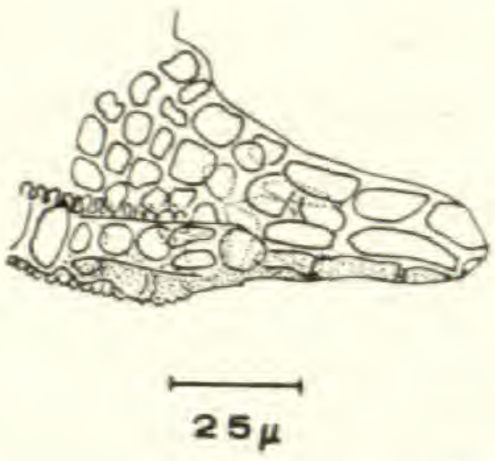
Dicranum fuscescens Turn. — Abundant; mostly blackish, radiculose plants, rarely clumped together. The leaves of fossil specimens are not crisped in wet specimens nor are the lamina undulate. Additional unrecognized species of *Dicranum* may occur in material segregated as this genus, but all specimens studied microscopically had at places along the leaf margin bistratose patches of cells characteristic of *D. fuscescens* (FIGURE 4e). This species is circumboreal in distribution and generally is found in forested areas. Evidently not reported before from North America as a subfossil. FIGURES 4d, e.

Bryoerythrophyllum recurvirostrum (Hedw.) Chen — Sparse; specimens reddish, in general poorly preserved, broken seta attached to one plant, archegonial cluster dissected free in another. Identification based on plants with strongly revolute leaves ending in a single, pointed smooth cell. Lower leaf cells of such plants are large, thin-walled, and epapillose; upper ones are smaller, thicker walled, and strongly papillose. A common moss across northern North America and the northern United States. Previously reported from a lateglacial deposit near Moose Jaw, Saskatchewan (De Vries & Bird, 1965). FIGURES 4f, g.

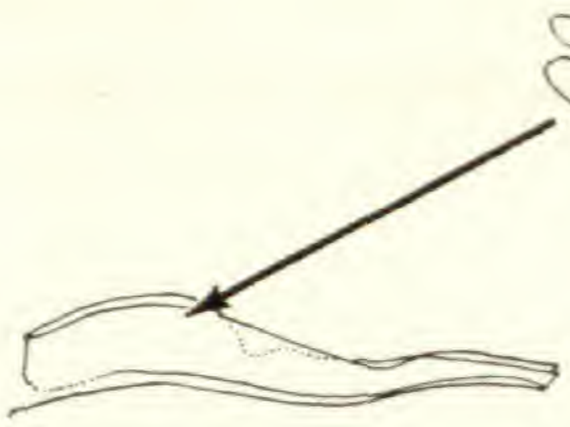
Tortella inclinata (Hedw. f.) Limpr. — Abundant; plants generally clumped and leaves broken or fragmented. Specimens named *Tortella* have leaves with plane margins, upper cells small and densely papillose,

---

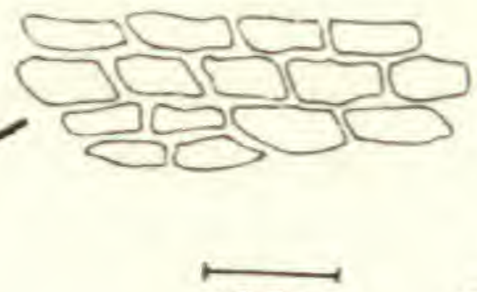
leaves from same stem, g, leaf apex showing teeth, h, *Distichium capillaceum*, leafy gametophyte with basal portion of seta attached, i, j, *Ditrichum flexicaule*, i, well-preserved leafy gametophyte, j, cell net in lamina of leaf at tip of arrow in i.



k

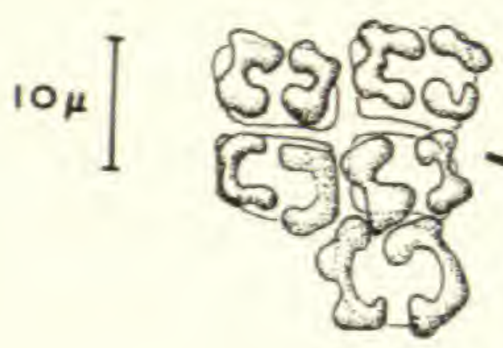


b

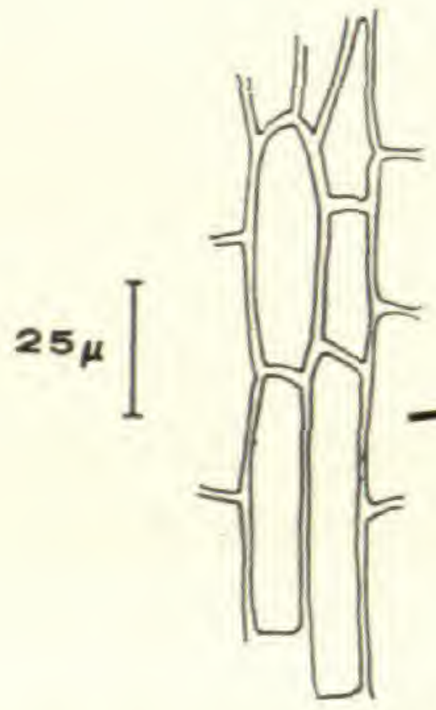


c

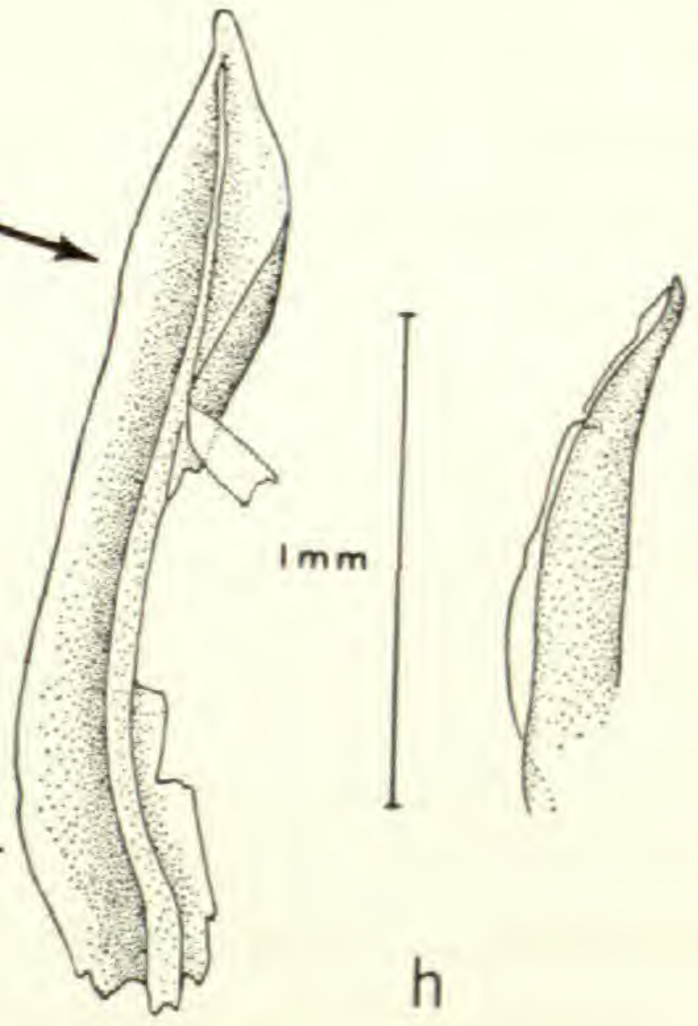
a



j



i

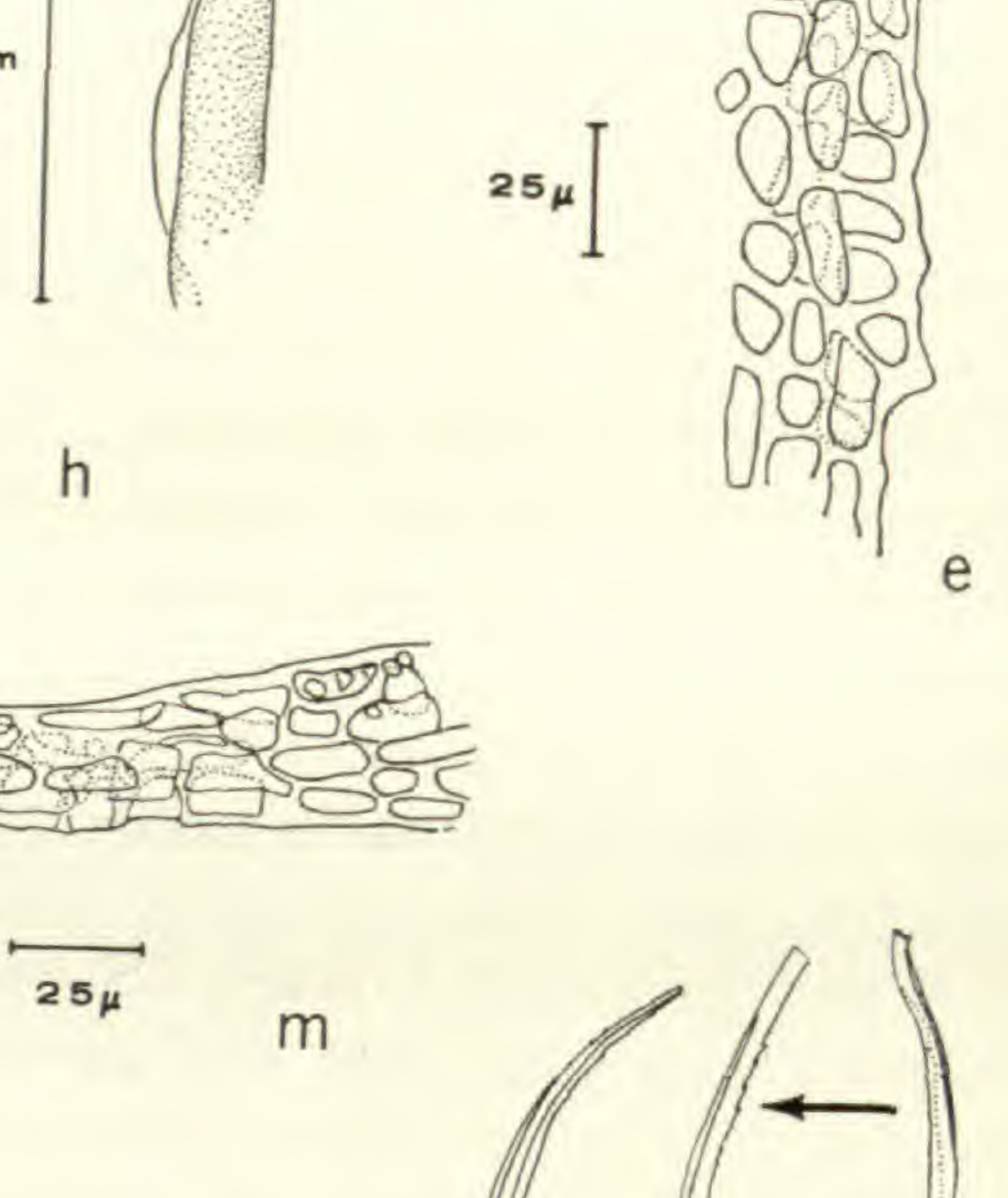


h

e

f

g



m

l

d

FIGURE 4. Subfossil mosses from Lockport site (cont.). a–e, Dicranaceae, a–c, *Dicranella Schreberiana*, a, leafy gametophyte, b, leaf from another plant, c, cell net at margin of leaf at arrow in b, d, e, *Dicranum fuscescens*, d, three leaves from same plant, e, cell net at margin of leaf at arrow in d; f–m, Pottiaceae, f,

and basal cells large and hyaline. Leaf laminae in some plants are mostly eroded away leaving only stems with the more resistant midribs attached. Cucullate leaf apices with the costa slightly excurrent are found in the fossil material identified as this species. At present in North America it occurs in southern Canada and the Great Lakes region; not reported from New York State (Ketchledge, 1957). Not known as a subfossil in North America. FIGURES 4h–k.

Tortella tortuosa (Hedw.) Limpr. — Rare; only one plant identified on the basis of long, narrow acuminate leaves that twisted when dried, although others may be present. A second *Tortella* with acuminate leaves, *T. fragilis*, may also occur. Specimens with broken leaf apices characteristic of this species were noted, but it is impossible to separate these from eroded and broken specimens that may be *T. tortuosa*. A widespread moss in boreal and temperate regions of North America, *T. tortuosa* has been found in the Two Creeks forest bed, Wisconsin (Culberson, 1955). FIGURES 4l, m.

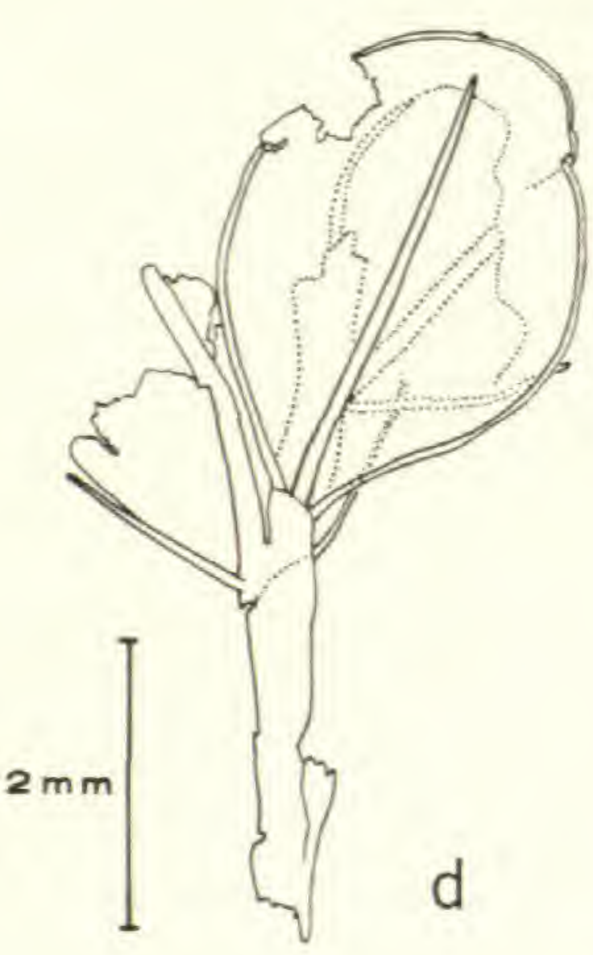
Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb. — Sparse; plants reddish brown, several with broken setae noted. Specimens identified had squarrose leaves with margins revolute nearly to the apex and the costa excurrent and toothed. Upper leaf cells are densely papillose, lower cells are mostly absent. At present a widespread moss in Canada and the northern United States. To my knowledge the only North American report of the species as a subfossil is from Bathurst Island in the Canadian High Arctic (Brassard & Steere, 1968). FIGURES 5a, b.

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb. — Abundant; leafy plants with the areolation of the Bryaceae were numerous and those with strongly decurrent leaves and percurrent to excurrent costas were referred to this species. Several plants with broken setae found. Although other species of *Bryum* may be represented, identification is not possible because of the absence of intact capsules with peristomes. A widespread, common species in boreal and arctic North America, extending southward into the northern United States. Reported previously from Pleistocene deposits in Michigan (Miller & Benninghoff, 1969), Wisconsin (Cheney, 1930), and Saskatchewan (De Vries & Bird, 1965). FIGURE 5c.

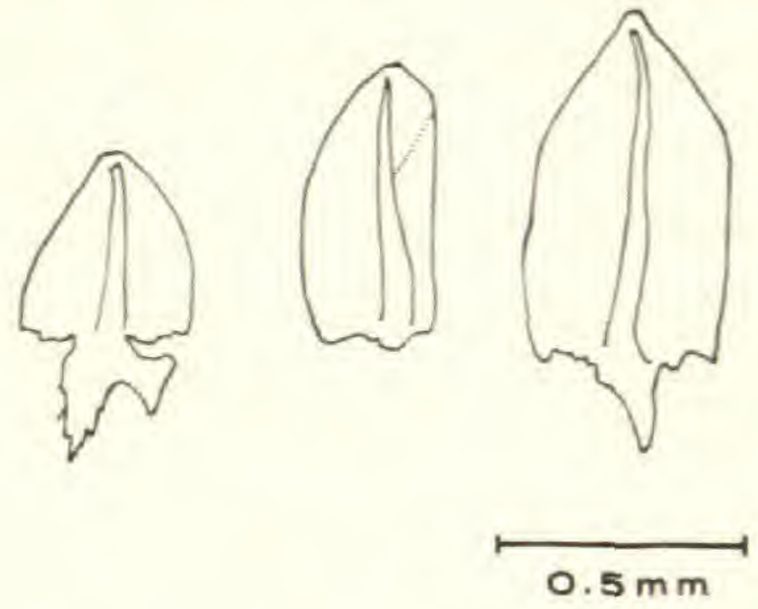
Mnium pseudopunctatum Bruch & Schimp. — Rare; one plant only. Identification based on shape of the leaves, the costa ending slightly be-

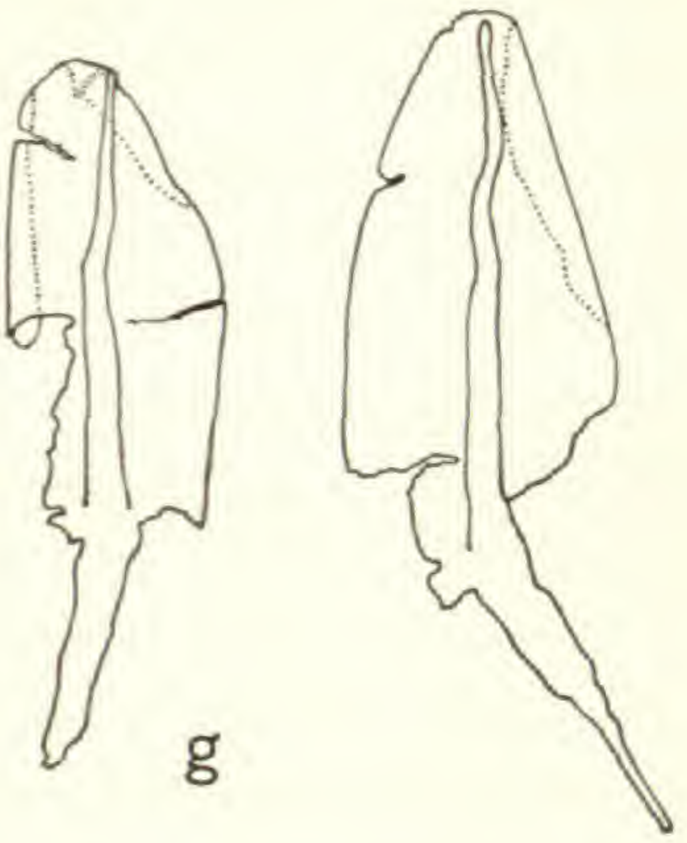
---

g, *Bryoerythrophyllum recurvirostrum*, f, leaf with strongly revolute margins, g, apex of young leaf from same plant leaf in g was taken, h–k, *Tortella inclinata*, h, two leaves from same plant, apices cupped, i, cell net near base of leaf at lower arrow in h, j, cell net near leaf apex at upper arrow in h, k, cell net at somewhat eroded apex of leaf, l, m, *T. tortuosa*, l, leaf, m, apex of another leaf from same plant.



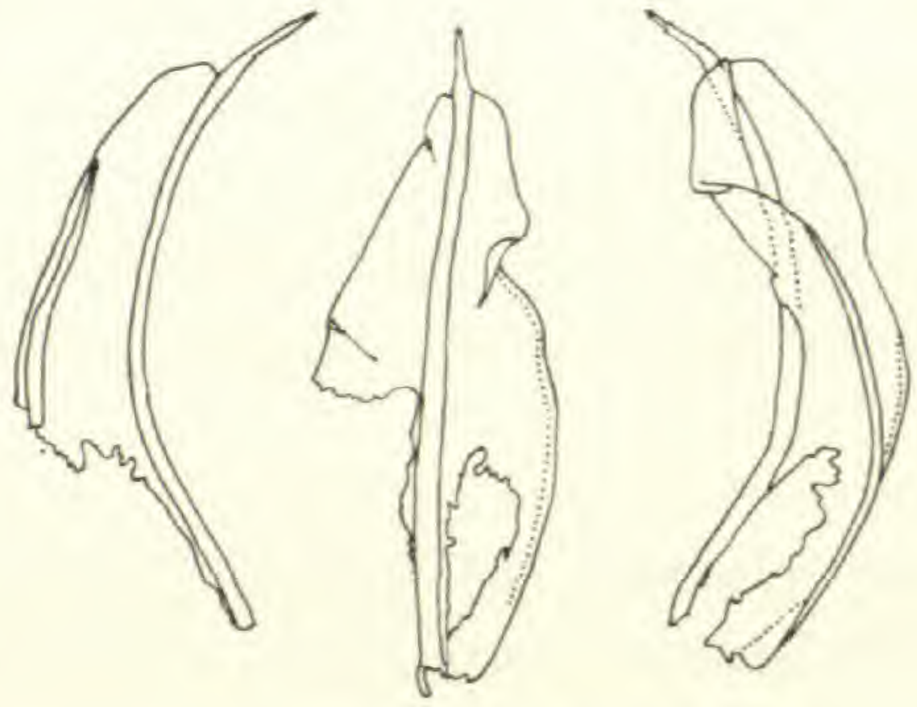
d





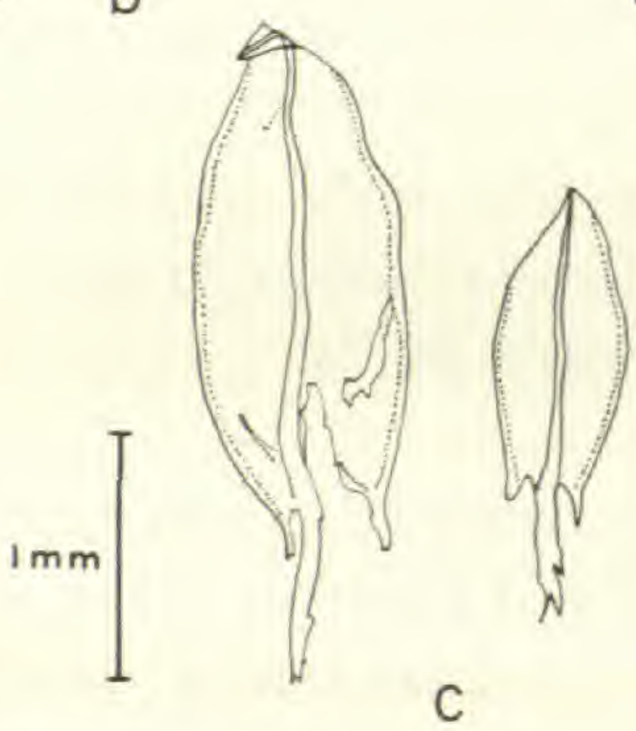
g

b

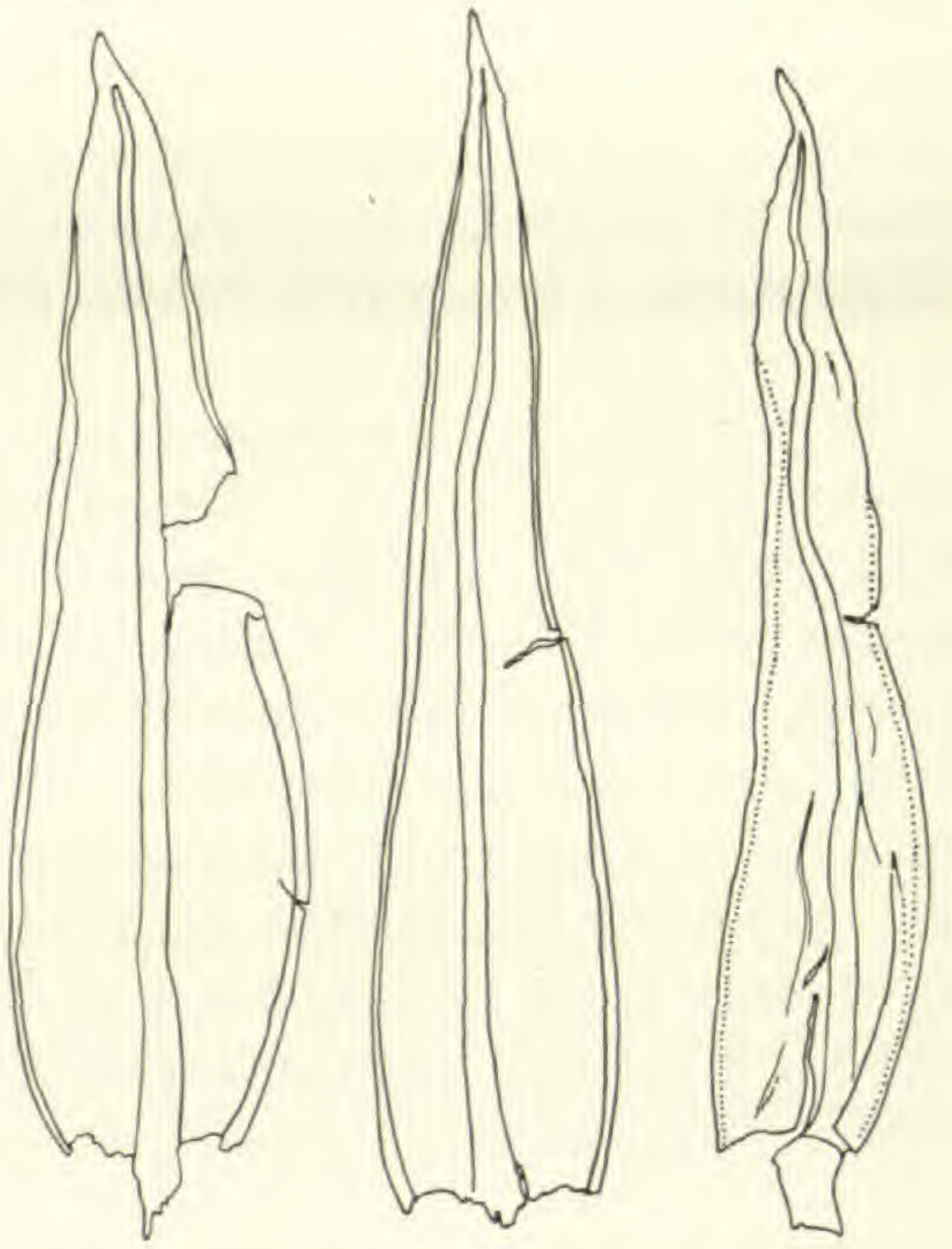


a

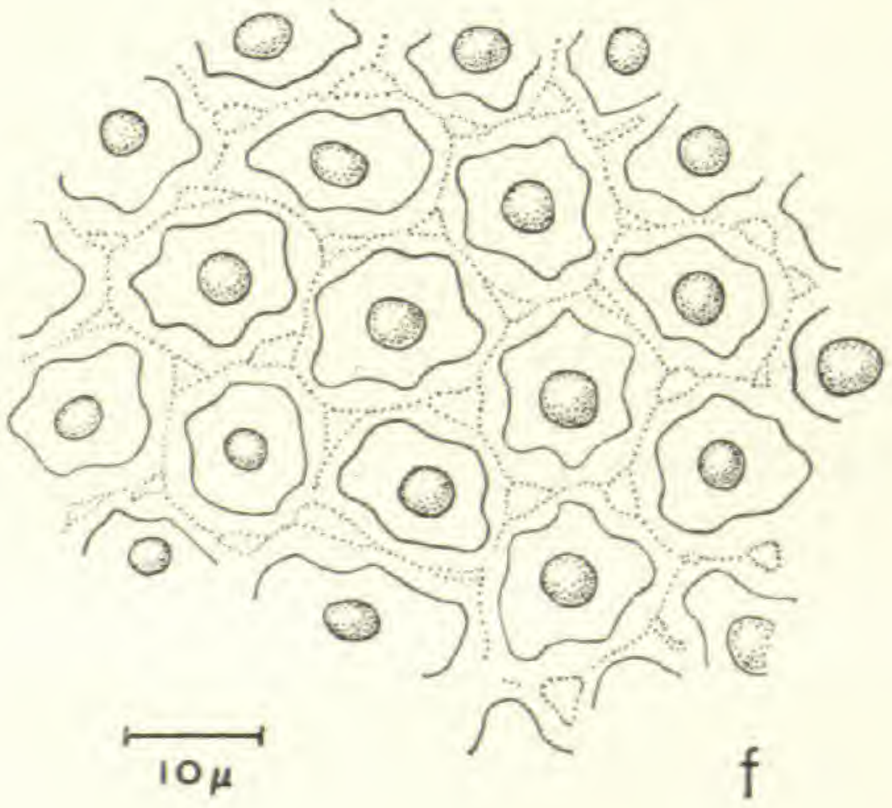
h



c



e



f

FIGURE 5. Subfossil mosses from Lockport site (cont.). a, b, Pottiaceae (concluded) a, b, *Tortula ruralis*, a, three leaves from same plant, large basal cells mostly lacking, b, cell net and papillae, abaxial leaf surface near apex; c, Bryaceae, *Bryum pseudotriquetrum*, two leaves from same plant showing basal decurrencies; d, Mniaceae, *Mnium pseudopunctatum*, part of leafy gametophyte; e–h, Aulacomniaceae, e, f, *Aulacomnium acuminatum*, e, three leaves from same

low the leaf apex, and the fact that this species is a calciphile as are most other mosses in the assemblage. Whether the specimen is synoicous, the condition in *M. pseudopunctatum*, or dioicous as in the closely related *M. punctatum*, which usually is not found in calcareous habitats, could not be determined. *Mnium pseudopunctatum* is a circumboreal species ranging southward in North America to the northern United States, but it has not been reported from New York State. To my knowledge, unknown as a subfossil in North America. FIGURE 5d.

Aulacomnium acuminatum (Lindb. & Arn.) Kindb. — Rather abundant; about fifteen stems with leaves more or less broken and eroded. This moss, one of a group of truly arctic Bryophyta (Steere, 1947), was identified on the basis of the leaves being revolute nearly to the acuminate apex and strongly incrassate leaf cells, each with a single large papilla. Its presence at the Lockport site is of considerable phytogeographic interest because currently this is a species almost entirely restricted to tundra communities. In North America it is known from Greenland (Holmen, 1957) and across the Canadian Arctic to Alaska (Steere, 1953). A remarkably disjunct station has recently been discovered near the north shore of Lake Superior (Williams, 1968), a region harboring an outlier of the arctic flora. Not known from New York State nor as a subfossil in North America. FIGURES 5e, f.

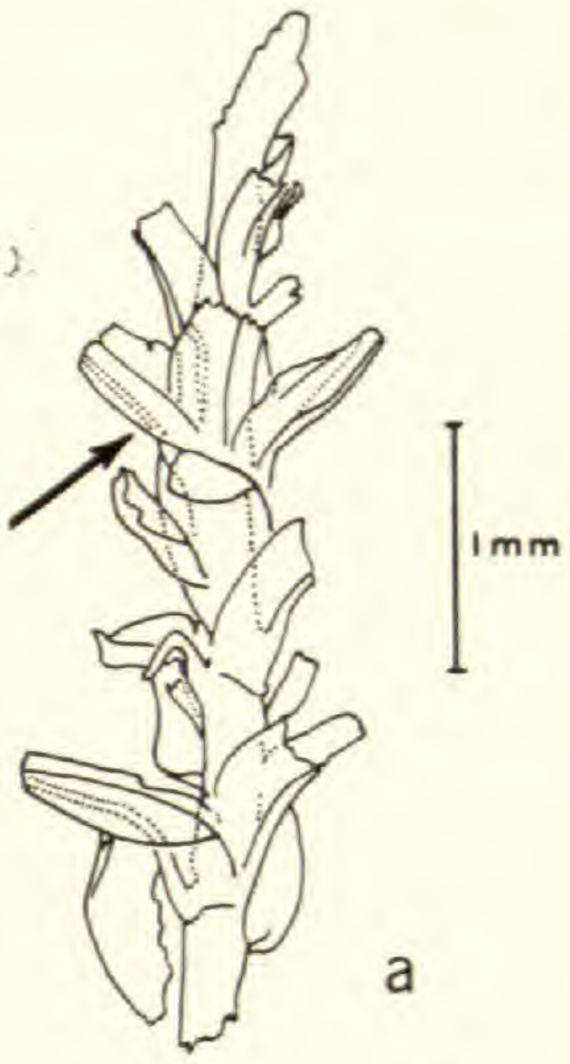
Aulacomnium palustre (Hedw.) Schwaegr. — Rare; one stem. Distinguished from the preceding species by scarcely bulging trigones, leaves mostly plane or revolute near the base only, and short acuminate leaf apices. A common moss on moist soil occurring across subarctic and boreal North America southward throughout most of the United States. Known previously from Pleistocene deposits in Minnesota (Rosendahl, 1948) and Iowa (Steere, 1941).

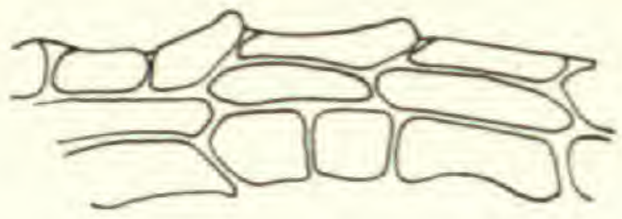
Aulacomnium turgidum (Wahlenb.) Schwaegr. — Rare; four incomplete leafy stems. Specimens referred here have short, wide leaves with broadly rounded apices and percurrent costas. In North America a wide ranging arctic, subarctic, and alpine species which Steere (1947) considers one of the most characteristic and common of all arctic mosses. In New York State known only from Mt. Marcy (*C. H. Peck s.n.*, NYS) and to my knowledge previously unreported from North America as a subfossil. FIGURES 5g, h.

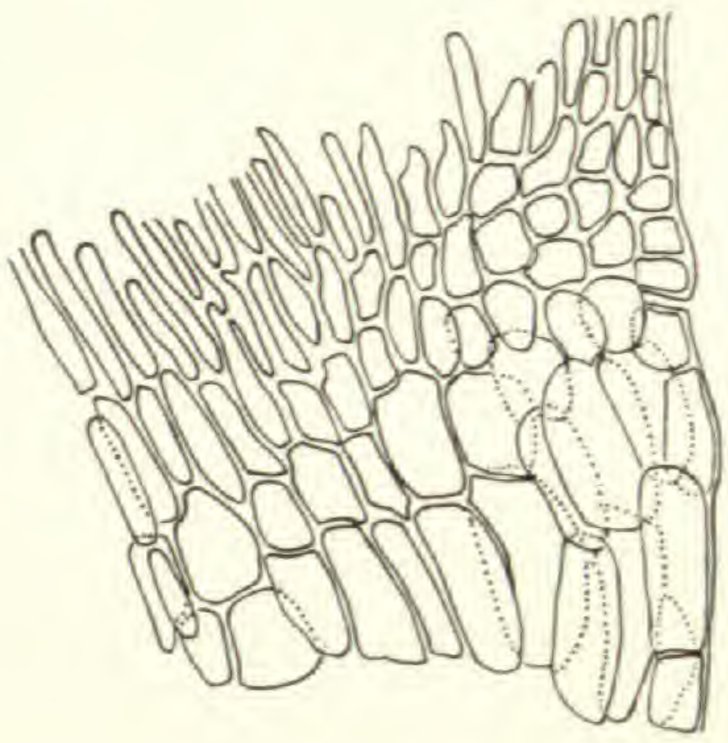
Meesia triquetra (Richt.) Aongstr. — Rare; only one plant, leaves torn and partly missing. The tristichous leaf arrangement is evident in the fossil specimen, and in one leaf a few of the characteristic marginal teeth are present, although they are eroded. A circumboreal species that in North America extends from arctic regions southward to New Jersey,

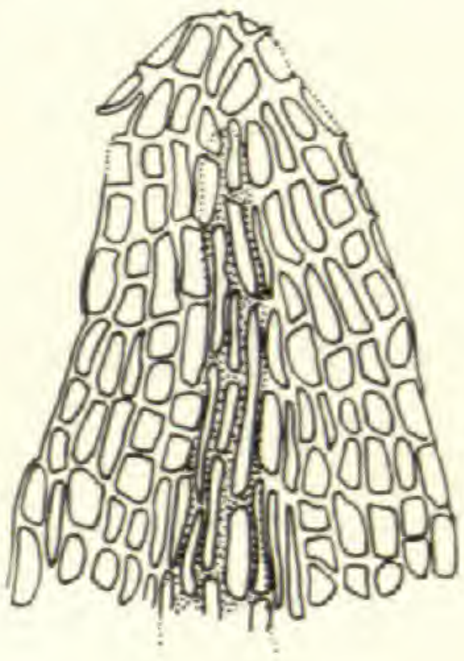
---

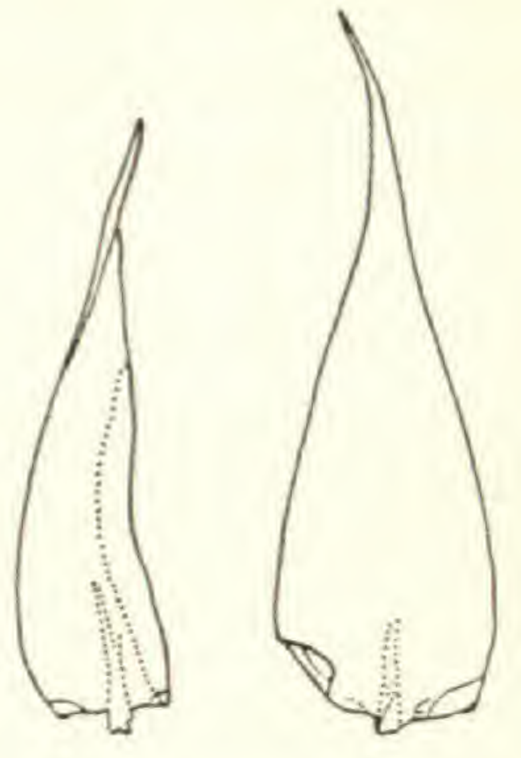
plant, f, cell net showing strongly incrassate cells and papillae, g, h, *A. turgidum*, g, five leaves from same plant, h, cell net showing papillose cells.

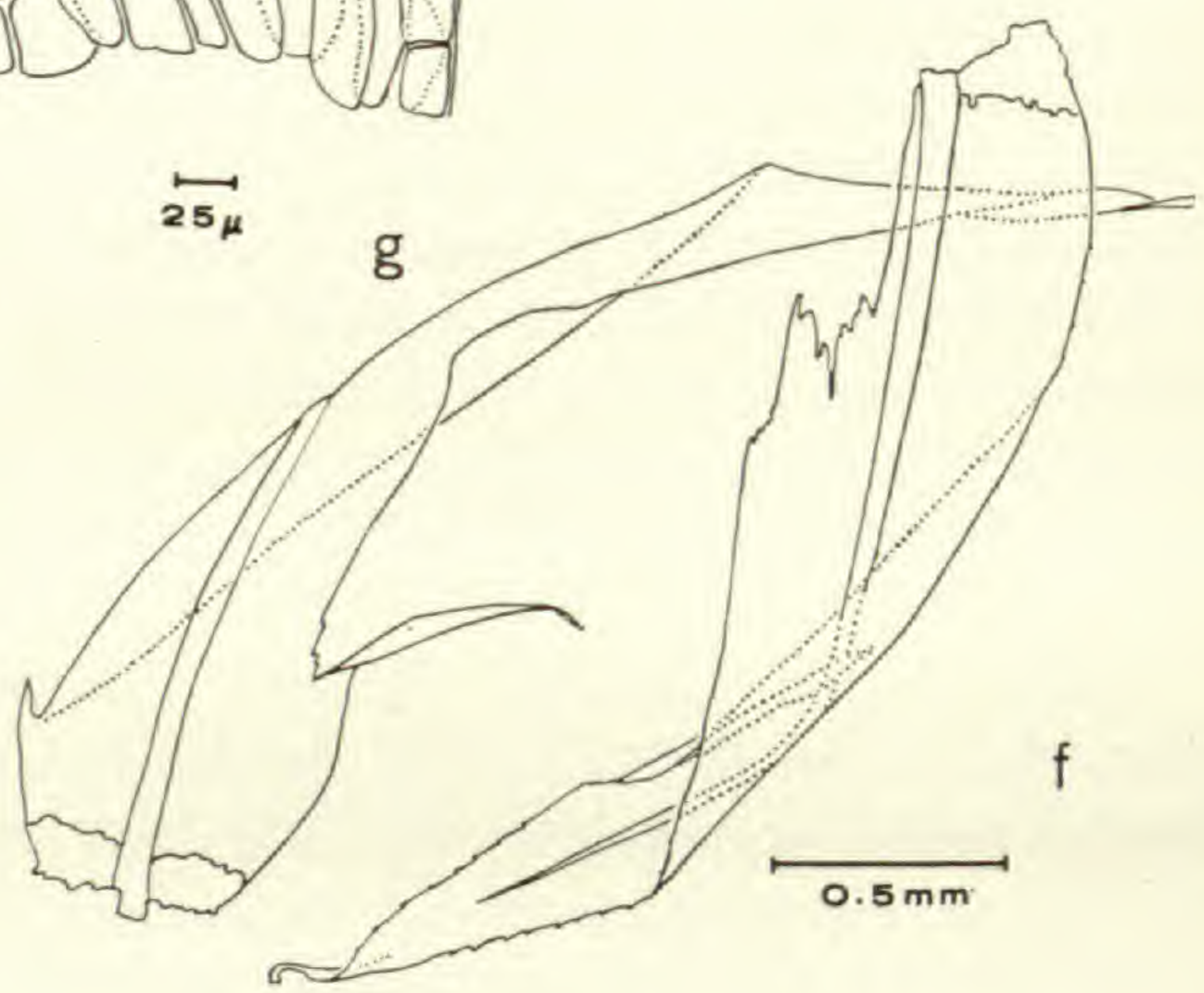












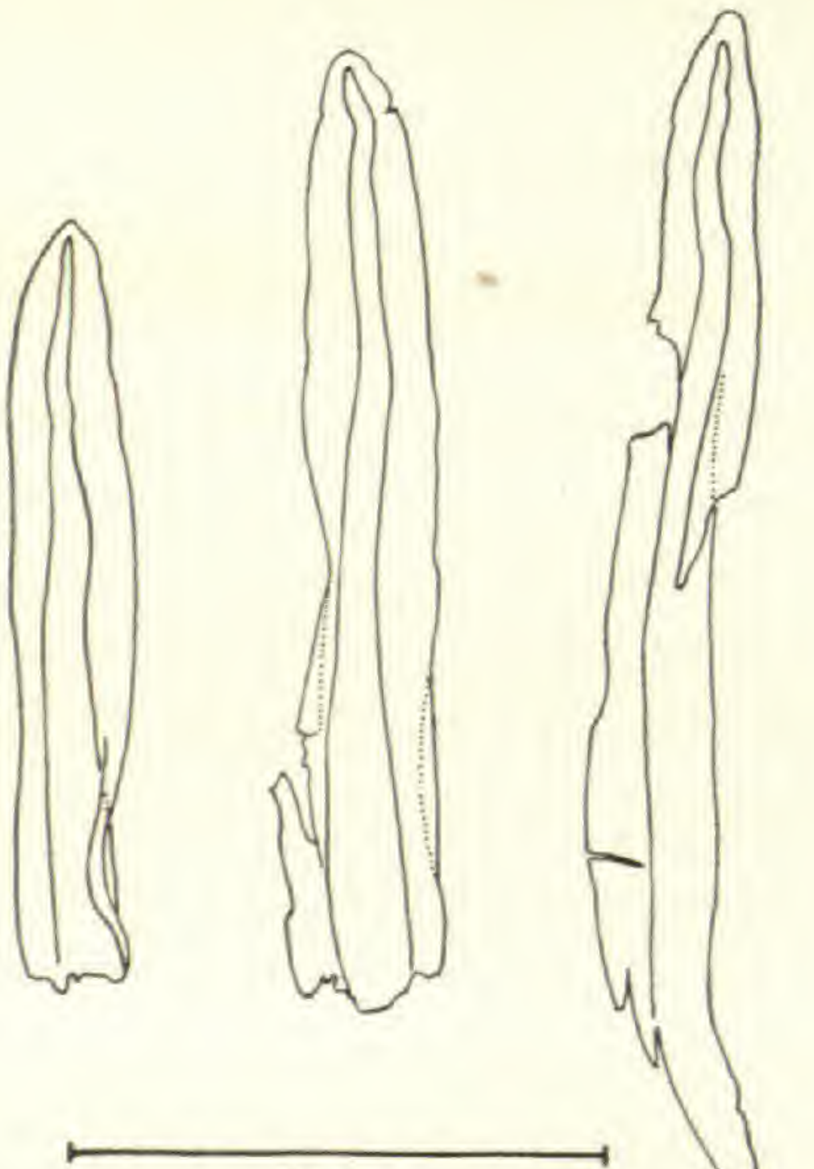


FIGURE 6. Subfossil mosses from Lockport site (cont.). a–d, Meesiaceae, a, b, *Meesia triquetra*, portion of leafy gametophyte, leaf apices mostly lacking, b, marginal cells of a leaf (at arrow in a) showing teeth, outer cell walls thin from abrasion and decay, c, d, *M. uliginosa*, c, three leaves from same plant, d,

the Great Lakes Region, and California. Apparently only one prior report as a subfossil in North America from undated peats, Bathurst Island, Canadian Arctic (Brassard & Steere, 1968). FIGURES 6a, b.

Meesia uliginosa Hedw. — Rather abundant; stems with linear-lingulate leaves in which the costa is broad and ends below a rounded apex. Range similar to the preceding species and also known previously in North America as a subfossil from Bathurst Island (Brassard & Steere, 1968). FIGURES 6c, d.

Abietinella abietina (Hedw.) Fleisch. — Rare; three specimens, one large leafy axis with side branches mostly broken off, the others small, apical fragments with few branches. The once-pinnate branching, unipapillose leaf cells, and paraphyllia are features used to identify the fossil material. This circumboreal moss occurs in North America from arctic regions southward to Virginia and Colorado in the mountains. As a subfossil, it has been found in Wisconsin (Culberson, 1955) and Saskatchewan (De Vries & Bird, 1965).

Campylium chrysophyllum (Brid.) J. Lange — Rare; one plant with several branches, identified on the basis of the more or less squarrose leaves with small groups of quadrate alar cells and the costa reaching to the middle of nearly all leaves. This, a more southern species than others present at the Lockport site, is found in eastern North America from southern Canada to Georgia and Texas. Apparently not previously reported as a subfossil from northern North American Pleistocene deposits.

Campylium stellatum (Hedw.) C. Jens. — Rather abundant; distinguished from the former species in the more strongly squarrose, long acuminate leaves generally lacking a costa (or if one is present, then short and double). Specimens were golden brown in color. A common calciphile, circumboreal in distribution, this moss occurs across northern Canada to Alaska and south to the northern United States. It has been reported from Pleistocene sediments in Michigan (Miller & Benninghoff, 1969; Stoutamire & Benninghoff, 1964), Wisconsin (Cheney, 1930), Minnesota (Rosendahl, 1948), and Iowa (Steere, 1941). FIGURE 6e.

Drepanocladus aduncus (Hedw.) Warnst. — Abundant; specimens with costate, more or less falcate-secund, entire leaves with conspicuous patches of inflated alar cells referred here. At present a widely distributed moss in North America, usually found in wet, often calcareous habitats. As a

---

leaf apex, midrib stippled; e–i, Amblystegiaceae, e, *Campylium stellatum*, two leaves from same plant, f, g, *Drepanocladus exannulatus*, f, two leaves from same plant, g, alar cells of another leaf, h, i, *Scorpidium turgescens*, h, portion of leafy gametophyte (specimen dried and rewetted to restore three dimensional form), i, leaf from another plant showing short, double costa.

subfossil, reported from Ontario (Coleman, 1895), Minnesota (Rosendahl, 1948), Saskatchewan (De Vries & Bird, 1965), and Iowa (Steere, 1941).

Drepanocladus exannulatus (B.S.G.) Warnst. — Rare; two fragments. Features used to distinguish this species include serrate leaves and inflated alar cells extending to the costa. Because of the small size of the fossil material, the pinnate branching seen in most recent specimens could not be established. Circumboreal in distribution; in North America found across northern Canada south to Pennsylvania and Colorado. Known from the Pleistocene of Iowa (Steere, 1941) and from postglacial moss peat at a site in the Yukon (Rampton, 1971). FIGURES 6f, g.

Drepanocladus fluitans (Hedw.) Warnst. — Rare; two branch fragments distinguished from other species of *Drepanocladus* in the deposit in having leaves weakly serrate at the base and groups of alar cells small and not clustered into prominent auricles. This is a common, nearly cosmopolitan aquatic or subaquatic moss occurring throughout Canada and the northern United States. It has been reported from Pleistocene sediments in Ontario (Penhallow, 1896), Ohio (Sears, 1967), Minnesota (Rosendahl, 1948), and Iowa (Steere, 1941).

Drepanocladus revolvens (Sw.) Warnst. — Rare; three fragments placed here on the basis of their long acuminate, strongly falcate-secund leaves that remained smooth or became only weakly striate when dried. Material possibly referable to var. *intermedius* (Lindb. ex C. J. Hartm.) Rich. & Wallace. Another circumboreal species that in North America extends from the arctic to the northern United States. Frequent as a subfossil in North America where reported from Bathurst Island (Brassard & Steere, 1968), Ontario (Penhallow, 1896), Pennsylvania (Schopf & Cross, 1947), Michigan (Miller & Benninghoff, 1969, as var. *intermedius*; Stoutamire & Benninghoff, 1964), Wisconsin (Cheney, 1930), Minnesota (Rosendahl, 1948), and Iowa (Steere, 1941).

Drepanocladus vernicosus (Lindb. ex C. Hartm.) Warnst. — Rather abundant; distinguished from the previous species on the basis of smaller size and less acuminate leaves. Distributed in North America about as *D. revolvens*. Known otherwise as a subfossil in this continent from Minnesota (Rosendahl, 1948).

Scorpidium turgescens (T. Jens.) Loeske — Abundant; numerous brownish leafy fragments to 2 cm. in length. If dried and rewetted, some specimens regain the turgid appearance of living plants. Leaves of fossil material are concave, the costa is generally short and double, and basal leaf cells are more or less quadrate and thick-walled. A circumpolar species; in North America ranging from arctic regions to the Great Lakes area where rare. Presently not known from New York State. Reports as a subfossil in North America from deposits in Michigan (Miller &

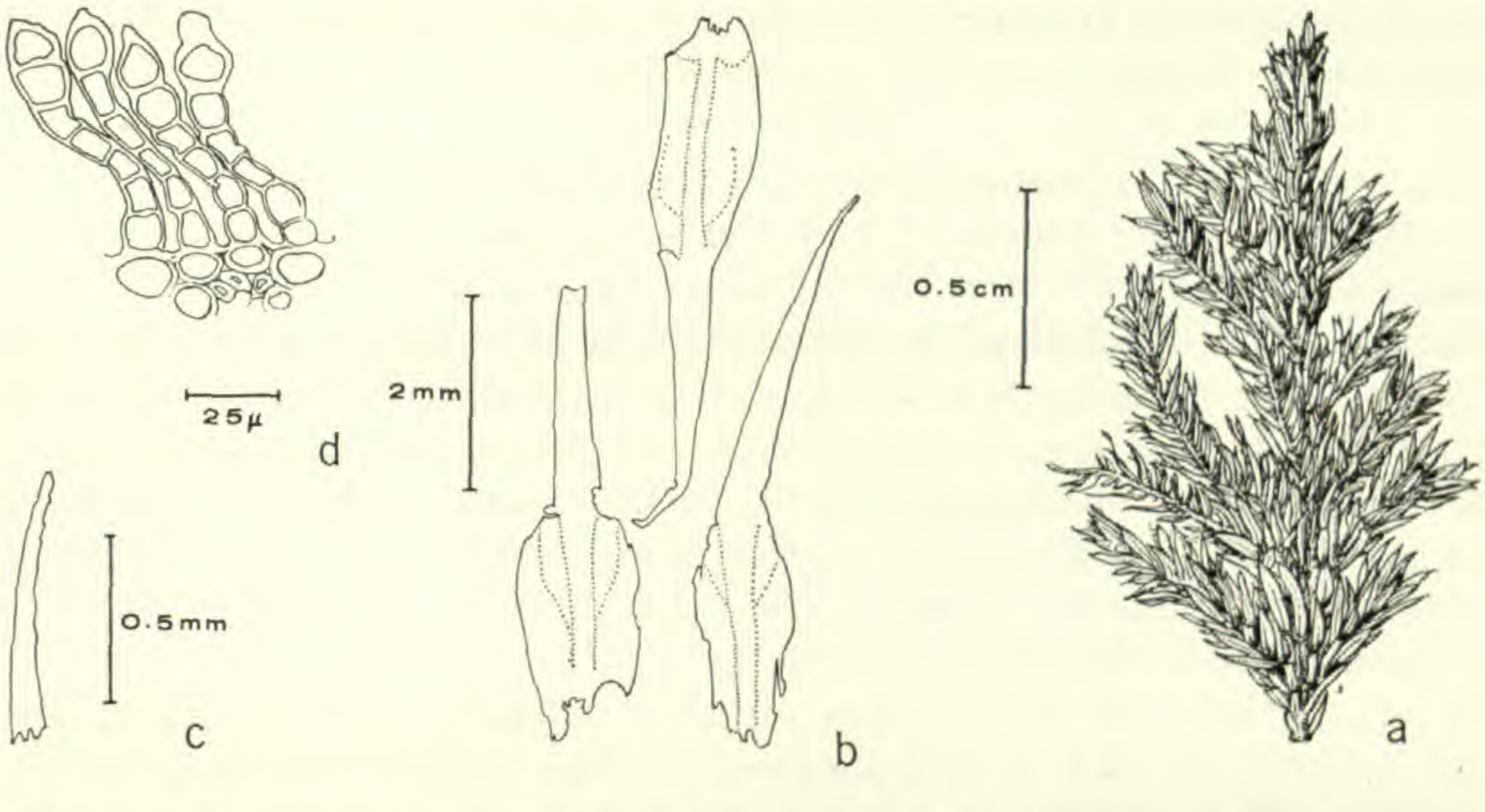


FIGURE 7. Subfossil mosses from Lockport site (concluded). a, Brachytheciaceae, *Tomenthypnum nitens*, apical region of a well-preserved leafy gametophyte; b–d, *Polytrichum juniperinum*, b, three leaves from same plant, c, apex of leaf at right showing teeth, d, four lamellae on abaxial leaf surface in cross-section.

Benninghoff, 1969), Wisconsin (Culberson, 1955), Minnesota (Rosendahl, 1948), and Iowa (Steere, 1941). FIGURES 6h, i.

Tomenthypnum nitens (Hedw.) Loeske — Abundant; large (to 2 cm.) and small fragments, pinnate branching frequent, leaves long-acuminate and deeply plicate. At present occurring in North America at calcareous places from arctic Canada and Alaska south to New Jersey and the Great Lakes region. Records of the species as a subfossil include reports from Bathurst Island (Brassard & Steere, 1968), New York (Muller, 1964), Wisconsin (Cheney, 1930), and Iowa (Steere, 1941). FIGURE 7a.

Hylocomium splendens (Hedw.) B.S.G. — Abundant; probably the most numerous moss in the deposit, represented by specimens ranging in size from nearly complete plants (proliferations poorly developed or broken off) to small fragments of branches with leaves, naked axes also present. Fossil material has black stems and branches, abruptly acuminate stem leaves with short double costas, and paraphyllia. Distributed from arctic North America southward to mountainous districts of North Carolina, Colorado, and California; otherwise circumboreal. North American records as a subfossil from Minnesota (Rosendahl, 1948), Saskatchewan (De Vries & Bird, 1965), and Iowa (Steere, 1941).

Polytrichum juniperinum Hedw. — Rather abundant; fragments of leafy plants and isolated leaves, blackish or red-brown in color. Identification based on entire leaf margins, toothed awns (teeth abraded), and pyriform terminal cells of the lamellae. A nearly cosmopolitan species, widely distributed in North America where previously reported from a

lateglacial deposit in eastern Massachusetts (Argus & Davis, 1962). FIGURES 7b–d.

TRACHEOPHYTA. Identifications of twenty-three species and three genera of vascular plants, represented in the organic bed by various kinds of megafossils, are treated in this section. Most diverse are seeds or seed-like fruits, but determinations are also based on cones, floral bracts, twigs with needles or buds, and wood. Much unidentified material including fragments of dicot and monocot leaves and stem or leaf bases of sedges or grasses occurs in the organic bed as well. At least five additional kinds of seeds or fruits are present, but they mostly were too abraded to permit positive identification. Apart from these, species of *Carex* other than those mentioned below are represented in the organic bed. According to Dr. F. J. Hermann, who studied all sedge fruits from the Lockport site, the unidentified part of the collection includes, "a few lenticular achenes which could represent any of hundreds of species between Sections Stellulatae, Ovales, Acutae, and others, and additional trigonous achenes of the Section Laxiflorae type, but possibly belonging to any of a score of other sections" (*in litt.*, Nov. 12, 1971).

In nearly all fruits that normally have thin outer layers (e.g., *Hippuris*, *Myriophyllum*, *Potamogeton*), these had been removed by abrasion or decay. Therefore, for comparative purposes specimens of recent collections were prepared by boiling fruits in 5 percent KOH for a few minutes, washing them in water, and peeling off the loosened outer tissue. A vouchered seed collection was used in making identifications also. Wood samples, about twenty-five in number and chosen at random from the organic bed, were sent to the USDA Forest Products Laboratory where all were identified as spruce (B. F. Kukachka *in litt.*, Sept. 30, 1971).

Based on habitat preference, the species identified may be divided into two groups: plants of aquatic or wetland sites and those generally found in drier, nonaquatic situations. These categories are broad and for some species not mutually exclusive. However, a classification of this kind is useful ecologically, and for that reason, species treated below are grouped accordingly. Using the abundance scale employed in the preceding section, thirteen of the species or genera represented in the organic bed are rare, two are sparse, two are rather abundant, and nine are abundant. Since only six of the species are not known to occur in western New York at the present time (Zenkert, 1934), detailed information on ranges is omitted except in these instances. *Gray's Manual of Botany* (Fernald, 1950) has been followed for nomenclature, for circumscription of the various taxa, and, in general, for ranges.

AQUATIC OR WETLAND SPECIES

Picea mariana (Mill.) BSP — Rather abundant; short, somewhat damaged cones bearing cone scales with erose margins, some winged spruce seeds probably belong here also. Growing on peat in kettle hole

bogs and occasionally in swamp or bog forests in western New York at the present time. A common component of the boreal forest, but in contrast to *P. glauca*, which also is represented in the organic bed, occurring mainly at wet sites.

Larix laricina (Du Roi) K. Koch — Rare; two incompletely winged seeds, the wing partly enclosing the seed. A characteristic tree of the boreal forest.

Typha sp. — Rare; three fruits. *Typha angustifolia* and *T. latifolia* apparently not distinguishable on the basis of fruit characters. However, a single tetrad of *T. latifolia* pollen was recovered from the organic bed, indicating the likelihood that the fruits are of this species. FIGURE 8a.

Sparganium sp.? — Rare; one fruit, calyx adherent. One of several possible species, all of which are rooted aquatics of shallow waters, shores, and wet peaty soils. FIGURE 8b.

Potamogeton alpinus Balbis — Abundant; endocarps of either var. *tenuifolius* (Raf.) Ogden or var. *subellipticus* (Fern.) Ogden, var. *alpinus* being considered European. Both varieties recognized in North America are inhabitants of calcareous waters. FIGURES 8c, d.

Potamogeton perfoliatus var. *bupleuroides* (Fern.) Farw. — Rare; three endocarps. This variety is found in calcareous or brackish waters. Endocarps of other species of *Potamogeton* may be present also. FIGURES 8e, f.

Zannichellia palustris var. *major* (Boenn.) W. D. J. Koch — Rare; three fruits. Distinguished from var. *palustris* by pedicellate fruits that are more or less dentate along the back. A true aquatic of coastal waters, occurring infrequently inland. FIGURE 8g.

Najas flexilis (Willd.) Rostk. & Schmidt — Sparse; five seeds. Another true aquatic. FIGURE 8h.

Eleocharis cf. *palustris* (L.) R. & S. — Abundant; yellow to dark brown achenes, somewhat variable in size and mostly with eroded tubercles referred here with some reservation because of the similarity of achenes of *E. Smallii* Britt. Actually both species may be represented. In *E. palustris* the tubercle is lanceolate or conic-ovoid, i.e., much higher than wide, whereas in *E. Smallii* tubercles are broader than long (cf. FIGURES 8i, j). Both occupy similar kinds of habitats — pond and stream margins, marshes, and sometimes deep water (particularly *E. palustris* var. *major*). *Eleocharis Smallii* is a species of eastern North America; *E. palustris* occurs in this region also but extends westward to Alaska and northern California. FIGURES 8i, j.

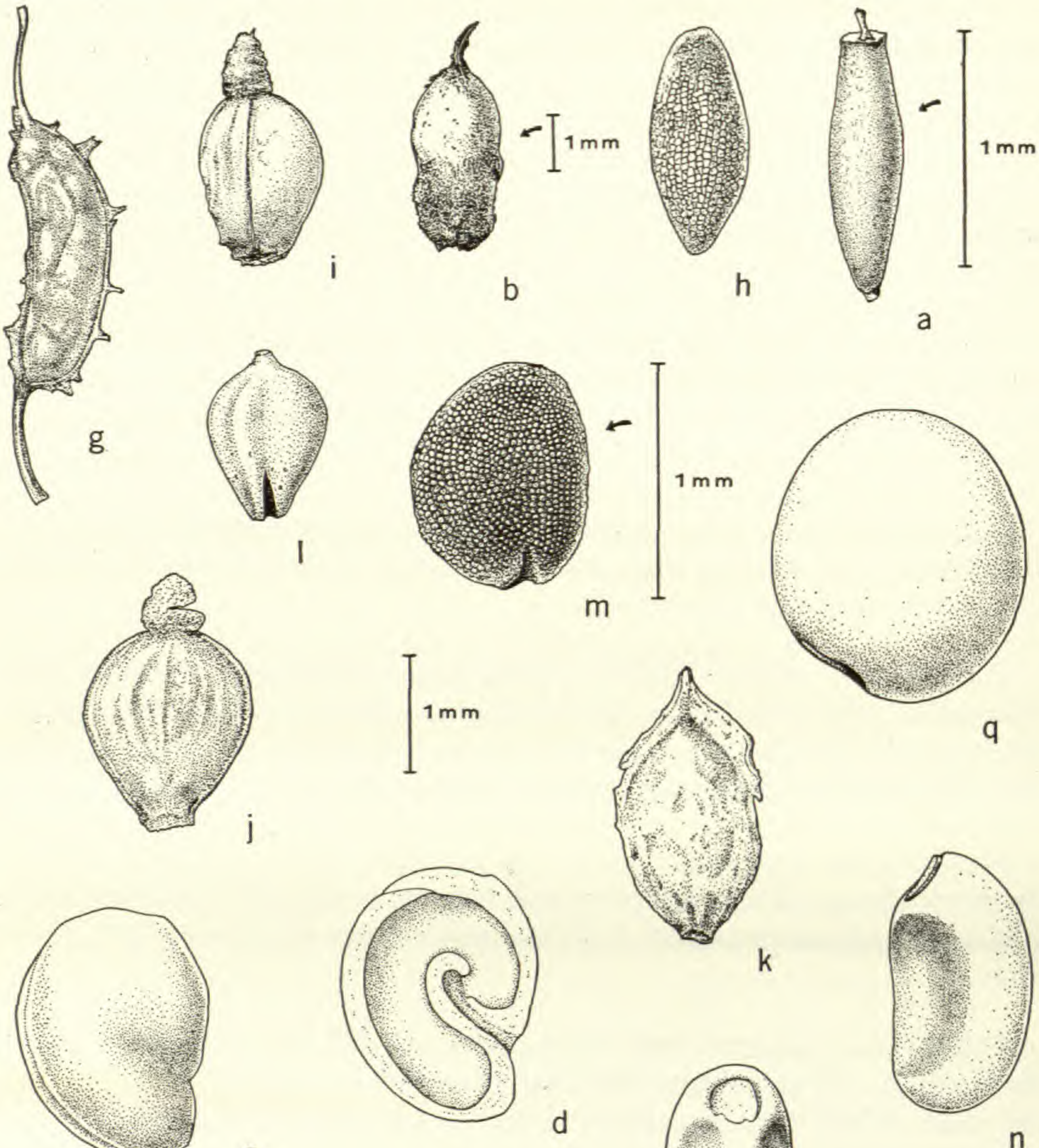


FIGURE 8. Fossil seeds and fruits of aquatic or wetland species found at Lockport site. a, fruit of *Typha* sp.; b, fruit of *Sparganium* sp.?; c, d, endocarp of *Potamogeton alpinus* var., d, same specimen in longitudinal section; e, f, endocarp of *Potamogeton perfoliatus* var. *bupleuroides*, f, same specimen in

Carex aquatilis Wahlenb. — Rare; two achenes with perigynia. Determined by F. J. Hermann who stressed that none of the species of *Carex* represented at the Lockport site can be considered named without question because too few characters are available upon which to base more certain identifications. This sedge is a plant of swales and pond margins in northern North America where southward it passes into var. *altior* (Rydb.) Fern. FIGURE 8k.

Carex viridula Michx. — Abundant; trigonous achenes, nearly half of all fruits of the Cyperaceae placed here. Usually a plant of marl bogs and wet calcareous gravels and shores. FIGURE 8l.

Rorippa islandica (Oeder) Borbás *s. lat.* — Rather abundant; seeds with cellular testa. It is impossible to refer the specimens to one of the three varieties recognized by Fernald (1950) because these are defined on vegetative and capsular features. FIGURE 8m.

Myriophyllum exalbescens Fern. — Rare; three fruits. An aquatic of deep to shallow, often calcareous waters. Pectinate bracts of flowering or fruiting plants, possibly of this species, were found also. FIGURES 8n, o.

Hippuris vulgaris L. — Abundant; fruits with calyx eroded away. Another true aquatic. Not known in western New York, although present in the central part of this state (Fernald, 1950). Rare or infrequent across northern New York (House, 1924). FIGURE 8p.

Menyanthes trifoliata var. *minor* Raf. — Abundant; smooth, black seeds with tough seed coats. A bog plant throughout New York (House, 1924), but northward found at a greater variety of wet or semi-wet habitats. FIGURE 8q.

NONAQUATIC SPECIES

Selaginella selaginoides (L.) Link — Abundant; megaspores, separated from those of *S. apoda* and *S. rupestris* on the nature of surface sculpturing as revealed by light microscopy and confirmed using a scanning electron microscope. Tetrads or single microspores occur in samples LS 1, LS 2, and LS 3. A calciphile not known in New York State but otherwise ranging from Labrador to Alaska and southward to northern Maine, the Bruce Peninsula (Ontario), northern Michigan and Minnesota, Colorado, and British Columbia.

---

longitudinal section; g, fruit of *Zannichellia palustris* var. *major*; h, seed of *Najas flexilis*; i, j, achenes of *Eleocharis* cf. *palustris*; k, fruit of *Carex aquatilis* with perigynium adherent; l, achene of *C. viridula*; m, seed of *Rorippa islandica*; n, o, somewhat abraded fruit of *Myriophyllum exalbescens*, two views of same fruit; p, fruit of *Hippuris vulgaris*; q, seed of *Menyanthes trifoliata*.

Picea glauca (Moench) Voss — Abundant; a single broken cone, isolated cone scales with entire edges and smooth umbos, glabrous twigs with and without needles, and, on the basis of size and shape, winged and nonwinged seeds. Most of the abundant wood in the organic bed probably belongs here or to *P. mariana*. Not presently a member of the flora of western New York, though found in the northern part of this state. A common boreal forest tree growing at more or less dry sites from Labrador to Alaska, south to the northern United States.

Carex lanuginosa Michx. — Rare; two trigonous achenes. A plant of meadows, swales, and wet shores, sometimes in calcareous areas. FIGURE 9a.

Carex Meadii Dew. — Rare; two achenes with adherent perigynia. A sedge found in meadows and depressions, primarily in eastern United States from Georgia to Texas, north to southern Ontario and Saskatchewan. Rare in western New York (one station only, Rumsey Woods, Erie Co., *F. W. Johnson s.n.*, fide records at New York State Museum). FIGURES 9b–d.

Carex cf. *Torreyi* Tuckerm. — Rare; one achene with perigynium. Not a member of the present flora of New York State. A western species growing in thickets and meadows from northern Alberta to Minnesota and South Dakota. FIGURE 9e.

Salix sp. — Sparse; twigs with buds covered by single scales.

Polygonum cf. *aviculare* L. *s. lat.* — Rare; two black, trigonous achenes. A widespread species of diverse habitats, var. *littorale* (Link) W. D. J. Koch ranging from Newfoundland to Alaska.

Potentilla anserina L. — Abundant; the most numerous seed-like fruit in the organic bed. Grows on calcareous sands and gravels usually along streams and lakes. FIGURES 9f–h.

Potentilla norvegica L. *s. lat.* — Rare; a single achene. Which variety of this wide ranging species is represented cannot be determined without the parent plant. FIGURE 9i.

Viola cf. *palustris* L. — Abundant; intact and broken seeds. The determination is fairly certain but cannot be positive because seeds of some violets of northeastern North America, e.g., *V. nephrophylla*, are very similar in size and shape. *Viola palustris* is an arctic-alpine plant of damp to wet sites, often near open water. Although not found in New York State, it reaches northern New England. FIGURE 9j.

Arctostaphylos Uva-ursi (L.) Spreng. — Rare; a single nutlet. Identi-

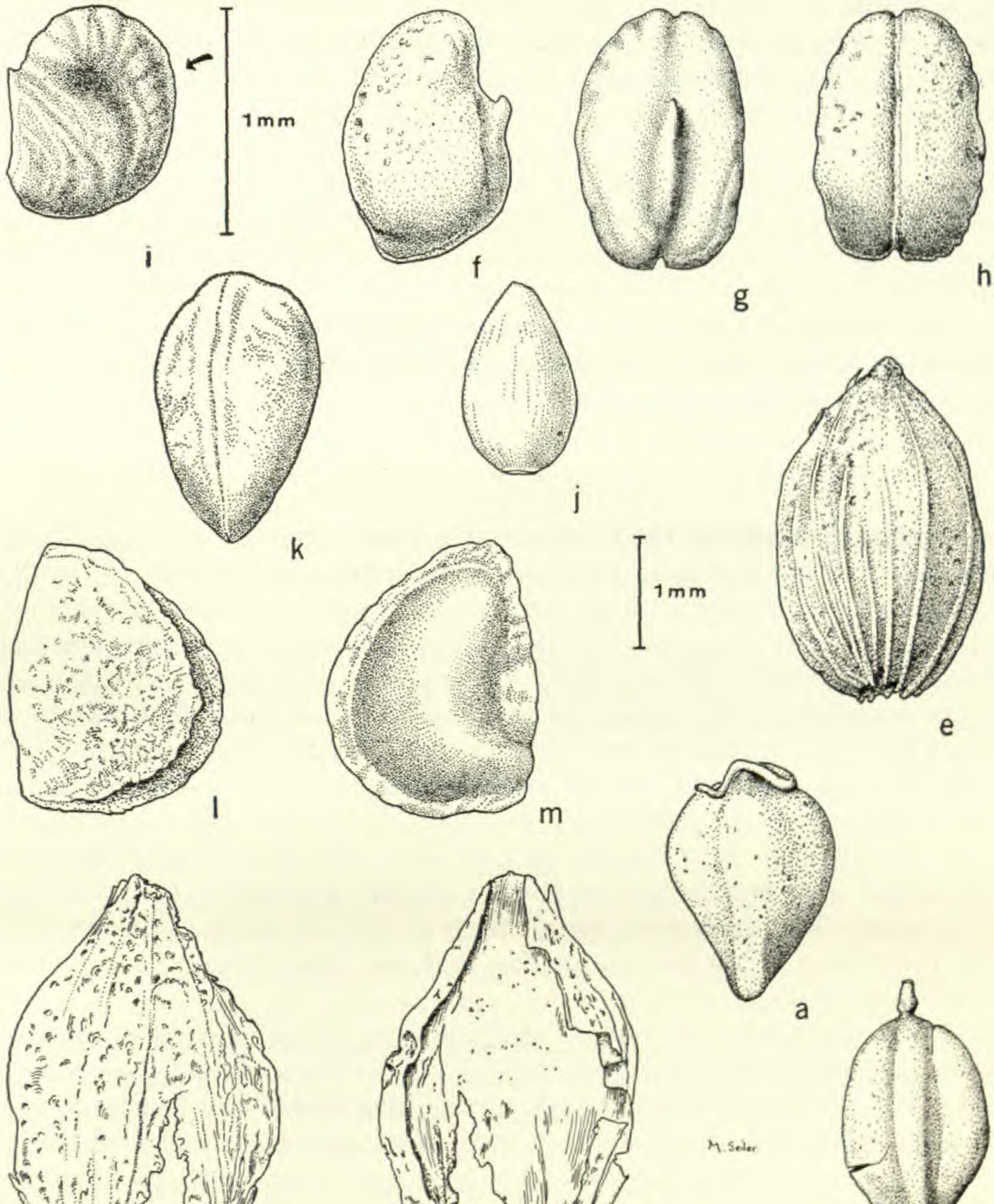


FIGURE 9. Fossil seeds, fruits, and perigynia of nonaquatic species found at Lockport site. a, achene of *Carex lanuginosa*; b–d, *C. Meadii*, b, external view of perigynium, c, interior (same specimen as in b), d, achene, specimen removed from perigynium illustrated in b and c; e, fruit of *C.* cf. *Torreyi* with perigynium adherent; f–h, achene of *Potentilla anserina* (different views of same fruit); i, achene of *P. norvegica*; j, seed of *Viola* cf. *palustris*; k–m, abraded nutlet of *Arctostaphylos Uva-ursi*, k, suture, l, from side, m, interior (different views of same specimen).

fied on the basis of size, shape, and the presence of a distinctive gap in the nutlet wall. In some herbarium specimens nutlets in the fleshy mature fruit may be laterally fused but in others they remain separate. Nutlets

of *A. alpina* Spreng. and *A. rubra* (Rehd. & Wils.) Fern. are shaped differently. An inhabitant of dry sandy or rocky areas, absent from western New York, but found elsewhere in the state, and common to the north and west. FIGURES 9k–m.

ANIMALIA. Although remains of various kinds of animals occur in the organic bed and associated sediments, most have not been identified or studied by specialists. The following groups were noted incidental to work on the plants: in the organic bed, fresh water bryozoans (statoblasts), ostracods (carapaces), beetles (exoskeleton fragments), mites, and a few snails (shells); and in lake silts, bivalves and snails (shells), and a mammoth tooth.

VEGETATIONAL INTERPRETATION AND DISCUSSION

Lateglacial forests of the Lockport area were comprised of associations of white and black spruce, jack and/or red pine, some balsam fir, larch, and birch, and perhaps certain other trees (e.g., black ash) occupying dry or wet sites depending on the habitat preference of these species. Communities dominated by herbs also existed, and the composition of these doubtless varied in relation to the position of the water table at a given location. Containing more sedge pollen than the others, sample LS 3 may document an early stage in development of spruce dominated vegetation in which herb communities were more abundant. This is consistent with the probable older age of the lake silts. However, if habitats near the strand were especially favorable to aquatic, lowland members of the Cyperaceae, over-representation of these in the spectrum could explain the difference. With the information at hand it is difficult to establish which alternative is correct.

Pollen assemblages in surface samples from boreal regions of eastern Canada, particularly the region around the southern end of James Bay (see data in Davis, 1967), closely match those from the Lockport site sediments. In this part of Canada today (and presumably around Lockport 12,000 years ago) the vegetation is a more or less open spruce woodland with wet site sedge or black spruce communities alternating with stands of white spruce, jack pine, and associated plants at locations where better drainage exists. Such communities dominated surfaces in northwestern New York during lateglacial time and extended at least 50 miles south to the Houghton and Protection bog areas and probably much farther.

These interpretations, as they relate to the Lockport site, are based primarily on pollen and seed-plant megafossil data, but they can be extended and refined considerably by information derived from an analysis of the habitat requirements of mosses represented in the organic bed. The moss assemblage is a mixed one indicating that a number of different communities contributed to the organic bed. This implies that the mosses did not grow exactly where they were found, but rather became

intermingled prior to burial, a fact independently confirmed by the abraded nature of wood in the deposit. The assemblage is comprised mostly of calciphiles, and presumably rock from the nearby Niagara escarpment and local deposits of calcareous till provided ready sources of carbonates.

The mosses identified are listed in TABLE 2, and as none of them is extinct knowledge of their current ecological requirements, when related to the probable landscape of the region, enables inferences to be made about habitats present near Lockport 12,000 years ago. These are listed in an idealized transect beginning at the shore of Glacial Lake Iroquois and proceeding inland, although, instead of the zonation which this implies, a habitat mosaic may have been present. A dry, sandy beach, perhaps near the lake shore or some distance inland, but in any case above the zone of continuous disturbance by waves, is the first habitat indicated. Behind the beach, between dunes and elsewhere, rich fens (see Du Rietz, 1949) and beach pools occurred in basins enriched by carbonates. On drier, gentle slopes adjacent to fens, a somewhat shaded habitat characterized by shrubs and perhaps occasional spruce trees occurred, and further inland, this vegetation type probably graded into forest. Acidic bog sites are indicated, and these probably were found near or perhaps as hummocks developed within fens. Five miles to the south, exposed areas of the Niagara escarpment with limestones and subordinate shale and sandstone provided habitats for those species which today occur in rocky situations. Certain of the mosses listed are found in more than one of these habitats, but others are of more restricted occurrence.

Other plants represented in the organic bed by megafossils fit well into these habitats. The species of *Chara* likely grew in alkaline waters of ponds and beach pools, in quiet bays of Lakes Iroquois and Tonawanda, or possibly along sluggish sections of the stream that filled the Lockport spillway. The presence of *Nitella flexilis* indicates that some circumneutral or slightly acidic water was also present. Such aquatic habitats also supported *Hippuris vulgaris*, *Najas flexilis*, *Myriophyllum exalbescens*, *Potamogeton* spp., and *Zannichellia palustris*. Fens and margins of ponds and beach pools are the expected sites for *Carex* spp., *Eleocharis palustris*, *Rorippa islandica*, *Salix* sp., *Selaginella selaginoides*, *Sparganium* sp., *Typha* sp., and *Viola palustris*. However, these species did not necessarily grow together because some require more acidic soil or drier sites than others. *Potentilla anserina* would have grown at moist, stony or sandy, calcareous places, perhaps near beach pools or along the shore of Lake Iroquois, and drier sites in the same area probably supported *Arctostaphylos Uva-ursi*. Another species of this area may have been *Polygonum aviculare*. *Menyanthes trifoliata* and *Picea mariana* belong to the acid bog category. Rock outcrop or boulder talus taxa are also few and depending on how moist and shaded the rocks were, include *Potentilla norvegica*, *Salix* sp., *Selaginella selaginoides*, some of the sedges, and possibly a few others. Forest species represented by megafossils are *Larix laricina*, *Picea glauca*, *P. mariana*, and perhaps *Salix* sp. Intermediate or additional habitats may have existed also.

TABLE 2. **Lockport site bryophyte fossils by habitat type.**

TAXA	SANDY CALCAREOUS STRAND	BEACH POOL OR FEN	FEN EDGE, MOIST ± SHADED	ACID BOG OR BOG HUMMOCK	FOREST	ROCK OUTCROP OR TALUS
Abietinella abietina (Hedw.) Fleisch.*	+	−	+	−	R	+
Ceratodon purpureus (Hedw.) Brid.*	+	−	+	−	−	−
Ditrichum flexicaule (Schwaegr.) Hampe	+	−	+	−	−	+
Tortella inclinata (Hedw. f.) Limpr.	+	−	−	−	−	+
T. tortuosa (Hedw.) Limpr.*	+	−	−	−	−	+
Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb.	+	−	−	−	−	+
Aulacomnium palustre (Hedw.) Schwaegr.*	−	+	+	+	R	−
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb.*	−	+	+	−	+	−
Campylium stellatum (Hedw.) C. Jens.*	−	+	+	−	−	−
Meesia triquetra (Richt.) Aongstr.	−	+	+	−	R	−
Drepanocladus aduncus (Hedw.) Warnst.*	−	+	−	−	−	−
D. exannulatus (B. S. G.) Warnst.*	−	+	−	−	−	−
D. fluitans (Hedw.) Warnst.	−	+	−	−	−	−
D. revolvens (Sw.) Warnst.*	−	+	+	−	−	−
D. vernicosus (Lindb. ex C. Hartm.) Warnst.*	−	+	−	−	−	−
Scorpidium turgescens (T. Jens.) Loeske	−	+	−	−	−	−
Tomenthypnum nitens (Hedw.) Loeske*	−	+	+	−	−	−
Aulacomnium acuminatum (Lindb. & Arn.) Kindb.	−	−	+	−	−	+
A. turgidum (Wahlenb.) Schwaegr.	−	−	+	−	R	+
Bryoerythrophyllum recurvirostrum (Hedw.) Chen	−	−	+	−	+	−
Campylium chrysophyllum (Brid.) J. Lange*	−	−	+	−	−	−
Dicranella Schreberiana (Hedw.) Schimp.	−	−	+	−	−	+
Distichium capillaceum (Hedw.) B. S. G.*	−	−	+	−	−	+
Fissidens osmundoides Hedw.	−	−	+	−	+	−
Hylocomium splendens (Hedw.) B. S. G.	−	−	+	−	R	+
Meesia uliginosa Hedw.	−	−	+	−	+	−
Mnium pseudopunctatum Bruch & Schimp.	−	−	−	+	−	−
Sphagnum magellanicum Brid.*	−	−	+	+	−	−
Polytrichum juniperinum Hedw.*	−	−	−	−	+	−
Dicranum fuscescens Turn.*	−	−	−	−	−	+

Key: + = characteristic of this habitat; − = not characteristic; R = rare or infrequent.
* Currently found in Lockport area (Ketchledge, 1957; Miller, 1971).

A close analogue of this vegetation exists today at places along the Straits of Mackinac, Michigan, where rich fens and beach pools occur between sandy beaches and inland stands of *Picea glauca*. Eastward, communities containing many of the same bryophytes and associated species are known from the Bruce Peninsula along the Lake Huron shore (Crum, 1966) and from the Bergen Swamp area in western New York, which is about 40 miles southeast of the Lockport site (Muenscher, 1946; Winne, 1950; Miller, 1971). Although both regions are strongly calcareous, Bergen Swamp is noteworthy because acid bog hummocks have developed directly on marl. Certain plants of these areas are boreal forest or subarctic disjuncts, and the presence of some of the disjuncts in a lateglacial deposit from an intermediate locality clearly establishes the relict status of their present occurrence in the Great Lakes region. Indeed, species represented in the Lockport organic bed also have been found in northern Michigan in slightly older sediments belonging to the Cary-Port Huron interstade (Miller & Benninghoff, 1969) indicating that along the Straits of Mackinac, beach pool – rich fen bryophyte communities have had a long, probably continuous history. During lateglacial time, such communities likely were widespread along the fluctuating strandlines of the ancestral Great Lakes, particularly those occurring between eastern Wisconsin and central New York, a region where calcareous bedrock is frequent.

Based primarily on information given by Ketchledge (1957), sixteen of the mosses represented in the organic bed (53 percent of the assemblage) occur near Lockport today, although some are considered rare in the area. Careful collecting would probably increase the percentage somewhat. Only *Aulacomnium acuminatum*, *Mnium pseudopunctatum*, *Scorpidium turgescens*, and *Tortella inclinata* have not been reported from elsewhere in New York State. Nearly all of the mosses are characteristic of the boreal forest and regions northward. For example, 87 percent (26 species) are listed by Steere (1947) as found in the Canadian eastern arctic, which encompasses the area from the Ungava Peninsula, Quebec, to the north end of Ellesmere Island. Three mosses, *Campylium chrysophyllum*, *Dicranella Schreberiana*, and *Tortella inclinata*, are the only more or less southern species in the deposit. *Tortella inclinata* is a characteristic though rare species of the Great Lakes region.

The mosses of greatest phytogeographical interest in the deposit are *Aulacomnium acuminatum* and *A. turgidum*. Steere (1947) considers the former to be an important component of high arctic vegetation. It is a circumpolar species widespread in the North American arctic and extends slightly into the subarctic in the western half of the continent. *Aulacomnium turgidum* is another circumpolar species which occurs across arctic and subarctic North America. Although very rare in northeastern United States, it is found at higher elevations southward through the White Mountains to the Adirondacks. The ecology of *A. acuminatum* in west Greenland has been treated by Holmen (1957). There it occurs abundantly in tundra where the following mosses found in the Lockport organic

bed are associates: *Tomenthypnum nitens* (in 7 of 9 samples), *Hylocomium splendens* (in 5 of 9), *Distichium capillaceum* (in 2 of 9), and *Ditrichum flexicaule* (in 2 of 9). In west Greenland *Cassiope tetragona* and *Dryas integrifolia* are commonly associated flowering plants.

The presence of *Aulacomnium acuminatum* and *A. turgidum* in the subfossil moss assemblage indicates that arctic-alpine vascular plants also may have grown near the Lake Iroquois strand at Lockport 12,000 years ago and raises the possibility that limited areas of tundra existed in the region. If this vegetation developed in response to a prevailing 'tundra' climate, then an interpretation involving the spruce woodland southwest of James Bay as a close vegetational and climatic analogue may be in error. It is more likely, however, that both mosses are relicts from a period of more or less widespread tundra vegetation which occurred in western New York some hundred years prior to their burial. The presence of the two taxa along the strand can be explained by postulating existence of microhabitats favorable to their survival. Since fossils of vascular plants characteristic of tundra communities have not been found in the deposit, and forest species are clearly present and abundant, this seems a tenable hypothesis.

As a group, the species of tracheophytes represented at the Lockport site are more southern in the distribution than the mosses, although about two-thirds of them extend to arctic or subarctic regions. Of the twenty-six vascular plants identified from megafossils, only six, *Arctostaphylos Uva-ursi*, *Carex Torreyi*, *Hippuris vulgaris*, *Picea glauca*, *Selaginella selaginoides*, and *Viola palustris*, are not members of the present flora of western New York, although they occur elsewhere in temperate eastern North America, some of them in other parts of New York State. Zenkert (1934) includes records from the Niagara River, about 20 miles west and southwest of Lockport for most of the aquatics found in the deposit. Few tracheophytes from the Lockport site are mainly southern in distribution.

SUMMARY AND CONCLUSIONS

Pollen from sediments deposited about 12,000 years ago during an early stage of Glacial Lake Iroquois show the landscape of northwestern New York State to have been dominated by forest communities containing black and white spruce with lesser amounts of jack and/or red pine, larch, and balsam fir. An extensive series of identified plant megafossils, particularly an assemblage of thirty mosses, many of which are calciphiles, supports this interpretation and permits recognition of a number of non-forest plant communities.

Rich fens must have been relatively common in the area because both fen and fen edge mosses are frequent. Drier habitats, perhaps on beach ridges, were present, and species that may have grown on or among the calcareous rocks of the nearby Niagara escarpment also occur, as do some mosses of acidic bog sites. Only a few species that today typically grow

in shaded spruce forests were identified. Others that sometimes grow in this habitat were also found, but are less useful indicators because they occur at open sites as well. The absence of a dominant forest element in the moss flora probably means that the landscape along this part of the Iroquois strand was occupied by a patchwork of dry and wet site herb and moss communities and that spruce occurred some distance behind the beach. Most of the spruce wood was probably carried to the site from inland by drainage through the spillway.

Nearly all of the fossil mosses are characteristic boreal forest species. Most range northward to the arctic tundra but many also occur in the Great Lakes states. For example, 93 percent of the assemblage presently grows in the Straits of Mackinac region of Michigan where the present zonation of the strand vegetation is similar to that which evidently existed in northwestern New York 12,000 years ago. An important difference, however, is that temperate coniferous-deciduous forest occurs today in the upland of northern Michigan but at this time is absent from western New York.

The most significant mosses from a paleoecological standpoint are *Aulacomnium acuminatum* and *A. turgidum* whose present North American ranges center in the arctic and subarctic. The southernmost station for the former is along the north shore of Lake Superior, an area well-known for its disjunct arctic-alpine plants. *Aulacomnium turgidum* has a greater number of occurrences along the southern edge of its range, but it also is found widely in the subarctic and arctic. In spite of the presence of these two mosses, evidence for tundra in northwestern New York 12,000 years ago is weak because of the absence of other tundra indicator species. Similarly, few truly temperate species occur, the moss *Campylium chrysophyllum* being the best example in this category.

A surprisingly large number of species represented at the Lockport site as megafossils still occur in the flora of western New York, although many are rare in the area. Out of thirty mosses, sixteen (53%) have been reported from northwestern New York. In addition, twenty of the twenty-six species or genera of vascular plants identified (77%) are known from the western end of the state, some from the nearby Niagara River or from Bergen Swamp, an area of rich fens. While derivation of present day representatives of species present during lateglacial time cannot be established with certainty, the floristic similarity between the two periods is great enough to indicate this possibility. In an area such as Bergen Swamp, where many members of the subfossil moss assemblage can be found growing at present, appropriate edaphic conditions have insured persistence of these species. Habitats found in Bergen Swamp are infrequent in New York State. Fossil evidence from the Lockport site indicates that during lateglacial time such habitats were more widespread south of Lake Ontario and probably occurred some distance eastward and westward within the region of calcareous bedrock and till. Carbonate leaching during postglacial soil development, changes in climate, and other factors severely restricted sites for calcicolous plants across the

southern portion of glaciated North America. In most cases the distribution of such plants is now disjunct due to partitioning of suitable habitats during postglacial time.

LITERATURE CITED

ANDERSON, L. E. 1954. Hoyer's solution as a rapid permanent mounting medium for bryophytes. Bryologist **57**: *242–244.*

ARGUS, G. W., & M. B. DAVIS. 1962. Macrofossils from a late-glacial deposit at Cambridge, Massachusetts. Am. Midl. Nat. **67**: 106–117.

BRASSARD, G. R., & W. C. STEERE. 1968. The mosses of Bathurst Island, N.W.T., Canada. Canad. Jour. Bot. **46**: 377–383.

BUCKLEY, J. D., M. A. TRAUTMAN, & E. H. WILLIS. 1968. Isotopes' radiocarbon measurements VI. Am. Jour. Sci. Radiocarbon Suppl. **10**: 246–294.

BUTLER, E. J. 1939. The occurrences and systematic position of the vesicular-arbuscular type of mycorrhizal fungi. Trans. Brit. Mycol. Soc. **22**: 274–301. *pl. 20.*

CALKIN, P. E. 1970. Strand lines and chronology of the glacial Great Lakes in northwestern New York. Ohio Jour. Sci. **70**: 78–96. *1 map.*

CHENEY, L. S. 1930. Wisconsin fossil mosses. Bryologist **33**: 66–68.

COLEMAN, A. P. 1895. Glacial and inter-glacial deposits near Toronto. Jour. Geol. **3**: 622–645.

COX, D. D. 1959. Some postglacial forests in central and eastern New York State as determined by the method of pollen analysis. Bull. N.Y. State Mus. Sci. Serv. *377. 52* pp.

CRUM, H. 1966. Bryophytes of Owen Sound and Bruce Peninsula, Ontario. Bull. Natl. Mus. Canada **216**: 102–122.

CULBERSON, W. L. 1955. The fossil mosses of the Two Creeks forest bed of Wisconsin. Am. Midl. Nat. **54**: 452–459.

DAILY, F. K. 1961. Glacial and post-glacial charophytes from New York and Indiana. Butler Univ. Bot. Studies **14**: 39–72.

———. 1968 [1969]. Some late glacial charophytes compared to modern species. Proc. Indiana Acad. Sci. **78**: 406–412.

DAVIS, M. B. 1967. Late-glacial climate in northern United States: A comparison of New England and the Great Lakes region, pp. 11–43. *In*: E. J. CUSHING & H. E. WRIGHT, JR. (Eds.) Quaternary paleoecology. vii + 433 pp. Yale Univ. Press. New Haven, Conn., & London.

DE VRIES, B., & C. D. BIRD. 1965. Bryophyte subfossils of a late-glacial deposit from the Missouri Coteau, Saskatchewan. Canad. Jour. Bot. **43**: 947–953.

DU RIETZ, G. E. 1949. Main units and main limits in Swedish mire vegetation. (In Swedish; English summary.) Sv. Bot. Tidskr. **43**: *274–309. 6 pls.*

FAEGRI, K., & J. IVERSEN. 1964. Textbook of pollen analysis. 2nd Rev. Ed. 237 pp. Munksgaard. Copenhagen.

FERNALD, M. L. 1950. Gray's manual of botany. 8th Ed. lxiv + 1632 pp. American Book Co. New York.

HOLMEN, K. 1957. Three west arctic moss species in Greenland. On the occurrence of *Cinclidium latifolium, Aulacomnium acuminatum* and *Trichostomum cuspidatissimum*. Meddel. Grønl. 156(3). 16 pp.

HOUSE, H. D. 1924. Annotated list of the ferns and flowering plants of New York State. Bull. N.Y. State Mus. 254. 759 pp.

KARROW, P. F., J. R. CLARK, & J. TERASMAE. 1961. The age of Lake Iroquois and Lake Ontario. Jour. Geol. **69:** 659–667.

KETCHLEDGE, E. H. 1957. Checklist of the mosses of New York State. Bull. N.Y. State Mus. 363. 55 pp.

KINDLE, E. M., & F. B. TAYLOR. 1913. Niagara folio, New York. Geologic Atlas of the United States. Folio 190. 26 pp. *4 maps & 25 pls.*

LYMAN, E. L., & B. B. COLEMAN. 1966. The bryoflora of the Genesee country, New York. 3. A preliminary survey of the bryophytes of Orleans County. Bryologist **69:** 118–124.

MILLER, N. G. 1971. Three additions to the moss flora of New York State. Bryologist **74:** 377, 378.

———. 1973. Late-glacial and postglacial vegetation change in southwestern New York State. Bull. N.Y. State Mus. Sci. Serv. 420. *In press.*

——— & W. S. BENNINGHOFF. 1969. Plant fossils from a Cary-Port Huron interstade deposit and their paleoecological interpretation. Geol. Soc. Am. Special Paper **123:** 225–248. *1 map.*

MUENSCHER, W. C. 1946. The vegetation of Bergen Swamp I. The vascular plants. Proc. Rochester Acad. Sci. **9:** 64–117.

MULLER, E. H. 1964. Quaternary section at Otto, New York. Am. Jour. Sci. **262:** 461–478.

PENHALLOW, D. P. 1896. Contributions to the Pleistocene flora of Canada. Proc. Trans. Roy. Soc. Can. II. **2**(4): 59–77.

RAMPTON, V. 1971. Late Quaternary vegetational and climatic history of the Snag-Klutlan area, southwestern Yukon Territory, Canada. Bull. Geol. Soc. Am. **82:** 959–978. *1 pl.*

ROSENDAHL, C. O. 1943. Some fossil fungi from Minnesota. Bull. Torrey Bot. Club **70:** 126–138.

———. 1948. A contribution to the knowledge of the Pleistocene flora of Minnesota. Ecology **29:** 284–315.

SCHOPF, J. M., & A. T. CROSS. 1947. A glacial age peat deposit near Pittsburgh. Am. Jour. Sci. **245:** 421–433. *2 pls.*

SEARS, P. B. 1967. The Castalia prairie. Ohio Jour. Sci. **67:** 78–88.

STEERE, W. C. 1941 [1942]. Pleistocene mosses from the Aftonian interglacial deposits of Iowa. Pap. Mich. Acad. Sci. Arts Lett. **27:** 75–104. *5 pls.*

———. 1947. Musci, pp. 370–490. *In:* N. POLUNIN (Ed.). Botany of the Canadian eastern arctic, Part II. Thallophyta and Bryophyta. Bull. Natl. Mus. Canada 97. v + 573 pp. *1 map.*

———. 1953. On the geographical distribution of arctic bryophytes. Publ. Stanford Univ. Biol. Sci. **11:** 30–47.

STOUTAMIRE, W. P., & W. S. BENNINGHOFF. 1964. Biotic assemblage associated with a mastodon skull from Oakland County, Michigan. Pap. Mich. Acad. Sci. Arts Lett. **49:** 47–60.

WILLIAMS, C. 1968. New and additional moss records for Ontario. Bryologist **71:** 282–284.

WINNE, W. T. 1950. The vegetation of Bergen Swamp VII. The bryophytes. Proc. Rochester Acad. Sci. **9:** 315–326.

WOOD, R. D. 1952. An analysis of ecological factors in the occurrence of Characeae of the Woods Hole region, Massachusetts. Ecology **33:** 104–109.

———. 1965. Monograph of the Characeae. xxiv + 904 pp. Cramer. Weinheim.

——— & W. C. MUENSCHER. 1956. The Characeae of the State of New York. Mem. Cornell Univ. Agr. Exper. Sta. 338. 77 pp.

WRIGHT, H. E., JR. 1971. Late Quaternary vegetational history of North America, pp. 425–464. *In*: K. K. TUREKIAN (Ed.). The Late Cenozoic glacial ages. xii + 606 pp. Yale Univ. Press. New Haven, Conn., & London.

ZENKERT, C. A. 1934. The flora of the Niagara Frontier region. Bull. Buffalo Soc. Nat. Sci. 16. x + 328 pp. *1 map.*

DEPARTMENT OF BOTANY
UNIVERSITY OF NORTH CAROLINA
CHAPEL HILL, N.C. 27514

A PROVISIONAL KEY AND ENUMERATION OF SPECIES OF SYZYGIUM (MYRTACEAE) FROM PAPUASIA

T. G. HARTLEY AND L. M. PERRY

THE IDENTIFICATION OF SPECIMENS of *Syzygium* * has always been difficult, partly on account of the large size and the lack of an overall treatment of the genus, and partly because, with a limited amount of material, it is difficult to estimate the variability within a species. When Hartley began to determine the *Syzygium* in his New Guinea collections (C.S.I.R.O. Phytochemical Survey, 1961–1965), he found the accumulation of unnamed material in the Arnold Arboretum herbarium was as large as that of the named collections. Further, a combination of the floristic studies available seemed scarcely adequate for his needs; thus began the endeavor to develop a provisional key for the region. Perry, not unaware of the difficulties inherent within the genus, joined the effort with great reluctance. After the publication of the Myrtaceae of the Archbold Expeditions (Merrill & Perry, 1942), the late Dr. Merrill, during a visit to the herbaria at Leiden, Kew, and the British Museum, made carbon rubbings and notes on various type collections of *Syzygium* which previously he had not had time to examine; further, through the kindness of the Directors at Kew, Leiden, and Berlin, the herbarium obtained some photographs of isotypes, paratypes, and a few holotypes. We already had small photographs of Ridley's types of the C. B. Kloss collection from West Irian (Wollaston Expedition). Only an Australian type from Kew and one New Guinea isotype from Leiden have been borrowed. An overall key to the species of the Asiatic-Pacific region is very desirable, but these are so numerous that it would take a few years to do a tolerably good study. The clavate-flowered species, particularly, need to be examined together; also *S. effusum* and its relatives from the Philippines south through New Guinea to Polynesia should be studied comprehensively.

Henderson, in his work on "The genus *Eugenia* (Myrtaceae) in Malaya" (Gard. Bull. Singapore 12: 12–14. 1949), indicates the useful characters in defining a species of *Syzygium*. We have found that most of these features are variable and suggest that the main difficulty in definition comes from lack of ability to evaluate the variations and exceptions when there are relatively few specimens which appear to belong together. For example, no. 5 in Henderson's list of characters: "the shape of the twigs, whether terete, angled, or winged, and the colour of their bark . . . are remarkably constant." Merrill and Perry described as new *S. papuasicum*,

* SCHMID, RUDOLF. 1972. A resolution of the *Eugenia-Syzygium* controversy (Myrtaceae). Am. Jour. Bot. **59**(4): 423–426. [April.]

represented by a number of specimens all with compressed or terete twigs, because of the angled branchlets indicated in the description of the closely related *S. acutangulum*. Now that we have more specimens, however, we have found one with both compressed and angled branchlets indicating that when this character is used the angle should be very pronounced, perhaps tending toward a very narrow wing. Another point seemingly trivial but worth mentioning is that the shape of the flower bud may or may not change as it approaches anthesis. Also, in some of the smaller-flowered species, the calyx may be both 4- and 5-lobed. Perhaps the most difficult character to deal with adequately is the plan of leaf venation which, Henderson says, "is very constant for each species. It is best seen in dried specimens." We have often found it difficult to distinguish between open and close venation and suggest that the two types may intergrade in some species. Further, the degree to which the venation is pronounced varies considerably in some of our species with wide altitudinal ranges, as for example, *S. buettnerianum*. We also suspect that the method of drying influences faintness or boldness of some venation patterns.

In most instances we have indicated the types of the accepted names, but we have not designated any choice to replace those types destroyed during World War II. We believe this should be left to someone having the opportunity to visit various herbaria, examine authentic material, and then make the best choice. The measurements given are all of dried material. Those of Merrill & Perry (1942) for flowers were mostly from material soaked in water and boiled, hence they are a little larger. In the key and the enumeration of species, no attempt has been made to portray natural relationships. Adjacent position or numbering is only a matter of convenience. The specimens cited in the EXSICCATAE and in the ENUMERATION OF SPECIES are deposited in the herbarium of the Arnold Arboretum of Harvard University, Cambridge, unless otherwise specified. Herbarium abbreviations used are from Lanjouw and Stafleu's *Index Herbariorum*, Part I. ed. 5 (Regnum Vegetabile, 31. 1964).

Provisional Key to Species of Syzygium

1. Flowers large, usually with conspicuous calyx lobes 4 mm. or more high and large petals; calyx tube immediately below the lobes 8 mm. or more in diameter (sometimes only 7–8 mm. in diameter and calyx lobes 2–4 mm. high — see second 23 in key). ..... (2).
   2. At least some parts of the plant pubescent or puberulent; leaves linear-lanceolate to oblong-lanceolate. ..... (3).
      3. Inflorescence lateral (flowers scattered along the length of the trunk) on short shoots 2–3.4 cm. long, not including peduncled flower; peduncle 1–1.5 cm. long; petals green; petiole 2–3 mm. long; younger branchlets, petioles, and peduncles puberulous. ..... 1. *S. cauliflorum.*
      3. Inflorescence terminal; young growth, veins of lower surface of young leaves and calyx hirtellous or velutinous.
         Petals greenish white or yellow; calyx tube in open flower 1–2 cm. long. ..... 2. *S. megalospermum.*
         Petals red; calyx tube in open flower 2–2.8 cm. long. ..... 3. *S. porphyrocarpum.*
   2. All parts of the plant glabrous (in *S. puberulum* calyx tube usually puberulous); leaves various in shape. ..... (4).
      4. Inflorescence consisting of solitary, or 1–3-clustered, flowers, but only one to an axis (except in some specimens of *S. daphne* and *S. gonatanthum*). ..... (5).
         5. Young branchlets winged, wings at apex to 5 mm. wide; leaves narrowly cordate, 20–30 cm. long, apex long acuminate (1.5–4 cm.). ..... 4. *S. cladopterum.*
         5. Young branchlets terete, compressed, or sharply tetragonous but not winged. ..... (6).
            6. Calyx tube (seen in fruit only) coarsely and longitudinally rugose. ..... 5. *S. macrocalyx.*
            6. Calyx tube not longitudinally rugose. ..... (7).
               7. Calyx tube 2 cm. or more long. ..... (8).
                  8. Petioles 5–15 mm. long; leaves 15–30 cm. long, primary veins easily seen. ..... (9).
                     9. Flowers yellow, terminal or lateral; peduncle 2–5 mm. long; pedicel 1–3 cm. long; leaves elliptic; petiole ca. 1.5 cm. long. ..... 6. *S. flavidum.*
                     9. Flowers white, pink, or red, axillary or lateral; peduncle 2–15 mm. long. ..... (10).
                        10. Flowers red, nodding when mature on curved peduncle 3–5 (–10–15, *fide* description) mm. long. ..... 7. *S. nutans.*
                        10. Flowers white or pale pink.
                            Leaves ovate-elliptic; flowers axillary and terminal; calyx tube at base 2–3 mm. broad; peduncle and pedicel 2 mm. thick, 5–10 mm. long, mostly not nodding. ..... 8. *S. insulare.*

Leaves obovate-elliptic; flowers on older branches; calyx tube at base 5 mm. broad; peduncle and pedicel 3–5 mm. thick, 7–10 mm. long. ..... 9. *S. burepense.*

8. Petioles 2–5 mm. long.
   Leaves 17–22 cm. long, 3.5–4.5 cm. wide, obtusely acuminate, primary veins visible but not prominent; branchlets terete. ..... 10. *S. dolichophyllum.*
   Leaves 8–15 cm. long, 2.5–6 cm. wide, abruptly and narrowly acuminate, primary veins impressed above, prominent below; branchlets tetragonous. ..... 11. *S. callianthum.*

7. Calyx tube 1–1.5 cm. long. ..... (11).
   11. Petioles 1.5–5 mm. long. ..... (12).
      12. Leaves ovate, shallowly cordate; petiole 1.5–2 mm. long; peduncle and pedicel tetragonous. ..... 12. *S. keysseri.*
      12. Leaves otherwise; petiole 2–5 mm. long. ..... (13).
         13. Flowers solitary or in twos or threes on long, slender peduncles and pedicels extending much beyond the subtending leaves. ..... 13. *S. daphne.*
   13. Flowers solitary on peduncles and pedicels shorter than the subtending leaves, when present. (14).
      14. Calyx tube verruculose at maturity. ..... 14. *S. trachyanthum.*
      14. Calyx tube not verruculose, but usually glandular. ..... (15).
         15. Leaves elongate lanceolate (between five and six times as long as broad).
            Flowers axillary and terminal; leaves tapering toward the base; apparently without reduced leaves or stipules. ..... 15. *S. salicinum.*
            Flowers generally on short, leafy shoots, single or loosely fascicled; leaf base rounded-cuneate or shortly cuneate; reduced leaves and stipules present. .. 16. *S. pyriforme.*
         15. Leaves elliptic to lanceolate (less than four times as long as broad). ..... (16).
            16. Primary veins not more than five unevenly distributed pairs, these and the intramarginal vein prominent on the lower surface. ..... 17. *S. erythropetalum.*
            16. Primary veins six or more pairs, mostly easily seen but not prominent on the lower surface.
               Petioles 2–3 mm. long; floral axis slender (ca. 1 mm. in diameter) and flexible; outer calyx lobes 2–3 mm. high. ..... 18. *S. subalatum.*

Petioles 4–5 mm. long; floral axis stouter (1–2 mm. in diameter) and erect; outer calyx lobes (seen only in bud) 5 mm. high. ..... 19. *S. sogerense.*

11. Petioles 5–15 mm. long; primary veins 4–8 pairs, equidistant or not. ..... (17).

17. Calyx tube, just above the very short basal stipe, truncate and slightly concave or flat. ..... 20. *S. tympananthum.*

17. Calyx tube infundibular.

Flowers white, creamy, or yellow; inflorescence axillary and/or lateral, flowers solitary or two or three on a very short peduncle; primary veins not equidistant. ..... 21. *S. gonatanthum.*

Flowers red; inflorescence lateral, subsessile; primary veins equidistant. ..... 22. *S. thomseni.*

4. Inflorescence consisting of few or many flowers (usually not solitary). ..... (18).

18. Leaf base cordate.

Ultimate branchlets acutely tetragonous; leaves oblong-lanceolate or ovate, 19–40 cm. long, 7.5–19 cm. wide, sessile; inflorescence axillary and lateral; calyx tube pyriform. ..... 23. *S. thalassicum.*

Ultimate branchlets terete or compressed; leaves elliptic or oblong-elliptic, 15–35 cm. long, 6.5–12 cm. wide; inflorescence terminal and/or axillary; calyx tube turbinate. ..... 24. *S. novoguineense.*

18. Leaf base not cordate (except occasionally in *S. madangense*, *S. samarangense*, and *S. goniopterum*). ..... (19).

19. Calyx tube strongly costate.

Leaves gradually narrowed at base to petiole; inflorescence (to 12 cm. long) open, terminal, lateral, or leaf-opposed; peduncle up to 3 cm. long. ..... 25. *S. goniocalyx.*

Leaves rounded to cordate at base; flowers axillary or terminal, clustered on short (about 5 mm. long) protrusions. ..... 26. *S. madangense.*

19. Calyx tube not costate. ..... (20).

20. Flowers in verticils on the axis of the inflorescence. ..... 27. *S. heterobotrys.*

20. Flowers not in verticils on the inflorescence axis. ..... (21).

21. Calyx tube infundibular and finely striate-verruculose (the latter characteristic very obvious in partly mature fruit); leaves narrowly obovate to elliptic. ..... 28. *S. lagerstroemioides.*

21. Calyx tube not striate-verruculose, or if so, then leaves broadly elliptic to suborbicular. ..... (22).

22. Flowers on short protrusions crowded at ends of thickened (6 mm. in diameter) branchlets from which smaller leafy branchlets 2–3 mm. in diameter may grow; calyx lobes 1–1.5 cm. high (large flowers). ..... 29. *S. randianum.*

22. Flowers not on thickened branchlets. ..... (23).
23. Calyx lobes 4–5 mm. high or more. ..... (24).
24. Axis and branchlets of the inflorescence stout (3–4 mm. thick) or flowers subsessile. ..... (25).
25. Inflorescence terminal.
Leaves elliptic, 14.5–16.5 cm. long, 6–8.5 cm. wide; calyx tube ± cylindric, to 1.3 cm. long, at base ca. 5 mm. broad, abruptly enlarging to ca. 1 cm. broad just below the calyx lobes. ..... 30. *S. normanbiense*.
Leaves broadly elliptic to suborbicular, 10–15 cm. long, 7–9 cm. wide; calyx tube turbinate, striate (in one collection striate-verruculose), somewhat abruptly contracted into a short, stout stipe. ..... 31. *S. suborbiculare*.
25. Inflorescence lateral and/or axillary. ..... (26).
26. Lower part of calyx subcylindric, rugose, longer than the broadened upper part.
Leaves dull when dried; flowers subsessile, glomerate, purplish. ..... 32. *S. leonhardii*.
Leaves shining on the upper surface when dried (as if varnished); inflorescence with a short axis to 2.5 cm. long; flowers pink. ..... 33. *S. vernicosum*.
26. Lower part of calyx tube not cylindric but more obviously tapered. .. (27).
27. Flowers white, calyx tube obtusely obconic.
Leaves lanceolate to oblanceolate, 8–20 cm. long, 4.5–7 cm. wide, primary veins obvious; petioles less than 5 mm. long. ..... 34. *S. synaptoneurum*.
Leaves elliptic or broadly oblong, 11–21 cm. long, 4.5–9 cm. wide, primary veins inconspicuous; petioles not less than 1 cm. long. ..... 35. *S. evenulosum*.
27. Flowers red to lilac colored; calyx tube turbinate.
Leaves usually oblanceolate, at least three times as long as broad, 16–50 cm. long, 6–18 cm. wide; petioles to 1 cm. long; flowers clustered on very short stalks (to 5 mm. long) or subsessile in axils of leaves or

on older branches. ..... 36. *S. versteegii.*
Leaves elliptic, less than three times as long as broad, 18–44 cm. long, 13–24 cm. wide; petioles 2–4.5 cm. long; inflorescence open. ..... 37. *S. pachycladum.*

24. Axis and branchlets of the inflorescence not stout (1–2 mm. broad, not including wings of *S. pteropodum*). ..... (28).
28. Inflorescence axis very obviously 4-winged. ..... 38. *S. pteropodum.*
28. Inflorescence axis not winged. ..... (29).
29. Leaves without a definite intramarginal vein, the primary veins anastomosing in various ways; inflorescence lateral.
Flowers white. ..... 39. *S. laqueatum.*
Flowers red. ..... 40. *S. malaccense s. l.*
29. Leaves with primary veins looping to form a definite intramarginal vein; inflorescence variously located. ..... (30).
30. Secondary veins and reticulation obvious; leaves 7–12 cm. long, 3.5–5 cm. wide, chartaceous, abundantly pellucid punctate; dried pericarp of fruit 4–5 mm. thick in lower part, apparently always hard. ..... 41. *S. multiglandulosum.*
30. Secondary veins and reticulation relatively inconspicuous. ..... (31).
31. Petiole 2–3.5 cm. long, ca. 6 mm. thick; leaves 24–57 cm. long, 12–27 cm. wide, rounded at base; calyx tube stipitate-obconic, ca. 3 cm. long. ..... 42. *S. spectabile.*
31. Petiole to 2 cm. long, not more than 3 mm. thick; calyx tube to 3 cm. long. ..... (32).
32. Leaves 10–32 cm. long, 5–14 cm. wide, base rounded or slightly cordate; petiole at most 1.2 cm. long; inflorescence terminal and axillary; calyx tube 1.4–1.5 cm. long; flowers white. ..... 43. *S. samarangense.*
32. Leaves narrowed to the petiole, mostly short-cuneate at base; inflorescence mostly lateral. ..... (33).

33. Leaves chartaceous, drying green, copiously pellucid punctate; petiole 0.8–1.8 cm. long.
    Leaves broadly elliptic to ovate, 18–29 cm. long, 9–17 cm. broad, nearly twice as long as wide, obtuse or slightly acutish; lower part of calyx tube (including stipe and ovary) 1.5–2 cm. long, at base ca. 2 mm. in diameter and 5 mm. just below the upper somewhat abruptly broadened and produced subcampanulate part, the latter ca. 7 mm. long and ca. 1.5 cm. in diameter. ..... 44. *S. amplum.*
    Leaves narrowly elliptic, 11–15 cm. long, 3.5–5.5 cm. wide, approximately three times as long as broad, acuminate; calyx tube with slender stipe ca. 5 mm. long, enlarging to turbinate, in all ca. 2.5 cm. long. ... 45. *S. validinerve.*
33. Leaves subcoriaceous to coriaceous, drying brownish green or reddish brown, scattered or sparsely pellucid punctate; petiole 0.5–1.5 cm. long.
    Inflorescence apparently short and few-flowered; flowers white; calyx tube broadly obconic-turbinate, scarcely stipitate, 1.5–1.7 cm. long. ..... 46. *S. womersleyi.*
    Inflorescence shortly racemose or paniculate-fascicled; flowers showy pink or red. ..... 40. *S. malaccense s. l.*

23. Calyx lobes 2–4 mm. high. ..... (34).
    34. Inflorescence terminal, axillary or sometimes lateral. ..... (35).
        35. Branchlets quadrangular, often narrowly 4-winged; leaves oblong-elliptic, 15–25 cm. long, 7–9 cm. wide, at base shallowly cordate or rounded. ..... 47. *S. goniopterum.*
        35. Branchlets terete or compressed, rarely 4-angled; leaf base cuneate or obtuse, sometimes appearing rounded. ..... (36).
            36. Leaf venation close (primary and secondary veins almost equally visible, especially on the upper surface); flowers red. ..... 48. *S. platypodum.*

36. Leaf venation open (secondary veins not so distinct as primary); flowers white. ..... (37).
37. Flowers obtusely pyriform, sessile, not stipitate. .. 49. *S. waikaiunense*.
37. Flowers stipitate. ..... (38).
38. Leaves elliptic, approximately twice as long as broad. ..... 50. *S. variabile*.
38. Leaves lance-oblong, more than three times as long as broad.
Calyx tube usually minutely puberulous, 15–18 mm. long; leaves acuminate. ..... 51. *S. puberulum*.
Calyx tube glabrous, 8–10 mm. long; leaves acute. ..... 52. *S. coalitum*.

34. Inflorescence lateral. ..... (39).
39. Leaves firmly coriaceous, drying brownish; primary veins and intramarginal vein impressed above, prominent below. ..... 53. *S. virescens*.
39. Leaves chartaceous or thinly coriaceous.
Leaves profusely pellucid puncticulate, acuminate and abaxially recurved at apex, secondary venation easily seen; stipe of flowers 1–2 mm. long. ..... 54. *S. phaeostictum*.
Leaves somewhat sparsely pellucid puncticulate, apex acuminate but not recurved, secondary venation inconspicuous; stipe of flowers 4–5 mm. long (very noticeable in the fruit). ..... 55. *S. hylochare*.

1. Flowers smaller, calyx tube immediately below calyx lobes less than 8 mm. in diameter (also see species above under second 23 in key. ..... (40).
40. Outer calyx lobes 2 mm. or more high (except sometimes smaller in *S. uniflorum* and *S. saliciforme*). ..... (41).
41. Leaves at base cordate or rounded or obtuse, subsessile or with petiole not over 5 mm. long. ..... (42).
42. Leaves lanceolate to oblong-lanceolate.
Inflorescence 1–3-flowered; peduncle and pedicels long and slender. ..... 13. *S. daphne*.
Inflorescence paniculate, showy, profusely flowered. ..... 56. *S. delicatulum*.
42. Leaves elliptic or ovate-oblong. ..... (43).
43. Flower buds clavate-turbinate; leaf base usually rounded or obtuse, sometimes cuneate with longer petiole. ..... 50. *S. variabile*.

43. Flower buds not clavate-turbinate. ..... (44).
    44. Branchlets narrowly winged; inflorescence terminal or lateral; flowers subpyriform with a stipe. ..... 47. *S. goniopterum*.
    44. Branchlets terete or compressed.
        Calyx tube hemispherical above, the lower and slender part longitudinally grooved and gradually tapering to a narrow base, lobes erect or inflexed after anthesis. ..... 57. *S. aqueum*.
        Calyx tube turbinate, smooth, shortly stipitate, lobes usually spreading and/or reflexed after anthesis. ..... 58. *S. roemeri*.
41. Leaves at base mostly cuneate, not cordate or rounded. ..... (45).
    45. Leaves at least three times as long as wide (linear-lanceolate to lanceolate or lance-elliptic). ..... (46).
        46. Primary veins 5–7 mm. apart; leaf apex subfalcate-acuminate; flowers in cymes or single; outer calyx lobes 1.5 mm. high. ..... 59. *S. saliciforme*.
        46. Primary veins 3–5 mm. apart.
            Flowers solitary, verruculose, sometimes outer calyx lobes only 1.5 mm. high. ..... 60. *S. uniflorum*.
            Inflorescence cymose; new branchlets and inflorescence axis acutely quadrangular. .. 61. *S. xylopiaceum*.
    45. Leaves mostly less than three times as long as wide (about three times in some specimens of the *S. hylophilum* complex). ..... (47).
        47. Leaves obtuse or subrounded or retuse at apex. ..... (48).
            48. Inflorescence lateral, flowers few and scattered on axis; leaves apparently without intramarginal vein. ..... 62. *S. garcinioides*.
            48. Inflorescence terminal, paniculate. ..... (49).
                49. Leaves subobovate-elliptic, chartaceous to coriaceous, intramarginal vein very close (0.5–0.7 mm.) to margin; petiole 6–8 mm. long; flower buds subclavate-infundibular. ..... 63. *S. cinctum*.
                49. Leaves elliptic, narrowed toward base, rigidly coriaceous when dry.
                    Leaves 7.5–12 cm. long, 4–8 cm. wide, secondary venation inconspicuous, intramarginal vein 3–4 mm. within margin; petiole ca. 1.5 cm. long; vegetative branchlets and branches of inflorescence conspicuously 4-angled; flower buds turbinate. ..... 64. *S. richardsonianum*.
                    Leaves 4.5–7 cm. long, 3.5–5 cm. wide, secondary veins and reticulations easily seen, intramarginal vein 2–3 mm. within the margin; petiole 5–10 mm. long; vegetative branchlets and branches of inflorescence terete or inconspicuously 4-angled; flower buds obconic. ..... 65. *S. sylvicola*.
        47. Leaves chiefly acuminate (in *S. hylophilum* complex also obtuse). ..... (50).

50. Leaves large, 20–37 cm. long, 6–14 cm. wide, primary veins impressed above, prominent below; inflorescence lateral and/or axillary, fascicled, ca. 4 cm. long; flower buds shining when dry. ..... 66. *S. rubro-punctatum.*

50. Leaves smaller, to 20 cm. long, primary veins, although easily seen, usually not so prominent below. ..... (51).

51. Inflorescence open or loose with many flowers. ..... (52).

52. Inflorescence terminal on new growth; leaves not closely reticulate, primary veins obvious above and below. ..... 67. *S. pergamaceum.*

52. Inflorescence chiefly lateral.

Flowers purple; calyx tube narrowly pyriform to turbinate; disc prolonged 1 mm. above and inside area of staminal insertion; leaves closely but inconspicuously reticulate, intramarginal vein 2–4 mm. within margin. ..... 68. *S. pluviatile.*

Flowers white; calyx tube obconic to turbinate with upper part subcampanulate; disc not prolonged; leaves not closely reticulate, intramarginal veins two, the inner 5–8 mm. within margin. ..... 69. *S. tierneyanum.*

51. Inflorescence with fewer flowers (to ca. 10, except sometimes in *S. fibrosum* and *S. malaccense* — to ca. 30). ..... (53).

53. Inflorescence lateral.

Leaves elliptic, 11–24 cm. long, 6–9 cm. wide, petiole 1–2 cm. long. .. 40. *S. malaccense s. l.*

Leaves oblong to narrowly elliptic, 5.5–9 cm. long, 2.5–4.5 cm. wide, petioles ca. 1 cm. long; calyx tube obconic-subcampanulate (in young fruit — past flowering), 8–10 mm. long including 1.5–3 mm. long stipe. ..... 70. *S. roseum.*

53. Inflorescence terminal and axillary, sometimes lateral. ..... (54).

54. Outer calyx lobes ca. 3–5 mm. high, half as wide or less. ..... 71. *S. fibrosum.*

54. Outer calyx lobes ca. 2–3 mm. high, but wider than high.

Inflorescence 2–3 cm. long; fruit white; calyx tube including stipe ca. 1 cm. long. ..... 72. *S. brevicymum.*

Inflorescence to 8 cm. long; fruit red; calyx tube including stipe 1–1.25 cm. long; leaves mostly chartaceous, variable in size, 7–15 cm. long, 2.5–9 cm. wide, with two intramarginal veins, the inner 4–12 mm. within margin; petiole 2–7 mm. long. ..... 73. *S. hylophilum.*

40. Outer calyx lobes not more than 2 mm. high, mostly less. ..... (55).
55. Lateral shoots and inflorescence at base mostly appearing to have pairs of reduced or bract-like or stipule-like leaves; inflorescence slender, often pendent. (As characterized in the segregate genus *Gelpkea* Bl.).
Axis of inflorescence very slender, thread-like, 0.2–0.3 mm. in diameter. ..... 74. *S. aeoranthum.*
Axis of inflorescence slender, 0.8 mm. in diameter. ..... 75. *S. longipes.*
55. Lateral shoots and inflorescences at base mostly without reduced or bract-like leaves. ..... (56).
56. Bracts of inflorescence apparently persistent (except in some specimens of *S. iteophyllum*, *S. pyrocarpum* and *S. dictyophlebium*). ..... (57).
57. Inflorescence short, not more than 2 cm. long.
Inflorescence cymose; calyx tube 3.4–4 mm. long (in original description, truncate), calyx lobes (in bud) 0.5 mm. long; leaves obovate-lanceolate to elliptic, shortly acuminate or subrounded at apex, acute at base; petiole 1–1.5 cm. long. ..... 76. *S. anomalum.*
Inflorescence paniculate; calyx tube 2–2.5 mm. long, calyx lobes scarcely 0.5 mm. long; leaves oblong-lanceolate, narrowed toward both ends, acumen ca. 1 cm. long, base acute; petiole ca. 1 cm. long. ..... 77. *S. pallens.*
57. Inflorescence longer, paniculate, 3–10(–20) cm. long. ..... (58).
58. Leaves with open venation. ..... (59).
59. Leaves chartaceous to subcoriaceous, conspicuously reticulate on upper and lower surfaces. ..... 78. *S. dictyophlebium.*
59. Leaves, if conspicuously reticulate, only so on the lower surface.
Leaves oblong-elliptic, large, 15–25 cm. long, 6–12 cm. wide; inflorescence lateral, large, branches squarrose. ..... 79. *S. acutangulum.*
Leaves smaller, 4–10 cm. long, 2.5–5 cm. wide, primary veins on lower surface (ca. 8 mm. between two adjacent veins) a little more distinct than secondary ones; inflorescence terminal, ca. 4 cm. long. ..... 80. *S. bracteosum.*
58. Leaves with close venation (secondary veins practically as prominent as primary). ..... (60).
60. Inflorescence terminal and axillary. ..... (61).
61. Leaves oblong or broadly oblanceolate-oblong, small, 5–6 cm. long, 2–2.5 cm. wide; primary veins on either side, especially below, barely distinct; flowers sessile, clustered at apices of branchlets of inflorescence. ..... 81. *S. torricellianum.*

61. Leaves larger, 10–16 cm. long, 3.5–9 cm. wide, primary veins usually distinctly manifest; flowers generally single at apices of branchlets of inflorescence.
Bracts of inflorescence short (ca. 0.5 mm. long) and pale, like the calyx lobes; dried flowers crinkly, shining. ..... 82. *S. viburnoides.*
Bracts of inflorescence longer (ca. 1 mm. long); calyx lobes ca. 1 mm. long; dried flowers glandular. ..... 83. *S. fastigiatum.*

60. Inflorescence lateral; also axis and branches of inflorescence with scaly, flaky bark.
Leaves narrowly oblong, apex long-acuminate, 12–18 cm. long, 3.5–4.5 cm. wide, primary veins inconspicuous; calyx tube barely 2 mm. long, shining, wrinkled. ..... 84. *S. iteophyllum.*
Leaves larger, obtusish to acuminate, 27–33 cm. long, 11–14 cm. wide, usually primary and secondary veins (sometimes reticulation also) distinctly manifest; calyx tube ca. 1 cm. long. ..... 85. *S. pyrocarpum.*

56. Bracts of inflorescence caducous or deciduous, i.e. inflorescence at full anthesis usually with only occasional bracts still attached or entirely wanting. ..... (62).

62. Bark of rachis and branchlets of inflorescence brown, scaly and flaky (often minute scales or flakes and not always obvious on newest inflorescence, but here finely sulcate and wrinkled). See also above, *S. iteophyllum* and *S. pyrocarpum.* ..... (63).

63. Inflorescence terminal and from uppermost axils forming subcorymbs; bark on branchlets of inflorescence, if not already exfoliating, appearing shriveled and finely sulcate. ..... 86. *S. buettnerianum.*

63. Inflorescence lateral, borne below the leaves on branches or trunk. ..... (64).

64. Branchlets tetragonous. ..... (65).

65. Leaves small, 5–7 cm. long, 2.5–3 cm. wide, with close venation; very young flowers shining. ..... 87. *S. squamatum.*

65. Leaves larger, 25–40 cm. long, 9–14 cm. wide; dried flowers dull.
Leaves 25–40 cm. long, 9–11 cm. wide, with open venation (secondaries inconspicuous); floral axis finely sulcate, decorticating here and there with minute flakes; young flower buds ca. 7 mm. long. ..... 88. *S. busuense.*
Leaves 27–33 cm. long, 11–14 cm. wide, with close venation (secondary veins and sometimes reticulation almost as obvious as primaries); flower buds ca. 1 cm. long. ..... 85. *S. pyrocarpum.*

64. Branchlets compressed or terete. ..... (66).

66. Leaves oblong-elliptic, acuminate, acumen 0.5–1 cm. long.
    Leaves 8–15 cm. long, 2.5–6.5 cm. wide, narrowed toward both ends; calyx tube pyriform to turbinate, 5–6 mm. long, (dried) longitudinally wrinkled and subsulcate. . . 89. *S. thornei.*
    Leaves 21–23 cm. long, 8.5–10 cm. wide, short cuneate at base; calyx tube obtusely subpyramidal, (dried) smooth. ..... 90. *S. sambogense.*
66. Leaves oblong-elliptic to elliptic with apex rounded or retuse or obtuse or obtusely and very shortly acuminate.
    Calyx tube varying from subcampanulate-obconic to turbinate, ca. 7 mm. long; leaves 5–21 cm. long, 3.5–11 cm. wide; petiole 0.5–1.5 cm. long. ..... 91. *S. furfuraceum.*
    Calyx tube campanulate, ca. 1 cm. long; bracts still plentiful on inflorescence; leaves 27–33 cm. long, 11.5–14 cm. wide; petiole to 2 cm. long. ..... 85. *S. pyrocarpum.*

62. Bark of rachis and branchlets of inflorescence not scaly or flaky. ..... (67).
67. Branchlets narrowly but obviously winged, each decussate pair of wings joining at base and apparently outlining the node (this characteristic not so easily seen in *S. benjaminum*). ..... (68).
68. Leaves 4–12 cm. long, 2.5–4.5 cm. wide, coriaceous, oblong to elliptic, acuminate at apex; petioles 2–5 mm. long; inflorescence paniculate, 8–10 cm. long. ..... 92. *S. taeniatum.*
68. Leaves smaller, 0.5–3.5 cm. long, 0.3–2.8 cm. wide; petioles 1–4 mm. long; inflorescence not more than 4 cm. long. ..... (69).
69. Inflorescence mostly axillary.
    Flowers solitary on short (to 2.5 mm. long) peduncles; leaves mostly small, 0.5–1.5 cm. long, 0.3–1.2 cm. wide. ..... 93. *S. alatum.*
    Flowers sessile in threes or occasionally solitary, on peduncles 0.5–2.5 cm. long; leaves larger, 1.5–3.2 cm. long, 0.8–1.5 cm. wide. ..... 94. *S. benjaminum.*
69. Inflorescence terminal.
    Flowers sessile at apex of branches with a very few short-pedunculate in the uppermost axils; leaves chartaceous, 1–2 cm. long, 1–1.5 cm. wide. ..... 95. *S. adelphicum.*
    Inflorescence a short, compact panicle 1.5–2 cm. long; leaves rigidly coriaceous, 1.5–3.5 cm. long, 1.5–2.8 cm. wide. ..... 96. *S. robbinsii.*
67. Branchlets tetragonous or compressed or terete, or if winged, the wings not outlining the nodes. . . (70).
70. Calyx tube elongate-clavate, at least three times as long as apex is broad. ..... (71).

71. Flower buds almost linear-clavate, about 20 mm. long, at base 3 mm. broad and at apex 5 mm. broad, obviously striate; leaves 9–18 cm. long, 4.5–8 cm. wide, elliptic or oblong-elliptic, obtusely acuminate, stiffly coriaceous when dry, primary veins impressed above, prominent below. ..... 97. *S. schumannianum.*

71. Flower buds clavate, at apex mostly not more than 5 mm. broad, at base (stipitate or not) ca. 1 mm. broad gradually enlarging upward to cyathiform or infundibular upper part; leaves coriaceous or chartaceous, primary veins not impressed above nor prominent below. ... (72).

72. Leaves small, 1.5–3 cm. long, 0.8–1.6 cm. wide, elliptic or oblong-elliptic, obtusish or acutish, stiff when dry; inflorescence terminal and axillary; flower buds very slender, 7–9 mm. long, apex 2.5–3 mm. broad; large tree. ..... 98. *S. carrii.*

72. Leaves generally 3–20 cm. long, 1–6 cm. wide, if smaller, then acuminate; shrubs or small trees. ..... (73).

73. Calyx tube vermicular-rugulose; dried leaves stiffly coriaceous, 3–4.8 cm. long, 1–2.7 cm. wide. ..... 99. *S. bicolor.*

73. Calyx tube glandular and sometimes striate but not vermicular-rugulose. .... (74).

74. Leaves 4–9 cm. long, 2.5–4 cm. wide, elliptic with acuminate apex tending to recurve, coriaceous, venation almost invisible; inflorescence terminal; calyx tube very slender, slightly angled, 5–8 mm. long, apex 2–2.5 mm. broad. ..... 100. *S. attenuatum.*

74. Leaves elliptic to oblong with long or short acumen not especially recurved, thinly coriaceous. ..... (75).

75. Inflorescence chiefly axillary and lateral; flowers variable in size; leaves 6–15 cm. long, 2.5–5.5 cm. wide, elliptic or oblong, acuminate, acute or obtusish; branchlets terete. ..... 101. *S. claviflorum.*

75. Inflorescence terminal and axillary; calyx tube glandular, sometimes striate. Branchlets sharply tetragonous, leaves 3.5–7 cm. long, 1.3–2.8 cm. wide, elliptic with cuneate base, acuminate (acumen 0.5–1.5 cm. long), thinly coriaceous to chartaceous; calyx tube 13–16 mm. long (including broader upper 3 mm.), at apex 3.5–4 mm. broad. ..... 102. *S. leptopodium.*

Branchlets terete; leaves 22–27 cm. long, 5–9 cm. wide, oblong with cor-

date or emarginate base; calyx tube 16 mm. long, apex 2–2.5 mm. broad. ..... 103. *S. subamplexicaule.*

70. Calyx tube not elongate-clavate, if clavate less than three times as long as apex is broad. .. (76).
76. Leaves with open venation, i.e. secondary veins mostly not parallel with primary, or, if originating at midrib, joining others before reaching intramarginal vein formed by confluent primaries. ..... (77).
77. Leaf base cordate or emarginate. ..... (78).
78. Leaves about twice as long as broad, 12–20 cm. long, 5.5–10 cm. wide, emarginate at base; panicle from defoliated branchlets, also terminal; calyx tube 4–5 mm. long. ..... 104. *S. nemorale.*
78. Leaves more than twice as long as broad, cordate at base.
Leaves very large, 52–87 cm. long, 15–34 cm. wide; inflorescence on the lower stem (not seen); infructescence with rachis 9 cm. long. ..... 105. *S. megistophyllum.*
Leaves large, 37 cm. long, 13 cm. wide; inflorescence terminal (not seen); infructescence 11 cm. long ..... 106. *S. camptodromum.*
77. Leaf base subrounded or rounded or rounded-cuneate or cuneate. ..... (79).
79. Inflorescence terminal and axillary (also lateral in *S. trivene*). ..... (80).
80. Leaves at least five times as long as broad.
Leaves linear-lanceolate, 4–9 cm. long, 0.8–1.3 cm. wide; inflorescence axillary, 3–9-flowered. ..... 107. *S. naiadum.*
Leaves lanceolate, 6–14 cm. long, 1–2 cm. wide; inflorescence axillary, 1–3-flowered (mostly single-flowered). ..... 59. *S. saliciforme.*
80. Leaves less than five times as long as broad. ..... (81).
81. Axis of inflorescence very short, flowers crowded at apex of stem or fewer in leaf axils, either suggesting a head. ..... 108. *S. capituliferum.*
81. Axis of inflorescence 5 cm. or more long. ..... (82).
82. Primary veins extending to the indurated cartilaginous margin of the leaves. ..... 109. *S. cartilagineum.*
82. Primary veins confluent to form an intramarginal vein within the margin. ..... (83).

83. Leaves elliptic with rounded or very short-acuminate apex, stiffly coriaceous when dry. ..... (84).
84. Leaves 4.5–7 cm. long, 3.5–5 cm. broad, reticulation easily seen. ..... 65. *S. sylvicola.*
84. Leaves 7–15 cm. long, 3.5–11 cm. wide, reticulation not readily seen.
Leaves mostly with short, recurved, obtuse acumen; fruit with calyx rim only a circular scar, umbilicate apex very shallow, saucer-like; mature flower buds 7–8 mm. long. .. .. 110. *S. subglobosum.*
Leaves obtuse or retuse at apex; fruit with calyx rim ca. 1 mm. high, umbilicate apex ca. 3 mm. deep; flower buds ca. 10 mm. long. ..... 111. *S. rubiginosum.*
83. Leaves coriaceous or thinly coriaceous or chartaceous when dry. ..... (85).
85. Calyx tube 2–3 mm. long; leaves lanceolate, narrowed into subfalcate acumen, principal veins and reticulation slightly paler in color and readily seen on the lower surface. .... 112. *S. triphlebium.*
85. Calyx tube 4–9 mm. long; leaves various, but veins and reticulation (whether obvious or not) drying the same color as the leaves. ..... (86).
86. Axes and branchlets of inflorescence thickish, a little more than 1 mm. in diameter, perhaps inflorescence terminal on year-old growth.
Calyx tube 8 mm. long, apex 5 mm. broad; leaves chartaceous, lanceolate or lance-elliptic, 15–25 cm. long, 5–12 cm. wide, base cuneate or obtuse. .... 113. *S. waterhousei.*

Calyx tube 4–5 mm. long, apex 3 mm. broad; leaves coriaceous, lance-ovate to elliptic, 6–10 cm. long, 2–5 cm. wide, base cuneate. ..... 114. *S. nitidum.*

86. Axes and branchlets of inflorescence a little more slender, 0.6–0.8 mm. in diameter.

Leaves at base subrounded, slightly decurrent, apex gradually and obtusely acuminate; flower buds 5–7 mm. long. ..... 115. *S. lorentzianum.*

Leaves at base cuneate, apex usually abruptly acuminate; flower buds 4–5 mm. long. ..... 116. *S. trivene.*

79. Inflorescence lateral (terminal in some specimens of *S. dictyophlebium*). ..... (87).

87. Calyx shining, wrinkled.

Leaves oblanceolate or suboblong, primary veins moderately prominent; only flower buds seen; calyx tube 4–4.5 mm. long including short (0.5 mm.) stipe, outer calyx lobes ca. 1.5 mm. high. ..... 117. *S. verniciflorum.*

Leaves elliptic to elliptic-lanceolate, acuminate, primary veins 5–10 mm. apart but sometimes almost as inconspicuous as the secondaries (hence, difficult to determine whether leaf has open or close venation); calyx tube ca. 3 mm. long, lobes less easily seen than in *S. verniciflorum.* ..... 118. *S. flavescens.*

87. Calyx dull, not noticeably shining. ..... (88).

88. Inflorescence with relatively few flowers.

Leaves coriaceous, primary veins more easily seen above than below, intramarginal vein not very well marked; inflorescence short, 2–3 cm. long. ..... 70. *S. roseum.*

Leaves chartaceous, primary veins more easily seen on the lower surface, inner intramarginal vein 4–11 mm. within margin; inflorescence 4–8 cm. long. ..... 73. *S. hylophilum.*

88. Inflorescence profusely many-flowered. ..... (89).

89. Leaves at least four times as long as wide; calyx tube globose-urceolate, very shortly (if at all) stipitate. ..... 119. *S. brassii.*

89. Leaves nearer twice or three times as long as wide; calyx tube ob-

conic to turbinate, infundibular or subcampanulate at apex of stipe. . . . . (90).

90. Leaves with rounded base and apex; inflorescence borne on trunk and main branches. . . . . 120. *S. kietanum.*

90. Leaves with cuneate base and acuminate to rounded apex. . . (91).

91. Leaves with inconspicuous reticulation. . . . . 69. *S. tierneyanum.*

91. Leaves with easily seen reticulation.

Calyx tube 4.5–5 mm. long, slenderly obconic, outer calyx lobes 1.5 mm. long; petals falling separately. . . . . 78. *S. dictyophlebium.*

Calyx tube (3–)6–7 mm. long, obtusely obconic, almost truncate or outer calyx lobes not more than 0.5 mm. high; petals calyptrate. . . . . 121. *S. branderhorstii.*

76. Leaves with close venation, i.e. either primaries and secondaries are scarcely distinguishable, or primaries fine but more easily seen than secondaries which seem to run parallel with them at least two-thirds of the distance to the intramarginal vein. . . . . (92).

92. Flowers solitary; leaves slender, 4–8 cm. long, 1–2.3 cm. wide. . . . . 60. *S. uniflorum.*

92. Inflorescence cymose or paniculate. . . . . (93).

93. Inflorescence chiefly lateral, occasionally terminal and axillary. . . . . (94).

94. Leaves elliptic, acuminate, 7–14 cm. long, 3–5.5 cm. wide; inflorescence widely branching.

Calyx tube ca. 5 mm. long, when dried subangled and tending to be striate toward base, outer lobes 1–1.5 mm. long. . . . . 122. *S. leptophlebioides.*

Calyx tube 4–5 mm. long, apex undulate or 4-dentate with rounded teeth. . . . . 123. *S. decipiens.*

94. Leaves elliptic, shortly and obtusely acuminate or obtusish. . . . . (95).

95. Leaves (when dry) shining, greenish or brownish green; stipe of calyx tube approximately as long as infundibular-subcampanulate upper part of the tube. . . . . 124. *S. rosaceum.*

95. Leaves (when dry) not shining, brownish; inflorescence not seen.
Leaves shortly and obtusely acuminate, 3.5–6.5 cm. long, 1.3–3 cm. wide; branchlets 4-angled; fruit globose-urceolate with very short stipe. .... 125. *S. badium.*
Leaves obtusish or with very short obtuse acumen, 12–18 cm. long, 3.5–9 cm. wide; branchlets slightly compressed; fruit pyriform or subobovoid, on numerous panicles (in type collection, axes 13–20 cm. long) in scattered clusters along the trunk. ..... 126. *S. acetosum.*

93. Inflorescence usually terminal and/or axillary. ..... (96).
96. Leaves abruptly and obtusely acuminate or obtusish or rounded or acutish. (97).
97. Leaves broadly linear-oblong, 4.5–13 cm. long, 1.3–3.5 cm. wide, veins very fine; branchlets 4-angled. ..... 127. *S. leptoneurum.*
97. Leaves not linear-oblong. ..... (98).
98. Leaves oblanceolate or elliptic, 10–14 cm. long, 4–7.5 cm. wide.
Leaves thickly coriaceous; fruits tending to be globose. ..... 128. *S. micrandrum.*
Leaves chartaceous; fruits oblong (about twice as long as broad). .... 129. *S. myriadenum.*

98. Leaves usually obovate, 4–10 cm. long, 1.5–5.5 cm. wide. ..... (99).
99. Reticulation practically as visible as primary and secondary veins; branchlets 4-angled. ..... 130. *S. homichlophilum.*
99. Reticulation less easily seen than the primary and secondary veins. ..... (100).
100. Leaves obovate, narrowed to petiole, apex rounded or sometimes with short, narrow, obtuse acumen, venation mostly inconspicuous or obscure; flowers small; calyx 2.5–4.5 mm. long, apex truncate or repand or definitely lobed, lobes ca. 0.5 mm. long, stipe 0.5–1.5 mm. long; fruit white. ..... 131. *S. effusum s. l.*
100. Leaves, if obovate and venation inconspicuous, then flowers larger, calyx tube more than 5 mm. long.

Dried specimens dark brown or red-brown; inflorescence mostly protruding beyond the leaves; calyx tube 7–9 mm. long; venation on lower leaf surface very inconspicuous. ..... 132. *S. subcorymbosum.*

Dried specimens brownish green or olive-green; inflorescence sometimes terminal but mostly lateral; calyx tube 9–12 mm. long; venation on lower leaf surface easily seen. ..... 124. *S. rosaceum.*

96. Leaves long-acuminate, mostly with slender, tapering acumen. ..... (101).
101. Leaves lanceolate, 6–8 cm. long, 1–1.7 cm. wide. .... 61. *S. xylopiaceum.*
101. Leaves broader than the above. ..... (102).
102. Inflorescence short (2–2.5 cm. long); leaves ovate with acumen ca. one-third the length of the leaf. ..... 133. *S. luehmannii.*
102. Inflorescence longer (4–8 cm. long); leaves with acumen ca. one-fourth the length of the leaf. ..... (103).
103. Calyx tube obconic-subcampanulate, 5 mm. long, apex 6 mm. in diameter, base ca. 1 mm. stipitate. ..... 134. *S. walkeri.*
103. Calyx tube clavate-pyriform or infundibular, 2.5–6 mm. long, apex up to 3 mm. in diameter, stipe of various lengths. (104).
104. Calyx tube stipitate-cyathiform, ca. 6 mm. long, apex a little over 2 mm. in diameter; leaves coriaceous, drying brown or dark brown, acumen almost linear. ..... 135. *S. rostratum.*
104. Calyx tube 2.5–3.5 mm. long, apex a little over 2 mm. in diameter; leaves thinly coriaceous to chartaceous. .. .. (105).
105. Leaves oblong-elliptic, 4.5–7 cm. long (including acumen 1 cm. long), 1.5–3.5 cm. wide, narrowed toward both ends; calyx tube infundibular 2.5–3 mm. long, stipitate. ..... 136. *S. plumeum.*

105. Leaves ovate-elliptic, 7–12 cm. long (including acumen 1–2 cm. long), 2.5–5 cm. wide; calyx tube 2.5–3 mm. long.
Calyx tube infundibular, stipitate; fruit depressed-globose. ..... 137. *S. finisterrae*.
Calyx tube clavate-pyriform; fruit cylindrical. ..
..... 138. *S. onesimum*.

1. **Syzygium cauliflorum** Hartley & Perry, sp. nov.

Arbor gracilis 8–10 m. alta; ramulis compressis puberulis, brunnescentibus, pilis brevissimis; foliis 12.5–16 cm. longis, 3–4.5 cm. latis (interdum paribus minoribus 1.5 cm. longis, 0.5 cm. latis inter majora), lanceolatis vel lineari-lanceolatis disperse pellucido-punctatis, apice ca. 1.5 cm. acuminatis, basi rotundatis vel leviter emarginatis, venis primariis ca. 17–20, inter se 5–10 mm. distantibus in venam intramarginalem a margine 2–4 mm. conjunctis; petiolo 2–3 mm. longo, puberulo; floribus (alabastris tantum visis) 1–2 in ramis puberulis brevibus (2–3.5 cm. longis) suffultis, et secus longitudinem trunci dispersis, apice ramorum bifoliato, foliis 5–6.5 cm. longis, 1 cm. latis, pedunculis 1–1.5 cm. longis, puberulis; calycis tubo basi ca. 3 mm. stipitato deinde turbinato vel fere late obconico, usque ad lobos (stipite 3 mm. incluso) ca. 2 cm. longo, lobis 5–7 mm. altis. HOLOTYPUS: *Brass 23608* (A).

Papua. MILNE BAY DISTRICT: Maneau Range, N slopes of Mt. Dayman, in oak forest substage, alt. 900 m., *Brass 23608*.

Among the species described from New Guinea this is perhaps nearest to *Syzygium polyphlebium* (Diels) Merr. & Perry. We have no material to represent the latter, and the original descriptions are based on different stages of development. *Syzygium polyphlebium* is described as a shrub 1.5 m. tall with leaves twice as large and with twice as many primary lateral veins. No information is given about the axes of the inflorescences (whether there are any or not) but the fact that the calyx lobes are obsolete in Diels' species would seem to set it apart from the plant here described, as does the pubescence of the branchlets, petioles, and peduncles of *S. cauliflorum*.

2. **Syzygium megalospermum** (Lauterb. & K. Schum.) Merr. & Perry, Jour. Arnold Arb. **23**: 264. 1942.

Jambosa megalosperma Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 472. 1901. TYPE: *Lauterbach 2434*, Territory of New Guinea, Madang District, Schumann River.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; lowland and foothill rain forests to about 360 meters.

3. **Syzygium porphyrocarpum** (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 250. 1942.

Eugenia porphyrocarpa Greves, Jour. Bot. **61**(Suppl.): 17. 1923. TYPE: *Forbes 298*, Papua, Central District, Sogeri, Mt. Wori-Wori (BM, holotype; A, carbon rubbings, notes).

DISTRIBUTION: Territory of New Guinea, Papua; foothill and montane rain forests, 500–2000 meters.

4. **Syzygium cladopterum** (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

Jambosa cladoptera Diels, Bot. Jahrb. **57:** 391. 1922. TYPE: *Schlechter 17337*, Territory of New Guinea, Madang District, Djamu.

DISTRIBUTION: Territory of New Guinea, Papua; lowland and foothill rain forests to 800 meters.

5. **Syzygium macrocalyx** Merr. & Perry, Jour. Arnold Arb. 23: 253. 1942. TYPE: *Clemens 3078*, Territory of New Guinea, Morobe District, Sattelberg, 1000 m. (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

6. **Syzygium flavidum** Hartley & Perry, sp. nov.

Arbor ca. 18 m. alta; ramulis compressis, pallide brunnescentibus; foliis leviter coriaceis, sub lente minute sed profuse pellucido-punctatis, olivaceis, ellipticis, 24–25 cm. longis, 11–11.5 cm. latis, apice acuminatis, basi cuneatis, venis primariis utrinsecus 8–10 supra manifestis subtus prominulis, secundariis subobscuris; petiolo 1–1.5 cm. longo; floribus (alabastris tantum visis) lateralibus vel terminalibus, solitariis vel 2–3-fasciculatis (?), pedunculatis, pedunculo ca. 1.2–3 cm. longo (vel fortasse pedunculo usque ad 5 mm. longo et pedicello 1–2.7 cm. longo); calycis tubo sub lobis 3–3.5 cm. longo, turbinato-obconico-stipitato, parte inferior superiore longiore; lobis 5–7 mm. altis. HOLOTYPUS: *Hartley 9936* (A).

Territory of New Guinea. MOROBE DISTRICT: near the Busu River about 7 miles N of Lae, lowland rain forest at about 60 m., *Hartley 9936*.

Although the leaves are larger, in general they resemble those of *Syzygium gonatanthum* in the distance between the primary veins, but the flower buds are about twice as large as the flowers of *S. gonatanthum*.

7. **Syzygium nutans** (K. Schum.) Merr. & Perry, Jour. Arnold Arb. 23: 263. 1942.

Eugenia nutans K. Schum. in K. Schum. & Hollr. Fl. Kaiser Wilhelms Land 90. 1889. TYPE: *Hollrung 818*, Territory of New Guinea, Sepik District (K, isotype; A, phot.).
Jambosa nutans (K. Schum.) Niedenzu, Nat. Pflanzenfam. III. **7:** 84. 1893.

DISTRIBUTION: Territory of New Guinea, Papua; lowland and foothill rain forests to 1050 meters.

8. **Syzygium insulare** Hartley & Perry, sp. nov.

Arbor usque 7.5 m. alta; ramulis brunnescentibus; foliis ellipticis vel elliptico-ovatis, 15–25 cm. longis, 6–9 cm. latis, apice acuminatis, basi rotundatis vel interdum obtusis, supra atrovirentibus, subtus pallidioribus,

venis primariis utrinsecus costa 10–14, utrinque distincte manifestis, venis reticulatis visis sed inconspicuis; petiolo 5–8 mm. longo crassiusculo supra canaliculato; floribus albis solitariis axillaribus et terminalibus, magnis; pedunculis pedicellisque 5 mm. longis; calycis tubo 1.8 cm. longo, obconico, lobis exterioribus 5 mm. longis, interioribus ± 8 mm. longis, petalis ca. 2 cm. longis; fructibus ovoideis usque 8(–15) cm. longis, rubris. HOLOTYPUS: *Floyd NGF 3546* (A).

Bismarck Archipelago. NEW BRITAIN: West Nakanai, Galilo village, near Cape Hoskins, *Floyd NGF 3546*; Talasea Subdistrict, upper slopes and summit of Mt. Lollo, an extinct volcano, alt. ca. 800 m., *NGF 10850*; foot of Mt. Bango, in *Pandanus* swamp, *NGF 10892*. **Solomon Islands.** BOUGAINVILLE: Karngu, Buin, *Kajewski 2248*. GUADALCANAL: Mt. Austin, ridge rain forest, alt. ca. 240 m., *BSIP 65*; Berande, rain forest at sea level, *Kajewski 2400*. SAN CRISTOBAL: Waimamura, *Brass 2649*.

In an earlier work (cf. Jour. Arnold Arb. 23: 263. 1942) Merrill and Perry associated the collections from the Solomon Islands with *Syzygium nutans*, noting that there were differences in the color of the flowers and the size of the fruits. However, now that we have at hand several collections of *S. nutans* as well as the photograph of the isotype in Kew, we are satisfied that the above cited specimens represent a distinct species. All the attached mature flowers on specimens of *S. nutans* have a short, bent axis so that the flowers are cernuous; in *S. insulare* it is difficult to tell since the flowers are all detached except one very small bud (6 mm. long) which is upright; the remains of the floral or fruiting axes, however, point upward, and the flowers are white.

9. **Syzygium burepense** Hartley & Perry, sp. nov.

Arbor ca. 10.5 m. alta, ramulis hornotinis ca. 4 mm. diametro brunnescentibus, novellis compressis; foliis coriaceis non pellucido-punctatis, obovato-ellipticis, 19–21.5 cm. longis, 7.5–9.5 cm. latis, basi fere rotundato-cuneatis, apice abrupte et breviter acuminatis, costa supra canaliculata subtus elevata, venis primariis utrinsecus costa ± 12 oblique patento-adscendentibus in venam intramarginalem ca. 4–7 mm. a margine distantem confluentibus, supra leviter impressis, subtus prominulis; petiolo 5–10 mm. longo; floribus lateralibus (in specimine typico) in ramulis ± 1 cm. diametro suffultis, ut videtur oppositis, singulis vel 2–3 a nodo oriundis; pedunculo ca. 5 mm. longo, pedicello ca. 3 mm. longo; calycis tubo 2–2.2 cm. longo, obtuse obconico, basi ca. 5 mm. diametro, sub lobis ca. 17 mm. lato; lobis 7–10 mm. altis; corolla pallide rosea; staminibus albis. HOLOTYPUS: *Hartley 11054* (A).

Territory of New Guinea. MOROBE DISTRICT: Burep River, ca. 15 miles NE of Lae, stream margin of lowland rain forest, alt. ca. 15 m., *Hartley 11054*.

We are at a loss to recognize the nearest relative of this new species. Its very short peduncle and pedicel suggest *Syzygium macrocalyx* but in the latter the infructescence is terminal and the leaves are smaller but

with similar venation. Also, the rugose fruit would seem to indicate a somewhat costate flower (flowering material not yet seen).

10. **Syzygium dolichophyllum** (Lauterb. & K. Schum.) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

Jambosa dolichophylla Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 471. 1901. TYPE: *Rodatz & Klink*, Territory of New Guinea, Bismarck Range.

DISTRIBUTION: West Irian, Territory of New Guinea; lowland and foothill rain forests to 1100 meters.

11. **Syzygium callianthum** Merr. & Perry, Jour. Arnold Arb. 23: 252. 1942. TYPE: *Brass 4146*, Papua, Central District, Mt. Tafa (A, holotype).

DISTRIBUTION: Papua; foothill and montane rain forests, 1400–2100 meters.

12. **Syzygium keysseri** (Schlechter) Merr. & Perry, Jour. Arnold Arb. 23: 253. 1942.

Jambosa keysseri Schlechter, Bot. Jahrb. **62:** 485. 1929. TYPE: *Keysser*, Territory of New Guinea, Morobe District, Sarawaket Range.

DISTRIBUTION: West Irian, Territory of New Guinea; montane rain forests, 2200–3000 meters.

13. **Syzygium daphne** (Ridley) Merr. & Perry, Jour. Arnold Arb. 23: 254. 1942.

Eugenia daphne Ridley, Trans. Linn. Soc. Bot. II. **9:** 45. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition (BM, holotype; A, phot.).

DISTRIBUTION: West Irian; along streams and in secondary growth in lowland and foothill forests.

14. **Syzygium trachyanthum** (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

Jambosa trachyantha Diels, Bot. Jahrb. **57:** 394. 1922. TYPE: *Ledermann 10871*, Territory of New Guinea, Sepik District, Malu.
Jambosa lagynocalyx Diels, *Ibid.*
Syzygium lagynocalyx (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

DISTRIBUTION: Territory of New Guinea, Papua; lowland, foothill and montane rain forests to 1800 meters.

15. **Syzygium salicinum** (Ridley) Merr. & Perry, Jour. Arnold Arb. 23: 254. 1942.

Eugenia salicina Ridley, Trans. Linn. Soc. Bot. II. **9**: 45. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition (BM, holotype; A, phot.).

DISTRIBUTION: West Irian, Papua; apparently restricted to stream banks in lowland and foothill forests.

16. **Syzygium pyriforme** Merr. & Perry, Jour. Arnold Arb. **23**: 259. 1942. TYPE: *Brass 6966*, Papua, Western District, Palmer River (A, holotype).

DISTRIBUTION: Papua; lowland and foothill rain forests to 1100 meters.

17. **Syzygium erythropetalum** Hartley & Perry, sp. nov.

Arbor ca. 17 m. alta; ramulis compressis cinereis; foliis 3.5–6 cm. longis, 1.3–2.5 cm. latis, coriaceis copiose pellucido-punctatis, in sicco fusco-brunnescentibus subtus pallidioribus, apice acuminatis, basi acutis, venis primariis utrinsecus costa ± 5 irregulariter inter se distantibus in venam intramarginalem (1.5–4 mm. intra marginem) confluentibus subtus prominentibus praecipue in parte inferiore laminae, secundariis utrinque visis sed inconspicuis; petiolo 3–6 mm. longo; floribus solitariis (?), pedunculo articulato vel pedunculo et pedicello 1–1.5 cm. longis; calycis tubo basi 1–2 mm. stipitato deinde 10–12 mm. longo campanulato; lobis 3–5 mm. altis; petalis 1–1.5 cm. longis, 1–1.2 cm. latis, rubescentibus; filamentis roseis. HOLOTYPUS: *Hoogland & Pullen 6059* (A).

Territory of New Guinea. WESTERN HIGHLANDS DISTRICT: near Tomla village, S slope of Mt. Hagen Range, forest on steep slope, alt. 2600 m., *Hoogland & Pullen 6059*.

This species is perhaps nearest to *Syzygium subalatum* (incl. *S. soliflorum*), but the venation of the leaves seems to differ in that the primary veins leave the midrib irregularly, and the prominent intramarginal vein seems to begin 2–7 mm. above the base of the leaf.

18. **Syzygium subalatum** (Ridley) Merr. & Perry, Jour. Arnold Arb. **23**: 249. 1942.

Eugenia subalata Ridley, Trans. Linn. Soc. Bot. II. **9**: 44. 1916; Greves, Jour. Bot. **61**(Suppl.): 18. 1923. TYPE: *B. Kloss*, West Irian, Wollaston Expedition (BM, holotype; A, phot.).
Jambosa soliflora Diels, Bot. Jahrb. **57**: 393. 1922.
Syzygium soliflorum (Diels) Merr. & Perry, Jour. Arnold Arb. **23**: 254. 1942.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; foothill and montane rain forests, 210–3200 meters.

19. **Syzygium sogerense** (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 250. 1942.

Eugenia sogerensis Greves, Jour. Bot. **61**(Suppl.): 18. 1923. SYNTYPES: *Forbes*

372, *408*, *725*, Papua, Central District, Sogeri and Mt. Wori-Wori (BM; A, isosyntype — *Forbes 372*).

DISTRIBUTION: Papua. Known only from the Forbes collections originally cited.

20. **Syzygium tympananthum** (Diels) Merr. & Perry, Jour. Arnold Arb. **23**: 255. 1942.

Jambosa tympanantha Diels, Bot. Jahrb. **57**: 393. 1922. TYPE: *Schlechter 17949*, Territory of New Guinea, Madang District, Finisterre Range.

DISTRIBUTION: West Irian, Territory of New Guinea; primary and secondary lowland and foothill rain forests, 180–1500 meters.

21. **Syzygium gonatanthum** (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 256. 1942.

Jambosa gonatantha Diels, Bot. Jahrb. **57**: 384. 1922. TYPE: *Ledermann 10620*, Territory of New Guinea, Sepik District, Malu (B, holotype; A, phot.).
Eugenia forbesii Greves, Jour. Bot. **61**(Suppl.): 16. 1923.
Syzygium forbesii (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 261. 1942.

DISTRIBUTION: Territory of New Guinea, Papua; lowland and foothill rain forests to 1400 meters.

22. **Syzygium thomsenii** (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

Jambosa thomseni Diels, Nova Guinea (Bot.) **14**: 91. 1924. TYPE: *Thomsen 658*, West Irian, Mamberamo District, Pionierbivak (L, isotype; A, phot.).

DISTRIBUTION: West Irian; lowland rain forest at 75 meters.

23. **Syzygium thalassicum** Merr. & Perry, Jour. Arnold Arb. **23**: 258. 1942. TYPE: *Brass 2971*, Solomon Islands, Ulawa (A, holotype).

DISTRIBUTION: Solomon Islands; ocean foreshores or beach rain forest. Cultivated in Hawaii.

24. **Syzygium novoguineense** Merr. & Perry, Jour. Arnold Arb. 23: 286. 1942. TYPE: *Zippelius* (L, holotype; A, carbon rubbing). "Myrtus auriculata Herb. Zipp. ex parte." Only data in next ref. *Jambosa auriculata* Bl. Mus. Bot. Lugd.-Bat. 1: 104. 1849, non *S. auriculatum* Brongn. & Gris (1865).

DISTRIBUTION: West Irian, Territory of New Guinea; lowland rain forests.

25. **Syzygium goniocalyx** (Lauterb.) Merr. & Perry, Jour. Arnold Arb. 23: 262. 1942.

Jambosa goniocalyx Lauterb. Nova Guinea (Bot.) 8: 851. 1912. TYPE: *von Roemer 223*, West Irian, south coast (L, isotype; A, phot.).

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; lowland and foothill rain forests to 1350 meters.

26. **Syzygium madangense** Hartley & Perry, sp. nov.

Arbor fruticosa usque 6 m. alta; ramulis ut videtur annotinis rotundatis fusco-cinereis; foliis tenuiter coriaceis, ovato-ellipticis, 25–29 cm. longis, 13.5–15 cm. latis, basi rotundatis usque cordatis, apice acuminatis, venis primariis utrinsecus costa ± 10 oblique patentibus irregulariter conjunctis sed non venam intramarginalem formantibus, subtus prominulis, secundariis interdum visis; petiolo brevissimo vel nullo; floribus axillaribus vel terminalibus subsessilibus conglomeratis magnis; in sicco calycis tubo obconico ± 8-costato, 2.5–2.7 cm. longo, basi ca. 4 mm. diametro, apice subtus lobis ca. 1.8 cm. diametro; lobis 5–8 mm. longis interdum carinatis; petalis cremeis apice persicinis. HOLOTYPUS: *K. J. White NGF 10300* (A).

Territory of New Guinea. MADANG DISTRICT: Josephstaal, one mile W of Pondoma village, alt. 75 m., *K. J. White NGF 10300.*

The dried ribbed calyx strongly resembles that of *Syzygium goniocalyx* but lacks the lower narrowed attenuate part which forms a stalk on the fruit of that species; however, the leaves of the two are quite different at the base. The end of a branchlet of our new species shows at least four clustered protrusions each marked by 2–5 scars not all of which appear to be the same age; however, no flowers are attached.

27. **Syzygium heterobotrys** Merr. & Perry, Jour. Arnold Arb. 23: 257. 1942. TYPE: *Brass 8238*, Papua, Western District, Lower Fly River, rain forest substage (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

28. **Syzygium lagerstroemioides** Merr. & Perry, Jour. Arnold Arb. 23: 262. 1942. TYPE: *Brass 1393*, Papua, Milne Bay District, Kurandi (A, holotype).

DISTRIBUTION: Territory of New Guinea, Papua; generally along streams in lowland, foothill and lower montane rain forests to 1570 meters.

29. **Syzygium randianum** Merr. & Perry, Jour. Arnold Arb. 23: 264. 1942. TYPE: *Brass 6673*, Papua, Western District, Upper Fly River, flood banks of creek at 80 m. (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

30. **Syzygium normanbiense** Hartley & Perry, sp. nov.

Arbor magna usque 35 m. alta; ramulis obtuse angulatis partim decorticatis; foliis 14.5–16.5 cm. longis, 6–8.5 cm. latis, disperse pellucido-punctatis, supra brunnescentibus, subtus olivaceis, ellipticis apice plerumque recurvato-acuminatis, basi breviter cuneatis vel fere attenuatis, venis primariis utrinsecus costa ± 20 prominulis oblique patentibus, secundariis et reticulo fere aequaliter prominulis; petiolo 1.5–2 cm. longo; inflorescentiis terminalibus, axe ca. 5 cm. longo, ramulis paucis, 1–2 cm. longis; floribus sessilibus, albis; bracteis non visis; calycis tubo ca. 1.5 cm. longo, ad basin 5 mm. diametro in parte inferiore fere cylindrico deinde versus apicem sub lobis subabrupte ampliato ± 1 cm. diametro; lobis 5–7 mm. longis, rotundatis. HOLOTYPUS: *Brass 25478* (A).

Papua. MILNE BAY DISTRICT: Normanby Island, Waikaiuna, rain forest of lower ridges, alt. 20 m., *Brass 25478*.

Perhaps this species is near *Syzygium caryophylloides*. It differs in the acuminate (not subacute or subrounded) leaf tips, larger inflorescence and flowers, and apparently caducous bracts. The flower buds are similar in shape to those of *S. randianum*, but considerably smaller.

31. **Syzygium suborbiculare** (Benth.) Hartley & Perry, comb. nov.

Eugenia suborbicularis Benth. Fl. Austral. **3:** 285. 1866. SYNTYPES: *W. Hill*, Queensland, Cape York (K); *A. Cunningham*, Queensland, Endeavour River.
Careya jambosoides Lauterb. Nova Guinea (Bot.) **8:** 313. 1910.
Eugenia jambosoides (Lauterb.) O. Schwarz, Repert. Sp. Nov. **24:** 90. 1927.
Syzygium jambosoides (Lauterb.) Merr. & Perry, Jour. Arnold Arb. **23:** 262. 1942.

West Irian. Merauke, *Versteegh BW 60*. **Papua.** WESTERN DISTRICT: Lower Fly River (east bank), Gaima, *Brass 8301*. **Australia.** NORTHERN TERRITORY: Darwin, *Schultz 557* (K); *Specht 1080* (A, K). QUEENSLAND: Cape York, *Damel* (K), *Moseley* (Challenger Expedition) (K), *Hill 41* (K), *136* (K).

The Australian specimens listed from Kew were borrowed to confirm our belief that the New Guinea collections designated as *Syzygium jambosoides* belong to this Australian species. The habitats given are savannah forest, or landward edge of coastal dune, or mixed open forest at base of sandstone scarp.

32. **Syzygium leonhardii** (Diels) Merr. & Perry, Jour. Arnold Arb. **23:** 258. 1942.

Jambosa leonhardii Diels, Bot. Jahrb. **57:** 384. 1922. TYPE: *Schultze Jena 177*, Territory of New Guinea, Sepik District.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; swampy woods or floodplain rain forest to about 1200 meters.

We have seen no authentic material of this species. Consequently, just as in many other instances, we have tried to estimate the variability of the characters from the original description and the key. In Diels' key we find the species listed in the part where the flowers are described thus: lower part of the receptacle (i.e. calyx tube) cylindric, longer than the upper. In the description: petiole 7–15 mm. long. These characters are mentioned in particular since a specimen collected in the Botanic Gardens, Bogor, seems to belong here; it has petioles 2.5–3 cm. long and flowers with the tubular part of the calyx tube ca. 2 cm. long and the enlarged upper part scarcely 1 cm. long — but it bears the name of another species.

33. **Syzygium vernicosum** Merr. & Perry, Jour. Arnold Arb. **23**: 260. 1942. TYPE: *Brass 8113*, Papua, Western District, Lower Fly River (A, holotype).

DISTRIBUTION: Papua; lowland and foothill rain forests.

34. **Syzygium synaptoneurum** (Lauterb. & K. Schum.) Merr. & Perry, Jour. Arnold Arb. **23**: 249. 1942.

Jambosa synaptoneura Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 475. 1901. TYPE: *Lauterbach 2356*, Territory of New Guinea, Madang District, Ssigaun (Sigaun).

DISTRIBUTION: West Irian, Territory of New Guinea; lowland rain forest.

The collections we have placed in this species do not have winged branchlets. The flowers and leaves, however, seem approximately to suit the description although the inflorescence is on old nodes as well as axillary and terminal on recent growth.

35. **Syzygium evenulosum** Merr. & Perry, Jour. Arnold Arb. **23**: 261. 1942. TYPE: *Brass & Versteegh 14108*, West Irian, Idenburg River, Bernhard Camp, foothill rain forest at 80 m. (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

36. **Syzygium versteegii** (Lauterb.) Merr. & Perry, Jour. Arnold Arb. **23**: 256. 1942.

Jambosa versteegii Lauterb. Nova Guinea (Bot.) **8**: 321. 1910. TYPE: *Versteeg 1386*, West Irian, Lorentz River (L, isotype; A, phot.).

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; lowland rain forests to 125 meters.

37. **Syzygium pachycladum** (Lauterb. & K. Schum.) Merr. & Perry, Jour. Arnold Arb. **23**: 258. 1942.

Jambosa pachyclada Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl.

Deutsche Schutzgebiete Südsee 474. 1901. TYPE: *Lauterbach 2841*, Territory of New Guinea, Madang District, Schumann River.

DISTRIBUTION: Territory of New Guinea; foothill and lower montane rain forests to 1200 meters.

38. **Syzygium pteropodum** (Lauterb. & K. Schum.) Merr. & Perry, Jour. Arnold Arb. 23: 263. 1942.

Jambosa pteropoda Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 473. 1901. TYPE: *Lauterbach 2214*, Territory of New Guinea, Madang District, Astrolabe Plain.

DISTRIBUTION: West Irian, Territory of New Guinea, Bismarck Archipelago; lowland and foothill rain forests to 1700 meters.

We are not at all sure that the specimens assigned to this species all belong together, but all have winged inflorescence axes and young branchlets which are very narrowly winged. In *Docters van Leeuwen 9660* (determined by Diels) the primary veins toward the base of the leaves are closer and more nearly ascending than in the other specimens; the base of the leaf is also narrower.

39. **Syzygium laqueatum** Merr. & Perry, Jour. Arnold Arb. 23: 257. 1942. TYPE: *Brass & Versteegh 11157*, West Irian, 18 km. W of Lake Habbema (A, holotype).

DISTRIBUTION: West Irian, Territory of New Guinea; foothill and montane rain forests, 1500–2350 meters.

40. **Syzygium malaccense** (L.) Merr. & Perry, Jour. Arnold Arb. 19: 215. 1938, *sensu lato*.

Eugenia malaccensis L. Sp. Pl. 470. 1753.
Jambosa malaccensis (L.) DC. Prodr. 3: 286. 1828.

DISTRIBUTION: Native of some part of the Indo-Malesian region and widely cultivated. In New Guinea and the Solomon Islands, a fairly common tree in rain forests at lower elevations.

We are not sure that the specimens placed here are *Syzygium malaccense* in the strict interpretation of the species; the dried leaves have the same texture, but the flowers are smaller, sometimes scarcely more than half as large, and in some instances the inflorescence seems to be longer and more profusely flowering as well as more openly branched than in *S. malaccense, sensu stricto*; e.g. the specimens: *Hoogland 5062* and *NGF 5678* with inflorescences 9 and 7 cm. long, respectively.

41. **Syzygium multiglandulosum** Merr. & Perry, Jour. Arnold Arb. 23: 269. 1942. TYPE: *Brass & Versteegh 13194*, West Irian, Idenburg River, Bernhard Camp (A, holotype).

DISTRIBUTION: West Irian; foothill rain forests, 650–1150 meters.

We have fragmentary specimens of some Clemens collections with flower buds, young fruit, and almost mature fruit from the Territory of New Guinea (Yunziang, Quembung and Ogeramnang). The leaves closely resemble those of *Syzygium multiglandulosum* in venation, but they are much stiffer in the dried state. Also, the pericarp of the fruit in these collections is not more than 2–3 mm. thick at base and looks as if it might have been fleshy before drying. That of *S. multiglandulosum* appears to be woody.

42. **Syzygium spectabile** Merr. & Perry, Jour. Arnold Arb. 23: 265. 1942. TYPE: *Brass 12995*, West Irian, Idenburg River, Bernhard Camp (A, holotype).

DISTRIBUTION: West Irian; foothill rain forests, 400–1200 meters.

43. **Syzygium samarangense** (Bl.) Merr. & Perry, Jour. Arnold Arb. 19: 115, 216. 1938.

Eugenia javanica Lam. Encycl. 3: 200. 1789, non *Syzygium javanicum* Miq. 1855.

Myrtus samarangensis Bl. Bijdr. 1084. 1826. TYPE: "in cultis." Bl. *Ibid.* 1085.

Jambosa javanica K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 470. 1901.

DISTRIBUTION: Lower Burma, south on various islands of Indonesia and the Philippines to New Guinea and the Solomon Islands; a common species of scrub back of ocean beach.

44. **Syzygium amplum** Hartley & Perry, sp. nov.

Arbor 15 m. alta; ramis teretibus, ramulis compressis, pallide brunnescentibus; foliis 17–29 cm. longis, 10–17 cm. latis, chartaceis vel tenuiter coriaceis, copiose pellucido-punctatis, ellipticis vel ovato-ellipticis obtusis basi cuneatis; venis primariis utrinsecus costa 10–12 oblique adscendentibus, in venam intramarginalem 4–9 mm. intra marginem arcuato-conjunctis, utrinque prominulis supra interdum impressis; petiolo 1.5–2 cm. longo; inflorescentiis plerumque lateralibus, axe ramulisque usque 1.5–3 cm. longis; floribus ad apicem ramulorum solitariis in sicco post anthesin subsulcatis; calycis tubo parte inferiore 1.5–2 cm. longo (basi 2 mm., apice partis angustae 4–5 mm. diametro) deinde subabrupte campanulato hic subtus lobis ca. 7 mm. longo, ca. 14 mm. lato, lobis exterioribus ca. 4 mm. longis, interioribus 8 mm. longis, dense minuteque pustulatis glandulosis, petalis etiam filamentis et stylo glandulosis. HOLOTYPUS: *Brass 32645* (A).

Territory of New Guinea. MOROBE DISTRICT: Umi River, Markham Valley, rain forest at 480 m., *Brass 32645*; Edie Creek, about 4 miles SW of Wau, oak

forest at 1500 m., *Hartley (leg. Sayers) 12614.* MADANG DISTRICT: Lower Ramu-Atitau Area, Aiome Patrol Post, lowland rain forest at ca. 100 m., *Pullen 977.* **Papua.** CENTRAL DISTRICT: Brown River, lowland rain forest, *NGF 7157.*

This species is perhaps related to *Syzygium pachycladum*, but the latter has no clearly marked marginal vein, a much more robust floral axis, and rose- to lilac-colored flowers. The profusion of minute glands in the leaves of *S. amplum* is not mentioned in the description of *S. pachycladum.*

45. **Syzygium validinerve** Hartley & Perry, sp. nov.

Arbor ca. 4.5 m. alta; cortice brunnescente, laevi; ramulis cinereis non angulatis; foliis anguste ellipticis basi acutis, apice acuminatis, moderate pellucido-punctatis, venis primariis utrinsecus costa ± 8 oblique adscendentibus irregulariter inter se distantibus intra marginem 5 mm. in venam confluentibus utrinque distincte manifestis sed non prominulis, vena marginali secundaria vix visa; petiolo 0.8–1.5 cm. longo, parte inferiore fusca; inflorescentia in ramulo defoliato ± 8 cm. longo, pedunculo et pedicello quoque ca. 2 cm. longo; calycis tubo in parte inferiore stipitate (± 5 mm.) gradatim sursum ampliato turbinato, in toto infra lobos ca. 2 cm. longo, 1 cm. diametro; lobis exterioribus 0.5 cm. interioribus 1 cm. longis; petalis et staminibus albis. HOLOTYPUS: *Hartley 12015* (A).

Territory of New Guinea. EASTERN HIGHLANDS DISTRICT: above Sassaura, montane rain forest at about 1800 m., *Hartley 12015.*

The brief description of the leaves of *Syzygium alutaceum* (Diels) Merr. & Perry has some likeness to this species but here the flowers are very much larger with large calyx lobes.

46. **Syzygium womersleyi** Hartley & Perry, sp. nov.

Arbor 6 m. vel plus (± 24 m.) alta; ramulis novellis compressis, brunnescentibus; foliis coriaceis 8–18(–25) cm. longis, 3–6(–8.5) cm. latis, apice obtusiusculis vel subrotundatis vel interdum acutiusculis, basi obtusis vel cuneatis, in sicco brunnescentibus, venis primariis utrinsecus costa 6–10 oblique et arcuatim adscendentibus interdum supra impressis subtus prominulis, secundariis saepe inconspicuis; petiolo 5–10 mm. longo; inflorescentiis lateralibus brevibus, axe 1–3 cm. longo, pauciramoso; floribus magnis; calycis tubo 1.5(–2) cm. longo, basi breviter stipitato deinde turbinato vel infundibulari, rubello; lobis 8–15 mm. altis; petalis et staminibus albis; fructibus ± oblongis vel brevioribus et ad apicem et basin angustatis. HOLOTYPUS: *Womersley & Hoogland NGF 4989* (A).

Territory of New Guinea. WESTERN HIGHLANDS DISTRICT: near Nondugl, alt. ca. 1680 m., *Womersley & Hoogland NGF 4989, NGF 4990, NGF 4845*; twelve miles N of Wabag, Porget logging area, mountain forest, alt. 2100 m., *NGF 11080, NGF 11257*; Kutu, near Mt. Hagen, *NGF 9610.* EASTERN HIGHLANDS DISTRICT: near Purosa, about 18 miles SW of Okapa, rain forest on slope, alt. 1500 m., *Hartley 13184*; Mt. Wilhelm, east slopes, in forest substage,

alt. 2650 m., *Brass 30716*. MOROBE DISTRICT: Sambanga, steep mountain forest, alt. 1500–1800 m., *Clemens 7414*. **Papua.** SOUTHERN HIGHLANDS DISTRICT: Enep, N of Mende, mixed *Nothofagus* forest, alt. 2130 m., *Schodde 2130*.

In the texture of the leaves and the position of the inflorescence (below the leaves) this species suggests *Syzygium malaccense*, but the flowers are white (red calyx, white petals and stamens) and few in an inflorescence.

47. **Syzygium goniopterum** (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 259. 1942.

Jambosa gonioptera Diels, Bot. Jahrb. **57:** 391. 1922. TYPE: *Ledermann 8689*, Territory of New Guinea, Sepik District (K, isotype; A, phot.).

DISTRIBUTION: Territory of New Guinea, Papua; lowland and foothill rain forests to 750 meters.

48. **Syzygium platypodum** Diels, Bot. Jahrb. **57:** 406. 1922. TYPE: *Schlechter 16380*, Territory of New Guinea, Madang District, Wobbe (K, isotype; A, phot.).

DISTRIBUTION: Territory of New Guinea; lowland, foothill and montane rain forests, 200–2010 meters.

We have hesitated about determining several higher altitude collections as Diels' species, but the only differences we have found are the somewhat smaller leaves and higher calyx lobes. Only part of our specimens show the prismatic character of the calyx tube, but since in a single specimen some flowers show the prismatic tendency while others are turbinate, it would appear to be a weak character in this instance. As to the calyx lobes, in the collections at hand the exterior ones are 2.5 mm. high and the inner pair is higher — a character which would place the plant in *Jambosa* as used by Diels. He simply says, "calyx lobes short." We suspect that this is because the type was only in bud with few open flowers.

49. **Syzygium waikaiunense** Hartley & Perry, sp. nov.

Arbor usque 25 m. alta; ramulis teretibus vel novellis forte sulcatis; foliis rigide coriaceis supra brunnescentibus subtus paulo pallidioribus ellipticis 5.5–11 cm. longis, 3–5 cm. latis, apice obtusis, basi angustatis, venis primariis utrinque visis sed plerumque inconspicuis inter se 2–3.5 mm. distantibus ± 1 mm. infra marginem laxe arcuato-anastomosantibus; petiolo 7–10 mm. longo; inflorescentiis terminalibus et axillaribus, axibus 1–4, floribus plerumque in apice congestis sessilibus, interdum flore uno infra-apicali; calycis tubo basi 2 mm., apice 7–8 mm. lato, obtuse obconico vel subturbinato, usque sub lobis 8–10 mm. longo, lobis 2–2.5 mm. altis; petalis ca. 7 × 7 mm. ad basin paulo angustatis. HOLOTYPUS: *Brass 25919* (A).

Papua. MILNE BAY DISTRICT: Normanby Island, mountains behind Waikaiuna Bay, rain forest on lower slopes, alt. 100 m., *Brass 25919*; Waikaiuna, rain forest at 20 m. alt., *Brass 25887*.

This species is related to *Syzygium micrandrum*, but differs in the obtuse, coriaceous leaves that are scarcely, if at all, punctate, and calyces that are obtuse at the base and not rugulose (under a lens).

50. **Syzygium variabile** Hartley & Perry, sp. nov.

Arbor mediocris multoties ramosa; cortice brunnescente, ramulis compressis; foliis (in typo 3–6 cm. longis, 1.7–3 cm. latis, in ceteris usque 14.5 × 6 cm.) ellipticis vel subovato-ellipticis subcoriaceis in sicco olivaceo-brunneis, non pellucido-punctatis, basi obtusis apice subobtusis, venis primariis utrinsecus costa ca. 8–10 utrinque manifestis, vena intramarginali intra marginem 2–4 mm.; petiolo plerumque brevi usque 5(–10) mm. longo; inflorescentiis terminalibus (vel axillaribus vel lateralibus) cymosis ca. 4–6 cm. longis, paucifloris, floribus sessilibus; calycis tubo anguste turbinato vel infundibulari 10–12 mm. longo inconspicue breviter stipitato, glanduloso; lobis 2–3 mm. longis; petalis 5–6 mm. longis singulatim caducis. HOLOTYPUS: *Womersley NGF 11423* (A).

Territory of New Guinea. WESTERN HIGHLANDS DISTRICT: Wahgi Valley near Banz, along creek in grassland country, alt. ca. 1750 m., *Hoogland & Pullen 6213*; foothills near Jimmi Divide, Banz, secondary growth at 1800 m. alt., *Robbins 602*; 1.5 miles W of Kawil on side of Paranuk River, alt. ca. 1600 m., *NGF 7684*; Nondugl, secondary growth, *NGF 4365*. EASTERN HIGHLANDS DISTRICT: NE slopes of Mt. Michael, gully in *Nothofagus* forest at 2000 m. alt., *Brass 31319*; Kini Creek, NE slopes of Mt. Michael, *Castanopsis* forest, alt. 1950 m., *Womersley NGF 11423*, gully forest, *NGF 11405*; Mt. Otto, S slopes, rocky creek bank in *Castanopsis* forest, alt. 2000 m., *Brass 31091*; Goroka Subdistrict, Upper Dunantina Valley, secondary forest on steep slope, alt. ca. 1700 m., *Hoogland & Pullen 5303*.

The specimens cited above show great variation in leaf size. Most have short petioles; only *NGF 11405* and *Brass 31319* have some petioles 1 cm. long. The leaf base is generally obtuse but varies to cuneate with the longer blades. One inflorescence of *Brass 31319* is 9 cm. long, also the leaves of the two numbers mentioned tend to be acuminate. Nevertheless, we believe these all to be one species.

The new species is possibly related to *Syzygium hylophilum* (including *Jambosa weinlandii, fide* Diels), but the leaves are generally not acuminate, and the flowers of *S. hylophilum* are a little smaller. In *NGF 4365* the flower buds are clavate, which may be due to their immaturity.

51. **Syzygium puberulum** Merr. & Perry, Jour. Arnold Arb. 23: 263. 1942. TYPE: *Brass 838*, Papua, Central District, Port Moresby (A, holotype).

DISTRIBUTION: Papua; in gullies and along streams in foothill forests to 450 meters.

In most specimens at hand the calyx tube is minutely puberulous, but this character is variable and in some specimens the tube is essentially glabrous, cf. *Brass 21800*, *Hoogland 4344*, *4683* and *Saunders 155*.

52. **Syzygium coalitum** (Greves) Hartley & Perry, comb. nov.

Eugenia coalita Greves, Jour. Bot. **61**(Suppl.): 15. 1923. TYPE: *Forbes 28*, Papua, Central District, Sogeri (BM, holotype).
Jambosa sargentiana Diels, Jour. Arnold Arb. **10:** 83. 1929.
Syzygium sargentianum (Diels) Merr. & Perry, Jour. Arnold Arb. **23:** 249. 1942.

DISTRIBUTION: Territory of New Guinea, Papua; mainly bordering streams in foothill forests, 360–450 meters.

Since the 1942 study, Merrill examined Greves' type.

53. **Syzygium virescens** Merr. & Perry, Jour. Arnold Arb. **23:** 260. 1942. TYPE: *Brass 13950*, West Irian, Idenburg River, Bernhard Camp (A, holotype).

DISTRIBUTION: West Irian, Papua; lowland rain forests to 50 meters.

54. **Syzygium phaeostictum** Merr. & Perry, Jour. Arnold Arb. **23:** 270. 1942. TYPE: *Brass & Versteegh 11935*, West Irian, Idenburg River, 15 km. SW of Bernhard Camp (A, holotype).

DISTRIBUTION: West Irian, Territory of New Guinea; foothill and lower montane rain forests, 1140–1650 meters.

55. **Syzygium hylochare** (Diels) Merr. & Perry, Jour. Arnold Arb. **23:** 249. 1942.

Jambosa hylocharis Diels, Jour. Arnold Arb. **10:** 83. 1929. TYPE: *Brass 1065*, Papua, Gulf District, Aroara, Vailala River (A, isotype).

DISTRIBUTION: Territory of New Guinea, Papua; foothill rain forests to 1100 meters.

56. **Syzygium delicatulum** Merr. & Perry, Jour. Arnold Arb. **23:** 273. 1942. TYPE: *Brass 2781*, Solomon Islands, San Cristobal, Waimasi (A, holotype).

DISTRIBUTION: New Britain, Solomon Islands; lowland and foothill rain forests to 1700 meters.

57. **Syzygium aqueum** (Burm. f.) Alston, Ann. Roy. Bot. Gard. Peradeniya **11:** 204. 1929.

Eugenia aquea Burm. f. Fl. Ind. 114. 1768. Based on *Jambosa aquea* Rumphius, Herb. Amboin. **1:** 126. *t. 38*, *f. 2*. 1741.
Jambosa aquea (Burm. f.) DC. Prodr. **3:** 288. 1828.

DISTRIBUTION: Territory of New Guinea; primary and secondary lowland and foothill rain forests. Cultivated since early botanical history in India and Malesia.

58. **Syzygium roemeri** (Lauterb.) Merr. & Perry, Jour. Arnold Arb. 23: 275. 1942.

Jambosa roemeri Lauterb. Nova Guinea (Bot.) **8:** 851. 1912. TYPE: *von Roemer 986*, West Irian, foothills of the Hellwig Mts. (L, isotype; A, phot.).

Jambosa rubella Rechinger, Repert. Sp. Nov. **11:** 183. 1912. Denkschr. Math.-Nat. K. Akad. Wiss. Wien **89:** 583. *f. 25* (Bot. Zool. Ergeb. Wiss. Forsch. Samoa – I. Neug.-Arch. Solomensins. **5:** 141). 1913.

Syzygium rubellum (Rech.) Merr. & Perry, Jour. Arnold Arb. **23:** 275. 1942.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; lowland, foothill and montane rain forests to 2100 meters.

59. **Syzygium saliciforme** Merr. & Perry, Jour. Arnold Arb. **23:** 253. 1942. TYPE: *Brass 7243*, Papua, Western District, Palmer River (A, holotype).

DISTRIBUTION: West Irian, Papua; apparently restricted to inundation banks of streams in lowland forests to 100 meters.

60. **Syzygium uniflorum** Merr. & Perry, Jour. Arnold Arb. **23:** 255. 1942. TYPE: *Brass 5608*, Papua, Central District, Kubuna, river-bed gravel banks at 100 m.

DISTRIBUTION: Known to us only from the type collection.

61. **Syzygium xylopiaceum** (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

Jambosa xylopiacea Diels, Bot. Jahrb. **57:** 392. 1922. TYPE: *Ledermann 8239*, Territory of New Guinea, Sepik District, Hunstein Mts.

DISTRIBUTION: Territory of New Guinea, Papua; stream borders in lowland forests to 300 meters.

62. **Syzygium garcinioides** (Ridley) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

Eugenia garcinioides Ridley, Trans. Linn. Soc. Bot. II. **9:** 44. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition, Camp III, at 650 m. (BM, holotype; A, phot.).

DISTRIBUTION: West Irian (no other data on habitat given).

63. **Syzygium cinctum** Merr. & Perry, Jour. Arnold Arb. **23:** 272. 1942. TYPE: *Brass 3344*, Solomon Islands, Ysabel, Tiratona (A, holotype).

Eugenia cincta (Merr. & Perry) Whitmore, Guide For. British Solomon Isl. 203. 1966; Gard. Bull. Singapore **22:** 16. 1967.

DISTRIBUTION: Solomon Islands; foothill rain forests to 600 meters.

64. **Syzygium richardsonianum** Merr. & Perry, Jour. Arnold Arb. **23:** 274. 1942. TYPE: *Brass 11354*, West Irian, Bele River, 18 km. NW of Lake Habbema (A, holotype).

DISTRIBUTION: West Irian, Territory of New Guinea; primary and secondary foothill and montane rain forests, 990–2800 meters.

We are not sure whether *NGF 24534* belongs here or not. The inflorescence is similar, but the branchlets are very narrowly winged and the bark, although cracked, is not flaking off as it is in the other specimens; further, it is very dark (almost black) in color, similar to that of *Syzygium subglobosum*.

65. **Syzygium sylvicola** Hartley & Perry, sp. nov.

Arbor 20–25 m. alta; ramulis teretibus, fuscis; foliis valde coriaceis, 4.5–6.5 cm. longis, 3.5–5 cm. latis, ellipticis apice rotundatis deinde brevissime obtuseque acuminatis, acumine 3–5 mm. longo, basi cuneatis vel rotundato-cuneatis, venis primariis inter se 5–7 mm. distantibus utrinque facile manifestis, secundariis etiam rete venularum fere aequaliter visis, vena intramarginali intra marginem 3–4 mm.; petiolo 7–10 mm. longo fusco; paniculis terminalibus 5–7 cm. longis, ramulis adscendentibus, bracteis deciduis; calycis tubo obconico, 7 mm. longo, basi 1 mm. apice 5–6 mm. diametro, lobis exterioribus 1.5 mm. altis; petalis in calyptram connatis (vel discretis). HOLOTYPUS: *Brass 30717* (A).

Territory of New Guinea. EASTERN HIGHLANDS DISTRICT: Mt. Wilhelm, east slopes, tall valley forest, alt. 2650 m., *Brass 30717*. **Papua.** CENTRAL DISTRICT: above The Gap, forest at ca. 2400 m., *Carr 13813*.

There is no doubt in our minds that these two specimens belong to the same species, although the Carr specimen has slightly larger flowers (calyx tube 9 mm. long, outer lobes 2.5–3 mm. high, and apex of the calyx 6–7 mm. in diameter) with petals that fall separately. The distinctive characteristic is the rather obvious venation of the very stiff dried leaves. Perhaps it is related to *Syzygium multiglandulosum*.

66. **Syzygium rubro-punctatum** (Ridley) Merr. & Perry, Jour. Arnold Arb. **23:** 268. 1942.

Eugenia rubro-punctata Ridley, Trans. Linn. Soc. Bot. II. **9:** 46. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition, Canoe Camp (BM, holotype; A, phot. and carbon rubbing).
Syzygium insculptum Merr. & Perry, Jour. Arnold Arb. **23:** 267. 1942.

DISTRIBUTION: West Irian (Wollaston Expedition), Papua (Fly River); lowland forests, 50–80 meters.

When Merrill and Perry described *Syzygium insculptum* the similarity in the two species was mentioned. Since then Merrill made a carbon rubbing of a part of a leaf of the Boden Kloss collection which exactly matches the same part in *S. insculptum*, so now we believe the difference in flower bud size is due to Ridley's type having very immature flower buds.

67. **Syzygium pergamaceum** (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 250. 1942.

Eugenia pergamacea Greves, Jour. Bot. **61**(Suppl.): 16. 1923. TYPE: *Forbes 805*, Papua, Central District, Sogeri, Mt. Koikoko (BM, holotype; A, carbon rubbing, notes).
Syzygium archboldianum Merr. & Perry, Jour. Arnold Arb. **23**: 271. 1942.
Syzygium discolor Merr. & Perry, *Ibid.* 274.

DISTRIBUTION: Aroe Islands, West Irian, Territory of New Guinea, Papua; primary and secondary lowland and foothill rain forests to 1150 meters.

We believe, from Merrill's carbon rubbing and notes, that both the above named species should be reduced to synonymy of the taxon named by Greves. Although the leaves of *Syzygium discolor* are not more than half as large as those of the rest of the collections, this size variation may be caused by some ecological factor rather than by a genetic difference; the flowers seem to resemble those of the other specimens.

68. **Syzygium pluviatile** Hartley & Perry, sp. nov.

Arbor magna; ramulis compressis vel obtuse 4-angulatis, brunnescentibus; foliis tenuibus et leviter coriaceis pellucido-punctatis, ellipticis, apice recurvis et basi acutis vel attenuatis, 8.5–11 cm. longis, 5.5–7.5 cm. latis, venis primariis inter se 6–7 mm. remotis, fere patentibus in venam intramarginalem a margine 2–4 mm. conjunctis, venis secundariis inconspicuis; petiolo 1–1.5 cm. longo fusco; inflorescentiis terminalibus (in specimine hoc in ramulo annotino) paniculatis ± 14 cm. longis latisque, cortice axis et ramorum ± rimoso; floribus purpureis sessilibus (alabastris tantum in typo), bracteis non visis; calycis tubo ca. (6–)12 mm. longo anguste pyriformi vel turbinato, basi 1.4–2 mm. lato, apice sub lobis ca. 6 mm. diametro, lobis exterioribus 2 mm. altis, interioribus ca. 4 mm. altis; disco intus 1 mm. superanti aream staminiferam. HOLOTYPUS: *Brass 28739* (A).

West Irian. Manokwari, Dessa, Momi, primary forest at ca. 10 m., *NIFS bb 33382*. **Territory of New Guinea.** MADANG DISTRICT: Lower Ramu-Atitau area, about 1/4 mile N of Josephstaal airstrip, flood-plain forest at ca. 90 m., *Saunders 959*. **Papua.** MILNE BAY DISTRICT: Woodlark Island, Kulumadau, rain forest on coral limestone ridge, alt. 100 m., *Brass 28739*.

In the holotype the inflorescence is terminal on a grayish brown, defoliated branchlet 5 mm. in diameter; the branchlet bearing leaves is

brownish, 3 mm. in diameter, and separate from the flowering one. The three cited specimens have in common an extension of the disc free for about 1 mm. above and within the area of staminal insertion. This is an unusual character in *Syzygium*. The species appears from the description to be most like *S. pyrrophloem* Diels, which differs in having numerous primary veins, (dried) longitudinally sulcate calyx tube, and calyx lobes often not separate from petals[?]. We are sure Diels would have considered our plant to be a member of the group which he called *Jambosa* on account of the obvious calyx lobes.

69. **Syzygium tierneyanum** (F. Muell.) Hartley & Perry, comb. nov.

Eugenia tierneyana F. Muell. Frag. Phytogr. Austral. **5:** 14. 1865; F. M. Bailey, Queensl. Fl. 2: 660. 1900. TYPE: *Dallachy*, Queensland, North Kennedy District, Dalrymple Creek.
Syzygium floribundum Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 476. 1901, non F. Muell. (1864).
Jambosa floribunda (Lauterb. & K. Schum.) Diels, Bot. Jahrb. **57:** 388. 1922.
Syzygium lauterbachianum Merr. & Perry, Jour. Arnold Arb. **23:** 268. 1942.
Syzygium lauterbachianum var. *phaeophloium* Merr. & Perry, *Ibid.*

DISTRIBUTION: West Irian, Territory of New Guinea, Papua, Solomon Islands, Queensland; lowland, foothill, and lower montane rain forests to 1350 meters.

We are not certain of the limits of this species, but we have included specimens which might reasonably belong. We would like to mention here two other described species, *S. platycarpa* (Diels) Merr. & Perry and *S. cornifolium* (Bl.) Merr. & Perry, which may be *S. tierneyanum*, or very closely related, but we are not sufficiently certain to place them in synonymy. We have a photograph of a paratype of *S. platycarpum* from the Berlin herbarium, and one specimen, *Brass 1148*, determined by Diels as spec. aff. *Jambosa platycarpa*. Merrill & Perry had determined it as *S. cornifolium*. However, we now have a photograph of the type of *S. cornifolium* from Leiden, and we suspect the Brass specimen may be *S. tierneyanum*, although the intramarginal vein is nearer the margin than that in some other collections. The distance of this inner intramarginal vein from the leaf margin seems to be variable, the collections of *S. tierneyanum* from the Solomon Islands, appear to have the greatest distance. *Syzygium cornifolium* was described on a collection from Celebes, but has been reported from New Guinea.

70. **Syzygium roseum** Merr. & Perry, Jour. Arnold Arb. **23:** 270. 1942. TYPE: *Brass 5618*, Papua, Western District, Oriomo River (A, holotype).

DISTRIBUTION: Papua; lowland alluvial rain forest. Known only from the type collection.

71. **Syzygium fibrosum** (F. M. Bailey) Hartley & Perry, comb. nov.

Eugenia fibrosa F. M. Bailey, Queensl. Fl. **2:** 662. 1900. TYPE: *F. M. Bailey*, Queensland, Moreton District, Somerset (BRI, holotype).

DISTRIBUTION: West Irian, Aroe Islands(?), Papua, Queensland; lowland and foothill monsoonal and evergreen forests to 1400 meters.

There is considerable variation in the few specimens we have determined as this species. The calyx lobes in *Carr 13031* (collected at 1400 m.), *Kanehira & Hatusima 13137* (fruit only), and *Kanehira & Hatusima 13171* (with buds) are very slender; the buds of *Kanehira & Hatusima 13171* are 10–11 mm. long and pointed at the apex. On the other hand, the buds of *NGF 8288* are ca. 6 mm. long and tend to be rounded at the apex. The only Queensland specimen we have which is not yet in flower has buds ca. 9 mm. long that only tend to be pointed at the apex.

72. **Syzygium brevicymum** (Diels) Merr. & Perry, Jour. Arnold Arb. **23**: 261. 1942.

Jambosa brevicyma Diels, Bot. Jahrb. **57:** 389. 1922. TYPE: *Ledermann 10414*, Territory of New Guinea, Sepik District, Malu (B, holotype; A, phot.).
Syzygium caudiferum Merr. & Perry, Jour. Arnold Arb. **23:** 272. 1942.

DISTRIBUTION: Territory of New Guinea, Papua, Bismarck Archipelago; lowland and foothill rain forests.

73. **Syzygium hylophilum** (Lauterb. & K. Schum.) Merr. & Perry, Jour. Arnold Arb. **23**: 273. 1942.

Jambosa hylophila Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 471. 1901. TYPE: *Lauterbach 50*, Territory of New Guinea, Morobe District, Butaneng [near Finschhafen].
Jambosa weinlandii K. Schum. Nachtr. Fl. Deutsche Schutzgebiete Südsee 326. 1905.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua(?), New Britain(?); lowland, foothill and montane rain forests to 2000 meters.

Without type and supporting collections this species has been difficult to define. In addition, there are two other species, *Syzygium dolichostylum* (Diels) Merr. & Perry and *S. riparium* (Diels) Merr. & Perry, which either belong here or seem to be very closely related. In the descriptions all of the species have reasonably short petioles, nearly the same number of primary veins, and inflorescences of approximately the same size. The calyx tube in *S. dolichostylum* is 1.5 cm. long, in the others 1–1.2 cm. long, but all are similar in shape and at present we have been unable to key them separately. Only *S. hylophilum* is in the key, and in the identification list of specimens all are designated as cf. 73.

74. **Syzygium aeoranthum** (Diels) Merr. & Perry, Jour. Arnold Arb. **23**: 249. 1942.

Jambosa aeorantha Diels, Nova Guinea (Bot.) **14**: 90. 1924. TYPE: *W. Feuilleteau de Bruyn 246*, West Irian, plain N of Van Rees Mts. (L, isotype; A, phot.).

DISTRIBUTION: West Irian, Territory of New Guinea; lowland and foothill rain forests.

75. **Syzygium longipes** Merr. & Perry, Jour. Arnold Arb. **23**: 274. 1942.

Eugenia longipes Warb. Bot. Jahrb. **13**: 391. 1891, non Berg (1854). TYPE: *Warburg*, Territory of New Guinea, Morobe District, Finschhafen.
Jambosa longipes (Warb.) Diels, Bot. Jahrb. **57**: 382. 1922.
Jambosa longipes var. *leptopoda* Diels, *Ibid.* 383.
Eugenia daphnoides Greves, Jour. Bot. **61**(Suppl.): 15. 1923.
Syzygium daphnoides (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 270. 1942.
Syzygium longipes var. *leptopodum* (Diels) Merr. & Perry, *Ibid.* 274.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; lowland and foothill rain forests.

Comparison of the types of *Eugenia pendula* (Bl.) DC. (described from Java, but apparently collected in Amboina, *fide* Amshoff, Blumea **5**: 496. 1945) and *E. stipularis* Miq. (from Amboina) is necessary to determine whether these and the New Guinea collections all belong to one species. Further, considerable variation exists among the specimens we have cited in the length of peduncle or axis of inflorescence. *Eugenia daphnoides* is described as having peduncles 5–8 cm. long, but in *E. longipes* Warb. they are said to be 10–30 cm. long. This seems to us not to be a specific difference. Also, we are not sure that the color of the flower (i.e. of the corolla and stamens — the calyx seems mostly to be red) is a useful characteristic here. Certainly most flowers are pink or red, but a few white flowers are listed as cf. 75, as is a specimen having an inflorescence with very short axis. One specimen, *Brass 28549*, has very fine thread-like axis and branchlets of inflorescences which seem to be terminal on year-old wood. Its real relationship may be elsewhere.

76. **Syzygium anomalum** Lauterb. Nova Guinea (Bot.) **8**: 853. 1912. TYPE (designated by Diels, Bot. Jahrb. **57**: 405. 1922): *Gjellerup 163*, West Irian, Hollandia (L, isotype; A, phot.).

DISTRIBUTION: Known to us only from the type region. Although Lauterbach cited also a *von Roemer* collection when describing this species in 1912, Diels doubted that the two collections were of the same species. However, the paucity of the material before him precluded a definite decision.

77. **Syzygium pallens** Merr. & Perry, Jour. Arnold Arb. **23**: 251. 1942. TYPE: *Brass 3936*, Papua, Central District, Ononge Road, Dieni, rain forest at 500 m. (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

78. **Syzygium dictyophlebium** Merr. & Perry, Jour. Arnold Arb. **23**: 267. 1942. TYPE: *Brass 5338*, Papua, Central District, Mafulu (A, holotype).

DISTRIBUTION: Territory of New Guinea, Papua, Queensland; foothill rain forests, 900–1250 meters.

The abundant flowers of this species are creamy and apple-scented (*fide Hoogland 5157*), the calyx tube pyriform, 6 mm. long below the lobes, the smaller pair of lobes 1–1.5 mm. high, the inner and larger pair 2.5–3 mm. high. Persistent floral bracts may also be present but this character is variable and in some specimens the bracts are deciduous before anthesis. In Proc. Roy. Soc. Queensl. **69**: 51. 1958, Blake cited *Hoogland 5157*, *NGF 8567* and *NGF 5214* under this species. *NGF 7475*, from Bulolo, also seems to belong here.

79. **Syzygium acutangulum** K. Schum. in K. Schum. & Hollr. Fl. Kaiser Wilhelms Land 89. 1889. TYPE: *Hollrung 643*, Territory of New Guinea, Sepik District (K, isotype; A, phot.).

Syzygium papuasicum Merr. & Perry, Jour. Arnold Arb. **23**: 251. 1942.

DISTRIBUTION: West Irian, Aroe Islands, Territory of New Guinea, Papua, New Britain, Solomon Islands; lowland and foothill rain forests to 1000 meters.

In the introduction we commented on the angular and compressed branchlets of this species. There is also variation in the leaves, which are acute in some specimens and acuminate in others. The fruiting specimens available to us appear somewhat atypical and are referred to as cf. 79 in the identification list. Unfortunately we do not have flowering and fruiting collections from the same locality.

80. **Syzygium bracteosum** Merr. & Perry, Jour. Arnold Arb. **23**: 250. 1942. TYPE: *Brass & Versteegh 11986*, West Irian, Bele River, 18 km. NW of Lake Habbema (A, holotype).

DISTRIBUTION: West Irian, Territory of New Guinea; foothill and montane rain forests, 1800–2300 meters.

81. **Syzygium torricellianum** Diels, Bot. Jahrb. **57**: 405. 1922. TYPE: *Schlechter 20270*, Territory of New Guinea, Sepik District, Torricelli Mts. (K, isotype; A, phot.).

DISTRIBUTION: West Irian, Territory of New Guinea; foothill rain forests, 900–1740 meters.

82. **Syzygium viburnoides** Diels, Bot. Jahrb. **57**: 405. 1922. TYPE: *Ledermann 7744*, Territory of New Guinea, Sepik District (K, isotype; A, phot.).

DISTRIBUTION: Territory of New Guinea, Papua; lowland and foothill rain forests.

83. **Syzygium fastigiatum** (Bl.) Merr. & Perry, Mem. Am. Acad. Arts Sci. **18**: 152. 1939 (Mem. Gray Herb. 4).

Calyptranthus fastigiata Bl. Bijdr. 1090. 1826. TYPE: probably *Blume* (L, holotype); forests of western Java.
Eugenia bibracteata Greves, Jour. Bot. **61**(Suppl.): 18. 1923.
Syzygium bibracteatum (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 249. 1942.

DISTRIBUTION: Burma, Malay Peninsula, Sumatra, Borneo, Java, New Guinea (West Irian, Territory of New Guinea, Papua), New Britain; lowland, foothill and lower montane rain forests.

84. **Syzygium iteophyllum** Diels, Bot. Jahrb. **57**: 414. 1922. TYPE: *Ledermann 8527*, Territory of New Guinea, Sepik District, Hunstein Mts.

DISTRIBUTION: Territory of New Guinea; lowland and foothill rain forests to 1200 meters.

We have been very much puzzled about this species and have not found anything to work with except the original description. We have at hand five herbarium sheets (all cited in the exsiccatae as cf. 84). Four appear to be of one species the dried specimens of which have pale olive-green, thin leaves, cauliflorous inflorescences, small, shining flowers with longitudinally and slenderly sulcate calyx tube (2–2.5 mm. long), and purple fruit. The axis of the inflorescence up to the first branch is 2–3.5 cm. long. Diels described the inflorescence axis as 5–7 cm. long, the only character in which our four specimens vary from the original description. In the original, however, the flowers were immature, so that their ultimate size is not known. In the fifth specimen at hand [*Hartley* (*leg. Sayers*) *12576*], collected at 1200 meters altitude (the others all from lowland rain forests), the inflorescence appears to be a branchlet probably collected from the stem. It is 6 cm. long to the first node (only one leaf attached) and the branching part of the inflorescence is 10.5 cm. long with rather immature, wrinkled flower buds. The leaves dried brownish. Although the label indicates, "fruit white, produced on the main trunk," no fruit was found (either separate or with the specimen).

85. **Syzygium pyrocarpum** (Greves) Merr. & Perry, Jour. Arnold Arb. 23: 280. 1942.

Eugenia pyrocarpa Greves, Jour. Bot. **61**(Suppl.): 17. 1923. TYPE: *Forbes 99*, Papua, Central District, Sogeri (BM, holotype; A, carbon rubbing of leaf, notes).
Eugenia xylantha Greves, *Ibid.* 18.
Syzygium xylanthum (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 280. 1942.

DISTRIBUTION: Papua; lowland and foothill rain forests to 450 meters.

Greves described *Eugenia pyrocarpa* as having complanate branchlets, strongly winged petioles, and a compact lateral cymose inflorescence. She says *E. xylantha* has strongly quadrangular branchlets, slightly winged petioles, and a loose lateral cymose inflorescence. Merrill, who examined both types, was of the opinion that the two were one species. On a carbon rubbing of *Syzygium xylanthum* he wrote "ultimate branchlet (one only) 4-angled, but its small branch terete."

86. **Syzygium buettnerianum** (K. Schum.) Niedenzu, Nat. Pflanzenfam. III. 7: 85. 1893; Diels, Bot. Jahrb. **57**: 406. 1922.

Eugenia buettneriana K. Schum. in K. Schum. & Hollr. Fl. Kaiser Wilhelms Land 89. 1889. TYPE: *Hollrung 658*, Territory of New Guinea, Sepik District (L, isotype; A, fragment).

DISTRIBUTION: West Irian, Territory of New Guinea, Papua, Solomon Islands; lowland, foothill, and montane rain forests to 2500 meters.

There is considerable altitudinal variation in this species which is reflected by a marked shortening of the inflorescence and the flowers in collections from the montane rain forests. Also, the leaves of the higher altitude specimens are more coriaceous with more pronounced venation than those of the lowland specimens. There are, however, intermediate specimens from foothill rain forests (ca. 1000 meters) and so we do not feel the montane extreme warrants any taxonomic status. Examples of the montane form are *Brass 31858*, *Hartley 12325*, and *Hoogland & Pullen 5961*. Examples of the intermediate form are *NGF 4065*, *NGF 19417* and *Schodde 2186*.

Syzygium buettnerianum is at least superficially similar to *S. subcorymbosum* (species no. 132), and the two have often been confused by recent New Guinea collectors. The distinguishing characters are given below.

S. BUETTNERIANUM	S. SUBCORYMBOSUM
1. Bark of branchlets and inflorescence finely scaly or at least sulcate and wrinkled.	1. Bark of branchlets and inflorescence smooth.
2. Flowers red.	2. Flowers white.
3. Fruits subglobose, 1–1.5 cm. in diameter.	3. Fruits barrel shaped, 2.5–3.5 cm. long.

87. **Syzygium squamatum** Merr. & Perry, Jour. Arnold Arb. 23: 277. 1942. TYPE: *Brass & Versteegh 13125*, West Irian, Bernhard Camp, Idenburg River, primary rain forest at 850 m. altitude.

DISTRIBUTION: Known to us only from the type collection.

88. **Syzygium busuense** Hartley & Perry, sp. nov.

Arbor parva ca. 6 m. alta; ramulis distincte tetragonis vel anguste alatis, brunnescentibus; foliis 25–30 cm. longis, 9–10.5 cm. latis, oblongo-ellipticis, basi cuneatis, apice obtusis deinde breviter acuminatis, acumine 0.5–1.5 cm. longo obtuso, chartaceis vel subcoriaceis, costa siccata utrinque prominente, venis primariis utrinque prominulis ca. 20-jugis oblique adscendentibus in venam intramarginalem ca. 3 mm. intra marginem anastomosantibus, secundariis inconspicuis; petiolo 1.5–2.5 cm. longo, 3 mm. diametro; inflorescentiis 7–12 cm. longis, 7 cm. latis, aperte thyrsoideis, cauligeris supra medium ramosis, bracteis deciduis, axi et ramulis confertim sulcatis interdum minute decorticantibus; floribus (alabastris et post anthesin vel fructibus juvenilibus) sessilibus in apice ramorum confertis; alabastro clavato 7 mm. longo, apice 3 mm. diametro, post anthesin calycis tubo 7 mm. longo, apice 5 mm. diametro, lobis ca. 0.5–1 mm. altis, vertice umbilicato 3 mm. profundo. HOLOTYPUS: *Floyd NGF 5683* (A).

Territory of New Guinea. MOROBE DISTRICT: Busu [River], near Lae, lowland rain forest, *Floyd NGF 5683*; Busu River about 12 miles N of Lae, rain forest on slope, alt. 30 m., *Hartley 11885*.

In general aspect of leaves this species has some resemblance to *Syzygium richardsii* Airy Shaw and *S. villamilii* (Merr.) Merr. & Perry, both of western Malesia, but it differs in being cauliflorous (the inflorescences in the western Malesian species are chiefly terminal) and having coarser and larger inflorescences. If an isotype of *S. cruriflorum* Diels is found, this species should be compared with it, although neither specimen cited as *S. busuense* has calyx lobes as large as those described by Diels.

89. **Syzygium thornei** Hartley & Perry, sp. nov.

Arbor ca. 13.5 m. alta; ramulis teretibus fuscis interdum decorticantibus; foliis ellipticis tenuiter coriaceis, 8–12 cm. longis, 3–5 cm. latis, apice acuminatis, acumine ± 1 cm. longo, basi cuneatis, costa utrinque paulo elevata, venis primariis inter se 5–7 mm. distantibus inconspicuis, secundariis vix visis sed interdum venis omnibus ut videtur tenuissimis et fere indistinctis; petiolo 5–8 mm. longo; paniculis ca. 6–8 cm. longis, e trunco etiam e ramis subter folia ortis; axi et ramulis hic illic decorticantibus, bracteis caducis; calycis tubo 5(–7) mm. longo turbinato, siccato longitudinaliter tenuiter sulcato, lobis exterioribus 1 mm. altis, interioribus paulo longioribus; fructibus obovoideis, 1.5 cm. longis, 0.9 cm. diametro. HOLOTYPUS: *Gray & Thorne NGF 12899* (A).

Territory of New Guinea. MOROBE DISTRICT: Morobe, *Womersley NGF 3140*.

Papua. CENTRAL DISTRICT: Brown River, lowland rain forest, alt. 60 m., *Gray & Thorne NGF 12899, Schodde 2560, NGF 5876.*

The collection from Morobe was distributed as *Syzygium dolichorhynchum* Diels *vel aff.* We have found no material of that species.

90. **Syzygium sambogense** Hartley & Perry, sp. nov.

Arbor parva, ca. 7 m. alta; ramulis teretibus brunneis decorticantibus; foliis 21–23 cm. longis, 8.5–10 cm. latis, ellipticis, basi late cuneatis, apice subabrupte obtuseque acuminatis, acumine 1–1.5 cm. longo, siccatis supra fusco-brunnescentibus subtus pallidioribus, venis primariis inter se 7–10 mm. distantibus, supra inconspicuis, subtus facile visis, secundariis manifestis, reticulo inconspicuo, vena intramarginali 2–3 mm. intra marginem; pedunculo 1.5–1.8 cm. longo; paniculis ut videtur lateralibus, ± compactis, axi et ramulis decorticantibus, ramulis ultimis brevibus 1–3-floribus sessilibus ferentibus; bracteis deciduis (hinc inde una visa); calycis tubo obpyramidali 5–6 mm. longo, lobis exterioribus 1 mm., interioribus 1.5 mm. longis; fructibus ovoideis, 1.2 cm. longis, fere 0.8 cm. diametro. HOLOTYPUS: *Hoogland 3838* (A).

Papua. NORTHERN DISTRICT: Samboga River near crossing W of Embi Lakes, stony riverside flooded by high water, alt. ca. 60 m., *Hoogland 3838.*

The leaves of *Syzygium sambogense* differ from those of *S. pyrocarpum* in the acuminate apex and the inconspicuous reticulate venation; the dried flowers are obtusely angular and about half as large as those of *S. pyrocarpum*, further, only single bracts are left here and there on the mature inflorescence of this plant, whereas in the specimens which we have associated with *S. pyrocarpum* each flower is subtended by bracts.

91. **Syzygium furfuraceum** Merr. & Perry, Jour. Arnold Arb. 23: 276. 1942. TYPE: *Clemens 2133*, Territory of New Guinea, Quembung (A, holotype).

Syzygium folidorhachis Merr. & Perry, *Ibid.*

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; lowland, foothill and montane rain forests to 2200 meters.

Some of the specimens included here differ in having the flowers somewhat narrowed towards the base into a fairly stout pseudostipe. This character is variable, however, and does not seem to have great significance in this species. We have reduced *Syzygium folidorhachis* to *S. furfuraceum*, since the distinguishing character of prominent reticulate venation of the leaves may well be the result of variation in habitat.

92. **Syzygium taeniatum** Diels, Bot. Jahrb. 57: 411. 1922. TYPE: *Ledermann 6705*, Territory of New Guinea, Sepik District, Malu (K, isotype; A, phot.).

Syzygium maschalocladum Merr. & Perry, Jour. Arnold Arb. **23:** 284. 1942.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; lowland, and foothill rain forests to 1050 meters.

93. **Syzygium alatum** (Lauterb.) Diels, Bot. Jahrb. **57:** 411. 1922.

Aphanomyrtus alata Lauterb. Nova Guinea (Bot.) **8:** 854. 1912. TYPE: *von Roemer 725*, West Irian, Hellwig Mts. (L, isotype; A, phot.).

Syzygium vaccinioides Merr. & Perry, Jour. Arnold Arb. **23:** 256. 1942.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; upper montane rain forests and cloud forests, 2700–3560 meters.

In spite of the difference in the size and shape of the leaves of the types of *Syzygium alatum* and *S. vaccinioides*, we now have enough material at hand to suggest that the two intergrade and probably belong to a single variable species. The wing character of the branchlets varies from straight to slightly, to very much, rippled and apparently is not correlated with relative length or width of leaves.

94. **Syzygium benjaminum** Diels, Bot. Jahrb. **57:** 411. 1922. TYPE: *Ledermann 10944*, Territory of New Guinea, Sepik District, Hunstein Mts.

Syzygium micropetalum Merr. & Perry, Jour. Arnold Arb. **23:** 293. 1942.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; montane rain forests and cloud forests, 1350–2700 meters.

Although we have seen only Diels' description, all our material appears to agree well with it and seems best placed here. The type of *Syzygium micropetalum* has somewhat larger leaves as well as both terminal and axillary inflorescences, but this may be the result of a more favorable habitat.

95. **Syzygium adelphicum** Diels, Nova Guinea (Bot.) **14:** 93. 1924. TYPE: *Lam 1971*, West Irian, Doorman Peak (L, holotype; A, phot.).

Syzygium adelphicum var. *adenanthum* Merr. & Perry, Jour. Arnold Arb. **23:** 292. 1942.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; montane rain forests and cloud forests, 2000–2070 meters.

Although *Syzygium adelphicum* var. *adenanthum*, with mostly more prominent primary veins, appears to be the commoner form, we have decided not to recognize varieties in this work since we are dealing with such a limited amount of material. The most distinctive character of the species appears to be the sessile, terminal inflorescence with sometimes short axillaries contributing to the appearance of a larger terminal cluster.

We also have a few specimens bearing an apparent compound inflorescence, e.g. *Eyma 4782*, *Clemens 7565A* and *Kanehira & Hatusima 13695*. More material is required to determine the significance of this variation.

96. **Syzygium robbinsii** Hartley & Perry, sp. nov.

Arbor 15 m. alta; ramis decorticatis; ramulis quadrangulis alatis, alis internodia decussate circumscribentibus; foliis 1.5–3.5 cm. longis, 1.5–2.8 cm. latis, late ellipticis basi et apice obtusis vel rotundatis, in sicco brunnescentibus, rigide coriaceis, subtus venis primariis prominulis, utrinsecus costa 7–9, rete distincte manifesto; petiolo 2–4 mm. longo, atrofusco; inflorescentiis ramosis (alabastris plerumque) compactis, 1.5–2 cm. longis bracteatis; axibus alatis; bracteis 2–3 mm. longis, inferioribus subrotundatis, superioribus oblongis, caducis; floribus sessilibus 2 vel 3 apicalibus; calycis tubo obconico 3 mm. longo, lobis 5 ca. 1 mm. longis; calyptra caduca vel petalis singillatim caducis. HOLOTYPUS: *Robbins 849* (A; BM, isotype).

Territory of New Guinea. EASTERN HIGHLANDS DISTRICT: Goroka Subdistrict, Mt. Otto area, Omahaiga River Valley, Collins' mill, lower montane forest, *Robbins 849*.

Superficially *Syzygium robbinsii* suggests *Eugenia wrayi* King, of the Malay Peninsula, but its branches are only quadrangular, not winged, and the reticulations of its leaves are finer and much less clearly visible.

97. **Syzygium schumannianum** (Niedenzu) Diels, Bot. Jahrb. **57**: 402. 1922.

Eugenia neurocalyx K. Schum. in K. Schum. & Hollr. Fl. Kaiser Wilhelms Land 90. 1889, non A. Gray (1854).
Jambosa schumanniana Niedenzu, Nat. Pflanzenfam. III. **7**: 84. 1893. TYPE: *Hollrung 749*, Territory of New Guinea, Sepik District.
Eugenia schumanniana (Niedenzu) Greves, Jour. Bot. **61**(Suppl.): 18. 1923.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua. The only habitat stated in our collections is that given by *Brass 13610*, West Irian, Bernhard Camp, Idenburg River: rain forest of more or less swampy river plain, 850 meters.

98. **Syzygium carrii** Hartley & Perry, sp. nov.

Arbor ca. 30 m. alta; ramis teretibus, ramulis tetragonis fusco-brunnescentibus; foliis 1.7–3 cm. longis, 1–1.7 cm. latis, coriaceis, pellucido-punctatis, ellipticis vel lanceolato-ellipticis obtusiusculis vel acutiusculis basi cuneatis, venis primariis inter se 1–2 mm. distantibus utrinque facile visis sed non prominulis; petiolo ca. 2 mm. longo ruguloso; inflorescentiis ± 2 cm. longis, terminalibus axillaribusque; axi gracili; alabastris anguste clavatis ca. 1 cm. longis ut videtur profuse glandulosis. HOLOTYPUS: *Carr 13511* (A).

West Irian. Arfak Mts., alt. 1500–2100 m., *Beccari 3896* (fragment). **Papua.** CENTRAL DISTRICT: Boridi, forest at 1500 m., *Carr 13511*.

This species is characterized by tetragonous branchlets, small, short-petiolate leaves, and slender, clavate flower buds. *Syzygium carrii* is apparently closely related to *S. leptopodium* (see note under species no. 102).

99. **Syzygium bicolor** Merr. & Perry, Jour. Arnold Arb. **23**: 286. 1942.
TYPE: *Brass 13018*, West Irian, Idenburg River, Bernhard Camp (A, holotype).

DISTRIBUTION: West Irian, Territory of New Guinea; foothill and montane rain forests, 1200–1800 meters.

100. **Syzygium attenuatum** (Miq.) Merr. & Perry, Mem. Am. Acad. Arts Sci. **18**(3): 185. 1939 (Mem. Gray Herb. 4).

Jambosa attenuata Miq. Fl. Ind. Bat. **1**(1): 437. 1855. TYPE: *Junghuhn*, Java. A note by Dr. Merrill indicates that he did not find Miquel's type at Leiden in 1930.

DISTRIBUTION: Malay Peninsula, Borneo, Java, Aroe Islands, West Irian, Territory of New Guinea, Papua; lowland and foothill rain forests to 1050 meters.

101. **Syzygium claviflorum** (Roxb.) Cowan & Cowan, Trees North. Bengal 67. 1929.

Eugenia claviflora Roxb. Fl. Ind. II. **2**: 488. 1832. TYPE: no specimen cited in original description; native in Chittagong.
Eugenia leptantha Wight, Ill. **2**: 15. 1841, non Benth. (1840).
Syzygium leptanthum (Wight) Niedenzu, Nat. Pflanzenfam. III. **7**: 85. 1893.
Eugenia leptalea Craib, Fl. Siam Enum. **1**: 649. 1931.

DISTRIBUTION: China and India throughout Malesia to Australia; in Papuasia from West Irian, Territory of New Guinea and Papua; lowland foothill and montane rain forests to 2300 meters.

A complete study of this group of clavate-flowered species is desirable both in the field and in the herbarium. There is considerable variation in the herbarium specimens placed together as *S. claviflorum* and sometimes no apparent correlation between the foliar and floral characters. For example, the leaves of *Hoogland & Pullen 6132* are 5–8 cm. long and 2–3.3 cm. wide, i.e. near the size of those of *Syzygium leptopodium*, but the flower buds are 2–2.3 cm. long and 5 mm. in diameter at the apex and are the largest among the specimens we have at hand. There are also other questions concerning both floral and foliar characters as well as those of branchlets needing study and evaluation.

102. **Syzygium leptopodium** Merr. & Perry, Jour. Arnold Arb. 23:

284. 1942. TYPE: *Clemens 5326*, Territory of New Guinea, Morobe District, Ogeramnang (A, holotype).

DISTRIBUTION: West Irian, Territory of New Guinea; foothill and montane rain forests, 550–1950 meters.

Some very small-leaved specimens of *Syzygium leptopodium* from West Irian seem to approach *S. carrii* in aspect, but in the former the leaves are acuminate rather than acute or obtuse and the plants are shrubs or small rather than large trees.

103. **Syzygium subamplexicaule** Merr. & Perry, Jour. Arnold Arb. 23: 285. 1942. TYPE: *Brass 8218*, Papua, Western District, Lower Fly River, rain forest on river bank (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

104. **Syzygium nemorale** Merr. & Perry, Jour. Arnold Arb. 23: 280. 1942. TYPE: *Brass 3456*, Solomon Islands, Ysabel, Sigana (A, holotype).

DISTRIBUTION: New Britain, Solomon Islands; lowland and foothill rain forests to 800 meters.

105. **Syzygium megistophyllum** Merr. & Perry, Jour. Arnold Arb. 23: 279. 1942. TYPE: *Brass 13340*, West Irian, Idenburg River, Bernhard Camp, *Agathis* forest at 900 m. (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

106. **Syzygium camptodromum** Merr. & Perry, Jour. Arnold Arb. 23: 285. 1942. TYPE: *Brass 3528*, Solomon Islands, Ysabel, Sigana, coastal rain forest (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

107. **Syzygium naiadum** (Diels) Merr. & Perry, Jour. Arnold Arb. 23: 249. 1942.

Jambosa naiadum Diels, Jour. Arnold Arb. 10: 82. 1929. TYPE: *Brass 754*, Papua, Central District, Budatobara (A, isotype).

DISTRIBUTION: West Irian, Papua; borders of streams, sea level to 100 meters.

108. **Syzygium capituliferum** Merr. & Perry, Jour. Arnold Arb. 23: 287. 1942. TYPE: *Brass 8482*, Papua, Western District, Wassi Kussa River, along stream in lowland rain forest (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

109. **Syzygium cartilagineum** Merr. & Perry, Jour. Arnold Arb. **23**: 287. 1942. TYPE: *Brass 3062*, Solomon Islands, San Cristobal, Hinuahaoro, montane forest at 900 m. (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

110. **Syzygium subglobosum** Merr. & Perry, Jour. Arnold Arb. **23**: 290. 1942. TYPE: *Brass & Versteegh 12584*, West Irian, Idenburg River, Bernhard Camp (A, holotype).

DISTRIBUTION: West Irian, Papua; foothill rain forests, 810–1830 meters.

111. **Syzygium rubiginosum** Merr. & Perry, Jour. Arnold Arb. **23**: 289. 1942. TYPE: *Brass 7491*, Papua, Western District, Middle Fly River, Lake Daviumbu (A, holotype).

DISTRIBUTION: Papua (Western District), Queensland; lowland rain forests.

112. **Syzygium triphlebium** Diels, Bot. Jahrb. **57**: 400. 1922. TYPE: *Ledermann 10288*, Territory of New Guinea, Sepik District, Lordberg (isotype seen by Dr. Merrill).

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; primary and secondary lowland and foothill rain forests to 1500 meters.

113. **Syzygium waterhousei** Merr. & Perry, Jour. Arnold Arb. **23**: 290. 1942. TYPE: *Brass 3208*, Solomon Islands, Ysabel, Tiratona (A, holotype).

DISTRIBUTION: New Britain, Solomon Islands; lowland and foothill rain forests to 600 meters.

114. **Syzygium nitidum** Benth. Hooker's London Jour. Bot. **2**: 221. 1843. SYNTYPES: *Hinds*, New Guinea (K); *Barclay*, Tobie (Tobi) Island (K; A, isosyntype).

Eugenia benthamii F. Muell. Descript. Notes Papuan Pl. **1**: 9. 1875. Based on *Syzygium nitidum* Benth.

Syzygium japenense Merr. & Perry, Jour. Arnold Arb. **23**: 288. 1942.

DISTRIBUTION: Philippines, Tobi Island, New Guinea (Japen Island); no habitat given except forest and roadside on some Philippine labels.

115. **Syzygium lorentzianum** Lauterb. Nova Guinea (Bot.) **8**: 852. 1912. TYPE: *Gjellerup 315*, West Irian, Hollandia.

DISTRIBUTION: West Irian (Hollandia); we have seen only *Brass 8864*, from the type locality; said to be common in secondary growth on a rocky slope.

116. **Syzygium trivene** (Ridley) Merr. & Perry, Jour. Arnold Arb. **23**: 288. 1942.

Eugenia trivenis Ridley, Trans. Linn. Soc. Bot. II. **9**: 47. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition (BM, holotype; A, phot. and carbon rubbing).

Syzygium modestum Diels, Bot. Jahrb. **57**: 400. 1922.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua, Solomon Islands; lowland and foothill rain forests to 1000 meters.

With the abundance of material at hand from the Territory of New Guinea, but only the description of *Syzygium modestum* Diels, we believe Diels' species is the same as Ridley's, which carries the older epithet. Although the bracts of the inflorescence are very small, they are present when the flowers are in bud and sometimes at anthesis; however, since the bracts are predominantly deciduous, we have placed this species under that division in the key.

117. **Syzygium verniciflorum** (Diels) Merr. & Perry, Jour. Arnold Arb. **23**: 249. 1942.

Jambosa verniciflora Diels, Bot. Jahrb. **57**: 387. 1922. TYPE: *Schlechter 17751*, Territory of New Guinea, Kani (K, isotype; A, phot.).

DISTRIBUTION: Territory of New Guinea; lowland rain forests to 100 meters.

118. **Syzygium flavescens** (Ridley) Merr. & Perry, Jour. Arnold Arb. **23**: 278. 1942.

Eugenia flavescens Ridley, Trans. Linn. Soc. Bot. II. **9**: 46. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition (BM, holotype; A, phot.).

DISTRIBUTION: West Irian, Papua; lowland rain forests to 800 meters.

119. **Syzygium brassii** Merr. & Perry, Jour. Arnold Arb. **23**: 277. 1942. TYPE: *Brass 7682*, Papua, Western District, Middle Fly River (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

Not to be confused with *Eugenia brassii* Merr. & Perry, Jour. Arnold Arb. **23**: 247. 1942.

120. **Syzygium kietanum** Rechinger, Repert. Sp. Nov. **11**: 183. 1912; Denkschr. Math.-Naturw. Kl. Akad. Wiss. Wien **89**: 585 (Bot. Zool. Ergeb. Wiss. Forsch. Samoa-I., Neug.-Arch., Salomonins. **5**: 143). 1913. TYPE: *Rechinger 4704*, Solomon Islands (W, holotype).

DISTRIBUTION: Solomon Islands; steep foreshores.

121. **Syzygium branderhorstii** Lauterb. Nova Guinea (Bot.) **8**: 322. 1910. TYPE: *Branderhorst 129*, West Irian, south coast, Okaba.

DISTRIBUTION: West Irian, Papua; lowland rain forests.

We have not seen the type of this species. We have a specimen, *Brass 844*, which Diels named (listed thus in White, Jour. Arnold Arb. **10**: 253. 1929). It is a good match for *Gjellerup 162*, and *Brass 27815*, also the leaves of *Anta 164* (inflorescence very immature). In these the dried calyx tube is 3–4 mm. long and longitudinally sulcate. Lauterbach described the ovary of *S. branderhorstii* as cyathiform, 6–7 mm. long, but apart from the size of the flowers we do not find other differences. We have a specimen, *Hoogland 4990*, with leaves reminding us of this species; but the lateral inflorescence is somewhat corymbose with branches ascending-spreading rather than widely spreading as in *S. branderhorstii*. Although inflorescence is only in bud, the calyx has definite lobes and below the enlarged top of the bud is an angled pseudostalk 2–2.5 mm. long. Since we have so little material of *S. branderhorstii*, we merely point out the characters by which this specimen seems to differ from it.

122. **Syzygium leptophlebioides** Merr. & Perry, Jour. Arnold Arb. **23**: 282. 1942. TYPE: *Brass 8979*, West Irian, Hollandia (A, holotype).

DISTRIBUTION: West Irian; lowland rain forests, 50–100 meters. Known to us only from the type locality.

123. **Syzygium decipiens** (Koords. & Val.) Merr. & Perry, Jour. Arnold Arb. **23**: 281. 1942.

Eugenia decipiens Koords. & Val. Meded. Lands Plant. **40**: 131 (Bijdr. Booms. Java 6). 1900; Atlas Baumart. Java **3**: *t. 495*. 1915. TYPE: described from two Koorders collections in fruit and two living trees (flowering in July and fruiting in October) in Hort. Bogor. So far as we know no single collection has been designated as the type.
Syzygium megalanthelium Diels, Nova Guinea (Bot.) **14**: 93. 1924.
Syzygium rectangulare Merr. & Perry, Jour. Arnold Arb. **23**: 282. 1942.

DISTRIBUTION: Java, Aroe Islands, West Irian, Territory of New Guinea, Solomon Islands; lowland rain forests to 140 meters.

We have reduced *Syzygium rectangulare* to *S. decipiens* as in this instance we are inclined to regard the angled base of the calyx and the obtusely angled fruits as variable characters. The embryos of the two are very similar in appearance.

124. **Syzygium rosaceum** Diels, Bot. Jahrb. **57**: 406. 1922. TYPE: *Ledermann 9029*, Territory of New Guinea, Sepik District, Etappenberg.

DISTRIBUTION: Territory of New Guinea, Papua; lowland and foothill rain forests to 1000 meters.

125. **Syzygium badium** Merr. & Perry, Jour. Arnold Arb. **23:** 281. 1942. TYPE: *Brass & Versteegh 11992*, West Irian, Idenburg River, 18 km. SW of Bernhard Camp, primary forest at 2200 m. (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

126. **Syzygium acetosum** Merr. & Perry, Jour. Arnold Arb. **23:** 280. 1942. TYPE: *Brass 6267*, Papua, Western District, Daru Island, lowland rain forest (A, holotype).

DISTRIBUTION: Known to us only from the type collection.

127. **Syzygium leptoneurum** Diels, Bot. Jahrb. **57:** 407. 1922. TYPE: *Schlechter 17379*, Territory of New Guinea, Morobe District, Waria River near Jatuna.

DISTRIBUTION: Territory of New Guinea, Papua; stream banks at low elevations.

128. **Syzygium micrandrum** (Ridley) Merr. & Perry, Jour. Arnold Arb. **23:** 294. 1942.

Eugenia micrandra Ridley, Trans. Linn. Soc. Bot. II. **9:** 48. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition (BM, holotype; A, phot.).

DISTRIBUTION: West Irian, Papua, Solomon Islands; lowland and foothill rain forests.

129. **Syzygium myriadenum** Merr. & Perry, Jour. Arnold Arb. **23:** 293. 1942. TYPE: *Kajewski 2713*, Solomon Islands, Guadalcanal, lowland rain forest at ca. 180 m. (A, holotype).

Eugenia myriadena (Merr. & Perry) Whitmore, Guide For. British Solomon Isl. 203. 1966; Gard. Bull. Singapore **22:** 16. 1967.

DISTRIBUTION: Known to us only from the type collection.

130. **Syzygium homichlophilum** Diels, Bot. Jahrb. **57:** 409. 1922. TYPE: *Ledermann 11797*, Territory of New Guinea, Sepik District, Schraderberg.

Syzygium retivenium Merr. & Perry, Jour. Arnold Arb. **23:** 294. 1942.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; montane rain forests and cloud forests, 1500–2650 meters.

We have received from Berlin a photograph of *Ledermann 11644*, a paratype and topotype of *Syzygium homichlophilum*. With this we have tried

to match Diels' species. He omitted any description of the branchlets, but those assumed to belong here are quadrangular with bark very often flaking off between the nodes.

131. **Syzygium effusum** (A. Gray) C. Muell. Walpers Ann. **4**: 838. 1857, *sensu lato*.

Eugenia effusa A. Gray, Bot. U. S. Expl. Exped. 524. 1854. TYPE: *U. S. Expl. Exped.*, Fiji, Mbua Bay (US, holotype; GH, isotype).
Eugenia sylvana Ridley, Trans. Linn. Soc. Bot. II. **9**: 48. 1916.
Syzygium leucoderme Diels, Bot. Jahrb. **57**: 409. 1922.
Eugenia nivifera Greves, Jour. Bot. **61**(Suppl.): 19. 1923.
Syzygium niviferum (Greves) Merr. & Perry, Jour. Arnold Arb. **23**: 250. 1942.
Syzygium doctersii Merr. & Perry, *Ibid.* 283.
Syzygium obtusum Merr. & Perry, *Ibid.* 294.
Syzygium sylvanum (Ridley) Merr. & Perry, *Ibid.* 295.

DISTRIBUTION: Throughout New Guinea east to Fiji; lowland, foothill and montane rain forests to 2800 meters.

We have a wide range of specimens that fall into this complex for which we have not been able to find any constant or correlating characters enabling us to recognize more than a single species. Some of the morphologic variation we have accepted includes, bark of branchlets gray to brown; leaves obovate to spatulate to elliptic, subcoriaceous to coriaceous, obtuse to abruptly short-acuminate at apex, 2–8 cm. long, 1.4–5.2 cm. broad; calyx tube (including stipe, when present) 3–4.5 mm. long; calyx lobes obsolete to 0.5 mm. high.

We have no specimens which seem to agree with Diels' description of *Syzygium ganophyllum* with shiny, narrow leaves. He compares his species with *S. mainitense* (Elmer) Merr., from the Philippines, of which we have several collections and which we think ought to be studied in conjunction with *S. effusum*.

Jambosa (*Clavimyrtus*) *arfakensis* Gibbs seems to be an elusive species. Diels says it belongs in the relationship of *Syzygium leucoderme*, but he does nothing further with it. One would need authentic collections from the type locality of *J. arfakensis* in order to distinguish the specific characters.

132. **Syzygium subcorymbosum** Merr. & Perry, Jour. Arnold Arb. **23**: 297. 1942. TYPE: *Brass 5573*, Papua, Central District, Kubuna (A, holotype).

DISTRIBUTION: West Irian, Territory of New Guinea, Papua, New Britain, Solomon Islands; lowland and foothill rain forests to 300 meters.

Similar to *Syzygium buettnerianum* (see note under species no. 86).

133. **Syzygium luehmannii** (F. Muell.) L. Johnson, Contrib. New S. Wales Natl. Herb. **3**: 99. 1962.

Eugenia luehmanni F. Muell. Victorian Nat. **9:** 10. 1892. TYPE: *S. Johnson*, Queensland, Cook District, Mt. Bartle Frere (MEL, holotype).
Eugenia parvifolia C. Moore, Jour. & Proc. Roy. Soc. New S. Wales **27:** 85. 1893, non DC. (1828).

DISTRIBUTION: Papua (Goodenough Island), eastern Queensland, northeastern New South Wales; in Papua in mossy oak forest at 1600 meters.

From Australia we have only a sterile specimen of this species (as *Eugenia parvifolia*) collected by W. D. Francis at Myer's Ferry, Southport, Queensland. The Brass collection from Goodenough Island matches this well, and the flowers and fruit correspond to the original descriptions. *Eugenia parvifolia* was placed in synonymy under *Syzygium luehmannii* by L. Johnson, *loc. cit.*

134. **Syzygium walkeri** Merr. & Perry in C. T. White, Jour. Arnold Arb. **31:** 101. 1950. TYPE: *F. S. Walker BSIP 249*, Solomon Islands, Guadalcanal, Buru-Buru River (A, holotype).

DISTRIBUTION: Solomon Islands; lowland rain forest.

135. **Syzygium rostratum** (Bl.) DC. Prodr. 3: 261. 1828.

Calyptranthus rostrata Bl. Bijdr. 1092. 1826. TYPE: probably *Blume* (L, holotype); "in sylvis altioribus."

DISTRIBUTION: Sumatra, Borneo, Java, West Irian; humid forest (*fide* Fl. Java).

136. **Syzygium plumeum** (Ridley) Merr. & Perry, Jour. Arnold Arb. **23:** 296. 1942.

Eugenia plumea Ridley, Trans. Linn. Soc. Bot. II. **9:** 46. 1916. TYPE: *B. Kloss*, West Irian, Wollaston Expedition (BM, holotype).
Syzygium leptanthelium Diels, Bot. Jahrb. **57:** 410. 1922.

DISTRIBUTION: West Irian, Territory of New Guinea, Papua; foothill and montane rain forests to 2300 meters.

137. **Syzygium finisterrae** (Lauterb.) Merr. & Perry, Jour. Arnold Arb. **23:** 295. 1942.

Eugenia finisterrae Lauterb. Repert. Sp. Nov. **13:** 240. 1914. TYPE: *Keysser 300*, Territory of New Guinea, Madang District, Finisterre Range.

DISTRIBUTION: Territory of New Guinea; foothill and lower montane rain forests; 600–1350 meters.

138. **Syzygium onesimum** Merr. & Perry, Jour. Arnold Arb. **23:** 296. 1942. TYPE: *Kajewski 2043*, Solomon Islands, Bougainville, Koniguru, Buin (A, holotype).

Eugenia onesima (Merr. & Perry) Whitmore, Guide For. British Solomon Isl. 203. 1966; Gard. Bull. Singapore **22:** 17. 1967.

DISTRIBUTION: Solomon Islands; lowland and foothill rain forests to 1000 meters.

UNMATCHED OR OTHERWISE EXCLUDED SPECIES DESCRIBED FROM PAPUASIA

Eugenia altipeta Greves, Jour. Bot. **61**(Suppl.): 14. 1923. Type should be re-examined. Doesn't look like *Eugenia*, according to Merrill.

Eugenia argyrocalyx Warb. Bot. Jahrb. **13:** 390. 1891 [**Syzygium argyrocalyx** (Warb.) Merr. & Perry, Jour. Arnold Arb. **23:** 264. 1942].

Eugenia baeuerlenii F. Muell. Australas. Jour. Pharm. **1:** 199. 1886. = **Cleistocalyx baeuerlenii** (F. Muell.) Merr. & Perry, *Ibid.* **18:** 331. 1937.

Eugenia bartonii F. M. Bailey, Proc. Roy. Soc. Queensl. **18:** 2. 1902 [**Syzygium bartonii** (F. M. Bailey) Merr. & Perry, *Ibid.* **23:** 250. 1942].

Eugenia brassii Merr. & Perry, *Ibid.* 247. = Eugenia *sensu stricto*.

Eugenia dispansa Ridley, Trans. Linn. Soc. Bot. II. **9:** 47. 1916 [**Acmena dispansa** (Ridley) Merr. & Perry, *Ibid.* **19:** 18. 1938].

Eugenia duplomarginata Greves, Jour. Bot. **61**(Suppl.): 15. 1923 [**Syzygium duplomarginatum** (Greves) Merr. & Perry, *Ibid.* **23:** 249. 1942].

Eugenia glomerata Warb. Bot. Jahrb. **13:** 390. 1891 [**Syzygium warburgii** Merr. & Perry, *Ibid.* 250].

Eugenia koikokoensis Greves, Jour. Bot. **61**(Suppl.): 20. 1923. Type should be re-examined. Merrill considered flower Jambosa-like. We were unable to match the carbon rubbing of the leaves.

Eugenia laevifolia Ridley, Trans. Linn. Soc. Bot. II. **9:** 48. 1916 = **Acmena laevifolia** (Ridley) Merr. & Perry, *loc. cit.* **19:** 18. 1938.

Eugenia lehuntei F. M. Bailey, Queensl. Agric. Jour. **9:** 411. 1910 [**Syzygium lehuntei** (F. M. Bailey) Merr. & Perry, *Ibid.* **23:** 250. 1942, or possibly belongs in *Acmena*].

Eugenia merokensis Greves, Jour. Bot. **61**(Suppl.): 16. 1923 [**Syzygium merokense** (Greves) Merr. & Perry, *Ibid.* 249].

Eugenia monetaria Ridley, Trans. Linn. Soc. Bot. II. **9:** 49. 1916 [**Syzygium monetarium** (Ridley) Merr. & Perry, *Ibid.* 249]. Photograph of type at A.

Eugenia pleiopetala F. Muell. Descript. Notes Papuan Pl. **1:** 106. 1875 = **Octamyrtus pleiopetala** (F. Muell.) Diels, Bot. Jahrb. **57:** 373. 1922.

Eugenia pterocalyx Greves, Jour. Bot. **61**(Suppl.): 17. 1923 [**Syzygium grevesianum** Merr. & Perry, *loc. cit.* 253].

Eugenia racemoides Greves, Jour. Bot. **61**(Suppl.): 20. 1923. The type of this species ought to be examined. We have no notes by Merrill, but from the description it might belong to *S. longipes s.l.*

Eugenia salomonensis Hemsley, Jour. Linn. Soc. Bot. **30:** 212. 1894 [**Syzygium salomonense** (Hemsley) Merr. & Perry, *loc. cit.* 273]. Photograph of type at A.

Eugenia salomonica C. T. White, Jour. Arnold Arb. **32:** 141. 1951 = Eugenia *sensu stricto*.

Eugenia salpingantha Greves, Jour. Bot. **61**(Suppl.): 19. 1923 [**Syzygium salpinganthum** (Greves) Merr. & Perry, *loc. cit.* 250].

Eugenia scolopacina Ridley, Trans. Linn. Soc. Bot. II. **9:** 49. 1916 = **Xanthomyrtus scolopacina** (Ridley) Diels, Bot. Jahrb. **57:** 365. 1922.

Eugenia trichotoma Greves, Jour. Bot. **61**(Suppl.): 19. 1923 [**Syzygium trichotomum** (Greves) Merr. & Perry, *loc. cit.* 250].

Eugenia vandewateri Ridley, Trans. Linn. Soc. Bot. II. **9:** 45. 1916 [**Syzygium vandewateri** (Ridley) Merr. & Perry, *Ibid.* 249]. Photograph and carbon rubbing of type at A.

Eugenia wollastonii Ridley, Trans. Linn. Soc. Bot. II. **9:** 47. 1916 [**Syzygium wollastonii** (Ridley) Merr. & Perry, *Ibid.* 249]. Photograph and carbon rubbing of type at A.

Jambosa alutacea Diels, Bot. Jahrb. **57:** 386. 1922 [**Syzygium alutaceum** (Diels) Merr. & Perry, *Ibid.* 270]. See note under *S. validinerve*, species no. 45.

Jambosa arfakensis Gibbs, Contr. Phytogr. Fl. Arfak Mts. 153. 1917. See note under *S. effusum*, species no. 131.

Jambosa bruynii Diels, Nova Guinea (Bot.) **14:** 92. 1924 [**Syzygium bruynii** (Diels) Merr. & Perry, *loc. cit.* 249]. Near *S. trachyanthum*, species no. 14.

Jambosa caryophylloides Lauterb. Bot. Jahrb. **45:** 363. 1911 [**Syzygium caryophylloides** (Lauterb.) Merr. & Perry, *Ibid.* 264].

Jambosa combretiflora Diels, Bot. Jahrb. **57:** 392. 1922 [**Syzygium combretiflorum** (Diels) Merr. & Perry, *Ibid.* 286].

Jambosa decoriflora Diels, *Ibid.* 396 [**Syzygium decoriflorum** (Diels) Merr. & Perry, *Ibid.* 249].

Jambosa dolichostyla Diels, Nova Guinea (Bot.) **14:** 91. 1924 [**Syzygium dolichostylum** (Diels) Merr. & Perry, *Ibid.* 272]. See note under *S. hylophilum*, species no. 73.

Jambosa eximiiflora Diels, *Ibid.* 92 [**Syzygium eximiiflorum** (Diels) Merr. & Perry, *Ibid.* 252].

Jambosa keroantha Diels, Bot. Jahrb. **57:** 385. 1922 [**Syzygium keroanthum** (Diels) Merr. & Perry, *Ibid.* 271].

Jambosa micrantha Rech. Repert. Sp. Nov. **11:** 183. 1912 [**Syzygium rechingeri** Merr. & Perry, *Ibid.* 249].

Jambosa ovalifolia Bl. Mus. Bot. Lugd.-Bat. **1:** 98. 1849 [**Syzygium ovalifolium** (Bl.) Merr. & Perry, *Ibid.* 260]. Photograph of type at A.

Jambosa pachyantha Diels, *loc. cit.* 395 [**Syzygium pachyanthum** (Diels) Merr. & Perry, *Ibid.* 249].

Jambosa papuana (Lauterb.) Diels, *Ibid.* 384 [based on ?*Decaspermum papuanum* Lauterb. Nova Guinea (Bot.) **8:** 319. 1910]. Photograph of type at A; no inflorescence visible.

Jambosa phacelantha Diels, *Ibid.* 390 [**Syzygium phacelanthum** (Diels) Merr. & Perry, *loc. cit.* 249].

Jambosa pilgeriana Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 473. 1900 [**Syzygium pilgerianum** (Lauterb. & K. Schum.) Merr. & Perry, *Ibid.* 255].

Jambosa platycarpa Diels, Bot. Jahrb. **57:** 385. 1922 [**Syzygium platycarpum** (Diels) Merr. & Perry, *Ibid.* 278]. See note under *S. tierneyanum*, species no. 69.

Jambosa polyphlebia Diels, *Ibid.* 391 [**Syzygium polyphlebium** (Diels) Merr. & Perry, *Ibid.* 249].

Jambosa pycnantha Diels, *Ibid.* 394 [**Syzygium dielsianum** Merr. & Perry, *Ibid.* 259].

Jambosa recurvo-venosa Lauterb. Nova Guinea (Bot.) **8:** 851. 1912 [**Syzygium recurvo-venosum** (Lauterb.) Diels, *Ibid.* 403].

Jambosa riparia Diels, *Ibid.* 389 [**Syzygium riparium** (Diels) Merr. & Perry, *loc. cit.* 249]. See note under *S. hylophilum*, species no. 73.

Jambosa sabangensis Lauterb. Nova Guinea (Bot.) **8:** 320. 1910 [**Syzygium sabangense** (Lauterb.) Merr. & Perry, *Ibid.* 249]. Photograph of type at A.

Jambosa tricolor Diels, *loc. cit.* 393 [**Syzygium tricolor** (Diels) Merr. & Perry, *Ibid.* 255].

Syzygium acmenioides Merr. & Perry, *Ibid.* 291. Cf. **Acmena hemilampra** (F. Muell. ex F. M. Bailey) Merr. & Perry, *Ibid.* **19:** 15. 1938.

Syzygium brachyanthelium Diels, *Ibid.* 412.

Syzygium caroli Diels, *Ibid.* 404. Photograph of type at A.

Syzygium chamaebuxus Diels, Nova Guinea (Bot.) **14:** 93. 1924. Perhaps a form of *S. adelphicum* Diels.

Syzygium cruriflorum Diels, Bot. Jahrb. **57:** 402. 1922.

Syzygium dictyoneurum Diels, *Ibid.* 404, and var. **oreogonum** Diels, *Ibid.* Perhaps the var. is the equivalent of *S. bracteosum*, species no. 80.

Syzygium dolichorhynchum Diels, *Ibid.* 413.

Syzygium ellipticum Lauterb. & K. Schum. in K. Schum. & Lauterb. Fl. Deutsche Schutzgebiete Südsee 476. 1900 = **Psidium guajava** L. Sp. Pl. 470. 1753, according to Merr. & Perry, Jour. Arnold Arb. **23:** 250. 1942.

Syzygium ganophyllum Diels, *loc. cit.* 408. 1922. See note under *S. effusum*, species no. 131.

Syzygium gjellerupii Lauterb. Nova Guinea (Bot.) **8:** 852. 1912. Photograph of type at A.

Syzygium gyrostemoneum Diels, *loc. cit.* 412. Photograph of type at A.

Syzygium heloanthum Diels, *Ibid.* 403. Perhaps the same as *S. leptopodium*, species no. 102.

Syzygium lamprophyllum Diels, *Ibid.* 411.

Syzygium leptophlebium Diels, *Ibid.* 406. Perhaps the same as *S. subcorymbosum*, species no. 132.

Syzygium orthoneurum Diels, *Ibid.* 400.

Syzygium oxyphyllum Diels, *Ibid.* 407. Photograph of type at A.

Syzygium peekelii Diels, *Ibid.* 414.

Syzygium petraeum Diels, *Ibid.* 410. Photograph of paratype at A.

Syzygium pullei Diels, *Ibid.* 401. 1922.

Syzygium pyrrophloem Diels, *Ibid.* 413.

Syzygium schlechteri Diels, *Ibid.* 402. Photograph of type at A.

Syzygium scytophyllum Diels, *Ibid.* 407. Photograph of type at A.

Syzygium subsimile Diels, *Ibid.* 401. Photograph of type at A.

Syzygium tolypanthum Diels, *Ibid.* 408.

INDEX TO EXSICCATAE

The numbers in parentheses refer to the corresponding species in the text.

Aet (Expedition Lundquist) *55* (59); *57* (132); *668* (122); *705* (97).
Aet & Idjan (Expedition van Dijk) *344* (40); *552* (75); *612* (114).
Anta (Expedition Wentholt) *164* (121); *167* (13).
Australian National University (ANU series) *750* (94).

Beccari *140* (32).
Boswezen, Forestry Division, Netherlands New Guinea (BW series) *60* (31); *1102* (132); *1382*, *1392*, *2160* (36); *2242* (86); *4773* (132); *9240* (67).
Botanic Garden Bogor *V. B. 47* (32).
Brass *551* (52); *600* (21); *657* (25); *714* (75); *754* (107); *838* (51); *844* (121); *955* (14); *1065* (55); *1079* (25); *1111* (36); *1148* (cf. 69); *1345* (75); *1392* (107); *1393* (28); *1433* (14); *1619* (79); *1653* (107); *2602* (40); *2649* (8); *2752* (69); *2781* (56); *2971* (23); *3006* (43); *3062* (109); *3150* (120); *3182* (43); *3208* (113); *3344* (63); *3445* (138); *3456* (104); *3464* (40); *3528* (106); *3922* (124); *3936* (77); *4146* (11); *4515* (93); *4854* (95); *4910* (18); *5338* (78); *5487* (58); *5573* (132); *5583* (127); *5606* (75); *5608* (60); *5772* (cf. 69); *5816* (70); *6267* (126); *6673* (29); *6681* (66); *6708* (75); *6966* (16); *7034* (4); *7243* (59); *7244* (15); *7323* (32); *7357* (72); *7422* (100); *7423* (124); *7475* (75); *7491*, *7510* (111); *7567*, *7658* (101); *7659* (118); *7682* (119); *7683* (124); *7694* (36); *7753* (67); *7954* (118); *8019* (36); *8102* (43); *8113* (33); *8126* (67); *8137* (25); *8211* (69); *8218* (103); *8238* (27); *8273* (69); *8301* (31); *8314* (86); *8334* (67); *8390* (111); *8482* (108); *8605* (101); *8864* (115); *8979* (122); *9001* (76); *9002* (92); *10804* (64); *11346* (131); *11354* (64); *11392* (12); *12144* (92); *12162* (54); *12995* (42); *13018* (99); *13340* (105); *13610* (97); *13930* (123); *13950* (53); *14056* (123); *21800* (cf. 75); *21931* (cf. 79); *22687* (91); *22865* (130); *23608* (1); *23780*, *23988* (7); *24042* (75); *24090* (7); *24225* (cf. 75); *24298* (40); *24641* (18); *24853* (133); *25441* (131); *25478* (30); *25523* (116); *25738* (131); *25572* (118); *25847* (83); *25887*, *25919* (49); *27179*, *27294* (118); *27729* (86); *27763* (cf. 92); *27815* (121); *27868* (92); *28215* (58); *28238* (75); *28342*, *28357* (82); *28549* (cf. 75); *28566* (118); *28594* (131); *28650* (83); *28739* (68); *28817*, *28895* (69); *28913* (2); *29240*, *29330* (116); *29566*, *29607* (95); *30000* (93); *30599* (94); *30681* (93); *30716* (46); *30717* (65); *30852* (94); *31091*, *31319* (50); *31320* (aff. 91); *31406* (95); *31858* (86); *31937* (18); *32291* (58); *32645* (44); *32653* (cf. 73).
Brass & Versteegh *10498* (64); *11111* (131); *11117* (80); *11134*, *11156* (94); *11157* (39); *11181* (131); *11909* (92); *11913* (131); *11917* (91); *11934* (81); *11935*, *11941* (54); *11945* (110); *11956* (39); *11986* (80); *11988* (131); *11992* (125); *11995* (95); *12543* (131); *12548* (41); *12552* (131); *12562* (36); *12573* (20); *12584* (110); *13106* (39); *13123* (100); *13125* (87); *13159* (20); *13194* (41); *13508* (39); *13577* (41); *13583* (cf. 91); *14030* (131); *14106* (22); *14108* (35).
British Solomon Islands Plants (BSIP series) *22* (123); *65* (8); *92* (43); *99* (23); *102* (40); *152* (63); *165*

(40); *168* (138); *194* (131); *249* (69); *255* (128); *6702* (cf. 83); *6862* (63); *9831* (83).

Buwalda *5019* (123); *5094* (67); *5408* (71); *5432* (79).

Carr *11314* (69); *11356* (127); *11562* (2); *11663* (10); *11780* (101); *11977* (28); *12051* (85); *12256* (91); *12269* (58); *12356* (51); *12454* (21); *12764* (3); *12767* (85); *12837* (75); *12921* (101); *13031* (71); *13511* (98); *13610* (18); *13747* (95); *13813* (65); *13846* (94); *13933* (58); *13995* (18); *14016* (75); *14034* (131); *14035* (cf. 73); *14383* (cf. 85); *14745* (11); *14922* (cf. 73); *15081* (95); *15289* (94); *15436* (32); *15596* (55); *15681* (18); *15727* (cf. 73).

Clemens *697a* (116); *874* (75); *1071* (20); *1082* (40); *1270* (131); *1420* (137); *1570* (91); *1760* (67); *1795* (131); *1853* (100); *2133* (91); *2136*, *2154* (131); *2220* (100); *2954* (18); *3004* (137); *3078* (5); *3620*, *3759* (38); *3951* (102); *3976*, *4077* (20); *4193* (137); *4291* (40); *4492* (86); *4526* (102); *4612* (131); *4831* (91); *5013* (86); *5056*, *5119a*, *5326* (102); *5450* (136); *5455* (38); *5459* (136); *6436* (18); *6459* (58); *6599* (136); *6867* (58); *7187* (86); *7414* (46); *7565a* (aff. 95); *7577* (18); *7747*, *7890* (58); *8038* (?21); *8041*, *8107a* (91); *8248*, *8283* (cf. 79); *8296* (47); *9428* (91); *9470* (?93); *9509* (95); *10471* (40); *10514*, *10837* (cf. 73); *10843* (47); *10851* (cf. 73); *10859* (79); *12273* (18); *40684* (cf. 73); *40741* (40); *41524* (83); *41680* (47).

Docters van Leeuwen *9491* (122); *9660* (38); *10423* (131); *11191* (122).

Eyma *4782* (aff. 95); *5395* (aff. 91); *5447* (62).

Forbes *101* (3); *372* (19); *399* (18); *546* (128); *547* (131); *729* (83).

Hartley *9630* (cf. 84); *9892* (57); *9936* (6); *9938* (21); *9951* (57); *10047* (40); *10064* (cf. 75); *10070* (116); *10106* (75); *10197* (116); *10233* (91); *10309* (cf. 84); *10404* (132); *10418*, *10481* (131); *10506* (132); *10531* (7); *10540* (83); *10550* (116); *10634* (52); *10649* (51); *10677* (2); *10824* (116); *10879* (cf. 79); *10897* (cf. 75); *10902* (57); *11042* (116); *11054* (9); *11088* (74); *11319* (2); *11332* (117); *11416* (131); *11426* (74); *11429* (28); *11438* (cf. 84); *11493* (131); *11503* (37); *11534* (cf. 73); *11668* (93); *11766* (116); *11791* (112); *11815*, *11833* (95); *11885* (88); *11994* (102); *11999* (101); *12007* (14); *12011* (99); *12015* (45); *12034* (cf. 73); *leg. Dunstone 12048* (101); *leg. Dunstone 12048a* (102); *12082* (14); *12088* (101); *12132* (131); *12214* (24); *12277* (21); *12320* (130); *12325* (86); *12326* (131); *12357* (74); *12368* (cf. 84); *12390* (21); *12415* (18); *12416* (102); *12448* (131); *12449* (86); *12455* (91 vel aff.); *leg. Sayers 12576* (cf. 84); *leg. Sayers 12595* (136); *leg. Sayers 12614* (44); *leg. Sayers 12617* (18); *12667* (92); *12672* (cf. 73); *12675* (55); *12719* (91); *12733* (130); *12833* (58); *12885* (136); *leg. Sayers 12936* (18); *12974* (93); *13085* (131); *13151* (131); *13156* (39); *13184* (46); *13210* (94); *13291* (131); *13303* (18); *13303a* (3).

Hoogland *3838* (90); *3894* (40); *3951* (21); *4025* (55); *4207* (7); *4344* (75); *4518* (86); *4651* (79); *4681* (cf. 61); *4682* (53); *4683* (cf. 75); *4800* (40); *4829* (86); *4954* (75); *4990* (aff. 121); *5012* (36); *5062* (40); *5157* (78); *5186* (47); *8939* (124).

Hoogland & Pullen *5303* (50); *5604* (95); *5812* (131); *5872* (18); *5961* (86); *6059* (17); *6092* (130); *6125* (95); *6132* (aff. 101); *6213* (50).

Hoogland & Taylor *3392* (131); *3735a* (40).

Kajewski *1543* (69); *1602* (113); *1661*, *1756* (cf. 79); *1814* (40); *2043* (138); *2052* (cf. 79); *2065* (131); *2207* (113); *2248* (8); *2322* (40); *2353* (104); *2400* (8); *2481* (104); *2491* (69); *2588* (cf. 134); *2629* (56); *2695* (123); *2703* (69); *2713* (129).

Kanehira & Hatusima *11937* (18); *12038* (42); *12800* (aff. 128); *13137*, *13171* (71); *13695* (aff. 95); *13934* (64).

Kostermans *70* (34); *160* (68); *196* (75); *214* (34); *357* (132); *383* (34); *2843* (36).

Lam *1005* (123).

Main *508* (67).

Native collector *4744* (116).

Netherlands Indies Forest Service series bossen buitengewesten (NIFS bb series) *21810* (131); *21851* (122); *22092* (79); *22297* (135); *25033* (40); *25048* (92); *25052* (76); *25055* (122); *25064* (135); *25256* (123, in part); *25302* (100); *25324* (67); *25468* (79); *25661* (123); *25678* (76); *25692* (2); *28981* (86); *30584* (114); *30677*, *30682*, *30688*, *30747*, *30750*, *30826* (135); *30962* (83); *33317* (86); *33536* (132); *33603* (86).

New Guinea Forces [now New Guinea Forest Department] (NGF series) *2595*, *2614* (40); *2914* (86); *2925* (91); *3129* (69); *3140* (89); *3154* (91); *3181*, *3224*, *3410* (40); *3504* (cf. 72); *3546* (8); *3557* (75); *3592* (57); *3709* (37); *3820* (7); *3927* (72); *3999* (57); *4065* (86); *4108* (132); *4217* (21); *4223* (52); *4345* (48); *4365* (50); *4473* (48); *4776* (cf. 73); *4845* (46); *4847* (cf. 73); *4984* (48); *4989*, *4990* (46); *5003* (132); *5174* (cf. 69); *5678* (40); *5683* (88); *5774* (36); *5864* (10); *5876* (89); *6009* (3); *6063* (102); *6128* (131); *6221* (75); *6509* (40); *6584* (43); *6766* (58); *6785* (93); *6786* (95); *7157* (44); *7177* (75); *7201* (36); *7204* (57); *7280* (132); *7352* (57); *7376* (18); *7442* (7); *7460* (aff. 91); *7475* (78); *7535* (57); *7684* (50); *7777* (131); *7833* (cf. 73); *7913* (38); *7940* (40); *8202* (75); *8288* (71); *8408* (136); *8528* (28); *8567* (78); *8577* (52); *8741* (80); *9008* (cf. 73); *9070* (20); *9313* (25); *9497*, *9603* (18); *9610* (46); *9954* (116); *9966* (21); *10046* (79); *10119* (aff. 91); *10245* (36); *10264* (38); *10300* (26); *10401* (132); *10412* (131); *10489* (40); *10601* (57); *10850* (8); *10853* (cf. 104); *10892* (8); *10947* (56); *10983* (43); *11045* (25); *11080* (46); *11104* (116); *11257* (46); *11386* (3); *11393* (102); *11401* (aff. 91); *11405*, *11423* (50); *11441* (95); *12899* (89); *13973* (18); *17034* (79); *17337* (86); *17753* (33); *17771* (83); *19088* (132); *19417* (86); *21457* (93); *21593* (67); *21598* (54); *21661* (102); *21724* (79); *24534* (64); *24608* (94); *25040* (116); *29618* (43); *29640* (40).

Pleyte *385* (36); *514* (107).

Pullen *314* (94); *476* (18); *553* (93); *684* (3); *977* (44); *985* (cf. 73); *1342* (57); *1478* (124); *2677* (131); *5515* (16).

Robbins *124* (102); *346* (95); *602* (50); *849* (96); *875* (130); *879* (48).

Royal Society Solomon Islands Expedition (RSS series) *132* (83).

van Royen *3256* (43); *4038* (100); *4047* (101); *4672* (79); *4945* (102).

van Royen & Sleumer *6140* (116); *6520* (123); *7053* (15); *7055* (cf. 75); *7131* (10); *7198* (95).

Saunders *144*, *173* (75); *179* (cf. 69); *671* (94); *786* (95); *959* (68).

Sawyer *107* (75).

Schodde *1807* (93); *2037* (94); *2040* (95); *2130* (46); *2138* (131); *2182* (91); *2186* (86); *2229* (110); *2244* (112); *2441* (cf. *75*); *2560* (89).
Stauffer & Sayers *5590* (102).
Stoddard *9*, *18* (123).
Warburg *20407* (57).
Waterhouse *120* (113); *417* (cf. *73*); *418* (43); *563-B* (86); *849-B* (120); *974* (cf. 73).

INDEX TO SPECIES AND SYNONYMS

Numbers in parentheses indicate species numbers, not page numbers. New species and new combinations are in **bold face** type; synonyms are in *italics*.

Aphanomyrtus
alata (93)

Calyptranthus
fastigiata (83)
rostrata (135)

Careya
jambosoides (31)

Eugenia
aquea (57)
benthamii (114)
bibracteata (83)
buettneriana (86)
cincta (63)
claviflora (101)
coalita (52)
daphne (13)
daphnoides (75)
decipiens (123)
effusa (131)
fibrosa (71)
finisterrae (137)
flavescens (118)
forbesii (21)
garcinioides (62)
jambosoides (31)
javanica (43)
leptalea (101)
longipes (75)
luehmanni (133)
malaccensis (40)
micrandra (128)
myriadenum (129)
neurocalyx (97)
nivifera (131)
nutans (7)
onesima (138)
parvifolia (133)
pergamacea (67)
plumea (136)
porphyrocarpa (3)
pyrocarpa (85)
rubro-punctata (66)
salicina (15)
schumanniana (97)
sogerensis (19)
subalata (18)
suborbicularis (31)
sylvana (131)
tierneyana (69)
trivenis (116)
xylantha (85)

Jambosa
aeorantha (74)
aquea (57)
attenuata (100)
auriculata (24)
brevicyma (72)
cladoptera (4)
dolichophylla (10)
floribunda (69)
gonatantha (21)
goniocalyx (25)
gonioptera (47)
hylocharis (55)
hylophila (73)
javanica (43)
keysseri (12)
lagynocalyx (14)
leonhardii (32)
longipes (75)
var. *leptopoda* (75)
malaccensis (40)
megalosperma (2)
naiadum (107)
nutans (7)
pachyclada (37)
pteropoda (38)
roemeri (58)
rubella (58)
sargentiana (52)
schumanniana (97)
soliflora (18)
synaptoneura (34)
thomseni (22)
trachyantha (14)
tympanantha (20)
verniciflora (117)
versteegii (36)

weinlandii (73)
xylopiacea (61)

Myrtus
samarangensis (43)

Syzygium
acetosum (126)
acutangulum (79)
adelphicum (95)
var. *adenanthum* (95)
aeoranthum (74)
alatum (93)
amplum (44)
anomalum (76)
aqueum (57)
archboldianum (67)
attenuatum (100)
badium (125)
benjaminum (94)
bibracteatum (83)
bicolor (99)
bracteosum (80)
branderhorstii (121)
brassii (119)
brevicymum (72)
buettnerianum (86)
burepense (9)
busuense (88)
callianthum (11)
camptodromum (106)
capituliferum (108)
carrii (98)
cartilagineum (109)
caudiferum (72)
cauliflorum (1)
cinctum (63)
cladopterum (4)
claviflorum (101)
coalitum (52)
daphne (13)
daphnoides (75)
decipiens (123)
delicatulum (56)
dictyophlebium (78)
discolor (67)
doctersii (131)
dolichophyllum (10)
effusum (131)
erythropetalum (17)
evenulosum (35)
fastigiatum (83)
fibrosum (71)
finisterrae (137)
flavescens (118)
flavidum (6)
floribundum (69)
folidorhachis (91)
forbesii (21)
furfuraceum (91)
garcinioides (62)
gonatanthum (21)
goniocalyx (25)
goniopterum (47)
heterobotrys (27)
homichlophilum (130)
hylochare (55)
hylophilum (73)
insculptum (66)
insulare (8)
iteophyllum (84)
jambosoides (31)
japenense (114)
javanicum (43)
keysseri (12)
kietanum (120)
lagerstroemioides (28)
lagynocalyx (14)
laqueatum (39)
lauterbachianum (69)
var. *phaeophloium* (69)
leonhardii (32)
leptanthelium (136)
leptanthum (101)
leptoneurum (127)
leptophlebioides (122)
leptopodium (102)
leucoderme (131)
longipes (75)
var. *leptopodum* (75)
lorentzianum (115)
luehmannii (133)
macrocalyx (5)
madangense (26)
malaccense (40)
maschalocladum (92)
megalanthelium (123)
megalospermum (2)
megistophyllum (105)
micrandrum (128)
micropetalum (94)
modestum (116)
multiglandulosum (41)
myriadenum (129)

naiadum (107)
nemorale (104)
niviferum (131)
normanbiense (30)
novoguineense (24)
nutans (7)
obtusum (131)
onesimum (138)
pachycladum (37)
pallens (77)
papuasicum (79)
pergamaceum (67)
phaeostictum (54)
platypodum (48)
plumeum (136)
pluviatile (68)
porphyrocarpum (3)
pteropodum (38)
puberulum (51)
pyriforme (16)
pyrocarpum (85)
randianum (29)
rectangulare (123)
retivenium (130)
richardsonianum (64)
robbinsii (96)
roemeri (58)
rosaceum (124)
roseum (70)
rostratum (135)
rubellum (58)
rubiginosum (111)
rubro-punctatum (66)
saliciforme (59)
salicinum (15)
samarangense (43)
sambogense (90)
sargentianum (52)
schumannianum (97)
sogerense (19)
soliflorum (18)
spectabile (42)
squamatum (87)
subalatum (18)
subamplexicaule (103)
subcorymbosum (132)
subglobosum (110)
suborbiculare (31)
sylvanum (131)
sylvicola (65)
synaptoneurum (34)
taeniatum (92)
thalassicum (23)
thomseni (22)
thornei (89)
tierneyanum (69)
torricellianum (81)
trachyanthum (14)
triphlebium (112)
trivene (116)
tympananthum (20)
uniflorum (60)
vaccinioides (93)
validinerve (45)
variabile (50)
verniciflorum (117)
vernicosum (33)
versteegii (36)
viburnoides (82)
virescens (53)
waikaiunense (49)
walkeri (134)
waterhousei (113)
womersleyi (46)
xylanthum (85)
xylopiaceum (61)

T. G. HARTLEY
C. S. I. R. O.
DIVISION OF LAND RESEARCH
HERBARIUM AUSTRALIENSE
CANBERRA, AUSTRALIA 2601

L. M. PERRY
ARNOLD ARBORETUM
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138

STUDIES OF PACIFIC ISLAND PLANTS, XXV.
THE MYRSINACEAE OF THE FIJIAN REGION *

ALBERT C. SMITH

3. **Tapeinosperma** Hook. f. in Benth. & Hook. f. Gen. Pl. **2**: 647. 1876; Mez in Pflanzenr. **9**(IV. 236): 162. 1902; Gillespie in Bishop Mus. Bull. **74**: 8. 1930; A. C. Sm. in Jour. Arnold Arb. **36**: 286. 1955.

Ardisia sensu Seem. Fl. Vit. 149, p. p. 1866; non Sw.

As has been pointed out by Gillespie (1930: 8), the genera *Tapeinosperma* and *Discocalyx* are not adequately separated by Mez's key character (1902: 13, 162, 212), which indicates the ovules to be 6–12 in the former and 3–5 in the latter. In fact, not one of the six Fijian species treated by Mez in *Tapeinosperma* has more than 5 ovules, but in other respects they seem to be correctly placed. The two genera have been maintained as distinct by subsequent authors, each represented by 50 or 60 species; but it is obvious that these authors, like Mez himself, were subjective in placing their novelties. Although *Tapeinosperma* and *Discocalyx* are not readily separable from some few species of *Ardisia* on the basis of having uniseriate rather than several-seriate ovules, they both have cylindric styles and obvious stigmas (e.g. FIGURES 53, 58) that readily distinguish them from *Ardisia* (cf. FIGURE 22).

Tapeinosperma was based by Hooker on two new species from New Caledonia, *T. vieillardii* Hook. f. and *T. lenormandii* Hook. f. Apparently the genus has not yet been lectotypified, but the former is well represented in herbaria; a student of the family as a whole should make a choice between these species. *Discocalyx* is based on *D. cybianthoides* (A. DC.) Mez, the only species listed by de Candolle in *Badula* sect. *Discocalyx*. This Philippine species is well represented in herbaria. These three nomenclaturally typical species are superficially quite similar in the size, shape, and texture of their leaves, and in having paniculate inflorescences aggregated around the tips of branchlets. Characteristically, such branchlets continue to grow and to bear new flushes of foliage, so that old inflorescences sometimes appear lateral. Nevertheless, on the basis of these original species, the two genera seem readily separable as follows:

Flowers hermaphrodite; pedicels distally swollen into the calyx, the calyx-tube remaining cupuliform and obvious, the lobes broadly dextrorsely imbricate; corolla conical in bud and with the lobes conspicuously dextrorsely contorted and inequilateral; stamens with the filaments proximally connate and adnate to the corolla-tube, but free and ligulate distally, the anthers dorsi-

* Continued from volume 54, page 41.

fixed near base; ovary attenuate into a cylindric, obvious style, the stigma truncate or inconspicuously discoid; fruits oblate, large, at least 25 mm. in diameter, the endocarp sometimes sharply angled. ..... *Tapeinosperma.*

Flowers unisexual; pedicels slenderly terete, the calyx subrotate, the tube short and inconspicuous, the lobes spreading, narrowly imbricate; corolla rounded in bud and with the lobes dextrorsely contorted but at length spreading, only slightly inequilateral; stamens with similar filaments, but these often inseparable from the corolla-tube, connate to apex and there bearing broadly basifixed (and seemingly sessile) anthers; ovary abruptly narrowed to a very short style, the stigma obviously peltate; fruits subglobose, small, less than 10 mm. in diameter, the endocarp smooth. ..... *Discocalyx.*

Unfortunately, most of these characters, in the light of presently known species of the complex, are no more dependable than the number of ovules. Many indubitable *Tapeinospermata* have slender pedicels and essentially rotate calyces (FIGURES 42, 54, 56); size and texture of the corolla is not a dependable criterion; and the fruits of *Tapeinosperma,* more often than not, are small and with a smooth endocarp. In my observation only the anther-attachment is a truly dependable character; the anthers of *Tapeinosperma* are always dorsifixed (sometimes *very* near the base) to the ligulate but often short free parts of the filaments (FIGURES 26, 33, 37, 43); in *Discocalyx* the anthers are always broadly basifixed on the filament-tube (FIGURES 59, 60, 64, 65), which is not distally divided into free parts and which is with difficulty separable from the corolla-tube; in fact, the anthers are usually described as sessile on the corolla. Additionally, the style at anthesis is characteristically longer than the ovary in *Tapeinosperma* (FIGURES 27, 31, 53) and shorter than the ovary in *Discocalyx* (FIGURE 61), but this is not always dependable (FIGURES 34, 58, 62), and stigmatic differences are inconsequential. In the Fijian region, all the species of this relationship appear to have hermaphrodite flowers.

The situation here discussed is only one of several that a future student of the entire Myrsinaceae should consider in detail. A final decision should obviously not be made on the basis of a regional study. It is conceivable that a quite different set of generic groupings (possibly based on endocarp characters) will ultimately prove more realistic. For purposes of the present regional revision, however, I retain the two genera primarily on the basis of staminal and stylar characters.

Slightly more than 60 species have now been assigned to *Tapeinosperma,* occurring abundantly in New Caledonia and sparingly in Australia, New Guinea, and Borneo, with two species here accredited to the New Hebrides and twelve to Fiji, where the generic range terminates (Smith, 1955: 286).

The species of *Tapeinosperma* in the Fijian Region normally have 5-merous hermaphrodite flowers, although 3-, 4-, 6-, or 7-merous flowers may occasionally occur (FIGURES 40, 41). In all of our taxa the bud-scales at the growing points of branchlets are basically lanceolate, chartaceous or subcoriaceous, and very early caducous. The branchlets are

inconspicuously lenticellate but are conspicuously cicatricose with the scars of fallen leaves (these being obdeltoid to transversely semi-elliptic) and inflorescences (these being elongate-oval or subglobose). At periods of anthesis the leaves are congested toward the apices of branchlets, while the inflorescences are aggregated above them close to the actual growing point and subtended by caducous scales; rarely the leaves and inflorescences are somewhat intermixed and the latter appear supra-axillary. Both vegetative and inflorescence parts are characteristically ornamented with conspicuous glands, which may be immersed or superficial, lineolate or punctate, and drying blackish, although in life they are usually red to purple. The inflorescences are basically paniculate, rarely congested and appearing subcapitate, but more often pinnate to tri- or even quadripinnate. The flowers are pedicellate, each subtended by a small, usually caducous bract. The calyx varies from clavate (FIGURE 45) to cupuliform (FIGURE 52) to essentially rotate (FIGURE 54), the lobes being narrowly or strongly dextrorsely imbricate in bud and inequilaterally shallowly retuse at apex. The corolla is conical to subglobose in bud and with lobes strongly dextrorsely contorted, but at full anthesis it becomes campanulate to essentially rotate, and the lobes are also inequilaterally emarginate or retuse. The filaments are proximally connate into a membranous tube lining and adnate to the corolla-tube, but distally they are free and ligulate (thus appearing to arise from the corolla near the base of its lobes). The anthers are prevailingly oblong-deltoid and dorsifixed near the base. The gynoecium is composed of a usually ovoid ovary that is attenuate into an obvious style; the stigma is inconspicuously discoid or subcapitate. The placenta is usually ovoid and acute and in our species bears 2–5 ovules in shallowly lateral or somewhat distal foveolae. The fruits are carnose when fresh but dry hard and coriaceous, usually rounded at base and umbonate at apex, the style being caducous; the exocarp is thin and usually gland-marked; the mesocarp is comparatively thick and succulent, but fibrous in drying; and the endocarp is bony, usually smooth but rarely ornamented. The single seed is subglobose to oblate and shallowly excavated at base. Unless particularly noteworthy, these points are omitted from the following species descriptions.

KEY TO SPECIES

Inflorescences subcapitate or congested-racemose or congested-pinnate-paniculate, the flower-subtending bracts large, 15–18 × 12–18 mm., subpersistent; flowers large, the calyx-lobes 6–10 mm. long, accrescent in fruit, the corolla 7–12 mm. long, with lobes 6–8 mm. long; fruits large, 20–35 mm. in diameter, the endocarp forming a bony putamen 15–25 mm. in diameter, conspicuously and irregularly 5-angled; leaf-blades prevailingly obovate, large, usually 20–58 × 6–16 cm., attenuate to a stout petiole, this variable in length from essentially none to 30 mm. ..... 1. *T. capitatum*.

Inflorescences paniculate (sometimes simply racemose in no. 14), not congested or subcapitate, the flower-subtending bracts not exceeding 3 mm. in length, caducous; flowers smaller, the calyx-lobes not exceeding 6 mm. in length,

the corolla not more than 6 mm. long, with lobes not exceeding 5 mm. in length; fruits not more than 15 mm. in diameter, the endocarp essentially smooth on the outer surface.

Leaf-blades narrowly cordate, rounded, or obtuse at base, very rarely acute, not decurrent on the petiole or only short-decurrent, the petiole terete or semiterete proximally.

Inflorescences 15–35 cm. long, the flowers large, the corolla 8–10 mm. in apical diameter, with lobes 4–5 × 3–4 mm.; leaf-blades very robust, narrowly oblong, 55–90 cm. long, 12–20 cm. broad, the petiole stout, 3–20 mm. long. ..... 2. *T. megaphyllum.*

Inflorescences smaller, rarely as long as 20 cm., the flowers comparatively small, the corolla 3–6 mm. in apical diameter, with lobes 1.8–3 × 1.3–2.8 mm.; leaf-blades not exceeding 40 × 15 cm.

Leaf-blades oblong to oblong-elliptic or oblong-lanceolate, usually 3 or 4 times as long as broad, the petiole obvious, at least 10 mm. long.

Petioles (15–) 20–70 mm. long, the leaf-blades variable but comparatively ample, usually 15–37 × 4–15 cm.; inflorescences bipinnately paniculate, 3–20 cm. long. ..... 3. *T. hornei.*

Petioles 10–35 mm. long, the leaf-blades smaller, 4–14 × 1–3.5 cm.; inflorescences pinnately paniculate, 2.5–5 cm. long. ..... 4. *T. divaricatum.*

Leaf-blades elongate-ligulate, many times longer than broad, 15–40 × 1–2.3 cm., the petiole inconspicuous, 1–10 mm. long; inflorescences often bi- or tripinnately paniculate, 4–12 cm. long. ..... 5. *T. ligulifolium.*

Leaf-blades attenuate or gradually narrowed toward base and long-decurrent on the petiole, this often narrowly winged or angled nearly to base (lacking in no. 14).

Calyx at anthesis cupuliform to turbinate or clavate, the tube obvious, the pedicel swollen distally, the calyx-limb eventually, at least in fruit, becoming rotate.

Leaf-blades comparatively large, usually 8–20 cm. long and 3–8.5 cm. broad; corolla 4–7 mm. in apical diameter; gynoecium about 3 mm. long at anthesis.

Calyx clavate or narrowly cupuliform, the lobes at anthesis 0.8–1.5 × 1.5–2.3 mm.; corolla-lobes 2–3 × 1.5–2.5 mm. .. 6. *T. clavatum.*

Calyx broadly cupuliform, the lobes at anthesis 1.5–3 × 2–4 mm.; corolla-lobes 3–5 × 2–4 mm.

Inflorescences (peduncle, rachis, branches, pedicels, and calyces) copiously puberulent or pilose (hairs 0.05–0.4 mm. long, glandular), soon glabrate; corolla-lobes ovate, 3–4 mm. long and broad, glabrous; anthers 1.5–1.8 mm. long. .. 7. *T. ampliflorum.*

Inflorescences copiously tomentellous (hairs 0.2–0.4 mm. long, multicellular, often irregularly branching, eglandular), the indument long persistent; corolla-lobes ovate or oblong, 4–5 × 2–3 mm., dorsally slightly pilose at least in bud; anthers about 1.2 mm. long. ..... 8. *T. chloranthum.*

Leaf-blades comparatively small, usually 5–13 cm. long and 2–5 cm. broad; calyx 2–3.5 mm. in apical diameter, the lobes 0.6–1.3 × 1–2.5 mm.; corolla 3–5 mm. in apical diameter, the lobes 2–3.5 × 1.5–2.5 mm.; gynoecium 1.5–2 mm. long at anthesis; inflorescences (peduncle, rachis, branches, pedicels, and calyx) minutely furfura-

ceous or capitate-glandular or copiously pilose with several- or many-celled hairs to 0.4 mm. long. ..... 9. *T. multiflorum.*

Calyx at anthesis rotate or subrotate, the tube very short and inconspicuous, not turbinate or clavate, the pedicel not swollen distally or very inconspicuously so.

Petioles usually 15 mm. or more long (rarely only 5 mm.); leaf-blades oblong-lanceolate, usually about 5 times as long as broad, 20–55 × 4–12 cm.

Calyx 3–4.5 mm. in diameter at anthesis, to 5 mm. in fruit, the lobes ovate-deltoid, 1–1.5 × 1–2 mm. at anthesis, not exceeding 2 × 2.5 mm. in fruit; leaf-blades 30–55 cm. long and 4–12 cm. broad. ..... 10. *T. grande.*

Calyx 7–10 mm. in diameter in fruit, the lobes oblong-ligulate, 3.5–6 × 1.5–2 mm. and strongly reflexed; leaf-blades (known only from type collection) 20–25 cm. long and 4–5.5 cm. broad. ..... 11. *T. babucense.*

Petioles not more than 12 mm. long; leaf-blades elliptic-oblong to oblanceolate or obovate, usually 3–4 times as long as broad, 8–30 × 2.5–8 cm.

Leaf-blades with an obvious petiole 5–12 mm. long; inflorescences comparatively lax and ample, 6–20 cm. long, many-flowered, the peduncle proportionately short.

Inflorescences tri- or quadripinnately paniculate, the peduncle, rachis, branches, pedicels, and calyces glandular-puberulent, often copiously so; pedicels 1–2.5 (–4) mm. long; mature fruits 6–7 mm. in diameter. ..... 12. *T. greenwoodii.*

Inflorescences pinnately paniculate, glabrous at anthesis; pedicels 3–10 mm. long; mature fruits 10–15 mm. in diameter; New Hebrides. ..... 13. *T. scrobiculatum.*

Leaf-blades long-attenuate at base and sessile, the actual base flattened above and rounded beneath; inflorescences simply racemose or narrowly paniculate, 1–7 cm. long, comparatively few-flowered, the peduncle proportionately long, 0.6–5.5 cm. long; New Hebrides. ..... 14. *T. kajewskii.*

1. **Tapeinosperma capitatum** (A. Gray) Mez in Pflanzenr. 9(IV. 236): 165, quoad basionymum, excl. descr. et spec. cit. 1902; J. W. Parham, Pl. Fiji Isl. 158. 1964. FIGURES 24–28.

Ardisia capitata A. Gray in Proc. Amer. Acad. Arts **5:** 331. 1862; Seem. Viti, 438. 1862, Fl. Vit. 150. 1866; Horne, A Year in Fiji, 257. 1881.

Tapeinosperma cephalophorum Gillespie in Bishop Mus. Bull. **74:** 8. *fig. 7.* 1930; J. W. Parham, Pl. Fiji Isl. 158. 1964.

Tapeinosperma punctatum Gillespie in Bishop Mus. Bull. **74:** 10. *fig. 9.* 1930; J. W. Parham, Pl. Fiji Isl. 160. 1964.

Shrub or tree to 10 m. high, glabrous throughout, the bud-scales to 20 × 10 mm.; branchlets robust, 8–20 mm. in diameter toward apex, at first irregularly angled but soon terete and grayish; leaves sometimes essentially sessile but usually with stout petioles 2.5–12 mm. in diameter and to 30 mm. long, these shallowly canaliculate and coriaceous-winged distally or nearly to base; leaf-blades subcoriaceous or thick-chartaceous,

oblanceolate or narrowly obovate to oblong-elliptic, (12–) 20–58 cm. long, (5–) 6–16 cm. broad, attenuate at base and long-decurrent on the petiole, rounded to obtusely cuspidate at apex, entire and narrowly recurved at margin, very copiously glandular-pustulate on both surfaces or with glands eventually becoming subimmersed, the costa very robust, immersed-glandular-lineolate, shallowly canaliculate above, prominent beneath, the principal secondary nerves 15–40 per side with lesser ones interspersed, the lower ones ascending, the others spreading, sharply elevated on both sides, copiously anastomosing toward margin, the veinlet-reticulation copious, strongly prominulous or subimmersed on both sides; inflorescences appearing subcapitate but actually congested-racemose or congested-pinnate-paniculate, 3–10 cm. long and 3–5 cm. broad, the peduncle stout, dorsiventrally flattened or subterete, immersed-glandular-lineolate, 1–8 cm. long; flowers 5–30, congested near apex of peduncle or borne on 3–6 short lateral branches congested along a short rachis, these branches sometimes bearing secondary shortened racemes of 4–6 flowers; primary bracts drying subcoriaceous, broadly elliptic or obovate, 12–25 × 10–18 mm., rounded or obtuse at apex, persistent into anthesis, copiously immersed-glandular-lineolate, the flower-subtending bracts similar but slightly smaller, 15–18 × 12–18 mm.; pedicels stout, (1–) 2–5 mm. long; flowers large, the calyx obconical-cupuliform, proximally carnose, 7–10 mm. long and 7–12 mm. in apical diameter, often accrescent in fruit to 20–35 mm. in diameter, copiously glandular-punctate, the tube short, less than 1 mm. long, the lobes chartaceous, strongly dextrorsely contorted, broadly elliptic or obovate, 6–10 × 4.5–6 mm. (in fruit often spreading, to 17 × 8 mm.), rounded at apex, narrowly scariose at margin; corolla carnose especially proximally, at first subglobose-cupuliform, becoming campanulate-clavate, 7–12 mm. long, 6–10 mm. in apical diameter, the tube 1.5–5 mm. long, the lobes broadly elliptic or obovate, 6–8 × 4–5 mm., rounded at apex, copiously and conspicuously glandular-punctate; filaments 0.5–1.5 mm. long, distally ligulate, carnose, the anthers carnose, oblong-deltoid, 2.5–4 mm. long, 1.5–2 mm. broad, copiously glandular-punctate on both surfaces, thickened and obtuse at apex; gynoecium 5–7 mm. long at anthesis, the ovary cylindric-conical, immersed-glandular-punctate, about 2 mm. long, the locule basal, the distal portion carnose, attenuate into a slender style 3–5 mm. long, the stigma subcapitate, 0.7–1.5 mm. in diameter, the ovules 3–5; fruits subglobose or oblate, in drying becoming obovoid and often 5-angled, 20–35 mm. in diameter, the exocarp brittle, copiously glandular-punctate or not, the mesocarp 5–8 mm. thick, the endocarp 0.5–0.7 mm. thick, forming a bony putamen, this irregularly broadly clavate, 15–20 × 20–25 mm., narrowly stipitate at base, flattened at apex, irregularly and coarsely glandular externally, conspicuously 5-angled, each angle produced into a conspicuous ridge often with 3 or 4 sharp coriaceous spines 2–4 mm. long; seed bluntly 5-angled, greatly contracted in drying.

TYPE LOCALITY: Ovalau, without further data; the type is a unicate

U. S. Exploring Expedition specimen collected in 1840. The two Gillespie species herewith reduced to synonymy are typified as follows: *T. cephalophorum* by *Gillespie 4441*, also from Ovalau; and *T. punctatum* by *Gillespie 3919*, from slopes at the base of Mt. Nanggaranambuluta (Lomalangi), near Nandarivatu, Mba Province, Viti Levu. The three type collections involved are cited and discussed below.

DISTRIBUTION: Endemic to Fiji and known from several high islands, where it occurs from near sea-level to an altitude of 1,100 m., usually in dense forest, where it is a locally frequent and often conspicuous element of the undergrowth. It has been noted as a shrub or tree, often slender and few-branched, 2–10 m. high, with a trunk to 40 cm. in diameter. It is conspicuous in its purplish peduncles and bracts and its large flowers and fruits. The calyx is green or yellowish to dark red, with reddish or purple glands; the corolla varies from white to waxy-pink and is marked by purplish glands; the anthers are yellow; and the fruit, at first greenish yellow, becomes bright red or scarlet to maroon at maturity. Flowers and fruits have been obtained at practically all seasons.

LOCAL NAMES: In spite of its conspicuous nature, *T. capitatum* has not acquired a standardized local name, but the following have been recorded in interior Viti Levu: *kandanu levu*, *masawe*, *lerendamu*, *utuvenekai*, and *kuluva ni tonda*.

Fiji. VITI LEVU: MBA: Mt. Mbatilamu, *Fiji Dept. Agr. 14803* (BISH, MASS, SUVA); Savundamatau Creek, west of Nandarivatu, *Webster & Hildreth 14247* (DAV); between Nandala and Nukunuku Creeks, *Smith 6202* (A, K, US); Mt. Nanggaranambuluta (Lomalangi), *Gillespie 3177* (A, BISH, UC), *3696* (BISH, UC), *3919* (BISH holotype of *T. punctatum*; isotype at UC), *Smith 4779*, *5014*, *6307* (all A, BISH, K, US); Nauwanga, near Nandarivatu, *Degener 14535*, *14675* (both A, BISH, K, NY, UC, US); Matomba, near Nandarivatu, *Degener 15363* (A, BISH, K, NY, UC, US); east of Nandala Creek, *Smith 5956* (A, BISH, K, US); valley of Nggaliwana Creek, north of Navai, *Smith 5383* (A, BISH, K, NY, US). NANDRONGA & NAVOSA: Nausori Highlands, *Fiji Dept. Agr. 11728* (BISH, SUVA), *12647* (*Melville et al. 7020*) (K, SUVA); near Vonolevu, *Fiji Dept. Agr. 1393* (SUVA). SERUA: Nathengathenga, inland from Namboutini, *Fiji Dept. For. 977* (K, SUVA); west of Waivunu Creek, between Ngaloa and Korovou, *Smith 9480* (BISH, GH, K, UC, US); vicinity of Ngaloa, *Degener 15132* (A, BISH, K, NY, UC, US); Ngaloa Nature Reserve, *Fiji Dept. Agr. 16597* (SUVA); vicinity of Taunovo Creek, east of Wainiyambia, *Smith 9594* (BISH, GH, US). NAMOSI: Veinungga Creek, *Horne 829* (K); Mt. Naitarandamu, *Gillespie 3247* (BISH, UC); between Korombasambasanga Range and Mt. Naitarandamu, *Smith 8479* (BISH, GH, K, UC, US); northern base of Korombasambasanga Range, *Smith 8635* (BISH, GH, K, SUVA, UC, US); track to Mt. Nambui, *Fiji Dept. Agr. 14536* (BISH, SUVA). NAITASIRI: Rairaimatuku Plateau, between Mt. Tomanivi and Nasonggo, *Smith 5784* (A, BISH, K, US); Wainisavulevu-Numbulolo divide, Taunaisali, *St. John 18315* (BISH, US); Mendrausuthu Range, *Fiji Dept. Agr. 15485* (BISH, MASS, SUVA); Waimanu River, *Fiji Dept. Agr. 665* (SUVA); Central Road, *Tothill 362* (K), *MacDaniels 1148* (BISH); vicinity of Tamavua, *Yeoward*, Feb. 22, 1897 (K), *Gillespie 2466* (BISH, UC). REWA: Mt. Korombamba, *Gillespie 2384* (BISH, UC,

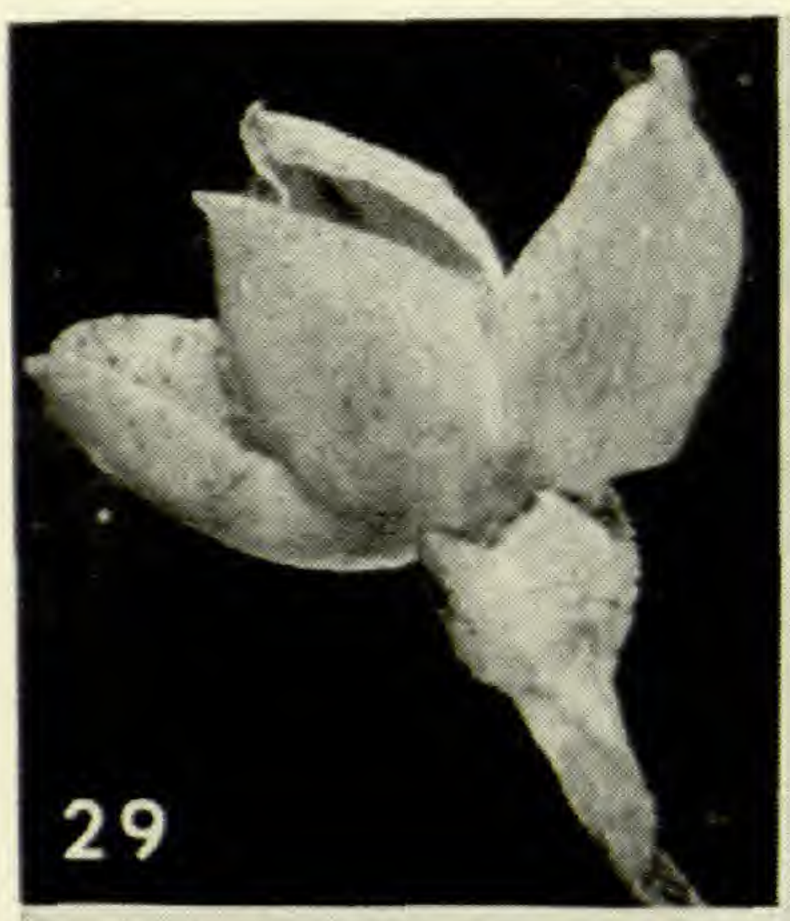
US). KANDAVU: Mt. Mbuke Levu, *Smith 225, 276* (both BISH, GH, K, NY, UC, US), *Fiji Dept. Agr. 14931* (BISH, SUVA); Lutumatavoro, *Fiji Dept. Agr. 14921* (SUVA). OVALAU: *U. S. Expl. Exped.* (US 49388 holotype); summit of Mt. Ndelaiovalau and adjacent ridge, *Smith 7589* (BISH, US); near summit of range west of Levuka, *Gillespie 4441* (BISH holotype of *T. cephalophorum*; isotypes at BISH, K, NY, UC). VANUA LEVU: MATHUATA-THAKAUNDROVE boundary: Crest of Korotini Range, between Navitho Pass and Mt. Ndelaikoro, *Smith 538* (BISH, GH, K, NY, UC, US). THAKAUNDROVE: Mt. Mbatini, *Smith 610* (BISH, GH, K, NY, UC, US); Navavau, *Fiji Dept. Agr. 16048* (A, BISH, MASS, SUVA, UC). TAVEUNI: Western slope between Somosomo and Wairiki, *Smith 749* (BISH, GH, K, NY, UC, US); Mt. Manuka, east of Wairiki, *Smith 8159* (BISH, GH, US); valley between Mt. Manuka and Mt. Koroturanga, *Smith 8305* (BISH, GH, K, UC, US). FIJI, without further locality: *Fiji Dept. Agr. 291* (SUVA).

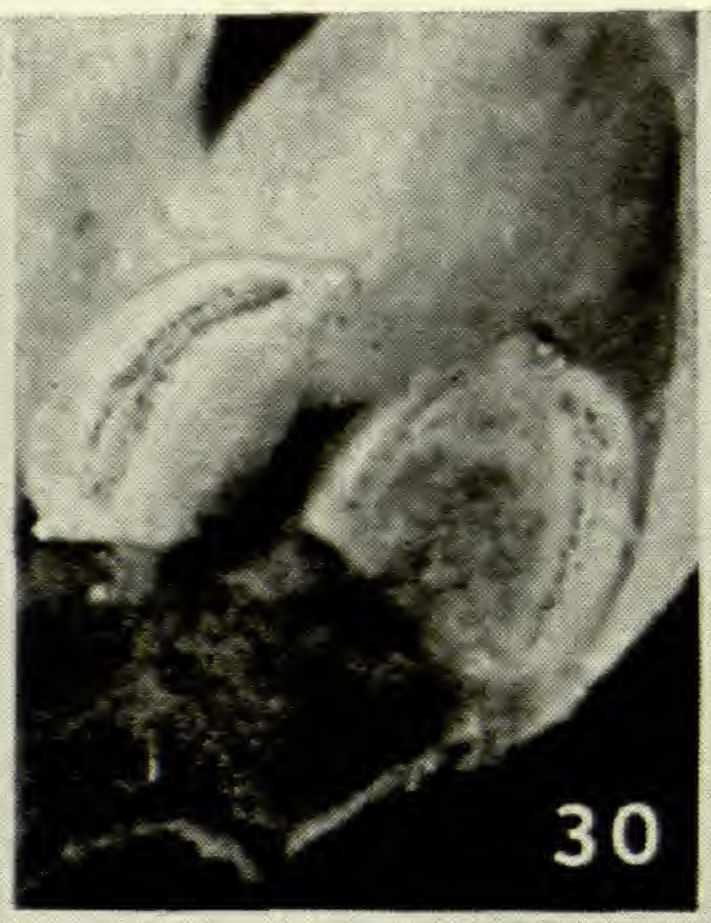
Mez did not see the type of *Ardisia capitata* A. Gray, a unicate specimen. His combination in *Tapeinosperma* is nomenclaturally correct and may be adopted, but his 1902 description and the two specimens then cited (*Seemann 293*, p. p. and *Horne 1076*) are referable to a very different species, *T. ligulatum*. This misinterpretation of Gray's type doubtless led Gillespie to redescribe *T. capitatum* as *T. cephalophorum*, based on a specimen from Ovalau in all respects similar to the Exploring Expedition holotype from the same island. Gillespie's second taxon of this relationship, *T. punctatum*, is typified by a Viti Levu specimen which he did not contrast with either *T. capitatum* or *T. cephalophorum*. Compared with the holotypes of these latter concepts, that of *T. punctatum* has the petioles comparatively slender and winged only distally rather than nearly to the base, the leaf-blades copiously marked by plane (rather than pustulate) glands, and the secondary nerves somewhat fewer. No consequential floral differences are noted, the dimensions stated by Gillespie for *T. punctatum* being inaccurately small. The abundant material of this complex now at hand indicates that such differences are merely individual within a strikingly distinct taxon.

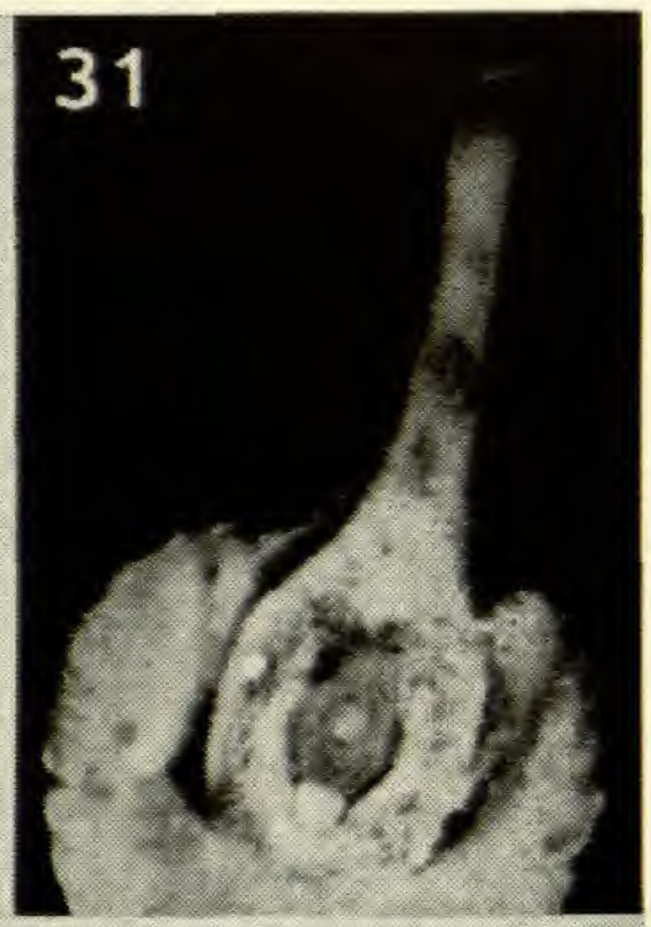
In fact, *T. capitatum* is so well characterized by its congested inflorescences, large bracts and flowers, and large fruits with a highly ornamented endocarp as to obviate comparison with its congeners in the Fijian Region. Gillespie indicated, in annotating *Tothill 362* (K), that: "I really think this will have to be made a distinct genus, neither *Tapeinosperma* nor *Ardisia*." One must note, however, that the large fruits and remarkably ornamented endocarps of *T. capitatum* are suggested in Hooker's two original New Caledonian species. A future student of the family may find better alignments than I have suggested for *Tapeinosperma* and *Discocalyx*, but the present species at least seems appropriately placed.

2. **Tapeinosperma megaphyllum** (Hemsl.) Mez in Pflanzenr. 9(IV. 236): 165. 1902; J. W. Parham, Pl. Fiji Isl. 160. 1964.
FIGURES 29–31.

Ardisia sp. n. Horne, A Year in Fiji, 257. 1881.

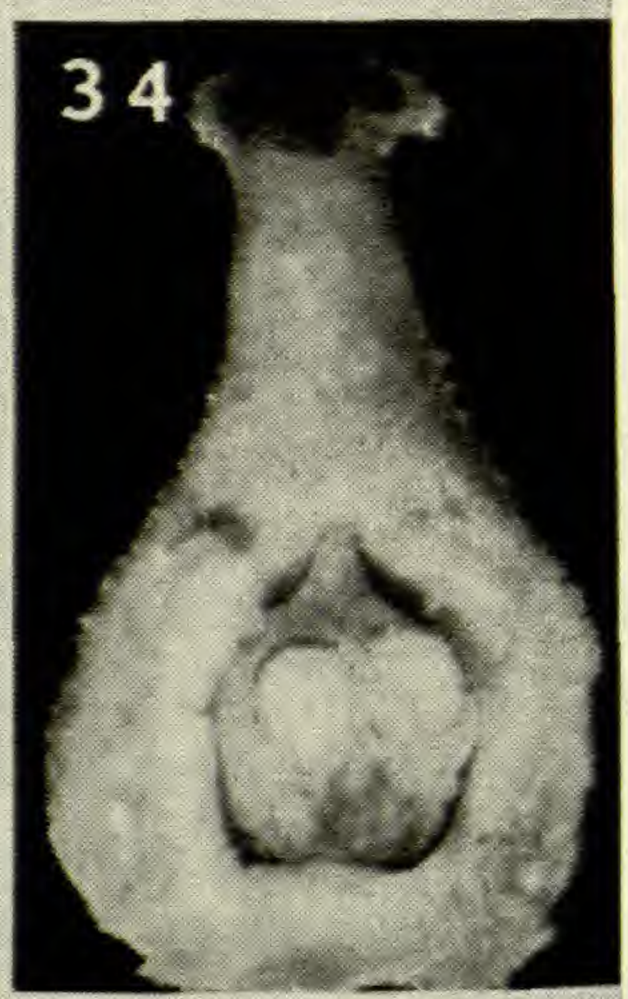

29

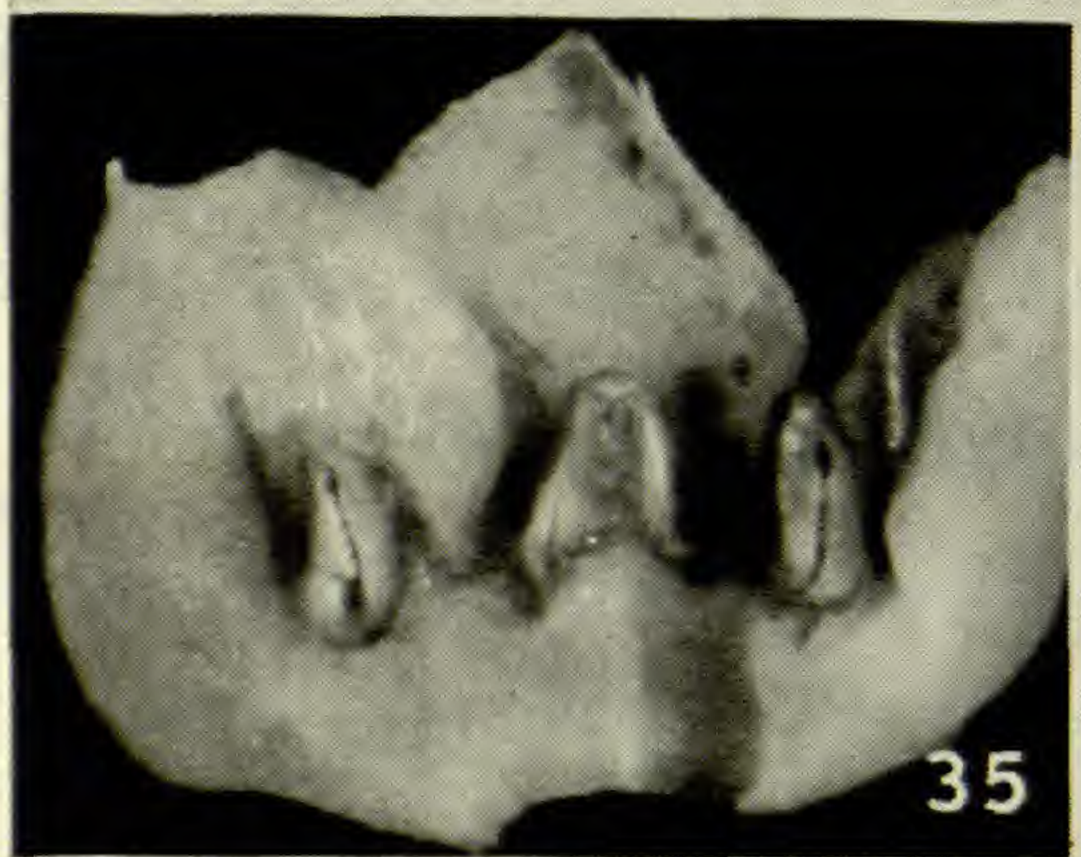

30


31

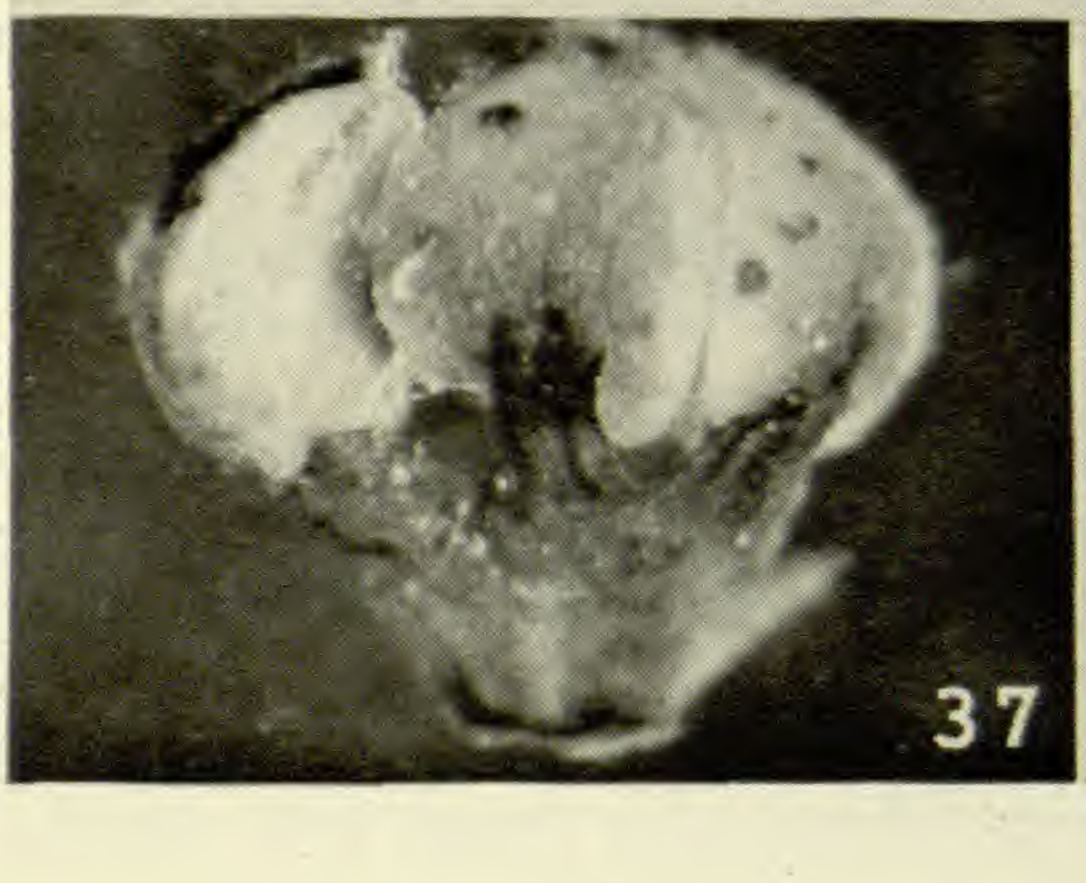
32

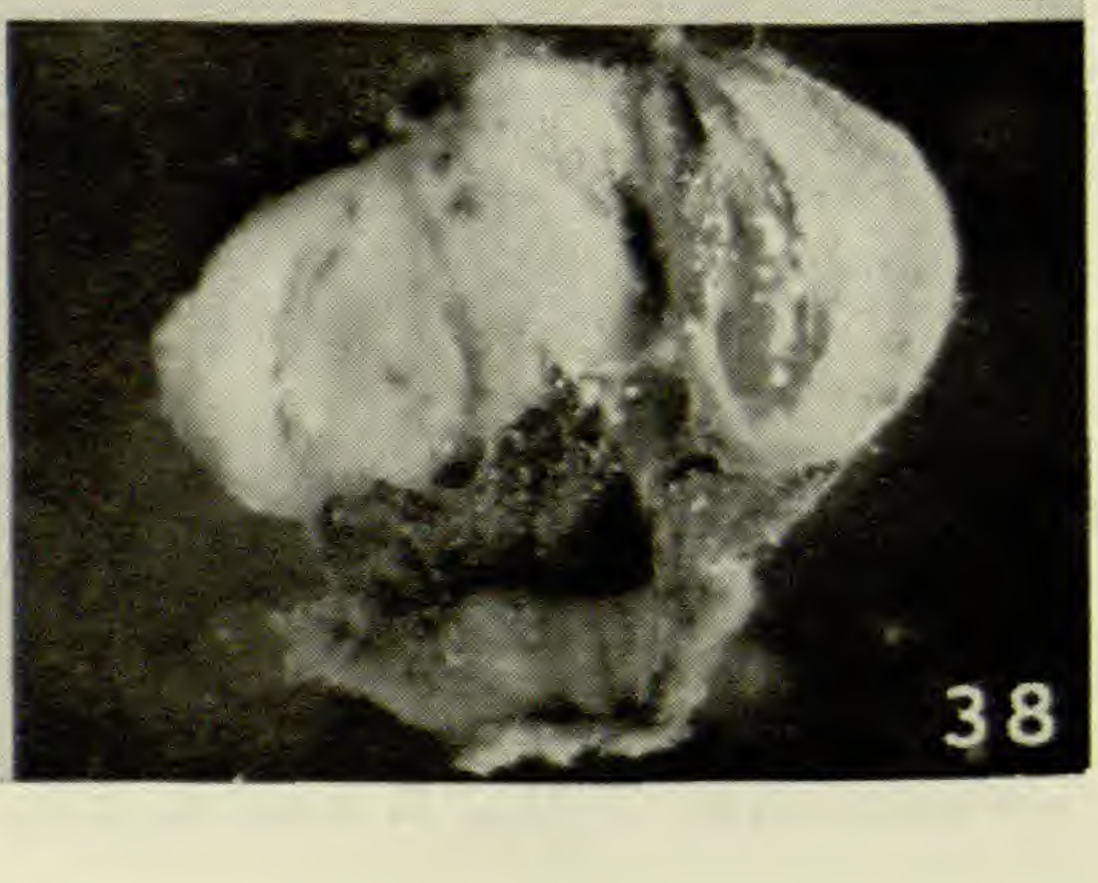
33


34


35

36


37


38

Ardisia megaphylla Hemsl. in Kew Bull. **1894:** 6. (Jan.) 1894; Oliver in Hook. Ic. Pl. **24:** *pl. 2316.* 1894.

Tree or slender, simple-stemmed shrub 2–4 m. high, the bud-scales and young parts copiously glandular with minutely stalked capitate glands; branchlets very stout, 12–20 mm. in diameter toward apex, subterete, brownish; leaves sometimes appearing subsessile but with stout petioles 10–15 mm. in diameter and 3–20 mm. long, these rugulose, semiterete, rigidly angled; leaf-blades coriaceous, narrowly oblong, 55–90 cm. long, 12–20 cm. broad, narrowly cordate or narrowly rounded at base, rounded or broadly and shallowly retuse at apex, cartilaginous-thickened at margin, immersed-glandular or glandular-pustulate on both surfaces, the costa stout, 5–10 mm. broad, flattened or broadly canaliculate above, very prominent beneath, the principal secondary nerves 20–30 per side, bluntly raised above and sharply so beneath, conspicuously anastomosing toward margin, the veinlet-reticulation bluntly prominulous on both sides or immersed above; inflorescences pyramidally bi- or tripinnately paniculate, 15–35 cm. long, 5–15 cm. broad, the peduncle stout, 4–13 cm. long, the branches 7–10, ascending, many-flowered, the rachis, branches, and pedicels with copious capitate, short-stalked or subsessile glands, sometimes soon glabrate, the branch-subtending bracts oblong-lanceolate, 3–4 mm. long, obtuse, glandular-ciliolate, copiously glandular without, the flower-subtending bracts similar, 0.5–1.5 mm. long; pedicels stout, rugulose, swollen distally, 3–10 mm. long at anthesis; flowers comparatively large, the calyx cupuliform, chartaceous to subcoriaceous, 2–3 mm. long and 2–4 mm. in apical diameter, minutely glandular-pilose without and soon glabrate, the tube thick-carnose and rugulose, 0.8–1.5 mm. long, the lobes carnose proximally, chartaceous distally, ovate, 1–1.8 × 1.5–2 mm., apiculate at apex, copiously glandular-punctate, glandular-ciliolate at margin; corolla thick-carnose proximally, subglobose in bud, becoming campanulate and subrotate, 5–6 mm. long, 8–10 mm. in apical diameter, the tube 0.6–1.5 mm. long, the lobes inequilaterally elliptic, 4–5 mm. long, 3–4 mm. broad, subacute at apex, distally glandular-punctate; filaments about 2 mm. long, the distal portions ligulate, subcarnose, 0.4–0.7 mm. long, the anthers carnose, oblong-deltoid, 1.5–1.8 mm. long, 1–1.5 mm. broad, dorsally immersed-glandular-punctate, obtusely apiculate at apex; gynoecium 3–3.5 mm. long at anthesis, the ovary ovoid-conical or ellipsoid, thick-walled, with immersed glands and externally with minute sessile capitate glands, attenuate into a stout style 1.5–2.5 mm. long (to 3

FIGURES 29–31. *Tapeinosperma megaphyllum*: all from *Smith 9232.* 29, flower, × 4; 30, two stamens attached to corolla, × 10; 31, gynoecium, with three calyx-lobes, sectioned ovary, and placenta, × 10. FIGURES 32–36. *Tapeinosperma hornei*: 32 and 33 from *Smith 9191*, 34–36 from *Degener 14560.* 32, flower, × 8; 33, flower with two calyx-lobes and two corolla-lobes removed, × 10; 34, gynoecium, with sectioned ovary and placenta, × 20; 35, three stamens attached to corolla, × 10; 36, stamens, ventral (left) and dorsal views, × 20. FIGURES 37, 38. *Tapeinosperma divaricatum*: both from *Fiji Dept. Agr. 12384.* 37, three stamens, dorsal view, × 15; 38, three stamens, ventral view, × 15.

mm. in young fruit), the stigma capitate, 0.3–0.4 mm. in diameter, the placenta ovoid to clavate, with 3 or 4 ovules; fruits strongly rugulose in drying, subglobose or obovoid-globose, 10–12 mm. in diameter, rounded or obtuse at base, the pericarp 2.5–3 mm. thick, the mesocarp copiously immersed-glandular, the endocarp about 0.5 mm. thick.

TYPE LOCALITY: In the original description, and also in the second description of the same year, two collections were cited: *Horne 429* and *Yeoward 1*. Mez in 1902 cited only the first of these, but did not formally designate it as the lectotype. The following facts are pertinent. The plate in Hooker's *Icones*, by Mathilda Smith, is clearly a composite; the small habit sketch with attached leaves is from Horne, as is the overlying inflorescence; the larger (divided) single leaf may be from Yeoward; *figures 1*, *2*, and *3* (calyx, enclosed gynoecium, and single calyx-lobe) are from Horne; *figures 4*, *5*, and *6* (fruit details) are from Yeoward. *Horne 429* is represented by one sheet at Kew and two at the Gray Herbarium, with attached leaves and old inflorescences; there are two Yeoward sheets at Kew, one bearing a detached leaf and the other a partial stem, inflorescence, and loose fruits. In view of these data I designate as lectotype the Kew sheet of *Horne 429*, which is in advanced flower; the corolla and stamens were supposed by Hemsley to be lacking, but in fact the lectotype does include a single corolla with stamens. *Horne 429*, from the island of Rambi, and the Yeoward specimen, from Viti Levu, are cited below.

DISTRIBUTION: Endemic to Fiji and apparently rare, thus far known from three islands, occurring from near sea-level to 590 m. altitude, in dense, shady forest. It has been noted as a tree or slender, simple-stemmed shrub 2–4 m. high, with dark metallic green or purplish green leaves. The inflorescence-branches and calyces are pinkish or rich pink; the corolla varies from nearly white to rich pink, or is yellowish and pink-tinged; and the anthers are pale yellow. Flowers have been obtained in March, October, November, and December, but only the Yeoward collection, made in October, bears mature fruits.

LOCAL NAME: The name *ndathea* (*dacea* in Fijian orthography) was provided by an informant of Yeoward (mentioned in a letter from him to W. Morris, then Assistant Director of Kew); the probably correct orthography would be *ndasia*, noted for other species of *Tapeinosperma*. Yeoward's informants also stated that the plant is sometimes a straight tree 100 feet high, which is certainly incorrect information.

Fiji. VITI LEVU: SERUA: Hills west of Waivunu Creek, between Ngaloa and Korovou, *Smith 9232* (BISH, K, GH, UC, US). NAMOSI or REWA: Queen's Road between Wainamboro Creek and Wainandoi River, *Vaughan 3339* (BM). NAITASIRI: Near road beyond Tamavua Village, *Gillespie 2462* (BISH, K, NY). NAITASIRI or REWA: Valley of Tamavua River 1–2 miles inland, *Yeoward 1*, Oct. 1893 (K). VANUA LEVU: MATHUATA: Mt. Numbuiloa, east of Lambasa,

Smith 6459 (A, K, US). RAMBI: *Horne 429*, March, 1878 (K lectotype; isolectotype at GH).

This apparently infrequent, but strikingly beautiful, component of the undergrowth is readily distinguished from its Fijian congeners by its comparatively huge leaf-blades, characteristically narrowly cordate at base and borne on short, stout petioles, its extended inflorescences, and its comparatively large flowers. Although the Yeoward locality is precisely stated in his letter to Morris, it cannot be assigned definitely to a modern Province. The Tamavua River arises in Naitasiri, then for a short time forms part of the boundary between Naitasiri and Rewa, and finally in its lower 1–2 miles enters the sea through Rewa. No forest of any description exists in that area at present.

3. **Tapeinosperma hornei** Mez in Pflanzenr. 9(IV. 236): 164. 1902; J. W. Parham, Pl. Fiji Isl. 160. 1964. FIGURES 32–36.

Ardisia sp. n. Horne, A Year in Fiji, 257. 1881.

Slender tree or shrub 2–9 m. high, the young parts copiously glandular-puberulent with few- to several-celled hairs to 0.1 mm. long, the vegetative parts early glabrate; branchlets stout, 3–10 mm. in diameter toward apex, soon becoming subterete and grayish, often swollen at nodes, sparsely verrucose-lenticellate; petioles variable, 1–5 mm. in diameter, (15–) 20–70 mm. long, shallowly canaliculate and sometimes shortly and narrowly winged distally, angled and semiterete proximally; leaf-blades thin-coriaceous, elliptic- to lanceolate-oblong, (11–) 15–37 cm. long, (2.5–) 4–15 cm. broad, narrowly subcordate or rounded or obtuse (or rarely acute) at base and abruptly decurrent on the petiole, obtuse or narrowly rounded at apex, thickened and narrowly recurved at margin, immersed-glandular or glandular-pustulate on both surfaces, the costa stout, shallowly canaliculate or essentially flattened above, prominent beneath, the principal secondary nerves 10–25 per side, spreading, raised or plane on both sides and sometimes inconspicuous, anastomosing toward margin, the veinlet-reticulation copious, prominulous or immersed on both sides; inflorescences sometimes borne on separate elongated branchlets, bipinnately paniculate, 3–20 cm. long, to 12 cm. broad, the peduncle 0.7–8 cm. long, the branches 4–15, spreading, 1–8 cm. long, many-flowered, the rachis, branches, and pedicels copiously and subpersistently glandular-puberulent, the branch-subtending bracts lanceolate, 1.5–2 mm. long, obtuse, dorsally puberulent, ciliolate, the flower-subtending bracts similar but 0.5–1 mm. long; pedicels slender and 1–4.5 mm. long at anthesis, becoming stout and rarely to 10 mm. long in fruit; calyx cupuliform, proximally carnose, becoming subcoriaceous in fruit, 1.5–2.5 mm. long and 2–4 mm. in apical diameter, sparsely immersed-glandular, puberulent like the pedicel but eventually subglabrate, the tube 0.5–1 mm. long, the lobes ovate-deltoid, 0.5–1.5 mm. long, 0.8–1.5 mm. broad, slightly enlarging in fruit, acute at apex, scariose or entire at margin, sparsely or copiously immersed-glandular, with conspicuous, several-celled cilia 0.1–0.3 mm. long; corolla thin-carnose,

campanulate or subrotate at anthesis, 2.5–3.5 mm. long, 3–5.5 mm. in apical diameter, conspicuously glandular-punctate distally, the tube less than 1 mm. long, the lobes oblong-elliptic or ovate, 1.8–2.5 mm. long, 1.3–2.8 mm. broad, rounded to subacute at apex; filaments 1–1.3 mm. long, the distal portions deltoid-ligulate, 0.2–0.5 mm. long, the anthers deltoid-oblong, 1–1.2 mm. long, 0.7–1 mm. broad, dorsally glandular-punctate, obtuse or truncate at apex; gynoecium 2–2.5 mm. long at anthesis, the ovary copiously sessile-capitate-glandular, tapering into a slenderly cylindric style 0.6–1.2 mm. long, the stigma subpeltate, 0.3–0.6 mm. in diameter, the placenta ovoid or clavate, with 2–4 distal ovules; fruits rugulose in drying, at first broadly fusiform but becoming ellipsoid or subglobose, 8–14 mm. in diameter, rounded or obtuse at base, the pericarp 1.5–2.5 mm. thick, the exocarp copiously glandular-punctate or -lineolate, the endocarp 0.2–0.3 mm. thick.

TYPE LOCALITY: The only collection cited by Mez is *Horne 883* (GH, K, LENINGRAD); the Kew sheet is herewith designated as the lectotype. Horne's field label indicates: "in woods near Vienuga, interior of Viti Levu." This locality was discussed by Horne (1881: 35, 37), but no such village seems now to exist. The locality refers to Veinungga Creek, a northern affluent of the Navua River which arises in Nandronga & Navosa Province (as Mavavu Creek), takes the name Veinungga Creek as it flows southward through Namosi Province, and in its final two or three miles flows through Serua Province. From Horne's discussion it is apparent that the village "Vienuga" was on that portion of the creek in the present Namosi Province.

DISTRIBUTION: Endemic to Fiji, where it is a frequent component of the undergrowth in the dense forest of central and southern Viti Levu; otherwise it is known only from Ovalau and Vanua Mbalavu. Except for the single collection from the last island, it occurs at altitudes of 100–1,150 m., often in deep shade, as a slender tree or simple-stemmed shrub 2–9 m. high, the foliage and inflorescences often being borne on separate branches. The inflorescence-branches, pedicels, and calyces are rich pink to purple; the corolla is commonly pale pink, or pink proximally and white distally, with yellowish or brownish glands; and the anthers are yellow. The fruit, green when young, becomes red to scarlet with purple glands. This attractive small plant may be found in flower or fruit at most times of the year.

LOCAL NAMES: On Viti Levu the following names have been recorded: *sila*, *sila ni veikau*, and *mokoelu* (in Mba); *samaloa* (in Serua); and *ndasia* (in Tailevu).

Fiji. VITI LEVU: MBA: Mt. Ndelaiyoö, west of Nandarivatu, *Smith 5069* (A, US); between Nandala and Nukunuku Creeks, between Nandariyatu and Lewa, *Smith 6208* (A, BISH, K, US); vicinity of Nandarivatu, *Gillespie 4164* (BISH), *4365*

(BISH, K, UC); Mt. Nanggaranambuluta, *Tothill 361* (BISH, K), *Gillespie 3697* (BISH), *Smith 4770* (A); Nauwanga, near Nandarivatu, *Degener 14560* (A, NY); Mt. Matomba, Nandala, *Degener 14437* (A, BISH, K, NY); Mt. Tomanivi, *Smith 5238* (A, BISH, K, US), *Fiji Dept. Agr. 12694* (*Melville et al. 7082*) (K, SUVA). NANDRONGA & NAVOSA: Northern portion of Rairaimatuku Plateau, between Nandrau and Rewasau, *Smith 5606* (A, BISH, K, US); vicinity of Mbelo, near Vatukarasa, *Tabualewa 15622* (A, BISH, K), *15636* (A). SERUA: Upper Navua River, *Fiji Dept. Agr. 15509* (BISH, SUVA), *15516* (SUVA); Vunambua Creek, Nambukelevu, *Fiji Dept. Agr. 14871* (BISH, SUVA); east of Navua River, near Nukusere, *Smith 9139* (BISH, GH, US); Nathengathenga, inland from Namboutini, *Fiji Dept. For. 462*, p. p. (*Damanu 111*) (K, SUVA); Namboutini, *Fiji Dept. For. 205* (*Bola 64*) (SUVA), *Bola 65* (K); west of Waivunu Creek, between Ngaloa and Korovou, *Smith 9259* (US), *9307* (BISH, GH, K, UC, US); north of Ngaloa, in drainage of Waininggere Creek, *Smith 9191* (BISH, GH, US). NAMOSI: *Duacia 1* (K); Veinungga Creek, July 1878, *Horne 883* (K lectotype; isotype at GH); vicinity of Wainavindrau Creek, between Korombasambasanga Range and Mt. Naitarandamu, *Smith 8447*, *8603* (both BISH, GH, K, SUVA, UC, US); vicinity of Namuamua, *Gillespie 3253* (BISH); track to Mt. Vakarongasiu, *Fiji Dept. Agr. 16107* (SUVA), *16114* (MASS, SUVA). NAITASIRI: Track from Waimbua to Waimanu River, *Fiji Dept. Agr. 15574* (SUVA); vicinity of Nasinu, *Gillespie 3482* (BISH, UC). TAILEVU: East of Wainimbuka River, in vicinity of Ndakuivuna, *Smith 7100* (US). REWA: Wainamboro Creek, *Fiji Dept. Agr. 5918* (SUVA); Mt. Korombamba, *Gillespie 2250* (BISH, UC), *Fiji Dept. Agr. 16543* (BISH, MASS, SUVA). OVALAU: Hills southeast of valley of Mbureta River, *Smith 7463* (BISH, GH, K, SUVA, UC, US). VANUA MBALAVU: Northern end of island, on limestone, *Bryan 577* (BISH, SUVA).

Tapeinosperma hornei, one of the locally abundant species of the genus, is characterized by its comparatively long petioles, ample leaf-blades that are usually subcordate to obtuse at base and scarcely decurrent on the petiole, and usually ample inflorescences with a subpersistent glandular indument. It is perhaps less closely allied to *T. megaphyllum* than indicated in my key, being more readily confused with *T. grande*, as noted below in the discussion of that species.

A probably undescribed species of *Tapeinosperma* of the general alliance of *T. hornei* is represented by *Fiji Dept. Agr. 15313* (BISH, SUVA), from the vicinity of Nasonggo, Naitasiri, Viti Levu. It differs from *T. hornei* in its more ample inflorescences with longer pedicels and its substantially larger corollas, but the material is inadequate for a satisfactory analysis. In having dorsifixed anthers, filaments notably ligulate distally, and a markedly long style, this taxon is definitely referable to *Tapeinosperma* rather than to *Discocalyx*, in which it bears a superficial similarity to *D. amplifolia*.

4. **Tapeinosperma divaricatum** (Gillespie) A. C. Sm., comb. nov.
FIGURES 37–41.

Discocalyx divaricata Gillespie in Bishop Mus. Bull. **74**: 10. *fig. 10*. 1930; J. W. Parham, Pl. Fiji Isl. 156. *fig. 59A*. 1964.

Shrub or slender tree 1–4 m. high, sometimes subscandent or becoming

a liana, the young parts copiously pilose with reddish, spreading, eglandular, several- or many-celled hairs 0.2–0.5 mm. long, the indument often persistent but sometimes evanescent on vegetative parts; branchlets slender, 1.5–3 mm. in diameter toward apices, terete, cinereous; petioles slender, 10–35 mm. long, shallowly canaliculate, semiterete proximally; leaf-blades chartaceous, oblong to oblong-lanceolate, 4–14 cm. long, 1–3.5 cm. broad, usually narrowly cordate to rounded at base but sometimes obtuse to subacute and short-decurrent on the petiole, gradually narrowed to an acute or obtuse callose-tipped apex, entire or undulate-crenate at margin (crenations about 2 per centimeter, each terminating a veinlet), dispersed-glandular-pustulate on both sides, often conspicuously pilose beneath but usually glabrate, the costa slender, plane or shallowly canaliculate above, sharply elevated beneath, the principal secondary nerves 7–15 per side, spreading, prominulous on both sides, inconspicuously anastomosing toward margin, the veinlet-reticulation inconspicuous, immersed to faintly prominulous on both sides; inflorescences subtended by sometimes obvious bud-scales that are subfoliaceous but soon caducous, pinnately paniculate, 2.5–5 cm. long, 1–4 cm. broad, the peduncle slender, 1–3 cm. long, the branches 3–6, short, spreading, each bearing 2–6 distal flowers, the rachis, branches, and pedicels copiously and subpersistently pilose with reddish, few-celled, glandular or eglandular hairs 0.05–0.2 mm. long, the branch- and flower-subtending bracts linear, 1–2 mm. long, acute, dorsally pilose and immersed-glandular, persistent to anthesis; pedicels 2–5 mm. long, becoming slightly thickened distally in fruit; flowers 5(often 4-, rarely 3-)-merous, the calyx chartaceous, rotate at anthesis, 2.5–3.5 mm. in apical diameter, sparsely or copiously immersed-glandular, pilose like the pedicel, the tube short, the lobes spreading at anthesis, ovate-deltoid, 1–1.3 mm. long and broad, acute at apex, glandular-ciliolate; corolla subcarnose proximally, submembranous distally, cupuliform-subrotate, 3–4 mm. long, 4–6 mm. in apical diameter, sparsely glandular-lineolate proximally and copiously glandular-punctate distally, the tube 0.5–1 mm. long, the lobes broadly elliptic, 2–3 mm. long, 1.3–2.5 mm. broad, rounded at apex; filaments 1–1.2 mm. long, the distal portions narrowly ligulate, 0.3–0.5 mm. long, the anthers ovoid-deltoid, 1–1.4 mm. long, about 1 mm. broad, immersed-glandular-punctate dorsally and sometimes ventrally toward the truncate apex; gynoecium 2–2.5 mm. long at anthesis, the ovary ellipsoid, sparsely immersed-glandular-punctate and sometimes minutely glandular-puberulent, tapering into a slender style 0.8–1.2 mm. long, the stigma discoid, 0.4–0.5 mm. in diameter, the ovules 2–4; fruits strongly rugulose at maturity, broadly fusiform or ellipsoid, 7–12 × 6–9 mm., narrowed to an obtuse base, the pericarp 0.8–1.5 mm. thick, the exocarp glandular, often lineolate proximally and punctate distally, the endocarp 0.3–0.5 mm. thick.

TYPE LOCALITY: Vicinity of Nandarivatu, Mba Province, Viti Levu, Fiji; the type is *Parks 20592*, cited below.

DISTRIBUTION: Endemic to Fiji and apparently to a limited upland area of northern and western Viti Levu, where it occurs at altitudes of 750–1,100 m. as a comparatively infrequent component of the dense forest undergrowth. It has been noted as a shrub or slender tree 1–4 m. high, sometimes with horizontal branches, and sometimes subscandent and becoming a liana. The inflorescence-branches, pedicels, and calyces are pink; the corolla varies from pink to maroon or rich purple; and the fruit, at first green with reddish glands, becomes bright red or scarlet. Flowers have been noted from May to August, but fruits persist through much of the year.

LOCAL NAME: The name *mbulumbulu* has been noted by Gillespie from Nandarivatu.

Fiji: VITI LEVU: MBA: Mt. Evans Range, *Greenwood 1162* (A, BISH); eastern slopes of Mt. Koroyanitu, Mt. Evans Range, *Smith 4250* (A, BISH, K, US); Mt. Mbatilamu, *Fiji Dept. Agr. 14809* (K, MASS, SUVA); northern slopes of Mt. Namendre, east of Mt. Koromba, *Smith 4526* (A, BISH, K, US); vicinity of Nandarivatu, *Tothill 203* (K), *Parks 20534* (UC), *20592*, July 1927 (BISH holotype; isotype at UC), *Gillespie 3843* (BISH, UC), *Fiji Dept. Agr. 12384* (BISH, SUVA), *O. & I. Degener 32049* (BISH); Mt. Nanggaranambuluta (Lomalangi), *Gillespie 4069.1* (BISH), *Smith 4823* (A, BISH, K, US); east of Nandala Creek, south of Nandarivatu, *Smith 6216* (A, K, US); Mt. Matomba, Nandala, *Degener 14449* (A, NY). NANDRONGA & NAVOSA: Nausori Highlands, *Fiji Dept. Agr. 13396* (BISH, SUVA).

The stamens of this species have the filaments narrowed and free distally, and the anthers are dorsifixed near the base; consequently it is referable to *Tapeinosperma* in the present context. Although superficially very distinct, it is basically similar to *T. hornei* and distinguished from that by its delicate facies, its small leaves and inflorescences, and its more copious and persistent indument. *Tapeinosperma divaricatum* has a limited distribution in northern and western Viti Levu, but even here certain local tendencies are noted. In the Nandarivatu area the leaf-blades are predominantly rounded to narrowly cordate, and the flowers seem always to be 5-merous; in the Mt. Evans and Mt. Koromba areas of western Viti Levu the leaf-blades are obtuse to subacute at base, and the flowers are often 4-merous, rarely 3-merous. This incipient differentiation is of interest in view of the isolation of the western ranges of Viti Levu from the central plateau.

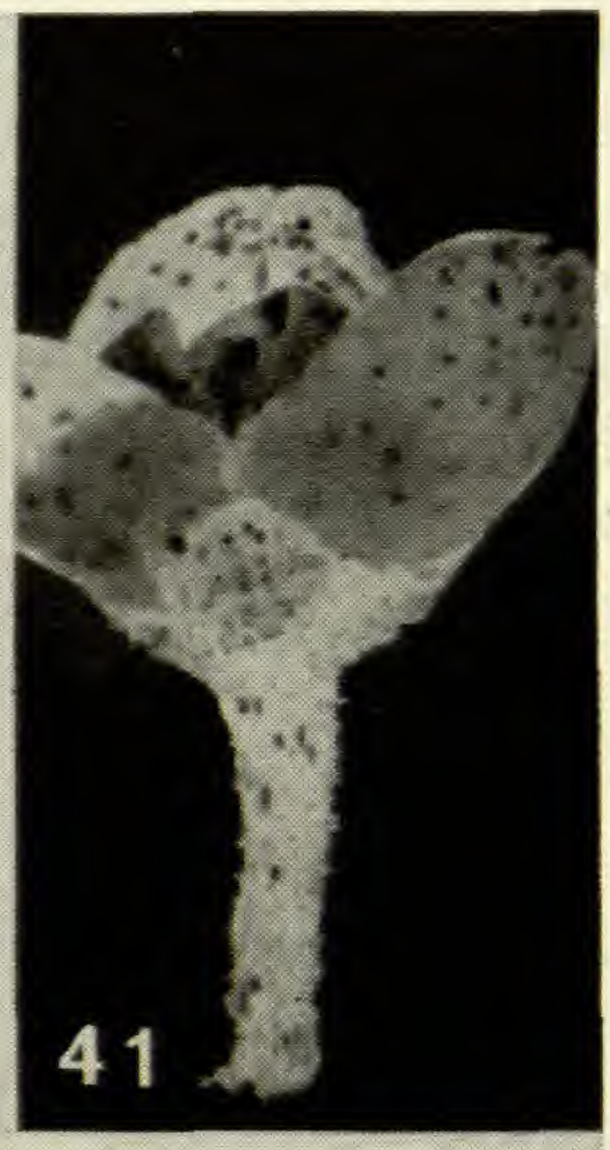
5. **Tapeinosperma ligulifolium** A. C. Sm. in Jour. Arnold Arb. 33: 107. 1952; J. W. Parham, Pl. Fiji Isl. 160. 1964. FIGURES 42–44.

Tapeinosperma capitatum sensu Mez in Pflanzenr. **9**(IV. 236): 165, quoad descr. et spec. cit., non sensu typi. 1902.

Shrub to 2 m. high, the young parts copiously but evanescently glandular-puberulent, the vegetative parts glabrous; branchlets stout, 3–5 mm. in diameter toward apex, terete, brownish near apex, cinereous below;

39

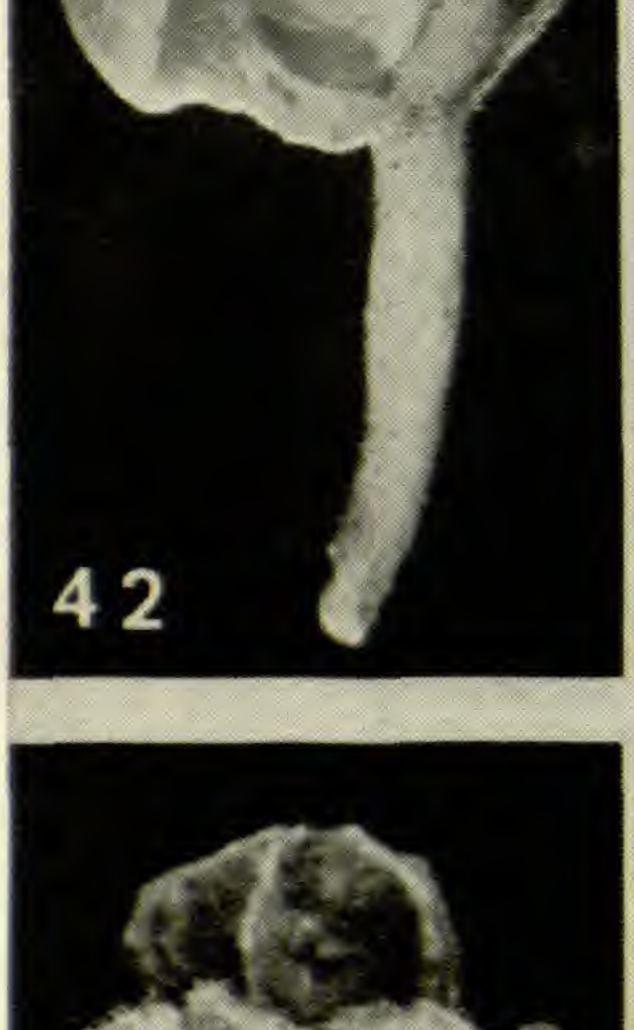
40

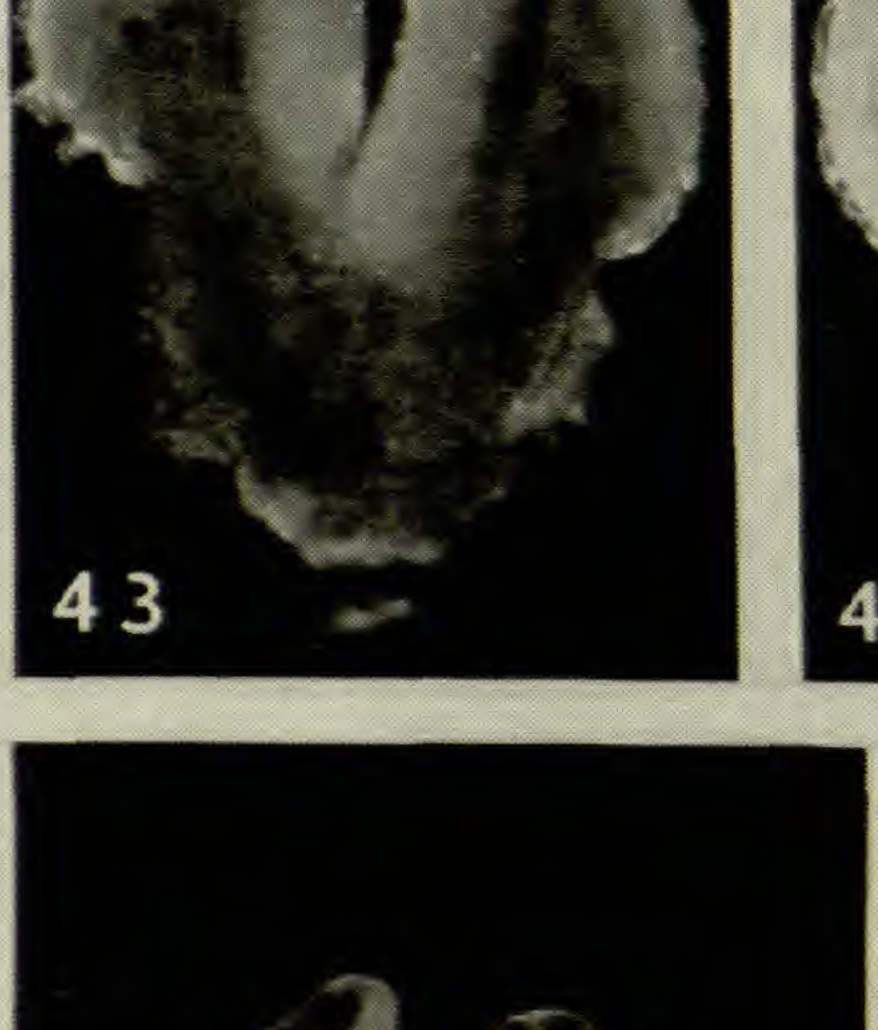

41

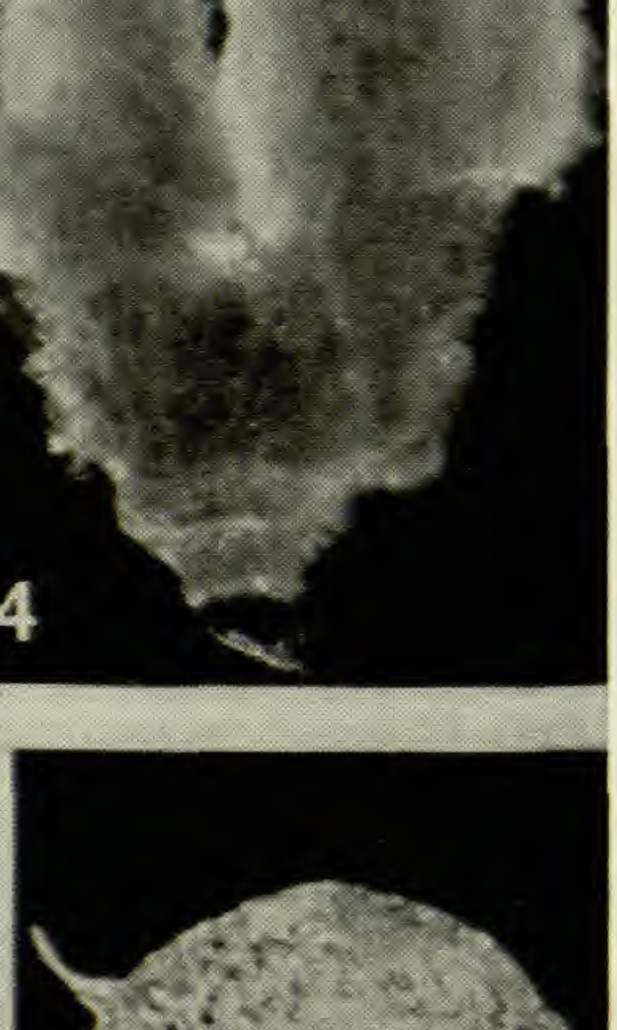
42

43

44


45


46


47

leaves often appearing subsessile, the petioles stout, rugulose, 2–4 mm. in diameter, 1–10 mm. long, semiterete or proximally subterete; leaf-blades coriaceous, elongate-ligulate, 15–40 cm. long, 1–2.3 cm. broad, broadly or narrowly obtuse or acute at base but scarcely decurrent or short-decurrent on the petiole, obtuse or narrowly rounded or shallowly retuse at apex, entire and usually strongly revolute at margin, with immersed or inconspicuously pustulate glands on both surfaces, the costa strongly impressed above, prominent beneath, the secondary nerves very numerous, 3–10 mm. apart, short, spreading, inconspicuously prominulous or immersed on both sides, anastomosing within the margin, the veinlet-reticulation inconspicuously prominulous or immersed on both sides; inflorescences narrowly paniculate or bi- or tripinnately paniculate, 4–12 cm. long, 2–6 cm. broad, the peduncle slender, 2–5 cm. long, the branches 4–10, spreading, to 3 cm. long, many-flowered, the rachis, branches, and pedicels sparsely glandular-pilose with hairs scarcely 0.1 mm. long, the flower-subtending bracts oblong-ligulate or oblanceolate, 0.5–1.5 mm. long, obtuse, dorsally glandular; pedicels slender, 2–3 mm. long, thickening in fruit; calyx cupuliform-rotate, about 1 mm. long, 2.5–3 mm. in apical diameter, glandular-pilose like the pedicel and also inconspicuously immersed-glandular, the tube short, the lobes lanceolate- or deltoid-ovate, 1–1.3 mm. long, 0.7–1 mm. broad, subacute at apex, minutely glandular-ciliolate; corolla thin-carnose, campanulate, eventually subrotate, 2.5–3 mm. long, 3–3.5 mm. in apical diameter, conspicuously glandular-lineolate proximally and punctate distally, the tube about 0.5 mm. long, the lobes ovate-suborbicular, about 2.5 mm. long and broad, rounded at apex; filaments 1–1.2 mm. long, the free portions carnose and ligulate, 0.4–0.5 mm. long, the anthers oblong-deltoid, 1.2–1.5 mm. long, dorsally obscurely glandular, subacute at apex; gynoecium about 2 mm. long at anthesis, the ovary oblong-ellipsoid, minutely glandular-papillose, attenuate into a style 0.8–1 mm. long, the stigma minutely subpeltate, the ovules 2–5; fruits irregularly rugulose in drying, subglobose, 7–8 mm. in diameter, the pericarp 1–1.5 mm. thick, the mesocarp with immersed glands, the endocarp 0.2–0.3 mm. thick.

TYPE LOCALITY: Summit ridge of Mt. Numbuiloa, east of Lambasa, Mathuata Province, Vanua Levu, Fiji; the type is *Smith 6522*.

DISTRIBUTION: The available data are too scarce to permit recognition of a distributional pattern, the species being known definitely only from the type locality and from Naitasiri Province in southeastern Viti Levu. The species has been found in the undergrowth of dense forest at altitudes

---

FIGURES 39–41. *Tapeinosperma divaricatum*: 39 from *Smith 4823*, 40 and 41 from *Smith 4526*. 39, 5-merous flower, × 8; 40, 4-merous flower, × 8; 41, 3-merous flower, × 8. FIGURES 42–44. *Tapeinosperma ligulifolium*: all from *Smith 6522*. 42, flower, × 8; 43, two stamens, dorsal view, × 20; 44, two stamens, ventral view, × 20. FIGURES 45–47. *Tapeinosperma clavatum*: 45 and 46 from *Smith 7693*, 47 from *Smith 5379*. 45, flower, × 8; 46, stamens, dorsal (left) and ventral views, × 20; 47, fruit, × 4.

of 200–590 m.; it is a shrub 1.5–2 m. high, with rich pink inflorescence-branches, calyces, and corollas. The specimens from Mathuata were in flower in November and December, and that from Naitasiri bore fruit in August. The Seemann specimen, in flower, and the Horne specimen, in fruit, lack data.

Fiji. VITI LEVU: NAITASIRI: Tholo-i-suva, *im Thurn 359*, p. p. (K). VANUA LEVU: MATHUATA: Mt. Numbuiloa, Nov. 6, 1947, *Smith 6522* (A holotype; fragment at US; photos at BISH, K, US); same locality, *Fiji Dept. Agr. 14625* (BISH, SUVA). FIJI, without further locality: *Seemann 293*, p. p. (K), *Horne 1076* (K).

This striking species, originally described from a unicate collection, is so distinct in its narrow, ligulate leaf-blades as to obviate comparisons. It is keyed with *Tapeinosperma megaphyllum* and *T. hornei* because of the essentially abrupt, although very narrow, bases of its leaf-blades and its subterete (although often negligible) petioles. It is readily distinguished from *T. grande* by these foliar characters and also by its smaller flowers.

Seemann 293 is a mixture; because of the then current method of handling collections, the sorting into taxa was done at the conclusion of a trip, and apparently Seemann sorted the unicate Kew specimen cited above into the material that later became the type material of *T. grande*. Gray, in two 1862 references, commented on the resemblance in foliage between his *Ardisia capitata* and *Seemann 293*, although it is a fairly remote resemblance. Subsequently Mez correctly interpreted *Ardisia grandis*, but his understanding of *Ardisia capitata* was incorrect, having been based on the narrow-leaved specimen of *Seemann 293* and on *Horne 1076*. Although Mez cited this narrow-leaved portion of *Seemann 293* as from Kandavu, there is no such indication on the sheet; it could have been obtained from any of Seemann's localities, possibly from Mathuata.

Another, quite different mixture here occurs in *im Thurn 359*; the portion cited above, dated August 1907, was apparently referred in sorting to the material that later served as the type collection of *Ixora bullata* Turrill (which had been collected at Tholo-i-suva on July 28, 1907). The two taxa are remarkably similar in foliage at first glance, although entirely unrelated taxonomically.

6. **Tapeinosperma clavatum** Mez in Pflanzenr. 9(IV. 236): 164. 1902; Gillespie in Bishop Mus. Bull. 74: 9. *fig. 8*. 1930; J. W. Parham, Pl. Fiji Isl. 158. 1964. FIGURES 45–47.

Ardisia humilis sensu A. Gray in Bonplandia **10:** 37. 1862; non auctt.
Ardisia sp. n. Horne, A Year in Fiji, 257. 1881.

Slender tree or shrub to 10 m. high, the young parts sparsely and minutely ferruginous-furfuraceous-lepidote, the indument evanescent, the vegetative parts glabrous; branchlets often swollen at nodes, variable, 1.5–7 mm. in diameter toward apex, distally rugulose or subangled, soon terete and grayish; petioles 7–20 mm. long, narrowly winged or coria-

ceous-angled nearly to base or semiterete proximally, obscurely glandular-lineolate; leaf-blades chartaceous or subcoriaceous, oblong-elliptic to obovate- or elliptic-lanceolate, (6–) 8–20 cm. long, (2–) 3–7 cm. broad, attenuate at base and long-decurrent on the petiole, obtuse or obtusely cuspidate and often inconspicuously retuse at apex, entire or undulate and sharply recurved at margin, punctate or lineolate with immersed or pustulate glands on both sides, the costa stout, plane above, prominent beneath, the principal secondary nerves 15–25 per side, spreading, sharply elevated on both surfaces, conspicuously anastomosing toward margin, the veinlet-reticulation copious, prominulous or plane on both surfaces; inflorescences bi- or tripinnately paniculate, 4–17 cm. long, 3–10 cm. broad, the branches 3–12, subascending, 1–5 cm. long, many-flowered, the rachis, branches, and pedicels at first copiously glandular-pilose with several-celled ferruginous hairs 0.1–0.2 mm. long, at length glabrate, the branch-subtending bracts lanceolate or oblanceolate, 2–6 mm. long, obtuse, copiously glandular-punctate and dorsally glandular-pilose, the flower-subtending bracts similar, 1–2 mm. long; pedicels stout, gradually swollen distally, 1–3 mm. long at anthesis, sometimes accrescent to 5 mm. long and apically broad in fruit; calyx clavate or narrowly cupuliform, thick-carnose at anthesis, 1.5–4 mm. long, 2.5–4 mm. in apical diameter, often glandular-pilose but eventually glabrate, the tube greatly thickened, immersed-glandular-punctate, the limb becoming subrotate and to 5 mm. in diameter in fruit, the lobes broadly ovate, 0.8–1.5 mm. long, 1.5–2.3 mm. broad, rounded at apex, copiously punctate, marginally scariose and conspicuously ciliolate; corolla subglobose in bud, becoming campanulate, 2.5–3.5 mm. long, 4–7 mm. in apical diameter, copiously immersed-punctate, the tube about 0.5 mm. long, the lobes asymmetrically thick-carnose and elliptic-obovate, 2–3 mm. long, 1.5–2.5 mm. broad, obtuse or rounded at apex; filaments short, the free portions 0.2–0.3 mm. long, the anthers carnose, oblong-deltoid, 0.7–1.5 mm. long, 0.5–1 mm. broad, truncate at apex; gynoecium about 3 mm. long at anthesis, the ovary ellipsoid, glabrous, narrowed into a style 0.6–1.6 mm. long, the stigma minutely peltate-capitate, the ovules 3; fruits obovoid, at length subglobose, 6–8 mm. in diameter at maturity, obtuse at base, the pericarp 1–1.5 mm. thick, the exocarp copiously glandular-punctate, the endocarp 0.3–0.5 mm. thick.

TYPE LOCALITY: Ovalau, in the mountains; of the two collections cited by Mez, *Horne 52* and *180*, the latter is somewhat the fuller, and the Kew sheet of it is herewith designated the lectotype.

DISTRIBUTION: Endemic to Fiji and thus far known from Viti Levu, Kandavu, and Ovalau, where it occurs in dense forest or in the thickets of crests and ridges at altitudes of 400–1,120 m. It has been noted as a shrub or small, slender tree 1.5–10 m. high; the corolla is greenish or white, with purple glands; and the fruit at maturity is bright or deep red. Flowers and fruits may be anticipated in most seasons.

LOCAL NAMES: *Sila* has been recorded in Mba Province; *ndasia* in both Nandronga & Navosa and Namosi.

Fiji. VITI LEVU: MBA: Mt. Koromba, *Smith 4665* (A, BISH, K, US); Savundamatau Creek, west of Nandarivatu, *Webster & Hildreth 14243* (DAV, MASS); Koro-O Road, west of Nandarivatu, *Fiji Dept. Agr. 13532* (BISH, K, SUVA); vicinity of Nandarivatu, *Gillespie 4037* (BISH, UC); Mt. Nanggaranambuluta (Lomalangi), *Gillespie 3699* (BISH, UC); ridge between Mt. Nanggaranambuluta and Mt. Namama, *Smith 4981a* (A, BISH, K, US); valley of Nggaliwana Creek, north of Navai, *Smith 5379* (A, BISH, K, NY, US). NANDRONGA & NAVOSA: Ridge above Koronayalewa, *Fiji Dept. Agr. 2481* (A, SUVA), *2482* (SUVA). SERUA: Track to Mt. Tikituru, *Fiji Dept. Agr. 14484* (BISH, SUVA). NAMOSI: Mt. Voma, *Gillespie 2674* (BISH, UC), *Fiji Dept. Agr. 1715* (SUVA), *11663* (SUVA). NAITASIRI: Northern portion of Rairaimatuku Plateau, between Mt. Tomanivi and Nasonggo, *Smith 5795* (A, BISH, K, US), *6110* (A, BISH, K, NY, US). KANDAVU: Mt. Mbuke Levu, *Smith 220, 270* (both BISH, GH, K, NY, UC, US). OVALAU: Mt. Korotolutolu, west of Thawathi, *Smith 8037* (BISH, GH, K, US); Mt. Korolevu, west of Lovoni Valley, *Smith 7532* (US); "tops of mountains," *Horne 52* (GH, K); mountains surrounding Lovoni Valley, Jan. 1878, *Horne 180* (K lectotype; isolectotype at GH); Mt. Tana Lailai and adjacent ridge, *Smith 7693* (BISH, GH, K, SUVA, UC, US); inland from Levuka, *Gillespie 4444* (BISH), *4513* (BISH, K, NY, UC, US). FIJI, without further locality: *U. S. Expl. Exped.* (US, det. by A. Gray as *Ardisia humilis*), *Fiji Dept. Agr. 1245* (SUVA), *3378* (BISH, SUVA).

This species and the remaining *Tapeinospermata* of the Fijian Region are characterized by having their leaf-blades proximally attenuate and long-decurrent on the petiole, which is often narrowly winged or angled nearly to its base, in contrast to the preceding four species, which have the leaf-blades more or less rounded at base and not decurrent or short-decurrent on the petiole, which is terete or semiterete proximally. *Tapeinosperma clavatum* and three related species have the calyx distinctly cupuliform to clavate, the calyx-tube and upper part of the pedicel being obviously swollen, although eventually the calyx-limb may become rotate. The present species is especially distinctive in its conspicuous calyx-tube, although its calyx-lobes and corollas are smaller than those of its two closest relatives, and additionally its indument is comparatively close and sparse.

7. **Tapeinosperma ampliflorum** A. C. Sm. in Contr. U. S. Nat. Herb. 37: 88. 1967. FIGURES 48–50.

Slender tree to 10 m. high, the young parts copiously puberulent with glandular hairs about 0.1 mm. long, the vegetative parts glabrous; branchlets stout, rugulose, becoming terete and cinereous, 4–8 mm. in diameter toward apex; petioles stout, to 5 mm. in diameter, 7–20 mm. long, narrowly coriaceous-winged or sharply angled nearly to base; leaf-blades coriaceous or subcoriaceous, obovate-elliptic or oblanceolate, (8–) 12–20 cm. long, (3–) 4–8.5 cm. broad, attenuate at base and long-decurrent on the petiole, obtuse or narrowly rounded at apex, entire and narrowly

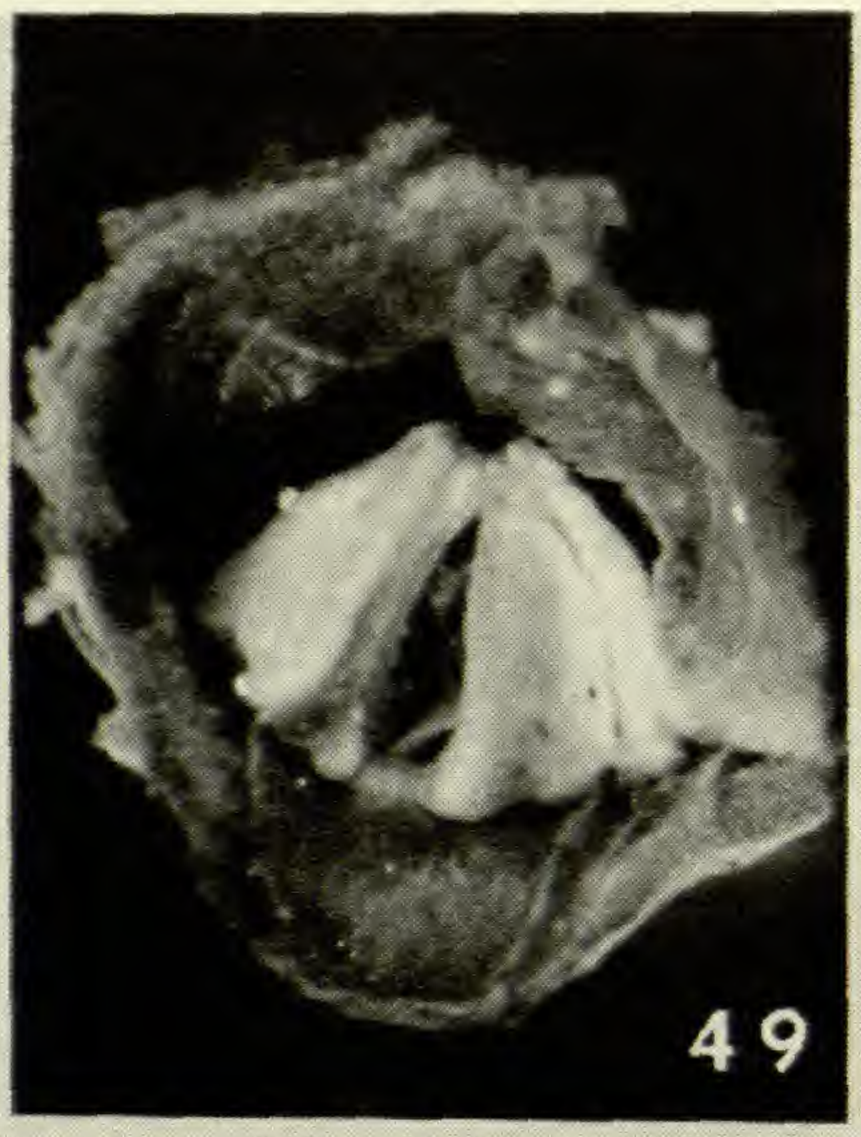
recurved at margin, copiously or sparsely immersed- or pustulate-glandular on both surfaces, the costa stout, subplane above, prominent beneath, the principal secondary nerves (12–) 15–25 per side, spreading, inconspicuously prominulous on both surfaces, anastomosing toward margin, the veinlet-reticulation subimmersed and often not apparent on either surface; inflorescences pinnately or bipinnately pyramidal-paniculate, 3–12 cm. long, 2–6 cm. broad, the branches 5–10, to 3 cm. long, comparatively few-flowered, the peduncle 1–5 cm. long, the rachis, branches, and pedicels copiously puberulent or pilose with brownish, glandular, sometimes several-celled hairs 0.05–4 mm. long, these parts and the calyx soon glabrate, the branch-subtending bracts oblong or lanceolate-obovate, 3–4.5 mm. long, obtuse, ciliolate, the flower-subtending bracts similar but less than 2 mm. long; pedicels stout, 1–4 mm. long, often accrescent to 5 mm. long and 2 mm. in diameter in fruit; calyx broadly cupuliform, 3.5–4 mm. long, 4.5–6 mm. in diameter, the limb becoming rotate and to 8 mm. in diameter in fruit, the lobes ovate, 2–3 mm. long, 2–4 mm. broad, cuspidate at apex, sparsely immersed-glandular, conspicuously ciliolate with multicellular, often obscurely glandular hairs 0.2–0.4 mm. long; corolla subglobose-cupuliform, at length subrotate, 3.5–5 mm. long, 4–5 mm. in apical diameter, the tube obconical-cylindric, about 2 mm. long, the lobes asymmetrically thick-carnose, ovate, 3–4 mm. long and broad, obtuse at apex, immersed-glandular; filaments 1–1.5 mm. long, the free portions short, deltoid-ligulate, the anthers deltoid-ovoid, 1.5–1.8 mm. long, about 1 mm. broad, obtuse, immersed-glandular; gynoecium about 3 mm. long at anthesis, the ovary conspicuously immersed-glandular, attenuate into a style 0.8–1.5 mm. long, the stigma peltate, 0.5–0.8 mm. in diameter, the ovules 3 or 4; fruits broadly fusiform or subglobose-obovoid, to 12 mm. long and 9 mm. broad, obtuse at base, the pericarp 1–1.5 mm. thick, the endocarp about 0.4 mm. thick.

TYPE LOCALITY: Hills east of Navua River, near Nukusere, Serua Province, Viti Levu, Fiji; the type is *Smith 9102*, cited below.

DISTRIBUTION: Endemic to Fiji and apparently infrequent on Viti Levu and Kandavu, occurring from near sea-level to about 900 m. in dense forests or on forested ridges. It has been noted as a tree, often slender, 4–10 m. high; the bracts and flower-buds are dull pink; the mature calyx and corolla are pink; and the fruit is dull brown to purple. The few available collections do not permit recognition of much seasonality.

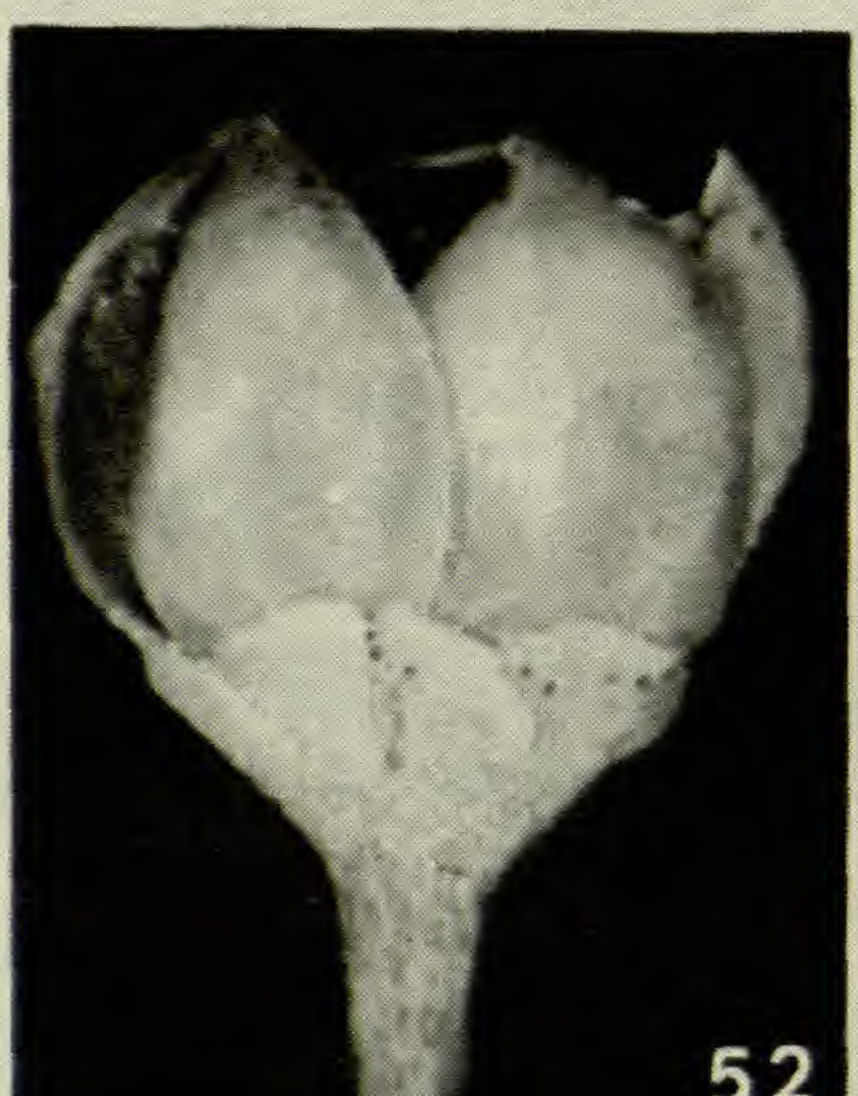
Fiji. VITI LEVU: MBA: Mt. Mbatilamu, Vunda, *Fiji Dept. Agr. 14126* (BISH, MASS, SUVA). SERUA: Hills east of Navua River, near Nukusere, Oct. 29, 1953, *Smith 9102* (US 2192113 holotype; isotypes at BISH, GH, K, SUVA, UC); Vatutavathe, vicinity of Ngaloa, *Degener 15176* (A, BISH, K, NY, UC, US). NAMOSI: Northern slopes of Korombasambasanga Range, in drainage of Wainavindrau Creek, *Smith 8743* (BISH, GH, K, SUVA, UC, US). NAITASIRI (?): "Suva" (but more likely north of Suva and hence in Naitasiri Province), *Tothill 525* (K).

48


49

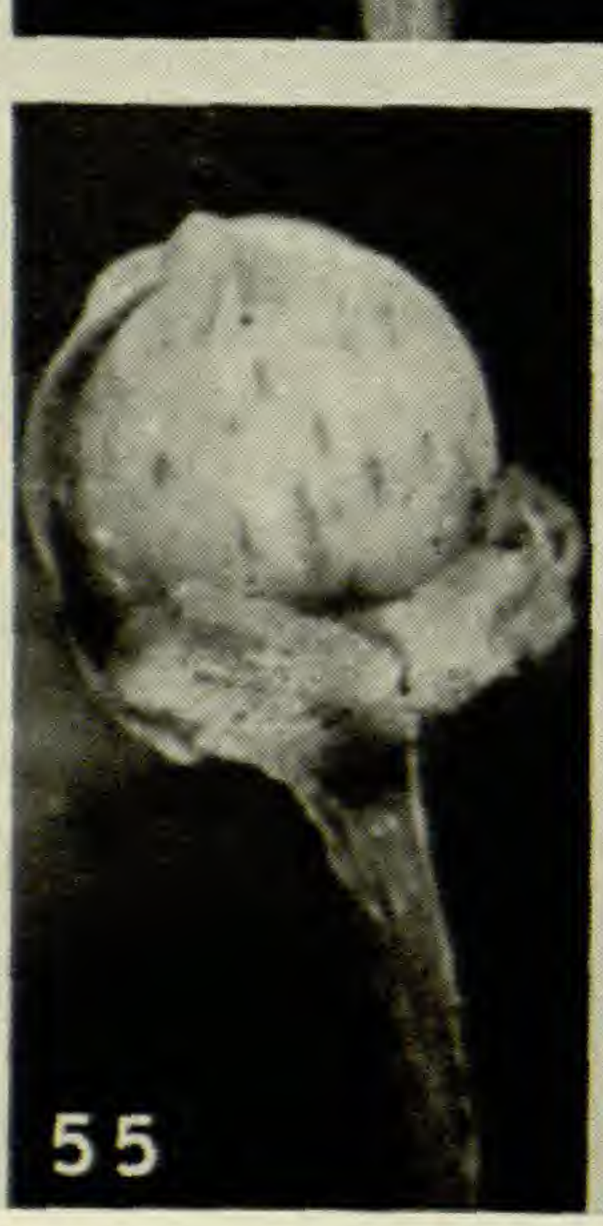
50

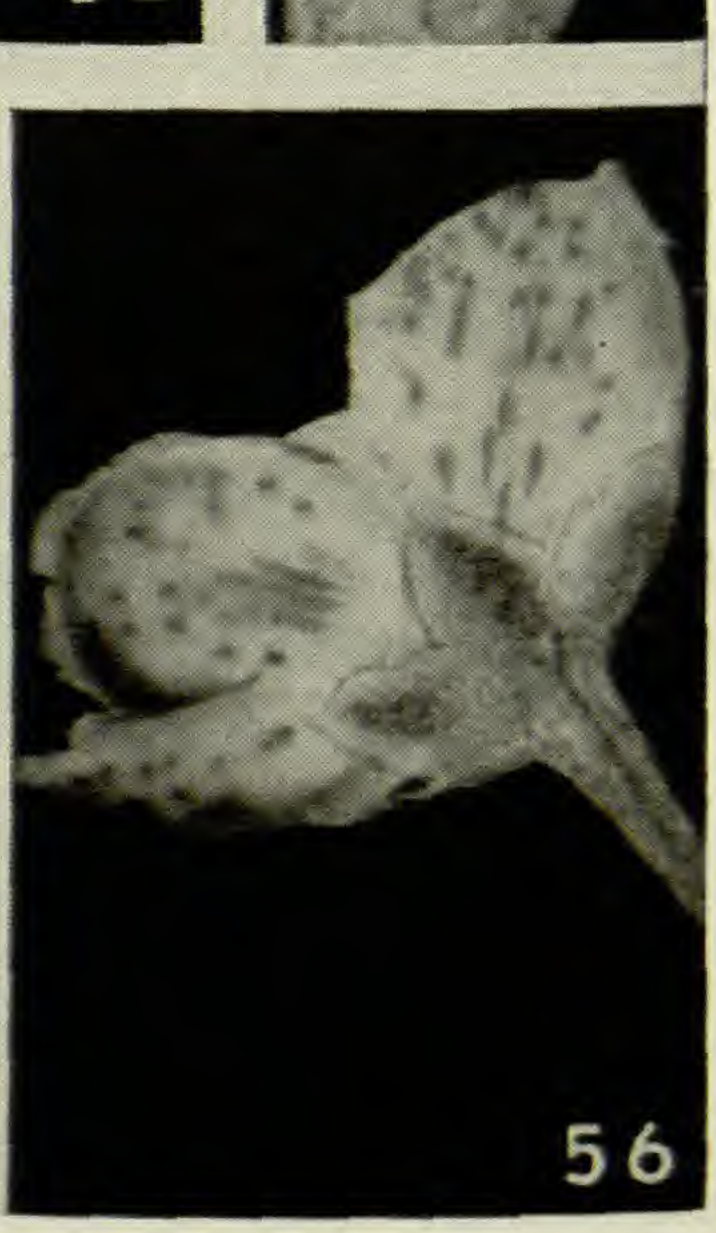
51


52

53

54


55


56

REWA: Mt. Korombamba, *Meebold 17041* (BISH). KANDAVU: Mt. Mbuke Levu, *Fiji Dept. Agr. 14932* (BISH, SUVA).

From the related *Tapeinosperma clavatum*, *T. ampliflorum* differs in its substantially larger flowers, especially as to the calyx- and corolla-lobes, its more broadly cupuliform calyx-tube, and the somewhat more abundant indument of its inflorescence-parts.

8. **Tapeinosperma chloranthum** A. C. Sm. in Jour. Arnold Arb. 33: 106. 1952; J. W. Parham, Pl. Fiji Isl. 158. 1964. FIGURE 51.

Tree to 12 m. high, the young parts copiously furfuraceous with minute irregular scales, these evanescent and the vegetative parts glabrous; branchlets swollen at nodes, usually terete and cinereous, 2.5–5 mm. in diameter toward apex; petioles robust, 8–15 mm. long, narrowly winged distally, semiterete at base; leaf-blades chartaceous, narrowly oblong-elliptic, 10–20 cm. long, 3–7.5 cm. broad, attenuate at base and long-decurrent on the petiole, obtuse or narrowly rounded at apex, entire and narrowly recurved at margin, inconspicuously pustulate- or immersed-glandular with scattered, oval or lineolate glands, the costa stout, immersed-glandular-lineolate, subplane above, prominent beneath, the principal secondary nerves 18–22 per side, sharply raised or prominulous on both surfaces, irregularly anastomosing toward margin, the veinlet-reticulation copious, prominulous on both surfaces or plane beneath; inflorescences bipinnately paniculate, at anthesis 5–12 cm. long and 4–6 cm. broad, accrescent to 20 × 12 cm. in fruit, the branches 5–10, spreading, many-flowered, the peduncle 1–4.5 cm. long, the rachis, branches, and pedicels copiously tomentellous with brownish, multicellular, often irregularly branching, eglandular hairs 0.2–0.4 mm. long, the branch-subtending bracts oblong-lanceolate, about 4 mm. long, subacute, the flower-subtending bracts similar but 1.5–3 mm. long; pedicels stout, 1–6 mm. long, swollen distally especially in fruit; flowers occasionally 6-merous, the calyx subcarnose, persistently tomentellous, broadly cupuliform, 3.5–4.5 mm. long, about 5 mm. in apical diameter and accrescent to 7 mm. in fruit, immersed-glandular, the limb at length rotate, the lobes ovate, 1.5–2.5 mm. long, 2–2.5 mm. broad, subacute at apex; corolla thick-carnose, infundibular-rotate, about 6 mm. long and in diameter (not seen fully mature), the tube 1–2 mm. long, the lobes ovate or oblong, 4–5 mm. long, 2–3 mm. broad, obtuse at apex, immersed-glandular, dorsally sparsely pilose with hairs

---

FIGURES 48–50. *Tapeinosperma ampliflorum*: 48 from *Smith 9102*, 49 and 50 from *Tothill 525*. 48, young flower, × 8; 49, two stamens attached to young corolla, × 10; 50, gynoecium of young flower, with three calyx-lobes, sectioned ovary, and placenta, × 10. FIGURE 51. *Tapeinosperma chloranthum*: flower, from *Smith 5820*, × 8. FIGURES 52, 53. *Tapeinosperma multiflorum*: both from *O. & I. Degener 32103*. 52, flower, × 8; 53, gynoecium, with two calyx-lobes, × 15. FIGURE 54. *Tapeinosperma greenwoodii*: flower with two corolla-lobes and two stamens removed, from *Greenwood 944*, × 8. FIGURE 55. *Tapeinosperma scrobiculatum*: flower, from *Kajewski 313*, × 8. FIGURE 56. *Tapeinosperma kajewskii*: flower, from *Kajewski 822*, × 5.

like those of the calyx; filaments with free portions about 0.4 mm. long, the anthers deltoid-ovoid, about 1.2 mm. long, obtuse, dorsally inconspicuously glandular; ovary minutely pale-glandular-puberulent, attenuate into a slender style about 1 mm. long, the stigma subpeltate, about 0.5 mm. in diameter, the ovules 3; fruits subglobose, 6–7 mm. in diameter, the pericarp about 1 mm. thick, the exocarp copiously glandular-punctate, the endocarp 0.2–0.3 mm. thick.

TYPE LOCALITY: Hills between Nggaliwana and Nandala Creeks, south of Nauwanga, Mba Province, Viti Levu, Fiji; the type is *Smith 5820*, cited below.

DISTRIBUTION: Endemic to Fiji and thus far known only from a limited montane area in the northern part of Viti Levu, occurring at altitudes of 700–1,050 m. in dense or secondary forest. It has been noted as a tree 7–12 m. high, with a trunk to 35 cm. in diameter; the corolla is dull green with purplish glands; and the fruit is red at maturity. The most mature flowers (but even these are not fully open) are those of the type, collected in August, and fruits have been obtained in April and August.

LOCAL NAME: *Kutumirase* was recorded for *Smith 4023*, but this name is usually applied to the genus *Maesa*.

Fiji. VITI LEVU: MBA: Slopes of Mt. Nairosa, eastern flank of Mt. Evans Range, *Smith 4023* (A, BISH, K, US); vicinity of Nandarivatu, *Fiji Dept. Agr. 13100* (SUVA); between Nggaliwana and Nandala Creeks, south of Nauwanga, Aug. 26, 1947, *Smith 5820* (A holotype; isotypes at BISH, K, US); Yavu, Nandala, *Fiji Dept. For. 1091* (*Damanu 205*) (A, K, SUVA); vicinity of Navai, *O. & I. Degener 32114* (BISH).

Tapeinosperma chloranthum, for which a good range of specimens is not yet at hand, seems amply differentiated from *T. ampliflorum* in the eglandular and long persistent tomentum of its inflorescence-parts; its corolla-lobes are proportionately longer than those of its ally and are dorsally pilose in a young state.

9. **Tapeinosperma multiflorum** (Gillespie) A. C. Sm., comb. nov.

FIGURES 52, 53.

Discocalyx multiflora Gillespie in Bishop Mus. Bull. **74:** 11. *fig. 11.* 1930; J. W. Parham, Pl. Fiji Isl. 156. 1964.

Discocalyx obtecta A. C. Sm. in Jour. Arnold Arb. **33:** 108. 1952; J. W. Parham, Pl. Fiji Isl. 156. 1964.

Slender tree or shrub to 9 m. high, the young parts minutely furfuraceous and also sparsely or copiously glandular-puberulent or pilose with several- or many-celled hairs to 0.4 mm. long, the vegetative parts soon glabrate; branchlets slender, swollen at nodes, terete, soon cinereous, 1–5 mm. in diameter toward apex; petioles slender, 3–20 mm. long, narrowly winged distally or nearly to base, semiterete at base; leaf-blades chartaceous or

subcoriaceous, elliptic to obovate or oblanceolate, 5–13 cm. long, (1.5–) 2–5 cm. broad, attenuate at base and long-decurrent on the petiole, broadly obtuse or narrowly rounded or obtusely cuspidate at apex, entire and slightly recurved at margin, often copiously glandular-pustulate or immersed glandular-lineolate on both surfaces, when young sometimes with copious superficial glands or ferruginous-lepidote beneath, the costa stout, flattened or slightly raised above, prominent beneath, the principal secondary nerves 8–18 per side, spreading, immersed to sharply elevated on both surfaces, anastomosing toward margin, the veinlet-reticulation subimmersed or prominulous on both surfaces; inflorescences often scattered toward ends of special slender peduncle-like branches to 18 cm. long, pinnately to tripinnately paniculate, 3–11 cm. long, 2–7 cm. broad, the branches 3–12, spreading, many-flowered, the peduncle 1.5–4 cm. long, the rachis, branches, and pedicels copiously puberulent with minutely stalked capitate glands or pilose and furfuraceous like the young parts, the branch-subtending bracts oblong- to obovate-lanceolate, 2–3.5 mm. long, obtuse, the flower-subtending bracts similar but 1–2 mm. long; pedicels 1–5 mm. long and slender at anthesis, often conspicuously enlarged distally; flowers turbinate in bud, the calyx cupuliform or pyriform, 1.5–2.5 mm. long, 2–3.5 mm. in apical diameter, often copiously immersed-glandular-punctate, the tube thick-carnose, obconical, the limb at length subrotate, the lobes ovate or deltoid, 0.6–1.3 mm. long, 1–2.5 mm. broad, acute to obtuse at apex, ciliolate with several-celled hairs 0.2–0.4 mm. long; corolla thick-carnose proximally, campanulate, becoming subrotate, 2.5–4 mm. long, 3–5 mm. in apical diameter, the tube 0.5–1 mm. long, the lobes inequilaterally oblong to elliptic, 2–3.5 mm. long, 1.5–2.5 mm. broad, obtuse to rounded at apex, immersed-glandular-punctate distally, rarely dorsally sparsely pilose; filaments with free portions 0.2–0.5 mm. long, the anthers oblong-deltoid, at anthesis 1–1.3 mm. long and 0.5–1 mm. broad, obtuse, dorsally sparsely immersed-glandular; gynoecium at anthesis 1.5–2 mm. long, the ovary ellipsoid or subconical, immersed-glandular-punctate and also with minutely stalked capitate glands, attenuate into a slender style 0.6–1.5 mm. long, the stigma peltate-capitate, 0.4–0.5 mm. in diameter, the ovules 2 or 3; fruits subglobose, 5–7 mm. in diameter, the pericarp 1.5–2 mm. thick, the exocarp rugulose in drying, copiously glandular-lineolate, the endocarp 0.2–0.3 mm. thick.

TYPE LOCALITY: Near summit of Mt. Naitarandamu, Namosi Province, Viti Levu, Fiji; the type is *Gillespie 5113*. The type of *Discocalyx obtecta* is *Smith 6217*, collected in hills east of Nandala Creek, about three miles south of Nandarivatu, Mba Province, Viti Levu. Both types are cited below.

DISTRIBUTION: Endemic to Fiji and known only from northern and central Viti Levu, with a single collection from Vanua Levu. The species occurs at altitudes of 725–1,323 m. in dense, shady forest, or in the thickets and mossy forest of high crests and ridges. It is reported as a

slender tree or simple-stemmed shrub 1.5–9 m. high, with a trunk to 20 cm. in diameter; the flower-buds are green with reddish glands and brown indument; the corolla is waxy-white with dark red glands; the anthers are deep red dorsally; and the fruit is red or at length purplish. Flowers have been collected between August and December, and mature fruits in June and July.

LOCAL NAMES: The name *sila* has been noted in Mba Province, and *sendua* in upper Naitasiri.

Fiji. VITI LEVU: MBA: Mt. Evans Range, *Greenwood 1149* (A, BISH, K, UC, US); Mt. Ndelainathovu, west of Nandarivatu, *Smith 4921* (A, BISH, K, US); Koroua Road, Nandarivatu, *Fiji Dept. Agr. 13037* (BISH, K, SUVA); Mt. Nanggaranambuluta (Lomalangi), *Gillespie 3788* (BISH), *3791* (BISH, UC), O. & I. *Degener 32103* (BISH, NY); east of Nandala Creek, Sept. 25, 1947, *Smith 6217* (A holotype of *Discocalyx obtecta*; isotypes at BISH, K, US); track to Navai, *Fiji Dept. Agr. 14452* (BISH, MASS, SUVA); between Nggaliwana and Tumbeindreketi Creeks, east of Navai, *Smith 6007* (A, BISH, K, NY, US); upper western slopes of Mt. Tomanivi, *Smith 5207* (A, BISH, K, US); summit of Mt. Tomanivi, *Smith 5912* (A, BISH, K, NY, US). NAMOSI: Near summit of Mt. Naitarandamu, *Gillespie 3296* (BISH, K), Sept. 28, 1927, *Gillespie 5113* (BISH holotype; isotype at UC). NAITASIRI: Wainisavulevu-Numbulolo divide, Taunaisali, *St. John 18323* (BISH, US). VANUA LEVU: THAKAUNDROVE: Summit of Mt. Mbatini, *Smith 709* (BISH, GH, K, NY, UC, US).

The two concepts here combined, both originally described in *Discocalyx*, seemed distinct on the basis of the types and the few other collections available at the time of the description of *D. obtecta*. *Discocalyx multiflora* has leaf-blades with the secondary nerves sharply elevated and the veinlets prominulous on both surfaces; its inflorescences have the rachis, pedicels, and calyces minutely furfuraceous or puberulent with short-stalked capitate glands. In contrast, *D. obtecta* has its secondary nerves and veinlets immersed or only slightly elevated; its inflorescence-indument consists of several- or many-celled hairs 0.2–0.4 mm. long, which are either gland-tipped or not. It is now apparent, however, that variation in the leaf-texture and in the consequent prominence of venation is too haphazard to be taxonomically useful; the heavier indument, also, seems characteristic of younger inflorescences and variable in its persistence. Consequently the two previously recognized taxa are here combined under the older epithet.

Although the essential characters pertaining to the calyx-tube, the style, and the anther-attachment dictate the place of the present taxon in *Tapeinosperma*, it may readily be confused with *Discocalyx fusca* and the immediate relatives of that species. Its actual relationship is with the group of *T. clavatum*, from which it is distinguished by its comparatively small leaves and flowers. The calyx- and corolla-lobes are much smaller than those of *T. ampliflorum* and *T. chloranthum*; *T. clavatum* itself has flower-parts not much larger than those of *T. multiflorum*, but its calyx-tube is proportionately narrower and its inflorescence-indument is usually evanescent.

10. **Tapeinosperma grande** (Seem.) Mez in Pflanzenr. 9(IV. 236): 164. 1902; J. W. Parham, Pl. Fiji Isl. 159. *fig. 60*. 1964.

Ardisia grandis Seem. in Bonplandia **9:** 257, nomen. 1861, Viti, 439, nomen. 1862; A. Gray in Proc. Amer. Acad. Arts **5:** 331, nomen. 1862, in Bonplandia **10:** 37, nomen. 1862; Seem. Fl. Vit. 150. *pl. 29*. 1866; Horne, A Year in Fiji, 257. 1881.

Slender tree or shrub to 6 m. high, the young parts copiously puberulent with minute glandular hairs not more than 0.1 mm. long, the vegetative parts soon glabrate; branchlets rugulose, stout, 6–10 mm. in diameter toward apex, distally angled, soon terete and cinereous; petioles stout, 4–7 mm. in diameter, (5–) 15–70 mm. long, narrowly canaliculate and coriaceous-winged distally, angled nearly to base and there semiterete; leaf-blades subcoriaceous, oblong-lanceolate, 30–55 cm. long, 4–12 cm. broad, attenuate at base and long-decurrent on the petiole, narrowly rounded or broadly obtuse at apex, entire and cartilaginous and often narrowly recurved at margin, glandular-pustulate on both surfaces but often obscurely so, the costa stout, plane or broadly and shallowly canaliculate above, prominent beneath, the principal secondary nerves 25–35 per side, sharply elevated on both surfaces, copiously anastomosing toward margin, the proximal ones ascending, the others spreading, the veinlet-reticulation copious, prominulous on both surfaces or subimmersed beneath; inflorescences pinnately or bipinnately paniculate, 3–11 cm. long, 3–6 cm. broad, the branches 5–10, spreading, many-flowered, the peduncle 1.5–6 cm. long, the rachis, branches, and pedicels copiously glandular-puberulent like the young parts, eventually glabrate, the branch-subtending bracts lanceolate, 1.5–2 mm. long, obtuse, sparsely glandular-puberulent without, the flower-subtending bracts similar but 0.7–1.5 mm. long; pedicels 1–5 mm. long, becoming stouter but not elongating in fruit; flowers apparently sometimes 6- or 7-merous, the calyx subrotate at anthesis, carnose proximally, 3–4.5 mm. in apical diameter at apex (to 5 mm. in fruit), glandular-puberulent like the pedicel, the tube short, the lobes 5–7, ovate-deltoid, at anthesis 1–1.5 × 1–2 mm., slightly accrescent to 2 × 2.5 mm. and often reflexed in fruit, obtuse to subacute at apex, copiously glandular-ciliolate; corolla carnose, campanulate, becoming subrotate, 4.5–5 mm. long, 4–7 mm. in apical diameter, copiously immersed-glandular-punctate distally, the tube 1–1.5 mm. long, the lobes ovate, 3–3.5 mm. long, 2–2.5 mm. broad, subacute at apex; filaments with free portions subcarnose, 0.3–0.5 mm. long, the anthers carnose, oblong-deltoid, about 2 mm. long and 1 mm. broad, obtuse; ovary tapering to a slender style about 1.5 mm. long, the stigma subcapitate; fruits coarsely rugulose in drying, ellipsoid-fusiform, becoming subglobose, at maturity about 11 mm. in diameter, broadly obtuse or rounded at base, the mature pericarp 1–3 mm. thick, the exocarp copiously or inconspicuously glandular-punctate or -lineolate, the endocarp 0.2–0.5 mm. thick.

TYPE LOCALITY: *Ardisia grandis* was mentioned in casual lists several

times prior to Seemann's valid publication of it in 1866; at that time he mentioned the only cited specimen, *Seemann 293*, as from Ovalau. However, the holotype at Kew bears his field label indicating: "Kandavu. Leaves leathery. Shrub." The available isotypes are without data. It is possible that the other portion of *Seemann 293*, discussed above under *T. ligulifolium*, came from Ovalau, but that is not indicated on the specimen. It seems advisable to follow Mez in considering Kandavu as the type locality of the present species. An account of Seemann's visits to Kandavu in August and September, 1860, is of interest (Seemann, 1862: 137–145, 211–218).

DISTRIBUTION: Endemic to Fiji and thus far known sparingly from four of the high islands, occurring from near sea-level to an altitude of about 850 m., as a slender tree or simple-stemmed shrub 2–6 m. high. The only satisfactorily mature flowers are those of the type collection, but mature fruits, which are red, have been obtained in various seasons.

LOCAL NAMES: The name *kaikaro* was noted from Nandronga & Navosa Province, and *ndasia* from Naitasiri.

Fiji. VITI LEVU: NANDRONGA & NAVOSA: Mbelo, near Vatukarasa, *Tabualewa 13033* (A, BISH, K, NY, UC, US). NAITASIRI: Vasila, Waindina, *Fiji Dept. Agr. 660* (SUVA); past Tamavua Village, *Gillespie 2024* (BISH). KANDAVU: *Seemann 293*, p. p., Aug. or Sept. 1860 (K holotype; isotypes at BM, GH), *Fiji Dept. Agr. 11951* (*Dept. For. 31, Watkins 700*) (MASS, SUVA); hills above Namalata and Ngaloa Bays, *Smith 163* (BISH, GH, K, NY, UC, US); Naikorokoro, *Fiji Dept. For.* (*Damanu 50*) (SUVA). NGAU: Slopes of Mt. Ndelaitho, on northern spur, toward Navukailangi, *Smith 7880* (US). VANUA LEVU: THAKAUNDROVE: Eastern drainage of Yanawai River, *Degener & Ordonez 14095, p. p.* (BISH, K; this number = *Ixora* sp. at A, UC, US); Vunimoli, Vaturamulo, *Fiji Dept. Agr. 15393* (SUVA); Mt. Mariko, *Smith 446* (BISH, K, NY).

The remaining species of *Tapeinosperma* in the Fijian Region have the calyx subrotate from a very short and inconspicuous tube, which is scarcely cupuliform and certainly not turbinate or clavate, in which respect they suggest *Discocalyx*; however, their stamens are clearly those of *Tapeinosperma*. The present species is very distinct in its large, narrow leaf-blades and robust petioles, but it may be confused with *T. hornei*; among the specimens referred to the latter are a few that incline toward *T. grande* in their leaf-proportions and narrowed bases. The following comparison should adequately separate these species:

Leaf-blades oblong-lanceolate, 30–55 × 4–12 cm., 5–7 times longer than broad, attenuate at base and long-decurrent on the petiole, the principal secondary nerves 25–35 per side; corolla 4.5–5 mm. long, the lobes 3–3.5 mm. long; anthers about 2 mm. long. ..... *T. grande.*

Leaf-blades prevailingly oblong-elliptic and 15–37 × 4–15 cm., usually 3–4 times longer than broad, usually subcordate to obtuse (rarely acute) at base and abruptly decurrent on the petiole, the principal secondary nerves 10–25 per side; corolla 2.5–3.5 mm. long, the lobes 1.8–2.5 mm. long; anthers 1–1.2 mm. long. ..... *T. hornei.*

11. **Tapeinosperma babucense** Mez in Pflanzenr. 9(IV. 236): 164. 1902; J. W. Parham, Pl. Fiji Isl. 158. 1964.

Ardisia sp. n. Horne, A Year in Fiji, 257. 1881.

Shrub to 3 m. high, the young parts copiously glandular-puberulent, the vegetative parts glabrous; branchlets rugulose, stout, 5–6 mm. in diameter toward apex, distally angled, soon terete and brownish to cinereous; petioles stout, 15–20 mm. long, narrowly winged distally, semiterete proximally; leaf-blades subcoriaceous, oblong-lanceolate, 20–25 cm. long, 4–5.5 cm. broad, attenuate at base and long-decurrent on the petiole, obtuse or narrowly rounded at apex, entire, slightly thickened, and narrowly recurved at margin, sparsely glandular-pustulate on both surfaces, the costa stout, flattened above, prominent beneath, the principal secondary nerves 20–25 per side, sharply elevated on both surfaces, copiously anastomosing toward margin, the proximal ones ascending, the distal ones spreading, the veinlet-reticulation copious, prominulous or immersed on both surfaces; inflorescences narrowly pinnately paniculate, in fruit 12–13 cm. long and 3–5 cm. broad, the branches 5–8, spreading, apparently comparatively few-flowered, the peduncle 4–6 cm. long, the rachis, branches, and pedicels with minute sessile capitate glands; pedicels in fruit stout, terete, 4–6 mm. long; flowers not seen; fruiting calyx chartaceous or thin-coriaceous, rotate, 7–10 mm. in apical diameter, glandular without like the pedicel, the tube short, flattened, the lobes 5 or 6, strongly reflexed, oblong-ligulate, 3.5–6 mm. long, 1.5–2 mm. broad, obtuse at apex, undulate and copiously glandular-ciliolate at margin; fruits strongly rugulose in drying, subglobose, 8–10 mm. in diameter, immersed-glandular-punctate.

TYPE LOCALITY: Horne's locality, "Babuca," is discussed in his book (1881: 45, 46), and is utilized for the specific epithet by Mez. No such village seems still in existence, but Horne's description clearly refers to the area drained by Namboumbutho Creek, a tributary of the Wailoa River, which flows into the Wainimala, a principal tributary of the Rewa. The modern village of Nanggelewai is at the junction of Namboumbutho Creek and the Wailoa River, essentially on the boundary of Naitasiri and Nandronga & Navosa Provinces, and from Horne's comments this village may indeed be his "Babuca." The type is *Horne 946*.

DISTRIBUTION: Known only from the unicate type collection, which Horne's field label indicates as a "shrub 10 feet or so." His specimen, collected in August, bears three leaves and good fruiting inflorescences with adequate calyces but with only two remaining fruits.

Fiji. VITI LEVU: NAITASIRI (or possibly NANDRONGA & NAVOSA): Mountains near Namboumbutho Creek, Aug. 1878, *Horne 946* (K holotype).

Although *T. babucense* is obviously an inadequately known taxon, it is clearly related to *T. grande*, from which it must be maintained as distinct on the basis of its large calyces with elongate, oblong-ligulate, strong-

ly reflexed lobes; the corresponding fruiting calyx-lobes of *T. grande* do not exceed 2 × 2.5 mm. Additionally, *T. babucense* has a less robust facies and smaller leaves. Apparently no collectors have visited the precise area of Viti Levu where Horne obtained this plant, but several have been within ten miles of the locality without turning up his striking species.

12. **Tapeinosperma greenwoodii** A. C. Sm. in Jour. Arnold Arb. 26: 103. 1945; J. W. Parham, Pl. Fiji Isl. 160. 1964. FIGURE 54.

Tree to 10 m. high, the young parts minutely glandular-puberulent, the vegetative parts soon glabrate; branchlets rugulose, stout, 3–6 mm. in diameter toward apex, subterete, cinereous; petioles stout, 5–10 mm. long, coriaceous-winged distally, angled to the semiterete base; leaf-blades chartaceous, elliptic-oblong or obovate, 10–21 cm. long, 4–8 cm. broad, gradually narrowed proximally and decurrent on the petiole, obtuse or obtusely cuspidate at apex, often undulate and slightly recurved at margin, glandular-pustulate on both surfaces, the glands at length immersed, the costa slightly canaliculate or plane above, prominent beneath, the principal secondary nerves 15–25, spreading, straight, strongly prominulous on both surfaces or subplane beneath, anastomosing toward margin, the veinlet-reticulation intricate, slightly prominulous or subplane on both surfaces; inflorescences tri- or quadripinnately paniculate, 10–20 cm. long, 6–14 cm. broad, the branches 8–12, spreading, 3–10 cm. long, many-flowered, the peduncle slender, 2.5–6 cm. long, the rachis, branches, and pedicels densely glandular-puberulent with 1– several-celled hairs 0.1–0.2 mm. long, the branch-subtending bracts deltoid-oblong, about 1.5 mm. long, subacute, puberulent on both sides, ciliolate, the flower-subtending bracts similar but 0.5–1 mm. long; pedicels terete, slender, 1–2.5 mm. long, sometimes to 4 mm. long in fruit; calyx rotate at anthesis or with the short tube rounded at base, 2–2.5 mm. in apical diameter, slightly accrescent to 3 or 4 mm. in fruit, sparsely glandular-puberulent without, the lobes broadly ovate, at anthesis 0.8–1 × 1–1.3 mm., slightly accrescent in fruit, rounded or obtuse at apex, epunctate, minutely or obviously glandular-ciliolate; corolla carnose, campanulate-subrotate, 3–4 mm. long and 5–7 mm. in apical diameter at anthesis, the tube less than 1 mm. long, the lobes spreading at anthesis, asymmetrically ovate, 3–3.5 mm. long, 2–2.5 mm. broad, sparsely glandular-lineolate proximally and minutely punctate distally; filaments about 1.5 mm. long, the free portions ligulate, about 0.5 mm. long, the anthers elongate-deltoid, 1–1.2 mm. long, 0.7–0.9 mm. broad, obtuse, dorsally inconspicuously glandular; gynoecium about 2 mm. long at anthesis, the ovary minutely glandular-pustulate, attenuate into a slender style 0.8–1.2 mm. long, the stigma minutely and obliquely subpeltate, the ovules 2; fruits subglobose, 6–7 mm. in diameter, the pericarp 0.8–1 mm. thick, the mesocarp copiously glandular-lineolate, the endocarp about 0.2 mm. thick.

TYPE LOCALITY: Mt. Evans Range, Mba Province, Viti Levu, Fiji; the

type is *Greenwood 944*, collected in 1942. Two years later Greenwood obtained additional material from the same tree; these specimens are not strictly isotypes, although in fact they are better than the holotype in bearing more mature flowers. According to Art. 7 (Int. Code Bot. Nomencl.), isotypes are parts of a single gathering made by a collector *at one time*.

DISTRIBUTION: Endemic to Fiji and thus far known sparingly from the montane area of northwestern Viti Levu, occurring in dense, low forest at altitudes of 880–1,050 m. The available specimens are from trees 3–10 m. high, with ample, dependent inflorescences; the corolla is pure white and the fruit is green, but doubtless becomes red at full maturity. The only flowering material is that of Greenwood, obtained in September and October; the other specimens, in fruit, were collected in January and May.

Fiji. VITI LEVU: MBA: Mt. Evans Range, Oct. 25, 1942, *Greenwood 944* (A holotype; isotypes at BISH, K, NY), from same tree on Sept. 24, 1944, *Greenwood 944* (A, UC, US); eastern slopes of Mt. Koroyanitu, Mt. Evans Range, *Smith 4133* (A, BISH, K, US); Mt. Mbatilamu, Vunda, *Fiji Dept. Agr. 14120* (BISH, K, SUVA).

Although its flowers are very similar to those of *T. grande*, the present species is readily distinguished by its more delicate leaves with shorter petioles and much smaller, proportionately broader blades, and by its more ample and finely divided inflorescences. *Tapeinosperma greenwoodii*, as noted in my original protologue, is more likely to invite comparison with *T. clavatum* and its immediate allies, which it more resembles in foliage. However, it lacks the clavate or cupuliform calyx-tube and distally swollen pedicels of those species, and it is further separated from each of them in details of indument and floral parts.

13. **Tapeinosperma scrobiculatum** (Seem.) Mez in Pflanzenr. 9(IV. 236): 169, quoad basionymum, excl. descr. et spec. cit. 1902; Guillaumin in Bull. Soc. Bot. France **74**: 700. 1927.

FIGURE 55.

Ardisia scrobiculata Seem. Fl. Vit. 150. 1866.
Tapeinosperma netor Guillaumin in Jour. Arnold Arb. **13**: 13. 1932.

Shrub or tree, reported to attain a height of 30 m., the young parts obscurely glandular-puberulent, the indument evanescent, the vegetative parts glabrous; branchlets robust, 3–7 mm. in diameter toward apex, distally rugulose or irregularly scrobiculate and angled, becoming terete, brownish; petioles stout, 8–12 mm. long, narrowly coriaceous-winged distally, semiterete proximally; leaf-blades chartaceous or subcoriaceous, oblanceolate, 12–30 cm. long, 3.5–8 cm. broad, attenuate at base and long-decurrent on the petiole, broadly obtuse or narrowly rounded at apex, entire and narrowly recurved at margin, copiously glandular-pustulate on both surfaces or less obviously so beneath, the costa stout, shallowly or

conspicuously canaliculate above, prominent beneath, the principal secondary nerves 16–25 per side, prominulous on both surfaces, copiously anastomosing toward margin, the proximal ones ascending, the distal ones spreading, the veinlet-reticulation copious, prominulous or plane on both surfaces; inflorescences glabrous throughout (except for calycine cilia), laxly pinnately paniculate, 6–15 cm. long, 5–10 cm. broad, the branches 4–8, to 5 cm. long, each with 4–7 flowers, the peduncle slender, 3–6 cm. long; pedicels slender at anthesis, 3–10 mm. long, obscurely glandular-pustulate, becoming stout and strongly rugulose in fruit; calyx chartaceous and rotate at anthesis, 3–3.5 mm. in apical diameter, slightly accrescent in fruit to 5 mm., copiously glandular-punctate, the tube short, about 0.5 mm. long, the lobes broadly ovate, 1–1.5 mm. long, 1.4–1.8 mm. broad, subacute at apex, copiously glandular-ciliolate; corolla thin-carnose, at first subglobose but becoming subrotate, 3.5–4.5 mm. long at anthesis, the tube scarcely 0.5 mm. long, the lobes elliptic, 3–4 mm. long, 2.5–3 mm. broad, subacute at apex, proximally glandular-lineolate and distally punctate, subentire or minutely erosulous; filaments less than 1 mm. long, the free portions ligulate, about 0.3 mm. long, the anthers ovoid-deltoid, about 1.5 mm. long, 0.8–1.3 mm. broad, subacute or obtuse, dorsally inconspicuously punctate; gynoecium 2–2.5 mm. long at anthesis, the ovary oblong-ovoid, subulate into a slender style 1–1.5 mm. long, the stigma minutely capitate, the ovules 2; fruits subglobose, 10–15 mm. in diameter, the pericarp about 1.5 mm. thick, the exocarp glandular-lineolate, the endocarp 0.3–0.5 mm. thick.

TYPE LOCALITY: Seemann's description is clear and adequate; in introducing it he states that his new species was discovered by M'Gillivray on Capt. Denham's expedition, and he cites *M'Gillivray* (BM, from Aneityum) and *Vieillard 397* (from New Caledonia). From the protologue it would seem evident that the M'Gillivray specimen was the principal basis of the description and it is herewith designated the lectotype. In 1902 Mez made the appropriate combination in *Tapeinosperma*, describing and citing only one New Caledonian collection, *Vieillard 353*, which clearly cannot be taken as the lectotype because it was not a specimen studied by Seemann. In Guillaumin's 1927 mention he merely cited the M'Gillivray specimen from Aneityum without comment. This cannot be taken as lectotypification, although it suggests that at the time Guillaumin thought the species a New Hebridean endemic. In describing two new species of *Tapeinosperma* in 1932, Guillaumin did not mention Seemann's species, although his *T. netor* clearly represents the same concept. In describing the latter, Guillaumin cited *Kajewski 313* (in flower, from Eromanga) and *768* (in fruit, from Aneityum) without indicating a type. Even though the taxon is herewith reduced to synonymy, I designate the Arnold Arboretum sheet of the former, flowering collection as the lectotype. The occurrence of *T. scrobiculatum* in New Caledonia is very dubious, although I have not seen *Vieillard 397*; the same collector's no. *353* (A, GH) differs from the New Hebridean taxon in its inconspicuously punctate

leaf-blades, more complex inflorescences with shorter pedicels, eciliolate calyx-lobes, lack of glandular punctations in the floral parts, and longer corolla-tube.

DISTRIBUTION: Presumably endemic to the New Hebrides, and known with certainty only from Eromanga and Aneityum in dense forest at altitudes of 200–400 m. It is probably a shrub or tree to 6 m. high, although *Kajewski 313* indicates it as a tree to 30 m. (this size is so at variance with other species of the genus as to be questionable). The corolla is pink, and the fruit red at maturity. The only definite dates indicate flowers in May and fruits in December and February.

LOCAL NAME: *Net-or* was recorded by Kajewski from Eromanga and is the basis of his specific epithet.

New Hebrides. EROMANGA: About 6 miles inland from Dillon Bay, May 28, 1928, *Kajewski 313* (A lectotype of *T. netor*; isolectotypes at K, NY, P); southeastern part of island, *Schmid 3259* (P). ANEITYUM: *M'Gillivray* (BM lectotype); Anelgauhat Bay, *Kajewski 768* (A, BISH, K, NY, P, US).

The relationship of *T. scrobiculatum* is apparently with the Fijian *T. greenwoodii*, which it resembles in foliage and in basic floral characters, but from which it differs in its more simply branched and glabrous inflorescences, longer pedicels, slightly larger calyces, and larger fruits. In Mez's treatment this New Hebridean taxon would also more closely approximate the Fijian than the New Caledonian species, the latter with one exception being keyed as having eciliolate calyx-lobes.

14. **Tapeinosperma kajewskii** Guillaumin in Jour. Arnold Arb. 13: 12. 1932. FIGURE 56.

Presumably a shrub or small tree, the young parts copiously puberulent with minute, brownish, glandular-swollen, evanescent hairs about 0.1 mm. long, the vegetative parts early glabrate; branchlets 2–4 mm. in diameter toward apex, at first angular, becoming terete and brownish; leaves sessile, leaving conspicuous scars; leaf-blades subcoriaceous, obovate to lanceolate-obovate, 8–15 cm. long, 2.5–5 cm. broad, long-attenuate proximally, at the actual base flattened above and rounded beneath, broadly obtuse at apex, entire and slightly thickened at margin, copiously punctate above with slightly raised glands, these less obvious beneath, the costa stout, flattened or faintly canaliculate above, prominent beneath, the principal secondary nerves 15–20 per side, inconspicuously raised on both surfaces, copiously anastomosing toward margin, the basal ones ascending, the others spreading, the veinlet-reticulation copious, prominulous on both surfaces or plane above; inflorescences in axils of caducous and sometimes subfoliaceous bracts, simply racemose or narrowly paniculate, 1–7 cm. long, composed of a conspicuous peduncle 0.6–5.5 cm. long with 2 or 3 subapical flowers or with 2 or 3 short, lateral, distal branches, the flowers

few, the peduncle and branches immersed-glandular-lineolate and minutely glandular-puberulent, soon glabrate, the branch-subtending bracts lanceolate, about 4 mm. long, attenuate distally, glandular-punctate and ciliolate, the flower-subtending bracts similar but 1.5–2 mm. long; pedicels 2–5 mm. long, minutely glandular-pustulate; calyx subrotate at anthesis, 3–4.5 mm. in apical diameter, slightly accrescent to 5 mm. in fruit, the tube about 1 mm. long, the lobes oblong-deltoid, 1–1.5 mm. long, 0.8–1.5 mm. broad, obtuse at apex, copiously immersed-glandular except toward margin, conspicuously glandular-ciliolate; corolla thin-carnose, campanulate-subrotate, 3–4.5 mm. long, (4–) 6–9 mm. in apical diameter, copiously glandular-lineolate proximally and -punctate distally, the tube 1–1.2 mm. long, the lobes spreading at anthesis, broadly ovate-oblong or elliptic, (2.5–) 3–4 mm. long, (2–) 2.5–3.3 mm. broad, rounded at apex, scariose and subentire at margin, with a faint midrib and 3 or 4 pairs of arcuate lateral nerves; filaments about 1.1 mm. long, the free portions ligulate, about 0.3 mm. long, the anthers ovoid-deltoid, 1.8–2 mm. long, about 1 mm. broad, truncate at apex, sparsely glandular-punctate dorsally; gynoecium about 3 mm. long at anthesis, the ovary immersed-glandular-punctate, tapering into a slender, glandular-punctate style 1–1.5 mm. long, the stigma peltate, 0.3–0.5 mm. in diameter, the ovules 3 or 4; fruits globose or slightly oblate, 11–13 mm. in diameter, the pericarp about 1 mm. thick, the exocarp copiously glandular-lineolate, the endocarp 0.3–0.4 mm. thick.

TYPE LOCALITY: Anelgauhat Bay, Aneityum, New Hebrides; the type is *Kajewski 822*, cited below.

DISTRIBUTION: Endemic to the New Hebrides and thus far known only from Aneityum. The two available collections do not indicate a habit, but the species is presumably a shrub or small tree and, according to Kajewski, is common in the rain-forest at an altitude of about 200 m.; the Morrison specimen was collected near the summit of the highest peak of the island, at about 700 m. The corolla (Kajewski) is pink to purple with purplish glands, and the fruit has brownish elongate glands. Flowers were obtained in February; fruits in February and June.

New Hebrides. ANEITYUM: Anelgauhat Bay, Feb. 28, 1929, *Kajewski 822* (A holotype; isotypes at BISH, K, NY, P, US); summit of peak, *Morrison*, June 26, 1896 (K).

Tapeinosperma seems represented in the New Hebrides by only two species which, although related, are quite different. *Tapeinosperma scrobiculatum* (including *T. netor*) has its leaves with petioles 8–12 mm. long, narrowly winged distally and semiterete proximally, while the leaves of *T. kajewskii* are strictly sessile, although the blade is attenuate to a base that is flattened above and rounded beneath. The leaf-blades of *T. scrobiculatum* are somewhat the larger and have the costa shallowly or conspicuously canaliculate above; in *T. kajewskii* the costa is flattened or very

faintly canaliculate on the upper surface. The inflorescences of the former species are laxly pinnately paniculate, 6–15 cm. long and 5–10 cm. broad, many-flowered, and with slender pedicels 3–10 mm. long at anthesis; the inflorescences of *T. kajewskii* are either simply racemose or sparsely and narrowly paniculate, comparatively few-flowered, and with shorter, more rigid pedicels. The available flowers are not in strictly comparable condition, but apparently the calyx-lobes of *T. scrobiculatum* are somewhat broader.

4. **Discocalyx** (A. DC.) Mez in Pflanzenr. 9(IV. 236): 211. 1902.

Badula sect. *Discocalyx* A. DC. in DC. Prodr. 8: 107. 1844.

Discocalyx has above been contrasted to *Tapeinosperma* and the suggestion made that both genera should be retained, following Mez's system, at least until the family again receives a competent and world-wide review. More than 50 species have been referred to *Discocalyx*, at least 35 of them from the Philippines, and the remainder from other parts of Malesia eastward to Micronesia, Fiji, and Tonga. As has been noted, some of the Fijian species have required transfer to *Tapeinosperma*, while others are here reduced to synonymy. Nevertheless, in our area there appear to occur three species in Fiji and one in Tonga, terminating the range of the genus to the east.

As stated above, the genera *Tapeinosperma* and *Discocalyx* in our area are not readily separable in the absence of stamens and styles, and even to observe differences in these characters a careful dissection is often required. In other respects the summary of generic characters given for *Tapeinosperma* may also be applied to *Discocalyx*, and such points are usually not stressed in the following descriptions.

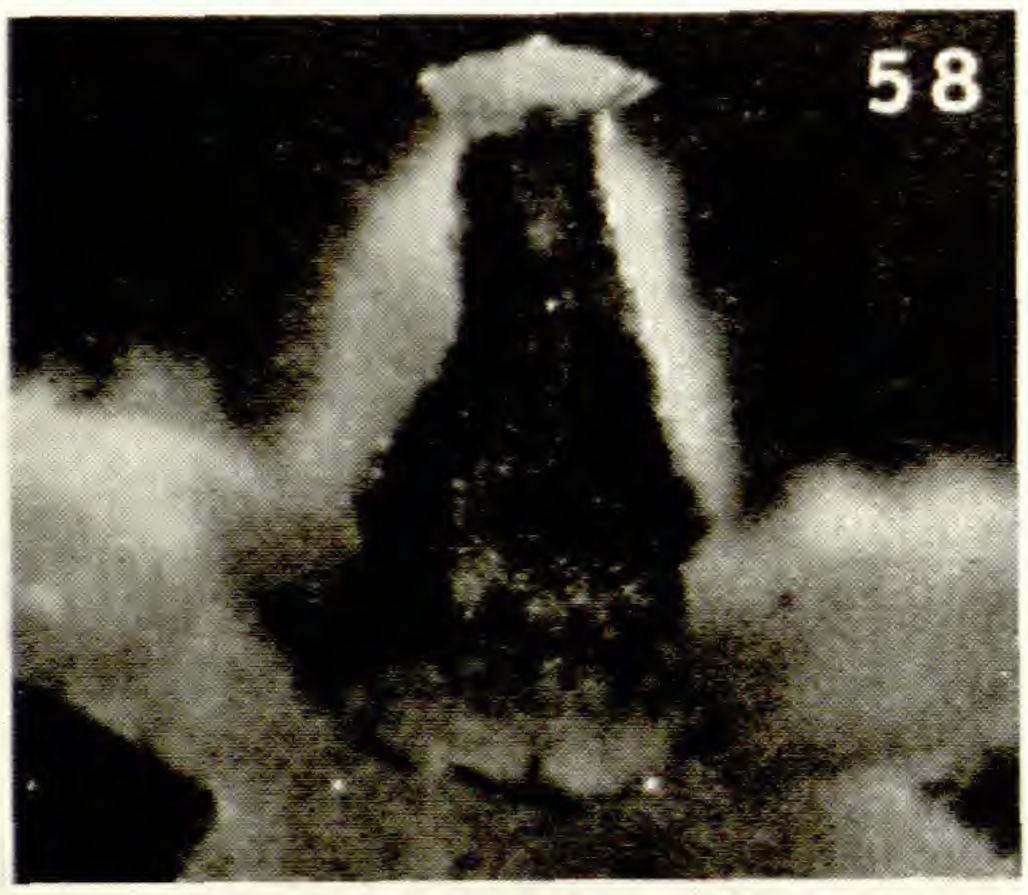
Key to Species

Petioles 5–20 (–30) mm. long, often narrowly winged nearly to base or angled proximally; leaf-blades comparatively small or at least narrow, usually 4–23 (–30) × 2–7 cm., attenuate at base and long-decurrent on the petiole. Flowers comparatively small, the calyx not exceeding 3 mm. in apical diameter, the lobes less than 1 mm. broad; corolla-lobes 1.5–2.5 × 1.2–2 mm.; fruits 4–7 mm. in diameter at maturity; petioles 5–17 mm. long; leaf-blades prevailingly elliptic to obovate, usually 4–18 × 2–6 cm.; Fiji. ..... 1. *D. fusca.*

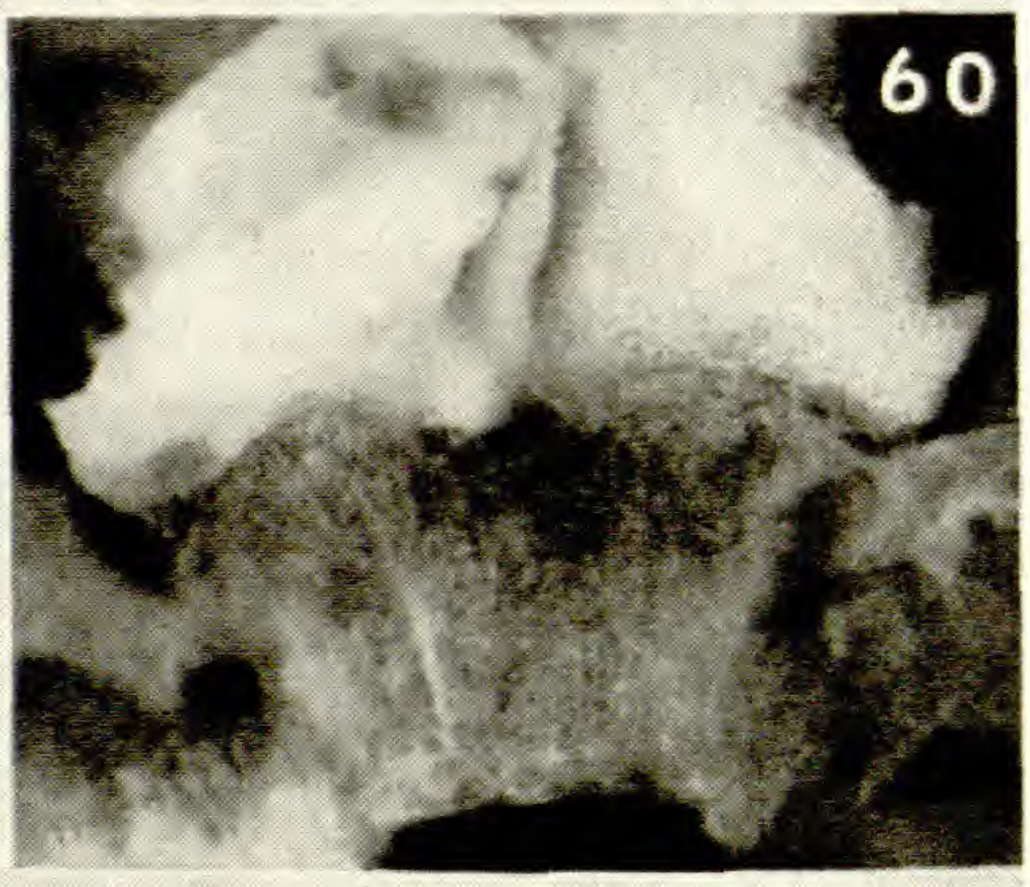
Flowers comparatively large, the calyx 3–3.5 mm. in apical diameter, the lobes 1.2–1.5 mm. broad; corolla-lobes 2.5–3.5 × 1.8–2.5 mm.; fruits 10–12 mm. in diameter at maturity; petioles 10–20 (–30) mm. long; leaf-blades elliptic- or obovate-lanceolate, 9–23 (–30) × 2.5–7 cm.; Tonga. ..... 2. *D. listeri.*

Petioles 30–110 mm. long, narrowly winged distally, semiterete or subterete proximally; leaf-blades comparatively ample, (12–) 17–44 × 6.5–22 cm., narrowly cordate to broadly obtuse at base and only short-decurrent on the petiole; Fiji.

57

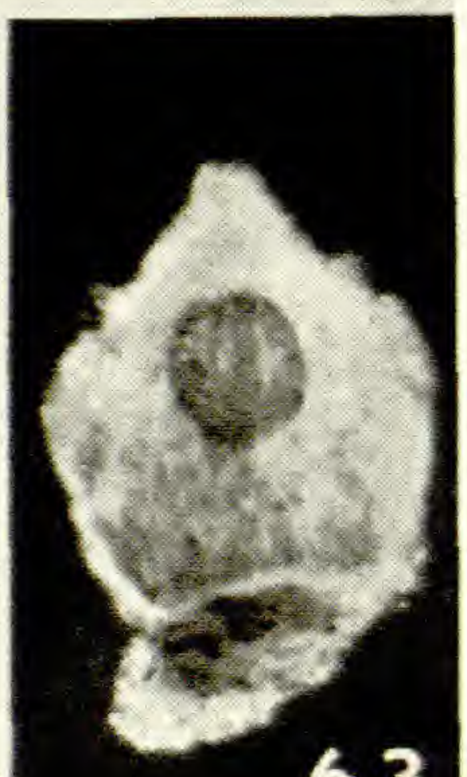

58

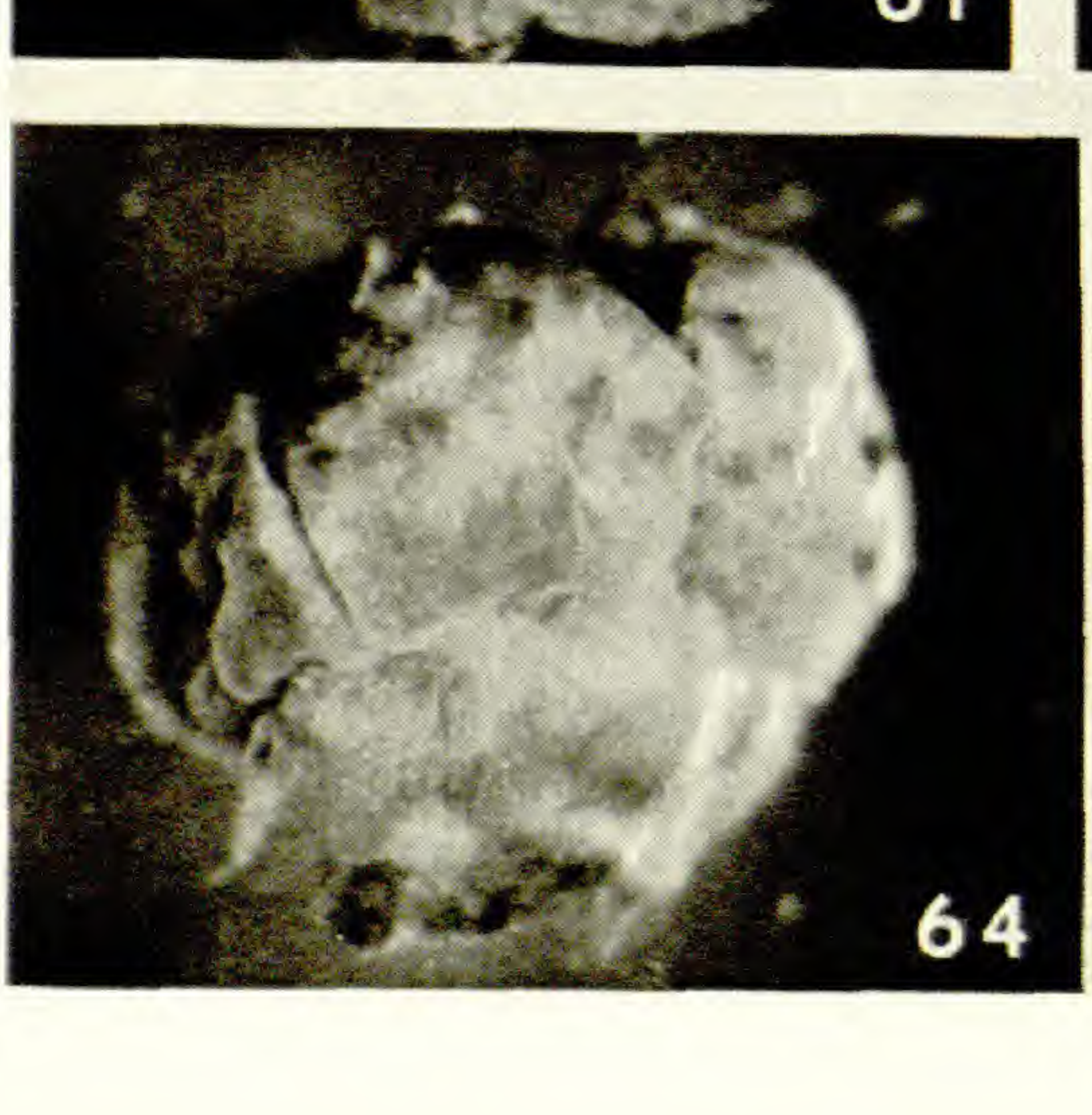
59

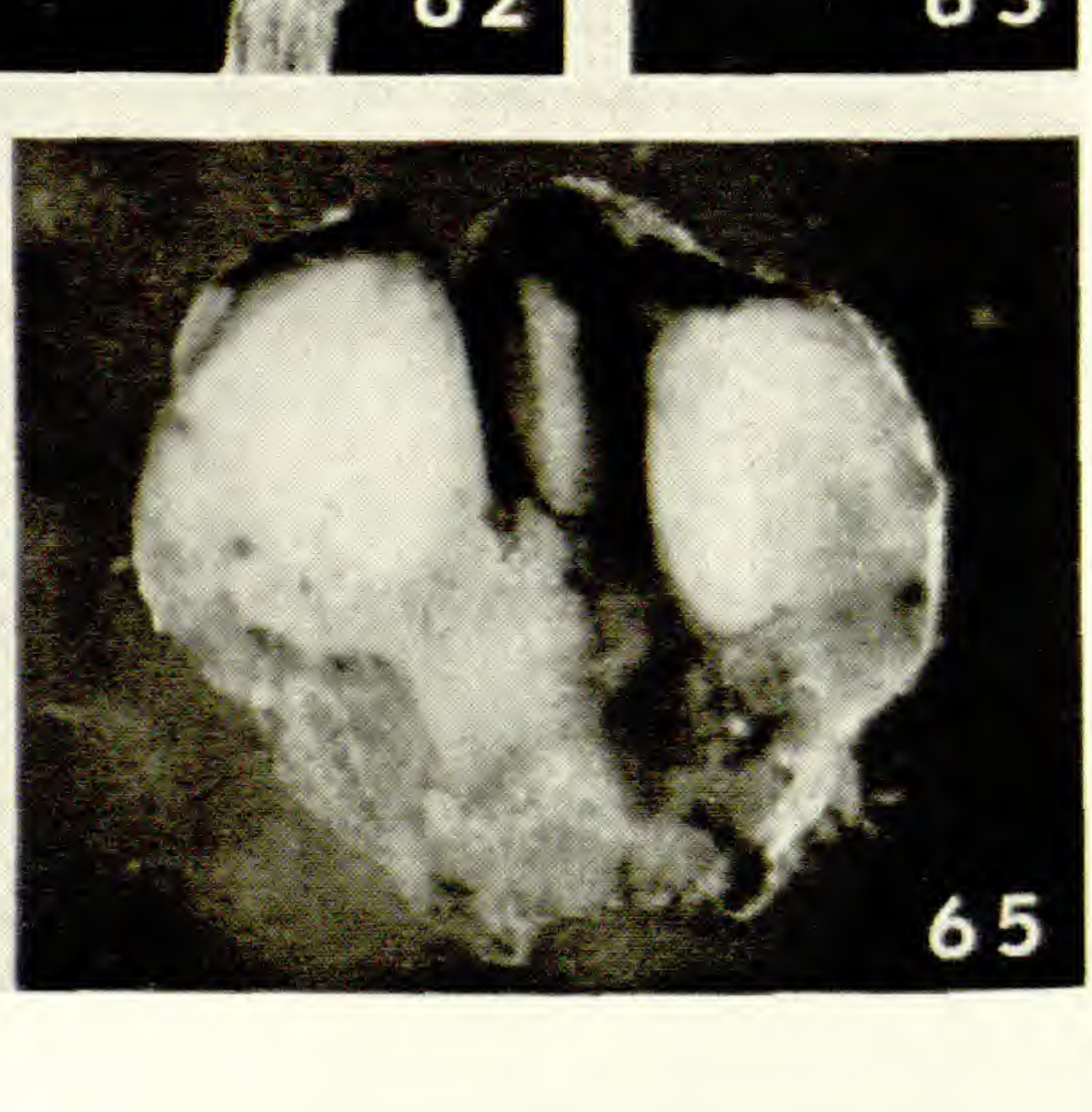

60

61

62


63


64


65

Indument of young parts inconspicuous, the hairs glandular or eglandular, 0.1–0.3 mm. long, evanescent, the inflorescences (rachis, etc.) glandular-puberulent with hairs not more than 0.1 mm. long; petioles usually 50–110 mm. long, the leaf-blades usually about twice as long as broad. ..... 3. *D. amplifolia.*

Indument persistent on foliage and inflorescences, the hairs 0.2–1.5 mm. long, several- to many-celled, eglandular; petioles 30–70 mm. long, the leaf-blades often about three times as long as broad. ..... 4. *D. crinita.*

1. **Discocalyx fusca** Gibbs in Jour. Linn. Soc. Bot. **39**: 155. *pl. 13, fig. 5–10.* 1909; J. W. Parham, Pl. Fiji Isl. 156. 1964.

FIGURES 57–60.

Discocalyx sylvestris A. C. Sm. in Bull. Torrey Bot. Club **70:** 547. 1943; J. W. Parham, Pl. Fiji Isl. 156. 1964; non *D. silvestris* Holth., 1942.
Discocalyx gillespieana A. C. Sm. in Jour. Arnold Arb. **33:** 109. 1952; J. W. Parham, Pl. Fiji Isl. 156. 1964.

Shrub or slender tree to 15 m. high, the young parts copiously furfuraceous with minute irregular scales and also puberulent or sparsely pilose (hairs several-celled, ferruginous, glandular or eglandular, 0.1–0.2 mm. long), the indument evanescent, only rarely persisting on some vegetative parts; branchlets slender, 1–5 mm. in diameter toward apex, sometimes swollen at nodes, terete, soon cinereous; petioles 5–17 mm. long, narrowly winged distally and usually nearly to base, semiterete at base; leaf-blades chartaceous or subcoriaceous, elliptic to oblong- or obovate-elliptic, (2–) 4–11 (–18) cm. long, (1–) 2–6 cm. broad, attenuate at base and long-decurrent on the petiole, rounded or broadly obtuse and sometimes faintly retuse at apex, entire and narrowly recurved at margin, immersed-glandular or with obscurely pustulate glands on both surfaces, the costa stout, essentially plane above, prominent beneath, the principal secondary nerves 5–20 (–25) per side, spreading, obviously elevated to plane or immersed on both surfaces, copiously or obscurely anastomosing toward margin, the veinlet-reticulation usually obscure, immersed to subprominulous on both surfaces; inflorescences pinnately or bipinnately paniculate, often compact, 2–9 cm. long, 1–4 cm. broad, the branches 2–10, spreading, usually many-flowered, the peduncle 1–4 cm. long or sometimes essentially none, the rachis, branches, and pedicels sparsely or obviously glandular-puberulent, often subglabrate at anthesis, the branch-subtending bracts oblong-lanceolate, 1–3 mm. long, acute or obtuse, dorsally glandular-puberulent or glabrous, sparsely or copiously ciliolate, the flower-subtending bracts similar but 0.5–2 mm. long; pedicels slender, 1.5–3 mm. long,

---

FIGURES 57–60. *Discocalyx fusca*: 57 and 59 from *Smith 9237*, 58 from *MacDaniels 1134*, 60 from *Gibbs 723*. 57, flower, × 10; 58, gynoecium, × 30; 59, two stamens, dorsal view, × 30; 60, two stamens, ventral view, showing broadly basifixed anthers, × 30. FIGURES 61–65. *Discocalyx listeri*: 61, 64, and 65 from *Parks 16320*, 62 and 63 from *Lister*. 61, flower, with one corolla-lobe removed, × 8; 62, gynoecium and calyx, × 10; 63, placenta, × 35; 64, three stamens, dorsal view, × 15; 65, three stamens, ventral view, × 15.

sometimes to 6 mm. in fruit; flowers sometimes 4- or 6-merous, the calyx rotate and 1.5–3 mm. in apical diameter, obscurely furfuraceous or glandular-puberulent without but usually glabrous, the tube short, the lobes spreading, deltoid-oblong, 0.5–1 mm. long and broad, obtuse or rounded at apex, immersed-glandular-punctate, copiously glandular-ciliolate; corolla thin-carnose, rotate at anthesis, 3.5–6 mm. in apical diameter, sparsely glandular-lineolate proximally and usually copiously punctate distally, the tube short, 0.5–0.7 mm. long, the lobes elliptic- to ovate-oblong, 1.5–2.5 mm. long, 1.2–2 mm. broad, rounded at apex; filaments connate in a membranous tube 0.3–0.7 mm. long adnate to corolla-tube and bearing apparently sessile anthers, these broadly basifixed, oblong-ovoid, 0.5–1 mm. long and slightly narrower, obtuse or truncate, sparsely or obviously glandular dorsally and distally; gynoecium 1.3–1.6 mm. long at anthesis, the ovary ovoid, sometimes obscurely furfuraceous or minutely sessile-glandular, attenuate to broadly obtuse at apex, the style usually 0.3–0.5 mm. long, rarely only 0.1 mm. long, the stigma peltate or slightly angled, 0.2–0.5 mm. in diameter, rarely to 0.7 mm. and erosulous or minutely fimbriolate, the ovules 2–5; fruits subglobose or slightly oblate, 4–7 mm. in diameter, usually rounded at base and apex, the minute style sometimes subpersistent, the pericarp 0.6–1 mm. thick, the exocarp glandular-lineolate, the endocarp 0.2–0.5 mm. thick.

TYPE LOCALITY: Vicinity of Nandarivatu, Mba Province, Viti Levu, Fiji; the type is *Gibbs 723*. The type of *Discocalyx sylvestris* is *MacDaniels 1134*, from "Central Road, Suva," at an elevation of 250 m., which would indicate an area actually in Naitasiri (not Rewa) Province northward from Suva, perhaps near Tholo-i-suva. The type of *D. gillespieana* is *Smith 5546*, from the northern part of the central plateau in Viti Levu, in Nandronga & Navosa Province. The three type collections here concerned are cited in the following geographic sequence.

DISTRIBUTION: Endemic to Fiji and thus far known only from the two large islands, Viti Levu and Vanua Levu, occurring at altitudes of 50–1,120 m. in dense or open forest, or in the low forest and thickets of upland crests. The species has been noted as an often slender tree or shrub 2–15 m. high, with a trunk to 10 cm. or perhaps more in diameter. The young inflorescence-parts are purplish; the calyx and corolla are rich pink to deep purplish red, the corolla-lobes sometimes being paler; the anthers are yellow with dark purple glands and the stigmas pale yellow; and the fruits are red, becoming purple at maturity. Flowers and fruits seem to occur at any season.

LOCAL NAMES: The name *vutuvutu* was noted by me in Nandronga & Navosa, and *mbumbu* in Thakaundrove.

Fiji. VITI LEVU: MBA: Eastern slopes of Mt. Koroyanitu, Mt. Evans Range, *Smith 4119* (A, US); Koro-O, west of Nandarivatu, *Fiji Dept. Agr. 13733* (BISH, MASS, SUVA); vicinity of Nandarivatu, Sept. 1907, *Gibbs 723* (BM holotype; iso-

type at K), *Parks 20720* (BISH, SUVA, UC, US), *Gillespie 4132* (BISH, NY, UC), *4317* (A, BISH, UC), *Fiji Dept. Agr. 12374* (BISH, SUVA); ridge between Mt. Nanggaranambuluta and Mt. Namama, east of Nandarivatu, *Smith 4962, 4981* (both A, BISH, K, US); vicinity of Nandala, *Degener 14376* (A, K, NY); vicinity of Navai, *Watkins 773* (K). NANDRONGA & NAVOSA: Nausori Highlands, *Fiji Dept. Agr. 13882* (BISH, K, MASS, SUVA); northern portion of Rairaimatuku Plateau, between Nandrau and Nanga, Aug. 7, 1947, *Smith 5546* (A holotype of *D. gillespieana*; isotypes at BISH, K, US); Nandevondevo, vicinity of Vanualevu, *Fiji Dept. For. 1184* (BISH, SUVA). SERUA: Hills west of Waivunu Creek, between Ngaloa and Korovou, *Smith 9237* (BISH, GH, K, SUVA, UC, US). NAMOSI: Hills north of Wainavindrau Creek, between Korombasambasanga Range and Mt. Naitarandamu, *Smith 8477* (BISH, GH, K, SUVA, UC, US). NAITASIRI: "Central Road, Suva" (i.e. probably near Tholo-i-suva), April 13, 1927, *MacDaniels 1134* (A holotype of *D. sylvestris*; isotype at BISH), April 1927, *Tothill 360* (probably coll. from same plant as preceding, BISH, K), Aug. 14, 1928, *Tothill* (BISH, K); vicinity of Tamavua Village, *Gillespie 2096* (A, BISH, K, NY, UC, US), *2406* (BISH, K, UC, US), *2449* (BISH, UC); vicinity of Nasinu, *Gillespie 3451* (BISH, UC). NAITASIRI-REWA boundary: Mt. Kombalevu, *Parks 20898* (BISH, UC, US). REWA: Mt. Korombamba, *Gillespie 2289* (BISH, K, NY, UC, US); "Suva" (probably northward, in Naitasiri), *Meebold 8150* (K). VITI LEVU, without further locality: *Parks 20951* (UC). VANUA LEVU: MBUA: Navotuvotu, summit of Mt. Seatura, *Smith 1659* (BISH, GH, K, UC, US). THAKAUNDROVE: Southern slopes of Korotini Range, below Navitho Pass, *Smith 498* (BISH, GH, K, NY, UC, US).

In describing *D. fusca*, Gibbs compared it with the Tongan *D. listeri*, but actually these taxa are not very similar except in the generic staminal character. The Fijian species has shorter petioles, smaller but proportionately broader leaf-blades, and smaller flowers and fruits than the Tongan species. *Discocalyx fusca* is more readily confused with *Tapeinosperma multiflorum*, which it closely resembles in foliage. If flowers are available, *D. fusca* is readily recognized by its terete (rather than distally enlarged) pedicels, its strictly rotate (rather than cupuliform or pyriform) calyx, its smaller flowers as to calyx- and corolla-lobes, its broadly basifixed anthers, and its shorter style. For what it is worth, the corolla of *D. fusca* is rich pink to purple, while that of *Tapeinosperma multiflorum* is noted as waxy-white. In fruit, the pedicel of *D. fusca* remains slenderly terete and the calyx is strictly rotate from its base, while the pedicel of the *Tapeinosperma* is distally swollen into a cupuliform calyx-tube proximal to the rotate limb.

In describing *D. sylvestris* in 1943 I contrasted it only with *D. multiflora* Gillespie (now referred to *Tapeinosperma*). On the basis of the ample material now available, it is evident that *D. sylvestris* could be kept apart from *D. fusca* only on the basis of foliage characters. As a rule, the specimens of this immediate relationship from southeastern Viti Levu (including the type of *D. sylvestris*) have leaf-blades that are consistently obovate, with broadly rounded apices, and with often immersed secondary nerves and veinlets, whereas those from upland Viti Levu have prevailingly elliptic leaf-blades, with broadly obtuse apices, and with more obvious venation. No significant inflorescence characters separate the avail-

able collections, and therefore I combine them. The two Vanua Levu specimens cited above differ from Viti Levu collections in having the leaf-blades consistently smaller and somewhat rhomboid, and in having the indument of the petioles and leaf-costas sometimes persisting to maturity.

Discocalyx gillespieana was originally contrasted with *D. sylvestris* on the basis of its differently proportioned leaves and its very short styles surmounted by a large, erose-margined stigma. The material at hand, however, indicates that the leaves of *D. fusca*, as now interpreted, are not unreasonably diverse. The large, subsessile stigma of the type of *D. gillespieana* is indeed unusual, but it is approached by that of a more recent collection, *Smith 9237*, which also has unusually large leaves. As here described, *D. fusca* is a variable taxon in some respects, but I find no presently satisfactory means of dividing it.

2. **Discocalyx listeri** (Stapf) Mez & Stapf in Pflanzenr. 9(IV. 236): 212. 1902; Yuncker in Bishop Mus. Bull. 220: 209. 1959. FIGURES 61–65.

Ardisia listeri Stapf in Jour. Linn. Soc. Bot. 30: 183, 213. 1894.

Slender shrub or tree to 4 m. high, the bud-scales minutely glandular with capitate glands, the vegetative parts glabrous; branchlets terete, 3–6 mm. in diameter toward apex, brownish; petioles slender, 1.5–4 mm. in diameter, 10–20 (–30) mm. long, shallowly canaliculate, narrowly coriaceous-winged in the distal half and angled proximally; leaf-blades chartaceous or subcoriaceous, elliptic- or obovate-lanceolate, 9–23 (–30) cm. long, 2.5–7 cm. broad, attenuate at base and long-decurrent on the petiole, broadly obtuse or narrowly rounded at apex, copiously or sparsely glandular-pustulate on both surfaces or with the glands immersed beneath, the costa conspicuous, flattened or shallowly canaliculate above, prominent beneath, the principal secondary nerves 13–20 per side, sharply prominulous on both surfaces, inconspicuously anastomosing toward margin, the lower ones ascending, the others spreading, the veinlet-reticulation inconspicuous, immersed or slightly prominulous on both surfaces; inflorescences pinnately paniculate, 4–7 cm. long, 3–4 cm. broad, the branches 3–6, spreading, each 3–10-flowered, the peduncle slender, 1.5–4 cm. long, the rachis, branches, and pedicels sparsely glandular with minute sessile capitate glands, the branch-subtending bracts lanceolate, about 3 mm. long, acute or obtuse, distally glandular-punctate, ciliolate, the flower-subtending bracts similar but 0.5–1 mm. long; pedicels slender, 3–5 mm. long; calyx at first shallowly cupuliform but soon rotate, 3–3.5 mm. in apical diameter, copiously glandular-punctate, the tube short, the lobes deltoid-ovate, about 1 mm. long, 1.2–1.5 mm. broad, obtuse or rounded at apex, scariose toward margin, copiously glandular-ciliolate; corolla thin-carnose, broadly campanulate, becoming subrotate, 4–4.5 mm. long, 5–8 mm. in apical diameter, the tube about 1.5 mm. long, the lobes soon spreading, oblong, 2.5–3.5 mm. long, 1.8–2.5 mm. broad, rounded or broadly obtuse

at apex, copiously glandular-punctate distally, entire or obscurely erosulous at margin; filaments appressed to corolla-tube in an adnate membranous tube 1–1.2 mm. long, the anthers broadly basifixed, carnose, deltoid-ovoid, 1.2–1.5 mm. long and slightly narrower, truncate and glandular at apex, copiously glandular dorsally and sparsely so ventrally; gynoecium 1.6–2 mm. long at anthesis, the ovary ellipsoid, thick-walled, copiously immersed-glandular, abruptly narrowed into a style 0.5–0.7 mm. long, the stigma peltate, 0.4–0.5 mm. in diameter, the ovules 3 or 4; fruits subglobose, 10–12 mm. in diameter, rounded or broadly obtuse at base, the exocarp copiously glandular-lineolate.

TYPE LOCALITY: 'Eua Island, Tonga; the type was collected by *J. J. Lister*.

DISTRIBUTION: Endemic to Tonga and thus far known only from 'Eua, where it occurs on limestone cliffs and in thick forest at altitudes of 100–325 m., on the upper parts of the island. It has been recorded as a slender shrub or small tree 1–4 m. high, with a trunk to 6 cm. in diameter. Parks (no. *16320*) notes the flowers as red, perhaps referring to both calyx and corolla, and the only fruiting specimen, his no. *16125*, indicates that the fruits are bright red. Flowers were collected in July and December, and fruits in June.

Tonga. 'EUA: On limestone cliff at summit of island, Dec. 1889, *Lister* (K holotype); on upper plateau, *Parks 16125* (K, UC), *16397* (UC); Liku terraces, *Parks 16320* (GH, K, UC, US), *16367* (BISH, UC).

The apparently rare Tongan endemic here described, the easternmost species of the genus, is quite distinct from the Fijian *D. fusca* as noted above. *Discocalyx listeri* has also been noted as occurring in the Solomon Islands (Whitmore, 1966: 177; Foreman, 1971: 51). One of the specimens supporting this record, *Waterhouse 83* (NY), has been examined; it has the bud-scales, petioles, lower surfaces of leaf-costas, and inflorescence-parts copiously pilose with several-celled eglandular hairs to 0.3 mm. long, the leaf-blades abruptly cuspidate at apex and with the costa deeply impressed above, and the inflorescence with a peduncle about 7 cm. long. In short, it bears little resemblance to *D. listeri* and (the NY specimen being without flowers) may not even belong in *Discocalyx*. Surely published records of this sort do little to clarify phytogeographic relationships.

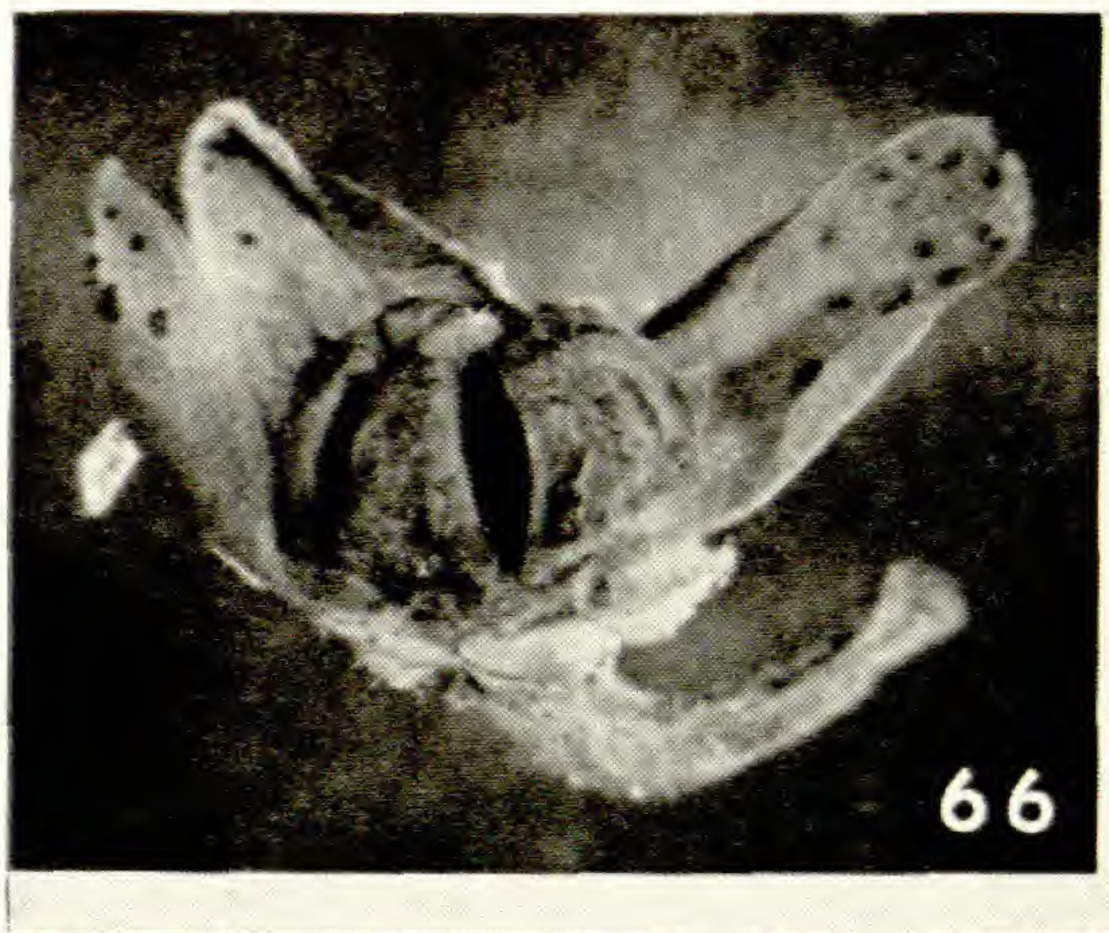
3. **Discocalyx amplifolia** A. C. Sm., sp. nov. FIGURES 66, 67.

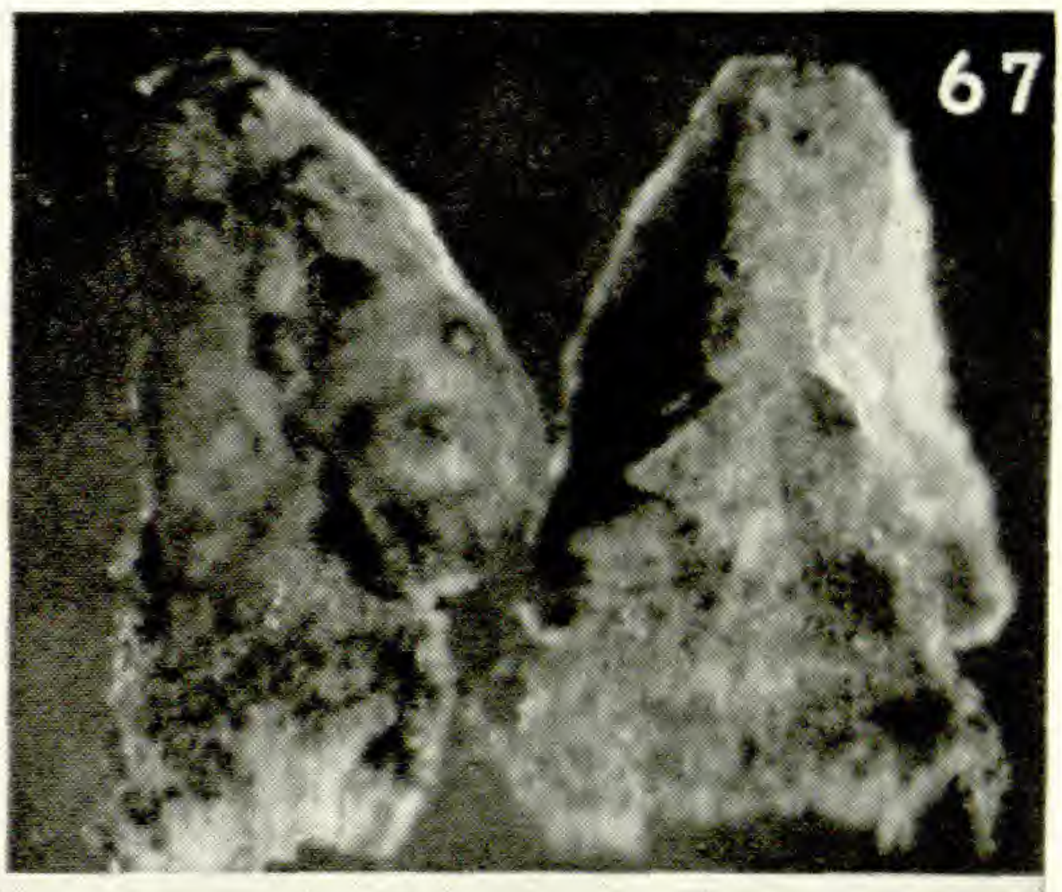
Frutex vel arbor ad 5 m. alta, partibus novellis copiose puberulis (pilis castaneis patulis 1–pluricellularibus interdum glandulosis 0.1–0.3 mm. longis), indumento evanescenti, partibus vegetativis mox glabratis; ramulis crassis apicem versus 5–10 mm. diametro teretibus cinereis; petiolis conspicuis (30–) 50–110 mm. longis, superne canaliculatis et anguste alatis, inferne angulatis et semiteretibus; foliorum laminis chartaceis late ellipticis vel obovato-ellipticis, (13–) 18–44 cm. longis, (6.5–) 10–22 cm.

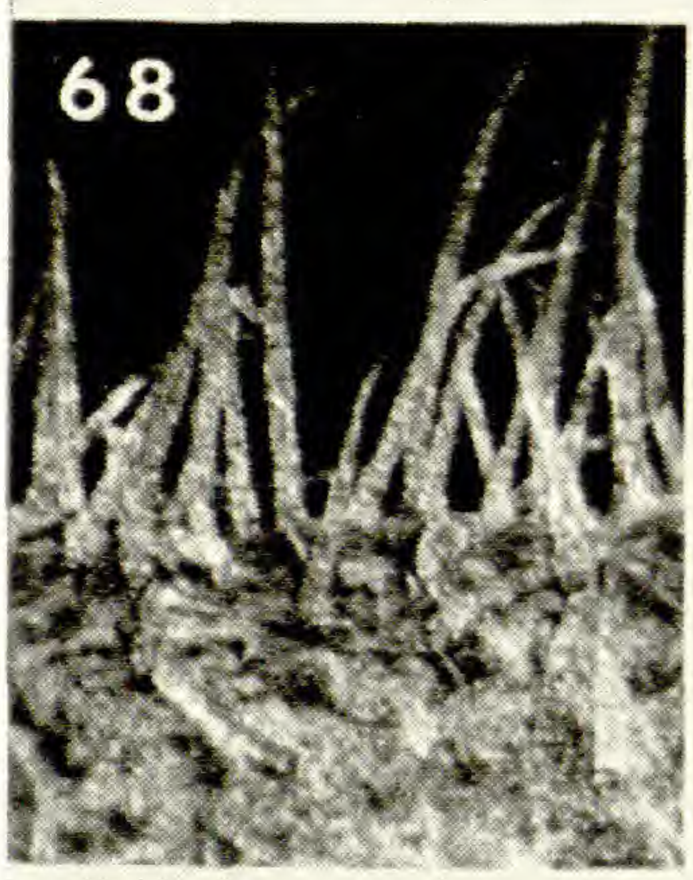
latis, basi saepe inaequaliter late obtusis vel rotundatis vel anguste subcordatis et in petiolum abrupte decurrentibus, apice rotundatis vel late obtusis, margine integris et anguste recurvatis, utrinque dispersim pustulato-glandulosis, costa valida supra plana vel paullo elevata subtus prominenti, nervis secundariis utrinsecus 9–15 patentibus supra planis subtus valde elevatis marginem versus curvatis et anastomosantibus, rete venularum copioso supra immerso subtus prominulo; inflorescentiis amplis late pinnato- vel bipinnato-paniculatis, sub anthesi 9–19 cm. longis et 5–10 cm. latis, sub fructu ad 22 × 15 cm., ramulis gracilibus patentibus 8–15 multifloris, pedunculo gracili 3–7 cm. longo ut rhachidi ramulis pedicellisque pilis ad 0.1 mm. longis copiose glanduloso-puberulis, bracteis sub ramulis ligulatis 2–3 mm. longis obtusis dorso glanduloso-puberulis ciliolatis, eis sub floribus similibus 0.5–1.2 mm. longis; pedicellis gracilibus 2–3.5 mm. longis; floribus 5-meris, calyce mox rotato sub anthesi apice 2.5–2.7 mm. sub fructu ad 4 mm. diametro extus minute glanduloso-puberulo, tubo brevi, lobis deltoideo-ovatis, 0.7–1 mm. longis, 1–1.3 mm. latis, apice obtusis, praeter margines glanduloso-ciliolatos conspicue glanduloso-punctatis; corolla tenuiter carnosa primo campanulata et 3–4 mm. longa sub anthesi rotata et apice 6–8 mm. diametro, tubo brevi 0.5–1 mm. longo, lobis oblongo-ellipticis, 2.5–3.1 mm. longis, 1.5–2 mm. latis, apice rotundatis, distaliter copiose glanduloso-punctatis infra medium pauci-lineolatis; filamentis in tubum membranaceum 0.5–0.9 mm. longum ad corollae tubum adnatis, antheris late basifixis, oblongo-deltoideis, 1–1.3 mm. longis, 0.8–1.5 mm. latis, apice truncatis, dorso conspicue glandulosis; gynoecio sub anthesi 1.8–2 mm. longo, ovario ovoideo superne in stylum 0.6–0.7 mm. longum abrupte angustato, stigmate peltato 0.4–0.6 mm. diametro fimbriato, placenta ovoidea acuta, ovulis 3–5 in foveolis distalibus vel lateralibus; fructibus maturis in sicco valde rugoso-verrucosis subglobosis vel subovoideis 7–10 mm. diametro, basi late obtusis, apice umbonatis, pericarpio 1–1.5 mm. crasso, mesocarpio carnoso copiose immerso-glanduloso, endocarpio osseo 0.3–0.5 mm. crasso.

TYPE LOCALITY: Waimanu River region, S. E. Nasele, Naitasiri Province, Viti Levu, Fiji; the type is *Fiji Dept. Agr. 15444* (collected by I. T. Kuruvoli).

FIGURES 66, 67. *Discocalyx amplifolia*: both from *Fiji Dept. Agr. 15444*. 66, flower, with two corolla-lobes removed, × 8; 67, stamens, dorsal (left) and ventral views, × 20. FIGURES 68–70. *Discocalyx crinita*: 68 from *Webster & Hildreth 14325*, 69 and 70 from *Fiji Dept. Agr. 15524*. 68, marginal portion of leaf-blade, lower surface, × 20; 69, gynoecium (past anthesis) and calyx, × 8; 70, sectioned gynoecium (past anthesis), with placenta, × 12. FIGURES 71–74. *Embelia gracilis*: 71 from *im Thurn 200*, 72 and 74 from *Smith 4920*, 73 from *Smith 5243*. 71, portion of ♂ inflorescence, × 15; 72, ♂ flower, × 20; 73, ♀ flower with two petals and two stamens removed, × 20; 74, portion of leaf-blade, lower surface, in transmitted light, × 10. FIGURE 75. *Embelia vaupelii*: portion of leaf-blade, lower surface, in transmitted light, from *Christophersen 2234*, × 10.

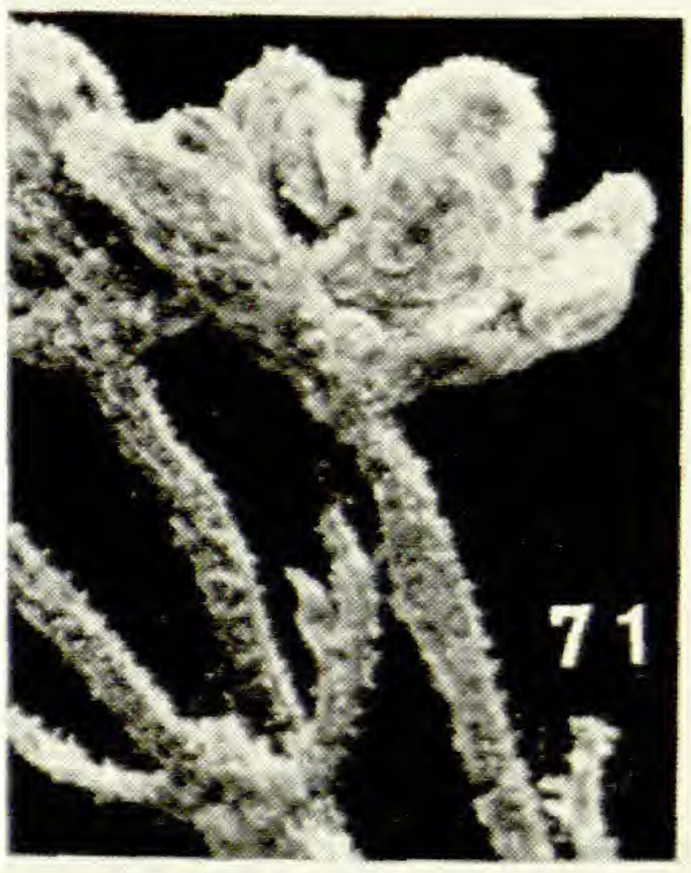

66


67


68

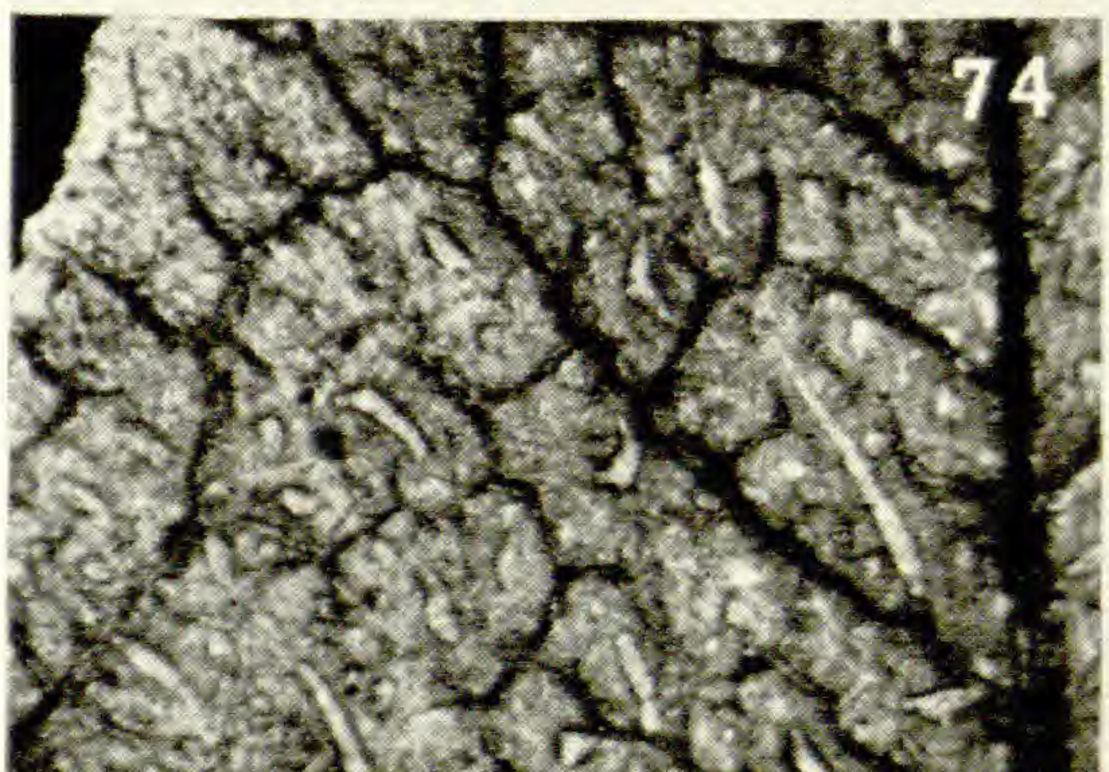
69

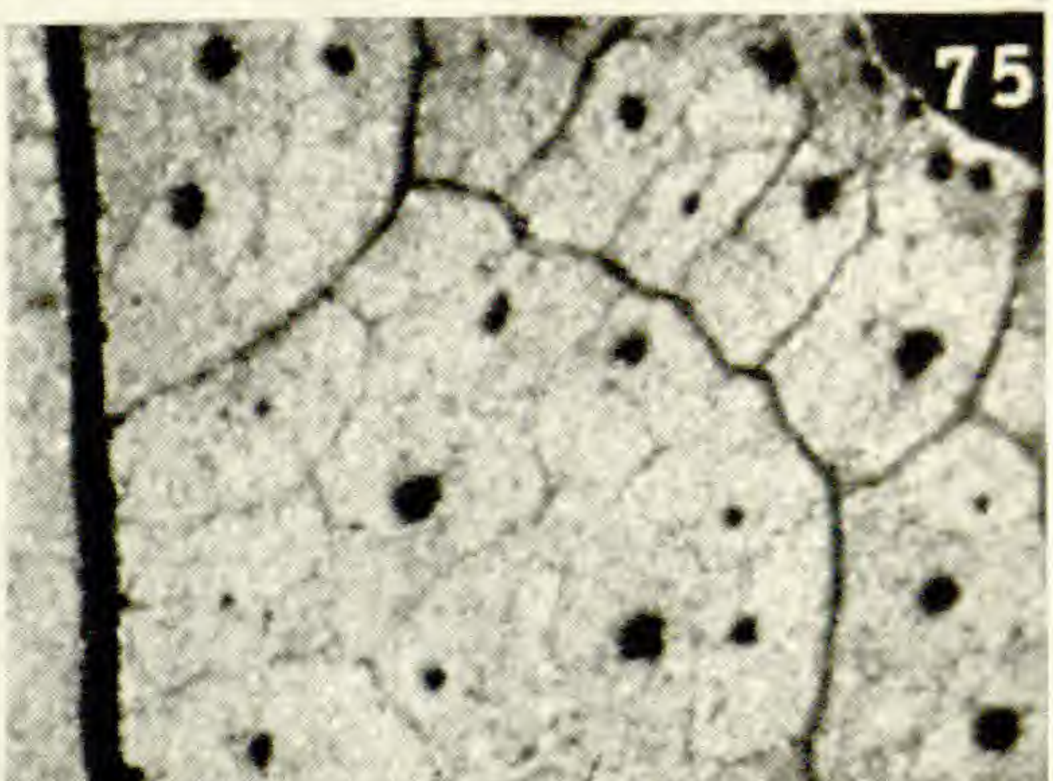
70


71

72

73


74


75

DISTRIBUTION: Endemic to Fiji and thus far known from scattered collections in southern and southeastern Viti Levu, with a single one from Vanua Levu. The species seems to occur in dense forest or secondary forest at altitudes from near sea-level to 450 m. It has been noted as a shrub or a compact, slender tree 2–5 m. high; the young inflorescences are red; the mature inflorescence-branches, pedicels, and fruiting calyces are dull purple; and the available fruits are green, although doubtless they become red or darker at full maturity. The only available mature flowers are those of the type, collected in July; fruits have been obtained in February, September, and October.

Fiji. VITI LEVU: NAMOSI: Valley of Wainambua Creek, south of Mt. Naitarandamu, *Smith 8798* (BISH, GH, K, UC, US); hills north of Wainavindrau Creek, between Korombasambasanga Range and Mt. Naitarandamu, *Smith 8474* (US). NAITASIRI: Waimanu River region, S. E. Nasele, July 10, 1967, *Fiji Dept. Agr. 15444* (BISH holotype; isotypes at MASS, SUVA). REWA: "Near Botanical Station" (i.e. near present Botanical Garden), *Yeoward*, Feb. 22, 1897 (K). VANUA LEVU: THAKAUNDROVE: Nggilokalou, *Fiji Dept. Agr. 16052* (BISH, MASS, SUVA).

Until mature flowers became available through the specimen designated as the type, the earlier collections here cited were questionably referred to *Tapeinosperma* as possibly representing *T. hornei*. It is now seen, however, that the present taxon has the broadly basifixed anthers and short style of *Discocalyx*, in which it has no close relatives in our area. The Vanua Levu collection bears very immature inflorescences, and the three remaining collections are in fruit. Even in the absence of anthers (which admittedly are difficult to assess in respect to their attachment), the new species may be distinguished from *Tapeinosperma hornei* (the only species of that genus that it simulates) as follows:

Petioles (15–) 20–70 mm. long; leaf-blades elliptic- to lanceolate-oblong, often about three times as long as broad, usually 15–37 cm. long and 4–15 cm. broad; corolla 3–5.5 mm. in apical diameter, the lobes 1.8–2.5 × 1.3–2.8 mm.; style 0.6–1.2 mm. long. ..... *Tapeinosperma hornei.*

Petioles (30–) 50–110 mm. long; leaf-blades broadly elliptic or obovate-elliptic, usually about twice as long as broad, usually 18–44 cm. long and 10–22 cm. broad; corolla 6–8 mm. in apical diameter, the lobes 2.5–3.1 × 1.5–2 mm.; style 0.6–0.7 mm. long. ..... *Discocalyx amplifolia.*

4. Discocalyx crinita A. C. Sm., sp. nov. FIGURES 68–70.

Arbor ad 9 m. alta, partibus novellis copiose pilosis (pilis patulis castaneis pluri- vel multicellularibus eglandulosis 0.2–0.6 mm. longis), indumento partibus vegetativis et inflorescentibus conspicue persistenti; ramulis crassis apicem versus 5–9 mm. diametro rugulosis mox teretibus et cinereis; petiolis crassis copiose pilosis 30–70 mm. longis, superne anguste alatis vel conspicue angulatis, inferne subteretibus; foliorum laminis chartaceis lanceolato-ellipticis, (12–) 17–30 cm. longis, 6.5–15 cm. latis, basi saepe inaequaliter anguste cordatis vel rotundatis, apice calloso-acutis,

margine subintegris saepe undulatis vel inconspicue calloso-crenulatis, utrinque pustulato-glandulosis et dispersim (vel marginem versus copiose) pilosis, pilis multicellularibus eglandulosis 0.6–1.5 mm. longis, eis paginae inferioris copiosioribus et cum aliis brevioribus interspersis, costa supra plana vel leviter elevata subtus prominenti, nervis secundariis principalibus 10–15 curvato-adscendentibus supra paullo elevatis vel impressis subtus acute elevatis, marginem versus anastomosantibus, rete venularum copioso supra immerso vel impresso subtus valde prominulo; inflorescentiis pinnato- vel bipinnato-paniculatis, paullo post anthesin 4–11 cm. longis et 2–5 cm. latis, ramulis 5–15 multifloris, pedunculo gracili 2–4 cm. longo ut rhachidi ramulis pedicellisque in modum partium novellarum copiose pilosis, bracteis sub floribus ligulatis 1–1.5 mm. longis acutis dorso copiose pilosis; pedicellis gracilibus 1.5–4 mm. longis; floribus post anthesin solum visis, calyce cupuliformi-subrotato 1.5–2 mm. longo et apice 2.5–3.5 mm. diametro, tubo brevi 0.5–0.7 mm. longo, lobis 5 vel 6 anguste dextrorse imbricatis deltoideis, 1.2–1.5 mm. longis latisque, apice subacutis, superne copiose glanduloso-punctatis, margine ciliis multicellularibus eglandulosis 0.2–0.5 mm. longis ornatis; corolla staminibusque non visis; gynoecio paullo post anthesin 2.5–4 mm. longo, ovario ovoideo copiose glanduloso-puberulo apice subacuto pariete crasso immerso-glanduloso, stylo crasso 0.2–0.3 mm. longo, stigmate peltato 0.6–0.8 mm. diametro, placenta ellipsoidea acuta, ovulis 3 vel 4 in foveolis distalibus.

TYPE LOCALITY: Upper Navua River, Serua Province, Viti Levu. Fiji; the type is *Fiji Dept. Agr. 15524* (collected by D. Koroiveibau & S. Vodonaivalu).

DISTRIBUTION: Endemic to Fiji and known sparsely only from Serua Province in south-central Viti Levu, occurring at altitudes of 140–600 m. in dense forest. It has been indicated as a tree 6–9 m. high, with the inflorescence-branches, calyx, and gynoecium reddish, the latter becoming purple. The available collections are all at about the same stage, lacking corollas and stamens, and were collected in June and July.

Fiji. VITI LEVU: SERUA: Upper Navua River, July 24, 1967, *Fiji Dept. Agr. 15524* (BISH holotype; isotype at SUVA); inland from Namboutini, *Fiji Dept. Agr. 14269* (K, SUVA); valley of Tawavulu Creek, north of Ngaloa, *Webster & Hildreth 14325* (DAV, MASS).

The strikingly distinct species here described, apparently quite local and overlooked until recent years, is referred to *Discocalyx* rather than *Tapeinosperma*, even in the absence of stamens, because of its extremely short style and its general similarity in foliage to the preceding new species, *D. amplifolia*. However, it is at once distinguished by the persistent indument of comparatively long, eglandular hairs, and also by the differently proportioned leaf-blades.

5. **Embelia** Burm. f. Fl. Ind. 62. 1768; Mez in Pflanzenr. 9(IV. 236): 295. 1902. *Nom. cons.*

Embelia is a large and complex Old World genus distributed from Africa eastward to southeastern Asia, New Guinea, and Australia, and into the Pacific to the Caroline Islands, with the two outlying species here discussed from Fiji, Samoa, and Tonga, and also with two Hawaiian species. These latter, according to Mez's treatment, belong to a different subgenus than the taxa from our area.

KEY TO SPECIES

Petioles 3–9 (–16) mm. long, the leaf-blades copiously and conspicuously punctate or short-lineolate with translucent glands; calyx-lobes pellucid-glandular, even in fruit; mature fruits 3–5 mm. in diameter; Fiji. . . 1. *E. gracilis.*

Petioles 7–20 mm. long, the leaf-blades dispersed-punctate with conspicuous, black, opaque, round or oval glands, these copious toward margin; calyx-lobes in fruit copiously black-punctate with opaque glands; mature fruits 5–6 mm. in diameter; Samoa and Tonga. . . . . 2. *E. vaupelii.*

1. **Embelia gracilis** Turrill in Jour. Linn. Soc. Bot. **43**: 30. 1915; A. C. Sm. in Sargentia **1**: 96. 1942; J. W. Parham, Pl. Fiji Isl. 156. 1964. FIGURES 71–74.

Dioecious scandent shrub or liana, the young parts copiously pilose, the hairs minute, ferruginous, usually 1-celled but sometimes several-celled, gland-tipped, less than 0.05 (rarely to 0.1) mm. long, the indument subpersistent on inflorescence-branches; branchlets slender, subterete, minutely glandular-pilose but soon glabrate, brownish or becoming grayish, 1–3 mm. in diameter toward apex, the lenticels on older parts copious, pale, round or oval; leaves alternate, the petioles slender, canaliculate, very narrowly winged or angled to base, glandular-pilose but at length glabrate, 3–9 (–16) mm. long, the blades chartaceous, drying brownish, copiously and conspicuously punctate or short-lineolate with translucent glands (these becoming immersed and obscure in older leaves), ovate or ovate-lanceolate to elliptic, 1.5–4.7 (–8) cm. long, 1–2.3 (–4.5) cm. broad, rounded or broadly obtuse at base and abruptly decurrent on the petiole, obtuse to obtusely acuminate at apex, entire or inconspicuously crenulate at margin, the costa plane or shallowly canaliculate above, sharply elevated beneath, the principal secondary nerves 4–8 per side, spreading, curved, irregularly anastomosing near margin, prominulous on both sides or plane above, the veinlet-reticulation copious and prominulous, becoming immersed in older blades; inflorescences paniculate, terminating short lateral branchlets, essentially epedunculate, 1.5–5 cm. long and broad, with 4–7 (rarely 2–12) spreading lateral branches subtended by bracts, these obovate-lanceolate, 1–4 mm. long, the inflorescence-axes, bracts, and pedicels copiously glandular-pilose at anthesis, the flowers numerous, borne singly in the axis of smaller bracts 0.5–1 mm. long, the

pedicels slender, 1.5–3.5 mm. long; flowers 4-merous, small, at anthesis 1–1.3 mm. long, the calyx subrotate, to 1 mm. in diameter at anthesis, in fruit becoming rotate and sometimes slightly accrescent to 1.8 mm. in diameter, the sinuses rounded, the lobes spreading, oblong-deltoid, 0.3–0.5 mm. long and broad at anthesis (and sometimes to 1 × 0.7 mm. in fruit), sparsely pellucid-glandular, glabrous or dorsally sparsely glandular-pilose, entire and glandular-ciliolate at margin; petals free, narrowly imbricate in bud, submembranous, elliptic-oblong, 1–1.4 mm. long, 0.5–0.7 mm. broad, sparsely pellucid-punctate, obtuse or subacute at apex, minutely glandular-ciliolate; filaments affixed near base of petals, slenderly ligulate, free for 0.3–0.5 mm., the anthers in ♂ flowers oblong-ovate, 0.3–0.5 mm. long, obtuse or inconspicuously mucronulate at apex, in ♀ flowers developed but sterile; gynoecium in ♂ flowers rudimentary, conical, sterile, in ♀ flowers ovoid, glabrous the style thick, 0.2–0.5 mm. long at anthesis, the stigma minutely bilobed or obscurely capitate, the placenta obovoid, sometimes laterally flattened, the ovules 2–4; mature fruits subglobose, 3–5 mm. in diameter, drying smooth or rugulose-costulate, copiously glandular-lineolate, the style sometimes elongating to 1 mm., eventually deciduous, the pericarp 0.4–0.5 mm. thick, the mesocarp carnose, thin, the endocarp crustaceous, 0.1–0.2 mm. thick.

TYPE LOCALITY: Navai, south of Nandarivatu, Mba Province, Viti Levu, Fiji; the type is *im Thurn 200*, a specimen with staminate flowers.

DISTRIBUTION: Endemic to Fiji, but thus far known only from the islands of Viti Levu and Taveuni. It occurs from near sea-level to 1,180 m. in forest sometimes noted as dense, sometimes as open and sunny. It has been noted as a sprawling or climbing liana, or sometimes as a shrub with the branches becoming scandent. The petals and filaments are white, the fruits red or scarlet. Although the species is fairly frequent in upland Viti Levu, it appears not to have been collected by any botanist earlier than im Thurn in 1906.

LOCAL NAMES: Recorded Fijian names are *wa kumarea* and *wa ni mbai* (in Mba), *wa kai* (in Nandronga & Navosa), *wa tuva* (in Namosi), and *wa ndrenga* (in Ra).

Fiji. VITI LEVU: MBA: Mt. Evans Range, *Greenwood 1148* (A, BISH, K, UC, US); Mt. Ndelainathovu, west of Nandarivatu, *Smith 4920* (A, BISH, K, US); vicinity of Nandarivatu, *Gillespie 4024* (BISH, UC), *Tothill 205* (K), *Degener 14307* (A); Sovutawambu, near Nandarivatu, *Degener 14662* (A, BISH, K, UC, US); Navai, March 28, 1906, *im Thurn 200* (K holotype; isotype at BM); Nggaliwana Creek, near Navai, *Webster & Hildreth 14119* (DAV, MASS); Mt. Tomanivi, *Smith 5243* (A, BISH, K, US). NANDRONGA & NAVOSA: Nausori Highlands, *Fiji Dept. Agr. 13308* (BISH, K, SUVA), *13343* (BISH, MASS, SUVA); northern portion of Rairaimatuku Plateau, *Smith 5416, 5489* (both A, BISH, K, US); vicinity of Mbelo, near Vatukarasa, *Degener 15259* (A, BISH, K), *15268* (A, BISH, K, UC, US). SERUA: Vicinity of Ngaloa, *Degener 15163* (A, BISH, K, UC, US).

NAMOSI: Wainandoi River, *Fiji Dept. Agr. 10800* (BISH, K, SUVA). RA: Vicinity of Rewasa, near Vaileka, *Degener 15453* (A, BISH, K, UC, US). TAVEUNI: Mt. Manuka, east of Wairiki, *Smith 8228* (BISH, GH, K, SUVA, UC, US). FIJI, without further locality: *Fiji Dept. Agr. 3880* (SUVA).

Although Turrill's original description is excellent, his placement of the species as an ally of *E. floribunda* Wall. (the only member of Mez's subgenus EMBELIOPSIS) seems incorrect. The Fijian species is better placed in subgen. EMBELIA (i.e. *Euembelia* Clarke sensu Mez), but it seems only distantly related to any of the Malesian species treated by Mez.

In my 1942 mention of this species I commented on the variation among the Degener collections. In general, however, the species is quite uniform, and especially so in upland Viti Levu. There are, however, three exceptionally robust collections (*Degener 15453, Smith 8228*, and *Fiji Dept. Agr. 3880*), which have petioles as much as 16 mm. long, leaf-blades up to 8 × 4.5 cm., and fruiting calyces with unusually large lobes. These extreme dimensions are noted parenthetically in the above description.

2. **Embelia vaupelii** Mez in Repert. Sp. Nov. **16**: 423. 1920.
FIGURE 75.

Maesa sp. Yuncker in Bishop Mus. Bull. **220**: 209. 1959.

Freely branched liana, presumably dioecious, the young parts copiously puberulent with minute, ferruginous, usually 1-celled, gland-tipped hairs less than 0.05 mm. long (and sometimes also with a few weak, several-celled, eglandular hairs to 0.2 mm. long), the indument subpersistent on some vegetative and inflorescence parts; branchlets subterete, slender, 0.5–2 mm. in diameter toward apex, soon glabrate, copiously or inconspicuously pale-lenticellate; petioles slender, glandular-puberulent but eventually glabrate, 7–20 mm. long, canaliculate, narrowly winged distally; leaf-blades submembranous, becoming chartaceous, dispersed-punctate with conspicuous glands (these black, opaque, round or oval, raised and obvious on both surfaces, copious near margin), ovate or elliptic-ovate, (2.5–) 4–9 cm. long, (1.5–) 2–6 cm. broad (on apparently juvenile specimens to 15 × 9 cm.), obtuse to rounded or subcordate at base and abruptly decurrent on the petiole, obtuse to obtusely acuminate at apex, entire or undulate and narrowly recurved at margin, the costa slender, plane or slightly raised above, prominent beneath and at first glandular-puberulent but soon glabrate, the principal secondary nerves 4–6 per side (to 8 on juvenile blades), spreading, strongly curved, with the copious veinlet-reticulation prominulous on both sides; inflorescences apparently terminal on short lateral branchlets, paniculate with 2–4 short spreading branches, 3–5 cm. long in fruit, essentially epedunculate, the rachis, branches, and pedicels at first glandular-puberulent, subglabrate in fruit; branch-subtending bracts caducous in fruit, the flower-subtending bracts subpersistent, lanceolate, 0.8–1.2 mm. long and about 0.2 mm. broad, copiously black-glandular-punctate, obscurely puberulent at margin; flowers (sec. Mez)

4-merous, to 1 mm. long in bud, the petals free, elliptic, narrowly rounded, minutely punctate, papillose-margined, the anthers in ♂ flowers essentially sessile, large, ovate, the gynoecium glabrous, with a thick style; pedicels stout and 2–3 mm. long in fruit, the fruiting calyx rotate, 2–2.5 mm. in diameter, the lobes deltoid, 0.5–0.8 mm. long, 1–1.5 mm. broad, acute, copiously black-glandular-punctate, the sinuses flattened; mature fruits subglobose, 5–6 mm. in diameter, tapering into the subpersistent style, this stout, conical, minutely 4-lobed, the pericarp about 0.5 mm. thick, the mesocarp thin, copiously black-glandular-punctate, the endocarp bony, 0.2–0.3 mm. thick, the seed subglobose, strongly excavated proximally, the testa castaneous, the embryo transverse.

TYPE LOCALITY: "Mataana, Samoa;" the type and only originally cited specimen was *Vaupel 583*, presumably deposited in the Berlin herbarium and therefore destroyed. No duplicate has been located, but if one exists it should be designated as the lectotype. The cited locality has not been found on modern maps, but it is evident from Vaupel's discussion of Samoan vegetation (1910: 48) that "Mataana" has an altitude of 1,600 m., which definitely places it on the island of Savaii. The reference is probably to Mt. Mataaga (lat. 13° 35′ S., long. 172° 26′ W.), which could be pronounced "Mataanga" and hence readily transcribed as "Mataana." It may be noted that Christophersen's locality Matavanu is in the same mountain area at lat. 13° 31′ S. and long. 172° 22′ W.

DISTRIBUTION: Inadequately known from Samoa (Savaii and Tutuila) and also from Tonga ('Eua), at altitudes from 260 m. ('Eua) to 1,600 m. (Savaii), in forest or, at the higher elevations, in crater-thickets. The few available collections indicate that the plant is a liana except for the Wisner specimen, said to come from a "tall tree," which may be questioned.

LOCAL NAME: The only recorded local name is *tu'amea*, indicated by Yuncker for the Tongan collection.

Samoa. SAVAII: In crater above Matavanu, *Christophersen 797* (BISH, K, NY), *Christophersen & Hume 2234* (A, BISH, NY, US); northeast of Salailua, *Christophersen 2557* (A, BISH, K, NY, UC, US). TUTUILA: Tafuna, *Wisner 56* (BISH).

Tonga. 'EUA: Above Fuai Plantation, in forest near "Smoky Hole," *Yuncker 15572* (BISH, BM, US).

As the Samoan holotype of this species has presumably been destroyed, the specimens cited above, hitherto unrecognized, are particularly welcome. The three Christophersen collections, all sterile, agree strikingly with the original description as to foliage details, the species being unmistakable in its indument and leaves, especially with reference to the conspicuous, black, opaque glands of the leaf-blades. The Wisner specimen, collected in fruiting condition on February 20, 1959, has slightly larger leaves; its fruiting inflorescences verify its place in *Embelia*. The Yuncker specimen is sterile and apparently juvenile, but its indument,

petioles, and leaf-blades in shape, texture, and glands are precisely like those of Samoan material. The leaves are larger and with more numerous secondaries, but the similarities are such that I have no hesitation in here recording *Embelia* from Tonga for the first time, and in referring the collection to *E. vaupelii*.

Mez describes the inflorescences of *E. vaupelii* as lateral toward the apices of branchlets, but they appear terminal on the Wisner specimen, although the material is not adequate to permit certainty. The relationship of *E. vaupelii* is probably with *E. gracilis*, but even when sterile the two species are readily separable in foliage in their strikingly different types of glandular ornamentation (FIGURES 74, 75).

6. **Rapanea** Aubl. Hist. Pl. Guiane 1: 121. 1775; Mez in Pflanzenr. 9(IV. 236): 342. 1902.

Although the genus *Rapanea* was accepted by Mez and most subsequent students of the Myrsinaceae, it has sometimes been merged with the older genus *Myrsine* L. (Hosaka, 1940). This viewpoint had been refuted by Degener (Fl. Haw. Fam. 240. *Rapanea volcanica*. 1939), and Oliver (1951) later pointed out that the type species of *Myrsine* has stamens with the filaments united into a flange on the inside of the corolla, a feature lacking in *Rapanea*. Actually, in *Myrsine* (sens. str.) the filaments are connate into a tube that is only proximally adnate to the corolla-tube, being dorsally free from the corolla and distally produced into obvious filaments. In *Rapanea* the filament-tube has lost its identity by a complete fusion with the corolla-tube, there is no "flange" (i.e. free filament-tube), and the anthers appear essentially sessile on the corolla-throat. Walker (1940) had retained *Rapanea* as a distinct genus in his treatment of the eastern Asiatic species, but later (1959), in reviewing the species of Taiwan, he submerged it in *Myrsine*, a conclusion followed by Li (1963) and Backer & Bakhuizen van den Brink (1965). It is unfortunate that such authors have accepted Hosaka's suggestion without a critical discussion of the situation. It certainly seems desirable to maintain *Rapanea* as a distinct genus, but to include in it *Suttonia* A. Rich., as recommended by both Degener and Oliver.

Rapanea, a very large pantropical genus, is represented in our area by seven species, of which four are here described as new. The following key is artificial. Perhaps good characters for separating the species exist in the flowers — at least in the stigmas — but for some of our species adequate flowering specimens are not known. They may, nevertheless, be distinguished by vegetative characters supplemented by certain features readily seen in fruiting specimens.

KEY TO SPECIES

Leaf-blades attenuate at base and long-decurrent on the petiole, this consequently narrowly winged nearly to base or at least in the distal half, semiterete

proximally, leaving a transversely semi-elliptic scar; leaves evenly spaced along branches, not whorled or congested.

Flowers and fruits sessile or on pedicels not exceeding 4 mm. in length.

Leaves comparatively small, the petioles slender, 2–15 mm. long, the blades rarely exceeding 11 × 3.5 cm.; calyx not exceeding 3.5 mm. in apical diameter even in fruit; fruits at maturity not exceeding 7 mm. in diameter, often much smaller.

Stigma farciminiform, much longer than broad, to 1.5 mm. long; New Hebrides (and New Caledonia). ..... 1. *R. modesta.*

Stigma capitate-angled, about as long as broad, the angles subalate; Fiji and Samoa. ..... 3. *R. myricifolia.*

Leaves comparatively large, the petioles stout, 7–20 mm. long, the blades usually 8–17 × 2.5–6 cm.; calyx, even in mature fruit, strictly sessile, comparatively large, 4–5 mm. in apical diameter; fruits comparatively large, 7–10 mm. in diameter at maturity, the stigma about 1.5 mm. long, obviously longer than broad; New Hebrides. . . 2. *R. amischocarpa.*

Flowers and fruits conspicuously pedicellate, the fruiting pedicels 6–9 mm. long, the mature fruits 7–8 mm. in diameter; leaf-blades narrowly elliptic, comparatively small, not exceeding 6.5 × 2.5 cm. and often much smaller; Samoa. ..... 4. *R. longipes.*

Leaf-blades obtuse or narrowly rounded at base and not appreciably decurrent on the petiole, this not winged, terete or subterete proximally, leaving a scar nearly as high as broad; leaves congested toward apices of branchlets or in irregular whorls, the blades comparatively large, rarely less than 9 × 3.5 cm.; flowers and fruits pedicellate; Fijian species.

Branchlets comparatively stout, usually 3–10 mm. in diameter toward apex; plants glabrous throughout.

Petioles 12–22 mm. long, the leaf-blades obovate, 11–15 × 4.5–7 cm.; inflorescences bearing 2–4 flowers at apex, the pedicels 4–6 mm. long, the flowers 5–7-merous; branchlets 5–10 mm. in diameter toward apex. ..... 5. *R. crassiramea.*

Petioles 3–5 mm. long, the leaf-blades narrowly elliptic, (7–) 9–13 × (2–) 3.5–5 cm.; inflorescences bearing 13–25 flowers at apex, the pedicels about 3 mm. long, the flowers 5 (or perhaps sometimes 4-)-merous; branchlets less robust, usually 3–4 mm. in diameter toward apex. ..... 6. *R. polyantha.*

Branchlets comparatively slender, 1.5–2.5 mm. in diameter toward apex; young parts pilose with minute glandular hairs, the indument sometimes very sparse and inconspicuous, but sometimes subpersistent on petioles and pedicels; petioles 3–10 mm. long; fruits 7–10 mm. in diameter, 1–4 maturing per inflorescence, on pedicels 1.5–4 mm. long. ..... 7. *R. hadrocarpa.*

1. **Rapanea modesta** Mez in Pflanzenr. 9(IV. 236): 367. 1902; Guillaumin in Jour. Arnold Arb. 13: 12. 1932.

Tree to 12 m. high, glabrous throughout, the branchlets terete, slender, 1.5–2 mm. in diameter toward apex, the older ones becoming grayish and inconspicuously lenticellate, the leaf-scars semi-elliptic, about 1.5 mm. broad and 1 mm. high; leaves scattered, the petioles slender, 5–7 mm. long, semiterete, winged nearly to base, the blades chartaceous, slightly asymmetric, pustulate-glandular-punctate on both sides, drying brownish,

slightly paler beneath, oblanceolate or elliptic-lanceolate, 4–11 cm. long, 1–4 cm. broad, attenuate at base and long-decurrent on the petiole, rounded or obtuse and inconspicuously retuse at apex, the costa nearly plane above, prominent beneath, the principal secondary nerves 12–18 per side, spreading or subascending, sharply prominulous on both sides, anastomosing and forming an inconspicuous collecting nerve 0.5–1.5 mm. within the margin, the veinlet-reticulation usually prominulous on both sides; inflorescences axillary or lateral on branchlets, glomerulate or short-verruciform, the axis not exceeding 1 × 1.5 mm. and bearing 1–3 flowers or fruits, the bracts deltoid-oblong, scarcely 0.7 × 0.5 mm., subacute, caducous; flowers essentially sessile, the pedicels in fruit less than 1 mm. long; fruiting calyx subrotate, 2–2.5 mm. in apical diameter, copiously or sparsely glandular-punctate or -lineolate, the lobes 4, deltoid, to 1 × 1 mm., subacute; fruits subglobose or slightly oblate, 2.5–4 mm. in diameter, copiously immersed-glandular-lineolate, rounded at base and apex, the stigma farciminiform, much longer than broad, to 1.5 mm. long, about 0.3 mm. in diameter, apparently inequilaterally furrowed distally, soon marcescent and caducous, leaving an inconspicuous umbo.

TYPE LOCALITY: New Caledonia; Mez cites *Balansa 991* and *2829*, one of which should be designated by a student of the region as the lectotype.

DISTRIBUTION: New Caledonia and the New Hebrides; infrequently collected, although Kajewski notes it as common on Efate, where it occurs in rain-forest as a tree up to 12 m. in height, with fruits becoming purple at maturity.

New Hebrides. EFATE: Undine Bay, *Morrison*, Aug. 18, 1896 (K), *Kajewski 237* (A, BISH, P, US). EROMANGA: South from Dillon Bay, *Morrison*, Aug. 5, 1896 (K).

Rapanea modesta, in superficial characters, is not readily separable from *R. myricifolia*. Mez implies that somewhat asymmetric leaves are characteristic of a group of New Caledonian species, including *R. modesta*, but in fact the leaves of *R. myricifolia* are sometimes also slightly asymmetric, and this character does not seem reliable. Nevertheless, the two species are not very closely allied if the stigmatic characters emphasized in Mez's key indicate genetic relationships, as they probably do. *Rapanea modesta* is correctly placed by Mez among the species with an elongate, styliform, or farciminiform stigma, an alliance that probably does not extend east of the New Hebrides. *Rapanea myricifolia* does not belong with these species, among which Mez placed it; its stigma is distinctly capitate-subquadrangular.

2. **Rapanea amischocarpa** A. C. Sm., sp. nov.

Rapanea sp. Guillaumin in Jour. Arnold Arb. **13:** 12. 1932, in Bull. Hist. Nat. Paris II. **9:** 292. 1937.

Arbor ad 25 m. alta ubique glabra vel partibus novellis obscure furfuraceo-lepidotis, ramulis validis subteretibus apicem versus 2–4 mm. diametro inconspicue lenticellatis, foliorum cicatricibus transversim semiellipticis ad 3 × 2.5 mm.; foliis secus ramulos dispersis, petiolis validis semiteretibus in sicco rugulosis 7–20 (juvenilibus ad 30) mm. longis supra medium anguste alatis, laminis chartaceis vel subcoriaceis in sicco utrinque badiis et obscure glanduloso-punctatis, oblanceolatis vel obovatis saepe inconspicue asymmetricis, (6–) 8–17 cm. longis, (2–) 2.5–6 cm. latis (juvenilibus ad 27 × 8.5 cm.), basi attenuatis et in petiolum longe decurrentibus, apice obtusis vel rotundatis saepe subretusis, margine anguste recurvatis, costa supra plana vel acute elevata subtus prominenti, nervis secundariis utrinsecus 17–30 cum aliis debilioribus interspersis subpatentibus utrinque prominulis vel subtus subimmersis marginem versus anastomosantibus, nervo collectivo 1–3 mm. intra marginem inconspicuo, nervo exteriore saepe manifesto, rete venularum utrinque immerso vel prominulo; inflorescentiis axillaribus vel secus ramulos lateralibus glomerulatis vel verruciformibus, axe sub fructu ad 3 × 3 mm. fructus 1 vel 2 subterminales gerenti, bracteis deltoideis ad 0.5 × 0.7 mm. obtusis saepe subpersistentibus; calyce sub fructu sessili subrotato basi valido apice 4–5 mm. diametro, lobis 5 obscure immerso-glandulosis late deltoideis subacutis ad 1 mm. longis et 2 mm. latis; fructibus subglobosis maturitate 7–10 mm. diametro immerso-glanduloso-punctatis, pericarpio 1.5–2 mm. crasso, endocarpio corneo 0.6–1 mm. crasso; stigmate marcescenti demum deciduo ut videtur quam lato longiore ad 1.5 mm. longo et 0.5 mm. lato forsan irregulariter anguste alato.

TYPE LOCALITY: Anelgauhat Bay, Aneityum, New Hebrides; the type is *Kajewski 751*.

DISTRIBUTION: Endemic to the Santa Cruz Islands and the New Hebrides, and known from several islands between Vanikoro and Aneityum. It is recorded as a tree 12–25 m. high occurring in rain-forest at elevations of 60–850 m. Kajewski indicates that the species is common on Vanikoro and Aneityum, and M. S. Johnson notes it as abundant in the lower canopy of the closed high forest on Eromanga. The leaves are said to be dark green with a light yellow midrib, and the fruits at maturity are purple or black.

LOCAL NAME: *Yaltorvu*, recorded from Eromanga by Johnson.

Santa Cruz Islands. VANIKORO: *Kajewski 583* (A, K, UC, US), *592* (A, K, UC, US), *666* (A, BISH, K, UC, US).

New Hebrides. AMBRIM: Mt. Toüo, *Aubert de la Rüe*, Jan. 21, 1936 (P). EROMANGA: Mt. William, *Johnson 52* (K). ANEITYUM: Anelgauhat Bay, alt. 60 m., Feb. 12, 1929, *Kajewski 751* (A holotype; isotypes at BISH, K, NY, P, US).

Although flowers are not available, *R. amischocarpa* merits recognition as a very distinct taxon related, among species known from the Fijian

Region, only to *R. modesta* Mez, from which it is readily distinguished by its robust habit, much larger leaves, calyces, fruits, etc. The New Caledonian *R. citrifolia* Mez may also be indicated as a relative, but in comparison the new species has predominantly obovate rather than oblong-elliptic leaf-blades and substantially larger calyces, although a satisfactory comparison is not feasible in the absence of flowers. The flowers and fruits of *R. citrifolia* are definitely short-pedicellate, in spite of Mez's descriptive phrase "pedicellis subnullis."

3. **Rapanea myricifolia** (A. Gray) Mez in Pflanzenr. 9(IV. 236): 366. 1902; J. W. Parham, Pl. Fiji Isl. 158. 1964. FIGURES 76–83.

Myrsine myricaefolia A. Gray in Proc. Amer. Acad. Arts **5:** 330. 1862, in Bonplandia **10:** 37. 1862; Seem. Viti, 438. 1862, Fl. Vit. 149. 1866; Horne, A Year in Fiji, 265. 1881.

Myrsine capitellata sensu Seem. in Bonplandia **9:** 257. 1861, Viti, 438. 1862; non auctt.

Ardisia sp. Seem. in Bonplandia **9:** 257. 1861.

Myrsine crassifolia sensu A. Gray in Bonplandia **10:** 37. 1862; Seem. Fl. Vit. 149. 1866; Horne, A Year in Fiji, 265. 1881; non R. Br.

Myrsine sp. n. Horne, A Year in Fiji, 265. 1881.

Rapanea samoensis Lauterb. in Bot. Jahrb. **41:** 232. 1908; Rechinger in Denkschr. Akad. Wiss. Wien **85:** 326. 1910; Setchell in Carnegie Inst. Wash. Publ. **341:** 61. 1924; Christophersen in Bishop Mus. Bull. **128:** 167. 1935; A. C. Sm. in Bishop Mus. Bull. **141:** 119, p. p. 1936; J. W. Parham, Pl. Fiji Isl. 158. 1964.

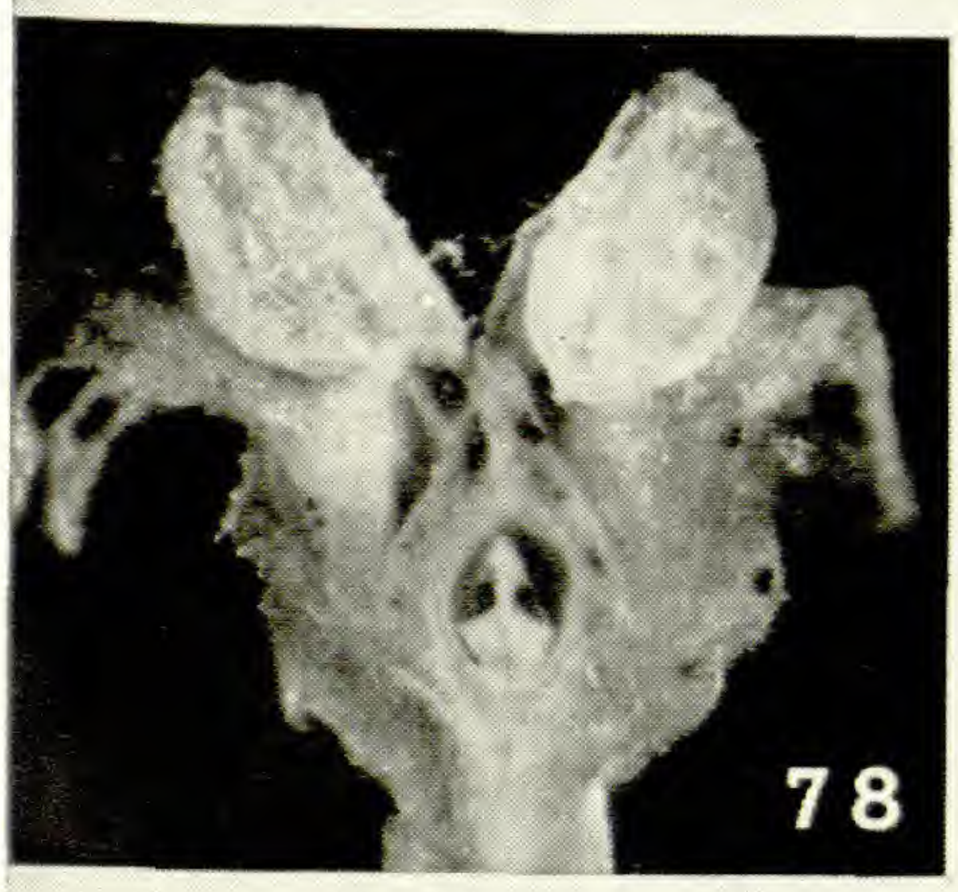
Shrub or tree 1–15 m. high, glabrous throughout, the branchlets terete, slender, 1–3.5 mm. in diameter toward apex, at first pale brown, the older ones becoming grayish and inconspicuously but sometimes abundantly lenticellate, the leaf-scars transversely semi-elliptic, 1–3 mm. broad; leaves scattered, the petioles often slender, semiterete or shallowly canaliculate, 2–15 mm. long, narrowly winged nearly to base, the blades chartaceous or thin-coriaceous, sometimes inconspicuously asymmetric, punctate or sometimes short-lineolate with raised or immersed glands on both sides, drying brownish, slightly paler beneath, obovate to lanceolate or obovate- or elliptic-lanceolate, (2–) 3–11 (–12) cm. long, (0.7–) 1–3.5 (–4) cm. broad, attenuate at base and long-decurrent on the petiole, obtuse to rounded and usually shallowly retuse at apex, the costa plane or elevated

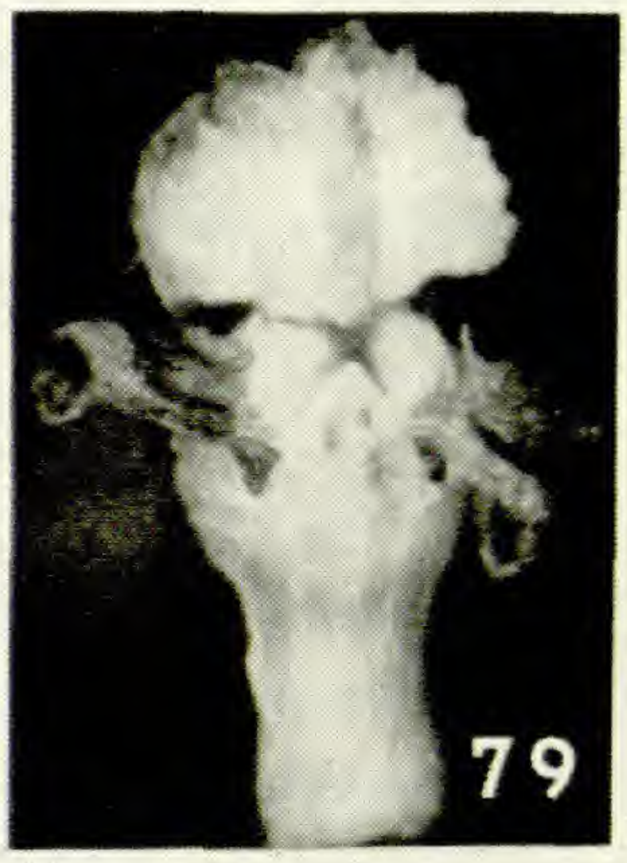
---

FIGURES 76–83. *Rapanea myricifolia*: 76 and 78 from *Smith 5191*, 77 from *Gillespie 2899*, 79 and 80 from *Fiji Dept. Agr. 13604*, 81 and 82 from *St. John 18159*, 83 from *Degener 14269*. 76, ♂ inflorescence, × 5; 77, ♂ flower, × 10; 78, sectioned functionally ♂ flower, with two corolla-lobes, two stamens, and gynoecium with partially developed placenta, × 15; 79, functionally ♀ flower, × 10; 80, sectioned functionally ♀ flower, with developed placenta, × 10; 81, mature fruit, with stigmatic scar, × 10; 82, sectioned fruit, with calyx, stigmatic scar, and developing seed, × 8; 83, young fruit, with calyx and marcescent stigma, × 10. FIGURES 84, 85. *Rapanea polyantha*: both from *Melville et al. 7059*. 84, ♂ inflorescence, × 5; 85, sectioned ♂ flower, with two corolla-lobes and two stamens, × 20.

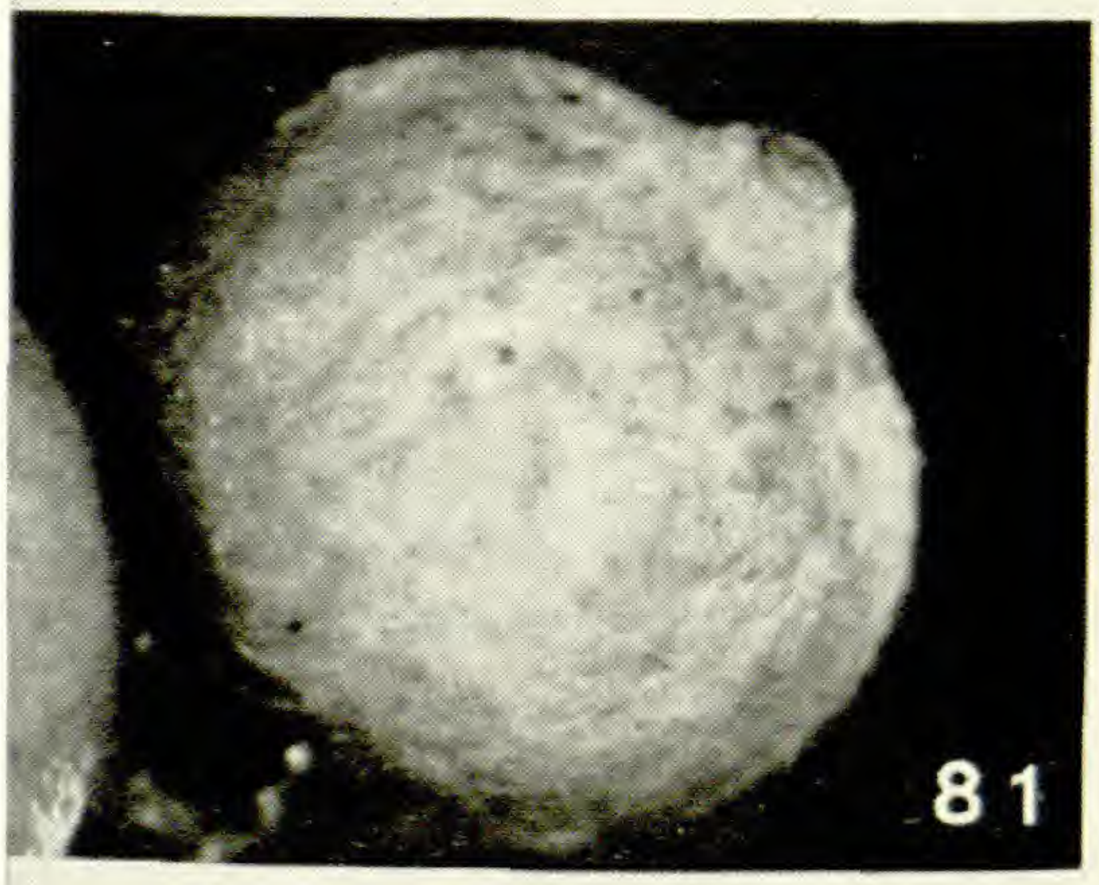
76

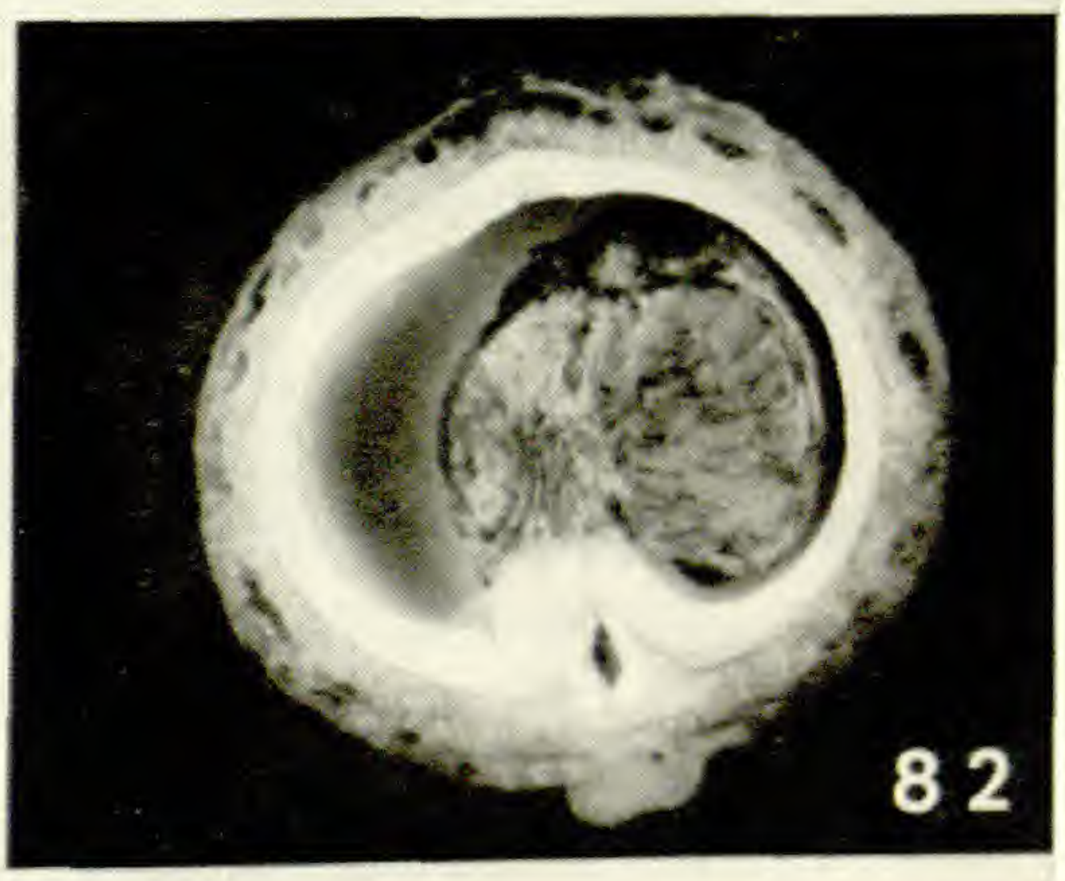
77


78

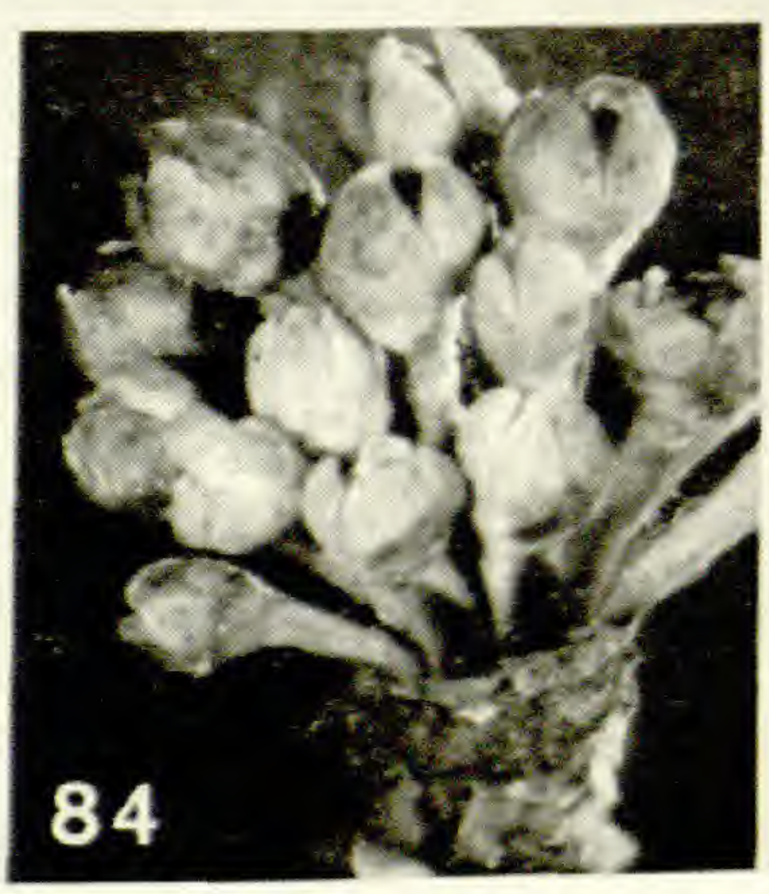

79

80


81


82

83


84

85

above, prominent beneath, the principal secondary nerves 8–25 per side, interspersed with others nearly as obvious, spreading or subascending, slightly elevated or prominulous or immersed on both sides, anastomosing and forming an inconspicuous collective nerve 0.5–2 mm. within the margin, sometimes with a weaker marginal nerve, the veinlet-reticulation prominulous or immersed on both sides; inflorescences axillary or lateral above leaf-scars, glomerulate or verruciform, the axis sometimes to 4 mm. long and 2 mm. in diameter and bearing 1–10 maturing flowers at apex, the bracts several to many and often persistent, broadly deltoid to ovate or oblong, 0.3–1 (–1.5) mm. long, 0.5–1 mm. broad, rounded or obtuse at apex, often obscurely ciliolate at margin; flowers functionally ♂ or ♀ (sometimes in the same inflorescence), 4- or 5-merous, the pedicels often minute but sometimes obvious, slender, to 2 mm. (rarely to 4 mm.) long in flower and fruit; calyx cupuliform, 1–2 mm. in apical diameter at anthesis, subrotate and slightly accrescent (rarely to 3.5 mm.) in fruit, the lobes deltoid to oblong, to 1 × 1 mm. at anthesis, sparsely or copiously punctate- or lineolate-glandular, acute to rounded at apex, minutely glandular-ciliolate; corolla submembranous, cupuliform and becoming subrotate, 1.4–2.5 mm. long, sometimes to 4 mm. in apical diameter, often copiously punctate- or lineolate-glandular, the lobes oblong, 1–1.8 × 0.5–1.5 mm., obtuse at apex, copiously but minutely glandular-ciliolate; filaments membranous, ligulate, adnate to corolla-tube, the anthers oblong-deltoid or ellipsoid, subsagittate at base, obtuse at apex, variable in size but when functional 1–2 mm. long; gynoecium obvious in functionally ♀ flowers, the ovary ellipsoid to subglobose, the stigma conspicuous, capitate-subquadrangular, at anthesis to 1.5 mm. long and 2 mm. broad, the angles subalate, the ovules 2–5 (–7), lateral and often distally uniseriate; gynoecium in functionally ♂ flowers none or apparent, then the stigma minute, the placenta sometimes developing but with apparently sterile ovules; fruits rarely more than 5 per inflorescence, globose or slightly oblate, 3–7 mm. in diameter, the pericarp to about 1 mm. thick, the mesocarp carnose, immersed-glandular-lineolate, the endocarp horny, 0.3–0.5 mm. thick, the apex rounded and inconspicuously umbonate, the stigma slightly accrescent but soon marcescent and caducous, leaving a conspicuous circular scar.

TYPE LOCALITY: Mathuata Province, Vanua Levu, Fiji; the type is a U. S. Exploring Expedition collection, cited in the sequence below. In his original publication Gray cited Exploring Expedition material from "Muthuata, Feejee Islands. Eimeo, Society Islands." Examination of the holotype and several isotypes indicates that a single collection was involved. All such material is labeled "Feejee Islands" with the exception of a single specimen (NY, where three isotypes are deposited) labeled "Eimeo, Society I." and annotated by Gray as his *Myrsine myricaefolia.* This specimen is certainly a part of the Fijian material, and one must assume that the mixed label was responsible for Gray's citation. All of the

type material may therefore be confidently assigned to the Fijian locality.

The holotype of *R. samoensis* was *Vaupel 173*, probably deposited at Berlin, from "Hinter Sologa," Savaii, Samoa. Fortunately several isotypes exist, among which it seems appropriate to designate the Kew sheet the lectotype, as cited in the sequence below.

DISTRIBUTION: Fiji and Samoa, locally abundant in both archipelagos at elevations from sea-level to the highest point of Viti Levu, 1,323 m., and to 1,500 m. on Savaii. Habitats vary from beach thickets and coastal forest to dry forest, thickets in grassland, and crest thickets; the species has been noted on limestone in Fiji and on lava flows in Samoa. Individuals are noted as trees or shrubs 1–15 m. in height, sometimes freely branched and sometimes compact; the calyx has brownish or purplish glands; the corolla is white or yellowish green, with pink to red, purple, or brownish glandular markings; the anthers are greenish white; and the fruits are at first green to red or purple, becoming black at maturity.

LOCAL NAMES AND USES: In spite of its abundance the species seems to lack a uniform Fijian name, the following (none of which is really reliable) having been noted only once each: *mbethembethe* (Yasawas); *sinu, ndoi ni vorsa*, and *mbuna kau ni mbure* (Mba); *sembala* (Nandronga & Navosa); *sinu nganga* (Serua); *sangali ni sakea* and *ndasea* (Mathuata). In Samoa, the name *saitamu* was noted by Setchell. In Fiji (Serua) the poles and timbers are considered useful, and in the Yasawas the plant is noted as having a medicinal use for eye trouble. On Tutuila it is indicated that the wood is used for clubs and chiefly staves of office.

Fiji. YASAWAS: WAYA ISLAND: Nangua, *St. John 18159* (BISH, K, SUVA, US). VITI LEVU: MBA: Vicinity of Nandarivatu, *Tothill 345* (BISH, K), *365* (K), *Parks 20510, 20675* (both BISH, SUVA, UC, US), *Gillespie 3908* (A, BISH), *4007* (BISH, UC), *4168* (BISH, UC), *4244* (BISH), *Smith 6063, 6269* (both A, BISH, K, NY, US), *Degener 14269* (A, BISH, K, NY, UC, US), *Fiji Dept. Agr. 8520* (SUVA); Mt. Nanggaranambuluta (Lomalangi), *Gillespie 3921* (BISH, NY, UC), *4063* (BISH, K, UC, US), *Fiji Dept. Agr. 2339* (SUVA), *2366* (A, SUVA); Mt. Kombalevu, *Gillespie 3739* (BISH); Nandala, *O. & I. Degener 32133* (BISH, NY), *32134* (BISH); Mt. Tomanivi (Victoria), *Gillespie 4119* (BISH), *Smith 5191* (A, BISH, K, US). NANDRONGA & NAVOSA: Nandrau, *Berry 69* (K, MASS, SUVA); Rairaimatuku Plateau, *Smith 5435* (A, K, NY, US); southern slopes of Nausori Highlands, Namosi Creek, *Smith 4602, 4727* (both A, BISH, K, US). SERUA: Namboutini, *Fiji Dept. Agr. 14009* (A, BISH, K, SUVA); Vicinity of Ngaloa, *Smith 9688* (BISH, GH, K, SUVA, UC, US), *Fiji Dept. For. 899* (K, SUVA); Taunovo Creek, *Smith 9566* (BISH, GH, K, SUVA, UC, US); Ndeumba Beach, *Fiji Dept. Agr. 13217* (SUVA). NAMOSI: North of Wainavindrau Creek, *Smith 8446* (BISH, GH, K, SUVA, UC, US); Mt. Voma, *Gillespie 2899* (BISH, K, NY, UC, US); Wainandoi, *Mead 1967* (K). RA: Mountains near Penang, *Greenwood 760* (K). TAILEVU: Vicinity of Nggelekuro, *Fiji Dept. Agr. 13604* (BISH, K, SUVA). REWA: Coast west of Suva, *MacDaniels 1070* (A, BISH); vicinity of Lami, *Gillespie 4603* (BISH), *Fiji Dept. Agr. 940* (A, BISH, SUVA). VITI LEVU & VANUA LEVU: Without further locality, *Seemann*

289 (BM, GH, K). MBENGGA: Lalati, *Fiji Dept. Agr. 13727* (BISH, K, SUVA). KANDAVU: *Seemann 290* (BM, GH, K). OVALAU: Mt. Koronimoko, *Smith 8072* (BISH, GH, K, SUVA, UC, US); Mt. Tana Lailai, *Smith 7709* (BISH, GH, K, SUVA, UC, US). VANUA LEVU: MATHUATA: "Mountains," *U. S. Expl. Exped.* (US 63446 holotype; isotypes at GH, K, NY); southern base of Mathuata Range, *Smith 6806* (A, BISH, K, NY, US); Mt. Numbuiloa, east of Lambasa, *Smith 6397, 6541* (both A, BISH, K, US), *Fiji Dept. Agr. 14640* (BISH, SUVA). THAKAUNDROVE-MATHUATA boundary: Korotini Range, *Smith 567* (BISH, GH, K, NY, UC, US). RAMBI: *Horne 455* (GH, K). TAVEUNI: Near lake above Somosomo, *Smith 877* (BISH, GH, K, NY, UC, US), *8354* (BISH, GH, K, SUVA, UC, US), *Fiji Dept. Agr. 14373* (BISH, K, SUVA). FULANGA: *Smith 1218* (BISH, GH, K, NY, UC, US). ONGEA NDRIKI: *Bryan 420* (A, BISH). FIJI, without further locality: *Horne 389* (GH, K).

Samoa. SAVAII: Fagalele-Falealupo, *Christophersen 3394* (BISH, NY, UC); between Letui and Aopo, *Bryan 147* (BISH, K, NY); Aopo-Asau, *Christophersen 3434* (BISH), *3435* (A, BISH); inland from Sologa, April 4, 1906, *Vaupel 173* (K lectotype; isotypes at BISH, US); Mataulanu lake shores, *Christophersen 865* (BISH, NY, US); Papa'afu, rim of crater, *Christophersen 2720* (BISH, K, NY, UC, US); Taga, *Christophersen 2835* (BISH, K); Near Salelologo, *Bristol 2478* (BISH). TUTUILA: Matafao trail, *Setchell 382* (BISH, UC, US); Matafao ridge, *Christophersen 1024* (BISH, NY, UC), *1046* (BISH, US), *1053* (BISH), *1065* (BISH, K, UC); top of Pioa, *Christophersen 3547* (BISH, UC), *3574* (BISH, US); top of S. Pioa, *Christophersen 1202* (BISH, NY). SAMOA, without further locality: *Whitmee 121* (K), *Powell* (K).

As indicated above in my discussion of *R. modesta,* vegetative characters scarcely permit the ready separation of that species and *R. myricifolia,* but the stigmatic characters of the two taxa are strikingly different and indicate different alliances. *Rapanea myricifolia* seems more closely allied to a group of seven Tahitian species recognized by Mez (1902: 372, 373), but if his descriptions are dependable none of these are conspecific with the taxon so abundant in Fiji and Samoa. At any rate, no Polynesian species has nomenclatural priority over *R. myricifolia.*

A painstaking examination of the many available collections of this immediate complex from Fiji and Samoa, including type material of *R. samoensis,* has been undertaken to see whether the two described taxa could be maintained at any level. At first glance one might assume that there are dependable differences in leaf-shape, as stated by Lauterbach. In general, the Fijian population is more inclined to have its leaf-blades lanceolate, with a ratio of length to breadth of about 4:1 (but often the blades are merely obovate, with a ratio of 2:1). On the other hand, the leaf-blades of the Samoan specimens are more uniformly inclined to be obovate, with a ratio of 2:1 or 3:1 (but less frequently the blades are lanceolate, with a ratio of 4:1). The inflorescence is basically similar in the two areas, but in Fiji it is often inclined to be comparatively elongate and verruciform, sometimes to 4 mm. long, and occasionally with as many as 10 flowers (but often the inflorescence is merely glomerulate and the flowers may be as few as 3 or even reduced to 1). The inflorescence of Samoan specimens is usually merely glomerulate, less often verruciform and to 2 mm. long, and the flowers are only rarely more than 5. Pedicel-length is not a reliable character, as in both areas the flowers (and fruits)

may be essentially sessile or the fruits may have pedicels up to 2 mm. long (or even longer in some Fijian collections). Among the Samoan specimens only 4-merous flowers have been noted; in Fiji the flowers are usually 4-merous but occasionally (even in the same inflorescence) 5-merous. The fruits in Fiji at maturity are noted to have a diameter of 3–5 (rarely to 6) mm., in Samoa 3.5–7 mm. From these notes it is apparent that no real differentiation with a geographic correlation exists, and therefore *R. samoensis* is not maintainable even as an infraspecific taxon. In the inclusive taxon leaf-size, leaf-texture, and the degree of obvious venation are highly variable, but presumably in response to local edaphic conditions rather than to genetic influence.

A few specimens from upland Viti Levu, Vanua Levu, and Taveuni (e.g., *Smith 567, 877, 5191, 8354*; *Fiji Dept. Agr. 14373*) seem to stand out because of their comparatively long pedicels (1.5–4 mm.) and conspicuous leaf-venation. However, certain lowland specimens (e.g., *Greenwood 760*; *Fiji Dept. For. 899*; *Fiji Dept. Agr. 14009*, the latter with exceptionally large leaves) also have the elongate pedicels, but their leaf-venation is not unusually conspicuous. At this time it seems advisable to recognize *R. myricifolia* as a fairly variable species, with reference to pedicel-length, leaf-shape, leaf-size, and venation, without attempting nomenclaturally to delimit populations within it.

4. **Rapanea longipes** A. C. Sm., sp. nov.

Rapanea sp. Christophersen in Bishop Mus. Bull. **128:** 167. 1935.

Frutex vel arbor ad 5 m. alta ubique glabra, ramulis subteretibus gracilibus apicem versus 1–2 mm. diametro inconspicue lenticellatis, foliorum cicatricibus transversim semi-ellipticis ad 1.5 × 0.8 mm.; foliis secus ramulos dispersis, petiolis gracilibus semiteretibus 5–10 mm. longis fere ad basim anguste alatis, laminis chartaceis in sicco supra fusco-viridibus subtus pallidioribus utrinque inconspicue glanduloso-punctatis, anguste ellipticis, (2–) 3–6.5 cm. longis, (0.8–) 1–2.5 cm. latis, basi attenuatis et in petiolum longe decurrentibus, apice obtusis interdum minute retusis, margine anguste recurvatis, costa supra plana subtus acute elevata, nervis secundariis inconspicuis utrinsecus 10–15 cum aliis debilioribus interspersis patentibus utrinque prominulis vel subimmersis, marginem versus anastomosantibus, nervo collectivo 0.4–0.8 mm. intra marginem inconspicuo, rete venularum copioso sed inconspicuo utrinque immerso vel prominulo; inflorescentiis in axillis foliorum delapsorum glomerulatis vel verruciformibus, axe sub fructu ad 2.5 × 1.5 mm., bracteis deltoideis ad 0.5 mm. longis latisque apice obtusis vel rotundatis haud persistentibus; pedicellis manifestis sub fructu 6–9 mm. longis basi paullo incrassatis; calyce sub fructu rotato apice 2.5–3 mm. diametro, lobis 5 obscure glanduloso-punctatis deltoideis ad 0.8 mm. longis et 1 mm. latis apice acutis margine saepe suberosis et obscure glanduloso-ciliolatis; fructibus apice inflorescentiae paucis initio obovoideis maturitate subglobosis 7–8 mm. diametro, basi et apice rotundatis, pericarpio ad 1 mm. crasso obscure immerso-glanduloso-lineolato, mesocarpio spongioso, endocarpio osseo 0.2–0.3 mm. crasso; stigmate

marcescenti ut videtur irregulariter subcapitato 0.6–1 mm. diametro demum deciduo.

TYPE LOCALITY: Above Letui, Savaii, Samoa; the type is *Christophersen 779*.

DISTRIBUTION: Endemic to Samoa and thus far known only from a limited area in upland Savaii at altitudes of 1,550–1,700 m.; it is recorded as a shrub or tree 3–5 m. high in wet montane forest, with a main stem or trunk to 10 cm. in diameter; the fruits are said to be green, but perhaps when fully mature they become purple or black.

Samoa. SAVAII: Forest above Letui, Tuisivi Range, alt. 1,600–1,700 m., Sept. 26, 1929, *Christophersen 779* (BISH holotype; isotypes at K, NY, P, UC, US), *791* (A, BISH, NY); above Matavanu, *Christophersen & Hume 2205* (BISH, K, NY, UC), *2238* (BISH, P, US).

In studying the flowering plants of Samoa, Christophersen suggested that the four collections above cited might belong to an undescribed species, which he refrained from naming in the absence of flowering material. In considering the leaves of this taxon as "identical" with those of certain Fijian collections of *R. myricifolia*, however, Christophersen was insufficiently critical, for the leaf-blades are more regularly elliptic in shape (rather than prevailingly obovate-lanceolate) than those of *R. myricifolia* and are in general thinner in texture and with more obvious venation. In addition to these somewhat intangible foliage differences, the strikingly elongate pedicels and the larger fruits apparent in this small upland population on Savaii make its specific recognition desirable, even though no additional material has become available since Christophersen's effective and discerning field studies of Samoan plants.

5. **Rapanea crassiramea** A. C. Sm. in Bull. Torrey Bot. Club 70: 547. 1943; J. W. Parham, Pl. Fiji Isl. 158. 1964.

Tree, glabrous throughout, the branchlets subterete, robust, 5–10 mm. in diameter toward apex, brown to grayish, the older parts copiously lenticellate, the leaf-scars abundant and conspicuous, transversely elliptic, 4–5 mm. broad, about 3 mm. high; leaves congested toward apices of branchlets, the petioles stout, slightly flattened above, 12–22 mm. long, the blades coriaceous, drying brownish, obovate, 11–15 cm. long, 4.5–7 cm. broad, narrowed to an obtuse base and abruptly short-decurrent on the petiole, broadly obtuse and often slightly emarginate at apex, narrowly recurved at margin, the costa conspicuous and prominent on both sides, the principal secondary nerves 12–15 per side, interspersed with others slightly less obvious, subspreading, raised on both surfaces, anastomosing and forming an irregular collective nerve 2–4 mm. within the margin, the veinlet-reticulation subimmersed or prominulous on both sides; inflorescences axillary or lateral above leaf-scars, glomerulate or verruciform, the axis sometimes cylindric and to 7 × 4 mm., bearing 2–4 flowers

at apex but with many subapical scars, the bracts deciduous; pedicels stout, 4–6 mm. long, the calyx (slightly past anthesis) thin-carnose, cupuliform, the lobes 5–7, usually 6, deltoid, about 1.5 mm. long and broad, subacute to obtuse at apex, minutely glandular-ciliolate; ovary after anthesis depressed-subglobose, the stigma caducous, the ovules about 5.

TYPE LOCALITY: Nandarivatu, Mba Province, Viti Levu, Fiji; the type is *Gillespie 4374*.

DISTRIBUTION: Known only from the type collection, made on wooded slopes at an altitude of 900 m.

Fiji. VITI LEVU: MBA: Nandarivatu, Dec. 16, 1927, *Gillespie 4374* (BISH holotype; fragment at A).

Since this species was first described in 1943 on the basis of a single collection no additional material has become available, although the type locality is now as well collected as any part of Fiji. The only other species of *Rapanea* thus far recorded from Fiji, *R. myricifolia*, is taxonomically so distinct as to obviate comparison. In fact, *R. crassiramea* and the two new species described below seem to form a small, isolated complex, characterized by robust habit, congested or irregularly whorled leaves, and essentially terete or semiterete rather than winged petioles. These characters, although seemingly not very basic, effectively remove these three species from the close relationship of other described Melanesian and Polynesian *Rapaneae*.

6. **Rapanea polyantha** A. C. Sm., sp. nov. FIGURES 84, 85.

Arbor gracilis ad 4.3 m. alta ubique praeter corollam glabra ut videtur dioica, ramulis teretibus crassis apicem versus plerumque 3–4 mm. diametro, initio fuscis mox cinereis inconspicue lenticellatis, foliorum cicatricibus transversim ellipticis ad 3 mm. latis et 2.5 mm. altis; foliis 3–6-subverticillatis, petiolis crassis (1.5–2.5 mm. diametro) teretibus 3–5 mm. longis, laminis subcoriaceis in sicco fuscescentibus subtus paullo pallidioribus, anguste ellipticis, (7–) 9–13 cm. longis, (2–) 3.5–5 cm. latis, basi anguste rotundatis vel obtusis, apice obtusis vel obtuse breviter cuspidatis, margine anguste recurvatis, costa conspicua supra plana vel canaliculata subtus prominenti, nervis secundariis utrinsecus 13–16 cum aliis paullo debilioribus interspersis irregulariter patentibus utrinque elevatis, intra marginem 1–5 mm. insolite anastomosantibus, rete venularum irregulari utrinque prominulo vel subimmerso; inflorescentiis ♂ solis visis numerosis secus ramulos infra folia saepe congestis, axe sub anthesi glomerulato vel verruciformi ad 2 mm. longo et 3 mm. diametro apice flores 13–25 congestos gerenti, cicatricibus florum delapsorum lateraliter manifestis, bracteis inconspicuis deltoideis ad 1 × 0.8 mm. apice acutis margine glanduloso-ciliolatis haud persistentibus; pedicellis gracilibus ad 3 mm. longis; floribus ♂ 5-meris vel corollae lobis interdum 4, calyce subrotato sub-

membranaceo apice ad 2 mm. diametro, lobis ovato-deltoideis ad 0.7–0.9 mm. immerso-glanduloso-punctatis vel lineolatis, apice subacutis, margine obscure erosulis; corolla submembranacea sub anthesi cupuliformi-subrotata ad 2.8 mm. longa et apice ad 3.5 mm. diametro extus copiose sed minutissime glanduloso-papillosa, lobis 4 vel 5 ovato-oblongis ad 2 × 2 mm. immerso-glanduloso-punctatis, apice acutis; staminibus 4 vel 5, filamentis corollae tubum adnatis, antheris oblongo-deltoideis 0.5–0.7 mm. longis latisque apice obtusis; gynoecio in floribus ♂ nullo.

TYPE LOCALITY: Mt. Tomanivi, Mba Province, Viti Levu, Fiji; the type is *Melville & Parham 7059*.

DISTRIBUTION: Known from only two collections, made in mixed tropical rain-forest in north-central Viti Levu at elevations of 1,127 m. (Gillespie) and about 1,220 m. (type); it is noted as a small tree to 4.3 m. high, the single trunk bearing a rounded or flat crown; the abundant flowers of the type have white corollas.

Fiji. VITI LEVU: MBA: Summit ridge of Mt. Tomanivi (Victoria), May 4, 1962, *R. & E. F. Melville & J. W. Parham 7059* (*Fiji Dept. Agr. 12681*) (K holotype; isotypes at A, BISH, SUVA); summit of Mt. Nanggaranambuluta (Lomalangi), *Gillespie 3795* (A, BISH).

The highest summit ridge of Fiji has been visited by many collectors, but it still discloses unexpected and totally distinct plant novelties such as the species here described. The Gillespie specimens, from a nearby high ridge, were collected in November 1927; although they are sterile, a few persisting inflorescence-axes indicate their place in *Rapanea*, and their leaves are very similar to those of the type. From *R. crassiramea*, its only close ally, *R. polyantha* differs strikingly in its very short petioles. Furthermore, its leaves appear to be whorled in separated clusters along its branchlets, rather than, as in *R. crassiramea*, being continuously congested and hence when falling leaving closely approximate and very conspicuous scars. Only staminate flowers are known for this novelty, whereas the known flowers of *R. crassiramea* were functionally pistillate, and therefore a direct comparison of flowers cannot be made. However, it appears that the inflorescences of *R. polyantha* are substantially less robust but much more copiously flowering than those of *R. crassiramea*.

7. **Rapanea hadrocarpa** A. C. Sm., sp. nov.

Rapanea samoensis sensu A. C. Sm. in Bishop Mus. Bull. **141:** 119, p. p. 1936; non Lauterb.

Arbor ad 8 m. alta, partibus novellis copiose vel sparsim minute glanduloso-capitato-pilosis, pilis haud 0.05 mm. longis, indumento plerumque evanescenti saepe petiolis pedicellisque subpersistenti; ramulis teretibus apicem versus 1.5–2.5 mm. diametro, primo fuscis mox cinereis copiose lenticellatis, foliorum cicatricibus subcircularibus ad 2.5 mm. latis et 2 mm. altis; foliis 3–5-subverticillatis, petiolis (1.2–1.5 mm. diametro) 3–

10 mm. longis inferne subteretibus superne semiteretibus, laminis chartaceis in sicco supra fuscis subtus pallidioribus vel subviridibus, utrinque pustulato-punctato-glandulosis glandulis demum immersis, lanceolato-obovatis vel ellipticis, (7–) 10–16 cm. longis, (2.5–) 3.5–6.5 cm. latis, basi abrupte obtusis, apice rotundatis vel obtusis plerumque inconspicue retusis, margine anguste recurvatis, costa supra plana vel leviter canaliculata subtus prominenti, nervis secundariis utrinsecus 15–25 inconspicuis subadscendentibus utrinque prominulis intra marginem 2–4 mm. laxe anastomosantibus, rete venularum inconspicuo laxo utrinque immerso; inflorescentiis axillaribus vel secus ramulos inter folia dispositis glomerulatis vel verruciformibus, axe sub fructu ad 3 mm. longo et 2.5 mm. diametro fructus maturos 1–4 apice gerenti, bracteis late deltoideis ad 0.7 × 1 mm. apice rotundatis vel obtusis subpersistentibus, dorso glandulis minute stipitatis copiose ornatis demum glabratis, margine ciliolatis; pedicellis in alabastro 1 mm. sub fructu 1.5–4 mm. longis; calyce sub fructu rotato apice 3–4 mm. diametro, lobis 4 vel 5 immerso-glandulosis late deltoideis ad 1 mm. longis et 1.5 mm. latis apice acutis vel obtusis margine copiose sed minute glanduloso-ciliolatis; fructibus globosis maturitate 7–10 mm. diametro basi et apice rotundatis, pericarpio 0.7–1.3 mm. crasso copiose immerso-glanduloso-punctato, mesocarpio spongioso, endocarpio osseo ad 0.2 mm. crasso; stigmate marcescenti et deciduo.

TYPE LOCALITY: Kambara Island, Fiji; the type is *Smith 1245*.

DISTRIBUTION: Endemic to Fiji and thus far known from a few scattered localities in southern Viti Levu and the Lau Group, at altitudes from near sea-level to 300 m.; it has been noted as a tree 4–8 m. high, often slender and with a trunk to 8 cm. in diameter, occurring in forested areas; the fruits are at first dull white with purplish glands, becoming red and doubtless eventually darker.

LOCAL NAME: Only the type collection bears a local name, *utu ni tandruku*.

Fiji. VITI LEVU: SERUA: Inland from Namboutini, *Fiji Dept. For. 459* (*Damanu 108*) (K, SUVA). REWA: Mt. Korombamba, *Fiji Dept. Agr. 16517* (BISH, MASS, SUVA). TUVUTHA: Central forest, *Bryan 549* (A, BISH, K, SUVA, UC, US). KAMBARA: Forest on limestone formation, March 2, 1934, *Smith 1245* (BISH holotype; isotypes at GH, K, NY, UC, US).

In referring my no. *1245* to *R. samoensis* in 1936 I was distinctly in error, as it bears little relationship to the other specimen then cited, no. *1218*, which indeed does represent *R. samoensis* (= *R. myricifolia*). The Kambara collection, with three others cited above, represents a distinct novelty, suggesting only *R. crassiramea* and *R. polyantha*. From these species *R. hadrocarpa* is distinguished by its comparatively slender branchlets and its indument. The new species, in fact, is the only known Fijian *Rapanea* to have a vegetative indument, which is composed of minute glandular hairs and seems often limited to the youngest parts, although sometimes

persisting on the petioles and pedicels into fruiting condition. On the type collection the indument is extremely sparse and scarcely apparent, only a few isolated hairs persisting here and there. Therefore, while it is not a very useful diagnostic character, the indument is nevertheless significant in suggesting that *R. hadrocarpa* may be less closely allied to the other large-leaved Fijian species than indicated in my key.

REFERENCES

BACKER, C. A., & R. C. BAKHUIZEN VAN DEN BRINK. Myrsinaceae. Fl. Java **2:** 194–203. 1965.

BALGOOY, M. M. J. VAN. Preliminary plant-geographical analysis of the Pacific. Blumea **10:** 385–430. 1960.

FOREMAN, D. B. A check list of the vascular plants of Bougainville, with descriptions of some common forest trees. Bot. Bull. Dept. Forest. Lae **5:** 1–194. 1971.

GILLESPIE, J. W. New plants from Fiji – I. Bishop Mus. Bull. **74:** 3–99. 1930.

HORNE, J. A Year in Fiji. 297 pp. 1881.

HOSAKA, E. Y. A revision of the Hawaiian species of *Myrsine* (*Suttonia, Rapanea*), (Myrsinaceae). Occ. Pap. Bishop Mus. **16:** 25–76. 1940.

LI, H.-L. Woody Flora of Taiwan. 974 pp. 1963.

METCALFE, C. R., & L. CHALK. Anatomy of the Dicotyledons. 1500 pp. 1950.

MEZ, C. Myrsinaceae. Pflanzenr. **9**(IV. 236): 1–437. *fig. 1–61.* 1902.

OLIVER, W. R. B. The flora of the Three Kings Islands: Additional notes: with note on *Suttonia.* Rec. Auckland Inst. Mus. **4:** 111, 112. 1951.

SEEMANN, B. Viti: An account of a government mission to the Vitian or Fijian Islands in the years 1860–61. 447 pp. 1862.

SMITH, A. C. Phanerogam genera with distributions terminating in Fiji. Jour. Arnold Arb. **36:** 273–292. 1955.

ST. JOHN, H. The date of publication of Forsters' *Characteres Generum Plantarum* and its relation to contemporary works. Naturaliste Canad. **98:** 561–581. 1971.

TAKHTAJAN, A. L. Flowering Plants: Origin and Dispersal. 310 pp. 1969.

THORNE, R. F. Biotic distribution patterns in the tropical Pacific. *In* GRESSITT, J. L. (ed.) Pacific Basin Biogeography, 311–350. Bishop Museum Press. 1964.

VAUPEL, F. Die Vegetation der Samoa-Inseln. Bot. Jahrb. **44**(Beibl. 102): 47–58. 1910.

WALKER, E. H. A revision of the eastern Asiatic Myrsinaceae. Philip. Jour. Sci. **73:** 1–258. 1940.

———. A revision of the Myrsinaceae of Taiwan. Quart. Jour. Taiwan Mus. **12:** 161–194. 1959.

WHITMORE, T. C. Guide to the forests of the British Solomon Islands. For. Record No. 2, For. Dept. Brit. Solomon Islands Protectorate. 208 pp. 1966.

DEPARTMENT OF BOTANY
UNIVERSITY OF MASSACHUSETTS
AMHERST, MASSACHUSETTS 01002

PRESENT STATUS AND PROBLEMS OF BAMBOO CLASSIFICATION *

D. GROSSER AND W. LIESE

STATUS OF BAMBOO CLASSIFICATION

THE FIRST BAMBOO CLASSIFICATION originates from Rumpf (1750) who divided the bamboos into 8 classes, all with the name *Arundo*. This classification system was used with little change by Linné (1753), Roxburgh (1814), and Ruprecht (1839), until Munro (1868) proposed his new system which is still applied in principle today. Bentham (1883) modified the system of Munro so that instead of three divisions (Triglossae (Arundinarae), Bambuseae verae, and Bacciferae) four subtribes were introduced. Hackel (1889) and Gamble (1896) adopted the system of Bentham unchanged. It is represented by the following arrangement:

CLASSIFICATION SYSTEM OF BENTHAM (1883)
[Including genera added by Hackel (1889) and Gamble (1896)]

Subtribe 1
Arundinarieae: Stamens usually 3, palea 2-keeled. Pericarp thin, adnate to the seed.
GENERA: *Arundinaria*, *Arthrostylidium*, *Phyllostachys*, *Athroostachys*, *Merostachys*, *Chusquea*, *Planotia*

Subtribe 2
Eubambuseae: Stamens 6, palea usually 2-keeled. Pericarp thin, adnate to the seed.
GENERA: *Nastus*, *Guadua*, *Bambusa*, *Thyrsostachys*, *Guaduella*, *Atractocarpa*, *Gigantochloa*, *Oxytenanthera*, *Puelia*

Subtribe 3
Dendrocalameae: Stamens 6, palea 2-keeled. Pericarp fleshy or crustaceous, separable from the seed.
GENERA: *Dendrocalamus*, *Melocalamus*, *Pseudostachyum*, *Teinostachyum*, *Greslania*, *Cephalostachyum*

Subtribe 4
Melocanneae: Stamens 6 or more, spikelets 1-flowered; palea none or similar to the flowering glume. Pericarp crustaceous or fleshy, separable from the seed.
GENERA: *Schizostachyum*, *Dinochloa*, *Melocanna*, *Ochlandra*.

* This investigation was supported by the Deutsche Forschungsgemeinschaft.

Slight modifications to the system of Bentham were made by E. G. Camus (1913) and by Stapf (1917). Camus arranged the genera in five tribes and four subtribes while Stapf combined the African genera *Puelia*, *Guaduella* and *Atractocarpa* of the second subtribe into a separate fifth subtribe (Pueliinae). The system of Stapf was adopted by Hubbard (1934) in Hutchinson's monograph "Monocotyledons." A markedly different system was proposed by A. Camus (1935) as an expansion of the system formulated by her father E. G. Camus (1913). She assigned all genera having filaments united to form a tube into a special tribe Synandrae, resulting in a total of seven tribes and four subtribes.

CLASSIFICATION SYSTEM OF A. CAMUS (1935)

	GENERA
Tribus I	
Arundinariae:	*Sasa, Oreiostachys, Arundinaria, Thamnocalamus, Fargesia, Phyllostachys, Microcalamus, Glaziophyton*
Tribus II	
Arthrostylideae:	*Arthrostylidium, Aulonemia, Merostachys*
Tribus III	
Chusqueae:	*Chusquea, Planotia*
Tribus IV	
Bambuseae verae:	*Guadua, Guaduella, Bambusa, Oreobambus, Nastus, Greslania, Thyrsostachys*
Tribus V	
Hickelieae:	*Hickelia*
Tribus VI	
Synandrae:	*Puelia, Atractocarpa, Gigantochloa, Oxytenanthera, Neohouzeaua*
Tribus VII	
Baccifereae	
Subtribus I	
Dendrocalaminae:	*Pseudostachyum, Teinostachyum, Dendrocalamus, Cephalostachyum, Melocalamus*
Subtribus II	
Melocanninae:	*Schizostachyum, Dinochloa, Melocanna, Ochlandra*
Subtribus III	
Pseudocoixinae:	*Pseudocoix.*
Subtribus IV	
Perrierbambusinae:	*Perrierbambus.*

Holttum (1946, 1956) regarded the tribe Synandrae of A. Camus as unnatural. In his opinion, the main differences between Bentham's subtribes, based on fruit-structure, are not in accordance with the observed natural characters. Although fruit structure is considered of basic importance by Munro (1868) and Bentham (1883), both studied only very few fruits and their limited observations were insufficient for the weight given them in their system. Furthermore, they neglected the structure of the ovary, the spikelet (except in the fourth subtribe), and the inflorescence. As a result, a thorough revision of bamboo classifica-

tion was considered necessary by Holttum (1956). As the basis for a natural classification he proposed a new system based on the structure of the ovary. In comparison with earlier systems it contains substantial changes within the four divisions to which the genera have been assigned.

CLASSIFICATION SYSTEM OF HOLTTUM (1956)

A. Schizostachyum type of ovary:
Melocanna, *Ochlandra*, *Schizostachyum* (including *Teinostachyum*, *Pseudostachyum*, *Cephalostachyum*, and *Neohouzeaua*).
B. Oxytenanthera type of ovary:
Oxytenanthera (sensu stricto).
C. Bambusa-Dendrocalamus type of ovary:
Melocalamus, *Dinochloa*, *Thyrsostachys*, *Bambusa*, *Guadua*, *Dendrocalamus*, *Gigantochloa*, *Racemobambos* (including *Chloothamnus*).
D. Arundinaria type of ovary.

There is hardly any other group of flowering plants so difficult to identify and classify as are the bamboos. This is mainly because the common identification based on flowers and fruits is seldom possible since most bamboo species flower only at irregular intervals and often die soon after. There are also species which mostly remain sterile. For example, in *Bambusa vulgaris*, one of the most common species, only very few flowering specimens have been observed, and fruiting has never been seen (McClure, 1966). Only a few species flower annually or even constantly, e.g., *Arundinaria wightiana*, *Bambusa lineata*, *Ochlandra rheedii*, *O. stridula*, *Schizostachyum brachyladum*, *S. gracile* and *S. grande* (Gamble, 1896; Holttum, 1946; Raizada & Chatterji, 1956). Furthermore, the flowers of many tropical bamboo species undergo changes during their development so that their morphological characteristics vary according to the time of observation. The preparation of collected material is often difficult because the flowers are easily damaged. Misinterpretations are then possible, when new species or genera are described on the basis of such flower fragments in which essential floral characteristics may be missing (McClure, 1957a). Consequently, many species may be described under different names or members of the same species may be placed in different genera, or the same name may be given to quite different species.

As a result of these difficulties and uncertainties, a rather confused picture results. This is reflected not only in the classification systems mentioned above but also in the estimates of the numbers of species and genera, which vary from 500 to more than 1000 species, and from 30 to about 90 genera. Actually, the bamboos may contain around 600 to 700 species, excluding the bamboo grasses "Sasa" from Japan, which alone comprise 6 genera with more than 600 species. McClure (1957b), who concentrated in his first revision on 88 genera, which he had checked,

later considered only 63 as "good," because he proved that several genera were described twice. The most important genera, together with the number of their species and their distribution, are listed in TABLE 1.

TABLE 1. **List of the more important bamboo genera with the number of their species and their distribution.**

GENERA	NUMBER OF SPECIES	DISTRIBUTION
ARTHROSTYLIDIUM Ruprecht	20	Central and South America
ARUNDINARIA Michaux	81	Asia, America, Africa
ATHROOSTACHYS Bentham	1	Brazil
ATRACTOCARPA Franchet	1	Congo
BAMBUSA Retzius corr. Schreber	73	Central and East Asia, Malaysia
BRACHYSTACHYUM Y. L. Keng	1	East Asia (China)
CEPHALOSTACHYUM Munro	9	India, Malaysia, Madagascar
CHIMONOBAMBUSA Makino	12	China, Japan, Korea, Taiwan
CHUSQUEA Kunth	71	Middle and South America
DENDROCALAMUS Nees	24	India–Philippines
DINOCHLOA Buse	9	Philippines, Java, Malaysia
FARGESIA Franchet	1–2	China
GIGANTOCHLOA Kurz ex Munro	12	India–Philippines
GUADUA Kunth	29	Middle and South America, Philippines
GUADUELLA Franchet	4	Central and West Africa
HICKELIA A. Camus	1	Madagascar
HITCHCOCKELLA A. Camus	1	Madagascar
INDOCALAMUS Nakai	7	China, Philippines
INDOSASA McClure		East Asia (China)
LELEBA** Nakai	(3)†	Japan
LINGNANIA McClure		China
MELOCALAMUS Bentham	1	India
MELOCANNA Trinius	2	India
MEROSTACHYS Sprengel	18	South America
NASTUS Jussieu	2–10	South America, Madagascar, Sumatra
NEOHOUZEAUA A. Camus	2	India, Indonesia, Laos
NEUROLEPIS Meisner	9	South America, New Guinea
NIPPONOBAMBUSA* Muroi	(12)†	Japan
OCHLANDRA Thwaites	11	Middle and East Asia, Malaysia, Ceylon, Madagascar
OREOBAMBUS K. Schumann	1	Africa (Usumbura)
OXYTENANTHERA Munro	16–18	Asia, New Guinea, Africa, Madagascar
PERRIERBAMBUS A. Camus	2	Madagascar
PHYLLOSTACHYS Siebold & Zuccarini	25	Japan, China, Taiwan, Indochina, Himalaya

PLEIOBLASTUS* Nakai	(93)†	China, Japan
PSEUDOCOIX A. Camus	1	Madagascar
PSEUDOSASA* Makino ex Nakai	4	Japan, Korea, China
PSEUDOSTACHYUM Munro	1–2	Himalaya (India)
PUELIA Franchet	1	West Africa, Congo, Gabon
RACEMOBAMBOS Holttum	5	Malaysia (Borneo)
SASA* Makino & Shibata	(400)†	Central and East Asia
SASAELLA* Makino	(132)†	Japan
SASAMORPHA* Nakai	(4)†	Japan, South China, Korea
SCHIZOSTACHYUM Nees	25	India–Philippines, Madagascar
SEMIARUNDINARIA Makino ex Nakai	(8–15)†	South China, Japan
SHIBATAEA Makino ex Nakai	1	China, Japan
SINARUNDINARIA Nakai		East Asia
SINOBAMBUSA Makino ex Nakai	(1)†	Japan
SINOCALAMUS McClure		China
TEINOSTACHYUM Munro	5	India, Ceylon
THYRSOSTACHYS Gamble	2	India, Thailand

* The genera in Japan called "SASA" comprise more than 600 species; they are distinguished from the group of bamboo species called "TAKE."

Division of the Bambusaceae in Japan

GENERA OF BAMBOO GRASS ("SASA")	GENERA OF BAMBOO ("TAKE")
Nipponobambusa	*Leleba***
Pleioblastus	*Phyllostachys*
Pseudosasa	*Semiarundinaria*
Sasa	*Sinobambusa*
Sasaella	*Chimonobambusa* (including *Tetragonocalamus*)
Sasamorpha	*Shibataea*

** In Japan all *Bambusa* species with thorny branches are combined in *Leleba*.

† The numbers of species growing in Japan. Sources: Raizada & Chatterji (1956); McClure (1957b); Ueda (1960); Prat (1960); Hino (1961); and Lin (1967).

Because the flowers of many bamboos appear only infrequently, special importance has to be given to the vegetative structures, too. A comprehensive description of the morphology of the vegetative parts of the bamboos is given by Holttum (1958) in his taxonomic account of the bamboos of the Malay Peninsula together with a key to these species based on vegetative characters. Of special value as diagnostic characters are the culm sheaths, which have been investigated in detail by Chatterji & Raizada (1963). Their description and key to the identification of 22 Indian bamboo species is, however, not satisfactory, since no distinctions were made between the ligule and the auricles (Holttum 1972). The key itself is rather restricted in its application because of considerable variations within the same species and an overlapping between different species and genera (Pattanath & Ramesh Rao, 1969). Furthermore, it can be used only for sheaths of mature culms, because in immature ones differences in shape, size, and texture of the sheaths may occur. It is also

necessary to recognize that culm sheaths, leafy twigs, and other vegetative structures alone are not satisfactory substitutes for herbarium material of flowering specimens, in spite of their usefulness for identification purposes. Holttum (1972) pointed out that he could not define any genus on vegetative characters only. However, the collection and study of individual bamboos cannot be deferred until they are flowering.

Therefore, McClure (1957a, 1966) proposed that at first a complete description of the vegetative structures of sterile bamboos should be made and the description of the reproductive structures should be added after flowering has been observed. These suggestions appear all the more important, since during flowering culm growth is more or less reduced, so that no new culms with sheaths are produced and the older sheaths soon disappear. This is why culm sheaths and flowers of the same plant are only rarely present together in herbaria.

CLASSIFICATION BASED ON ANATOMICAL CHARACTERS

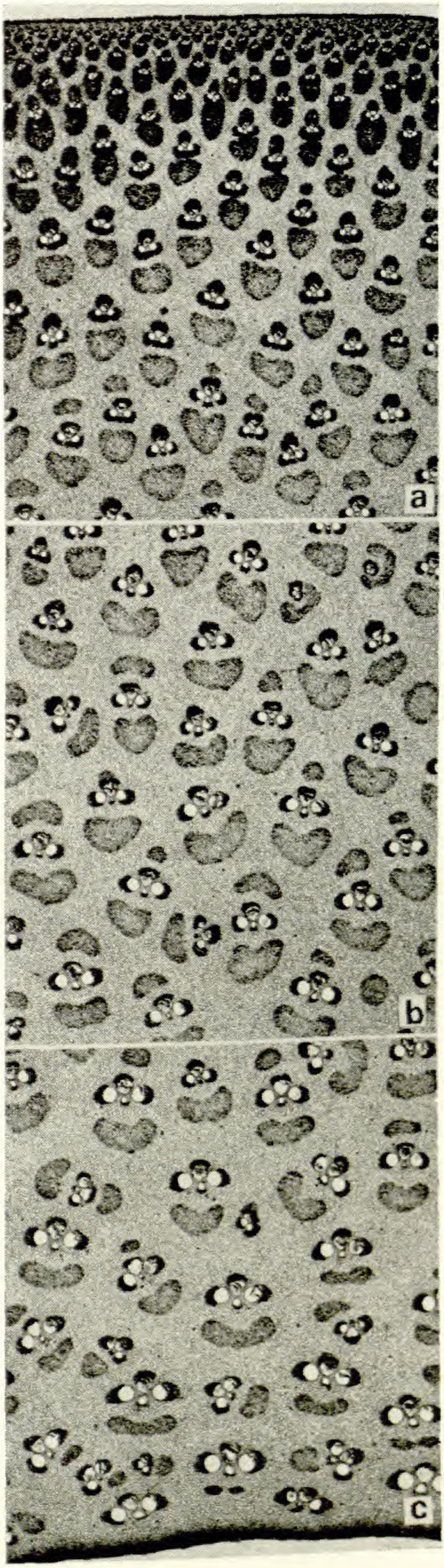
Intensive investigations were carried out on 52 species of bamboo in 14 genera, collected in India, Bangla Desh, Thailand, Indonesia, the Philippines, Taiwan, and Japan, which are listed in detail by Grosser (1971) in his contribution to the histology and classification of Asian bamboo species. The results have revealed that the anatomical characters of the bamboo culms are of considerable value for taxonomic identification, since distinct differences in the structure of the vascular bundles exist between various genera as well as between many species. For most of the species investigated a characteristic shape, size, and arrangement of the vascular bundles could be demonstrated, on the basis of which an anatomical classification system has been devised, which is discussed in the following section.

In order to understand the principles of this system the anatomical structure of bamboo culms must be described briefly (for details see Grosser, 1971; Grosser & Liese, 1971; Grosser & Zamuco, 1971).

The anatomical structure of bamboo culms is mainly determined by the collateral vascular bundles embedded in the parenchymatous tissue. The vascular bundles are small, numerous and close to each other near the periphery, becoming larger and more widely distributed towards the center of the culm. However, in the inner culm of plants of many species the bundles appear smaller again. Consequently, they reach their maximum size in the central zone where they also exhibit their characteristic form (FIGURE 1). The phloem and xylem part of each bundle is surrounded by sclerenchymatous sheaths, differing in size and shape according to their position within the culm of the given bamboo species. Each vascular bundle in the central zone possesses four of these sheaths; two lateral on either side of the vessels, and two polar, surrounding the phloem

---

FIGURE 1. *Dendrocalamus giganteus* Munro. Cross section of culm wall, a, outer, b, middle, c, inner part of the culm, all, × 11.


a
b
c

and the intercellular space. Additionally, many genera possess isolated fiber strands, situated either only on the inner side of the vascular bundle or on the inner and outer sides; they are separated from the central vascular strand by a few rows of parenchyma cells. Consequently, two structural types of arrangement of the supporting tissue can be distinguished: sheaths and strands. Bamboo species with isolated fiber strands, therefore, possess vascular bundles consisting of two or even three parts, depending on whether one or two fiber bundles are present in addition to the central vascular strand. On the other hand, bamboo species with only sclerenchyma sheaths have vascular bundles consisting of only one part. Depending on the presence or absence of these types of vascular structures, four basic vascular bundle types can be distinguished. These are described in detail in TABLE 2 and illustrated in FIGURES 2, 3, 4, and 5.

TABLE 2. **Basic vascular bundle types in bamboos** (from Grosser & Liese 1971)*

Vascular bundle type I (a)

CHARACTERISTICS: Consisting of one part (central vascular strand); supporting tissue only as sclerenchyma sheaths; intercellular space with tyloses.

OCCURRENCE: In all species with leptomorph rhizomes throughout the culm as the only type (*Arundinaria, Phyllostachys*). See FIGURE 2.

Vascular bundle type II (b)

CHARACTERISTICS: Consisting of one part (central vascular strand): supporting tissue only as sclerenchyma sheaths; sheath at the intercellular space (protoxylem) strikingly larger than the other ones; intercellular space without tyloses.

OCCURRENCE: In species with pachymorph rhizomes growing either in single-culm-formation (*Melocanna*) or in clumps (*Cephalostachyum, Schizostachyum, Teinostachyum*). In *Cephalostachyum* as the only type throughout the culm; in *Melocanna, Schizostachyum, Teinostachyum* in the basal internodes often together with type III. See FIGURE 3.

Vascular bundle type III (c)

CHARACTERISTICS: Consisting of two parts (central vascular strand and one fiber strand); fiber strand inside the central strand; sheath at the intercellular space (protoxylem) generally smaller than the others.

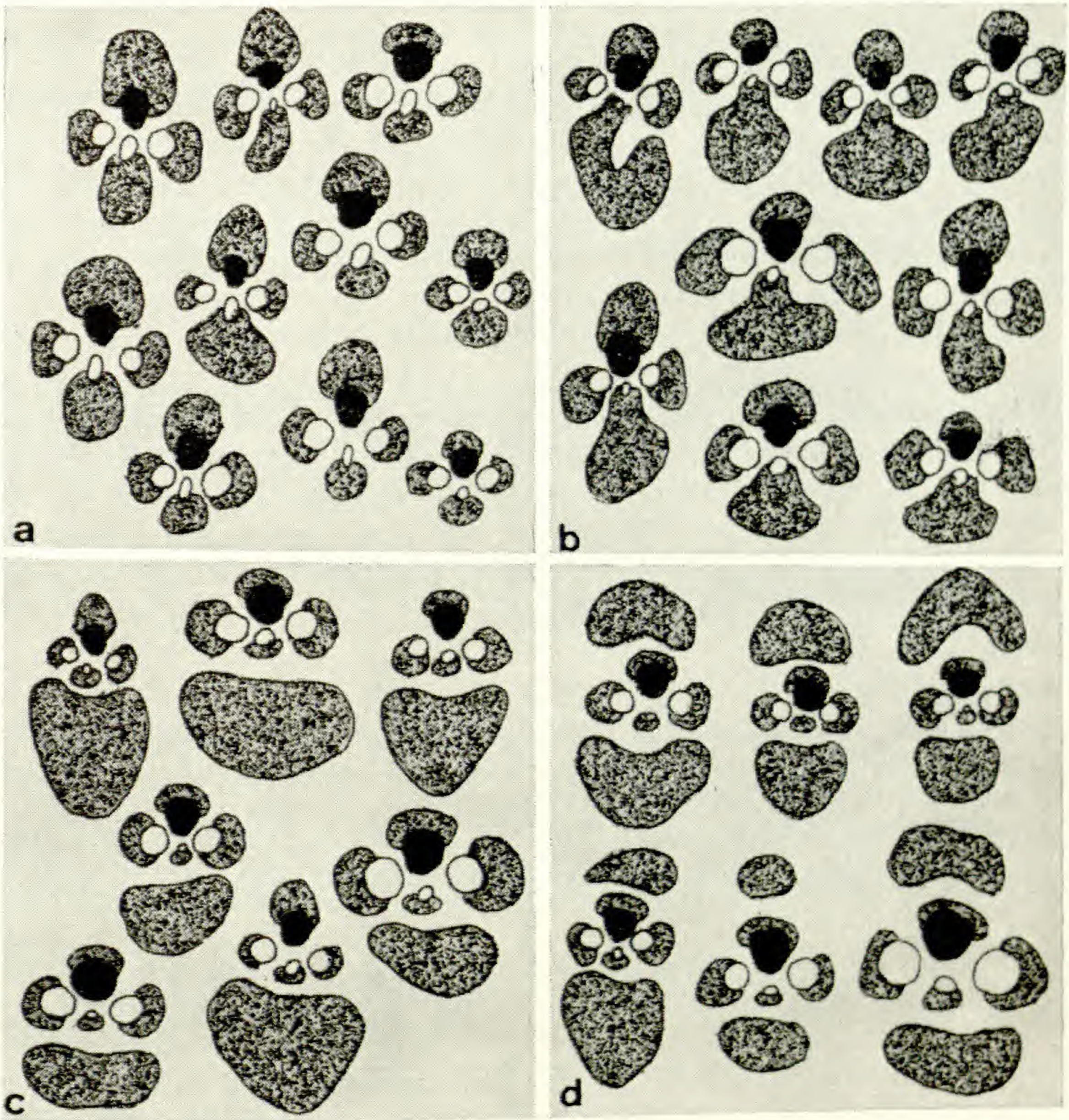
OCCURRENCE: In clump-forming species with pachymorph rhizomes (*Bambusa, Dendrocalamus, Gigantochloa, Thyrsostachys*); at the basal internodes combined mostly with type IV, in the middle and upper parts as the only type. In *Melocanna, Schizostachyum*, and *Teinostachyum* combined at the basal internodes with type II. In some *Oxytenanthera* species, as the only type throughout the culm. See FIGURE 4.

Vascular bundle type IV (d)

CHARACTERISTICS: Consisting of three parts (central vascular strand and two fiber strands); fiber strands outside and inside the central strand.

OCCURRENCE: In clump-forming species with pachymorph rhizomes (*Bambusa, Dendrocalamus, Gigantochloa, Thyrsostachys*): mostly at the basal internodes, seldom at the middle part; always combined with type III. See FIGURE 5.

*TABLE 2 (text and illustrations) from Grosser & Liese 1971, reproduced here by permission of Springer-Verlag, Berlin.



Based on the presence of these four basic types as well as combinations of them within one culm, an anatomical system of classification can be drawn up. It consists of four main groups, one of which is divided into two sub-groups:

GROUP A — Genera having vascular bundle type I consisting of one part:
Arundinaria, Phyllostachys, Tetragonocalamus.

GROUP B — Genera having vascular bundle type II consisting of one part.

GROUP B 1 — Genera having type II alone:
Cephalostachyum.

GROUP B 2 — Genera having type II combined with type III, consisting of two parts:
Melocanna, Schizostachyum, Teinostachyum.

GROUP C — Genera having vascular bundle type III consisting of two parts alone:
Oxytenanthera.

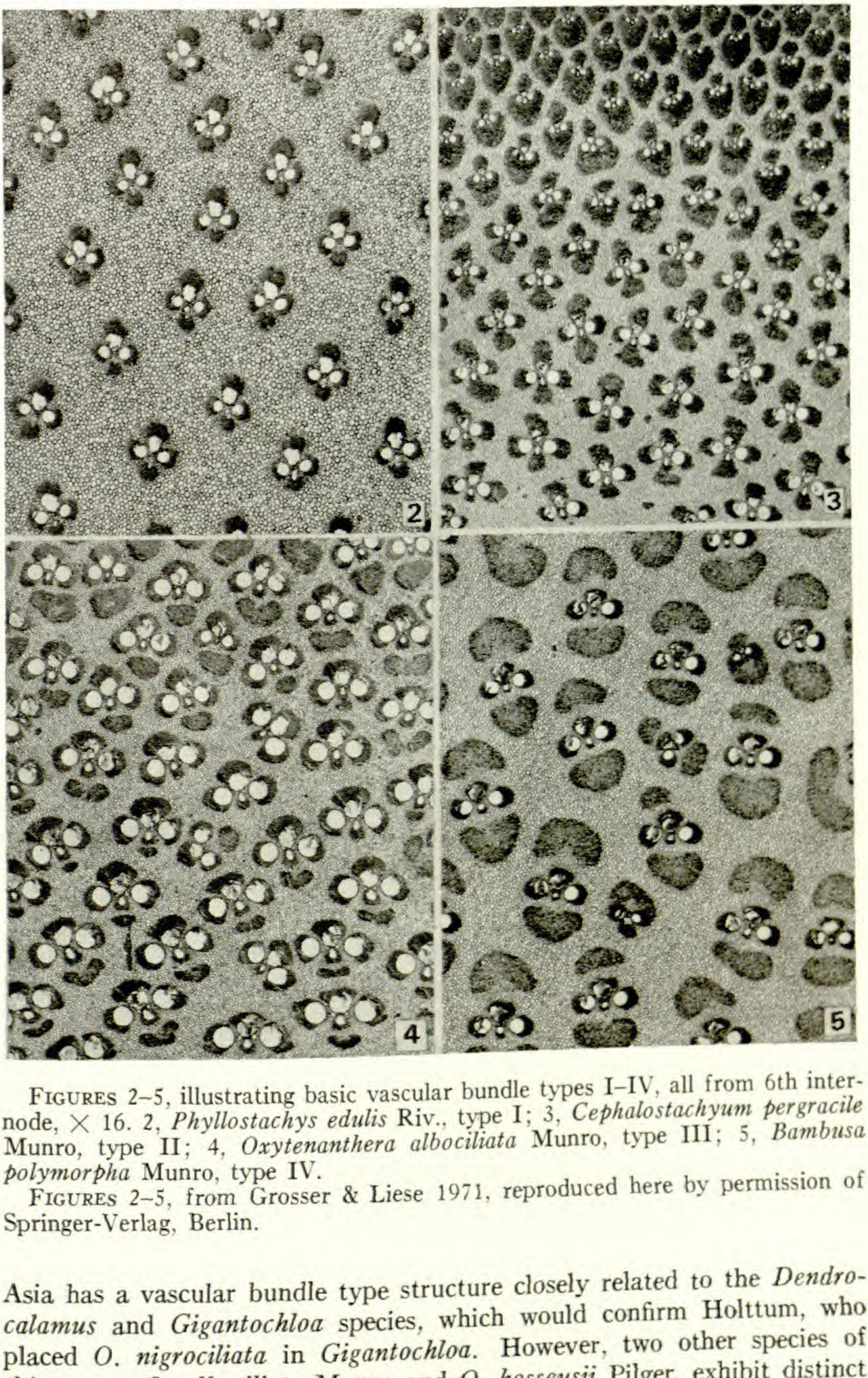
GROUP D — Genera having type III, consisting of two parts combined with type IV consisting of three parts:
Bambusa, Dendrocalamus, Gigantochloa, Thyrsostachys.

GROUP A with the vascular bundle type I consisting of one part, in general characterizes the leptomorph genera which are growing monopodially, whereas the pachymorph genera with sympodial growth are typified by the GROUPS B, C, and D with the vascular bundle types II, III, and IV, consisting of one, two, and three parts respectively (see TABLE 2). Between these two morphologically different bamboo groups there also exist distinct structural differences. As far as the distribution of genera is concerned, our classification system based on vascular bundle types is in accordance to a large extent with Holttum's (1956) which is based on similarities in reproductive structures. The anatomical results confirm Holttum's opinion that neither the widely applied system of Munro modified by Bentham (1883), nor the system by A. Camus (1935) agrees with the natural order.

The genera *Bambusa* and *Dendrocalamus*, which in the older classifications have been placed for nearly a century in different subtribes or tribes, possess very similar anatomical structures. Pattanath & Ramesh Rao (1969) also noted that both genera have several anatomical features in common. Therefore, both genera should be grouped together as Holttum also proposed. Furthermore, on the basis of their vascular bundles the genera *Gigantochloa* and *Thyrsostachys* belong to the Bambusa-Dendrocalamus-GROUP D. On the other hand, *Dendrocalamus* has a distinctly different structure from *Teinostachyum* and *Cephalostachyum* so that these two genera cannot be placed together with *Dendrocalamus* in one group as was formerly done, but rather into different groups as suggested by Holttum. The *Teinostachyum* and *Schizostachyum* species investigated have such a similar structure that Holttum's proposal to include the *Teinostachyum* species in the genus *Schizostachyum* would conform with the natural order. The extent to which this also applies to *Pseudostachyum* and *Neohouzeaua* has not so far been determined anatomically. However, in contrast to the proposal of Holttum, the genus *Cephalostachyum* appears to be anatomically less related to the genus *Schizostachyum* so that its inclusion in the latter should be examined further.

The genus *Melocanna* belongs to GROUP B, together with the genera *Cephalostachyum* and *Schizostachyum* including *Teinostachyum*. It shows, however, more similarities with *Schizostachyum* than with *Cephalostachyum*. All four genera possess the vascular bundle type II which is present either alone (*Cephalostachyum*) or in combination with type III (*Melocanna*, *Schizostachyum* and *Teinostachyum*) so that two SUBGROUPS, B 1 and B 2, can be distinguished.

The genus *Oxytenanthera* forms a separate group, both on the basis of its morphology in the system of Holttum as well as from the anatomical point of view. Holttum (1956) shows that *Oxytenanthera* species from Asia described by Munro & Gamble are either species of *Dendrocalamus* or species of *Gigantochloa* and concludes that the genus *Oxytenanthera* is exclusively African. Consequently, his "group B — ovary of the Oxytenanthera type" should be restricted to the African species (type species *O. abyssinica* (A. Richard) Munro). In fact *O. nigrociliata* Munro from



FIGURES 2–5, illustrating basic vascular bundle types I–IV, all from 6th internode, × 16. 2, *Phyllostachys edulis* Riv., type I; 3, *Cephalostachyum pergracile* Munro, type II; 4, *Oxytenanthera albociliata* Munro, type III; 5, *Bambusa polymorpha* Munro, type IV.

FIGURES 2–5, from Grosser & Liese 1971, reproduced here by permission of Springer-Verlag, Berlin.

Asia has a vascular bundle type structure closely related to the *Dendrocalamus* and *Gigantochloa* species, which would confirm Holttum, who placed *O. nigrociliata* in *Gigantochloa*. However, two other species of this genus, *O. albociliata* Munro and *O. hosseusii* Pilger, exhibit distinct differences from *Dendrocalamus* and *Gigantochloa* (Grosser, 1971; Grosser & Liese, 1971). The same differing structure probably occurs in the

African *O. abyssinica* as can be concluded from investigations of a few basal internodes obtained from Sudan. Pattanath & Ramesh Rao (1969) also indicate a vascular bundle structure for basal internodes of *O. abyssinica* which appears to be similar to that of *Oxytenanthera albociliata*.

At least some species of *Oxytenanthera* growing in Asia probably possess an anatomical structure closely related to *Oxytenanthera abyssinica*. However, only a thorough investigation of their morphology, especially of the reproductive structures, and the histology of the genus will clarify which of the 16 to 18 species of *Oxytenanthera* described so far belong to the genus *Oxytenanthera* sensu Holttum, and those which must be included in the genera *Dendrocalamus* and *Gigantochloa*. Holttum (1972) points out that his assessment of the distinctiveness of the ovary characters of *O. abyssinica* was possibly wrong and that these observations need a re-analysis. Therefore *O. abyssinica* (type species) might be more closely related to *Dendrocalamus* than was previously thought. Otherwise, two anatomical groups could be differentiated: one closely corresponding to *Dendrocalamus* and *Gigantochloa* (e.g., *O. nigrociliata*, placed in *Gigantochloa* by Holttum), and the other not corresponding to these genera (e.g., *O. abyssinica*, *O. hosseusii* and *O. albociliata*, the last one placed in *Dendrocalamus* by Holttum).

At first glance, a revision appears necessary for *Dendrocalamus membranaceus* Munro because the anatomy of this species, collected in the Botanical Garden of the Forest Research Institute, Dehra Dun (India), differs considerably from the other eight *Dendrocalamus* species investigated so far, but resembles markedly *O. albociliata*. Its affinity to the genus *Dendrocalamus*, therefore, appears questionable from the histological viewpoint. More likely this species belongs to *Oxytenanthera*. Parker (see Chatterji & Raizada, 1963) assumed on morphological evidence that *D. membranaceus* Munro and *Oxytenanthera lacei* Gamble are identical. But Holttum (1972) definitely regards *D. membranaceus* as a species of *Dendrocalamus*; it has short spikelets with 2 or 3 perfect florets, much like those of *Dendrocalamus strictus* (Roxb.) Nees, the type species of the genus. Therefore the culms collected as *D. membranaceus* in Dehra Dun may in fact belong to another species. An anatomical comparison with plants from other botanical gardens appears necessary to obtain conclusive results.

In cases where the thickness of the culm wall is insufficient (e.g., *Bambusa multiplex* (Lour.) Raeusch, a species with only small thin-walled culms) the vascular bundle type IV with its three parts appears only rarely in internodes near the ground. Also in other *Bambusa* and *Dendrocalamus* species vascular bundles of the basic type IV may not be developed if the culm remains small and thin-walled because of unsuitable growing conditions. For the formation of vascular bundle type IV, the culm wall must have a thickness of at least 10–25 mm., according to the species. Consequently, species belonging to the GROUP D may have vascular bundle types of the GROUP C in their smaller culms. For the pachy-

morph genera a classification into four different culm types has been described inyolving three vascular bundle types: B (divided into B1 and B2), C, and D. In contrast, all leptomorph genera have the same vascular bundle type, represented by GROUP A. Consequently, not only species of the genera *Arundinaria*, *Phyllostachys* and *Tetragonocalamus* investigated by the authors (Grosser, 1971; Grosser & Liese, 1971) but also leptomorph species of the genera *Brachystachyum*, *Chimonobambusa*, *Indocalamus*, *Phyllostachys*, *Pleioblastus*, *Pseudosasa*, *Semiarundinaria*, *Sinobambusa*, and *Shibataea* (investigated by Li & Chin, 1960; and by Li, Chin & Yao, 1962) possess these types of vascular bundles. The Chinese authors have grouped the 24 species from 14 genera investigated into 15 different culm types, designated as different anatomical groups. They have chosen for their anatomical characterization the vascular bundle sequences from internodes of the middle of the culm. Such sequences consist of the radial order of vascular bundles across the culm-wall from the periphery towards the center. However, form, size, and distribution of the vascular bundles vary considerably across the culm-wall. Furthermore, each bamboo species has a more or less typical sequence of vascular bundles. Thus, their classification system is rather complex leading to 15 different types for only 24 species; the conformity of species related to each other becomes unclear. Also, the system refers only to the internodes from the middle part of the culm, whereas the vascular bundles and their sequences vary considerably in height position within one culm (Grosser, 1971; Grosser & Liese, 1971). Therefore, the classification system by Li, Chin & Yao (1960, 1962) cannot be regarded as representative either for the whole culm or for the species itself.

CONCLUSIONS

The results of our anatomical investigations on 52 bamboo species of 14 genera clearly demonstrate that for the classification of species and genera into natural systematic groups not only the morphology of the reproductive structures can be used, but also anatomical characters, in particular the structure of the vascular bundles. Because many bamboo species flower only rarely, classification systems based solely on reproductive characters, such as those of Munro (1868), Bentham (1883), Gamble (1896), E. G. Camus (1913), A. Camus (1935), and Holttum (1956) have limited value for the identification of standing culms. Similarly, morphological features of vegetative organs such as culm sheaths, are suitable for identification purposes only to a limited extent because of their variation in the same species, and their overlapping between species and genera. Additionally they are absent in culms cut for use. Other morphological features like the habit of the culms, the number and length of internodes, wall thickness, etc. are by themselves only of restricted diagnostic value. Consequently, more emphasis should be placed on anatomical structure, because significant anatomical differences exist

between species of a genus and between genera. These differences can be applied successfully for the designation of bamboo genera into natural systematic units and for the further development of a modern bamboo classification. For a system of identification of bamboos — to be more independent of any one morphological state (e.g., sterile, flowering, cut, converted) — it is suggested that the following approach should be adopted:

A. Consideration of the *morphology of reproductive structures* — according to Holttum's classification.
B. Consideration of the *morphology of all important vegetative organs* — according to the results of Holttum (1958) and Chatterji & Raizada (1963) and the proposals of McClure (1957a, 1966).
C. Consideration of *anatomical characters of the culms* — according to the vascular bundle types described above (Grosser & Liese, 1971) and the results of study of the epidermal structure by Ghosh & Negi (1960) and Pattanath & Ramesh Rao (1969).

SUMMARY

In the present paper the current status and problems of bamboo classification are discussed. Comparative histological investigations on 52 bamboo species from 14 genera, collected in seven Asian countries, have shown that certain anatomical features of the culm are of taxonomic value. They can be used successfully in addition to morphological characters of the reproductive and vegetative organs for the differentiation of bamboo into natural systematic units. The classification system presented is based on four vascular bundle types and combinations of them within one culm. This system coincides to a large extent with the classification of Holttum based on the structure of the ovary. Both the systems as well as the older classifications are discussed.

REFERENCES

BENTHAM, G. Gramineae. IN: BENTHAM, G., & J. D. HOOKER. Genera Plantarum. 3(2): [Bambuseae] 1076, 1077; 1094–1096; 1207–1215. 1883. London. Reeve.

CAMUS, A. Classification des Bambusées. Arch. Mus. Hist. Nat. Paris. Sér. 6. **12:** 601–605. 1935.

CAMUS, E. G. Les Bambusées: monographie, biologie, culture, principaux usages. 1913. Paris. Paul Lechevalier, 215 pp.

CHATTERJI, R. N., & M. B. RAIZADA. Culm-sheaths as an aid to identification of bamboos. Indian Forester **89:** 744–756. 1963.

GAMBLE, J. S. The Bambuseae of British India. Ann. Roy. Bot. Gard. Calcutta **7:** xvii + 133 pp. 1896. Reprinted by Willmer Brothers, Ltd. Birkenhead, England. 1966.

GHOSH, S. S., & B. S. NEGI. Anatomy of Indian bamboos. Part I. Epidermal features of *Bambusa arundinacea* Willd., *B. polymorpha* Munro, *B. vulgaris* Schrad., *Dendrocalamus membranaceus* Munro, *D. strictus* Nees and *Melocanna bambusoides* Trin. Indian Forester **86:** 719–727. 1960.

GROSSER, D. Beitrag zur Histologie und Klassifikation asiatischer Bambusarten. Mitt. Bundesforschungsanstalt Forst- und Holzwirtschaft, Reinbek, Nr. 85. 321 pp. *pls. 1–23.* 1971.

——— & W. LIESE. On the anatomy of Asian bamboos, with special reference to their vascular bundles. Wood Sci. Technol. **5**(4): 290–312. 1971.

——— & G. I. T. ZAMUCO, JR. Anatomy of some bamboo species in the Philippines. Philippine Jour. Sci. **100**(1): [in press]. 1971.

HACKEL, E. Gramineae. IN: ENGLER, A., & K. PRANTL. Nat. Pflanzenfam. II. Abt. 2. [Bambuseae] 89–97. 1889. Leipzig. Engelmann.

HINO, I. Icones Fungorum Bambusicolorum Japonicorum. The Fuji Bamboo Garden. 335 pp. 1961.

HOLTTUM, R. E. The classification of Malayan bamboos. Jour. Arnold Arb. **27:** 340–346. 1946.

———. The classification of bamboos. Phytomorphology **6:** 73–90. 1956.

———. The bamboos of the Malayan Peninsula. Gard. Bull. Singapore **16:** 1–135. 1958.

———. Letter to Prof. Dr. W. Liese dated 16. Feb. 1972.

HUBBARD, C. E. Gramineae. IN: HUTCHINSON, J. The families of flowering plants. II. Monocotyledons. [Bambuseae] 203–205. 1934. Oxford.

LI, C.-L., & T.-C. CHIN. Anatomical studies of some Chinese bamboos. Acta Bot. Sin. **9:** 76–97. 1960.

———, ———, & H.-S. YAO. Further anatomical studies of some Chinese bamboos. Acta Bot. Sin. **10:** 15–28. 1962.

LIN, W.-C. The species and distribution of bamboos in the Republic of Malagasy (Madagascar). East African Spec. Bull. Taiwan For. Res. Inst. No. 4, 34 pp. 1967.

LINNÉ, C. VON: Species Plantarum. 1753.

MCCLURE, F. A. The taxonomic conquest of the bamboos with notes on their silvicultural status in the Americas. Paper presented to the 4th World Forestry Congress, Dehra Dun 1954. IN: Tropical Silviculture **2:** 304–308. 1957a. Rome.

———. Typification of the genera of the Bambusoideae. Taxon **6:** 199–210. 1957b.

———. The bamboos: a fresh perspective. Harvard Univ. Press, Cambridge, Mass. xv + 347 pp. 1966.

MUNRO, W. A monograph of the Bambusaceae. Trans. Linn. Soc. London. Bot. **26:** 1–157. 1868.

PATTANATH, P. G., & K. RAMESH RAO. Epidermal and internodal structure of the culm as an aid to identification and classification of bamboos. IN: Recent advances in the anatomy of tropical seed plants. Proc. 1st Nat. Symp. Muslim Univ. Aligarh. 179–196. 1969. Hindustan Publ. Corp. India.

PRAT, H. Vers une classification naturelle des Graminées. Bull. Soc. Bot. France **107:** 32–79. 1960.

RAIZADA, M. B., & R. N. CHATTERJI. World distribution of bamboo with special reference to the Indian species and their more important uses. Indian Forester **82:** 215–218. 1956.

ROXBURGH, W. Hortus Bengalensis. 1814.

RUMPF, G. E. Het Amboinsch Kruid-boek (Herbarium Amboinense). Amsterdam. 1750.

RUPRECHT, F. J. Bambuseas monographice expoint. Acad. St. Pétersburg. I–

XVIII. 1–71. 1839. Reprint: Bambuseae. Mem. Acad. St. Pétersb. (VI) Sci. Nat. 3(1): 91–165. 1840.

STAPF, O. System der Gramineae. IN: D. PRAIN, Fl. Trop. Africa 9: 1917.

UEDA, K. Studies on the physiology of bamboo with reference to practical application. Bull. Kyoto Univ. Forests, No. 30. 167 pp. 1960.

DR. D. GROSSER
INSTITUT FÜR HOLZFORSCHUNG
UND HOLZTECHNIK
D–8 UNIVERSITÄT MÜNCHEN
WINZERERSTR. 45

PROF. DR. W. LIESE
INSTITUT FÜR HOLZBIOLOGIE UND
HOLZSCHUTZ DER BUNDESFORSCHUNGSANSTALT
FÜR FORST- UND HOLZWIRTSCHAFT
D-205 HAMBURG-LOHBRÜGGE
LEUSCHNERSTR. 91d

NOTES ON WEST INDIAN MYRTACEAE

ROGERS MCVAUGH

THE FOLLOWING NOMENCLATURAL and taxonomic notes and descriptions of taxa new to science have resulted from floristic studies on the Myrtaceae of the Lesser Antilles. Abbreviations for herbaria are those of Lanjouw and Stafleu, *Index Herbariorum* (Reg. Veg. 31: [vi], 251 pp. 1964).

Calyptranthes pallens Griseb. Veg. Kar. 67. 1857.

Calyptranthes chytraculia δ *pauciflora* Berg, Linnaea **27**: 27. 1855.

The name is often incorrectly cited as "*Calyptranthes pallens* (Poir.) Griseb." As noted previously (Fieldiana Bot. **29**: 408. 1963), *C. pallens* Griseb. was based wholly on *C. chytraculia* δ *pauciflora* Berg, which in turn was based on a specimen collected in Guadeloupe by Bertero (herb. Sonder., ?MEL, not seen). *Eugenia pallens* Poir. (in Lam. Encyc. Suppl. 3: 122. 1813), however, was based on a specimen from St. Thomas (*Ledru*!, at P). Ledru's specimen is a good flowering specimen of *Calyptranthes pallens*.

Eugenia foetida Pers. Syn. Pl. **2**: 29. Nov. 1806.

Myrtus buxifolia Sw. Prodr. 78. 1788. *Myrtus axillaris* sensu Poir. in Lam. Encyc. **4**: 412. 1797, non Sw. 1788. *Eugenia buxifolia* (Sw.) Willd. Sp. Pl. **2**: 960. 1800, non Lam. 1789. *Eugenia myrtoides* Poir. in Lam. Encyc. Suppl. **3**: 125. 1813.

This common species of the Caribbean region was known as *Eugenia buxifolia* until recently, when it was pointed out anew that the name is illegitimate. It has been treated under the name *Eugenia myrtoides*, and more recently under that of *Eugenia maleolens* Pers. (Syn. Pl. **2**: 29. Nov. 1806).

Eugenia myrtoides Poir. was a name intended to replace the illegitimate *E. buxifolia*. The type of the latter (Hispaniola, *Swartz*!, BM; MICH neg. 1991) clearly represents the species long known as *E. buxifolia*. The type of *E. maleolens* Pers., however, represents another species, viz. *E. monticola* (Sw.) DC. *Eugenia maleolens* was based on "*E. foetida* Vahl in herb. Juss." Number 13927A of the Jussieu Herbarium (P!; MICH neg. 1972) is marked by Jussieu "Eugenia Antilles St. Croix–donné par M. Richard 1791," and in another hand "Eugenia foetida Vahl." The leaves are "ovato-lanceolatis acuminatis" as described by Persoon for *E. maleolens*, and it most probably is the type of that name. The specimen is certainly referable to *E. monticola*.

Eugenia foetida was described as having "fol. oblanceolatis obtusis." It was said to have come from the Antilles "cum priore" (i.e. *E. maleolens*), and the specimen cited was "Richard in herb. Juss." Number 13929 of the Jussieu Herbarium (P!; MICH neg. 1973) is marked by Jussieu "Eugenia foetidissima Rich. Antilles. St. Croix–donné par M. Richard 1791." The leaves are as described by Persoon, and there can be hardly any doubt that the plant is the type of *E. foetida*. It is an ample specimen with scattered immature fruits that presumably represent the "flor. axillaribus solitariis" of the original description. It is clearly of the same species as the type of *Myrtus buxifolia* Sw.

Eugenia hodgei McVaugh, sp. nov.

Arbor 8-metralis, trunco 10 cm. diam., maturitate glaber, hypanthio pedicellisque conferte et minute pilis ca. 0.1 mm. longis hispidulis; calycis lobis, bracteis bracteolisque ciliatis aliter fere glabris; folia elliptica vel obovata vel fere orbicularia, coriacea, supra lucida et atroviridia, subtus pallida, 3.5–6.5 cm. longa, 2.5–4 cm. lata, plerumque 1.5–2-plo longiora quam latiora, apice rotundata vel obtusa, basi acuta vel marginibus ad angulum 90° divergentibus; petioli 4–5 mm. longi; nervus medius supra versus basin saltem canaliculatus; venae laterales utroque latere ca. 6, rectae, subtus prominentiores; venae marginales a marginibus paullo incrassatis revolutisque 1.5–4 mm. remotae, inter venas laterales arcuatae; racemi solitarii vel bini, e nodis defoliatis oriundi, 2–8-flori, rhachidi 2–3 mm. longa vel breviore, 1.5 mm. crassa, bracteis persistentibus instructa; pedicelli 2.5–5 mm. longi; bracteolae subquadratae vel latiores quam longiores, fere vel omnino contiguae, ciliatae, usque ad 0.7 mm. latae; alabastra floresque aperti non visi; hypanthium post anthesin obovoideum, basi subrotundatum, apice truncatum, ca. 1.3 mm. longum crassumque; calycis lobi late rotundati, pallidi, translucentes, glandulis magnis punctati, ciliati sed aliter glabri, majores 1.5–1.7 mm. lati, 0.7–1 mm. longi; discus post anthesin conspicuus, 1.5 mm. latus, minute rareque hispidulus, cicatricibus staminalibus pallidis magnis conspicuis, centro glabro depresso dimidio angustiore; stylus non visus; stamina ca. 50; ovarium biloculare, ovulis quoque loculo 10–12, in placentis centralibus confertis.

Dominica: Xerophytic, wooded slopes west of Morne Gay house, Badineau Estate, alt. ca. 350 m., one of the dominant trees of the scrub forest, 24 III 1940, *W. H. Hodge & B. T. Hodge 2230* (GH, type).

This plant does not seem especially closely related to any other species in the Lesser Antilles or northeastern South America. It is one of many small-flowered species with sparingly pubescent herbage and greatly reduced racemes of short-pedicelled flowers. It may be confused with *E. procera* (in which the pedicels are glabrous and 5–12 mm. long), with *E. axillaris* (in which the flowers are nearly or quite glabrous and the leaves acute or acuminate), and with *E. monticola* or *E. foetida* (in which the leaves are flat in drying and the midvein not grooved nor depressed on the upper surface).

Myrcia antillana McVaugh, sp. nov.

Myrcia edulis sensu Urban, Bot. Jahrb. **19:** 581. 1895, not *Aulomyrcia edulis* Berg, 1861. *Myrcia edulis* var. *dominicana* Krug & Urb. ex Urb. Bot. Jahrb. **19:** 582. 1895.

Arbor usque ad 10–12 m. altus, 20–30 cm. diam., maturitate fere glaber, ramulis paniculisque (floribus exceptis) densiuscule pilis ascendentibus vel appressis, cupreis vel pallide rufis, partim dibrachiatis, strigosis; folia rigide coriacea, subtus in siccitate plerumque cuprea, supra atro-ferruginea; laminae late ellipticae vel elliptico-obovatae, 5–12(–20) cm. longae, 3–6(–11) cm. latae, 1.5–2-plo longiores quam latiores, apice obtuse brevi-acuminatae vel obtusae, basi obtuse angulatae, rotundatae, rariuscule subcordatae vel acutae; petioli 5–7 mm. longi, 2–3 mm. crassi, stratis exterioribus mox suberantibus rimosis exfoliantibus; nervus medius supra impressus; paniculae 6–15 cm. longae, patenti-ramosae, 2–3-plo compositae, floribus plurimis subsessilibus, prope ramulorum apices aggregatis; bracteae ovatae, induratae, per anthesin persistentes; alabastra 3–4 mm. longa, late pyriformia, fere glabra, hypanthii basi angusta sparse pilosa; calycis lobi 5, intus apicibus puberulis exceptis glabri, inaequales, rotundati, usque ad 1 mm. longi, 2.5 mm. lati, in alabastro appressi, sub anthesi patentes, aetate demum decidui vel subdecidui; discus glaber, patelliformis, ca. 3–3.5 mm. latus; stylus ca. 5 mm. longus; stamina 75–100; fructus depresso-globosus, diametro 1.2–2 cm.; ovarium biloculare, loculis biovulatis.

Lesser Antilles from Dominica to St. Vincent, at elevations from 150 to 850 m. above sea level, flowering from February to June.

Guadeloupe: Ravine-Chaude, *Duss 3510* (NY); Sofaya, above Ste. Rose, *Holdridge 446* (NY); without locality, *L'Herminier* (G, MICH).

Dominica: without locality, *Ramage* (K, lectotype, and A, photo. of lectotype of *M. edulis* var. *dominicana*); along the river near Deux Branches, *Hodge 3488* (GH); Brantridge Estate near Pont Casse, *Ernst 1199* (MICH).

St. Lucia: Savanne Edmund Dist., southeast of Piton Troumassée, *Proctor 17733* (A, MICH), *17697* (A, MICH), *17973* (A; MICH, type); summit of Piton Cochon, *J. S. Beard 183* (A); Castries W. W. Reserve, *J. S. Beard 478* (A), probably same locality ["Forestière"], *P. Beard 1053* (GH), *Sturrock 558* (A).

St. Vincent: Mt. Brisbane, *Morton 5982a* (US); Mt. St. Andrews, *Howard 18010* (A); Charlotte Parish, Mt. Grand Bonhomme, *Proctor 26063* (GH, MICH); without locality, *H. H. & G. W. Smith 1553* (GH, NY).

Specimens from Dominica were treated by Urban as a distinct variety because the leaves were relatively longer, and longer-pointed, than those from other islands. The relationships of this species are apparently with *Myrcia inaequiloba* and *M. decorticans* of northeastern South America (see Mem. N. Y. Bot. Gard. **18**(2): 85. 1969).

Myrcia citrifolia (Aubl.) Urb. Repert. Sp. Nov. **16**: 150. 1920.

Myrtus citrifolia Aubl. Fl. Guiane Fr. index p. 20. 1775.

Primarily a West Indian species, *Myrcia citrifolia* is represented by two well-marked and partly geographically separated varieties. In var. *imrayana* (Griseb.) Stehlé & Quent. (Fl. Guad. Dépend. Mart. 2(fasc. 3): 57. 1949) the leaves are prevailingly elliptic-obovate, dull or scarcely glossy; the pubescence of the young shoots is relatively abundant; the panicles are relatively crowded, the flowers irregularly disposed, and the common peduncles elongate. The type was from Dominica (*Imray*!, isolectotype, GH). In var. *citrifolia* the leaves are mostly elliptic to subor-bicular, rigid and glossy; the pubescence is scanty; the panicles are very openly branched, regularly forked, short-peduncled. The name *Myrtus citrifolia* was based wholly upon "MYRTUS cotini folio. PLUM. CAT. 19. Myrtus foliis alternis, ovatis. BURM. *Amer. p.* 203. *t.* 208. *fig.* 2" (Aublet, Fl. Guiane Fr. 513. 1775). Burman's plate cited by Aublet represents a markedly round-leaved plant with open inflorescence (i.e., what I take to be var. *citrifolia*); the plate itself seems to have been based with some modifications upon a Plumier drawing at P (Bibliothèque Centrale). (Plumier mss. vol. 7, *pl. 83*!, "Myrtus cotini folio.") According to the manuscript accompanying the Plumier drawing, the plant came originally from Martinique ["illam regionem qua vulgo (Le Cul de Sac à Vache) vocitatur"].

Psidium longipes (Berg) McVaugh, comb. nov.

Eugenia longipes Berg, Linnaea **27:** 150. Jan. 1856. *Myrtus verrucosa* Berg, Linnaea **27:** 405. Feb. 1856. *Eugenia orbicularis* Berg, Linnaea **30:** 678. 1861. *Eugenia bahamensis* Kiaersk. Bot. Tidsskr. **17:** 266. preprint 1890. *Myrtus anguillensis* Urb. Symb. Antill. **6:** 21. 1909. *Anamomis longipes* (Berg) Britton ex Small, Fl. Miami 132. 1913. *Anamomis bahamensis* (Kiaersk.) Britton ex Small, Fl. Florida Keys 104. 1913. *Myrtus bahamensis* (Kiaersk.) Urb. Ark. Bot. **21A**(5): 18. 1927. *Mosiera bahamensis* (Kiaersk.) Small, Man. Southeast. Fl. 937. 1933. *Mosiera longipes* (Berg) Small, Man. Southeast Fl. 937. 1933. *Myrtus orbicularis* (Berg) Burret, Notizbl. Bot. Gart. Berlin **15:** 482. 1941.

This has traditionally been treated as a group of three species, one ("*longipes*" or "*verrucosa*") in Florida and the Bahamas, one ("*bahamensis*") mostly in the Bahamas, and the third ("*orbicularis*") in the northern Lesser Antilles. As late as Urban's revision of West Indian Myrtaceae (1895), all three were included in *Eugenia* primarily because of the 4-merous flowers. Britton and his associates supposed erroneously that these taxa were congeners of Grisebach's *Anamomis fragrans*, which belongs to quite a different group of genera. It was not until the work of Burret (1941; see above) that all were assigned a place in *Myrtus*, although each was treated as a separate species. Even this last disposition is open to question.

As implied by Burret in his overview of *Myrtus*, and as argued in more detail in Taxon 17: 402, 403. 1968, *Myrtus* as a genus is difficult to defend in the American flora. Burret retained in his conception of the worldwide genus only 14 species of the West Indies in addition to the type

and one North African species. In my opinion he did not go far enough. The West Indian species I have studied have more in common with other American species of *Psidium* than with *Myrtus communis* L., the type-species of its genus.

It was pointed out (Fieldiana Bot. 29: 514–516. 1963) that the most reliable distinction between *Myrtus* and *Psidium* is not the feature of open vs. closed calyx, as many workers following Bentham and Niedenzu have supposed (cf. Alain in Fl. Cub. 3: 410. 1953). In fact, about two-thirds of all known species of *Psidium* have an open 4- or 5-lobed calyx. The primary observable difference between these two genera is in the degree to which the hypanthium splits between the calyx-lobes after anthesis; in *Myrtus* proper the calyx-lobes remain contiguous even in fruit; in *Psidium* the calyx and hypanthium split irregularly between the lobes, often down to the summit of the ovary.

In all the forms of *Psidium longipes*, as far as I have observed them, the fruiting calyx develops short but definite fissures between the lobes in the manner of other unquestioned species of *Psidium* in the West Indies. In view of the calyx character and the strong morphological resemblances between *P. longipes* and such species as *P. rotundatum* Griseb. of Cuba, it seems appropriate to transfer *Eugenia* (or *Anamomis*, or *Mosiera*) *longipes*, to *Psidium*. Another species of the same affinity is **Psidium moensis** (Britt. & Wils.) McVaugh, comb. nov. (*Eugenia moensis* Britt. & Wils. Mem. Torrey Bot. Club 16: 88. 1920). In the absence of fruit, this plant was described as a *Eugenia* because of the 4-lobed calyx and axillary flowers. Fruiting specimens now at hand, e.g., *Clemente & Alain 4026* (GH), clearly show the pimentoid character of the seeds and the calyx of *Psidium*.

As there has been no suggestion that there may be reproductive barriers between the island populations representing "*longipes*," "*bahamensis*," and "*orbicularis*," it seems unrealistic to treat the populations as separate species, even though the extremes may be recognizable morphologically. I find no qualitative differences among them; the existing differences are in presence or absence of pubescence, in size and shape of leaves, length of petioles and peduncles, and perhaps in size of flowers. These features may be summarized as follows:

Plants essentially glabrous; leaves 1–2.7 cm. long, 0.7–1.8 cm. wide, 2–3 times as long as wide, elliptic or ovate, obtuse to rounded or acute at tip and base; petioles 1–2 mm. long; peduncles (0.8–)1.7–2.5(–3.5) cm. long; bracteoles 1.5–3 mm. long; floral disk 2.5–3.5 mm. wide; southern Florida, Bahamas. ..... var. *longipes*.

Plants glabrous or the branchlets hispidulous; leaves 1–4.5 cm. long, (0.7–)1–2(–3.5) cm. wide, elliptic to orbicular, rounded to obtusely pointed at apex, rounded to subcordate (rarely acute) at base; petioles 1.5–4 mm. long; peduncles 1.5–4(–5) cm. long; bracteoles 2.5–4 mm. long; floral disk 2.7–4 mm. wide.

Plants mostly glabrous (some populations from the eastern Bahamas and Caicos Islands pubescent); leaves elliptic-ovate or elliptic, 0.7–2(–3.5)

cm. wide, 1.25–2 times as long as wide; peduncles 2–4(–5) cm. long. Bahamas, Turks & Caicos Islands. ..... "*bahamensis*."

Plants mostly pubescent (some populations on Antigua glabrous); leaves broadly ovate or elliptic to suborbicular, (0.7–)1–2(–2.8) cm. wide, as wide as long or up to 1.5 times as long as wide; peduncles 1.5–2 cm. long; Anguilla, St. Barthélemy, Antigua, Barbuda. .... "*orbicularis*."

Many populations in the Bahamas seem intermediate in leaf-form between typical "*longipes*" and "*orbicularis*." There seems to be no clear distinction between the rather variable taxon that has been called "*bahamensis*," and the somewhat less variable "*orbicularis*." It seems appropriate and useful, however, to distinguish nomenclaturally between the morphological extremes that are also separated geographically:

1. **Psidium longipes**, var. **longipes**. *Eugenia longipes* Berg, the type from Florida, *Cabanis s.n.* (B, presumably now destroyed).
2. **Psidium longipes** var. **orbiculare** (Berg) McVaugh, comb. nov. *Eugenia orbicularis* Berg, the type from Barbuda ("Barbados"), *Richard*! (P). *Eugenia bahamensis* Kiaersk., the type from Acklin's Island, *Eggers 3917* (not seen, presumably at C). *Myrtus anguillensis* Urb., the type from Anguilla, *Boldingh 3509*B! (isotype, NY).

Broad-leaved and narrow-leaved forms occur both in "*bahamensis*" and "*orbicularis*," but I cannot correlate these differences with others. The type of *Eugenia bahamensis* represented one of the pubescent populations with relatively broad leaves, i.e., more like "*orbicularis*" than "*longipes*." *Myrtus anguillensis* is a plant with leaves tending to be obovate rather than elliptic.

UNIVERSITY HERBARIUM
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48104

THREE NEW SPECIES OF PICRAMNIA (SIMAROUBACEAE) FROM CENTRAL AMERICA

DUNCAN M. PORTER

DURING THE MID-1940's, Dr. Arthur Cronquist published a series of useful papers on the systematics of the American species of the family Simaroubaceae (Cronquist 1944a, b, c, d, 1945). All indigenous genera, save one, were treated in detail. Unfortunately, that genus not treated, *Picramnia* Sw., remains the most poorly known of the family. One must still agree with Macbride (1949, p. 695) that "No Peruvian genus is more in need of general revision than this; in many cases species have been described from partial material or incompletely if not inaccurately . . ." Pending such a revision, the relationships of the three new species described below remain obscure.

Picramnia allenii D. M. Porter, sp. nov.

Picramnia quaternaria primo adspectu maxime simile, sed floribus trimeris.

FIGURES 1 and 2.

TYPE. **Panama.** COCLÉ: Mountains beyond La Pintada, 400–600 m. Small tree 4 m. 16 February 1935, *A. A. Hunter & P. H. Allen 538* (MO, holotype; F, GH, NY, US, isotypes).

Shrubs or small trees, 1–7 m. high; branchlets yellowish appressed-tomentulose, becoming glabrate. Leaves alternate, pinnate, 18–24.5 cm. long, petiole and rachis yellowish appressed-tomentulose, becoming almost glabrate; leaflets 12–20, mainly an even number, alternate to the lowermost subopposite or opposite, ovate to elliptic, narrowly acuminate apically, rounded and markedly inequilateral basally, the margins entire, revolute, chartaceous, yellowish appressed-tomentulose above and beneath on the main vein and marginally, the blade sparingly pubescent, 22–75 mm. long and 8–23 mm. wide, the terminal leaflets largest, the lowermost smallest and reflexed, the petiolules yellowish appressed-tomentulose, 2–3 mm. long. Staminate racemes subterminal, becoming axillary, aggregated to solitary, simple or rarely once branched, densely flowered, yellowish appressed-tomentulose, to 38 cm. long. Staminate flowers 3-merous, numerous, 1–several aggregated in clusters, white or greenish, the pedicels spreading, yellowish appressed-tomentulose, to 3 mm. long; sepals 3, ovate, apiculate, appressed-pubescent, ca. 1.5 mm. long and 1 mm. wide; petals 3, narrowly elliptic, apiculate, glabrous to rarely sparingly pubescent, longer than the sepals, ca. 1.5 mm. long; stamens 3, exserted,

FIGURES 1, 2. *Picramnia allenii* D. M. Porter: 1, photograph of holotype specimen; 2, close-up of staminate raceme.

the filaments filiform, glabrous, ca. 2.5 mm. long, the anthers basifixed, 2-lobed, the lobes separated; ovary absent. Carpellate racemes solitary or in pairs, yellowish appressed-tomentulose, to 28 cm. long. Carpellate flowers 3-merous, the pedicels appressed-tomentulose, articulated basally, 1–1.5 cm. long in fruit; sepals 3, broadly triangular, appressed-pubescent, persistent and spreading in fruit, ca. 2 mm. long and 1 mm. wide; style bilobed, the lobes recurved and persisting in fruit. Berries red or orange, ellipsoid to obovoid, appressed-pubescent to glabrate, to 1.5 cm. long; seeds 1.

This species is named for the late Paul Hamilton Allen (1911–1963), a graduate of the Missouri Botanical Garden and long-time collector of the Central American flora. It appears to be a rather common shrub or small tree in forests and cut-over areas at altitudes from 500 to 1500 meters from the Panamanian provinces of Coclé and Chiriquí northwestward to central Costa Rica. Only the Costa Rican collections examined are

listed below, as Panamanian exsiccatae will be cited in the forthcoming treatment of the Simaroubaceae for the *Flora of Panama.*

Costa Rica. ALAJUELA: Between Alajuela and Volcán Poás, *Greenman & Greenman 5403* (MO). CARTAGO: NW slope of Cerro Carpintera above La Unión de Tres Ríos, 1320–1500 m., *Dodge & Thomas 4841* (MO). SAN JOSÉ: 5 mi. ESE of Desamparados, *Croat 1064* (MO); Escazu, ca. 1300 m., *Solís R. 304* (MO); San José, 1100 m., *Smith 6464* (MO), *Tonduz 10140* (MO); San Pedro, *Greenman & Greenman 5281* (MO), fence tree bordering coffee plantation, vicinity of San Pedro, *Godfrey 67211* (MO).

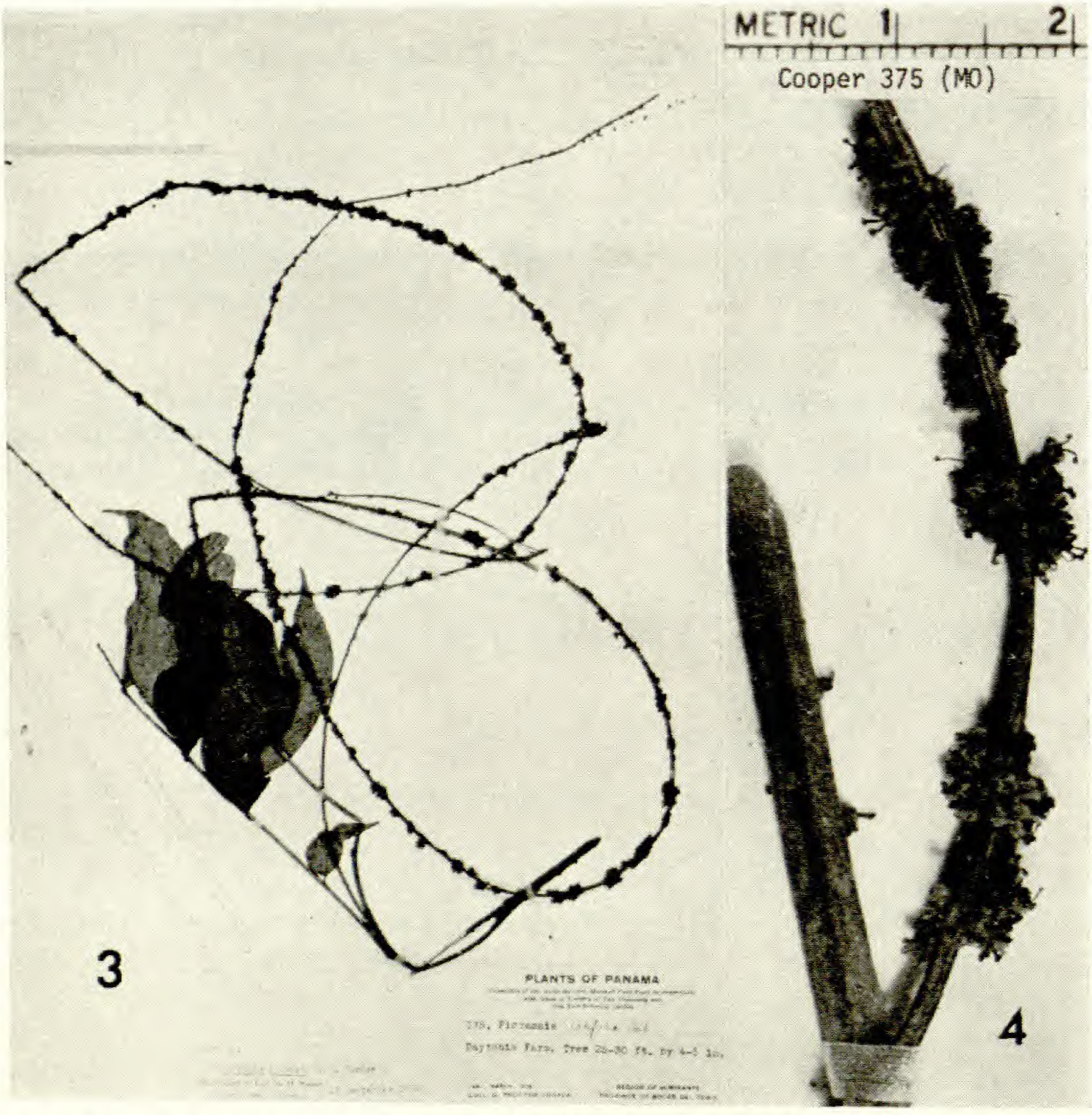
Picramnia allenii is similar vegetatively to *P. quaternaria* Donn. Sm., a species of southern Mexico, Guatemala, Honduras, El Salvador, and Nicaragua. Almost all collections examined had been labeled as *P. quaternaria.* However, the flowers of *P. allenii* are 3-merous, while those of *P. quaternaria* are 4-merous, and the two are allopatric in distribution. Common names reported from Costa Rica are *caregre* (fide *Solís R. 304*) and *caregue* (fide *Smith 6464* and *Tonduz 10140*).

Picramnia cooperi D. M. Porter, sp. nov.

Picramnia latifolia primo adspectu maxime simile, sed floribus trimeris. FIGURES 3 and 4.

TYPE: **Panama.** BOCAS DEL TORO: Region of Almirante. Daytonia Farm. Tree 25–30 ft. by 4–5 in. January–March 1928, *G. Proctor Cooper 375* (GH, holotype; F, NY, US, isotypes).

Shrubs or small trees, 2–10 m. high; branchlets yellowish appressed-pubescent, becoming glabrate. Leaves alternate, pinnate, ca. 25 cm. long; petiole and the rachis sparingly appressed-pubescent, becoming glabrate; leaflets 7–8, alternate to subopposite, ovate to elliptic or oblong, acute to obtuse and abruptly acuminate apically, rarely retuse, acute to obtuse and inequilateral basally, the margins entire, revolute, chartaceous, the blade sparingly appressed-pubescent, especially basally, on the veins beneath, and marginally, becoming glabrate, 5–12 cm. long and 21–53 mm. wide, the terminal and subterminal leaflets largest, the petiolules pubescent, ca. 3 mm. long. Staminate racemes axillary, aggregated or solitary, simple, densely flowered, yellowish appressed-pubescent, 68–96 cm. long. Staminate flowers 3-merous, numerous, several together in clusters, cream-colored, the pedicels sparingly yellowish appressed-pubescent, to ca. 1 mm. long; sepals 3, broadly ovate, yellowish appressed-pubescent, 2 mm. long and 1.5 mm. wide; petals 3, oblanceolate, apiculate, hooded, glabrous, longer than the sepals, ca. 2 mm. long; stamens 3, exserted, the filaments subulate, glabrous, 3 mm. long, the anthers basifixed, 2-lobed, the lobes separated; disc 3-lobed, each lobe in turn bilobed and extending between 2 stamens; ovary conical, glabrous, the style and stigma absent. Carpellate racemes, flowers, and fruits unknown.



FIGURES 3, 4. *Picramnia cooperi* D. M. Porter: 3, photograph of holotype specimen; 4, close-up of staminate raceme.

This species is named for George Proctor Cooper of the United Fruit Company, who collected plants in Panama for the Yale School of Forestry in the late 1920's. It is known only from the province of Bocas del Toro.

Additional collection examined: **Panama.** BOCAS DEL TORO: Vicinity of Chiriquí Lagoon, *von Wedel 1226*, in part (MO).

Picramnia cooperi apparently is a shrub or small tree of the rain forest. It superficially resembles *P. latifolia* Tul., which also occurs in Bocas del Toro, but it is easily distinguished from the latter by its pubescence, 3-merous flowers, and much longer inflorescences. *Von Wedel 1226* is a mixed collection of *P. cooperi* and *P. latifolia*. The branch with the leaves is *P. latifolia*, while the unattached partial inflorescence is *P. cooperi*. The trichomes of the appressed-pubescent inflorescence and those of the appressed-puberulent branch and leaves are quite different from one another.

FIGURES 5–7. *Picramnia dwyeri* D. M. Porter: 5, photograph of holotype specimen; 6, close-up of carpellate raceme; 7, close-up of immature berry.

Picramnia dwyeri D. M. Porter, sp. nov.

Picramnia antidesma primo adspectu maxime simile, sed foliolis pubescentibus et floribus tetrameris.

TYPE. **Panama.** PANAMA: Between Cañasas and Sabalo, elev. ca. 100 m. Shrub; flowers green; fruits red. 26 September 1967, *J. A. Duke 14456* (MO, holotype).

Shrubs or small trees, ca. 2 m. high; branchlets densely yellowish-to-mentose, finally becoming glabrate. Leaves alternate, pinnate, to 24 cm. long; petiole and the rachis densely yellowish-tomentose; leaflets ca. 8–13 (–17), alternate, the lowermost subopposite, ovate to obovate or oblanceolate, the terminals elliptic, abruptly short-acuminate apically, markedly inequilateral basally, the margins entire, revolute, chartaceous, the midrib indented above and prominent beneath, appressed yellowish-pubescent on the margin and on the midrib beneath, minutely puberulent

in the sulcus above, the blade sparingly pubescent beneath, to 5 (8.8) cm. long and 2 (4.5) cm. wide, the terminal leaflets largest, the lowermost smallest and reflexed, the petiolules densely yellowish-tomentose, 1–2 mm. long. Staminate racemes terminal, aggregated, simple, yellowish appressed-pubescent, to 20 cm. long. Staminate flowers 4-merous, 1–2 together, green, the pedicels spreading, sparingly pubescent, 1–1.5 mm. long; sepals 4, connate basally, narrowly ovate, apiculate, yellowish appressed-pubescent, ca. 1.5 mm. long; petals 4, narrowly lanceolate, glabrous, a little longer than the sepals, 2 mm. long; stamens 4, exserted, the filaments subulate, glabrous, adnate basally to the petals, ca. 3 mm. long, the anthers basifixed, 2-lobed, the lobes separated; ovary rudimentary, tomentose, the style and stigma absent. Carpellate racemes terminal, solitary, simple, densely appressed yellowish-pubescent, to 32 cm. long in fruit. Carpellate flowers 4-merous, in clusters of 3 that alternate on the inflorescence, usually only 1 of the 3 forming a fruit, the pedicels thickened apically, appressed yellowish-pubescent, articulated basally, 3–8 mm. long in fruit; sepals 4, triangular, acute, appressed yellowish-pubescent, persistent and spreading in fruit; petals 4, narrowly triangular, shorter than the sepals; style bilobed, the lobes recurved and persisting in fruit. Berries green maturing red, obovoid or rarely ellipsoid, appressed-pubescent, 2-loculed, 7–15 mm. long; seeds 1–2.

This species is named for John Duncan Dwyer, Professor of Biology at St. Louis University, and efficient collector and determiner of Panamanian plants. It is an understory shrub or small tree of lowland monsoon forests, known only from Panama.

Additional collections examined. **Panama.** DARIEN: Bolamina, small hill, *Duke & Bristan 388* (MO). Near Refugio, 15–21 mi. N of Santa Fé, ca. 30 m., *Duke 10303* (MO). Río San José, *Duke & Bristan 416* (MO). Río Tuira, between Río Paya and Río Pucro, *Duke & Kirkbride 14054* (F, MO). Teotuma, ca. 100 m., *Duke 10061* (MO). SAN BLAS: Río Chucunaque, 2–10 mi. above Cuna–Darién boundary, *Duke 8567* (MO). VERAGUAS: Isla de Coiba, *Dwyer 2333* (MO, SIU), *2337* (MO).

Picramnia dwyeri superficially resembles the northern South American and Antillean *P. antidesma* Sw., an almost glabrous species with 3-merous flowers. The latter is often ascribed to Mexico and Central America, but collections so identified represent other taxa. *Picramnia dwyeri* is known as *korbugia* and *pakaburwi* by the Bayano Cuna Indians (fide *Duke 14456*). The berry "has bad taste" (fide *Duke & Bristan 388*).

LITERATURE CITED

CRONQUIST, A. 1944a. Studies in the Simaroubaceae. I. The genus *Castela*. Jour. Arnold Arb. **25**: 122–128.

———. 1944b. Studies in the Simaroubaceae. II. The genus *Simarouba*. Bull. Torrey Bot. Club. **71**: 226–234.

———. 1944c. Studies in the Simaroubaceae. III. The genus *Simaba*. Lloydia **7**: 81–92.
———. 1944d. Studies in the Simaroubaceae. IV. Resume of the American genera. Brittonia **5**: 128–147.
———. 1945. Additional notes on the Simaroubaceae. *Ibid*. **5**: 469, 470.
MACBRIDE, J. F. 1949. Flora of Peru: Simaroubaceae. Field Mus. Nat. Hist. Publ. Bot. **13**(3:2): 689–703.

DEPARTMENT OF BOTANY
NATIONAL MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C. 20560.

THE KRAMERIACEAE IN THE SOUTHEASTERN UNITED STATES [1]

KENNETH R. ROBERTSON

KRAMERIACEAE Dumortier, Anal. Fam. 20, 23. 1829, nom. cons.
(RATANY FAMILY)

A distinctive monogeneric family, mostly of arid regions in the New World. The family is characterized by shrubby or herbaceous perennial habit; exstipulate, simple and entire or rarely trifoliolate leaves; irregular flowers; petaloid calyx that much exceeds the dimorphic petals; stamens confined to the adaxial part of the flowers; apically dehiscent anthers; bicarpellate gynoecium with one fertile and one sterile carpel; and spiny, one-seeded, indehiscent fruits. TYPE GENUS: *Krameria* L.

Krameria is a quite singular genus, and its phyletic placement is problematical. It has been treated by various authors as the sole member of Krameriaceae, of the Polygalales; as tribe Kramerieae, of the Polygalaceae; as Krameriaceae, of the Rosales; as subfamily Kramerioideae, of the Leguminosae; and as tribe Kramerieae, subfamily Caesalpinioideae, of the Leguminosae. The structure of the wood, the exstipulate leaves, the vascular anatomy of the pedicel and receptacle, and the number and size of the chromosomes, as well as the frequency of chromosomal chiasmata, definitely indicate that *Krameria* is not closely allied to Leguminosae. Comparative information on Polygalaceae is mostly lacking, but three- or four-colporate pollen, adaxial stamens, collateral ovules, and seeds with endosperm are features never or seldom found in that family. Until more is known of *Krameria* and its supposed relatives, it seems best to keep the genus in its own family of uncertain affinities.

1. **Krameria** Linnaeus in Loefling, Iter Hisp. 195. 1758.

Perennial herbs [or, more often, low, much-branched, spinescent shrubs] from thick crowns on woody rootstocks; root system of long, few-branched taproots and/or horizontal lateral roots [some species root parasites];

[1] Prepared for a Generic Flora of the Southeastern United States, a joint project of the Arnold Arboretum and the Gray Herbarium of Harvard University made possible by the National Science Foundation (Grant GB–6459X, principal investigator, Carroll E. Wood, Jr.). This treatment, the seventieth to be published, follows the scheme outlined in the first paper of the series (Jour. Arnold Arb. **39:** 296–346. 1958). The area covered includes North and South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, and Louisiana. The descriptions are based on the plants in this area, with additional information from extraterritorial taxa in brackets. I am indebted to Professor Wood for his pertinent comments and to Ms. J. E. Hanhisalo for checking the bibliography and typing the manuscript.

plants often densely pubescent with simple [and glandular] trichomes. Leaves small, alternate, simple and entire [or rarely trifoliolate], sessile [or shortly petiolate]; stipules absent. Inflorescences axillary, 1-flowered [or, by condensation of the distal internodes, of terminal racemose clusters], the pedicels with 2 opposite, foliaceous bracts, both pedicels and bracts persistent after the fruits have fallen. Flowers perfect, irregular, resupinate or not, the perianth red-purple [or yellow]. Sepals 5 [4], quincuncially imbricate in aestivation, petaloid, much larger than petals, slightly unequal, the abaxial one somewhat gibbous, all deciduous. Petals 5 [4], dimorphic, the 3 adaxial ones long clawed, the claws connate [or free], the blades small, orbicular [or absent] the 2 abaxial petals sessile, thick, fleshy, glandlike. Androecium of 4 [3, 5] stamens in 2 unequal pairs opposite the 3 adaxial petals, a fifth, sterile stamen rarely found on the opposite side of the flower; filaments thick, basally connate [or distinct] and free or partly adnate to the claws of the adaxial petals; anthers narrowly conical, basifixed, opening by apical pores or slits; pollen 3- or 4-colporate, oblate-spheroidal, the sexine bacculate and striate. Gynoecium superior, syncarpous, of 1 fertile and 1 sterile carpel, the fertile carpel with 2 collateral anatropous ovules, pendulous from an adaxial placenta near the top of the locule; style obliquely terminal; stigma terminal, punctiform. Fruit dry, pubescent [or glabrous], nearly globose to ovoid, indehiscent, covered with long spines, 1-seeded; seeds without endosperm, the seed coat smooth, membranaceous; embryo straight, the cotyledons thick and fleshy, planoconvex, basally sagittate, the radicle superior. Base chromosome number 6. TYPE SPECIES: *K. Ixine* L.; see Linnaeus, Syst. Nat. ed. 10. 899. 1759. (Dedicated to Johann Georg Heinrich Kramer, an 18th Century Austrian botanist.) — RATANY, RHATANY.

Twenty or more species of xerophytes in four largely disjunct regions: *Krameria Ixine* in the West Indies from Hispaniola to Grenada, in northern South America, and perhaps in Paraguay; possibly 15 species in deserts of southwestern North America from California and Texas to Honduras; about four species in cordilleran South America from Peru to northern Chile and Argentina; and perhaps no more than six species in eastern Brazil. *Krameria lanceolata* Torrey occurs in the southern United States and adjacent Mexico. The genus has been revised only regionally, and the relationships between species occurring in the different geographical areas are difficult to determine.

Krameria lanceolata (*K. spathulata* Small in Britton), $2n = 12$, one of the most widely distributed species of the genus, occurs from mid-peninsular Florida to Georgia, and apparently disjunctly in Arkansas, Oklahoma, southern Kansas, Texas, southeasternmost Colorado, southeastern Arizona, Chihuahua, and Coahuila. It is found most commonly in open rocky or sandy areas. It is easily distinguished by its prostrate or trailing herbaceous stems; canescent linear leaves; bright wine-colored, irregular, solitary flowers with petaloid sepals and dimorphic petals (the adaxial three with long claws, the abaxial two glandlike); paired sta-

mens with thick, basally united filaments and tapering anthers that dehisce apically; and echinate, indehiscent fruits. Some plants of this species from northern Mexico have yellow flowers; whether these are merely a color form or a taxon worthy of recognition remains to be seen. The name *Krameria secundiflora* DC., based on a Sessé & Mociño drawing and sometimes applied to this species, should be rejected as an ambiguous name.

Meiotic chromosomes of the species of *Krameria* that have been examined cytologically are among the largest known from the dicotyledons, perhaps exceeded only by some species of *Paeonia* (Ranunculaceae) and of *Phoradendron* and *Psittacanthus* (Loranthaceae). At anaphase I, the longest chromosome of *K. lanceolata*, as observed by Lewis, *et al.*, measured 24.6 μm., the shortest was 10 μm., and the average length of the six was 17.3 μm.

Some species of *Krameria*, while outwardly appearing to be completely autotrophic, are partly parasitic on the root systems of other species. *Krameria Grayi* Rose & Painter (*K. canescens* Gray, non Willd.), white ratany, $2n = 12$, has been found parasitizing species of *Acacia*, *Ambrosia*, *Encelia*, *Ephedra*, *Larrea*, *Lycium*, *Menodora*, *Parkinsonia*, *Prosopis*, and *Ziziphus*. Seedlings of *K. Grayi* can be independent for an undetermined period of time but soon become attached to roots of host species if they are growing in association with them. In contrast to most desert perennials, which have either deep taproots or specialized water-storage organs, the roots of *K. Grayi* are usually thin and largely superficial (although Kuijt has illustrated a plant of this species with a long taproot). *Krameria parvifolia* Bentham, range ratany, and *K. paucifolia* (Rose) Rose also are reported to be root parasites.

Flowers of *Krameria* species are papilionaceous in appearance and seemingly adapted for entomophily, although there have been no reports on specific pollinators. It is difficult to determine floral orientation on herbarium specimens, but populations of some species, including *K. lanceolata*, have resupinate flowers. The intraspecific constancy of this feature and its effect on pollination are not known. The fruits of *K. lanceolata* have spines that are pubescent below with small bumps or barbs toward the apices; some other species have one to numerous retrorse barbs above or four large barbs at the tips of the spines. The fruits probably are dispersed by fur-bearing animals. Kuijt observed that many fully formed fruits of *K. Grayi* are empty; the same condition seems to be fairly common in *K. lanceolata*. A case of vivipary was seen by Palmer in *K. Grayi* (see Vasey & Rose). Kuijt's observation that the fleshy petals enlarge with the fruit and eventually surround it could not be substantiated from herbarium specimens, which suggest instead that the petals are promptly deciduous in most species.

According to Bentham's unique interpretation of the flower, the calyx is composed of the four large sepals, the abaxial, gibbous sepal representing a connate pair. The fifth, small "sepal," which is sometimes absent, represents the corolla. The three clawed "petals" and the two lateral

stamens comprise the outer androecial whorl, while the two upper stamens and the two fleshy "petals" form the inner staminal series. While this most interesting theory would support an alliance of *Krameria* with Polygalaceae, more recent studies have shown it to be incorrect. Milby, however, found that each of the adaxial, clawed petals of *K. lanceolata* has a single vascular trace (as in the stamens) while the abaxial, glandlike petals have several veins. Milby's study showing that the gynoecium of *Krameria* has a fertile carpel and a sterile one reaffirms Baillon's frequently overlooked observation (1873) that the ovary initially has two locules, one of which does not develop.

The dried roots of *Krameria triandra* Ruiz & Pavon, Peruvian ratany; *K. argentea* Martius, Para or Brazilian ratany; *K. tomentosa* Saint-Hilaire, Savanilla ratany; and *K. Ixine* contain a powerful astringent, and these species have been listed in pharmacopoeias as useful in the treatment of various conditions, such as diarrhea, hemorrhages, tumors, and sores. The roots of these species contain a high concentration of tannin, and they have been used in tanning of leather. *Krameria triandra* has also been used as a tooth powder and as an additive to port wine. The Indians of the American Southwest used infusions of twigs of *K. parvifolia* for the treatment of eye sores, and they obtained red, brown, and yellow dyes from the stems and roots of this species. *Krameria parvifolia* and *K. Grayi* are favorite browse plants of range animals.

REFERENCES:

BENTHAM, G. Plantae Hartwegianae. iv + 393 pp. London. 1839–1857. [*Krameria*, 13, 14; unique theory on morphology of its flower.]

BAILLON, H. Sur les *Krameria* et leur symetrie florale. Adansonia **11**: 15–23. *pl. 3*. 1873.

———. Polygalacées. Hist. Pl. **5**: 71–92. 1874. (English transl. M. M. Hartog. The Natural History of Plants **5**: 71–92. 1878.) [*Krameria* in tribe Krameriеae; illustrations.]

BENSON, L., & R. A. DARROW. The trees and shrubs of the southwestern deserts. ed. 2. x + 437 pp. *34 pls*. Tucson & Albuquerque 1954. [Leguminosae subfam. Kramerioideae, 151, 192–197.]

BRITTON, N. L. Krameriaceae. N. Am. Fl. **23**(4): 195–200. 1930.

CANNON, W. A. The root habits and parasitism of *Krameria canescens* Gray. *In*: D. T. MACDOUGAL & W. A. CANNON, The conditions of parasitism in plants. Carnegie Inst. Publ. **129**: 5–24. *pls. 1–3*. 1910. [= *K. Grayi* Rose & Painter.]

CHODAT, R. Systématique des Cramériacées. Bibliot. Univ. Arch. Sci. Phys. Nat. III. **23**: 495–499. 1890. [Includes synopsis of genus.]

CORRELL, D. S., & M. C. JOHNSTON, & collaborators. Manual of the vascular plants of Texas. xv + 1881 pp. *Frontisp. + 1 map*. Texas Research Foundation, Renner, Texas. 1970. [Krameriaceae, 889, 890.]

COTTON, J. G. S. Étude comparée sur le genre *Krameria* et les racines qu'il fournit a la médecine. Thèse Éc. Supérieure Pharm. Paris. 103 pp. *1 pl.* Paris. 1868.

CRONQUIST, A. The evolution and classification of flowering plants. xii + 396 pp. Boston. 1968. [Krameriaceae in Polygalales, 274–277.]

DANDY, J. E. Index of generic names of vascular plants, 1753–1774. Regnum Veg. **51:** 1–130. 1967. [See entry on p. 16 under Löfling.]

DOMINGUEZ, J. A. Contribución al estudio de la *Krameria Iluca* Phil. Trab. Mus. Farm. Buenos Aires **24:** 1–7. *pls. 1–4*. 1909.

ERDTMAN, G. The systematic position of the genus *Diclidanthera* Mart. Bot. Not. **1944:** 80–84. 1944. [*Krameria, figs. 11–12j*; pollen morphology excludes this genus from Polygalaceae.]

GRAY, A. Ord. Krameriaceae? Gen. Pl. U.S. Ill. **2:** *225–229. pls. 185, 186*. 1849.

HARTMANN, D. H. *Krameria. In*: J. F. MACBRIDE, Fl. Peru. Publ. Field Mus. Bot. **13**(3): 506, 507. 1943.

HEIMSCH, C., JR., Comparative anatomy of the secondary xylem of the "Gruinales" and "Terebinthales" of Wettstein with reference to taxonomic grouping. Lilloa **8:** 83–198. *pls. 1–17*. 1942. [*Krameria*, 132, 191.]

HEUSSER, C. J. Pollen and spores of Chile. xiv + 167 pp. Tucson, Arizona. 1971. [*Krameria Iluca, K. cistoidea*, 39, *figs. 378, 379*.]

HUTCHINSON, J. The genera of flowering plants. Vol. **2.** xi + 659 pp. London. 1967. [Krameriaceae in Polygalales, 344.]

KUIJT, J. The biology of parasitic flowering plants. [xii] + 246 pp. Berkeley & Los Angeles. 1969. [Krameriaceae, 154–157; illustrations and photographs.]

KUNZ, M. Die systematische Stellung der Gattung *Krameria* unter besonderer Berücksichtigung der Anatomie. Beih. Bot. Centralbl. **30**(2): 412–427. 1913.

LARSON, D. A., & J. J. SKVARLA. The morphology and fine structure of *Polygala alba* Nutt. and *P. incarnata* L. Pollen Spores **3:** 21–32. 1961. [Includes electron photomicrograph of *K. lanceolata* pollen showing its baculate sexine.]

LEWIS, W. H., H. L. STRIPLING, & R. G. Ross. Chromosome numbers for some angiosperms of the southern United States and Mexico. Rhodora **64:** 147–161. 1962. [*K. lanceolata*, p. 151, $n = 6$.]

MARTIN, P. S., & C. M. DREW. Scanning electron photomicrographs of southwestern pollen grains. Jour. Arizona Acad. Sci. **5:** 147–176. 1969. [*K. Grayi*, 150, *fig. 35*.]

METCALFE, C. R., & L. CHALK. Krameriaceae. Anat. Dicot. **1:** 535–538. 1950.

MILBY, T. H. Floral anatomy of *Krameria lanceolata*. Am. Jour. Bot. **58:** 569–576. 1971. [Gynoecium bicarpellate, genus not closely allied to Leguminosae.]

RICKETT, H. W. Wildflowers of the United States. Vol. 3. Texas. Part 1. xii + 274 pp. *pls. 1–81*. New York. 1969. [*Krameria*, 236–238, *pl. 69*; *K. lanceolata* illustrated in color.] Vol. 4. The Southwestern States. Part 2. v + pp. 242–519. *pls. 80–170*. New York. 1970. [*Krameria*, 354, 355, *pl. 115*; *K. lanceolata, K. parvifolia, K. Grayi* illustrated in color.]

SCHULZE-MENZ, G. K. Rosales. *In*: H. MELCHIOR, Engler's Syllabus der Pflanzenfamilien. ed. 12. **2:** 193–242. 1964. [Krameriaceae, 240.]

SHREVE, F., & I. L. WIGGINS. Vegetation and flora of the Sonoran Desert. Vol. **1.** x + 840 pp. Stanford, California. 1964. [Krameriaceae, 731–735.]

SOUKUP, J. Las Krameriáceas, Podostemáceas, Oxalidáceas, Geraniáceas, Tropeoláceas, Zigofiláceas, Lináceas y Humiriáceas del Peru, sus géneros y lista de especies. Biota **7:** 83–102. 1968. [Krameriaceae, 83.]

STANDLEY, P. C. Trees and shrubs of Mexico (Fagaceae–Fabaceae). Contr. U.S. Natl. Herb. **23:** 171–515 + xxxvii. 1922. [Krameriaceae, 346–348.]

STERLING, C. M. *Krameria canescens* Gray. Univ. Kansas Sci. Bull. **6:** 363–372. *pls. 15–22*. 1912. [Anatomical study.]

TAUBERT, P. Leguminosae. Nat. Pflanzenfam. III. 3: 70–388. 1891–1894. [Caesalpinioideae-Kramerieae, 166–168.]

TURNER, B. L. Chromosome numbers in the genus *Krameria*: evidence for familial status. Rhodora **60**: 101–106. 1958. [$x = 6$.]

VASEY, G., & J. N. ROSE. List of plants collected by Dr. Edward Palmer in Lower California and western Mexico in 1890. Contr. U. S. Natl. Herb. **1**: 63–90. *pl. 1.* 1890. [Includes Palmer's field observations on *Krameria*, 66, 81.]

WILLIS, J. C. A dictionary of the flowering plants and ferns. ed. 7. (Revised by H. K. Airy Shaw.) xxii + 1214 pp. + liii pp. (Key to the families of flowering plants.) Cambridge, England. 1966. [Krameriaceae, 605.]

ARNOLD ARBORETUM
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138

XII INTERNATIONAL BOTANICAL CONGRESS — JUNE 23–30, 1975

A. TAKHTAJAN

THE CLOSING PLENARY SESSION of the XI International Botanical Congress held at Seattle, U.S.A., in 1969, accepted an invitation issued by the Academy of Sciences of the U.S.S.R. to convene the XII International Botanical Congress in the City of Leningrad in 1975. In 1971 the Organizing Committee was appointed: consisting of a chairman (A. L. Takhtajan); four vice-chairmen (A. A. Prokofiev, A. A. Theodorov, N. V. Tsitsin, A. A. Yatsenko-Khmelevsky); a secretary-general (O. V. Zalensky); a scientific secretary (N. S. Snigirevskaya); and a number of members at large. The XII International Botanical Congress is intended to facilitate interdisciplinary communication among botanists as well as an informal exchange of ideas. A number of sections are planned, including special ones to accommodate mycologists (also lichenologists), phycologists, and bryologists.

The Congress will be divided between organized half-day symposia and half-day contributed paper sessions. In addition to the opening and closing plenary sessions, two evening lectures are being scheduled. All special interest groups wishing to apply for space and time during the Congress should do so by writing as soon as possible to the secretary-general, Dr. Oleg Zalensky, Komarov Botanical Institute of the Academy of Sciences of the U.S.S.R., 2, Prof. Popov Street, Leningrad 197022, U.S.S.R.

The sessions of the Nomenclature Section will take place, as usual, immediately before the opening of the Congress— in this instance June 20–23. Four days are set aside in order to enable the Section to convene for six to eight sessions of two to four hours each.

A meeting of the International Association of Botanic Gardens (President Academician N. V. Tsitsin) will be held in Moscow at the Main Botanical Garden of the Academy of Sciences of the U.S.S.R. on June 20.

A tentative schedule of scientific field trips has been planned for the immediate pre-Congress and post-Congress periods. The principal purpose of these trips is to acquaint visiting botanists with as many interesting and unique features of the flora and vegetation of various regions of the U.S.S.R. as possible. Some specialized trips for phycologists, lichenologists, bryologists, and palaeobotanists are also planned.

The double postcards announcing the XII International Botanical Congress were mailed during the last months of 1972. Those who wish to receive further information on the Congress should return their interest cards as soon as possible, so that they will be placed on the mailing list for the First Information Circular expected to be published June–July 1973.

QK1
.H32

JOURNAL OF THE ARNOLD ARBORETUM

MISSOURI BOTANICAL

JUL 26 1973

GARDEN LIBRARY

Volume 54 HARVARD UNIVERSITY Number 3

Journal of the Arnold Arboretum

Published quarterly in January, April, July, and October by the Arnold Arboretum, Harvard University.

Subscription price $16.00 per year, beginning January, 1972.

Subscriptions and remittances should be sent to Ms. Ellen Bernstein, Arnold Arboretum, 22 Divinity Avenue, Cambridge, Massachusetts 02138, U.S.A.

Volumes I–XLV, reprinted, and some back numbers of volumes 46–50 are available from the Kraus Reprint Corporation, 16 East 46th Street, New York, New York 10017, U.S.A.

EDITORIAL STAFF

B. G. Schubert, Editor

C. E. Wood, Jr.

S. A. Spongberg

CIRCULATION

E. Bernstein

Printed at the Harvard University Printing Office, Boston, Massachusetts

---

COVER: *Ginkgo biloba* L., the maidenhair tree, so-called from the fancied resemblance of its leaves to those of the maidenhair fern. In China it has also been called the silver apricot, from the hard inner seed coat which is silvery when cleaned and vaguely resembles an apricot pit, and the duck-foot tree, from the resemblance of the leaves to the webbed feet of ducks.

The drawing for the cover and the devices for the back cover and reprints were planned and drawn by Karen Stoutsenberger Velmure from specimens taken from a tree cultivated in the Arnold Arboretum of Harvard University.

We want to assure the purists among our readers that our *Ginkgo* does not have leaves with open parallel venation. We think, however, that an exact reproduction of the dense dichotomous veins would have produced a much less dramatic design.

Second-class postage paid at Boston, Massachusetts

JOURNAL
OF THE
ARNOLD ARBORETUM

VOL. 54 JULY 1973 NUMBER 3

SUCCESSION *

WILLIAM H. DRURY AND IAN C. T. NISBET

IN ITS WIDEST SENSE the term "succession" refers to observed sequences of vegetation associations or animal groups. Some occur in space, such as a sequence of zones of grasses, shrubs, and trees on the side of many ponds; or a sequence of zones of vegetation on the side of a mountain. Other sequences occur in time, as, for example, a sequence of vegetation types occurring after an "old field" or a gravel pit is abandoned.

DEFINITION

In ecological literature, the term succession is usually used to imply sequences in time. However, only short-term changes can be observed directly, and most descriptions of long-term changes are based on observation of spatial sequences. In order to provide a unified description on which a general theory can be based, it is necessary to assume a homology between a spatial sequence of zones of vegetation visible at one time in a landscape and a long-term sequence of vegetation types on a single site (Gleason 1927: 320 and 324). This assumption is consistent with and reinforced by the classical geomorphological theory (Davis 1909) of landscape development (for discussion see Hack & Goodlett 1960, McCormick 1968, Drury & Nisbet 1971).

Functional effects have been ascribed to the observed sequences. For example, MacArthur and Connell (1966) describe the changes in organisms on an abandoned field, in stored grain, and in a jar of water. Then they comment: "This gives us a clue to all of the true replacements of succession: *each species alters the environment in such a way that it can no longer grow so successfully as others*." (Italics theirs.)

Another property ascribed to succession is that the changes are progressive, that is, directional, and it is possible to predict which species will replace others in the course of a succession. MacArthur and Connell, in the same chapter (1966) say:

> In the case of forest succession, each species is able to stand deeper shade than the previous one, and as the forest grows the canopy becomes thicker

* Contribution No. 90 from the Scientific Staff, Massachusetts Audubon Society.

> and casts an even deeper shade. In this new, deeper shade other species are more successful. . . . Foresters have tables of 'tolerance' of different tree species; tolerant species are those that are successful in shade. As expected, the climax forests are composed of the most tolerant species. . . .

Hence the theory of succession allows one to predict the characteristics of those species which will replace others, and to recognize unstable or successional species. Thus, species and associations of organisms have been assigned to places in a successional order.

Succession is supposed to continue until the species combination best suited to the regional climate and the site are established. Many authors believe this reflects the development of a particularly well-adjusted configuration of species (Braun 1950, Clements 1916, 1936, Dansereau 1957, Daubenmire 1968, Odum 1959, Oosting 1958); other authors believe it to be simply running out of available species (Gleason 1926, 1927, Cooper 1926). But obviously the concept of succession is inseparable from that of climax (Whittaker 1965), even if it is possible to equivocate by suggesting that change continues at a very slow rate in the "climax."

The concept of climax has been used in a highly inconsistent way (Whittaker 1953), and there is a rich literature challenging, defending, and redefining climax and the nature of plant communities (see reviews by Whittaker 1953, MacIntosh 1967 and the replies in *The Botanical Review* 1968, and Langford & Buell 1969). The concept of succession has seldom been critically reviewed (but see Egler 1954 and McCormick 1968).

There are several vegetational types conventionally referred to as successional. Cowles (1911) classified successions into regional, topographic, and biotic types. These include (a) the "major vegetation zones" (biomes or latitudinal and altitudinal sequences); (b) pond margins, peat bogs, and marshes, or sand dunes; (c) old fields, or changes following fire. Among other successions are included patterns of plants on floodplains, around the snouts of retreating glaciers, on landslides, and the sequences of species in the course of the history of colonization of islands and the microcosms of laboratory infusions.

The primary bases for assigning plant associations to a position in a succession are size of the dominant plants, complexity of the vegetation structure and the number of species present. Successional series are generally recognized as extending from associations of low stature, few species and simple structure to associations of tall plants, many species and complex structure: (a) encrusting, prostrate, decumbent or emergent forms; (b) grasses and sedges; (c) perennial wildflowers and low thickets; (d) tall shrubs and scattered, taller trees, or stands of uniformly aged trees with little underbrush; (e) a canopy of trees with understory of saplings and ground cover of several levels.

On the longest time-scale, some successions are credited to sites not previously occupied by vegetation; these are called Primary Successions. If the site has been previously occupied, the succession is called Secondary. Tansley (1935) distinguished Autogenic Successions, "in which suc-

cessive changes are brought about by the action of the plants themselves on the habitat," from Allogenic Successions, "in which the changes are brought about by external factors." Primary successions were divided by Clements (1916) into hydroseres, xeroseres, etc., according to the moisture conditions of the site.

Ponds and lakes have been put into a quasi-successional sequence from Oligotrophic (deep lakes, poor in nutrients, with little visible floating vegetation) to Eutrophic (shallow lakes, rich in nutrients, often covered with floating plants). Zones of vegetation occur in the sea below high tide and have been described on the coasts of the Pacific (Ricketts & Calvin 1968) and the Atlantic, of Europe (Yonge 1949) and the United States (Dexter 1947, Lamb & Zimmermann 1964, Stephenson & Stephenson 1954). However, we know of no assignment of such algal zones to successional stages, although the zones of emergent vegetation immediately above high tide in salt marshes are usually classified in successional terms.

Historical Review

Descriptions of zones of vegetation and of changes in vegetation on one site are available from Theophrastus (300 B.C.) onwards. The idea that one community of plants might alter its site[1] and prepare the way for another is also old (Buffon 1742). Several authors during the 19th century (e.g. Kerner 1863) described zones and sequences of vegetation, but did not formulate a model for the ecological events involved. In 1863 Thoreau recognized that pine stands on upland soils in central New England were followed after logging by even-aged hardwood stands which today are the main forest type of the region. He named this trend forest succession (Spurr 1952). Hult (1885) recognized "developmental changes" in vegetation, yet it was the work of Cowles (1899, 1901, 1911) which formulated the concept of succession. Clements's brilliant and exhaustive studies (1905, 1916, 1920, 1928, 1934, 1936) appear to be responsible for its general acceptance, because he made of it the mechanism of progress in his visionary system for plant ecology. His developmental model, in which climax was regarded as a superorganism and succession its embryonic development (Clements 1916: 161) was consistent with deterministic, closed system models current in several branches of earth science of that time.

Apparently it was Clements's experience in the grasslands which convinced him of the validity and integrity of grassland communities (in contrast to the previously held opinion that they were unnatural) and led him to the concept of the vital integrity of plant associations. Following Clements, ecologists were for several decades preoccupied with mapping and monitoring the natural communities of North America and discovering their structures, consistencies and inconsistencies. In this

[1] In botanical usage, site refers to a place and a set of habitat conditions suitable for the growth of a particular species or vegetation association. For example, in the course of succession, "each species alters the site."

period, strongly divergent schools of thought developed with regard to the nature of plant and animal communities (MacIntosh 1967, Langford & Buell 1969).

During the last decades there has been a shift to attempts to develop a general theory of structural and functional characteristics of communities (Hutchinson 1957, 1965, MacArthur *et al.* 1966, Levins 1966, 1968). Yet there has been little or no resolution of the contradictory assumptions about the nature of plant and animal communities. Most theoretical formulations retain the deterministic assumptions to a greater or lesser degree; hence, implicitly or explicitly, they relegate the majority of species and communities to "successional" status, with less than maximum fitness. It is no wonder then, that there is a lack of clarity in current theoretical formulations of community interactions or of successional trends (Johnson & Valentine 1971).

CONTEMPORARY CONCEPTS OF SUCCESSION

In spite of little uniformity in detail there is considerable agreement on the general trends of "community development," as quotations from recent reviews by Odum (1969) and Whittaker (1970) illustrate. Our intent in quoting these passages is to identify what is generally accepted by contemporary ecologists,[2] not to assign opinions.

Whittaker (1970: 73):

> In any particular habitat in the landscape, however, the climax community may have been destroyed or may not yet have developed. In this habitat the communities go through progressive development of parallel and interacting changes in environments and communities, a succession. Through the course of succession community production, height, and mass, species-diversity, relative stability, and soil depth and differentiation all tend to increase (though there are exceptions). The end point of succession is a climax community of relatively stable species composition and steady-state function, adapted to its habitat and essentially permanent in its habitat if undisturbed.

Odum (1969: 262):

> Ecological succession may be defined in terms of the following three parameters: (i) It is an orderly process of community development that is reasonably directional and, therefore, predictable. (ii) It results from modification of the physical environment by the community; that is succession is community-controlled even though the physical environment determines the pattern, the rate of change, and often sets limits as to how far development can go. (iii) It culminates in a stabilized ecosystem in which maximum biomass (or high information content) and symbiotic function between organisms are maintained per unit of available energy flow. In a word, the "strategy" of succession as a short-term process is basically

[2] In what follows, we refer to this as the contemporary view of succession. Perhaps it should already be called the *traditional* view, because some younger ecologists (e.g., Johnson & Valentine 1971, Krebs 1972) have recently started to question the logical and factual basis of some of its assertions.

> the same as the "strategy" of long-term evolutionary development of the biosphere — namely, increased control of, or homeostasis with, the physical environment in the sense of achieving maximum protection from its perturbations.

Generally agreed upon successional trends are listed in TABLE 1 (after Odum 1969).

REQUIREMENTS OF A GENERALIZED THEORY

It will be apparent from the foregoing survey that a number of different types of phenomena have been drawn together under the term succession. For the purposes of this paper, it is useful to classify successions into three broad categories.

a) Temporal sequences on one site with climate and physiography substantially stable. This category includes most of the classical types of secondary succession and perhaps some primary successions.

b) Temporal sequences on one site with the local environment changing under the influence of extrinsic factors (e.g., climatic change, erosion, deposition, changes in drainage, input of nutrients, etc.). This category (allogenic succession of Tansley) includes many primary successions (especially successions in lakes and ponds) and some secondary successions.

c) Spatial sequences on adjacent sites. These are used to infer temporal changes, at least on the time-scale appropriate to vegetational change. Changes on a longer (geological) time-scale are not now usually included in the successional scheme.

Theories of succession are usually formulated explicitly to describe and explain temporal sequences of type (a). However, as we pointed out at the beginning of this paper, only short-term observations of such changes are available: hence most of the observational basis for the theories is derived from sequences of type (c). Accordingly the primary task of a review is to examine how well observations of type (c) and of short-term changes in type (a) conform to the generalizations of the contemporary theory.

The extent to which observations of type (b) successions are relevant to contemporary theory is less clear. They were explicitly included in the classical theories, as developmental sequences leading to the climatically determined end-point (Clements 1916, 1936). Contemporary theories, however, although recognizing control by the physical environment (see quotation from Odum 1969 above), place primary emphasis on community-controlled changes and tend to treat cases where external factors are dominant (e.g. agricultural management, or eutrophication of lakes) as exceptions to or temporary reversals of the successional process (Odum 1959, 1969). On the other hand one of the most thorough studies of changes in species diversity within developing lakes (Goulden 1969) was interpreted entirely within the framework of the contemporary theory. In this paper we take the view that external factors make at least some contribution to change in all real systems (i.e., that "pure" type (a)

TABLE 1. **A tabular model of ecological succession: trends to be expected in the development of ecosystems.** (After Odum's *Table 1*. 1969)

ECOSYSTEM ATTRIBUTES	DEVELOPMENTAL STAGES	MATURE STAGES
	COMMUNITY ENERGETICS	
1. Gross production/community respiration (P/R ratio)	Greater or less than 1	Approaches 1
2. Gross production/standing crop biomass (P/B ratio)	High	Low
3. Biomass supported/unit energy flow (B/E ratio)	Low	High
4. Net community production (yield)	High	Low
5. Food chains	Linear, predominantly grazing	Weblike, predominantly detritus
	COMMUNITY STRUCTURE	
6. Total organic matter	Small	Large
7. Inorganic nutrients	Extrabiotic	Intrabiotric
8. Species diversity — variety component	Low	High
9. Species diversity — equitability component	Low	High
10. Biochemical diversity	Low	High
11. Stratification and spatial heterogeneity (pattern diversity)	Poorly organized	Well organized
	LIFE HISTORY	
12. Niche specialization	Broad	Narrow
13. Size of organism	Small	Large
14. Life cycles	Short, simple	Long, complex
	NUTRIENT CYCLING	
15. Mineral cycles	Open	Closed
16. Nutrient exchange rate, between organisms and equitability component	Rapid	Slow
17. Role of detritus in nutrient regeneration	Unimportant	Important
	SELECTION PRESSURE	
18. Growth form	For rapid growth ("r-selection")	For feedback control ("K-selection")
19. Production	Quantity	Quality
	OVERALL HOMEOSTASIS	
20. Internal symbiosis	Undeveloped	Developed
21. Nutrient conservation	Poor	Good
22. Stability (resistance to external perturbations)	Poor	Good
23. Entropy	High	Low
24. Information	Low	High

successions are an abstraction), and that any acceptable generalization about succession must be able to describe adequately a reasonable number of real systems. However, for a fair test of the contemporary theory, it is necessary to consider primarily cases where the effects of external factors are relatively modest. Extreme cases of type (c) successions will be considered separately at the end of this review.

REVIEW OF AVAILABLE FIELD EVIDENCE

In this section we will examine the Odum-Whittaker criteria by reviewing observational studies of successional systems, and we will show that many of the observed structural or physiological characteristics of the communities do not conform to their generalization. That is, changes in species or life form are not necessarily or consistently accompanied by the other functional changes that are supposed to accompany them. We do not assume that every succession should show all the characteristics ascribed by the ideal sequence. On the other hand, we think that the counter-instances we present are sufficient to show that the Odum-Whittaker formulation of succession is not acceptable as a generalization on the basis of the informal and anecdotal arguments presented to date.

The following general comments may be a desirable introduction to this review.

We have not attempted to cover all the vast literature on vegetational sequences. For each topic under discussion, we have selected the two or three best-documented studies known to us. It is not often realized how few detailed quantitative studies have been made of even short-term changes in vegetation. While there are doubtless important studies that we have not quoted, we have not selectively omitted studies supporting the contemporary theory. Indeed, many of the studies we quote appear in Odum and Whittaker's bibliographies.

Our review is largely restricted to studies of forest succession in areas of temperate climate (including studies of lakes and bogs in forested regions). Succession in other habitats has not been studied in comparable detail. We know of no adequate quantitative evidence for extending contemporary theories of succession to such habitats as grassland, deserts, or tundra.

We have placed emphasis on studies of old-field succession, as this is the best documented example of secondary succession. It might be argued that old fields, having been previously forested, are already "prepared" for the regrowth of the climax forest. However, the contemporary theory of succession is itself based very heavily on studies of old fields (Odum 1969, Whittaker 1970, MacArthur & Connell 1966, etc.), so it is appropriately tested by observations in them.

Although we present evidence opposing contemporary generalizations about succession we do not claim that generalizations about vegetational change are impossible. We ourselves, in concluding, present a very broad generalization as an alternative explanation. More limited generalizations

may be possible about certain groups of species or certain floristic regions; comparison of these generalizations may give more biological insight than attempts to develop comprehensive theories.

In evaluating evidence and in our alternative explanation, we have placed some emphasis on natural selection. Natural selection has been neglected in theories of succession because most of them have been primarily concerned with adducing community properties. However, natural selection must act on every species, including "successional" species, to adjust them to their environment, including the communities in which they live. In our view, generalizations about the behavior of communities should be viewed with caution unless they can be reconciled with the action of natural selection on the individual organism.

BIOENERGETICS

STATEMENT OF HYPOTHESIS. Margalef (1968: 30): "Biomass increases during succession as, almost always, does primary production; however, the ratio of primary production to total biomass drops." FIGURE 1 (from

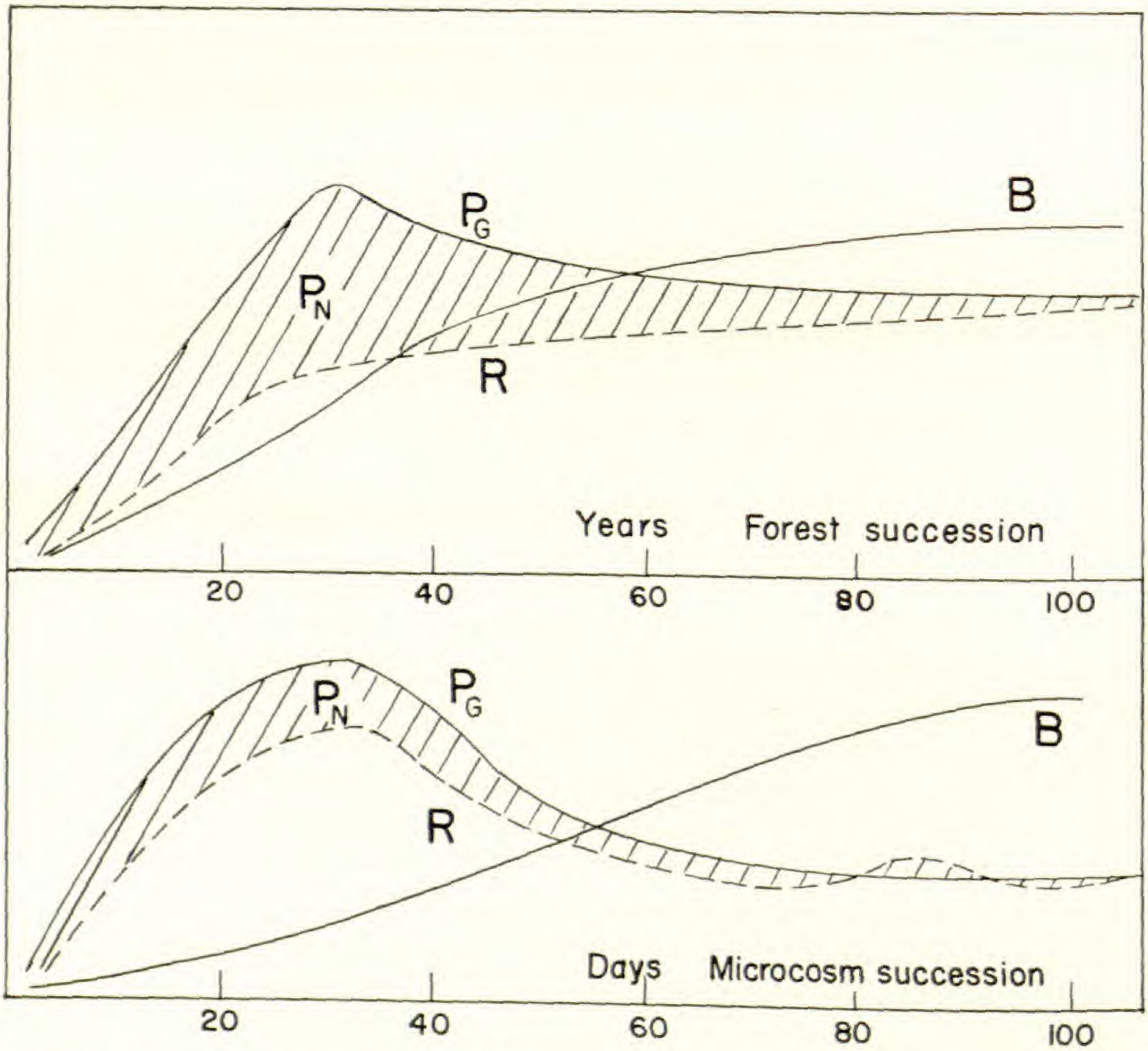


FIGURE 1 (after Odum, 1969). Comparison of the energetics of succession in a forest and a laboratory microcosm. P_G, gross production; P_N, net production; R, total community respiration; B, total biomass.

Odum 1969: 264) illustrates the energetic changes during succession, comparing a forest with a laboratory microcosm. Both production and diversity were described as increasing toward the climax, but both reached a maximum just before the climax stage was reached. They continued at a high, but not maximum, value in the climax. At that stage community respiration is approximately equated to photosynthesis (Bormann 1969:163). Therefore production and diversity should be correlated.

FIELD EVIDENCE. a) Old field successions have been studied in detail as illustrative of the developmental changes involved in more general cases.

Odum (1960) made a detailed study over seven years of changes in species composition and organic production in an old field in Georgia (FIGURE 2, from Odum 1969) about which he wrote the following paragraphs (p. 48):

> If we consider that species composition and species diversity represent "structural" features of the community and that productivity is a "functional" attribute, then it is clear that structurally the "old-field" community changed gradually and continuously, but that functionally a temporary steady-state was established during the period of forb dominance. The study clearly showed that productivity does not necessarily change with change in species, nor necessarily increase with succession as has often been assumed.
>
> The trends so far observed suggest a tentative hypothesis regarding the relationship of energy to succession. From the functional standpoint succession may involve a series of steady-states each associated with a major life form rather than a continuous change associated with species change as is usually postulated. It may be further suggested that an increase in productivity, even if only a temporary "bloom," would be most likely to occur in transition from one life form to another since a new life form may be able to utilize accumulated limiting materials not available to the previous life form.

b) Whittaker (1965:251) cast doubts on the hypothesized correlation between increasing diversity and increasing production in the course of a successional development. In his extensive studies of plant communities, plant production, foliage insects, and birds in the Great Smoky Mountains, he has given measures of diversity (the number of vascular plant species) in quadrats and measured net production.

> Variations in species-diversity do not simply parallel variations in community production. In the Great Smoky Mountains, production and diversity are not significantly correlated either in vegetation samples or in samples of foliage insects. The magnificent redwood forests of the California and Oregon coasts, probably among the most productive of temperate-zone climax forests, have low species diversity.

TABLE 2, plotted in FIGURE 3, was made by combining *Table 1* from Whittaker (1965) with *Table VI* from Whittaker (1966). It supports the conclusion that there is no demonstrated increase in production with increase in diversity.

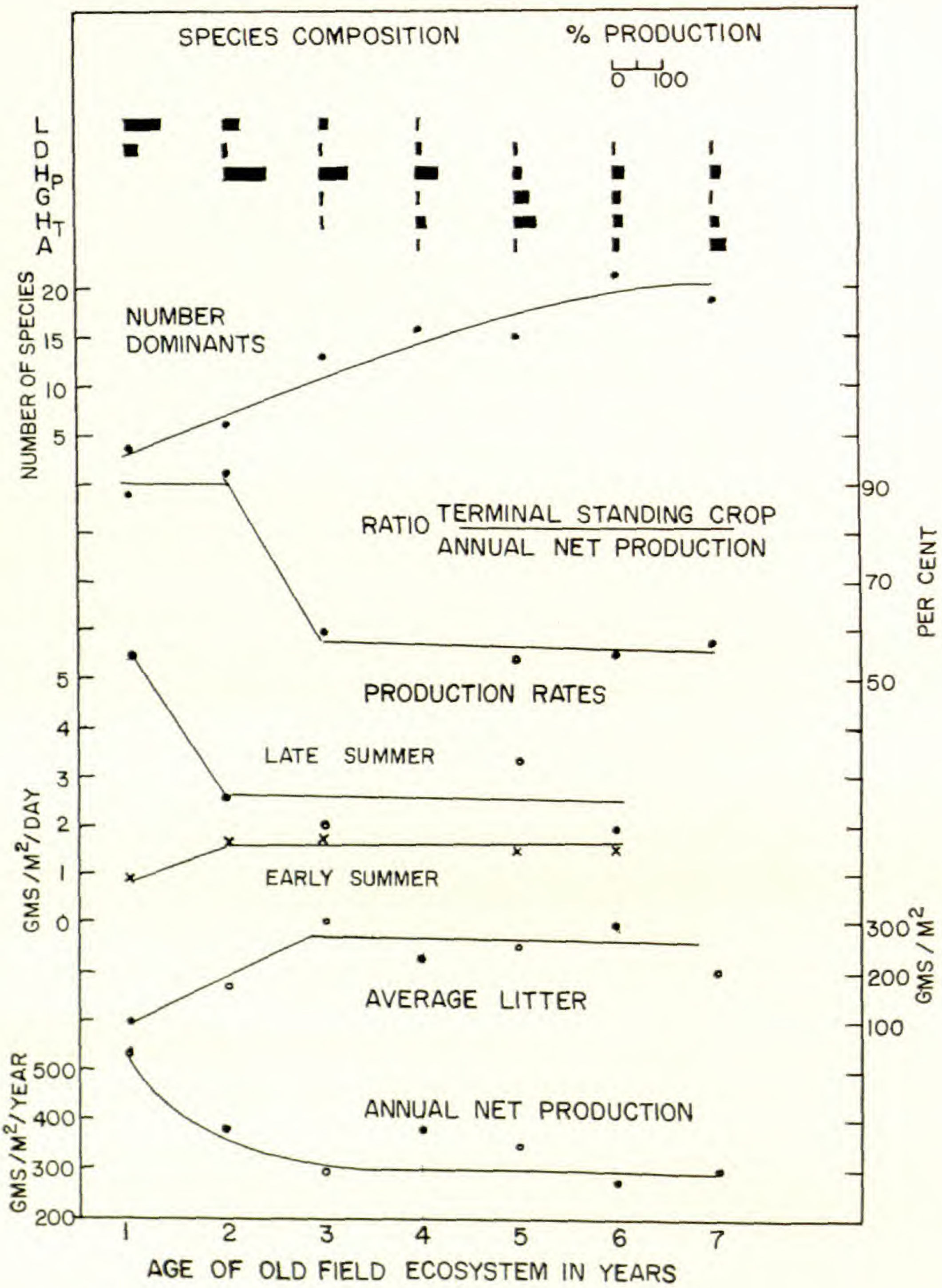


FIGURE 2 (after Odum, 1960). An old-field ecosystem during the first seven years of natural succession, comparing the major structural attributes (species composition and diversity) and functional attributes (productivity). The relative importance in terms of the per cent of total annual production of six major taxa are shown in the top bar diagram. The six taxa are: L — *Leptilon*; D — *Digitaria*; H_P — *Haplopappus*; G — *Gnaphalium obtusifolium*; H_T — *Heterotheca*; A — *Andropogon*. The number of dominants includes all species contributing more than 1 gm/m²/year to annual production. The relative stability of productivity features contrasts with marked changes in species composition and increase in species diversity.

TABLE 2. **Species diversity and above ground net production, Great Smoky Mountains.** (After Whittaker, 1965, 1966)

SAMPLE NO.		DIVERSITY *	PRODUCTION †
			HEATH BALDS
9	High mixed heath	8	983
			FOREST HEATHS
10	Pine forest, Cade's Cove	27	875
11	Pine forest, Pittman Center	32	991
12	Pine heath, Brushy Mountain	23	578
13	Pine heath, Greenbrier Pinnacle	20	419
14	Chestnut oak heath	23	539
15	Hemlock-beech cove forest	40	1333
16	Hemlock-rhododendron forest	5	1022
17	Spruce-rhododendron forest	7	812
			FORESTS
18	Deciduous cove forest	43	1221
19	Cove forest transition	44	1911
20	Oak-hickory forest	26	1203
21	Chestnut oak forest	27	1465
22	Successional tulip forest	35	2408
23	Upper deciduous cove forest	39	1097
24	Hemlock mixed cove forest	31	1183
25	Gray beech forest	29	668
26	Gray beech forest	21	906
27	Northern red oak forest	41	828
28	Red oak, white oak forest	32	568
29	Spruce-fir forest	17	1024
30	Spruce-fir forest	14	944
31	Spruce-fir forest	14	1402
32	Fraser fir forest	14	566
33	Fraser fir forest	6	653

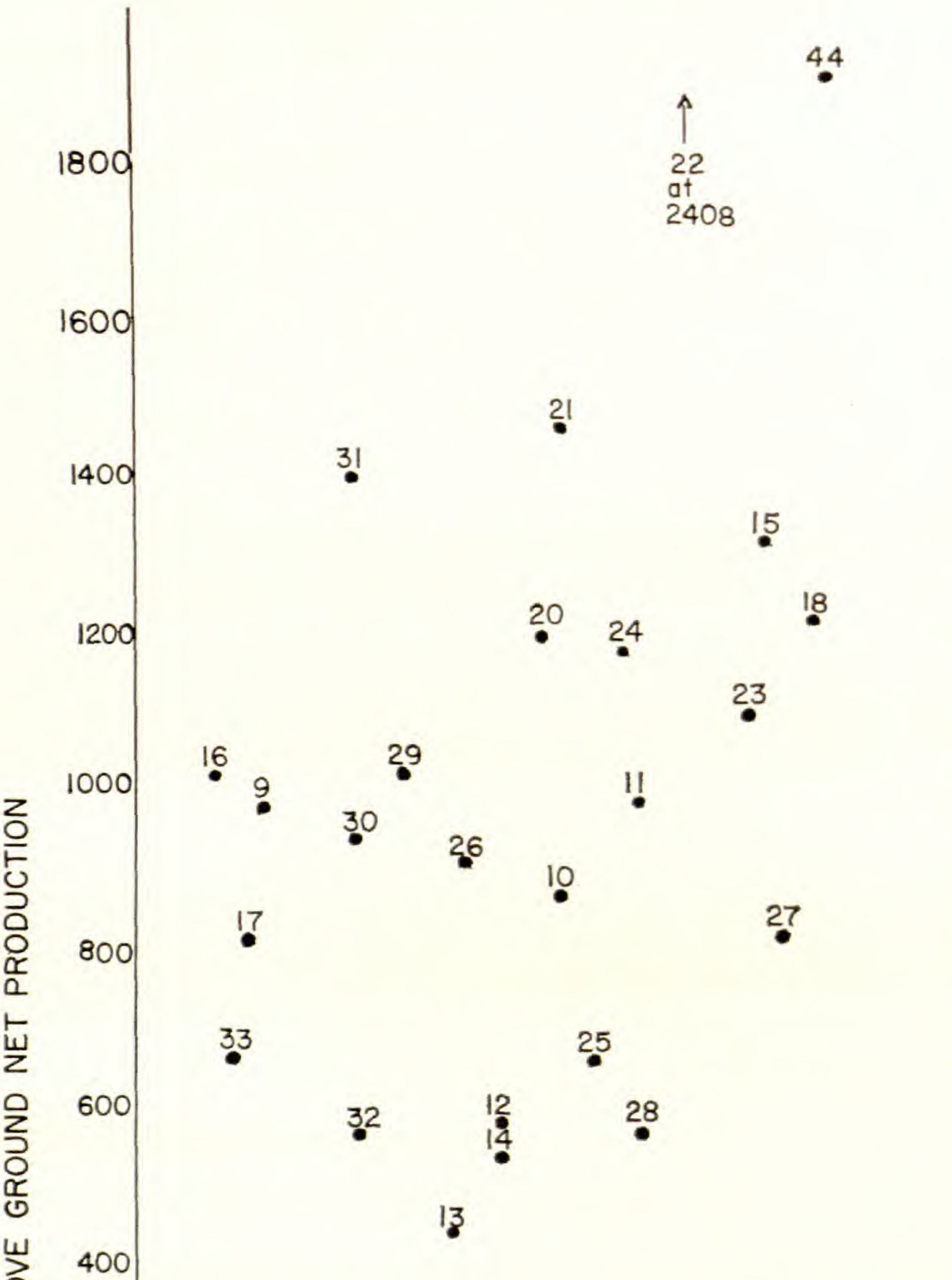
* Column 1 — DIVERSITY indicates the number of species in quadrat, from *Table 1* in Whittaker 1965.

† Column 2 — PRODUCTION equals total net above ground production, from *Table 6* in Whittaker 1966.

SOIL DEVELOPMENT

STATEMENT OF HYPOTHESIS. Whittaker (1970:69) stated: "A number of trends or progressive developments underlie most successional processes. There is usually progressive development of the soil, with increasing depth, increasing organic content, and increasing differentiation of layers or horizons toward the mature soil of the final community. . . ."

Two points in this statement call for examination. First, the length of time involved in development, and second, the differentiation of soils into layers as they mature. Central to the argument is the idea that successive generations of plants leave their remains which are incorporated


TOTAL ABOVE GROUND NET PRODUCTION
1800
1600
1400
1200
1000
800
600
400
200
10
20
30
40
50
DIVERSITY = TOTAL NUMBER OF SPECIES
44
22 at 2408
21
31
15
20
24
18
23
16
29
9
11
30
26
10
17
27
33
25
32
12
14
28
13

into the mineral soil and humified while nutrients and minerals are leached and deposited at specific depths in the process of soil formation.

a) The time scale within which progressive soil development takes place has seldom been specified explicitly. But it is clearly implied that development of a mature soil profile is coterminous with succession, and is therefore a process which approaches completion and equilibrium in the climax. Because successions are generally believed to take a very long time (Clements 1916, Braun 1950) it is clearly implied that soil development requires a very long time for its consummation. "Succession in general appears to be very slow, and the vegetational history of any particular habitat is more apt to be measured in thousands of years, or even tens of thousands, than in centuries or decades" (Gleason 1927:301). "Cowles and others cherished the hope that the old black oak dunes might *eventually* succeed to typical mesophytic forest even though they had not done so in all of post-glacial time — that it was merely a question of too slow a rate and too little time" (Olson 1958:155). Cowles (1901:177) blamed "the slowness of humus accumulation . . . , perhaps more than all else."

b) Soil development involves increasing differentiation of soil horizons, so that processes which stir up and homogenize the soil into a uniform layer must be considered to reverse the process of soil development and to run counter to successional development.

FIELD EVIDENCE. a) Time scale of soil development. Olson (1958) reexamined chronological details of soil development in the vegetation of the Indiana sand dunes studied a half-century earlier by Cowles.

The ages of the dunes and hence of the period available for development of soils upon them were derived from ages of trees or dates of subsequently buried fences on younger dunes and from radiocarbon dating of older ridges and raised shore lines. Age estimates are of course subject to error (up to 20%) but as Olson said: "Present Great Lakes chronology is far superior to any available only a decade ago and covers a much longer period than most previous quantitative studies of succession."

Our FIGURE 4 (Olson 1958, *Fig. 19*) graphs cation exchange relations as function of time age in the process of soil development. "The cation exchange capacity of dune soils is another important variable that increases along with humus content. The exchange complex is initially saturated with calcium and other metallic ions that are valuable in plant nutrition, but gradually these basic ions are partially replaced by hydrogen ions (exchangeable acidity) as soil development proceeds under the influence of vegetation" (Olson 1958:160). FIGURE 4 shows rapid changes

---

FIGURE 3 (after Whittaker 1965, 1966). Community diversity is compared to community productivity in the Great Smoky Mountains vegetation. Diversity (the number of vascular plant species) in quadrat samples numbered 9–33 in *Table I* of Whittaker (1965) is compared to productivity (total above ground net production) in the same numbered quadrat samples taken from *Table VI* of Whittaker (1966).

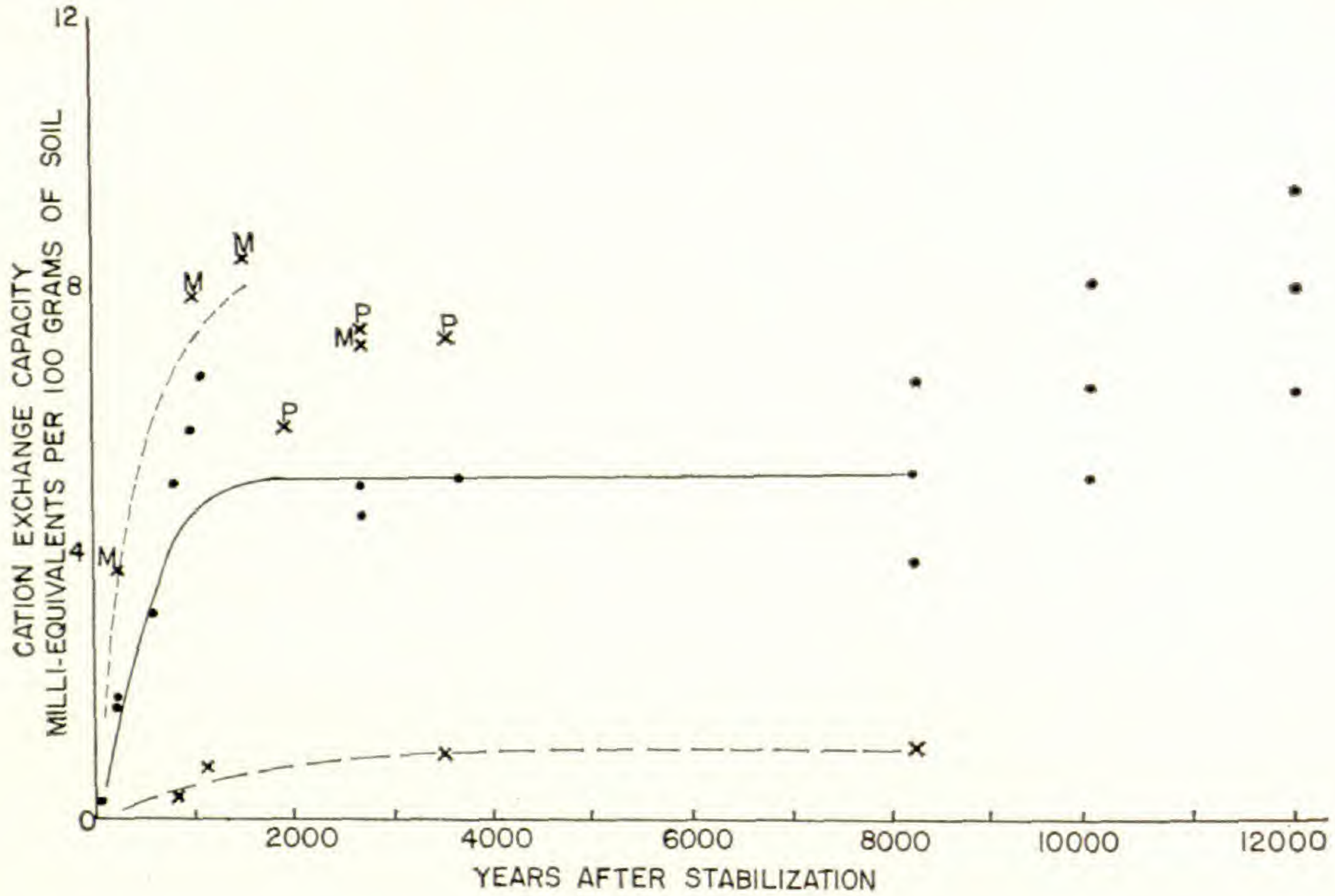


FIGURE 4. Cation exchange capacity (soil nitrogen or humus content) as a function of dune age (Olson 1958). "Cation exchange capacity of dune soils . . . increases along with humus content. . . . The exchange capacity of both surface soils and lower horizons increases in proportion to soil nitrogen. Heavy line for 0–1 dm. layer, main black oak dune series. Closely spaced light dashed line is a possible alternative trend for mesic soils. Open dashed line, 1–4 dm. layer. Samples for three areas with more than the usual prairie cover are marked by "P." Samples from mesophytic pockets or lee slopes are marked by "M." These pockets show basswood, red oak, or sugar maple which were absent on more "normal" topographic situations. The two oldest dune systems (Glenwood and Calumet) do not seem to fit the ideal scheme: instead of scattering around the same trend, thin levels of nitrogen and other properties related to humus content seem to be higher. . . . One may recall the higher silt and clay contents of these soils and might suspect that the resulting textural and moisture differences would help maintain higher nitrogen levels here." (From Olson 1958.)

in the first 1000 years, followed by many thousands of years without further development.

Olson in his summary (p. 168) concluded that:

3. Soil analyses of carbon, nitrogen, moisture equivalent, carbonates, acidity, and cation exchange relations show how most soil improvement of the original barren dune sand occurs within about a thousand years after stabilization. The pattern of change on older dunes promises little further improvement and perhaps even deterioration of fertility.

4. Low fertility favors vegetation with low nutrient requirements. But such vegetation probably is relatively ineffective in returning nutrient to the dune surface in its litter and thus aggravates low fertility. Leaching of nutrients out of the sand-dune ecosystem and the low moisture reserve of

> most dune surfaces help account for the poor prospects for successional replacement of the black oak-blueberry community by the more exacting species of the mesophytic forest. . . .

Olson's studies indicated that soil development has been rapid in terms of the ages of the present dunes. Soils on a relatively young dune surface have developed to a steady state, but those on surfaces many times older have not "progressed." The growth of trees appeared to be in response to physical stabilization of the dune-hollow rather than soil preparation.

b) Stratification in soil development. Goodlett (1954) studied the distribution of forest tree species related to the depths and structure of soil. He found wind-throw to be an active force in determining the structure of soils in the deciduous forests of Pennsylvania:

> The unplowed areas of Potter County are characterized by pronounced microrelief of mounds and pits. . . . Most of the mounds are old, and have resulted from the fall of trees that grew in the presettlement forest. . . . The evidence indicates that wind-throw has disturbed the soil materials to a depth of 2 to 3 feet throughout the past 200 to 300 years, and probably since the reoccupation of the region by forest trees. Lutz and Griswold (1939) made a study of the influence of tree wind-throw in southern New Hampshire, and suggested that "all soils which bear, or in the past have borne, forest stands have been more or less disturbed."
> Disturbance of the upper parts of the surficial deposits by wind-throw over long periods of time probably produces the high degree of variability observed in soil profiles over short horizontal distances. Existing soil profiles are disturbed, inverted, or destroyed within the depth of upheaval. . . .

Lutz (1940) described the effect of uprooting trees upon the structure of the soil in southern New Hampshire, a forest vegetation which would be generally accepted as climax:

> . . . as a result of disturbance, horizons may be very irregular, occasionally with long tongues forming the upper layers penetrating deeply into the layers below. Further, horizons may be discontinuous and masses of soil material may be translocated to positions above or below those normally occupied. Frequently, material from upper and lower horizons is rather intimately mixed. The vertical and horizontal movements of rocks two or more feet in diameter is evidence of the tremendous forces involved. . . .

Farmers plowing the soil have leveled the mound-and-pit topography characteristic of the forest floor in old-growth stands. Because most of the soils of the northeastern United States have been plowed, and most studies of forests have until recently been made in that region, the real condition of the soils of the pre-Colonial "climax" forests has not been examined.

These studies of soil development and modification in early and late forest successional stages indicate that soils develop rapidly in response to the vegetation types on the site. No evidence indicated that development of a profile is associated with the replacement of the vegetation type

responsible by another one. In the northeastern forest region there is evidence that the mature old-growth forest grew on soils which were immature by theoretical standards.

SEQUENCE OF VEGETATION TYPES

STATEMENT OF HYPOTHESIS. Whittaker (1970) describes the process: "One dominant species modified the soil and microclimate in ways that made possible the entry of a second species, which became dominant and modified [its] environment in ways that suppressed the first and made possible the entry of a third dominant, which in turn altered its environment."

In order to understand why species compositions change, we need to know if species associations replace each other as groups; whether later communities replace early stages, or if many of the final and climax species are present on the site from the start. Also, do the species of the early stages facilitate or inhibit the establishment of the species of later stages? If the early stages are removed, is the appearance of later communities delayed or accelerated? And finally, do successions always go in one direction? Do lateral and retrogressive successions occur and under what conditions?

The question — Are the early successional stages made up exclusively of species of lower life form or is it possible that most species are present as seedlings from the start and the visible successional sequences are the overt expression of sequential conspicuousness reflecting different growth rates and sizes at maturity?

In a review of old field succession Egler (1954) presented two opposed hypotheses. In his "relay floristics" one floristic group relays the site to another until some relatively stable stage is reached. This sequence would illustrate simple or classical succession.

In his "initial floristic composition," "Up to the year of abandonment, the land is receiving many species as seeds and living roots. . . . After abandonment, development unfolds from this initial flora, without additional increments by further invasion (for the purpose of this discussion)."

Typological thinking (Mayr 1963) as applied to plant associations could make this contrast too black and white, but if a moderate number of the species of later stages should prove to be present as small individuals in the early successional stages, the observation would throw doubt on the purported importance of the early successional stages in modifying the environment.

FIELD EVIDENCE from several studies is cited in the paragraphs which follow.

a) Clements (1916:59, 1928:103) observed that cases of "initial floristic composition" occur:

> Secondary areas such as burns, fallow fields, drained areas, etc., contain a large number of germules often representing several successive stages. In

some cases it seems that the seeds and fruits for the dominants of all stages, including the climax, are present at the time of initiation.

b) Niering and Egler (1955: 359), referring to plant succession along power lines in Connecticut, said:

> It has been found that the majority of woody plants of the so-called later "stages" and old field "succession" have not been currently invading. To the contrary, it appears that they had invaded at the same time as or previous to the earliest stages.

c) Hack and Goodlett (1960) studying a forested valley in Virginia damaged by a flood, reported:

> Sycamore and black locust trees rapidly covered the scarred areas on the valley bottoms, but six years after the flood most of the tree species characteristic of the undamaged mature forest were present.

Elsewhere these same authors reported that the tree seedlings first colonizing the landslides on the slopes were identical to the species of trees found on older, pre-Columbian forested landslides. They said:

> Many of the landslides terminated in large piles of rock, soil and uprooted trees. Old debris fans, mantled by mature trees of large diameter, indicate that similar floods have occurred in this area in the recent past, creating slides similar to those formed by the 1949 cloud-burst. The vegetation of these areas of older slides shows an adjustment of composition to topographic form.

d) Marquis (1967) reported on the vegetation composition on a site after clear cutting of an old growth stand of northern hardwoods. See TABLE 3 (from Marquis 1967). Tree species are identified as shade tolerant (i.e. climax), intermediate, and intolerant (i.e. sun requiring or successional). He said (p. 6):

> Five years after cutting, four tolerant species comprised over half of the total numbers of stems. This proportion has increased gradually as the stand matured so that tolerant species account for 63 per cent of the stems at 30 years of age. . . . If left to mature naturally, this stand will become increasingly similar to an uneven-aged stand. . . . Red maple and white ash should survive past 100 years, but eventually they too will mature and the stand will then be dominated by the original, long-lived climax species — beech and sugar maple with small amounts of yellow birch. . . .

Detailed studies are needed to establish at what stages "climax" species colonize a site. For example, for a critical resolution of this in Marquis's (1967) study, it would be necessary to have marked trees in the understory at the time of clear cutting. It would also of course be necessary to eliminate from consideration stump sprouts and coppice which came up after cutting. Nevertheless, this and the previous studies suggest that individual trees which make up the "climax" forest were present from the start. Hence the studies throw doubt upon the functional aspects of alteration of the environment by successional species.

TABLE 3. **Species composition in northern hardwoods stand.** (From Marquis 1967)

	AT TIME OF CUTTING		5 YEARS AFTER CUTTING	30 YEARS AFTER CUTTING
	OLD-GROWTH STAND Trees 4.6 inches d.b.h. and larger	SAPLING UNDERSTORY Trees 1 foot high to 1.5 inches d.b.h.	Trees 1 foot high or higher	Trees 0.6 inches d.b.h. or larger
	Percent of basal area	Percent of stems per acre	Percent of stems per acre	Percent of stems per acre
TOLERANT				
Beech	61	26	19	30
Sugar maple	15	56	29	29
Striped maple		16	4	2
Conifers		1	<.5	2
INTERMEDIATE				
Yellow birch	15	1	8	12
White ash	tr.	<.5	1	2
Red maple	tr.	—	1	4
INTOLERANT				
Paper birch	tr.	—	10	11
Aspen		<.5	3	2

Another question: Do the species of the early stages facilitate or inhibit the establishment of species of later stages?

A phenomenon called reaction, "the effect which a plant or a community exerts upon its habitat" (Clements 1916) is generally acknowledged to be central to autogenic replacement of communities. Clements (1916:79) said: "Reaction is thus the keynote to all succession, for it furnishes the explanation of the orderly progression by stages and the increasing stabilization which produces a final climax."

FIELD EVIDENCE from several studies is cited here.

a) McCormick (1968:9) said:

> There is no question that reactions do occur. A single plant, whether lichen or redwood, casts shade, changes the pattern of air movements, produces organic material that may become humus, and affects the site in other ways. The importance of such effects in succession, however, has not been tested adequately and certainly the generalization that these effects constitute the driving force of succession is not substantiated.

He then went on to examine the effects at an early or pioneer stage of succession on an old field and reports:

> In a series of experiments initiated at the Waterloo Mills Research Station, Devon, Pennsylvania, in 1965 and repeated in 1966 and 1967, annual plants were removed as seedlings from some sections of a recently plowed field, but were allowed to grow elsewhere. According to reaction theory, an annual vegetation is necessary to "prepare the way" for perennial plants on such a site. By the end of each summer, however, perennial plants were several times as abundant on areas kept free of annuals. The biomass (dry weights) of individual perennial plants on the annual-free areas were many (15 to 82) times as great as those on areas with annuals. Many goldenrods, asters, black-eyed susans, and other perennial plants flowered on annual-free sections, but were sterile on plots covered with annuals (McCormick *et al.*, Mss.). This experiment does not refute the general theory of the reaction mechanism. However, it does seriously question the reality of the theory and indicates that the theory was not valid for the early old field situation in which it was tested.

b) Pound and Egler (1953) found that on a fire line cleared and spike-harrowed in 1934–1936 ". . . the accidental absence of suitable conditions for germination and development of tree seeds and the absence of root-suckering trees allowed the formation of a dense low vegetation that has since prevented the mass invasion of trees."

c) Niering and Egler (1955) documented the exclusion of trees of the "next successional" stage by a closed canopy of the shrub nannyberry over a period of 25 years. They suggested that minor silvicultural steps could lead to more or less indefinite exclusion of trees by the closed shrub canopy once it is established.

> The *Viburnum* thicket has apparently been in existence for a quarter of a century as a self-perpetuating shrub type. Some of the tallest, oldest *Vi-*

> *burnum* stems are dead or dying, and will be replaced by younger stems, with no change in the overall height or appearance of the community. . . . The transgressives, barring accidents, would presumably grow to maturity and change at least a portion of the area into forest. . . . It seems reasonably certain, however, that the *Viburnum* thicket is not "permanent," and that eventually, in 30, 60 or 90 years, an occasional tree will break through and convert the area to forest. On the other hand, the number of such maturing trees of the past 25 years has been so small that economic control of them, as by artificial means, would appear to be an extremely low-cost procedure requiring attention only at intervals much greater than a decade. . . .
>
> In most instances, it has been found that shrub-dominated vegetation tends to resist invasion by tree seedlings, whereas upland eastern grasslands are relatively open to invasion by pines, ashes, maples, elms, birches and tulip poplar.

d) Both "early" and "late" stage trees may be suppressed if overtopped. In the same way that red cedar and gray birch can be overtopped and suppressed in oak-hickory forests of southeastern New England, so saplings of red oak, white oak, elm, white ash, sugar maple, red maple, pignut hickory, basswood, and beech can be found in the understory of tall forests of old field pine in central New England (Raup & Carlson 1941, Lutz & Cline 1947). While the pines are on average 90 to 100 years old (aged by counts of annual rings on increment borer samples), the hardwoods, though slender, are on average 50 to 70 years old. With the cutting of the overtopping pine, the suppressed hardwoods flourish.

e) J. A. Kadlec (in litt.) has observed in experimental game management areas in Michigan that removal of "pioneer" trees such as aspens speeded the appearance of species of later successional stages.

f) Olson (1958) observed that on the sand dunes he studied the first tree species to be established inhibited the successful colonization of the site by competitors. A closed stand of black oak-blueberry tended to regenerate itself instead of being replaced by the beech-maple "climax," because of the acid leaf litter these species produce and the low rate of return of nutrients to the soil.

g) The production by plants, through the roots or in the litter, of chemicals which inhibit the germination or growth of plants of their own or other species has received wide attention as a physiological phenomenon for many years (review by Whittaker & Feeny 1971).

That plants should release products which facilitate the growth of their own species and inhibit the growth of other species makes better sense according to natural selection than that they should alter their habitat in such a way as to facilitate the growth of other competing species. Several publications indicate that some "early successional" species do produce chemicals which inhibit the growth of later stage species.

Rice (1964) showed inhibition of nitrogen fixing and nitrifying bacteria by old field grasses which apparently gave them competitive advantage over grass of later successional stages. Brown and Roti (1963) found that perennial goldenrods produce a chemical which inhibited the

germination of seeds of jack pine, a pioneer tree on old fields in Michigan. Brian (1949) and Harley (1952) showed that the shrub, ling, produced substances which inhibit mycorrhizal fungi — and, therefore, trees which require them.

An additional question: Are successions unidirectional?

Pond margins, marshes, and bogs have been generally cited as illustrations of typical successions (Smith 1966:182–191, BSCS "Green Version" 1963). The classical illustration of bog succession follows the sequence of (a) floating aquatics, (b) sedge-sphagnum floating bog which is followed by progressive compaction and humification, (c) succession of sphagnum species to produce a heath peat bog, and (d) (a hypothetical extension) a bog forest covering a peat-filled lowland.

FIELD EVIDENCE from several studies is cited here.

a) Several detailed studies of large bogs in the coniferous forest regions of North America and Europe have failed to find this standard sequence and led their authors to doubt even that it necessarily occurs. Drury (1956) in Alaska, and Sjörs (1948, 1950, 1955) in Sweden and the Hudson's Bay lowland drew conclusions similar to those of Heinselman in the region of Glacial Lake Agassiz of Minnesota (1963:370):

> Neither the process of bog expansion nor the patterned bogs and fens of the Lake Agassiz region fit the classical picture of succession in the Lake States. Conclusions are that: (1) Few bogs in this region are the result of a single successional sequence. (2) The bog types cannot be regarded as stages in an orderly development toward mesophytism. (3) Raising of bog surfaces by peat accumulation does not necessarily mean progression toward mesophytism. Such rises often cause concurrent rises of the water table and promote site deterioration. (4) The climax concept does not contribute to understanding bog history in this region.

b) Johnson and Raup (1947) found that the peat of a peat island in a salt marsh on the Taunton River in Massachusetts gave no indication of succession of marsh grasses. The peat indicated continuous stream cutting and redeposition and most plant remains were of one type, salt-water cord-grass. Progression of vegetation types in a successional sequence was not found.

c) Walker (1970) summarized his study of the courses and rates of British post-glacial hydroseres using peat and mud stratigraphy, amplified by pollen diagrams by saying:

> . . . Although certain sequences of transitions are 'preferred' in certain site types, variety is the keynote of the hydroseral succession. In spite of this, the data clearly indicated that bog is the natural 'climax' of autogenic hydroseres throughout the British Isles and the transition from fen to oakwood is unsubstantiated.

The term bog as referred to in this quotation is distinguished by a variety of *Sphagnum* species and acid tolerant plants such as Dwarf Cranberry, Sweet Gale, Cotton Grass, and Heath.

To summarize this section on the sequence of vegetation types, those cases in which detailed studies of forest succession have been made do not indicate an orderly replacement of early successional species by members of later communities. They indicate instead that in the usual case almost all species have established before the "succession starts" or that they colonize during the first few years. Hence in many cases the manifest "succession" is a sequential expression of conspicuousness which reflects the maturing of species having different speeds of growth and sizes at maturity.

In fact it appears in those cases where critical examination has been made, that early and middle successional stages suppress climax species and delay the expression of later stages. Detailed studies of events in the hydrosere indicate that successional trends are readily deflected or reversed in response to changes in water level which are externally controlled. In one case at least early successional stages (mosses) invade a forest and stimulate a rise in water table — hence reverse succession by autogenic processes. Their presence leads to replacement of the forest by heath-birch stage (Sjörs 1948, Drury 1956, Heinselman 1963).

DIVERSITY, STABILITY, AND REPRODUCTIVE STRATEGIES

STATEMENT OF HYPOTHESIS from Margalef (1968:31):

> Diversity very often increases. Sometimes diversity increases to a certain value and then decreases again toward the final stage of succession. . . . Fluctuations are damped and rhythms change from reactions directly induced by external agents to indirect responses to stimuli associated with ecologically significant factors; the ultimate trend is to endogenous rhythms. . . .
>
> In the later states of succession, a relative constancy of numbers is achieved, and populations are not forced to reconstruct themselves rapidly after drastic and extensive destruction. The natural trend is toward a reduction in the number of offspring produced and better protection for the young.

First: DIVERSITY.

STATEMENT OF HYPOTHESIS: Diversity in most contemporary usage refers simply to the total number of species present. The term has in the past, however, referred to all ill-defined, more complex (and more useful) concepts of community diversity including structural variety and relative frequencies of species in addition to taxonomic variety. There have been such "diverse" uses of the term that Hurlbert (1971) said: "The recent literature on species diversity contains many semantic, conceptual, and technical problems. It is suggested that, as a result of these problems species diversity has become a meaningless concept. . . ." It is used here in its simplest sense — the number of species present.

In order to clarify the ecological significance of the increase in species diversity in the course of "successional" sequences, we need to establish which of the following statements is valid:

a) The successional sequence is the result of a process of replacement of less successful by more successful communities in which the more diverse communities are more successful.

b) The increase of species diversity is a reflection of later emergence into prominence of species which were present at the start as inconspicuous seeds and seedlings.

c) The process of succession combines (b) with progressive species enrichment (independent of modification) as a result of continuing colonization of the site. Then, species will be added first which are numerous, close at hand, and/or have highly developed means of dispersal. With the passing of time, less numerous species — those occurring at a greater distance and/or those having less effective means of dispersal — will arrive "by chance."

d) Diversity is a result of microtopographic and other special influences such as herbivore predation, and thus only partially a result of "intrinsic" processes.

e) "Diversity" is uniformly expressed in all parts of a community. Diversity in the herb layer is correlated with diversity in the shrub and tree layers, and with diversity in the insect and bird species.

Although (a) conforms to the classical descriptions of succession, contemporary ecologists consider the process of succession to result primarily from species by species replacements. Evidence of community by community replacements is inadequate.

Evidence for (b), that some successional changes result from sequential growth rates of the members of a largely complete initial floristic composition, was presented in the first part of this section. Very detailed studies which are not available at present are necessary to confirm that this is the case. Similarly, detailed studies would be necessary to eliminate the probability that (c) is a major ancillary process in most successional sequences.

Evidence that (d) plays a decisive part and that there are inconsistencies with regard to (e) would suggest that diversity is an ecological phenomenon independent of succession.

FIELD EVIDENCE from several studies is cited here.

a) Goulden (1969) discussed temporal changes in diversity correlated with what he called development of species associations in fresh water lakes. He based his conclusions on counts of the numbers of species found in cores of lake sediments, including the earliest stages of the lake's history. Interpreting his data from one lake, he described the sequence of events as follows:

> The initial rapid immigration of species into the lake is followed by a period during which the common species become less common and the rare species less rare, which is usually associated with a change in dominant species. The sharp increase in diversity [3] is terminated with the attainment of max-

[3] In this passage, Goulden used the term "diversity" to refer to the information-theoretic measure of weighted species abundance.

> imum diversity for a given number of species. A third phase follows in which additional rare species are established. . . .

The pattern Goulden reports is consistent with ideas presented by Darwin (1859) and Wallace (1876, 1880) and discussed in general by Darlington (1957) and in detail by MacArthur and Wilson (1967). Gleason (1917:474) emphasized that the arrival of additional species simply by migration is a major aspect of "successional" change. At first, common, widespread and well dispersed species rapidly appear. These are followed by less common, well dispersed or widespread species, which have different competitive strategies such as larger size or longer life span. With their arrival we can expect a change in dominance. Last, the widely dispersed, infrequent "rarities" appear at increasing time intervals.

b) Hack and Goodlett (1960) found in the floodplains of main valleys (i.e. higher order valleys) of the Little River in northern Virginia, a northern hardwood forest enriched by many species "extremely rare or absent in the northern hardwood forests of the hollows. . . . The number of non-tree species is generally larger than in the northern hardwood stands of first order valleys." In other words the floodplain, subject to repeated ravages and destruction by high water, and therefore the youngest, most unstable surface, supports the most diverse forests. The hollows, which for geomorphic reasons are subject to a higher rate of creep than most slopes, also support a relatively diverse northern hardwood forest, and the noses, the most stable surfaces of the area, support forests of the lowest diversity.

c) Observed diversity may indeed reflect external circumstances more than the actual number of species present, as has been shown by some experiments carried out in old fields in an originally forested area of Britain (Harper 1969:49):

> Generalizing from the controlled experiments and the results of post Myxomatosis surveys, the effects of rabbit removal appear to be (i) the release and demonstration of hitherto unsuspected floristic richesse in the rabbit-grazed communities: species which in the past had been regularly nibbled and suppressed, flowered and showed their true identity. . . .

When protection from grazing was continued over a long period, in controlled experiments using fertilizers and fenced plots on native hill pastures in central Wales: "The effect of this long period of freedom from grazing in each year was to reduce the number of species present, and the normal result was virtually exclusive development of one or two species of grass. . . ." These results show that "unrestricted stock access was a conservative force on the vegetation and only controlled (heavy) but intermittent grazing allowed the richer flora to develop." They further show that complete removal of grazing was also a conservative force in some cases, while in other cases there was a "later return of a new diversity associated with the entry of species belonging to phases of succession towards scrub. . . ." (Milton 1940, 1947).

According to these field studies, the number of species in a plant association may reflect primarily special circumstances of soil, microtopography, disturbance, or predation by grazing mammals (and release from grazing) which allow certain species a local differential advantage and which suppress the tendency of some species to become dominant and exclude other species.

d) Whittaker (1965:251, 252), referring to his own field experience, said:

> Diversity is as high in the disturbed, immature forests as in mature stable forests of corresponding environments. Tree-stratum diversities increase from high elevations toward low. Diversities of herb and shrub species show no clear relation to elevation below 1400 meters in the Smokies. In both the Siskiyou and Santa Catalina Mountains herb diversities increase from low to middle elevations and decrease from these to high elevations. Along the moisture gradient in the Smokies, the highest tree diversities are in intermediate sites, the highest shrub diversities are in intermediate-to-dry sites, and the highest herb densities are in moist sites. Diversities of the three strata are scarcely correlated, and numbers of insect and bird species are not simply correlated with numbers of plant species.

Hence diversity is inconsistently expressed and increased diversity is by no means an exclusive property of the later stages of vegetation succession.

Second: STABILITY.

STATEMENT OF HYPOTHESIS. No generally accepted definition of stability in ecological systems is available (Brookhaven Symposia in Biology No. 22, 1969). It is not clear whether the term means dampened fluctuations of numbers or long survival until extinction. We know of no comparative study which has confirmed the generally accepted idea that all or the majority of species populations fluctuate less in areas of greater ecological diversity. It is in fact clear that some animal species vary greatly in numbers (squirrels, rabbits, mice, chickadees, foxes) in some complex habitats, while others in the same habitats do not. On the other hand, not all species in the "simple ecosystems" in the north show the periodic spectacular changes in numbers which successional theory predicts.

Third: REPRODUCTIVE STRATEGIES.

STATEMENT OF HYPOTHESIS. Wynne-Edwards (1959, 1962) argued in general that reproductive rates are adjusted to mortality rates in order to avoid overexploitation of food supplies and consequent crashes. MacArthur and Connell (1966) rephrased the argument and applied it specifically to climax habitats. Adjustment of reproductive rate to mortality rate also appears inherent in the concept of "K-selection," at least in its original formulation for closed populations on islands (MacArthur & Wilson 1968:149).

FIELD EVIDENCE.

Adjusted reproduction has been demonstrated only in specially formulated genetic models and there is no evidence that they correspond

to natural populations. It seems extremely improbable in plants, which produce vast quantities of seed and in any case do not overexploit their "food supply" or suffer crashes.

In animals, overproduction has been demonstrated even in a climax species by Kluyver and Tinbergen (1953); Kluyver (1966) demonstrated by experiment in the same species that mortality was adjusted to reproduction and not vice versa. However, the subject is still debated (Lack 1966, Skutch 1967). It is indeed likely that animals raise more young in areas where net production is very high (Crook 1965), but this can be understood as a response to variable food supplies within the context of r-selection (Lack 1966, 1968).

ALLOGENIC VS. AUTOGENIC — SAND DUNES, PONDS AND MARSHES, FLOOD PLAINS, AND MORAINES

STATEMENT OF HYPOTHESIS. One of Odum's (1969) hypotheses about succession is that the process is community controlled. Olson (1958:132) put it that change of an ecosystem could proceed as a function of time *even if all other variables remained constant*. If, however, vegetation changes occur in response to site changes produced by extrinsic events, then the "sequences" are not developmental but simply reflect the ecological truism that different species require different habitats.

FIELD EVIDENCE from several studies is cited here.

a) Excavations in Alaskan bogs (Drury 1956) indicated that the "late successional" bog forests were simply perched upon a thick peat composed of species of emergent mosses mixed with alluvial and aeolian silt. Where the water table had been locally lowered by deposition of silt, forest had grown up. Where the water table had risen, the forest had been replaced by bog. Other studies of bogs (Sjörs 1955, Heinselman 1963) also indicate that the observed changes are not developmental. Johnson and Raup's (1947) excavations at Grassy Island gave no indication of succession in the sediment record, but instead showed evidence of a continuing process of stream erosion and deposition, with plants colonizing newly deposited banks and being destroyed as the river's meanders migrated across the marsh.

b) Moraines abandoned below mountain glaciers have been used to illustrate primary succession from bare soil through tundra and willow-alder shrubs to needle-leaved forest. Cooper's work in Glacier Bay (1923) and Sigafoos and Hendricks's on Mt. Rainier (1969) suggest on the contrary that moraine vegetation is generally at equilibrium with the present conditions. In fact, where local conditions are suitable, vegetation of an "advanced successional stage" grows on or next to the ice. In 1948 and 1950 Drury found a spruce forest 50–60 feet tall growing on the moraine, underlain by ice, of the stagnant Matanuska Glacier in Alaska. In Iceland at the edge of Vatnajökull Glacier, birch grows next to the ice and on sites covered by ice as recently as 1934 (Lindroth 1970).

In these extreme habitats, a site's edaphic and microclimate conditions differ according to topography and geomorphic changes beyond the control of (although influenced by) the vegetation. At each site various species whose propagules are already available or are constantly reaching the site are able to become established. Hence each vegetation type or zone appears to be in equilibrium with the present environment, in the same way as the several zones of vegetation on a mountainside.

SKETCH OF AN ALTERNATIVE EXPLANATION

The statements of Odum, Whittaker and Margalef quoted in this paper (including TABLE 1) represent a set of generalizations about succession as now understood. Steps toward a theory of succession have been made by Margalef (1963, 1968), who related succession to an increase in information content, by MacArthur and Connell (1966) in their revival of Clements's (1916, 1936) analogy between succession and embryonic development, and by Odum (1969) in his statement that succession is community-controlled. The common feature of these theories is that they attribute succession to properties of the community.

In this paper we have quoted a number of detailed studies which disagree with the Odum-Whittaker generalization. Whittaker (1953) and McCormick (1968) have previously mentioned a number of similar exceptions. Hence, although there may be other studies which are consistent with it, it is unacceptable as a generalization. Nevertheless, there is a body of interrelated facts to be explained. In the remainder of this paper we will sketch in broad outline an alternative explanation of these facts as we see them.

POINT OF DEPARTURE. The starting-point for such an explanation is three sets of observations on succession in forested regions [4] which we believe to be widely accepted.

1) On sites which are cleared but initially free of seeds, certain kinds of plant species (usually those of depressed life forms) tend to appear first; others (including those of successively larger and more complex life forms) appear later. Sites illustrating this sequence ("primary succession") are rare in nature: examples include exposed sandbanks, volcanic deposits, receding glaciers and mine tailings. Although many textbooks give hypothetical accounts of such successions, very few cases have been actually observed and only the early stages in succession have been described. Evidence about later stages in primary succession is conflicting (e.g., Olson 1958) or lacking.

2) On sites which are cleared but not initially free of seeds, there is usually a similar vegetational sequence, often apparently involving the same kinds of plants, but usually taking place more rapidly ("secondary

[4] In our opinion there are as yet insufficient precise observations on successional sequences in non-forested ecosystems to support any generalizations about them, or to incorporate them into a comprehensive theory.

succession"). Again most published studies are of the early stages in succession and accounts of the later stages are largely hypothetical. The evidence summarized in this paper suggests that the later stages of succession are not consistently unidirectional, and that forest succession is better represented by the lower half of FIGURE 1 than by the upper half.

3) Spatial gradients of several kinds of stress (climatic, chemical or radiological) give rise to similar sequences in space of life forms and vegetation. The congruence between sequences produced by different kinds of stress is reasonably well documented (see review by Woodwell 1970), although few detailed descriptions are available for any but climatic stresses.

The main task in constructing a theory of forest succession is to explain the apparent congruence between the stress-induced sequences and the early and middle stages of primary and secondary successions.

STRESS GRADIENTS. Vegetational sequences on stress gradients are reasonably well understood (Woodwell 1970). Each species appears to be specialized to a certain type of site and is competitively superior within a limited range of conditions, so that different species are dominant at different points along environmental gradients (MacIntosh 1967, Whittaker 1953). Plants of higher life form dominate under low stress conditions, but are unable to withstand higher stresses. The contrasting selection pressures have been considered by Raunkiaer (1934), who classified plants into life forms according to the location of their protected growing points. Those plants, geophytes, whose buds are well protected in the ground must grow their photosynthetic structures each year. They are readily overtopped. Tall, dominant plants, phanerophytes, have competitive advantages but their buds are vulnerable to drying winds, ice, fire, and radiation. Chamaephytes, whose buds are within a couple of meters of the ground, are intermediate in adaptations.

Woodwell (1970) emphasized that plants of higher life form usually have a larger ratio of supportive structures to productive structures: hence they have a smaller margin of reserve productive capacity to repair damage and are more susceptible to stress. Thus much of the observed correlation between stress gradients and vegetational sequences can be related to the problems of organization of a complex organism, together with the competitive pressure for plant species to evolve specializations to a limited range of environments.

SECONDARY SUCCESSIONS. Turning to secondary successions, most of the studies cited in this paper suggest that the early stages in secondary successions can be understood adequately in terms of differential growth. Changes in the later stages are not consistently unidirectional and appear to be influenced primarily by external factors such as grazing, stream cutting, and storm damage, which recur on a time-scale shorter than that required for intrinsic development. Whereas the classical and contemporary theories of succession place primary importance on the role of

early successional plants in modifying their environment and permitting later vegetational stages to become established, the studies cited in this paper suggest that modifications of the environment by plants act frequently or generally to *delay* succession. The mechanisms involved include competition for nutrients, shading, pH modification and allelopathy (allotoxicity).[5]

The studies of secondary successions cited in this paper suggest that the plants dominant in the later stages were present either from the beginning, or at least from a very early stage. Their inconspicuousness in the early stages appears to be a consequence of their slow growth and/or their suppression by other species (and, to some extent, to the preoccupation of botanists with the dominant species). That is, most of the detailed observations are consistent with the "initial floristic composition" model of secondary succession (Egler 1954).

Cases in which one species, or a group of species of the same life-form, succeed in dominating the vegetation and maintaining a quasi-stationary state for a time, do not necessarily provide good evidence for the "relay floristics" model. The data of Olson (1958), Niering and Egler (1955), Raup and Carlson (1941), McCormick (1968), and Brown and Roti (1963) suggest that they should be interpreted as delays in the growth sequence, effected by successful suppression of growing subdominant plants by the temporarily dominant species. The replacement of the dominant plants by species of the next higher life form may require external disturbance (Niering & Egler 1955, Olson 1958, Raup & Carlson 1941). In the contemporary theory of succession, this replacement is in part explained as a consequence of continued high net productivity. In fact, however, net productivity is relatively low during the quasi-stationary periods and increases rapidly when a new set of plants becomes dominant (Odum 1960). These flushes of productivity are most easily explained by the hypothesis of release from suppression by the previously dominant plants.

PRIMARY SUCCESSIONS. Genuine observations on primary successions are meager. It seems to be generally accepted that primary succession takes place more slowly than secondary succession, but the relative roles of soil development, external supply of nutrients, exposure, and seed immigration in controlling the rate of development remain largely hypothetical.

[5] Autotoxicity constitutes a limited exception to this generalization. There is at least one well documented case in which autotoxicity in a herbaceous annual appeared to accelerate or at least permit its rapid replacement in a grassland succession (Wilson & Rice 1968). However, even in this case the autotoxic chemicals were also allotoxic (see also Parenti & Rice 1969). The importance of autotoxicity in successions needs to be investigated further, but its explanation should be sought within the framework of natural selection theory. Tentatively, we suggest that autotoxicity might be a by-product of selection for producing allotoxic chemicals whose primary function would be in interspecific competition. Autotoxicity would not be selected against in species whose individuals disperse their seeds beyond the range of their own toxins, and might even serve a function in intraspecific competition in such species. To interpret its function as facilitating the establishment of other species would be teleological.

The observations quoted in this paper of "late successional" trees growing on stagnant glaciers and close behind retreating glaciers suggest that the role of soil development in primary successions has been exaggerated, and that species of later stages can become established within a few years of initial exposure. The rapid growth of forest on Krakatoa and the dominance of phanerophytes there from the very start (Richards 1952) suggests the same conclusion. The data of Olson (1958) suggest that the availability of water and nutrients may be more important limiting factors on the rate of establishment of species than the age, thickness, or organic content of the soil. Tentatively, however, we also ascribe importance to the rate of dispersal of seeds, since "early successional" species tend also to have adaptations for rapid dispersal.

CONGRUENCE OF TEMPORAL AND SPATIAL SEQUENCES. Species dominant in early stages of secondary or primary successions are those characteristic of high-stress sites (Woodwell 1970). According to the present interpretation, they achieve early dominance primarily because they grow faster than species adapted to lower-stress sites. A generalized explanation for the differential growth is given in the arguments of Raunkiaer and Woodwell summarized above. The early dominant species maintain dominance for as long as possible by suppressing competitors, but are replaced because in general they live less long and grow less tall than their successors. In primary successions (but to a much lesser extent in secondary successions) the establishment of the low-stress species may be delayed by delays in immigration and by physical stresses.

According to this highly generalized explanation, therefore, most of the phenomena of succession should be understood as resulting from the differential growth, differential survival, and perhaps differential dispersal of species adapted to grow at different points on stress gradients. The appearance of orderly replacement of "communities" of successively higher life forms results, at least in part, from the temporary dominance of certain species over their successors. Net productivity remains high throughout succession simply because the plants are growing, and it is reduced during the periods at which full-grown plants suppress their potential successors. Net productivity rises when larger plants replace smaller plants, but this is a consequence of the growth of the larger plants and is not a cause of the replacement (as the contemporary theories imply).

Under this interpretation, succession on a single site usually involves a sequence of species (rather than simply the growth of the ultimately dominant species) because no one species can dominate the vegetation throughout the period of growth. In other words the basic cause of the phenomenon of succession is the known correlation between stress tolerance, rapid growth, small size, short life, and wide dispersal of seed. The few exceptions to this general correlation — mangroves, redwoods, coconut palms, douglas firs — are also exceptions to the generalization of succession: they are both "early successional" and "climax" species.

ADAPTATIONS TO DIVERSE SITES. Contemporary theories of geomorphological development (e.g. Chorley 1962) emphasize the continuity of the processes of uplift and erosion (in contrast to the classical concepts of cycles of erosion (Davis 1909) on which the classical theory of plant ecology was based (Clements 1936: for discussion see Drury & Nisbet 1971)). As a consequence, gradients of exposure, soil type, moisture, and other stresses can be assumed to exist continuously in essentially every geographic region. This permits the specialization of different species to different points along the stress gradients, under the pressure of interspecific competition. One extreme evolutionary strategy is to occupy sites at the extreme upper end of the stress gradient, and to grow and reproduce rapidly (during the favorable growing season) before fluctuations in weather make the site intolerable. The other extreme strategy is to occupy the most sheltered sites, to dominate the vegetation by growing as large as possible, and to live as long as possible. Species which adopt these extreme strategies may be equally well adapted to their own environments: there is no need to suppose that the species adapted to the exposed sites are "immature" or "less fit." In geological terms, the sheltered sites are as transitory as the exposed sites.

When new unvegetated sites become exposed, plants adapted to exposed sites are pre-adapted to occupy them and to grow well, provided that they can colonize them before they are occupied by competing species. Thus efficient seed dispersal will give a competitive advantage to individuals of the stress tolerant species. This advantage would contribute to the evolution of efficient dispersal mechanisms in these species.

ESSENTIAL HYPOTHESES. To place these arguments into a deductive framework, it is necessary to formulate the following hypotheses which differ at least in emphasis from those in contemporary theories of succession.

1) Gradients of soil conditions and exposure to stress exist continuously in essentially every geographic region, as a result of continuous geological processes of uplift and erosion.

2) Different species are specialized to grow under different site conditions, under the pressure of interspecific competition.

3) Individual plants already growing on a site generally have a competitive advantage over seedlings and immigrant individuals, but the advantage is often reduced by disturbance.

4) Dispersal mechanisms and tolerance of physical stress are correlated (together they constitute colonizing ability).

5) Colonizing ability and growth rate tend to be inversely correlated with size at maturity and with longevity.

Hypothesis (1) is geologically trivial, but it needs to be stated explicitly because it conflicts with the classical concept of landscape stability which underlay classical succession theory. Hypotheses (2) and (3) are biologically trivial, but represent the explicit introduction of natural selection into succession theory, in which it is customarily neglected.

Hypotheses (4) and (5) are the key statements underlying our explanation of succession. They amount to the assertion that certain adaptive strategies are mutually exclusive: species whose seeds travel far and grow fast in harsh conditions cannot also grow large and live long. There is a well-known correlation between size, longevity, and low growth-rate. We suggest that this correlation, together with the Raunkiaer-Woodwell argument, comprise a sufficient explanation of the broad features of succession.

An explanation of the correlation might be sought either in theories of senescence, or in theories of the organization of organisms. In any case, we suggest that a complete theory of vegetational succession should be sought at the organismic, physiological or cellular level, and not in emergent properties of populations or communities. The former approach seems more consistent with the theory of natural selection.

SUMMARY

In contemporary usage the term succession refers to a sequence of changes in the species composition of a community, which is supposed to be associated with a sequence of changes in its structural and functional properties. The term succession is generally used for temporal sequences of vegetation on the same site, but only the early stages in the sequence can be observed and the later stages are usually inferred from observations on spatial sequences on adjacent sites. The term is customarily applied to sequences in many types of environment, although few detailed studies have been reported except for temperate forested regions. Contemporary theories of succession in general ascribe the observed phenomena to the action of the community itself in changing the environment.

This paper discusses a number of detailed studies of succession in forested regions, and shows that most of them do not conform to the contemporary generalization. The changes in structural and functional properties are not consistently associated with changes in species composition; the later stages in succession are not consistently unidirectional; and the effects of species already on the site appear frequently to delay rather than facilitate successional replacement.

An alternative explanation is outlined which is based on the observed congruence between temporal sequences of vegetation and spatial sequences along environmental gradients. According to this explanation, most of the phenomena of succession can be understood as consequences of differential growth, differential survival (and perhaps also differential colonizing ability) of species adapted to growth at different points on environmental gradients. The appearance of successive replacement of one "community" or "association" by another results in part from interspecific competition which permits one group of plants temporarily to suppress more slowly growing successors. The structural and functional changes associated with successional change result primarily from the known correlations in plants between size, longevity, and slow growth. A compre-

hensive theory of succession should be sought at the organismic or cellular level, and not in emergent properties of communities.

ACKNOWLEDGMENTS

Discussions with Madhav Gadgil and Robert Trivers helped greatly in clarifying the ideas in this paper. Rolla Tryon made helpful suggestions for revising an earlier draft. We thank also three anonymous reviewers whose comments made clear to us that the traditional view of succession is alive and well among our peers.

SCIENTIFIC NAMES OF PLANT SPECIES REFERRED TO IN THE TEXT

Balsam fir	*Abies balsamea* (L.) Mill.
Fraser fir	*Abies Fraseri* (Pursh) Poir.
Hemlock	*Tsuga canadensis* (L.) Carr.
Spruce	*Picea* spp.
White pine	*Pinus Strobus* L.
Jack pine	*Pinus Banksiana* Lamb.
Red cedar	*Juniperus virginiana* L.
Redwood	*Sequoia sempervirens* (Lamb.) Endl.
Douglas fir	*Pseudotsuga taxifolia* (Poir.) Britt.
Salt-water cord-grass	*Spartina alterniflora* Loisel.
Cotton grass	*Eriophorum* sp.
Coconut palm	*Cocos nucifera* L.
Greenbrier	*Smilax* spp.
Quaking aspen (Aspen)	*Populus tremuloides* Michx.
Sweet Gale	*Myrica Gale* L.
Pignut hickory	*Carya glabra* (Mill.) Sweet
Yellow birch	*Betula lutea* Michx. f.
Gray birch	*Betula populifolia* Marsh.
Paper birch	*Betula papyrifera* Marsh.
Beech	*Fagus grandifolia* Ehrh.
White oak	*Quercus alba* L.
Chestnut oak	*Quercus Prinus* L.
Red oak	*Quercus rubra* L.
Black oak	*Quercus velutina* Lam.
American elm	*Ulmus americana* L.
Tulip poplar	*Liriodendron Tulipifera* L.
Sycamore	*Platanus occidentalis* L.
Pin cherry	*Prunus pensylvanica* L. f.
Black locust	*Robinia Pseudo-Acacia* L.
Striped maple	*Acer pensylvanicum* L.
Sugar maple	*Acer saccharum* Marsh.
Red maple	*Acer rubrum* L.
Basswood	*Tilia americana* L.
Dwarf cranberry	*Vaccinium Oxycoccos* L.
Blueberry	*Vaccinium* spp.
Heath	*Erica Tetralix* L.

Ling	*Calluna vulgaris* (L.) Hull
White ash	*Fraxinus americana* L.
Nannyberry	*Viburnum Lentago* L.
Goldenrod	*Solidago* spp.
	Solidago uliginosa Nutt.
	Solidago juncea Ait.
Aster	*Aster* sp.
Black-eyed Susan	*Rudbeckia serotina* Nutt.

LITERATURE CITED

BIOLOGICAL SCIENCES CURRICULUM STUDY. MOORE, J. A., *et al.* 1963. Biological science: an inquiry into life. Harcourt Brace and World, New York.

BORMANN, F. H. 1969. A holistic approach to nutrient cycling problems in plant communities, pp. 149–165. In K. N. H. GREENIDGE (*ed.*) Essays in plant geography and ecology. Nova Scotia Museum, Halifax.

BOTANICAL REVIEW, several authors. 1968. The continuum concept of vegetation: responses. Bot. Rev. **34**: 253–332.

BRAUN, E. L. 1950. Deciduous forests of eastern North America. Blackiston, Philadelphia. 596 pp.

BRIAN, P. W. 1949. The production of antibiotics by microörganisms in relation to biological equilibria in the soil. Symp. Soc. Exptl. Biol. **3**: 357–372.

BROOKHAVEN SYMPOSIA IN BIOLOGY, No. 22. 1969. Diversity and stability in ecological systems. Brookhaven National Laboratory, May 26–28, 1969. U.S. Dept. of Commerce, Springfield, Va. 264 pp.

BROWN, R. T., & J. R. ROTI. 1963. The "Solidago factor" in jack pine seed germination. Bull. Ecol. Soc. **44**: 113.

BUFFON, G. L. L. 1742. Memoire sur la culture des forêts. Hist. Acad. Roy. Sci. (1742): 233–246.

CHORLEY, R. J. 1962. Geomorphology and general systems theory. U.S. Geol. Survey Prof. Paper 500-B.

CLEMENTS, F. E. 1916. Plant succession. Carnegie Inst. Wash. Publ. 242. 512 pp.

———. 1920. Plant indicators. Carnegie Inst. Wash. Publ. 290.

———. 1928. Plant succession and indicators. H. W. Wilson, New York. 453 pp.

———. 1934. The relict method in dynamic ecology. Jour. Ecology **22**: 39–68.

———. 1936. Nature and structure of the climax. *Ibid.* **24**: 252–284.

COOPER, W. S. 1923. The recent ecological history of Glacier Bay, Alaska. Ecology **4**: 93–128, 223–246, 355–365.

———. 1926. The fundamentals of vegetational change. *Ibid.* **7**: 391–413.

COWLES, H. C. 1899. The ecological relations of the vegetation on the sand dunes of Lake Michigan. Bot. Gaz. **27**: 95–117, 167–202, 281–308, 361–391.

———. 1901. The physiographic ecology of Chicago and vicinity. *Ibid.* **31**: 73–108, 145–182.

———. 1911. The causes of vegetative cycles. *Ibid.* **51**: 161–183.

CROOK, J. H. 1965. The adaptive significance of avian social organizations. Symp. Zool. Soc. London **14**: 181–218.

DANSEREAU, P. 1957. Biogeography — an ecological perspective. Ronald Press Co., New York. 392 pp.

DARLINGTON, P. J. 1957. Zoogeography: the geographical distribution of animals. John Wiley & Sons, Inc., New York. 675 pp.

DARWIN, C. 1859. On the origin of species by means of natural selection. John Murray, London. 490 pp.

DAUBENMIRE, R. 1968. Plant communities. Harper & Row Publ., New York, Evanston, and London. 300 pp.

DAVIS, W. M. 1909. Geographical essays. Ginn & Co., Boston. 777 pp.

DEXTER, R. W. 1947. The marine communities of a tidal inlet at Cape Ann, Massachusetts: a study in bio-ecology. Ecol. Monogr. **17:** 261–294.

DRURY, W. H. 1956. Bog flats and physiographic processes in the Upper Kuskokwim River Region, Alaska. Contr. Gray Herbarium, Harvard Univ. No. 178, Cambridge. 130 pp.

——— & I. C. T. NISBET. 1971. Inter-relations between developmental models in geomorphology, plant ecology and animal ecology. General Systems **16:** 57–68.

EGLER, F. E. 1954. Vegetation science concepts. 1. Initial floristic composition — a factor in old-field vegetation development. Vegetatio **4:** 412–417.

GLEASON, H. A. 1917. The structure and development of the plant association. Bull. Torrey Bot. Club **44:** 463–481.

———. 1926. The individualistic concept of the plant association. *Ibid.* **53:** 7–26.

———. 1927. Further views on the succession concept. Ecology 8: 299–326.

GOODLETT, J. C. 1954. Vegetation adjacent to the border of the Wisconsin drift in Potter County, Pennsylvania. Harvard Forest Bull. 25. 93 pp.

GOULDEN, C. E. 1969. Temporal changes in diversity, pp. 96–100. In Brookhaven Symposia in Biology 22.

HACK, J. T., & J. C. GOODLETT. 1960. Geomorphology and forest ecology of a mountain region in the central Appalachians. U.S. Geol. Surv. Prof. Paper 347. 64 pp.

HARLEY, J. L. 1952. Association between microörganisms and higher plants (*mycorrhiza*). Ann. Review Microbiol. **6:** 367–386.

HARPER, J. L. 1969. The role of predation in vegetational diversity, pp. 48–61. In Brookhaven Symposia in Biology 22.

HEINSELMAN, M. L. 1963. Forest sites, bog processes, and peatland types in the Glacial Lake Agassiz Region, Minnesota. Ecol. Monogr. **33:** 327–374.

HULT, R. 1885. Blekinges vegetation. Ett bidrag till växformationernas utvecklingshistorie. Medd. Soc. Fenn. XII. 1885. 161 pp.

HURLBERT, S. H. 1971. The nonconcept of species diversity: a critique and alternative parameters. Ecology **52:** 577–586.

HUTCHINSON, G. E. 1957. Concluding remarks, pp. 415–427. In Cold Spring Harbor Symposia on Quantitative Biology 22.

———. 1965. The ecological theater and the evolutionary play. Yale Univ. Press, New Haven. 139 pp.

JOHNSON, E., & W. VALENTINE. 1971. Two recent textbooks reviewed. Ecology **52:** 733, 734.

JOHNSON, F., & H. M. RAUP. 1947. Grassy Island — archaeological and botanical investigations of an Indian site on the Taunton River, Mass. Papers of the Robert S. Peabody Foundation for Archaeology 1: 1–68.

KERNER, A. VON M. 1863. Das Pflanzenleben des Danaulandes. The plantlife of the Danube Basin. Trans. by H. S. CONARD in "The background of plant ecology." Iowa State College Press, Ames. 238 pp.

KLUYVER, H. N. 1966. Regulation of a bird population. Ostrich, Suppl. **6:** 389–396.

——— & L. TINBERGEN. 1953. Territory and the regulation of density in titmice. Arch. Neerl. Zool. **10:** 265–289.

LACK, D. 1966. Population studies of birds. Clarendon Press, Oxford. 341 pp. (Appendix Section 3, Animal dispersion, pp. 299–312.)

———. 1968. Ecological adaptations for breeding in birds. Methuen & Co., Ltd., London. 409 pp.

LAMB, I. M., & M. H. ZIMMERMANN. 1964. Marine vegetation of Cape Ann, Essex County, Mass. Rhodora **66:** 217–254.

LANGFORD, A. N., & M. F. BUELL. 1969. Integration, identity and stability in the plant association, pp. 83–135. In J. B. CRAGG (*ed.*) Advances in ecological research, Vol. 6.

LEVINS, R. 1966. The strategy of model building in ecology. Am. Sci. **54:** 421–431.

———. 1968. Evolution in changing environments. Princeton Univ. Press, Princeton. 120 pp.

LINDROTH, C. H. 1970. Survival of animals and plants on ice-free refugia. Endeavour **29:** 129–134.

LUTZ, H. J. 1940. Disturbance of forest soil resulting from the uprooting of trees. Yale School of Forestry Bull. 45.

——— & A. C. CLINE. 1947. Results of the first thirty years of experimentation in silviculture in the Harvard Forest, 1908–1938. Part 1. The conversion of stands of old field origin by various methods of cutting and subsequent treatments. Harvard Forest Bull. 23. 182 pp.

——— & F. S. GRISWOLD. 1939. The influence of tree roots on soil morphology. Am. Jour. Sci. **237:** 389–400.

MACARTHUR, R. H., & J. H. CONNELL. 1966. The biology of populations. J. Wiley & Sons, New York. 200 pp.

———, H. RECHER, & M. CODY. 1966. On the relation between habitat selection and species diversity. Am. Nat. **100:** 319–327.

——— & E. O. WILSON. 1967. The theory of island biogeography. Monographs in population biology. Princeton Univ. Press, Princeton. 203 pp.

MACINTOSH, R. P. 1967. The continuum concept of vegetation. Bot. Review **33:** 130–187.

MARGALEF, R. 1963. On certain unifying principles in ecology. Am. Nat. **97:** 357–374.

———. 1968. Perspectives in ecological theory. Univ. Chicago Press, Chicago. 111 pp.

MARQUIS, D. A. 1967. Clearcutting in northern hardwoods. U.S. Forest Service Research Paper NE-85. N.E. Forest Expt. Sta., Upper Darby, Pa. 13 pp.

MCCORMICK, J. 1968. Succession. VIA 1, p. 22–35, 131, 132. Student Publication, Graduate School of Fine Arts, Univ. Pennsylvania.

MILTON, W. E. J. 1940. The effect of manuring, grazing and cutting on the yield, botanical and chemical composition of natural hill pastures. I. Yield and botanical section. Jour. Ecology **28:** 326–356.

——— & R. O. DAVIES. 1947. The yield, botanical and chemical composition of natural hill herbage under manuring, controlled grazing and hay conditions. I. Yield and botanical section. II. Chemical section. *Ibid.* **35:** 65–95.

NIERING, W. A., & F. E. EGLER. 1955. A shrub community of *Viburnum lentago*, stable for twenty-five years. Ecology **36:** 356–360.

ODUM, E. P. 1959. Fundamentals of ecology (2nd edition). W. B. Saunders Co., Philadelphia. 546 pp.

———. 1960. Organic production and turnover in old field succession. Ecology **41:** 34–48.

———. 1969. The strategy of ecosystem development. Science **164:** 262–270.

OLSON, J. S. 1958. Rates of succession and soil changes on southern Lake Michigan sand dunes. Bot. Gaz. **119:** 125–170.

OOSTING, H. J. 1956. The study of plant communities (2nd edition). W. H. Freeman & Co., San Francisco. 440 pp.

PARENTI, R. L., & E. L. RICE. 1969. Inhibitional effects of *Digitaria sanguinalis* and possible role in old-field succession. Bull. Torrey Bot. Club **96:** 70–78.

POUND, C. E., & F. E. EGLER. 1953. Brush control in southeastern New York: fifteen years of stable tree-less communities. Ecology **34:** 63–73.

RAUNKIAER, C. 1934. The life forms of plants and statistical plant geography. Clarendon Press, Oxford. 632 pp.

RAUP, H. M., & R. E. CARLSON. 1941. The history of land use in the Harvard Forest. Harvard Forest Bull. 20. 64 pp.

RICHARDS, P. W. 1952. The tropical rain forest. Cambridge University Press, Cambridge. 450 pp.

RICKETTS, E. F., & J. CALVIN. 1968. Between Pacific tides. (Revised by J. H. HEDGPETH.) Stanford, Calif. 614 pp.

RICE, E. L. 1964. Inhibition of nitrogen-fixing and nitrifying bacteria by seed plants (1). Ecology **45:** 824–837.

SIGAFOOS, R. S., & E. L. HENDRICKS. 1969. The time interval between stabilization of alpine glacial deposits and establishment of tree seedlings. U.S. Geol. Survey Prof. Paper 650-B, pp. B89–B93.

SJÖRS, H. 1948. Myrvegetation i Bergslagen. Acta Phytogeogr. Suec. 21. Uppsala. 340 pp.

———. 1950. Regional studies in north Swedish mire vegetation. Bot. Not. **1950:** 175–222.

———. 1955. Remarks on ecosystems. Svensk Bot. Tidskr. **49**(1–2): 155–169.

SKUTCH, A. F. 1967. Adaptive limitation of the reproductive rate of birds. Ibis **109:** 579–599.

SMITH, R. L. 1966. Ecology and field biology. Harper & Row Publ., New York, Evanston, & London. 686 pp.

SPURR, S. H. 1952. Origin of the concept of forest succession. Ecology **33:** 426, 427.

STEPHENSON, T. A., & A. STEPHENSON. 1954. Life between the tide-marks in North America. IIIA. Nova Scotia and Prince Edward Island: description of the region. IIIB. Nova Scotia and Prince Edward Island: the geographical features of the region. Jour. Ecology **42:** 14–45, 46–70.

——— & ———. 1961. Life between tide-marks in North America. IVA, IVB. Vancouver Island I, II. *Ibid.* **49:** 1–29, 229–243.

TANSLEY, A. G. 1935. The use and abuse of vegetational terms and concepts. Ecology **16:** 284–307.

THEOPHRASTUS. ca. 300 B.C. An enquiry into plants. Book IV: "Of the trees and plants special to particular districts and positions." Sir Arthur Hort Edition 1916. Heinemann, London.

THOREAU, H. D. 1860. Succession of forest trees. Mass. Board Agriculture Report VIII.

WALKER, D. 1970. Direction and rate in some British post glacial hydroseres. Studies in the Vegetational History of the British Isles: 117–139. D. WALKER & R. G. WEST, *eds*. Cambridge.

WALLACE, A. R. 1876. The geographical distribution of animals. 2 Vols.

———. 1880. Island life. London.

WHITTAKER, R. H. 1953. A consideration of climax theory: the climax as a population and pattern. Ecol. Monogr. **23:** 41–78.

———. 1965. Dominance and diversity in land plant communities. Science **147:** 250–260.

———. 1966. Forest dimensions and production in the Great Smoky Mountains. Ecology **47:** 103–121.

———. 1967. Gradient analysis of vegetation. Biol. Rev. **42:** 207–264.

———. 1970. Communities and ecosystems. The Macmillan Co., London & Toronto. 162 pp.

——— & P. P. FEENY. 1971. Allelochemics: chemical interactions between species. Science **171:** 757–770.

WILSON, R. E., & E. L. RICE. 1968. Allelopathy as expressed by *Helianthus annuus* and its role in old-field succession. Bull. Torrey Bot. Club **95:** 432–448.

WOODWELL, G. M. 1970. Effects of pollution on the structure and physiology of ecosystems. Science **168:** 429–433.

WYNNE-EDWARDS, V. C. 1959. The control of population-density through social behaviour: a hypothesis. Ibis **101:** 436–441.

———. 1962. Animal dispersion in relation to social behaviour. Hafner, New York. 653 pp.

YONGE, C. M. 1949. The sea shore. Collins, London.

MASSACHUSETTS AUDUBON SOCIETY
LINCOLN, MASSACHUSETTS 01773

CHROMOSOME COUNTS IN CULTIVATED JUNIPERS

MARION T. HALL, APARNA MUKHERJEE, AND WEBSTER R. CROWLEY

SAX AND SAX (1933) showed the base chromosome number in the gymnosperms, with the exception of the Gnetales, to be $n(x) = 12$. Variations from the base number were postulated to be the results of gain of a chromosome by duplication ($n = 13$ *Pseudotsuga*), loss of a chromosome and autoploidy ($n = 22$ in *Pseudolarix*), and loss of a chromosome following translocation of segments in the Cupressaceae and Taxodiaceae ($n = 11$ in *Juniperus*, *Taxodium*, and *Taiwania*). Further variations in number are the result of polyploidy, presumably autopolyploidy, but to only a minor extent. Sax and Sax studied either somatic or meiotic chromosomes in 53 species and 16 genera of Coniferales.

Mehra and Khoshoo (1956) briefly reviewed the cytology of the conifers and presented chromosome counts and other observations from somatic and meiotic preparations for 41 species in 14 genera in the Pinaceae, Taxodiaceae, and Cupressaceae. Their conclusions were generally in agreement with Sax and Sax; moreover they were careful to determine number and positions of secondary constrictions and the regularity of meiosis in *Juniperus phoenicea*, *J. bermudiana*, and *J. scopulorum*. They showed counts for *Cunninghamia* and *Cryptomeria* ($n = 11$) for the Taxodiaceae and numbers ($n = 11$) for *Actinostrobus*, *Callitris*, *Widdringtonia*, *Tetraclinis*, *Thuja*, *Cupressus* in the Cupressaceae. They supplied counts for *Juniperus procera*, *J. phoenicea*, and *J. bermudiana* ($n = 11$).

In a recent paper Evans and Rasmussen (1971) illustrated a compilation of documented chromosome counts for *Juniperus* L. In their *Table I* they show nine species (or 10 if *J. virginiana* var. *scopulorum* is considered to be *J. scopulorum*), and they list the count by Jensen and Levan, 1941, for *J. squamata* 'Meyeri' ($2n = 44$) for a total of 11 species or cultivars of species.

We are surveying the cultivated junipers of the Morton Arboretum for chromosome counts. Those currently documented are shown in TABLE 1 where they are arranged by sections. In section OXYCEDRUS we show counts of chromosomes for two species, two varieties, and four cultivars. In section SABINA we present counts for two varieties and ten cultivars.

MATERIALS AND METHODS

The 20 different plant taxa listed in TABLE 1 are a small portion of the living juniper collections at the Arboretum. We believe that spring wood after adequate hardening is best for use as propagation material from junipers. Therefore, the cuttings were taken in mid-summer and propagated

TABLE 1. **Chromosome Counts in Cultivated Junipers.**

SPECIES, VARIETIES, AND CULTIVARS	ARBORETUM ACCESSION NUMBER	CHROMOSOME COUNTS OBTAINED	CHROMOSOME COUNTS RECORDED IN THE LITERATURE
Section OXYCEDRUS			
1. *Juniperus communis* L. var. *communis*	990–62	$2n = 22$	1. Sax & Sax (1933)
2. *Juniperus communis* L. var. *depressa* Pursh	616–44	$2n = 22$	1. Löve & Löve (1933)
3. *Juniperus communis* L. 'Candelabriformis'	356–62	$2n = 22$	
4. *Juniperus communis* L. 'Hibernica'	14–61	$2n = 22$	
5. *Juniperus communis* L. 'Suecica'	399–51	$2n = 22$	
6. *Juniperus communis* L. 'Suecica Nana'	16–42	$2n = 22$	
7. *Juniperus formosana* Hayata	439–54	$2n = 22$	
8. *Juniperus rigida* S. & Z.	519–53	$2n = 22$	8. Sax & Sax (1933)
Section SABINA			
9. *Juniperus chinensis* L. var. *chinensis*	714–56	$2n = 44$	
10. *Juniperus chinensis* L. 'Blaauw'	708–56	$2n = 22$	
11. *Juniperus chinensis* L. 'Pfitzeriana'	25–60	$2n = 44$	11. Sax & Sax (1933)
12. *Juniperus chinensis* L. 'Shimpaku'	606–60	$2n = 22$	
13. *Juniperus horizontalis* Moench 'Alpina'	945–62	$2n = 22$	
14. *Juniperus horizontalis* Moench 'Variegata'	340–57	$2n = 22$	
15. *Juniperus horizontalis* Moench 'Wiltonii'	311–57	$2n = 22$	
16. *Juniperus scopulorum* Sarg. 'Moffetii'	609–60	$2n = 22$	
17. *Juniperus scopulorum* Sarg. 'Silver King'	612–60	$2n = 22$	
18. *Juniperus squamata* Lamb. var. *Fargesii* Rehd. & Wils.	444–54	$2n = 44$	
19. *Juniperus virginiana* L. 'Cupressifolia'	436–61	$2n = 22$	
20. *Juniperus virginiana* L. 'Pseudocupressus'	619–60	$2n = 22$	

in mist chambers with a medium of well-washed sharp sand. Minimal nutrient leaching occurs for junipers with their heavy cuticles, so that no compensatory treatment was required. Efficacy of rooting is a function of growth form; the horizontal types root rapidly and well while the upright kinds root slowly and poorly.

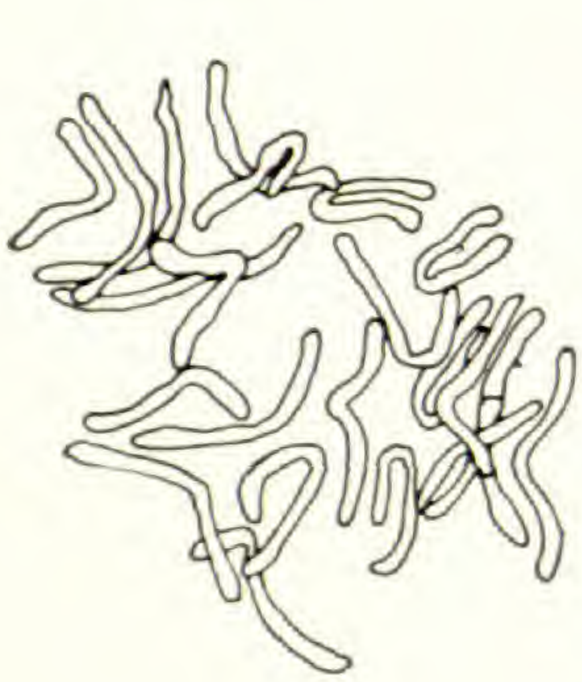
The successful cuttings were potted and for the study those cuttings that had thick, whitish, shiny root tips were chosen. It was determined through periodic sampling that the mitotic divisions accumulated from 9:00 a.m. to 11:00 a.m. Root tips 3 mm. in length were collected during this time period for pre-treatment and fixation. Several kinds of pre-treatment solutions were employed for mitotic arrest, but a saturated solution of aesculine proved best, provided pre-treatment lasted no more than six hours. After the six hours of pre-treatment, the tips were hydrolysed for five minutes in a mixture of concentrated hydrochloric acid and 95% ethanol (1:3), and the tissue hardened and fixed in modified Carnoy's solution (absolute ethanol: chloroform: glacial acetic acid, 6:3:1 by volume) for 15 to 20 minutes.

The fixed root tips were then squashed on glass slides with 2% acetic-orcein and mounted in a 1% solution of the dye, gently heated, and sealed with paraffin wax. Sufficient numbers of preparations were examined to obtain characteristic and accurate chromosome counts. Photomicrographs were taken for a permanent record, and camera lucida drawings were made for greater clarity. Voucher slides were also made available in permanent mounts.

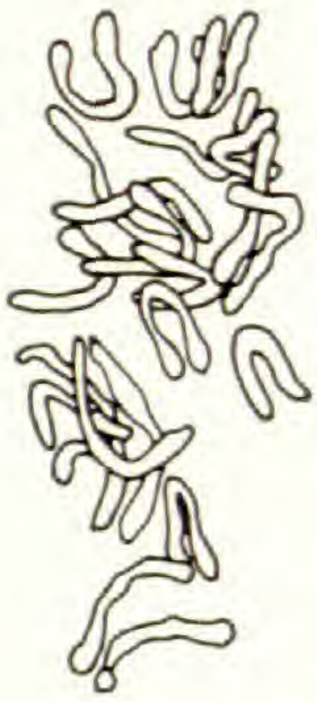
Results and Discussion

The three species so far counted in the section Oxycedrus are diploids ($2n = 22$), as are all the counts from the literature involving species of this section. These chromosomes are isobrachial with no apparent distinguishing characteristics between the species from root tip preparations. Similarly a tentative count for *Juniperus conferta* Parl. suggests it is diploid, but not enough material has been seen to establish the count definitely. *Juniperus rigida*, *J. conferta*, and *J. communis* form a close species group on the basis of morphological characters and the chromosome data agree. Likewise morphological data indicate that *J. formosana* forms a second species group in section Oxycedrus along with *J. taxifolia*, *J. macrocarpa*, *J. cedrus*, *J. oxycedrus*, and *J. brevifolia*, but the chromosome data do not appear distinctive for each of these two groups, at least from preliminary studies.

Section Sabina is large in number and diversity of species. Most of the counts in the literature for species of section Sabina indicate that they are diploid ($2n = 22$), e.g., *Juniperus bermudiana*, *J. horizontalis*, *J. horizontalis* 'Plumosa Compacta,' *J. phoenicea*, *J. procera*, *J. sabina*, *J. sabina* 'Von Ehren,' *J. scopulorum*, and *J. virginiana*. Of these diploids all have more or less isobrachial chromosomes except *J. horizontalis* which has one chromosome pair with subterminal centromeres. The authors have

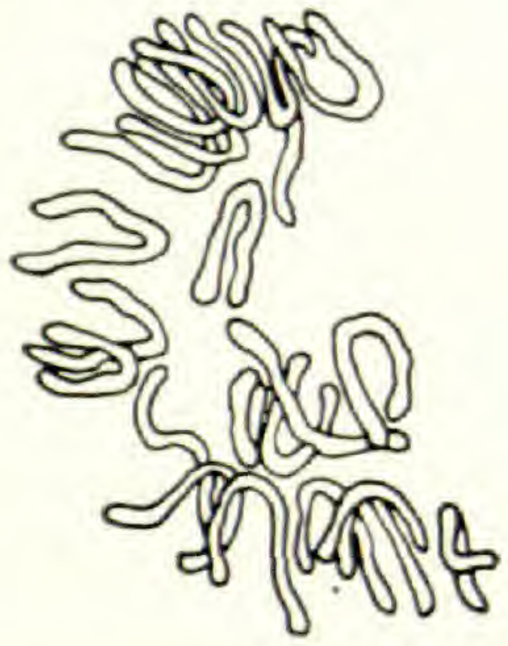


1

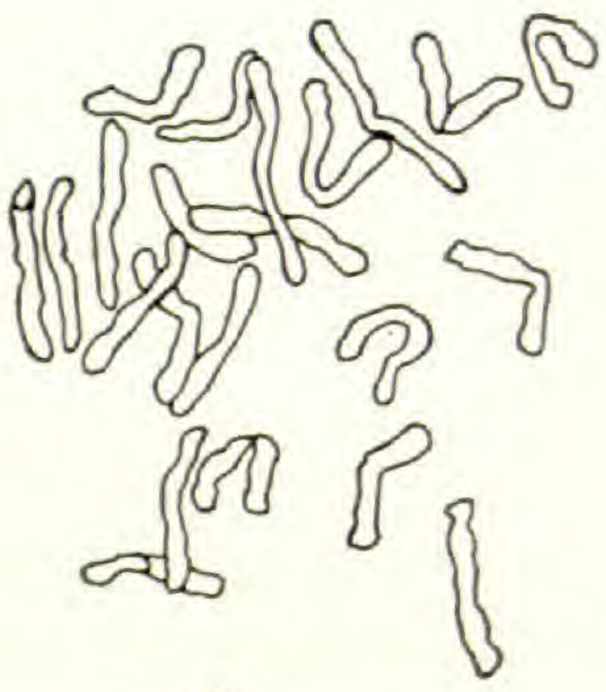


2

3

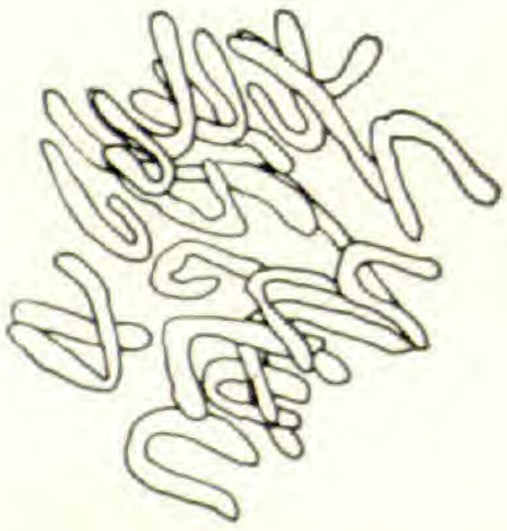


4



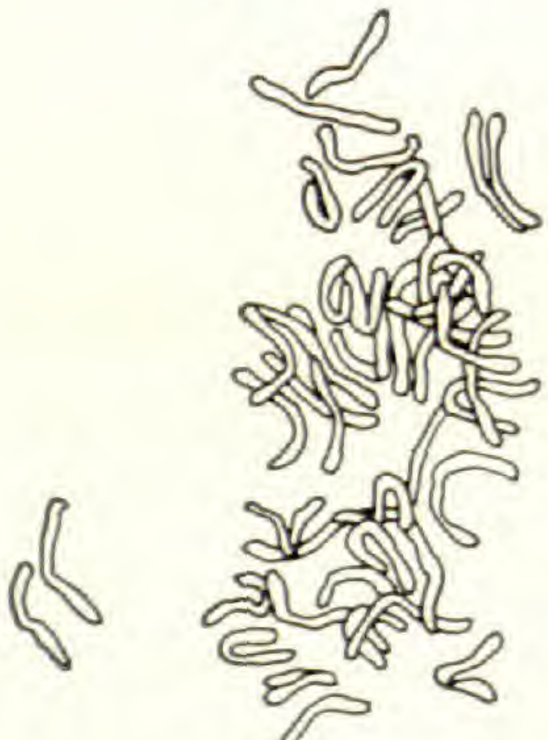
5

6

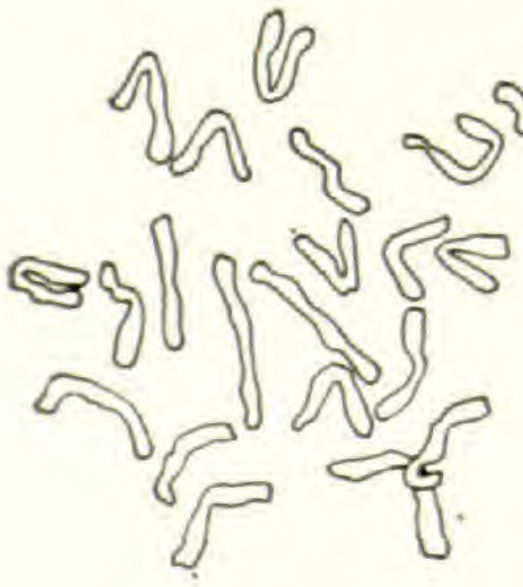


7

8



9

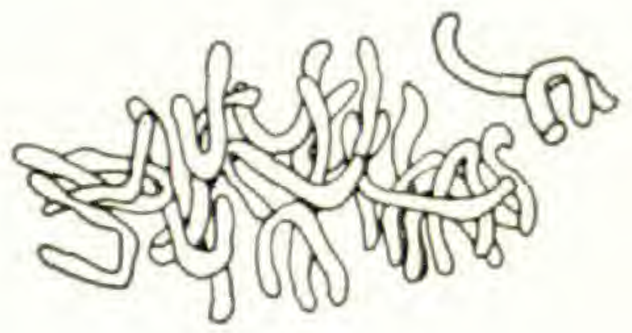


10

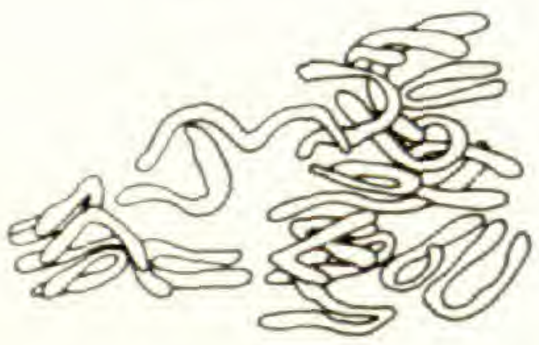
FIGURE 1. Drawings of the chromosome complement of junipers numbered 1 through 10 in TABLE 1. Drawings numbered 3, 6, and 9 are approximately × 750; those numbered 1, 2, 4, 5, 7, 8, and 10, are × 1000.

11

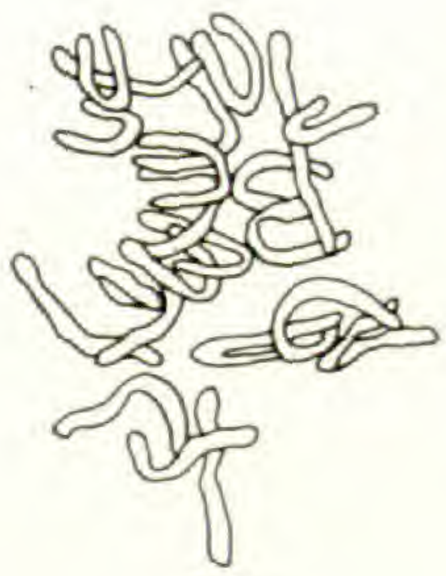
12



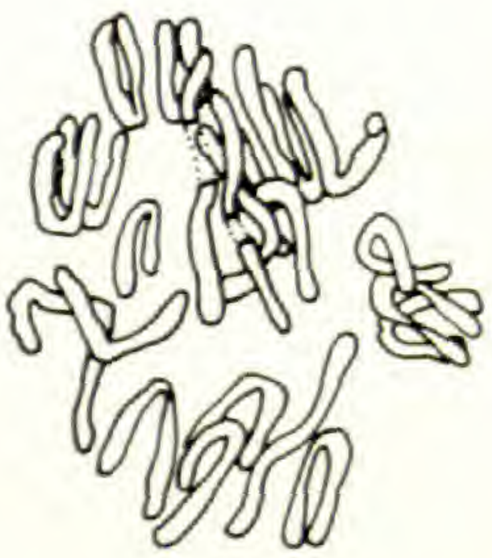
13



14



15

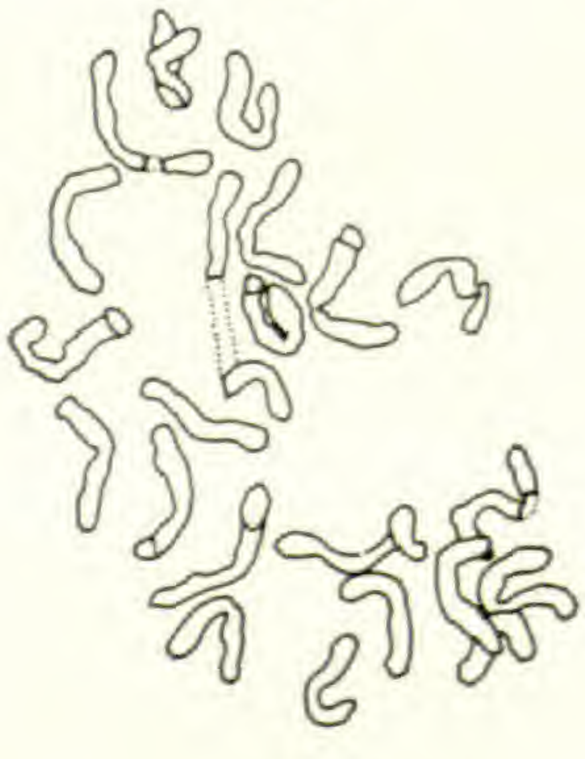


16

17

18

19



20

FIGURE 2. Drawings of the chromosome complement of junipers numbered 11 to 20 in TABLE 1. All drawings are approximately × 1000.

preliminary counts for *Juniperus Ashei*, *J. virginiana* (wild type from the Ozarks), and *J. monosperma* all with the diploid number ($2n = 22$). *Juniperus monosperma*, like *J. horizontalis*, shows one pair of chromosomes with subterminal centromeres.

A look at our TABLE 1 indicates that *Juniperus chinensis* 'Blaauw' and 'Shimpaku' (Plumosa group) are diploids. The two cultivars each of *J. scopulorum* and *J. virginiana* are diploids. Three cultivars of *J. horizontalis* are diploids.

From those species of which chromosomes have been examined, polyploidy is the most obvious factor in their differentiation. Triploidy has been reported in *J. virginiana* by Stiff (1951) who found one triploid in an open-pollinated wild population of red cedar growing at Blandy Farm. It resembled the diploids in growth habit and general appearance but had larger stomata. Evans and Rasmussen (1971) have found *J. chinensis* 'Hetzii' to be triploid.

Jensen and Levan (1941) reported *J. squamata* 'Meyeri' to be a tetraploid. We show that *J. squamata* var. *Fargesii* is also tetraploid ($2n = 44$). Sax and Sax (1933) reported *J. chinensis* 'Pfitzeriana' to be tetraploid and our material of cv. Pfitzeriana at the Morton Arboretum is also tetraploid ($2n = 44$). Our data show also that our cultivated material of *J. chinensis* var. *chinensis* is tetraploid ($2n = 44$). It will be interesting to determine if all the cultivated var. *chinensis* is actually tetraploid and if there are, then, diploid wild populations of *J. chinensis* var. *chinensis*. While *J. chinensis* 'Blaauw' and 'Shimpaku' are diploids they differ markedly in morphology from other variants of *J. chinensis*, that is, all those not members of the Plumosa group. Enough data are available to repudiate van Melle's (1946) effort to place the Pfitzeriana group and the Plumosa group in a new species *J. media*. If these two groups belong in a species other than *J. chinensis*, they certainly do not belong together.

It appears to us that careful chromosome studies when combined with other available data may offer no more than minor assistance in indicating relationships between cultivars, varieties, and in some cases, species of *Juniperus*. Nevertheless, counts should be made available in all juniper species, varieties, and cultivars as quickly as possible. With additional data chromosome studies may prove to be more useful. For example, *J. chinensis* 'Hetzii' has been said to be an interspecific hybrid. Since it is triploid, successful efforts in synthesizing the cultivar under controlled conditions, might produce interesting data to confirm or refute earlier reports.

ACKNOWLEDGMENTS

The authors extend thanks to Nancy Hart, Michael Beasley, and Carol Doty for their aid in preparing illustrations and manuscript.

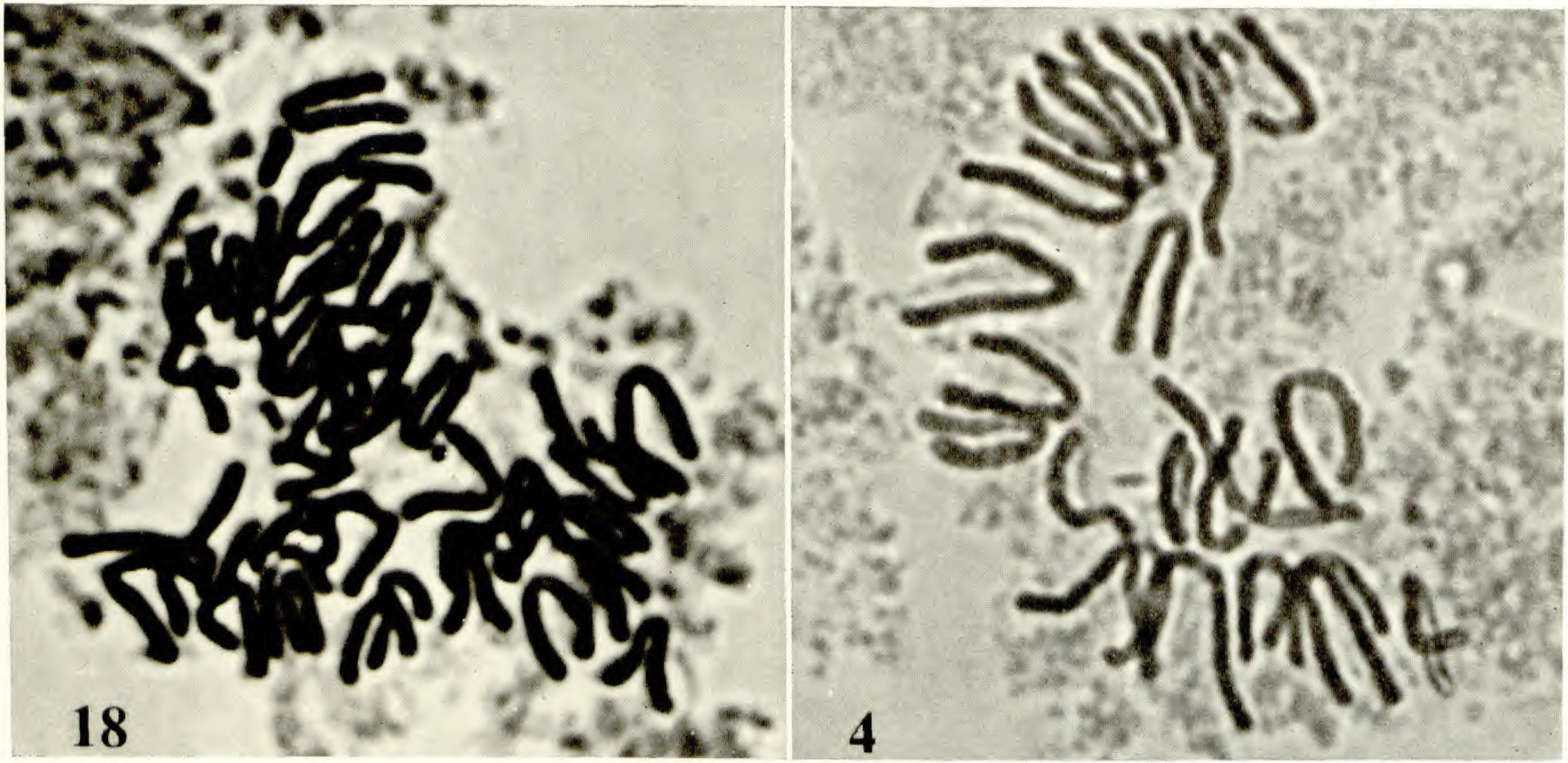


FIGURE 3. Photomicrograph of the chromosome complement of a diploid juniper, no. 4 (as in TABLE 1), *Juniperus communis* 'Hibernica,' and of a tetraploid, *J. squamata* var. *Fargesii*, no. 18 (as in TABLE 1).

LITERATURE CITED

EVANS, G. E., & H. P. RASMUSSEN. 1971. Chromosome counts in three cultivars of *Juniperus* L. Bot. Gaz. **132**: 259–262.

JENSEN, H., & A. LEVAN. 1941. Colchicine induced tetraploidy in *Sequoiadendron giganteum*. Hereditas **27**: 220–224.

MEHRA, P. N., & T. N. KHOSHOO. 1956. Cytology of conifers. I. Jour. Genet. **54**: 165–180.

SAX, K., & H. J. SAX. 1933. Chromosome number and morphology in the conifers. Jour. Arnold Arb. **14**: 356–375.

STIFF, M. L. 1951. A naturally occurring triploid juniper. Virginia Jour. Sci. **2**: 317.

VAN MELLE, P. J. 1946. The junipers commonly included in *Juniperus chinensis* L. Phytologia **2**: 185–194.

THE MORTON ARBORETUM
LISLE, ILLINOIS 60532

NOTES ON THE PIPERACEAE OF THE LESSER ANTILLES

RICHARD A. HOWARD

THE FOLLOWING NOTES were derived from a study of the Piperaceae in preparation for a flora of the Lesser Antilles. Casimir de Candolle published an account of the family in Urban's *Symbolae Antillanae* in 1902, recognizing 154 species and additional varieties in the Antilles. Subsequently numerous new taxa have been added by Urban, C. de Candolle, Trelease and Stehlé, so the family stands today as one of the larger families of the area, and one with a high percentage of endemic species. The difficulty of establishing a valid species concept within the family and the existing overdescription of taxa is recognized. A treatment of species from a small area is not a satisfactory and certainly not a scientific approach. No monographer is available, and one might ask if a single lifetime would be enough to straighten out one of the worst messes in plant taxonomy.

Subsequent to De Candolle's treatment in 1902 is his analytical key to the Piperaceae published posthumously (Candollea 1: 65–415. 1923). In the period from 1930 to 1940 Henri Stehlé collected extensively in the French Islands of Guadeloupe and Martinique and sent his materials to Trelease. Trelease supplied identifications which Stehlé published in a variety of ways. Often the names alone were given as a list of the flora of an area or island (e.g., Flore de la Guadeloupe et Dépendances 2(1): 2, 3, 8. 1937), often with type collections cited, but since descriptions were lacking, these names were *nomina nuda*. Stehlé planned and apparently wrote a treatment of the family; however, only a part was published as "Flore descriptive des antilles françaises II, Les Piperales, Piperacées et Chloranthacées," Fascicule 1, 1–144. 1940. In various subsequent publications it is indicated that this work was completed. The part cited covers the three genera, *Pothomorphe*, *Sarcorhachis*, and *Piper*, and six of the 42 species of *Peperomia* included within a key to the genus. This appears to be an independent publication; however, it is one which parallels but is more comprehensive than that of the Bulletin Agricole Martinique (9(3): 145–221. 1941), a publication which cannot be located in libraries in the United States. Stehlé prepared the illustrations for the unpublished part of this paper, and photographs of them are associated with herbarium specimens in the Trelease collections at the University of Illinois. A word of warning must be expressed over the inconsistencies or errors which exist between the specimens which Stehlé and Trelease annotated, the early usually invalid publication, and the subsequent publications. Trelease frequently used local place names as epithets. Both Trelease and Stehlé have handwriting of difficult legibility.

In their coöperative effort, numbers on specimens are reversed; types are changed; taxonomic status altered; and spellings are varied.

Yuncker and Trelease collaborated in the preparation of the two-volume work, *The Piperaceae of Northern South America*, published in 1950. A few of the species of the Lesser Antilles are included in this work. Yuncker also published treatments of the family for Panama (Annals Missouri Bot. Gard. **37**: 1–120. 1950); Trinidad and Tobago (Lilloa **26**: 239–278. 1953); Jamaica (Bull. Inst. Jamaica, Science Ser. **11**: 1–56. 1960); and for the Netherlands Antilles (Uitg. Nat. Stud. voor Suriname **42**: 71–87. 1966). All of these publications have been useful in consideration of the taxa within the Lesser Antilles. More recently Burger's treatment for the *Flora of Costa Rica* (Fieldiana Bot. **35**: 5–227. 1971) represents a major contribution with notes which have value to the present work. In all of these there has been a gradual addition of synonyms by the reduction of taxa described by C. de Candolle and by Trelease. However, none of the works has given consideration to the "names" published by Trelease and Stehlé for the Lesser Antilles.

The species concept of Trelease and Stehlé cannot be accepted today. These authors clearly state that their use of a name applies to a plant occurring on a particular island, and they admit that the same plant on another island or in South America or Central America has a different specific name. In this practice, for example, they ignored all older epithets which were based on plants collected from Dominica, the island between Guadeloupe and Martinique, or on islands north or south of the French islands. The present study might receive comparable criticism, for it is not possible to consider all of the species which have been described for the Greater Antilles or for South America and Central America. There is slight satisfaction in recognizing that, in general, older names are those of the Antillean area, and that my colleagues have been equally guilty in not considering Antillean taxa in their comparisons.

Stehlé stresses the importance of knowing the plants of the Piperaceae in the field. He reported the differences between juvenile and mature foliage, and the changes to be observed when specimens are taken into cultivation. However, he handles minor variations in leaf shape or pubescence by recognition of an excessive number of forms and varieties. The present study is based on much more material than was available to earlier workers in the area, and on personal collections and field observations. Field work by Walter Hodge and the recent collaborators on the Smithsonian Institution project has amassed large numbers of vouchers from Dominica. My own work with several colleagues has added many specimens from St. Vincent and St. Lucia. The collections of George Proctor from islands throughout the area have been most important for filling in geographic gaps and producing high quality specimens. The work of Proctor and much of my own has been supported at times by grants from the National Science Foundation.

The plants of the Piperaceae are mostly succulent, and unless prepared quickly and properly in the field, result in poor quality herbarium speci-

mens. With the use of heat the specimens can be dried quickly. The generally accepted idea that some species turn black on drying is not necessarily true. Unfortunately, heat for drying was not always available to earlier collectors and the quality of many collections is poor. The types of many of the Trelease and Stehlé species can only be described as fragments, and are contained in packets. The succulence of the specimens, particularly in *Peperomia*, presents additional problems in the understanding of previous descriptions. Inflorescences may be crushed in pressing, and the final appearance varies with the age of the inflorescence. Flowering inflorescences must be prepared differently from infructescences. The adhesion of the bract and the pedicel often reported in species of *Peperomia* is commonly an artifact of compression. The number of stamens per flower in species of *Piper* is at best a difficult characteristic to ascertain, although it appears to be associated with the shape of the mature drupe: i.e., three stamens with a triangular drupe, four stamens with drupes that are round or oblong in top view. Dahlstedt's monograph (Kongl. Sv. Vet. Akad. Handl. 33(2): 1–218. 1900) contains many illustrations of fruit types within *Peperomia*. It is often difficult to find and select mature fruiting specimens in the field, and as the fruits are glandular in most cases in the Lesser Antilles, these adhere to the pressing papers and are lost. The packaging of a few infructescences with mature fruit in packets in the field has proven to be most useful.

Little is known of the floral biology of the Piperaceae. I have found no data on pollinators or on methods of fruit distribution. Some species of *Piper* are known to be dioecious. Such a condition is suggested for other species from the examination of much herbarium material, but no field observations have been made to verify this conclusion. In some species of *Peperomia* it appears that the fertility is extremely low, or that many fruits abort in development. Abnormal fruits have been observed also as larger than previously reported for the species, and appearing to be empty when dissected. This is indeed a group in need of study.

I have been able to examine the type specimens of most of the taxa considered in the present work. Regrettably, some of the authentic specimens have been lost or cannot be located. I am grateful for the cooperation I have received from staff members of many herbaria in the search for specimens or for the solutions to specific problems. A complication of this investigation has been the failure of earlier authors to cite the location of a particular type. De Candolle and Dahlstedt saw material from several herbaria. They also worked with mixed collections so that a species is often based on a particular collection "in part" or with a suffix letter, as 123b. The problem of the Duss collections is a familiar one to workers on the Antillean flora. Someone in the past thought his several collections of different numbers were the same species, and distributed the specimens with one, two, three, or even four different collection numbers on the same label. The problem of the identification of isotypes is obvious when the holotype is one of those numbers "in part."

In the following notes extensive new synonymy is suggested. For con-

venience the synonymous taxa are listed alphabetically under the accepted species. To aid others in finding a specific name, I am supplying here alphabetical lists of names which have been used under treatments of *Peperomia* and *Piper*, and I indicate their present assignment. Some of the names given have been found only on herbarium sheets in the handwriting of De Candolle or Trelease. While the listing of such names is not usually an acceptable practice, it is done here for three reasons. Some of the collections are widely distributed: e.g., Duss, Stehlé, H. H. & G. W. Smith. Trelease traveled extensively and annotated specimens in many herbaria, and the majority of the unpublished binomials or trinomials are his. Finally, Stehlé's writings are often in obscure or local agricultural journals of Martinique and Guadeloupe, some of which have not been located. The author has no copies (personal communication), and the librarians on those islands, although cooperative, have not found the articles. There is a possibility that some of the names have appeared in print.

The distributions cited include only those islands from which I have seen specimens.

Lepianthes Rafinesque, Sylva Tellur. 84. 1838

Pothomorphe Miquel, Comm. Phyt. 36. 1840. TYPE SPECIES: *Piper umbellatum* L.

The generic name *Lepianthes*, suggested by Rafinesque, has been overlooked by all recent workers except for Trelease and Yuncker (Piperaceae North. S. Am. 2: 435. 1950), and Yuncker (Ann. Missouri Bot. Gard. 37: 72. 1950), who listed the name in the synonymy of *Pothomorphe* but rejected it by stating "*Lepianthes* Raf. Sylv. Tellur. 85. 1838, not *Lepanthes* Sw. 1799." Rafinesque noted that the genus *Piper* had increased to about 150 species and that he would "endeavor to indicate several Genera of it." The majority of his genera are not acceptable, but recently the name *Pothomorphe* has been used for the plants with peltate leaves and stalked umbellate inflorescences. De Candolle (Symb. Antill. 3: 208–211. 1902) used *Piper peltatum* and *P. umbellatum* for the two common species of *Pothomorphe*, but Britton and his co-workers, León, Trelease, Yuncker, Stehlé, Burger, and Adams have all accepted *Pothomorphe* in their respective floras. Recently Liogier (Rhodora 67: 327. 1965) corrected the nomenclature of Britton and Wilson in their Sci. Surv. Porto Rico Virgin Is. from *Pothomorphe peltata* and *Pothomorphe umbellata* to assignment of these species in *Piper*. He offered no discussion. Burger, however, noted that (Fieldiana Bot. 35: 197. 1971) some species described in the genus *Piper* are more closely related to species of *Pothomorphe* than they are to some species of *Piper*. He concluded "that the lack of a functional classification within *Piper* and these very unusual inflorescences make it advisable to maintain the genus *Pothomorphe*."

If the genus *Pothomorphe* is accepted as distinct from *Piper*, then

Rafinesque's name must be used. Certainly there can be no confusion between *Lepanthes* Sw. (Orchidaceae) and *Lepianthes* Raf. (although the latter name is spelled *Lepianthus* in the Index of Sylv. Tellur. 180. 1838). Nor is there need to propose the name of this small genus for conservation.

Rafinesque cited four species to be included in *Lepianthes* when he stated "Type Lep. vel P. umbellatum, peltatum, maculosum, granulatum and many others." The combinations are attributed to him in Index Kewensis. *Piper umbellatum* L. and *Piper peltatum* L. are generally accepted as species of *Pothomorphe*. *Piper maculosum* L. is accepted by Trelease and Yuncker (Piperaceae North. S. Am. 2: 721. 1950) and others as *Peperomia maculosa* (L.) Hook. "Piper granulatum" as listed by Rafinesque presents a problem. It is not a Linnaean species. Merrill (Index Rafinesquianus p. 106. 1949) suggested this epithet is a misspelling of *Piper granulosum* Ruiz & Pavon, a species currently recognized in the flora of Peru. Subsequently *Piper granulatum* was published by Trelease (Contr. U.S. Natl. Herb. 26: 175. 1929) with *Pittier 3593* as the type, collected in 1891 in Costa Rica. *Lepianthes granulatum* Raf. is stated to be the equivalent of *Piper angustifolium* (Index Kew. 3: 55. 1904), a name which was published independently by Lamarck, Roxburgh, and Ruiz & Pavon.

Additional species of *Pothomorphe* are recorded in the literature. Older names are to be found in Miquel's work (Syst. Piperacearum 202–216. 1843). Trelease described several species in the Flora of Panama (Ann. Missouri Bot. Gard. 27: 306, 307. 1940), and Yuncker added one for Ecuador (Ark. Bot. 4: 410. 1962). Rather than add to the confusion of names in this family, I leave the possible new combinations to others who can evaluate the species.

The type species of the genus *Pothomorphe* selected by Britton and Wilson (Sci. Surv. Porto Rico Virgin Is. 5: 229. 1924) was *Piper umbellatum* L. Trelease and Yuncker (Piperaceae North. S. Am. 2: 435. 1950) incorrectly indicated *Piper peltata* as the type species.

Lepianthes peltata (L.) Raf. Sylv. Tellur. 84. 1838.

Piper peltatum L. Sp. Pl. 1: 30. 1753 (sphalm. pelatum). TYPE: Hispaniola (?), *Plumier*, Amer. 56. *t. 74*. 1693.
Pothomorphe peltata (L.) Miq. Comm. Phyt. 37. 1840.
Pothomorphe dussii Trel. in Stehlé, Fl. Descr. Antill. Fr. 2(1): 61. *pl. 1*. 1940. TYPE: Martinique, *Duss 1340* (holotype US).

Stehlé distinguished *Pothomorphe dussii* from *P. peltata* by leaves which are rounded, deltoid-acuminate, and retuse at the base, and by its fewer, shorter spikes. These characteristics are within the range of variation of a wide-ranging species. The illustration made by Stehlé is purely imaginative and does not conform to any of the specimens cited; nor does it agree with the descriptions given. It is in fact more similar to *Lepianthes umbellata* than to *L. peltata*.

DISTRIBUTION: Montserrat, Dominica, Martinique, St. Lucia, St. Vincent, Grenada, Barbados.

Peperomia Ruiz & Pavon, Prodr. 8. 1794

In the original generic description Ruiz and Pavon mention three species of *Piper* described by Linnaeus. No type species was designated. Their later comprehensive treatment of the genus (Fl. Peruv. Chil. 1: 29–33. 1798) contained 24 species and illustrations of most of them. Hugo Dahlstedt, Casimir de Candolle, and William Trelease apparently never selected a lectotype. Britton (Flora of Bermuda 94. 1918) appears to have been the first to choose a "type species," selecting *Peperomia secunda* Ruiz & Pavon. This selection is repeated in Britton and Millspaugh's *The Bahama Flora* (101. 1920). In the Sci. Surv. Porto Rico Virgin Is. (5: 223. 1924), Britton and Wilson chose *Peperomia scutellaefolia* Ruiz & Pavon as the type species. The only explanation for this unnecessary change appears to be that *P. scutellaefolia* is the first species listed by Ruiz and Pavon, while *P. secunda* is the third. In The Piperaceae of Northern South America (2: 443. 1950) Trelease and Yuncker designated *Peperomia pellucida* (L.) H.B.K. as the type species.

Peperomia alpina A. Dietr.

The identification "Peperomia alpina A. Dietr.?" was given to a collection by *H. H. and G. W. Smith 1643* from St. Vincent in a list in Kew Bull. 1893, p. 272. The specimen in the herbarium at Kew was annotated "P. vincentensis" by Trelease, but this name has not been published. The specimen is *Peperomia myrtifolia* (Vahl) A. Dietr., and is quite distinct from *Peperomia alpina* (Sw.) A. Dietr. as currently recognized in the flora of Jamaica.

Peperomia blanda (Jacq.) H.B.K. Nov. Gen. & Sp. 1: 56. 1816.

Piper blandum Jacq. Collect. 3: 211. 1791. TYPE: Venezuela.

Yuncker (Fl. Neth. Antill. 2: 78, 79. 1966) accepted this species in his treatment of *Peperomia* of the Netherlands Antilles. I have seen but one (*Boldingh 3041*) of the specimens he cited from Curaçao, St. Eustatius, and St. Martin, and refer that specimen to *Peperomia questeliana*. A further discussion of the nomenclature is given under that species.

Peperomia ciliata Kunth, H.B.K. Nov. Gen. & Sp. 1: 56. 1816.

Grisebach (Fl. Brit. W. Ind. Is. 168. 1860) recorded this species from Antigua, and recent material has been so identified. De Candolle (Urb. Symb. Antill. 3: 266. 1902) cited under this name a specimen from Puerto Rico and the record of Grisebach from Antigua and Trinidad. Britton and Wilson (Sci. Surv. Porto Rico Virgin Is. 5: 228. 1924) considered

the Puerto Rican material to be "Peperomia humilis" (= *Peperomia questeliana*). Trelease and Yuncker (Piperaceae North. S. Am. 2: 557. 1950) placed *P. ciliata* H.B.K. in the synonymy of *Peperomia blanda* and recognized the variety *P. blanda* var. *langsdorfii*. They attributed both taxa to the West Indies. The Antigua material I have seen is assigned to *Peperomia questeliana* in this paper.

Peperomia cordifolia (Sw.) A. Dietr. in L. Sp. Pl. ed. 6. 1: 154. 1831.

This species has been attributed to Jamaica and Dominica by several authors including Adams (Flora Jam. 207. 1972). A loan from Kew included two sheets which by their shape were clearly once one sheet and held four small specimens of *Peperomia*. Annotations clearly indicate that one specimen collected by Imray on Dominica, numbered 331, is *Peperomia rotundifolia* (L.) H.B.K. This specimen also bears an annotation label supplied by Trelease, suggesting it is the "Type of *P. imrayana* (ined.)." The other three specimens were collected by McFayden in Jamaica, and are *Peperomia cordifolia*, a species considered endemic to Jamaica.

Peperomia emarginella (Wikstr.) DC. Prodr. 16(1): 437. 1869.

Piper emarginellum Wikstr. Stockh. Kongl. Vet. Akad. Handl. 1827: 56. 1828. TYPE: Jamaica, *Swartz*.
Peperomia emarginella var. *exilis* (Miq.) Stehlé, Bull. Soc. Bot. Fr. 85: 576. 1938.
Acrocarpidium exile Miq. Syst. Piperacearum 56. 1843. TYPE: Ind. Occ. *Poiteau* [G-hb. Delessert].
Peperomia exilis (Miq.) Griseb. Fl. Br. W. Ind. Is. 164. 1860.

DISTRIBUTION: St. Kitts, Nevis, Dominica, St. Vincent.

Peperomia glabella (Sw.) Dietr. in L. Sp. Pl. ed. 6. 1: 156. 1831.

Piper glabellum Sw. Prodr. 16. 1788. TYPE: Jamaica, *Swartz*.
Peperomia glabella var. *eustatiana* C. DC. in Urb. Symb. Antill. 3: 236. 1902. TYPE: St. Eustatius, *Suringar*.
Peperomia glabella var. *nervulosa* (C. DC.) Yuncker, Ann. Missouri Bot. Gard. 37: 98. 1950. TYPE: Surinam, *Hostmann 437*.
Peperomia sabae Trel. Unpublished herbarium name.
Piper scandens Sw. Prodr. 16. 1788.

Trelease and Yuncker Piperaceae North. S. Am. 2: 587, 590, 591. 1950) recognize *Peperomia glabella* and raise the question of its relationship to *Peperomia nigropunctata* Miq. which is based on material from Martinique. In 1966 Yuncker (Fl. Neth. Antill. 2: 79–81. 1966) recognized both species using the key character of "stems subnodally lineately ciliate; petioles ciliate . . ." to characterize *P. glabella*. In the same treatment he recognized var. *glabella* and var. *nervulosa* but did not mention De Candolle's var. *eustatiana*. The three varieties are based on variations in venation, surface reticulation, and leaf shape, and do not appear worthy of further recognition.

Burger (Fieldiana Bot. **35**: 37. 1971) used *Peperomia glabella* and included *P. nigropunctata* among the synonyms assigned to it. I have maintained the two species using as a distinguishing character the presence or absence of ciliate pubescence on the petiole and in lines on the stem below the node. *P. glabella* can be recognized in the field by the characteristic light color of stems and leaves and the greater number of spikes, in contrast to the darker green color of stems and leaves and the fewer spikes of *P. nigropunctata*.

A collection from Barbados (*Eggers 7359*), cited by Dahlstedt (Kongl. Sv. Vet. Akad. Handl. **33**(2): 119. 1900) under the name *Peperomia caulibarbis*, was referred to *P. glabella* by De Candolle (Urb. Symb. Antill. **3**: 235. 1902). *Peperomia caulibarbis* Miq. Syst. Piperacearum 98. 1843 was typified by the collection of *Gaudichaud 287* from Brazil.

DISTRIBUTION: Saba, St. Eustatius, St. Vincent, Grenada.

Peperomia hernandiifolia (Vahl) Dietr. in L. Sp. Pl. ed. 6. **1**: 157. 1831.

Piper hernandifolium Vahl, Enum. **1**: 344. 1804. TYPE: Ind. Occ.
Peperomia ponthieui Miq. Syst. Piperacearum 186. 1843. TYPE: Guadeloupe, *Ponthieu s.n.*

DISRTIBUTION: Saba, St. Kitts, Nevis, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Grenada.

Peperomia hirtella Miq. in Hooker, Lond. Jour. Bot. **4**: 414. 1845.

TYPE: Dominica, *Imray 244* (K).

Peperomia allorgeana Stehlé, Candollea **8**: 76. 1940. TYPE: Martinique, *H. & M. Stehlé 3386.*
Peperomia allorgeana forma *genuina* Stehlé, Fl. Descr. Antill. Fr. **2**(1): 137. 1940. TYPE: Guadeloupe, *Stehlé 3386* (Herb. Stehlé).
Peperomia allorgeana forma *lata* Trel. in Stehlé, *Ibid.* 141. TYPE: Martinique, *Stehlé 3389* (ILL).
Peperomia allorgeana forma *major* Trel. in Stehlé, *Ibid.* 140. TYPE: Martinique, *Stehlé 3211* (ILL).
Peperomia allorgeana forma *minor* Trel. in Stehlé, *Ibid.* TYPE: Martinique, *Stehlé 3390* (ILL).
Peperomia belangeri C. DC. Prodr. **16**(1): 411. 1869. TYPE: Martinique, *Belanger 137* (G–hb. Boiss.) not seen.
Peperomia bracteiflora C. DC. Mem. Soc. Phys. Hist. Nat. Genève **27**(2): 317. 1882. TYPE: Martinique, *Hahn 647* (G–DC).
Peperomia bracteiflora var. *stigmatifera* C. DC. in Urb. Symb. Antill. **3**: 274. 1902. TYPE: Martinique, *Duss 16.*
Peperomia casimiri Heurck & Müll. Arg. in Heurck, Obs. Bot. fasc. **1**: 111. 1870. TYPE: Trinidad, *Sieber s.n.* (G–DC, photo.).
Peperomia cataractaegaudens Trel. in Stehlé Fl. Descr. Antill. Fr. **2**(1): 144. 1940. TYPE: Guadeloupe, *H. & M. Stehlé 1625* (NY).
Peperomia dissitiflora C. DC. in Briq. Ann. Jard. Bot. Genève **2**: 279. 1898. TYPE: Martinique, *Hahn 649*, not seen.

Peperomia dussii C. DC. in Urb. Symb. Antill. **3:** 231. 1902. TYPE: Martinique, *Duss, 14* in part (G–DC, photo.).

Peperomia evadens Trel. in Stehlé, Fl. Descr. Antill. Fr. **2**(1): 134. 1940. TYPE: Guadeloupe, *Stehlé 330* (NY).

Peperomia hahnii C. DC. in Linnaea **37:** 368. 1872. TYPE: Martinique, *Hahn 257* (G–DC, photo.).

Peperomia herminieri C. DC. Mem. Soc. Phys. Hist. Nat. Genève **27**(2): 306. *t. 14.* 1882. TYPE: Guadeloupe, *l'Herminier s.n.* (G–hb. Boiss.)

Peperomia herminieri var. *stigmatifera* C. DC. in Urb. Symb. Antill. **3:** 273. 1902. SYNTYPES: Guadeloupe, *Duss 2567a*; Martinique, *Duss 4038.*

Peperomia subbracteiflora C. DC. in Urb. *Ibid.* **5:** 298. 1907. TYPE: Guadeloupe, *Duss 4107* in Herb. Duss.

Peperomia subvillosa Heurck & Müll. Arg. in Heurck, Obs. Bot. fasc. **1:** 113. 1876. TYPE: Martinique, *Sieber s.n.* (Herb. Heurck).

Peperomia subvillosa forma *candolleana* Stehlé & Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 61. 1948. TYPE: Guadeloupe, *Duss 15* (B).

Peperomia subvillosa forma *dumauseana* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* TYPE: Guadeloupe, *Stehlé 3369.*

Miquel based *Peperomia hirtella* on a collection by Imray from Dominica, and the holotype (K) has been seen. No additional collections from Dominica or elsewhere have been assigned to this species by subsequent authors or collectors. Instead, the numerous minor morphological variations of leaf form have been described as new taxa by three principal workers who regarded their species as island endemics. A comparison of the types of most species cited above with the holotype indicates to me that only one species with a distribution including Guadeloupe, Dominica, Martinique, and St. Lucia is involved.

Peperomia hirtella is an erect plant with varying degrees of pubescence on the stems and leaves. The character of a bracteate short-stalked flower appears to be an artifact of drying.

DISTRIBUTION: Guadeloupe, Dominica, Martinique, St. Lucia.

Peperomia hispidula (Sw.) Dietr. in L. Sp. Pl. ed. 6. **1:** 165. 1831.

Piper hispidulum Sw. Prodr. 15. 1788.

Dahlstedt (Kongl. Sv. Vet. Akad. Handl. **33**(2): 14. 1900) attributed this species to Martinique on the basis of the lower of two fragments mounted on a single sheet in the Willdenow herbarium. The distribution of Jamaica and Martinique is similarly reported by Adams (Fl. Jam. 205. 1972). De Candolle noted (Urb. Symb. Antill. **3:** 224. 1902) that Urban, in a letter, suggested that the upper plant (*Peperomia rotundifolia* as *P. nummularifolia*) was collected by Isert in Martinique, and that the lower collection (*Peperomia hispidula*) was probably a Swartz specimen from Jamaica. *Peperomia hispidula* appears to be a plant of Hispaniola and Jamaica; the lectotype was selected by Urban.

Peperomia magnoliifolia (Jacq.) Dietr. in L. Sp. Pl. ed. 6. 1: 153. 1831.

Piper magnoliaefolium Jacq. Collect. 3: 210. 1798. TYPE: Venezuela.
Peperomia amplexicaulis (Sw.) Dietr. var. *magnoliaefolia* (Dietr.) Griseb. Fl. Brit. W. Ind. Is. 167. 1860.
Peperomia conulifera Trel. in Stehlé, Bull. Soc. Bot. Fr. **84:** 409. 1937 (invalid); in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 44. 1948 (valid). TYPE: Barbados, *Eggers 7202* (US ex Stehlé).
Peperomia conulifera var. *acutifolia* Trel. in Stehlé, Bull. Soc. Bot. Fr. **85:** 578. 1938 (invalid). TYPE: Guadeloupe, *Stehlé 1620* (NY ex Trel.).
Peperomia conulifera var. *kerveganti* Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 46. 1948 (*nomen nudum*). TYPE: Martinique, *Stehlé & Kervegant 2324* (NY ex Trel.).
Peperomia conulifera var. *matoubana* Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 45. *f. 1.* 1948 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 2558* (NY).
Peperomia conulifera var. *Stehleae* Trel. in Stehlé, Bull. Soc. Bot. Fr. **83:** 628. 1936 (*nomen nudum*); *Ibid.* **85:** 579. 1938 (invalid); in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 45. *f. 3.* 1948 (*nomen nudum*). TYPE: Marie Galante, *Mme. Stehlé 299* (ILL).
Peperomia conulifera var. *Stehlei* Trel. in Stehlé, Bull. Soc. Bot. Fr. **83:** 628. 1936 (*nomen nudum*); in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 46. *45. f. 2.* 1948 (valid). TYPE: Guadeloupe, *Stehlé 24* (NY).
Peperomia conulifera var. *tenuispica* Trel. in Stehlé & Quentin, *Ibid. 45. f. 5.* (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 2547* (NY ex Trel.).
Peperomia conulifera var. *tivoliana* Trel. in Stehlé & Quentin, *Ibid.* 46. (*nomen nudum*). TYPE: Martinique, *Stehlé 2328* (NY ex Trel.).
Peperomia conulifera var. *typica* Trel. in Stehlé & Quentin, *Ibid.* 46. (*nomen nudum*). TYPE: not indicated.
Peperomia glandulirostrea var. *stehleae* Trel. in Stehlé, Bull. Soc. Bot. Fr. **83:** 628. 1936 (*nomen nudum*). TYPE: Guadeloupe, *M. Stehlé s.n.*
Peperomia praestigiatrix Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(1): 3. 1937 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1619* (NY ex Trel.).
Peperomia pustulaebacca Trel. in Stehlé, Carib. For. 6, Suppl. 344. 1945 (*nomen nudum*). TYPE: Barbados, *Stehlé 1647* (NY ex Trel.).
Peperomia pustulatibacca Trel. & Stehlé in Stehlé, Candollea **10:** 288. 1946 (valid). TYPE: Barbados, *H. & M. Stehlé 1647* (NY).

De Candolle (Urb. Symb. Antill. 3: 254. 1902) did not recognize *Peperomia magnoliifolia*, placing it in the synonymy of *P. obtusifolia* (L.) A. Dietr. More recent authors offer alternate treatments. Trelease and Yuncker (Piperaceae North. S. Am. **2**: 651. 1950) distinguish the two species primarily on the basis of the slender, sharply hooked beak of *P. obtusifolia* and the awl-shaped, tapering but straight beak of *P. magnoliifolia*. Burger (Fieldiana Bot. **35**: 52. 1971) accepts *P. obtusifolia* but does not list *P. magnoliifolia* in synonymy. He stated "the criteria used by Yuncker to separate *P. magnoliaefolia* from *P. obtusifolia* are not biologically significant." Adams (Fl. Jam. 204. 1972) uses the fruit characters to distinguish the species, and on this basis mature specimens of the Lesser

Antillean plants may be assigned easily to the appropriate one of these two taxa.

The name *Peperomia conulifera* Trel. was used in print by Stehlé frequently before its publication with a Latin diagnosis in 1948. At that time he indicated the species was "*Peperomia magnoliaefolia* pro parte" and "*Peperomia obtusifolia* pro parte." Technically the epithet was superfluous when published, for Stehlé also listed in synonymy *Peperomia cuneata* Miq., a species which I place in the synonymy of *P. obtusifolia*. Although Stehlé failed to give any characters distinguishing *P. conulifera*, the illustrations he published show the straight fruit beak of *P. magnoliifolia*, a character verified by an examination of many specimens annotated by Trelease and by Stehlé.

No place of publication has been found for the species *Peperomia glandulirostrea*, and the variety cited is only listed by Stehlé, and is, therefore, a *nomen nudum*.

The collection *Stehlé 1619* is the only one cited for *Peperomia praestigiatrix*. The type sheet (NY) is *P. magnoliifolia*, but the specimen under the same number at Illinois is *P. nigropunctata* Miq.

DISTRIBUTION: Saba, Montserrat, St. Eustatius, St. Martin, Nevis, Guadeloupe, Martinique, Dominica, Grenada, Grenadines, St. Vincent, Barbados, Marie Galante, La Desirade.

Peperomia myrtifolia (Vahl) A. Dietr. in L. Sp. Pl. ed. 6. **1**: 147. 1831.

Piper myrtifolia Vahl, Enum. **1**: 341. 1804. TYPE: St. Croix, *Pflug s.n.* (C).
Peperomia auberyana Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 57. 1948. TYPE: Guadeloupe, *Aubrey 1622* (ILL, NY).
Peperomia barthelemyana Trel. in Questel, Flora St. Barth. 94. 1941 (invalid); Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 58. 1948 (valid). TYPE: St. Barts, *Questel 275* (NY).
Peperomia barthelemyana var. *genuina* Stehlé & Quentin, *Ibid.* TYPE: St. Barts, *Questel 275* (NY).
Peperomia barthelemyana Trel. var. *reducta* Trel. in Questel, Flora St. Barth. 94. 1941 (invalid); Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 58. 1948 (valid). TYPE: St. Barts, *Questel 361* (NY).
Peperomia boldinghii C. DC. in Urb. Symb. Antill. **7**: 186. 1912. TYPE: Saba, *Boldingh 2105*.
Peperomia broadwayi C. DC. *Ibid.* **3**: 240. 1902. TYPE: Martinique, *Duss 1262* (US 846008, selected by Trel.).
Peperomia doleana Trel. in Stehlé, Candollea **10**: 288. 1946. TYPE: Guadeloupe, *Trelease 66* (ILL).
Peperomia dolosa Trel. in Stehlé, Bull. Soc. Bot. Fr. **83**: 628. 1936 (*nomen nudum*); Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 52. 1948 (valid). TYPE: Iles des Saintes, *H. & M. Stehlé 155*.
Peperomia guadeloupensis C. DC. in Seeman, Jour. Bot. **4**: 139. 1866. TYPE: many syntypes from several islands.
Peperomia myrtifolia var. *major* Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 59. 1948. TYPE: St. Barts, *Questel 803* (NY).

Peperomia myrtifolia var. *typica* Trel. in Stehlé & Quentin, *Ibid.* TYPE: St. Barts, *Questel 804* (NY).

Peperomia persuccosa C. DC., Fedde Repert. Spec. Nov. **15:** 3. 1917. TYPE: Guadeloupe, *Duss 2830.*

Peperomia persuccosa var. *benae* Stehlé, Candollea **10:** 289. 1946. TYPE: Guadeloupe, *Bena, Stehlé & Quentin 5260* (Herb. H. & M. Stehlé, not seen).

Peperomia persuccosa var. *bertautii* Stehlé, *Ibid.* TYPE: Guadeloupe, *Stehlé 5259.*

Peperomia rupertiana C. DC. Prodr. **16**(1): 413. 1869. TYPE: Dominica, *Prince Rupert s.n.* (K).

Peperomia rupertiana var. *genuina* Stehlé, Candollea **10:** 290. 1946. TYPE: Dominica, *Jardin s.n.* (not seen).

Peperomia rupertiana var. *pinchonii* Stehlé, *Ibid.* 291. TYPE: Martinique, *Stehlé & Pinchon 5833* (Herb. H. & M. Stehlé).

Peperomia rupertiana var. *rosetteana* Stehlé, *Ibid.* 291. TYPE: Martinique, *Stehlé & Rose-Rosette 3744* (Herb. H. & M. Stehlé).

Piper tenuiflorum Vahl in West, Bidr. Ste. Croix 195. 1793, not Opiz in Presl, Reliq. Haenk **3:** 163. 1828, from Mexico.

Peperomia vanhuerckii C. DC. in Heurck & Müll. Arg. Obs. Bot. fasc. **1:** 116. 1876. TYPE: Martinique, *Sieber s.n.* (G–DC) microfiche.

Peperomia vincentensis Trel. ined. TYPE: St. Vincent, *H. H. & G. W. Smith 1643.*

This taxon is commonly cited as "Peperomia myrtifolia (Vahl) Miq." (Syst. Pip. 92. 1843). Miquel listed *Piper myrtifolia* Vahl with a question mark, and cited only a Sellow collection from Brazil. The description indicates that he was considering a different species; the Miquel combination is a later homonym of *P. myrtifolia* (Vahl) A. Dietr.

The oldest basionym for this species would be *Piper tenuiflorum* Vahl in West (1793); however, this epithet cannot now be transferred to *Peperomia* since it is antedated by *Peperomia tenuiflorum* Opiz in Presl (1828) for a species from Mexico. *Peperomia myrtifolia* (Vahl) A. Dietr. is the oldest available name and is based on *Piper myrtifolia* Vahl which is typified by a Pflug collection from St. Croix. This specimen in the herbarium at Copenhagen represents an erect plant which rooted only at the lower nodes, if at all, along the stem. Recent collections from St. Croix compare favorably with the original description and the holotype. The plants generally occur on rocks and in drier habitats, contrasting with the other species of *Peperomia* from the Lesser Antilles. The stems are glabrous. The leaves are moderately black-punctate and show a tremendous range of variation in shape and size from the lower leaves of a stem to the upper, and also between plants of different ages.

Most specimens assigned to this species have been identified in herbaria as *Peperomia guadeloupensis* C. DC. and this epithet was accepted by Trelease (Fl. Neth. Antill. 2: 82. 1966). The original description of *P. guadeloupensis* is not explicit, and specimens are cited from Cuba, St. Croix, Guadeloupe and Ecuador. No lectotype has been selected subsequently, to my knowledge.

Specimens of *Peperomia barthelemyana* and its varieties in the herbarium of the New York Botanical Garden carry the annotation "Yuncker, letter to Monachino Sept. 24, 1953, thinks = *P. myrtifolia*."

The type specimen of *Peperomia vanhuerckii* represents the extreme expression of this species in having short broad leaves with a rounded base. Stehlé and Quentin (Fl. Guad. Depend. **2**(2): 62. 1948) suggest this is a glabrous form of *P. subvillosa*. This leaf shape is matched by recent collections from St. Kitts, which can be included within the range of variation accepted for the species.

DISTRIBUTION: St. Croix, St. Barts, Saba, St. Eustatius, Montserrat, Redonda, St. Kitts, Guadeloupe, La Desirade, Dominica, Martinique, St. Lucia, St. Vincent, Grenadines, Grenada, Barbados.

Peperomia nigropunctata Miq. Syst. Pip. 188. 1843. TYPE: Martinique, *Sieber 6* (B, isotype GH)

Peperomia acuminata DC. Symb. Antill. **3**: 242. 1902, not Ruiz & Pavon, Fl. Peruv. Chil. **1**: 32. 1798.

Peperomia ajoupana Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(1): 3. 1937 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1772*.

Peperomia balineorum Trel. in Stehlé, Bull. Soc. Bot. Fr. **84**: 408. 1937 (*nomen nudum*); Trel. & Stehlé in Stehlé, Candollea **8**: 80. 1940 (valid). TYPE: Guadeloupe, *H. & M. Stehlé 230*.

Peperomia balneolorum Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(1): 3. 1937 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1348*.

Peperomia glabella var. *nigropunctata* Dahlst. Kongl. Sv. Vet. Akad. Handl. **33**: 122. 1900.

Peperomia houelmonte Trel. in Stehlé, Bull. Soc. Bot. Fr. **83**: 628. 1936 (*nomen nudum*), in Stehlé & Quentin, Fl. Guad. Depend. **2**(1): 3. 1937 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 365*.

Peperomia martinicensis C. DC. (msc.) in Stehlé, Bull. Soc. Bot. Fr. **84**: 409. 1937 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé & Branquec 975*.

Peperomia martinicensis Trel. in Stehlé, *Ibid.* **85**: 578. 1938 (*nomen nudum*). TYPE: Martinique, *Hahn 649* (US 38124).

Peperomia martinicensis var. *lata* Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(1): 3. 1937 (*nomen nudum*). TYPE: Martinique, *Stehlé 976*.

Peperomia martinicensis almeana Trel. Herbarium name never published. TYPE: Martinique, *Stehlé 2354* (ILL).

Peperomia nigrescens Stehlé, Candollea **8**: 80. 1940. TYPE: Guadeloupe, *H. Stehlé & Quentin 233*.

Peperomia palpebrata Trel. in Stehlé, Bull. Soc. Bot. Fr. **84**: 409. 1937 (invalid); **85**: 577. 1938 (*nomen nudum*); Candollea **8**: 81. 1940 (valid). TYPE: Martinique, *H. & M. Stehlé* "*894*," error for *984* (holotype, NY).

Peperomia palpebrata var. *absalonis* Trel. in Stehlé, Bull. Soc. Bot. Fr. **85**: 577. 1938 (invalid). TYPE: Martinique, *Stehlé 2169*.

Peperomia palpebrata var. *carbetensis* Trel. Herbarium name never published.

Peperomia palpebrata var. *lata* Trel. & Stehlé in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 63. 1948 (*nomen nudum*). TYPE: Martinique, *H. & M. Stehlé 3248*.

Peperomia palpebrata var. *major* Trel. in Stehlé, Bull. Soc. Bot. Fr. **85:** 578. 1938 (invalid). TYPE: Martinique, *Stehlé 2193.*

Peperomia palpebrata var. *paniculata* Trel. & Stehlé in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 63. 1948 (*nomen nudum*). TYPE: No specimens cited.

Peperomia palpebrata var. *ramulosior* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* (*nomen nudum*). TYPE: No specimens cited.

Peperomia palpebrata var. *typica* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* (*nomen nudum*).

Peperomia stehleana Trel. in Stehlé, Bull. Soc. Bot. Fr. **83:** 627. 1936 (*nomen nudum*); **84:** 408. 1937 (*nomen nudum*); Candollea **8:** 79. 1940 (valid). TYPE: Guadeloupe, *H. & M. Stehlé 25* (holotype, NY).

Peperomia stehleana var. *ajoupana* Trel. & Stehlé in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 49, 50. *f. 3.* 1948 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1722.*

Peperomia stehleana var. *balineorum* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* 49. (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1348.*

Peperomia stehleana var. *bourgesensis* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* 49, *50. f. 4.* (*nomen nudum*). TYPE: Guadeloupe, *H. & M. Stehlé 2557.*

Peperomia stehleana var. *branquecii* Stehlé & Trel. in Stehlé & Quentin, *Ibid. f. 6.* 1948 (valid). TYPE: Guadeloupe, collected by R. P. Branquec cited as *Stehlé 2550* (holotype, NY).

Peperomia stehleana var. *charpentieri* Trel. & Stehlé in Stehlé & Quentin, *Ibid. f. 1.* (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 2551.*

Peperomia stehleana var. *houelmonti* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* 49. (*nomen nudum*).

Peperomia stehleana var. *praestigiatrix* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1619.*

Peperomia stehleana var. *regretteana* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* 49, 50. *f. 5* (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 2552.*

Peperomia stehleana var. *tardenaevifera* Trel. in Stehlé, Bull. Soc. Bot. Fr. **83:** 629. 1936 (*nomen nudum*); in Stehlé & Quentin, Fl. Guad. Depend. **2**(1): 3. 1937 (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 336.*

Peperomia stehleana var. *tardigranulata* Trel. in Stehlé & Quentin, *Ibid.* (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1752.*

Peperomia stehleana var. *typica* Trel. & Stehlé, in Stehlé & Quentin, *Ibid.* **2**(2): 49, 50. *f. 2.* 1948 (*nomen nudum*).

Peperomia stehleana var. *variifolia* Trel. & Stehlé in Stehlé & Quentin, *Ibid.* 49. (*nomen nudum*). TYPE: Guadeloupe, *Stehlé 1233.*

Peperomia thionvilleana Trel. in Stehlé & Quentin, *Ibid.* 59. TYPE: Guadeloupe, *H. & M. Stehlé & Quentin 2582.*

Peperomia wilsonii Stehlé, Candollea **8:** 78. 1940; Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 55, 56. 1948. TYPE: Guadeloupe, *H. & M. Stehlé 2545.*

An extensive new synonymy is presented above for this much misunderstood species.

In the original description of *Peperomia nigropunctata* Miquel cited a single collection, *Sieber 6* from Martinique, with the type in Berlin. Such a specimen apparently no longer exists, but a duplicate was found in the collections of the Gray Herbarium, identified as *Piper monostachyon.* The isotype agrees completely with the description given by Miquel. The

specimen represents a climbing plant, rooting freely at the nodes. It has variously shaped leaves which are primarily ovate and acuminate at the apex. The plant is glabrous except for a few short hairs at the ciliate leaf apex. The leaves and the inflorescence are heavily black-punctate when dry.

In 1869 Casimir de Candolle (Prodr. 16(1): 409) accepted the species *P. nigropunctata* and cited additional specimens from St. Thomas, Cuba, and Antigua.

Hugo Dahlstedt in 1900 (Kongl. Sv. Vet. Akad. Handl. 33(2): 122) referred the Miquel species to varietal status as *Peperomia glabella* (Sw.) Dietr. var. *nigropunctata* (Miq.) Dahlst., citing additional specimens from other islands in the Greater and Lesser Antilles as well as from Brazil. I consider *Peperomia glabella* to be a distinct species, as do Trelease and Yuncker (Piperaceae North. S. Am. 2: 587. 1950), Yuncker (Bull. Inst. Jamaica Sci. Ser. 11: 40. 1960), and Adams (Fl. Jamaica 207. 1972), although Burger (Fieldiana Bot. 35: 37. 1971) reduced *P. nigropunctata* to complete synonymy under *P. glabella*. Yuncker also accepted *P. nigropunctata* in his treatment of the Piperaceae in the Netherlands Antilles (Fl. Neth. Ant. 2: 81. 1966).

Casimir de Candolle later presented still another opinion in his treatment of the genus (Urb. Symb. Antill. 3: 242. 1902) when he reduced *P. nigropunctata* to the synonymy of *Peperomia acuminata* (L.) DC., based on *Piper acuminatum* L. This, however, is not *Peperomia acuminata* Ruiz & Pavon (Fl. Peruv. Chil. 1: 32. 1798) and probably not *Piper acuminata* L. (Sp. Pl. 1: 30. 1753) which is based on a Plumier reference and a plant from Hispaniola.

The name *Peperomia martinicensis* has been used several times, but was never validly published. In 1937 Stehlé attributed the name to De Candolle as a manuscript annotation, and in 1938 he attributed the epithet to Trelease who, he said, described the species in a letter. In synonymy Stehlé & Trelease list "Peperomia acuminata auct. p.p. pour l'archipel caribe."

After using the name *Peperomia stehleana* in several publications, Stehlé finally supplied valid publication for it (Candollea 8: 79, 81. 1940) as well as for *Peperomia palpebrata* Trel. in Stehlé. No mention is made of *Peperomia martinicensis*, however, and Stehlé repeated "Peperomia nigropunctata Miq. pro. part. Syst. 188. 1843 et auct. mult. pro insula Guadelupa," and for *Peperomia palpebrata* he stated "Espèce polymorphe, incluse dans le '*complexus glabellae*' équivalente du P. Stehleana Trel. de la Guadeloupe . . ." and noted that his *P. palpebrata* was endemic to Martinique. In 1948 Stehlé & Quentin (Fl. Guad. Depend. 2(2): 62) noted that *P. palpebrata* is the homologue of *P. stehleana* Trel. for Guadeloupe and of *P. acuminata* C. DC. and *P. nigropunctata* of French Guiana. Subsequently a number of varieties were described, some validly published and some not, based on variations in leaf shape. All taxa are clearly to be included in *Peperomia nigropunctata* Miq.

A specimen of *Peperomia houelmonte* Trel. in the Illinois herbarium

bears an annotation in Trelease's hand that the species equals *Peperomia stehleana*.

I have not seen the single specimen (*Stehlé & Quentin 233*, Herb. Stehlé) cited in the description of *Peperomia nigrescens* (Candollea **8**: 80. 1940). None of Stehlé's subsequent papers again refers to the species except for his incompleted monograph of the Piperaceae (Fl. Desc. Antill. Fr. 2(1): 126. 1940) where the name is included in the key. No specimens in either the herbarium at New York or the one at Illinois bear this name. Stehlé, in his observations, compares the new species to *Peperomia nigropunctata* and the varieties of *P. stehleana*, all of which are included in the present consideration.

Peperomia wilsonii Stehlé is based on a collection from Guadeloupe by *H. & M. Stehlé 2545*. The species is said to be distinctive in possessing long cilia on the peltate bracts of the inflorescence, and is so illustrated by Stehlé & Quentin (Fl. Guad. Depend. 2(2): 56. 1948). Such a character would indeed be unusual in *Peperomia*. I have examined two specimens of the type number (NY, ILL) and found no evidence of the cilia.

DISTRIBUTION: St. Martin, St. Kitts, Nevis, Montserrat, Antigua, Guadeloupe, Marie Galante, Dominica, Martinique, St. Lucia.

Peperomia obtusifolia (L.) A. Dietr. in L. Sp. Pl. ed. 6. 1: 154. 1831.

Piper obtusifolium L. Sp. Pl. **1**: 30. 1753. TYPE: "America calidiore," "prototype" ex Yuncker, Plumier, Pl. Amer. p. 53. *pl. 70*. 1693, ex Santo Domingo.

Peperomia cuneata Miq. in Hook. Lond. Jour. Bot. **4**: 429. 1845. TYPE: St. Vincent, *Guilding s.n.* (K).

Peperomia obtusifolia var. *cuneata* Duss, Fl. Phan. Antill. Fr. 173. 1897.

Peperomia obtusifolia forma *oblongifolia* Miq. in Hook. Lond. Jour. Bot. **4**: 429. 1845. SYNTYPES.

The relationship of this species is discussed under *Peperomia magnoliifolia* (q.v.). *Peperomia cuneata* Miq. is a small-leafed variant.

DISTRIBUTION: Antigua, Guadeloupe, Dominica, St. Lucia, St. Vincent, Grenada.

Peperomia pellucida (L.) H.B.K. Nov. Gen. & Sp. 1: 53. 1816.

Piper pellucidum L. Sp. Pl. **1**: 30. 1753. TYPE: America calidiore, Plum. Pl. Amer. 54. *t. 72*. 1693.

Peperomia pellucida baileyana Trel. Herbarium name, never published. TYPE: Martinique, *L. H. & E. Z. Bailey 297* (ILL).

This is the only truly weedy species of *Peperomia* in the Lesser Antilles. It is common as an adventive in gardens, on rock paths and walls.

DISTRIBUTION: Saba, St. Eustatius, St. Kitts, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Grenada, Barbados.

Peperomia questeliana Stehlé & Trel. in Stehlé, Candollea **8**: 77. 1940. TYPE: St. Bartholomew, *Questel 2518* (Herb. Stehlé).

Piper humile Vahl, Enum. **1**: 349. 1804, not Miller 1804. TYPE: St. Croix, *West.*

Peperomia humilis (Vahl) A. Dietr. in L. Sp. Pl. ed. 6. **1**: 168. 1831.

Peperomia humilis var. *stehlei* Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 54. 1948. TYPE: Guadeloupe, *H. & M. Stehlé & Quentin 2547* (NY).

This species has been called *Peperomia humilis* (Vahl) Dietr. in the majority of floras of the Antilles. Unfortunately the basionym *Piper humile* Vahl (Enum. **1**: 349) was published after June 28, 1804 (Stafleu, Reg. Veg. **52**: 480. 1967) and so is a later homonym of *Piper humile* Miller (Dict. No. 4, 1768) and *Piper humile* Mill. ex Poir. (Lam. Encycl. Meth. **5**: 473. 1804) published Jan. 11, 1804 (Chron. Bot. **5**: 439. 1939).

Piper humile Miller was renamed *Piper milleri* Römer & Schultes (Syst. Veg. **1**: 337. 1817) and the species was placed in the synonymy of *Peperomia obtusifolia* (L.) Dietr. by C. de Candolle (Urb. Symb. Antill. **3**: 254. 1902).

Casimir de Candolle (Urb. Symb. Antill. **3**: 266. 1902) accepted the epithet *Peperomia langsdorfii* (Miq.) Miq. (Syst. Pip. 116. 1843) for this species, placing in synonymy *Peperomia humilis* (Vahl) A. Dietr. and *Piper humile* Vahl. Britton and Wilson (Sci. Surv. Porto Rico Virgin Is. **5**: 228. 1924) used the older epithet *Piper humile* Vahl not recognizing that it was a later homonym. They placed in synonymy *Peperomia langsdorfii* Miq.

Peperomia langsdorfii (Miq.) Miq. is based on material, theoretically from Brazil, cultivated in Europe. The oldest use of the specific epithet appears to be *Piper langsdorfii* Schrank & Martius (Hort. Reg. Monacensis 47. 1829) as a *nomen nudum*. Miquel described the plant in 1839 (Icon. Comment. phytogr. **2**: 52. *tab. 8, f. f*) as *Micropiper langsdorfii* suggesting the species was similar to *Peperomia blanda*. The combination in *Peperomia* was made by Miquel in 1842 (Syst. Pip. 116). The species is currently offered in the Index Seminum of various European botanical gardens, but no specimens of cultivated material can be located.

Trelease and Yuncker (Piperaceae North S. Am. **2**: 558. 1950) accepted *Peperomia blanda* var. *langsdorfii* (Miq.) Henschen (Nova Acta Soc. Sci. Upsal. ser. 3. **8**: 39. 1873) indicating its distribution to be Trinidad, Venezuela, Colombia, and Brazil. Material from this range identified and annotated by Trelease and Yuncker is not the same as the specimens of the Lesser Antilles and St. Croix.

None of the other synonyms given by the various authors seem to apply to the plants of the Lesser Antilles, and the only available name appears to be *Peperomia questeliana* Stehlé & Trelease, which was described as a new species and without comparison with other species of the area. Since the specimens are from St. Barts, the species was not included in Stehlé's key (Fl. Descr. Antill. Fr. **2**(1): 120–126. 1940).

The location of Stehlé's personal herbarium cannot be determined at this time, and the cited specimen has not been seen. A poorly prepared isotype (ILL) consists of a packet of fragments.

DISTRIBUTION: St. Croix, St. Martin, Antigua, St. Barts, St. Kitts, Guadeloupe.

Peperomia rotundifolia (L.) H.B.K. Nov. Gen. & Sp. 1: 54. 1816.

Piper rotundifolium L. Sp. Pl. 1: 30. 1753. TYPE: America calidiore, prob. Martinique, *fide* Yuncker; Plum. Pl. Amer. 52. *pl. 69*. 1693.
Peperomia imrayana Trel. ined. TYPE: Dominica, *Imray 331* (K).
Piper nummularifolium Sw. Prodr. 16. 1788. TYPE: Jamaica.
Peperomia nummularifolia (Sw.) H.B.K. Nov. Gen. & Sp. 1: 54. 1816.
Acrocarpidium nummularifolium forma *pilosior* Miq. Linnaea 18: 710. 1844. TYPE: Mexico, *Schiede s.n.*
Peperomia rotundifolia var. *nummularifolia* (Kunth) Stehlé, Bull. Soc. Bot. Fr. 85: 577. 1938.
Peperomia rotundifolia var. *pilosior* (Miq.) C. DC. in Urb. Symb. Antill. 3: 230. 1902.
Peperomia rotundifolia forma *pubescens* C. DC. ex Dahlst. in Dahlst. Kongl. Sv. Vet. Akad. Handl. 33(2): 102. 1900.
Peperomia vernouana Trel. in Stehlé & Quentin, Fl. Guad. Depend. 2(2): 55. 1948. TYPE: Guadeloupe, *H. & M. Stehlé & Quentin 3003* (NY).

DISTRIBUTION: Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Grenada.

Peperomia serpens (Sw.) Loud. Hort. Brit. 13. 1830.

Piper serpens Sw. Prodr. 16. 1788. TYPE: Jamaica, *Swartz*.
Piper guildingianum Spreng. Syst. Veg. cur. post. 20. 1827 (illegit.).
Acrocarpidium guildingianum Miq. in Hook. Lond. Jour. Bot. 4: 412. 1845 (illegit.).
Peperomia reniformis Hook. Exot. Fl. 3: *pl. 164*. 1827. TYPE: cultivated plant from St. Vincent, *Guilding*.
Peperomia repens H.B.K. Nov. Gen. & Sp. 1: 54. 1816. TYPE: Cumanacon, Nova Andalusia.
Peperomia scandens Ruiz & Pavon, Fl. Peruv. Chil. 1: 32. *pl. 51, f.b.* 1798. TYPE: Peru.
Piper scandens (Ruiz & Pavon) Vahl, Enum. 1: 346. 1804, not Swartz 1788.

Casimir de Candolle (Symb. Antill. 3: 248. 1902) used the name *Peperomia scandens* Ruiz & Pavon for this species, placing in its synonymy *Piper serpens* Sw., with a question. Britton and Wilson (Sci. Surv. Porto Rico Virgin Is. 5: 224. 1924) and more recent authors have used the nomenclature given above.

Piper scandens Sw. (Prodr. 16. 1788) has been used incorrectly as the basionym in some annotations. Trelease and Yuncker (Piperaceae North. S. Am. 2: 587. 1950) reported that *Piper scandens* Sw. is to be referred to *Peperomia glabella*.

DISTRIBUTION: St. Eustatius, St. Kitts, St. Lucia, St. Vincent, Grenada.

Peperomia smithiana C. DC. in Urb. Symb. Antill. 3: 235. 1902. TYPE: St. Vincent, *H. H. & G. W. Smith 1645b*.

Peperomia diaphanoides Dahlst. var. *vincentensis* Dahlst. Kongl. Sv. Vet. Akad. Handl. 33(2): 114. 1900. TYPE: St. Vincent, *H. H. & G. W. Smith 1645* (Herb. Krug & Urb.).

De Candolle did not indicate the location of the holotype in the original description. The specimen in the Kew herbarium so marked is numbered "Smith 1646." The type locality is Morne Garu not "Morne Gavon" as published.

The type of *Peperomia diaphanoides* var. *vincentensis* Dahlst. was not located in Berlin. The specimen of the same number at Kew does not agree with the description given by Dahlstedt. The distinctions to separate *P. smithiana* and *P. diaphanoides* var. *vincentensis*, used in the key to the Antillean taxa by De Candolle (Urb. Symb. Antill. 3: 219. 1902), are obviously based on the published descriptions and not on the specimens. The two taxa cannot be separated as De Candolle suggested, and are here considered identical.

DISTRIBUTION: St. Lucia, St. Vincent.

Peperomia tenella (Sw.) A. Dietr. in L. Sp. Pl. ed. 6. 1: 153. 1831.

Piper tenellum Sw. Prodr. 16. 1788. TYPE: Jamaica, *Swartz*.
Peperomia tenella var. *epiphytica* Trel. in Stehlé, Bull. Soc. Bot. Fr. 83: 628. 1936 (*nomen nudum*); Stehlé & Quentin, Fl. Guad. Depend. 2(2): 41. 1948. TYPE: Guadeloupe, *Duss 3248* (US 846773).

DISTRIBUTION: Guadeloupe, Dominica.

Peperomia trifolia (L.) A. Dietr. in L. Sp. Pl. ed. 6. 1: 173. 1831.

Piper trifolia L. Sp. Pl. 1: 30. 1753. TYPE: Martinique ex Yuncker, Plumier plate.
Peperomia balbisii Dahlst. in Duss, Fl. Phan. Antill. Fr. 174. 1897. TYPE: Guadeloupe, *Duss 2566*; Kongl. Sv. Vet. Akad. Handl. 33(2): 164. 1900. SYNTYPES: Guadeloupe, *Balbis* (Herb. Spreng.), *Duss 2566, 2836*.
Peperomia caespitiformans Trel., in Stehlé & Quentin, Fl. Guad. Depend. 2(1): 3. 1937 (*nomen nudum*). TYPE: Guadeloupe, *H. & M. Stehlé 1753*.
Peperomia caespitiformis Trel. Herbarium spelling, never published.
Peperomia coespitiformans Trel. in Stehlé, Fl. Descr. Antill. Fr. 2(1): 120. 1940; Stehlé & Quentin, Fl. Guad. Depend. 2(2): 53. 1948.
Peperomia fimbriata Miq. Syst. Pip. 178. 1843. TYPE: St. Lucia, *Anderson* (Herb. Deless.).
Peperomia obovata C. DC. in Urb. Symb. Antill. 3: 269. 1902.
Piper obovatum Vahl, Eclog. 1: 5. 1796, not Ruiz & Pavon 1794. TYPE: Montserrat, *Ryan*.
Peperomia obversa (Vahl) Dietr. in L. Sp. Pl. ed. 6. 1: 173. 1831.
Piper obversum Vahl, Enum. 1: 354. 1804 (illegit.).
Peperomia ovalifolia Hook. Exot. Fl. 3: 165. 1827. TYPE: cultivated plant from St. Vincent, *Guilding*.

Peperomia trifolia var. *balbisii*. Herbarium name, never published.
Peperomia trifolia forma *genuina* Stehlé in Stehlé & Quentin, Fl. Guad. Depend. 2(2): 48. *f. 5*. 1948 (illegit.).
Peperomia trifolia forma *obovalifolia* Stehlé in Stehlé & Quentin, *Ibid. f. 2.* (illegit.). TYPE: No specimens cited.
Peperomia trifolia forma *suborbiculata* Stehlé in Stehlé & Quentin, Fl. Guad. Depend. 2(2): 48. *f. 1*. 1948 (illegit.). TYPE: No specimens cited.

Several authors have used the citation *Peperomia trifolia* (Sw.) A. Dietr., but the basionym is *Piper trifolia L.* The formae Stehlé listed and illustrated have no descriptive text, nor specimen citations. The combinations must be considered illegitimate.

Two specimens of the type number of *Peperomia caespitiformans* Trel. were studied and neither agreed with the descriptions given by Stehlé. There is no evidence for the "pseudocupule" and the leaves are frequently ternate.

Hooker described *Peperomia ovalifolia*, citing specimens collected by Guilding from St. Vincent and Imray from Santo Domingo. Imray collected only on Dominica, to my knowledge, which must surely be the island intended.

Dahlstedt (Kongl. Sv. Vet. Akad. Handl. 33(2): 167. 1900) emended De Candolle's description of *Peperomia grisebachii* and included in its distribution plants from Cuba and Montserrat, the latter being a Ryan specimen, the type of *P. obovatum* Vahl.

Leon and Alain (Fl. Cuba 2: 24. 1951) regard *P. grisebachii* as endemic to Cuba.

DISTRIBUTION: Nevis, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Grenada.

Peperomia truncigaudens C. DC. in Urb. Symb. Antill. 3: 237. 1902. TYPE: Guadeloupe, *Duss 3616b*.

This is one of the few species of the Lesser Antilles with opposite leaves. I have seen but one specimen "Duss 3616" in the herbarium of the New York Botanical Garden. De Candolle cited "Duss 3616b" as the only collection in the original description. I have been unable to locate a citation for a Duss collection of the same number without the sub "b" in De Candolle's treatment of the Piperaceae in Symbolae Antillanae. The NY specimen agrees with the original diagnosis.

DISTRIBUTION: Guadeloupe, known only from the type collection.

Peperomia urocarpa Fisch. & Mey. Index Sem. Petrop. 4: 42, no. 1577. 1837. TYPE: Cultivated plant in Europe, from Brazil. No specimens cited.

Peperomia davisii Britton, Torreya 2: 43. 1902. TYPE: St. Kitts, *Britton & Cowell 506* (NY).
Peperomia fumeana Stehlé & Trel. in Stehlé, Bull. Soc. Bot. Fr. 84: 408. 1937. TYPE: Guadeloupe, *Stehlé 340*.

Peperomia fumeana var. *genuina* Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 51, 52. 1948. TYPE: Guadeloupe, *Stehlé 340*.

Peperomia fumeana var. *Stehlei* Trel. in Stehlé, Bull. Soc. Bot. Fr. **84**: 408. 1937; Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 51, 52. 1948. TYPE: Guadeloupe, *Stehlé 370*.

Peperomia hederacea Miq. in Mart. Fl. Bras. **4**(1): 20. 1853 (illegit.), superfluous.

Acrocarpidium majus Miq. Syst. Pip. 60. 1843. SYNTYPES: *Gaudichaud* (Herb. Deless.), *Sellow 1204* (B).

Peperomia major (Miq.) C. DC. in Prodr. **16**(1): 432. 1869.

Peperomia negotiosa Trel. in Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 60. 1948. TYPE: Guadeloupe, *H. & M. Stehlé & Quentin 1613*.

This species has never been typified. The original description does not refer to a collection, and there is no indication in the work of subsequent authors that one exists. I have not seen specimens from cultivation in Europe.

Britton regarded *Peperomia davisii* as endemic to St. Kitts. The original collection, clonal propagations of it, and additional collections have been studied, and all are indistinguishable from material which has been called *P. urocarpa*.

In 1935 Stehlé (Fl. Guad. Depend. **1**: 206) cited "Peperomia fumeana nov. sp." with a brief invalid description in French. In the addenda and errata of the same volume (page 268) he stated "Au lieu de Peperomia fumeana lire Peperomia davisii Britton." On page 226 he cited again "Peperomia fumeana Trel." which in the errata (page 269) he suggested be deleted. However, Stehlé did publish validly *Peperomia fumeana* (Bull. Soc. Bot. Fr. **84**: 408. 1937), adding the comment that it is intermediate between *P. urocarpa* and *P. davisii*. In 1948 Stehlé illustrated *Peperomia fumeana* Stehlé & Trelease (Stehlé & Quentin, Fl. Guad. Depend. **2**(2): 49.) and cited in its synonymy "P. urocarpa Fisch. & Mey. pro insula Guad." and "P. inophylla Griseb. pro insula Guad."

DISTRIBUTION: Saba, St. Kitts, Guadeloupe.

Peperomia vincentiana Miq. in Hook. Jour. Bot. **4**: 415. 1845. TYPE: St. Vincent, *Guilding* (K).

DISTRIBUTION: St. Vincent, Grenada.

Piper L. Sp. Pl. **1**: 28. 1753.

TYPE SPECIES: *Piper nigrum* L. (Britt. & Wils. Sci. Surv. Porto Rico Virgin Is. **5**: 219. 1924).

Piper aduncum L. Sp. Pl. **1**: 29. 1753. TYPE: Jamaica.

Piper hebecarpum C. DC. in Urb. Symb. Antill. **3**: 183. 1902. SYNTYPES: Martinique, *Duss 18, 1334*.

Piper martinicense C. DC. in Briquet, Ann. Jard. Bot. Genève **2**: 259. 1898. TYPE: Martinique, *Hahn 1143* (G–DC).

Piper martinicense var. *genuinum* Stehlé, Fl. Descr. Antill. Fr. 2(1): 106. 1940.

Piper martinicense var. *montis-pilati* C. DC. in Urb. Symb. Antill. 3: 196. 1902. SYNTYPES: Martinique, *Hahn 267*, *Duss 4472*.

Piper stehleorum Trel. in Stehlé, Fl. Descr. Antill. Fr. 2(1): 100. 1940. TYPE: Guadeloupe, *H. & M. Stehlé 3257* (ILL).

Piper subrectinerve C. DC. in Urb. Symb. Antill. 3: 180. 1902. SYNTYPES: St. Vincent, *Eggers 6924, 6736*.

To my knowledge no lectotype has been selected for this species. Linnaeus cited three references, *Piper longum* etc. Sloan. hist. 1: 135. *t. 87, f. 2*. 1696; *Saururus foliis ovato-lanceolatis*, etc. Hort. cliff. 140, Roy. lugdb. 8; and *Saururus arborescens* etc. Plum. amer. 58. *t. 77*. An appropriate specimen probably can be found in the Clifford or Sloane herbaria.

Piper hebecarpum C. DC. was distinguished from *P. aduncum* by De Candolle on the basis of the shape of the leaf base. Two collections were cited, *Duss 18* and *Duss 1334*. I have seen two collections of this where both numbers appear on one label, one being "18, 1334" and the other "1334, 18." De Candolle did not recognize *P. aduncum* as occurring on Martinique. The Duss collections are within the range of variation of *P. aduncum* on adjacent islands.

Stehlé supplied a footnote to the original description of *Piper stehleorum* comparing this species with *P. aduncum* of Grenada and *P. hebecarpum* of Martinique. The syntypes examined do not differ significantly from material of the wide-ranging *P. aduncum*. Trelease had annotated one of the syntypes, *Stehlé 3257*, in the herbarium at Illinois as the "type."

Piper subrectinerve C. DC. is a representative of *P. aduncum* on the island of St. Vincent. Sufficient additional collections from the area of the type collection allow this species to be assigned here in synonymy.

DISTRIBUTION: Guadeloupe, Dominica, Martinique, St. Vincent, Grenada.

Piper aequale Vahl, Eclog. 1: 4. *t. 3*. 1796. TYPE: Montserrat, *Ryan* (C).

Piper aequale forma *acutispicum* Trel. in Stehlé, Fl. Descr. Antill. Fr. 2(1): 82. 1940. TYPE: Martinique, *Stehlé 3382* (ILL).

Piper aequale var. *dussii* C. DC. in Urb. Symb. Antill. 3: 204. 1902. TYPE: Guadeloupe, *Duss 2565* (US).

Piper aequale var. *lasiocarpum* C. DC. in Urb. *Ibid.* SYNTYPES: Martinique and St. Vincent.

Piper aequale var. *latifolium* Stehlé, Fl. Descr. Antill. Fr. 2(1): 82. 1940 (*nomen nudum*).

Piper aequale var. *latum* Trel. in Stehlé, Bull. Soc. Bot. Fr. 83: 627. 1926 (*nomen nudum*); Fl. Descr. Antill. Fr. 2(1): 81. *pl. 4, f. 1*. 1940. TYPE: Guadeloupe, *H. & M. Stehlé 362*.

Piper aequale var. *ovalifolium* C. DC. Prodr. 16(1): 311. 1869. TYPE: Trinidad, *Sieber 192*.

Piper aequale var. *typicum* Stehlé, Fl. Descr. Antill. Fr. 2(1): 80. 1940.

Piper aequale var. *variifolium* Trel. in Stehlé, *Ibid.* 81. TYPE: Guadeloupe, *H. & M. Stehlé 3394* (holotype, ILL).
Piper dominicanum C. DC. in Urb. Symb. Antill. **3:** 205. 1902. TYPE: Dominica, *Duss 19.*
Piper hahnii C. DC. Linnaea **37:** 354. 1871–3 as to description, not as to holotype cited.

The subspecific taxa described by the several authors are based on variations of leaf shape. These names may be applied to single herbarium specimens but the several leaf forms can be found on single plants when examined in the field. *Piper aequale* var. *dussii* is supposed to be a climbing plant; however, the label data state the plant is "accidentally more or less climbing."

Piper dominicanum C. DC. is based on a collection from Dominica, *Duss 19*, but no herbarium location is given. Such a specimen could not be located in the De Candolle herbarium. A specimen, *Duss 19* (NY), is also cited from Martinique as a syntype of *Piper aequale* var. *lasiocarpum*. De Candolle distinguished *Piper dominicanum* from *Piper aequale* only on the size of the leaf. Many of the recent collections of Hodge from Dominica approach the size noted by De Candolle.

DISTRIBUTION: Montserrat, St. Kitts, Nevis, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent.

Piper amalago L. Sp. Pl. 1: 29. 1753.

Piper amalago var. *medium* (Jacq.) Yuncker, Brittonia **14:** 189. 1962.
Piper fishlockii Trel. Herbarium name never published. TYPE: Tortola, *Fishlock 149.*
Piper mac-intoshii Trel. in Stehlé, Carib. For. 6, Suppl. 386. 1945 (*nomen nudum*); Candollea **10:** 286. 1946. TYPE: Barbados, *MacIntosh 3001* (NY).
Piper plantagineum Lam. Tab. Encycl. Ill. **1:** 80. 1791. TYPE: Hispaniola.
Enckea sieberi Miq. Syst. Pip. 358. 1843. SYNTYPES: Trinidad, St. Croix.
Piper sieberi C. DC. Prodr. **16**(1): 248. 1869.

Yuncker (Brittonia **14:** 189. 1962) studied material of *Piper amalago* and *P. medium* throughout the range, and stated that they "are very closely related forms of what appears to be the same species." He concluded "that *P. medium* should be regarded as having at most varietal status," to which he assigned it. Subsequently Burger (Fieldiana Bot. **35:** 99. 1971) and Adams (Fl. Jam. 211. 1972) have accepted *P. amalago* as the correct name for plants of Costa Rica and Jamaica, respectively.

The typification of this species raises some question of the lectotype. Miquel (Syst. Pip. 258. 1843) noted that Linnaeus (Sp. Pl. 1: 29. 1753) included three references in the protologue and suggested that the name be expunged from botanical catalogues. De Candolle (Prodr. **16**(1): 248. 1869) restricted *Piper amalago* L. to the synonyms of Sloane and Plukenet of the second edition of Species Plantarum (p. 41) although he cited the Clifford reference among the examples listed. In his treatment of the Piperaceae for the Antilles (Urb. Symb. Antill. **3:** 167.

1902), C. de Candolle cited "Sp. Pl. ed. 1" without qualification, but ed. 2 "*quoad syn. Sloane.*" It appears that *Piper longum* etc., Sloane hist. 1. p. 134. *t. 87, f. 1*, is to be considered the type, and a specimen of this may exist in the British Museum.

Piper medium Jacq. (Ic. Pl. Rar. 1: *2. t. 8.* 1781) is illustrated in its original publication; and for most species Jacquin described, the illustration serves as the type. However, in the Illinois herbarium there is a sheet, a mixed collection, which is labeled "Piper medium Jacq., ex herb. Endlicher, Wien cult., in horte Schönbrunn." Trelease has annotated the one fertile fragment, "I take this to be equivalent to a co-type of P. medium." The other two fragments on the same sheet are sterile and obviously different. They were not identified by Trelease, and are not representative of any species in the Lesser Antilles. The "Schönbrunn" specimen has a very slight pubescence on the petioles.

Trelease examined the Lamarck Herbarium material and found three specimens labeled "Piper plantagineum." One of these, a specimen of M. Bodier, came from Guadeloupe and he reported it to be *P. sieberi.* The other two sheets are extraterritorial.

DISTRIBUTION: Montserrat, Antigua, Guadeloupe, Martinique, Marie Galante, St. Vincent.

Piper andersonii C. DC. in Urb. Symb. Antill. 3: 194. 1902.

No material labeled as this species has been located. De Candolle cited the type as St. Lucia, *Anderson*, herb. Forsyth nunc Kew et Krug & Urb. A request to the Forsyth Herbarium at Cambridge, England, produced three possible specimens, two of them collected by Anderson in St. Vincent in 1790, both of which are *Piper aequale* Vahl. The third specimen, collected in St. Lucia in 1785, had only the letter "B" for a collector, and this was *Piper amalago* L. A specimen loaned from the Kew Herbarium was collected by Anderson on St. Lucia. The printed label indicates it is a part of the Herb. Forsyth purchased in 1835. Only the genus name, *Piper*, is written on the label. An annotation by "R.A.R." suggests *Piper aequale* Vahl for this specimen and I agree.

De Candolle's description, especially the character of a vaginate petiole given in the key, suggests this species to be *Piper glabrescens.* Although De Candolle compared his species with *Piper citrifolium* Lam. he placed *Piper andersonii* in the text next to his *Piper macrophyllum* which is *Piper glabrescens.* Stehlé (Bull. Soc. Bot. Fr. **85**: 576. 1938) stated that Trelease had concluded his *Piper nottirbanum* and *Piper andersonii* DC. were very similar.

In spite of my inability to locate an authentic specimen, I have assigned *Piper andersonii* to the synonymy of *Piper glabrescens* on the basis of the published description.

Piper arboreum Aubl. Pl. Guian. 1: 23. 1775.

A collection by *Hahn 1216* (GH) is referred to this species. It was

made in the Jardin des Plantes, Martinique, in 1871, and remained unidentified for a century.

Piper betle L. Sp. Pl. 1: 28. 1753.

This species is reported from cultivation on the islands of Guadeloupe, Martinique, and St. Vincent by De Candolle (Urb. Symb. Antill. 3: 214. 1902). A few specimens so identified have been seen. The collection of *H. H. & G. W. Smith 1641* from St. Vincent (GH) is sterile and may well be this species. The specimen *Duss 2833* cited by De Candolle (Urb. Symb. Antill. 3: 214. 1902) and Stehlé (Fl. Descr. Antill. Fr. 2(1): 76. 1940) is in flowering condition, but seems to be assigned more properly to *Piper nigrum*. De Candolle did not examine any material but accepted Duss's identification. A specimen of *Duss 2833* was seen in the herbarium of the New York Botanical Garden.

Piper dilatatum L. C. Rich. Act. Hist. Nat. Paris 1: 105. 1792. TYPE: Area not specified.

Piper dilatatum var. *broadwayi* Trel. in Stehlé, Bull. Soc. Bot. Fr. 83: 627. 1936 (*nomen nudum*). TYPE: Guadeloupe, *Trelease 69* (ILL).

Piper dilatatum forma *calcicolens* Stehlé, Fl. Descr. Antill. Fr. 2(1): 93. 1940. TYPE: Guadeloupe, *H. & M. Stehlé 1143.*

Piper dilatatum forma *diamantense* Trel. in Stehlé, *Ibid.* 96. SYNTYPES: Martinique. LECTOTYPE: *H. & M. Stehlé 3215* (ILL).

Piper dilatatum forma *diversifolium* Stehlé, *Ibid.* 94. SYNTYPES.

Piper dilatatum forma *magnifolium* Stehlé. *Ibid.* 92. SYNTYPES.

Piper dilatatum forma *medium* Stehlé, *Ibid.* 93. SYNTYPES.

Piper dilatatum forma *naris-fractae* Stehlé, *Ibid.* 95. TYPE: Guadeloupe, *Duss 4174.*

Piper dilatatum forma *vauclinii* Trel. in Stehlé, *Ibid.* 94. TYPE: Martinique. LECTOTYPE: *H. & M. Stehlé 3208* (ILL).

Piper dilatatum var. *vincentianum* C. DC. in Urb. Symb. Antill. 3: 198. 1902. SYNTYPES.

Piper antiguanum Trel. Herbarium name, never published. TYPE: Antigua, *Rose, Fitch & Russell 3323* (NY).

Piper balbisianum C. DC. in Urb. Symb. Antill. 3: 205. 1902. TYPE: Guadeloupe, *Bertero* (B).

Piper boxii Trel. ined. TYPE: Antigua, *Box 829.*

Piper calciseligens Trel. in Stehlé, Bull. Soc. Bot. Fr. 84: 411. 1937 (*nomen nudum*); Fl. Descr. Antill. Fr. 2(1): 97. 1940. TYPE: Guadeloupe, *H. & M. Stehlé 1340.*

Piper eggersii C. DC. in Urb. Symb. Antill. 3: 200. 1902. TYPE: Barbados, *Eggers 7157.*

Piper naris-fractae Trel. in Stehlé, Fl. Descr. Antill. Fr. 2(1): 95. 1940 (invalid). TYPE: Guadeloupe, *Duss 4174* (G).

Piper readii C. DC. in Urb. Symb. Antill. 3: 197. 1902. TYPE: Guadeloupe, *Read.*

Piper shaferi Trel. ined. TYPE: Montserrat, *Shafer 252.*

Schilleria ulmifolia Kunth, Linnaea 13: 698. 1839. TYPE: Martinique, *Sieber 7.*

Piper dilatatum has been recognized as a species with considerable morphological variation. Stehlé (Fl. Descr. Antill. Fr. 2(1): 91. 1940) discussed the occurrence of juvenile as well as adult leaf forms; and the variation in the form of the leaves as well as in their pubescence and texture both in fresh condition and after drying. Nevertheless, he concluded that seven forms are to be recognized. The publication of these names was not in accordance with the International Code of Botanical Nomenclature, and the epithets are illegitimate.

Piper readii was described by De Candolle with a single collection by Read cited from Guadeloupe. No indication was given of the location of the type specimen, and such a collection could not be located by the staff in the herbarium at Geneva. Two specimens collected by Read are in the herbarium at the Philadelphia Academy, one of which, labeled "Piper capense" agrees with the published description. This specimen should be referred to *Piper dilatatum*.

De Candolle suggested in the original description of *Piper eggersii* that the style was persistent in the fruit producing a pointed drupe. An examination of two isotypes does not reveal this characteristic.

DISTRIBUTION: Saba, St. Eustatius, Antigua, Montserrat, St. Kitts, Nevis, Guadeloupe, Dominica, Martinique, Marie Galante, St. Lucia, St. Vincent, Grenada, Grenadines, Barbados.

Piper dussii C. DC. in Urb. Symb. Antill. 3: 190. 1902. TYPE: Guadeloupe, *Duss 2835*.

Piper dussii forma *Branquecanum* Stehlé, Fl. Descr. Antill. Fr. 2(1): 111. 1940. TYPE: Guadeloupe, *R. P. Branquec & H. & M. Stehlé 974*.
Piper dussii forma *dogueanum* Stehlé, *Ibid.* TYPE: Martinique, *H. & M. Stehlé 2320*.
Piper dussii forma *quentinianum* Stehlé, *Ibid.* 112. TYPE: Guadeloupe, SYNTYPES.
Piper dussii forma *scabridum* (C. DC.) Stehlé, *Ibid.* 113. TYPE: Martinique, *Duss 1337*.
Piper dussii var. *scabridum* C. DC. in Urb. Symb. Antill. 3: 191. 1902. TYPE: Martinique, *Duss 1337*.
Piper broadwayi C. DC. *Ibid.* SYNTYPES: Guadeloupe, Dominica, Grenada.
Piper hahnii C. DC. Linnaea 37: 354. 1871–3 as to holotype, *Hahn 263*.
Piper latilimbum C. DC. in Urb. Symb. Antill. 5: 295. 1907. TYPE: Guadeloupe, *Duss 4079*.

Stehlé (Fl. Descr. Antill. Fr. 2(1): 110. 1940) commented that plants of *Piper dussii* exhibited different aspects between juvenile and mature conditions. He reported the transplanting of specimens into a trial garden where different leaf shapes, sizes, and degrees of scabridity permitted the recognition of the several forms. When examined over the range of the species, these minor variations are not significant.

De Candolle cited three collections, *Krauss n. 1818* from Guadeloupe; *Ramage s.n.* from Dominica; and *Broadway 1480* from Grenada in the

original description of *P. broadwayi*. I have photographs of the first two collections which are referred to *Piper dussii*.

Stehlé (Fl. Descr. Antill. Fr. 2(1): 96. 1940) cited "Krauss s.n. 1818, in herb. C. de Candolle à Genève" among the specimens he considered to be *Piper dilatatum* forma *diamentense* Trel. Krauss collected in Guadeloupe prior to 1838 (Urb. Symb. Antill. 3: 69. 1902) and it is not clear if "1818" is the date or the collector's number. Two Krauss specimens are in the Prodromus herbarium, both annotated *P. broadwayi* by De Candolle.

Piper latilimbum C. DC. was distinguished from *P. dussii* by De Candolle by its larger leaves scabrous above, and the intramedullary bundles two-seriate. Independent work on the vascular structure of the stem, node and petiole of species of *Piper* indicates that the number of series of medullary bundles depends on the position of the section taken in relation to the node. A section from the middle of the internode may be one-seriate, whereupon the bundles branch into two series prior to the departure of the external series into the petiole. The number of series of intramedullary bundles is not a distinctive characteristic in the species of *Piper* which have been examined.

The type collection of *Piper latilimbum* (*Duss 4079*) is mixed. Two sheets referable here have fruit oblong in outline. One sheet (NY) having the fruit triangular in outline is referred to *Piper dilatatum*.

Trelease had annotated several herbarium specimens as "Piper dussii latilimbum" and "Piper dussii broadwayi," suggesting he, too, felt *P. latilimbum* and *P. broadwayi* were not distinctive species. One specimen labeled *Piper dussii broadwayi* is *H. & M. Stehlé 363* cited as a syntype of *Piper dussii* forma *quentinianum* Stehlé.

DISTRIBUTION: Nevis, Montserrat, Antigua, Guadeloupe, Dominica, Martinique, Marie Galante, St. Lucia, St. Vincent, Grenadines.

Piper glabrescens (Miq.) DC. Prodr. 16(1): 271. 1869.

Artanthe glabrescens Miq. in Hook. Lond. Jour. Bot. 4: 461. 1845. TYPE: British Guiana, *Parker* (K).

Piper glabrescens var. *venezuelense* (C. DC.) Trel. & Yuncker, Piperaceae North. S. Am. 1: 215. 1950.

Piper andersonii C. DC. in Urb. Symb. Antill. 3: 194. 1902. TYPE: St. Lucia, *Anderson*.

Piper macrophyllum H.B.K. Nov. Gen. & Sp. 1: 39. 1816, not Sw. 1788.

Piper nottirbanum Trel. in Stehlé, Bull. Soc. Bot. Fr. 85: 576. 1938. TYPE: Guadeloupe, *H. & M. Stehlé 1748*.

Piper quentini Trel. in Stehlé, *Ibid.* 84: 410. 1937 (*nomen nudum*); Candollea 8: 74. 1940 [as *Quentinii*]. TYPE: Guadeloupe.

Piper treleasanum Brit. & Wils. Sci. Surv. Porto Rico Virgin Is. 5: 222. 1924; Stehlé, Bull. Soc. Bot. Fr. 83: 627. 1936.

Piper venezuelense C. DC. Seem. Jour. Bot. 4: 216. 1866. TYPE: Venezuela, *Fendler 2572*.

De Candolle (Urb. Symb. Antill. 3: 194. 1902) accepted the name *Piper macrophyllum* Kunth for this species by excluding Swartz's plant from Kunth's circumscription and assigning the name *P. macrophyllum* Sw. to the synonymy of his *P. geniculatum* (= *P. arboreum*). Britton and Wilson (Sci. Surv. Porto Rico Virgin Is. 5: 222. 1924) supplied a new name for the species honoring William Trelease as *Piper treleasanum*.

Stehlé (Bull. Soc. Bot. Fr. 85: 576. 1938) proposed "**Piper nottirbanum** Trel. nov. spec." for "*Piper macrophyllum* Kunth et auct. mult. p.p. *Piper treleasanum* Brit. & Wils., p.p. (pour les Iles Caraïbes)," restricting the species to Martinique and Guadeloupe, and possibly St. Vincent, and cited *Stehlé 1748* as the type. He recognized the publication was invalid, and in 1940 (Fl. Descr. Antill. Fr. 2(1): 103. 1940) supplied a Latin description and cited the same type. The "type specimen" (ILL) consists of a single leaf and a three-inch piece of stem, but it still shows the characteristic stipular scars, pubescence, and glands of *P. glabrescens*.

A comparable and equally confusing situation involves *Piper quentinii*, which was published without description in 1937 but with a collection "Stehlé 1337" selected as the type. The valid description, published in Latin in 1940, is attributed to Trelease, and the type is indicated as *R. P. Quentin & H. Stehlé 1337*. The holotype at Illinois is designated in Trelease's handwriting as Father Quentin "1737." Also in 1940 (Fl. Descr. Antill. Fr. 2(1): 87. 1940), Stehlé cited "Quentin & Stehlé 1237." Neither of the type collections (ILL, NY) agrees with the illustration published by Stehlé (Fl. Descr. Antill. Fr. 2(1): 86. 1940) and both are sterile, consisting of very poorly preserved leaves. However, they can be referred to *Piper glabrescens* without question.

In their treatment of the Piperaceae of Northern South America (p. 215. *f. 178*. 1950) Trelease and Yuncker appear to have placed, for the first time, *Piper macrophyllum* H.B.K. and *P. treleasanum* Brit. & Wils. in the synonymy of *P. glabrescens* (Miq.) C. DC. However, they recognized also variety *venezuelense* on the basis of its pubescence. Yuncker annotated several collections from St. Vincent as this variety, yet the pubescence characteristic is to be found in many specimens cited by them under the species.

DISTRIBUTION: Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent.

Piper hahnii C. DC. Linnaea 37: 354. 1871–3.

Piper hahnii was published by C. de Candolle on the basis of a single specimen, *Hahn 263*, in the De Candolle herbarium (G–DC). The species was not included in De Candolle's treatment of the Antillean Piperaceae published in Urban's Symbolae Antillanae (3: 159–274. 1902). Stehlé, however, accepted the species in his treatment of the Piperaceae (Fl. Descr. Antill. Fr. 2(1): 84. 1940) and commented in a footnote: "The name of Hahnii DC. is in the handwriting of C. de Candolle on two sheets

in his herbarium in Geneva, collected by L. Hahn, in Martinique in 1867. The two specimens bear the same number *262* (sic), on one of them is inscribed 'Piper Hahnii C. DC. 1896,' and on the other 'Piper Hahnii C. DC. = Piper aequale Vahl, C. DC. 1907.' In his study of the Piperaceae of the Antilles, in Urb. Symb. Antill. 3: 1902, the species is not given as a valid binomial or as an invalid synonym, and the number 262 of Hahn is not cited in the enumeration of Antillean specimens of *Piper aequale* of Vahl or of its numerous varieties. In 'Piperacearum clavis analytica,' a posthumous work of C. de Candolle published in 1923, in Candollea 1: 65–415, Index Generis Piper p. 251, *P. Hahnii* C. DC. is cited (in Roman characters) as a species he maintains. Thus, with Prof. Wm. Trelease we think that the species is valid and has affinities to Piper aequale."

A request for a photograph of the type specimen of *P. hahnii* in Geneva produced a photograph of the collection *Hahn 263* made in Martinique, which bears the annotation *P. broadwayi* C. DC. No photographs of the collection *Hahn 262* were supplied.

De Candolle's original description of *P. hahnii* is similar to that Vahl published for *Piper aequale*. The type specimen cited and represented by *Hahn 263* is clearly a different species.

Stehlé has distinguished *P. hahnii* from *P. aequale* in his key by the leaf base characters of rounded or subcordate for the former, and base acute or narrowed for the latter. The additional specimens cited by Stehlé and Trelease are all to be referred to *P. aequale*.

The disposition of *Piper hahnii*, therefore, is to refer the description to the synonymy of *Piper aequale* Vahl and the holotype to *Piper dussii* C. DC.

Piper hispidum Sw. Prodr. 15. 1788.

Piper scabrum Sw. Fl. Ind. Occ. **1:** 59. 1797, not Lam. 1791.
Piper hirsutum Sw. *Ibid.* 60. (illegit.).
Piper hispidum var. *plurinerve* C. DC. Urb. Symb. Antill. **3:** 188. 1902. TYPE: St. Vincent, syntypes.
Piper malanganum Trel. in Stehlé, Bull. Soc. Bot. Fr. **83:** 627. 1937 (*nomen nudum*); Candollea **8:** 75. 1940. TYPE: Guadeloupe, *Stehlé 338*.
Piper dussii forma *dugommierianum* Trel. in Stehlé, Bull. Soc. Bot. Fr. **84:** 411. 1937 (*nomen nudum*); Fl. Descr. Antill. Fr. **2**(1): 112. 1940. TYPE: Guadeloupe, *H. & M. Stehlé 1292*.

Until the recent work of Burger (Fieldiana Bot. **35:** 142, 175. 1971), *Piper hispidum* Sw. and *Piper scabrum* Sw. (not Lam.) were considered synonymous. Adams (Fl. Jamaica 212. 1972) continues such a treatment. Burger, however, found a distinguishing characteristic in the shoot apex, recognized *Piper hispidum* Sw., and accepted the name *Piper sanctifelicis* Trel. for *Piper scabrum* Sw. I have had great difficulty in applying the ligule characteristic Burger described to the vast majority of specimens from the Antilles, and even to those from Costa Rica that Burger annotated. Burger stated "*Piper hispidum* and its allies are taxonomically

the most difficult group of pipers in Costa Rica" and "*Piper hispidum* should be considered as no more than a first approximation in treating a very difficult group of plants." Regarding *Piper sancti-felicis* Trel., Burger stated: "The rigidity of botanical nomenclature does not permit the use of Swartz's *P. scabrum*; I am sure that there must be another name earlier than that of Trelease." Burger did not cite *Piper hirsutum* Sw., and, therefore, did not indicate whether he saw the type of this older name. I can suggest further that *Piper dussii* and the synonyms given under that species must also be considered by some future worker who examines the "*Piper hispidum* complex" on a broader geographic scale.

I am accepting *Piper hispidum* for a relatively few collections from the Lesser Antilles in which the leaves are scabrous above from stiff, ascending hairs generally parallel to the leaf surface and arising from enlarged leaf bases. The hairs are not persistent, but their swollen bases form the "scabrous" condition of the upper leaf surface. This material also is much more pubescent on the stem than is the material which has been accepted as *P. dussii*. *Piper dussii* tends to have larger leaves than *P. hispidum* in this treatment. It has been recognized that young plants of *Piper dussii* have much larger and broader leaves than do the mature plants. Comparable specimens are not available or assigned to *Piper hispidum*. The present treatment is not completely satisfactory, and much pan-Caribbean collection and study is needed to clarify not only this species complex but all of the Piperaceae.

Piper malanganum was published with the citation of two collections, *Stehlé 338* as the type and *Questel 1376*. I have seen the type but not the Questel collection. The specimen is poorly prepared and consists of aged and much riddled leaves. The species as represented by the type specimen is not distinct. It appears to be best assigned to the synonymy of *Piper hispidum*.

DISTRIBUTION: St. Kitts, Guadeloupe, Martinique, St. Vincent.

Piper nigrum L. Sp. Pl. 1: 28. 1753.

This species was introduced and cultivated at Camp Jacob on Guadeloupe, according to data on a specimen, *Duss 2832*, collected in 1893. The most recent collection is from the Botanical Garden in Roseau, Dominica, made in 1958 (*Proctor 17525*). These are the only records I have seen from the Lesser Antilles.

Piper reticulatum L. Sp. Pl. 1: 29. 1753. TYPE: Martinique.

Piper duchassaingii C. DC. Prodr. **16**(1): 251. 1869. TYPE: Guadeloupe, *Duchassaing*.
Discipiper reticulatum (L.) Trel. & Stehlé, Candollea **10**: 283. 1946.
Enckea smilacifolia Griseb. Fl. Brit. W. I. 169. 1860.

Linnaeus cited discordant elements in the protologue of this species in both Species Plantarum ed. 1. 1: 29 and ed. 2. 1: 41. De Candolle

(Prodr. 16(1): 295. 1869) limited the species to the Plumier reference (Pl. Amer. 57. *t. 75*. 1693) for a plant from Martinique.

Trelease and Stehlé defined the genus *Discipiper* with *Piper reticulatum* and *Piper nicoyanum* as the basionyms of the only two species. The presence of a disc at the base of the style persisting in the mature fruit was regarded as the distinguishing characteristic. Yuncker did not accept the genus in his treatment of the family in the Netherlands Antilles (Fl. Neth. Antill. 2: 73. 1966) and recognized *Piper reticulatum*. Burger (Fieldiana Bot. 35: 99, 172. 1971) did not cite the generic name *Discipiper* but recognized *Piper reticulatum* and cited *Piper nicoyanum* DC. in the synonymy of *Piper amalago*. He noted the "disc-like area around the stigmas" in the fruit of *P. reticulatum*, but he did not comment on its existence in his disposition of *P. nicoyanum*.

DISTRIBUTION: St. Eustatius, St. Kitts, Antigua, Montserrat, Guadeloupe, Dominica, Martinique, Marie Galante, St. Vincent.

Piper retrofractum Vahl, Enum. 1: 314. 1804.

This climbing heterophyllous species is represented in the Lesser Antilles by specimens collected by *H. & M. Stehlé* (*3251, 3572*), from a plant cultivated in the Jardin d'Essais of Tivoli, Martinique, in 1939.

Piper sanctum (Miq.) Schlecht. ex C. DC. Prodr. 16(1): 330. 1869.

Artanthe? sancta Miq. Linnaea 18: 714. 1844. TYPE: Mexico, *Schiede 105*.
Piper papantlense C. DC. Prodr. 16(1): 338. 1869. TYPE: Mexico, *Fischer 74*.

Piper papantlense C. DC. was attributed to the Lesser Antilles by De Candolle (Urb. Symb. Antill. 3: 212. 1902) on the basis of a specimen of a cultivated plant sent from Dominica to Kew by Imray. Three specimens are in the Kew herbarium, two having the annotation "Rec'd from Mr. Imray in 1877," but these were collected from the Kew Gardens on May 30, 1892. The third is a later collection dated April 1898. Mr. Peter Green of Kew kindly supplied the following information. "I have looked up Kew entry No. 284–77 and find that this consignment was, in fact, sent by Imray from Dominica and was received here on the 16 June 1877. It came in a Wardian case and from this I presume that the *Piper* was received as a living plant. It was not listed on arrival in the entry book with the other half dozen or so miscellaneous plants but the name was added subsequently. However, there is no reason to doubt that it was other than part of this consignment and there is a note in 1892 saying, 'Please send fruit when ripe'." No subsequent material from specimens growing in Dominica has been seen. Two of the sheets (K) are labeled respectively "Piper papantlense C. DC." and "Piper aff. P. papantlense." The specimens are comparable to recent material from Mexico annotated by Gómez-Pompa, who assigned the name *P. papantlense* to the synonymy of *Piper sanctum* (Edic. Inst. Méx. Rec. Nat. Renov. México 147. 1966).

Piper tuberculatum Jacq. Icon. Pl. Rar. 2(2): *pl. 211.* 1786.

The collection *Duss 2831* (NY) bears a label indicating this species was introduced and cultivated in several gardens at Basse Terre, Guadeloupe, in 1894. Stehlé (Fl. Descr. Antill. Fr. 2(1): 99. 1940) attributed this plant to "habitation La Jacinthe, jardin de Mazé." No modern collections have been seen.

Piper unguiculatum Ruiz & Pavon, Fl. Peruv. Chil. 1: 34. *pl. 57. f.b.* 1798.

Piper glaucescens Jacq. Eclog. 112. *pl. 76.* 1811.

The collection *Duss 4090* made in the botanical garden of Basse Terre, Guadeloupe, in 1902, was identified by C. de Candolle as *Piper unguiculatum*. An earlier collection from the same garden, *Duss 2833a*, was originally identified as "Piper recurvatum L.," apparently an unpublished name, and later annotated as *P. unguiculatum* by Trelease.

Specimens of this species have not been located in any herbarium. Trelease, in his treatment of the genus *Piper* for the Flora of Peru (Publ. Field Mus. Nat. Hist., Bot. 13: 248. 1936), cited the Ruiz and Pavon type and noted "Introduced into cultivation at Madrid by Ruiz & Pavon, and at present known only as cultivated in botanical gardens."

Sarcorhachis Trelease, Contr. U.S. Natl. Herb. 26: 16. 1927

TYPE SPECIES: *Piper incurvum* Sieber ex Schult.

Sarcorhachis incurva (Sieber ex Schult.) Trel. Contr. U.S. Natl. Herb. 26: 16. 1927.

Piper incurvum Sieber ex Schultes, L. Mant. Syst. Veg. 1: 238. 1822. TYPE: Guadeloupe, *Sieber 254.*

Piper guadeloupense C. DC. in Briq. Ann. Jard. Bot. Genève 2: 264. 1898. SYNTYPES from Guadeloupe, Dominica, Guiana.

Sarcorhachis incurva var. *stehlei* Trel. ex Stehlé, Bull. Soc. Bot. Fr. 83: 627. 1936 (*nomen nudum*); Fl. Descr. Antill. Fr. 2(1): 67. *pl. 2.* 1940. TYPE: Guadeloupe, syntypes.

Sarcorhachis incurva var. *treleasii* Stehlé, *Ibid.* TYPE: Guadeloupe, *H. & M. Stehlé, 1677.*

Sarcorhachis incurva var. *typica* Trel. in Stehlé, *Ibid.* 66. TYPE: Martinique, *Hahn 1303.*

Artanthe martinicae Miq. Syst. Pip. 413. 1843. TYPE: Martinique, *Sieber 254.*

The original generic description published by Trelease has been emended by Steyermark (Pittieria 3: 29–37. 1971) to acknowledge that the axillary spikes may be solitary or two and that the stigmas are four or five. Steyermark also concluded that the varieties described by Trelease and Stehlé cannot be distinguished from the typical material.

The basionym is credited either to Sieber ex Schultes or Sieber ex DC. (Prodr. 16(1): 294. 1869). In fact both are original descriptions, as is

that of *Artanthe martinicae* Miquel; all are based on the same collection, *Sieber 254*. Stehlé selected a different collection for the holotype of his var. *typica*, *Hahn 1303*, one of the syntypes cited in De Candolle's description of *Piper guadeloupense*.

FINDING LIST

The following list includes those names commonly assigned to specimens collected in the Lesser Antilles. It is not intended as a complete index to the epithets included in the text, nor to all the combinations which exist for the species. The names are followed by the equivalents accepted in this paper. The accepted species names are given with author citations in their proper alphabetical sequence. Names which are maintained appear in **boldface** type, names treated as synonyms are in *italics*.

Lepianthes
peltata (L.) Raf.

Peperomia
acuminata p.p. = **nigropunctata**
ajoupana = **nigropunctata**
allorgeana = **hirtella**
forma *genuina* = **hirtella**
forma *lata* = **hirtella**
forma *major* = **hirtella**
forma *minor* = **hirtella**
alpina q.v. = **myrtifolia**
auberyana = **myrtifolia**
balbisii = **trifolia**
balineorum = **nigropunctata**
balneolorum = **nigropunctata**
barthelemyana = **myrtifolia**
var. *genuina* = **myrtifolia**
var. *reducta* = **myrtifolia**
belangeri = **hirtella**
blanda p.p., q.v. = **questeliana**
boldinghii = **myrtifolia**
bracteiflora = **hirtella**
var. *stigmatifera* = **hirtella**
broadwayi = **myrtifolia**
caespitiformans = **trifolia**
caespitiformis = **trifolia**
caulibarbis = **glabella**
casimiri = **hirtella**
cataractaegaudens = **hirtella**
ciliata p.p., q.v. = **questeliana**
coespitiformans = **trifolia**
conulifera = **magnoliifolia**
var. *acutifolia* = **magnoliifolia**
var. *kerveganti* = **magnoliifolia**
var. *matoubana* = **magnoliifolia**
var. *stehleae* = **magnoliifolia**
var. *stehlei* = **magnoliifolia**
var. *tenuispica* = **magnoliifolia**
var. *tivoliana* = **magnoliifolia**
var. *typica* = **magnoliifolia**
cordifolia (Sw.) A. Dietr.
cuneata = **obtusifolia**
davisii = **urocarpa**
diaphanoides
var. *vincentensis* = **smithiana**
dissitiflora = **hirtella**
doleana = **myrtifolia**
dolosa = **myrtifolia**
dussii = **hirtella**
emarginella (Sw.) DC.
var. *exilis* = **emarginella**
evadens = **hirtella**
exilis = **emarginella**
fimbriata = **trifolia**
fumeana = **urocarpa**
var. *genuina* = **urocarpa**
var. *stehlei* = **urocarpa**
glabella (Sw.) A. Dietr.
var. *eustatiana* = **glabella**
var. *nervulosa* = **glabella**
glandulirostrea = **magnoliifolia**
var. *stehleae* = **magnoliifolia**
grisebachii p.p. = **trifolia**
guadaloupensis = **myrtifolia**
guildingianum = **serpens**
hahnii = **hirtella**
hederacea = **urocarpa**
herminieri = **hirtella**
var. *stigmatifera* = **hirtella**
hernandiifolia (Vahl) A. Dietr.
hirtella Miq.
hispidula (Sw.) Dietr. q.v.
houelmonte = **nigropunctata**

humilis = **questeliana**
var. *stehlei* = **questeliana**
imrayana = **rotundifolia**
langsdorfii p.p. = **questeliana**
magnoliifolia (Jacq.) Dietr.
major = **urocarpa**
martinicensis = **nigropunctata**
var. *almeana* = **nigropunctata**
var. *lata* = **nigropunctata**
myrtifolia (Vahl) A. Dietr.
var. *major* = **myrtifolia**
var. *typica* = **myrtifolia**
negotiosa = **urocarpa**
nigrescens = **nigropunctata**
nigropunctata Miq.
nummularifolia = **rotundifolia**
obovata = **trifolia**
obtusifolia (L.) Dietr.
forma *oblongifolia* = **obtusifolia**
obversum = **trifolia**
ovalifolia = **trifolia**
palpebrata = **nigropunctata**
var. *absalonia* = **nigropunctata**
var. *carbetensis* = **nigropunctata**
var. *lata* = **nigropunctata**
var. *major* = **nigropunctata**
var. *paniculata* = **nigropunctata**
var. *ramulosior* = **nigropunctata**
var. *typica* = **nigropunctata**
pellucida (L.) H.B.K.
var. *baileyana* = **pellucida**
persuccosa = **myrtifolia**
var. *benae* = **myrtifolia**
var. *bertautii* = **myrtifolia**
ponthieui = **hernandiifolia**
praestigiatrix = **magnoliifolia**
pustulatibacca = **magnoliifolia**
questeliana Stehlé & Trel.
reniformis = **serpens**
rotundifolia (L.) H.B.K.
var. *nummularifolia* = **rotundifolia**
var. *pilosior* = **rotundifolia**
rupertiana = **myrtifolia**
var. *genuina* = **myrtifolia**
var. *pinchonii* = **myrtifolia**
var. *rosetteana* = **myrtifolia**
sabae = **glabella**
scandens = **serpens**
serpens (Sw.) Loud.
smithiana C. DC.
stehleana = **nigropunctata**
var. *ajoupana* = **nigropunctata**
var. *balneolorum* = **nigropunctata**
var. *bourgesensis* = **nigropunctata**
var. *branqueci* = **nigropunctata**
var. *houelmonti* = **nigropunctata**
var. *praestigiatrix* = **nigropunctata**
var. *regretteana* = **nigropunctata**
var. *tardenaevifera* = **nigropunctata**
var. *typica* = **nigropunctata**
subbracteiflora = **hirtella**
subvillosa = **hirtella**
forma *candolleana* = **hirtella**
forma *dumauseana* = **hirtella**
tenella (Sw.) A. Dietr.
var. *epiphytica* = **tenella**
thionvilleana = **nigropunctata**
trifolia (L.) A. Dietr.
var. *balbisii* = **trifolia**
forma *genuina* = **trifolia**
forma *obovalifolia* = **trifolia**
forma *suborbiculata* = **trifolia**
truncigaudens C. DC.
urocarpa Fisch & Mey.
vanhuerckii = **myrtifolia**
vernouana = **rotundifolia**
vincentensis = **myrtifolia**
vincentiana Miq.
wilsonii = **nigropunctata**

Piper
aduncum L.
aequale Vahl
forma *acutispicum* = **aequale**
var. *dussii* = **aequale**
var. *lasiocarpum* = **aequale**
var. *latum* = **aequale**
var. *ovalifolium* = **aequale**
var. *typica* = **aequale**
amalago L.
var. *variifolium* = **aequale**
andersoni = **glabrescens**
antiguanum = **dilatatum**
arboreum Aubl.
balbisianum = **dilatatum**
betle L.
boxii = **dilatatum**
broadwayi = **dussii**
calciseligens = **dilatatum**
dilatatum L. C. Rich.
forma *calcicolens* = **dilatatum**
forma *diamentense* = **dilatatum**
forma *diversifolium* = **dilatatum**

forma *magnifolium* = **dilatatum**
forma *medium* = **dilatatum**
forma *naris-fractae* = **dilatatum**
forma *vauclinii* = **dilatatum**
var. *broadwayi* = **dilatatum**
var. *vincentianum* = **dilatatum**
dominicanum = **aequale**
duchassaingii = **reticulatum**
dussii C. DC.
forma *branquecanum* = **dussii**
forma *dogueanum* = **dussii**
forma *dugommierianum* = **hispidum**
forma *quentinianum* = **dussii**
forma *scabridum* = **dussii**
var. *dugommierianum* = **hispidum**
var. *scabrum* = **dussii**
eggersii = **dilatatum**
fishlockii = **amalago**
glabrescens (Miq.) DC.
var. *venezuelense* = **glabrescens**
guadaloupense = **Sarcorhachis incurva**
hahnii (description) q.v. = **aequale**
hahnii (holotype) = **dussii**
hebecarpum = **aduncum**
hirsutum = **hispidum**
hispidum Sw.
var. *magnifolium* = **hispidum**
var. *plurinerve* = **hispidum**
incurvum = **Sarcorhachis incurva**
latilimbum = **dussii**
mac-intoshii = **amalago**
macrophyllum Sw. = **arborescens**
macrophyllum H.B.K. = **glabrescens**
malanganum = **hispidum**
martinicense = **aduncum**
var. *montis-pilati* = **aduncum**
naris-fractae = **dilatatum**
nottirbanum = **glabrescens**
nigrum L.
papantlense = **sanctum**
peltatum = *Lepianthes peltatum*
plantagineum = **amalago**
quentini = **glabrescens**
readii = **dilatatum**
reticulatum L.
retrofractum Vahl
sanctum (Miq.) Schlecht.
scabrum Lam. = **aduncum**
scabrum Sw. = **hispidum**
shaferi = **dilatatum**
sieberi = **amalago**
stehleorum = **aduncum**
subrectinerve = **aduncum**
tuberculatum Jacq.
unguiculatum Ruiz & Pavon
verrucosum Sw. = **arboreum**
verrucosum Willd. = **dilatatum**

Pothomorphe
dussii = **Lepianthes peltata**
peltata = **Lepianthes peltata**

Sarcorhachis
incurva (Sieber ex Schultes) Trel.
var. *stehlei* = **incurva**
var. *treleasii* = **incurva**
var. *typica* = **incurva**

Schilleria ulmifolia = **Piper dilatatum**

ARNOLD ARBORETUM
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138

CYTOLOGY OF WEST HIMALAYAN BETULACEAE AND SALICACEAE

P. N. MEHRA AND T. S. SAREEN

THE FAMILY BETULACEAE includes six genera and over 100 species distributed chiefly in the Northern Hemisphere. It contributes significantly to the forest economy of various countries of the world. Its most important genus from the point of view of lumber is *Betula*. Species of *Alnus* are exploited locally. Oil of birch is extracted from twigs of *Betula lenta*. *Corylus avellana* is the source of European hazelnuts. Four genera with nine species are met in the Himalayas. Of these *Betula cylindrostachys* and *Corylus ferox* are restricted to the Eastern Himalayas.

Constituting the family Salicaceae are only two genera, *Populus* and *Salix* with 40 and 100 species respectively. Ranging between trees and shrubs (dioecious, rare individuals monoecious), they have almost worldwide representation, prevailingly in north temperate regions. The Indian members, roughly 30, are Himalayan with rare exceptions. *Salix* alone includes no less than 25 indigenous species. They are mostly water loving and fast growing. A few of the willows serve for protection of river banks. Economic importance is attached to this group for ornamentals, in the manufacture of furniture, baskets, and bats, and for tannin, and balsam. Six species of this genus have been investigated.

MATERIAL AND METHODS

The material was obtained mostly from trees in nature in the Western Himalayas. Chromosome numbers were determined from squash preparations of anthers fixed in Carnoy's fluid, and also from young leaves in one species, *Carpinus viminea*. Leaf-tips were pretreated with 0.003M solution of 8-hydroxyquinoline. Squashes of pollen mother cells and leaf-tips were accomplished in acetocarmine and acetolacmoid respectively. All figures are at a uniform magnification of × 1360. The voucher specimens have been deposited in the Panjab University Herbarium (India).

RESULTS AND DISCUSSION

Cytological data of 12 species are summarized in TABLE 1. Meiosis was observed to be normal in all but two species. All taxa were characterized by small chromosomes.

BETULACEAE:

Betula alnoides yields good timber for plywood and cabinet work. The chromosome number $n = 14$ (FIGURE 1) is documented for the first

time. *B. utilis* is a high altitude species ascending to tree line in the Western Himalayas and is seldom found below 3,000 meters. Its wood is much used in the inner ranges for building purposes. Studies on trees from different places consistently revealed $n = 28$ (FIGURE 10). Woodworth (1930) reported $n = 14$ for var. *prattii*. Thus, diploid and tetraploid races based on $x = 14$ are evident within the species.

Alnus nepalensis is a commercial timber of limited utility in house construction. The count of $n = 28$ (FIGURE 2) is the first cytological report for this species. *Alnus* was earlier presumed to be based on $x = 14$, but Chiba's (1966) observations of $2n = 21$ in triploid *Alnus* hybrids are suggestive of $x = 7$ as the base number for the genus.

Corylus colurna, $2n = 28$, was investigated from Mussoorie and Simla during two consecutive years. All the individuals examined exhibited anomalous meiosis. Three quadrivalents and eight bivalents were noticed at metaphase-I (FIGURE 11). About 80% of the pollen grains were well filled and stainable. The quadrivalents probably indicate a basic number lower than 14. It may well be $x = 7$. Woodworth (1929) found two bivalents commonly fused in this species, and also reported that throughout the genus *Corylus* pairing of 1, 2, or 3 bivalents often made the gametic number appear less than 14. Kasapligil (1968) determined $n = 7$–10, $2n = 18$, 22 in the same species.

Carpinus is a diploid genus based on $x = 8$. Johnsson's (1942) report of intraspecific polyploidy in *C. betulus* ($2n = 16$, 64) is the only departure. Both *C. viminea* (FIGURE 3) and *C. faginea* (FIGURE 5), each with haploid chromosome number $n = 8$, are reported on for the first time. In *C. viminea* the somatic metaphase showed 16 chromosomes with median and sub-median centromeres (FIGURE 4). One pair of chromosomes was somewhat larger than the rest in the complement.

SALICACEAE:

Six species of *Salix* have been studied here. *S. acmophylla* with $n = 19$ (FIGURE 9) has not been cytologically worked out before. A new cytotype was discovered in *S. tetrasperma* ($n = 38$) and *S. daphnoides* ($2n = 152$). Previous reports in *S. elegans* ($n = 19$), *S. alba* ($n = 38$) and *S. babylonica* ($n = 38$) have been confirmed.

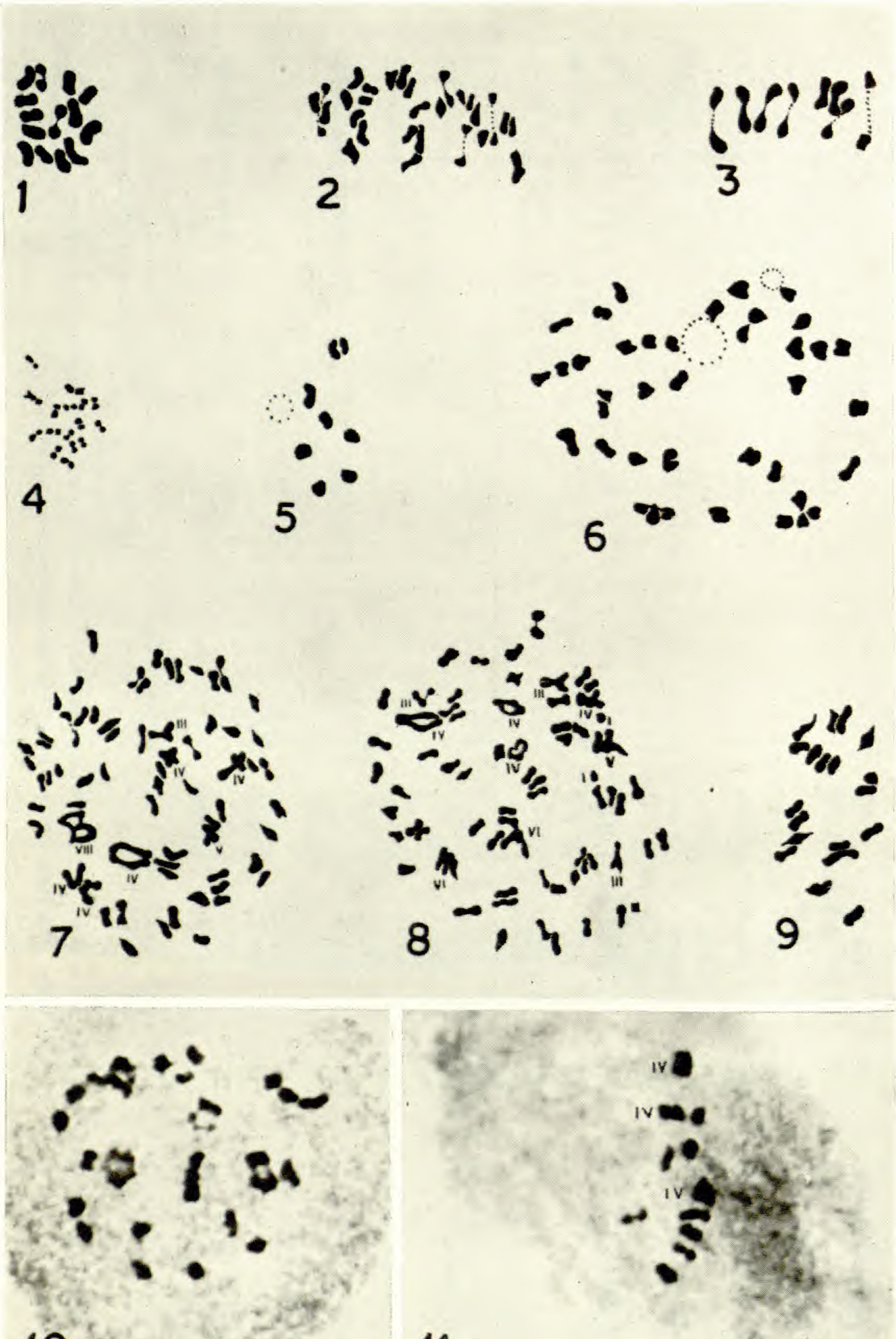
Salix tetrasperma is the only timber tree of *Salix* in India which has a wide distributional range. It is known to be polymorphic with several varieties (cf. Hooker, 1885). The population at Pinjore, near Chandigarh, revealed 38 bivalents and two nucleoli at diakinesis (FIGURE 6). Sobti and Singh (1961) reported the haploid chromosome number $n = 19$ from Jammu. Obviously, diploid and tetraploid races of the species exist in India.

S. daphnoides shows intraspecific polyploidy. Previous chromosome records stand at diploid and triploid levels on $x = 19$ (see TABLE 1). The taxon reported on here is octaploid with $2n = 152$. It showed meiotic irregularities resulting in 20% pollen sterility. The types of pairing configurations observed at metaphase-I were $1_{VIII} + 1_{V} + 5_{IV} + 1_{III}$

TABLE 1. **Chromosome numbers in Betulaceae and Salicaceae.**

TAXON	SOURCE	CHROMOSOME COUNT	PREVIOUS FINDINGS
BETULACEAE			
**Betula alnoides* Buch.-Ham.	Nainital, 1, 950 m.	$n = 14$	
†*B. utilis* D. Don	Almora: Dwali, 3,000 m.	$n = 28$	$n = 14$: Woodworth, 1930.
**Alnus nepalensis* D. Don	Nainital: Bhowali, 1,600 m.	$n = 28$	
Corylus colurna L.	Mussoorie: Depot round, 2,200 m.; Simla, 2,000 m.	$2n = 28$	$n = 14$: Woodworth, 1929. $n = 7$–10, $2n = 18$, 22: Kasapligil, 1968.
**Carpinus viminea* Wall. ex Lindl.	Nainital, 1,950 m.	$n = 8$ $2n = 16$	
**C. faginea* Lindl.	Nainital: Colona, 1,500 m.	$n = 8$	
SALICACEAE			
†*Salix tetrasperma* Roxb.	Chandigarh: Pinjore, 350 m.	$n = 38$	$n = 19$: Sobti & Singh, 1961.
†*S. daphnoides* Vill.	Simla: Huttoo, 3,150 m.	$2n = 152$	$n = 19$ or $2n = 38$: Blackburn & Harrison, 1924; Håkansson, 1944; Marklund *vide* Löve & Löve, 1961. $2n = 57$: Wilkinson, 1944, 1954.
**S. acmophylla* Boiss.	Nainital: Nakuchiatal, 1,200 m.	$n = 19$	
S. elegans Wall.	Nainital: Cheena peak, 2,550 m.	$n = 19$	$n = 19$: Mehra & Singh, 1962
S. alba L.	Nainital: 1,950 m.	$n = 38$	$n = 38$ or $2n = 76$: Blackburn & Harrison, 1924; Wilkinson, 1941; Håkansson, 1955; Marklund *vide* Löve & Löve, 1961.
S. babylonica L.	Mussoorie, 1,950 m.	$n = 38$	$n = 38$ or $2n = 76$: Nakajima, 1942; Bowden, 1945; Almeida, 1946; Suda, 1960, 1963.

* Species worked out for the first time.
†New cytotype.



FIGURES 1–11. 1–9, drawings of the chromosome complements; 10 and 11, photomicrographs of the chromosome complements. 1, *Betula alnoides*, M–I, $n = 14$; 2, *Alnus nepalensis*, M-I–A-I, $n = 28$; 3 and 4, *Carpinus viminea*, 3,

$+ 58_{II}$ (FIGURE 7) and $2_{VI} + 1_V + 4_{IV} + 3_{III} + 54_{II} + 2_I$ (FIGURE 8).

Salix, like *Betula* and *Alnus*, is one of the rare arboreal genera which are rich in frequency of polyploidy.

SUMMARY

Cytological observations have been made on twelve species including three commercial timbers. For five species the first chromosome counts are furnished. New cytotypes are here reported in three species which show intraspecific euploidy. These are *Betula utilis* (n = 14, 28), *Salix tetrasperma* (*n* = 19, 38), and *S. daphnoides* (*2n* = 38, 57, 152). Two species, *Corylus colurna* and *Salix daphnoides*, exhibited abnormal meiotic behavior affecting pollen fertility.

ACKNOWLEDGMENTS

We wish to express our grateful thanks to the sponsoring authorities of the United States Government for financial assistance under PL-480 (Grant A7-FS-12) to the senior author.

LITERATURE CITED

ALMEIDA, J. L. F. DE. 1946. Sobre a cariologia de *Salix solviifolia* Brot. e *S. babylonica* L. Bol. Soc. Brot. **20:** 201–239.

BLACKBURN, K. B., & J. W. H. HARRISON. 1924. A preliminary account of the chromosomes and chromosome behaviour in the Salicaceae. Ann. Bot. **38:** 361–378.

BOWDEN, W. M. 1945. A list of chromosome numbers in higher plants II. Menispermaceae to Verbenaceae. Am. Jour. Bot. **32:** 191–201.

CHIBA, S. 1966. Studies on tree improvement by means of artificial hybridization and polyploidy in *Alnus* and *Populus* species. Bull. Oji Inst. For. Tree Impr. Kuriyama, Hokeido No. **1:** pp. 165.

HÅKANSSON, A. 1944. Die chromosomenpaarung von zwei *Salix* Bastarden. Hereditas **30:** 639–641.

———. 1955. Chromosome numbers and meiosis in certain salices. *Ibid.* **41:** 454–482.

HOOKER, J. D. 1885. Flora of British India. Vol. V. L. Reeve & Co., London.

JOHNSSON, H. 1942. Die chromosomenzahl von *Carpinus betulus* L. Hereditas **28:** 228–230.

KASAPLIGIL, B. 1968. Chromosome studies in the genus *Corylus*. Sci. Rep. Fac. Sci., Ege Univ. No. **59:** 1–14.

LÖVE, A., & D. LÖVE. 1961. Chromosome numbers of Central and North-west European plant species. Op. Bot. **5:** 1–581.

M-I–A-I, *n* = 8; 4, somatic metaphase, *2n* = 16; 5, *Carpinus faginea*, diakinesis, *n* = 8; 6, *Salix tetrasperma*, diakinesis, *n* = 38; 7 and 8, *Salix daphnoides*, 7, M-I, $1_{VIII} + 1_V + 5_{IV} + 1_{III} + 58_{II}$; 8, M-I, $2_{VI} + 1_V + 4_{IV} + 3_{III} + 54_{II} + 2_I$; 9, *Salix acmophylla*, M-I, *n* = 19; 10, *Betula utilis*, M-I, *n* = 28; 11, *Corylus colurna*, M-I, $3_{IV} + 8_{II}$.

MEHRA, P. N., & A. SINGH. 1962. Cytological observations on some North Indian Trees. Res. Bull. Panjab Univ. (n.s.) **13:** 311, 312.

NAKAJIMA, G. 1942. Cytological studies in some flowering dioecious plants, with special reference to the sex chromosomes. Cytologia **12:** 262–270.

SOBTI, S. N., & S. D. SINGH. 1961. A chromosome survey of Indian medicinal plants. Part I. Proc. Indian Acad. Sci. B. **54:** 138–144.

SUDA, Y. 1960. The chromosome numbers in some Japanese Salicaceous plants III. Sci. Rep. Tohoku Univ. Sendai, Japan. Ser. 4. **26:** 25–36.

———. 1963. The chromosome numbers of Salicaceous plants in relation to their taxonomy. *Ibid.* **27:** 147–153.

WILKINSON, J. 1941. The cytology of the cricket bat willow (*Salix alba* var. *caerulea*). Ann. Bot. (n.s.) **5:** 149–165.

———. 1944. The cytology of *Salix* in relation to its taxonomy. *Ibid.* **8:** 269–284.

———. 1954. The cytotaxonomy of some *Salix* species. VIII Congr. Int. Bot., Rapp. et Comm. **9** & **10:** 91, 92.

WOODWORTH, R. H. 1929. Cytological studies in the Betulaceae II. *Corylus* and *Alnus*. Bot. Gaz. **88:** 383–399.

———. 1930. Cytological studies in the Betulaceae IV. *Betula, Carpinus, Ostrya, Ostryopsis*. *Ibid.* **90:** 108–115.

DEPARTMENT OF BOTANY
PANJAB UNIVERSITY
CHANDIGARH-14 (INDIA)

QK1
.H32

JOURNAL OF THE ARNOLD ARBORETUM

Volume 54 HARVARD UNIVERSITY Number 4

MISSOURI BOTANICAL
NOV 27 1973
GARDEN LIBRARY

US ISSN 0004–2625

Journal of the Arnold Arboretum

Published quarterly in January, April, July, and October by the Arnold Arboretum, Harvard University.

Subscription price $16.00 per year, beginning January, 1972.

Subscriptions and remittances should be sent to Ms. Ellen Bernstein, Arnold Arboretum, 22 Divinity Avenue, Cambridge, Massachusetts 02138, U.S.A.

Volumes I–XLV, reprinted, and some back numbers of volumes 46–50 are available from the Kraus Reprint Corporation, 16 East 46th Street, New York, New York 10017, U.S.A.

EDITORIAL STAFF

B. G. Schubert, Editor

C. E. Wood, Jr.

S. A. Spongberg

CIRCULATION

E. Bernstein

Printed at the Harvard University Printing Office, Boston, Massachusetts

---

COVER: *Ginkgo biloba* L., the maidenhair tree, so-called from the fancied resemblance of its leaves to those of the maidenhair fern. In China it has also been called the silver apricot, from the hard inner seed coat which is silvery when cleaned and vaguely resembles an apricot pit, and the duck-foot tree, from the resemblance of the leaves to the webbed feet of ducks.

The drawing for the cover was planned and drawn by Karen Stoutsenberger Velmure from specimens taken from a tree cultivated in the Arnold Arboretum of Harvard University.

We want to assure the purists among our readers that our *Ginkgo* does not have leaves with open parallel venation. We think, however, that an exact reproduction of the dense dichotomous veins would have produced a much less dramatic design.

Second-class postage paid at Boston, Massachusetts

JOURNAL
OF THE
ARNOLD ARBORETUM

VOL. 54 OCTOBER 1973 NUMBER 4

LAZELLA HARENBERG SCHWARTEN
1900–1973

RICHARD A. HOWARD

A GOOD LIBRARY is an integral part of a major arboretum, and a dedicated librarian is an asset upon which an entire organization may depend. Lazella Schwarten was a botanist's librarian whose willingness to help the staff and professional visitors was her contribution to the success of many people. Hers was a major supportive role for twenty-three years in the work of the Arnold Arboretum, and concurrently for thirteen years at the Gray Herbarium at Harvard. Before and throughout this period she made a bibliographic contribution to systematic botany as a whole.

Lazella Schwarten was born in New York City on December 8, 1900. Her grade school years were spent in Germany. After her family returned to the United States in 1910, she attended high school at Hunter College (1914–1918). Lazella married early but her husband died suddenly, leaving her to raise their son and daughter, then twelve and eleven years old. Her efforts on their behalf were admired by those who knew her in this period of the Depression years. Their accomplishments in later years were a source of pride to her.

Mrs. Schwarten was employed as a typist at the New York Botanical Garden in 1931, but after she took a library course at Columbia University and enrolled in the Science Course for Gardeners at the Botanical Garden, she was appointed a Library Assistant at the Garden in 1936. It was in this period that she began the bibliographic projects for the Torrey Botanical Club and the American Society of Plant Taxonomists which she was to continue loyally and without too much recognition until her retirement.

In 1944, during the administration of Dr. E. D. Merrill as Director of the Arnold Arboretum, Lazella Schwarten was invited to accept an appointment as Librarian of the Arboretum. Here an active staff was concerned with bibliographic programs, as exemplified by the research of Merrill, Rehder, A. C. Smith, Kobuski, and Croizat. Lazella learned the library well, and it expanded and improved under her leadership.

In 1954 the library of the Arnold Arboretum was divided; the horticul-

ture section remained in Jamaica Plain, and that of floristic and systematic botany was moved to the Harvard University Herbaria Building in Cambridge to be integrated with the library of the Gray Herbarium into one superb library. Mrs. Schwarten again proved her capabilities in the organization of this material, adapting two different and historic systems into a single working library. The library supporting horticultural activities in Jamaica Plain was reorganized simultaneously, incorporating the Arnold Arboretum books on forestry which had been on deposit at the Harvard Forest, in Petersham, Massachusetts. All of this was accomplished with the least possible disruption of the scientific work of many of the staff members.

Mrs. Schwarten retired reluctantly on July 1, 1967, after twenty-three years of service at Harvard. For this occasion the staff had assembled letters of testimony within the organization, and from botanists of other institutions whom Mrs. Schwarten had helped during their visits. This bound volume was apparently most appreciated for she acknowledged every one of the letters and the tributes she had received. She left Cambridge to live in a small house on the lovely grounds of the home of her daughter and son-in-law in Readington, New Jersey. Here for a few years she enjoyed gardening, her first chance after years of apartment dwelling to put her acquaintance with horticultural books to work in cultivating plants. Ill health eventually limited her activities, and she died on January 2, 1973, in Flemington, New Jersey.

I have indicated that service to others was her commitment. She gave freely of her energies to any who needed her help. Impatient with incompetence or laxity, she always did more than her share of the work of the institution. She relaxed only in her small apartment, enjoying recorded symphonies, attending the Boston Symphony concerts on a regular basis, and adding to her collection of old glass.

While at the New York Botanical Garden, Mrs. Schwarten was given the unpaid role of Bibliographer for the Torrey Botanical Club in 1940. She worked with Dr. Harold Rickett in preparing the *Index to American Botanical Literature* which was published in the quarterly *Bulletin of the Torrey Botanical Club* and reprinted in card-form for distribution to several dozen institutions. Although she was supposed to have some coworkers, I know from experience that Lazella, in her own style, carried the burden of compiling the titles, reading proof, and handling most of the correspondence. She brought much of this responsibility to Massachusetts and continued working on the project until her retirement.

During the formative years of the now flourishing American Society of Plant Taxonomists, Mrs. Schwarten worked closely with the late Dr. Wendell Camp in editing not only the issues of the *Taxonomic Index*, but in doing her best to temper his comments and reviews. From the early mimeographed issues she served as collaborator and Associate Editor through twenty volumes. When this publication included selected items from the *Index to American Botanical Literature*, it was Mrs. Schwarten who prepared the copy.

The annual reports of the directors of the Arnold Arboretum have always included a list of the publications of the staff and students. Mrs. Schwarten supplied this material, and no director needed to ask her for copy. She knew the manuscript deadlines and her material was ready. She prepared the bibliographies of such botanists as Merrill, Bailey, Fernald, Palmer, Faull, Kobuski, and Johnston which accompanied their obituaries in several publications. Her credit lines were all too brief.

With Harold Rickett she began a compilation of a standard list of abbreviations of botanical titles. This was published in 1947 in the *Bulletin of the Torrey Botanical Club*. An appendix to this work was compiled and issued in 1961, and together these lists served as the reference for proper uniform and convenient citation of botanical periodicals for many years.

Without a background of formal college education, Lazella Schwarten became a professional by her own hard work. She was proud of her recognition as a Professional Librarian by a Certificate of Librarianship issued to her by the Commonwealth of Massachusetts in 1950. Hers was a lifetime of unselfish, special contribution to others.

ARNOLD ARBORETUM
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138

CHROMOSOME NUMBERS OF TREE SPECIES OF A LOWLAND TROPICAL COMMUNITY

K. S. BAWA

CHROMOSOMAL CYTOLOGY HAS PLAYED a significant role in elucidating cytogenetic relationships among higher plants of the North Temperate Zone. However, for plants of the tropics, especially trees, even the chromosome numbers are not known for most species. Cytological data are particularly scarce for trees of the neotropics since almost all available data are from Asiatic or African species (see for example, Mangenot & Mangenot, 1962; Mehra & Bawa, 1969; Styles & Vosa, 1971; Hans, 1972).

This paper reports chromosome numbers of tree species of a lowland tropical semideciduous forest in Costa Rica. A total of 66 species in 56 genera from 32 families were investigated; chromosome counts for 45 species and 16 genera were made for the first time.

MATERIAL AND METHODS

Material for chromosomal studies was collected from Hacienda Ciruelas, 5 km. northwest of Bagaces and Hacienda La Pacifica, 5 km. northwest of Cañas in Guanacaste Province, Costa Rica. The vegetation of these sites has been described in detail by Holdridge *et al.* (1971) and Daubenmire (1972), and need not be elaborated upon here.

Floral buds were fixed in acetic alcohol (1:3), and after 24 to 28 hours transferred to 70 per cent alcohol. The buds were then stored at 0° C until the time of cytological examination. Standard cytological techniques (Sharma & Sharma, 1965) were employed for the study of chromosomes. In most species observations were made of material from two or three individuals.

Voucher specimens have been deposited in the Herbarium, Missouri Botanical Garden, St. Louis, Missouri, U.S.A. (MO).

RESULTS AND INTERPRETATION

The results are summarized in TABLE 1 in which are listed chromosome numbers together with ploidy level and previous cytological reports, if any, for all investigated taxa.

A detailed interpretation of chromosome numbers in each family must await accumulation of more data; however, numbers of a few taxa merit some comments which are presented below:

LEGUMINOSAE

The present report of $n = 11$ for *Andira inermis*, and $n = 10$ for

Piscidia carthagenensis differs from $n = 10$ and $n = 11$ reported for those species, respectively, by Atchison (1951).

MALPIGHIACEAE

The current finding of $n = 12$ for *Byrsonima crassifolia* from several different localities is at variance with $2n = 20$ reported for this species by Nanda (1962). The same is true for *Malpighia glabra* in which the gametic number was observed to be $n = 10$ in contrast to $2n = 40$ reported by Pal (1964).

Kyhos (1966) has found $2n = 12$ in *Galphimia glauca*. It is, therefore, likely that $x = 12$, reported in several taxa of Malpighiaceae, is of polyploid derivation.

BOMBACACEAE

The family is characterized by the presence of high chromosome numbers. With the exception of *Durio zibethinus* ($n = 28$) all other taxa have $n = 36$ or more. The present report of $n = 45$ for *Ochroma pyramidale* differs from $n = 36$, 39, and 44 reported for this species under the name of *O. lagopus* by Baker and Baker (1968). In addition, *Bombacopsis quinata* was observed to have $n = 46$, but Baker and Baker (l.c.) recorded $n = 36$ for this species. The infraspecific variation in chromosome numbers also exists in several other taxa of the family. The variation in chromosome numbers could be, a) due to errors in the counting of chromosomes which could result from incomplete separation of a large number of chromosomes at metaphase or, b) due to the presence of accessory chromosomes. The first possibility is minimized by the fact that counts by Baker and Baker and those reported here are based on observations of many cells from several individuals. The second possibility has been discussed by Baker and Baker, but the presence of accessory chromosomes remains to be established. The present data do not indicate the occurrence of accessory chromosomes because the same number of bivalents was observed in each cell. Clearly, more intensive cytological work on the family is needed to establish the true nature of chromosomal variability.

The basic number in the family is probably $x = 9$, and the whole assemblage appears to be an ancient polyploid series.

BORAGINACEAE

The genus *Cordia* shows remarkable variation in chromosome numbers at the interspecific level; such variation is uncommon in tropical woody genera. According to Britton (1951), the base number of the genus is $x = 8$ because two species from India are reported to have $2n = 16$.

The present report of $n = 15$ for *C. alliodora* from several individuals contrasts sharply with $2n = 72$ found by Britton (1951) in this species. I have no doubt about the correct identification of my voucher specimens, but I have been unable to check Britton's material. Since *C. alliodora* is a species of major importance to forestry in Central America, more intensive investigations are needed to detect the pattern of intraspecific variability in chromosome numbers, if it exists.

DISCUSSION

A common feature that most trees share is the high basic number: in 48 out of 56 genera the basic chromosome number is $x = 11$ or more. The same is true for tropical woody genera investigated from Africa and Asia (Mangenot & Mangenot, 1962, Mehra & Bawa, 1969). To the extent that the recombination index is a function of chromosome number, the high chromosome number must lead to an increase in the number of recombinants among the gametes of an individual (Lewis & John, 1963). The obligatory outcrossing mechanisms that characterize a majority of trees mentioned in this report (Bawa, 1973) further increase the number of recombinants but now among the zygotes. Thus both the meiotic system and the breeding system in tropical trees supplement each other in increasing the array of genotypes that result from a given reproductive cycle. It is beyond the scope of this paper to deal with the significance of the vast recombination potential of the genetic systems that appear to characterize most tropical trees investigated so far, but it needs to be emphasized that most tropical tree species are not characterized by the presence of a genetic system that conserves variation as is often assumed (see for example Catinot, 1972, Fedorov, 1966).

It is not only the tropical woody genera that have high basic numbers; genera in some herbaceous families of the tropics such as Bromeliaceae, Commelinaceae, and Orchidaceae also have basic numbers that exceed $x = 11$ (cf. Stebbins, 1971). However, in those families that contain both herbaceous and woody taxa as, for example, the Leguminosae which are cytologically well known, the former have a lower basic number than the latter (Atchison, 1951; Solbrig, 1972). Grant (1963) has also pointed out a similar difference in the basic numbers of herbaceous and woody taxa of flowering plants in general.

According to Ehrendorfer *et al.* (1968), the numbers higher than $x = 11$ in woody angiosperms are probably of polyploid origin. If this assumption is correct, polyploids among the Costa Rican tree species amount to 70 per cent. However, if all chromosome numbers are considered as diploid unless they are multiples of lower numbers found in related genera, the frequency of polyploids is reduced to about 50 per cent. The true percentage of polyploids probably lies between these two extremes. Since one third to one half of all angiosperms are presumed to be polyploid (Hanelt, 1966; Löve & Löve, 1967; Grant, 1971; Stebbins, 1971; de Wet, 1971), the frequency of polyploidy among tropical trees is higher than in flowering plants as a whole.

Although the frequency of polyploids among tropical woody taxa is high, polyploid series within genera are not common (Stebbins, 1971). As shown in TABLE II most genera found in the semideciduous forest have evolved at either the diploid or at the polyploid level: genera which contain diploid species have few or no polyploids and those which contain polyploid species have few or no diploids. Furthermore, in the latter

TABLE I: Summary of cytological results.

NAME	VOUCHER NUMBER	GAMETIC CHROMOSOME NUMBER	PLOIDY LEVEL	PREVIOUS REPORT
FAGACEAE				
****Quercus oleoides*** Cham. & Schlecht.	119	12	diploid	
ULMACEAE				
****Trema micrantha*** (L.) Blume	252	10	diploid	
MORACEAE				
Cecropia peltata L.	265	14	diploid	$2n = 28$: Krause, 1931
PROTEACEAE				
***Roupala complicata* HBK.	269	14	tetraploid	
OLACACEAE				
***Ximenia americana* L.	169	13	?	
POLYGONACEAE				
****Triplaris americana* L.	239	11	diploid	
ANNONACEAE				
****Annona purpurea*** Moc. & Sessé	247	7	diploid	
****A. reticulata* L.	202	7	diploid	
Sapranthus palanga R. E. Fries	142	9	diploid	
LAURACEAE				
****Ocotea veraguensis* Mez	127	12	diploid	

TABLE I: Summary of cytological results. (*Continued*)

NAME	VOUCHER NUMBER	GAMETIC CHROMOSOME NUMBER	PLOIDY LEVEL	PREVIOUS REPORT
CAPPARACEAE				
***Crataeva tapia* L.	240	13	?	
LEGUMINOSAE: Mimosoideae				
Enterolobium cyclocarpum (Jacq.) Griseb.	170	13	diploid	$2n = 26$: Atchison, 1951
***Pithecolobium racemiflorum* Donn. Smith	270	13	diploid	
P. saman (Jacq.) Benth.	195	13	diploid	$2n = 26$: Atchison, 1951 Simmonds, 1954
LEGUMINOSAE: Caesalpinioideae				
Cassia biflora L.	165	14	tetraploid	$2n = 28$: Irwin & Turner, 1960
Hymenaea courbaril L.	168	12	diploid	$2n = 24$: Atchison, 1954; Berger *et al.*, 1958
LEGUMINOSAE: Papilionoideae				
Andira inermis (Swartz) HBK.	129	11	diploid	$2n = 20$: Atchison, 1951
***Dalbergia retusa* Hemsl.	191	10	diploid	
***Lonchocarpus costaricensis* (Donn. Smith) Pittier	184	11	diploid	
***L. eriocarinalis* Micheli	190	11	diploid	
***L. guatemalensis* Benth.	261	11	diploid	
***L. nitidus* (Vog.) Benth. complex	216	11	diploid	
Piscidia carthagenensis Jacq.	264	10	diploid	$2n = 22$: Atchison, 1951
***Platymiscium pleiostachyum* Donn. Smith	271	9	diploid	
***Pterocarpus rohrii* Vahl	125	10	diploid	
SIMAROUBACEAE				
**Simarouba glauca* DC.	110	16	tetraploid	
BURSERACEAE				
***Bursera simarouba* (L.) Sarg.	268	12	diploid	
***B. tomentosa* (Jacq.) Tr. & Planch.	211	12	diploid	
MELIACEAE				
***Trichilia arborea* C. DC.	272	25	tetraploid	
MALPIGHIACEAE				
Byrsonima crassifolia (L.) HBK.	118	12	tetraploid?	$2n = 20$: Nanda, 1962 $2n = 24$: Fouët, 1966
Malpighia glabra L.	163	10	diploid?	$2n = 40$: Pal, 1964
EUPHORBIACEAE				
**Bernardia nicaraguensis* Standl. & L. O. Williams	177	26	tetraploid	
Garcia nutans Rohr	259	33	hexaploid	$2n = 36$: Miller & Webster, 1966
Hura crepitans L.	221	22	tetraploid	$2n = 36$: Miège, 1962 $2n = 44$: Datta, 1967
ANACARDIACEAE				
Spondias mombin L.	183	16	tetraploid	$2n = 32$: Simmonds, 1954

TABLE I: Summary of cytological results. (*Continued*)

NAME	VOUCHER NUMBER	GAMETIC CHROMOSOME NUMBER	PLOIDY LEVEL	PREVIOUS REPORT
HIPPOCRATEACEAE				
**Hemiangium excelsum* (HBK.) A. C. Smith	156	30	tetraploid	
SAPINDACEAE				
**Allophylus occidentalis* (Swartz) Radlk.	210	14	tetraploid	
**Cupania americana* L.	108	16	tetraploid	
**Thouinidium decandrum* (Humb. & Bonpl.) Radlk.	133	ca. 14	tetraploid	
ELAEOCARPACEAE				
**Muntingia calabura* L.	120	14	tetraploid	
**Sloanea terniflora* (Moc. & Sessé) Standl.	149	13	tetraploid	
TILIACEAE				
**Apeiba tibourbou* Aubl.	205	18	tetraploid	
Luehea candida (Moc. & Sessé) Mart. & Zucc.	198	18	tetraploid	$2n = 36$: Gadella *et al.*, 1969
BOMBACACEAE				
Bombacopsis quinata (Jacq.) Dugand	106	46	decaploid?	$2n = 72$: Baker & Baker, 1968
Ochroma pyramidale (Cav. ex Lam.) Urban	145	45	decaploid?	$2n = 72, 78, 88$: Baker & Baker, 1968

***Pseudobombax septenatum* (Jacq.) Dugand	141	ca. 44	decaploid?	
STERCULIACEAE				
Guazuma tomentosa HBK.	132	8	diploid	$2n = 16$: Youngman, 1931
***Sterculia apetala* (Jacq.) Karst.	187	20	tetraploid	
DILLENIACEAE				
**Curatella americana* L.	116	ca. 12	diploid	
OCHNACEAE				
***Ouratea wrightii* Riley	185	13	diploid	
MYRSINACEAE				
***Ardisia revoluta* HBK.	162	23	tetraploid	
THEOPHRASTACEAE				
Jacquinia aurantiaca Ait.	111	18	tetraploid	$2n = 36$: Faure, 1968
SAPOTACEAE				
***Manilkara zapota* (L.) P. van Royen	214	12	diploid	
**Mastichodendron capiri* Cronquist var. *tempisque* (Pittier) Cronquist	146	11	diploid	
EBENACEAE				
***Diospyros nicaraguensis* Standl.	204	15	diploid	
STYRACACEAE				
***Styrax argenteus* Presl	114	8	diploid	

TABLE I: Summary of cytological results. (*Continued*)

NAME	VOUCHER NUMBER	GAMETIC CHROMOSOME NUMBER	PLOIDY LEVEL	PREVIOUS REPORT
APOCYNACEAE				
Plumeria rubra L. var. *acutifolia* Poir.	167	18	tetraploid	$2n = 36$: Singh, 1954; Tapadar & Sen, 1960; Nanda, 1962
**Stemmadenia donnell-smithii* (Rose) Woodson	176	19	tetraploid	
BORAGINACEAE				
**Bourreria quirosii* Standl.	148	19	?	
Cordia alliodora (Ruiz & Pav.) Cham.	105	15	tetraploid	$2n = 72$: Britton, 1951
***C. collococca* Sond.	199	14	tetraploid	
***C. dentata* Poir.	229	24	hexaploid	
***C. panamensis* Riley	217	14	tetraploid	
***C. inerma* (Mill.) Johnston	223	14	tetraploid	
BIGNONIACEAE				
Tabebuia rosea (Bertol.) DC.	126	20	diploid	$2n = 40$: Venkatasubban, 1944
T. palmeri Rose	273	20	diploid	$2n = 40$: Pathak *et al.*, 1949

* Genera investigated for the first time.
** Species investigated for the first time.

TABLE II: **Frequency of polyploid species in woody genera of a lowland tropical semideciduous forest in Costa Rica.**[1,2]

NAME	BASIC NUMBER	NUMBER OF DIPLOID SPECIES	NUMBER OF POLYPLOID SPECIES
Piper	13	7	6
Annona	7	7	2
Bauhinia	7	—	15
Cassia	7	31	84
Caesalpinia	12	20	—
Acacia	13	66	27
Albizia	13	13	2
Pithecolobium	13	8	1
Lonchocarpus	11	13	1
Pterocarpus	11	7	2
Zanthoxylum	9?	—	6
Trichilia	14	1	8
Cedrela	12?	—	8
Malpighia	10	4	1
Margaritaria	7	2	19
Sterculia	10	—	9
Ouratea	12	12	1
Eugenia	11	8	7
Ardisia	—	1	6
Diospyros	15	13	6
Plumeria	9	—	5
Cordia	8	—	15
Tabebuia	20	10	—
Psychotria	11	16	2

[1] Based on chromosome counts reported in Bolkhovskikh *et al.* (1969).

[2] Only those genera in which chromosome counts for more than five species are known are tabulated.

group of genera, within a genus most species usually have the same ploidy level.

Polyploid series within species are also not common, but rarely have tropical tree species been subjected to the sort of intensive studies that are necessary to reveal intraspecific variability in chromosome numbers; in most species investigated to date, chromosome counts have been based on the study of few individuals. Among species mentioned in this report, *Cordia alliodora*, *Ochroma pyramidale*, *Bombacopsis quinata* and *Pseudobombax septenatum* appear to have polyploid series (TABLE I). The reasons for the low frequency of polyploid series have been pointed out by Stebbins (1971), and need not be elaborated upon here.

SUMMARY

This paper reports chromosome numbers of tree species of a lowland tropical semideciduous forest in Costa Rica. A total of 66 species in

56 genera from 32 families were investigated, chromosome counts for 45 species and 16 genera were made for the first time. A common feature of most species is the high basic number; in 48 out of 56 genera, the basic number is $x = 11$ or more. Such numbers are probably of polyploid derivation. However, although the frequency of polyploids among tropical woody taxa is high, polyploid series within genera and species are rare.

ACKNOWLEDGMENTS

Funds for the field work were made available by a grant (F 69/16) from the Organization for Tropical Studies. The draft of the manuscript was prepared while the author held a Fellowship funded by the Bullard, Cabot, and Atkins Foundations of Harvard University. I thank H. G. Baker, B. G. Schubert, O. T. Solbrig, and R. F. Stettler for their comments on the manuscript. The cooperation of G. W. Frankie, G. H. Hartshorn, and P. A. Opler in collection of material is acknowledged. J. Dwyer and W. H. Hatheway helped in the identification of voucher specimens. Laboratory facilities for some of the work were provided by R. Rodriguez of the University of Costa Rica.

LITERATURE CITED

ATCHISON, E. 1951. Studies in the Leguminosae VI. Chromosome numbers among tropical woody species. Am. Jour. Bot. **38:** 538–546.

BAKER, H. G., & I. BAKER. 1968. Chromosome numbers in the Bombacaceae. Bot. Gaz. **129:** 294–296.

BAWA, K. S. 1973. Breeding systems of tree species of a lowland tropical community. Evolution (in press).

BERGER, C. A., E. R. WITKUS, & R. M. MCMAHON. 1958. Cytotaxonomic studies in the Leguminosae. Bull. Torrey Bot. Club. **85:** 405–414.

BOLKHOVSKIKH, Z., V. GRIF, T. MATVEJEVA, & O. ZAKHARYEVA. 1969. Chromosome numbers of flowering plants. Komarov Botanical Institute, Leningrad. 996 pp.

BORGMANN, E. 1964. Anteil der Polyploiden in der Flora des Bismarcksgebirges von Ostneuguinea. Bot. Zeitschr. **52:** 118–173.

BRITTON, D. M. 1951. Cytogenetic studies on the Boraginaceae. Brittonia **7:** 233–266.

CATINOT, R. 1972. Biological and economic opportunities and limitations to the manipulations of the tropical forest ecosystem. Proc. Seventh World Forestry Congress. Buenos Aires, Argentina (in press).

DATTA, N. 1967. In IOPB chromosome number reports XII. Taxon **16:** 344–349.

DAUBENMIRE, R. 1972. Phenology and other characteristics of tropical semideciduous forest in northwestern Costa Rica. Jour. Ecol. **60:** 147–170.

DESAI, S. 1960. Cytology of Rutaceae and Simarubaceae. Cytologia **25:** 28–35.

EHRENDORFER, F., F. KRENDEL, E. HABLER, & W. SAUER. 1968. Chromosome numbers and evolution in primitive angiosperms. Taxon **17:** 337–353.

FAURE, P. 1968. Contribution a l'étude caryo-taxinomique des Myrsinaceae et des Theophrastaceae. Mém. Mus. Nat. Hist. Naturelle, Ser. B. **18:** 37–58.

FEDOROV, A. A. 1966. The structure of tropical rain forest and speciation in the humid tropics. Jour. Ecol. **54:** 1–11.

FOUËT, M. 1966. Contribution à l'étude cyto-taxonomique des Malpighiacées. Adansonia **6:** 457–505.

GADELLA, T. W. J., E. KLIPHUIS, J. LINDEMAN, & E. A. MENNEGA. 1969. Chromosome numbers and seedling morphology of some Angiospermae collected in Brazil. Acta. Bot. Neerl. **18:** 74–83.

GRANT, V. 1963. Origin of adaptations. Columbia Univ. Press, New York. 606 pp.

———. 1971. Plant speciation. Columbia Univ. Press, New York. 435 pp.

HANELT, V. P. 1966. Polyploidie — Frequenz und geographische Verbreitung bei höheren Pflanzen. Biol. Rundschau **4:** 185–196.

HANS, A. S. 1972. Cytomorphology of arborescent Moraceae. Jour. Arnold Arb. **53:** 216–225.

HOLDRIDGE, L. R., W. C. GRENKE, W. H. HATHEWAY, T. LIANG, & J. A. TOSI, JR. 1971. Forest environments in tropical life zones: a pilot study. Pergamon Press, New York. 747 pp.

IRWIN, H. S., & B. L. TURNER. 1960. Chromosomal relationships and taxonomic considerations on the genus *Cassia*. Am. Jour. Bot. **47:** 309–318.

KRAUSE, O. 1931. Zytologische Studien bei den Urticales unter besonderer Berücksichtigung der Gattung *Dorstenia*. Planta **13:** 29–84.

KYHOS, D. W. 1966. *In*: Documented chromosome numbers of plants. Madroño **18:** 245, 246.

LEWIS, K., & B. JOHN. 1963. Chromosome marker. Little, Brown & Co., Boston. 489 pp.

LÖVE, A., & D. LÖVE. 1967. Polyploidy and altitude: Mt. Washington. Biol. Zentralblatt **86** (supplement): 307–322.

MANGENOT, S., & G. MANGENOT. 1962. Enquète sur les nombres chromosomiques dans une collection d'espèces tropicales. Rév. Cytol. et Biol. Vég. **25:** 411–447.

MEHRA, P. N., & K. S. BAWA. 1969. Chromosomal evolution in tropical hardwoods. Evolution **23:** 466–481.

MIÈGE, J. 1962. Quatrième liste de nombres chromosomiques d'espèces d'Afrique Occidentale. Rév. Cytol. et Biol. Vég. **24:** 149–164.

MILLER, K. I., & G. L. WEBSTER. 1966. Chromosome numbers in the Euphorbiaceae. Brittonia **18:** 372–379.

NANDA, P. C. 1962. Chromosome numbers of some trees and shrubs. Jour. Indian Bot. Soc. **4:** 271–277.

PAL, M. 1964. Chromosome numbers in some Indian angiosperms I. Proc. Indian Acad. Sci. **60:** 347–350.

PATHAK, G. N., B. SINGH, K. M. TIWARI, A. N. SRIVASTAVA, & K. K. PANDE. 1949. Chromosome numbers in some angiospermous plants. Curr. Sci. **18:** 347.

SHARMA, A. K., & A. SHARMA. 1965. Chromosome techniques: theory and practice. Butterworths, London. 474 pp.

SIMMONDS, N. W. 1954. Chromosome behaviour of some tropical plants. Heredity **8:** 139–146.

SINGH, B. 1951. Chromosome numbers in some flowering plants. Curr. Sci. **20:** 105.

SOLBRIG, O. T. 1972. Cytology and cytogenetics of shrubs. pp. 123–137. *In*: MCKELL, C. M., J. M. BLAISDELL, & J. R. GOODIN (*Eds.*). Wildland Shrubs

— their biology and utilization. Intermountain Forest and Range Experiment Station, U.S. Dept. Agric. Ogden, Utah.
STEBBINS, G. L., JR. 1971. Chromosomal evolution in higher plants. Addison-Wesley, Reading, Massachusetts. 216 pp.
STYLES, B. T., & C. G. VOSA. 1971. Chromosome numbers in the Meliaceae. Taxon **20:** 485–499.
TAPADAR, N. N. R., & N. K. SEN. 1960. Cytotaxonomical studies on the economic plants of the family Apocynaceae. Caryologia **12:** 367–397.
VENKATASUBBAN, K. R. 1944. Cytological studies in Bignoniaceae. Annamali Univ. Publ. **1, 2,** and **3:** 1–207.
WET, J. M. J. DE. 1971. Polyploidy and evolution in plants. Taxon **20:** 29–35.
YOUNGMAN, W. 1931. Studies on the cytology of Hibisceae II. The behaviour of the nucleus during cell division in the root-tip of *Thespesia populnea* and comparative observations of the phenomenon in related plants. Ann. Bot. **45:** 49–72.

GRAY HERBARIUM
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138

THE ENUMERATIO AND SELECTARUM OF NICOLAUS VON JACQUIN

Richard A. Howard

In his introductions to the facsimile editions of Jacquin's *Enumeratio Systematica Plantarum*, 1760 (Sertum Botanicum V, 1967) and *Selectarum Stirpium Americanarum Historia*, 1763 (Hafner Publ. 1971), Frans Stafleu has supplied biographical and bibliographical information on Nicolaus Jacquin, and on these two important early volumes which concern the nomenclature of many common plants of the Caribbean area. Stafleu emphasizes that the two volumes must be studied together, for the *Enumeratio* is to be regarded as a "Prodromus" to the *Selectarum* in which many of the species are given more ample descriptions and localities of origin or are illustrated. All too often in modern botanical work the place of publication of Jacquin's names is given as the *Selectarum* with the date 1763, when the correct citation is the *Enumeratio* published in 1760. A survey of the two volumes, with emphasis on the taxa mentioned in the *Enumeratio*, reveals that many of the binomials are not in use today either for accepted species, or as basionyms or synonyms. For others, Jacquin illegitimately substituted a new name in the *Selectarum* or reduced his own name to the synonymy of an earlier published name of Linnaeus, Loefling, Guettard, or Miller.

In this paper I have attempted to give modern equivalents of all of the names used in Jacquin's *Enumeratio*, including corrected citations when necessary. Although many of the plants described are common in the Caribbean area, only a very few names can be typified by association with specimens collected by Jacquin. Some names can be typified by an illustration in the *Selectarum*. Hopefully this listing will lead monographers and curators to search for additional holotype specimens rather than to designate neotypes as many are doing.

Jacquin was a student of medicine in Vienna in 1752. Stafleu relates that during this period "Jacquin's botanical interests remained alive, certainly also because of the rich collections in the imperial gardens at Schoenbrunn. Franz I of Austria, who took great interest in botany, and especially in his garden, became acquainted with Jacquin and considered him the right man to send on a collecting trip to the West Indies. Jacquin was to collect plants and animals for the Schoenbrunn garden and for the Hof-Naturalien-Cabinet. The plants were to be mainly living plants. . . ." The party of which Jacquin was a member arrived in Martinique on June 28, 1755, and during a four-year stay visited St. Vincent, Grenada, Curaçao, Aruba, Venezuela, and Colombia to the south, and Guadeloupe, St. Kitts, St. Eustatius, St. Maarten, St. Barthelemy, "Domingo" (being Haiti and the Dominican Republic) and Cuba, before leaving in January, 1759, for

Austria via Spain. Jacquin reached Vienna again in July of 1759. Stafleu reported "The consignments of living plants had been considerable; herbarium material was scanty, but many drawings and descriptions had been made on the spot." As the material grew at the Schoenbrunn gardens, Jacquin made or had made additional sketches which were to be published.

The *Enumeratio* was published in 1760 in Leiden. The exact date cannot be determined with certainty. Rothmaler, according to Stafleu, without citing proof, fixes the date as 15 May 1760. Stafleu concluded that this is a reasonable but arbitrary date which cannot be followed in the absence of supporting information. He also quotes a letter, dated Aug. 17, 1760, from Gronovius to Linnaeus, indicating that Gronovius was expediting the work and was "expecting publication" at any time. One can conclude from the nature of the *Enumeratio* that Jacquin was anxious to report on the many plants he saw and to indicate the ones that were new, possibly to bring credit to his sponsor and the Schoenbrunn gardens. Hence, the concise *Enumeratio* was published and was followed by the more elaborate treatment of the *Selectarum*.

Stafleu freely translated the Preface of the *Selectarum* and indicated that Jacquin said in effect: "At every step we found plants described by our predecessors, and others that were new . . . . I have therefore given special attention to genera in which new or rare species deviate from the commonly accepted concept. My descriptions are usually based on more than one individual, in order to avoid regarding fortuitous details as characteristics. All descriptions are based on living material and drawn up with the greatest possible care." Many of the genera in Jacquin's works, therefore, appear to be new contributions and many are indeed quite different in circumscription from those of the same name published earlier by others.

The primary difficulty of working with the *Enumeratio* is the brevity of the specific descriptions which are occasionally only one word or a symbol. When these taxa have been considered in the *Selectarum*, the descriptions are ample; bibliographic references are often supplied; and many are illustrated. Nevertheless, some problems of recognition will be settled only by reference to a specimen, and very few have been located in the years subsequent to Jacquin's publications. The history of the Jacquin herbarium specimens has been given by Stafleu (Taxonomic Literature, Reg. Veg. 52: 230. 1967; Enumeratio iii. facsimile ed. Introduction. 1967). More recently D'Arcy (Taxon 19(4): 554–560. 1970) has described his quest for authentic material. In searching monographic literature for the preparation of this listing, only a dozen references to types have been found with the specimens, mostly described as fragments, in London (BM), Vienna (W), and Budapest (BP).

Although Jacquin followed the binomial nomenclature of Linnaeus and arranged his volumes in accordance with the sexual system, he was not consistent in accepting Linnaeus's names. In the *Enumeratio* Jacquin cited *Species Plantarum* and *Systema Naturae* of Linnaeus; Loefling's *Iter Hispanica*, which should also be credited to Linnaeus; and Browne's

Natural History of Jamaica. It is possible that Jacquin had with him on his travels the *Species Plantarum*, and perhaps he had access to Browne's work. Loefling's report, however, was published by Linnaeus in December of 1758 while Jacquin was in the West Indies, and the *Systema* was published from May to June, 1759, while Jacquin was en route home. If Jacquin truly made original sketches and possibly descriptions in the field, it must have been a shock to him to receive Loefling's *Iter Hispanica* and Linnaeus's *Systema* after his return and to find that many of the plants he thought were new had been described only a few months earlier. Perhaps for this reason Jacquin was not consistent in citing Linnaeus's names for species for which both authors cited earlier references of Browne or Catesby or others.

In the second edition of *Species Plantarum*, published in 1762, Linnaeus referred by number to plates of Jacquin's *Selectarum*, published in 1763. This was noted by Sargent (Garden and Forest 3: 260. 1890), who suspected some error, but as Stafleu (Select. [facsimile] F13. 1971) noted, many of the plates were sent to Linnaeus who expressed his opinion, usually approval, before the entire work left the printer for distribution. An excellent example of the possible difference of opinion of these two men is the publication of *Burseria* by Jacquin and *Bursera* by Linnaeus. Jacquin's failure to cite Linnaeus's work consistently in the *Enumeratio* presents problems in nomenclature, and examples are found in *Swietenia mahagoni*, *Casearia nitida*, and species of *Anguria*.

In 1759 Linnaeus (Syst. ed. 10. 940. 1759) published *Cedrela Mahag.* and cited "*Catesb. car. 2.t.*81," which is a description and illustration of the Mahogony of the Bahamas. Clearly "Mahag." is an abbreviation, and the ending Linnaeus wished to use is uncertain. In 1760 Jacquin (Enum. 20. 1760) published *Swietenia mahagoni*, also based on "*Catesb. Car. 2. t.* 81." A literal interpretation of Art. 63 of the International Code of Botanical Nomenclature suggests that *Swietenia mahagoni* is illegitimate, being superfluous, since the name is based on the same type as that of Linnaeus. If Linnaeus intended his name to be *Cedrela "mahagoni"* then the specific epithet cannot be transferred to *Swietenia*. Recent workers (Styles, Jour. Oxford Univ. Forest. Soc. ser. 6. 4: 17–20. 1968; Adams, Flowering Plants of Jamaica 394. 1972) have assumed that Jacquin was making a new combination, and cite the binomial as *Swietenia mahagoni* (L.) Jacq. 1760. It is only by assuming that Jacquin, having cited Linnaeus's *Systema* elsewhere in the *Enumeratio*, intended to do so here, that the *Enumeratio* of 1760 can be regarded as the place of publication of the combination.

In view of the historic and broad use of the name *Swietenia mahagoni*, and the turmoil that would result from a change of name due to a strict application of the rules of nomenclature, it seems appropriate to accept the intention of Jacquin to make a new combination and disregard his oversight in not citing the basionym.

A comparable situation concerns *Samyda nitida* L. and *Casearia nitida* Jacq. Fortunately this species or these species are not of economic im-

portance. Linnaeus (Syst. ed. 10. 1025. 1759) published *Samyda nitida* citing *Brown., jam.* 217. *n.* 1. The following year Jacquin published *Casearia nitida* (Enum. 21. 1760) also citing *Brown. jam.* 1. p. 217. According to Article 63 the Jacquin name is illegitimate, being superfluous, and the Linnaean specific epithet cannot be transferred to *Casearia*. The combination *Casearia nitida* (L.) Jacq. (e.g. Adams, Flowering Plants of Jamaica 488. 1972) is at best an implied combination. In the *Selectarum* (p. 132. 1763) Jacquin supplied a more elaborate description; gave Cartagena as the area of origin; and cited "*Brown. jam.* 1 *p.* 217. *t.* 23. *f.* 3?" suggesting that his plant from South America may not be the same as the Browne collection from Jamaica. This remains a problem for a monographer of *Casearia* for it appears that *Samyda nitida* is a *Casearia* and requires a new name, as does *Casearia nitida* of Jacquin.

Anguria Jacq. is a later homonym of *Anguria* Miller. The species Jacquin cited bear the same epithets as those used by Linnaeus, and are based on the same references. No problem arises as the species must be transferred to the genus *Psiguria*.

It has been generally stated, as it was by Stafleu, that Jacquin "for unknown reasons did not refer to the 1760 publication of his new taxa in his *Historia*." Although Jacquin did not give page references to the *Enumeratio* in the *Selectarum*, he did refer to the *Enumeratio* by title under *Byttneria* (Select. p. 77) and to his treatment of taxa described in the *Enumeratio* under *Cynanchum* (Select. p. 83), *Burseria* (Select. p. 95), and *Axyris* (Select. p. 245).

In making a systematic survey of the names published in the *Enumeratio*, a modern usage of Jacquin's binomials has been found for all but the following species.

Brunfelsia spinosa — without location
Cordia juglandifolia — Domingo
Helicteres barbadensis — locality uncertain
Helicteres carthagenensis — Cartagena
Laetia completa — Cartagena
Loranthus biracemosus — Houstoun collection without location
Loranthus pedunculatus — Cartagena
Loranthus sessilis — Cartagena
Melastoma septemnervia — Martinique
Mimosa retusa — Cartagena
Myrtus triflora — Cartagena
Petesia tomentosa — Cartagena
Phaseolus sclareodes — Havana, Cuba
Rondeletia disperma — Baru and Tierra Bomba, Cartagena
Scoparia procumbens — Cartagena
Tetragonotheca parviflora — without location
Vicia disticha — without location

For each of these an equivalent, often cited with a question mark, was given in the initial volumes of *Index Kewensis*. Some have been mentioned subsequently by monographers as unrecognized or unplaced names. The

proper disposition of these species names appears to depend on the location of authentic herbarium specimens collected or distributed by Jacquin.

In the *Enumeratio* Jacquin published 71 new genera or elaborated generic descriptions. Of these, 21 are now considered as previously published by Linnaeus in *Species Plantarum* (1753) and one in the *Systema* (1759). Two are now placed in the synonymy of earlier Linnaean names. One of Jacquin's generic names was published earlier by Linnaeus–Loefling (1758); three others are synonyms of Loefling names, and one is a synonym of a genus published by Guettard. One generic name was published earlier by Miller (1754); two are rejected as later homonyms of Miller names; and six are now attributed to Browne (1756). Four of Jacquin's generic names are *nomina rejicienda* in favor of other conserved names.

Twenty-three of Jacquin's genera are recognized as validly published in the *Enumeratio*. In addition, four of Jacquin's generic names have been conserved, two over names of Linnaeus (1759), one over a name of Loefling (1758), and one over a name of Miller (1754). Two other genera described by Jacquin have been conserved with corrected spellings.

Geographic locations for the species published in the *Enumeratio* generally can be found in the *Selectarum*. The majority of the species were collected near Cartagena, Colombia, in the specific locations of Baru and Tierra Bomba. Collections made on Curaçao, Grenada, and St. Eustatius are without specific localities. On Martinique, Jacquin gathered material at "Case Pilote" = Case-Pilote, "Roberti" = le Robert, "Sancti Francisci" = le François, "Divi Petri" = St. Pierre, "Montio Calebasse" = Morne Calebasse, "Carbet" = le Carbet, and "Rivière Capot" = Rivière Capot. The specific locations of "Philippsi" = Filipsburg, St. Martin; Kingston, and "San Jago de la Vega" = Spanishtown, Jamaica, and Havana, Cuba, were given. Jacquin's collections from "Domingo," now known as Hispaniola or Haiti, and the Dominican Republic, were made at Cap Français (near Cap Haitien) and Jacquesi (between Cap Haitien and Fort Liberté) on the northern coast, at Leogane on the southern peninsula, and at "Porto Principis" = Port au Prince. One "Domingo" location given by Jacquin as "Bayaha" is listed in old geographies as a locality in the southwestern part of the Dominican Republic and may be Barahona or near that town.

In compiling the list of equivalents which follows, I have been aided significantly by the work of the late Armando Dugand of Colombia. In 1966, Dugand (Caldasia 9(45): 400. 1966) wrote "Más tarde publicaré, Dios mediante, un catálogo de todas las especies cartageneras de Jacquin, citando en primer lugar el nombre con que él las dio a conocer al mundo científico; y dando además el nombre técnico que hoy tienen o deben llevar conforme a los estudios taxonómicos que se han publicado desde la época de Jacquin hasta la nuestra. Si llegara a publicarse esta obrita llevará por título *Plantae Jacquinianae Carthagenenses*, en homenaje a la memoria del primer botánico de renombre que pisó tierra de Colombia y dio a reconocer una parte pequeña pero interesante de nuestra rica flora." Regrettably, Dr. Dugand did not live to complete his studies, so it remains

for some botanist familiar with the coastal flora of Colombia to locate the plants of the Cartagena region that Jacquin collected and named, which were beyond the scope of the present study.

A final word of appreciation to the several correspondents who helped on various aspects of this study, with particular gratitude to my colleague, Dr. Leslie Garay, for his generous help with the unusually difficult Latin employed by Jacquin.

The species of Jacquin's *Enumeratio*, alphabetically arranged with modern equivalents.[1]

ACALYPHA CARTHAGENENSIS, Enum. *32*; Select. *253*. *t. 180*, *f. 57*. Cartagena = **Acalypha carthagenensis** Jacq.

ACALYPHA CORENSIS, Enum. *32*; Select. *254*. *t. 161*. Domingo, Martinique, Venezuela = **Bernardia corensis** (Jacq.) Müll.-Arg.

ACALYPHA VILLOSA, Enum. *32*; Select. *254*. *t. 183*, *f. 61*. Cartagena = **Acalypha villosa** Jacq.

ACHYRANTHES ALTISSIMA, Enum. 17, citing *Sloane Jam. t.* 91, *f. 2*; Select. 81. Not illustrated. Domingo = **Chamissoa altissima** (Jacq.) H.B.K.

AGAVE HEXAPETALA, Enum. 18; Select. 100. *t. 175*, *f. 28*, renamed *Agave cubensis*. Cuba = **Furcraea hexapetala** (Jacq.) Urb.

ALPINIA SPICATA, Enum. 11; Select. 1. *t. 1*. Martinique = **Costus spicatus** (Jacq.) Sw.

AMERIMNON, Enum. 7 = **Dalbergia** L. f. Conserved name.

AMERIMNON BROWNII, Enum. *27*, citing *Brown. Jam.* I. *p.* 288; Select. 199. *t. 180*, *f. 58*, as "brownei." Cartagena, Jamaica, Domingo = **Dalbergia brownei** (Jacq.) Urb.

AMYRIS, Enum. 3 = **Amyris** P. Br. (1756).

AMYRIS MARITIMA, Enum. 19; Select. 107. Not illustrated. Havana, Cuba = **Amyris maritima** Jacq.

ANACARDIUM, Enum. 4 = Anacardium L. (1753).

ANACARDIUM OCCIDENTALIS, not in Enum.; Select. 124. *t. 181*, *f. 35*. Caribaeis & Continente = **Anacardium occidentalis** L.

ANGURIA, Enum. 9, not *Anguria* Miller 1754 = **Psiguria** Arn. ex Hook. Jour. Bot. 3: 247. 1841.

Although *Anguria* Miller is a *nomen rejiciendum*, *Anguria* Jacq. con-

[1] Throughout the list which is presented here references to "Enum." or "Select." followed by a page number and the word "citing" indicate an exact quotation, including typography. This accounts for the Roman numeral one which appears frequently in an otherwise Arabic sequence, e.g., 192, 1074.

tinues to be used in various floras of the Caribbean area. Jeffrey (Kew Bull. 16: 197, 198. 1962) considered the need to conserve *Anguria* Jacq. but pointed out alternate action involving a careful study of *Anguria* Jacq. and *Gurania* Cogniaux. He concluded by noting "there are at present more binomials available under *Gurania* than under *Anguria* itself and it could be substituted for *Anguria* Jacq. without great inconvenience." In a footnote Jeffrey also indicated that "conservation over *Psiguria* Arn. . . . which has no binomials . . . would be necessary." Both Airy Shaw (Dictionary of Flowering Plants 64. 1966) and Dandy (Reg. Veg. 51: 27. 1967) indicated subsequently the equivalence of *Psiguria* Arn. ex Hook. with *Anguria* Jacq. Although no combinations exist in *Psiguria* three are here proposed for species mentioned by Jacquin as *Anguria*. Many additional species remain in need of new combinations in *Psiguria*.

ANGURIA PEDATA, Enum. 31, citing *Plum. ic.* 23; Select. 242. *t. 155*, citing *Linn. syst. E. p.* 1279.

Linnaeus (Syst. Nat. ed. 10. 1279. 1759.) described *Cucumis pedatus* citing *Plum. ic.* 23. *Anguria pedata* Jacq. based on the same type is illegitimate, being superfluous when published in 1760 or to be considered as a new combination when published in 1763. Schlechtendal (Linnaea 24: 711–715. 1851) concluded that two plants were involved, and described *Anguria polyphyllos* typified by "Plum. pl. Amer. ed. Burm. p. 13. t. 23" and *Anguria dentata* Schldl. based on Jacquin, "sel. Amer. stirp. hist. p. 243. t. 155, exclus. syn. omn." and typified by a collection from Santo Domingo illustrated by Jacquin.

Cogniaux (Pflanzenreich IV. 275(1): 180. 1916) recognized *Anguria pedata* Jacq. with varieties *dentata* (Schlechtd.) Cogn. and *polyphyllos* (Schlechtd.) Cogn., citing a Jacquin collection under the former and the Plumier reference for the latter. Moscoso (Cat. Flor. Domingensis 640. 1943) did not recognize all of the varieties. The correct name for the species should be **Psiguria pedata** (L.) R. A. Howard, comb. nov. BASIONYM: *Cucumis pedatus* L. Syst. Nat. ed. 10. 1279. 1759. TYPE: Plumier, Pl. Amer. ed. Burm. p. 13. *pl. 23.*

ANGURIA TRILOBATA, Enum. 31, citing *Plum. ic.* 22; Select. 243. *t. 156*, citing *Linn. syst. B. p.* 1279. Cartagena.

The difficulty here is comparable to the problem of the preceding species with additional complications. Linnaeus described *Cucumis trilobatus* based on Plumier ic. 22. *Anguria trilobata* Jacq. based on the same type is illegitimate, being superfluous in 1760, or to be considered a new combination as published in 1763 if the earlier work is ignored.

Schlechtendal (Linnaea 24: 708–710. 1851) considered the treatments of Jacquin to involve two species, one in Hispaniola and one in Colombia. He described *Anguria Jacquiniana* Schldl. based on "*A. trilobata* Jacq. sel. Amer. stirp. hist. p. 243. t. 156 (excl. syn. omn.)" and noted "Habitata Carthagenae in sylvis montis de la Popa. Junio mascula planta floret.

(Jacquin coll.)." For the Plumier plant from the Antilles Schlechtendal (l.c. 709) applied the new name *Anguria Plumieriana* Schldl.

Cogniaux (Pflanzenreich IV. 275(1)(Heft 66): 188, 189. 1916) altered the work of Schlechtendal. He accepted *A. trilobata* Jacq. listing *A. Jacquiniana* Schldl. as a synonym and cited a Jacquin specimen as in Herb. Brit. Mus. from "Popa-Berg bei Carthagena" in Colombia. He also accepted *A. Plumieriana* Schldl. with the Plumier polynomial and *plate 22* cited, and listed collections from the Antilles and Colombia.

The correct names of the two species are: **Psiguria trilobata** (L.) R. A. Howard, comb. nov. BASIONYM: *Cucumis trilobatus* L. Syst. Nat. ed. 10. 1279. 1759. TYPE: Plumier, Pl. Amer. ed. Burm. *pl. 22*; and **Psiguria jacquiniana** (Schldl.) R. A. Howard, comb. nov. BASIONYM: *Anguria jacquiniana* Schldl. Linnaea 24: 708. 1851. TYPE: *Jacquin s.n.* (BM, not seen), Colombia.

AQUARTIA, Enum. 1 = **Solanum** L. (1753).

AQUARTIA ACULEATA, Enum. 12; Select. 15. *t. 12*. Domingo = **Solanum aculeatum** (Jacq.) Schulz.

ARALIA CAPITATA, Enum. 18; Select. 89. *t. 111*. Martinique = **Oreopanax capitata** (Jacq.) Dcne. & Planch.

ARISTOLOCHIA ANGUICIDA, Enum. 30; Select. 234. *t. 146*. Cartagena = **Aristolochia anguicida** Jacq.

ARISTOLOCHIA CAUDATA, Enum. 30; Select. 233. *t. 145*. Cap Français, Haiti = **Aristolochia caudata** Jacq.

ARISTOLOCHIA MAXIMA, Enum. 30; Select. 233. *t. 146*. Cartagena = **Aristolochia pentandra** Jacq.

ARISTOLOCHIA PENTANDRA, Enum. 30; Select. 233. *t. 147*. Havana = **Aristolochia pentandra** Jacq.

ARUM HEDERACEUM, Enum. 31, citing *Plum. Amer. t.* 51. *fig. d.*; Select. 240. *t. 152*. Cartagena = **Philodendron hederaceum** (Jacq.) Schott.

ARUM SEGUINE, Enum. 31, citing *Plum. Amer. t.* 51. *f. b.*; Select. 239. *t. 151*. Caribaeis = **Dieffenbachia seguine** (Jacq.) Schott.

ASCLEPIAS ALTISSIMA, Enum. 17; Select. 84. *t. 51*, as *Cynanchum altissimum*. Cartagena = **Marsdenia altissima** (Jacq.) Dugand.

ASCLEPIAS CLAUSA, Enum. 17; Select. 87. *t. 60, f. 2*, as *Cynanchum clausum*. Cartagena = **Sarcostemma clausum** (Jacq.) R. & S.

ASCLEPIAS FILIFORMIS, Enum. 17; Select. 86. *t. 60, f. 1*, as *Cynanchum filiforme*. Cartagena = **Cynanchum filiforme** (Jacq.) Jacq.

ASCLEPIAS LONGIFLORA, Enum. 17; Select. 85. *t. 59*, as *Cynanchum longiflorum*. Cartagena = **Macroscepis longiflora** (Jacq.) Sprengel.

ASCLEPIAS MARITIMA, Enum. 17; Select. 83. *t. 56*, as *Cynanchum maritimum*. Tierra Bomba, Cartagena = **Matelea maritima** (Jacq.) Woodson.

ASCLEPIAS PLANIFLORA, Enum. 17; Select. 82. *t. 55*, as *Cynanchum planiflorum*. Cartagena = **Matelea planiflora** (Jacq.) Dugand.

ASCLEPIAS RACEMOSA, Enum. 17; Select. 81. *t. 54*, as *Cynanchum racemosum*. Cartagena = **Cynanchum racemosum** (Jacq.) Jacq.

ASCLEPIAS UNDULATA, Enum. 17; Select. 85. *t. 58*, as *Cynanchum undulatum*. Cartagena = **Marsdenia undulata** (Jacq.) Dugand.

ASTRONIUM, Enum. 10 = **Astronium** Jacq.

ASTRONIUM GRAVEOLENS, Enum. 33; Select. 261. *t. 181, f. 96*. Cartagena = **Astronium graveolens** Jacq.

AVICENNIA, Enum. 6 = **Avicennia** L. (1753).

AVICENNIA NITIDA, Enum. 25; Select. 177. *t. 112, f. 1*. Martinique = **Avicennia germinans** (L.) L.

AVICENNIA TOMENTOSA, Enum. 25, citing *Linn. syst. A. p.* 1122; Select. 178. *t. 112, f. 2*. Caribaeis & Continente = **Avicennia germinans** (L.) L.

BATIS, Enum. 10 = **Batis** L. (1759).

BATIS MARITIMA, not in Enum.; Select. 260. *t. 40, f. 4*. Caribaeis & Continente = **Batis maritima** L.

BAUHINIA GLABRA, Enum. 20; Select. 119. *t. 173, f. 3*. Cartagena = **Bauhinia glabra** Jacq. or **Schnella glabra** (Jacq.) Dugand.

BELLIS RAMOSA, Enum. 28; Select. 216. *t. 129*, as "Bellis ? ramosa." Domingo and Martinique = **Eclipta alba** (L.) Hassk. (Conserved type.)

BIGNONIA DICHOTOMA, Enum. 25; Select. 183. Not illustrated. Cartagena = **Arrabidea obliqua** (H.B.K.) Bureau. (Not *Arrabidea dichotoma* (Vell.) Bur.)

BIGNONIA ECHINATA, Enum. 25; Select. 183. *t. 176, f. 52*. Cartagena = **Pithecoctenium echinatum** (Jacq.) K. Schum.

BIGNONIA LONGISSIMA, Enum. 25, citing *Plum. ic.* 57; Select. 182. *t. 176, f. 78*. Domingo = **Catalpa longissima** (Jacq.) Dum.-Cours. (1802).

BIGNONIA ORBICULATA, Enum. 25; Select. 184. *t. 180, f. 79*. Cartagena = **Anemopaegma orbiculatum** (Jacq.) DC.

BIGNONIA PANICULATA, Enum. 25, citing *Linn. spec. pl.* [*Bignonia* no.] **5**; Select. 183. *t. 116*. Cartagena = **Amphilophium paniculatum** (L.) H.B.K.

BOCCONIA, Enum. 5 = **Bocconia** L. (1753).

BOCCONIA FRUTESCENS, Enum. 22, citing *Linn. spec. pl.* I. *p.* 505; Select. 146, not illustrated. Cuba, Domingo, Jamaica = **Bocconia frutescens** L.

BOEHMERIA, Enum. 9 = **Boehmeria** Jacq.

BOEHMERIA RAMIFLORA, Enum. 31; Select. 246. *t. 157.* Martinique = **Boehmeria ramiflora** Jacq.

BOMBAX PENTANDRUM, Enum. 26, citing *Linn. spec. pl.* [*Bombax* no.] 2; Select. 191. *t. 176, f. 70.* Caribaeis = **Ceiba pentandra** (L.) Gaertn.

BOMBAX QUINATUM, Enum. 26, citing *Linn. spec. pl.* [*Bombax* no.] 1; Select. 192. *t. 176, f. 71.* Cartagena = **Bombacopsis quinata** (Jacq.) Dugand.

BOMBAX SEPTENATUM, Enum. 26; Select. 193. Not illustrated. Cartagena = **Pseudobombax septenatum** (Jacq.) Dugand.

BOURRERIA, Enum. 2 = **Bourreria** Browne (1756).

BOURRERIA EXSUCCA, Enum. 14; Select. 45. *t. 173, f. 17*, as "Beurreria." Cartagena = **Bourreria cumanensis** (Loefl.) Schulz.

BOURRERIA SUCCULENTA, Enum. 14; Select. 44 as "Beurreria." Not illustrated. Caribaeis = **Bourreria succulenta** Jacq.

The type locality was given as Curaçao by Johnston (Jour. Arnold Arb. 30: 128. 1949) and as Martinique by Stearn (Jour. Arnold Arb. 52: 621. 1971). Neither saw Jacquin specimens.

BROMELIA KARATAS, Enum. 18, citing *Plum. gen.* 10; Select. 90. *t. 178, f. 26.* Martinique, Cuba = **Bromelia karata** L. (1753).

BROWNAEA, Enum. 6 = **Brownea** Jacq. (Name conserved with corrected spelling.)

BROWNAEA COCCINEA, Enum. 26; Select. 194. *t. 121.* Venezuela = **Brownea coccinea** Jacq.

BRUNSFELSIA SPINOSA, Enum. 14. Not in Select. No locality given. = **Brunfelsia spinosa** Jacq. ex Index Kewensis.

A student of *Brunfelsia*, Mr. T. Plowman, cannot place the preceding name and no authentic material has been located.

CACTUS PITAJAYA, Enum. 23; Select. 151. Not illustrated. Cartagena = **Acanthocereus pitajaya** (Jacq.) Dugand ex Croiz. Caldasia 2(7): 135. 1943.

Dugand stated later (Phytologia 13: 382. 1966) that *Acanthocereus pitajaya* could not be assigned to a genus.

CALLICARPA INTEGRIFOLIA, Enum. 12; Select. 15. *t. 173, f. 7.* Cartagena = **Aegiphila integrifolia** (Jacq.) Jackson.

CAPPARIS AMYGDALIFOLIA, Enum. 24, citing Breynia, *Plum. gen.* 40; Select. 161. *t. 103*, as "CAPPARIS (*Breynia*)." Caribaeis & Continente = **Capparis indica** (L.) Fawc. & Rendle.

CAPPARIS COMOSA, Enum. 23; Select. 160. Not illustrated. Jaquesi, Haiti = **Capparis comosa** Jacq.

CAPPARIS CYNALLOPHORA, Enum. 23, citing *Linn. syst.* 2. p. 1071 ["cynophallophora"]; Select. 158. *t. 98*. Caribaeis & Venezuela = **Capparis flexuosa** (L.) L.

CAPPARIS ELAEAGNIFOLIA, Enum. 23; Select. 160. *t. 100*. Renamed "Capparis octandra" (illegitimate) Domingo = **Capparis ferruginea** L.

CAPPARIS EUSTACHIANA, Enum. 23; Select. 159. Not illustrated. Saint Eustatius = **Capparis eustachiana** Jacq.

CAPPARIS FRONDOSA, Enum. 24; Select. 162. *t. 104*. Cartagena & Domingo = **Capparis baducca** L.

CAPPARIS HASTATA, Enum. 23; Select. 159. *t. 174, f. 56*. Cartagena = **Capparis flexuosa** L. forma **hastata** (Jacq.) Dugand (1941) but later as **Capparis hastata** Jacq. (Dugand, Caldasia **10**: 219. 1968.)

CAPPARIS JAMAICENSIS, Enum. 23; Select. 60. Not illustrated. Domingo = **Capparis cynophallophora** L.

CAPPARIS LINEARIS, Enum. 24; Select. 161. *t. 102*. Cartagena = **Capparis linearis** Jacq.

CAPPARIS NEMOROSA, Enum. 24; Select. 164. *t. 181, f. 69*. Cartagena = **Belencita nemorosa** (Jacq.) Dugand.

CAPPARIS PULCHERRIMA, Enum. 24; Select. 163. *t. 106*. Cartagena = **Capparis pulcherrima** Jacq.

CAPPARIS TENUISILIQUA, Enum. 24; Select. 162. *t. 105*. Cartagena = **Capparis tenuisiliqua** Jacq.

CAPPARIS VERRUCOSA, Enum. 23; Select. 159. *t. 99*. Cartagena = **Capparis verrucosa** Jacq.

CASEARIA, Enum. 4 = **Casearia** Jacq.

CASEARIA ACULEATA, Enum. 21, citing *Plum. ic.* 147. *f.* 1; Select. 133. Not illustrated = **Casearia aculeata** Jacq.

CASEARIA DECANDRA, Enum. 21; Select. 133. *t. 85*. Case-Pilote, Martinique = **Casearia decandra** Jacq. TYPE: *Jacquin s.n.* (BM).

CASEARIA NITIDA, Enum. 21, citing Samyda *Brown. Jam.* I. p. 217; Select. 132, citing *Brown. jam. p.* 217. *t.* 23, *f.* 3*?*. Cartagena. Not illustrated.

Linnaeus (Syst. ed. 10. 1025. 1759) published *Samyda nitida* based on

the same type. Jacquin's name of 1760, is, therefore, illegitimate being superfluous and Linnaeus's specific epithet cannot be transferred to *Casearia*. As Jacquin questioned "*?*" the Browne reference in the *Selectarum* and indicated a plant from Cartagena it appears that two plants are involved here, Browne's from Jamaica and Jacquin's from Cartagena. Both plants, therefore, require new names which should be supplied by a monographer of the genus.

CASSYTHA, Enum. 3 = **Cassytha** L. (1753).

CASSYTHA FILIFORMIS, Enum. 20, citing *Linn. spec. pl.* I. *p.* 35; Select. 115. *t. 79*. Tierra Bomba near Cartagena, Colombia = **Cassytha filiformis** L.

CHAETAEA, Enum. 2 = **Byttneria** Loefl. (1758).

CHAETAEA ACULEATA, Enum. 17; Select. 76 as "BYTTNERIA (*aculeata*) Linn."

Linnaeus, editing Loefling's work, accepted the genus *Byttneria* Loefl. (nom. conserv.), Iter Hisp. p. 313. 1758, and added a specific epithet of "scabra" in the Systema (ed. 10. 939. 1759). Jacquin (Select. p. 77) stated he had not seen Loefling's work when he published the genus *Chaetaea* but he accepted *Byttneria*, naming the species incorrectly as *Byttneria aculeata*. He recorded a difference of opinion on the flower structure from that reported by Linnaeus (Systema 907, 939, 1365). Further, Jacquin cited material from Cartagena and from Domingo and referred to the large leaves of some plants and the smaller leaves of younger plants. In 1770 Jacquin (Hort. Vindob. 1: 10. *t. 29*) described and illustrated *Byttneria microphylla* from Hispaniola and a specimen and copies of the illustration are in the Linnaean herbarium (266.1, 266.2, 266.3) Moscoso Cat. Flor. Domingensis 371. 1943) recognizes *B. microphylla* and places *Chaetaea aculeata* Jacq. and *Byttneria aculeata* Jacq. in synonymy. This is apparently based on the work of Urban (Symb. Antill. 8: 431. 1920) in which *Buettneria microphylla* is given with the synonymy of *Chaetaea aculeata* Jacq. in part, and *Byttneria aculeata* Jacq. in part. It appears that Urban was accepting the Domingo collections cited in the *Selectarum* as being the same as *B. microphylla* and implying that the specimen from Cartagena was something else, i.e., *Byttneria scabra* L. To the best of my knowledge the name *Byttneria scabra* L. has not been used in modern floras.

CHIOCOCCA NOCTURNA, Enum. 16; Select. 68. Domingo = **Cestrum nocturnum** L. 1753.

CHIOCOCCA RACEMOSA, Enum. 16, citing *Brown. Jam.* 164; Select. 68. Not illustrated. Cartagena & Jamaica = **Chiococca alba** (L.) Hitchc.

CHOMELIA, Enum. 1 = **Chomelia** Jacq.

CHOMELIA SPINOSA, Enum. 12; Select. 18. *t. 13*. Cartagena = **Chomelia spinosa** Jacq.

CHRYSOBALANUS, Enum. 5 = **Chrysobalanus L. (1753).**

CHRYSOBALANUS ICACO, Enum. 23, citing *Linn. spec. pl.* I. *p.* 513; Select. 154. *t. 94.* Caribaeis & Continente = **Chrysobalanus icaco L.**

CHRYSOPHYLLUM, Enum. 5 = **Chrysophyllum L. (1753).**

CHRYSOPHYLLUM ARGENTEUM, Enum. 15; Select. 53. *t. 38, f. 1.* Martinique = **Chrysophyllum argenteum** Jacq. *Cynodendron argenteum* (Jacq.) Baehni (1965) has not been accepted by subsequent workers.

CHRYSOPHYLLUM CAINITO, Enum. 15, citing *Linn. spec. pl.* I. *p.* 192; Select. 51. *t. 37, f. 1* = **Chrysophyllum cainito** L. Urban, Symb. Antill., typifies this species as "L. Sp. Pl. 1: 192 exclud. var."

CHRYSOPHYLLUM GLABRUM, Enum. 15; Select. 53. *t. 38, f. 2,* omitting the specific epithet. Martinique = **Chrysophyllum argenteum** Jacq. *Cynodendron argenteum* (Jacq.) Baehni (1965) has not been accepted by recent workers.

CINCHONA CARIBAEA, Enum. 16; Select. 61. *t. 179, f. 95.* Havana & Domingo = **Exostema caribaeum** (Jacq.) R. & S.

CLEMATIS POLYGAMA, Enum. 24; Select. 171, as "ATRAGENE (*polygama*)." Not illustrated. Havana, Cuba = **Clematis dioica L.**

CLEOME PROCUMBENS, Enum. 26; Select. 189. *t. 120.* Domingo = **Cleome procumbens** Jacq.

CLEOME SERRATA, Enum. 26; Select. 190. *t. 180, f. 43.* Cartagena = **Cleome serrata** Jacq.

CLEOME SPINOSA, Enum. 26, citing *Brown. Jam.* I. *p.* 273; Select. 190. Not illustrated. Jamaica = **Cleome spinosa** Jacq.

CLINOPODIUM MARTINICENSE, Enum. 25; Select. 173. *t. 176, f. 75.* Martinique = **Leucas martinicensis** (Jacq.) Ait. f.

CLUSIA ALBA, Enum. 34, citing *Plum. ic.* 87. *f.* 1; Select. 271. *t. 166.* Martinique = **Clusia major L.**

CLUSIA FLAVA, Enum. 34, citing *Sloane hist. Jam.* 2. *t.* 200, *f.* 1.; Select. 272. *t. 167.* Jamaica = **Clusia flava** Jacq.

CLUSIA ROSEA, Enum. 34, citing *Catesb. car.* 2. *t.* 99; Select. 270. Domingo = **Clusia rosea** Jacq.

CLUSIA VENOSA, Enum. 34, citing *Plum. ic.* 87. *f.* 2; Select. 273. Not illustrated. Martinique = **Clusia minor L.**

COCCOLOBA BARBADENSIS, Enum. 37, citing *Houst. cat.* = **Coccoloba barbadensis** Jacq.

COCCOLOBA CORONATA, Enum. 19; Select. 114. *t. 77*. Cartagena = **Coccoloba coronata** Jacq.

COCCOLOBA DIVERSIFOLIA, Enum. 19; Select. 114. *t. 76*. Domingo = **Coccoloba diversifolia** Jacq.

COCCOLOBA EMARGINATA, Enum. 37, citing *Houst.* [coll. Herb. Mygind.] = **Neomillspaughia emarginata** (Gross) Blake. See Howard, Jour. Arnold Arb. **40**: 196. 1959.

COCCOLOBA FLAVESCENS, Enum. 19; Select. 114. *t. 75*. Porto Principis, Domingo = **Coccoloba flavescens** Jacq.

COCCOLOBA GRANDIFOLIA, Enum. 19; Select. 113. Not illustrated. Martinique = **Coccoloba pubescens** L.

COCCOLOBA LEOGANENSIS, Enum. 19; Select. 113. *t. 178, f. 33*. Porto Principis & Leogane, Haiti = **Coccoloba leoganensis** Jacq. A fragment of this collection is in the British Museum.

COCCOLOBA NIVEA, Enum. 19; Select. 115. *t. 78*. Domingo & Martinique = **Coccoloba venosa** L. 1759.

COCCOLOBA OBTUSIFOLIA, Enum. 19; Select. 114. *t. 74*. Cartagena = **Coccoloba obtusifolia** Jacq.

COCCOLOBA UVIFERA, Enum. 19, citing *Plum. ic.* 145; Select. 112. *t. 73*. Caribaeis & Continente = **Coccoloba uvifera** (L.) L.

COFFEA OCCIDENTALIS, Enum. 16, citing *Plum. ic.* 156. *f. 2*; Select. 67. *t. 47*. Cap Français, Haiti = **Faramea occidentalis** (L.) A. Rich. Based on *Ixora occidentalis* L. Syst. Nat. ed. 10. 893, with same type.

COMBRETUM DECANDRUM, Enum. 19; Select. 104. Not illustrated. Cartagena = **Combretum decandrum** Jacq.

COMBRETUM LAXUM, Enum. 19; Select. 104. Not illustrated. Domingo = **Combretum laxum** Jacq.

Exell (Jour. Linn. Soc. Bot. **55**: 126. 1953) reported that a fragment of Jacquin's collection of *Combretum laxum* is in the British Museum.

COMBRETUM SECUNDUM, Enum. 19; Select. 103. *t. 176, f. 30*. Cartagena = **Combretum fruticosum** (Loefl.) Stuntz.

COMOCLADIA DENTATA, Enum. 12; Select. 13. *t. 173, f. 4*. Havana = **Comocladia dentata** Jacq.

COMOCLADIA INTEGRIFOLIA, Enum. 12, citing *Brown. Jam.* 124; Select. 12, citing *Linn. syst. A.* [ed. 10.] *p.* 861. Not illustrated. Domingo & Jamaica = **Comocladia pinnatifolia** L. 1759 with same type.

COPAIVA, Enum. 4 = **Copaifera** L. (1762), conserved generic name.

COPAÏVA OFFICINALIS, Enum. 21, citing *Marcgr. Bras. l.* 3, *c.* 17; Se-

lect. 133. *t. 86.* Carbet, Martinique & Continente = **Copaifera officinalis** (Jacq.) L. (1762).

CORDIA, Enum. *2* = **Cordia** L. (1753).

CORDIA JUGLANDIFOLIA, Enum. 14; Select. 43. Not illustrated. Domingo.

This species does not appear to have been considered by I. M. Johnston in his extensive studies of *Cordia* in tropical America. It is listed in Moscoso's *Catalogus Plantae Domingensis* (1943) but has never been recollected.

CROTON BALSAMIFERUM, Enum. 32; Select. 255. *t. 163, f. 3.* Martinique & Curaçao = **Croton balsamiferus** Jacq.

This specific epithet has been used in recent publications as "balsamifer" for no apparent reason.

CROTON LINEARE, Enum. 32; Select. 256. *t. 162, f. 4.* "valle arenoso Corensi" = **Croton linearis** Jacq.

CROTON NIVEUM, Enum. 32; Select. 255. *t. 162, f. 2.* Cartagena = **Croton niveus** Jacq.

CROTON POLYGAMUM, Enum. 32; Select. 255. Not illustrated. Cartagena = **Argythamnia polygama** (Jacq.) Ktze.

CROTON PROCUMBENS, Enum. 32; Select. 254. Not illustrated. Cartagena = **Croton procumbens** Jacq.

CYTHAREXYLUM TERES, Enum. 26; Select. 185. *t. 117*, as "Citharexylum." Martinique = **Citharexylum spinosum** L.

CYTHAREXYLUM QUADRANGULARE, Enum. 26; Select. 186, as "Citharexylum." Not illustrated. Martinique = **Citharexylum spinosum** L.

DALECHAMPIA, Enum. 9 = **Dalechampia** L. (1753).

DALECHAMPIA SCANDENS, Enum. 31, citing *Plum. Amer. t.* 101; Select. 252. *t. 160.* Domingo = **Dalechampia scandens** L.

DIOSPYROS INCONSTANS, Enum. 34; Select. 276. *t. 174, f. 67.* Cartagena = **Diospyros inconstans** Jacq.

DIPHYSA, Enum. 7 = **Diphysa** Jacq.

DIPHYSA CARTHAGENENSIS, Enum. 28; Select. 208. *t. 180, f. 51.* Cartagena = **Diphysa carthagenensis** Jacq.

DODONAEA, Enum. 3 = **Dodonaea** Mill. (1754).

DODONAEA VISCOSA, Enum. 19, citing *Sloane Jam. t.* 162. *f.* 3; Select. 109. Not illustrated. Jamaica & Cartagena = **Dodonaea viscosa** Jacq.

DOLICHOS ALTISSIMUS, Enum. 27; Select. 203. *t. 182, f. 85.* Martinique = **Mucuna urens** (L.) Fawc. & Rendle. (For a discussion of this

and the following two species see Fawcett & Rendle, Jour. Bot. **55**: 36. 1917.)

DOLICHOS PRURIENS, Enum. 27, citing *Linn. syst. C. p.* 1162; Select. 201. *t. 122.* Caribaeis = **Mucuna pruriens** (L.) P. DC.

DOLICHOS URENS, Enum. 27, citing *Linn. syst. D. p.* 1162; Select. 202. *t. 182, f. 84.* Caribaeis = **Mucuna sloanei** Fawc. & Rendle.

DURANTA, Enum. 6 = **Duranta** L. (1753).

DURANTA ELLISIA, Enum. 26, citing *Linn. syst.* 1121 (illegitimate); Select. 187. *t. 176, f. 77.* Jamaica = **Duranta repens** L.

DURANTA PLUMIERI, Enum. 26, citing *Linn. spec. pl.* 1 & 2. *p.* 637 (illegitimate); Select. 186. *t. 176, f. 76.* Domingo = **Duranta repens** L.

ECHITES, Enum. 2 = **Echites** P. Br. (1756).

ECHITES AGGLUTINATA, Enum. 12; Select. 31. *t. 23* as "adglutinata." Cap Français, Haiti = **Prestonia agglutinata** (Jacq.) Woodson.

ECHITES BIFLORA, Enum. 13, citing *Plum. Amer. t.* 96; Select. 30. *t. 21.* Caribaeis = **Rhabdadenia biflora** (Jacq.) Müll.-Arg.

ECHITES CORYMBOSA, Enum. 13; Select. 34. *t. 30.* Domingo = **Forsteronia corymbosa** (Jacq.) G. F. W. Meyer.

ECHITES QUINQUANGULARIS, Enum. 13; Select. 32. *t. 25.* Cartagena = **Prestonia quinquangularis** (Jacq.) Spreng.

ECHITES REPENS, Enum. 13; Select. 33. *t. 28.* Domingo = **Mesechites repens** (Jacq.) Miers.

ECHITES SPICATA, Enum. 13; Select. 34. *t. 29.* Cartagena = **Forsteronia spicata** (Jacq.) G. F. W. Meyer.

ECHITES SUBERECTA, Enum. 13, citing *Sloane Jam. t.* 130. *f.* 2; Select. 32. *t. 26.* Jamaica, Domingo = **Urechites lutea** (L.) Britton. BASIONYM: **Vinca lutea** L. (1756).

ECHITES TOROSA, Enum. 13, citing *Brown. Jam. t.* 16, *f.* 2; Select. 33. *t. 27.* Jamaica = **Mandevilla torosa** (Jacq.) Woodson.

ECHITES TRIFIDA, Enum. 13; Select. 31. *t. 24.* Cartagena = **Mesechites trifida** (Jacq.) Müll.-Arg.

ECHITES UMBELLATA, Enum. 13, citing *Plum. ic.* 216. *f.* 2; Select. 30. *t. 22.* Jamaica, Domingo, Cuba = **Echites umbellata** Jacq.

EHRETIA, Enum. 2 = **Ehretia L.** (1759).

EHRETIA SPINOSA, Enum. 14; Select. 46. *t. 180, f. 18.* Cartagena = **Rochefortia spinosa** (Jacq.) Urb.

EHRETIA TINIFOLIA, Enum. 14, citing *Brown. Jam. t.* 16, *f.* 1; Select. 45, citing *Linn. syst. A. p.* 936. Not illustrated. Cuba, Jamaica = **Ehretia tinifolia** L. (1759).

ELAPHRIUM, Enum. 3 = **Bursera** Jacq. ex L. 1762. Conserved name.

ELAPHRIUM GLABRUM, Enum. 19; Select. 106. *t. 71, f. 4.* Cartagena = **Bursera glabra** (Jacq.) Triana & Planch.

ELAPHRIUM TOMENTOSUM, Enum. 19; Select. 105. *t. 71, f. 1, 2, 3.* Curaçao = **Bursera tomentosa** (Jacq.) Triana & Planch.

ELATERIUM, Enum. 9 = **Rytidostylis** Hook. & Arn. (not *Elaterium* Mill. 1754).

ELATERIUM CARTHAGENENSE, Enum. 31; Select. 241. *t. 154.* Cartagena = **Rytidostylis carthagenensis** (Jacq.) Ktze. See also Jeffrey in Kew Bull. 16: 197, 198. 1962.

EPIDENDRUM ALTISSIMUM, Enum. 30, citing *Sloane, hist. Jam.* I. *t.* 148. *f.* 1; Select. 229. *t. 141.* Martinique = **Oncidium altissimum** (Jacq.) Sw.

For a discussion of the typification of *Oncidium*, and of *Epidendrum altissimum* Jacq. and the other species now considered to be in *Oncidium*, see the article by N. H. Williams and R. L. Dressler in Taxon 22: 221–227. 1973.

EPIDENDRUM CARTHAGENENSE, Enum. 30; Select. 228. *t. 133, f. 4.* Cartagena = **Oncidium carthagenense** (Jacq.) Sw.

EPIDENDRUM CEBOLLETA, Enum. 30; Select. 230. *t. 131, f. 2.* Cartagena = **Oncidium cebolleta** (Jacq.) Sw.

EPIDENDRUM CILIARE, Enum. 29, citing *Plum. ic.* 179. *f.* 2; Select. 224. *t. 179, f. 89.* Martinique = **Epidendrum ciliare** L. (1759).

EPIDENDRUM COCCINEUM, Enum. 29, citing *Plum. ic.* 180. *f.* 1.; Select. 222. *t. 134.* Martinique = **Maxillaria coccineum** (Jacq.) L. O. Wms.

EPIDENDRUM CONCRETUM, Enum. 30; Select. 228. Not illustrated. Martinique = **Epidendrum concretum** Jacq.

This name cannot be placed with any accuracy in the absence of herbarium material. Garay (pers. comm.) suggests it might be *Ponthieva racemosa* (Walt.) Mohr.

EPIDENDRUM DIFFORME, Enum. 29; Select. 223. *t. 136.* Martinique = **Epidendrum difforme** Jacq.

EPIDENDRUM GLOBOSUM, Enum. 29; Select. 22. *t. 133, f. 1.* Martinique = **Jacquiniella globosa** (Jacq.) Schlecht.

EPIDENDRUM LINEARE, Enum. 29, citing *Plum. ic.* 182. *f.* 1; Select. 221. *t. 131, f. 1.* Martinique = **Isochilus linearis** (Jacq.) R. Br.

EPIDENDRUM NOCTURNUM, Enum. 29; Select. 225. *t. 139*. Martinique = **Epidendrum nocturnum** Jacq.

EPIDENDRUM NODOSUM, Enum. 29, citing *Linn. spec. pl. 7. p.* 953; Select. 226. *t. 140*. Baru, Cartagena, Colombia = **Brassavola nodosa** (L.) Lindl.

EPIDENDRUM OPHIOGLOSSOIDES, Enum. 29, citing *Plum. ic.* 176. *f.* 3; Select. 225. *t. 133, f. 2*. Martinique = **Pleurothallis ophioglossoides** (Jacq.) Garay & Sweet.

EPIDENDRUM RAMOSUM, Enum. 29; Select. 221. *t. 132*. Martinique = **Epidendrum rigidum** Jacq.

EPIDENDRUM RUSCIFOLIUM, Enum. 29, citing *Plum. ic.* 176. *f.* 2; Select. 226. *t. 133, f. 3*. Martinique = **Pleurothallis ruscifolia** (Jacq.) R. Br.

EPIDENDRUM SECUNDUM, Enum. 29, citing *Plum. ic.* 184. *f.* 1; Select. 224. *t. 137*. Martinique = **Epidendrum secundum** Jacq.

EPIDENDRUM TETRAPETALUM, Enum. 30; Select. 230. *t. 142*. Jamaica = **Oncidium tetrapetalum** (Jacq.) Willd.

ERYTHROXYLUM CARTHAGENENSE, Enum. 21; Select. 134. *t. 87*. Cartagena = **Erythroxylum carthagenense** Jacq.

ERYTHROXYLUM HAVANENSE, Enum. 21; Select. 135. *t. 87, f. 2*. Havana = **Erythroxylum havanense** Jacq.

EUGENIA CARTHAGENENSIS, Enum. 23; Select. 152. *t. 178, f. 53*. Cartagena = **Eugenia carthagenensis** Jacq. Dr. Rogers McVaugh, author of extensive studies on this family, was not able to locate material of this species or to place it satisfactorily.

EUGENIA PSEUDOPSIDIUM, Enum. 23; Select. 152, *t. 93*. Martinique = **Eugenia pseudopsidium** Jacq.

EUPHORBIA BOMBENSIS, Enum. 22; Select. 151. Not illustrated. Cartagena = **Chamaesyce bombensis** (Jacq.) Dugand.

EUPHORBIA MESEMBRIANTHEMIFOLIA, Enum. 22; Select. 150. Not illustrated. Cartagena = **Chamaesyce mesembrianthemifolia** (Jacq.) Dugand.

EUPHORBIA OBLITERATA, Enum. 22; Select. 151. Not illustrated. Cartagena = **Euphorbia hirta** L.

This species has not been included in any recent flora or monograph. Gooding *et al.*, in the Flora of Barbados (p. 249. 1965), assign the name as used by Maycock to the synonymy of *Euphorbia hirta*.

FAGARA TRAGODES, Enum. 12, citing Schinus *Linn. spec. pl. p.* 389; Select. 21. *t. 14*. Porto Principes = **Zanthoxylum tragodes** (L.) DC. or **Fagara tragodes** (L.) Jacq.

GENTIANA APHYLLA, Enum. 17; Select. 87. *t. 60*. Martinique = **Leiphaimos aphylla** (Jacq.) Gilg.

GEOFFROEA, Enum. 7 = **Geoffroea** Jacq.

GEOFFROEA SPINOSA, Enum. 28 [as GEOFFRAEA]; Select. 207. *t. 180, f. 62*. Cartagena = **Geoffroea spinosa** Jacq.

GINORIA, Enum. 5 = **Ginoria** Jacq.

GINORIA AMERICANA, Enum. 22; Select. 148. *t. 91*. Cuba = **Ginoria americana** Jacq.

HAMELIA, Enum. 2 = **Hamelia** Jacq.

HAMELIA ERECTA, Enum. 16; Select. 17. Not illustrated. Cartagena = **Hamelia patens** Jacq.

According to Elias (pers. comm.) L'Héritier (Sert. Angl. p. 4. 1788) was the first to combine these species under *H. patens*.

HAMELIA PATENS, Enum. 16; Select. 72. *t. 50*. Domingo = **Hamelia patens** Jacq.

HAPALANTHUS, Enum. 1 = **Callisia** Loefl. (1758).

HAPALANTHUS REPENS, Enum. 12; Select. 11. *t. 11*, citing Loefl. hisp. 305. Not illustrated. Martinique = **Callisia repens** (Jacq.) L. 1762.

HEDYOTIS AMERICANA, Enum. 12; Select. 20. Not illustrated. Havana, Cuba = **Rachicallis americana** (Jacq.) Ktze.

HEISTERIA, Enum. 4 = **Heisteria** Jacq.

HEISTERIA COCCINEA, Enum. 20; Select. 126. *t. 81*. Martinique = **Heisteria coccinea** Jacq.

HELICTERES, Enum. 8 = **Helicteres** L. (1753).

HELICTERES BARBADENSIS, Enum. 38.

This species was described in a section of the *Enumeratio* considering collections in the herbarium of Mygind. Most of the species treated were collected by Houstoun and a few have been placed satisfactorily. Of these *Paullinia barbadensis* (Enum. 36) is now considered to be from Jamaica, while *Coccoloba barbadensis* (Enum. 37) is a plant from Mexico. There is no assurance that *Helicteres barbadensis* is from Barbados. No authentic material has been seen. *Helicteres* is not reported from Barbados in the Flora of Barbados by Gooding *et al.*, and only *Helicteres jamaicensis* is listed by Adams in the *Flowering Plants of Jamaica*. The binomial has not been applied to any modern collections from Mexico, Central America, or northern South America.

HELICTERES BARUENSIS, Enum. 30; Select. 236. *t. 149*. Baru, Cartagena, Colombia = **Helicteres baruensis** Jacq.

HELICTERES CARTHAGENENSIS, Enum. 30; Select. 237. *t. 150*. Cartagena = **Helicteres carthagenensis** Jacq.

The plant is described as having cordate serrate leaves which are tomentose on both sides. The illustration, however, is of a leafless inflorescence, and of a fruit with straight carpels, both unusual conditions in *Helicteres*. The binomial has not been used in recent literature. No similar collection has been seen from the area of Cartagena.

HELICTERES APETALA, Enum. 30; Select. 238. *t. 181, f. 98*. Cartagena = **Sterculia apetala** (Jacq.) Karsten.

This species was transferred to *Sterculia* and renamed *Sterculia carthaginensis* by Cavanilles (Mon. Cl. Diss. Dec. 6: 353. 1788). Although this name has been used in some publications, it is illegitimate.

HELICTERES JAMAICENSIS, Enum. 30, citing *Linn. spec. pl.* 1; Select. 235. *t. 179, f. 99*. Jamaica.

Typification is needed to retain the use of the well known *Helicteres jamaicensis* Jacq. since Jacquin cited "*Linn. spec. pl.* 1" which is *Helicteres isora* L. and a variety. The Linnaean species is based on four references: Hort. Cliff. 433; Pluk. Alm. 181. *t. 245, f. 2* from Ind. Or.; Raj. hist. 1765; and Rheede mal. 6. *p.* 55. *t. 30*. For variety β. Linnaeus cited *Pluk. alm.* 182. *t.* 245. *f.* 3 and *Sloan. jam.* 97. *hist.* 1. *p. 22* (an error for 220). *Helicteres isora* L. may be typified by the illustration of the closed fruit accompanying the foliage in Pluk. Alm. 181. *t. 245, f. 2*. This is a plant of tropical Asia found occasionally in cultivation in the American tropics. For *Helicteres jamaicensis* Jacquin (Enum. 30. 1760) does not distinguish within the *Species Plantarum* reference, although the illustration given in the *Selectarum, t. 179, f. 99* is of Linnaeus's *Helicteres isora* L. var. β., and is comparable to the illustration of Pluk. Alm. 182. *t. 245, f. 3*. Swartz (Prodomus 98. 1788) cited after *Helicteres jamaicensis* the *Selectarum* reference and "Helicteres isora. b." The holotype of *Helicteres jamaicensis* Jacq. is, therefore, the figure given by Jacquin (Select. *t. 179, f. 99*) stated to be "Helicteris jamaicensis fructus" (Select. *Explicatio Tabularum*).

HERNANDIA, Enum. 9 = **Hernandia** L. (1753).

HERNANDIA SONORA, Select. 245. Not illustrated. Martinique = **Hernandia sonora** L.

HILLIA, Enum. 3 = **Hillia** Jacq.

HILLIA PARASITICA, Enum. 18; Select. 96. *t. 66*. Martinique = **Hillia parasitica** Jacq.

HIPPOCRATEA, Enum. 1 = **Hippocratea** L. (1753).

HIPPOCRATEA SCANDENS, Enum. 12, citing *Linn. spec. pl.* 1. *p.* 1191; Select. 9. *t. 9*. Martinique, Domingo, Cartagena = **Hippocratea volubilis** L.

HIPPOMANE MANÇANILLA, Enum. 31, citing *Linn. spec. pl.* I. 1191; Select. 250. *t. 159*. Martinique, Grenada, Caribaeis & Continente = **Hippomane mancinella** L.

HIRAEA RECLINATA, Enum. 21; Select. 137. *t. 176, f. 42*. Cartagena = **Hiraea reclinata** Jacq.

HOMALIUM, Enum. 5 = **Homalium** Jacq.

HOMALIUM RACEMOSUM, Enum. 24; Select. 170. *t. 183, f. 72*. Martinique = **Homalium racemosum** Jacq.

HYBANTHUS, Enum. 2 = **Hybanthus** Jacq. (listed unnecessarily as a conserved name).

HYBANTHUS HAVANENSIS, Enum. 17; Select. 77. *t. 175, f. 24, 25*. Havana, Cuba = **Hybanthus havanensis** Jacq.

HYPERICUM CAYENNENSE, Enum. 28; Select. 213. Not illustrated. Cayenne, French Guiana = **Vismia cayennensis** (Jacq.) Pers.

IPOMAEA CARNEA, Enum. 13; Select. 26. *t. 18*. Cartagena = **Ipomoea carnea** Jacq.

IPOMAEA FILIFORMIS, Enum. 13; Select. 27. *t. 19*. Martinique = **Jacquemontia solanifolia** (L.) Hall. f.

IPOMAEA REPANDA, Enum. 13; Select. 28. *t. 20*. Martinique = **Ipomoea repanda** Jacq.

IRIS MARTINICENSIS, Enum. 12; Select. 7. *t. 7*. Martinique = **Trimezia martinicensis** (Jacq.) Herbert.

IXORA ALTERNIFOLIA, Enum. 12, citing *Plum. ic.* 157. *f.* 1; Select. 16. *t. 177, f. 8*. Martinique = **Cestrum alternifolium** (Jacq.) Schulz.

JACQUINIA, Enum. 2 = **Jaquinia** L. (1759). It seems apparent that Jacquin was correcting the spelling of his own name.

JACQUINIA ARMILLARIS, Enum. 15; Select. 53. *t.* 39. Curaçao, Martinique, Cartagena = **Jacquinia armillaris** Jacq.

This species is commonly cited as *Jacquinia barbasco* (Loefl.) Mez, and based on "Chrysophyllum barbasco Loefl." Loefling, however, used "barbasco" as a common name, not a specific epithet (Iter Hisp. 204, 207. 1758).

JACQUINIA LINEARIS, Enum. 15; Select. 54. *t. 40, f. 1*. Porto Principis, Haiti = **Jacquinia linearis** Jacq.

JACQUINIA RUSCIFOLIA, Enum. 15, citing *Linn. flor. Jam. p.* 27; *Dill. Elth. t.* 123; Select. 54. Not illustrated. Havana, Cuba = **Jacquinia aculeata** (L.) Mez.

JATROPHA CARTHAGENENSIS, Enum. 32; Select. 256. *t. 162, f. 1*. Cartagena = **Manihot carthagenensis** (Jacq.) Müll.-Arg.

JATROPHA HASTATA, Enum. 32; Select. 256. *t. 173, f. 54.* Cultivated in Domingo = **Jatropha hastata** Jacq.

JATROPHA INTEGERRIMA, Enum. 32; Select. 256. *t. 183, f. 74.* Havana, Cuba = **Jatropha integerrima** Jacq.

McVaugh (Bull. Torrey Bot. Club 72: 274, 275. 1945) suggested that *Jatropha hastata* and *Jatropha integerrima* are merely variants of one species and should be merged under the name *Jatropha integerrima.* Further studies suggest that morphological variation can be associated with definite geographic ranges. Under cultivation these do not vary and should be recognized as cultivars at least.

JUSTICIA CARTHAGENENSIS, Enum. 11; Select. 5. *t. 5.* Cartagena = **Justicia carthagenensis** Jacq.

JUSTICIA EUSTACHIANA, Enum. 11; Select. 4. *t. 4.* Saint Eustatius = **Justicia eustachiana** Jacq.

JUSTICIA HIRSUTA, Enum. 11; Select. 4. Not illustrated. Martinique = **Gonzalagunia hirsuta** (Jacq.) Schum.

In the *Observationum Botanicarum* (II: 7. *t. 32.* 1767), Jacquin transferred *Justicia hirsuta* to *Barleria* and published an illustration. He retained the descriptive polynomial given in the Enumeratio "dianthera; foliis lanceolato-acuminatis; floribus subspicatus; bracteis setaceis; caule hirsuto." Lindau (Urban, Symb. Antill. 2: 221. 1900) suggested the description and illustration were based on heterogeneous elements, the flowers being an *Odontonema*, perhaps from Central or South America and the foliage from an unnamed plant. Urban (Symb. Antill. 4: 585. 1911) associated the foliage with *Gonzalagunia spicata* (Lam.) Maza. Subsequent authors have varied in their acceptance of these associations. Britton (Britton & Wilson, Sci. Surv. Puerto Rico Virgin Is. 6: 229. 1925) and Williams & Cheesman (Fl. Trin. & Tob. 2: 14. 1928) used the binomial *Duggena hirsuta* (Jacq.) Britton, while Standley (N. Am. Fl. 32(2): 135. 1921), and Gooding *et al.* (Fl. Barbados 404. 1965) have rejected the Jacquin name in favor of *Duggena* or *Gonzalagunia spicata.*

There appears to be no question that the foliage illustrated by Jacquin is that of *Gonzalagunia.* The description of "dianthera" was altered by Jacquin (Observ. Bot. 2: 8. 1767) "there are two sterile stamens in addition to the fertile ones, as was stated subsequently in Justicia nitida. Therefore, it is appropriate to transfer both to Barleria. In acquaintance with better material, I have ordered it to be engraved hirsute by which [character] it coincides in appearance of nitida." An examination of the Jacquin illustration reveals that the ovary is drawn as inferior to the calyx lobes in the lower flowers, quite in contrast to the completely free sepals of *Odontonema.* The corolla tube is straight and the petals flare in contrast to a curved corolla tube and strongly bilabiate corolla with exserted stamens of *Odontonema.* Flowers are five parted in many plants of *Gonzalagunia*, as I have observed in the field. The flowers of *Gonzalagunia* are heterostylous, a previously unrecognized character, yet even

in the short styled forms the stamens are included in the orifice of the tube or only barely exserted, and number four or five depending on the number of corolla lobes. *Odontonema nitida* does have staminodes associated at the base of the long filaments but these are 0.5 mm. long, at most, in the flowers I have dissected. It is doubtful if Jacquin would have observed these staminodes which are nearly hidden in the basal pubescence. Finally, Jacquin's comment that he ordered the plate to be engraved hirsute suggests that he was growing the plant at Schoenbrunn and removes the possibility of the "planta mixta" suggested by Lindau. The basionym *Justicia hirsuta* Jacq. (Enum. 11. 1760) should be retained for this plant and the combination **Gonzalagunia hirsuta** (Jacq.) Schum. be used instead of *Gonzalagunia spicata* (Lam.) Maza.

JUSTICIA MARTINICENSIS, Enum. 11; Select. 5. *t. 2, f. 3.* Martinique = **Dicliptera martinicensis** (Jacq.) Juss.

JUSTICIA NITIDA, Enum. 11; Select. 5. Not illustrated. Martinique = **Odontonema nitida** (Jacq.) Kuntze.

JUSTICIA PECTORALIS, Enum. 11; Select. 3. *f. 3.* Domingo and Martinique = **Justicia pectoralis** Jacq.

JUSTICIA PULCHERRIMA, Enum. 11; Select. 6. *t. 2, f. 4.* Cartagena = **Aphelandra pulcherrima** (Jacq.) H.B.K.

JUSTICIA SESSILIS, Enum. 11; Select. 3. *t. 2, f. 2.* Saint Eustatius = **Justicia sessilis** Jacq.

JUSTICIA SPINOSA, Enum. 11; Select. 2. *t. 2, f. 1.* Porto Principis = **Oplonia spinosa** (Jacq.) Raf.

KLEINIA, Enum. 8 = **Porophyllum** Guett. (1754).

KLEINIA RUDERALIS, Enum. 28; Select. 215. *t. 127.* Domingo & Martinique = **Porophyllum ruderale** (Jacq.) Cass.

LAETIA APETALA, Enum. 24, citing *Linn. syst.* 1074; Select. 167. *t. 108.* Cartagena. (This name is illegitimate, being based on same type as *Laetia americana* L. Syst. ed. 10. 1074. (May-June) 1759) = **Laetia americana** L.

LAETIA COMPLETA, Enum. 24; Select. 167. *t. 183, f. 60.* Cartagena = **Laetia completa** Jacq.
This name was recognized in *Index Kewensis* but has not been used in any subsequent treatment known to me.

LAUGIERIA, Enum. 2 = **Guettarda** L. (1753).

LAUGIERIA ODORATA, Enum. 16; Select. 177. *f. 21.* Cartagena and Havana, Cuba = **Guettarda odorata** (Jacq.) Lam.

LECYTHIS, Enum. 5 = **Lecythis** Loefl. (1758).

LECYTHIS MINOR, Select. 168. *t. 109.* Cartagena = **Lecythis minor** Jacq.

LIPPIA HEMISPHAERICA, Enum. 25; Select. 176. *t. 179, f. 100*. Cartagena = **Lippia americana** L.

LORANTHUS BIRACEMOSUS, Enum. 35 = **Loranthus biracemosus** Jacq. ex Index Kewensis.

This species was based on a Houstoun collection in the Mygind Herbarium. Urban (Bot. Jahrb. **24**: 71. 1897) could not place the species and it is not included in any modern treatment known to me. Dr. J. Kuijt, currently a student of the Loranthaceae, has not located any specimens of these Jacquin species of *Loranthus* and is consequently unable to place the names in accepted genera (pers. comm.).

LORANTHUS PEDUNCULATUS, Enum. 18; Select. 98. Not illustrated. Cartagena = **Struthanthus pedunculatus** (Jacq.) G. Don.

This species has not been placed in any modern treatment known to me.

LORANTHUS SESSILIS, Enum. 18; Select. 99. Not illustrated. Cartagena = **Struthanthus sessilis** (Jacq.) G. Don.

This species has not been placed in any modern treatment known to me.

LORANTHUS SPICATUS, Enum. 18; Select. 97. *t. 68*. Cartagena = **Oryctanthus spicatus** (Jacq.) Eichl.

LORANTHUS UNIFLORUS, Enum. 18; Select. 98. *t. 69*. Domingo = **Dendropemon uniflorus** (Jacq.) Steud.

LYTHRUM CARTHAGENENSIS, Enum. 22; Select. 148. Not illustrated. Cartagena = **Cuphea carthagenensis** (Jacq.) Macbr.

MALPIGHIA DIPHYLLA, Enum. 21; Select. 136. Not illustrated. Cartagena = **Byrsonima diphylla** (Jacq.) DC.

MALPIGHIA GRANDIFOLIA, Enum. 21; Select. 137. Not illustrated. Martinique = **Bunchosia grandifolia** (Jacq.) Juss.

This species was regarded as unassignable by Small (N. Am. Fl. **25**: 160. 1910). However, Niedenzu (Pflanzenreich IV. **141**(Heft 94): 672. 1928) suggested the placement in *Bunchosia*, although with some doubt. No authentic material has been reported.

MALPIGHIA MARTINICENSIS, Enum. 21; Select. 136. Not illustrated. Martinique = **Malpighia martinicensis** Jacq.

The treatments of this species by monographers, by Small as *M. urens* (N. Am. Fl. **25**: 158. 1910), and by Niedenzu who maintained it (Pflanzenreich IV. **141**(Heft 94): 628. 1928), are inconsistent. Jacquin's descriptions are inadequate in this complicated genus and a specimen collected or annotated by Jacquin is badly needed to clarify the problem. A student of the genus, Mr. José Vivaldi, has not seen any material attributable to Jacquin.

MALPIGHIA NITIDA, Enum. 21; Select. 136. Not illustrated. Cartagena = **Bunchosia nitida** (Jacq.) L. C. Rich. in Juss.

MALPIGHIA ODORATA, Enum. 21; Select. 136. *t. 177, f. 41.* Cartagena = **Bunchosia odorata** (Jacq.) Juss.

Although *Malpighia odorata* has been selected and recognized as the type species of the genus *Bunchosia*, Morton questioned the validity of this designation (Taxon **17**: 317. 1968).

MELASTOMA SEPTEMNERVIA, Enum. 20; Select. 131. Not illustrated. Martinique = **Melastoma septemnervia** ex Index Kewensis. This binomial was not considered by Naudin or Cogniaux and cannot be placed.

MELIA GUAREA, Enum. 20; Select. 126. *t. 176, f. 37.* Cuba = **Guarea guidonia** (L.) Sleumer. See Taxon **5**: 194. 1956 for further discussion.

MELICOCCUS, Enum. 3 = **Melicoccus** Jacq.

MELICOCCUS BIJUGATUS, Enum. 19, citing *Brown. Jam.* I. *p.* 210; Select. 108. *t. 72.* Cartagena = **Melicoccus bijugatus** Jacq.

MENTZELIA, Enum. 5 = **Mentzelia** L. (1753).

MENTZELIA, Select. 164 as *M. aspera* citing *Linn. sp. pl.* I. *p.* 516. Curaçao = **Mentzelia aspera** L.

MIMOSA MANGENSIS, Enum. 34; Select. 267. Not illustrated. Cartagena = **Pithecolobium mangense** (Jacq.) Macbr.

MIMOSA RETUSA, Enum. 34; Select. 267. Not illustrated. Cartagena. Bentham (Trans. Linn. Soc. **30**: 528. 1875) accepted *Acacia riparia* H.B.K. (Nov. Gen. Sp. Pl. **4**: 276. 1824) and listed as a synonym "*Mimosa retusa* Jacq. Stirp. Amer. 267 ex desc." Recent authors have followed Bentham. The Jacquin species was not considered in the treatment of North American Flora presumably because of its origin in Cartagena. Macbride (Field Mus. Pub. Bot. **13**(3): 83. 1943, notes under *A. riparia* that "*Mimosa retusa* Jacquin . . . does not seem to have been considered by Britton and Killip." I am assuming that Bentham's general conclusions are acceptable and therefore the combination **Acacia retusa** (Jacq.) R. A. Howard comb. nov. is needed. BASIONYM: *Mimosa retusa* Jacq. Enum. 34. 1760.

MORINDA MUSCOSA, Enum. 16; Select. 65. *t. 45.* Martinique = **Cephaelis muscosa** (Jacq.) Sw. or = **Psychotria muscosa** (Jacq.) Steyermark (Mem. N. Y. Bot. Gard. **23**: 671. 1972).

MUNTINGIA, Enum. 5 = **Muntingia** L. (1753).

MUNTINGIA CALABURA, not in Enum.; Select. 166. *t. 107.* citing *Linn. sp. pl.* I. *p.* 509. Domingo = **Muntingia calabura** L. 1753.

MUSAENDA FORMOSA, Enum. 16; Select. 70. *t. 48*. Cartagena = **Randia mussaenda** (Jacq.) Schum.

MUSAENDA SPINOSA, Enum. 16; Select. 70. *t. 49*. Cartagena & Martinique = **Randia armata** (Sw.) DC.

MYGINDA, Enum. 1 = **Myginda** Jacq.

MYGINDA URAGOGA, Enum. 12; Select. 24. *t. 16*. Cartagena & St. Martin = **Myginda uragoga** Jacq.
See Urban, Symb. Antill. **5**: 72, 79. 1904 & **8**: 384. 1920, for comments.

MYROSPERMUM, Enum. 4 = **Myrospermum** Jacq.

MYROSPERMUM FRUTESCENS, Enum. 20; Select. 120. *t. 174, f. 34*. Cartagena = **Myrospermum frutescens** Jacq.

MYRTUS TRIFLORA, Enum. 23; Select. 153. *t. 183, f. 59*. Cartagena = **Eugenia triflora** ex Index Kewensis.
Rogers McVaugh (pers. comm.) has been unable to find herbarium material of this taxon and it cannot be placed satisfactorily.

NISSOLIA, Enum. 7 = **Nissolia** Jacq. Conserved name.

NISSOLIA ARBOREA, Enum. 27; Select. 199. *t. 174, f. 48*. Cartagena = **Machaerium arboreum** (Jacq.) Vog.

NISSOLIA FRUTICOSA, Enum. 27; Select. 198. *t. 179, f. 44*. Cartagena = **Nissolia fruticosa** Jacq. Type species of genus, conserved.
According to Rudd (Contr. U.S. Natl. Herb. **32**(2): 192. 1956) the Jacquin type of this specimen is in the British Museum.

OENOTHERA OCTOVALVIS, Enum. 19, citing *Plum. ic.* 175. *f.* 1; Select. 102. *t. 70*. Caribaeis = **Ludwigia octovalvis** (Jacq.) Raven.

ORCHIS SETACEA, Enum. 29; Select. 220. Not illustrated. Martinique = **Habenaria monorrhiza** (Sw.) Rchb. f. Not *Habenaria setacea* Lindl.

PAULLINIA BARBADENSIS, Enum. 36; Mygind Herb. = **Paullinia barbadensis** Jacq. Radlkofer (Pflanzenreich IV. **165**(Heft 98b): 334. 1932) indicated he saw a type in the herb. Univ. Pestinae.
None of the species Jacquin described (Enum. 35–38) credited to the Mygind herbarium can be found in Budapest. Two have more recently been cited from the Banks Herbarium at the British Museum but the others have not been located.

PAULLINIA TOMENTOSA, Enum. 37. Mygind Herb. = **Paullinia tomentosa** Jacq. Houstoun specimen of Herb. Mygind in Herb. Banks (BM).

PECTIS PUNCTATA, Enum. 28, citing *Plum. ic.* 86. *f.* 1; Select. 216. *t. 128*. Cartagena = **Pectis linifolia** L. (1759).

PEFLIS TETRANDRA, Enum. 18, citing *Brown. Jam.* I. *p.* 145; Select. 100. *t. 182, f. 29*. Havana, Cuba = **Lucya tetrandra** (L.) Schum. BASIONYM: *Peplis tetrandra* L. 1759, with same holotype.

PETESIA TOMENTOSA, Enum. 12; Select. 18. Not illustrated. Cartagena.

Petesia L. (Syst. Nat. ed. 10. 894. 1759) is regarded as a synonym of *Rondeletia* L. (1753). *Petesia tomentosa* Jacq. is not the same plant as *Rondeletia tomentosa* Sw. from Jamaica. The Jacquin taxon cannot be placed.

A Field Museum photo, #81 of Herb. Kunth ex Herb. Bonpl. (Herb. Berlin) is labeled as of the type specimen. The collection, from Rio Magdalena, Colombia, has two leaves only and does not match the Jacquin description.

PETITIA, Enum. 1 = **Petitia** Jacq.

PETITIA DOMINGENSIS, Enum. 12; Select. 14. *t. 182, f. 6.* Domingo = **Petitia domingensis** Jacq.

PETRAEA, Enum. 6 = **Petrea** L. (1753).

PETRAEA, Select. 180, *t. 114* as *Petraea volubilis* citing *Linn. sp. pl.* I. *p.* 626. 1753. = **Petrea volubilis** L.

PHASEOLUS SCLAREODES, Enum. 27; Select. 201. Not illustrated. Havana, Cuba = **Phaseolus sclareodes** as "sclaraeoides Jacq." in Index Kewensis. Not considered in recent floristic treatments.

PISCIDIA ERYTHRINA, Enum. 27, citing *Linn. syst.* "1755" (Sphalm. 1155); Select. 209. Not illustrated. Jamaica = **Piscidia piscipula** (L.) Sarg. BASIONYM: *Erythrina piscipula* L. 1753.

PISCIDIA CARTHAGENENSIS, Enum. 27; Select. 210. Not illustrated. Cartagena = **Piscidia carthagenensis** Jacq. See Rudd, Phytologia **18**: 490. 1969.

PISTIA, Enum. 8 = **Pistia** L. 1753.

PORTULACA PANICULATA, Enum. 22; Select. 148. Not illustrated. Domingo and Martinique = **Talinum paniculata** (Jacq.) Gaertn.

Portulaca paniculata Jacq. is not illustrated and no specimens have been seen by previous workers, yet this is the basionym of the taxon proposed by Dandy (Taxon **18**(4): 465. 1969) as the lectotype of *Talinum* A. L. Jussieu without discussion of the fact that Britton and Wilson (Sci. Surv. Puerto Rico Virgin Is. **5**(2): 298. 1924) proposed *Portulaca triangularis* Jacq. as the type species for which they gave the reference to Adanson (Fam. Pl. **2**: 245. 1763).

The Committee for Spermatophyta (McVaugh, Taxon **20** (2/3): 385. 1971) agreed that *Talinum* required conservation but did not consider the proposal by Dandy to be acceptable. The conservation of *Talinum* and the typification of the genus currently remains in limbo.

PORTULACA TRIANGULARIS, Enum. 22, citing *Plum. ic.* 150. *f.* 2; Select. 147. Not illustrated. Caribaeis = **Talinum triangulare** (Jacq.) Willd.

In many publications, the most recent being F. Segadas-Vianna *et al.*

(Flora Ecol. Restingas S. E. Brasil, 2. Portulacaceae 31. 1965), *Portulaca fruticosa* L. (Syst. Nat. ed. 10. 1045. 1759) is listed in the synonymy of *Talinum triangulare* (Jacq.) Willd. Being an older name it would appear to be the proper basionym. Dandy (Taxon 18(4): 465. 1969) discussed *Portulaca fruticosa* L. noting the confusion in Linnaeus's works relating to this taxon. He also noted that there was no supporting specimen available and in essence he rejected the name *Portulaca fruticosa* as ambiguous.

POTHOS ACAULIS, Enum. 31, citing *Plum. Amer. t.* 57, *fig. innominata supra fig. i*; Select. 240. *t. 153*. Martinique = **Anthurium acaule** (Jacq.) Schott.

PSORALEA CARTHAGENENSIS, Enum. 27, citing *Pluk. Phyt. t.* 166, *f.* 2; Select. 206. Not illustrated. Martinique = **Dalea carthaginensis** (Jacq.) Macbr.

PSYCHOTRIA CARTHAGENENSIS, Enum. 16; Select. 65. *t. 174, f. 22*. Cartagena = **Psychotria carthagenensis** Jacq. For discussion see Steyermark, Mem. N. Y. Bot. Gard. 23: 468. 1972.

PSYCHOTRIA DOMINGENSIS, Enum. 16; Select. 66. Not illustrated. Domingo = **Palicourea domingensis** (Jacq.) P. DC.

PSYCHOTRIA HERBACEA, Enum. 16 citing *Rheede Mal.* 10. *t.* 21; Select. 66. *t. 46*. Martinique = **Geophila repens** (L.) Johnston. For discussion see Sargentia 8: 281. 1949, and Steyermark, Mem. N. Y. Bot. Gard. 23: footnote 389, 395. 1972.

RAUVOLFIA HIRSUTA, Enum. 14, citing *Brown. Jam. t.* 1, *p.* 180; Select. 47. Not illustrated. Domingo = **Rauvolfia tetraphylla** L.

For discussion of this and the following species of *Rauvolfia*, see Rao, Ann. Missouri Bot. Gard. 43: 235, 334. 1956.

RAUVOLFIA NITIDA, Enum. 14; Select. 47. Not illustrated. Domingo = **Rauvolfia nitida** Jacq.

RAUVOLFIA TOMENTOSA, Enum. 14; Select. 48. Not illustrated. Cartagena = **Rauvolfia tetraphylla** L.

Rao stated he saw a specimen annotated by Jacquin in Vienna but he failed to cite the collection in the specimens listed.

RHAMNUS COLUBRINUS, Enum. 16, citing *Commel. Amst. t.* 90; Select. 74. Not illustrated. Martinique, Domingo, Cuba, Jamaica = **Colubrina arborescens** (Mill.) Sarg.

RHAMNUS CUBENSIS, Enum. 16; Select. 75. Not illustrated. Cuba = **Colubrina cubensis** (Jacq.) Brongn.

RHAMNUS DOMINGENSIS, Enum. 17; Select. 264. *t. 179, f. 4* as *Gouania glabra*, (illegitimate). Domingo = **Gouania lupuloides** (L.) Urb. BASIONYM: *Banisteria lupuloides* L. 1753.

RHAMNUS IGUANAEUS, Enum. 16, citing *Commel. Amst. t.* 73; Select. 74. Not illustrated. Caribaeis & Continente = **Celtis iguanaeus** (Jacq.) Sarg.

RHAMNUS POLYGAMUS, Enum. 17; Select. 263, as *Gouania tomentosa* (illegitimate) Domingo = **Gouania polygama** (Jacq.) Urb.

ROBINIA SEPIUM, Enum. 28; Select. 211. *t. 179, f. 101.* Cartagena = **Gliricidia sepium** (Jacq.) Kunth, Synop. **4**: 80. 1825.

Credit for the transfer of this species to *Gliricidia* has been given to several authors. Kunth appears to have been the first to make the combination.

ROBINIA VIOLACEA, Enum. 28; Select. 210. *t. 177, f. 49.* Cartagena = **Lonchocarpus violaceus** (Jacq.) DC.

RONDELETIA ODORATA, Enum. 16; Select. 59. *t. 42.* Havana, Cuba = **Rondeletia odorata** Jacq.

RONDELETIA DISPERMA, Enum. 16; Select. 59. Not illustrated. "Baru, Tierra Bomba, Colombia" = **Rondeletia disperma** Jacq. The name is not used in any modern treatment.

RUSSELIA, Enum. 6 = **Russelia** Jacq.

RUSSELIA SARMENTOSA, Enum. 25; Select. 178. *t. 113.* Havana, Cuba = **Russelia sarmentosa** Jacq.

RUYSCHIA, Enum. 2 = **Ruyschia** Jacq.

RUYSCHIA CLUSIAEFOLIA, Enum. 17; Select. 75. *t. 51, f. 2.* Martinique = **Ruyschia clusiaefolia** Jacq.

SAMYDA, Enum. 4 = **Samyda** Jacq. (Name conserved over *Samyda* L. 1753.)

SAMYDA DECANDRA, Enum. 21; Select. 131. Not illustrated. St. Martin = **Samyda dodecandra** Jacq.

SAMYDA DODECANDRA, Enum. 21, citing *Plum. ic.* 146, *f.* 2; Select. 132. Not illustrated. Domingo = **Samyda dodecandra** Jacq.

SAPIUM, Enum. 9 = **Sapium** P. Br. 1756.

SAPIUM AUCUPARIUM, Enum. 31, citing *Plum. ic.* 171, *f.* 2. *Brown. Jam.* 1. *p.* 338; Select. 249. *t. 158.* Cartagena.

Treatments of this taxon have varied greatly. One interpretation is that of Croizat (Jour. Arnold Arb. **24**: 174. 1943) and the most recent that of Jablonski (Phytologia **16**: 393–434. 1968). Jablonski could not find in Vienna any material seen or collected by Jacquin (p. 404). He could not identify the Plumier reference (p. 404) and he assigned the Browne reference to *Sapium jamaicense* Sw. (p. 398).

SCHAEFFERIA, Enum. 10 = **Schaefferia** Jacq.

SCHAEFFERIA FRUTESCENS, Enum. 33; Select. 259. Not illustrated. Cartagena = **Schaefferia frutescens** Jacq.

SCOPARIA PROCUMBENS, Enum. 12; Select. 18. Not illustrated. Cartagena = **Scoparia dulcis** ex Index Kewensis and Mueller Arg. in DC. Prodr. 10: 431. 1846, with doubt. Not considered in recent treatments. Pennell did not list the epithet in his "Scrophulariaceae of Colombia I. (Contrib. N. Y. Bot. Gard. 27: 1920).

SCUTELLARIA HAVANENSIS, Enum. 25; Select. 172. Not illustrated. Havana, Cuba = **Scutellaria havanensis** Jacq.

SECURIDACA, Enum. 7 = **Securidaca** L. 1759, name conserved.

SECURIDACA ERECTA, Enum. 27, citing *Brown. Jam.* I. *p.* 287 = **Securidaca diversifolia** (L.) Blake.

The description in the *Enumeratio* is short "Securidaca caule erecto" and followed by reference to a description by Browne. It is this Browne reference which forms the basis of *Securidaca virgata* Sw. (Prodr. 104. 1788).

In the *Selectarum* (p. 197. *t. 183, f. 39*. 1763) Jacquin does not repeat the Browne reference, describes a plant briefly and reports it from Case Pilote, Martinique. Urban (Repert. Sp. Nov. Beih. **5**: 96. 1920) noted "*Securidaca erecta* Jacq. (1760) p. 27 (excl. cit. Brown.) et Sel. Amer. p. 197 . . ." It is apparently on this basis that Blake (Contr. U. S. Natl. Herb. **23**: 594. 1923) referred *Securidaca erecta* Jacq. to the synonymy of *Securidaca diversifolia* (L.) Blake. The assumption must be made that Jacquin changed his mind between publication of the *Enumeratio* and the *Selectarum* and accepted the fact that his species was different from that described by Browne. Fawcett and Rendle (Flora Jam. **4**: 246. 1920) accepted Jacquin's original reference to Browne as the typification of *Securidaca erecta* and placed *S. virgata* Sw. in synonymy. Blake (N. Am. Fl. **25**: 372. 1924) rejected this conclusion and used *S. virgata*. Adams (Flowering Plants of Jamaica 403. 1972) has followed Blake. *Securidaca* has been conserved (#4275) with the type *S. volubilis* L., 1759, a taxonomic synonym of *S. diversifolia*. *Securidaca diversifolia* (L.) Blake is known from Martinique but not from Jamaica. The typification of *Securidaca erecta* Jacq., therefore, rests on the *Selectarum* citation and the locale of Martinique and not on that of the *Enumeratio*. The protologue of *Polygala diversifolia* L. was changed successively in *Species Plantarum*, ed. 1, *Systema Naturae*, ed. 10, and *Species Plantarum*, ed. 2. However, Blake (Contr. Gray Herb. **47**: 15. 1916) typified the species by his statement "Linnaeus's *Polygala diversifolia* was based solely on a Cliffortian specimen, now in the British Museum, of *Securidaca volubilis* L., of which it becomes a synonym." He did not retain this viewpoint. No special locality is given for the Clifford specimen but *S. diversifolia* is not known today from Jamaica. The specimen labeled *Polygala diversifolia* in the Linnaean herbarium (882.20) is a mixed collection and neither the fruiting

(?) specimen nor the single leaf appear to be *Polygala* and certainly not *Securidaca*.

SECURIDACA SCANDENS, Enum. 27, citing *Linn. spec. pl.* 1 = **Dalbergia monetaria** L. f.

This is a complicated story comparable to that of *Securidaca erecta*, but one in which an opposite conclusion has been reached, i.e., the *Enumeratio* citation is identified and the *Selectarum* protologue is not.

In the *Enumeratio* Jacquin cited a Linnaean reference, Sp. Pl. (707, as *Securidaca volubilis*) where Linnaeus gives a polynomial of Plumier (Spec. 19) referring to a white-flowered cauliflorous plant now recognized as *Dalbergia monetaria* L. f. Taken as published, Jacquin's binomial is illegitimate, being superfluous, although the name is applied currently to a species of *Securidaca* from South America.

Urban (Fedde Repert. Sp. Nov. **16**: 136. 1919; Beih. **5**: 95. 1920) proposed the combination "Dalbergia volubilis (L.) Urb. not Roxb." with the basionym *Securidaca volubilis* L. The earlier name proposed by Roxburgh was for a plant from India, while the Linnaean name was associated with a plant described by Plumier from the Americas. **Dalbergia monetaria** L. f. appears to be the first available name for the Western Hemisphere plant.

It is also true that Linnaeus changed his mind. He described "Securidaca volubilis" citing Browne Jam. 287 (Sp. Pl. 707. 1753) and in the second edition of *Species Plantarum* (p. 922. 1763) Linnaeus accepted *Securidaca erecta* Jacq. and repeated the Browne reference.

In the *Selectarum* (p. 197. *t. 183, f. 83*) Jacquin described and illustrated a species of *Securidaca* from Cartagena. In the protologue Jacquin added a question mark to the Linnaean reference to *Securidaca volubilis* but cited in addition *Browne, Jam. 2, p.* 241 (pagination error for 288) which Grisebach (Fl. Brit. W. I. Is. 30. 1859) later named *Securidaca brownei*. The description given could apply to *Securidaca brownei*, however that species is today regarded as endemic to Jamaica. I cannot explain the statement by Fawcett and Rendle (Flora Jam. **4**: 247. 1920) that "The specimen of *S. volubilis* L. Sp. Pl. 707 in the Linnean Herbarium is *Nissolia fruticosa* Jacq." Blake was able to locate and photograph (GH) a Jacquin collection of *Securidaca scandens* in the British Museum which he has labeled as the type. This is a *Securidaca*. Five detached leaves, a short piece of stem and some flowers comprise the specimen attributed to Cartagena. From the small photograph of poor quality made in 1925, this material appears comparable to recent collections named *Securidaca scandens* from the Cartagena area. Since the binomial *Securidaca scandens* Jacq. is illegitimate, a new name must be found for this material by someone willing to monograph the South American species of *Securidaca*.

Thus, in summary, *Securidaca scandens* Jacq. (1760) has been identified by Urban on the basis of the Plumier reference given by Jacquin. The altered description of *Securidaca scandens* Jacq. (1763), excluding the

references to Linnaeus and Browne, remains that of a plant without a name.

SICYOS EDULIS, Enum. *32*; Select. *258*. *t. 163*. Cuba = **Sechium edule** (Jacq.) Sw.

SIDA TRISULCATA, Enum. *26*; Select. *195*. Not illustrated. Domingo = **Abutilon trisulcatum** (Jacq.) Urb.

SIDEROXYLUM FOETIDISSIMUM, Enum. *15*; Select. *55*. Not illustrated. Domingo = **Mastichodendron foetidissimum** (Jacq.) Lam.

SIDEROXYLUM PAUCIFLORUM, Enum. *15*; Select. *55*. Not illustrated. Domingo = **Mastichodendron foetidissimum** (Jacq.) Lam.

SIDEROXYLUM SAPOTA, Enum. *15*, citing *Sloane Jam. t. 218*; Select. *56*. *t. 182, f. 19*, as *Achras sapota major*. Cartagena, Cuba, Jamaica = **Pouteria sapota** (Jacq.) Moore & Stearn, Taxon **16**: 383. 1967.

SMILAX HASTATA, Enum. *33*; Select. *262*. *t. 179, f. 103*. Domingo = **Smilax hastata** Jacq.

SMILAX HAVANENSIS, Enum. *33*; Select. *262*. *t. 179, f. 102*. Havana, Cuba = **Smilax havanensis** Jacq.

SOLANUM BOMBENSE, Enum. *15*; Select. *49*. Not illustrated. Cartagena = **Solanum glabrum** *fide* Index Kewensis.

Dunal (DC. Prodr. **13**(1): 102. 1852) referred "S. Bombense Jacq. Amer. p. 49?" to the synonymy of his *Solanum glabrum*. Later (*ibid*. p. 270) Dunal cited *S. bombense* for specimens in the Banks herbarium under his *Solanum stenorchis*. Since the Banks Herbarium does contain some material from Jacquin it is possible that these collections do represent holotype material of Jacquin's species. *Solanum stenorchis* Dunal may well be a synonym of *Solanum bombense*.

SOLANUM HAVANENSE, Enum. *15*; Select. *49*. *t. 35*. Havana, Cuba = **Solanum havanense** Jacq.

SOLANUM RACEMOSUM, Enum. *15*; Select. *50*. *t. 36*. Martinique = **Solanum racemosum** Jacq.

SOLANUM SUBINERME, Enum. *15*; Select. *50*. *t. 36*. Martinique = **Solanum subinerme** Jacq.

D'Arcy (pers. comm.) reports that "the type, consisting of the leaf and flower from which the plate was made is at the British Museum."

SOLANUM TRISTE, Enum. *15*; Select. *50*. *t. 40, f. 2*. Martinique = **Solanum triste** Jacq.

SOPHORA HAVANENSIS, Enum. *20*; Select. *118*. *t. 173, f. 1*. Havana, Cuba = **Sophora tomentosa** L.

SPERMACOCE SPINOSA, Enum. 12; Select. 21. Not illustrated. Havana, Cuba.

Steyermark (Mem. N. Y. Bot. Gard. 23: 814. 1972) concluded that this name is ambiguous and should be rejected. It is not his *Borreria densiflora* DC.

SPILANTHES, Enum. 8 = **Spilanthes** Jacq.

SPILANTHES INSIPIDA, Enum. 28; Select. 215. *t. 126, f. 2.* Havana, Cuba = **Spilanthes insipida** Jacq.

SPILANTHES URENS, Enum. 28; Select. 214. *t. 126, f. 1.* Cartagena = **Spilanthes urens** Jacq.

SPINACIA LITTORALIS, Enum. 33; Select. 244. *t. 235* as *Axyris pentandra* (illegitimate). Cuba = **Atriplex cristata** H. & B. ex Willd. Sp. Pl. 4: 959. 1806.

Jacquin (Select. 244) refers to his earlier assignment of this plant to *Spinacia.* Fawcett and Rendle (Jour. Bot. 64: 15. 1926) reported that a specimen of *Spinacia littoralis* was in the Banks Herbarium (BM) and they made the combination *Atriplex littoralis* based on *Spinacia littoralis* Jacq. This is not *Atriplex littoralis* L. (Sp. Pl. 1054. 1753). The name *Atriplex cristata* H. & B. ex Willd. appears to be the next available name.

STRUMPFIA, Enum. 8 = **Strumpfia** Jacq.

STRUMPFIA MARITIMA, Enum. 28, citing *Sloane Jam.* 2. *t.* 189, *f.* 2; Select. 218. Not illustrated. Curaçao = **Strumpfia maritima** Jacq.

SURIANA, Enum. 4 = **Suriana** L. (1753).

SWIETENIA, Enum. 4 = **Swietenia** Jacq.

SWIETENIA MAHAGONI, Enum. 20, citing *Catesb. Car.* 2. *t.* 81; Select. 127, citing *Linn. syst. B.p.* 940. [1759]. Not illustrated. Caribaeis = **Swietenia mahagoni** (L.) Jacq. 1760.

"CEDRELA *Mahag.*" (L. Syst. Nat. ed. 10. 940. 1759) and *Swietenia mahagoni* Jacq. (Enum. 20. 1760) are based on the same type, Catesby Car. 2. *t. 81.* According to article 63, Jacquin's name is illegitimate but can be used if it is considered to be a new combination.

SYMPLOCOS, Enum. 5 = **Symplocos** Jacq.

SYMPLOCOS MARTINICENSIS, Enum. 24; Select. 166. *t. 175, f. 68.* Martinique = **Symplocos martinicensis** Jacq.

TABERNAEMONTANA AMYGDALIFOLIA, Enum. 14; Select. 39. *t. 181, f. 15.* Cartagena = **Tabernaemontana amygdalifolia** Jacq.

TABERNAEMONTANA CYMOSA, Enum. 14; Select. 39. *t. 181, f. 14.* Cartagena = **Peschiera cymosa** (Jacq.) Dugand.

TABERNAEMONTANA GRANDIFLORA, Enum. 14; Select. 40. *t. 31.* Cartagena = **Stemmadenia grandiflora** (Jacq.) Miers.

TEREBINTHUS, Enum. 3 = **Bursera** Jacq. ex L. Sp. Pl. ed. 2. 471. 1762 (conserved name).

Terebinthus Jacq. is a later homonym of *Terebinthus* Mill. (1754) which is a combination of *Pistacia* L. and *Bursera* L. (Airy Shaw, Dict. 1107. 1966). Jacquin's description, however, is of *Bursera* alone.

TEREBINTHUS BROWNII, Enum. 18, citing *Sloane Jam. t.* 199.

Urban (Symb. Antill. **5**: 402. 1908) proposed the name *Metopium brownei* and cited as synonyms *Rhus metopium Linn. Syst. X ed. II (1759) p. 964*, and *Terebinthus Brownii Jacq. Enum. (1760) p. 18*, among others. Urban did not use parentheses to designate parenthetical authors or authors of basionyms and he did not use tautonyms. All recent authors have referred to this taxon as *Metopium brownei* (Jacq.) Urb.

The question of typification arises. *Terebinthus brownii* Jacq. refers to Sloane, Jam. *t.* 199 which contains three figures, *Figures 1* and *2* of the Sloane plate are *Bursera simaruba* while *figure 3* is *Metopium*. Jacquin abandoned the epithet "brownii" in a further discussion of *Burseria gummifera* (Select. 94. 1763). Brownii as a specific epithet should be considered as an illegitimate name and a later synonym in *Bursera*.

Urban's treatment, therefore, should be considered as a new name for *Metopium brownei*, not a transfer of a Jacquin species. The type could be that of *Rhus metopium* L., an illustration by Browne, or of *Terebinthus maxima* Sloane, *plate 199, fig. 3*. The latter is more typical of the species and should be considered the lectotype.

TETRAGONOTHECA PARVIFLORA, Enum. 28. Not given in Select. = **Tetragonotheca** *fide* Index Kewensis.

McCart, a recent student of this genus, concluded that the description does not refer to a *Tetragonotheca*. He was unable to locate any authentic material.

TEUCRIUM CUBENSE, Enum. 25; Select. 47. Not illustrated. Cuba = **Teucrium cubense** Jacq.

TOURNEFORTIA MACULATA, Enum. 14; Select. 47. Not illustrated. Cartagena = **Tournefortia maculata** Jacq.

TRADESCANTIA GENICULATA, Enum. 18, citing *Plum. ic.* 116. *f.* 2; Select. 94. *t. 64.* Martinique = **Gibasis geniculata** (Jacq.) Rohweder.

TRAGIA HEXANDRA, Enum. 31; Select. 245. *t. 173, f. 63.* Havana, Cuba = **Platygyne hexandra** (Jacq.) Müll.-Arg.

TRICHILIA, Enum. 4 = **Trichilia** P. Br. 1756.

TRICHILIA HAVANENSIS, Enum. 20; Select. 129. *t. 175, f. 38.* Havana, Cuba = **Trichilia havanensis** Jacq.

TRICHILIA SPONDIODES, Enum. 20, citing *Brown. Jam.* I, *p.* 278; Select. 128. Not illustrated. Domingo, Jamaica, Cartagena = **Trichilia hirta** L.

The Browne reference cited by Jacquin was considered by Linnaeus (Syst. Nat. ed. 10. 1020. 1759) to represent two species. *Trichilia hirta* L. is based on Browne, 278. *f. 1. Trichilia glabra* L. is based on Browne, 278. *f. 2.* The description given by Jacquin (Enum. 20) is "racemis axilaribus; foliis pinnatis; foliolis lanceolato-ovatis" and the Jacquin epithet has been referred to *T. hirta* L. by Wilson (N. Am. Fl. **25:** 286. 1924) and subsequent workers.

TRICHILIA TRIFOLIA, Enum. 20, citing *Linn. syst.* [ed. 10.] 1020; Select. 129–132. Curaçao & Continente = **Trichilia trifolia** L. In 1762 Linnaeus (Sp. Pl. ed. 2. 551) changed this epithet to "trifoliata" which has been used in recent floras.

TRIGONIA, Enum. 3 = **Cupania** L. (1753).

TRIGONIA TOMENTOSA, Enum. 19; Select. 102. Not illustrated. Domingo = **Cupania americana** L.

TRIUMFETTA LAPPULA, Enum. 22, citing *Linn. spec. pl.* I. *p.* 444; Select. 146. Not illustrated. Martinique = **Triumfetta lappula** L.

TRIUMFETTA RHOMBOIDEA, Enum. 22; Select. 147. *t. 90.* Martinique = **Triumfetta rhomboidea** Jacq.

TRIUMFETTA SEMITRILOBA, Enum. 22, citing *Brown. Jam. 2. p.* 233; Select. 146. Not illustrated. Caribaeis = **Triumfetta semitriloba** Jacq.

UTRICULARIA ALPINA, Enum. 11; Select. 7. *t. 6.* Martinique = **Utricularia alpina** Jacq.

VARRONIA, Enum. 2 = **Varronia** P. Br. (1756).

VARRONIA ALBA, Enum. 14, citing *Commel. Amst. t.* 80; Select. 41. Not illustrated. Cartagena and Curaçao = **Cordia alba** (Jacq.) R. & S.

VARRONIA CURASSAVICA, Enum. 14, citing *Brown. Jam. 2. p.* 172; Select. 40, without specific epithet. Not illustrated. Curaçao = **Cordia curassavica** (Jacq.) R. & S.

VARRONIA GLOBOSA, Enum. 14; Select. 41. Not illustrated. Caribaeis = **Cordia globosa** (Jacq.) H.B.K.

VARRONIA HUMILIS, Enum. 14, citing *Brown. Jam. t.* 13, *f.* 2; Select. 41. Not illustrated. Caribaeis = **Cordia globosa** (Jacq.) Kunth var. **humilis** (Jacq.) Johnst.

VARRONIA MACROSTACHYA, Enum. 14; Select. 41, as "macrostachia." Not illustrated. Cartagena = **Cordia curassavica** (Jacq.) R. & S. See the discussion by I. M. Johnston, Jour. Arnold Arb. **30:** 99. 1949.

VARRONIA MARTINICENSIS, Enum. 14; Select. 41. *t. 32*. Martinique = **Cordia martinicensis** (Jacq.) R. & S.

VARRONIA MIRABILOIDES, Enum. 14; Select. 41. *t. 33*. Domingo = **Cordia mirabiloides** (Jacq.) R. & S.

VICIA DISTICHA, Enum. 27. Omitted in Select. = **Vicia disticha** in Index Kewensis.

Mr. C. R. Gunn, a student of the genus *Vicia*, reported that the description is not of a *Vicia*. No material has been seen and the specific epithet has not been used in any treatment known to me.

VICIA LITTORALIS, Enum. 27; Select. 206. *t. 124*. Cartagena = **Tephrosia littoralis** (Jacq.) Pers.

WEDELIA, Enum. 8 = **Wedelia** Jacq. Conserved name.

WEDELIA FRUTICOSA, Enum. 28; Select. 217. *t. 130*, as *Wedelia frutescens* (illegitimate), Cartagena = **Wedelia fruticosa** Jacq.

XIMENIA, Enum. 3 = **Ximenia** L. (1753).

XIMENIA MULTIFLORA, Enum. 19, citing *Plum. gen.* 6; Select. 106. *t. 177, f. 31*. Cartagena & Domingo = **Ximenia americana** L. 1753.

ZYGOPHYLLUM ARBOREUM, Enum. 20; Select. 130. *t. 83*. Cartagena = **Bulnesia arborea** (Jacq.) Engl. The reference for the publication of this combination has been cited variously but the correct citation is Nat. Pflanzenfam. III. 4: 84. 1896.

ARNOLD ARBORETUM
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138

REVISION OF KENTROTHAMNUS (RHAMNACEAE)

MARSHALL C. JOHNSTON

THE GENUS *Kentrothamnus* was established by Suessenguth and Overkott (Fedde Repert. Sp. Nov. **50**: 326. 1941) to accommodate South American plants which are related to *Colletia* Juss. and *Discaria* Gill. & Hook., differing from the former in the lack of any revolute nectarial structure at the rim of the disk and from the latter in the thin disk lining the cup. The generic distinctions of these three, *Colletia*, *Discaria*, and *Kentrothamnus*, are obviously tenuous. Escalante (Bol. Soc. Arg. Bot. 1: 223. 1946), in effect, submerged *Kentrothamnus* in *Discaria*, but this procedure seems to me to have no greater merit than simply to merge all three genera under the name *Colletia*, a radical course of action which I, at least tentatively, reject.

A specimen of *Kentrothamnus* which came into possession of J. Miers was described by him (Ann. Mag. Nat. Hist. ser. 3. **5**: 491. 1860) in the genus *Trevoa* Hook.; this is a natural consequence of the nature of the disk, which did not permit him to refer the species to either *Colletia* or *Discaria*. Had the specimen been in fruit, of course, Miers would have had to face the problem of generic assignment which was ultimately faced and solved by Suessenguth and Overkott. Miers's specific epithet is the earliest one available for *Kentrothamnus* and the transfer is made below.

Kentrothamnus, in its lack of the revolute nectary of *Colletia*, and its lack of the swollen disk of *Discaria*, as well as in its undistinguished capsular fruits (like those of *Colletia*, *Discaria* and *Ceanothus* L.), possesses a combination of a number of characters probably primitive in the Tribe Colletieae. Of all the South American plants of this tribe, *Kentrothamnus* probably comes closest to being an "ancestral" type, and of all of them it is most similar to the solitary North American genus of the tribe, *Adolphia* Meisn.

Kentrothamnus Suessenguth & Overkott, Fedde Repert. Sp. Nov. **50**: 326. 1941. Generico-specific description: Shrubs 1–4 m. tall; branches decussate, terete, in at least 2 size-classes, the primaries elongate and arcuate, the secondaries 1–8 cm. long, 1–2 mm. thick, rigid and thorn-tipped, all olive-green to olive-brown and rather densely pubescent with yellowish straightish or crisped, spreading or somewhat retrorsely curved hairs 0.1–0.3 mm. long, occasionally the secondaries with shorter thorn-tipped tertiaries, each secondary and tertiary branch usually with only one leaf- or flower-bearing node near the middle, the young developing primaries with many such nodes. Leaves decussate (sometimes slightly offset, not perfectly opposite); blades obovate to ovate to oblong, 3–15 mm. long, 3–4 mm. wide, penninerved, with more or less dense pubescence of yellowish antrorse-appressed crisped hairs 0.1–0.2 mm. long; petioles more or

less 1 mm. long, slender, pubescent; stipules subulate, ca. 1 mm. long, pubescent, dark, caducous leaving a minute blackish gland-like structure at base of each side of the petiole. Flowers solitary or in few-flowered fascicles, bisexual, 5-merous, nodding on pedicels 1–2 mm. long (elongating to 2–5 mm. in fruit); floral cup 3–4 mm. long, the lower moiety (the part lined by the disk and destined by accrescence to become the fruit-pedestal) hemispheric, pale reddish green, the upper moiety slightly campanulate, whitish with vertical roseate stripes leading to the stamen-attachments, the inner surface smooth, the outer pubescent with whitish crisped more or less spreading hairs 0.2–0.3 mm. long; sepals deltoid, ca. 1.5 mm. long, whitish; petals ca. 1 mm. long with a short basal claw and an ovate hoodlike portion, whitish; stamens at first hooded by the petals, then exposed by petal-reflexing; filaments whitish; disk lining the lower moiety of the cup, thin or at rim slightly thickened at the reddish vertical stripes of the cup and between those stripes. Ovary 3-celled, free from the disk and from the cup, glabrous; style about equalling the sepals. Fruit a 3-parted schizocarpous pedestalled capsule ca. 5 mm. long, the 3 parts at maturity separating from each other and from the pedestal and each splitting in a ventral-apical midline to release the seed. TYPE SPECIES here designated: *K. penninervius* Suessenguth & Overkott.

Kentrothamnus weddellianus (Miers) M. C. Johnst., comb. nov.

Trevoa weddelliana Miers, Ann. Mag. Nat. Hist. ser. 3. **5**: 491. 1860. (TYPE: Bolivia, circa Chuquisaca, *d'Orbigny 1212*, BM–MIERS!, isotype, BR!)

Colletia foliosa Rusby, Mem. Torrey Bot. Club **3**(3): 16. 1893. (TYPE: Bolivia, vicinity of Cochabamba, 1891, *A. M. Bang 978*, holotype NY!, isotypes BM! E! K! M! NY! US!).

Colletia foliosa var. (β) *microphylla* O. Kuntze, Rev. Gen. Pl. **3**(2): 38. 1898. (TYPE: Bolivia, Cochabamba, 3000 m., 26 Mar. 1892, *O. Kuntze s.n.*, holotype NY!, isotype, US!).

Kentrothamnus foliosus (Rusby) Suesseng., Fedde Repert. Sp. Nov. **50**: 327. 1941.

Kentrothamnus penninervius Suesseng. & Overk., Fedde Repert. Sp. Nov. **50**: 327. 1941. (TYPE: Bolivia, Sala-sala-Tasnapaloa, 3600 m., 12 Mai 1927, *Troll 3360*, holotype B!, isotype M!).

Discaria weddelliana (Miers) Escalante, Bol. Soc. Arg. Bot. **1**: 223. 1946.

The description is given above, since the genus is considered to be monotypic. Suessenguth and Overkott (loc. cit., and in Natürlichen Pflanzenfamilien ed. 2. **20d**: 164, 165. 1953) attempted to distinguish two species, mainly on the basis of the placement of slightly swollen portions of the upper margin of the nectarial disk (below the centers of the sepals in *K. penninervius*, below the stamens in *K. foliosus*). Examination of considerably more material than was available to those authors indicates the presence of the level of variation one expects in Rhamnaceae not only from plant to plant in a population, but from stage to stage in anthesis in the same flower. Field observations are necessary to establish the exact sites and sequences of swelling and nectar production in the disk at anthesis.

Specimens seen in addition to the types are cited below:

Bolivia: Challapass, 3800 m., 18 Mar. 1892, *O. Kuntze s.n.* (NY); Cochabamba, Colón, a disused brewery a few km. from Cochabamba, 16 Jan. 1949, *Miss W. M. A. Brooke 5114* (NY); near Cervecería Colón, Quebrada Colón, ca. 20 km. E of Cochabamba in dense thicket near riverbank, 2800 m., 14 Mar. 1939, *W. J. Eyerdam 24787* (UC); Cochabamba, canyon above Taquiña, 12 km. N of Cochabamba, 1 Nov. 1942, *M. Cárdenas & H. Cutler 7409* (GH); cercado de Cochabamba, Cerro San Pedro (falderío), 2575 m., terrenos pedregosos y secos, 23 Apr. 1966, *Roy F. Steinbach 115* (GH).

Argentina: Prov. Jujuy, Dept. Yavi, La Quiaca-Villazon, 3442 m., 24 Jan. 1940, *Schreiter 11230* (GH, NY); Jujuy, Dept. Santa Catalina, Cuesta de Toquero, camino a Sta. Catalina, 21 Jan. 1940, *A. L. Cabrera 7791* (GH).

On the label cited above, Miss Brooke notes that an extraction of the plant is made for use as soap and shampoos. No other economic data are at hand.

It seems clear from the label data that the plant grows in very arid scrub on rocky mountain-slopes, and that it grows taller (3–4 m.) near stream banks than in the more xeric places (1–2 m.).

HERBARIUM AND DEPARTMENT OF BOTANY
THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

INDEX

Abies balsamea, 363
— fraseri, 363
Abietinella abietina, 141, 152
Abutilon trisulcatum, 466
Acacia, 324, 431
— retusa, 459
— riparia, 459
Acalypha carthagenensis, 440
— corensis, 440
— villosa, 440
Acanthocereus pitajaya, 444
Acer, 130
— pensylvanicum, 363
— saccharum, 363
Achras sapota major, 466
Achyranthes altissima, 440
Acmena dispansa, 218
— laevifolia, 218
Acrocarpidium exile, 383
— majus, 397
— nummularifolium f. pilosior, 394
Actinostrobus, 369
Adolphia, 471
Aegiphila, 120
— integrifolia, 444
Agave cubensis, 440
— hexapetala, 440
Albizia, 431
Allophylus occidentalis, 428
Alnus, 412, 417
— nepalensis, 413, 414
Alpinia spicata, 440
Ambrosia, 324
Amentotaxus, The Wood of, 111
Amentotaxus, 111, 117, 118
— argotaenia, 111, 112, 114, 116, 119
— cathayensis, 111, 116, 119
— formosana, 111, 116, 119
— yunnanensis, 119
American elm, 363
Amerimnon, 440
— brownii, 440
Amphilophium paniculatum, 443
Amyris, 440
— maritima, 440
Anacardiaceae, 427
Anacardium, 440
— occidentalis, 440
Anamomis bahamensis, 312
— longipes, 312
Andira inermis, 426
Anemopaegma orbiculatum, 443
Anguria, 440
— dentata, 441
— jacquiniana, 441
— pedata, 441
— — dentata, 441
— — polyphyllos, 441
— plumieriana, 442
— polyphyllos, 441
— trilobata, 441
Annona, 431
— purpurea, 425
— reticulata, 425
Annonaceae, 425
Anthurium acaule, 462
Apeiba tibourbou, 428
Aphelandra pulcherrima, 457
Apocynaceae, 430
Aquartia, 442
— aculeata, 442
Aralia capitata, 442
Araucariaceae, 117
Arctostaphylos alpina, 150
— rubra, 150
— uva-ursi, 148
Ardisia, 2, 36, 40, 235, 237, 246, 431
— brackenridgei, 36
— capitata, 232, 235, 246
— crispa, 40
— grandis, 255
— humilis, 41, 246
— listeri, 268
— megaphylla, 237
— pachyrhachis, 40
— revoluta, 429
— storckii, 37, 38, 40
— vitiensis, 36, 38
Argythamnia polygama, 449
Aristolochia anguicida, 442
— caudata, 442
— maxima, 442
— pentandra, 442
Arrabidea obliqua, 443
Artanthe glabrescens, 403
— martinicae, 408
— sancta, 407
Arthrostylidium, 293, 294, 296
Arum hederaceum, 442
— seguine, 442
Arundinaria, 293, 294, 296, 300, 301, 305
— wightiana, 295

Asclepias altissima, 442
— clausa, 442
— filiformis, 442
— longiflora, 442
— maritima, 443
— planiflora, 443
— racemosa, 443
— undulata, 443
Aster, 364
Astronium, 443
— graveolens, 443
Athroostachys, 293, 296
Atractocarpa, 293, 294, 296
Atragene polygama, 447
Atriplex cristata, 467
— littoralis, 467
Aulacomnium acuminatum, 153, 154, 156
— palustre, 139, 152
— turgidum, 139, 153, 154, 156
Aulonemia, 294
Avicennia, 443
— germinans, 443
— nitida, 443
— tomentosa, 443
Axyris pentandra, 467

Badula sect. Discocalyx, 228
Baeobotrys, 3, 6, 22
— nemoralis, 21
Balsam fir, 363
Bamboo Classification, Present Status and Problems of, 293
Bambusa, 293–296, 300–302, 304
— lineata, 295
Banisteria lupuloides, 462
Barleria, 456
Basswood, 363
Batis, 443
— maritima, 443
Bauhinia, 431
— glabra, 443
Bawa, K. S. Chromosome Numbers of Tree Species of a Lowland Tropical Community, 422
Beech, 363
Belencita nemorosa, 445
Bellis ramosa, 443
Bernardia corensis, 440
— nicaraguensis, 427
Betula, 412, 417
— alnoides, 412, 414
— cylindrostachys, 412
— lenta, 412
— lutea, 363
— papyrifera, 363
— populifolia, 363
— utilis, 413, 414, 417
Betulaceae and Salicaceae, Cytology of West Himalayan, 412
Betulaceae, 412, 414
Bignonia dichotoma, 443
— echinata, 443
— longissima, 443
— orbiculata, 443
— paniculata, 443
Bignoniaceae, 430
Bitter-weed, 68
Black locust, 363
Black oak, 363
Black-eyed Susan, 364
Bladhia crispa, 40
Blueberry, 363
Bocconia, 443
— frutescens, 444
Boehmeria, 444
— ramiflora, 444
Bombacaceae, 428
Bombacopsis quinata, 428, 444
Bombax pentandrum, 444
— quinatum, 444
— septenatum, 444
Boraginaceae, 430
Borreria densiflora, 467
Bourreria, 444
— cumanensis, 444
— exsucca, 444
— quirosii, 430
— succulenta, 444
Brassavola nodosa, 452
Brazil and Guyana in the Genus Hymenaea (Leguminosae, Caesalpinioideae), New Taxa from, 94
Bromelia karata, 444
— karatas, 444
Brownaea, 444
— coccinea, 444
Brownea, 444
— coccinea, 444
Brunfelsia spinosa, 438, 444
Brunsfelsia spinosa, 444
Bryoerythrophyllum recurvirostrum, 135, 153
Bryum pseudotriquetrum, 137
Bulnesia arborea, 470
Bunchosia grandifolia, 458
— nitida, 459
— odorata, 459
Bursera, 451, 468
—glabra, 451
— simarouba, 427
— simaruba, 468
— tomentosa, 427, 451
Burseraceae, 427

Burseria gummifera, 468
Byrsonima crassifolia, 427
— diphylla, 458
Byttneria, 446
— aculeata, 446
— microphylla, 446
— scabra, 446
Cactus pitajaya, 444
Caesalpinia, 431
Caesalpinioideae, 94
Callicarpa integrifolia, 444
Callisia, 453
— repens, 453
Callitris, 369
Calluna vulgaris, 364
Calyptranthes pallens, 309
Campylium chrysophyllum, 141, 153, 154
— stellatum, 141, 152
Capparaceae, 426
Capparis amygdalifolia, 445
— baducca, 445
— breynia, 445
— comosa, 445
— cynallophora, 445
— cynophallophora, 445
— elaeagnifolia, 445
— eustachiana, 445
— ferruginea, 445
— flexuosa, 445
— — — hastata, 445
— frondosa, 445
— hastata, 445
— indica, 445
— jamaicensis, 445
— linearis, 445
— nemorosa, 445
— octandra, 445
— pulcherrima, 445
— tenuisiliqua, 445
— verrucosa, 445
Carex aquatilis, 147
— lanuginosa, 148
— meadii, 148
— torreyi, 148
— viridula, 147
Caroline Islands, The Genus Cyrtandra in the Ryukyu and, 105
Carpinus, 413
— betulus, 413
— faginea, 413
— viminea, 412–414
Carya, 130
— glabra, 363
Caryophyllaceae, 130
Casearia, 445
— aculeata, 445
— decandra, 445
— nitida, 445
Cassia, 431
— biflora, 426
Cassytha, 446
— filiformis, 446
Catalpa longissima, 443
Catananche, 50
Cat's ears, 63
Ceanothus, 471
Cecropia peltata, 425
Cedrela, 431, 467
Ceiba pentandra, 444
Celtis iguanaeus, 463
Cephaelis muscosa, 459
Cephalostachyum, 293–296, 300–302
Ceratodon purpureus, 133, 152
Central America, Three New Species of Picramnia (Simaroubaceae) from, 315
Cestrum alternifolium, 455
— nocturnum, 446
Chaetaea, 446
— aculeata, 446
Chamaesyce bombensis, 452
— mesembrianthemifolia, 452
Chamissoa altissima, 440
Chara, 151
— sejuncta, 132
Characeae, 132
Charophyta, 132
Chestnut oak, 363
Chicory, 48
Chimonobambusa, 296
Chiococca alba, 446
— nocturna, 446
— racemosa, 446
Chomelia, 446
— spinosa, 446
Chondrilla, 50
Chromosome Counts in Cultivated Junipers, 369
Chromosome Numbers of Tree Species of a Lowland Tropical Community, 422
Chrysobalanus, 447
— icaco, 447
Chrysophyllum, 447
— argenteum, 447
— cainito, 447
— glabrum, 447
Chusquea, 293, 296
Cichorium, 46, 47, 49
— sect. Acanthophyton, 48
— sect. Cichorium, 48
Cinchona caribaea, 447

Citharexylum (Verbenaceae): An Addendum, Dioecism in, 120
Citharexylum, 120, 449
— fruticosum, 120
— montevidense, 120
— spinosum, 449
Cleistocalyx baeuerlenii, 218
Clematis dioica, 447
— polygama, 447
Cleome procumbens, 447
— serrata, 447
— spinosa, 447
Clinopodium martinicense, 447
Clusia alba, 447
— flava, 447
— major, 447
— minor, 447
— rosea, 447
— venosa, 447
Coccoloba barbadensis, 447, 453
— coronata, 448
— diversifolia, 448
— emarginata, 448
— flavescens, 448
— grandifolia, 448
— leoganensis, 448
— nivea, 448
— obtusifolia, 448
— pubescens, 448
— uvifera, 448
— venosa, 448
Coconut palm, 363
Cocos nucifera, 363
Coffea occidentalis, 448
Colletia, 471
— foliosa, 472
— — (β) microphylla, 472
Colubrina arborescens, 462
— cubensis, 462
Combretum decandrum, 448
— fruticosum, 448
— laxum, 448
— secundum, 448
Comocladia dentata, 448
— integrifolia, 448
— pinnatifolia, 448
Compositae, in the Southeastern United States, The Genera of Lactuceae, 42
Compositae, 42, 43, 55
Coniferineae, 111
Copaifera, 448
— officinalis, 449
Copaiva, 448
— officinalis, 448
Cordia, 431, 449
— alba, 469
Cordia alliodora, 430
— collococca, 430
— curassavica, 469
— dentata, 430
— globosa, 469
— inerma, 430
— juglandifolia, 438, 449
— martinicensis, 470
— mirabiloides, 470
— panamensis, 430
Corylus, 130
— avellana, 412
— colurna, 413, 414, 417
— ferox, 412
Costus spicatus, 440
Cotton grass, 363
Crataeva tapis, 426
Crepis, 44, 46, 50, 73, 85, 90–92
— sect. Berinia, 92
— sect. Crepis, 91
— sect. Hostia, 91
— sect. Ixerodopsis, 91
— sect. Lepidoseris, 92
— sect. Namauchenes, 91
— sect. Phaecasium, 91
— sect. Phytodesia, 91
— sect. Psilochaenia, 91, 92
Croton balsamiferum, 449
— balsamiferus, 449
— lineare, 449
— linearis, 449
— niveum, 449
— niveus, 449
— polygamum, 449
— procumbens, 449
Crowley, Webster R., Aparna Mukherjee, and Marion T. Hall. Chromosome Counts in Cultivated Junipers, 369
Cryptomeria, 369
Cucumis pedatus, 441
— trilobatus, 441
Cunninghamia, 369
Cupania, 469
— americana, 428, 469
Cuphea carthagenensis, 458
Cupressaceae, 369
Cupressus, 369
Curatella americana, 429
Cynanchum altissimum, 442
— clausum, 442
— filiforme, 442
— longiflorum, 442
— maritimum, 443
— planiflorum, 443
— racemosum, 443
— undulatum, 443

Cynodendron argenteum, 447
Cyrtandra in the Ryukyu and Caroline Islands, The Genus, 105
Cyrtandra, 105, 106
— cumingii, 108
— cymosa, 110
— iriomotensis, 107
— jonesii, 105
— kusaimontana, 105, 106, 108, 109
— palawensis, 105–107
— ponapensis, 109, 110
— samoensis, 110
— tempestii, 110
— todaiensis, 105–107
— urvillei, 105, 106, 109, 110
— yaeyamae, 105–107
Cytharexylum quadrangulare, 449
— teres, 449
Cytology of West Himalayan Betulaceae and Salicaceae, 412

Dalbergia, 440
— brownei, 440
— monetaria, 465
— retusa, 426
— carthaginensis, 462
Dalechampia, 449
— scandens, 449
Dandelion, 83
Dendrocalamus, 293, 294, 296, 300–304
— strictus, 304
Dendropemon uniflorus, 458
Detarieae, 94
Dicliptera martinicensis, 457
Dicranella schreberiana, 135, 153, 154
Dicranum fuscescens, 135, 153
Dieffenbachia seguine, 442
Dilleniaceae, 429
Dinochloa, 293–296
Dioecism in Citharexylum (Verbenaceae): An Addendum, 120
Diospyros, 431
— inconstans, 449
— nicaraguensis, 429
Diphysa, 449
— carthagenensis, 449
Discaria, 471
— weddelliana, 472
Discipiper reticulatum, 406
Discocalyx, 2, 3, 228, 229, 235, 241, 254, 263, 269, 272, 273
— amplifolia, 265, 269, 272, 273
— crinita, 265, 272
— cymbianthoides, 228
— divaricata, 241
Discocalyx fusca, 254, 263, 265, 267, 268
— gillespieana, 265, 268
— listeri, 263, 269
— multiflora, 252, 254, 267
— obtecta, 252–254
— sylvestris, 265, 266, 268
Distichium capillaceum, 133, 153
— inclinatum, 133
Districhum flexicaule, 135, 152
Dodonaea, 449
— viscosa, 449
Dolichos altissimus, 449
— pruriens, 450
— urens, 450
Douglas fir, 363
Drepanocladus aduncus, 141, 152
— exannulatus, 142, 153
— fluitans, 142, 153
— revolvens, 142, 153
— vernicosus, 142, 153
DRURY, WILLIAM H. and IAN C. T. NISBET. Succession, 331
Dubyaea, 43, 50, 92
Duggena hirsuta, 456
— spicata, 456
Duranta, 450
— ellisia, 450
— plumieri, 450
— repens, 450
Dwarf cranberry, 363
Dwarf dandelions, 51

Ebenaceae, 429
Echites, 450
— agglutinata, 450
— biflora, 450
— corymbosa, 450
— quinquangularis, 450
— repens, 450
— spicata, 450
— suberecta, 450
— torosa, 450
— trifida, 450
— umbellata, 450
Eclipta alba, 443
Ehretia, 450
— spinosa, 450
— tinifolia, 451
Elaeocarpaceae, 428
Elaphrium, 451
— glabrum, 451
— tomentosum, 451
Elaterium, 451
— carthagenense, 451
Eleocharis palustris, 145

Embelia, 3, 274, 277, 278
— gracilis, 274, 278
— vaupelii, 276, 278
Encelia, 324
Enckea sieberi, 399
— smilacifolia, 406
Enterolobium cyclocarpum, 426
Enumeratio and Selectarum of Nicolaus von Jacquin, The, 435
Ephedra, 324
Epidendrum altissimum, 451
— carthagenense, 451
— cebolleta, 451
— ciliare, 451
— coccineum, 451
— concretum, 451
— difforme, 451
— globosum, 451
— lineare, 451
— nocturnum, 452
— nodosum, 452
— ophioglossoides, 452
— ramosum, 452
— rigidum, 452
— ruscifolium, 452
— secundum, 452
— tetrapetalum, 452
Erica tetralix, 363
Ericaceae, 130
Eriophorum, 363
Erythrina piscipula, 461
Erythroxylum carthagenense, 452
— havanense, 452
Eugenia, 312, 431
— argyrocalyx, 218
— baeuerlenii, 218
— bahamensis, 312, 314
— bartonii, 218
— brassii, 218
— buxifolia, 309
— carthagenensis, 452
— dispansa, 218
— duplomarginata, 218
— foetida, 309, 310
— glomerata, 218
— hodgei, 310
— koikokoensis, 218
— laevifolia, 218
— lehuntei, 218
— longipes, 312
— maleolens, 309
— merokensis, 218
— monetaria, 218
— monticola, 309, 310
— myrtoides, 309
— onesima, 218
— pallens, 309
Eugenia pleiopetala, 218
— pseudopsidium, 452
— pterocalyx, 218
— racemoides, 218
— salomonensis, 218
— salpingantha, 218
— scolopacina, 219
— trichotoma, 219
— triflora, 460
— vanderwateri, 219
— wollastonii, 219
Euphorbia bombensis, 452
— hirta, 452
— mesembrianthemifolia, 452
— obliterata, 452
Euphorbiaceae, 427
Exostema caribaeum, 447

Fagaceae, 452
Fagara tragodes, 452
Fagus, 130
— grandifolia, 363
False dandelion, 56
Faramea occidentalis, 448
Fargesia, 294, 296
Fijian Region, Studies of Pacific Island Plants XXV, The Myrsinaceae of the, 1
Fissidens osmundoides, 133, 153
Flowering straw, 57
Forsteronia corymbosa, 450
— spicata, 450
Fraser fir, 363
Fraxinus americana, 364
Furcraea hexapetala, 440

Garcia nutans, 427
Garhadiolus, 68
Genera of Lactuceae (Compositae) in the Southeastern United States, The, 42
Gentiana aphylla, 453
Genus Cyrtandra in the Ryukyu and Caroline Islands, The, 105
Geoffraea, 453
Geoffroea, 453
— spinosa, 453
Geophila repens, 462
Gibasis geniculata, 468
Gigantochloa, 293–295, 300–304
GILLETT, GEORGE W. The Genus Cyrtandra in the Ryukyu and Caroline Islands, 105
Ginoria, 453
— americana, 453
Glaziophyton, 294
Gliricidia sepium, 463
Goat's beard, 60
Goldenrod, 364

Gonzalagunia, 456
— hirsuta, 456
— spicata, 456
Gouania glabra, 462
— lupuloides, 462
— polygama, 463
— tomentosa, 463
Gramineae tribe Arthrostylideae, 294
— tribe Arundinariae, 294
— tribe Baccifereae, 294
— tribe Bambuseae verae, 294
— tribe Bambuseae subtribe Arundinarieae, 293
— subtribe Dendrocalameae, 293
— subtribe Eubambuseae, 293
— subtribe Melocanneae, 293
— tribe Chusqueae, 294
— tribe Hickelieae, 294
Gray birch, 363
Greenbrier, 363
Greslania, 293, 294
GROSSER, D., and W. LIESE. Present Status and Problems of Bamboo Classification, 293
Guadua, 293, 294, 296
Guaduella, 293, 294, 296
Guarea guidonia, 459
Guazuma tomentosa, 429
Guettarda, 457
— odorata, 457
Gurania, 441
Guyana in the Genus Hymenaea (Leguminosae, Caesalpinioideae), New Taxa from Brazil and, 94

Habenaria monorrhiza, 460
— setacea, 460
HALL, MARION T., APARNA MUKHERJEE, and WEBSTER R. CROWLEY. Chromosome Counts in Cultivated Junipers, 369
Hamelia, 453
— erecta, 453
— patens, 453
Hapalanthus, 453
— repens, 453
HARTLEY, T. G., and L. M. PERRY. A Provisional Key and Enumeration of Species of Syzygium (Myrtaceae) from Papuasia, 160
Hawkbit, 65
Hawk's Beard, 91
Hawk-weed, 73
Heath, 363
Hedyotis americana, 453
Hedypnois, 68
Heisteria, 452
— coccinea, 453
Helicteres, 453
— apetala, 454
— barbadensis, 438, 453
— baruensis, 453
— carthagenensis, 438, 454
— isora, 454
— jamaicensis, 453, 454
Hemiangium excelsum, 428
Hemlock, 363
Hernandia, 454
— sonora, 454
Hickelia, 294
Hieracium, 47, 73, 75
— subg. Hieracium, 75
— subg. Pilostella, 73–75
— subg. Stenotheca, 73, 75
Hillia, 454
— parasitica, 454
Hippocratea, 454
— scandens, 454
— volubilis, 454
Hippocrateaceae, 428
Hippomane mançanilla, 455
— mancinella, 455
Hippuris vulgaris, 147, 151
Hiraea reclinata, 455
Hitchcockella, 296
Homalium, 455
— racemosum, 455
HOWARD, RICHARD A. Lazella Harenberg Schwarten, 1900–1973 [obituary], 419
HOWARD, RICHARD A. Notes on the Piperaceae of the Lesser Antilles, 377
HOWARD, RICHARD A. The Enumeratio and Selectarum of Nicolaus von Jacquin, 435
Hura crepitans, 427
Hybanthus, 455
— havanensis, 455
Hylocomium splendens, 143, 153
Hymenaea (Leguminosae, Caesalpinioideae), New Taxa from Brazil and Guyana in the Genus, 94
Hymenaea, 94, 96, 97
— aurea, 96, 97
— courbaril, 96, 426
— davisii, 94, 102
— eriogyne, 97
— latifolia, 100, 101, 103
— oblongifolia, 94, 100, 102
— — davisii, 103
— — latifolia, 97, 101, 103
— — oblongifolia, 101, 103
— — palustris, 101, 103
— palustris, 94, 101, 102

Hymenaea parvifolia, 97
— torrei, 97
Hymenonema, 50
Hypericum cayennense, 455
Hypochoeris, 46, 62–64, 67
— sect. Achyrophorus, 63
— sect. Hypochoeris, 63

Indocalamus, 296
Indosasa, 296
Ipomaea carnea, 455
— filiformis, 455
— repanda, 455
Ipomoea carnea, 455
— repanda, 455
Iris martinicensis, 455
Isochilus linearis, 451
Ixeris, 90
Ixora alternifolia, 455
— occidentalis, 448

Jack pine, 363
Jacquemontia solanifolia, 455
Jacquin, The Enumeratio and Selectarum of Nicolaus von, 435
Jacquinia, 455
— aculeata, 455
— armillaris, 455
— aurantiaca, 429
— barbasco, 455
— linearis, 455
— ruscifolia, 455
Jacquiniella globosa, 451
Jambosa alutacea, 219
— arfakensis, 219
— bruynii, 219
— caryophylloides, 219
— combretiflora, 219
— decoriflora, 219
— dolichostyla, 219
— eximiiflora, 219
— keroantha, 219
— micrantha, 219
— pachyantha, 219
— papuana, 219
— phacelantha, 219
— pilgeriana, 219
— platycarpa, 219
— polyphlebia, 219
— pycnantha, 220
— recurvo-venosa, 220
— sabangensis, 220
— tricolor, 220
Jaquinia, 455
Jatropha carthagenensis, 455
— hastata, 456
— integerrima, 456
Johnston, Marshall C. Revision of Kentrothamnus (Rhamnaceae), 471
Juglans, 130
Junipers, Chromosome Counts in Cultivated, 369
Juniperus, 369
— sect. Oxycedrus, 369–371
— sect. Sabina, 369–371
— ashei, 374
— bermudiana, 369, 371
— brevifolia, 371
— cedrus, 371
— chinensis var. chinensis, 370
— — cv. Blaauw, 370
— — cv. Pfitzeriana, 370
— — cv. Shimpaku, 370
— communis var. communis, 370
— — depressa, 370
— — cv. Candelabriformis, 370
— — cv. Hibernica, 370
— — cv. Suecica, 370
— — cv. Suecica Nana, 370
— conferta, 371
— formosana, 370
— horizontalis, 374
— — cv. Alpina, 370
— — cv. Variegata, 370
— — cv. Wiltonii, 370
— macrocarpa, 371
— monosperma, 374
— oxycedrus, 371
— phoenicea, 369
— procera, 369, 371
— rigida, 370, 371
— scopulorum, 369, 371
— — cv. Moffetii, 370
— — cv. Silver King, 370
— squamata var. fargesii, 370
— virginiana, 363
— — cv. Cupressifolia, 370
— — cv. Pseudocupressus, 370
Justicia carthagenensis, 456
— eustachiana, 456
— hirsuta, 456
— martinicensis, 457
— nitida, 456, 457
— pectoralis, 457
— pulcherrima, 457
— sessilis, 457
— spinosa, 457

Kentrothamnus (Rhamnaceae), Revision of, 471
Kentrothamnus, 471
— foliosus, 472
— penninervius, 472
— weddellianus, 472

Kleinia, 457
— ruderalis, 457
Krameria, 322, 324, 325
Krameriaceae in the Southeastern United States, The, 322
Krameriaceae, 322
Krigia, 46, 51, 55, 56
— sect. Cymbia, 52, 54
— sect. Krigia, 54

Lactuca, 47, 56, 71, 72, 79, 81
— sect. Mulgedium, 72, 80, 81
— subg. Lactuca, 79, 81
— subg. Lactucastrum, 80
— subg. Mycelis, 79
Lactuceae (Compositae) in the Southeastern United States, The Genera of, 42
Laetia americana, 457
— apetala, 457
— completa, 438, 457
LANGENHEIM, JEAN H., and YIN-TSE LEE. New Taxa from Brazil and Guyana in the Genus Hymenaea (Leguminosae, Caesalpinioideae), 94
Lapsana, 46, 88, 89
Larix laricina, 145
Larrea, 324
Lateglacial Plants and Plant Communities in Northwestern New York State, 123
Laugieria, 457
— odorata, 457
Launaea, 47, 50, 71
Lauraceae, 425
Lecythis, 457
— minor, 457
LEE, YIN-TSE, and JEAN H. LANGENHEIM. New Taxa from Brazil and Guyana in the Genus Hymenaea (Leguminosae, Caesalpinioideae), 94
Leguminosae, Caesalpinioideae, New Taxa from Brazil and Guyana in the Genus Hymenaea, 94
Leguminosae, 94, 322
— subfam. Caesalpinioideae, 426
— subfam. Mimosoideae, 426
— subfam. Papilionoideae, 426
Leiphaimos aphylla, 453
Leleba, 296
Leontodon, 46, 64–66, 85
— sect. Oporinia, 66
— sect. Thrincia, 65
Lepanthes, 381
Lepianthes, 380, 381
— granulata, 381
— umbellata, 381

Lettuce, 79
Leucas martinicensis, 447
LIESE, W., and D. GROSSER. Present Status and Problems of Bamboo Classification, 293
Lignania, 296
Ling, 364
Lippia, 120
— americana, 458
— hemisphaerica, 458
Liriodendron tulipifera, 363
Lonchocarpus, 431
— costaricensis, 426
— eriocarinalis, 426
— guatemalensis, 426
— nitidus, 426
— violaceus, 463
Loranthaceae, 458
Loranthus biracemosus, 438, 458
— pedunculatus, 438, 458
— sessilis, 438, 458
— spicatus, 458
— uniflorus, 458
Lowland Tropical Community, Chromosome Numbers of Tree Species of a, 422
Lucya tetrandra, 460
Ludwigia octovalvis, 460
Luehea candida, 428
Lygodesmia, 46, 57, 58
Lycium, 324
Lycopodiaceae, 130
Lythrum carthagenensis, 458

Machaerium arboreum, 460
Macroscepis longiflora, 442
MCVAUGH, ROGERS. Notes on West Indian Myrtaceae, 309
Maesa, 2–4, 6, 19, 27, 276
— ambrymensis, 7, 23, 24
— aneiteensis, 6, 12, 13
— aubertii, 7, 18, 19, 21
— baeobotrys, 21
— banksiana, 7, 20, 21
— bennettii, 6, 10, 12, 13
— corylifolia 6, 8, 12–15, 17
— densiflora, 30, 32, 33
— efatensis, 21, 22
— eramangensis, 7, 17–19
— grandis, 15–17
— indica, 15, 33
— insularia, 4, 8, 24, 26
— lenticillata, 33–35
— macrophylla, 8
— nemoralis, 7, 15, 16, 21, 22, 24, 27, 29, 30
— neriifolia, 33–35
— parksii, 31–33

Maesa pentecostes, 19, 21
— persicaefolia, 30
— persicifolia, 4, 7, 8, 14, 16, 26, 30, 32, 33, 36
— pickeringii, 6, 13–15
— samoana, 4, 8, 15, 17, 24, 26, 28–30
— stenophylla, 33, 34, 36
— tabacifolia, 4, 7, 15, 17, 18, 21, 26, 28
— tongensis, 8, 28–30
— vitiensis, 4, 8, 29, 32–34, 36
Malpighia, 431
— diphylla, 458
— glabra, 427
— grandifolia, 458
— martinicensis, 458
— nitida, 459
— odorata, 459
Malpighiaceae, 427
Mandevilla torosa, 450
Manihot carthagenensis, 455
Manilkara zapota, 429
Margaritaria, 431
Marsdenia altissima, 442
— undulata, 443
Mastichodendron capiri var. tempisque, 429
— foetidissimum, 466
Matelea maritima, 443
— planiflora, 443
Maxillaria coccineum, 451
Meesia triquetra, 139, 152
— uliginosa, 141, 153
Mehra, P. N., and T. S. Sareen. Cytology of West Himalayan Betulaceae and Salicaceae, 412
Melastoma septemnervia, 438, 459
Melia guarea, 459
Meliaceae, 427
Melicoccus, 459
— bijugatus, 459
Melocalamus, 293, 294, 296
Melocanna, 293–296, 300–302
Menodora, 324
Mentzelia, 459
— aspera, 459
Menyanthes trifoliata var. minor, 147
Merostachys, 293, 294, 296
Mesechites repens, 450
— trifida, 450
Metopium brownei, 468
Microcalamus, 294
Micropiper langsdorfii, 393
Miller, Howard J. The Wood of Amentotaxus, 111
Miller, Norton. Lateglacial Plants and Plant Communities in Northwestern New York State, 123
Mimosa mangensis, 459
— retusa, 438, 459
Mnium pseudopunctatum, 137, 139, 153, 154
Moraceae, 425
Morinda muscosa, 459
Mosiera bahamensis, 312
— longipes, 312
— orbicularis, 312
Mucuna pruriens, 450
— sloanei, 450
— urens, 449
Mukherjee, Aparna, Webster R. Crowley, and Marion T. Hall. Chromosome Counts in Cultivated Junipers, 369
Muntingia, 459
— calabura, 428, 459
Musaenda formosa, 460
— spinosa, 460
Myginda, 460
— uragoga, 460
Myrcia antillana, 311
— citrifolia, 311, 312
— decorticans, 311
— edulis, 311
— — dominicana, 311
— inaequiloba, 311
Myrica Gale, 363
Myriophyllum, 130
— exalbescens, 147
Myrospermum, 460
— frutescens, 460
Myrsinaceae of the Fijian Region, Studies of Pacific Island Plants, The, 1
Myrsinaceae, 1, 2, 4, 429
Myrsine, 37, 278, 282
— brackenridgei, 36, 38, 40
— capitella, 282
— crassifolia, 282
— myricaefolia, 282, 284
Myrtaceae, Notes on West Indian, 309
Myrtaceae from Papuasia, A Provisional Key and Enumeration of Species of Syzygium, 160
Myrtus, 312, 313
— anguillensis, 312, 314
— axillaris, 309
— bahamensis, 312
— buxifolia, 309, 310
— citrifolia, 311
— triflora, 438, 460
— verrucosa, 312

Najas flexilis, 145, 151
Nannyberry, 364
Nastus, 293, 294, 296

Nemopanthus, 130
Neohouzeaua, 294, 296
Neomillspaughia emarginata, 448
Neurolepis, 296
New Taxa from Brazil and Guyana in the Genus Hymenaea (Leguminosae, Caesalpinioideae), 94
Nipplewort, 88
Nipponobambusa, 296, 297
NISBET, IAN C. T., and WILLIAM H. DRURY. Succession, 331
Nissolia, 460
— arborea, 460
— fruticosa, 460, 465
Nitella flexilis, 132, 151
Notes on the Piperaceae of the Lesser Antilles, 377
Notes on West Indian Myrtaceae, 309

Ochlandra, 293–296
— rheedii, 295
— stridula, 295
Ochnaceae, 429
Ochroma pyramidale, 428
Ocotea veraguensis, 425
Octamyrtus pleiopetala, 218
Odontonema, 456
— nitida, 457
Oenothera octovalvis, 460
Olacaceae, 425
Oncidium altissimum, 451
— carthagenense, 451
— cebolleta, 451
— tetrapetalum, 452
Ophioglossaceae, 130
Oplonia spinosa, 457
Oreopanax capitata, 442
Orchis setacea, 460
Oreiostachys, 294
Oreobambus, 294, 296
Oryctanthus spicatus, 458
Osmundaceae, 130
Ouratea, 431
— wrightii, 429
Ox-tongue, 68
Oxytenanthera, 293–296, 300, 302, 304
— abyssinica, 304
Pacific Island Plants, XXV. The Myrsinaceae of the Fijian Region, Studies of, 1, 128
Paeonia, 324
Palicourea domingensis, 462
Paper birch, 363
Papuasia, A Provisional Key and Enumeration of Species of Syzygium (Myrtaceae) from, 160
Parkinsonia, 324
Paullinia barbadensis, 453, 460
— tomentosa, 460
Pectis linifolia, 460
— punctata, 460
Pediastrum, 130
Peltogyne, 100
Peperomia, 377, 379–382, 409
— acuminata, 389, 409
— ajoupana, 389, 409
— allorgeana, 384, 409
— — — genuina, 384, 409
— — — lata, 384, 409
— — — major, 384, 409
— — — minor, 384, 409
— alpina, 382, 409
— amplexicaulis, 386
— auberyana, 387, 409
— balbisii, 395, 409
— balineorum, 389, 409
— balneolorum, 389, 409
— barthelemyana, 387, 389, 409
— — genuina, 387, 409
— — reducta, 387, 409
— belangeri, 384, 409
— blanda, 393, 409
— — langsdorfii, 383, 393
— boldinghii, 387, 409
— bracteiflora, 384, 409
— — stigmatifera, 384, 409
— broadwayi, 387, 409
— caespitiformans, 395, 396, 409
— caespitiformis, 395, 409
— casimiri, 384, 409
— cataractaegaudens, 384, 409
— caulibarbis, 384, 409
— ciliata, 382, 409
— conulifera, 386, 387, 409
— — acutifolia, 386, 409
— — kerveganti, 386, 409
— — matoubana, 386, 409
— — stehleae, 386, 409
— — stehlei, 386, 409
— — tenuispica, 386, 409
— — tivoliana, 386, 409
— — typica, 386, 409
— cordifolia, 386, 409
— cuneata, 392, 409
— davisii, 396, 409
— diaphanoides, 395, 409
— — vincentensis, 395, 409
— dissitiflora, 384, 409
— doleana, 387, 409
— dolosa, 387, 409
— dussii, 385, 409
— emarginella, 383, 409
— — exilis, 383, 409
— evadens, 384, 409

Peperomia exilis, 383, 409
— fimbriata, 395, 409
— fumeana, 396, 409
— — genuina, 397, 409
— — stehlei, 397, 409
— glabella, 383, 394, 409
— — eustatiana, 383, 409
— — nervulosa, 383, 409
— — nigropunctata, 389
— glandulirostrea var. stehleae, 386, 409
— grisebachii, 396, 409
— guadeloupensis, 387, 409
— hahnii, 385
— hederacea, 397, 409
— herminieri, 385, 409
— — stigmatifera, 385, 409
— hernandiifolia, 384, 409
— hirtella, 384, 385, 409
— hispidula, 385, 409
— houelmonte, 389, 409
— humilis, 393, 410
— — stehlei, 393, 410
— imrayana, 394, 410
— langsdorfii, 393, 410
— magnoliifolia, 386, 410
— martinicensis, 389, 391, 410
— — almeana, 389, 410
— — lata, 389, 410
— myrtifolia, 387, 410
— — major, 387, 410
— — typica, 388, 410
— nigrescens, 389, 392, 410
— nigropunctata, 383, 384, 389, 410
— nummularifolia, 394, 410
— obovata, 395, 410
— obtusifolia, 392, 410
— obversa, 395, 410
— ovalifolia, 395, 396, 410
— palpebrata, 389, 391, 410
— — absalonis, 389, 410
— — carbetensis, 389, 410
— — lata, 389, 410
— — major, 390, 410
— — paniculata, 390, 410
— — ramulosior, 390, 410
— — typica, 390, 410
— pellucida, 382, 392, 410
— — baileyana, 392, 410
— persuccosa, 388, 410
— — benae, 388, 410
— — bertautii, 388, 410
— ponthieui, 384, 410
— praestigiatrix, 386, 387, 410
— pustulatibacca, 386, 410
— questeliana, 382, 392, 393, 410
— reniformis, 394, 410
— repens, 394
Peperomia rotundifolia, 394, 410
— — — pubescens, 394
— — nummularifolia, 394, 410
— — pilosior, 394, 410
— rupertiana, 388, 410
— — genuina, 388, 410
— — pinchonii, 388, 410
— — rosetteana, 388, 410
— sabae, 383, 410
— scandens, 383, 394, 410
— scutellaefolia, 382
— serpens, 394, 410
— smithiana, 395, 410
— stehleana, 390–392, 410
— — ajoupana, 390, 410
— — balineorum, 390, 410
— — bourgesensis, 390, 410
— — branquecii, 390, 410
— — charpentieri, 390
— — houelmonti, 390, 410
— — praestigiatrix, 390, 410
— — regretteana, 390, 410
— — tardenaevifera, 390, 410
— — tardigranulata, 390
— — typica, 390, 410
— — variifolia, 390
— subbracteiflora, 385, 410
— subvillosa, 385, 410
— — — candolleana, 385, 410
— — — dumauseana, 385, 410
— tenella, 395, 410
— — epiphytica, 395, 410
— tenuiflorum, 388
— thionvilleana, 390, 410
— trifolia, 395, 396, 410
— — — genuina, 396, 410
— — — obovalifolia, 396, 410
— — — suborbiculata, 396, 410
— — balbisii, 396, 410
— truncigaudens, 396, 410
— urocarpa, 396, 397, 410
— vanhuerkii, 388, 389, 410
— vernouana, 394, 410
— vincentensis, 388, 410
— vincentiana, 397, 410
— wilsonii, 390, 392, 410
Peplis tetrandra, 460
Perrierbambus, 294, 296
Perry, L. M., and T. G. Hartley. A Provisional Key and Enumeration of Species of Syzygium (Myrtaceae) from Papuasia, 160
Peschiera cymosa, 467
Petesia tomentosa, 438, 461
Petitia, 461
— domingensis, 461

Petraea, 461
— volubilis, 461
Petrea, 461
— volubilis, 461
Phaseolus sclareodes, 438, 461
Philodendron hederaceum, 442
Phoradendron, 324
Phyllostachys, 293, 294, 296, 300, 301, 305
Picea, 363
— glauca 131, 145, 148, 151
— mariana, 131, 144, 151
Picramnia (Simaroubaceae) from Central America, Three New Species of, 315
Picramnia allenii, 315, 317
— antidesma, 319, 320
— cooperi, 317, 318
— dwyeri, 319, 320
— latifolia, 317, 318
— quaternaria, 315, 317
Picris, 46, 47
— sect. Helminthia, 68
Picrosia, 57
Pignut hickory, 363
Pin cherry, 363
Pinus banksiana, 131, 363
— resinosa, 131
— strobus, 130, 131, 363
Piper, 377, 379, 380, 382, 397, 431
— aduncum, 397, 410
— aequale, 398, 405, 410
— — — acutispicum, 398, 410
— — dussii, 398, 410
— — lasiocarpum, 398, 399, 410
— — latum, 398, 410
— — latifolium, 398
— — ovalifolium, 398, 410
— — typica 398, 410
— — variifolium, 399, 410
— amalago, 399, 400, 410
— — medium, 399
— andersonii, 400, 403, 410
— antiguanum, 401, 410
— arboreum, 400, 410
— balbisianum, 401, 410
— betle, 401, 410
— boxii, 401, 410
— broadwayi, 402, 403, 410
— calciseligens, 401, 410
— citrifolium, 400
— dilatatum, 401–403, 410
— — — calcicolens, 401, 410
— — — diamentense, 401, 403, 410
— — — diversifolium, 401, 410
— — — magnifolium, 401, 411
— — — medium, 401, 411
— — — naris-fractae, 401, 411
— — — vauclinii, 401, 411
Piper dilatatum broadwayi, 401, 411
— — vincentianum, 401, 411
— dominicanum, 399, 411
— duchassaingii, 406, 411
— dussii, 402, 411
— — — branquecanum, 402, 411
— — — dogueanum, 402, 411
— — — dugommieranum, 405, 411
— — — quentinianum, 402, 403, 411
— — — scabridum, 402, 411
— — scabridum, 402
— — scabrum, 411
— eggersii, 401, 402, 411
— emarginellum, 383
— fishlockii, 399, 411
— glabellum, 383
— glabrescens, 400, 403, 411
— — venezuelense, 403, 411
— glaucescens, 408
— granulatum, 381
— guadeloupense, 408, 409, 411
— guildingianum, 394
— hahnii, 399, 402, 404, 405, 411
— hebecarpum, 397, 398, 411
— hirsutum, 405, 411
— hispidulum, 385
— hispidum, 405, 406, 411
— — plurinerve, 405, 411
— humile, 393
— incurvum, 408, 411
— langsdorfii, 393
— latilimbum, 402, 403, 411
— longum, 400
— mac-intoshii, 399, 411
— macrophyllum, 400, 403, 404, 411
— magnoliaefolium, 386
— martinicense, 397, 411
— — genuinum, 398
— — montis-pilati, 398, 411
— medium, 399, 400
— myrtifolia, 389
— malanganum, 405, 406, 411
— naris-fractae, 401, 411
— nicoyanum, 407
— nigrum, 397, 406, 411
— nottirbanum, 400, 403, 411
— nummularifolium, 394
— obovatum, 395
— obtusifolium, 392
— obversum, 395
— papantlense, 407, 411
— pellucidum, 392
— peltatum, 380, 381, 411
— plantagineum, 399, 411
— quentini, 403, 404, 411
— readii, 401, 411
— reticulatum, 406, 407, 411

Piper retrofractum, 407, 411
— rotundifolium, 394
— sanctum, 407, 411
— scabrum, 405, 411
— scandens, 394
— serpens, 394
— shaferi, 401, 411
— sieberi, 399, 411
— stehleorum, 398, 411
— subrectinerve, 398, 411
— tenellum, 395
— treleasanum, 403
— tuberculatum, 408, 411
— umbellatum, 380, 381
— unguiculatum, 408, 411
— venezuelense, 403
Piperaceae of the Lesser Antilles, Notes on the, 377
Piperaceae, 378, 379
Piscidia carthagenensis, 427, 461
— erythrina, 461
— piscipula, 461
Pistacia, 468
Pistia, 461
Pithecoctenium echinatum, 443
Pithecolobium, 431
— mangense, 459
— racemiflorum, 426
— saman, 426
Planotia, 293, 294
Platanus, 130
— occidentalis, 363
Platygyne hexandra, 468
Platymiscium pleiostachyum, 427
Pleioblastus, 297
Pleurothallis ophioglossoides, 452
— ruscifolia, 452
Plumeria, 431
— rubra var. acutifolia, 430
Polygala diversifolia, 464
Polygalaceae, 322
Polygonaceae, 425
Polygonum aviculare, 148
Polypodiaceae, 130
Polytrichum juniperinum, 143, 153
Ponthieva racemosa, 451
Populus, 412
— tremuloides, 363
Porophyllum, 457
— ruderale, 457
PORTER, DUNCAN M. Three New Species of Picramnia (Simaroubaceae) from Central America, 315
Portulaca fruticosa, 462
— paniculata, 461
— triangularis, 461
Potamogeton, 130, 151
— alpinus, 145
— perfoliatus var. bupleuroides, 145
Potentilla anserina, 148, 151
— norvegica, 148
Pothomorphe, 377, 380, 411
— dussii, 381, 411
— peltata, 380, 381, 411
— umbellata, 380
Pothos acaulis, 462
Pouteria sapota, 466
Prenanthes, 47, 50, 56, 76, 78, 81
— subg. Nabalus, 77, 78
— subg. Prenanthes, 78
Present Status and Problems of Bamboo Classification, 293
Prestonia agglutinata, 450
— quinquangularis, 450
Prosopis, 324
Proteaceae, 425
Protocyrtandra todaiensis, 107
Provisional Key and Enumeration of Species of Syzygium (Myrtaceae) from Papuasia, A, 160
Prunus pensylvanica, 363
Pseudobombax septenatum, 429, 444
Pseudocoix, 294, 297
Pseudostachyum, 293, 295, 297
Pseudotsuga, 369
— taxifolia, 363
Psidium, 313
— longipes, 312, 313
— — longipes, 314
— — orbiculare, 314
Psiguria, 440
— jacquiniana, 442
— pedata, 441
— trilobata, 442
Psittacanthus, 324
Psoralea carthagenensis, 462
Psychotria, 431
— carthagenensis, 462
— domingensis, 462
— herbacea, 462
— muscosa, 459
Pterocarpus, 431
— rohrii, 427
Puelia, 293, 294, 297
Pyrrhopappus, 47, 55

Quaking aspen, 363
Quercus alba, 363
— oleoides, 425
— prinus, 363
— rubra, 363
— velutina, 363

Racemobambos, 297
Rachicallis americana, 453
Rafinesquia, 58
Randia armata, 460
— mussaenda, 460
Ranunculaceae, 324
Ranunculus, 130
Rapanea, 3, 278, 280, 287
— amischocarpa, 279–281
— citrifolia, 282
— crassiramea, 279, 288, 290, 291
— hadrocarpa, 279, 290–292
— longipes, 279, 287
— modesta, 279, 280, 282, 286
— myricifolia, 279, 280, 282, 286
— polyantha, 279, 289–291
— samoensis, 282, 285, 286, 290
— volcanica, 278
Ratany, 323
Ratany family, 322
Rattlesnake root, 76
Rauvolfia hirsuta, 462
— nitida, 462
— tetraphylla, 462
— tomentosa, 462
Red cedar, 363
Red maple, 363
Red oak, 363
Redwood, 363
Revision of Kentrothamnus (Rhamnaceae), 471
Rhabdadenia biflora, 450
Rhamnaceae, Revision of Kentrothamnus, 471
Rhamnus colubrinus, 462
— cubensis, 462
— domingensis, 462
— iguanaeus, 463
— polygamus, 463
Rhatany, 323
Rhizophagites butleri, 131, 132
Rhus metopium, 468
ROBERTSON, KENNETH R. The Krameriaceae in the Southeastern United States, 322
Robinia pseudo-acacia, 363
— sepium, 463
— violacea, 463
Rochefortia spinosa, 450
Rondeletia disperma, 438, 463
— odorata, 463
— tomentosa, 461
Rorippa islandica, 147
Roupala complicata, 425
Rudbeckia serotina, 364
Rumex, 130
Rush-pink, 57
Russelia, 463
— sarmentosa, 463
Ruyschia, 463
— clusiaefolia, 463
Rytidostylis, 451
— carthagenensis, 451
Ryukyu and Caroline Islands, The Genus Cyrtandra in the, 105

Salicaceae, Cytology of West Himalayan Betulaceae and, 412
Salix, 148, 412, 413, 417
— acmophylla, 413, 415
— alba, 415
— babylonica, 415
— daphnoides, 413, 414, 417
— elegans, 415
— tetrasperma, 413, 414, 417
Salt-water cord grass, 363
Samyda, 463
— decandra, 463
— dodecandra, 463
— nitida, 445
Sapindaceae, 428
Sapium, 463
— aucuparium, 463
— jamaicense, 463
Sapotaceae, 429
Sapranthus palanga, 425
Sarcorhachis, 377, 408, 411
— incurva, 408, 411
— — stehlei, 408, 411
— — treleasii, 408, 411
— — typica, 408, 411
Sarcostemma clausum, 442
SAREEN, T. S., and P. N. MEHRA. Cytology of West Himalayan Betulaceae and Salicaceae, 412
Sasa, 294, 297
Sasaella, 297
Sasamorpha, 297
Saururus arborescens, 398
— foliis ovato-lanceolatis, 398
Sax [notice], Karl, 493
Schaefferia, 463
— frutescens, 464
Schilleria ulmifolia, 401, 411
Schizostachyum, 293–295, 297, 300–302
— brachycladum, 295
— gracile, 295
— grande, 295
Schnella glabra, 443
Schwarten, Lazella Harenberg, 1900–1973 [obituary], 419
Scoparia dulcis, 464
— procumbens, 438, 464
Scorpidium turgescens, 142, 153

Scorzonera, 61
Scutellaria havanensis, 464
Sechium edule, 466
Securidaca, 464
— brownei, 465
— diversifolia, 464
— erecta, 464, 465
— scandens, 465
— virgata, 464
— volubilis, 464, 465
Selaginella apoda, 147
— rupestris, 147
— selaginoides, 130, 131, 147
Selectarum of Nicolaus von Jacquin, The Enumeratio and, 435
Semiarundinaria, 297
Sequoia sempervirens, 363
Shibataea, 297
Sicyos edulis, 466
Sida trisulcata, 466
Sideroxylum foetidissimum, 466
— pauciflorum, 466
— sapota, 466
Simarouba glauca, 427
Simaroubaceae from Central America, Three New Species of Picramnia, 315
Simaroubaceae, 315, 317, 427
Sinarundinaria, 297
Sinobambusa, 297
Sinocalamus, 297
Skeleton weed, 57
Sloanea terniflora, 428
Smilax, 363
— hastata, 466
— havanensis, 466
SMITH, ALBERT C. Studies of Pacific Island Plants, XXV. The Myrsinaceae of the Fijian Region, 1, 228
Solanum, 442
— aculeatum, 442
— bombense, 466
— glabrum, 466
— havanense, 466
— racemosum, 466
— stenorchis, 466
— subinerme, 466
— triste, 466
Solidago, 363
— uliginosa, 363
Sonchus, 47, 56, 69, 71, 72
— subg. Dendrosonchus, 69
— subg. Origosonchus, 69
— subg. Sonchus, 69
Soroseris, 43
Southeastern United States, The Genera of Lactuceae (Compositae) in the, 42
Southeastern United States, The Krameriaceae in the, 322
Sow-thistle, 69
Sparganium, 130, 145
Spartina alterniflora, 363
Spermacoce spinosa, 467
Sphagnum, 351
— magellanicum, 133, 153
Spilanthes, 467
— insipida, 467
— urens, 467
Spinacia littoralis, 467
Spondias mombin, 427
Spruce, 363
Statement of ownership, 122
Stemmadenia donnell-smithii, 430
— grandiflora, 468
Stephanomeria, 58, 59
Sterculia, 431
— apetala, 429, 454
— carthagensis, 454
Sterculiaceae, 429
Striped maple, 363
Strumpfia, 467
— maritima, 467
Struthanthus pedunculatus, 458
— sessilis, 458
Studies of Pacific Island Plants, XXV. The Myrsinaceae of the Fijian Region, 1, 228
Styracaceae, 429
Styrax argenteus, 429
Succession, 331
Sugar maple, 363
Suriana, 467
Suttonia, 278
Sweet Gale, 363
Swietenia, 467
— mahagoni, 467
Sycamore, 363
Symplocos, 467
— martinicensis, 467
Syzygium (Myrtaceae) from Papuasia, A Provisional Key and Enumeration of Species of, 160
Syzygium, 160
— acetosum, 179
— acmenioides, 220
— acutangulum, 171, 203
— adelphicum, 173, 208
— aeoranthum, 171, 202
— alutaceum, 219
— amplum, 167, 192
— anomalum, 171, 202
— aqueum, 169, 196
— argyrocalyx, 218

Syzygium attenuatum, 174, 210
— badium, 179, 215
— bartonii, 218
— benjaminum, 173, 208
— bicolor, 174, 210
— brachyanthelium, 220
— bracteosum, 171, 203
— branderhorstii, 178, 214
— brassii, 177, 213
— bruynii, 219
— burepense, 163, 184
— busuense, 172
— callianthum, 163, 185
— camptodromum, 175, 211
— capituliferum, 175, 211
— caroli, 220
— carrii, 174, 209
— cartalagineum, 175
— caryophylloides, 219
— cauliflorum, 162, 182
— chamaebuxus, 220
— cinctum, 169, 197
— cladopterum, 162, 183
— claviflorum, 174, 210
— coalitum, 168, 196
— combretiflorum, 219
— cruriflorum, 220
— daphne, 163, 185
— decipiens, 178, 214
— deciflorum, 219
— dictyoneurum, 220
— dictyophlebium, 171, 203
— dolichophyllum, 163, 185
— effusum, 160, 179, 216
— ellipticum, 220
— erythropetalum, 163, 186
— evenulosum, 165, 190
— eximiiflorum, 219
— fastigiatum, 172, 204
— fibrosum, 170, 201
— finisterrae, 181, 217
— flavescens, 177, 213
— flavidum, 162, 183
— furfuraceum, 173, 206
— ganophyllum, 220
— garcinioides, 169, 197
— gjellerupii, 220
— gonatanthum, 164, 187
— goniocalyx, 164, 188
— goniopterum, 167, 194
— grevesianum, 218
— gyrostemoneum, 220
— heloanthum, 220
— heterobotrys, 164, 188
— homichlophilum, 179
— hylochare, 168, 196
— hylophilum, 169, 170, 201
Syzygium insulare, 162, 183
— iteophyllum, 172, 204
— keroanthum, 219
— keyserri, 163, 185
— kietanum, 178, 213
— lagerstroemioides, 164, 188
— lamprophyllum, 220
— laqueatum, 166, 191
— lehuntei, 218
— leonhardii, 165, 189
— leptoneurum, 179
— leptophlebium, 220
— leptopodium, 174, 210
— lorentzianum, 177, 212
— luehmannii, 180, 216
— macrocalyx, 162, 183
— madangense, 164, 188
— megalospermum, 162, 182
— malaccense, 166, 167, 191
— megistophyllum, 175, 211
— monetarium, 218
— multiglandulosum, 166, 191
— myriadenum, 179, 215
— naiadum, 175, 211
— nemorale, 175, 211
— nitidum, 177, 212
— normanbiense, 165, 189
— novoguineense, 164, 187
— nutans, 162, 183
— onesimum, 181, 217
— orthoneurum, 220
— ovalifolium, 219
— oxyphyllum, 220
— pachyanthum, 219
— pachycladum, 166, 190
— pallens, 171, 203
— papuasicum, 160
— peekelii, 220
— pergamaceum, 170, 199
— petraeum, 220
— phacelanthum, 219
— phaeostictum, 168, 196
— pilgerianum, 219
— platycarpum, 219
— platypodum, 167, 194
— plumeum, 180, 217
— pluviatile, 199
— polyphlebium, 219
— porphyrocarpum, 162, 182
— pteropodum, 166, 191
— puberulum, 168, 195
— pullei, 220
— pyriforme, 163, 186
— pyrrophloem, 220
— randianum, 164, 188
— rechingeri, 219
— richardsonianum, 169, 198

Syzygium robbinsii, 173, 209
— roseum, 170, 177, 200
— rubiginosum, 176, 212
— rubro-punctatum, 170, 198
— saliciforme, 169, 197
— salicinum, 163, 185
— salomonense, 218
— samarangense, 166, 192
— sambogense, 173, 206
— schlechteri, 220
— schumannianum, 174, 209
— scytophyllum, 220
— sogerense, 164, 186
— spectabile, 166, 192
— squamatum, 172, 206
— subalatum, 163, 186
—subamplexicaule, 175, 211
— subglobosum, 176, 212
— suborbiculare, 165, 189
— subsimile, 220
— sylvicola, 169, 176, 198
— synaptoneurum, 165, 190
— thallasicum, 164, 187
— thomsenii, 164, 187
— thornei, 173, 206
— tierneyanum, 170, 200
— tolypanthum, 220
— torricellianum, 171
— trachyanthum, 163, 185
— trichotomum, 219
— triphlebium, 176
— trivene, 177, 213
— tympananthum, 164, 187
— uniflorum, 169, 197
— valdinerve, 167, 193
— vanderwateri, 219
— variabile, 168, 195
— verniciflorum, 177, 213
— vernicosum, 165, 190
— versteegii, 166, 190
— viburnoides, 172, 204
— virescens, 168, 196
— waikaiunense, 168, 194
— warburgii, 218
— waterhousei, 176
— wollastonii, 219
— womersleyi, 167, 193
— xylopiaceum, 169, 197

Tabebuia, 431
— palmeri, 430
— rosea, 430
Tabernaemontana amygdalifolia, 467
— cymosa, 467
— grandiflora, 468
Talinum, 461
— paniculata, 461
Talinum triangulare, 461
Tapeinosperma, 2, 228, 229, 235, 237, 241, 243, 256, 260, 267, 272, 273
— ampliflorum, 231, 248, 254
— babucense, 232, 257
— capitatum, 230, 232, 234, 243
— cephalophorum, 232
— chloranthum, 231, 251, 252
— clavatum, 231, 246, 248, 254
— divaricatum, 231, 241, 243
— grande, 232, 241, 255–257
— greenwoodii, 232, 258
— hornei, 231, 239, 241, 243, 246, 256, 272
— kajewskii, 232, 261, 263
— ligulifolium, 231, 243, 256
— megaphyllum, 231, 235, 241, 246
— multiflorum, 232, 252, 254, 267
— netor, 259
— punctatum, 232
— scrobiculatum, 232, 259, 260, 262
— viellardii, 228
Taraxacum, 47, 50, 64, 66, 83, 86
— sect. Erythrocarpum, 84
— sect. Taraxacum, 84
Taxaceae, 111
Taxodiaceae, 369
Teinostachyum, 293–295, 297–302
Tephrosia littoralis, 470
Terebinthus, 468
— brownii, 468
— maxima, 468
Tetraclinis, 369
Tetragonotheca parviflora, 438, 468
Teucrium cubense, 468
Thalictrum, 130
Thamnocalamus, 294
Thamnoseris, 58
Theophrastaceae, 429
Thouinidium decandrum, 428
Three New Species of Picramnia (Simaroubaceae) from Central America, 315
Thyrsostachys, 293–295, 297, 300, 301
Tilia americana, 363
Tiliaceae, 428
Tinus storckii, 37
Tolypella glomerata, 132
Tomenthypnum nitens, 143, 153, 154
Tomlinson, P. B. Dioecism in Citharexylum (Verbenaceae): An Addendum, 120
Tortella inclinata, 135, 152
— tortuosa, 137, 152
Tortula ruralis, 137, 152
Tournefortia maculata, 468
Tourneuxia, 61
Trachylobium, 94
Tradescantia geniculata, 468

Tragia hexandra, 468
Tragopogon, 46, 60, 61
Tree Species of a Lowland Tropical Community, Chromosome Numbers of, 422
Trema micrantha, 425
Trevoa weddelliana, 472
Trichilia, 431, 468
— arborea, 427
— glabra, 469
— havanensis, 468
— hirta, 469
— spondiodes, 469
— trifolia, 469
Trigonia, 469
— tomentosa, 469
Trimezia martinicensis, 455
Triplaris americana, 425
Triumfetta lappula, 469
— rhomboidea, 469
— semitriloba, 469
Tsuga, 130
— canadensis, 363
Tulip poplar, 363
Typha, 130, 145

Ulmaceae, 425
Ulmus, 130
— americana, 363
Urechites lutea, 450
Urticaceae, 130
Utricularia, 130
— alpina, 469

Vaccinium, 363
— oxycoccos, 363
Varronia, 469
— alba, 469
— curassavica, 469
— globosa, 469
— humilis, 469
— macrostachya, 469
Varronia martinicensis, 470
— mirabiloides, 470
Verbenaceae: An Addendum, Dioecism in Citharexylum, 120
Verbenaceae, 120
Viburnum, 349
— lentago, 364
Vicia disticha, 438, 470
— littoralis, 470
Vinca lutea, 450
Viola palustris, 148, 151
Virea, 67
Vismia cayennensis, 455
VUILLEUMIER, BERYL SIMPSON. The Genera of Lactuceae (Compositae) in the Southeastern United States, 42

Wedelia, 470
— frutescens, 470
— fruticosa, 470
West Indian Myrtaceae, Notes on, 309
White ash, 364
White oak, 363
White pine, 363
Widdringtonia, 369
Wild lettuce, 79
Wood of Amentotaxus, The, 111

Xanthomyrtus scolopacina, 219
Ximenia, 470
— americana, 425, 470
— multiflora, 470

Yellow birch, 363
Youngia 46, 89–91

Zannichellia palustris, 145, 151
Zanthoxylum, 431
— tragodes, 452
Ziziphus, 324
Zygophyllum arboreum, 470

KARL SAX

Spokane, Washington – November 2, 1892

Bryn Mawr, Pennsylvania – October 8, 1973

We record with regret the death of Dr. Sax, Professor of Botany at Harvard University from 1935 to 1959 and Director of the Arnold Arboretum from 1947 to 1954.