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page 9, line 24
for Mueller-Argentius read Mueller-Argoviensis

page 11, line 1
for *Mueller-Argentius* read *Mueller-Argoviensis*

page 11, line 3
for *rigidlfolia* read *rigidifolia*

page 45, line 33
for behvaior read behavior

page 52, line 34
for pair read pairs

page 55, line 30
for show read shows

page 57, line 3
for occurs read occur

page 97, line 23
for (*Reichb.*) read (*Reichb.f.*)

page 111, line 26
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THE GENUS HEVEA IN COLOMBIA

BY
RICHARD EVANS SCHULTES[1]

I.

IN RECENT YEARS, as a direct result of the emergency created by the present war, there has been evidenced considerable interest in the wild stands of *Hevea* in eastern Colombia. Exploitation of these stands is about to enter its third consecutive year. In addition to the tapping of the wild trees for rubber, there is being carried out a scientific study and search of the stands for superior clones for plantation programs in Latin America.

A knowledge of the distribution of the chief species of *Hevea* is, obviously, of prime importance for such commercial and scientific work. Up to the present time, we have had a very incomplete comprehension of this economic genus as it occurs in Colombia. In fact, less is known about the genus in Colombia, the northwesternmost extent of its range, than in any other part of the vast area where *Hevea* occurs naturally. This has been due largely to the lack of botanical exploration of eastern Colombia.

The need for a provisional summary of the distribution of the species seems to be urgent, and it appears hardly advisable to await the more exhaustive studies which

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may, and most probably will, be made in the future, before presenting a general and admittedly provisional outline of the problem.

For three and a half years,[2] I have been engaged in botanical work on the Amazonian watershed of Colombia. This work has been carried out principally along the following rivers: Vaupés, Itilla, Ajaju, Macaya, Apaporis, Cananarí, Piraparaná, Caquetá, Miritiparaná, Putumayo, Loretoyacu, Hamacayacu and Boiauassú, and in the Leticia area of the "trapecio amazonico." In addition to my own observations and collections, I have had data kindly made available to me by Hans G. Sorenson of the Office of Rubber Plant Investigations of the United States Department of Agriculture and Paul H. Allen of the Rubber Development Corporation. I have also had the benefit of numerous conferences with Dr. Adolpho Ducke whose knowledge of *Hevea* in Brazil is extensive and profound. From these sources, it has been possible to reconstruct the distribution of the genus in Colombia according to river systems. It should be borne in mind that the range of *Hevea* in Colombia covers a vast area, extraordinarily difficult for travel and rather varied as to topography. We have observations from only a few localities in this great drainage-area and adequate herbarium material from still fewer localities.

It is evident that there remains much to do before we can understand fully the details of the specific distribution of *Hevea* in Colombia. Only a beginning has been made. Fortunately, however, this beginning has been well extended over a wide area so that we have, geographically speaking, a relatively complete representa-

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tion for nearly the entire Amazonian watershed. The only major drainage-area for which, to the best of my knowledge, absolutely nothing is known is the Inirida River, north of the Vaupés. Among the minor drainage areas which we still must explore are the great sandstone mesas whose rivers pour their waters into the Yarí River, emptying into the Caquetá below Araracuara; the Cahuinarí, also flowing into the Caquetá; and the small but geographically strategical Cotuhé, entering the Putumayo River near the Brazilian border.

It is not always easy to define certain species of *Hevea.* The identifications of some collections must be made with reservation because of incomplete material. For the most part, however, the broad specific lines have been established. It seems to me that in eastern Colombia there may exist a number of subspecific variations which cannot easily be accommodated to concepts already described and established. There are perhaps even some undescribed species to be found in the more remote parts of Colombia's Amazonian watershed, especially those areas which we now know to be rich in endemics.

In the present short summary, I have purposely refrained from consideration of any but the most easily recognized and well-established subspecific concepts. The complete and critical treatment of the subspecific variations in *Hevea* in Colombia must await much more study and exploration. For one thing, we still do not have enough representative flowering and fruiting specimens to attempt to present even an outline of all the varieties and forms of the principal species. Furthermore, we are learning that bark characters, hitherto unstudied, except in isolated cases, are of unexpected importance in distinguishing between subspecific variants in *Hevea;* we must retrace some of our steps and examine the barks of thousands of trees in numerous areas before making a

final decision and before the preparation of a critical taxonomic treatment.

Even in the case of a number of easily accessible localities in eastern Colombia, we are at a disadvantage because the herbarium material which is available is sterile. The very short flowering and fruiting seasons of *Hevea* make it impossible to gather complete material over a wide area in the same year. Sterile material, while better than no material, has very definite limitations as to its value in taxonomic work on *Hevea*. One example of the handicaps imposed by incomplete specimens may be presented. In the gigantic crevasses and faults in one of the grotesque sandstone mountains near the confluence of the Ajaju and Macaya Rivers in the upper Apaporis basin, there exists a curious colony of very tall trees representing apparently an undescribed variety of *Hevea guianensis*. It has excellent bark characters as well as peculiarities in leaf pilosity. Unfortunately, however, only very immature capsules could be obtained. Nothing is known of the seeds or flowers. This highly interesting tree, growing under conditions of psammophytic and physiological drought some 600 to 800 feet above the surrounding forest floor or about 1600 feet above sea-level, may prove to be an important link in our understanding of the distribution or even of the phylogenetic interrelationships of the *Hevea guianensis*-complex.[3]

These considerations serve merely to emphasize the need for continued and systematically planned *Hevea*

[3] This highland tree appears to have a number of striking similarities with the highland representatives of the *Hevea guianensis*-complex which I have recently had occasion to examine in the forests on the slopes along the upper Huallaga River in Peru. It is very evident that the greatest need at the moment is for more detailed taxonomic and distributional studies of the poorly understood species and varieties of *Hevea* in highland regions.

field-research. It is conceded that on the basis of herbarium studies alone it will be difficult to clarify our understanding of *Hevea*—its specific and varietal limitations, its history and its present distribution. This is perhaps one of the outstanding examples of the necessity for close correlation of field and herbarium studies and for close collaboration of the field and herbarium workers. We must guard against minimizing the fundamental importance of herbarium methods and studies in handling the genus *Hevea*. Yet, at the same time, we should recognize that recourse must be made to methods not traditionally employed in systematics and to characters which, in some instances, can be appreciated only in the field.

Some botanists believe that the genus *Hevea* may have had its origins in highland areas or on the slopes of mountains near the headwaters of the affluents of the Amazon and that the more primitive species and varieties are to be expected along the westernmost fringes of the range of the genus. In connection with such theoretical concepts, a study of *Hevea* in Colombia, as well as in Peru, holds especial interest, inasmuch as these countries have in their territories the highlands and slopes which would seem to have been most favorable for the early differentiation of the genus.

II.

As stated above, the present study is preliminary and provisional. It is not yet possible to present a consideration of all of the taxonomic entities of subspecific rank which have been found in Colombia. Therefore, the following enumeration of the entities which have been found in the eastern regions of Colombia includes only three easily distinguishable varieties and no forms. An asterisk indicates a species or variety not yet known to occur in Colombia but known from localities so near the Colom-

bian frontier as to suggest the probability of its occurrence within the boundaries of this country.

Hevea Benthamiana *Mueller-Argentius*
Hevea brasiliensis (*HBK.*) *Muell.-Arg.* var. subconcolor *Ducke*
Hevea Foxii *Huber*
*Hevea glabrescens *Huber*
Hevea guianensis *Aublet*
Hevea guianensis *Aubl.* var. lutea (*Benth.*) *Ducke & R. E. Schultes*
Hevea pauciflora (*Spruce ex Benth.*) *Muell.-Arg.* var. coriacea *Ducke*
*Hevea rigidifolia (*Benth.*) *Mueller-Argentius*
Hevea viridis *Huber*
Hevea viridis *Huber* var. toxicodendroides *R. E. Schultes & E. L. Vinton*

Hevea Benthamiana *Mueller-Argentius* in Linnaea 34 (1865) 204.

Hevea Benthamiana is usually found in those swampy regions commonly known as "rebalsés" or "igapós," areas which are subjected to heavy yearly inundations during the rainy seasons and which are more or less permanently boggy. This species is often closely associated with *Hevea viridis* and *H. pauciflora* var. *coriacea*, often hybridizing with the latter and possibly also to a lesser extent with the former.[4]

Frequently, this species is seen in association with the interesting "moriche" or "canangucho" palm (*Mauritia minor*), one of the most striking indicators of igapó areas. Because of its predilection for moist and acidic habitats, *Hevea Benthamiana* generally occurs close to and along the banks of rivers and creeks (especially those which carry little suspended clay or sand and which are known as "aguas negras"), rarely invading the usually higher hinterland. This species has no special common name in

[4] The most extensive hybridization of *Hevea* which I have seen in Colombian forests is that of *Hevea Benthamiana* × *H. pauciflora* var. *coriacea* in the Río Miritiparaná above the Raudal de Chimborazo where there are stands of the hybrid and of the two parents.

Colombia other than "siringa" or "siringa blanca." It yields a product only slightly inferior to that of *Hevea brasiliensis.*

Hevea Benthamiana is represented in various parts of eastern Colombia by a number of rather distinct varieties and forms which are not yet sufficiently well understood to be described. I believe that more exploration and study will show that this is the most variable species in Colombia.

Hevea brasiliensis (*HBK.*) *Muell.-Arg.* var. **subconcolor** *Ducke* in Arch. Jard. Bot. Rio Janeiro 6 (1933) 55.

Hevea nitida Mueller-Argentius in Martius Fl. Bras. 11 (1874) 301.

Hevea brasiliensis, a widespread species in the Amazon Valley, occurs in Colombia apparently only in the southern half of the "trapecio amazonico"—in the Leticia area—where it is represented by the very strikingly distinct variety *subconcolor*. This variety, with firmly chartaceous or thinly coriaceous leaflets which are nearly as green beneath as above and very glossy on both surfaces, was described from the nearby Brazilian locality of São Paulo de Olivença. In Colombia, it is a tree of heavily floodable areas and occurs along river and creek banks, but not to any appreciable extent on land which is above the height of the annual floodwaters. In Leticia, it is referred to as "siringa fina." It yields the highest grade of Colombian *Hevea* rubber, the so-called "Up-River" or "Alto-Río" grade.

The specific concept described by Mueller in 1874 under the name *Hevea nitida* is known only from the type material which von Martius collected "in prov. do Alto Amazonas, in silvis secus flumina Solimoës et Amazonium." In his "Revision of the Genus Hevea, mainly the

Brazilian Species," Ducke cited *Hevea nitida* as an insufficiently known species, stating, in part: "I compared a leaf of the type. . . . [which] resembles, in the nearly equal colour of both surfaces, the leaves of *H. viridis* but [it] is more coriaceous and has a different form." Mueller wrote in the original description that the leaflets are "subtus vix pallidiora" and that the concept is "evidenter affinis *H. rigidifoliae* et *H. Brasiliensis*, sed folia minus rigide coriacea quam in priore et margine haud recurva, distinctius venosa, et capsulae et semina multo minora quam in posteriore, a qua insuper colore foliorum recedit."

The type locality of *Hevea nitida* coincides with the region where the concept *Hevea brasiliensis* var. *subconcolor* is known to be rather widely distributed.

After having studied individually thousands of trees of the variety of *Hevea brasiliensis* which occurs in the "trapecio amazonico"—which have been determined both by Dr. Ducke and by myself as representing the concept *H. brasiliensis* var. *subconcolor*—I am convinced that this variety is identical with the concept *H. nitida*. All the characters of *Hevea nitida* mentioned by Mueller in his ample description agree with those described by Ducke for his variety *subconcolor*. Consequently, I believe that it is advisable to reduce *H. nitida* to synonymy. Because of the International Rule requiring the use of the earliest name under the rank maintained, it is impossible to use the earlier epithet *nitida* as the varietal designation.

Hevea Foxii *Huber* in Bol. Mus. Goeldi 7 (1913) 228.

Hevea Foxii, for which the common name "ituri" has been reported, is a very poorly understood species known only from the type material which was collected at El

Retiro near the headwaters of the Río Igaraparaná. In 1942, I searched carefully along the Igaraparaná from La Chorrera to its confluence with the Río Putumayo, but could not find a tree showing characters similar to those ascribed to this species. Extensive collections of topotypical material of *Hevea Foxii* are urgently needed before we can evaluate critically its exact relationship to *H. guianensis* var. *lutea* with which it appears to be allied.[5]

* **Hevea glabrescens** *Huber* in Bol. Mus. Goeldi 7 (1913) 230.

Described from material gathered on the Río Putumayo, *Hevea glabrescens* is rather poorly understood as a species. In 1942, I attempted to collect topotypical material, but without success. It cannot be a common species, for I did not find it in any locality along the Putumayo. Its relationships would seem to be with *Hevea guianensis* var. *lutea*.[5] Although the type was collected on the Peruvian bank of the Río Putumayo, there seems little reason to believe that it does not occur on both sides of the river.

Hevea guianensis *Aublet* Pl. Guian. 2 (1775) 228.

Hevea guianensis *Aubl.* var. **lutea** (*Benth.*) *Ducke et R. E. Schultes comb. nov.*

Hevea lutea (Benth.) Mueller-Argentius in Linnaea 34 (1865) 204.

During several conferences which I had with Dr. Adolpho Ducke in Manaos in June, 1944, it became evident that we had arrived quite independently at the conclusion that *Hevea lutea* actually represents only a variety of the widely distributed and very variable *H.*

[5] Ducke (Arch. Jard. Bot. Rio Janeiro 5 (1930) 152) has considered *Hevea Foxii* and *H. glabrescens* as varieties of *H. lutea* and has made the appropriate nomenclatorial transfers.

guianensis. We have both encountered variability in the characters which have been used to maintain *H. lutea* as a species. In 1943 (Arquiv. Serv. Florest. Rio Janeiro 2 (1943) 31) Ducke stated: "Quanto as relacões de afinidade entre as especies *guianensis* e *lutea*, e a descoberta de uma forma que parece representar uma transicão de *guianensis* var. *occidentalis* para *lutea* var. *pilosula*." Hans G. Sorenson likewise believes, after very extensive field work in the Amazon Valley, that *H. lutea* represents but a variety of *Hevea guianensis*.

Hevea guianensis and *H. guianensis* var. *lutea* occur most commonly on "tierra firme" and on higher and well-drained knolls or river banks. They comprise the most widespread complex of Colombian representatives of *Hevea*. Furthermore, they occur coexistantly and are extremely abundant where the annual inundation does not exert a direct flooding or "drowning" influence for long periods. Of the two, *Hevea guianensis* var. *lutea* is by far the more abundant in most regions. Both are known generally as "siringa amarilla" because they have yellowish latexes; in regions bordering Brazil, the name "borracha fraca" is current. In Leticia, the Peruvian term "jebe debil" is used. While these trees yield a weak rubber in some regions, the rubber from the Vaupés, which comes for the most part from *Hevea guianensis* var. *lutea*, is considered to be good. There are numerous localized varieties and forms of both concepts.

Hevea pauciflora (*Spruce ex Benth.*) *Muell.-Arg.* var. **coriacea** *Ducke* in Arch. Inst. Biol. Veg. Rio Janeiro 2 (1935) 239.

Hevea pauciflora var. *coriacea*, a small to medium-sized tree, occurs in light (catinga-type) forests on the slopes of rocky hills or in the vicinity of rock outcrops. It is not common in Colombia. The latex is whitish. This species is never tapped.

***Hevea rigidifolia** (*Benth.*) *Mueller-Argentius* in Linnaea 34 (1865) 203.

Hevea rigidlfolia, collected by Spruce in catinga forests along the Río Vaupés at Panuré in Brazil (near the Colombian boundary), is known only from the type material. It seems entirely probable that this species will be found in Colombia. I have examined a duplicate type which is preserved in the Gray Herbarium and find that it is an extraordinarily distinct species which resembles no other known representative of the genus. The leaflets are glabrous, glossy, rigidly thick-coriaceous with strong, recurvate margins.

Hevea viridis Huber in Rev. Cult. Colon. 10 (1902) 194.

Hevea viridis occurs in two very different habitats, but always in the vicinity of sandstone or granitic rock outcrops. In the igapós subjected to heavy inundation each year, it becomes a very robust tree; on rocky hillsides and sterile places near falls and rapids, it is a medium sized and poorly developed tree, superficially resembling *Hevea pauciflora* var. *coriacea*. Its chief characters, however, are exceedingly constant despite the wide variance in its chosen habitats. I have never encountered *Hevea viridis* in the areas of inundation where rock outcrops are remote. The latex of this species is yellowish (in igapós) or, rarely, white (in drier, rockier locations) and gives a sticky rubber devoid of elasticity. It not only yields a product which is of no commercial value, but it will spoil the latexes of other species if mixed with them. In the Vaupés, the common name is "siringa pegajosa."

Hevea viridis *Huber* var. **toxicodendroides** *R. E. Schultes & E. L. Vinton* in Caldasia 3 (1944) 25.

Hevea viridis var. *toxicodendroides* is a bushy or shrub-

by representative of the genus found on the sterile tops of sandstone mountains in the Caquetá and Vaupés. It yields a rubber which is described by chemists as "very good," an exceedingly interesting report in view of the inferior and worthless quality of the rubber of *Hevea viridis* itself. Unfortunately, due to its diminutive size, *Hevea viridis* var. *toxicodendroides* is commercially without value because it cannot be tapped. Nevertheless, it represents a very interesting variety which might be of use in a breeding program. It has no common name which has come to my attention.

III.

The distribution of *Hevea* in Colombia can best be understood if it be presented according to river-systems.

Vaupes River Basin: The Itilla and the Vaupés itself above the falls of Yuruparí are populated by an abundance of *Hevea guianensis* var. *lutea*, considerable *H. guianensis* and a relatively small amount of *H. Benthamiana; H. viridis* is apparently entirely absent. Below Yuruparí, the Vaupés is very rocky, interrupted by innumerable rapids and one finds proportionately less *Hevea guianensis* var. *lutea*, little *H. guianensis* but much more *H. Benthamiana; H. viridis* is extremely abundant in igapós near rock outcrops; *H. viridis* var. *toxicodendroides* is found on sandstone mesas at Yapobodá near the headwaters of the affluent Cuduyarí and on Cerro Circasia; *H. rigidifolia* may occur below Mitú near the Brazilian border.

Apaporis River Basin: In the upper and middle basins above the falls of Jerijerimo (which correspond to Yuruparí geologically and geographically), the most abundant trees are *Hevea guianensis* var. *lutea* and *H. guianensis; H. Benthamiana* (including several unusual

forms) is common; on the numerous sandstone hills, especially on Cerro Chiribiquete and Cerro de la Campana, *H. viridis* var. *toxicodendroides* is extraordinarily abundant; *H. viridis* is found only in the vicinity of Jerijerimo. The affluents of the upper and middle basins—the Ajaju, Macaya, Macayarí, Tacunema and Cananarí—are similarly populated. In the lower basin, from the Cachivera (rapids) de Jerijerimo to the Cachivera de Yayacopí, the composition of the *Hevea* flora resembles that of the upper and middle basins; the large affluent, the Pirapar-aná, is also similar. From Yayacopí downstream to the mouth of the Apaporis, however, *Hevea Benthamiana* predominates along the banks, while the *H. guianensis*-complex is relegated to the higher hinterland mesas; *H. viridis* is found, but apparently not in abundance, in the vicinity of the Cachivera de Yayacopí. (The lowest affluent of the Apaporis, the Taraíra, is said by "caucheros" to have practically no *Hevea* along its banks. If this be true, it curiously coincides with conditions which Allen found on the Río Papurí, an affluent of the lower Vaupés in the same general region as the Taraíra.)

It is interesting to note here that the results of a mile-by-mile census of *Hevea* which I made along a 62 kilometer path connecting the middle Vaupés and the middle Apaporis basins indicates that *Hevea Benthamiana* is almost completely absent on the high hinterlands and that the only representatives of the genus encountered are *H. guianensis* and *H. guianensis* var. *lutea*, the latter by far the more abundant. Similar results were obtained on a 36 kilometer traverse which I studied between the Itilla and the Macaya.

Caqueta River Basin: *Hevea guianensis* var. *lutea* and, to a lesser extent, *H. guianensis* are found in abundance along the Caquetá upstream from a point about

eighty miles above the Cachivera de Cordova (near La Pedrera), but from Cordova to this point, *Hevea Benthamiana* predominates on the inundable banks. On the sandstone mesa at Araracuara, *Hevea viridis* var. *toxicodendroides* occurs, but not in abundance as at Chiribiquete on the Apaporis. Below Cordova, the only species found along the banks is *Hevea Benthamiana*, with the exception of a small colony of *H. pauciflora* var. *coriacea* on and around the base of Cerro de LaPedrera. In the Miritiparaná, *Hevea Benthamiana* is the only species found below the lowest rapids where the banks are subject to heavy flooding. Above the rapids, *Hevea guianensis* var. *lutea* and *H. guianensis* are more abundant, except in certain localities (especially in several large igapós) where *H. Benthamiana* and *H. pauciflora* var. *coriacea* also occur in abundance in sandy catingas and on rocky elevations in the neighborhood of the numerous falls and rapids of the Miritiparaná. In the hinterland of the upper reaches of the river, *Hevea guianensis* and its variety *lutea* are found to the exclusion of *H. Benthamiana* but not of *H. pauciflora* var. *coriacea*. I suspect that *Hevea viridis* also occurs in the Miritiparaná, but no trees were encountered.

Putumayo River Basin: The Putumayo, with its main affluents—the Caraparaná and Igaraparaná—is perhaps the most uniform area of Colombia as far as the distribution of *Hevea* is concerned. *Hevea*, as an important element of the flora, does not extend upstream in the Putumayo beyond Caucaya. From this point nearly to Arica, the chief representatives of the genus are *Hevea guianensis* and its variety *lutea*. Below Arica (or the mouth of the Igaraparaná), *H. Benthamiana* begins to appear, and, near the Brazilian border and possibly also in the Río Cotuhé, it predominates over the other two in

the floodable areas. In the Caraparaná and Igaraparaná, formerly the centres of the famous and powerful Casa Arana which exploited rubber with Indian labor forced by torture and death, *Hevea guianensis* and *H. guianensis* var. *lutea* predominate. Only a small amount of *Hevea Benthamiana* is found along the lower reaches of the Igaraparaná and in the vicinity of the Quebrada Menaje. Nothing is known about the distribution of the little understood species *Hevea Foxii* and *H. glabrescens* of this basin. I did not find *Hevea viridis* in the Putumayo drainage area, but Ducke reports one collection of this species from Occidente on the Río Putumayo.

Amazon River Basin: Colombia has only a very short stretch of the Amazon, the southern limit of the wedge-shaped "trapecio amazonico." Nevertheless, this short stretch, receiving several small rivers or large creeks (the Loretoyacu, Hamacayacu, etc.) is of special importance in a study of *Hevea*. This small area is the only part of Colombia where *Hevea brasiliensis* occurs. As yet, we do not know exactly how far into the "trapecio" this species penetrates, but it probably reaches only to the headwaters of the creeks which empty directly into the Amazon above Leticia. In this area, however, *Hevea brasiliensis* var. *subconcolor* predominates, occurring in swampy habitats to the exclusion of other species. There are several very distinct forms of the variety in the Leticia area. On the few higher knolls, *Hevea guianensis* is represented.

IV.

The following key has been prepared with the needs of the field man in mind. A number of the characters—position of the leaflets, color of the latex, consistency and color of the bark, etc.—are rather easily observed in the field even though they may not be available to the stu-

dent who is limited to herbarium material. Such field characters can be of much greater value in the preparation of keys to the smaller subspecific entities and should be carefully noted and annotated by all collectors.

Hevea rigidifolia and *H. glabrescens* have not been included in the key because they have yet to be seen in Colombia. *Hevea Foxii* has been omitted pending the collection of more material and information concerning its characters and relationships.

KEY TO THE GENUS HEVEA IN COLOMBIA

A. Leaflets horizontal or reclinate in relation to the petiole (sometimes slightly erect in *H. pauciflora* var. *coriacea*). Latex normally pure white (in *H. viridis* yellowish or white). Habitat: bogs, swamps or sterile and rocky locations.

B. Capsules (ordinarily about 4 cm. or less in diameter) and seeds medium sized. Seeds 300–750 per kilo (except in *H. pauciflora* var. *coriacea*). Disk of staminate flower well-developed. Inflorescence pubescent to nearly glabrous. Leaflets normally coriaceous or subcoriaceous.

C. Leaflets ordinarily horizontal. Inflorescence pubescent, very rarely subglabrescent. Seeds under 360 per kilo.

D. Leaflets variously pubescent beneath (usually reddish or ferruginous). Buds of staminate flower acuminate. Anthers normally 7–9 (rarely 5–10) in two irregular verticels. Latex yields very elastic, high-quality rubber. Large trees of floodable forests. Seeds 330–360 per kilo, with large dark brown or black spots, somewhat elongate-ovoid, not angular.

H. Benthamiana

DD. Leaflets glabrous beneath. Buds of staminate flower obtuse. Anthers normally 10 in two regular verticels. Latex yields a sticky, non-elastic rubber of no commercial value. Medium sized trees of rocky or sandy locations in catinga forests. Seeds not seen for Colombian specimens but apparently larger than those of *H. Benthamiana*.

H. pauciflora var. *coriacea*

CC. Leaflets ordinarily reclinate, occasionally approaching a semi-horizontal position. Inflorescence subglabrous. Seeds more than 450 per kilo.

E. Erect trees 30–100 feet tall. Trunk thick, cylindrical. Leaflets semi-horizontal to strongly reclinate, usually more or less flat, subcoriaceous. Seeds 450–500 per kilo. Bark clear brown or reddish brown, smooth. Habitat: bogs or well watered rocky slopes.

H. viridis

EE. Erect or semi-prostrate treelets or bushes 8–15 feet tall (rarely up to 25 feet). Trunk slender, weak, often gnarled. Leaflets strongly reclinate, folded at right angles along midrib, firmly coriaceous. Seeds very small, probably 650–750 per kilo. Bark checkered, roughish, brownish or light gray. Habitat: dry sterile sandstone mesas.

H. viridis var. *toxicodendroides*

BB. Capsules (ordinarily 5 cm. or more in diameter) and seeds large. Seeds about 200 per kilo. Disk of staminate flower non-existent or very slightly developed. Inflorescence densely pubescent or rarely subglabrescent. Leaflets ordinarily somewhat membranaceous-papyraceous, reclinate.

H. brasiliensis var. *subconcolor*

AA. Leaflets strongly erect, in relation to the petiole. Latex normally yellowish. Habitat: forests not subject to long periods of annual flooding, headwaters of creeks.

F. Latex usually deep yellow, often orange-yellow. Staminate buds obtuse or short-acuminate. Inflorescence usually pubescent. Anthers 5 (often 4–6) in one regular verticel. Seeds 500 per kilo.

H. guianensis

FF. Latex usually cream-color to yellow. Staminate buds very strongly acuminate. Inflorescence pubescent or subglabrous. Anthers 5 (rarely 6–8) in one irregular or in two irregular or regular verticels. Seeds 500 per kilo.

H. guianensis var. *lutea*

EXPLANATION OF THE ILLUSTRATIONS

PLATE I. Upper figure. Typical rubber-tapper's camp, Loretoyacu River, Amazonas. Here a group of five smoke-houses and several balls of smoked rubber ready for selling can be seen.

Lower figure. A rubber-tapper smoking latex into balls, Loretoyacu River, Amazonas. This ball, the product of about six days' tapping, weighs about 25 kilos. The latex is from *Hevea brasiliensis* var. *subconcolor*. In the Vaupés, latex is coagulated with acid and not with smoke, and the rubber is prepared in sheets.

PLATE II. Upper figure. Exploiting *Hevea brasiliensis* var. *subconcolor*, Loretoyacu River, Amazonas. In the "trapecio amazonico," trees of this variety sometimes attain a diameter of four feet.

Lower figure. Leaves and flowers of *Hevea brasiliensis* var. *subconcolor*, Loretoyacu River, Amazonas. Note the brilliance of the leaflets.

PLATE III. Upper figure. *Hevea guianensis* on the highland knolls of the Loretoyacu River, Amazonas.

Lower figure. *Hevea guianensis* var. *lutea*, Macaya River, Vaupés.

PLATE IV. Upper figure. Young leaves of *Hevea viridis* showing their lustrous surfaces, near Tayasú, Vaupés River, Vaupés.

Lower figure. Trunk of *Hevea viridis*, near Tayasú, Vaupés River, Vaupés.

PLATE V. Upper figure. *Hevea viridis* var. *toxicodendroides* at the type locality, Cerro Chiribiquete, Vaupés. This illustrates the erect habit of the plant.

Lower figure. Cretaceous sandstone ridges of the upper Apaporis River basin, Vaupés, where *Hevea viridis* var. *toxicodendroides* abounds on the xerophytic summits.

PLATE VI. Upper figure. Seeds of *Hevea viridis* from lower Vaupés River, Vaupés.

Lower figure. *Hevea viridis* var. *toxicodendroides* with fruit. Cerro Chiribiquete, Apaporis River, Vaupés.

Plate I





Plate II





Plate III





Plate IV





PLATE V





Plate VI





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THE ORIGIN AND NATURE OF THE EAR OF MAIZE

BY
PAUL C. MANGELSDORF

OF ALL THE New World plants which excited the curiosity and wonder of the herbalists of the immediate post-Columbian period, none, perhaps, proved to be more intriguing than Indian corn or maize. The ears of this plant, and to a lesser extent the tassels, were quite baffling to the students of that period and have continued to perplex botanists for more than four centuries. Nowhere has the recognition of the peculiarities of the maize inflorescence been more vividly expressed than by Lyte in his *New Herbal* of 1619 (6)*. The page on which maize is described is reproduced as Plate VII of this paper. The description of the inflorescences is as follows: "This Corne is a marvellous strange plant, nothing resembling any other kind of grayne; for it bringeth forth his seede cleane contrarie from the place whereas the Floures grow, which is against the nature and kinds of all other plants, which bring forth their fruit there, whereas they have borne their Floure. . . . at the highest of the stalkes, grow idle and barren eares, which bring forth nothing but the floures or blossomes. . . . "

The wonderment of the herbalist of the sixteenth cen-

*This description, in slightly different form, first appeared in an edition entitled *A Nievve Herball* in 1578.

tury has persisted almost undiminished to the botanist of the twentieth. True, the modern student recognizes that Lyte's description of maize is somewhat lacking in accuracy from the technical botanical standpoint. Maize does not, as Lyte believed, bear its seeds "cleane contrarie from the place whereas the Floures grow" and therefore it is not, as he contended, "against the nature and kinds of all other plants." Nevertheless, the botanist of today would not deny that maize is indeed a "marvellous strange plant," and he would unhesitatingly agree with Lyte that its uniqueness lies in its inflorescences, particularly in the pistillate inflorescence, the ear.

In its general vegetative characteristics maize does not differ essentially from other grasses especially the larger cultivated species; its affinity to sugar cane and the sorghums, for example, is easily recognized. But nowhere among the Gramineae, indeed nowhere in the Plant Kingdom, is there a fruit which in its external aspects at least seems to be more than remotely comparable to the ear of maize. It is quite understandable, therefore, that the ear of maize has been the subject of numerous observations, investigations and conjectures. Nor is it surprising that the problem of its origin and morphological nature has remained to a large extent unsolved.

This paper, despite the unqualified language of its title, does not presume to present a final solution to the problem of the origin and nature of the ear of maize. Botanical problems of this kind are seldom susceptible of complete and definitive solutions. However, in the course of extensive studies of maize-teosinte hybrids and of hybrids of pod corn with a peculiar variety of maize obtained from the Guarany Indians of Paraguay, a number of interesting phenomena have been encountered which appear to shed new light upon the problem of the maize ear. Before considering the new facts, it seems de-

sirable to review the previous evidence and hypotheses which bear upon the problem. Only the essential features of the earlier hypotheses will be considered here since the rather extensive literature on the subject has been thoroughly reviewed in recent years by several writers. The reader is referred to the papers of Weatherwax (19), Mangelsdorf and Reeves (13), and Reeves (15) for additional details.

Historical Considerations

The Maize Ear Described

The ear of maize, though not easily interpreted, is not difficult to describe. It is a spike upon whose thickened axis (the cob) naked grains (caryopses) are borne in longitudinal or somewhat spiral rows; eight, ten, twelve or more in number. The number of rows is always even because the spikelets upon which the grains are borne are paired, a characteristic in which maize differs from its nearest relatives, teosinte and Tripsacum, whose spikelets are solitary. Each rank of paired spikelets is clearly the equivalent of two rows of grain in the mature ear. The ear is enclosed in husks which are modified, overlapping leaf-sheaths. The ear is obviously the terminal inflorescence of a lateral branch whose internodes have, probably during the course of domestication, become drastically contracted.

Homology of Ear and Tassel

The general nature of the ear is sufficiently clear so that there can be little doubt that it is the homologue of the central spike* of the staminate inflorescence, the tassel. This homology may have been vaguely suspected by some of the earlier students including Wigand, Ascher-

*In one of his recent papers Weatherwax (19) calls this structure a "terminal raceme." I prefer the older but equally appropriate "central spike."

son and Goebel,* but it seems to have been first clearly recognized by Mrs. Kellerman (9) who postulated that the ear has developed phylogenetically from the *central stem*‡ of the primitive tassel. Montgomery (14) apparently unaware of Mrs. Kellerman's suggestion, independently arrived at the same conclusion, illustrating it with an interesting series of transition stages to show how the change from a staminate central spike of the tassel to a pistillate ear might have occurred.

Since the appearance of Montgomery's paper the homology of the ear with the central spike of the tassel has not been seriously challenged except, perhaps, by indirection. Strong evidence, amounting almost to proof, of the homology of the two structures has recently been furnished by Langham (11) who showed that in segregates of maize-teosinte hybrids there is a close correlation between the ear and the central spike of the tassel in the expression of distichy and polystichy. A recent paper by Bonnett (3) is illustrated with striking photographs which reveal, among other things, that in the early stages of development the two structures, ear and central spike, are scarcely distinguishable.

Anderson (1) has recently pointed out that some of the important characteristics of the ear are closely correlated with characteristics of the lateral branches of the tassel. These observations, as will be shown later, are not in conflict with the conception of the ear as the homologue of the central spike of the tassel.

The fact that the ear is the homologue of the central spike does not, however, solve the problem of the origin of the ear. As Collins (4) pointed out many years ago,

* Cf. Weatherwax (19) or Mangelsdorf and Reeves (13) for references.

‡ Italics hers.

the central spike is as much in need of explanation as the ear.

Hypotheses Regarding the Ear of Maize

There have been three general hypotheses regarding the ear of maize: (1) That it is the product of the fusion of two or more distichous (two-ranked) spikes. (2) That it originated from the shortening and twisting of a distichous spike. (3) That it is the result of the transformation of a panicle to a spike through the reduction of branches.

The Fusion Hypothesis. It is not surprising that botanists familiar with the compound nature of many fruits should, when confronted with an ear of maize, think immediately in terms of fusion. And when branched ears, ears apparently "disrupted" into their component parts, are encountered, the fusion hypothesis becomes almost inevitable. Little wonder that this hypothesis is the oldest of the three and has been, by all odds, the most popular. Ascherson, Hackel, Harshberger, Gernert, Wordsell, and Goebel* have all interpreted the ear of maize as arising through the fusion of two-ranked spikes either like those of teosinte or Tripsacum, or like the lateral branches of the maize tassel.

The serious weakness of the fusion hypothesis, so far as maize is concerned, is that there is no concrete evidence in support of it and considerable evidence in conflict with it. Branched ears, bifurcated or many-branched at the tip or bearing branches at the base, have repeatedly been regarded as evidence for the compound nature of the maize ear. But the majority of these branched ears prove upon examination to represent a type of branching which

* Cf. Weatherwax (19) or Mangelsdorf and Reeves (13) for references.

is not easily attributable to the "disruption" of a compound structure into its component parts. Weatherwax (16) regards ears branched at the tip as nothing more than anomalies "giving no more clue to the past than is afforded by Siamese twins." And now Reeves (15) has virtually committed to the category of *reductio ad absurdum* the argument for fusion based upon branching, when he points out that the two types of branching most commonly encountered in the ear, basal branching and bifurcation of the tip, have their counterparts in the stem, the first in the well-known basal tillering or "suckering" of the stalk, the second in the bifurcated stalks which he described (15). Reeves contends that if branching of the ear is regarded as evidence of its compound nature, then corresponding types of branching in the culm must be regarded as evidence that it, too, is a compound structure resulting from fusion.

Aside from branched ears, which upon close examination obviously fail to support the fusion hypothesis, what is the evidence for fusion? Apparently there is none. Weatherwax (18) states that both the young ear and the young tassel develop from ordinary growing points and that there is nothing to suggest a compound nature. Bonnett's studies (3) support this statement, although he does not specifically discuss the question of fusion. Weatherwax has observed (19) that the vascular bundles of the cob are distributed in approximately the same manner as those of the stem and therefore furnish no indication of fusion. Reeves (15) too, has made a detailed study of the vascular system and the arrangement of the rachis segments and finds no structural feature of any kind which suggests that the maize ear is the product of fusion.

Weatherwax (16, 18, 19) seems to regard as the most critical evidence in conflict with the fusion theory, the

fact that the fusion of distichous branches (in which the spikelets are paired or must become paired to produce an ear of maize) should result in ears in which the number of ranks of paired spikelets is always even and the number of rows of grain is always a multiple of four. Thus a fusion of two such spikes or branches would produce an ear with four ranks of paired spikelets and eight rows of grain; a fusion of three spikes or branches, an ear with six ranks of paired spikelets and twelve rows of grain, etc. Weatherwax assumes that ears in which the number of ranks of paired spikelets is odd and the number of rows of grain not a multiple of four (ears with ten, fourteen and eighteen rows of grain, for example) cannot have been the product of fusion of two-ranked spikes. Since such ears do occur Weatherwax concludes that the fusion hypothesis is confronted with serious mathematical inconsistencies.

Kempton (10), in an attempt to reconcile these apparent inconsistencies, has suggested that ears in which the number of ranks of paired spikelets is odd may be the result of the abortion of a row of paired spikelets or the abortion of the pediceled* spikelets in both ranks of one of the component branches. Kempton was of the opinion that both of these phenomena are of common occurrence, but it is now doubtful if either one occurs. Weatherwax (19) found no vestiges of the supposedly aborted spikelets and Dr. Reeves and I have examined numerous ten-rowed ears without finding a trace of them, although there is no difficulty in seeing them in both teosinte and Tripsacum where normally only one spikelet in each pair is functional.

Kempton (10) also suggested that ears in which the

* Both members of a pair of pistillate spikelets are actually sessile, but one is potentially pediceled and is the homologue of the pediceled staminate spikelet.

number of rows of grain is a multiple of four are more numerous than ears in which the row number is not a multiple of four. Even before the suggestion was made, East (7) had shown that such is, indeed, the case. East offered no morphological explanation for the multimodal distribution and it still remains to be satisfactorily explained. Reeves (unpublished) has suggested that the peculiar distribution reported by East may be the result of past selection for straight-rowed ears, a suggestion based on the fact that there is a tendency, discovered by Fujita (8), for ears with an odd number of ranks of paired spikelets to be twisted.

But whatever the explanation of the low frequency of ears with ranks of paired spikelets in odd numbers, the fact that *any* ears of this kind occur has generally been regarded as evidence against the fusion theory. Perhaps more weight has been assigned to this evidence than is deserved. There are undoubtedly ways (one will be mentioned later) in which rows of spikelets might be lost without leaving readily discoverable vestiges. Furthermore if fusion is thought of in a phylogenetic rather than in an ontogenetic sense, it is scarcely necessary to assume that the compound structure resulting from fusion must still exhibit all of the features of its original component parts. Finally the absence of anatomical evidence of fusion is by no means final proof that it has not occurred. There are numerous structures in plants in which anatomical evidence for fusion is lacking or at least not readily discernible, but which are nevertheless regarded as compound structures. In these instances, however, some other kind of evidence for fusion is usually at hand; for example, a series of forms involving different species which illustrates a transition from the condition in which the components are entirely separated to that in which they are completely joined. In the case of maize there

appears to be no evidence *of any kind* to support the fusion hypothesis with respect to the ear. Yet fusion does occur in maize. It is almost certain that the slightly branched styles, the well-known "silks" are compound structures resulting from the fusion of the two stylar branches characteristic of grasses.* I have seen several cases of fusion of the pedicel of a staminate spikelet with the surface of the rachis. And an actual instance of the fusion of two of the branches of a maize tassel, the kind of fusion which might have given rise to the ear, will be described later in this paper. Nevertheless, the fusion hypothesis of the origin of the maize ear, though the most obvious, and at first glance the most plausible, actually appears to have little to commend it.

Reduction of Branches. The second hypothesis, that the ear of maize has been derived from a panicle through the reduction of branches until each branch is now represented by a pair of spikelets, was suggested by Collins (4). But the general theory that spikes are more specialized than panicles and have originated from these through the reduction of branches is, as Reeves (15) has pointed out, an old one.

This hypothesis would seem to be especially appropriate when applied to maize whose staminate inflorescence, the tassel, is a perfect illustration of a combination of spike and panicle, a structure in which the reduction of branches either has not proceeded to completion or has been confined to the upper part of the inflorescence. Furthermore it is not difficult to find extreme forms which lend credence to the hypothesis; for example, tassels which consist only of central spikes or ears which bear well-defined basal branches.

Collins felt that the chief objection to this hypothesis

*Cf. Weatherwax (18) p. 123.

lay in the fact that in most cases the change from branches to spikelet is abrupt. In the tassel there are usually only well-defined branches at the base and only spikelets on the central spike. In most cases there is no transition from branches to spikelets. Collins found some evidence of such a transition in varieties of pod corn, but the condition in pod corn was by no means as convincing as the various transition stages later described and illustrated by Weatherwax (16) in branch (ramosa) maize.

The studies of Bonnett (3) have a bearing on this problem for they show that in the development of the tassel there are no discernible differences between the initials that become the lateral branches and those which become differentiated into spikelets.

The conception of the ear of maize as a spike homologous to the central spike of the tassel, and like the latter having arisen through the reduction of branches, (a reduction usually completed in the ear, but seldom in the tassel) appears to be clear, reasonable and in complete harmony with the facts. Weatherwax (16, 19) contends, however, that this hypothesis alone is not adequate since it does not answer the question of how the polystichous condition originated in maize or other grasses. He, therefore, interprets the maize ear in terms of spiral phyllotaxy. The four-rowed ear (like the arrangement of the leaves on the stem) is regarded as including a single spiral; the eight-rowed ear includes two spirals, etc.

Weatherwax has made an important contribution in recognizing and describing the spiral phyllotaxy characteristics of some (probably not of all) maize ears, and in showing the resemblance of the maize ear to the spikes of other grasses such as Pennisetum. Phyllotaxy, however, describes rather than explains the change from the distichous condition typical of the grasses in general to the polystichous condition characteristic of the inflores-

cences of maize. To say that the many-ranked ear of maize departs from its two-ranked prototype by virtue of its more complex phyllotaxy is scarcely more explanatory than to say that the former has more numerous ranks than the latter. Nevertheless phyllotaxy, as will become apparent later, is immensely important.

Actually, as Reeves (15) points out, the polystichous inflorescence is sufficiently common in various genera of grasses so that no special explanation of its occurrence in maize is required. Its origin is a problem of the Gramineae as a group rather than of maize alone. The uniqueness of maize lies not so much in its polystichous ear as in the fact that its staminate inflorescence is usually a modified panicle while its pistillate inflorescence is usually a spike. Collins' hypothesis furnishes a very satisfactory explanation of the steps involved in the transformation of one to the other.

Anderson's (1) observations, previously mentioned, that the characteristics of the ear are correlated with characteristics of the lateral branches of the tassel, may be interpreted to mean, not that the ear is the product of fusion and that the lateral branches are homologues of its component parts, but simply that the lateral branches are capable of revealing what kind of panicle it is that has become modified to produce the ear.

Twisting of a Two-Ranked Spike. The third hypothesis, that the polystichous maize ear arose through the shortening and twisting of a two-ranked spike, such as the spike of teosinte, was also formulated by Collins (5). This hypothesis grew out of observations made by him on the pistillate spikes of an F_2 population of a maize-teosinte hybrid from which a series of specimens could be selected to illustrate the steps involved in changing a structure like the spike of teosinte to one resem-

bling the ear of maize. These steps, not necessarily in this order, are as follows:

1. The solitary pistillate spikelets characteristic of teosinte become paired spikelets typical of maize as the aborted member of each pair becomes functional.

2. The axis of the rachis shortens with the result that adjacent rachis segments assume positions in the same horizontal plane and become "yoked" in pairs. This change, combined with the preceding one, results in a four-rowed ear.

3. A twisting of the axis causes alternate segments to assume positions in a plane at right angles to that occupied by adjacent segments above and below. This, combined with the changes already described, produces an eight-rowed ear. Ears with higher row numbers are produced by further twisting of the axis.

There is no doubt that the series of transition forms which Collins described do occur in segregates of maize-teosinte hybrids. Nor is there any doubt that the ear of maize *could* have arisen from the spike of teosinte through such a series of changes. Indeed if maize had originated from teosinte the changes which have actually occurred must have been very similar to those which Collins has described.

Collins did not imply, however, that maize had actually been derived from teosinte by this series of steps and in fact he carefully pointed out that these intermediate steps explained the evolution of the ear only in a mechanical sense.

Even in a strictly mechanical sense, however, the hypothesis has not been satisfactory. Weatherwax (19) has objected to it on the grounds that there is no evidence in maize of the supposed "yoking" of pairs of spikelets on opposite sides of the rachis. Collins believed that he had evidence for yoking in ears in which some of the rows

of grain were interrupted. He stated that among many ears examined, in which rows were dropped between the base and the tip of the ear, in no instance were the dropped rows either adjacent or separated by two rows, but always (when the dropped rows could be determined with reasonable certainty) on opposite sides of the ear.

Weatherwax (17) showed, however, that when rows are dropped between the base and tip of the ear, it is always a pair of adjoining rows which is eliminated and not rows on opposite sides of the rachis. It is difficult to see how Collins, usually a keen observer, could have been so completely in error in this instance. Actually his statement, though highly inaccurate, has some basis in fact; for in segregates of maize-teosinte hybrids there is in some four-ranked ears a definite tendency for the spikelets in one plane to be predominantly paired while those in the plane at right angles are predominantly single. In other words in ears in which yoking is obvious, there is a definite tendency for the spikelets diametrically opposed to each other on the axis to be alike with respect to the abortion and development of spikelets.

In considering the yoking hypothesis there is some danger, as has already been apparent in the case of the fusion hypothesis, of thinking only in rigid terms. Is it not possible that as the axis becomes thickened, the yoking, if it occurs at all, would become less obvious and the tendency for spikelets on opposite sides of the rachis to exhibit identical behavior would become less pronounced and would, indeed, disappear completely? Is it necessary, in other words, to conclude that yoking has not occurred in the development of the maize ear because the spikelets on opposite sides of the axis, in ordinary ears of maize, are not alike in their behvaior? These questions will be discussed further when new evidence from maize-teosinte hybrids is considered.

Evidence for Fusion

The fusion hypothesis, as has already been mentioned, has been, to a large extent, dismissed because (a) anatomical and other evidence for fusion has been lacking and (b) it has been thought that the hypothesis leads to mathematical inconsistencies with regard to row number. New evidence renders both of these objections somewhat less pertinent than they previously were.

During the summer of 1944, Mrs. P. C. Mangelsdorf in taking notes on the number of ranks in the central spike of tassels among segregates of maize-teosinte hybrids, encountered a clear-cut case of fusion of two of the lateral branches of the tassel. This is illustrated in Fig. 1. The two branches are joined for a distance of slightly more than half of their length. There is no doubt that this is a case of fusion rather than fasciation for the lower region in which the two parts are joined is distinctly four-ranked, a condition which I have never before encountered in a lateral branch of the tassel, while the two unjoined parts of the upper region are both distinctly two-ranked and differ in no important detail from the remaining branches on this tassel.

The fused portion of this branch is not radially symmetrical but exhibits a distinct dorsiventral character since only the adjoining edges of the two component parts are fused. Had the two entire dorsal surfaces of the branches become fused, or had a third branch become fused at both of its edges to the free edges of the other two, thus forming a cylinder, the structure would have been indistinguishable from the central spike of the tassel.

This single specimen makes it clear that a polystichous structure similar to the central spike of the tassel (which is the homologue of the ear) can arise in maize through

the fusion of distichous branches. It does not prove that the ear of maize did actually arise in this way, although it would undoubtedly have been regarded as proof by earlier proponents of the fusion hypothesis.

Also during the summer of 1944 my attention was called to some peculiarities of *Tripsacum dactyloides* (L.) L. by Dr. Leon Croizat who suggested that they seem to have a bearing on the question of fusion. In this species the inner surfaces of the several branches of the terminal inflorescences are so sculptured that the irregularities of one branch are reciprocal to those of the adjoining branch. Because of this the branches, when brought together, form a cylinder which bears spikelets on its circumference; a structure comparable to an ear of maize. I do not regard this condition as evidence for fusion as it is obviously nothing more than the result of the considerable compression to which the inflorescence is subjected while still in the sheath. The same condition in less conspicuous form is regularly encountered in maize tassels where the lateral



FIGURE 1. A case of fusion of two of the lateral branches of a maize tassel. The two-ranked branches are joined for slightly more than half of their length, but separated for the remainder.

branches during development have been compressed around the central spike. Indeed compression is a common phenomenon in the grass inflorescence. Its importance has been clearly recognized by several students of the Gramineae and has been strongly emphasized by Arber (2). The Tripsacum inflorescence is of interest, in my opinion, not in indicating fusion, but in suggesting (as pointed out by Dr. Croizat) how maize ears with odd numbers of rows of paired spikelets and rows of grain not in multiples of four *might* have originated through fusion. This possibility is illustrated in Fig. 2. Fig. 2a

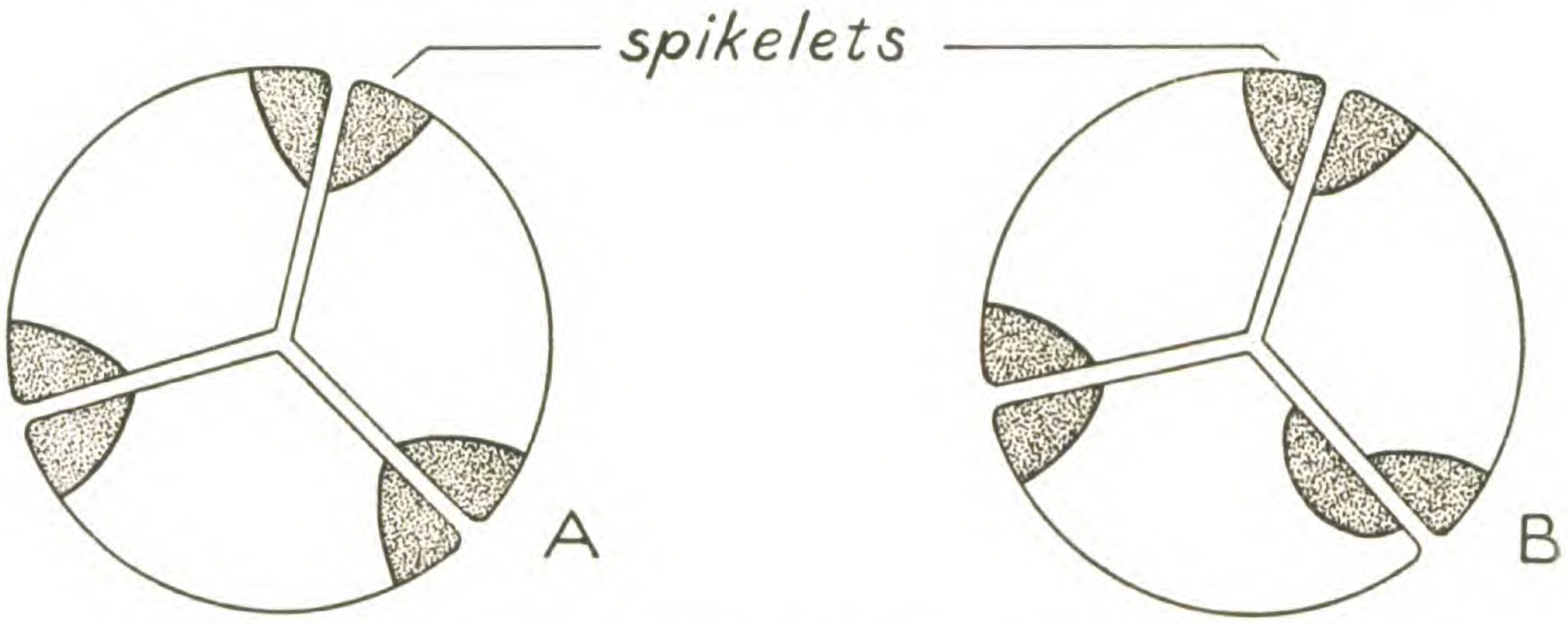


FIGURE 2. Diagrams showing how fusion of two-ranked branches such as those of Tripsacum might give rise to ears with rows of paired spikelets in odd numbers. With the development of the abortive spikelet, the structure illustrated in diagram A would give rise to a twelve-rowed ear. But the condition illustrated in B, because one row of spikelets is abnormally oriented and "buried," would produce a ten-rowed ear.

shows the condition most commonly encountered when three branches are brought together to form a cylinder. Had an ear of maize originated through the fusion of three branches such as these illustrated it would have become a twelve-rowed ear for the circumference of the axis bears six rows of spikelets which, though solitary in Tripsacum, are always paired in maize.

Fig. 2b illustrates a condition encountered much less

commonly but by no means rarely. Here one of the branches is asymmetrical with respect to the position of its spikelets. Were these three branches to fuse to produce an "ear" it would be a ten-rowed ear for here the circumference bears only five rows of spikelets; the sixth is "buried" in the cob. Its vestiges, if they remain at all, are not likely to be found on the surface.

I do not intend to suggest that the ear of maize did actually originate from the fusion of two-ranked branches such as these of Tripsacum, nor do I wish to explain the occurrence of ears with rows of paired spikelets in odd numbers as the result of the "burying" of a row of spikelets in the cob. It is very doubtful if the points at which the spikelets are to appear are so rigidly fixed in the undifferentiated primordium of the spike that its accidental disorientation could result in the suppression of an entire row of spikelets. On the other hand, if this is true, then it is probably also true that ears with pairs of spikelets in odd numbers are not necessarily inconsistent with the fusion hypothesis. For if we think of fusion in rigid terms, the joining during ontogeny of spikes each bearing the primordia of two ranks of paired spikelets, then the condition illustrated in Fig. 2b is a reasonable and valid explanation of how a row of paired spikelets might be lost without leaving clearly discernible vestiges. Add to this the fact that fusion of branches has actually been observed in maize and it becomes apparent that the possibility of fusion in the development of the maize ear cannot be dogmatically dismissed. Nevertheless the fusion hypothesis, in spite of the new evidence which may appear to support it, remains scarcely more satisfactory than it was before.

Hybrids of Guarany Maize and Pod Corn

The real nature of the ear of maize, at least of one type

of ear, is strikingly revealed by ears from a cross of pod corn (tunicate maize) with a variety of maize obtained from the Guarany Indians of Paraguay. The Guarany maize has many peculiar and interesting characteristics. It is one of the few varieties from the lowlands of South America whose chromosomes are knobless or almost so. It exhibits almost all of the dominant genes known in maize, a condition to be expected in a primitive variety. It has the most slender and most flexible rachis ever encountered in a cultivated variety of maize. Finally, it has the peculiar characteristic, under some conditions, of exhibiting in the ear an indeterminate habit of growth. When this happens the ear protrudes far beyond the husks and the exposed region of the ear becomes greatly elongated to produce a lax and flexible spike. This condition was first encountered in 1941. An attempt made in 1942 to induce it through treatment did not succeed. In 1944 the condition again occurred spontaneously. What the factors are which are involved in its occurrence is not known. Bonnett (3) states that both staminate and pistillate inflorescences in maize are potentially indeterminate. Apparently the potentiality persists for a longer period in the Guarany maize than in ordinary maize and an opportunity is afforded for environment to play a part. It is of some interest in this connection to note that the indeterminate nature of the ears was much more pronounced in a late-planted row which flowered during a period of very favorable weather, than it was in earlier planted rows which came into bloom during a hot dry period.

The stock in which the indeterminate ears occurred in 1944 was one which had been derived from a hybrid of Guarany maize and pod corn which had been twice backcrossed to Guarany and was therefore seven-eighths Guarany in its germplasm. Tunicate and non-tunicate ears

occurred in approximately equal numbers and both were affected by the elongation which had occurred. The effects were much more striking in the tunicate ears and especially so in the ear illustrated in Plate VIII which represents an extreme example of elongation.

A study of this and similar ears reveals the real nature of the ear of maize more clearly than has ever been possible by anatomical studies. It should be pointed out that these ears are not abnormalities in the sense that the normal course of development has gone drastically awry —they are not teratological phenomena. Instead, the normal potentialities of the ear, apparently always present, have been more completely developed than is usually the case. This, in combination with the tunicate condition, has resulted in ears so elongated and stretched out that the individual nodes of the rachis and the arrangement of the spikelets upon them are clearly revealed, as illustrated by Plate IX.* There is apparently no essential difference between the structure of the ear at the base where it was completely enclosed in the husks and at the tip where it was completely free from the pressure and restraint exerted by the husks. There is a gradual transition, not an abrupt change, from one condition to the other.

There are several definite and important conclusions to be drawn from these elongated ears of Guarany pod corn:

Homologies. There is now no doubt, if there was doubt before, that the ear is the homologue of the central

*The use of genetic characters in studying the nature of various structures of maize and its relatives offers important possibilities. The tunicate gene transferred to teosinte by repeated backcrossing furnishes a most convincing demonstration that the shell of the teosinte fruit is composed of a rachis segment and an indurated glume, as it has been described, and that it is the pedicellate spikelet which is aborted.

spike of the tassel. Except that the spikelets are pistillate instead of staminate and that both spikelets are sessile or almost so, the elongated portion of these ears is scarcely distinguishable from the central spike. Furthermore, for some reason (for which mere coincidence is not a satisfying explanation) a number of these ears have basal branches. Such ears correspond, not to the central spike alone, but to the central spike plus a few of the upper lateral branches of the tassel.

Fusion. The evidence against the fusion hypothesis now amounts almost to complete proof at least for this type of ear. The rachis is a simple stem-like structure exhibiting not the slightest evidence of fusion in external morphology or internal anatomy. There is no more reason for suspecting fusion in this rachis than in the rachis of wheat, oats, barley or other cereals.

Phyllotaxy. The phyllotaxy is verticillate or whorled rather than spiral. The ear is a simple spike with the spikelets arranged in whorls at the nodes (Plate IX). The number of pairs of spikelets at each node varies, but it is usually two or three. On one ear, beginning with the first node at the tip, the number of pairs of spikelets was 1, 1, 2, 2.5, 3, 2.5, 3 respectively for the first seven nodes. Thereafter three pairs of spikelets occurred at every node up to the 67th, beyond which it was impossible to distinguish the nodes. In a second ear the number of pairs of spikelets was 2, 2, 2, 2, 2, 2, 2.5 for the first seven nodes; two pairs of spikelets each on nodes eight to twenty-four; three or four pairs of spikelets on all additional nodes.

There is a tendency for the pairs of spikelets at one node to alternate in position on the circumference with those at adjacent nodes above and below. In a region of the ear where two pair of spikelets at each node is the

predominating condition, the result is a decussate arrangement which, since the spikelets are paired, actually appears as a double decussate condition.

Spiral phyllotaxy, when it occurs, seems to be accidental. There are regions of the ear in which the phyllotaxy ostensibly is spiral, but this is apparently the result of crowding, and is not the underlying or basic arrangement. This will become clearer when the number of rows is discussed.

Number of Rows. The number of rows is variable. In the elongated region of the ear the spikelets do not appear to be arranged in definite rows, and the orderly arrangement characteristic of most maize ears is lacking. In the basal portion of the ears, the part covered by husks, the grains are arranged in rows, but the number is not constant. It increases rapidly toward the base. In one case row numbers of eight, ten, twelve and fourteen were counted on a single ear. There is not, however, the definite dropping of a pair of rows at any point, as in the cobs described by Weatherwax (17). At one level of the ear eight rows can be counted, at another (lower) level ten, but it is difficult to determine the points where pairs of rows have terminated.

The number of rows is largely independent of the underlying arrangement of the spikelets. In one ear in which the number of rows increased progressively from eight to ten, and from ten to twelve, the underlying arrangement of the spikelets remained the same, three pairs of spikelets at each node. The fact that there are rows at all seems to be largely the consequence of crowding. The spikelets apparently are forcibly crowded into that arrangement which is the most efficient from the standpoint of utilizing space. Certainly there is no definite underlying structure which results in the orientation

of the spikelets into clear-cut ranks as in the case of ears of many North American varieties. Straight rows in this case are probably similar to the rows seen in young inflorescences of Pennisetum (Weatherwax, 19).

Pairs of Rows. Lines of demarcation between pairs of rows, commonly seen in ears of North American varieties, usually separate one rank of paired spikelets from the adjoining rank of paired spikelets. In the Guarany maize the lines of demarcation *separate the two spikelets of the same pair* and a pair of rows thus represents spikelets from two adjacent ranks of spikelets intermeshing with each other like the teeth of gears. This is illustrated in Plate X.

Compaction of the Inflorescence. Since the chief, if not the only real, difference between the upper and lower regions of these ears is one of elongation, it follows that one of the important characteristics of the normal ear of maize lies in the fact that it is a strongly compacted inflorescence. In the ears of Guarany pod corn there is a strong correlation between the amount of compaction and other characteristics. As the ear becomes more compacted, the internodes become shorter, the rachis becomes thicker and the *number of rows of grain increases.* These associated changes are illustrated by the three specimens shown in Plate X.

The correlation between condensation of spikelets on the lateral branches of the tassel and the number of rows on the ear which Anderson (1) has reported may represent one manifestation of the relationship between compaction and number of rows. But since the correlation which he observed is characteristic of North American maize and apparently does not hold for South American varieties (1), it is more likely that condensation of spikelets is correlated with the number of spirals of the under-

lying spiral phyllotaxy which, as will be shown later, is characteristic of North American maize.

If these elongated inflorescences of Guarany pod corn are a valid criterion (and there seems to be no good reason to doubt that they are since they do not appear to represent a teratological condition), then the ear of maize is much less complex than has generally been supposed. It is nothing more than a strongly compacted spike in which pairs of spikelets are borne in varying number in whorls at the nodes of a simple non- or weakly-articulated rachis. This description, however, applies only to ears of the general type exemplified by the Guarany variety. A second type of ear apparently exists and is considered below.

Crosses of Maize and Teosinte

The hypothesis, already discussed, of a polystichous ear developing from a distichous spike through shortening and twisting of the axis was based on observations which Collins (5) had made upon segregates from maize-teosinte hybrids. In his paper he showed photographs of spikes representing the various steps assumed to have been involved; the restoration of the aborted spikelet, the yoking of adjacent segments of the rachis, and finally the change from distichy to polystichy. His figures are not too convincing. Especially lacking are specimens showing the transition from independent to yoked rachis segments. Nevertheless his description is correct in its principal details. My own material, probably because I have had much larger populations than Collins to draw from, show the transition from the independent to the yoked condition much more clearly than did his (Plate XI, figs. A, B, C). In teosinte the joints of the rachis stand almost directly above or below one another to produce a structure which Collins has aptly described as

"resembling a string of triangular beads" (Plate XI, fig. A). As the axis shortens or the rachis segments increase in size, the segments tend to lose their linear orientation and to assume a zigzag arrangement (Plate XI, fig. B). Finally adjacent segments, whose spikelets arise on opposite sides of the axis, become diametrically opposed to each other and yoked to each other (Plate XI, fig. C).

The other steps which Collins described also occur regularly and here, too, my material is better for purposes of illustration than was his. The change from solitary to paired spikelets is shown in Plate XI, figs. A and D. This may occur either before or after the rachis segments have become yoked. The change from distichy to polystichy to produce an eight-rowed ear is shown in Plate XI, figs. E and F. Collins attributed this change to a twisting of the axis and the term is satisfactory if it is not used too literally. What actually occurs is that the yoked segments become arrayed in two planes instead of one, an arrangement which makes much more efficient use of the circumference of the rachis as a spikelet-bearing surface. Collins showed diagrammatically how ears with additional row numbers would be produced by additional "twisting" of the axis. These were not encountered in my material. A number of ten-rowed ears occurred, but they were, for the most part, "disharmonious" ears with twisted cobs. Apparently the only "normal" ears in which the yoking is readily discernible are four-rowed and eight-rowed ears.

An important change which Collins did not note, or at any rate did not describe, is the compaction of the inflorescence. A spike which has passed through the three stages which he described is still far removed from an ear of maize. It must pass through still another stage, a change from a lax spike to a compacted spike. Plate XI, fig. G illustrates an eight-rowed spike which has become

compacted and which is recognizable as an ear of maize.

What conclusions can be drawn from this series of transition forms which occurs in maize-teosinte hybrids? Collins was cautious on this point, stating that these intermediate forms are of value primarily in throwing light upon the morphology of the ear and explaining its evolution in a mechanical sense. Weatherwax (18) was even more circumspect in his statement on this subject, which follows: "Hybrids between maize and teosinté will always exhibit suggestive series; but, until we are more sure of the homologies between these two genera, it is futile to expect much information from the hybrids, for they will be speaking in a language that we cannot understand."

Now, when the homologies of maize and teosinte are somewhat better understood than they were two decades and more ago, and when the rôle of genetic mechanisms in evolution has also become much clearer, speculation on the meaning of the hybrid forms may be permitted.

If maize has originated from teosinte under domestication, as some students of the problem have assumed, then hybrids of the two species are capable of revealing something about the nature and extent of the genetic changes which have occurred. If we accept this interpretation we need only to state here that the genetic changes involved have been numerous and far reaching in their effects, and that the period of domestication of maize has either been very long indeed or mutations must have occurred at an unprecedented rate, for maize differs from teosinte by numerous genes distributed among a number of different chromosomes. If on the other hand teosinte is the product of the hybridization of maize and Tripsacum, as postulated by Mangelsdorf and Reeves (13), then hybrids of maize and teosinte simply show the effects which are produced upon maize by various doses

of Tripsacum germplasm. This becomes especially important in considering the correlative hypothesis of Mangelsdorf and Reeves (13) that new types of maize originating directly or indirectly from the hybridization of maize and Tripsacum comprise the majority of the varieties of Central and North America.

Teosinte (Tripsacum) germplasm consistently has certain definite effects upon the structure of the ear of maize. These effects vary considerably with the amount of teosinte germplasm involved and with the genetic level at which it is operating. In spikes approximately intermediate between those of maize or teosinte (spikes similar to those borne on F_1 plants of maize-teosinte hybrids), small differences in the proportion of maize and teosinte germplasm can mean drastic changes in external morphology, for example: from distichy to polystichy or from single spikelets to paired spikelets. As the segregates approach either end of the range, however, much larger increments are necessary to produce these changes.

These facts, revealed by F_2 segregates of maize-teosinte hybrids, are even better illustrated by stocks in which an entire teosinte chromosome or a part of a chromosome has been transferred to a uniform inbred strain of maize by repeated backcrossing accompanied by selection. Stocks developed in this way are isogenic in nine of their ten chromosomes and therefore approximately identical with the original inbred strain of maize. The remaining chromosome, however, has been substituted for, wholly or in part, by a corresponding chromosome from teosinte.

The substitution of a small amount of teosinte germplasm for maize germplasm at this level has no apparent effect whatever upon such characteristics as paired and single spikelets; the spikelets remain completely paired. But these doses of teosinte germplasm do consistently reduce the number of rows of grain and they consistently

tend to make the cob stiffer and more indurated, and to give the rows of grain a rigid vertical alignment sometimes accompanied by spaces between pairs of rows. The end product of these various tendencies is most commonly an eight-rowed ear in which spikelets in one plane are diametrically opposed to each other, while those in the plane at right angles to the first are also opposed to each other but in positions alternating exactly with those in the first plane.

Here, then, is precisely the kind of ear which would have developed according to Collins' yoking and twisting hypothesis. The only difference is that the rachis having become large, and sometimes pithy, the yoking is no longer actually apparent. But these ears also conform completely to Weatherwax's conception of the ear as an example of spiral phyllotaxy. Indeed the spiral phyllotaxy is so rigid that the addition of another pair of rows of grain, the equivalent of a half-spiral, results in an unbalanced phyllotaxy usually accompanied by a twisting of the cob. This type of ear is obviously quite different from that illustrated by the Guarany pod corn; and yet the one is nothing more than a modified form of the other.

That there are differences in maize varieties with respect to phyllotaxy in the branches of the tassel has already been noted by Anderson (1) who finds a spiral phyllotaxy predominating in some varieties, a whorled phyllotaxy apparently characteristic of others.

Other Differences in Maize Types

If there are in nature two types of ears, one with a whorled phyllotaxy another with a spiral phyllotaxy, it is reasonable to suspect that other differences between the two types also exist.

Arrangement of Spikelets. Another important difference in the two types may lie in the arrangement of the sessile and pediceled spikelets on the ear. If the ear of maize is a spike only recently derived from a panicle by reduction of branches then the arrangement of the paired spikelets with respect to the position of the pediceled and sessile member of each pair should be largely a random one because the branches of the panicle are arranged at random with respect to the position of the pediceled and sessile spikelet of the lowest pair. If, however, the ear has come under the influence of Tripsacum genes to the extent that it behaves as a structure derived from the distichous spike of teosinte, then the arrangement of the spikelets may well be a systematic one.

Unless I have inadvertently overlooked a reference to it in the literature, the question of the arrangement of sessile and pediceled spikelets on the ear seems never to have been answered. Collins (5), assuming that it is always pediceled spikelets which abort when rows of grain are dropped between the base and tip of the ear, asserted that he had never seen an instance where the dropped rows were either adjacent or separated by two rows. This he regarded as evidence that the arrangement of pediceled and sessile spikelets around the circumference of the ear is not the one expected from the fusion of two-ranked spikes. He apparently concluded, although he certainly did not prove, that the arrangement is, instead, the one that would be expected if the ear had resulted from yoking and twisting in the distichous spike.

Actually, since all pistillate spikelets are sessile (although one member of each pair is potentially pediceled) it is impossible to determine from the external appearance of the ear the nature of the arrangement of its spikelets. But since the central spike of the tassel is clearly the homologue of the ear, and since on the central spike the

sessile and pediceled spikelets are often readily distinguished, it should be possible to draw some inferences about spikelet arrangements in the ear by studying them on the central spike.

The spikelets on the central spike of the tassel are borne in more or less distinct rows. These are less clear cut, to be sure, than those on the ear, but can nevertheless be traced with a fair degree of accuracy. The position and arrangement of the spikelets on a central spike can be charted by tracing a vertical rank of spikelets from its base, determining the position of each pair by actual measurement and noting whether the pediceled spikelet is at the right or left of the sessile one. This is repeated with each vertical rank until the entire circumference of the spike has been charted.

A chart of the spikelets of the central spike, prepared in this way, is almost the equivalent of peeling the surface of the rachis, unrolling it and spreading it flat.

Plate XII, figs. D and E, shows in diagrammatic form the relative position and the arrangement of sessile and pediceled spikelets on portions of central spikes of two inbred strains of maize; the first a strain of the Guarany variety; the second a North American strain well known to agronomists, K155.

It is to be noted that in the Guarany maize the arrangement of the spikelets with respect to the position of the sessile and pediceled is a random one, or at least the deviation from randomness on any single row is clearly not significant.

The central spike of K155 presents quite a different aspect. In one row (the center row in the diagram) the spikelets are arranged at random, but in the remaining rows the arrangement is either clearly systematic or it approaches this condition. In the second row from the left, for example, the pediceled spikelet is at the left in

all (seven) pairs. In the fourth row the pediceled spikelet is at the right in all (eight) pairs. A systematic arrangement is also closely approached in the first and fifth rows, the former having the pediceled spikelet at the right in six of the seven pairs, the latter having the pediceled spikelet at the left in eight of the ten pairs.

It is to be noted further that the second and fifth rows in this diagram are mirror images of the first and fourth with respect to the position of the pediceled and sessile spikelets.

How does the arrangement in Fig. E compare with the arrangement theoretically expected if the ear of maize had originated from the spike of teosinte by yoking and twisting? Plate XII, fig. A shows the arrangement in teosinte when the abortive spikelet becomes functional, as it does in some cases, especially when the tunicate gene is superimposed upon teosinte by crossing and backcrossing. Here the arrangement is completely systematic and the two ranks are mirror images of each other with respect to the position of pediceled and sessile spikelets.

Plate XII, fig. B shows the theoretical arrangement after yoking has occurred. This arrangement has actually been seen in a segregate from a maize-teosinte hybrid in which the spikelets were yoked, both spikelets of each pair were functional and the pediceled spikelets were distinguishable from the sessile ones.

Plate XII, fig. C shows the theoretical arrangement resulting from yoking combined with twisting of the axis. Here rows one and three and rows two and four (rows diametrically opposed to each other on a cylindrical rachis) are mirror images of each other with respect to arrangement as well as position of the spikelets.

In two important characteristics, systematic arrangement of the spikelet and mirror imagery, K155 is like the ear theoretically developed from the spike of teosinte

through yoking and twisting. But in a third important feature, the sequence of pediceled and sessile spikelets, there is a distinct difference. In the ear developed from teosinte by yoking and twisting (Fig. C) the sequence is **PSPSSPSP**. No matter at what point this sequence begins it always involves at some point on the circumference two rows of sessile spikelets adjacent to each other and diametrically opposed on the rachis to two rows of pediceled spikelets adjacent to each other. In **K155** (fig. E) on the other hand (omitting the single row with random arrangement and letting the letters **S** and **P** respectively, represent the predominating condition in each row of spikelets) the sequence is **SPPSSPPS**. Here no matter on which row the sequence begins, the pattern is one of two rows of sessile spikelets alternating with two rows of pediceled spikelets.

This sequence is not unique to **K155**. It has been observed in other strains where the arrangement of spikelets approaches the systematic.

The sequence illustrated in Fig. C has also been observed in several varieties. This means, if it means anything at all, that the ear of maize sometimes behaves as though it had been derived from the spike of teosinte by twisting of the axis in the sense in which Collins used the term. Whether this sequence is as common as the other remains to be determined.

Other evidence that both random and systematic arrangement of spikelets occur is found in ears which are partly or wholly staminate at the apex. When wholly staminate both spikelets are usually, though not always, sessile as they are when wholly pistillate. When the spikelets are mixed, however, the pistillate one is usually sessile, the staminate one pediceled. In the Guarany variety the arrangement of staminate and pistillate spikelets, when the two are mixed, seems to be essentially

random. In ears derived from maize-teosinte crosses which have been repeatedly backcrossed to maize, the arrangement is definitely systematic.

The entire subject of spikelet arrangement deserves more study. In the meantime it is already reasonably clear that on the central spike of the tassel, at least, the arrangement approaches a random condition in some varieties and is systematic in others. There is reason to suspect that these differences occur also on the ears. It is supposed that the random arrangement is characteristic of "pure" maize; the systematic of Tripsacum-contaminated maize. Varieties which are completely random or completely systematic in the arrangement of their spikelets are perhaps not common, the majority of varieties probably exhibiting some degree of intermediacy between the two extremes.

Twisted Ears and Odd Numbers of Paired Rows. Attention has been called to Fujita's observation that ears in which the number of rows of paired spikelets is odd are often slightly twisted with the rows of grain exhibiting a tendency to form weak spirals. And mention has also been made of the fact that there is, in North American maize at least, a preponderance of ears with rows of paired spikelets in even numbers as opposed to those with rows in odd numbers. The two phenomena are probably related and both may well be the result of Tripsacum influence. At any rate they are most strikingly displayed in segregates of maize-teosinte hybrids. The predominance of ears with rows of spikelets (in this case single as well as paired spikelets) in even numbers is well illustrated by the following frequency distribution.

Population	Number of Rows of Spikelets				Total
	2	3	4	5	
(Durango Teosinte × Maize) F2	65	45	58	9	177
(Nobogame Teosinte × Maize) F2	86	71	115	27	299

In both crosses there is a decided deficiency of three- and five-ranked ears as opposed to two- and four-ranked ears. Also in both crosses there is a tendency for the three- and five-ranked ears to be twisted. They are obviously the result of a structural unbalance or asymmetry which induces stresses with visible effects.

These phenomena, so conspicuous in maize-teosinte hybrids, are also readily discernible in maize. There are several explanations for them:

1. Reeves (15) suggests that there is a preponderance of ears with rows of spikelets in even numbers because the basic unit of the ear is a *pair* of rows of spikelets rather than a single row. Thus an eight-rowed ear is much more likely to become a twelve-rowed ear than it is to change to a ten-rowed ear. He regards these units as hereditary and in a broad sense they undoubtedly are. It seems more probable, however, that the unit, a pair of rows of spikelets, is a developmental rather than an hereditary one for it is not uncommon in maize-teosinte hybrids to find two-ranked and four-ranked spikes on the same plant. This is not to say that the number of ranks is independent of heredity. There is abundant evidence that the contrary is true. But apparently the genes do little more than determine in a general way whether the spike is to be few-ranked or many-ranked, while developmental factors determine the size of the units by which the differences are to be attained.

2. Any ear strongly influenced by Tripsacum is likely to exhibit a spiral phyllotaxy so rigid that only those combinations which involve complete spirals will be balanced and symmetrical and hence are more likely to occur than those involving fractional spirals. This is perhaps no more than another way of saying that spiral phyllotaxy explains and accounts for the fact mentioned

above: that the unit of development is a pair of rows of spikelets.

3. Reeves (15) has also pointed out that with a spiral phyllotaxy the rachis segments are probably hexagonal, fitting together "like the engaged teeth of mechanical gears." With an odd number of rows of paired spikelets there is a physical necessity for some kind of distortion. Either the rachis segments must change shape or the ear must become twisted.

The net result of these various factors, which are closely related to each other, is that there is a strong tendency for rows of spikelets to occur in even numbers. When they do occur in odd numbers there is a strong tendency for the ear to be twisted. Stated in still another way; there is a strong tendency for ears of maize to be balanced and symmetrical, rather than unbalanced and asymmetrical

The above discussion applies especially to ears with a rigid spiral phyllotaxy and indurated tissues, the kind of ear derived from maize-teosinte crosses and the kind presumably resulting in nature from Tripsacum contamination. What of "pure" maize, with its whorled phyllotaxy and random arrangement of spikelets, with respect to these phenomena? Many varieties of Bolivian and Peruvian maize, both prehistoric and modern, have rows of grain more strongly spiral than those of the twisted ears of North American varieties. Extreme forms, as Anderson (unpublished) has noted, have "spiral cross-rowing in two directions, like a pine cone." But this condition in Bolivian and Peruvian maize does not give the impression of abnormality. Like the pine cone with which it has been compared, it appears to be perfectly normal. Furthermore the occurrence of spiral rows in Bolivian and Peruvian maize is usually independent of row number. Ears with pairs of rows in even numbers are

no less subject to the occurrence of spiral rows than ears with pairs in odd number.

Finally, in varieties of this kind there is not the preponderance of ears whose rows of paired spikelets are in even numbers, so commonly found in North American varieties. Ears with ten, fourteen and eighteen rows are as frequent as ears with eight, twelve and sixteen rows. This, like the presence of spiral cross-rows, is characteristic of both prehistoric and modern varieties as is shown by the following frequency distribution, which includes modern ears from Isla del Sol in Lake Titicaca and prehistoric ears excavated by Dr. Julio Tello from the Paracas Necropolis in Peru and by Dr. Junius Bird from Arica, Chile. Data on row numbers in the last named collections were kindly furnished by Dr. Edgar Anderson. The situation is the same in all three cases; there is no deficiency of ears in which the number of pairs of rows is odd, indeed the modal number in all cases is fourteen.

Collection	Number of Rows of Grain							Total
	10	12	14	16	18	20	22	
Isla del Sol, Bolivia	5	12	19	9	5			50
Paracas, Peru (Prehistoric)		4	10	5	2	2	1	24
Arica, Chile "	1	14	24	10	2			51

Discussion and Conclusions

The conclusion that there are two morphologically distinct types of maize ears is not new. Mangelsdorf and Reeves (13) have previously suggested that the maize varieties of America comprise two more or less distinct groups: (1) "pure" maize which traces its descent directly from the original wild corn; (2) Tripsacum-contaminated maize resulting directly or indirectly from the hybridization of maize and Tripsacum. It was assumed that the differences between these two groups were reflected in

the ears, but no attempt was made to distinguish them on the basis of differences in their basic structures beyond pointing out that many of the Andean varieties (presumably "pure" maize) are characterized by irregular rows of grain, while many Central and North American varieties (presumably contaminated by Tripsacum) exhibit straight rows frequently separated in pairs. Extreme types approaching these descriptions were found by Mangelsdorf and Cameron (12) in a study of maize varieties of western Guatemala and are illustrated in their paper.

Now the evidence that there are two kinds of maize ears basically different in origin, structure and phyllotaxy, if not conclusive, is at least highly convincing.

The first type of ear which is characteristic of the Guarany pod corn and is probably typical of "pure" maize may be described as a compacted spike with pairs of pistillate spikelets borne in varying numbers at the nodes of a simple, weakly articulate rachis. The ear has a whorled phyllotaxy but may assume, more or less fortuitously, especially if the rows and kernels are crowded, the aspect of spiral phyllotaxy. The rows may be straight, especially if the row number is low; but straight rows like spiral phyllotaxy seem to be, as they are in certain other grass spikes, fortuitous rather than the reflection of a particular kind of underlying structure. Straight rows, in some cases at least, seem to represent nothing more than an efficient arrangement assumed upon crowding. Pairs of rows are not distinctly separated and if there is sometimes an apparent line of demarcation between pairs of rows it separates the two spikelets of the same pair and not two pairs of spikelets. The number of rows is a reflection of the degree of compaction rather than of the complexity of the phyllotaxy for the number of rows can change decidedly from base to tip without any change in the underlying phyllotaxy. With respect

to the position of the sessile and potentially pedicellate spikelets, the arrangement of spikelets on the ear is random or nearly so. The tissues of the rachis and glumes are not strongly indurated. There is no tendency, as in many North American varieties, for ears with pairs of rows in odd numbers, ten, fourteen, eighteen, etc., to be in the minority or for such ears to be twisted.

This type of ear is fundamentally identical with the spikes of certain other species of grasses and like many of them is probably derived from a panicle as the result of reduction of branches. There is not the slightest evidence of fusion. There is abundant evidence, however, that the ear is derived from a panicle for the central spike of the tassel, which is unquestionably the homologue of the ear, is still surrounded with basal branches. Indeed the tassel is a perfect example of a combination of panicle and spike and illustrates splendidly the transition from one to the other. The change from panicle to spike is obviously relatively recent, but whether it is the product of domestication, wholly or in part, there is at present no way of determining. The fact that the Guarany variety, which is primitive in certain other characteristics, frequently exhibits basal branching of the ear, suggests, though it does not prove, that the wild maize with which domestication began was at least moderately branched in its lateral (probably pistillate) inflorescences.

This type of ear, it may be said again, differs in no single important characteristic from the inflorescences of other grasses. True, it usually is wholly pistillate, but there are other grass inflorescences, such as the pistillate forms of the dioecious species of *Monantochloë*, *Jouvea*, *Buchloë* and *Eragrostis*, which are entirely pistillate. It usually has a massive rachis and large caryopses, but there are varieties of sorghum which have the rachis thicker than the most slender maize cob and the cary-

opses larger than the smallest maize kernels. This ear of maize seems not to possess a single characteristic in which it is consistently unique. Its uniqueness lies rather in the particular combination of characters which it possesses. The fact that it is wholly pistillate, bears large caryopses on a massive rachis and is a strongly compacted inflorescence, readily distinguishes it from all other grass inflorescences.

Of these characteristics the last, compaction, is by no means the least important. Once this fact is recognized —that the ear of maize is one of the most strongly compacted of all inflorescences—then much of the mystery which has surrounded the ear disappears and it becomes scarcely more difficult to understand than a head of cabbage which also is a strongly compacted but otherwise relatively simple structure.

The second type of maize ear, the type which presumably results from Tripsacum-contamination is, like the first, a compact spike. It differs from "pure" maize primarily in having a spiral rather than a whorled phyllotaxy and a systematic rather than a random arrangement of sessile and pedicellate spikelets. Indeed a brief description would appropriately term the first "whorled-random"; the second "spiral-systematic." But there are other differences as well. The tissues of the rachis and glumes of the spiral-systematic type are usually indurated; the rachis as a whole being quite tough, though evidence of an inherent rachis fragility is sometimes discernible. The rows of grain are distinct and not infrequently separated in pairs. When this occurs a pair of rows is the equivalent of a row of paired spikelets. The tendency for a rigid vertical alignment of the spikelets is so strong, probably as the result of an inflexible spiral phyllotaxy, that ears in which the number of pairs of rows is odd are in the minority and are usually twisted.

The spiral-systematic ear, like its putative precursor the whorled-random ear, furnishes no evidence whatever of fusion. It does, however, have the aspect of a fusion product and especially is this true of eight-rowed ears in which the pairs of rows are distinctly separated with shallow clefts or apparent lines of fissure in the cob corresponding to the lines of demarcation. Furthermore the sequence of sessile and pedicellate spikelets around the circumference, **SSPPSSPP**, sometimes encountered, is the kind of sequence which would be expected as the result of fusion of two-ranked branches. Nevertheless there is neither evidence of fusion nor necessity for assuming that it has occurred.

There is perhaps no single characteristic by which these two types of maize ears can always be distinguished from each other. Actually pure forms of either are probably rare and intermediate forms are more common than the basic types. There are, however, several circumstances usually associated with the two general types. The "pure" maize with its derivatives is the predominating type in the Andean region of Peru, Bolivia and Ecuador and in the adjoining lowlands of South America, particularly in Paraguay. It is also the predominating type in the prehistoric maize of South America. The same or a similar ear is found at high altitudes in Guatemala and, also at high altitudes, in some localities in Mexico.

The Tripsacum-contaminated maize is typical of most of North and Central America and of most of the lowlands of South America.

It is realized that there is still no actual proof for the existence of "pure" and Tripsacum-contaminated maize. Nevertheless it is now reasonably certain that there are two basically different types of maize ears with more or less distinct patterns of geographical distribution. Since

there is complete interfertility in maize varieties from all parts of America, it is logical to conclude that the one has been derived from the other. Segregates from maize-teosinte crosses and isogenic stocks developed by repeated backcrossing of such crosses to inbred strains of maize demonstrate that teosinte genes can produce the changes by which the two types are distinguished. All of these facts indicate, though they obviously do not prove, that a pure maize originating in South America and bearing ears characterized by whorled phyllotaxy and random arrangement of sessile and pedicellate spikelets has become modified by the introduction of Tripsacum (teosinte) germplasm to produce an ear characterized by spiral phyllotaxy and systematic arrangement of spikelets.

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LITERATURE CITED

1. Anderson, Edgar, 1944. Homologies of the ear and tassel in *Zea Mays*. Ann. Mo. Bot. Gard. 31: 325–342.
2. Arber, Agnes, 1934. The Gramineae. Cambridge, England.
3. Bonnett, O. T., 1940. Development of the staminate and pistillate inflorescences of sweet corn. Journ. Agric. Res. 60: 25–37.
4. Collins, G. N., 1912. Origin of maize. Journ. Wash. Acad. Sci. 2: 520–530.
5. Collins, G. N., 1919. Structure of the maize ear as indicated in Zea-Euchlaena hybrids. Journ. Agric. Res. 17: 127–135.
6. Dodoens, Rembert (Lyte, Henry), 1619. A new herbal, or historie of Plants: . . . . London.
7. East, E. M., 1910. A Mendelian interpretation of variation that is apparently continuous. Amer. Nat. 44: 65–82.
8. Fujita, T., 1939. Über die Organstellung bei Maiskolben. Japanese Journ. Bot. 10: 113–140.
9. Kellerman, W.A., 1895. The primitive corn. Meehan's Monthly 5: 44.
10. Kempton, J. H., 1919. The ancestry of maize. Journ. Wash. Acad. Sci. 9: 3–11.
11. Langham, D. G., 1940. The inheritance of intergeneric differences in Zea-Euchlaena hybrids. Genetics 25: 88–107.
12. Mangelsdorf, P. C. and Cameron, J. W., 1942. Western Guatemala a secondary center of origin of cultivated maize varieties. Bot. Mus. Leaflets, Harv. Univ. 10: 217–252.
13. Mangelsdorf, P. C. and Reeves, R. G., 1939. The origin of Indian corn and its relatives. Texas Agric. Exper. Sta. Bull. 574.
14. Montgomery, E. G., 1906. What is an ear of corn? Pop. Sci. Monthly 68: 55–62.
15. Reeves, R. G. (in press). Morphology of the maize ear with reference to its origin.
16. Weatherwax, Paul, 1918. The evolution of maize. Bull. Torrey Bot. Club 45: 309–342.
17. Weatherwax, Paul, 1920. A misconception as to the structure of the ear of maize. Bull. Torrey Bot. Club 47: 359-362.
18. Weatherwax, Paul, 1923. The story of the maize plant. Chicago.
19. Weatherwax, Paul, 1935. The phylogeny of *Zea Mays*. Amer. Midland Nat. 16: 1–71.

EXPLANATION OF THE ILLUSTRATIONS

PLATE VII. Reproduction of a page of Lyte's (1619) *New Herbal*, which describes the inflorescences of maize.

PLATE VIII. Example of extreme elongation in an ear of Guarany pod corn. The lower half of this ear was enclosed by the husk and is compacted with the kernels arranged in rows. The upper half was free of the husks and is intensely elongated.

PLATE IX. The basic structure of the maize ear is illustrated by this enlarged ($\times 1.5$) photograph of the elongated terminal portion of an ear of Guarany pod corn. A pair of spikelets has been removed at each node to show the simple rachis bearing spikelets in whorls at the nodes.

PLATE X. Relation between compactness and number of rows. The left ear has eight rows at the tip; fourteen rows at the base. The center ear and the naked rachis at right show how the internodes become progressively shorter toward the base. The number of spikelets at each node remains approximately the same.

PLATE XI. Transitions from teosinte to maize illustrated by the pistillate spikes of F2 segregates of a maize-teosinte hybrid. A. Most teosinte-like spike with single spikelets alternating in two ranks. B, C. Transition from independent to yoked rachis segments. D. Approximately like A, except that spikelets are paired. E. Yoked rachis segments combined with paired spikelets to produce a distichous, four-rowed spike, bearing four spikelets at each joint of the rachis. F. Portion of spike and single rachis joint of an eight-rowed spike derived from a four-rowed spike by "twisting" of the axis. G. Most maize-like spike. It differs from F primarily in degree of compaction.

PLATE XII. The arrangement of sessile and pedicellate spikelets around the circumference of various spikes. A. Teosinte spike. B. Teosinte spike with yoking of rachis segments. C. Theoretical arrangement resulting from yoking combined with twisting of the axis. D. Actual arrangement of spikelets on a portion of the central spike of the tassel of an inbred strain of Guarany maize. Note that arrangement is random or nearly so. E. Actual arrangement on a portion of the central spike of North American inbred K155. Note that arrangement is strongly systematic.

Of Turkie Corne, or Indian wheat.

The kindes.

TUrkiſh wheat is of one, and of many ſorts. A man ſhall not find in this country (in faſhion and growing) more than one kind, but in colour the ſæde or grayne doth much differ: for one beareth a browne grayne or corne, the other a red, the third a yellow, and the fourth a white corne or grayne. The which colour doth likewiſe remayne both in the eares and floures.

The deſcription.

THis Corne is a maruellous ſtrange plant, nothing reſembling any other kind of grayne: for it bringeth forth his ſæde cleane contrarie from the place whereas the Floures grow, which is againſt the nature and kinds of all other plants, which bring forth their fruit there, whereas they haue borne their Floure. This Corne beareth a high helme or ſtemme, and very long, round, thicke, firme, and below towards the roote of a brownish colour, with ſundrie knots and ioynts, from the which dependeth long, and large leaues, like the leaues of Spire or Poleræde: at the higheſt of the ſtalkes, grow idle and barren eares, which bring forth nothing but the floures or bloſſomes, which are ſometimes browne, ſometimes red, ſometimes yellow, and ſometimes white, agréable with the colour of the fruit, which commeth forth afterward. The fruitfull eares do grow, vpon the ſides of the ſtems amongſt the leaues, the which eares bée great and thicke, and couered with many leaues, ſo that one cannot ſee the ſayd eares, vppon the vppermoſt part of the ſayd eares there grow many long hayrie thrædes, which iſſue forth at the ends or poynts of the leaues, couering the eare, and doe ſhew themſelues about the time that the fruit or eare wareth ripe. The grayne or ſæde which groweth in the eares, is about the quantitie or bigneſſe of a Peaſe, of colour in the out-ſide, ſometimes browne, ſometimes redde, and ſometimes white, and in the in-ſide it is in colour white, and in taſte ſweet, growing orderly about the eares, in nine or ten ranges or rowes.

The place.

This grayne groweth in Turkie, whereas it is vſed in the time of dearth.

The time.

It is ſowne in Aprill, and ripe in Auguſt.

The names.

They doe now call this grayne, Frumentum Turcicum, and Frumentum Aſiaticum: in French, *Blé de Turquie*, or *Blé Sarazin*: in high Dutch, Turkie Korn: in baſe Almaigne, Torckſchcozen: in Engliſh, Turkiſh Corne, or Indian-wheat.

The nature, and vertues.

There is as yet no certayne erperience of the naturall vertues of this corne.

The bread that is made thereof is drye and hard, hauing very ſmall fatneſſe or moyſture, wherefore men may eaſily iudge, that it nouriſheth but little, and is euill of digeſtion, nothing comparable to the bread made of Wheat, as ſome haue falſly affirmed.

Plate VIII

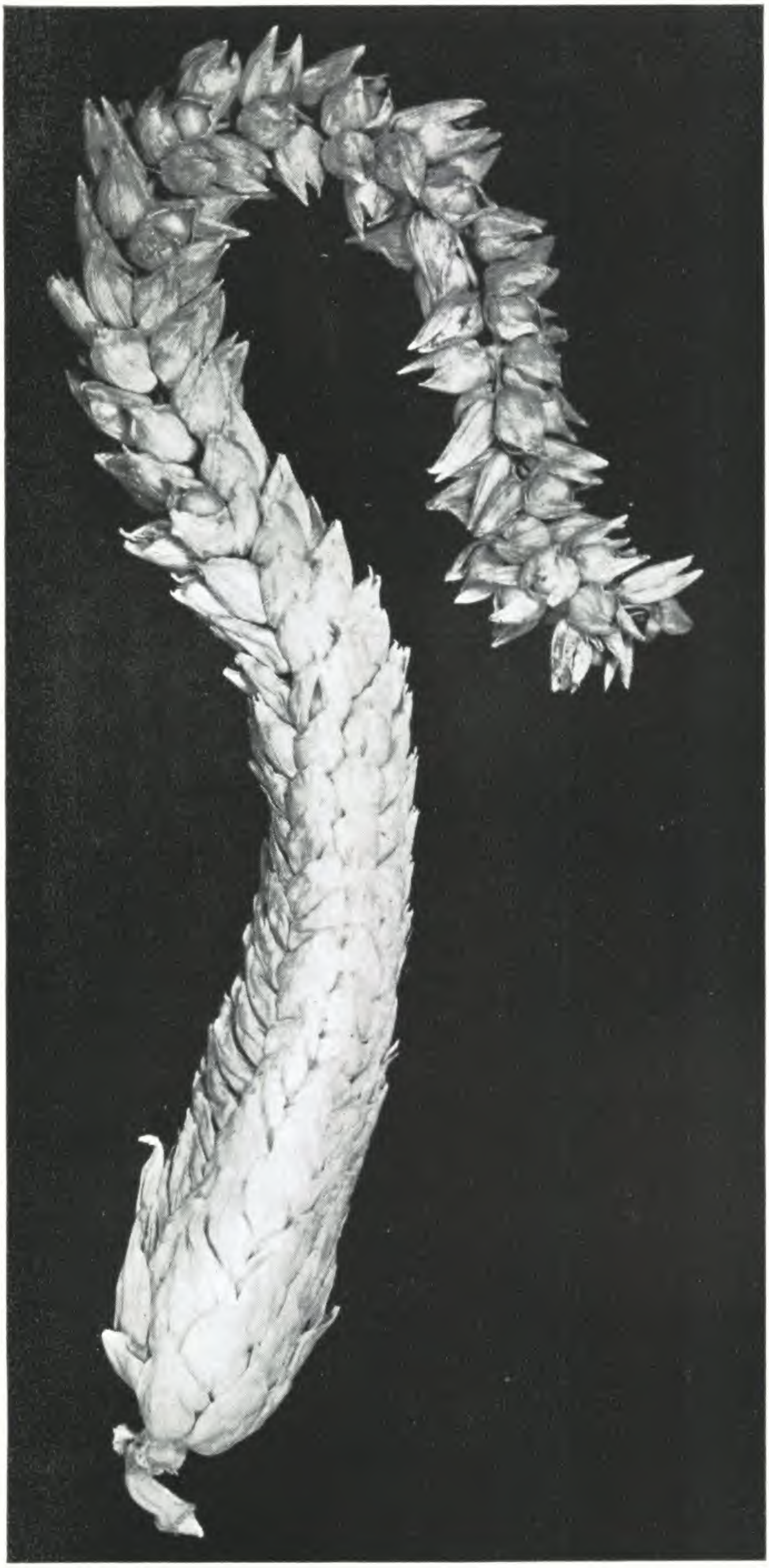


Plate IX

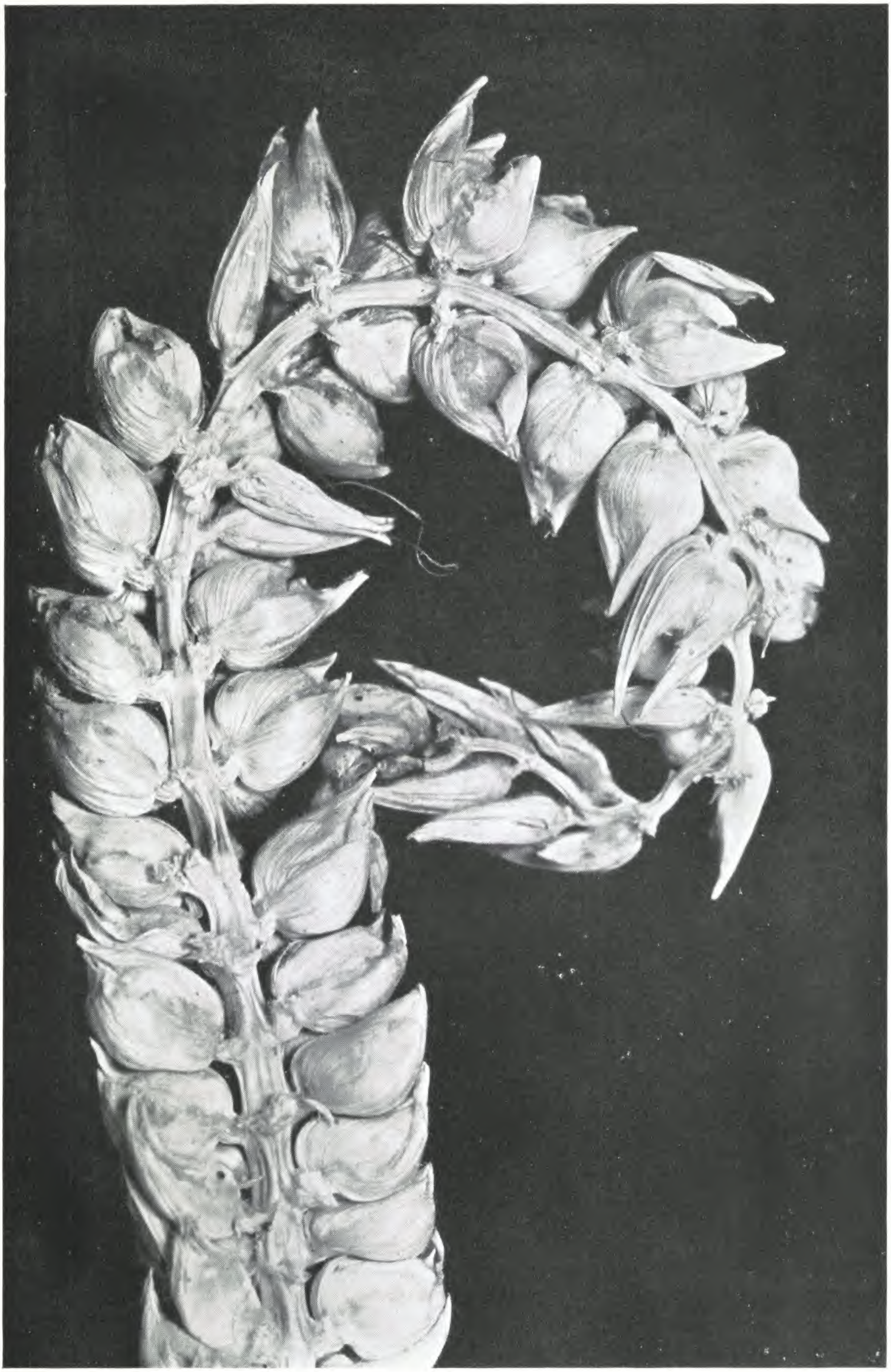


Plate X

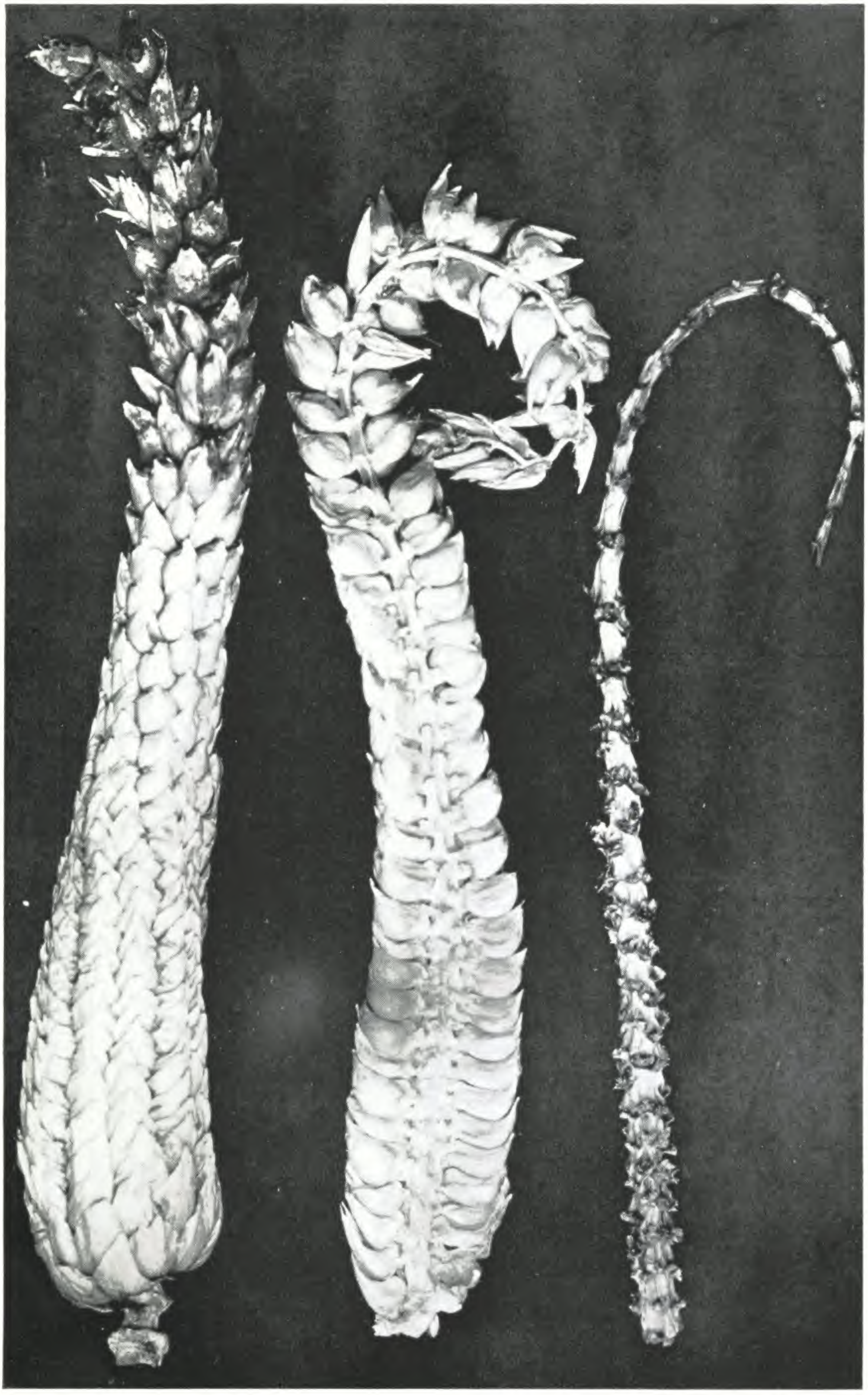


Plate XI

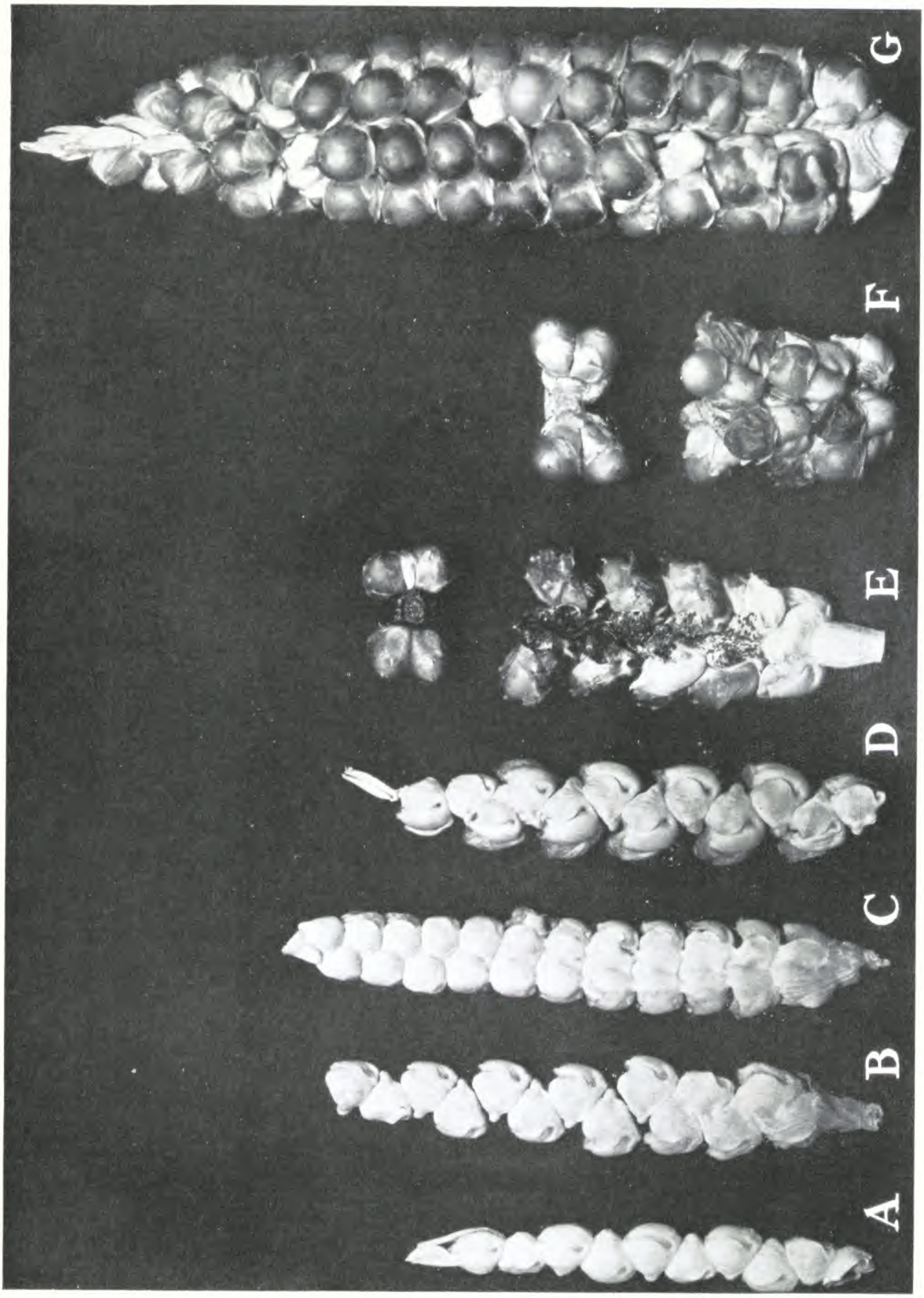


Plate XII



A



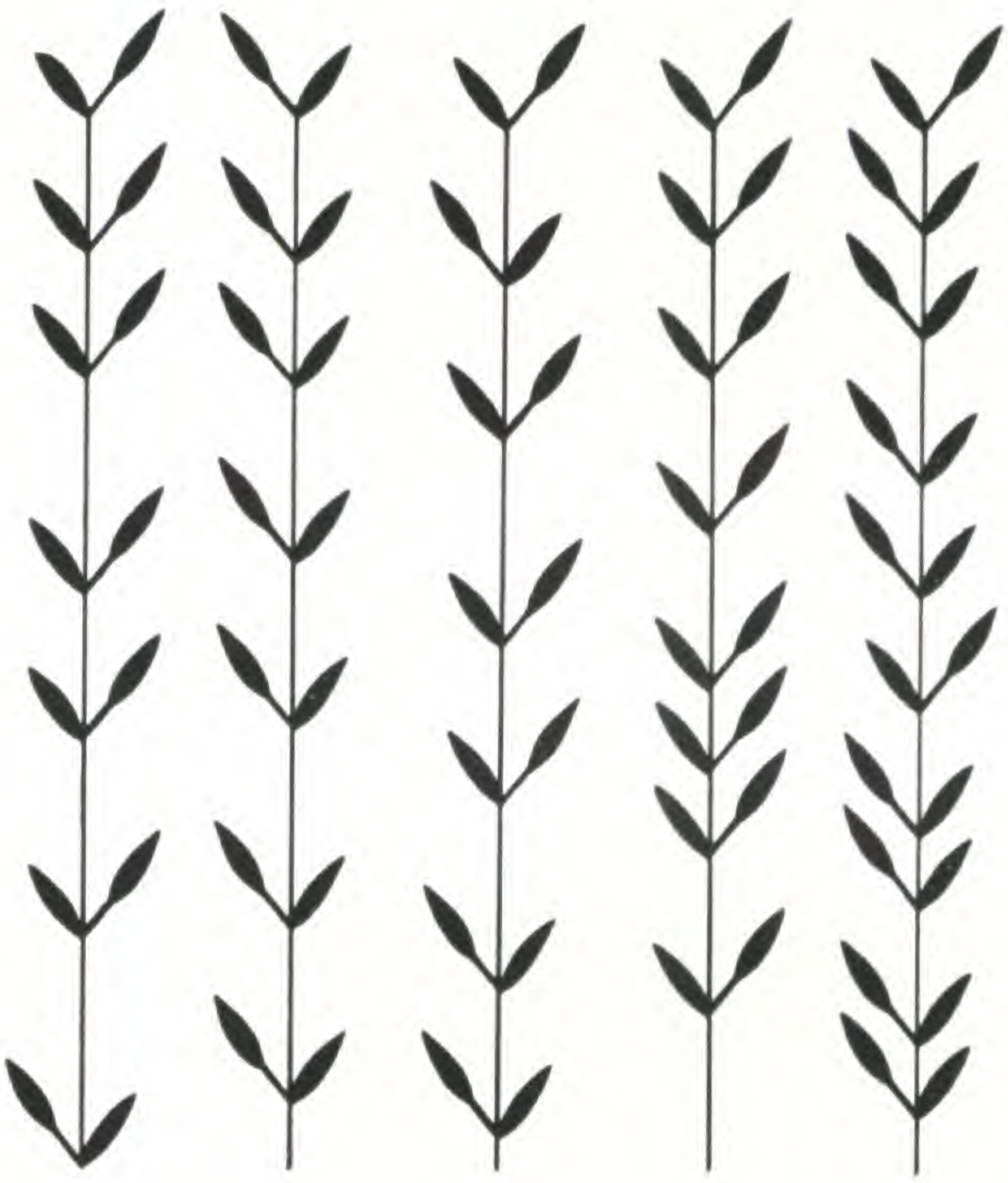
B



C



D



E

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AFRICAN ORCHIDS XVI.

BY

V. S. SUMMERHAYES

(*Royal Botanic Gardens, Kew*)

A SUGGESTED re-classification of the genus *Diaphananthe* Schltr. together with descriptions of new species and new combinations in the genus form the greater part of this contribution. There are also descriptions of new species of other genera of Angraecoid orchids and of one species of *Polystachya*. The sequence, as in previous contributions, is that of Schlechter's "Das System der Orchidaceen" (Notizbl. Bot. Gart. Berlin, 9 (1926) 563–591). The type specimens of all the new species are in the Kew Herbarium.

Polystachya (§ **Cultriformes**) **canaliculata** *Summerhayes sp. nov.;* a *P. fulvilabia* Schltr. foliis angustioribus, inflorescentiis foliis multo brevioribus, floribus albis nec flavis, sepalis obtusis vel apiculatis, labelli ungue brevi, lobo intermedio ruguloso canaliculato; a *P. Mildbraedii* Kraenzl. mento breviore, labello basi magis angustato lobis lateralibus minoribus lobo intermedio ruguloso satis distinguenda.

Herba epiphytica; caules caespitosi, erecti, usque ad 12 cm. alti, leviter ancipites, siccitate sulcati, apice monophylli, basi cataphylla vaginiformi lineari acuta usque ad 7.5 cm. longa instructi. *Folium* erectum, lineari-ligulatum, apice rotundatum, basi cuneatum, 9–25 cm. longum,

5–8 mm. latum, quinquenervosum. *Inflorescentia* erecta, folio multo brevior, 4–7 cm. alta, superne subdense pauciflora; pedunculus gracilis, 3–5 cm. longus, laevis, subteres vel leviter anceps, supra medium vagina singula instructus; bracteae subpatentes, triangulari-ovatae, acuminatae, 1–2 mm. longae. *Flores* patentes, albi, rubro-notati; pedicellus (cum ovario) 7–9 mm. longus. *Sepalum* intermedium lanceolato-oblongum, apice apiculatum, basi leviter dilatatum, 5.5–7 mm. longum, 3.5–4 mm. latum; sepala lateralia oblique triangularia, subacuta, margine superiore (postice) 8.5–9.5 mm. longa, inferiore 5.5–6.5 mm. longa, basi 7.5–8 mm. lata, mentum obtusum 6–7 mm. longum formantia. *Petala* oblique oblongo-subspathulata, apice rotundata, 6–7 mm. longa, 2.25–2.5 mm. lata. *Labellum* curvato-deflexum ex ungue brevi lato ambitu oblongum, infra medium trilobatum, totum 9–10 mm. longum, 6–7 mm. latum (explanatum); lobus intermedius suborbiculari-quadratus, apice recurvato-apiculatus ut videtur retusus, marginibus undulatis, 5–5.5 mm. longus, 5–5.25 mm. latus, rugulosus, farinaceo-pilosus, secus medium canaliculatus; lobi laterales erecti, ab intermedio angulo recto sejuncti, incurvatim triangulares, subacuti, fere 1.5 mm. longi et lati. *Columna* subteres, antice excavata, circiter 2.5 mm. longa; anthera hemisphaerica, dorso cristata, antice leviter producta; rostellum leviter productum; stigma transverse oblongo-ellipticum.

TANGANYIKA TERRITORY: Nguru Mts., Mhonda, 600 m. alt., in deep shade in fork of forest tree, April 1943, *Moreau 353* (TYPE). "One glossy deep grass-green leaf. Flower glistening white with two narrow crimson lines running from anther base to column foot. No scent."

It is not easy to decide which species is the nearest relative of this addition to sect. *Cultriformes*. The narrow leaf and general flower structure indicate its affinity with *P. Mildbraedii* Kraenzl. and *P. gracilenta* Kraenzl., but there is also a strong resemblance to *P. fulvilabia*

Schltr. and other species with short few-flowered simple inflorescences. So far as I am aware this is the first species of sect. *Cultriformes* recorded from the Nguru Mountains.

Rhipidoglossum densiflorum *Summerhayes sp. nov.;* affine *R. obanensi* (Rendle) Summerh., a quo foliis apice valde inaequaliter bilobatis lobo longiore acuto lobo breviore fere nullo, floribus paulo majoribus, sepalis lateralibus quam intermedio longioribus angustioribusque, labello late orbiculari vel flabellato-orbiculari apice leviter exciso basi ante ostium calcaris callo transverso perhumili instructo satis distinguendum.

Herba epiphytica; caulis elongatus, usque ad 40–45 cm. longus, 2–3.5 mm. diametro, teres, superne multifoliatus, inferne vaginis foliorum delapsorum partim circumdatus, radices numerosas flexuosas ramosas laeves 3–4 mm. diametro emittens. *Folia* adscendentia vel fere patentia, 1–2 cm. distantia; vagina inferne arcta, superne subdilatata, leviter compressa, valde nervosa, apice truncata, 1–2 cm. longa; lamina oblanceolata, oblongo-vel elliptico-lanceolata vel anguste lanceolata, apice valde inaequaliter bilobata, lobulo longiore leviter incurvato acuto 2–10 mm. longo, lobulo breviore brevissimo vel fere nullo, basi angustata, 4–12 cm. longa, 8–23 mm. lata, siccitate multinervosa, tenuiter coriacea. *Inflorescentiae* singulae vel geminae, foliis multo breviores, 1–4 cm. longae, fere ad basin dense multiflorae, basi vaginis paucis ovatis obtusis instructae; rhachis teres; bracteae vaginantes, superne dilatatae, truncatae vel subacutae, vix 1 mm. longae, 1–2 mm. distantes. *Flores* patentes, albi vel pallide cremei, eos *Convallariae majalis* revocantes, tepalis ± conniventibus; pedicellus cum ovario 2–3 mm. longus. *Sepalum* intermedium late ellipticum, apice obtusum vel rotundatum brevissime apiculatum, 2.4–2.8

mm. longum, 1.7–1.9 mm. latum, concavum, trinervium; sepala lateralia oblique late elliptico-lanceolata, apice subacuta, vel obtusa, 3–3.5 mm. longa, 1.3–1.7 mm. lata, 1–3-nervia. *Petala* suborbicularia, apice obscure apiculata, 2.25–2.75 mm. longa, 2–2.6 mm. lata, trinervia, nervis lateralibus ramosis. *Labellum* late orbiculare, flabellato-orbiculare vel fere transverse ellipticum, apice excisum, antice subtruncatum vel rotundatum et brevissime bilobatum, 2.75–3.75 mm. longum, 3.5–4.7 mm. latum, multinervosum, basi ante ostium calcaris callo transverso perhumili leviter emarginato instructum; calcar e basi angustiore dilatatum, ellipsoideum, apice rotundatum, 2–3 mm. longum, circiter 1.75 mm. diametro. *Columna* deflexa, crassa, antice excavata, apice truncata, 1–1.25 mm. longa, androclinio leviter excavato; anthera oblonga, valde convexa, antice truncata; pollinia subsphaeroidea vel ellipsoidea, circiter 0.5 mm. longa, stipitibus duobus subspathulato-ligulatis deorsum angustatis 0.75 mm. longis, viscidiis duobus elliptico-oblongis antice truncatis postice rotundatis; rostellum trilobum, lobo intermedio porrecto carnoso subspathulato, lobis lateralibus intermedio brevioribus rotundato-triangularibus; fovea stigmatica quadrata. *Capsulae* ellipsoideae, inferne angustatae, leviter curvatae, 1–1.25 cm. longae, 5 mm. diametro.

Uganda: Bunyoro, Budongo Forest, Sept. 1933, *Eggeling 1431* (Uganda Forest Service No. 1376); Sept. 1935, *Eggeling 2172;* same date, *Hancock 13 A;* Nov. 1943, in fruit, flowered Busingiro Aug. 1944, *Eggeling 5475;* Bugoma Forest, 1050 m. alt., *Dawe 759;* Masaka, South Buddu, *Fyffe 187;* Mengo, Kyagwe, Sept. 1921, *Lankester 29;* Mabira Forest, 1200 m. alt., Sept.–Oct. 1920, *Dümmer 4438.*

Gabon: Upper Ngounyé River, waterfall on Mboumi River, at Mbigou, Nov. 1925, *Le Testu 5767* (Type).

Angola: Moxico Distr., River Lupula, in evergreen vegetation, Jan. 1938, *Milne-Redhead 4239.*

This striking little species well illustrates the difficulties of classification of the group of genera of which it is a

constituent species. I have placed it, for the time being, in *Rhipidoglossum*, since it is clearly closely related to *R. obanense* (Rendle) Summerh. and *R. globuloso-calcaratum* (De Wildem.) Summerh. with which it shares the short dense inflorescences and short swollen spur. The orbicular curiously veined petals are also almost identical with those in other species of *Rhipidoglossum*. On the other hand in the shape of the leaves and the tendency of the whole plant to blacken on drying the species resembles the genus *Sarcorhynchus*. The narrow excision at the apex of the lip may be looked upon as an intermediate between the entire lip-apex of *S. polyanthus* (Kraenzl.) Schltr. and the deeply lobed lip of *S. bilobatus* Summerh., described later in this paper. Another complication is the presence of a low transverse rim-like callus just in front of the spur. Although technically this should place the species in *Diaphananthe* the callus is so unlike the ordinary tooth found in that genus and the plant shows so little resemblance to other species of *Diaphananthe* that it scarcely seems advisable to include it therein.

Further work and discoveries of yet more intermediate species may make it necessary to consider all three genera as forming a single one under the earliest name *Diaphananthe*, but I do not feel that the evidence so far warrants such a change.

Rhipidoglossum microphyllum *Summerhayes sp. nov.;* a *R. longicalcari* Summerh. habitu graciliore, radicibus numerosissimis, foliis multo minoribus, petalis ellipticis, labello apice subacuto, calcari breviore facile distinguendum.

Rhipidoglossum ? sp. Schlechter in Engler. Bot. Jahrb. 53 (1915) 605.

Herba epiphytica; caulis ± erectus, gracilis, leviter

flexuosus, usque ad 15 cm. longus, 1–1.5 mm. diametro, teres, apice 3–7-foliatus, radices numerosissimas flexuosas simplices ± recurvatas saepissime compressas usque ad 20 cm. longas 2–3 mm. latas griseas per totam longitudinem dense emittens. *Folia* parva, erecto-patentia vel patentia, usque ad 5 mm. distantia; vagina arcta, valde nervosa, 4–5 mm. longa; lamina oblonga vel oblongo-ligulata, apice paulo inaequaliter bilobata, lobulis rotundatis, 7–18 mm. longa, 2–5 mm. lata, griseo-viridis. *Inflorescentiae* ex axillis foliorum delapsorum exortae, folia superantes, arcuato-decurvatae, 1.5–2.5 cm. longae, sublaxe 4–8-florae; pedunculus 7–10 mm. longus, vaginis 3–4 infimis truncatis superioribus lanceolatis acutis instructus; rhachis fractiflexa, teres; bracteae laxe ochreatae, apice triangulares acutae, 1–1.5 mm. longae. *Flores* patentes, cremei, 1.5–2.5 mm. distantes; pedicellus cum ovario 3–3.5 mm. longus. *Sepalum* intermedium obovato-oblongum, apice subacutum, 3 mm. longum, 1.5 mm. latum, concavum; sepala lateralia oblique et leviter curvatim oblongo-ligulata, apice subacuta, 3.75 mm. longa, circiter 1 mm. lata, superne dorso carinata; omnia sepala trinervia. *Petala* oblique elliptica, apice rotundata, 2.75 mm. longa, 1.5 mm. lata, trinervia, nervis lateralibus ± ramosis. *Labellum* elliptico-lanceolatum, subacutum, 3 mm. longum, vix 1 mm. latum, multinervosum; calcar valde incurvatum, cylindricum, apice leviter dilatatum, circiter 7 mm. longum et 0.5 mm. diametro. *Columna* brevis, crassa, antice excavata, 1 mm. longa, androclinio levissime excavato; anthera subhemisphaerica, antice vix producta; pollinia globosa, 0.3 mm. diametro, stipitibus duobus linearibus deorsum sensim angustatis 0.5 mm. longis, viscidiis duobus ellipticis; rostellum productum, lobo intermedio convexo crasso, lobis lateralibus brevioribus triangularibus; fovea stigmatica quadrata; ovarium papillis nigris sparsis instructum.

TANGANYIKA TERRITORY: Neu Langenburg Distr., Bundali Mts., Ngulu Mt., 1400 m. alt., March 1914, *Stolz 2554* (TYPE.)

A somewhat aberrant member of the genus characterised by the slender stems emitting a mass of aerial roots, the very small leaves, the elliptical petals and the narrow entire lip. It is probably most closely allied to *R. longicalcar* Summerh. in which the lip is also longer than broad. The column and pollinarium characters agree well with those in other species of *Rhipidoglossum*.

Rhipidoglossum rutilum (*Reichenbach filius*) *Schlechter* in Beih. Bot. Centralbl. 36, Abt. 2 (1918) 81—Summerhayes in Blumea, Suppl. 1 (1937) 85.

Mystacidium Kaessnerianum Kraenzlin in Vierteljahrsschr. Nat. Ges. Zürich, 60 (1915) 395.

The type gathering of Kraenzlin's species (*Kässner 741*) was cited by me under *R. rutilum* (Rchb.f.) Schltr. in the reference given above, but I had overlooked the original description. This agrees admirably with that of *R. rutilum* and there can be no doubt as to the identity of the two.

Oeonia volucris (*Thouars*) *Sprengel* Syst. Veg. 3 (1826) 727.

Epidendrum volucre Thouars Orch. Iles Austr.-Afr. (1822) t. 81.

Until now this combination has been generally credited to Durand and Schinz, Consp. Fl. Afr. 5 (1895) 51, but the above reference has nearly 70 years' priority. Sprengel uses the original spelling *Aeonia*, but as "*Oeonia* Lindl." has been conserved against two earlier names and general usage also favours this spelling, it would appear best to maintain it. Confusion with the Crassulaceous genus *Aeonium* Webb & Benth. is also avoided.

DIAPHANANTHE *Schlechter*

An examination of material of practically all the spe-

cies of *Diaphananthe*, including most of the type specimens, has enabled me to reduce some species to synonymy while on the other hand I have added to the number by transferences from other genera and by describing several new species. The details of these changes are given below under the headings of the various species recognised. I am still doubtful as to the exact relationships of a few of the species and also have insufficient material of what may prove to be additional new species. The total number of species on my present reckoning is 24, which is one more than the total in Schlechter's account of the genus (Beih. Bot. Centralbl. 36, Abt. 2 (1918) 95–101).

Schlechter divided the genus into three sections as follows:–

1. Eu-Diaphananthe. Stems very short; pedicels arising singly.
2. Gibbostium. Stems much elongated; pedicels arising singly.
3. Enantianthe. Stem rather short; leaves fleshy; pedicels opposite or whorled.

This arrangement is to a certain extent convenient in classifying the species, but it takes no account of the two quite different types of column structure found in the genus. One group of species containing the lectotype species (*D. pellucida* (Lindl.) Schltr. of Beih. Bot. Centralbl. 36, Abt. 2 (1918) 97) possesses a narrow acute decurved rostellum and a common viscidium to which the pollinia are attached by separate stipites. The other group possesses a column similar to that in the genus *Rhipidoglossum*, the rostellum being distinctly trilobed with a fleshy porrect middle-lobe while each pollinium is furnished with a separate stipe and viscidium.

The species are enumerated below in accordance with what I think are the affinities of the species, but I have

refrained from giving names to the various divisions and subdivisions as I do not feel that our knowledge of the genus and its nearest allies is anything like complete.

A. Column rather short, tapering upwards, androclinium rather small and sloping upwards; rostellum beak-like, deflexed, bilobed on removal of pollinarium, lobes subulate; stipites two attached to a common viscidium.

a) Stems very short with a rosette of leaves or only slightly elongated; flowers alternate.

1. D. pellucida (*Lindl.*) *Schltr.*
2. D. bueae (*Schltr.*) *Schltr.*
3. D. Plehniana (*Schltr.*) *Schltr.*
4. D. Quintasii (*Rolfe*) *Schltr.*

b) Stems elongated, leafy along a great deal of their length; flowers alternate.

5. D. bidens (*Sw. ex Pers.*) *Schltr.*
6. D. subclavata (*Rolfe*) *Schltr.*
7. D. acuta (*Ridl.*) *Schltr.*
8. D. papagayi (*Reichb.f.*) *Schltr.*
9. D. congolensis (*De Wildem.*) *Summerh.*
10. D. divitiflora (*Kraenzl.*) *Schltr.*

c) Stems long or short; flowers opposite or verticillate.

11. D. fragrantissima (*Reichb.*) *Schltr.*
12. D. Welwitschii (*Reichb.f.*) *Schltr.*
13. D. vandiformis (*Kraenzl.*) *Schltr.*

B. Column short and truncate, androclinium large, occupying the whole of the apex; rostellum porrect, trilobed on removal of pollinaria, middle lobe fleshy, more or less spathulate, laterals shorter, triangular; stipites 2, each attached to a separate viscidium.

a) Stems short or only slightly elongated.

14. D. kamerunensis (*Schltr.*) *Schltr.*
15. D. curvata (*Rolfe*) *Summerh.*
16. D. polydactyla (*Kraenzl.*) *Summerh.*
17. D. Mildbraedii (*Kraenzl.*) *Schltr.*
18. D. tenerrima (*Kraenzl.*) *Summerh.*
19. D. pulchella *Summerh.*
20. D. ugandensis (*Rendle*) *Summerh.*

b) Stems much elongated.

21. D. Stolzii *Schltr.*
22. D. Schimperiana (*A. Rich.*) *Summerh.*
23. D. tenuicalcar *Summerh.*
24. D. subsimplex *Summerh.*

The column in group B is almost identical with that in the genera *Rhipidoglossum* Schltr. and *Sarcorhynchus* Schltr., but in many other features the various species may resemble closely species in group A. The charac-

teristic *Diaphananthe* tooth at the opening of the spur is present in all but one of the species of group B and is often identical with the similar structure in species belonging to group A. In *D. curvata* (Rolfe) Summerh. this callus takes the form of a transverse ridge, but on other grounds the species seems correctly referred to *Diaphananthe*.

Diaphananthe bidens (*Swartz ex Persoon*) *Schlechter* Die Orchideen (1914) 593.

Limodorum bidens Afzelius ex Swartz in Kongl. Vetens. Akad. Handl. 21 (1800) 243, *nomen tantum*— Swartz ex Persoon Syn. Pl. 2 (1807) 521, descript.
Angraecum ashantense Lindley in Edwards Bot. Reg. (1843) misc. p. 56.
Angraecum monodon Lindley in Lindley & Paxton Flower Garden 2 (1851–52) 102, fig. 187.
Angraecum Bakeri Kraenzlin in Mitt. Deutsch. Schutzgeb. 2 (1889) 159.
Mystacidium productum Kraenzlin in Engler. Bot. Jahrb. 22 (1895) 30.
Listrostachys mystacidioides Kraenzlin l.c. 28 (1900) 170.
Listrostachys longissima Kraenzlin l.c. 48 (1912) 400.
Angraecum subfalcifolium De Wildeman in Bull. Jard. Bot. Brux. 5 (1916) 192.
Diaphananthe ashantensis Schlechter in Beih. Bot. Centralbl. 36, Abt. 2 (1918) 98.
Diaphananthe monodon Schlechter l.c.
Diaphananthe mystacidioides Schlechter l.c. 99.
Diaphananthe producta Schlechter l.c.
Diaphananthe subfalcifolia Schlechter l.c. 100.
Mystacidium Duemmerianum Kraenzlin in Vierteljahrsschr. Nat. Ges. Zürich 74 (1929) 100.
An examination and careful analysis of nearly sixty

gatherings from an area extending from Sierra Leone to Uganda, leads to the conclusion that the above "species" are merely forms of one widely distributed species. This shows considerable variation in leaf size and shape and in the detailed structure of the lip; there is also a less marked variation in flower size.

Unfortunately it has not been possible to examine the types of some of the above names and there seems little likelihood that such examination ever will be possible. These species therefore will have to be interpreted in the light of other gatherings from the same general areas. The descriptions of *Angraecum Bakeri*, *Listrostachys mystacidioides* and *L. longissima* do not include any features, or combination of characters, which cannot be found in other gatherings both from the east and from the west. The spur appears to be longer in relation to the lip than in most other specimens, but even as regards this character Kraenzlin's own descriptions are somewhat contradictory.

From the description the flowers in *Listrostachys subfalcifolia* are larger than in any other gathering, but some collections from the Belgian Congo (e.g. *Corbisier 503*) have flowers almost as large and are otherwise evidently *D. bidens*.

Mystacidium Duemmerianum Kraenzl. is a puzzling case. The type gathering is *Dümmer 4437* of which there are duplicates at Kew and at the British Museum. These specimens are certainly referable to *D. bidens*, the only remarkable feature being the consistently short inflorescences which otherwise are quite normal. Kraenzlin's description, although it fits the Kew and British Museum material in most respects, seems to have been drawn up from a plant bearing considerably smaller flowers with shorter and broader tepals. In view of the poor state of preservation of the duplicates it seems probable that

Kraenzlin was unable to discover a well-preserved flower on the type sheet except in the bud stage when preservation is often better. This would explain the short perianth members since it is a well-known fact that there is considerable growth in length as the flower develops. There is, however, a possibility that *Dümmer 4437* is a mixture of two species and that Kraenzlin's type differs from the material seen.

So far as can be judged from the description, *Diaphananthe subclavata* (Rolfe) Schltr. (*Angraecum subclavatum* Rolfe in Bolet. Soc. Broter. 9 (1892) 140) seems also to be referable to *D. bidens*. Unfortunately no specimen could be discovered in the herbaria at the British Museum or at Coimbra. Admittedly Rolfe described the pollinia originally as having only a single stipe, but he stated that the species is allied to *Listrostachys ashantensis*. However, in the Flora of Tropical Africa (vol. 7, p. 160) he transfers the species to *Listrostachys* which, as understood by him there, possesses two separate stipites in the pollinarium. *D. bidens* has been recorded from Fernando Po and there seems no reason why such a widely spread species should not also occur in São Tomé.

Arrangement of the specimens in a geographical sequence from west to east shows that those occurring to the west of the Cameroons Mountain have on the whole shorter and broader leaves than those to the east and south. There is no absolute distinction, however, moderately long-leaved forms being found in Sierra Leone and short-leaved ones in Gabon. The flowers in the "Congo" group are on the whole slightly larger and the spur relatively shorter than in gatherings from "Upper Guinea," but again there is no hard and fast line of demarcation. With regard to variations in the labellum, which have been used by some authors for differentiating purposes, it is obvious that considerable variations occur.

The lip is usually more or less quadrate with rounded base, the apex truncate and somewhat emarginate with a short central apiculus, and the margins normally irregularly dentate especially in the anticous part. Sometimes the lip is narrowed towards the front, sometimes it is somewhat pandurate, while in other cases there is no obvious emargination. The spur is much narrowed at the base and obtuse at the apex. It varies from being the same length as the lip to a little more than half as long again. On the whole the western or "Upper Guinea" specimens have a relatively longer spur than those from the Congo basin region, but here again there is no sharp distinction.

On the whole the evidence so far available does not appear to be sufficient to justify the recognition of two geographical varieties.

Diaphananthe congolensis (*De Wildeman*) ***Summerhayes comb. nov.***

Mystacidium congolense De Wildeman Not. Pl. Utiles Congo 1 (1903) 151—Summerhayes in Blumea Suppl. 1 (1937) 80, in obs.

Rhipidoglossum rutilum Schlechter in Beih. Bot. Centralbl. 36, Abt. 2 (1918) 81, partly.

This species is closely allied to *D. divitiflora* (Kraenzl.) Schltr. and may eventually prove to be conspecific. At present I have not seen sufficient material of either species to make a definite decision.

Diaphananthe fragrantissima (*Reichenbach filius*) *Schlechter* in Beih. Bot. Centralbl. 36, Abt. 2 (1918) 100.

Listrostachys fragrantissima Reichenbach filius in Flora 48 (1865) 190.

Listrostachys Kirkii Rolfe in Dyer Fl. Trop. Afr. 7 (1897) 164.

Listrostachys falcata De Wildeman Not. Pl. Utiles Congo 1 (1903) 147.

Listrostachys fimbriata Rolfe in Bull. Misc. Inform. Kew (1906) 115.
Angraecum Muanse Kraenzlin in Orchis 2 (1908) 99.
Diaphananthe falcata Schlechter in Beih. Bot. Centralbl. 36, Abt. 2 (1918) 100.
Diaphananthe fimbriata Schlechter l.c.
Diaphananthe Kirkii Schlechter l.c. 101.
Diaphananthe Muansae Schlechter l.c.

I fail to see any differences between the above species on comparison of the descriptions and 30 gatherings including type specimens, although there is certainly some variation in flower size and particularly in lip structure. The lip varies in the degree of laceration or fimbriation of the margins and in the length of the apiculus although this is usually at least one quarter of the length of the rest of the lip and sometimes as much as two-thirds. The spur is variously thickened in the distal part, acute or obtuse, and either shorter or longer than the lip. So far I have been unable to correlate the variations in any of the above characters, while in general facies, including habit, inflorescence, shape of tepals, general lip construction and column structure all the specimens exhibit a remarkable uniformity.

Judging from the material available and the notes of collectors the stem is upright at first while still short and the leaves are then recurved downwards and may almost meet below. As the stem elongates the root system is not strong enough to hold it up and it gradually falls over, the leaves produced subsequently then becoming more and more hanging and consequently straighter.

D. Welwitschii (Reichb.f.) Schltr. which is, so far as I am aware, only known from the type gathering, has elongated upright stems with short closely imbricate almost erect leaves which are rounded and unequally bilobed at the apex. The inflorescences and flowers closely

resemble those of *D. fragrantissima*. *D. vandiformis* (Kraenzl.) Schltr., judging from the photograph in Schlechter Die Orchideen, fig. 202, has apparently a habit similar to that in *D. Welwitschii*, but the leaves are much longer and spreading. Until it is possible to see material of this species from the Cameroons it had best be left as a separate species.

As now understood *D. fragrantissima* occurs in Ou-bangui-Chari, Eastern Belgian Congo, southern Sudan, Uganda, northern Tanganyika Territory, Angola and North-Western Rhodesia. From the data available it appears generally to inhabit gallery forests and dryish woodlands in savanna regions, either epiphytic or on rocks.

Diaphananthe pulchella *Summerhayes sp. nov.;* a *D. Stolzii* Schltr. caule multo breviore, foliis longioribus angustioribusque, inflorescentiis longioribus, floribus minoribus, tepalis obtusissimis vel rotundatis; a *D. ugandensi* (Rendle) Summerh. floribus majoribus, labello subflabellato distinguenda.

Herba epiphytica, pulchella; caulis brevis vel ± elongatus, ± dependens, usque ad 13 cm. longus, 3–4 mm. diametro, superne dense 4–9-foliatus, inferne vaginis foliorum delapsorum fere omnino circumdatus, radices flexuosas ramosas, griseas, laeves, 4–6 mm. diametro per totam longitudinem emittens. *Folia* circiter 7.5 mm. distantia, patentia; vagina arcta, leviter compressa, valde nervosa, 5–10 mm. longa; lamina oblongo-ligulata, ligulata vel lineari-ligulata, apice inaequaliter bilobulata, lobulis rotundatis vel obtusissimis longiore 4–11 mm. longo, basi leviter angustata, 4.5–15 cm. longa, 7–11 mm. lata, ± coriacea. *Inflorescentiae* ex axillis foliorum vel foliorum delapsorum exortae, singulae, simpliciter racemosae, dependentes, 6–15 cm. longae, sublaxe mul-

tiflorae; pedunculus 1–2 cm. longus, vaginis paucis ovatis subacutis instructus; rhachis teres, circiter 1 mm. diametro; bracteae 6–9 (-13) mm. distantes, ochreatae, ovato-triangulares, acutae, 1.5–3 mm. longae. *Flores* patentes, pallide viridi-lutei, cremei-viridescentes vel viridescentes, translucentes; pedicellus cum ovario 3–4 mm. longus. *Sepalum* intermedium erectum, concavum, ellipticum, oblongo-ellipticum vel obovato-ellipticum, apice obtusissimum vel rotundatum, 4.75–7.25 mm. longum, 2.5–3.75 mm. latum; sepala lateralia leviter curvatim oblonga vel elliptico-oblonga, apice rotundata, 5.75–7.5 mm. longa, 2–3.5 mm. lata; omnia sepala trinervia, nervis lateralibus saepius ramosis. *Petala* oblique ovata vel lanceolato-ovata, apice breviter acuminata, marginibus superne irregularibus vel fere denticulatis, 4.25–7.25 mm. longa, 3–4.75 mm. lata, 3–5-nervia, nervis lateralibus ramosis. *Labellum* late flabellato-suborbiculare, apice ± excisum apiculo saepe interjecto, antice obscurissime tri-vel quadrilobatum, marginibus irregulariter denticulatis vel excisis, totum 6–9.25 mm. longum, 7.25–10 mm. latum, nervis numerosis ± radiantibus, ante orificium calcaris callo erecto dentiformi instructum; calcar incurvatum, ex ore latiore angustatum, deinde fusiformi-cylindricum, apice angustatum, 8.5–11.5 mm. longum. *Columna* incurvatim porrecta, crassa, subteres, 1.8–2.8 mm. longa, apice truncata, androclinio leviter excavato; anthera subhemisphaerica, antice producta truncata; pollinia subsphaeroidea vel pyriformi-sphaeroidea, 0.65-0.8 mm. diametro, stipitibus linearibus superne leviter dilatatis inferne subulatis 1.05–1.4 mm. longis, viscidiis duobus distinctis orbicularibus; rostellum convexum, antice productum, trilobum, lobo intermedio leviter spathulato carnoso, lobis lateralibus dimidio brevioribus incurvatim triangularibus acutis; fovea stigmatica elliptico-quadrata.

KENYA COLONY: Mt. Elgon; Kitale, Caves of Elgon Farm, 2010 m. alt., May 1931, *Tweedie 10;* same locality, 2160 m. alt., on Acacia at edge of forest, May 1941, *Tweedie 571;* Suam Saw Mill, 2370 m. alt., edge of forest, high up on *Podocarpus gracilior*, May 1941, *Tweedie 570;* no local., 1800 m. alt., in forest, Feb. 1933 *Napier*, Coryndon Mus. No. 2524; Ngong, 10 miles W. of Nairobi, 1800 m. alt., Nov. 1638, *Cunningham-van Someren 512.*

TANGANYIKA TERRITORY: Masai-land, 50 miles S. of Moshi, Lolbeni Mt., in rich primary forest, April 1943, *Page-Jones in Moreau 569;* W. Usambara Mts., eastern edge, Mazumbai, 1350 m. alt., forest edge, March 1943, *Moreau 611;* E. Usambara Mt., Amani, 900 m. alt. in rain-forest canopy, April 1942, *Moreau 64* (TYPE); Tanga Prov. Handeni, 45 miles S W of Korogwe, 720 m. alt. in semi-evergreen bush, March 1943, *Moreau 610.*

Diaphananthe pulchella *Summerh.* var. **geniculata** *Summerhayes var. nov.;* a typo inflorescentiis saepius longioribus, floribus paulo majoribus, sepalis lateralibus longioribus angustioribusque ligulatis basin versus lateraliter geniculatis vel abrupte curvatis; pollinii stipitibus 1.5–1.6 mm. longis differt.

UGANDA: Toro: Bwamba, Sempaya, Aug. 1937, *Eggeling 2392;* no local., 1500 m. alt., in forests, *Lankester in Snowden 739.* Bunyoro: Bugumolo, in savannah, usually on *Acacia Sieberiana* rarely on *Combretum Binderianum*, Aug. 1935, *Eggeling 2153* (TYPE); Hoima, 1200 m., Aug. 1940, *Purseglove 983;* same local., Dec. 1942 (in fruit), flowered at Busingiro, Aug. 1943 & July-Aug. 1944, *Eggeling 5360.* Busoga: Kitumbazi, Sept. 1921, *Lankester 26.* Also seen (flowers matched) by W. J. Eggeling at Aduku in Lango Prov. and at Metu, West Nile Prov.

The variety may be distinguished from the type of the species especially by the narrow strap-shaped lateral sepals which are suddenly bent in the posticous direction about one-third way from the base and by the longer stipites to the pollinia. Each stipes is narrowly strap-shaped with a broader rounded apex and tapers gradually towards the base where it is narrowest. In the type the basal part of the stipes is somewhat thickened and the tapering from above downwards is not so marked. In both type and variety the pollinia are of the same size. There is some indication from habitat data that the va-

riety is a savanna plant, whereas the type appears to occur mainly in forests or at the forest margins.

D. pulchella is evidently most closely related to *D. ugandensis* (Rendle) Summerh. The latter has smaller flowers with a differently shaped lip. This latter organ is more or less orbicular, the basal margins being rounded but entire whereas in the apical part they are irregularly toothed. At the apex is a broad sublunate truncated sinus with a small central apiculus. In *D. pulchella* the basal part of the lip is distinctly cuneate-flabellate while the front margins are irregularly dentate and more or less obscurely trilobed, the middle lobe being narrowly and sometimes rather deeply incised to form two sub-lobes which give a four-lobed appearance to the whole. The narrow apical sinus or cleft has sometimes a small central apiculus. So far as the lateral sepals and pollinarium are concerned *D. ugandensis* more closely agrees with the Kenya and Tanganyika type form of *D. pulchella* than with the Uganda variety *geniculata* with which it occurs.

Diaphananthe Schimperiana (*A. Richard*) *Summerhayes comb. nov.*

Dendrobium ? Schimperianum A. Richard Tent. Fl. Abyss. 2 (1851) 282.

Angraecum Schimperianum Reichenbach filius in Walp. Ann. 3 (1852–3) 573.

This species is omitted by Schlechter from his account of the Angraecoid Orchids. From dissections made of a rather withered flower on a duplicate of the type, taken together with Reichenbach's description, it is evident that the species should be referred to *Diaphananthe*. Here it is clearly related to *D. Stolzii* Schltr. and *D. pulchella* Summerh. From *D. Stolzii* it may be distinguished by the much longer leaves with a more unequal apex in which the shorter lobe is scarcely evident. In

D. Stolzii the leaves are widest towards the apex, the latter being unequally bilobed with both lobes rounded and quite distinct. The long stem and relatively short spikes distinguish the Abyssinian species from *D. pulchella*. It differs from both *D. Stolzii* and *D. pulchella* in the shape of the lip which is broadest near the base, slightly pandurate and quite distinctly, if shortly, lacerate or fimbriate on the anterior angles. The column, although much swollen following fertilisation, is clearly of the *Rhipidoglossum* type, being trilobed with a central fleshy and porrect middle lobe.

Diaphananthe subsimplex *Summerhayes sp. nov.;* a *D. Stolzii* Schltr. foliis angustioribus, floribus multo minoribus, labello suborbiculari-quadrato apice obscurissime trilobo; a *D. tenuicalcari* Summerh. foliis apice nec angustatis sed lobulis rotundatis, floribus minoribus, calcari multo breviore differt.

Herba epiphytica, glaberrima; caulis elongatus, ± dependens, pauciramosus, 10–35 cm. longus, 2.5–3 mm. diametro, superne laxe foliatus inferne vaginis foliorum delapsorum fere omnino circumdatus, radices flexuosas simplices usque ad 35 cm. longas et 4 mm. diametro laeves griseas vel brunnescentes per totam longitudinem emittens. *Folia* erecto- ad recurvato-patentia, 1–2 cm. distantia; vagina arcta, valde nervosa, apice truncata, 7–15 mm. longa, leviter compressa; lamina ligulata (si mavis lineari-oblonga), apice inaequaliter bilobulata, lobulis rotundatis longiore usque ad 8 mm. longo, basi ± abrupte angustata, 2.5–8.5 cm. longa, 5–12 mm. lata, subcarnosa. *Inflorescentiae* axillares, simpliciter racemosae, patentes, 1.5–4 cm. longae, subdense 5–13-florae; bracteae 2–7 mm. distantes, ochreatae, triangulares, subacutae, 1–2.5 mm. longae. *Flores* patentes, cremei ad ochracei, ± viridi-tincti; pedicellus cum ovario 2.5–3

mm. longus. *Sepalum* intermedium oblongo- vel ovato-ellipticum, apice rotundatum vel obtusissimum, 2.7–4 mm. longum, 1.5–2 mm. latum, saepissime trinervium; sepala lateralia oblique oblonga vel oblongo-elliptica, apice obtusa, 3.3–4.5 mm. longa, 1.3–1.6 mm. lata, 1–3-nervia. *Petala* oblique triangulari-ovata, acuta, margine antico inferne dilatato, 2.8–3.5 mm. longa, 1.7–2.7 mm. lata, trinervia, nervis lateralibus saepe ramosis. *Labellum* suborbiculari-quadratum, apice obtusum vel obscurissime bi-vel trilobulatum, basi rotundato-cuneatum, 2.5–3.6 mm. longum, 2.8–3.5 mm. latum, basi ante orificium calcaris callo obtuso dentiformi instructum, disco multinervoso; calcar leviter incurvatum, cylindricum, apice leviter angustatum, 4.4–6.75 mm. longum, circiter 1 mm. diametro. *Columna* deorsum porrecta, crassa, brevis, apice truncata, 1.2–1.5 mm. alta, androclinio leviter excavato; anthera hemisphaerica, antice producta truncata; pollinia fere globosa, circiter 0.5 mm. diametro, stipitibus duobus linearibus superne dilatatis apice rotundatis 0.6 mm. longis, viscidiis duobus separatis orbicularibus; rostellum productum, lobo intermedio convexo carnoso apice subspathulato rotundato, lobis lateralibus duplo brevioribus triangularibus subacutis; fovea stigmatica quadrata, margine inferiore ± prominente.

Uganda: Karamoja, Napak, 2250 m. alt., in ravine forest, occasional, May 1940, *Thomas 3644*.

Kenya Colony: Mt. Elgon, Suam River Valley, 1950–2100 m. alt., Nov. 1934, *Tweedie 289;* July 1936, *Tweedie 329; 330;* Aberdare Mts., Kinangop, 2640–2670 m. alt., close to river, April 1938, *Chandler 2400;* Western Aberdare Mts., Kinobop Forest Station, 2580 m. alt., June 1931, *Dale 2863;* Chyulu Hills, Central part, 1650 m. alt., in rain forest, June 1938, *Bally*, Coryndon Mus. No. 7853; Nanyuki, N W of Mt. Kenia, 2040 m. alt., on bole of large tree by river, June 1943, *Moreau 578* (Type).

This species resembles strongly *Rhipidoglossum xanthopollinium* (Reichb.f.) Schltr., not only in the general habit and flower size, but also in the structure of the col-

umn which is of the *Rhipidoglossum* type. It possesses, however, a distinct tooth in the mouth of the spur and, moreover, the petals are markedly acute and similar in shape to those in other species of *Diaphananthe*. As I pointed out in my revision of *Rhipidoglossum* (Blumea Suppl. 1, 78–9: 1937) the two genera are very closely allied, but it still appears advantageous to maintain them as separate entities for the time being.

Diaphananthe tenerrima (*Kraenzlin*) *Summerhayes comb. nov.*

Listrostachys tenerrima Kraenzlin in Vierteljahrsschr. Nat. Ges. Zürich 68 (1923) 424.

This species was reduced to *D. Mildbraedii* (Kraenzl.) Schltr. by Schlechter in the Berlin Herbarium but on comparison of the two type gatherings the differences, especially in the floral characters, warrant their separation as distinct species. The sepals and petals in *D. tenerrima* are broader and rounded at the apex while the lip is transversely elliptical and quite rounded in front instead of obovate and apiculate as in *D. Mildbraedii*. In vegetative characters there is admittedly a close resemblance between the two species and both came from the volcanic area near Lake Kivu.

Diaphananthe tenuicalcar *Summerhayes sp. nov.;* affinis *D. Stolzii* Schltr. et *D. Schimperianae* (A.Rich.) Summerh., ab hac foliis plus duplo minoribus, ab illa foliis apice angustioribus lobulis acutis, floribus minoribus sed calcari longiore tenuissimo, ab utraque statura minore, inflorescentiis multo brevioribus floribus densioribus distinguitur.

Herba verosimiliter epiphytica, glaberrima; caulis elongatus, 7–16 cm. longus, circiter 3 mm. diametro, apice circiter 3-foliatus, inferne vaginis foliorum delapsorum ± circumdatus, radices numerosas reflexo-arcuatas

laeves griseas 3 mm. diametro per totam longitudinem emittens. *Folia* 6–8 mm. distantia, adscendentia vel ± patentia; vagina subarcta, 6–8 mm. longa, nervosa; lamina oblique vel curvatim oblongo-lanceolata, basi abrupte angustata, apice breviter et inaequaliter bilobulata, lobulo longiore 4–6 mm. longo acuto, lobulo breviore usque ad 1 mm. longo subacuto, 4–5 cm. longa, 1–1.3 cm. lata, textura verosimiliter tenuis. *Inflorescentiae* ex axillis foliorum natae, solitariae, erecto-patentes, 1–1.7 cm. longae, 3–4-florae, basi vaginis paucis instructae; bracteae 2.5–4 mm. distantes, ochreatae, triangulares, acutae, 1.5–2 mm. longae. *Flores* albi; pedicellus cum ovario 0.8–1.2 cm. longus. *Sepalum intermedium* oblongo-ellipticum, apice rotundatum, 4.5 mm. longum, fere 3 mm. latum, concavum, trinervium; sepala lateralia leviter curvata vel obliqua, ligulato-oblonga, obtusa, 5 mm. longa, 2.5 mm. lata, sub-trinervia. *Petala* oblique et irregulariter ovata, apice acuta, basi margine antico rotundato-dilatata, 4.5–5 mm. longa, 3 mm. lata, trinervia, nervis lateralibus ramosis, saccis crystalliferis numerosis distincte notata. *Labellum* flabellatim obtriangulare, apice anguste retusum apiculo interjecto, 7.5 mm. longum, antice 6.5 mm. latum, multinervium, basi ante ostium calcaris callo humili dentiformi instructum; calcar ex ore lato filiformi-cylindricum, apice sensim angustatum, leviter incurvatum, fere 2.5 cm. longum, circiter 0.75 mm. diametro. *Columna* crassa, subteres, 1.6 mm. longa; anthera subhemisphaerica, antice breviter producta truncata; pollinia sphaeroidia, 0.6 mm. diametro, stipitibus linearibus superne subspathulatis inferne subulatis 1.5 mm. longis, viscidiis duobus distinctis oblongis postice acutis 0.8 mm. longis; rostellum porrectum, lobo intermedio rostrum anatis revocanti, lobis lateralibus multo brevioribus curvatim linearibus apice truncatis; fovea stigmatifera quadrata.

Uganda: Karamoja, Napak, 2250 m. alt., in ravine forest, occasional orchid with masses of small white flowers, May 1940, *Thomas 3645*.

Another member of the group with elongated stems and *Rhipidoglossum* type of column bearing separate viscidia on each side of a fleshy often more or less clavate obtuse rostellum middle-lobe. The present species is characterised by the short few-flowered inflorescences and the relatively long slender spur.

Diaphananthe ugandensis (*Rendle*) *Summerhayes comb. nov.*

Mystacidium ugandense Rendle in Journ. Linn. Soc. London Bot. 37 (1905) 220.

This species is also omitted from Schlechter's monograph of the Angraecoid Orchids, but an examination of the type specimen shows it to be a typical member of *Diaphananthe* with a well-developed tooth in the mouth of the spur. Vegetatively the plant resembles *Rhipidoglossum xanthopollinium* (Reichb.f.) Schltr. but may be readily distinguished by the floral characters. Material collected in Uganda by Mr. W. J. Eggeling and agreeing well in floral structure and other respects with the type, (*Bagshawe 425*), has larger and more laxly flowered inflorescences. The column is of the *Rhipidoglossum* type found in other members of *Diaphananthe* (*D. Stolzii* Schltr., for example), there being two separate vicidias and stipites and a trifid rostellum with a fleshy central lobe. From *D. pulchella* Summerh., which is probably its nearest ally, the species differs in the narrower leaves, slightly smaller flowers and differently shaped lip. This is relatively broader, and lunately truncate at the apex with a distinct central apiculus.

Sarcorhynchus bilobatus *Summerhayes sp. nov.;* a *S. polyantho* (Kraenzl.) Schltr. planta majore, foliis

duplo latioribus, tepalis latioribus, labello profunde bilobato, calcari multo longiore incurvato facile distinguendus.

Planta epiphytica vel rarius terrestris; caulis elongatus, pauciramosus, usque ad 50 cm. longus, verosimiliter plus minusve dependens, circiter 4–6 mm. diametro, fere teres vel sectione ellipticus, radices 3–6 cm. distantes ad 15 cm. longas et 4 mm. diametro laeves griseas per totam longitudinem emittens. *Folia* disticha, 1.5–3 cm. distantia, fere patentia; vagina arcta, dorso leviter carinata, nervosa, 1.5–2.5 cm. longa, apice truncata; lamina elliptico-oblonga vel fere elliptica, apice oblique inaequaliter bilobata, lobulis subconniventibus lobulo breviore vix distincto, basi subrotundata vel rotundata, 5–9.5 cm. longa, 1.5–4.25 cm. lata, siccitate nigrescens. *Inflorescentiae* 1–3-natae, folia aequantes vel paulo superantes, 5–9 cm. longae, fere ad basin subdense multiflorae, basi vaginis paucis ochreatis infimis truncatis superioribus lanceolatis acutis instructae; rhachis teres, leviter flexa; bracteae laxe vaginantes, ochreatae, truncatae, 1–2 mm. longae, 3–4 mm. distantes. *Flores* patentes, pellucidi, albidi vel viridescentes; pedicellus (cum ovario) 2–3 mm. longus. *Sepalum* intermedium elliptico-oblongum vel oblongo-obovatum, apice rotundatum, 3.75–4.75 mm. longum, 2–3.25 mm. latum; sepala lateralia oblique vel leviter curvatim ligulato-oblonga, apice rotundata, 4.5–5.5 mm. longa, 1.75–2.5 mm. lata, dorso humiliter carinata; omnia sepala trinervia. *Petala* oblique elliptico-oblonga vel elliptico-ovata, apice breviter acuminata, basi subrotundata, 3.5–4 mm. longa, 2–3 mm. lata, binervia vel trinervia, nervis lateralibus ramosis. *Labellum* ambitu late subpandurato-oblongum, trientibus duobus apicalibus recurvatis, triente apicali profunde trilobatum, in toto 4.75–5.75 mm. longum, 3.5–4.8 mm. latum; lobus intermedius brevissimus, dentiformis; lobi

laterales subconniventes, oblique lanceolato-oblongi, 1.5–1.7 mm. longi, 1.25–2 mm. lati, marginibus leviter incisis; calcar incurvatim dependens, cylindricum, apicem versus leviter angustatum, subacutum, 7–8.25 mm. longum, 1.75–2 mm. diametro. *Columma* horizontalis, semiteres, 1.3–1.75 mm. longa; anthera compresse hemisphaerica, antice breviter producta; pollinia subsphaeroidea, stipitibus subspathulato-ligulatis deorsum angustatis 0.6–0.8 mm. longis, viscidiis separatis fere orbicularibus antice truncatis; rostellum porrectum, lobo intermedio carnoso lanceolato, lobis lateralibus dimidio breviore leviter incurvatis obtusis; stigma quadrato-ellipticum.

UGANDA: Kigezi, Rutenga, Oct. 1940, *Eggeling 4212* (TYPE); Toro; Ruwenzori, Namwamba Valley, 1875 m. alt., in dense forest by river, Jan. 1935, *Taylor 2807 a;* Toro, near mouth of Mpanga River, on rock close to river, Sept. 1906, *Bagshawe 1205;* Ankole, 1 mile from Mbarara on shorter Kabale road, April 1944, *Eggeling 5496*.

An outstanding addition to this small but interesting genus, and occupying an intermediate position as regards geographical distribution, the two other species coming from the Cameroons and Tanganyika Territory respectively. *S. bilobatus* has a longer stem and broader leaves than the other species, but differs most markedly in the lip being deeply incised in the apical third with two large somewhat connivent lateral lobes and a very much smaller triangular middle lobe; the spur is also much longer. As in the other species the leaves blacken somewhat during drying while all three have similarly shaped tepals. In column and pollinarium characters the species agree well.

Mystacidium tanganyikense *Summerhayes sp. nov.;* a *M. venoso* Harvey ex Rolfe foliis apice acutioribus, petalis latioribus, labelli calcari breviore, rostelli lobis lateralibus crassioribus haud barbatis sed tantum papil-

losis, pollinii stipitibus brevioribus latioribusque; a *M. caffro* Bolus foliis majoribus, perianthii segmentis longioribus angustioribusque, labello basi ampliato apice acuminato, calcari haud apice inflato, pollinii stipitibus latioribus viscidiis minoribus satis distinguitur.

Planta parva, epiphytica; caulis brevissimus, vix 1 cm. longus, radices numerosas flexuosas tenues emittens. *Folia* circiter quarto, plus minusve dependentia, ligulata vel lanceolata-ligulata, apice breviter inaequaliter bilobata, lobulis subacutis, 3–6 cm. longa, 8–14 mm. lata. *Inflorescentiae* dependentes, foliis duplo vel fere duplo longiores, dimidio apicali laxiuscule 5–12-florae, 5–10 cm. longae; pedunculus gracilis, vaginis paucis distantibus instructus; rhachis gracilis, interdum levissime flexuosa; bracteae vaginis similes, ovatae, acutae vel acuminatae, 1–2 mm. longae, 3–7 mm. distantes. *Flores* subpatentes, virides, flavido-virides vel cremei, fragrantes; pedicellus tenuis, cum ovario 6–9 mm. longus. *Sepalum* intermedium recurvatum, lanceolatum, leviter acuminatum, apice ipso obtusum, 5–7.75 mm. longum, 1.5–2 mm. latum; sepala lateralia recurvata, oblique lanceolato-ligulata, apice obtusa, 6–8.5 mm. longa, 1.25–1.75 mm. lata; omnia sepala trinervia. *Petala* deltoideo-lanceolata, dimidio superiore valde angustata, apice sub-acuta, 4.75–7.25 mm. longa, prope basin 1.5–2.5 mm. lata, inferne trinervia; omnia tepala saccis crystalliferis minutis numerosis instructa, dimidio basali tenuiora et pallidiora. *Labellum* basi valde ampliatum ita ut videtur obscure trilobatum, lobis lateralibus rotundatis semiorbicularibus, in calcar sensim angustatum, dimidio apicali (lobus intermedius) valde angustatum, lineari-ligulatum, sectione V-forme, apice anguste obtusum; totum labellum 4.7–6.6 mm. longum, 2.75–3 mm. latum; calcar anguste cylindricum, leviter incurvatum, 17–21 mm. longum. *Columna* brevis, crassa, circiter 1.5 mm. alta, androclinio leviter

excavato. *Anthera* hemisphaerica, antice leviter producta; pollinia subsphaerica, stipitibus duobus ligulatis deorsum angustatis circiter 1.5 mm. longis, viscidiis duobus lineari-oblongis antice acutis 0.8–0.9 mm. longis. *Rostellum* valde deorsum productum, viscidiis amotis trifidum; lobus intermedius subspathulato-ligulatus; lobi laterales breviores, lineares, acuti; omnes lobi dense papillosi.

TANGANYIKA TERRITORY: Lake Daluti, 10 miles east of Arusha, in complete shade on underside of forest liane, June 1942, *Moreau 317* (TYPE); Uluguru Mts., west side of Lukwangule Plateau, 2400 m. alt., epiphytic in dry evergreen forest on *Xymalos monospora* Baill., Jan. 1943, *Moreau 474*.

A characteristic member of the genus differing from its allies rather in the combination of characters than in any outstanding feature. It is more closely allied to several South African species than to its Tropical African congeners.

Angraecopsis holochila *Summerhayes sp. nov.;* species distinctissima, ab aliis speciebus labello fere integro, calcari plus 2 cm. longo, pollinii viscidio communi, stipitibus longis divaricatis facile distinguenda.

Herba parva, epiphytica; caulis brevissimus, fere 0.5 cm. longus, paucifoliatus, radices flexuosas griseas glabras emittens. *Folia* saepius duo, oblongo-ligulata vel oblanceolato-ligulata, apice rotundata, leviter inaequaliter obscureque bilobata, basi angustata, 3.5–5.5 cm. longa, 3–7 mm. lata. *Inflorescentiae* dependentes vel deflexae, foliis aequilongae vel breviores, laxiuscule 3–5-florae; pedunculus gracilis, teres, 1.5–2.5 cm. longus, vaginis duobus vel tribus, acutis, 3–3.5 mm. longis instructus; bracteae ochreatae, ovatae, acutae, 2–3 mm. longae, 5–10 mm. distantes. *Flores* patentes, sordide flavi; pedicellus (cum ovario) gracilis, 5–8 mm. longus. *Sepalum* intermedium ellipticum, apice rotundatum vel leviter retusum, 3.25 mm. longum, 1.75 mm. latum; sepala lateralia par-

ellela, incurvatim oblanceolato-subspathulata, apice rotundata, 4.5 mm. longa, superne 1.5–1.75 mm. lata. *Petala* basi cum sepalis lateralibus breviter connata, oblique ovata, subacuta, margine antico inferne dilatata, 3 mm. longa, vix 2 mm. lata; omnia tepala trinervia. *Labellum* subquadrato-ovatum, obscurissime trilobatum, 3 mm. longum, 1.75 mm. latum; calcar incurvatim dependens, ex ore lato filiformi-cylindricum, apice leviter angustatum, 1.75–2.25 cm. longum, 0.3 mm. diametro. *Columna* incurvata, crassiuscula, 0.7 mm. longa. *Anthera* subhemisphaerica, antice vix producta; pollinia subsphaerica, 0.45 mm. diametro, stipitibus duobus divaricatis corniformibus 0.7 mm. longis, viscidio suborbiculari convexo antico breviter fisso. *Rostellum* breviter productum, latum, obtusum, viscidio amoto bifidum.

UGANDA: Karamoja, Napak, 2250 m. alt., in ravine forest, occasional, May 1940, *Thomas 3646*.

This interesting little species possesses the dwarf habit, small leaves and delicate inflorescence characteristic of many species of *Angraecopsis*. The somewhat spathulate lateral sepals curve forward parallel to one another on each side of the lip and for a short distance at the base are united to the anticous margin of the petals, both of which features are found in several other species of the genus. The lip, however, is outstanding in being practically entire with only the suspicion of a small rounded lateral lobe on each side about half way between the base and apex. The pollinia have a broad common viscidium, from the sides of which the two stipites diverge in a manner recalling the horns on a cow's head. This structure of the pollinarium is quite distinct from that in *A. parviflora* (Thou.) Schltr. on the one hand and from that of *A. breviloba* Summerh. and its allies on the other.

On the whole, however, the species seems best placed in *Angraecopsis* in spite of the distinctive characters mentioned.

Sci

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PLANTAE AUSTRO-AMERICANAE III*

BY

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DE PLANTIS PRINCIPALITER COLOMBIAE ORIENTALIS OBSERVATIONES

A NUMBER OF recently made collections, chiefly from eastern Colombia, represent hitherto undescribed concepts or range extensions. It appears advisable to present the following notes on the significance of these collections as a contribution to our rapidly growing understanding of the flora of the northwesternmost reaches of the Amazonian system.

It is with pleasure that I acknowledge the interest of Dr. Lyman B. Smith of the Gray Herbarium in identifying the bromeliads which are enumerated and of Dr. Leon Croizat of the Arnold Arboretum for his determinations of the species of *Mediocactus* and *Sapium* which are discussed.

The photographs were taken by the writer.

BALANOPHORACEAE

Helosis guyannensis *L. C. Richard* in Mém. Mus. Hist. Nat. Paris 8 (1822) 416, t. 20.

This curious, red, fungus-like saprophyte, of rather wide occurrence in the Amazon Valley, has apparently

* Plantae Austro-Americanae I and II were published in Caldasia 6 (1943) 11–26 and 9 (1944) 325–336 respectively.

not been reported hitherto from eastern Colombia. In the *trapecio amazonico* of Colombia, it is known by the Brazilian name *flor da terra*, and a strong decoction of the entire plant is highly esteemed in the treatment of dysenteric disturbances and diarrhea.

COLOMBIA: Amazonas, Loretoyacu River, Lake Pichuna, small, scarlet root-parasite growing in clumps in wet soil in forests, November 1944, *R. E. Schultes 6196*.

BOMBACACEAE

Septotheca Tessmannii *Ulbrich* in Notizbl. Bot. Gart. Berlin 9 (1924) 129, t. 3.

I have noticed individuals of this gigantic tree on some of the sandy islands of the Amazon River in the Colombian *trapecio amazonico*, but no fertile specimens were available. The collection cited below, from the Brazilian island of Aramaça near Tabatinga, only a few kilometers from the Colombo-Brazilian boundary, is a close match for the type which came from a not-too-distant locality on the Río Ucayali in Loreto, Peru. This species has apparently not been reported hitherto from Colombia or Brazil.

BRAZIL: Amazonas, Ilha Aramaça, near Tabatinga. Enormous tree, 90 ft. tall, with buttress roots, flowers greenish yellow. *Zapoterana*. October 1944, *R. E. Schultes 6150*.

BROMELIACEAE

Aechmea Mertensii (*Meyer*) *Schultes filius* in Roemer & Schultes Syst. 7 (1830) 1272.

This very widespread Amazonian species is rather abundant in the Vaupés.

COLOMBIA: Vaupés, Alto Río Vaupés, vecindades de Miraflores, más o menos 300 m. de altura. Parásita con flores de color rojo; frutos blancos con el apice rojo, Enero 4, 1944, *G. Gutierrez 515*.

Navia acaulis *Martius ex Schultes filius* in Roemer & Schultes Syst. 7 (1830) 1196.

For more than a century, *Navia acaulis* was known only from the type collection made by Martius in Araracuara on the Río Caquetá. Recently, several additional collections have been made in eastern Colombia which extend the known range of this interesting species. In Caldasia 5 (1942) 8, Dr. L. B. Smith reported the second collection which was made by Cuatrecasas on the granitic ridges at San José del Guaviare (*Cuatrecasas 7707*). This represents a considerable range extension northward. Later, *Navia acaulis* was discovered and collected on several of the sandstone mountains of the Upper Apaporis Basin; these collections are cited below. It is an interesting ecological note that Cuatrecasas found *Navia acaulis* growing on granitic terrain at San José (where sandstone also occurs), whereas at both the type locality at Araracuara and on the Apaporis mountains, the plant is endemic on quarzite ridges.

COLOMBIA: Vaupés, Upper Apaporis Basin, Ajaju River, Mount Campana, sandstone shelf at base of mountain, alt. 900–1500 feet above sea-level, June 1–6, 1943, *R. E. Schultes 5570.* Caquetá, upper Apaporis Basin, Apaporis River, Mount Castillo (10 km. below Ajaju-Macaya confluence), sandstone, xerophytic conditions, shady crevasses and faults, alt. 350–1000 ft. above forest floor, July 27, 1943, *R. E. Schultes 5656.*

Navia bicolor *L. B. Smith sp. nov.*

Subacaulis, solitaria vel 6–7 aggregatae; foliis multis, dense rosulatis, 9–14 cm. longis, vaginis quam laminis paulo latioribus, omnino occultatis; laminis lineari-oblongis, acutis vel acuminatis, 15–19 mm. latis, supra glabris viridibusque, in sicco nervatis, subtus dense adpresseque albo-lanatis, margine densissime minuteque serrulatis sed prope apicem integris; scapo ad 3 cm. longo, glabro; inflorescentia dense capituliformi sed spicis apices versus distinctis, bracteis exterioribus paulo floccosis exceptis glabra, ad 35 mm. diametro; bracteis florigeris late

ovatis acuminatis, sepala subaequantibus, integris, pungentibus; floribus subsessilibus; sepalis oblongis, acutis, 5.5 mm. longis; petalis albis, laminis lanceolatis, 3 mm. longis, apice valde inflexis.

Dr. Smith writes: "*Navia bicolor* derives its specific name from the sharp contrast between the green glabrous upper side of the leaf and the white felt-like covering of the under side. This and the relatively great width of the leaf quickly distinguish it from all other known species of *Navia*."

COLOMBIA: Vaupés, Cerro de Chiribiquete, a un lado del Río Macaya. "Hierba de flores amarillas y brácteas blancas." Enero 17, 1944, *G. Gutierrez 653* (TYPE in Gray Herb.); upper Apaporis Basin, Macaya River, Mount Chiribiquete, sandstone, xerophytic conditions, savanna, alt. 1300–2100 ft. (390–630 m.), May 15–16, 1943, *R. E. Schultes 5444* (COTYPE in Gray Herb.).

Navia graminifolia *L. B. Smith sp. nov.*

Caulibus ramosis, densissime foliatis; foliis persistentibus; vaginis parvis, ovatis; laminis linearibus, acuminatis, ca. 10 cm. longis, infra 3 mm. latis, nervatis, mox omnino glabris, margine subdense minuteque serrulatis; scapo gracili, ad 15 mm. longo, glabro; inflorescentia dense capituliformi, 15–18 mm. diametro, glabra; bracteis florigeris late ovato acuminatis, quam sepalis multo brevioribus; floribus subsessilibus; sepalis oblongis, acutis, 5 mm. longis; petalis flavis, laminis lanceolatis, 3 mm. longis, apice valde inflexis.

Dr. Smith writes: "*Navia graminifolia* appears to be closely related to *N. Schultesiana*, but its longer and much more persistent leaves make the branches practically indistinguishable and give the plant an entirely different habit."

COLOMBIA: Vaupés, upper Apaporis Basin, Macaya River, Mount Chiribiquete, sandstone, xerophytic conditions, savanna, alt. 1300–2100 ft. (390–630 m.), May 15-16, 1943, *R. E. Schultes 5492* (TYPE in Gray Herb.).

Navia Schultesiana *L. B. Smith* in Caldasia 12 (1944) 131.

Diagrammatic drawings of critical parts of the leaf, flowers and inflorescence were published with the recent description of this concept. In view of the appreciable contribution which the Apaporis collections have made to our knowledge of this very small genus, it seems advisable to publish the accompanying habit photograph of a complete colony of *Navia Schultesiana*.

Pitcairnia patentiflora *L. B. Smith* in Contrib. Gray Herb. 127 (1939) 18, t. 1, fig. 4.

A xerophytic species of sandstone exposures, *Pitcairnia patentiflora* is known only from the type locality, Mount Duida in Venezuela, and from Mount Chiribiquete.

COLOMBIA: Vaupés, Cerro Chiribiquete, a un lado del Río Macaya. Hierba de hojas acaules y frutos rojos, Enero 17, 1944, *G. Gutierrez 672*.

Vriesia chrysostachys *E. Morren* in Belg. Hortic. 31 (1881) 87.

This species of *Vriesia* occurs in extraordinary abundance in rocky places under light forest in the creeks and brooks which drain the Cerros Pacú, Cacurí and Circasia on the Vaupés River above Mitu. It is known from Trinidad to eastern Peru where the type was collected.

COLOMBIA: Vaupés, Lower Vaupés River, Caño Pacú near Tayasú and Circasia, alt. 280 m., savannah, forming dense masses on rocks, March 6, 1944, *R. E. Schultes 5826*.

Vriesia socialis *L. B. Smith sp. nov.*

Verisimiliter acaulis, ad 5 dm. alta; foliis ignotis; scapo recto, 6 mm. diametro, glabro; scapi bracteis erectis, quam internodiis bene brevioribus, ellipticis, acutis, membranaceis, obscure punctulato-lepidotis; inflorescentia erecta, simplicissima, laxissime secundeque 6–7-

flora, 10–12 cm. longa, glabra; rhachide flexuosa; bracteis florigeris cum floribus secunde versis, ovatis, acutis, nullo modo carinatis, ad 25 mm. longis, quam internodiis paulo longioribus, membranaceis; floribus subpatentibus; pedicellis robustis, 7 mm. longis; sepalis suboblongis, ad 4 cm. longis, bracteas capsulasque multo superantibus, 9 mm. latis, ecarinatis, tenuibus; petalis ignotis; capsulis crasse ellipsoideis, ad 24 mm. longis.



VRIESIA SOCIALIS. Inflorescence, one half natural size. Sepal, natural size.

Dr. Smith states: "In my treatment of the species of *Vriesia* with a simple secund-flowered inflorescence in "Lilloa" VI, 388 (1941), *Vriesia socialis* would run down to the vicinity of *V. brassicoides* and *V. Platzmannii*, both of them native of southeastern Brazil over two thousand miles distant. *Vriesia socialis* has much longer and narrower sepals and both its sepals and floral bracts are much thinner than in either Brazilian species."

COLOMBIA: Vaupés, forming dense masses with *Vriesia chrysostachys* on rocks, savanna along banks of Caño Pacú, affluent of Vaupés near Tayasú and Circasia, alt. 280 m., March 6, 1944, *R. E. Schultes 5826A* (TYPE in Gray Herb.).

Burmanniaceae

Gymnosiphon cornutus (*Benth.*) *Bentham & Hooker filius* Gen. Pl. 3 (1883) 458.

The collection cited below establishes the occurrence of *Gymnosiphon cornutus* in the Colombian Amazonas. This species is much rarer in herbaria and is apparently much more restricted in its distribution than the closely related *Gymnosiphon tenellus* (Benth.) Urban which occurs from Guatemala to Brazil.

Colombia: Amazonas, Loretoyacu River, Lake Pichuna, pale bluish white root-parasite found with *Triuris* and *Leiphaimos*, November 1944, *R. E. Schultes 6180 A.*

Cactaceae

Mediocactus megalanthus (*Schum.*) *Britton & Rose* Cactaceae 2 (1920) 212, fig. 292.

The occurrence of this beautiful epiphytic cactus within the boundaries of Colombia is established by the collection *Schultes 5811.* Croizat (Caldasia 9 (1944) 350) had previously included it in an enumeration of cacti which were to be expected in Colombia. The type was collected at Tarapoto, Peru, far from the Vaupés.

Mediocactus megalanthus is said to have the largest flowers of any of the *Cactaceae.*

Colombia: Vaupés, extensive vine-like epiphyte. Leaves triangular in cross section, ash-grey with very small spines. Joints 3–4 feet long. Flower large and showy. Petals white, sepals light brownish red and yellowish. Pedicel reddish green, fleshy with red-tipped bracts, each with a small spine in the axil. Hanging on gigantic trees. Río Vaupés, 5 kilometers above Cerro Circasia, March 4, 1944, *R. E. Schultes 5811.*

Euphorbiaceae

Hevea viridis *Huber* var. **toxicodendroides** *R. E. Schultes & E. L. Vinton* in Caldasia 11 (July, 1944) 25.

"*Hevea toxicodendroides* R. E. Schultes" ex P. H. Allen in Mo. Bot. Gard. Bull. 32 (February, 1944) 50; *nomen nudum*.

It is unfortunate that the nomen "*Hevea toxicodendroides*" was published inadvertently in a letter which Mr. Allen wrote from the field and which appeared in print before the description of the new variety.

Sapium Cuatrecasasii *Croizat* in Journ. Arnold Arbor. 24 (1943) 172.

This concept was described from material collected in the Valle de Sibundoy in the Alto Putumayo not remote from the locality of *Schultes 5145* which is the second collection which has been made. The close relationship of the flora of the Sibundoy Mountains and the so-called Villalobos Range southwest of Pitalito in Huila is obvious from numerous collections of species which are known only from these two areas. Among these, we may cite *Ficus sibundoya* Dugand and *Saurauia putumayonis* R. E. Schultes & H. Garcia-Barriga, both of which were described from material from the Sibundoy area and later turned up in the region of the Villalobos.

COLOMBIA: Huila, area of Rio Villalobos, southwest of Pitalito, 1500–2000 m. alt. "Cauchillo blanco." Latex thin, yellow, does not easily coagulate. Bark grey-red, smooth. Tree 80 ft. high, diam. 1.5 ft. Jan. 3–13, 1943, *R. E. Schultes 5145*.

FLACOURTIACEAE

Mayna integrifolia (*Kuhlm.*) *R. E. Schultes comb. nov.*

Carpotroche integrifolia Kuhlmann in Mem. Inst. Oswaldo Cruz 21 (1928) 396, t. 68.

In 1912, Dr. Adolpho Ducke collected the type of *Mayna integrifolia*, an exceedingly interesting and very distinct species, "in silvis non inundatis prope Puerto Cordoba, Río Caquetá, Colombia, juxta fines Brasiliens."

This region is very poorly known and is rich in endemic or restricted species, as is indicated by the classic collections of Von Martius from La Pedrera.

Mayna integrifolia has since been collected by Dr. Ducke on the Upper Amazon River (Solimões) at São Paulo Olivença, near the Colombian border. I have examined three excellent collections (*Ducke 387, 405, 24013*) which are unquestionably referable to this concept.

Mayna longifolia *Poeppig* var. **phasmatocarpa** *R. E. Schultes var. nov.*

Arbuscula vel arbor parva, usque ad 6 m. sed saepissime circa 3.5 m. alta, in parte superiore parce ramificata foliosaque. Truncus erectus, usque ad 6 cm. (saepius 3–4 cm.) in diametro, nigro vel atrogriseo-fulvo cum cortice terete protectus. Rami, ramuli, petiolique striati, fulvo-rubescentes, aliquid scabro-scariosi vel minute squamiferi; ramuli juveniles obscure et primo pulverulento-puberuli. Folia alterna, simplicia, ampla, firmissime chartacea, pallide viridia, subconcoloria. Petioli 6–8 cm. longi, robusti, obscure puberuli. Stipulae 5 mm. longae, deciduae. Foliorum laminae obovato-lanceolatae, margine integrae, apice breviter acuminatae, basi attenuato-cuneatae, nervis secundariis viginti ad viginti-quinque marginem versus potius arcuatis, pertiis reticulatis; supra glabrae, nitidae, nervis satis prominentibus, pilis minutis et deciduis prope nervos; infra pallidiores, epidermide et nervis satis dense sed minutissime et molliter pilosiusculis, nervo medio robusto, valde elevato; 40–50 cm. longae, 11–14 cm. latae in statu adulto. Monoecia. Flores in fasciculis brevibus caulinaribus congesti, inflorescentiis paucifloris. Alabastra globosa, 5–6 mm. in diametro, minute et dense pulverulento-tomentulosa. Bracteae minutae, subsquamiformes. Flores staminiferi albi, 1.5

(rarenter 1.3)- 1.8 cm. in diametro, brevissime pedicellati; pedicelli usque ad 5 mm. longi, pulverulenti. Sepala tria, saepissime aliquid inaequalia; majus rotundato-ovatum vel late ovato-ellipticum, 6 mm. longum, 5 mm. latum, apice subacutum, extus dense pubescens, intus glabrum, carnoso-subcoriaceum; minora elliptica, apice obtusa, 7–8 mm. longa, 4 mm. lata, extus praeter prope marginem pubescentia, intus glabra. Stamina circa triginta quinque usque ad quinquaginta, petalis multo breviora, libera, erecta, antheris sessilibus vel subsessilibus, lineari-ellipticis, utrinque obtusis, apice poricidis, densissime pilosis vel hirsutis, 4 mm. longis. Petala septem, subaequalia, alba, membranacea, extus pulverulenta, intus glabra, elongato-elliptica, apice obtusa, margine subsinuosa, 6–7 mm. longa, 3–4 mm. lata. Capsulae ovoideae vel aspectu subsphaericae, basi obscure acuminatae vel saepe rotundatae (numquam umbilicatae), apice obscure et breviter acuminatae sed aspectu praeter costas alasque obtuse rotundatae, sepalis persistentibus, 4–5 cm. longae, 3.5–4 cm. in diametro maturitate, longe pedunculatae (pedunculi robusti, pulverulenti, usque ad 2 cm. longi), extus omnino albae luridae, subdense sed minute et propter colorem inconspicue puberulentae, saepius novemcostatae, costis longitudinalibus suturalibus et dorsalibus prominentissimis cum alis membranaceis irregulariter et profunde lacerato-fimbriatis, usque ad 8 vel 12 mm. altis. Semina aequalia, obovato-rhombica, plus minusve quinquaginta, 10 mm. $\times$6 mm. $\times$5 mm., in sicco straminea, extus valde carnosa tamquam pulpa arillata involuta, cum pulpa atrocrocea vel forte miniana, acidula vel demum in maturitate dulcia, cum testa tenuiter papyracea crustaceaque, puberulenta et grossiuscule ruguloso-granulosa, raphe elongata fulva in pulpa recepta. Crescit in silvis umbrosis humidisque in terra fertili qua quotannis diluviem profundam sustinet. In provincia Vaupesensi

ab agrestibus "cacaoito" et "cacao blanco," ab indigenis tribubus Karijonorum "ha-pe′-ta-ke" appelatur.

Mayna longifolia var. *phasmatocarpa* differs from *M. longifolia* in the length of the petioles, the size and shape of the leaves, their margin (entire, instead of sinuate), the pilosity (pubescent only on the under side, instead of usually on both sides), the size and alation of the capsules, and in several floral characters, especially in the sepals and petals. This new variety, known only from the Upper Vaupés River where it is abundant, is apparently the northwesternmost representative of the widespread Amazonian *Mayna longifolia*. To the best of my knowledge, *Mayna longifolia* has not been collected in eastern Colombia, but the extensive range of this species and its apparent abundance in adjacent Peruvian and Brazilian localities (in Loreto and at Tabatinga respectively) would seem to indicate that it may yet be discovered in Colombia.

The varietal epithet *phasmatocarpa* has reference to the ghastly white color of the fruit. I collected fruits which were ripe almost to the point of opening, and they showed no sign of darkening into a brown or a green as has been reported for some species. Furthermore, natives of the region state that the fruit is always white. The resemblance of the plant, especially the fruit, to *Herrania* (a member of the *Sterculiaceae*) is interestingly borne out by the common names *cacaoito* and *cacao blanco* which the settlers in the Vaupes apply to *Mayna longifolia* var. *phasmatocarpa*. We may note also that in Brazil, *Mayna longifolia* is known as *cacau branco* and in Loreto, Peru, as *cacahuito*.

The brilliant orange-vermillion pulp surrounding the seeds of this plant is usually somewhat acidulous, but, according to natives, it is sweet when the fruit is completely ripe. The Karijona Indians, who call the species

ha-pe'-ta-ke, when on hunting trips, often place a few of these seeds in the mouth for the sweet taste. There is apparently no other use made of the plant in the Vaupés.

COLOMBIA: Vaupés, Vaupés River, near confluence of Unilla and Itilla Rivers, at "Las Bocas," alt. c. 200 m., in forest. Treelet 12 ft. tall. Bark grey and brown mottled or black, thin. Basal diameter 1½–2 inches. Fruit cauline, pure white, 9-ribbed with two fringes deeply fimbriated on each rib. Inflorescence in fascicles. Stems have strong odor of cyanide. Leaves firmly papyraceous. Seeds with vermillion aril. Flowers cream-white. January 13, 1944, *R. E. Schultes 5728* (TYPE in Econ. Herb. Oakes Ames); Vaupés River, Puerto Naré. Small treelet 18 ft. tall. Basal diameter 3 inches. Bark smooth, brown. Fruits pure snow-white. Seeds numerous, brownish yellow with brilliant orange aril. "Cacao blanco," cacaoito." Karijona: "ha-pe'-take," April 10, 1943, *R. E. Schultes 5378*. Ibid. Flowers white. Treelet 11–15 ft. tall. Basal diameter 3 inches. April 10, 1943, *R. E. Schultes 5366;* Vaupés River, near Miraflores, February, 1944, *G. Gutierrez V. 797*.

LORANTHACEAE

Phthirusa magdalenae (*Cham. & Schlecht.*) Eichler ex Martius Fl. Brasil. 5, pt. 2 (1866–68) 55.

This parasite is very commonly found attacking *Hevea* trees in the Upper Apaporis Basin.

COLOMBIA: Vaupés, Upper Apaporis Basin, confluence of Ajaju and Macaya (Puerto Hevea), forest, alt. ca. 900 ft., July 23, 1944, *R.E. Schultes 5641*.

MORACEAE

Castilla Ulei *Warb.* forma **lecithogalacta** *R. E. Schultes forma nov.*

A *Castilla Ulei* foliis amplioribus, subtus densus molliter ferrugineo-tomentosis, margine integris sine setis denticulatis, fructibus multo majoribus (diametro paene ×2 ad 2½), fructuum bracteis apice longissime (4 mm.) acuminatis, cortice fere albo, vulgo tenuiore, latice luride flavo-luteo differt.

In reality, little is known about the genus *Castilla* in the Amazon for there is relatively little good material in our herbaria. Under *Castilla Ulei*, moreover, one can find material which would appear to represent several species.

Even less is known of the subspecific variations of *Castilla Ulei*. This is due chiefly to the lack of extensive and systematic field studies devoted primarily to this tree. Furthermore, the general collector is handicapped in making comparative studies and collections of *Castilla Ulei* because of the size and habit of the tree. It is my belief, after having seen a relatively large number of individuals of this species in the Vaupés and Apaporis basins of eastern Colombia, that there are many undescribed subspecific variants in *Castilla* as is the case in *Hevea*. Old *caucheros* (rubber workers) who have cut *Castilla* all their lives have distinguishing names for the different "types" of trees which produce the so-called *caucho negro* of commerce. These "types" probably would be found to represent taxonomically distinct subspecific variants, for it is my experience that the *caucheros* of eastern Colombia are rather keen in their perception of differences in plants. These subspecific variants of *Castilla Ulei* cannot be fully understood, however, until some investigator carries out field studies on thousands of individuals over a rather wide area.

The form described here, *lecithogalacta*, is one of the most common and widely recognized of the "types" of *caucho negro* in the Upper Vaupés River. The very appropriate name *yema de huevo* ("egg-yolk") refers to the bright yellow color of the latex. As the latex, which is extremely thick, flows out of the cuts, it is a deep cream; on contact with the air, however, it almost immediately deepens in color and very shortly becomes a yellow so brilliant that one finds it difficult to realize that one is

actually dealing with *Castilla Ulei*. The latex of this species is usually a pure white or, at the most, a light cream. That the color of the latex, in the concept which I have just described, is not due to soil or other site-factors is borne out by the facts that (1) there are numerous morphological characters which likewise differentiate forma *lecithogalacta* from typical *Castilla Ulei;* and (2) I encountered this form in several rather widely separated localities, in each locality growing in association with individuals of *Castilla Ulei* which yielded the usual white latex.

The epithet which I have applied to the new form refers to the unusual color of the latex and is a rendition into Greek of the common name *yema de huevo*.

COLOMBIA: Vaupés, Río Vaupés near Puerto Naré, alt. 900 ft. Tree 100 ft. tall, 2 ft. in diameter. Latex brilliantly yellow. Bark light ashy grey or almost white, smooth. Common name: *yema de huevo*. February 18, 1944, *R. E. Schultes 5798* (TYPE in Econ. Herb. Oakes Ames).

TRIURIDACEAE

Triuris hyalina *Miers* in Proc. Linn. Soc. London 1 (1841) 96.

Schultes 6180 represents the first collection of a member of this rare family from Colombia and, apparently from the entire northwestern sector of South America.

COLOMBIA: Amazonas, Río Loretoyacu, Laguna Pichuna. Very small, white root-parasite. November, 1944, *R. E. Schultes 6180*.

VELLOZIACEAE

Vellozia phantasmagoria *R. E. Schultes sp. nov.*

Frutex usque ad quattuor pedes altus. Caudex fibroso-lignosus, erectus, basi usque ad 3 cm. in diametro, indivisus vel saepius bi- vel trifurcatus, foliorum vaginis cinereo-stramineis persistentibus arcte adpressis, spiraliter

imbricatim dispositis obtectus, in parte superiore distincte lineatis. Folia in apice ramorum subrosulate conferta, non numerosa, rigide erecta sed exteriora etiam juniora saepe aliquid subpatentia, plana, valde sicca, coriacea, dense et minute albo-hirsuta, pilis in marginibus irregulariter plurichotome ramosis, linearia, margine integra, apice longissima et sensim acuminata, 250–300 mm. (plerumque 280–290 mm.) longa, 10–11 mm. lata. Flores duo usque ad quinque, pseudoterminales, grandes, speciosissimi, albi, quam foliis breviores, longissime pedunculati; pedunculo filiformi, triquetro, superne minute squamoso-echinato, inferne glabro, rubro-fulvo, usque ad 8 cm. longo. Perigonii tubus tenuis gracilisque, cylindricus, 50–55 mm. longus, 2.5 mm. in diametro, dense viscoso-glandulosus; limbus infundibuliformis, vivo 60–80 cm. in diametro, segmentis elongate lanceolato-obovatis vel paene pseudospathulatis, 50–60 mm. longis, 8–9 mm. latis, apice acutis, extus in parte inferiore glandulosis. Stamina octodecim, tepalis multo breviora; antherae elongatissime ellipsoideae, glabrae, albae, quam filimenta multo longiores, antheris lateralibus plus minusve 9 mm. longis, mediana 7 mm. longa, sed omnes subaequales. Ovarium oblongo-clavatum, apice truncatum, paleis iis pedunculi similibus sed multo robustioribus, viscoso-glandulosis, sordide luteis densissime ornatum. Stylus filiformis, 6–8 cm. longus, trigonus, inclusus, stamina superans. Stigma trilobatum. Capsula adhuc ignota. Crescit in montibus siccis areno-saxosisque in provincia colombiana Vaupesensi.

Vellozia phantasmagoria is the first representative of the genus known from northwestern South America. It is apparently not closely related to any previously described species.

The specific epithet has reference to the peculiar habit of this showy and anomalous plant. This species occurs

on some of the flat, dry sandstone expanses on the summit of Mount Chiribiquete in dense stands which, at first sight, seem fanciful and unreal to the observer because of the oddity of the shrub. A description of the unusual habitat of *Vellozia phantasmagoria* has been published in Caldasia 12 (1944) 124–130.

Vellozia phantasmagoria has its flowering period in December. When the type was collected on January 18, only a few flowers were found, although several thousand plants were seen.

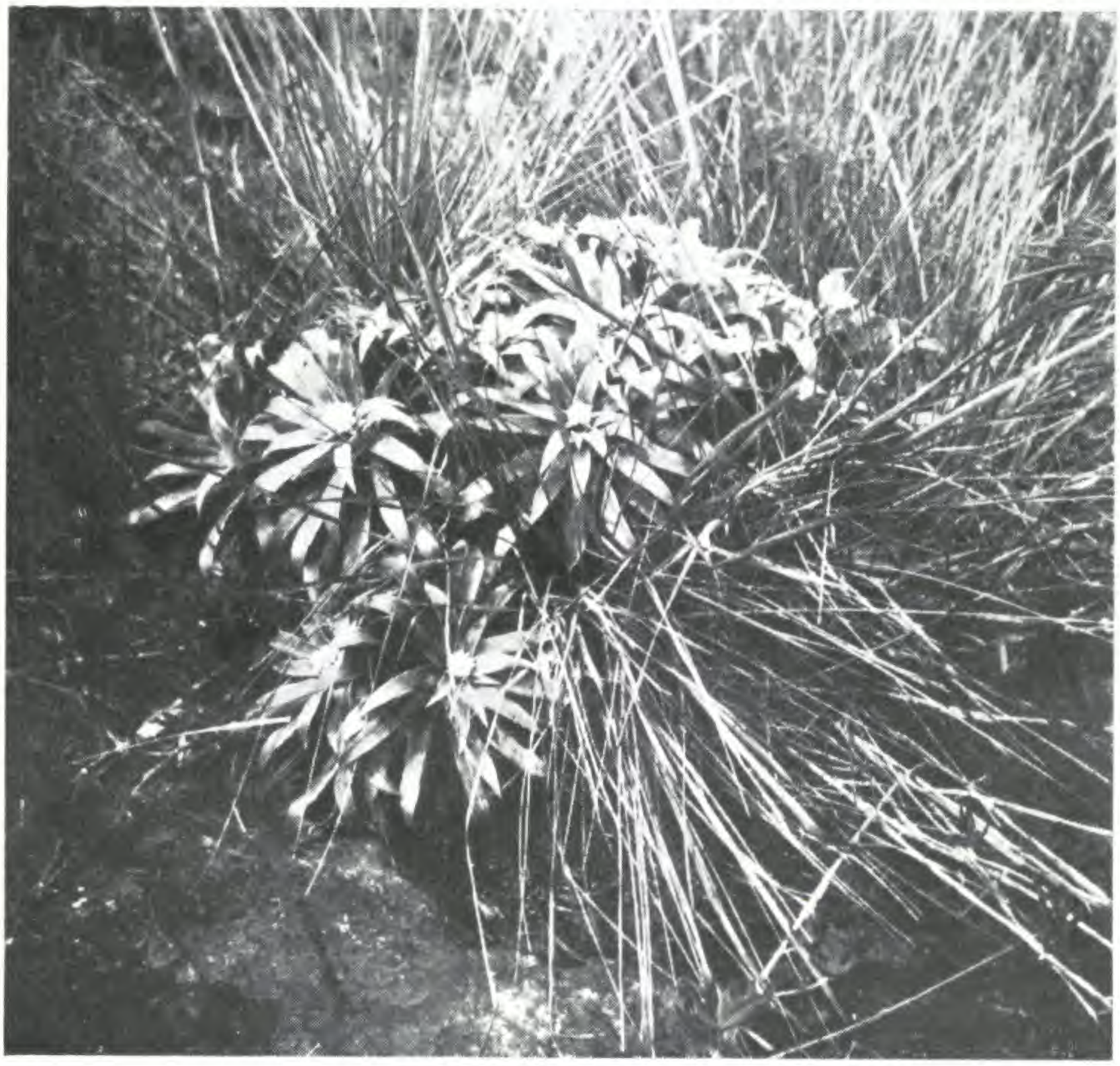
COLOMBIA: Vaupés, Upper Apaporis Basin, Macaya River, Mount Chiribiquete, sandstone, xerophytic conditions, savannah, alt. 400–1200 ft. above the forest floor or 1300–2100 ft. above sea-level, January 18, 1944, *R. E. Schultes 5741* (TYPE in Herb. Gray; DUPLICATE TYPE in Herb. Nac. Colomb.).

Plate XIII



Helosis guyannensis *L. C. Rich.* A photograph of the plant which furnished the collection *Schultes 6196*, Loretoyacu River, Amazonas, Colombia.

Plate XIV



Navia bicolor *L. B. Smith.* A photograph of the plant from which the collection *Schultes 5444* was obtained. Mount Chiribiquete, Vaupés, Colombia.

Plate XV



Navia Schultesiana *L. B. Smith*. A photograph of the colony from which the type collection was made. Mount Castillo, Caquetá, Colombia.

Plate XVI



Mediocactus megalanthus (*Schum.*) *Britt. & Rose.* A habit photograph of the plant from which the collection *Schultes 5811* was taken, Vaupés River, Vaupés, Colombia.

Plate XVII



Mayna integrifolia (*Kuhlm.*) *R. E. Schultes.* A photograph of the type.

Plate XVIII



Mayna longifolia *Poepp.* var. phasmatocarpa *R. E. Schultes.* A habit photograph showing the characteristic waxy-white fruits. *Schultes 5378*, Vaupés River, Vaupés, Colombia.

Plate XIX



Vellozia phantasmagoria *R. E. Schultes*. A habit photograph of the type material. Mount Chiribiquete, Vaupés, Colombia.

Plate XX



Vellozia phantasmagoria *R. E. Schultes.* The flower of the type specimen, Mount Chiribiquete, Vaupés, Colombia.

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ORCHIDACEAE NOVAE GUINEAE I[1]

BY

LOUIS O. WILLIAMS

THE ORCHIDS described and discussed here were collected in New Guinea either by Mr. L. J. Brass on the third Archbold Expedition in 1936–1937[2] or by Mrs. Mary Strong Clemens in 1940–1941.

The material collected by Mr. Brass is well prepared; in most cases there are duplicates which will be distributed by the Arnold Arboretum. The types of all new species described are in the Oakes Ames Orchid Herbarium, Harvard University, Cambridge, Massachusetts.

Paphiopedilum papuanum (*Ridl.*) *L.O.Williams comb. nov.*

Cypripedium papuanum Ridley in Gard. Chron. ser. 3, 58 (1915) 131, fig. 43.

Paphiopedilum papuanum is closely allied to *P. violascens* Schltr., which also comes from New Guinea.

Pterostylis caulescens *L. O. Williams sp. nov.*

Herbae graciles, terrestres, usque ad ca. 20 cm. altae. Caules flexuosi, foliosi. Folia basalia ignota. Folia caulium longe petiolata; lamina elliptica vel elliptico-lanceolata, acuta, membranacea. Inflorescentia uniflora.

[1] Botanical Results of the Archbold Expeditions.

[2] For an account of this expedition see A. L. Rand and L. J. Brass in Bull. Am. Mus. Nat. Hist. 77 (1940) 341–380, tt. 21–42.

Sepalum dorsale lanceolatum, acuminatum. Sepala lateralia lanceolata, acuminata, basi connata. Petala elliptico-lanceolata, acuta, leviter arcuata. Labellum anguste oblongo-ellipticum, basi appendice penicillata ornatum. Columna generis.

Slender terrestrial herbs up to about 20 cm. tall. Stems flexuose, foliose. Basal leaves unknown. Cauline leaves long-petiolate; lamina 5.5–7.5 cm. long, 1.4–1.8 cm. broad, elliptic or elliptic-lanceolate, acute, membranaceous, tapering to the petiole at the base; petiole 2–5 cm. long and 0.2–0.3 cm. broad, canaliculate, semiamplexicaul at the base. Flower terminal, solitary. Dorsal sepal about 3 cm. long and 1 cm. broad, lanceolate, acuminate, about 9-nerved, puberulent dorsally. Lateral sepals about 3 cm. long and 0.4–0.5 cm. broad, lanceolate, acuminate, puberulent dorsally, connate at the base for about one third of their length or less. Petals about 3 cm. long and 0.5 cm. broad, elliptic or elliptic-lanceolate, acute, somewhat arcuate, 7- to 9-nerved, puberulent dorsally. Lip about 13 mm. long and 4 mm. broad, narrowly oblong-elliptic, with a conduplicate ridge down the center, papilliferous, originating from the apex of the column-foot, with a recurved flattened appendage at the base which is about 4 mm. long and penicillate at the apex. Column of the genus, about 13 mm. long; column-foot about 4 mm. long.

British New Guinea: alpine, bush margin, Rawlinson Range, Morobe District, alt. 10,000–12,000 ft., flowers flesh pink, September 22, 1941, *Clemens s.n.* (Type in Herb. Ames No. 61211).

Pterostylis caulescens is easily distinguished from the other two known species of the genus in New Guinea by its large cauline leaves. The material from which this species is described is not very good.

Pterostylis papuana *Rolfe* in Kew Bull. (1899)

112—J.J.Smith in Nova Guinea 12, pt. 3 (1915) 185, t. 61, fig. 99.

NETHERLANDS NEW GUINEA: vicinity of Lake Habbema, *Brass 9214, 9215, 9598, 10810, 10880;* about 5 km. northeast of Wilhelmina-top, *Brass & Myer-Drees 9406.*

The six collections cited constitute an excellent series of this uncommon species, from young to mature examples.

Calochilus caeruleus *L. O. Williams sp. nov.*

Herbae terrestres, graciles, efoliosae vel subefoliosae, usque ad 7 dm. altae. Caules stricti. Folia caulium bracteiformia, acuta vel acuminata, scariosa vel subscariosa. Inflorescentia racemosa, laxa, pauciflora; bracteae ovato-lanceolatae, acuminatae. Sepalum dorsale suborbiculari-ovatum, acutum, cucullatum. Sepala lateralia ovata, acuta, leviter obliqua, basi connata. Petala oblonga, leviter arcuata, obtusa. Labellum obovato-cuneatum; discus callis digitiformibus elongatis acutis ornatus. Columna generis.

Slender, terrestrial, leafless or nearly leafless herbs up to 7 dm. tall. Stems up to 3 mm. in diameter, strict, with about three short, bract-like leaves or bracts. The cauline leaves or bracts 1–4 cm. long, sheathing, acute or acuminate, scarious or subscarious. Inflorescence a lax few-flowered raceme; bracts up to 1 cm. long, ovate-lanceolate, acuminate. Flowers smaller than usual in the genus. Dorsal sepal about 7 mm. long and about 6 mm. broad when expanded, suborbicular-ovate, acute, strongly cucullate. Lateral sepals about 7 mm. long and 4 mm. broad, ovate, acute, slightly oblique, connate for a short distance at the base. Petals about 6 mm. long and 3 mm. broad, oblong, somewhat arcuate, obtuse, minutely verrucose dorsally. Lip about 14 mm. long and 8 mm. broad near the apex, obovate-cuneate, gradually

narrowed to the base, the proximal margins fimbriated; the disc with the proximal two thirds densely adorned with elongated, acute, finger-like calli and with two inconspicuous parallel, sublamellate calli at the base, the distal third calvous or essentially so. Column of the genus, about 4 mm. long, auriculate winged at the base; anther about 2.5 mm. long.

British New Guinea: sporadic on poorly drained soils, savannah forests, Tarara, Wassi Kussa River, Western District, stems green, erect from an ovoid tuber, flowers green densely mottled and shaded with red, beard of the labellum a deep metallic blue at the base, distal two thirds maroon-red, January 1937, *Brass 8600* (Type in Herb. Ames No. 61165).

Calochilus is a small genus of some ten or twelve species which has its center of distribution in Australia. It belongs to a group that is essentially Australian. The genus is also represented in Tasmania, New Zealand and New Caledonia. The species described here extends the range of the genus to New Guinea.

Calochilus caeruleus is easily distinguished from all other species of the genus by the obovate-cuneate lip, as well as by other details of the perianth. The leafless or nearly leafless stem is unusual in the genus.

Drakaea irritabilis (*Mueller*) *Reichenbach filius* Beitrage Syst. Pflanzenk. (1871) 68; Xenia Orch. 2 (1874) 203, t. 189—Bentham Fl. Austral. 6 (1873) 368.
Arthrochilus irratabilis Mueller Fragm. 1 (1854) 43.

Papua: savannah forest, occasional on wet flats, Tarara, Wassi Kussa River, Western Division, flowers green, January 1937, *Brass 8722*.

Drakaea is a small genus of about seven species previously known only in Australia. Six of the seven species seem to be limited in their distribution to West Australia. One species, *Drakaea irritabilis*, is known from the eastern coast of Australia, in Queensland, and now from the region of the Fly River in Papua.

We have seen only Reichenbach's figure, cited above, and the various descriptions. Although our specimens differ somewhat from Reichenbach's plate and were collected some 1600 kilometers distant from previously recorded localities, they will probably be found to be identical when they are compared with authentic material in London.

Erythrodes adscendens *L. O. Williams sp. nov.*

Herbae parvae, adscendentes, terrestres, usque ad 35 cm. longae. Folia breviter petiolata; lamina lanceolata vel lanceolato-ovata, obtusa vel acuta; petiolus brevis. Sepalum dorsale late ellipticum, cucullatum, apice clavellatum, carnosum. Sepala lateralia elliptico-oblonga, obtusa, leviter obliqua, apice clavellata. Petala late elliptico-oblonga, obtusa, apice carnosa. Labellum calcaratum; lamina oblonga, obtusa, emarginata, apice carnosa, puberula, callo V-formi ornata.

Small ascending, terrestrial herbs up to 35 cm. long. Rhizome decumbent, stem-like. Stems repent or ascending, slender, leaf-bearing to the middle or beyond. Leaves short-petiolate; lamina 2–6.5 cm. long and 0.6–1.5 cm. broad, lanceolate to lanceolate-ovate, obtuse or acute; petiole short, up to 5 mm. long, from an amplexicaul, membranaceous sheath. Inflorescence a lax, few-flowered spike or raceme; the rachis pubescent above; bracts 5–10 mm. long, lanceolate, acuminate, membranaceous, usually exceeding the ovary. Dorsal sepal about 4 mm. long and 1.5–2 mm. broad, broadly elliptic, cucullate; the apex clavellate, fleshy and obtuse. Lateral sepals about 4 mm. long and 1.5–2.2 mm. broad, elliptic-oblong, obtuse, slightly oblique, the apex fleshy-thickened. Petals about 4 mm. long and 1.5 mm. broad, elliptic-oblong, obtuse, the apex fleshy-thickened. Lip spurred; the lamina 3–3.5 mm. long and 1.5–2 mm. broad, oblong, ob-

tuse, emarginate, the apex fleshy-thickened and obscurely pubescent, disc with a V-shaped callus; spur 3.5–5 mm. long and 1.5–2 mm. in diameter, straight, the tip simple, acute or obtuse, with two stipitate glands near the middle inside. Column of the genus.

British New Guinea: forming open ground cover in forest on flood plains, Fairfax Islands, Lower Fly River, flowers white, October 1936, *Brass 8193* (Type in Herb. Ames); Matap, Morobe District, alt. 5000-6000 ft., flowers white, February 6–April 6, 1940, *Clemens 11252*.

Erythrodes adscendens and *E. sutricalcar*, the species described below, are unique among the species of Erythrodes in New Guinea (if not in all of Oceania) in having a spur that is not bilobed or didymous. These species add further strength to Ames' contention (Orch. 7 (1922) 63–66) that *Physurus* (neotropic) and *Erythrodes* (paleotropic) are synonymous.

There are apparently no near allies of *Erythrodes adscendens* in the immediate area of Oceania, except *E. sutricalcar*. Superficially the species somewhat resembles *Erythrodes platensis* (Haum.) L. Wms. from South America.

It is with some hesitation that we unite the two collections cited above as one species. The Clemens specimen is the smaller of the two, with smaller leaves and shorter stems, but has slightly larger flowers. The flower parts seem to be essentially the same as those in the Brass collection. The Brass collection comes from near sea-level, while Mrs. Clemens found the plants at 5000–6000 feet altitude.

Erythrodes sutricalcar *L. O. Williams sp. nov.*

Herbae parvae, adscendentes, terrestres, usque ad 25 cm. longae. Folia petiolata; lamina elliptica vel ovato-lanceolata, acuta. Inflorescentia racemosa, conferta, pauciflora; bracteae lineares vel lineari-lanceolatae, acutae

vel acuminatae. Sepalum dorsale late lanceolatum, obtusum, cucullatum. Sepala lateralia anguste oblonga, obtusa, cucullata. Petala elliptico-oblonga, obtusa. Labellum calcaratum; lamina late oblonga vel subquadrata, obscure trilobata, emarginata; discus carnosus et callosus; calcar simplex, intus bicallosum, callo sutriforme ornatum.

Small erect or ascending, terrestrial herbs up to about 25 cm. long. Stems slender, leafy up to about the middle. Leaves petiolate; lamina 2.5–4.5 cm. long and 1–2 cm. broad, elliptic to (usually) ovate-lanceolate, acute; petiole 1–1.5 cm. long, constricted below the lamina but expanded at the base and amplexicaul or semiamplexicaul. Inflorescence a dense, few-flowered raceme; rachis and stem immediately below the inflorescence pubescent; bracts up to 8 mm. long, linear to linear-lanceolate, acute or acuminate, cucullate. Flowers green. Dorsal sepal about 4 mm. long and 2 mm. broad, broadly lanceolate, obtuse, cucullate, 1-nerved, the apex callose-thickened. Lateral sepals about 4 mm. long and 2–2.5 mm. broad, narrowly oblong, obtuse, 1-nerved, cucullate, the apex callose-thickened. Petals 3.5–4 mm. long and 1.5–2 mm. broad, elliptic-oblong, obtuse, 1-nerved, the apex callose-thickened, rapidly constricted at the base, lightly adnate to the dorsal sepal. Lip spurred; lamina about 3 mm. long and 2.5–3 mm. broad, broadly oblong or subquadrate, three-lobed with the lateral lobes small, basal and inconspicuous, the margins membranaceous and strongly involute, the apex emarginate, the disc thickened and with a longitudinal fleshy callus which is more or less divided at the base; spur about 5–6 mm. long and 2.5–3 mm. in greatest diameter, constricted at the throat, becoming broad and inflated in the middle but again constricted at the simple tip, with a suture-like callus-thickening on the posterior side and with two re-

trorse, stipitate glands on the anterior wall within. Column of the genus, 2–2.5 mm. long.

British New Guinea: abundant around small stagnant pools in flood-plain forest, Palmer River 2 miles below junction with Black River (long. ca. 141°30′ E., lat. ca. 5°55′ S.), alt. 100 meters, pale fleshy ascending herbs ca. 25 cm. high, flowers green, July 1936, *Brass 7199* (Type in Herb. Ames).

Erythrodes sutricalcar is most closely allied to *E. adscendens* L.Wms., but is easily distinguished by the differently shaped leaves, by the inflated spur, and by the details of the lip, petals and sepals.

The specific name is in allusion to the suture-like callus-thickening on the posterior wall of the spur.

Malaxis seleniglossa (*Schltr.*) ***L.O. Williams comb. nov.***

Microstylis seleniglossa Schlechter in Fedde Repert. Beihefte 1 (1911) 115; in Fedde Repert. Beihefte 21 (1923) t. 44, fig. 152.

British New Guinea: Amieng on Yaneng River, a tributary of the Buso River, above mouth of Tosapik Creek, Morobe District, elevation 5000–6000 ft., buds green, April 3, 1941, *Clemens 12095a*.

The determination was made from the description and floral analysis cited.

Dendrobium cyananthum ***L.O. Williams sp. nov.***

Herbae parvae, epiphyticae, caespitosae, usque ad 10 cm. longae. Folia lineari-filiformia, coriacea vel subteretia. Inflorescentia brevis, uni- usque ad triflora. Sepalum dorsale lanceolatum, acutum vel acuminatum, leviter cucullatum. Sepala lateralia basi mentum formantia; lamina lanceolato-triangularis, acuta vel acuminata, leviter obliqua. Petala lineari-oblanceolata, acuta vel acuminata. Labellum oblongo-oblanceolatum, acutum, prope apicem subtrilobulatum, leviter carnosum, ecallosum.

Small caespitose, epiphytic herbs up to about 10 cm.

long. Stems 1–3 cm. long and about 2–3 mm. in diameter, cylindric to subfusiform, with several nodes, branched or simple, one- to several-leaved, the leaves borne terminally and from the uppermost nodes. Leaves 3–6 cm. long and 1.2 mm. broad, linear-filiform, coriaceous or subterete. Inflorescence terminal, short, one- to three-flowered; bracts oval to suborbicular, chartaceous, subaristate, shorter than the ovary. Flowers large for the section, pale slate blue with the lip deep red. Ovary strongly three-winged. Dorsal sepal 8–10 mm. long and 3–4 mm. broad, lanceolate, acute or acuminate, five-nerved, slightly cucullate. Lateral sepals adnate to the column-foot and elongated at the base into a mentum; lamina free, 8–10 mm. long and 4–5 mm. broad, lanceolate-triangular, acute or acuminate, somewhat oblique, base forming a mentum 16–20 mm. long which is saccate-cylindric and closed for about 8–9 mm. Petals about 7–9 mm. long and 1.5–2 mm. broad, linear-oblanceolate, acute or acuminate, two- (three-) nerved. Lip (free portion) about 12 mm. long and 3.5–4 mm. broad, oblong-oblanceolate, acute, subtrilobulate toward the tip, seven-nerved, somewhat fleshy but ecallose. Column short, about 3 mm. long, but the column-foot much elongated and about 16–20 mm. or more long.

British New Guinea: Amieng, on Yaneng River, a tributary of the Buso River, above mouth of Tosapik Creek, Morobe District, elevation 5000–6000 ft., flowers pale slate blue, lip deep red, tube purplish pink, March 26, 1941, *Clemens 12089b* (Type in Herb. Ames).

Dendrobium cyananthum belongs to the subgenus Eudendrobium, section Oxyglossum of Schlechter's treatment of the "Deutsch-Neu-Guinea" species of the genus in Fedde Repert. 1 (1912) 440 et seq. It is most closely allied to *D. cyanocentrum* Schltr., but is a larger plant with flowers twice or more as large, narrower petals, larger leaves and other distinguishing details.

It is quite impossible to say from macroscopic examination just where the column-foot ends and where the sepalar tissue starts in the mentum. Likewise the lip is completely fused with the sepals below the point where the sepals are connate and the tissue is impossible to differentiate.

Dendrobium dischorense (*Schltr.*) *L.O.Williams comb. nov.*

Cadetia dischorensis Schlechter in Fedde Repert. Beihefte 1 (1912) 429.

British New Guinea: mountain bush, Matap Station, Morobe District, alt. 4000–6000 ft., March 1, 1940, *Clemens 11216* (in Herb. Univ. Michigan; fragment in Herb. Ames).

There are three isotypes of this species in the Ames Herbarium.

Dendrobium fantasticum *L.O.Williams sp. nov.*

Herbae epiphyticae, graciles, usque ad 40 cm. altae. Folia elliptica vel late lanceolata, acuta vel acuminata, coriacea, breviter petiolata, erecta vel suberecta. Inflorescentia foliis subaequalis, tri- usque ad decem-flora. Sepalum dorsale oblongo-ellipticum, obtusum, prope apicem constrictum. Sepala lateralia ovato-lanceolata, basi mentum subsaccatum formantia. Petala linearia vel linearispathulata, obtusa vel truncata, falcata. Labellum breviter unguiculatum; unguis compressus, carnosus, arcuatus; lamina trilobulata, lobus medius emarginatus. Columna sectionis.

Slender, epiphytic herbs up to 40 cm. tall. Stems cylindric or slightly swollen at the apex, indurated, sulcate when dry, with several joints, up to 5 mm. in diameter, bifoliate at the apex. Leaves 8–12 cm. long and 2–2.8 cm. broad, elliptic to broadly lanceolate, acute or acuminate, coriaceous, short-petiolate, erect or suberect.

Inflorescences one or more from the axils of the leaves or from the nodes of the stem, about as long as the leaves, 3- to 10-flowered, peduncle slender, with one or more semiamplexicaul bracts below; bracts of the inflorescence 3–5 mm. long, ovate-lanceolate, acute, cucullate. Flowers dull purple with greenish white and yellow markings. Dorsal sepal 10–12 mm. long and 5–6 mm. broad, oblong-elliptic, obtuse, constricted near the apex, 5-nerved. Lateral sepals about 8 mm. long and 6–8 mm. broad, 5-nerved, ovate-lanceolate, prolonged at the base and with the column-foot forming a subsaccate mentum; the mentum laterally compressed, about 5 mm. deep and 6–7 mm. across the mouth. Petals 10–12 mm. long and 2 mm. broad, linear to linear-spatulate, obtuse or truncate, the apex sometimes obscurely lobulate, falcate, 2- to 3-nerved. Lip short-unguiculate; claw about 4–5 mm. long, laterally compressed and fleshy, about 2 mm. thick, arcuate, with two longitudinal calli which become three in front; lamina 14–18 mm. broad and about 10 mm. long, 3-lobed, subcochleate, with a single subumbonate or 3-ridged callus at the base; lateral lobes spreading, about 3 mm. broad, obtuse; mid-lobe emarginate almost to its base, about 4 mm. long with each segment about 1.5 mm. broad, acute. Column of the section, 3.5–4.5 mm. long.

NETHERLANDS NEW GUINEA: common low epiphyte on ridges, rain forest, 6 km. southwest of Bernhard Camp, Idenberg River, flowers a pale brownish purple, alt. 1200 m., February 1939, *Brass 12844* (TYPE in Herb. Ames).

BRITISH NEW GUINEA: Amieng, on Yaneng River, a tributary of the Buso River, above mouth of Tosapik Creek, Morobe District, flowers dull purple with greenish white and purple markings, alt. 5000–6000 ft., May 22, 1941, *Clemens 12213*.

Dendrobium fantasticum belongs to the subgenus Athecebium, section Latourea of Schlechter's treatment of the orchids of "Deutsch-Neu-Guinea" in Fedde Re-

pert. Beihefte 1 (1912) 440 et seq. Specifically it is most closely allied to *Dendrobium aberrans* Schltr., from which it is easily distinguished by the larger leaves, longer stems which are not much swollen, by the entire, obtuse or truncate petals, by the lamina of the lip which has quite different calli, as well as by the general shape of the mentum and by other details of the flower.

Dendrobium palustre *L. O. Williams sp. nov.*

Herbae epiphyticae, parvae, erectae vel adscendentes. Folia petiolata; lamina elliptica, acuta vel obtusa, coriacea; petiolus canaliculatus. Inflorescentia racemosa, brevis, tri- usque ad quinqueflora. Sepalum dorsale ovato-lanceolatum, acuminatum. Sepala lateralia mentum formantia; lamina ovato-lanceolata, acuminata. Petala subrhombico-oblanceolata, acuta vel acuminata. Labellum oblongo-oblanceolatum, apice trilobulatum, acuminatum, basi sepalis lateralibus adnatum. Columna sectionis.

Small caespitose, epiphytic, erect or ascending herbs up to about 20 cm. long. Pseudobulbs up to 8 cm. long and 0.5 cm. in diameter, unifoliate. Leaves 11–13 cm. long and 1.3–2.3 cm. broad, petiolate; lamina 7–10 cm. long, elliptic, acute or obtuse, coriaceous; petiole up to 5 cm. long, canaliculate. Inflorescence a short 3- to 5-flowered raceme borne in the axil of the leaf or at a node. Flowers large for the section, green with purple lines, the lip white. Dorsal sepal 9–11 mm. long and about 4 mm. broad, ovate-lanceolate, acuminate, 5-nerved. Lateral sepals elongated at the base and forming a mentum with the column-foot; lamina 9–11 mm. long and 4–5 mm. broad, ovate-lanceolate, acuminate, 5-nerved; bases 15–18 mm. long, adnate to the column-foot and forming a mentum which is spur-like for 8–10 mm. at the tip. Petals 7–9 mm. long and 3–3.5 mm. broad, obliquely

subrhombic-oblanceolate, acute to acuminate, 3-nerved, very obscurely denticulate toward the apex. Lip (free portion) 13–15 mm. long and about 5 mm. broad near the apex, oblong-oblanceolate, trilobulate at the apex, acuminate, adnate to the lateral sepals at the base, ecallose. Column of the section.

British New Guinea: in tufted clumps, boggy margin of Conifer Pond in mosses near the ground, Amieng on Yaneng River, a tributary of the Buso River, above mouth of Tosapik Creek, Morobe District, flowers green with purple lines, lip white, alt. 5000–6000 ft., March 25, 1941, *Clemens 12056c* (Type in Herb. Univ. Michigan; fragment in Herb. Ames).

Dendrobium palustre belongs to the subgenus Eudendrobium, section Oxyglossum and is most closely allied to *D. petiolatum* Schltr. and to *D. undatialatum* Schltr. It is easily distinguished from both of these species in being a larger plant with larger flowers and in having several differences in floral detail.

Calanthe fissa *L. O. Williams sp. nov.*

Herbae graciles, erectae, usque ad ca. 6 dm. altae. Inflorescentia multiflora, conferta. Sepala late oblanceolata vel elliptica, acuta, cucullata. Petala oblanceolata, obtusa, basi columnae adnata. Labellum trilobatum, calcaratum; lobi laterales explanati, lineares, obtusi; lobus medius linearis, emarginatus. Columna generis.

Slender, erect, terrestrial herbs up to about 6 dm. tall. Stems short, indurated. Leaves narrowed to a petiole at the base; lamina 25–40 cm. long and 2.5–4 cm. broad, linear-elliptic, acute or acuminate, with seven to nine main nerves; petiole 20–35 cm. long, indurated. Inflorescence up to about 8 dm. long, scapose, slender, many-flowered above, glabrous; bracts 1–2 cm. long, linear to linear-lanceolate, acute; raceme compact, 10–20 cm. long, up to fifty-flowered. Sepals about 10–12 mm. long

and 5–6 mm. broad, broadly oblanceolate to elliptic, acute, 5-nerved, cucullate. Petals 10–12 mm. long and 3–4 mm. broad, oblanceolate, obtuse, 3-nerved, adnate to the column at the base for about 4 mm. by their anterior margins. Labellum digitately 3-lobed, spurred; lateral lobes somewhat explanate, 8–10 mm. long and 2–3 mm. broad, linear, obtuse; mid-lobe about 10 mm. long and 2.5 mm. broad, linear, emarginate to about the middle, the lobules parallel and acute; disc at the tip of the column with several small calli in three lines; spur 8–10 mm. long, slender, obtuse. Column of the genus.

British New Guinea: Amieng on the Yaneng River, a tributary of the Buso River, above mouth of Tosapik Creek, Morobe District, at 5000–6000 ft. alt., flowers pale green, lip white, April 3, 1941, *Clemens 12093* (Type in Herb. Ames).

Calanthe fissa is allied to *C. finisterrae* Schltr. from which it is distinguished by the lobing of the lip and its proportions, and by the much narrower and more deeply divided mid-lobe.

Pedilochilus Clemensiae *L. O. Williams sp. nov.*

Herbae parvae, epiphyticae. Pseudobulbi fusiformes vel anguste ovoidei, unifoliati. Folia lineari-elliptica, acuta, coriacea, petiolata. Inflorescentia lateralis, uniflora, folia excedens. Sepalum dorsale ellipticum vel oblanceolatum, acutum, trinervium. Sepala lateralia oblongo-obovata, leviter obliqua, apiculata. Petala oblongo-subsigmoidea, apiculata. Labellum unguiculatum, cymbiforme et apice saccatum. Columna generis.

Small epiphytic herbs from a repent rhizome. Pseudobulbs 1–2 cm. long and 2–4 mm. in diameter, aggregated, fusiform to narrowly ovoid, unifoliate. Leaves (only two seen) 5–5.5 cm. long including the petiole and about 6 mm. broad, linear-elliptic, acute, coriaceous, petiolate, the petiole about 1 cm. long. Inflorescence about

7–9 cm. long, one-flowered, exceeding the leaf, lateral, with two small apiculate bracts about 4 mm. long on the rachis. Flowers large for the genus. Dorsal sepal 10–11 mm. long and 4 mm. broad, elliptic or oblanceolate, acute, with three main nerves, margins minutely undulate. Lateral sepals about 14 mm. long and 6 mm. broad, oblong-ovate, slightly oblique, apiculate, 3- to 5-nerved, decurrent on the column-foot. Petals 5–6 mm. long and about 2.5 mm. broad, oblong-subsigmoid, apiculate, 1-nerved, strongly winged dorsally along the nerve. Lip about 10 mm. long and 5 mm. deep, unguiculate, cymbiform and saccate especially toward the apex, apex with a short recurved apicule, base of the sac with two lamellate calli 3–4 mm. long, with two small erect lanceolate auricles about 1.5 mm. long and a small lamellate callus about 1 mm. long at the apex of the small claw (or at the base of the lip). Column about 1 mm. long, with two terminal, erect, subulate stelidia; column-foot about 2 mm. long; anther about 1.25 mm. long, apparently erect; pollinia two deeply sulcate ellipsoid masses.

BRITISH NEW GUINEA: base of mossy trunk, conifer bush by pond, at 5000–6000 ft. alt., Amieng, Morobe, flowers golden with wine labellum, March 13, 1941, *Clemens 12008* (TYPE in Herb. Ames No. 60625).

Pedilochilus Clemensiae seems to be most closely allied to *P. terrestre* J. J. Sm., described from Netherlands New Guinea. *Pedilochilus Clemensiae* is distinguished by the longer leaves, shorter peduncle, eciliate dorsal sepal and by the shape of the floral parts.

Pedilochilus is a small genus of about twenty-four species. With the exception of one species in Celebes and an undescribed one in the New Hebrides, the genus is limited to New Guinea. *Pedilochilus* is closely allied to *Bulbophyllum*, of which it may eventually prove to be but a section.

Bulbophyllum schizopetalum *L. O. Williams sp. nov.*

Herbae epiphyticae, usque ad ultra 20 cm. longae. Folia elliptica, breviter acuminata, coriacea. Inflorescentiae fasciculatae, uni- vel pauciflorae. Sepalum dorsale lanceolatum vel lineari-lanceolatum, acutum, trinervium. Sepala lateralia lanceolata vel elliptico-lanceolata, acuta, leviter obliqua, trinervia. Petala bi- vel trilobata, quam sepala breviora. Labellum lineari-oblongum, semiteres, obtusum, muriculatum. Columna sectionis.

Epiphytic, repent herbs up to more than 20 cm. long. Rhizome stem-like, covered with semiamplexicaul, cucullate, ovate, short-acuminate bracts which are 7–15 mm. long. Pseudobulbs 1.5–2 cm. long and about 0.4–0.8 cm. in diameter, ellipsoid to ovoid, unifoliate. Leaves 6–10 cm. long and 1.5–3 cm. broad, straight or arcuate, short-acuminate, coriaceous. Inflorescences 1- to few-flowered fascicles borne from the base of the pseudobulbs and from the axils of all of the bracts at each of the nodes of the rhizome, about equaling the subtending bracts. Dorsal sepal 6–7 mm. long and 1.5–2 mm. broad, lanceolate to linear-lanceolate, acute, 3-nerved. Lateral sepals 6–7.5 mm. long and 2.5–3 mm. broad, lanceolate to elliptic-lanceolate, acute, slightly oblique, 3-nerved, the margins somewhat involute, free. Petals about 1.5 mm. long and 1.25 mm. broad, strongly 2- to 3-lobed, the posterior and middle lobes largest, the anterior lobe small or almost wanting, so the petals appear to be about equally divided in most cases; the posterior lobe round, the terminal lobe acute. Lip about 4 mm. long, 1 mm. broad and 0.75 mm. deep, linear-oblong, apical two thirds densely muriculate, the basal third much less so and with a smooth, subcanaliculate area above on the basal half. Column of the section, about 2 mm. long.

British New Guinea: Amieng on Yaneng River, a tributary of the

Buso River, above the mouth of Tosapik Creek, Morobe District, elevation 5000–6000 ft., flowers wine red, March 14, 1941, *Clemens 12018* (TYPE in Herb. Ames).

Bulbophyllum schizopetalum belongs in the subgenus Hapalochilus, section Trachychilus of Schlechter's treatment in Die Orchideen von Deutsch Neu-Guinea (Fedde Repert. 1 (1912) 693 et seq.). The species is apparently closely allied to *B. xanthophaeum* Schltr., but differs in the narrower sepals, in the more deeply lobed petals, in the smaller lip (which also differs in its muriculations and in not being sulcate below) and in the larger leaves.

Chitonanthera Brassii *L. O. Williams sp. nov.*

Herbae parvae, epiphyticae, pendentes, usque ad ca. 20 cm. longae. Folia linearia vel oblongo-linearia, recta vel falcata. Inflorescentia quam folia brevior. Sepalum dorsale ovato-lanceolatum, acutum, naviculare. Sepala lateralia ovata, leviter obliqua. Petala linearia, obtusa. Labellum lineare, obtusum. Columna generis, pollinia quatuor.

Small, pendent, flexuose, epiphytic herbs up to about 20 cm. long. Stems slender, fractiflex, covered with the bases of the leaves or exposed in age, internodes 4–5 mm. long. Leaves 6–10 mm. long and 1–2 mm. broad, linear to oblong-linear, straight or falcate, acute or subulate, erect-spreading, laterally compressed, articulate; leaf-sheaths covering the stem, decurrent, extended above into a petiole which is about 2 mm. long and similar to the lamina. Inflorescence 1- to 3-flowered, shorter than the subtending leaf. Sepals united into a short tube at the base. Dorsal sepal about 2 mm. long and 1–1.3 mm. broad, ovate-lanceolate, acute, navicular. Lateral sepals 2–2.5 mm. long and about 1.5 mm. broad, ovate, slightly oblique. Petals about 0.6–1 mm. long and 0.1 mm. broad, linear, obtuse, puberulent. Lip about 1.5 mm.

long and 0.3 mm. broad, linear, obtuse, puberulent above and laterally but glabrous beneath, attached near the base of the column. Column of the genus, about 0.7 mm. long; pollinia four.

British New Guinea: epiphyte in ridge crest forest, Mt. Tafa, Central Division, alt. 2400 m., May–September 1933, *Brass 4902;* amongst moss on tree trunks of ridge forest trees, stems pendent, single or in tufts, flat fleshy leaves, Mt. Tafa, Central Division, alt. 2400 m., May–September 1933, *Brass 5036* (Type in Herb. Ames No. 57612).

Chitonanthera Brassii is allied to *C. angustifolia* Schltr., but differs in its narrower petals and leaves.

Chitonanthera filiformis *L. O. Williams sp. nov.*

Herbae epiphyticae, parvae, usque ad 10 cm. longae. Folia filiformia, teretia, articulata. Inflorescentia foliis aequalis. Sepalum dorsale ovatum, obtusum, uninervium. Sepala lateralia ovata, obtusa, leviter obliqua. Petala rhombico-reniformia vel rhombico-orbicularia, obtusa, uninervia. Labellum oblongo-lanceolatum, obtusum, cymbiforme, bicallosum. Columna generis.

Small, matted, epiphytic herbs up to 10 cm. long. Stems slender, flexuose, fractiflex; internodes 4–10 mm. long. Leaves 5–20 mm. long (mostly 10–15 mm. long) and 0.25–0.5 mm. in diameter, filiform, terete, articulate; leaf-sheaths covering the stem, the apex extending out 1–2 mm. from the stem to the articulation with the lamina. Inflorescence short, about equal to the subtending leaf or shorter, few-flowered; rachis filiform, fractiflex; bracts about 1 mm. long, ovate-triangular, acuminate, verrucose dorsally. Sepals united for a short distance at the base, fleshy; dorsal sepal 1.5–2 mm. long and 1.2–1.5 mm. broad, ovate, obtuse, 1-nerved; lateral sepals about 1.2–1.5 mm. long and 0.8–1.2 mm. broad, broadly ovate, obtuse, somewhat oblique, 1-nerved. Petals about 0.5 mm. long and 0.7 mm. broad, rhombic-

reniform to rhombic-orbicular, obtuse, 1-nerved. Lip about 0.75 mm. long and 0.3 mm. broad, oblong-lanceolate, obtuse, cymbiform, with two parallel fleshy costae covering the basal half. Column about 0.5 mm. long, reflexed, with two fleshy stelidia opposite the pouch-like stigma. Ovary verrucose.

NETHERLANDS NEW GUINEA: tufted in moss on trees of closed forest, common, Lake Habbema, flowers very small and orange-colored, alt. 3225 m., August 1938, *Brass 9360* (TYPE in Herb. Ames No. 61584); epiphyte in moss, subalpine forest, Lake Habbema, alt. 3225 m., August 1938, *Brass 9369A*.

Chitonanthera filiformis is most closely allied to *C. tenuis* (J.J.Sm.) L.Wms. (cf. below), but is easily distinguished by its filiform leaves, slender stems and the details of the flower and column.

Chitonanthera filiformis *L. Wms.* var. **brachyphylla** *L.O.Williams var. nov.*

Folia 1.5–3 mm. longa. Internodia caulium 2–4 mm. longa.

NETHERLANDS NEW GUINEA: common epiphyte in open mossy thickets, Lake Habbema, alt. 3225 m., flowers orange-colored, August 1938, *Brass 9437* (TYPE in Herb. Ames).

Variety *brachyphylla*, at first glance, appears to be amply distinct, but closer study shows it to have flowers identical with those of the species and to differ mainly in the short leaves and in the short internodes of the stem.

Chitonanthera gracilis *L. O. Williams sp. nov.*

Herbae epiphyticae, flexuosae, usque ad ca. 15 cm. longae. Folia linearia vel elliptico-linearia, acuta, falcata vel recta. Sepala basi in tubo connata. Sepalum dorsale ovatum vel ovato-orbiculare, obtusum vel acutum, carnosum. Sepala lateralia late ovato-orbicularia vel subtriangularia, obtusa vel acuta, carnosa. Petala obovata vel

oblanceolata, obtusa vel subtruncata. Labellum cupulatum et carnosissimum, apice sagittatum, obtusum, puberulum.

Small epiphytic, flexuose herbs up to about 15 cm. long. Stems slender, flexuose, obscurely fractiflex; internodes about 5 mm. long. Leaves 8–15 mm. long and 1–2 mm. broad, linear to elliptic-linear, acute, falcate or straight, spreading, laterally compressed, articulate; leaf-sheaths covering the stem, usually ancipitous. Inflorescence elongated, much exceeding the subtending leaf, 3–9 cm. long, borne in the axils of the leaves, a several- to many-flowered spike or raceme; bracts 1.5–3 mm. long, lanceolate-triangular, acute or aristate, cucullate, decurrent on the rachis, smooth or verrucose externally, glabrous. Sepals united into a tube for a short distance at the base. Dorsal sepal about 2–2.5 mm. long and 1.5–2 mm. broad, ovate to ovate-orbicular, obtuse or acute, fleshy, 1-nerved, Lateral sepals 2–2.5 mm. long and 1.5–2 mm. broad, ovate-orbicular to subtriangular, obtuse or acute, fleshy, 1-nerved. Petals about 1 mm. long and 0.5 mm. broad, obovate to oblanceolate, obtuse to subtruncate, sometimes obscurely unguiculate, 1-nerved, puberulent. Lip 2–2.5 mm. long and 1–1.5 mm. broad, adnate to the column; the basal portion cupulate and very fleshy, 1–1.5 mm. in diameter, puberulent; terminal part about 1–1.5 mm. long and 0.75–1 mm. broad, sagittate, obtuse, the basal angles sharp, not fleshy, puberulent, attached to the under side of the basal part. Column about 0.5 mm. long and as broad or broader; pollinia eight, of two sizes, the larger subreniform about 0.25 mm. long and 0.12 mm. broad, the smaller broadly reniform 0.1–0.15 mm. long and 0.08–0.1 mm. broad.

BRITISH NEW GUINEA: Ulap trail, Matap, Morobe District, flowers vivid brick red, April 6, 1940, *Clemens 11341* (TYPE in Herb. Ames).

Chitonanthera gracilis is allied to *C. calceiformis* J. J.

Sm. from which it is distinguished by the larger leaves, by the different form of the basal part of the lip, by the dorsal sepal being smaller than the lateral sepals (not vice versa), as well as by less prominent details of the flowers and vegetative parts.

Chitonanthera tenuis (*J. J. Sm.*) *L. O. Williams comb. nov.*

Vonrömeria tenuis J. J. Smith in Bull. Dép. Agric. Ind. néerl. No. 39 (1910) 22; in Nova Guinea 8, pt. 3 (1912) 598, t. 108B; in Nova Guinea 12, pt. 1 (1913) 96.

Octarrhena tenuis J. J. Smith in Fedde Repert. 12 (1913) 25; in Nova Guinea 14, pt. 3 (1929) 487.

NETHERLANDS NEW GUINEA: epiphyte in a low thicket, Lake Habbema, alt. 3225 m., August 1938, *Brass 9273;* massed on logs in forest opening, 9 km. NE. of Lake Habbema, alt. 2800 m., October 1938, *Brass 10790* and *10884;* at the foot of Doorman-top, alt. 2250 m., October 17, 1920, *Lam 1609.*

BRITISH NEW GUINEA: common on forest trees, Murray Pass, Wharton Range, Central Division, alt. 2840 m., June–September 1933, *Brass 4509.*

Dissections and study of the several collections of this species which are available seem to indicate that it should be referred to *Chitonanthera* rather than to *Octarrhena.* If the present specimens were to be referred to *Octarrhena,* probably the entire genus *Chitonanthera* should be placed there. This course does not seem justified at the present time.

Smith describes and illustrates the lateral sepals of this species as being connate nearly to their apices. This is not the case, for several dissections show that they are merely overlapping and coherent above. The sepals are connate at the base as in other species of the genus. The column is described and illustrated as having a column-foot. However, if present, the column-foot is very ob-

scure, and it is probable that the lip is attached to the very short broad column as in other species of *Chitonanthera*.

Chitonanthera Lorentzii *J.J.Smith* in Nova Guinea 14, pt. 3 (1929) 483.

I have determined *Brass 9040* and *Brass & Myer-Drees 9669* as this species. The stems are long, and consequently the plants appear tall. One of these specimens has the rachis broadly winged while in the other the wing is less prominent.

Chitonanthera suborbicularis *J. J. Smith* in Nova Guinea 14, pt. 3 (1929) 485, t. 80.

I have determined three specimens, *Brass & Myer-Drees 9670*, *9924* and *10384*, as this species. These specimens seem to differ from those mentioned under the foregoing species mainly in having shorter stems. The flowers in *C. Lorentzii* and *C. suborbicularis* seem to be identical or practically so, and it is probable that the two species will prove to be the same.

Phreatia phreatioides (*J. J. Sm.*) *L. O. Williams comb. nov.*

Thelasis phreatioides J. J. Smith in Bull. Dép. Agric. Ind. néerl. 45 (1911) 11; in Nova Guinea 8, pt. 3 (1912) 602, t. 110 B.

Phreatia digulana Schlechter in Fedde Repert. Beihefte 1 (1913) 911; in Fedde Repert. Beihefte 21 (1923) t. 308, fig. 1222.

The combination *Phreatia phreatioides* must be used. It is not a tautonym as treated by Schlechter.

Arachnis Muelleri (*Kränzl.*) *J. J. Smith* in Bull. Jard. Bot. Buit. ser. 3, 13 (1914) 47.

Vanda Muelleri Kränzlin in Oesterr. Bot. Zeitschr. 44 (1894) 461.
Vandopsis Muelleri Schlechter in Fedde Repert. 10 (1911) 196; in Fedde Repert. Beihefte 1 (1914) 972.
Stauropsis Imthurnii Rolfe in Bot. Mag. 143 (1917) t. 8714; in Orch. Rev. 26 (1918) 149, 167.
Arachnis Imthurnii L. O. Williams in Bot. Mus. Leafl. Harv. Univ. 5 (1937) 58.

Solomon Islands and British New Guinea.

BRITISH NEW GUINEA: common on tops of rocks in Eucalyptus savannah, forests, Roma, Central Division, alt. 650 meters, February 14, 1936, *Brass 6205*.

Material of this species from the Solomon Islands, received in 1937 was thought to be the same as Rolfe's *Stauropsis Imthurnii*. Excellent specimens are now at hand from New Guinea. It is probable that all of these are referable to Kränzlin's rather poorly described *Vanda Muelleri* which J. J. Smith has transferred to Arachnis.

Mr. L. J. Brass' field description of the plant in New Guinea is of interest: "Very conspicuous large plants, usually several grouped together; with about 20 long, leathery, drooping leaves arranged in two series on an erect stem about 15–20 cm. long below the leaves. Leaf nerves quite obscure, edges [of the leaves] thin and sharp. Panicles two or more, produced in leaf axils but lateral below leaves at time of opening of flowers, over 2 meters long. Flowers fragrant, spotted brown and yellow."

EXPLANATION OF THE ILLUSTRATIONS

PLATE XXI. PTEROSTYLIS CAULESCENS *L.O.Wms.* 1, plant drawn natural size. 2, dorsal sepal, three times natural size. 3, lateral sepals, three times natural size. 4, petal, three times natural size. 5, column from below, three times natural size. 6, column and lip from the side, three times natural size. 7, lip and column-foot from above, three times natural size. 8, cross section of the lip, three times natural size.

PLATE XXII. CALOCHILUS CAERULEUS *L.Wms.* 1, fruiting habit of plant, reduced to one half natural size. 2, inflorescence, natural size. 3, column and lip from the side, enlarged three times. 4, the lip spread out, enlarged two times. 5, petal, enlarged three times. 6, lateral sepal, enlarged three times. 7, dorsal sepal, enlarged three times.

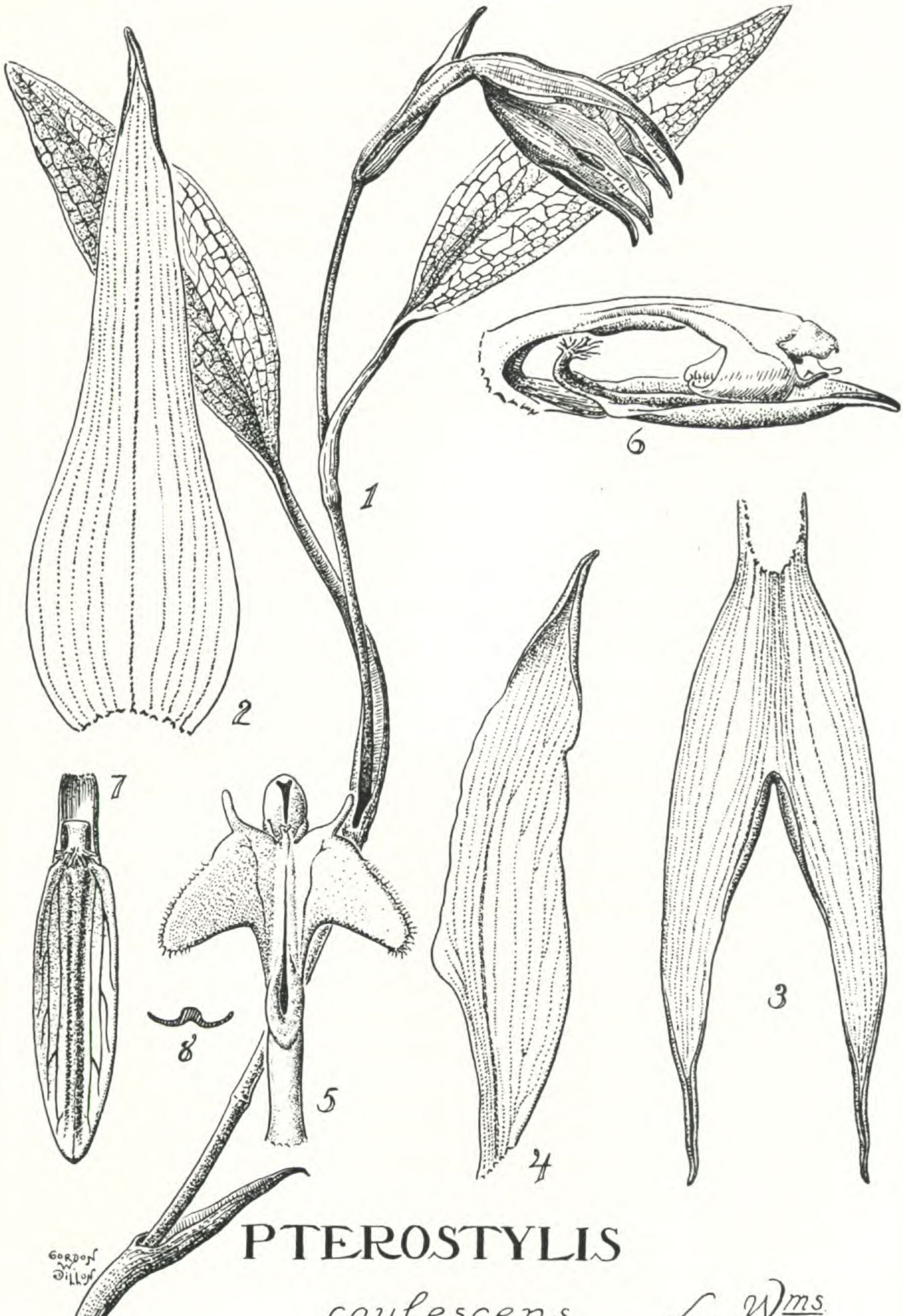
PEDILOCHILUS CLEMENSIAE *L.Wms.* 8, habit, natural size. 9, column and lip from the side, enlarged three times. 10, petal, enlarged two times. 11, dorsal sepal, enlarged two times. 12, lateral sepal, enlarged two times.

PLATE XXIII. CHITONANTHERA BRASSII *L.Wms.* 1, habit, natural size. 2, flower from the front, enlarged five times. 3, flower from the side, enlarged five times.

CHITONANTHERA GRACILIS *L. Wms.* 4, habit, natural size. 5, flower from the front, enlarged five times. 6, lateral view of flower, enlarged five times.

CHITONANTHERA FILIFORMIS *L.Wms.* 7, habit, natural size. 8, flower from above, enlarged five times. 9, flower from the side, enlarged five times.

Plate XXI



PTEROSTYLIS

caulescens L. Wms.

CALOCHILUS

caeruleus L. Wms.



PEDILOCHILUS

Clemensiae L. Wms.

Plate XXIII



CHITONANTHERA *Brassii* *L. W*ms.

NOTES ON THE FAMILY CORSIACEAE[1]

BY
LOUIS O. WILLIAMS

THE CORSIACEAE is a small family of saprophytic herbs similar in appearance to the Orchidaceae. Although rare, specimens are occasionally included in collections of orchids sent in for determination. The family is more closely allied to the Burmanniaceae and Thismiaceae than to the Orchidaceae and, like them, is included in the Burmanniales.

The two genera which comprise the Corsiaceae are of special interest because of their distribution. *Corsia*, with nine species, seems to be limited to the island of New Guinea, while *Arachnitis*, with a single species, is found in Chile and Argentina.

CORSIA *Beccari*

Corsia *Beccari* Malesia 1 (1878) 238, t. 9.

The genus *Corsia* was not ascribed to any family by Beccari when he described it. Bentham and Hooker, in their Genera Plantarum, placed the genus in the Burmanniaceae; Engler, in Die natürlichen Pflanzenfamilien, placed it in the same family. Rudolf Schlechter seems to have been the first to give *Corsia* and *Arachnitis* family rank. Schlechter's treatment was apparently followed by Jonker, the monographer of the Burmanniaceae, who excluded both the genera from that family.

The new species of *Corsia* described below were included in collections of orchids from New Guinea.

Corsia purpurata *L. O. Williams sp. nov.*

Herbae saprophyticae, erectae, efoliosae, perennes, usque ad ca. 15 cm. altae. Inflorescentia uniflora. Sepala lateralia et petala similia vel petala minora, lanceolata vel

[1]Botanical Results of the Archbold Expeditions.

ovato-lanceolata, acuminata, reflexa, leviter obliqua. Sepalum dorsale unguiculatum; lamina late suborbiculari-ovalis, obtusa vel apice obscure emarginata, basi callo lamellato ornata. Androecium et gynoecium generis.

Simple, erect, leafless, saprophytic, perennial herbs up to about 15 cm. tall. Stems slender, terete; bracts 5–14 mm. long, scarious, lanceolate to ovate, acute to apiculate. Inflorescence 1-flowered; bracts like those of the stem. Flower erect, purple. Lateral sepals and petals similar or the petals slightly smaller, 5.5–7 mm. long and 2–2.5 mm. broad, lanceolate to lanceolate-ovate, acuminate, reflexed, slightly oblique. Dorsal sepal unguiculate; lamina about 10–12 mm. long and 9–10 mm. broad, suborbicular-oval, obtuse or slightly emarginate at the apex, with an upright lamellate callus at the base which extends back on the claw; claw about 4–5 mm. long, laterally compressed, fleshy. Stamens spreading; anthers subrotund, about 0.8 mm. long and 1.2 mm. broad; filaments about 1.5 mm. long. Styles connate, cylindric, obtuse.

NETHERLANDS NEW GUINEA: common saprophyte on leafy ground of oak forest, Bele River, 18 km. northeast of Lake Habbema, alt. 2300 meters, plant tinged with purple, flowers purple, November 1938, *Brass 11419* (TYPE in Herb. Ames No. 43917).

Corsia purpurata is easily distinguished from all other species of the genus by the broad lateral sepals, by the petals, and by the erect lamellate callus at the base of the dorsal sepal. The nearest ally seems to be *Corsia crenata* J. J. Sm. from which, however, it is easily distinguished by the lateral sepals and petals as well as by the very differently shaped dorsal sepal.

Corsia acuminata *L. O. Williams sp. nov.*

Herbae erectae, efoliosae, saprophyticae, usque ad 20 cm. altae. Caules graciles; bracteae caulium oblongae vel lanceolatae, acutae vel apiculatae. Inflorescentia uni-

flora. Sepala lateralia et petala lineari-lanceolata, acuminata, leviter obliqua, reflexa. Sepalum dorsale unguiculatum; lamina transverse ovalis, callo lamellato proximato ornata; unguis gracilis, carnosus, compressus. Stamina et stigmata generis.

Simple, erect, leafless, saprophytic, perennial herbs up to 20 cm. tall. Stems slender; bracts 10–15 mm. long, amplexicaul at the base, oblong or lanceolate, acute or apiculate, membranaceous. Inflorescence 1-flowered. Flowers erect, dull garnet-colored. Lateral sepals and petals 6–7 mm. long and 1.32–2 mm. broad, linear-lanceolate, acuminate, slightly oblique, 1-nerved, reflexed, similar except that the petal opposite the dorsal sepal is the smallest. Dorsal sepal unguiculate, 16–20 mm. long (including the claw) and about 20 mm. broad; lamina about 12 mm. long and 20 mm. broad, transversely oval, with a callus-thickening below the center and a small upright lamellate callus about 1.5 mm. high near the junction with the claw; claw 4–5 mm. long, slender, fleshy, laterally compressed. Stamens with the filaments about 1.5 mm. long. Styles about 2 mm. long, joined, cylindric.

British New Guinea: in wet forest, Ogeramnang, Morobe District, alt. 6000 ft., flowers dull garnet, December 2, 1936, *Clemens 4475* (Type in Herb. Ames No. 53722).

Corsia acuminata is most closely allied to *C. unguiculata* Schltr., from which it is distinguished by the very broad lamina and the differently shaped lateral sepals and petals.

Arachnitis *Philippi*

Arachnitis *Philippi* in Bot. Zeit. 22 (1864) 217, non *Arachnites* F. W. Schmidt (1793). Conserved name.

Achratinis Kuntze in Post & Kuntze, Lexic. Gen. Phan. (1903) 4.

Arachnitis Phil. has been conserved by the Special Committee for Phanerogamae and Pteridophyta ap-

pointed by the Sixth International Botanical Congress, Amsterdam, 1935. (Cf. Kew Bull. (1940) 86, 95.)

It is unfortunate that the name was conserved with the original spelling. Arachnitis is a medical term and does not mean "spider-like" as Philippi obviously intended. Philippi himself in a later paper changed the spelling to Arachnites,—and was followed by Bentham and Hooker in the Genera Plantarum and by Engler in Die natürlichen Pflanzenfamilien. Inasmuch as *Arachnitis* was conserved over *Arachnites*, the two being considered orthographic variants, the orthographically correct spelling should have been adopted.

Philippi ascribed his *Arachnitis* to the Orchidaceae but apparently with some doubt, for he wrote: "Ich habe mich gefragt, ob die Blume vielleicht verdreht, und ob dieses Blättchen das Labellum wäre. aber es gehört bestimmt der *äusseren* Reihe des Perigons an, und hat auch derbe Kelchstruktur."

Arachnitis is a monotypic genus of the New World.

Arachnitis uniflora *Philippi* in Bot. Zeit. 22 (1864) 217.

ARGENTINA: Nothofagus woods, Llao Llao, Parque Nacional de Nahuel Huapi, *Hunnewell 15928* (Gray Herb.); saprophytic on humus, deep shade of Nothofagus, north bank of Lago Rico, southwest branch of Lago Argentino, Glacier National Park, Gob. Santa Cruz, Depto. Lago Argentino, alt. 270 m., January 12, 1939, *Eyerdam, Beetle & Grondona 24326* (Gray Herb.); beech forest at Puerto Nuevo, Lago Nahuel Huapi, alt. 770 m., December 30, 1933, *Ljungner 599* (Herb. N.Y. Bot. Gard.).

CHILE: Valdivia, *Philippi*, (U. S. Nat. Herb.); Prov. Magellanes, alt. ca. 200 m., January 1931, *Hicken 424* (Gray Herb.).

EXPLANATION OF THE ILLUSTRATION

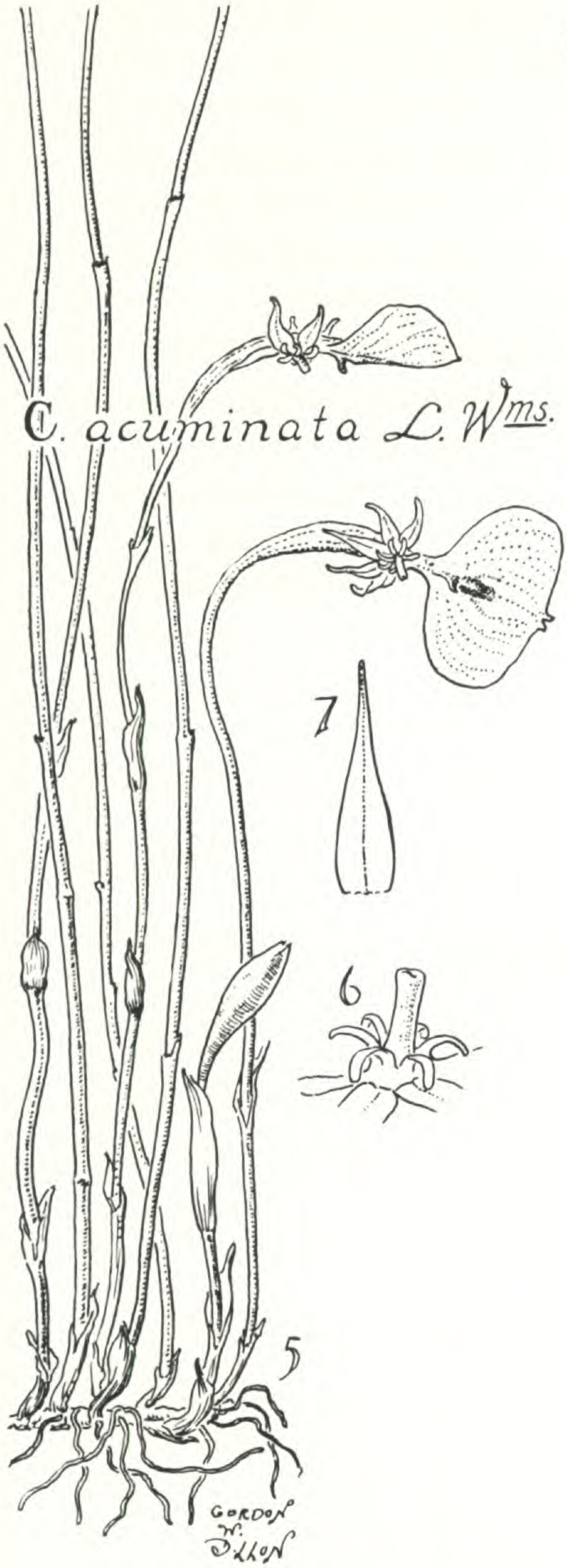
PLATE XXIV. CORSIA PURPURATA *L. Wms.* 1, habit, natural size. 2, dorsal sepal, twice natural size. 3, flower with dorsal sepal removed, three times natural size. 4, anther, ten times natural size.

CORSIA ACUMINATA *L. Wms.* 5, habit, natural size. 6, style and filaments, five times natural size. 7, petal, three times natural size.

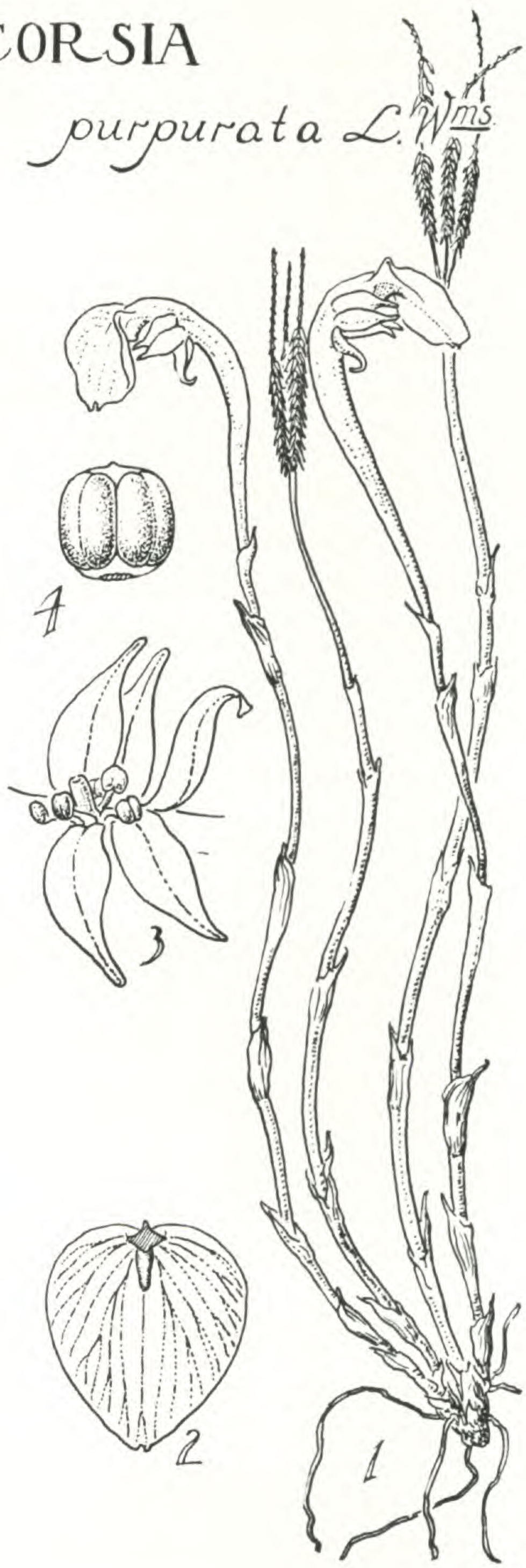
PLATE XXIV

CORSIA

purpurata L. Wms.



C. acuminata L. Wms.



GORDON W. DILLON

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CAMBRIDGE, MASSACHUSETTS, MARCH 27, 1946 VOL. 12, NO. 6

ORCHIDACEAE PERUVIANAE VI

BY
CHARLES SCHWEINFURTH

THE FOLLOWING ARTICLE consists of amplifications, nomenclatorial notes and diagnoses of new species, all concerning Peruvian orchids. The novelties are in the genera Cryptocentrum, Neokoehleria, Trichopilia and Notylia.

Cyrtoglottis gracilipes *Schlechter* in Fedde Repert. Beihefte 7 (1920) 182; ex Mansfeld in Fedde Repert. Beihefte 57 (1929) t. 65, nr. 250.

This Colombian orchid is now exemplified by three Peruvian collections, in which there appear to be certain discrepancies from the type. One plant bears an oblong-ovoid, rather than "narrowly oblong," pseudobulb, and another has a larger pseudobulb about 3 cm. long. The leaves are elliptic-oblong, rather than "ligulate," commonly longer than specified (up to 10.2 cm. long) and always wider (up to 2.8 cm. broad). The dorsal sepal is 2.6–3 cm. (not 2.3 cm.) long, and the lateral sepals are up to 3.5 cm. long. The lip, which has a more or less distinct lateral lobule above the middle on each side, is often somewhat wider than specified and the column is sometimes over 8 mm. (not 7 mm.) long.

JUNIN: Chanchamayo Valley, at 1500 meters altitude, September 1930, *Carlos Schunke 1119;* same locality, at 1600 meters altitude, June 1930, *Carlos Schunke 1734;* Schunke Hacienda, above San Ramón,

at 1400–1700 meters altitude, epiphyte in dense forest, "three perianth segments and column salmon-pink; lip purple-dotted," *E. P. Killip & A. C. Smith 24883.*

Trigonidium tenue *Loddiges ex Lindley* in Bot. Reg. 25 (1839) Misc. p. 44, no. 59—Cogniaux in Martius Fl. Bras. 3, pt. 6 (1904) 102.

Trigonidium peruvianum Schlechter in Fedde Repert. Beihefte 9 (1921) 107; ex Mansfeld in Fedde Repert. Beihefte 57 (1929) t. 127, nr. 497.

The concept, *Trigonidium peruvianum*, is represented as having subobtuse petals, whereas those of *T. tenue* are sharply acute. Aside from slight variations in floral measurements, there are no other significant differences between these species. The tricarinate callus on the lip, which is attributed to *T. peruvianum*, is doubtless represented by three central approximate more or less callose-thickened lines shown on the lower portion of the lip of *T. tenue*.

It appears entirely reasonable, therefore, to reduce *T. peruvianum* to the earlier *T. tenue*.

Cryptocentrum inaequisepalum *C. Schweinfurth sp. nov.*

Herba gracilis, pro genere altior, epiphytica. Caulis brevis, foliorum vaginis numerosis, distichis, imbricatis obtectus. Folia anguste linearia, in sicco arcuata, abrupte obtusa, inferne conduplicata. Inflorescentiae laterales, basales, numerosae, uniflorae, filiformes, vaginis anguste tubulatis ornatae. Sepalum dorsale lineari-lanceolatum, acutum. Sepala lateralia longiora, oblique lanceolato-linearia, acuta. Petala multo breviora, oblique lineari-lanceolata, longe acuminata. Labellum in calcar elongatum extensum; pars libera lanceolata, longe acuminata, infra dilatata et concava; calcar filiformi-cylindraceum. Columna perbrevis, more generis.

Plant slender, epiphytic, rather tall for the genus, about 20 cm. high. Roots fibrous, filiform, numerous, glabrous. Stem short, entirely invested by numerous distichous imbricating leaf-sheaths of which only the upper ones bear approximate blades, about 3.3 cm long. Leaves narrowly linear, arcuate in the dried specimen, abruptly obtuse, about 20 cm. or less long, 3.2 mm. or less wide, conduplicate below in the dried plant. Inflorescences lateral, basal, numerous, spreading, 1-flowered; peduncle filiform, up to 8.3 cm. long, adorned with several close tubular sheaths which are short and imbricating near the base and elongate and separated above. Ovary entirely concealed and surpassed by an elongate tubular bract. Flower rather large, yellow-green, translucent. Segments spreading. Sepals connate into a tube at base, as in the genus. Dorsal sepal linear-lanceolate, complicate-acute or subacuminate, 5-nerved, free part about 15.5 mm. long and 3.7 mm. wide below. Lateral sepals obliquely lanceolate-linear, complicate-acute, 5-nerved, free part about 19 mm. long and 3 mm. wide, produced below into an elongate spur. Petals much shorter than the sepals in natural position, obliquely linear-lanceolate, long-acuminate, 3-nerved, about 13.5 mm. long and 3 mm. wide near the base, with the margins of the basal part more or less irregular. Lip produced into an elongate spur; free portion lanceolate, long-acuminate to an acute tip, cuneate near the base, 3-nerved, about 9.8 mm. long and 4.2 mm. wide across the dilated and concave lower portion when expanded; spur filiform-cylindric, about 16 mm. long, subobtuse. Column very short and stout, straight, wing-dilated with a concave upper portion, about 2.2 mm. high at the back.

Cryptocentrum inaequisepalum has two apparent allies. The Colombian *C. pergracile* Schltr. is a smaller plant, with shorter leaves, much shorter sepals and a 7- (not 3-)

nerved lip. The Costa Rican *C. gracilipes* Schltr. has broader leaves, similarly smaller sepals and differently shaped, 5-nerved petals.

Ayacucho: Aina, between Huanta and Río Apurimac, at 750–1000 meters altitude, epiphyte in open woods, May 7, 17, 1929, *E. P. Killip & A. C. Smith 23154* (Type in Herb. Ames No. 61960).

Cryptocentrum peruvianum (*Cogn.*) *C. Schweinfurth comb. nov.*

Centroglossa ? peruviana Cogniaux in Bull. Soc. Roy. Bot. Belg. 43 (1906) 331.

An examination of the type material of Cogniaux' concept, borrowed from the Herbier du Jardin Botanique de l'État at Brussels, shows conclusively that it is very dissimilar to the genus *Centroglossa* as illustrated by Cogniaux (in Martius Fl. Bras. 3, pt. 6 (1904) t. 46, figs. 1 and 2). It should be referred to the genus *Cryptocentrum*, bearing the combination above.

The combination *Cryptocentrum peruvianum* was used by Schlechter (in Fedde Repert. Beihefte 27 (1924) 103) in the discussion of *C. Hoppii*. No description was given and no other occurrence of the combination has been found in literature. Consequently the Schlechter usage is a nomen and cannot affect the combination here made.

Contrary to the description, the sepals and petals are acute or acuminate, and neither obtuse nor truncate—a characterization doubtless due to the fact that in the type specimen these organs usually appear to be broken off at the tip. In addition, the lip, like the entire perianth, is fleshy and not membranaceous as described, and it is lanceolate in outline, rather than ovate-rhomboid.

Cryptocentrum peruvianum has two rather close allies. It appears to differ from the Colombian *Cryptocentrum Hoppii* Schltr. (which I have not seen) in having broader leaves, purple (not greenish yellow) flowers and a longer

spur. It is separable from the Costa Rican *C. Standleyi* Ames in having broader leaves, relatively shorter scapes and much smaller flowers, especially the spur.

Cryptocentrum pseudobulbosum *C. Schweinfurth sp. nov.*

Herba pusilla, caespitosa, pseudobulbifera. Pseudobulbi perparvi, in sicco cylindracei, apice bifoliati, vaginis foliiferis juventute circumdati. Folia anguste linearia, abrupte acuta. Inflorescentiae laterales, basales, filiformes, patentes, uniflorae. Flos parvus. Sepala more generis basi connata. Sepala lineari-lanceolata, acuta. Petala anguste lanceolata, acuminata. Labellum in calcar productum; pars libera lanceolata, acuminata, inferne concava leviter trilobata; calcar pertenue, cylindraceum, obtusum. Columna perbrevis, apice concavo dilatata.

Plant small, caespitose, 4–5 cm. tall. Roots numerous, fibrous, filiform, flexuous. Pseudobulbs very small, cylindric, complanate and closely striate-rugose in the dried specimen, bifoliate at the apex, about 7.5 mm. long, surrounded in youth by one or more pairs of leaf-bearing sheaths. Leaves narrowly linear, abruptly acute, up to 4 cm. long and 2 mm. wide, conduplicate below. Inflorescences lateral, basal, filiform, spreading, with several close tubular sheaths, 1-flowered, the peduncle about 4 cm. long. Flower small, nervose. Sepals connate below as in the genus, 5-nerved. Dorsal sepal (free portion) linear-lanceolate, abruptly acute and apiculate, about 7.2 mm. long and 2 mm. wide below. Lateral sepals (free portion) very similar to the dorsal sepal but slightly larger and suboblique. Petals narrowly lanceolate, acuminate, slightly shorter than the sepals in natural position, with minutely irregular margins, 2 mm. wide, 3-nerved. Lip produced into a long spur; free portion lanceolate in outline, long-acuminate, cuneate toward the narrow base,

more or less lightly 3-lobed below the middle, concave below, about 9 mm. long and 3.8 mm. wide across the lateral lobes when expanded, 3-nerved; lateral lobes erect, very broadly rounded; mid-lobe much larger, linear-triangular; spur very slender, cylindric, obtuse, about 9.5 mm. long. Column short, straight, about 2.2 mm. long at the back, with a pair of porrect semiorbicular auricles above.

This species is at present unique in the genus in having pseudobulbs. It differs from *Cryptocentrum minus* Schltr. also in having longer, narrower acute sepals and narrower petals.

JUNIN: Chanchamayo Valley, at 1800 meters altitude, October, "1924–1927," *Carlos Schunke s.n.* (TYPE in Herb. Field Mus. No. 571630).

Neokoehleria equitans *Schlechter* in Fedde Repert. 10 (1912) 390; ex Mansfeld in Fedde Repert. Beihefte 58 (1930) t. 53, nr. 211.

A recently identified plant from the same region as the type appears to be referable to this concept. It shows, however, certain discrepancies. The plant is vegetatively larger than specified. The pseudobulb is about 15 mm. long, rather than 5–8 mm. long. The leaf is not equitant (as is shown by a photograph of the type), but is linear and 11.6 cm. long, instead of 4.5–8.5 cm. long. The inflorescence is also longer, being about 14.7 cm. long. The flowers are slightly smaller, but in general they are of nearly the same form. The sepals are about 5 mm. (instead of 6.5 mm.) long. The petals are broadly rounded above, rather than obtuse, and the slightly shorter lip is more or less retuse, instead of rounded at the apex.

JUNIN: Chanchamayo Valley, at 1500 meters altitude, December 1923, *Carlos Schunke 550.*

Neokoehleria paniculata *C. Schweinfurth sp. nov.*

Herba pusilla, inconspicua. Rhizoma abbreviatum.

Pseudobulbi perparvi, oblongo-cylindracei ut videtur, monophylli. Folium anguste lineare, in sicco valde carnosum et cylindraceum ut videtur. Inflorescentiae laterales, basales, vulgo laxe ramosae. Flores minuti, membranacei. Sepalum dorsale elliptico-oblongum. Sepala lateralia in laminam rotundato-ovatam connata, infra in calcar crassum apice truncatum producta. Petala oblique cuneato-obovata, apice late rotundato. Labellum oblongo-obovatum, apice rotundatum, postice in calcaria duo tenuia productum; discus lamellis duabus planas dimidio inferiore ornatus. Columna crassa, clavata.

Plant very small, inconspicuous. Roots fibrous, flexuous, glabrous, numerous. Pseudobulbs small, caespitose, oblong-cylindric and deeply striate-rugose in the dried specimen, unifoliate at the apex, about 11 mm. or less long, concealed in youth by several distichous imbricating evanescent sheaths. Leaf narrowly linear, acute, apparently fleshy-thickened and semicylindric in section, slightly cuneate-narrowed to a sessile conduplicate base, about 8.9 cm. long and 3–5 mm. wide (only one complete blade present). Inflorescences lateral, basal, numerous, commonly loosely branched or paniculate with short more or less recurved several-flowered branches, enveloped at base by several distichous imbricating scarious sheaths. Floral bracts widely spreading, lanceolate, concave. Flowers very small, membranaceous. Dorsal sepal elliptic-oblong, subacute, concave, 4.7–5 mm. long and 2 mm. wide. Lateral sepals connate into a suborbicular-ovate concave retuse lamina which is bicarinate without and about 2.5 mm. long, produced below into a stout spur which is subquadrate-cylindric, abruptly truncate and about 2.3 mm. long. Petals obliquely cuneate-obovate, very broadly rounded or subtruncate and concave above, 4.5–5 mm. long and 3 mm. wide near the apex. Lip oblong-obovate, broadly rounded at the (imperfect)

apex, very obscurely trilobed above the middle, about 3.8 mm. long and 2 mm. across the widest part, produced at base into a pair of narrow lightly sigmoid spurs which are connate below, terminate in a more or less dilated obtuse apex and are about 2.5 mm. long; disc adorned through the lower half with a pair of semiobovate flat lamellae. Column stout, clavate, about 3.7 mm. long, terminating in a prominent ovate concave clinandrium. Anther semiovoid, 1-celled. Pollinia two, pyriform. Stipe elongate, cuneate-spatulate.

This species appears to be unique in the genus in having paniculate inflorescences. It is further distinguished from *N. peruviana* Schltr. by the stout truncate spur.

JUNIN: Chanchamayo Valley, at 1800 meters altitude, November "1924–1927," *Carlos Schunke 545* (TYPE in Herb. Field Mus. No. *571603*).

Neokoehleria peruviana *Schlechter* in Fedde Repert. 10 (1912) 391; ex Mansfeld in Fedde Repert. Beihefte 58 (1930) t. 54, nr. 213.

On the basis of a photograph of the type collection and a recently examined plant which is surely referable to this concept, several amplifications and corrections are necessary.

The leaves are not equitant as described, and they vary from linear to oblong-lanceolate with a width sometimes reaching 8 mm., instead of 4 mm. as described. The lamina formed by the lateral sepals is minutely bidentate, rather than subacute. The sac formed by the basal prolongation of the lateral sepals is only about 2.8 mm. (instead of 4 mm.) long, and it is abruptly truncate and scarcely retuse, rather than bifid as described. The appendages extending from the base of the lip are about 2 mm. (instead of 1.5 mm.) long, and the column is 3–3.3 mm. (rather than 4 mm.) long.

Trizeuxis falcata *Lindley* Collect. Bot. (1823) t. 2—Hooker Exot. Fl. 2 (1824) t. 126—Cogniaux in Urban Symb. Antill. 6 (1910) 627.

Trizeuxis andina Schlechter in Fedde Repert. Beihefte 10 (1922) 52; ex Mansfeld in Fedde Repert. Beihefte 57 (1929) t. 141, nr. 552.

A comparison of authentic material of *Trizeuxis falcata* from the type locality of Trinidad, supplemented by the plates above cited, with the description and analysis of the Bolivian *T. andina* Schltr., shows that these concepts should be regarded as conspecific.

The flowers of the Trinidad material examined seem to be exactly the same size as those of *T. andina* (not somewhat larger, as indicated), and the lip of the West Indian plant is, like *T. andina*, slightly broader at the base than above when expanded. At any rate, this character appears to be variable and at most inconspicuous.

This dainty little species extends from Costa Rica and Panama southward to Brazil, Bolivia and Peru, and also occurs on the island of Trinidad in the West Indies.

Trichopilia fragrans (*Lindl.*) *Reichenbach filius* var. **grata** (*Reichb.f.*) *C. Schweinfurth comb. nov.*

Trichopilia grata Reichenbach filius in Gard. Chron. (1868) 1338.

As shown by the type description of *Trichopilia grata*, supplemented by a drawing of the inflorescence and an analysis of the flower from the Reichenbach Herbarium at Vienna, this concept is very similar to the widespread and variable *T. fragrans*. Indeed, the single noteworthy difference between these species appears to rest on the central keel of the lip, which is rather low and uniform in *T. fragrans*, but is rather conspicuous, dilated and abruptly cut off in front in *T. grata*.

The vegetative parts of *T. grata*, although they are

not illustrated, the color of the flowers and the general form of the floral segments of the two concepts, seem to be nearly identical.

In the description of *T. grata*, the pseudobulbs are said to be diphyllous, but it would seem that this characterization must be based either upon an error or upon an abnormality, because every example of Trichopilia noted has a 1-leaved pseudobulb.

The two Peruvian collections cited below have unifoliate pseudobulbs, and, except for the keel character above noted, have the same characters and measurements as *T. fragrans*.

CUZCO: Prov. Quispicanchi, Marcapata Valley, evergreen hard-leaved bushwood consisting of shrubs and trees, at 1800 meters altitude, February 20, 1929, "Labellum white with central yellow spot, the other tepals greenish," *A. Weberbauer 7840.*

JUNIN: Rio Mantaro, "1909–1914," *A. Weberbauer 6582.*

Neodryas rhodoneura *Reichenbach filius* in Bot. Zeit. 10 (1852) 835; Xen. Orch. 1 (1854) 38, t. 16, figs. II 12–25.

Neodryas Mandonii Reichenbach filius Xen. Orch. 3 (1878) 21.

Neodryas latilabia Smith & Harris in Contrib. Gray Herb. Harvard Univ. 117 (1937) 39, figs. a–c.

Neodryas reniformis Smith & Harris in Contrib. Gray Herb. Harvard Univ. 117 (1937) 39, figs. d–g.

An isotype of *Neodryas Mandonii* (*G. Mandon 1146*) in the Gray Herbarium seems to be inseparable from *N. rhodoneura* as represented by the detailed description and illustrations in Xen. Orch. 1, p. 38, t. 16, figs. The specimens of *N. Mandonii* do not have a depressed-pyriform pseudobulb as described, but an oblong or pyriform-cylindric pseudobulb as illustrated for *N. rhodoneura*. The only significant difference between these concepts is that *N. Mandonii* is described as having a

5-lamellate callus, whereas *N. rhodoneura* is noted as having a 6-lamellate callus—i.e., four central lobes with a pair of outer calli. The actual truth of the matter, as shown by a critical examination of the type of *N. Mandonii*, is that the callus at the base of the flaring anterior portion of the lip has four distinct lobes with a more or less developed shorter median portion connecting the two pairs of side lobes—a feature which is obscure or absent in the freshly boiled flowers but which becomes more distinct as the flower dries out. The two series of central lobes described and illustrated for *N. rhodoneura* are explained by the fact that these median callus-lobes are sometimes lightly indented in the middle.

The type of *N. latilabia* differs from the other forms of this variable species only in having somewhat broader and more ovoid pseudobulbs. Its flower, and especially the lip, corresponds well with the type of *N. Mandonii*, but the color is noted as red or red-orange rather than purple.

Neodryas reniformis does not appear to differ in any noticeable degree from *N. rhodoneura*.

Brassia caudata (*L.*) *Lindley* in Bot. Reg. 10 (1824) t. 832—Hooker in Bot. Mag. 62 (1835) t. 3451—Fawcett & Rendle Fl. Jam. 1 (1910) 129, t. 28, figs. 7–9.

Epidendrum caudatum Linnaeus Sp. Pl., ed. 2 (1763) 1349.

Malaxis caudata Willdenow Sp. Pl. 4 (1805) 93.

Oncidium caudatum Reichenbach filius in Walpers Ann. 6 (1863) 766.

Brassia Lewisii Rolfe in Orch. Rev. 1 (1893) 199.

Judging from the description, supplemented by a photograph of the type at Kew and by several specimens in

the Ames Herbarium referred to that species, *Brassia Lewisii* cannot be separated from the widespread and variable *B. caudata*. The former concept, the habitat of which was unknown, does not show a single appreciable difference. The relative length of the petals and lip, sometimes relied upon for the separation of *B. caudata* from *B. Lewisii*, is a very variable character even in a single collection and, therefore, appears to be of no specific weight.

Brassia caudata extends from southern Florida, the West Indies and Mexico through Central America and most of the countries of northern South America as far south as Peru (Dept. of Loreto) and Bolivia.

Brassia Forgetiana *Hort. ex Gard. Chron.* ser. 3, 48 (1910) 434, 463, 471, fig. 209, *nomen tantum.*

This concept, which is one of the Peruvian discoveries of the late collector M. Louis Forget, made its first appearance in The Gardeners' Chronicle (l.c.) where the brief diagnosis is chiefly confined to remarks on the color of the flowers. The excellent figure which appears on p. 471 of that volume has a revealing floral analysis which would have been regarded as evidence of satisfactory publication if it had appeared two years earlier (according to the International Rules of Botanical Nomenclature). Since there is apparently no subsequent diagnosis to validate this concept, I now propose to furnish both a Latin diagnosis and a detailed description (so that the concept can take its place among validly described and understood species).

Herba magna ut videtur. Folium magnum, oblongum vel elliptico-oblongum, apice abrupte subacutum vel rotundatum, parte inferiore conduplicata. Racemus arcuatus, dense multiflorus. Florum bracteae parvae, ovatae vel ovato-lanceolatae, valde concavae, quam ovarium

pedicellatum multo breviores. Flores pro genere mediocres, segmentis late patentibus. Sepalum dorsale anguste lanceolatum, perlonge acuminatum. Sepala lateralia oblique lineari-lanceolata, perlonge acuminata, paulo longiora. Petala oblique lineari-lanceolata, longe acuminata, falcato-incurva, sepalo dorsali multo breviora. Labellum pandurato-oblongum, apice rotundatum et longe cuspidatum, basi sessili rotundatum, quam sepala multo brevius; discus basi cum callis duobus carnosis approximatis parte apicali conjunctis. Columna perparva, generis typica.

Plant large, said to be allied to *B. maculata* R. Br. Leaf (but one incomplete blade illustrated) large, oblong or elliptic-oblong, abruptly subacute or rounded at the apex, over 30 cm. long, 6–7 cm. wide. Raceme arcuate, densely many-flowered, the rachis being nearly 20 cm. long. Floral bracts small, ovate or ovate-lanceolate, acuminate, clasping, about one third as long as the pedicellate ovary. Flowers medium-sized for the genus, with horizontally spreading segments, greenish white with transverse chocolate or chocolate-purple bars near the base of the sepals and petals. Dorsal sepal narrowly lanceolate, long-acuminate, concave, about 6 cm. long and 6–6.5 mm. wide below the middle. Lateral sepals linear-lanceolate, long-acuminate, oblique, slightly falcate-incurved, about 6.5 cm. long and 6 mm. wide near the base. Petals linear-lanceolate, oblique, long-acuminate, falcate-incurved, nearly 4 cm. long when expanded, about 5 mm. wide near the base. Lip pandurate-oblong, rounded and very abruptly long-cuspidate at the apex, sessile at the rounded base, nearly 4.5 cm. long, about 1 cm. wide near the base and 0.9 cm. wide near the apex; disc at the base with a pair of approximate longitudinal fleshy calli which are fused above into a slightly dilated abruptly truncate and trilobulate apex. Column very

short and stout, about 6 mm. high, with a large stigmatic cavity.

PERU: Habitat not recorded, *L. Forget s.n.;* introduced by Messrs. Sander.

Notylia Buchtienii *Schlechter* in Fedde Repert. 10 (1912) 458; ex Mansfeld in Fedde Repert. Beihefte 58 (1930) t. 55, nr. 217.

Notylia moyobambae Schlechter in Fedde Repert. Beihefte 9 (1921) 108; ex Mansfeld in Fedde Repert. Beihefte 57 (1929) t. 127, nr. 498.

The Peruvian *Notylia moyobambae*, which was described from the inflorescences only, appears to differ from the Bolivian *N. Buchtienii* only in the following particulars. It has decurved (not strict) inflorescences with much shorter peduncles and racemes, slightly larger flowers (sepals 7 mm. long as contrasted with 5.5 mm. long), sharper apices to the sepals and petals, and a rounded instead of cordate-auriculate base to the lamina of the lip.

Several Peruvian specimens from the general region where *N. moyobambae* was collected, however, are surely referable to *N. Buchtienii*. Two of these collections have suberect inflorescences approaching those of *N. moyobambae;* the racemes of one collection vary from 6.4 cm. long (shorter than the maximum of 10 cm. cited for *N. moyobambae*) to about 19 cm. long (nearly equaling the minimum of 22 cm. of *N. Buchtienii*). In general, the size of the flowers coincides well with that of *N. Buchtienii*, but one collection shows flowers almost as large as those of *N. moyobambae*. All of these Peruvian specimens have the base of the lip more or less cordate-auriculate as in *N. Buchtienii*. This character is variable in the different collections and appears to vary even in flowers of the same number from being cordate to being cuneate-rounded.

It does not seem wise, therefore, to recognize *N. moyobambae* as separable from *N. Buchtienii*.

Notylia carnosiflora *C. Schweinfurth sp. nov.*

Herba parva. Pseudobulbi breves, complanato-cylindracei, unifoliati, vaginis pluribus distichis valde imbricatis vestiti. Folia elliptico-oblonga, apice rotundata, basi leviter cuneata, valde coriacea. Inflorescentia lateralis, basalis, arcuato-recurva, brevis; racemus subdense pluriflorus. Flores reflexi, cum segmentis carnosis patentibus. Sepalum dorsale valde fornicatum et concavum, oblongum, acutum. Sepala lateralia in laminam elliptico-oblongam tubulari-concavam apice minutissime bidentatam connata. Petala oblique elliptico-lanceolata vel oblongo-oblanceolata, falcato-incurva. Labellum breviter unguiculatum, quam petala multo brevius; lamina triangulari-ovata, acuta vel acuminata, basi callosa. Columna brevis, crassa.

Plant small. Roots fibrous, glabrous. Rhizome apparently abbreviated. Pseudobulb short, complanate-cylindric, unifoliate, rugose-striate in the dried specimen, about 1 cm. long, invested and concealed by several distichous closely imbricating sheaths of which the upper pair is leaf-bearing. Leaves elliptic-oblong, rounded at the apex, shortly cuneate-narrowed below with a complicate base, 4.6–6.2 cm. long, 1.3–1.9 cm. wide, thickly coriaceous. Inflorescence lateral, basal, arcuate-recurved; peduncle about 3.5 cm. long, with few sheaths which are remote above; raceme about 3 cm. long (apparently abnormally shortened in our specimen), subdensely several-flowered, with small reflexed bracts. Flowers small, reflexed, with spreading fleshy segments. Dorsal sepal strongly fornicate and concave, oblong, acute, about 7.5 mm. or less long in natural position, about 2.6 mm. wide when expanded. Lateral sepals connate into an elliptic-

oblong tubular-concave lamina which is minutely bidentate at the apex, about 7.5 mm. long and 3 mm. wide when expanded. Petals obliquely elliptic-lanceolate or oblong-oblanceolate, falcate-incurved, acute, about 5.9 mm. long and 1.2 mm. wide. Lip spreading from the column at a right angle, very shortly clawed, about 3.5 mm. long; claw abbreviated, very fleshy, about 0.75 mm. long; lamina triangular-ovate, acute or short-acuminate, subcordate at base, about 2.9 mm. long, up to 2 mm. wide at the base; disc with a fleshy minutely pubescent callus (continued from the claw) through the lower portion. Column short, stout, commonly dilated at base, about 2.9 mm. long, minutely pubescent.

This species differs from the Brazilian *Notylia pubescens* Lindl. in its much smaller leaves, fleshy (not membranaceous) flowers and shorter less attenuate lip.

JUNIN: Chanchamayo Valley, at 1800 meters altitude, September "1924–1927," *Carlos Schunke s.n.* (TYPE in Herb. Field Mus. No. 571652).

Notylia conduplicans *C. Schweinfurth sp. nov.*

Herba mediocris. Pseudobulbi parvi, complanato-cylindracei, unifoliati, vaginis pluribus distichis imbricatis vestiti. Folia oblonga vel elliptico-oblonga, apice late rotundata, basi plusminusve cuneata. Inflorescentia foliis distincte longior, parte superiore dense multiflora. Flores parvi, reflexi, omnino glabri, cum segmentis membranaceis late patentibus. Sepalum dorsale valde fornicatum, profunde concavum, lanceolato- vel elliptico-oblongum. Sepala lateralia in laminam subaequalem profunde tubulari-concavam, apice breviter bidentatam connata. Petala oblonga, obliqua, sepalis paulo breviora. Labellum distincte unguiculatum; lamina conduplicata, lateraliter visa recurvo-sigmoidea, acuta vel breviter acuminata, expansa ovato-cordata. Columna cylindracea, more generis.

Plant medium-sized, 28–33 cm. high, epiphytic. Rhizome abbreviated. Roots fibrous, glabrous, elongate. Pseudobulbs (only one present in each plant) small, complanate-cylindric, unifoliate, rugose-striate in the dried specimen, about 1.5 cm. long, surrounded and mostly concealed by several pairs of distichous closely imbricating sheaths of which the upper one or two sheaths are leaf-bearing. Leaves oblong or elliptic-oblong, broadly rounded and often apiculate (sometimes with slightly unequal lobes) above, more or less narrowed to a cuneate conduplicate base, coriaceous, 8.2–18.2 cm. long, 2.7–3.1 cm. wide. Inflorescence lateral, basal, gently arcuate-spreading or deflexed; peduncle about 9.5 cm. or less long, bearing several remote short tubular sheaths; raceme 21–22 cm. long, densely many-flowered. Floral bracts small, linear-triangular, spreading or reflexed, much shorter than the pedicellate ovary. Flowers reflexed, small, bright green and white, glabrous throughout, with widely spreading membranaceous segments. Dorsal sepal strongly fornicate and concave, lanceolate-oblong or elliptic-oblong, about 5.6 mm. or less long in natural position and 2.2 mm. wide when expanded, obtuse, carinate above. Lateral sepals connate into a lanceolate-oblong tubular-concave lamina which is very shortly bilobed at the apex with a dorsal subapical mucro, about 5.5 mm. or less long and 1.8 mm. or less wide when expanded. Petals obliquely oblong, acute, about 5 mm. long and 1.1 mm. wide. Lip adnate to the base of the column, about 3 mm. or less long, prominently clawed; claw narrow, about 1 mm. long, with a high central keel extending onto the middle of the lamina; lamina with conduplicate sides, recurved and sigmoid when viewed from the side, when expanded ovate-cordate, acute or shortly acuminate, up to 2 mm. in greatest length, about 1.6 mm. wide. Column cylindric, abruptly

reflexed near the apex, 3.1–3.9 mm. long at the back. Anther dorsal, pyriform-concave. Pollinia two, complanate-obovoid with a linear-cuneate stipe.

This species is closely allied to *Notylia Amesii* Smith & Harris from British Guiana, with which it was formerly confused, but is distinct in having differently colored more membranaceous flowers, a larger lip and a slightly longer column.

Loreto: Mishuyacu, near Iquitos, at 100 meters altitude, in forest, February to March, 1939, *G. Klug 999;* vicinity of Iquitos, at 100 meters altitude, epiphyte in dense forest, November to December 1936, *Klug 10031* (Type in Herb. Ames No. 62135).

Notylia mirabilis *C. Schweinfurth sp. nov.*

Herba pro genere minima, epiphytica. Caules abbreviati, foliorum circulo omnino celati. Folia equitantia, parva, profunde imbricantia, pauca, lineari-oblonga vel elliptico-linearia, plusminusve falcato-recurva, exarticulata. Scapus filiformis, supra cum ramulis strictis uni-vel paucifloris. Flores parvi, membranacei. Sepalum dorsale ovato-oblongum, acutum, valde concavum. Sepala lateralia fere omnino libera, oblique elliptico-lanceolata, acuminata. Petala lanceolata, supra angustata. Labellum unguiculatum; unguis perangustus, carnosus; lamina concava, obovata, antice late rotundata et apiculata, postice auriculata. Columna tenuis, apice abrupte dilatata.

Plant very small, caespitose, epiphytic, 2.5–4.5 cm. high. Roots numerous, fibrous, glabrous, flexuous. Rhizome abbreviated. Stems abbreviated, entirely concealed by the flabelliform clusters of leaves. Leaves equitant, closely imbricated, four to six (two or three on each side), obliquely linear-oblong, linear-lanceolate or elliptic-linear, commonly strongly falcate-recurved, acute to subobtuse, unjointed to sheaths at base, about 1.4 cm. or less long from the apex to the base on the lower side, 1.5–3.5 mm. wide. Inflorescence filiform, erect to slight-

ly arcuate, much exceeding the clusters of leaves, apparently 2.5–3.5 cm. long, near the apex with several ascending to strict 1- to few-flowered branches (and thus paniculate). Floral bracts minute, ovate, concave. Flowers small, thinly membranaceous, light lilac and dark violet, with widely spreading segments. Sepals and petals 1-nerved. Dorsal sepal ovate-oblong, acute, deeply concave, dorsally carinate except at the apex, about 3.6 mm. or less long, about 2 mm. or less wide. Lateral sepals connate at the very base, obliquely elliptic-lanceolate, acuminate, carinate near the base, about 4 mm. or less long and 1.1 mm. wide. Petals lanceolate, lightly oblique, narrowed to an acute apex, about 4 mm. or less long and 1.3 mm. or less wide. Lip about equaling the lateral sepals, unguiculate; claw relatively long and slender, fleshy, subterete, somewhat dilated above, about 1.3 mm. or less long; lamina concave, simple, obovate when expanded, broadly rounded in front with a prominent apicule, auriculate at the base, about 2.8 mm. long and 2 mm. wide, with slightly irregular margins. Column slender below, very abruptly dilated at the apex (especially at the back), about 2 mm. long. Anther dorsal; pollinia two.

This little species is apparently allied to the Brazilian *Notylia rosea* (Rodr.) Cogn., but differs in having much smaller leaves and flowers, broader sepals, and a dissimilar lip and column.

Loreto: vicinity of Iquitos, at 100 meters altitude, on dead tree, July 1937, *G. Klug 10112* (Type in Herb. Ames No. 62158).

Notylia parvilabia *C. Schweinfurth sp. nov.*

Herba parvula, caespitosa. Pseudobulbi parvi, aggregati, complanato-cylindracei, unifoliati, vaginis pluribus distichis valde imbricatis vestiti. Folia oblonga vel oblanceolato-oblonga, apice rotundata, infra plusminusve

angustata. Inflorescentia lateralis, basalis, arcuato-recurva, foliis longior. Racemus dense multiflorus. Bracteae floresque reflexi. Flores parvi, omnino glabri, segmentis patentibus. Sepalum dorsale valde fornicatum et concavum, expansum lanceolato-oblongum, acutum. Sepala lateralia in laminam oblongo-lanceolatam vel lanceolato-ellipticam minute bidentatam connata. Petala lanceolato-oblonga vel oblanceolato-oblonga, subacuta. Labellum parvum, unguiculatum; lamina rhombico-ovata, parte inferiore carinata. Columna satis longa, cylindracea.

Plant small, caespitose. Roots fibrous, glabrous. Rhizome abbreviated. Pseudobulbs small, aggregated, complanate-cylindric, unifoliate, rugose-striate in the dried specimen, about 1.3 cm. or less long, invested and more or less concealed by several distichous closely imbricating sheaths of which the upper one or two on each side are leaf-bearing. Leaves oblong or oblanceolate-oblong, rounded at the apex with slightly unequal lobes and a caducous apicule, more or less narrowed below with a conduplicate base, 4.8–11.3 cm. long, about 1.4 cm. or less wide, thickly coriaceous, with the mid-nerve rather prominently exserted beneath. Inflorescences lateral, basal, solitary, arcuate-recurved, more or less surpassing the leaves; peduncle about 7.5 cm. or less long, provided with a few short, erect-spreading sheaths which are remote above and imbricating at the base; raceme densely many-flowered (incomplete in our specimens). Floral bracts short, linear-lanceolate, reflexed. Flowers small, reflexed, entirely glabrous, with widely spreading subfleshy segments. Dorsal sepal strongly fornicate and concave, when expanded lanceolate-oblong, acute, about 5 mm. or less long and 2 mm. wide. Lateral sepals connate into an oblong-lanceolate or lanceolate-elliptic deeply concave lamina which is minutely bidentate at the apex and is about as long and broad as the dorsal

sepal. Petals lanceolate-oblong or oblanceolate-oblong, subacute, more or less oblique, about 4 mm. long, 1–1.2 mm. wide. Lip small, adnate to the base of the column, distinctly shorter than the column, conspicuously clawed, up to 2.2 mm. long; claw about 1 mm. or less long, gradually merging with the lamina, with a high central keel that extends to about the middle of the lamina; lamina rhombic-ovate with incurved sides, narrowed to a subacute apex, about 1.6 mm. wide when expanded. Column long, cylindric, abruptly recurved at the apex, about 3.5 mm. or less long at the back, more or less clavate.

This species is allied to *Notylia Koehleri* Schltr., which has a lip about equaling the petals and much exceeding the column.

JUNIN: Chanchamayo Valley, at 1200 meters altitude, September 1930, *Carlos Schunke 2054* (TYPE in Herb. Field Mus. No. 622365); same locality and date, at 1500 meters altitude, *Carlos Schunke 1106*.

Notylia peruviana (*Schltr.*) *C. Schweinfurth comb. nov.*

Dipteranthus peruvianus Schlechter in Orchis 10 (1916) 187, t. 44, figs. 8–16.

As noted by my colleague, Dr. L. O. Williams, this concept does not represent a member of the genus *Dipteranthus* Rodr., but is a true *Notylia*. Therefore, the above combination is proposed.

This species appears to be very closely allied to *Notylia boliviensis* Schltr., which has also been collected in Peru, and is vegetatively nearly inseparable. It differs from the latter species, however, in having a lax (not dense) raceme with somewhat smaller flowers, in having obtuse (not acute nor acuminate) petals, and in having a lip which is ovate-suborbicular rather than subquadrate-ovate.

Notylia rhombilabia *C. Schweinfurth sp. nov.*

Herba mediocris, gracilis. Pseudobulbi anguste complanato-cylindracei, unifoliati, vaginis subtribus distichis valde imbricantibus superne foliiferis obtecti. Folia linearia vel lineari-elliptica, subacuta et valde mucronata, basi angustata et conduplicata, coriacea. Inflorescentia lateralis, basalis, basi abrupte deflexa, supra subdense multiflora. Flores reflexi, cum segmentis late patentibus. Sepalum dorsale valde fornicatum et concavum, expansum oblongo-lanceolatum, acutum. Sepala lateralia in laminam oblongo-ellipticam profunde concavam longe bidentatam connata, apicibus recurvis. Petala linearia, falcato-incurva, acuta. Labellum rhombicum vel ovato-rhombicum, longe acuminatum, basi cuneatum. Columna cylindracea, supra leviter contracta.

Plant medium-sized, slender. Rhizome apparently abbreviated. Roots fibrous, glabrous, elongate, somewhat branched. Pseudobulbs narrowly complanate-cylindric, unifoliate, rugose-striate when dry, up to 1.8 cm. long, invested and partly concealed by two or three pairs of distichous deeply imbricating sheaths of which the upper one or two on each side are leaf-bearing. Leaves linear or elliptic-linear, subacute with a conspicuous caducous mucro, slightly cuneate-narrowed below to a conduplicate base, coriaceous, with the mid-nerve carinate beneath, up to 13.2 cm. long and 1.2 cm. wide (sometimes very small). Inflorescence lateral, basal, sharply deflexed near the base, commonly much surpassing the leaves, subdensely many-flowered above, rarely one-branched below; peduncle about 11.9 cm. or less long, provided with several small erect-spreading sheaths which are remote above and imbricating at the base; raceme 10–13.6 cm. long, straight or flexuous. Floral bracts linear-lanceolate, the longest ones (at the base of the raceme) a little shorter than the pedicellate ovary. Flowers re-

flexed, light green and white, entirely glabrous, with widely spreading segments. Sepals subfleshy, lip fleshy. Dorsal sepal strongly fornicate and concave, when expanded lanceolate-oblong, acute, about 8 mm. long, up to 3 mm. wide. Lateral sepals connate into an oblong-elliptic deeply concave lamina which is sharply bidentate to above the middle with lobules recurved at the apex, about 7.5 mm. long and 4 mm. wide when expanded. Petals linear, falcate-incurved, acute, up to 7.5 mm. long and 1.1 mm. wide. Lip adnate to the column at the base, rhombic or ovate-rhombic with rounded spreading sides, more or less abruptly long-acuminate, cuneate below (often slightly incurved on each side) to a sessile base, about 6 mm. long, up to 4.1 mm. wide; disc with a low callose keel extending from the base to about the middle. Column cylindric, slightly tapering above, about 4.8 mm. long at the back, somewhat sigmoid-recurved near the apex.

The allied *Notylia Lehmanniana* Kränzl. from Colombia differs from this species in having racemes floriferous to the base and flowers less than half as large.

Florally *N. rhombilabia* is very similar to the Panamanian *N. latilabia* A. & S., but it is very dissimilar in vegetative parts.

Loreto: vicinity of Iquitos, at 100 meters altitude, epiphyte in dense forest, November to December 1936, *G. Klug 10028* (Type in Herb. Ames No. 62159).

EXPLANATION OF THE ILLUSTRATIONS

PLATE XXV. NOTYLIA CONDUPLICANS *C. Schweinf.* 1, habit, four fifths natural size. 2, flower, from side, four times natural size. 3, dorsal sepal, eight times natural size. 4, petal, eight times natural size. 5, lateral sepals, eight times natural size. 6, column and lip, from side, eight times natural size.

PLATE XXVI. NOTYLIA PARVILABIA *C. Schweinf.* 1, habit, natural size. 2, flower, from side, five times natural size. 3, dorsal sepal, eight times natural size. 4, petal, eight times natural size. 5, lateral sepals, eight times natural size. 6, lip and column, from side, eight times natural size. 7, lip, expanded, from above, sixteen times natural size.

PLATE XXVII. NOTYLIA RHOMBILABIA *C. Schweinf.* 1, habit, four fifths natural size. 2, flower, oblique view, four times natural size. 3, dorsal sepal, four times natural size. 4, petal, four times natural size. 5, lateral sepals, four times natural size. 6, lip, expanded, from above, four times natural size. 7, lip and column from side, four times natural size. 8, anther, four times natural size.

PLATE XXVIII. NOTYLIA CARNOSIFLORA *C. Schweinf.* 1, habit, natural size. 2, flower, twice natural size. 3, dorsal sepal, four times natural size. 4, petal, four times natural size. 5, lateral sepals, four times natural size. 6, lip and column, from side, four times natural size. 7, lip, expanded, from above, six times natural size.

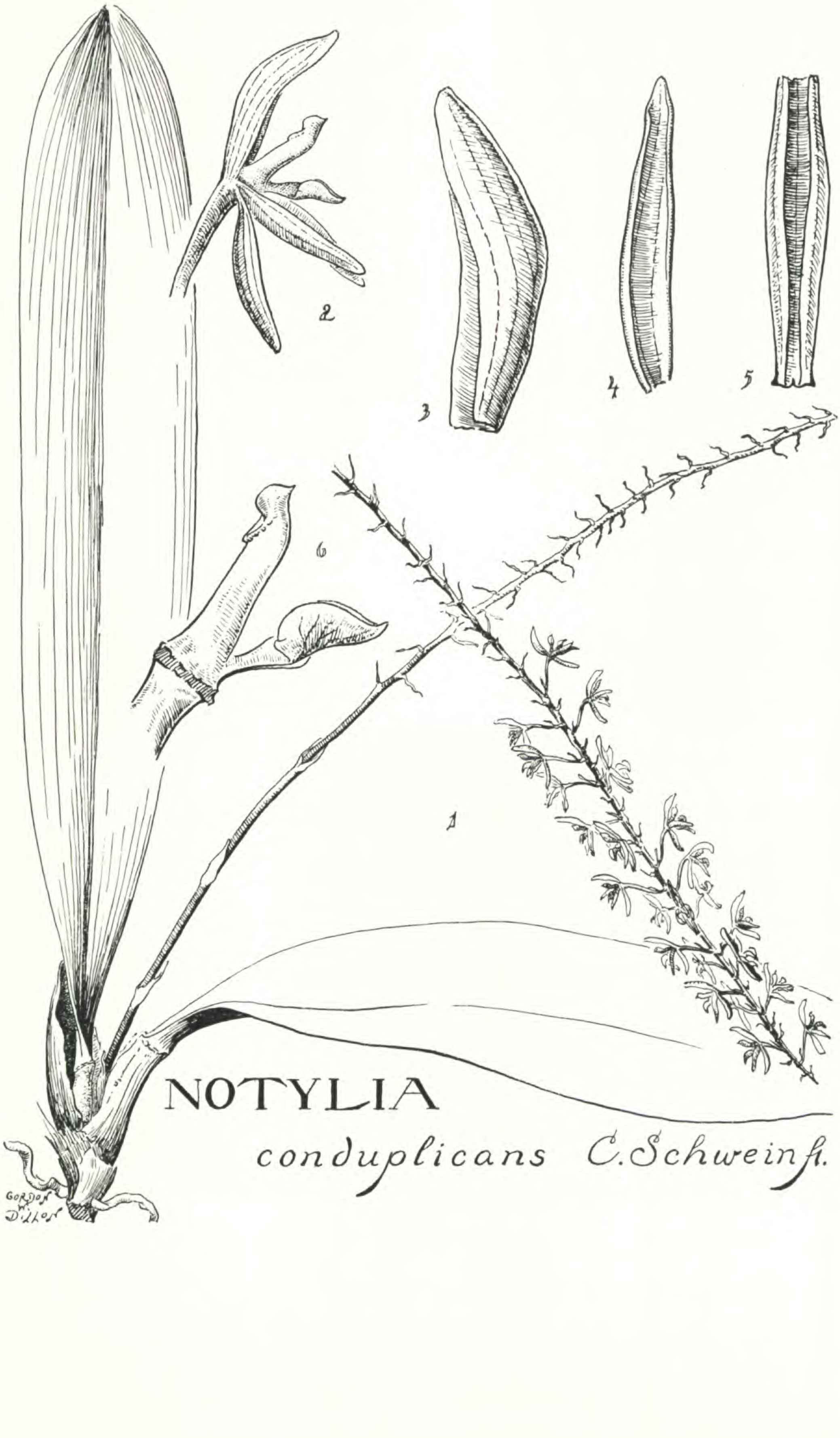
NOTYLIA MIRABILIS *C. Schweinf.* 8, habit, natural size. 9, flower, five times natural size. 10, dorsal sepal, six times natural size. 11, petal, six times natural size. 12, lateral sepal, six times natural size. 13, lip, from above, six times natural size. 14, lip, from the side, six times natural size.

PLATE XXIX. NEOKOEHLERIA PANICULATA *C. Schweinf.* 1, habit, natural size. 2, flower, eight times natural size. 3, dorsal sepal, four times natural size. 4, petal, four times natural size. 5, lateral sepals, four times natural size. 6, lip and column, from side, eight times natural size. 7, lip, from above, eight times natural size.

PLATE XXX. CRYPTOCENTRUM INAEQUISEPALUM *C. Schweinf.* 1, habit, four fifths natural size. 2, flower, twice natural size. 3, dorsal sepal, twice natural size. 4, petal, twice natural size. 5, lateral sepal, twice natural size. 6, lip, from side, twice natural size. 7, lip, from above, four times natural size. 8, column, six times natural size.

PLATE XXXI. CRYPTOCENTRUM PSEUDOBULBOSUM *C. Schweinf.* 1, habit, twice natural size. 2, flower, three times natural size. 3, dorsal sepal, three times natural size. 4, petal, three times natural size. 5, lateral sepal, three times natural size. 6, lip, from side, three times natural size. 7, lip, from above, three times natural size. 8, column, six times natural size.

Plate XXV



NOTYLIA

conduplicans C. Schweinfl.

PLATE XXVI

NOTYLIA

parvilabia C. Schweinf.



PLATE XXVII

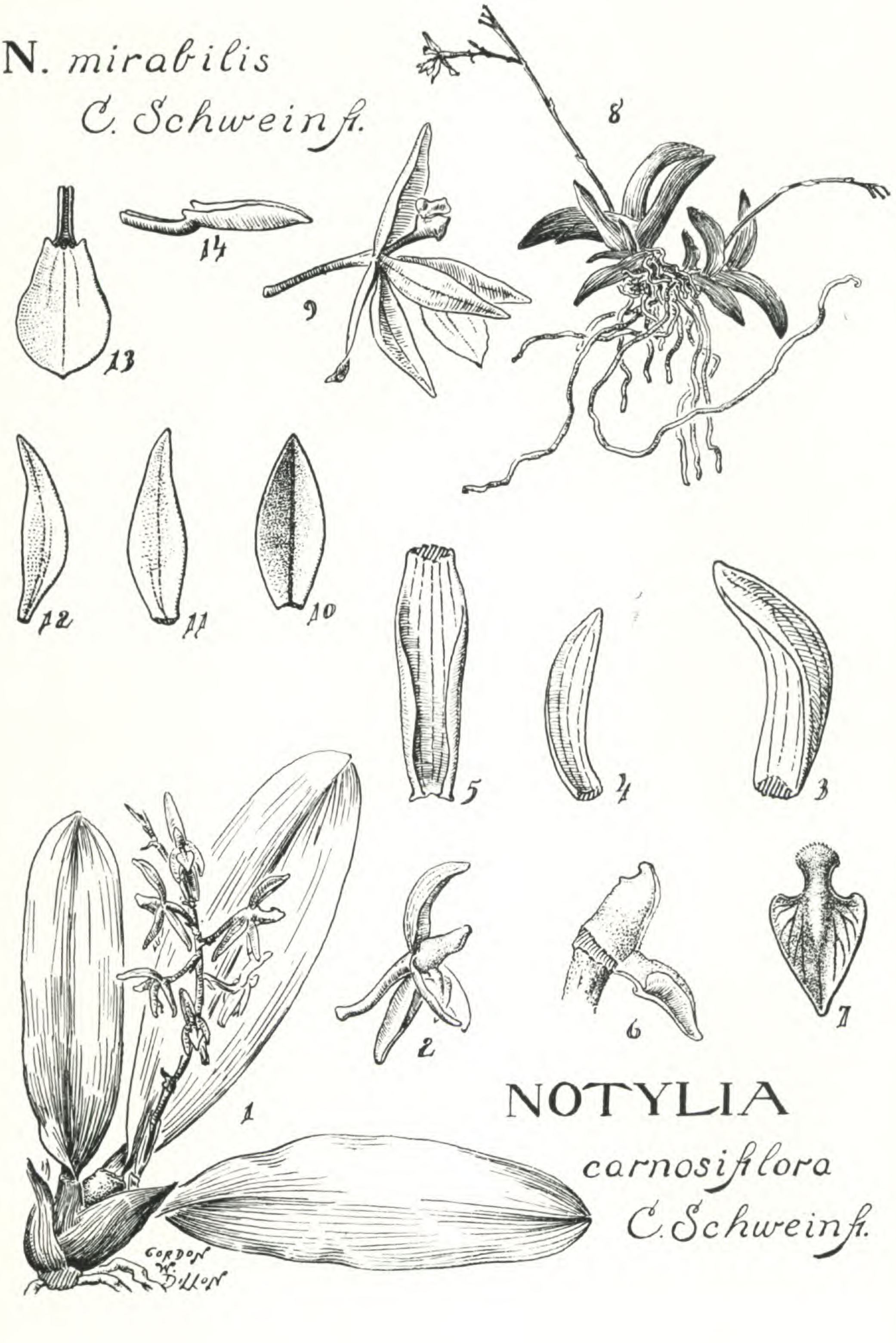
NOTYLIA

rhombilabia C. Schweinf.



PLATE XXVIII

N. *mirabilis*
C. Schweinfl.



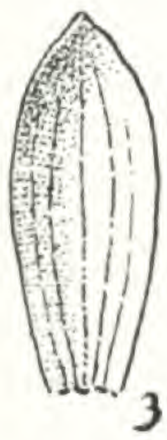
GORDON W. DILLON

NOTYLIA
carnosiflora
C. Schweinfl.

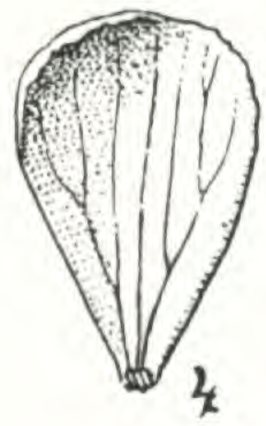
PLATE XXIX

NEOKOEHLERIA

paniculata C. Schweinf.

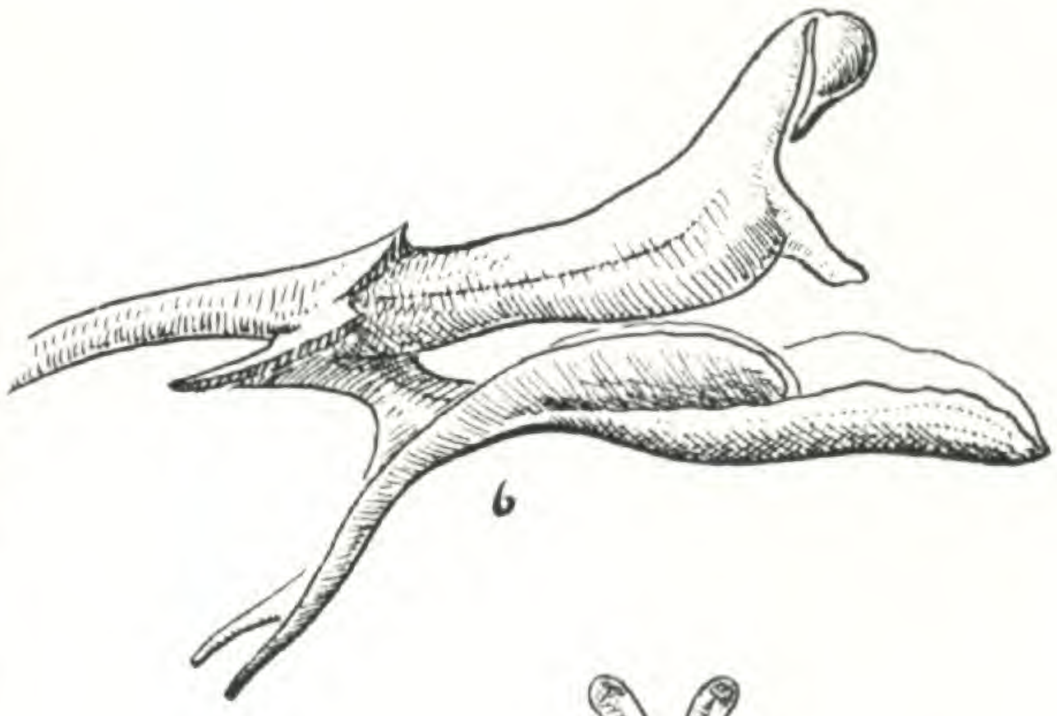


3



4

5



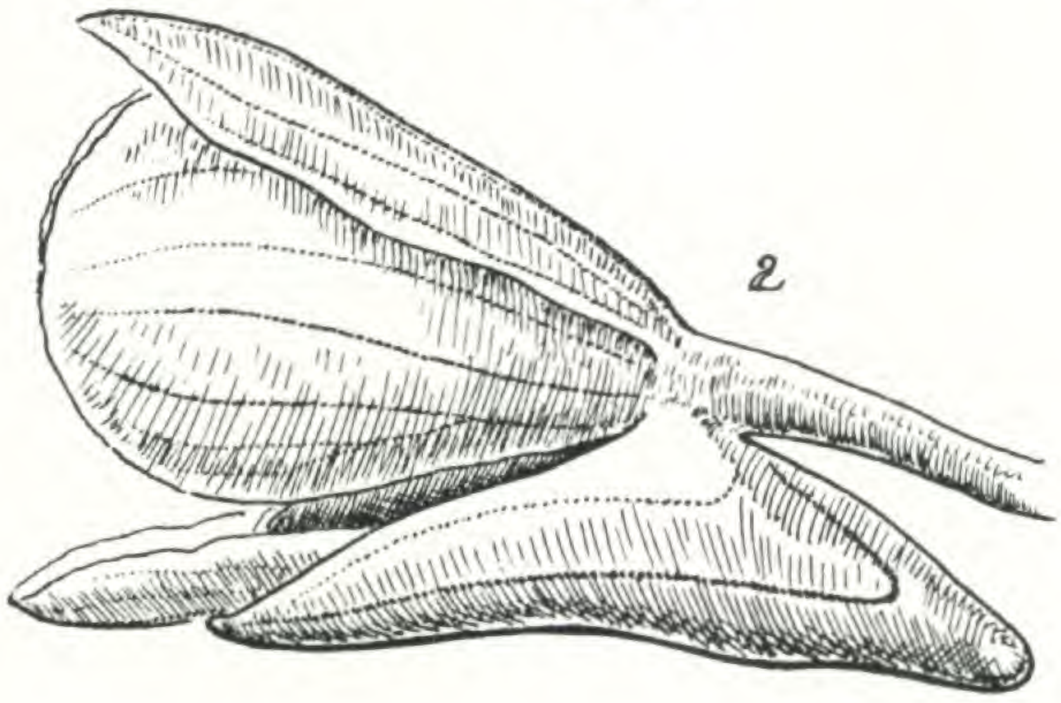
6



1



7



2

PLATE XXX

CRYPTOCENTRUM

inaequisepalum C. Schweinf.

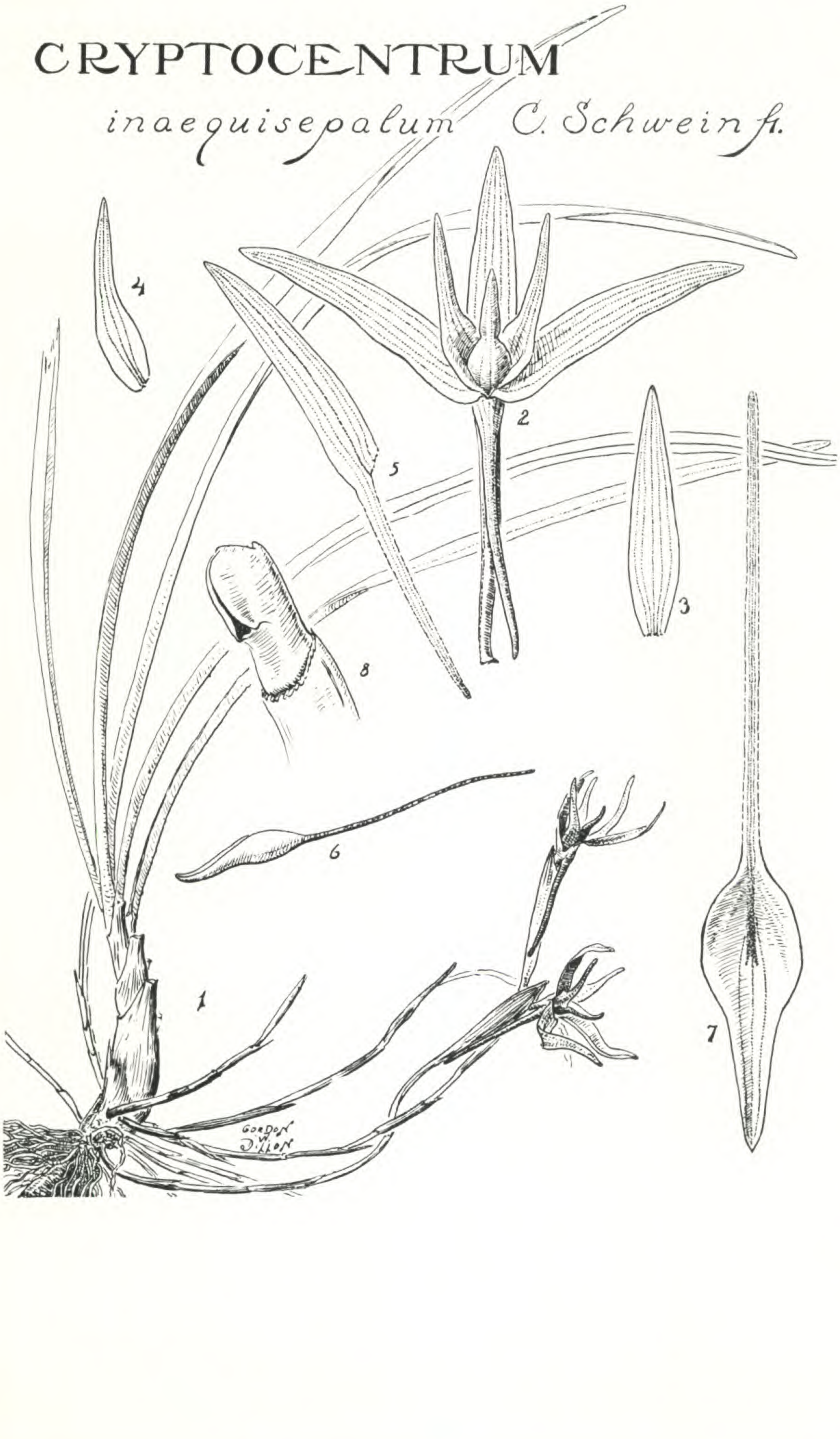
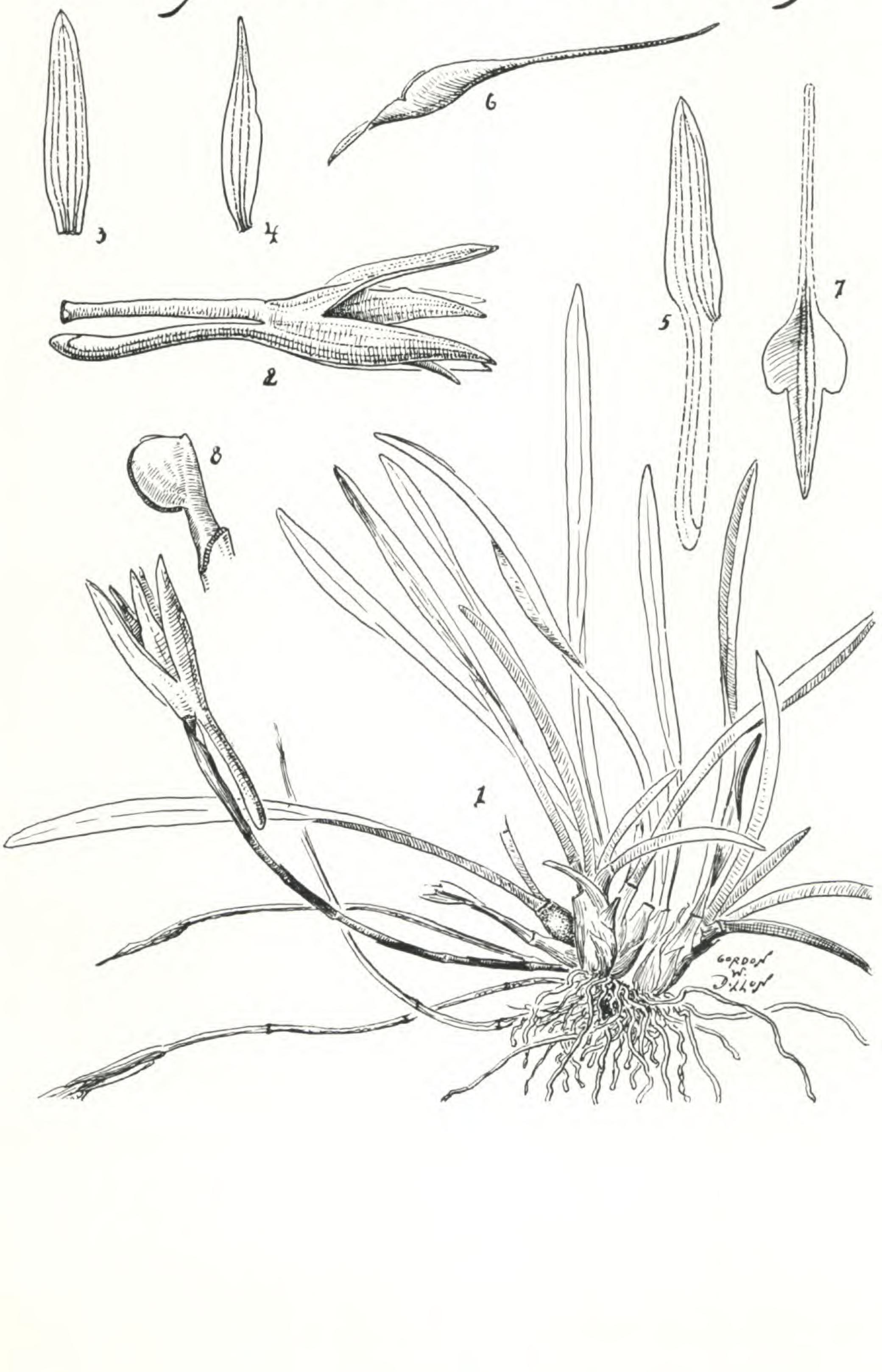


PLATE XXXI

CRYPTOCENTRUM

pseudobulbosum C. Schweinfl.



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CAMBRIDGE, MASSACHUSETTS, APRIL 17, 1946 VOL. 12, NO. 7

NEW AND INTERESTING MEXICAN ORCHIDS

BY
LOUIS O. WILLIAMS

IN 1938 I went to Mexico to see the orchid herbarium of Erik Oestlund and if possible to secure it as an addition to the Ames Herbarium at Harvard University. The Oestlund heirs gave the collection to the Ames Herbarium and it was forwarded to Cambridge.

The collection was carefully studied and has now been incorporated with the Ames Herbarium.

The Oestlund collections were made principally by Otto Nagel, Juan González and Mr. Oestlund, with the occasional help of others. The herbarium is by far the largest single collection of orchids ever made in Mexico, consisting of about four thousand numbers, many of them in duplicate. The serial numbers run from 500 to 8037. A large portion of the numbers in the series, however, are not represented by specimens.

Papers describing novelties from the Oestlund herbarium have appeared occasionally in this journal as the study and naming of the collection progressed. This paper describes the last of such novelties, as well as some others that were discovered in other collections during the time that the Oestlund collection was being studied.

A complete set of the Oestlund specimens, as well as the types of all of the novelties described from it, is to

be found in the Ames Herbarium. The second and third sets from the collection are to be found in the Herbarium of the Missouri Botanical Garden and in the United States National Herbarium.

Spiranthes chartacea *L. O. Williams sp. nov.*

Herbae erectae, terrestres, usque ad 4.5 dm. altae. Folia elliptica ut videtur. Inflorescentia confertiflora, pauci- vel multiflora. Sepalum dorsale lanceolatum, acutum. Sepala lateralia linearia, acuta. Petala late oblanceolata, falcata, unguiculata, acuta, apice plusminusve denticulata. Labellum panduratum, breviter unguiculatum.

Erect, terrestrial herbs, up to 4.5 dm. tall. Scape covered with chartaceous, lanceolate, acute or acuminate bracts, with the remains of the leaves toward the base. Leaves not present at the flowering stage, apparently elliptic and perhaps up to 8 cm. long and 1.5 cm. broad. Inflorescence up to 7 cm. long, congested, few- to several-flowered; floral bracts up to 2.5 cm. long, ovate-lanceolate to ovate, acuminate, chartaceous, striated. Dorsal sepal 7–9 mm. long and 2.5–3 mm. broad, lanceolate, acute, 3-nerved, pubescent dorsally nearly to the apex. Lateral sepals 8–10 mm. long and 1.5–2 mm. broad, linear, acute, 3-nerved, pubescent dorsally to about the middle, forming a short mentum at the base. Petals 6–8 mm. long and about 2 mm. broad, broadly oblanceolate, falcate, unguiculate, acute, 3-nerved, the apical half more or less denticulate, adnate to the dorsal sepal. Lip 9–10 mm. long and 4–5 mm. broad, panduate, short-unguiculate; terminal lobe 5–6 mm. long and 4–5 mm. broad, oval to suborbicular, acute to truncate, entire or more or less denticulate, both surfaces papillose; basal lobes about 2 mm. long and 4 mm. across, rounded, adnate to the column; claw about 2 mm. long and 1 mm.

broad, the margins fleshy-thickened, short-pubescent. Column about 5 mm. long including the lanceolate or lanceolate-triangular, flattened rostellum.

Mexico: under pines, Barranca del Laurel, northeast of Ciudad Guzmán, State of Jalisco, altitude 2000 m., longitude 103°26′ west, latitude 19°42′ north, February 26, 1936, *Nagel & Navarro 5408;* under pines, Barranca del Laurel, northeast of Ciudad Guzmán, State of Jalisco, altitude 2000 m., longitude 103°26′ west, latitude 19°42′ north, March 8, 1936, *Nagel & Navarro 5419* (Type in Herb. Ames No. 54606).

There are a number of species of Spiranthes in Mexico which have chartaceous or semi-chartaceous floral and cauline bracts. *Spiranthes chartacea* is perhaps more closely allied to *S. albovaginata* C. Schweinf. than to any of the other species, but it is amply distinct in the shape of the lip, sepals and petals.

Spiranthes congestiflora *L. O. Williams sp. nov.*

Herbae terrestres, erectae, usque ad 20 cm. altae. Folia ignota. Inflorescentia congestiflora, subcapitata, pauci- vel pluriflora. Sepalum dorsale lineari-lanceolatum, acutum, carnosum. Sepala lateralia linearia vel lineari-lanceolata, acuta, leviter falcata, carnosa. Petala anguste oblanceolato-spathulata, acuta vel obtusa, carnosa. Labellum lineari-oblongum, supra basim et sub apice constrictum. Columna sectionis.

Small, erect, terrestrial herbs, up to 20 cm. tall. Scape slender, with several scarious, semiamplexicaul, ovate-lanceolate bracts. Leaves unknown. Inflorescence congested, subcapitate, few- to several-flowered. Dorsal sepal 15–19 mm. long and 3–4 mm. broad, linear-lanceolate, acute, fleshy, 3- to 5-nerved. Lateral sepals 14–16 mm. long and 2.5–3.5 mm. broad, linear or linear-lanceolate, acute, slightly falcate, 3-(4-)nerved, fleshy. Petals 14–15 mm. long and about 2.5 mm. broad, narrowly oblanceolate-spatulate, acute or obtuse, fleshy, 3-nerved. Lip

15–17 mm. long and about 6 mm. broad, linear-oblong in outline, constricted above the base and again below the apex; terminal portion ovate, crenulate, obtuse or acute; basal portion concave; disc pubescent. Column of the section Sarcoglottis.

Mexico: Barranca del Laurel, Moralia, State of Michoacán, altitude 2000 m., "9 . 5 . 1912," *Arséne 9026* (Type in U. S. Nat. Herb.).

Spiranthes congestiflora resembles several of the species of the Sarcoglottis section of Spiranthes, but does not match any one known to me. The congested inflorescence is distinctive.

Spiranthes falcata *L. O. Williams sp. nov.*

Herbae terrestres, graciles, 17–35 cm. altae. Inflorescentia brevis, pauciflora. Sepalum dorsale lanceolatum, acutum vel obtusum, trinervium. Sepala lateralia lineari-lanceolata, acuta vel obtusa, trinervia. Petala elliptico-lanceolata, falcata, acuta vel obtusa, trinervia. Labellum oblongo-panduratum; lobus terminalis subrotundatus, obtusus; lobi laterales acriter angulati. Columna generis.

Small, erect, terrestrial, slender herbs, 17–35 cm. tall. Stems slender, more or less covered with scarious, hyaline, striated, semiamplexicaul bracts. Leaves withered at anthesis, apparently elliptic and 4–8 cm. long, basal or nearly so. Inflorescence short, few-flowered; floral bracts similar to the cauline bracts, lanceolate to ovate-lanceolate, acuminate. Dorsal sepal about 5 mm. long and 2 mm. broad, lanceolate, acute or slightly obtuse, 3-nerved. Lateral sepals about 5 mm. long and 1.5 mm. broad, linear-lanceolate, acute or obtuse, 3-nerved. Petals about 5 mm. long and 1.5 mm. broad, elliptic-lanceolate, falcate, acute or obtuse, 3-nerved, lightly adnate to the dorsal sepal. Lip 6–7 mm. long and 3–3.5 mm. broad, oblong-pandurate, somewhat attenuated at the base;

terminal lobe subrotund, obtuse, upper surface papilliferous; basal half of the lip with two sharply angled lobes, disc puberulent. Column 4–5 mm. long, puberulent below; anther subrotund, with a callus-thickening in the middle.

Mexico: in oak and pine forest between Guanacevi and Guadalupe y Calvo, Durango to Chihuahua, longitude ca. 105°56′ west, latitude 25°56′ north, at ca. 2200 meters altitude, February 24, 1936, *Juan G.* [*onzáles*] *5023* (Type in Herb. Ames No. 51352); ibid, February 10, 1936, *Juan G.* [*onzáles*] *5018*.

Both of the specimens cited were flowered in Cuernavaca from roots sent in by the collector.

Spiranthes falcata is somewhat allied to *S. eriophora* Robins. & Greenm.

Spiranthes Gonzalezii *L. O. Williams sp. nov.*

Herbae parvae, terrestres, usque ad 25 cm. altae. Folia rosulata, oblanceolata vel obovata, obtusa vel acuta. Sepalum dorsale ovato-lanceolatum, obtusum. Sepala lateralia lanceolata, obtusa. Petala lineari-oblonga vel lineari-lanceolata, obtusa, leviter falcata. Labellum ovato-sagittatum, prope apicem constrictum, breviter unguiculatum, plusminusve carnosum.

Small terrestrial herbs up to about 25 cm. tall. Scapes slender, with several scarious bracts. Leaves basal, 6–14 cm. long and 1.3–3.5 cm. broad, oblanceolate to obovate, obtuse or acute, thin, tapering gradually into a short petiole. Inflorescence strict, many-flowered; flowers small for the genus. Dorsal sepal about 3 mm. long and 1.5 mm. broad, ovate-lanceolate, obtuse, obscurely 3-nerved. Lateral sepals about 3 mm. long and 1 mm. broad, lanceolate, obtuse, 1-nerved. Petals about 3 mm. long and 0.75 mm. broad, linear-oblong to linear-lanceolate, obtuse, slightly falcate, 1-(2-)nerved, lightly adnate to the dorsal sepal. Lip about 2.5 mm. long and 1.5 mm.

broad, ovate-sagittate, prominently constricted toward the apex, short-unguiculate, more or less fleshy, the basal auricles especially so, 3- to 5-nerved. Column about 2 mm. long; anther about 1.5 mm. long, ovate-lanceolate.

MEXICO: Volcán Ceboruco, State of Nayarit, altitude 1300 m., longitude 104°31′ west, latitude 21°08′ north, November 14, 1935, *Juan G. [onzáles] 5077* (TYPE in Herb. Ames No. 51337).

Spiranthes Gonzalezii is not closely related to any species known to me, but seems to be somewhat allied to *S. sparsiflora* C. Schweinf.

Juan Gonzáles, for whom this species is named, is a native Mexican who collected a large number of orchids under the direction of Erik Oestlund and Otto Nagel. Although he apparently spelled his name Gonzáles (on labels often Juan G.) the correct Spanish form González is used in the specific name.

Spiranthes Nagelii *L. O. Williams sp. nov.*

Herbae terrestres, graciles, 12–30 cm. altae. Folia rosulata vel subrosulata, lanceolata, ovato-lanceolata, ovato-oblonga vel suborbicularia. Inflorescentia pauciflora. Sepalum dorsale lanceolatum, acutum vel acuminatum. Sepala lateralia lineari-lanceolata, acuta, leviter falcata. Petala linearia, acuta, leviter falcata. Labellum oblongo-ovale, subpanduratum, breviter unguiculatum.

Slender terrestrial herbs, 12–30 cm. tall. Scapes slender, with several scarious, semiamplexicaul, lanceolate, acute or acuminate bracts, pubescent at least above. Leaves basal or nearly so, 3–9 cm. long and 2–5.5 cm. broad, lanceolate, ovate-lanceolate or ovate-oblong to suborbicular, acute or obtuse, thin; petiole 1–4 cm. long. Inflorescence few-flowered. Dorsal sepal about 13–15 mm. long and 3–4.5 mm. broad, lanceolate, acute or acuminate, 3-nerved, pubescent dorsally. Lateral sepals 10–13 mm. long and 2–3 mm. broad, linear to linear-

lanceolate, acute, somewhat falcate, 3-nerved, pubescent dorsally. Petals 11–14 mm. long and 1–1.5 mm. broad, linear, acute, slightly falcate, narrowest at the base, 1-nerved, adnate to the dorsal sepal above. Lip 13–17 mm. long and 5–6.5 mm. broad, oblong-oval, subpandurate, sharply constricted at the base and with two small basal auricles, short-unguiculate, pubescent on both sides at the base. Column 10–12 mm. long, prominently pubescent on the inner side, especially toward the base.

MEXICO: in soft black soil, region of Villa Juarez, State of San Luis Potosí, altitude ca. 1900 m., October 27, 1936, *Dino 6497;* on rocks in leaf mold, mountains above Tamasopo, State of San Luis Potosí, flowers pale pink, altitude ca. 700 m., August 20, 1937, *Dino 6931 in part;* in loose black soil, mountains in district of Juarez near Cerritos, State of San Luis Potosí, altitude ca. 1900 m., longitude 100° 49′ west, latitude 22°10′ north, flowers pale pink, September 3, 1936, *Nagel & Dino 6187* (TYPE in Herb. Ames No. 51255); in loose black soil, mountains near Cerritos, State of San Luis Potosí, altitude 1800 m., longitude 100°16′ west, latitude 22°26′ north, flowers pale pink, September 22, 1936, *Nagel & Dino 6343.*

Spiranthes Nagelii is closely allied to *S. durangensis* A. & S., from which it is distinguished by its broad leaves which are present at flowering time. In *S. durangensis* the leaves are lacking at anthesis or, if present, are lanceolate. The lip of *S. Nagelii* is only slightly constricted toward the middle and has basal calli which form small auricles; in *S. durangensis* the lip is prominently constricted near the middle and lacks basal calli or auricles.

The species is dedicated to Mr. Otto Nagel, one of the most discriminating of the collectors of Mexican Orchidaceae.

Spiranthes pseudogoodyerioides *L. O. Williams sp. nov.*

Herbae parvae, terrestres, usque ad 2 dm. altae. Folia rosulata, ovalia, oblonga vel oblongo-ovata, acuta vel leviter acuminata. Sepalum dorsale triangulari-lanceola-

tum, cochleatum. Sepala lateralia late lanceolata, leviter obliqua, acuta. Petala elliptica, arcuata, acuta. Labellum sagittatum, leviter carnosum.

Small terrestrial, acaulescent herbs, up to 2 dm. tall. Leaves basal, petiolate; lamina 2–8 cm. long and 1.3–4 cm. broad, oval, oblong or oblong-ovate, acute or somewhat acuminate, 5- to 7-nerved, submembranaceous; petiole slender, shorter than the lamina. Scape erect, covered with scarious, lanceolate, acuminate bracts. Inflorescence compact. Flowers small. Dorsal sepal about 2 mm. long and about 1.25 mm. broad, triangular-lanceolate, cochleate, 1-nerved, pubescent dorsally. Lateral sepals about 2 mm. long and 1.2 mm. broad, broadly lanceolate, somewhat oblique, acute, 1-nerved, pubescent dorsally. Petals 1.5 mm. long and 0.6 mm. broad, elliptic, arcuate, acute, 1-nerved. Lip 1.5–1.8 mm. long and 1–1.5 mm. broad, sagittate, somewhat fleshy, 1-nerved. Column about 1.25 mm. long; anther erect, ovate. Ovary densely pubescent.

Mexico: on rocks in shady, damp places near Verásteguí below "Las Canoas," State of San Luis Potosí, sepals dark dingy green, petals gray-red, lip whitish with posterior half orange, longitude ca. 99°28′ west, latitude ca. 21°57′ north, altitude ca. 800–900 m., *Dino 5268* (Type in Herb. Ames No. 51234); on rocks in loamy soil, below "Las Canoas" near "Espinazo del Diablo," State of San Luis Potosí, longitude 99°28′ west, latitude 21°57′ north, altitude ca. 700 m., *Nagel & Dino 5222*.

Spiranthes pseudogoodyerioides is closely allied to the Cuban *S. Wrightii* (Reichb.f.) Schltr. from which it is distinguished by the petals, by the 1-nerved (or obscurely 3-nerved) lip—in contrast to a strongly 3-nerved lip with the veins thickened—and by the leaves which are abruptly contracted to the petioles.

Spiranthes pseudopyramidalis *L. O. Williams sp. nov.*

Herbae erectae, graciles, terrestres, 3–5 dm. altae. In-

florescentia spicata, multiflora, congestiflora. Sepalum dorsale lanceolatum, acutum, leviter cochleatum. Sepala lateralia linearia vel lineari-lanceolata, obtusa vel acuta, leviter arcuata. Petala anguste elliptica, semilunata. Labellum lineari-oblongum et panduratum vel lanceolato-subpanduratum, obtusum.

Slender, erect, terrestrial herbs, 3–5 dm. tall. Stems covered with white, scarious, amplexicaul, striated, marcescent bracts. Leaves withering before anthesis, apparently up to about 12 cm. long and 3 cm. broad, elliptic, basal or on the lower part of the stem. Inflorescence a compact, many-flowered spike; bracts 0.7–1.5 mm. long, lanceolate to ovate-lanceolate, acuminate or acute, striate-nerved. Dorsal sepal 4.5–6 mm. long and 1–1.5 mm. broad, lanceolate, acute, slightly cochleate, 3-nerved, pubescent dorsally. Lateral sepals 4.5–6 mm. long and 1–1.5 mm. broad, linear to linear-lanceolate, obtuse or acute, slightly arcuate, obscurely 3-nerved, pubescent dorsally. Petals 4–6 mm. long and 0.8–1.2 mm. broad, narrowly elliptic, semilunate, 1-nerved, lightly adnate to the dorsal sepal. Lip 5.5–6.5 mm. long and 2–3.5 mm. broad, from linear-oblong and pandurate to lanceolate-subpandurate, obtuse, apex sharply recurved, inconspicuously articulate at the base. Column about 3–3.5 mm. long.

Mexico: in black soil between rocks in scanty oak forest, Mt. Toro, west of Jaleaca, State of Guerrero, longitude ca. 99°38′ west, latitude 17°23′ north, altitude 1700 m., February 27, 1943, *Juan G. [onzáles] 3270;* stone fence, San Lucas, district of Temascaltepec, State of México, April 23, 1935, *Hinton 7653;* in loamy soil in oak-pine forest, 30 km. southwest of Miahuatlán (de las Flores), State of Oaxaca, longitude 96°41′ west, latitude 16°12′ north, altitude 2300 m., March 28, 1934, *Nagel 3717;* in oak woods, Cerro San Felipe, State of Oaxaca, March 24, 1934, *Nagel 3743* (Type in Herb. Ames No. 51220); in loamy soil in oak-pine forest, Cerro San Felipe, State of Oaxaca, March 21, 1934, *Nagel 3759;* in loamy soil on grassy exposed slopes, mountains southeast of Ayntla Piñón, State of Oaxaca, longitude 96° 04′ west, latitude 16°59′ north, April 5, 1934, *Nagel 3787.*

Spiranthes pseudopyramidalis is allied to *S. pyramidalis* Lindl. from which it is distinguished by the shape of the lip which is straight at the base and not geniculate, by the apex which is sharply recurved and not straight, and by the calli which are glabrous and not densely pubescent. The bracts of the stem and of the inflorescence are whiter in color.

Spiranthes pubicaulis *L. O. Williams sp. nov.*

Herbae terrestres, erectae, graciles, usque ad 21 cm. altae. Folia ignota. Inflorescentia brevis, plusminusve laxa. Sepalum dorsale lanceolatum, acutum, trinervium, basi leviter concavum. Sepala lateralia triangulari-lanceolata, acuta, leviter arcuata, trinervia. Petala lanceolata, falcata, tri- usque ad quinque-nervia. Labellum oblongo-panduratum, trinervium. Columna generis.

Erect, slender, terrestrial herbs, up to 21 cm. tall. Scape slender, pubescent from base to apex, with three to four semiamplexicaul, subscarious, lanceolate to ovate-lanceolate bracts. Leaves unknown. Inflorescence short, rather lax, up to about 15-flowered. Dorsal sepal about 6 mm. long and 3 mm. broad, lanceolate, acute, densely pubescent dorsally, 3-nerved, somewhat concave at the base. Lateral sepals 6–7 mm. long and 2.5–3 mm. broad, triangular-lanceolate, acute, slightly arcuate, 3-nerved, densely pubescent dorsally. Petals 5–6 mm. long and about 2 mm. broad, lanceolate, falcate, 3- to 5-nerved. Lip about 8 mm. long and 4 mm. broad, oblong-panduRate, obscurely pubescent, the three main nerves with lateral branches; terminal half suborbicular, crenulate, papillose above; basal half suborbicular, attenuated to the base and with two marginal callus-thickenings, pubescent on both sides at the base. Column about 5 mm. long; rostellum short, subulate. Ovary densely pubescent.

Mexico: "Jaltipan," Vera Cruz, July 5, 1910, *Orcutt 5056* (Type in Dudley Herbarium, Stanford University No. 155015).

Spiranthes pubicaulis is not closely allied to any previously described species, but is somewhat related to ***S. tenella*** L. Wms. which is described below.

Spiranthes tenella *L. O. Williams sp. nov.*

Herbae terrestres, graciles, erectae, usque ad 35 cm. altae. Inflorescentia brevis, pauciflora. Sepalum dorsale elliptico-lanceolatum, acutum, trinervium. Sepala lateralia lineari-lanceolata, acuta, uninervia. Petala linearia, acuta, arcuata vel leviter sigmoidea, uninervia. Labellum oblongo-subpanduratum. Columna generis.

Slender, erect, terrestrial herbs, up to about 35 cm. tall. Stems very slender, about 1–1.5 mm. in diameter, with several semiamplexicaul, scarious, striated, acuminate sheaths. Inflorescence short, lax, few-flowered. Dorsal sepal about 8–10 mm. long and 2–3 mm. broad, elliptic-lanceolate, acute, 3-nerved. Lateral sepals about 7–8 mm. long and 1.5–2 mm. broad, linear-lanceolate, acute, 1-nerved. Petals 8–9 mm. long, about 1.5 mm. broad, linear, acute, arcuate or slightly sigmoid, 1-nerved. Lip about 9–10 mm. long and 5–6 mm. broad, oblong-subpandurate when expanded, both the apical and basal halves more or less rounded; terminal half squarrose above; basal half with pubescence extending from the base through the middle; claw about 1 mm. long.

MEXICO: near Guadalupe y Calvo, Chihuahua, longitude 105°36′ west, latitude 26°28′ north, at 2000–2500 meters altitude, lip snow white with yellowish brown veining, sepals and petals pink, veined Vandyke red, April 13, 1936, *Juan G.* [*onzáles*] *5027* (TYPE in Herb. Ames No. 51244).

Spiranthes tenella is more closely allied to *Spiranthes pubicaulis* than to any species previously described.

Spiranthes tenuissima *L. O. Williams sp. nov.*

Herbae terrestres, graciles, erectae, usque ad 30 cm. altae. Inflorescentia elongata, plusminusve densa. Sepa-

lum dorsale lanceolatum, acutum. Sepala lateralia ligulata vel lanceolata, acuta, leviter arcuata. Labellum lineari-oblongum vel oblongo-lanceolatum, obtusum, ad basim attenuatum et subauriculatum.

Small, slender, erect, terrestrial herbs, up to 30 cm. tall. Roots fleshy, fascicled, fusiform. Stems very slender, provided with several scarious, acuminate bracts on the lower half. Leaves appearing before the flowers and soon withering, up to about 8 cm. long and 1.5 cm. broad, petiolate; the blade elliptic, acute, attenuated into the petiole at the base. Inflorescence a strict, slender, many-flowered raceme, up to about 16 cm. long; floral bracts 2–5 mm. long, cucullate, lanceolate, acuminate or aristate. Flowers small, white suffused with pink. Sepals lightly connate at the base and forming a tube. Dorsal sepal 2–3 mm. long and 0.5–0.7 mm. broad, lanceolate, acute. Lateral sepals 3–4 mm. long and 0.6–1 mm. broad, ligulate to lanceolate, acute, slightly arcuate, decurrent on the ovary and forming a subsaccate pouch into which the base of the lip fits. Petals 2.5–3 mm. long and 0.6–0.8 mm. broad, ligulate, obtuse, arcuate, lightly adnate to the dorsal sepal. Lip 3–4 mm. long and about 1.2 mm. broad, linear-oblong to oblong-lanceolate, obtuse, apex often crenulate-crisped, narrowed to the base and provided with two subauricular callus-thickenings.

Mexico: mountains of Tlapacapan, west of Yantepec, State of Morelos, longitude 99°04′ west, latitude 18°53′ north, altitude about 1700 m., February 12, 1934, *Juan G. [onzáles] 3369* (Type in Herb. Ames No. 51335); mountains above Puente de Ixtla, State of Morelos, longitude 99°09′ west, latitude 18°37′ north, altitude 1400 m., March 1, 1934, *Nagel & Juan G. [onzáles] 3675*.

Spiranthes triliniata *Lindl.* var. **crenulata** *L.O. Williams var. nov.*

Haec varietas labelli lobo medio longiore crenulato a specie differt. Sepala lateralia obtusa.

MEXICO: grass field, La Mesa, Necaxa, Puebla, longitude 98°0′ west, latitude 20°11′ north, February 21, 1932, *Fröderström 2592* (TYPE in Herb. Ames No. 51295).

Variety *crenulata* is closely allied to var. *thelymitra* of which it is perhaps only a minor variation. The collection was made at the northernmost station for the species.

Corymborchis forcipigera (*Reichb.f.*) *L. O. Williams comb. nov.*

Macrostylis forcipigera Reichenbach filius in Bonplandia 2 (1854) 96.

Corymborchis cubensis Acuña in Bol. Téc. 60, Est. Exp. Agron. Santiago de Las Vegas (1939) 51; emend. and validated by Correll in Bot. Mus. Leafl. Harv. Univ. 8 (1940) 125.

Although no record of the type of this species is available, the original description leaves little doubt as to the species intended. The species occurs in Mexico, Guatemala, and Costa Rica, throughout the West Indies and in Colombia.

It is interesting to note that Reichenbach described both of the American species of Corymborchis (under Macrostylis) in the same year. These names seem to have escaped the attention of subsequent systematists.

Pleurothallis aristocratica *L. O. Williams sp. nov.*

Herbae parvae, epiphyticae. Folia oblanceolata, obtusa, coriacea, quam caules secundarii duplo longiora. Inflorescentia quam folia brevior. Sepalum dorsale anguste oblongum, obtusum, quinquenervium, subgaleatum, quam sepala lateralia longius, dorso apice apiculatum. Sepala lateralia usque ad super medium connata, ovata, recurvata, acuta, apiculata, basi gibbosa. Petala obovata vel deltoideo-obovata, obtusa, trinervia, leviter obliqua, unguiculata. Labellum unguiculatum, subcor-

datum, obtusum; basis biauriculata. Columna generis, arcuata.

Small, caespitose, epiphytic herbs. Secondary stems 2–4 cm. long, slender, covered with one or two scarious sheaths which are soon deciduous. Leaves 5–8 cm. long, 1.2–1.6 cm. broad, oblanceolate, obtuse, coriaceous, about twice as long as the secondary stems. Inflorescence few-flowered, shorter than the subtending leaf. Dorsal sepal 10–12 mm. long, 3–5 mm. broad, narrowly oblong, obtuse, 5-nerved, subgaleate, exceeding the lateral sepals, dorsally apiculate at the apex. Lateral sepals 7–8 mm. long, the pair about 6 mm. broad, connate for a little more than half their length, ovate, strongly gibbous at the base and strongly recurved, each sepal 3-nerved, acute, apiculate. Petals 4–4.5 mm. long and about 2.5 mm. broad, obovate or deltoid-obovate, obtuse, 3-nerved, somewhat oblique, unguiculate. Lip unguiculate, claw about 1 mm. long, short-biauriculate at the base; lamina 2.5–3 mm. long and about 2–2.5 mm. broad, subcordate, obtuse, somewhat constricted toward the apex, with two crescent-shaped lamellate calli extending from the base nearly to the apex and with two smaller, serrate-lamellate calli at the middle near the base. Column 4–5 mm. long, arcuate, anterior half winged with the wings serrulate; pollinia two, ceraceous; column-foot about 2 mm. long.

Mexico: on trees in oak forest near Omiltemi, State of Guerrero, at 1840 meters altitude, longitude 99°41′ west, latitude 17°30′ north, April 22, 1935, *Juan G.* [*onzáles*] *3245* (Type in Herb. Ames No. 51931).

The type is a specimen collected at the locality indicated and flowered in a greenhouse in Mexico City.

Pleurothallis aristocratica is allied to *P. hieroglyphica* Ames from which it may be distinguished by: 1) flowers about twice as large, 2) striated not mottled sepals, 3)

dorsal sepal 5-nerved, not 3-nerved, 4) lip with four lamellate calli instead of two, 5) petals 3-nerved not 1-nerved.

Pleurothallis involuta *L. O. Williams sp. nov.*

Herbae perparvae, repentes vel caespitosae, epiphyticae. Folia elliptico-ovalia vel ovalia, obtusa vel plusminusve acuta, marginata. Inflorescentia uni- vel pauciflora, quam folia longior. Sepalum dorsale naviculare, oblongo-lanceolatum, acutum, uninervium. Sepala lateralia basi plusminusve libera, obliqua, oblongo-lanceolata, uninervia. Petala anguste rhombica, acuta, leviter obliqua. Labellum lanceolatum, obtusum, leviter naviculare, ciliatum, basi biauriculatum, bicallosum. Columna generis.

Very small, repent or apparently caespitose, epiphytic herbs. Secondary stems very short, about 1 mm. long. Leaves elliptic-oval to oval, obtuse or somewhat acute, marginate, 4–6 mm. long, 2.5–4 mm. broad. Peduncle up to about 15 mm. long, much exceeding the subtending leaf. Inflorescence a one- to few-flowered raceme. Dorsal sepal about 2–2.5 mm. long and 1 mm. broad, navicular, oblong-lanceolate, acute, 1-nerved. Lateral sepals about 2–2.5 mm. long and 0.75–1 mm. broad, free nearly to their base, obliquely oblong-lanceolate, 1-nerved. Petals narrowly rhombic, acute, slightly oblique, obscurely 1-nerved, about 2 mm. long and 0.75 mm. broad. Lip lanceolate, obtuse, somewhat navicular, ciliate, biauriculate at the base, the auricles membranaceous, with a callus-thickening on either side of the middle which extends from the base to the apex and is involute toward the apex, about 1.5–2 mm. long and 0.5–0.75 mm. broad. Column about 1.5 mm. long, shorter than the petals.

Mexico: on tree trunks and branches, malpais near Urupán, State of Michoacán, at 1700 meters altitude, petals and lip brown, sepals

Chartreuse yellow with rose-purple diffusion, September 14, 1936, *Lozado 6130;* on trees, Barranca de la Mina, southwest of Urupán, State of Michoacán, at 1300 meters altitude, longitude 101°58′ west, latitude 19°26′ north, lip and petals brown, sepals Chartreuse yellow with purplish infusion, April 20, 1933, *Nagel 2249* (TYPE in Herb. Ames No. 51956).

Pleurothallis involuta is allied to ***P. abjecta*** Ames from which it may be distinguished by the lateral sepals being free nearly to the base, not merely retuse; by the differently shaped petals; by the smaller flowers; and by the smaller elliptic-oval to oval epetiolate leaves, instead of oblanceolate-elliptic petiolate leaves.

Both collections of this species were intimately associated with another small orchid, *Jacquiniella leucomelana* (Reichb.f.) Schltr.

This species appears to be caespitose when in its natural dense clusters, but the individual primary stems are actually found to be repent when they are separated from the mass.

Pleurothallis longispicata *L.O.Williams sp. nov.*

Herbae parvae, caespitosae, epiphyticae, usque ad 4.5 cm. altae. Folia elliptica vel oblanceolata, obtusa, carnosa. Inflorescentia pluriflora, quam folia longior. Sepalum dorsale oblongo-lanceolatum, acutum vel obtusum, carnosum, trinervium. Sepala lateralia connata, oblongo-ovalia, basi gibbosa, trinervia. Petala oblongo-elliptica, obtusa, uninervia. Labellum subhastatum vel trilobulatum; lobi laterales parvi, obtusi; lobus medius oblongus, verrucosus, bicallosus. Columna generis.

Small, caespitose, epiphytic herbs. Secondary stems 2.5–4.5 cm. long, slender, covered with one or two scarious, brown sheaths which are often verrucose toward the base. Leaves 2.5 cm. long and 0.8–1.5 cm. broad, elliptic to oblanceolate, obtuse, fleshy, about as long as or longer or shorter than the secondary stems. Inflores-

cence a several-flowered raceme which much exceeds the subtending leaf. Dorsal sepal about 5 mm. long and 1.5 mm. broad, oblong-lanceolate, acute or obtuse, 3-nerved, fleshy, somewhat navicular. Lateral sepals connate for about two thirds of their length, about 4–4.5 mm. long, the pair about 2.5 mm. broad, oblong-oval, gibbous at the base, acute, each sepal 3-nerved. Petals about 2.5 mm. long and 1.2 mm. broad, oblong-elliptic, obtuse, 1-nerved. Lip about 3 mm. long and 1.5 mm. broad, subhastate or 3-lobed; the lateral lobes small, obtuse; mid-lobe oblong, verrucose, with an inconspicuous callus extending from each sinus toward the apex. Column about 2.5 mm. long, arcuate, clinandrium denticulate; column-foot about 1 mm. long.

MEXICO: Mt. Zempoala, State of Morelos, at about 3000 meters altitude, longitude 99°19′ west, latitude 19°01′ north, 1932, *Juan G.* [*onzáles*] *2678;* Cumbres de la Cruz, between Urupán & los Reyes, State of Michoacán, flowers greenish with many purple dots, at 1700 meters altitude, September 20, 1935, *Juan G.* [*onzáles*] *4922;* near Coalcomán, State of Michoacán, flowers greenish yellow with dark dots, at ca. 1700 meters altitude, longitude 103°09′ west, latitude 18°47′ north, June 22, 1933, *Halbinger 1752* (TYPE in Herb. Ames No. 51941); on coffee shrubs, humid forest near Hacienda San Antonio, foot hills of Volcán Colima, sepals and petals dingy yellow, lip dull purple, at 900 meters altitude, longitude 103°46′ west, latitude 19° 26′ north, September 15, 1934, *Nagel 4022.*

Pleurothallis longispicata has no near allies in Mexico or Central America.

Pleurothallis oblanceolata *L. O. Williams sp. nov.*

Herbae parvae, epiphyticae, repentes vel caespitosae. Caules secundarii breves. Folia anguste oblanceolata, obtusa, coriacea. Inflorescentia uni- ad triflora; pedunculus filiformis, quam folia brevior. Sepalum dorsale lanceolatum, acutum, cucullatum, trinervium. Sepala lateralia sepalo dorsali similia sed leviter gibbosa. Petala lanceolata, acuminata, integra vel paulo serrulata, uninervia.

Labellum lineari-lanceolatum, acutum, intus paulo papillosum, basi biauriculatum. Columna alata, apice lacerata, breviter pedata.

Small, repent, or apparently caespitose, epiphytic herbs. Secondary stems short, mostly less than 5 mm. long. Leaves narrowly oblanceolate, obtuse, coriaceous, gradually tapered to the base, 25–45 mm. long, 4–7 mm. broad. Inflorescence 1- to 3-flowered (mostly one); the peduncle filiform, shorter than the subtending leaf; bracts ostiolate, mucronate, about 1.5 mm. long. Dorsal sepal about 3.5 mm. long and 1.1 mm. broad, lanceolate, acute, cucullate, 3-nerved, median nerve thickened and raised on the back. Lateral sepals about 3.5 mm. long and 0.8 mm. broad, free almost to the base, but the joined portion somewhat gibbous, otherwise as the dorsal sepal. Petals about 3 mm. long and 0.75 mm. broad, lanceolate, abruptly acuminate from the middle, entire or minutely serrulate, 1-nerved. Lip about 2.5 mm. long and 0.5 mm. broad, linear-lanceolate, acute, upper surface papilliferous (especially toward the base), slightly fleshy, obscurely sulcate along the median line, 3-nerved; base biauriculate, the auricles thin and membranaceous, about 0.1 mm. long. Column about 1.5 mm. long, winged and lacerated toward the apex; rostellum about 0.2 mm. long, oblong, navicular, exactly closing the stigmatic opening; column-foot about 0.5 mm. long, extending into the gibbous bases of the lateral sepals.

Mexico: in damp forests on trees, Pacific side, river valley, Copalita, northwest of Pluma Hidalgo, at 1000–1100 meters altitude, longitude 96°28′ west, latitude 15°57′ north, sepals amber yellow, petals and lip blackish purple, September 1, 1937, *Nagel & Juan G.* [*onzáles*] *6456* (Type in Herb. Ames No. 51909).

Pleurothallis oblanceolata is closely allied to *P. minutalis* Lindl. It may be distinguished as follows:

P. oblanceolata	*P. minutalis*
Lip about six times longer than broad, biauriculate at the base.	Lip about three times longer than broad, not auriculate at the base.
Petals abruptly acuminate, entire or minutely serrulate.	Petals not acuminate, serrulate.

In addition there seem to be some differences in the column; the leaves of *P. oblanceolata* are comparatively long and narrow.

Pleurothallis Oestlundiana *L. O. Williams sp. nov.*

Herbae caespitosae, epiphyticae, usque ad 13 cm. altae. Caules secundarii graciles. Folia oblanceolata, obtusa, coriacea, caulibus subaequalia. Pedunculi uni vel plures, quam folia breviores. Sepalum dorsale anguste oblongo-spathulatum, obtusum, trinervium. Sepala lateralia usque ad supra medium connata, uninervia, apice integra vel obscure dentata. Labellum lanceolato-obovatum, carnosum. Columna generis.

Caespitose, epiphytic herbs, up to 13 cm. tall. Secondary stems slender, 2.5–5 cm. long, covered with one or two scarious brown sheaths which are puberulent on the angles. Leaves 3–7 cm. long, 0.6–1.4 cm. broad, oblanceolate, obtuse, coriaceous, usually tapered gradually into a short petiole, about as long as or a little longer or shorter than the secondary stems. Peduncles one or several from the base of the subtending leaves, shorter than the leaf. Dorsal sepal 5–7 mm. long, 2–3 mm. broad, narrowly oblong-spatulate, obtuse, 3-nerved. Lateral sepals joined for about three quarters of their length, about 5.5 mm. long, the pair 3.5 mm. broad, oblong, acute, gibbous at the base, each sepal 3-nerved. Petals about 2.5 mm. long and 1.7 mm. broad, broadly clavate, 1-nerved, the apex entire or obscurely dentate. Lip about 4.5 mm. long and 2 mm. broad toward the tip, lanceolate-

obovate, posterior portion very fleshy with erect sides, anterior portion much thinner and verrucose. Column about 2 mm. long, slightly arcuate, clinandrium entire or denticulate; column-foot long, about 1.2 mm.

Mexico: on trees in oak forest, region of Tenería, northwest of Taxco, State of Guerrero, sepals and petals greenish yellow with dull purplish infusion, longitude 99°43′ west, latitude 18°36′ north, at 2300 meters altitude, July 23, 1932, *Juan G. [onzáles] 1062* (Type in Herb. Ames No. 51792); on trees, near Mexicapa, mountains northwest of Cuernavaca, State of Morelos, sepals and petals greenish yellow, lip dull pinkish purple, longitude 99°19′ west, latitude 18°59′ north, at 2300 meters altitude, July 8, 1932, *Juan G. [onzáles] 2674.*

Pleurothallis Oestlundiana is not closely allied to any Central American Pleurothallis. Superficially it somewhat resembles *P. obovata* Lindl.

Scaphyglottis pachyphylla *L. O. Williams sp. nov.*

Herbae parvae, repentes. Rhizomata elongata, simplicia vel ramosa. Pseudobulbi fusiformes vel ovoidei, unifoliati, approximati. Folia linearia vel lanceolata, acuta vel plusminusve obtusa, carnosissima vel teretia. Inflorescentia uniflora. Sepala lanceolata, acuta, quinquenervia. Petala lanceolata, obtusa vel acuta, quinquenervia. Labellum unguiculatum; unguis geniculatus et paulo cochleatus; lamina oblonga vel ovalis, callo subpeltato ad unguis et laminae junctionem ornata.

Small, repent, epiphytic herbs. Rhizome elongated, simple or branched, younger portions covered with bracts which soon fall away. Pseudobulbs 3–10 mm. long, 2–5 mm. thick, fusiform to ovoid, unifoliate, approximate, about 4–8 mm. apart. Leaves 1.2–3 cm. long, 2–5 mm. broad, linear to lanceolate, acute to somewhat obtuse, very fleshy or terete. Inflorescence 1-flowered; peduncle sheathed by hyaline bracts which are soon deciduous; bract subtending the flower 4–8 mm. long, ovate, acuminate. Flower large for the size of the plant. Sepals

8–9 mm. long, 3–3.5 mm. broad, erect or spreading, lanceolate, acute, 5-nerved. Petals 7.5–9 mm. long and 3–4 mm. broad, lanceolate, acute or obtuse, 5-nerved. Lip 8–12 mm. long, 5–6.5 mm. broad, short-clawed; the claw geniculate and somewhat cochleate; the lamina oblong to oval, with a subpeltate callus at the junction of the claw and the lamina; callus about 2.5–3 mm. long and 2–2.5 mm. broad. Column about 4 mm. long; column-foot about 1.5 mm. long; pollinia six, four of equal size and two much reduced, ceraceous, the larger ones laterally compressed.

MEXICO: near Santa Bárbara, southwest of Chilpancingo, State of Guerrero, longitude 99°50′ west, latitude 17°19′ north, at about 1800 meters altitude, November 15, 1932, *Juan G. [onzáles] 1666;* epiphyte on Trompillo, Cumbre, District of Temascaltepec, State of México, at 2750 meters altitude, September 15, 1932, *Hinton 1691* (TYPE in Herb. Ames No. 49613); on tree trunks, region of Temascaltepec, State of México, at 2800 meters altitude, September 15, 1932, *Hinton 1742;* on trees, mountains near Taxco, State of Guerrero, longitude 99°33′ west, latitude 18°33′ north, at 1900 meters altitude, September 1, 1937, *Lira 6947;* malpais on "siempre viva" trees, open places in oak-pine forest, Mt. "Cerro Chico," northwest of Urupán, State of Michoacán, flowers pale green with brown marks on the lip, September 30, 1935, *Nagel 2243;* on trees in mixed forest, near "Los Fresnos" southwest of Guayameo, State of Guerrero, longitude 101°26′ west, latitude 18°11′ north, flowers pale green with brownish marks on the lip, at 2400 meters altitude, September 24, 1933, *Nagel 3112;* on trees in forest west of Taxco, State of Guerrero, longitude ca. 99° 37′ west, latitude ca. 18°32′ north, at ca. 1900 meters altitude, July 23, 1932, *Nagel & Juan G. [onzáles] 1074.*

Bletia ensifolia *L. O. Williams sp. nov.*

Herbae terrestres, usque ad 7 dm. altae. Cormi approximati, pyriformes. Folia ensiformia vel lineari-ensiformia, acuta. Sepalum dorsale oblanceolatum vel ellipticum, acutum, plurinervium. Sepala lateralia lanceolata vel elliptico-lanceolata, acuta, plurinervia. Petala oblanceolata, obtusa, leviter obliqua, apice serrulata. Labellum obovato-orbiculare, trilobatum, nervis crassis vel mediis

sublamellatis; lobi laterales lati, apice rotundati; lobus medius brevis, emarginatus. Columna generis.

Terrestrial herbs, up to 7 dm. tall. Corms approximate, pyriform, up to 4 cm. long and 1.5 cm. thick. Leaves 8–30 cm. long and 2–8 mm. broad, ensiform to linear-ensiform, acute. Inflorescence few-flowered; bracts 4–10 mm. long, lanceolate, acuminate, scarious. Dorsal sepal about 20 mm. long and 4.5 mm. broad, oblanceolate or elliptic, acute, several-nerved. Lateral sepals about 18 mm. long and 5.5 mm. broad, arcuate, lanceolate or elliptic-lanceolate, acute, several-nerved. Petals about 20 mm. long and 4.5 mm. broad, oblanceolate, obtuse, slightly oblique, apical portion more or less serrulate. Lip about 18 mm. long and 18 mm. broad, obovate-orbicular in outline, 3-lobed, with several ridge-like thickened veins or the central ones sublamellate; lateral lobes broad, rounded at the apex; mid-lobe short, emarginate. Column 10–12 mm. long.

Mexico: rocky wooded hills near Guadalajara, State of Jalisco, August 29, 1893, *Pringle 4513;* Barranca de Río Blanco near Guadalajara, State of Jalisco, at 5000 ft. altitude, July 21, 1902, *Pringle 11184* (Type in Herb. Ames No. 4471).

The distinguishing characters of this species are the narrow leaves and the broad lip, which is about as broad as long. It does not seem to be closely allied to any other species.

Bletia Greenmaniana *L. O. Williams sp. nov.*

Herbae terrestres, erectae, usque ad 7 dm. altae. Folia lanceolata, oblanceolata vel linearia, acuta vel acuminata, plicata, basi in petiolum attenuata. Sepala lanceolata, acuta, septemnervia. Petala oblanceolata vel elliptica. Labellum obovatum, integrum vel leviter undulatum; nervi medii incrassati. Columna arcuata, alata.

Erect, terrestrial herbs, up to 7 dm. tall. Scape with

one or two scarious bracts, otherwise naked. Leaves 25–45 cm. long, 0.6–2.2 cm. broad, lanceolate, oblanceolate or linear, acute or acuminate, plicate, tapered into a narrow petiolar base. Inflorescence 2- to 5-flowered; bracts up to 15 mm. long, ovate-lanceolate, acuminate, scarious. Sepals about 32–35 mm. long and 8 mm. broad, lanceolate, acute, about 7-nerved, mid-nerve lamellate dorsally. Petals about 33 mm. long and 10–11 mm. broad, oblanceolate to elliptic, the mid-nerve with or without a short lamellate callus at the base of the petal. Lip about 35 mm. long and 20 mm. broad, obovate, entire or somewhat undulate, the central nerves thickened, but not lamellate. Column about 28 mm. long, arcuate, winged, the apex inconspicuously auriculate.

MEXICO: région de Orizaba, état Vera Cruz, 28 Juillet 1865–1866, *Bourgeau 2812* (TYPE in Gray Herb.); Mt. Orizaba, State of Vera Cruz, at 4000 ft. altitude, August 31, 1891, *Seaton 523*.

Bletia Greenmaniana is superficially similar to *B. reflexa* Lindl. It is, however, distinguished from all of the species known to me by its entire or, at most, somewhat undulate lip.

Dr. J. M. Greenman indicated, many years ago, that the two specimens cited above were different from anything then known to him. They still seem to be undescribed, so it is with pleasure that the species is named for Dr. Greenman.

Bletia Nagelii *L. O. Williams sp. nov.*

Herbae terrestres, usque ad 5 dm. altae. Cormus subglobosus vel pyriformis. Folia linearia, acuta, plicata. Inflorescentia pauci- vel pluriflora; bracteae lanceolatae, acuminatae, scariosae. Sepalum dorsale oblanceolatum, acutum, quinque- vel septemnervium. Sepala lateralia falcato-oblanceolata vel falcato-elliptica, acuta, quinque- vel septemnervia, basi mentum breve formantia. Petala

falcato-oblanceolata, obtusa, quinque- vel septemnervia. Labellum oblongo-obovatum, trilobatum, quinque- vel septemcallosum, columnae et columnae pedi adnatum; lobi laterales parvi, obtusi; lobus medius plicatus, retusus. Columna arcuata, alata.

Terrestrial herbs, up to 5 dm. tall. Corms subglobose or pyriform, 1–2 cm. long and about as thick or thicker. Leaves up to 50 cm. long, about 0.4–1 cm. broad, linear, acute, plicate (at least when dry). Inflorescence few- to several-flowered; bracts 2–8 mm. long, lanceolate, acuminate, scarious. Dorsal sepal about 15 mm. long and 3.5 mm. broad, oblanceolate, acute, 5- to 7-nerved. Lateral sepals about 14 mm. long and 4 mm. broad, falcate-oblanceolate or falcate-elliptic, acute 5- to 7-nerved, forming a short mentum at the base. Petals about 12 mm. long and 4 mm. broad, falcate-oblanceolate, obtuse, 5- to 7-nerved. Lip about 13–14 mm. long and 8 mm. broad, oblong-obovate in outline, 3-lobed, with five to seven lamellate calli extending from about the middle toward the apex, adnate to the column and column-foot for about 3 mm. at the base; lateral lobes small, obtuse; mid-lobe much plicated, retuse. Column erect, 10–12 mm. long, arcuate, winged.

MEXICO: under oak shrubs, "Loma de Ocate," Mt. San Felipe, State of Oaxaca, at 1900 meters altitude, flowers white, November 15, 1937, *Conzatti & Nagel 7113* (TYPE in Herb. Ames No. 57225).

An unusual species with very narrow leaves and white flowers.

Catasetum roseum (*Lindl.*) *Reichenbach filius* in Gard. Chron. (1872) 1003.

Clowesia rosea Lindley in Bot. Reg. 29 (1843) t. 39 and Misc. p. 25.

This curious little Catasetum, which is allied to *C. Warczewitzii* Lindl. & Paxt., has apparently never before

been reported from a wild specimen. It was described about one hundred years ago from greenhouse material. Lindley received flowers of the plant, from which he described the species, and soon afterward he illustrated it in the Botanical Register. Lindley's material, which was in cultivation in England, was said to have originated in Brazil. Recently we have received three different collections of this species from Mexico which perhaps indicates that the garden material on which the species was originally based came from Mexico rather than from Brazil. It is interesting to note that all of the species of the subgenus Clowesia are Central American,—a fact which also points to a Mexican rather than a Brazilian origin of this species.

EXPLANATION OF THE ILLUSTRATIONS

PLATE XXXII. SPIRANTHES PUBICAULIS *L. Wms.* 1, plant, one half natural size. 2, flower, opened out, two and one half times natural size.

SPIRANTHES FALCATA *L. Wms.* 3, plant, one half natural size. 4, flower, opened out, two and one half times natural size.

SPIRANTHES TENELLA *L. Wms.* 5, plant, one half natural size. 6, flower, opened out, one and one half times natural size.

SPIRANTHES NAGELII *L. Wms.* 7, plant, one half natural size. 8, flower, opened out, natural size.

SPIRANTHES CONGESTIFLORA *L. Wms.* 9, plant, one half natural size. 10, flower, opened out, natural size.

PLATE XXXIII. SPIRANTHES PSEUDOGOODYERIOIDES *L. Wms.* 1, plant, one half natural size. 2, flower, opened out, five times natural size.

SPIRANTHES GONZALEZII *L. Wms.* 3, plant, one half natural size. 4, flower, opened out, five times natural size.

SPIRANTHES PSEUDOPYRAMIDALIS *L. Wms.* 5, plant, one half natural size. 6, flower, opened out, two and one half times natural size.

SPIRANTHES TENUISSIMA *L. Wms.* 7, plant, one half natural size. 8, flower, opened out, five times natural size.

PLATE XXXII

SPIRANTHES

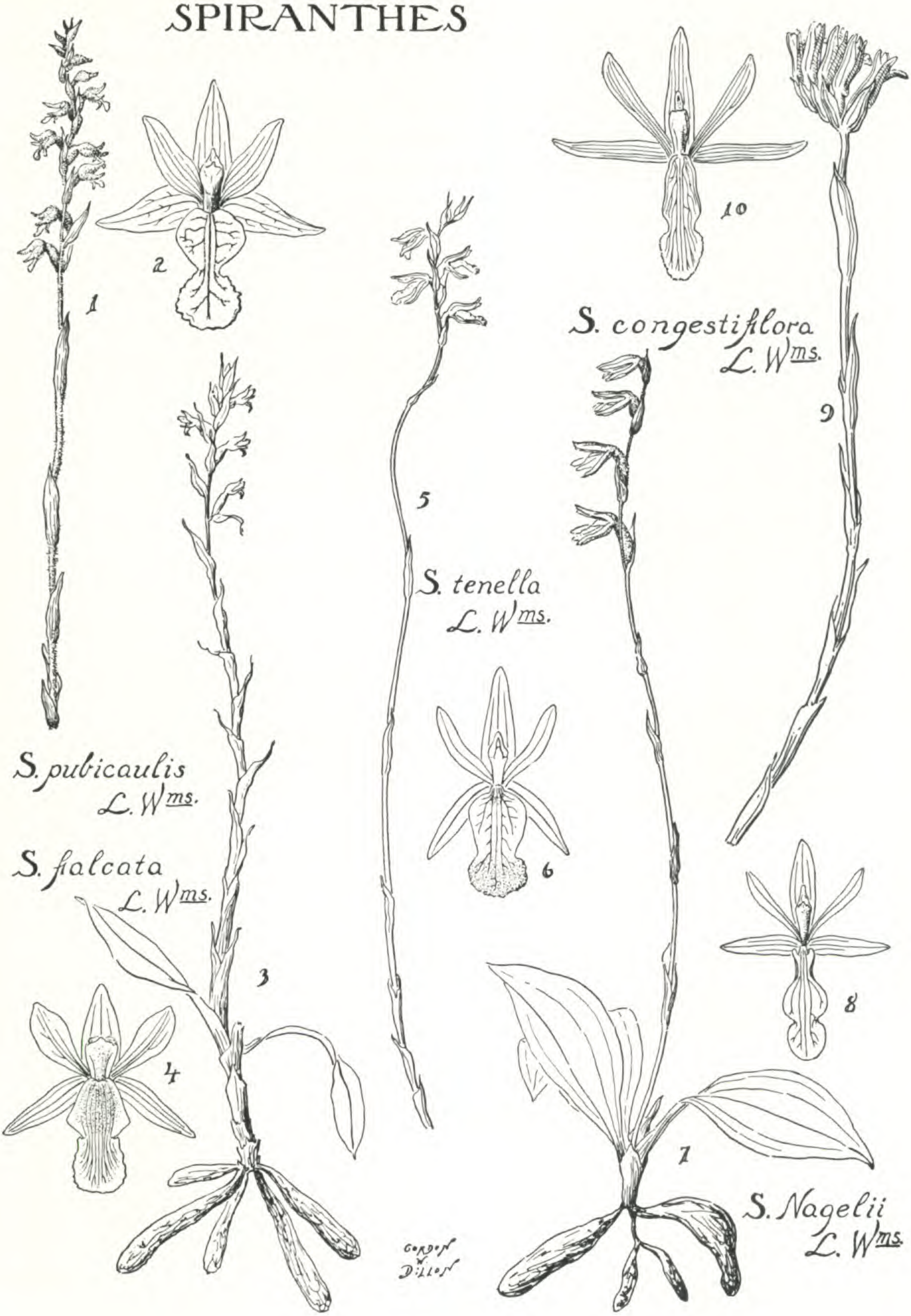
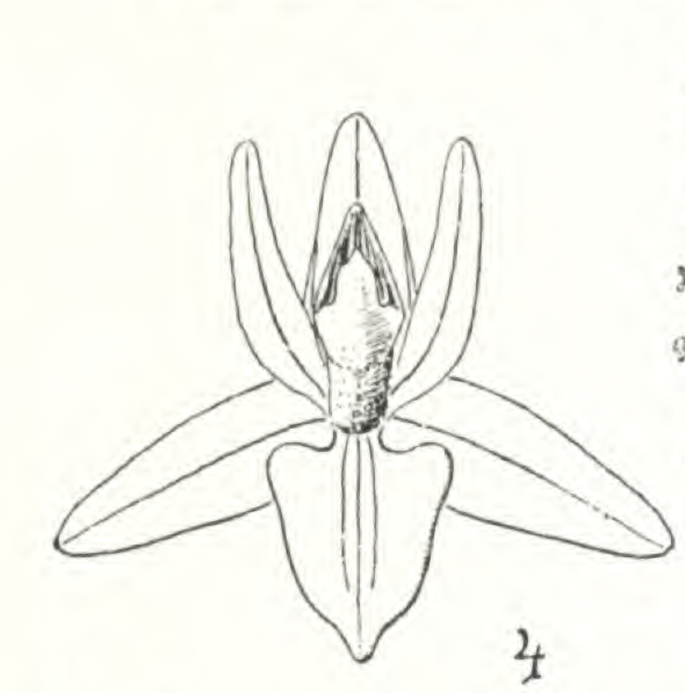


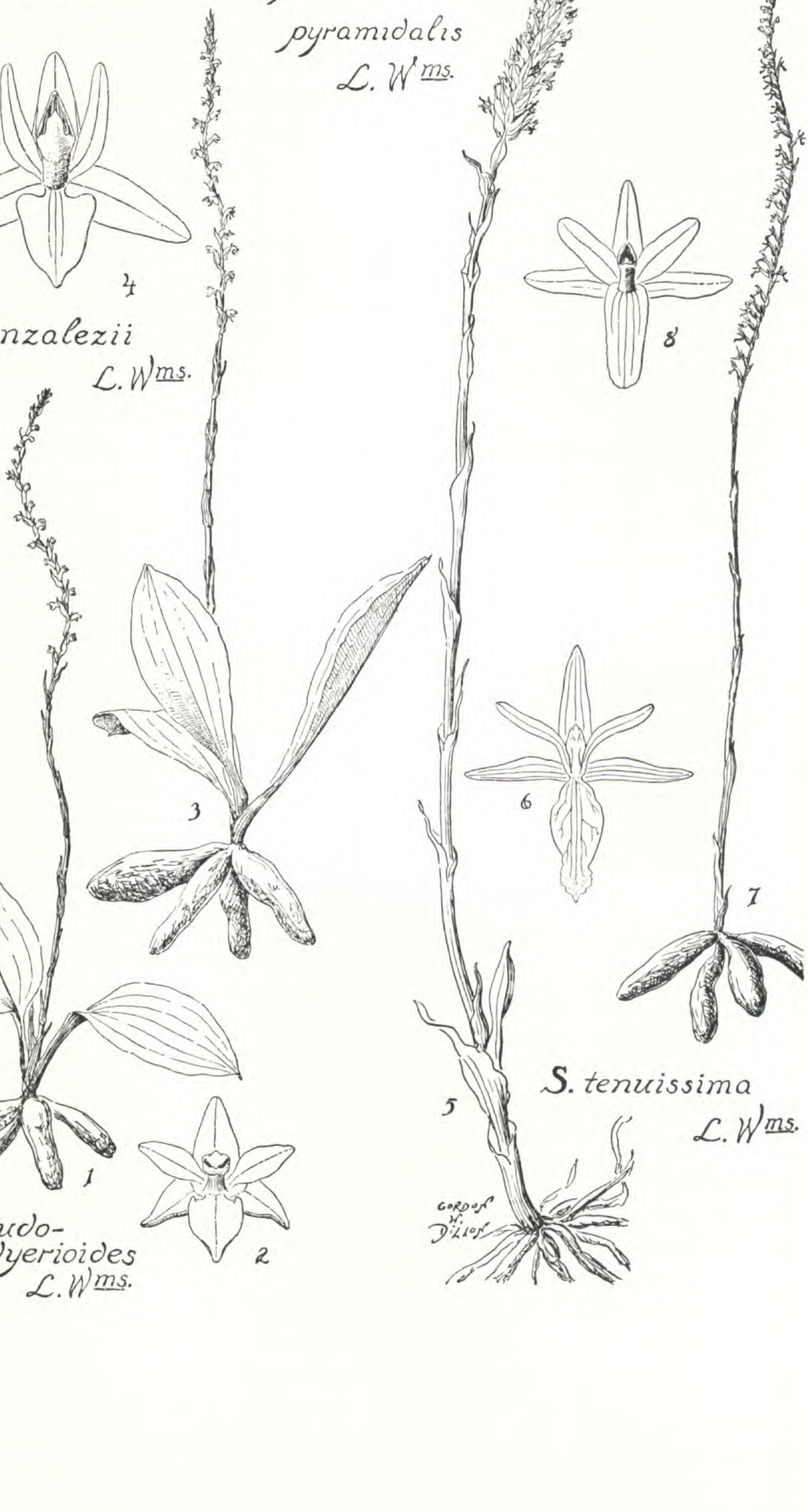
PLATE XXXIII

SPIRANTHES *pseudo-pyramidalis L. Wms.*



4

S. Gonzalezii L. Wms.



S. pseudo-goodyerioides L. Wms.

S. tenuissima L. Wms.

GORDON W. DILLON

TWO ORCHIDS FROM HAITI

BY

LOUIS O. WILLIAMS

MR. L. R. HOLDRIDGE, a keen collector of the flora of Haiti, has communicated the two orchids mentioned below, along with an excellent collection of others.

Lepanthes purpurata *L. O. Williams sp. nov.*

Herbae parvae, caespitosae, epiphyticae, usque ad ca. 5.5 cm. altae. Folia late elliptica, ovata vel late ovata, obtusa vel breviter acuminata. Sepalum dorsale lanceolatum vel triangulari-lanceolatum, acuminatum. Petala bilobata. Labellum trulliforme, emarginatum, obtusum, basi auriculatum.

Small, caespitose, epiphytic herbs up to about 5.5 cm. tall. Secondary stems up to about 3.5 cm. long, slender, with three to five infundibuliform sheaths which disintegrate with age, the sheaths with several prominent nerves which are hispid-pubescent. Leaves 1–2.2 cm. long and 0.5–1.2 cm. broad, broadly elliptic to ovate or broadly ovate, obtuse to shortly acuminate, subciliate, contracted into a very short petiole at the base. Inflorescence consisting of one or more short, distichous, few-flowered racemes, shorter than the subtending leaves. Sepals shortly connate at their bases. Dorsal sepal 4.5–5 mm. long and 2–3 mm. broad, lanceolate to triangular-lanceolate, acuminate, 3-nerved. Lateral sepals 4–4.5 mm. long and 1.5–2.5 mm. broad, broadly lanceolate to ovate-lanceolate, acuminate, connate to the middle. Petals bilobed, the lobes transverse, about 0.5 mm. long and 3.5 mm. broad; anterior lobe linear-oblong, obtuse, about 1.5 mm. broad; posterior lobe similar to the anterior, about 2 mm. broad, subsigmoid. Lip about 1.2 mm. long and

1 mm. broad, trulliform, emarginate, obtuse, 3-nerved, obscurely auriculate on the basal angles, claw adnate to the column.

HAITI: epiphyte, near Petite Source, Morne des Commissaires, leaves purple beneath, flowers yellow with red center, altitude 1450 m., May 1, 1942, *Holdridge 1173;* epiphyte on hardwood trunks, Guimbi Galata, Morne des Commissaires, leaves dull green above, deep dull purple below, altitude 1800 m., *Holdridge 1293* (TYPE in Herb. Ames).

Lepanthes purpurata is most nearly allied to *L. quadrata* Fawc. & Rendle. It is easily distinguished, however, by the emarginate, obscurely auriculate lip, by the broader leaves and by the longer inflorescence.

Cattleyopsis Holdridgei *L. O. Williams nom. nov.*

Epidendrum roseum Schlechter in Urban Symb. Antill. 7 (1913) 497; Correll in Bot. Mus. Leafl. Harv. Univ. 10 (1941) 48, non Gérard 1848.

Cattleyopsis rosea Mansfeld in Ark. Bot. 20A (1926) 17.

HAITI: epiphytic, near Petite Source, Morne des Commissaires, altitude 1450 m., May 1, 1942, *Holdridge 1174.*

This species must be retained in Cattleyopsis if that genus can be maintained. Mansfeld points out that the plant is a Cattleyopsis: "Da ferner acht etwas ungleiche Pollinien verhanden sind (am Original fehlen die Antheren), gehört die Pflanze unzweifelhaft zu *Cattleyopsis.*" Correll returned it to Epidendrum, without comment, in his study of this and two allied genera.

The name *Cattleyopsis rosea*, being based on a homonym, must be replaced. It is a pleasure to rename this attractive plant for Mr. L. R. Holdridge.

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RACES OF MAIZE IN SOUTH AMERICA

BY

HUGH C. CUTLER[1]

SOUTH AMERICAN highland maize has long attracted attention because it differs so greatly from the maize commonly grown in North America and Europe. Following the discovery of teosinte, Mexico and Central America were considered of greater importance in the study of the origin and evolution of maize. Interest in South America as the original home of maize, however, has been renewed since Mangelsdorf and Reeves published their tripartite hypothesis (1939): that maize originated in South America; that Euchlaena is a recent hybrid of maize and Tripsacum produced in Central America by the crossing of cultivated maize with native Tripsacum; and that the addition of Tripsacum germplasm to maize produced the types of maize which are now most common in Central and North America. With their hypothesis as a basis it has been possible to carry on a program of study and experimentation which has led to a more complete knowledge of the composition and distribution of South American maize and related grasses, and to further evidence which has a bearing on the origin and dispersal of maize. Since 1939 a surprising

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amount of new information about maize has been obtained and, for the most part, it fits the Mangelsdorf and Reeves hypothesis better than any other. It is now possible at least to outline the characteristics of some of the major races of South American maize (Coroico, Guarani, Coastal Tropical Flint, Altiplano, Uchukilla, Valle, Cuzco) as a result of this study.

At various times in the past, scientific names have been proposed for certain groups of South American maize. Most numerous are the names based on collections made by the Russian expeditions of 1925–26 (Kuleshov 1930, Kozuhkov 1935). While these names may have been of some value in calling attention to certain peculiarities, they do not group the variations into practical working divisions or reflect natural relationships. As Anderson and Cutler pointed out (1942), it is too early to attempt an accurate classification of maize since good material is still lacking from critical areas, and some of the material now available is as yet incompletely studied. Also, many of the characters essential to a careful and conservative analysis of the relationships of races in Zea are imperfectly known and rarely utilized. To propose taxonomic categories and increase the confusion of synonymy which already clouds *Zea Mays* L. is unwise while critical studies are still in their primary stages.

Constancy and changeability of Maize varieties

Scarcely less amazing than the great diversity of maize which is familiar to all students of the plant is the fact that so many of the varieties cultivated today have remained constant over so long a period of time. Indian fields form plant populations where optimum conditions for the evolution of new races are present. Here are centers where plants grow isolated from their relatives cultivated by other Indian tribes or by other divisions of

the same tribe, and where there is only occasional interchange of seeds as the result of war or commerce. That more races have not arisen is probably the result of rigid and constant selection toward definite standards. These standards vary in different districts and even today are often regulated by traditions and religious beliefs. Branched ears are preferred in some parts of Guatemala while in other areas different types are chosen. Ceremonial customs play a definite part. Large ears are often dressed in clothes and placed on an altar or carried about during a dance, then kept for planting the next season. Giving the best ears to the gods means that a standard of quality is maintained, but since many ears are planted, there is still room for considerable variation. Present day natives are not as careful as their fathers, for in addition to forgetting many customs which had a practical foundation, they have lost some of their hostility toward outsiders and frequently interchange products. They may even spend part of their time working in mines or in rubber or cattle areas, and when they return to their own land carry with them seeds of foreign origin. In most cases it is possible to determine which are the recently introduced varieties.

Prehistoric migrations of crop plants were probably slow, but new modes and routes of transportation and the destruction of many regional barriers have led to the rapid interchange of plants and weeds with the consequent introduction of new types. Many of the old cultivated plants have been discarded in favor of the new. Even where new plants have not appeared changes in customs may handicap the collector of old forms.

A case in point is sugar corn in Bolivia. Sugar corn was once highly prized in Bolivia for parching and especially for making *chicha*, an alcoholic drink. When the Incas ruled and thievery was punished severely, sugar

corn was easily kept in a fairly pure condition simply by growing it in isolated fields. Now, in order to conceal it from thieves, it is planted amid the less desirable field corn, which has a similar appearance and which flowers about the same time. The crop is safeguarded by this practice since thieves are unable to distinguish the sugar corn in the field, but another result is that one now rarely sees ears of sweet corn which do not show contamination with other varieties. Similarly, sweet grains are of sporadic occurrence in nearly all the other races of maize in Bolivia and Peru.

Almost the same story can be told of *culli*, a deep reddish-purple type, which, like sweet corn, was once prized and maintained in a more or less pure state. Now it, too, is contaminated with other varieties and has left its mark upon them as well.

Methods of collecting and study

For reliable studies of the races of maize, their origin, spread and present distribution, it is necessary to have extensive data. Hasty trips through markets may serve to collect an impressive mass of ears and seeds which are useful for some studies but fail to tell the whole story. In spite of the selection of fairly uniform ears by native planters, the amount of variation in their fields is astonishing to one accustomed only to commercial maize plantings in the United States. An ideal collection would include some indication of the character of the plant and the amount of variation in a typical planting, the tassel, and some indication of the genotype of the plant for characters may be concealed by dominant alleles, dominant inhibitors or strong expressions of other genes which affect the same parts. Since some of these data can be secured only after long study in the field and by growing cultures under controlled conditions, ideal material for

study is rarely seen. It must be recognized further that a collection of plants is rarely a random sample of the population. Botanists have more or less innocently practiced misrepresentation for many years by selecting specimens of a convenient size or those which were the most attractive, the most nearly perfect or the most unusual, even when these were unique in the population they were supposed to represent. Thus, in the case of maize, colored or freak ears frequently receive more attention than normal ones. For example, in a harvest of 8000 ears at Santiago de Chiquitos, Bolivia, only four ears differed from the predominating type, yet in a collection representing this lot three of the atypical ears were included and only four of the major type.

The present paper is based upon collections made and studied in South America and checked by growing plants in the same or similar localities; and upon collections at the Botanical Museum of Harvard University, the Escola Superior de Agricultura Luiz Queiroz in Piracicaba, Brazil, the Instituto Agronomico of Campinas, Brazil, the Missouri Botanical Garden, the Pioneer Hi-Bred Corn Company, and the Universidad Autonoma Simon Bolivar at Cochabamba, Bolivia. Through the kindness of the directors and staff of the Escola Superior de Agricultura and the Universidad Simon Bolivar, it was possible to grow and study native maize in their experimental fields.

The valleys of Peru and Bolivia have long been supposed to possess the greatest diversity of maize types and for this reason much emphasis has been laid upon this center, while little attention has been paid to the maize of the eastern Andean slopes and the adjacent lowlands. It is true that the highland areas do have a large number of visibly different types, but one must consider also the invisible variation, that which is recessive and masked by

a few dominant characters, or is concealed by the action of inhibitors. From a few selected ears of lowland Bolivian corn nearly all the variations found in the valleys and highlands could be produced, as well as variations which are found in no other place but the lowlands.

Variations in the nature of the ear

The structure of the maize ear has, in the past, been poorly understood by many botanists, probably because it is difficult to study the mature and woody ear. Recently, the work of Weatherwax (1935), Anderson (1944) and Mangelsdorf (1945) has done much to demonstrate the true nature of its structure, but the general opinion persists that the origin of the ear must have been unique and nearly miraculous. That this is not the case is evidenced by the fact that ear-like structures may be found in grasses which normally do not bear them.

St. Augustine grass, *Stenotaphrum secundatum* (Walt.) O. Kuntze, a member of the Paniceae, usually has two rows of solitary fertile spikelets in alveoli on a flattened corky rachis. A variation occasionally found (although not as common as one with paired spikelets, one sessile and the other pedicellate) has four rows of alveoli on a much broadened and thickened rachis which has little tendency to disarticulate.

In the genus Trichachne, also in the Paniceae, there is an even more striking resemblance to the maize ear. This does not imply that this grass is concerned in the evolution of maize, but merely shows that the development of the ear and tassel as female and hermaphroditic or male inflorescences is not as difficult as might be thought. In this genus there may occur the usual normal plants with ordinary hermaphroditic inflorescences, plants with a lateral "ear" and a terminal hermaphroditic inflorescence or tassel, and plants with "ears" borne

terminally and without a tassel. The internode pattern of normal plants of Trichachne follows that of ordinary grasses; the pattern of plants with the lateral "ear" and a terminal inflorescence follows that of the usual maize plant, and the pattern of plants with the terminal "ear" closely adheres to the pattern established by maize plants with terminal ears. The "ear" in Trichachne is a fasciation in which longitudinal growth is halted so that the inflorescence is enclosed by the leaves of the culm on which it is borne. It is significant that anthers do not develop in the "ears" although some of the seeds are nearly normal in size and apparently variable. Trichachne has been collected in both the fasciated and ordinary form in Jamaica, Surinam, Bolivia and the states of Ceara, Baia, Goiaz and Mato Groso in Brazil. Detailed information upon it will be presented in a later paper.

Maize in South America may be considered as influenced by three tendencies which may be termed Tripsacoid, Andropogonoid, and fasciated. Mangelsdorf and Reeves (1939) have postulated that there is some Tripsacum influence in North American maize, and suggested that some South American maize in the Andean region is also contaminated, but to a lesser degree. Further evidence supports this theory. The similarity of much lowland maize, especially that of Paraguay and Bolivia, to segregates from maize-teosinte crosses; the occurrence of *Tripsacum australe* Cutler and Anderson, a species without terminal chromosome knobs (Graner and Addison 1944); and morphological similarities between *T. australe* and some of the South American varieties of Zea suggest two possibilities. Either there is considerable Tripsacum contamination which cannot be correlated with chromosome knobs or some types of South American maize show resemblance to Tripsacum because they are not distantly removed from it. The great diversity

in *T. australe* suggests that in South America, as in Central and North America, Zea contamination has probably increased the variability of Tripsacum. The most obvious effects of the Tripsacoid tendency are compression and condensation, with hardening of the parts, straightening of rows, reduction in row number, shortening of pedicels and sinking of parts into pits or alveoli on the rachis. Tripsacum, Zea and related grasses probably had some common ancestor and it is usually impossible to decide definitely how some particular variation might have been introduced.

The term "Andropogonoid" is not meant to suggest that this tendency is derived directly from the genus Andropogon or even from the family of this name, but the effect is so reminiscent of some Andropogons that it is well to keep the similarity in mind. The Andropogonoid tendency is toward freely branched parts, long pedicels and fibrous, as opposed to brittle parts.

A type of fasciation in which there is shortening of the longitudinal axis with continued development of the parts probably plays a much greater role in maize than is usually admitted. The origin of the ear as a fasciation was suggested long ago, but received little serious consideration. Recently, Anderson (1944) suggested that Mexican Pyramidal maize is fasciated. Fasciations occur frequently in other wild and cultivated plants (White 1945). A familiar example is cockscomb, which is rarely seen except as a fasciated plant. *Oca*, an oxalis cultivated in the Andes and parts of Mexico, produces its best edible rhizomes on plants with fasciated stems. The ear-like structure of Trichachne is probably a fasciation. Fasciations may be produced by the environment or be hereditary (although some of the hereditary ones appear only under certain conditions), and probably possess modifiers. If a primitive maize was a fasciation, it would have

been in the homozygous condition when removed from its relatives and now would give little indication of being a fasciation. Besides this, the fasciation, if it acted like the one described in Trichachne, would hasten the divergence from its parent forms. Within the ear the anthers might become non-functional, although the seeds would continue to be produced. Tassel glumes, lemmas and paleas are loosely wrapped about large seeds so, if the size of seeds were increased, birds and insects would soon eliminate those plants which bore large seeds exposed on the tassel.

The general characteristics of South American maize

The Plant

Ordinarily the length of time to maturity is correlated with the number of leaves and the height of the plant, but when maize is grown under conditions differing from those of its natural habitat, this relationship is less exact. Maize from low altitudes requires more time to mature in high latitudes, while maize of temperate zones is precocious and dwarfed in the tropics. Plant height is directly related to length of season if allowance is made for the tillers. The races of maize described below vary in the length of time to maturity. Altiplano maize requires about 44 days from seed to first silk; Uchukilla, 56; Valle, 55 to 130; Guarani, 55 to 100 or more; Cuzco, 90 to 140. Coroico maize grown in Cochabamba was the latest and most tillered of all the races. While many of the plants had silks after 90 days, some required 140 before the main ear silked, and ears on the tillers were still far from this stage.

Tillers range from small basal shoots which never tassel or bear ears to stalks indistinguishable from the primary axis. Tillers are common in lowland maize. One

plant of Coroico maize had twenty nearly equal tillers and many plants had five or more. Although all these tillers were basal, one may consider these plants as tending to branch from the stem, for the shanks of the ears were greatly elongated on many plants. Seedlings and very young plants of Coroico maize have laterally flattened culms, as compared with the terete ones of most other types. This resembles some grasses and probably is correlated with tillering.

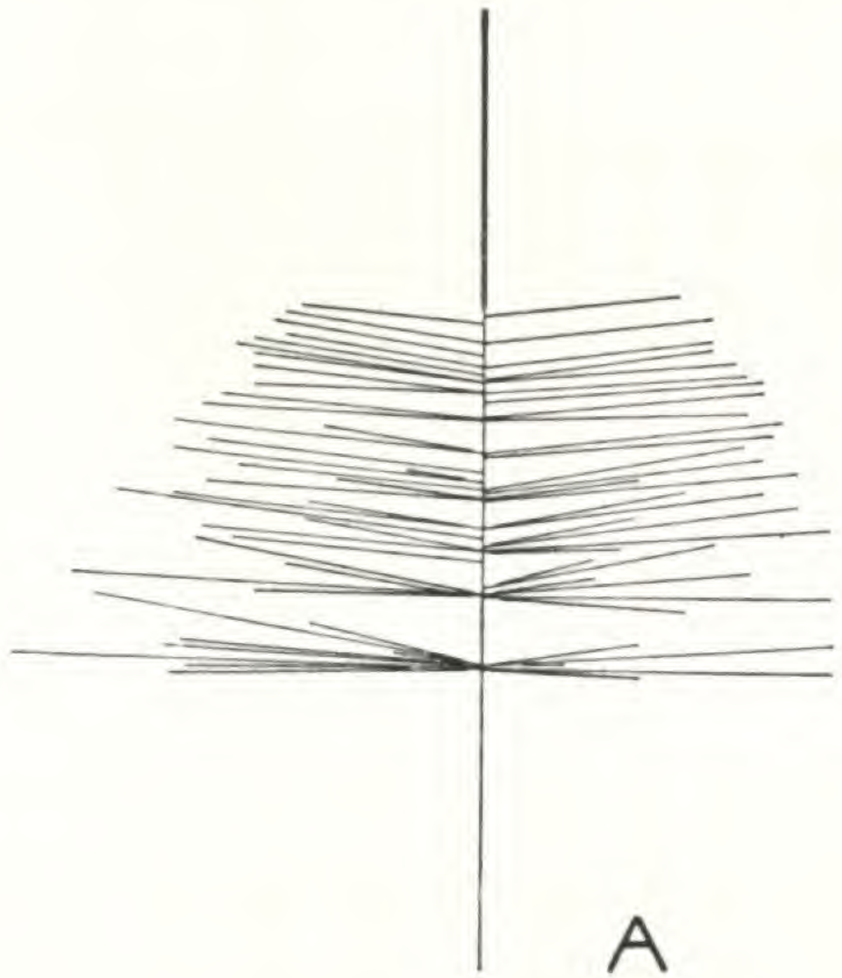
Leaves vary in shape, but it is difficult to measure them rapidly and to make comparison. Coroico leaves are more slender than those of the highland types, have a deeper channel over the midrib and the sheath is pubescent. Guarani maize has hairs along the edges and the upper part of the sheath, while highland maize usually has very little hair restricted to the edges near the auricles or may be practically glabrous.

The Tassel

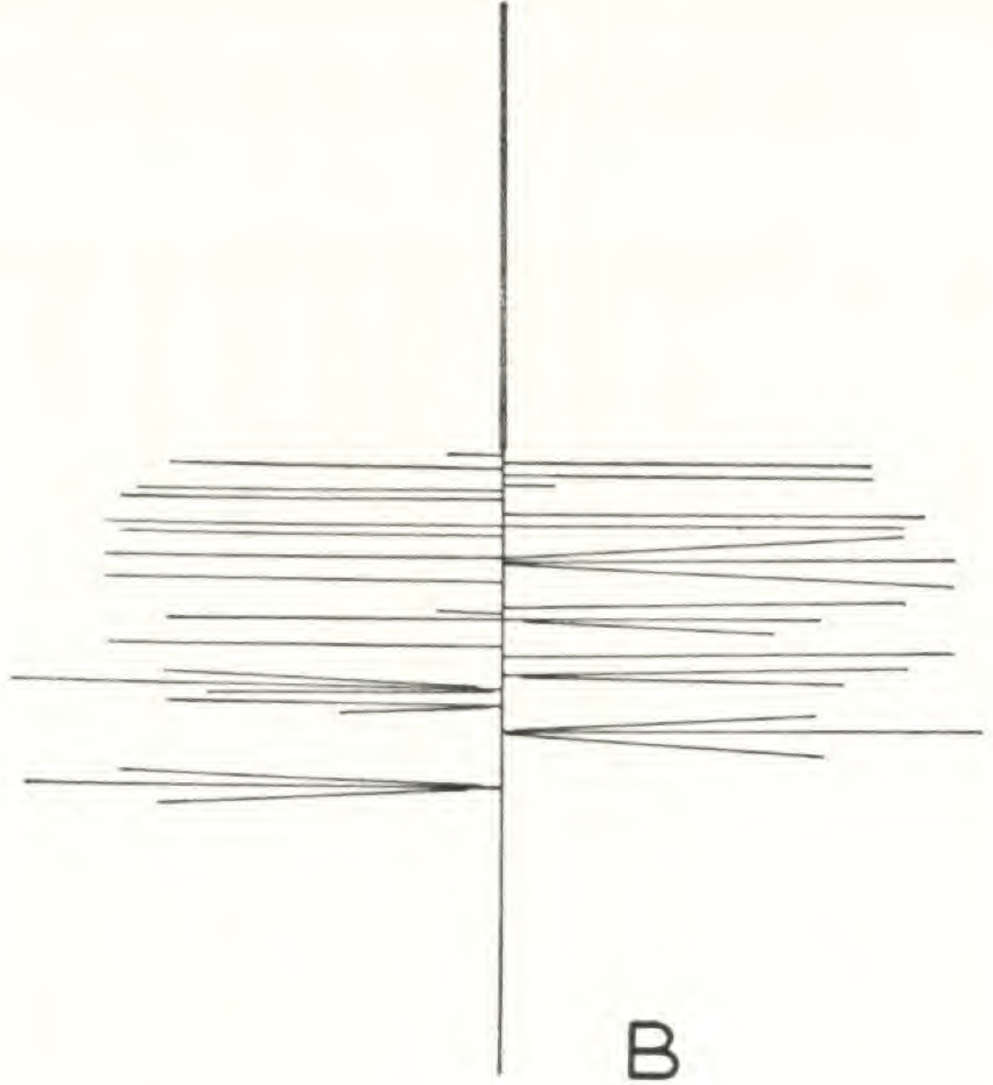
Tassel branches are fairly constant in number for each race and, although unfavorable environmental conditions may reduce the number of branches, the reduction usually is within the range of the race. Fasciation may increase the number of branches just as it affects the number of spikelet pairs at a node and this has probably been the cause of the high number of branches in Bolivian sugar corn tassels (Figure 1 F), double that of other maize of the same race. The series of diagrams of typical tassels (Figure 1) shows that there is great difference in the number of branches, their length and points of origin.

Sterile Zone is a term employed for the distance meas-

FIGURE I (shown on opposite page). Tassel diagrams. A. Coroico maize. B. Guarani maize. C. Altiplano maize. D. Uchukilla maize. E. Valle maize (*morocho* or *huilcaparo*). F. Valle maize (*chuspillo* or sweet). G. Cuzco maize.



A



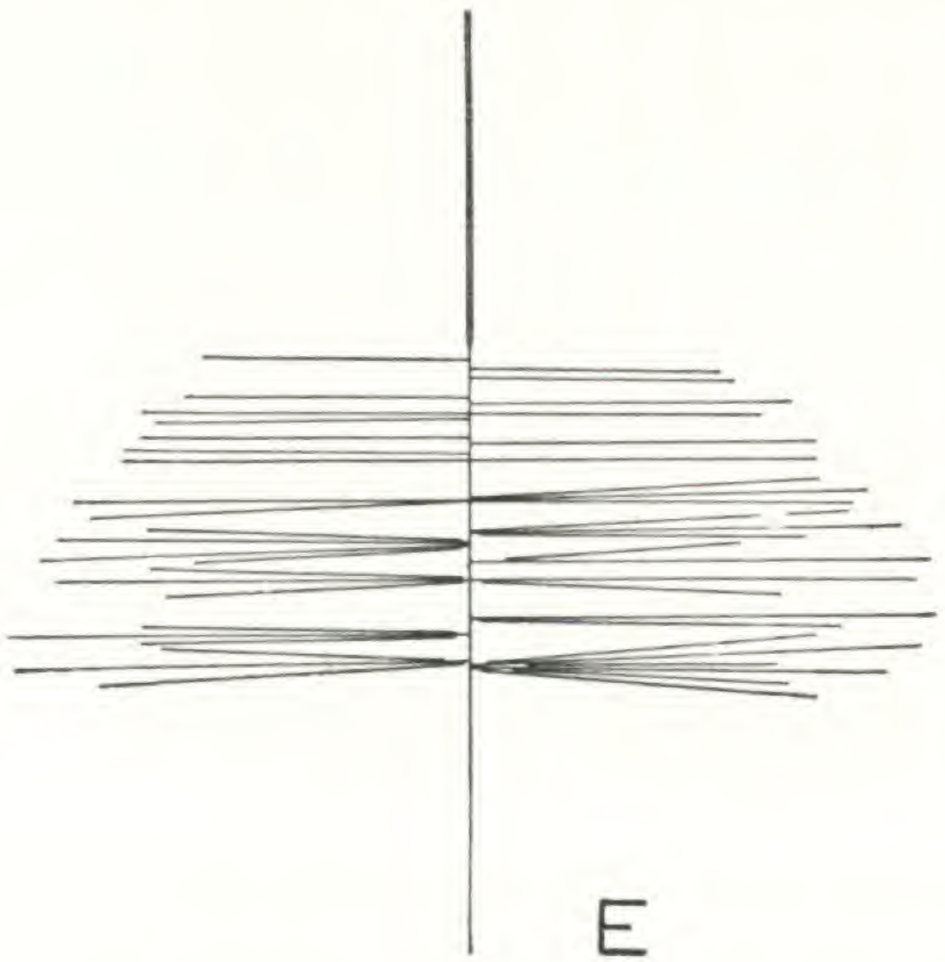
B



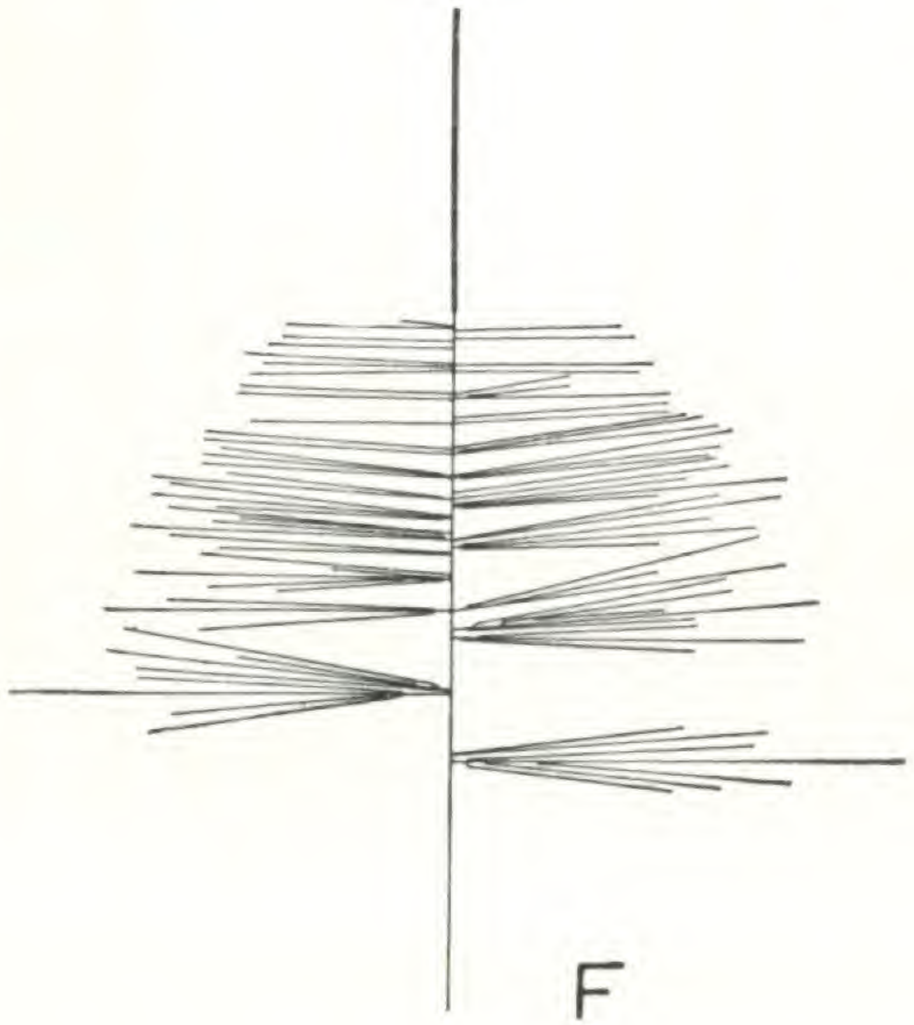
C



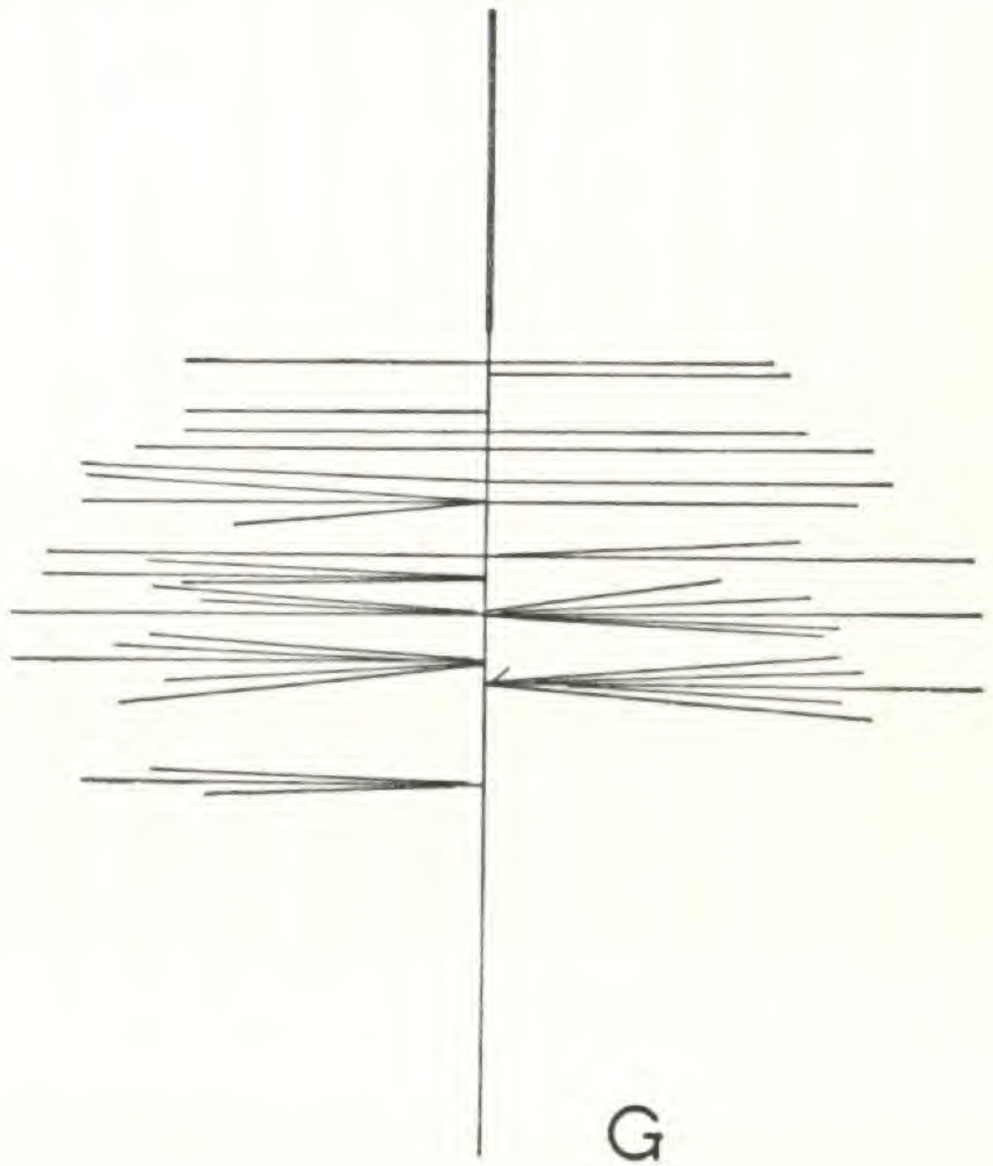
D



E



F



G

ured on the third secondary branch of the tassel, from the central axis to the base of the first spikelet. Tripsacoid influence greatly condenses this distance, although adverse conditions may also do this.

Glume shape is correlated with grain shape as Anderson suggested (1944). In Tripsacum and Tripsacoid maize the glumes are broad at the tip, not tapered to a point as in those plants considered as pure maize, just as grains of Tripsacoid maize are widest near the tip, often flattened across the top.

Anthers vary in shape and size, but no good correlation with any tendency or within any race could be discovered. This is also true of pollen. The maize which is considered most contaminated by other grass species has small pollen, just as one would expect because practically all other grass pollen is much smaller than that of maize. The pollen of other maize (sweet corn, for example) is occasionally small.

The arrangement of paired spikelets on the tassel branches is highly indicative of tendencies which are present in the plant. One of the spikelets is usually pedicellate while the other is sessile, a condition which is not only common in grasses but is found in the Palmaceae and many other plant families. The arrangement of these pairs on the branches is nearly always regular (Figure 2 A) and any variant follows certain forms. An index of the divergence from regularity of arrangement has been devised by Dr. Edgar Anderson (1944) and called *condensation index*. His definition, "The average number of spikelet pairs per apparent node in the most condensed central three quarters of the basal-most secondary branch," is applicable to most North American tassels, but when one studies the arrangement of spikelets of all maize, it is apparent that condensation index is increased in two distinct ways, by condensation and by multiplica-

tion. With condensation one internode or more may be so condensed that the spikelet pairs appear in whorls at one apparent node, as they do in much North American and in some Guarani maize (Figure 2 B), and the sessile and pedicellate spikelets retain the arrangement one

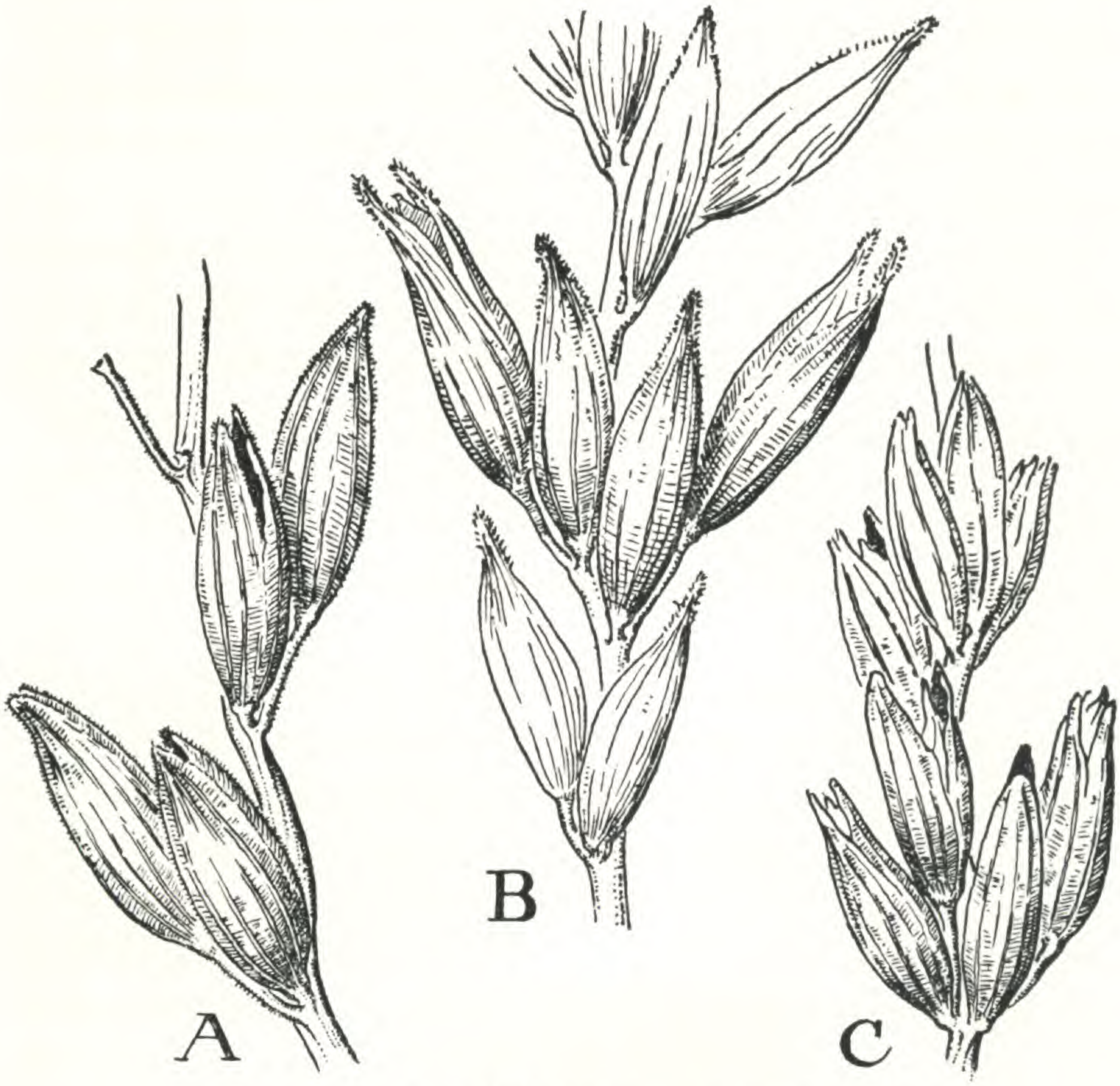


FIGURE 2. Spikelet arrangement on tassel.

would expect if a normal branch had been greatly shortened. With multiplication, however, the arrangement is different, with the sessile and pedicellate spikelets alternating at the nodes as if the primordia had branched to give rise to more pairs of spikelets (Figure 2C). *Spikelet-node index* (Table I) may be defined as the average number of spikelet pairs per apparent node of the basal-

most secondary branch in the three-quarters with the most spikelets. This includes multiplication and condensation, and if one recalls that in the races described here, only Guarani has a large amount of condensation and little multiplication, this index is a satisfactory measure of disturbance to the basic arrangement and still is simple to measure.

TABLE I. Median values of some ear and tassel characters of races of maize described in this paper.

	Coroico	Guarani	Altiplano	Uchukilla	Valle, excluding sweet	Valle, sweet only	Cuzco
Number of rows of grain	9	12	14	8	14	20	8
Mid-cob width in mm.	12	23	21	15	23	26	22
Kernal width divided by kernel thickness	1.5	1.8	1.3	1.9	2.0	1.65	2.3
Kernel length in mm.	9	9	11	11	14	12	15
Number of tassel branches	43	32	14	24	36	84	34
Sterile zone length, mm.	5	4	3	6	8	14	12
Spikelet-node index	1.1	1.3	1.1	1.1	1.1	1.2	1.1
Percent subsessile spikelets	4	6	10	6	4	36	8

The percent of sub-sessile spikelets is another measure of the amount of disturbance to the basic spikelet pair arrangement (Table I). It is taken from the same basal-most secondary branch as the spikelet-node index. Sub-sessile spikelets result from the Tripsacoid tendency to shorten pedicels or indicate irregularities in the order of the spikelets. In a series of spikelets with the pedicellate spikelet on the left, a sub-sessile pair of spikelets is often followed by several pairs with the pedicellate spikelet on the right.

The Ear

The shape of the ear varies greatly from one race to

another, but is remarkably constant within the races (Plates XXXV–XXXVII). It has not been studied as well as it should have been because it is dependent upon numerous factors and measurements and comparisons are difficult to make. One of the peculiarities of Tripsacoid maize, which has high numbers of chromosome knobs in Central and North America, is the long naked cob-tip, which is also found in some Guarani maize of Paraguay. Andean maize and Guatemalan highland maize with few chromosome knobs have the tip of the ear completely covered by grains. Ears of Longfellow flint and some ears from the Iroquois tribes of New York also have this grain-covered tip.

Anderson (1944) has indicated a correlation between high condensation index and high row number in North American maize, and it is probable that the high row number in Bolivian sweet (Plate XXXVII, G, H) is brought about by the same fasciation which increased the number of tassel branches. Row number is dependent upon many factors and little is known about the manner in which it is regulated. It is, however, relatively constant within each race (Table I) and with the exception of the two lowland races, Coroico and Guarani, usually does not vary much within a race.

Mangelsdorf has shown that there probably are two types of arrangement for the ear and tassel (1945). His studies were made on tassels and tunicate ears of Guarani maize. More recently a method [1] of distinguishing between the paired spikelets of an ear has been developed and the ears examined support his contention that Tripsacoid types tend to have a systematic arrangement while

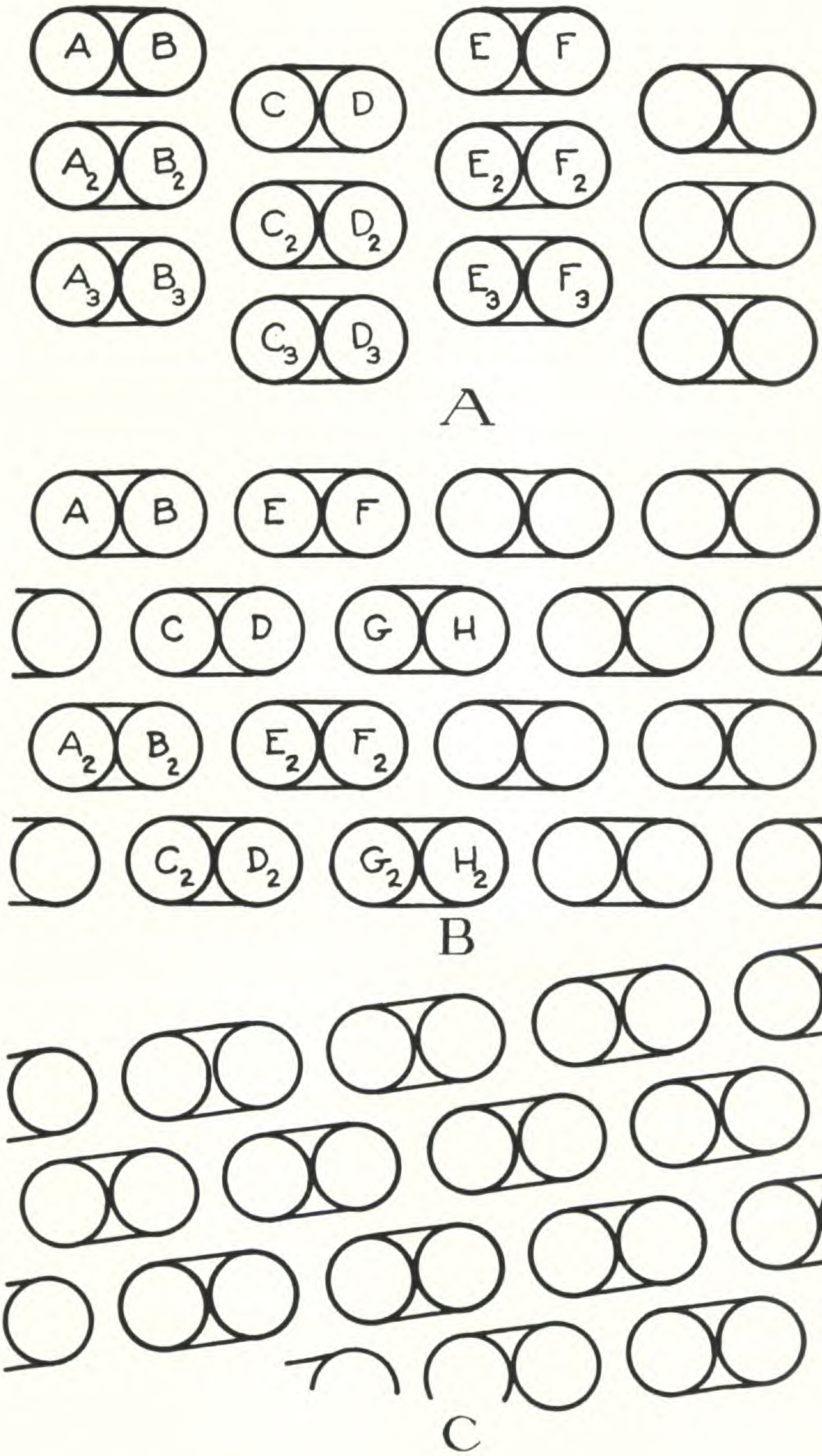
[1] Plate XXXIV shows an alicole of a maize ear after the lower glume has been cut away and the upper glume and the parts above it torn off. Note that one spikelet arose from a hair-fringed callus located in the bottom of the alveolus while the other was attached to the side of the alveolus at a point farther from the center of the cob.

purer maize types have a somewhat whorled or random arrangement, although there occasionally is a suggestion of spiralling.

Let us suppose that we slit a corn ear down one side and spread it flat upon this page. Then an ordinary ear with eight rows of grains could be shown as in Figure 3 A. Each pair of grains arises from a pair of spikelets and comprises, with the related parts of the cob, the alicole. The alicoles are arranged in vertical rows, the adjoining rows of alicoles shifted slightly (Figure 4 A). The arrangement may be interpreted as being derived from a spiral, from a whorled arrangement in which compression and the forcing of the alicoles into the most compact order results in the position shift of the vertical rows, or even from the fusion of vertical rows of paired spikelets. In ordinary maize, then, ears with eight rows of grains have four rows of alicoles, for each alicole bears two grains (diagrams Figure 3, and sketches Figure 4).

In the Coroico race, however, the arrangement differs in that, although an ear has eight rows of grains, it also has eight rows of alicoles as shown in Figure 4 B. The alicoles are placed like bricks, each alicole being covered by half of an alicole from the right and half of an alicole from the left so that in any row of grains, one-half of the row will come from one row of alicoles and the other half will come from an adjacent row of alicoles (Figure 4 B). The arrangement of the alicoles in Coroico maize and the location of the spikelet pairs upon a fibrous pedestal which is nearly twice as tall as wide, instead of upon the ligneous lower ridge of the alveolus as in nearly all

FIGURE 3 (shown on opposite page). Alicole and grain arrangements diagramed as though the ear was split open and spread out.
A. Normal arrangement of 8-rowed ear.
B. Coroico arrangement of 8-rowed ear.
C. Coroico arrangement of 9-rowed ear.


A B
C D
E F
A2 B2
C2 D2
E2 F2
A3 B3
C3 D3
E3 F3
A
A B E F
C D G H
A2 B2 E2 F2
B
C2 D2 G2 H2
C

other races of maize, suggests an arrangement which could be derived from a shortened or condensed panicle. This arrangement leads to two curious situations in numbers of rows of grains.

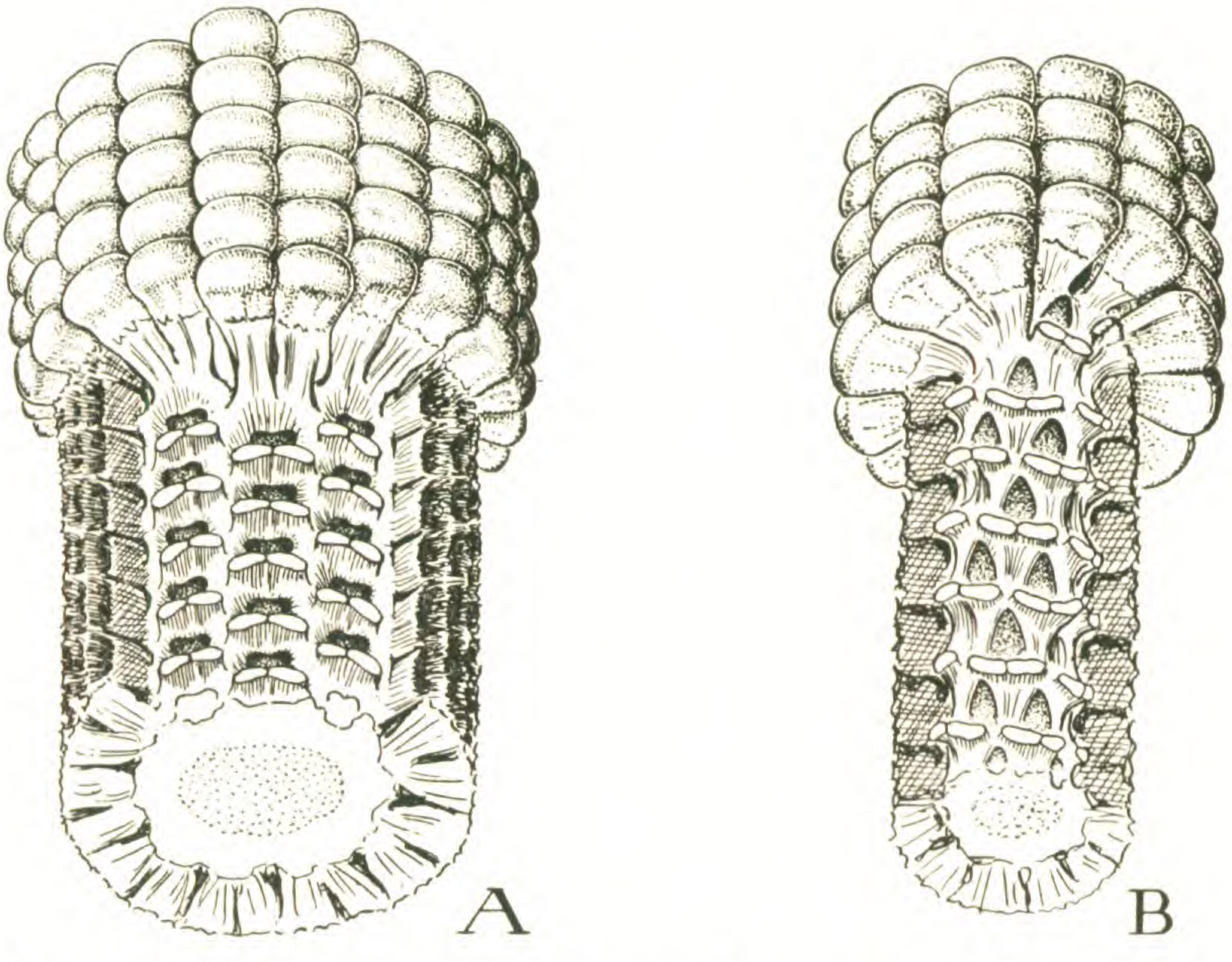


FIGURE 4. Arrangement of alicoles on the maize ear. The spikelets have been cut away in some of the alicoles and only the bases or pedestals left.
A. Normal arrangement of alicoles.
B. Coroico arrangement of alicoles.

Most unusual is the occurrence of ears with an odd number of rows of grains. It is true that ears are occasionally found in which part of the ear has an odd number of rows, but in the one case which was examined, an ear of the inbred R4 obtained from Dr. William L. Brown, this results from abortion of one of the paired grains in some of the alicoles, and an odd number of rows of grains is found only on a portion of the ear. On some of the Coroico ears there were 9 rows of grains

(Figure 3 C) over the entire ear except for a small portion at the base where there was a slightly irregular arrangement, based apparently on nine rows. Some of the progeny of these ears had 9 rows of grains and of alicoles.

A second novelty is the potential increase in number of rows of grains which is possessed by the Coroico race. If the ear is condensed longitudinally or spread out laterally, the grains and the alicoles assume the position of those in ordinary ears with the eight rows of alicoles arranged to form sixteen rows of grain. There is good evidence that this change occurs, for ears from localities near Coroico usually have row numbers near 16 or less (Plate XXXV, E, F, G), and have a high degree of tessellation or interlocking of the grains.

Is it possible that ears with row numbers less than 16 are affected by contamination or by selection for larger and softer grains which also reduced row number? The oldest South American prehistoric ears have 14–16 rows of small grains while later prehistoric ears have fewer rows of larger and softer grains or may have more rows and still have small hard seeds. This probably represents the development of maize for special uses from an original 16-rowed type, one type for boiling, parching or grinding, the other for popping. It is significant that much of the oldest maize in South America bears the paired female spikelets upon a pedestal similar to that in Coroico maize.

Prehistoric and pop corn are not included in this paper because they present special problems. Pop corn has primitive types as well as recent developments which owe much of their character to mixture with the races described here. In prehistoric maize there is much of the same problem, with some primitive types which persisted until quite recently and other types which may either represent developments in the region where their remains

are now found or which may in prehistoric times have been introduced from another region. The study of prehistoric maize must be based largely upon the ears, for even where other material is found, it is practically never associated with an ear. For this reason a special set of characters must be utilized. The most useful ones are in the glumes and alveoles of the ear, but before valuable prehistoric material can be studied with maximum profit, a technique must be developed which will not destroy the specimens being studied.

Thickness of cob varies greatly and is quite independent of the number of rows of grains. The cob may be fibrous and flexible or lignified, hard and stiff. The paired female spikelets may be attached by a broad base to the lower margin of the alveolus so that a definite line of separation between glumes and cob is lacking, or the spikelets may be borne on a pedestal as much as 2 mm. tall. Glumes vary from horny, thickened and sculptured masses to delicate membranes, although the variation within each race is rarely very great. Lemmas and paleas vary much less.

Grains range from bird-shot sized spheres through pointed, beaked, polygonal, dented and other forms to the broad Cuzco grain. Most difficult to interpret is the occurrence of denting, and until some information on the cause and control of denting is available, it is impossible to discuss the distribution intelligently. Denting is found occasionally in all the races although it is often so slight as to be barely perceptible. It is strongly present in some Valle and Cuzco maize.

Isodiametrical polygonal grains which are widest at their tips are usually correlated with tesselation. This arrangement and shape of the grain is characteristic of Coroico and Guarani maize, which might lead one to suspect that they have been contaminated with Tripsacum,

since a similar arrangement and shape occurs in ears from maize-teosinte crosses. Ears of Cuzco maize with more than the usual number of rows of grain often have isodiametrical grains in a tesselated arrangement. If this had been the result of Tripsacum contamination, one would expect to find it in the ears with lower row numbers instead of becoming more marked in the higher row numbers. *Salpor* of Guatemala and *Cacahuatzintle* of Mexico are similar to the many-rowed forms of Cuzco and occasionally have isodiametrical tesselate arranged grains.

Kernel width divided by thickness gives a positive number which is an index to the grain cross section (Table I). Variations in grain size are common in some of the races studied and when prehistoric specimens and pop corns are compared with races described here, it may be noticed that, although there are often vast differences in the sizes of grains, there are similarities in the shapes.

Colors have been used very little in this study for the examples found in most collections are the extremes. Colors are controlled by numerous factors which may interact, be modified or inhibited, be restricted in action to certain areas of the plant, or have a broad effect over nearly the entire plant. The most significant feature of colors in South American maize is the frequent occurrence of browns and reds or purples. These colors are common in grasses. Brown grains are not only colored by a combination such as yellow or orange endosperm plus blue or purple pericarp, but by true brown pigments.

The common maize of many districts is often divided into two types, a yellow and a white. This is true of the altiplano, where there is a flint with yellow endosperm and a white flour maize; of the valleys, where there are yellow and white forms of Cuzco; and of the Paraguay basin lowlands, where there is a flour maize with a yellow

("brown") aleurone and a white flint which belong to the Guarani race of maize.

Highland maize is susceptible to smut just as the varieties classified by Mangelsdorf and Cameron (1942) as Andean were susceptible. Perhaps there is some connection between the use of corn smut as food, a common practice in the highlands, and its occurrence. Lowland maize grown at an altitude of 2,500 meters in Cochabamba, Bolivia, was rarely attacked by smut. On the other hand, lowland maize grown in Cochabamba was badly damaged by rust. Coroico maize was most severely infested, then Guarani and least of all the Coastal Flints and the highland races. Several commercial yellow dent inbreds from the United States were so badly covered with rust that they died before tasseling.

Races of South American maize

Coroico maize

Coroico maize is the most unusual race known so far. Some of its characteristics are found in other races, especially in Guarani (Plate XXXV, C, D, E, F, G) but these are encountered less frequently in areas remote from Coroico, Bolivia, and no ears of this race have been discovered more than a short distance from Coroico. At present the race is restricted to those ears which have the alternate arrangement of alicoles or which approach this condition and have enough of the other characters (slender flexible ear, spikelet pairs on a pedestal, brown-orange aleurone and brownish cob) to distinguish them definitely from Guarani which is to the south and east, and from mixtures with the Coastal Tropical Flints, which are found in parts of eastern Ecuador, and in Brazil as far east as the states of Goias, Maranhao and Ceara. The town of Coroico is in a transition area close to the division between the highland and lowland Indian groups

on the margin between the lowlands and the highlands, and not far from the separation of the Amazon and Paraguay River basins.

The most peculiar characteristic of Coroico maize (Plate XXXV, A, B) is the arrangement of the alicoles which has been described on page 272. The long, slender and flexible ears have a light brown cob with very little pith and the shallow alveoles and slender pedestals do not stiffen the ears like the trusswork system of deep alveoles with the horny attached glumes of North American and most South American cobs. The isodiametrical grains are nearly always brown-orange in color due to the presence either of the brown aleurone characteristic of Guarani maize or to a brown-orange aleurone hitherto unknown to students of maize. The presence of a dominant inhibitor for other aleurone colors makes grains of any color except brown-orange infrequent in this race.

The plant of Coroico maize is as distinct from the other races of South America as is the ear. When grown in Cochabamba it tillers abundantly and has narrow leaves with a distinct hairy channel over the midrib. All of the leaf sheaths have hairs which are stiffer and straighter than those found in the pubescent types of Central America.

Guarani maize

This is the maize grown throughout most of the lowlands and plains of the Paraguay River basin, an area inhabited mainly by the Guarani Indians and related groups. The ears (Plate XXXV, C, D) usually have 12 or 14 rows of grains, are of good size, nearly cylindrical, with the naked cob protruding beyond the grains as in Tripsacoid types. The number of chromosome knobs in the plants Mangelsdorf studied was extremely low and some plants had no knobs. Although the cobs are

cream-colored, firm, quite stiff and possess moderate pith cavities and alveoles, some characters, especially in those ears from Santa Cruz Province on the southeastern Bolivian border, suggest Coroico maize. The grains in Santa Cruz Province are smaller, so strongly tesselated at times that the pairs almost overlap, and a dominant aleurone color inhibitor is found in most ears.

There are two types of Guarani maize, grown for separate purposes and planted separately: yellow soft flour, called *abati moroti*, and crystal-white flint, called *abati tupi*. The yellow color of the flour maize is formed by a brown aleurone, other colors being absent when the dominant color inhibitor is present. The flour types appear to be the older form. The ears of flint are stiffer, more ligneous, more cylindrical; the alveoli are deeply sunk into the cob, and the grains are rounded at the top, less flattened and less compressed by the husks.

The apparent uniformity of Guarani maize must not be interpreted as a lack of potential variation. Concealed within this race, in part by modifiers and inhibitors and by human selection of two definite varieties, is an amazing amount of potential variation. From selected Guarani ears it might be possible to develop many of the varieties of South American highland maize and still have some characters which are not found in other varieties.

Coastal Tropical Flint

The orange-yellow tropical flint which is the most common maize in Europe, Cuba and throughout the Caribbean area, is also found in eastern Ecuador, Brazil and Argentina. This variety belongs to the race of tropical flints described by Anderson and Cutler (1942) and probably has been spread by the Arawak, Carib and Tupi-Guarani groups which populated coastal areas from Cuba to Argentina. In Brazil, where it is called *Cateto*, it was

previously limited to the coast, but is now spreading rapidly to the interior where Guarani maize was grown (Plate XXXV, H, I). The tight husks prevent much damage to the growing or stored ears and the hard flint grains resist weevils. There has been much active and intelligent work carried out in the selection of improved varieties of Cateto. Much of the seed grown by that name throughout Brazil originated in the State of São Paulo and may be contaminated with North American maize. The ears have 12 to 16 rows of flattened, not isodiametrical, grains, are slightly tapered and have an enlarged base, although this may not be evident in some ears.

Altiplano maize

Altiplano maize is widely distributed throughout the higher or less favorable parts of the Andes from Argentina and Chile to Ecuador and probably Colombia.

Altiplano maize plants are small and early, with few leaves and tassel branches, occasionally with one or two tillers, and nearly always with red or purple plant color on leaves and culms. The ears are small and nearly spherical, averaging about 14 rows of grains although often these rows cannot be distinguished until the grains are removed and the arrangement of the alicoles studied. The grains vary from hard pop to soft flour, with a wide assortment of endosperm, aleurone and pericarp colors, and grain shapes from nearly spherical through ovoid, pointed, beaked, imbricated and, very rarely, minutely dented.

When plants are grown under adverse conditions or near their growth limits, it is difficult to distinguish between the effects of environment and heredity. The small plants and nubbin-like ears of Altiplano maize (Plate XXXVI, A, B) resemble those produced under ad-

verse conditions, yet when seeds are planted in a more favorable environment, as in material from Lake Titicaca planted under irrigation in Cochabamba, there is little or no change. The specimens of maize Anderson described from Río Loa, Chile (1943), as well as most of the prehistoric material discovered within the present range of the race, falls within the range of variation of Altiplano maize. Like most of the prehistoric material, Altiplano maize probably does not represent a primitive type but may be one of the early developments which could withstand the environment in which it is grown and may indicate the nature of the primitive type from which it was developed.

Uchukilla maize

The name, *Uchukilla*, is applied in Bolivia and Peru to a small crystal-white flint grown on the slopes of valleys at about 2600 meters altitude. The race includes, however, some flour and semi-flint varieties, usually yellow and often red, which are known locally by other names. The plants are small and mature earlier than other races in the same district, usually requiring 50 days from time of planting to the appearance of the silks. The ears (Plate XXXVI, C, D, E) are small, with 8 or 10 straight rows of grains. These grains are widest about two thirds of the distance from the base to the tip, and frequently very slightly beaked, pointed or dented. Ears of Altiplano maize which have low row numbers and a less spherical ear shape than usual approach Uchukilla in appearance. It is nearly always possible, however, to distinguish the few and distinct rows of nearly diamond-shaped flattened grains of Uchukilla from the larger number of somewhat irregular rows of rounded or slightly pointed and imbricated grains of Altiplano maize.

Valle maize

The favored places for human habitation in Bolivia and Peru are the highland valleys and it is in these valleys that agriculture is changing most rapidly. No longer are these valleys isolated centers where the people live shut off from their neighbors, and conserve their customs, habits and crop plants inviolate. No longer do feudal landowners and the state church, be they Incaic or modern, hold the workers to the soil, toiling on designated crops and laboring in a limited area. Now restrictions are few, travel is easy and rapid, and an influx of foreign materials and methods has changed the passive Indian to a confused citizen. With the loss of native customs, there has been less rigidity in selection of seed for planting; with the introduction of foreign customs and methods, such as drinking beer instead of chicha, or using animals instead of human labor, new varieties of plants are required. Maize in the valleys is in a volatile condition, with old types being lost and abandoned or modified to suit the newer concepts. An example of this has been given in the growing of two special types of Valle maize, sweet and Culli, or cherry pericarp, maize.

The four divisions of Valle maize, *hanka sara* or the mixture for toasting, *Culli* or the cherry pericarp *chicha* maize, *morocho* or the ordinary field and general use maize, and *chuspillo*, the sugar maize, differ greatly in length of growing season, size of plant and number of rows of grains. All, except *chuspillo*, have long grains which are widest slightly above their center, and usually dented and medium-sized strongly tapering or pyramidal ears with enlarged butts. As in all the races of maize discussed in this paper, with the exception of Guarani and Coastal Tropical Flint, the tip of the ear is rounded and covered with grains.

Heterogeneity in Valle maize is increased by the plant-

ing of a special corn for parching. The seed for this planting is obtained from ears which vary in color or grain shapes from the varieties normally planted, and which are floury or nearly so. This seed, known as *hanka sara* or *sechys* in Bolivia, thus contains the most varied assortment of grain shapes, colors and markings which can be found anywhere (Plate XXXVII, A, B). Dr. Martin Cardenas, rector of the Universidad Autonoma Simon Bolivar at Cochabamba, suggested that a critical study of this group would reveal many varieties no longer in cultivation in a pure form. Most of these varieties, however, would fall into the Valle race of maize and probably within the variation, except for color and some extremes in grain shape, of the other three divisions.

Culli or *morado* recalls the purple dye corn of the Hopi Indians. The plant is the earliest of the Valle maize, smaller, the grains shorter and thicker, and the row number usually lower (10 or 12) than others of this race. It suggests a close relationship with the very similar Uchukilla.

Morocho or *huilcaparo* is the most important maize of the Valley of Cochabamba and similar forms are the most common types of maize in other valleys of Bolivia, Peru and Ecuador. Although the present form usually has 14 or 16 rows of slightly dented flint grains and a brownish color, there is a tendency to select ears which are more variable in row number, softer and more dented and yellow-orange in color. The cob is nearly always a rust-red color.

Chuspillo or *chulpi* is the sweet corn, eaten only in the form of dried toasted grains or used by the wealthier natives in the preparation of a special *chicha*, but never eaten in the form of green fresh corn. The plant is very similar to that of *morocho*, but the leaves are a lighter green. The most curious feature of *chuspillo* is that the number

of tassel branches and the number of rows of grain are approximately double those of *morocho*. The high spikelet-node index of *chuspillo* suggests that it differs not only because it is sweet, but because there has been some fasciation. There are frequent branched ears and some splayed tips or slight bear-pawing, but the flattened and bear-pawed ears which are associated with high row numbers and high spikelet-node indices in North American maize are not found in South American highland sweet corn, nor is condensation usually found in the tassel branches, though multiplication is common and characteristic (Table I).

The gene for sugary endosperm in Valle maize is probably the same as that involved in North American sweet corn, but there is some suggestion that there may be modifiers, for frequently the grains are not completely translucent, but are opaque for part of their length when crossed with North American sweet. It is also possible that there is more than one gene for sugar present.

Multiplication of row number has crowded the grains so that they are very slender, almost nail-like and the ear has become more rounded, with less tapering to a point and no visible enlargement of the butt. The grains are usually light yellow or nearly white, though occasionally red. In the purer forms the cob is white, but some cobs are red or rust-red, especially where there has been opportunity for crossing with *morocho*.

Two type of ears, one tunicate (called *paca sara* or hidden maize in Quechua) and the other with the double-grained spikelets such as are found in Country Gentleman (called *cuti sara* or turned maize in Quechua), are used as medicine in the Bolivian highlands. When planted these gave many ears which were of Valle type, but others had characters of Coroico or Guarani mingled with those of Valle maize. It is impossible to say where

these peculiar and primitive types arose, but it is probable they will be found commonly in Valle maize because of the preservation of the heterogenous *hanka sara* or mixed toasting corn group.

Cuzco maize

This is the most famous South American maize for the grains are so much larger than any others that they have been collected more often and introduced in many places. It is likely that the extremes of Cuzco represent a comparatively modern development, for in the valleys near Cochabamba, Bolivia, with conditions as favorable as those in Cuzco, Peru, the two forms (Plate XXXVI, F, G, H, I) of this race are known by Spanish descriptive names, *mais amarillo* and *mais blanco* instead of the Quechua names by which they are known in Cuzco. The soft texture of the floury endosperm resembles that of *salpor* of Guatemala and *cacahuazintle* of Mexico. Like these two varieties, Cuzco maize may also be flinty, a form in which it can be transported or stored in areas where insects and mold would damage floury ears.

The ears are moderately long, tapered from a frequently enlarged and irregular butt to a round grain-covered tip. Typical ears of Cuzco maize have eight rows of grains with spikelets so strongly paired that the cob in cross section appears like a cross, with deep sulci between the rows of paired spikelets. Frequently the second and third ears on a plant or ears grown under difficult conditions are distichous, with a flattened cob bearing one row of paired spikelets on each edge, somewhat resembling, even to the turned up lower glumes, some of the progeny of teosinte-maize crosses. The grains on these ears, as on ears which have not been completely pollinated, are elongated spheres with a slightly pointed tip (the shape of the grains in teosinte and Tripsacum). Cuz-

co grains are usually wide, flattened, slightly dented and with a small beak or overhang on the upper edge similar to that found in much Valle maize, in Mexican pyramidal dents, and some North American dents.

Just as in Guarani maize, planters made two main divisions of Cuzco maize, white and yellow, but unlike Guarani, there usually is no difference in the endosperm and both are floury. The large haciendas of Bolivia are selecting ears with 10 or 12 rows for their plantings and most of these show clearly by their shape and color that they have been crossed with *morocho*, the most common Valle maize. The yellow ears show most contamination with other races. Both white and yellow Cuzco may have calico pericarp, but most of the ears which exhibit other colors are contaminated by other races of maize.

LITERATURE CITED

Anderson, Edgar, 1944. A variety of maize from the Rio Loa. Ann. Mo. Bot. Gard. 30: 469–474.

Anderson, Edgar, 1944. Homologies of the ear and tassel in *Zea Mays*. Ann. Mo. Bot. Gard. 31: 325–342.

Anderson, Edgar and Cutler, Hugh C., 1942. Races of *Zea Mays:* I. Their recognition and classification. Ann. Mo. Bot. Gard. 29: 69–88.

Graner, E. A. and Addison, George, 1944. Meiose em *Tripsacum australe* Cutler e Anderson. Anais da Escola de Agricultura, Piracicaba, Brazil. 1944, 213–224.

Kozuchov, I. V., 1935. Results of investigations of world sorts of maize (in Russian). Bull. Appl. Bot. Gen. & Pl. Breed. Ser. A, 16: 5–18.

Kuleshov, H. N., 1930. The maize of Mexico, Guatemala, Cuba, Panama and Colombia. Bull. Appl. Bot. Gen. and Pl. Breed., Supplement 47: 117–141. English summary 492–501.

Mangelsdorf, P. C., 1945. The origin and nature of the ear of maize. Bot. Mus. Leafl. Harv. Univ. 12: 33–75.

Mangelsdorf, P. C. and Cameron, J. W., 1942. Western Guatemala a secondary center of origin of cultivated maize varieties. Bot. Mus. Leafl. Harv. Univ. 10: 217–252.

Mangelsdorf, P. C. and Reeves, R. G., 1939. The origin of Indian corn and its relatives. Texas Agric. Exper. Sta. Bull. 574.

Weatherwax, Paul, 1935. The phylogeny of *Zea mays*. Amer. Midl. Nat. 16: 1–71.

White, O. E., 1945. The biology of fasciation. Journ. Hered. 34: 11–22.

EXPLANATION OF THE ILLUSTRATIONS

PLATE XXXIV. Three alicoles of a maize ear with the lower glumes cut away and the upper glumes and parts of the spikelets above the upper glumes torn off to show the attachment of the pairs of spikelets. One spikelet of each pair arose from a hair-fringed callus in the depths of the alveolus while the other spikelet was attached to the side of the alveolus further from the center of the cob.

PLATE XXXV. Representative ears of South American maize. A. Coroico maize, Coroico, Bolivia. B. Coroico maize, Coroico, Bolivia. C. Guarani maize, yellow flour, Concepcion, Paraguay. D. Guarani maize, white flint, Concepcion, Paraguay. E. Guarani maize, with characters approaching Coroico, near Robore, Bolivia. F. Guarani maize, with characters approaching Coroico, near Robore, Bolivia. G. Guarani maize, with characters approaching Coroico, near Magdalena de Itenez, Bolivia. H. Coastal Flint maize, State of Maranhào, Brazil. I. Coastal Flint maize with Guarani influence, State of Ceará, Brazil.

PLATE XXXVI. Representative ears of South American maize. A. Altiplano maize from shores of Lake Titicaca, Bolivia. B. Altiplano maize from shores of Lake Titicaca, Bolivia. C. Uchukilla maize, Cochabamba, Bolivia. D. Uchukilla maize, Cochabamba, Bolivia. E. Uchukilla maize, Tarija, Bolivia. F. Cuzco maize, white, Cliza, Bolivia. G. Cuzco maize, white, Cochabamba, Bolivia. H. Cuzco maize, yellow, Cochabamba, Bolivia. I. Cuzco maize, yellow, Sacaba, Bolivia.

PLATE XXXVII. Representative ears of South American maize. All the ears shown in this plate are Valle maize. A. Toasting maize, a speckled ear in the mixed group of Valle maize, Sucre, Bolivia. B. Toasting maize, a white-capped red ear in the mixed group of Valle maize, Cochabamba, Bolivia. C. *Culli*, Cliza, Bolivia. D. *Culli*, Cliza, Bolivia. E. *Morocho* or *huilcaparo*, the common field corn, Cliza, Bolivia. F. *Morocho* or *huilcaparo*, the common field corn, Sacaba, Bolivia. G. *Chuspillo*, sweet corn, grown among *morocho* at Cochabamba, Bolivia. H. *Chuspillo*, sweet corn, Cochabamba, Bolivia.

Plate XXXIV



Plate XXXV

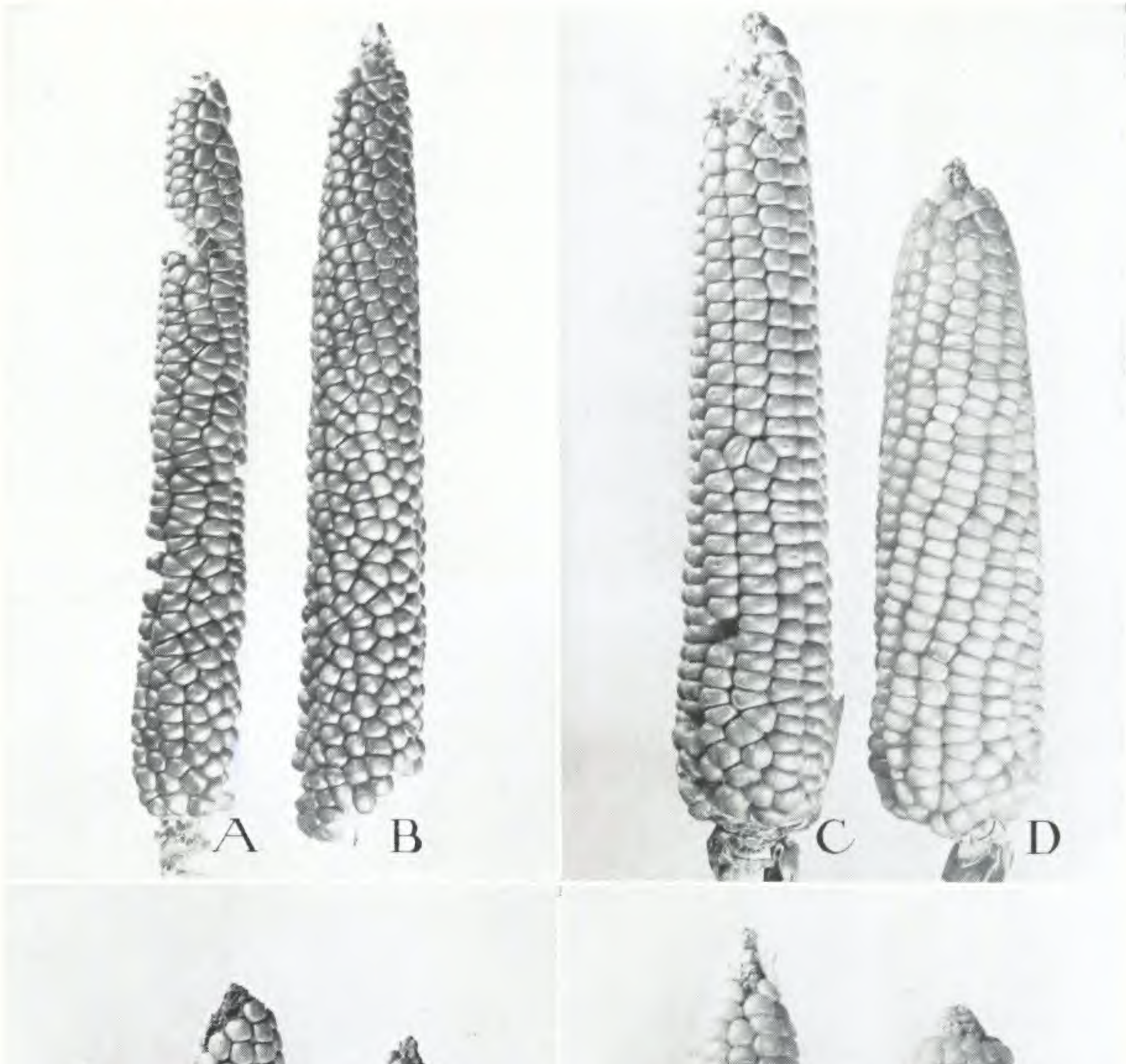
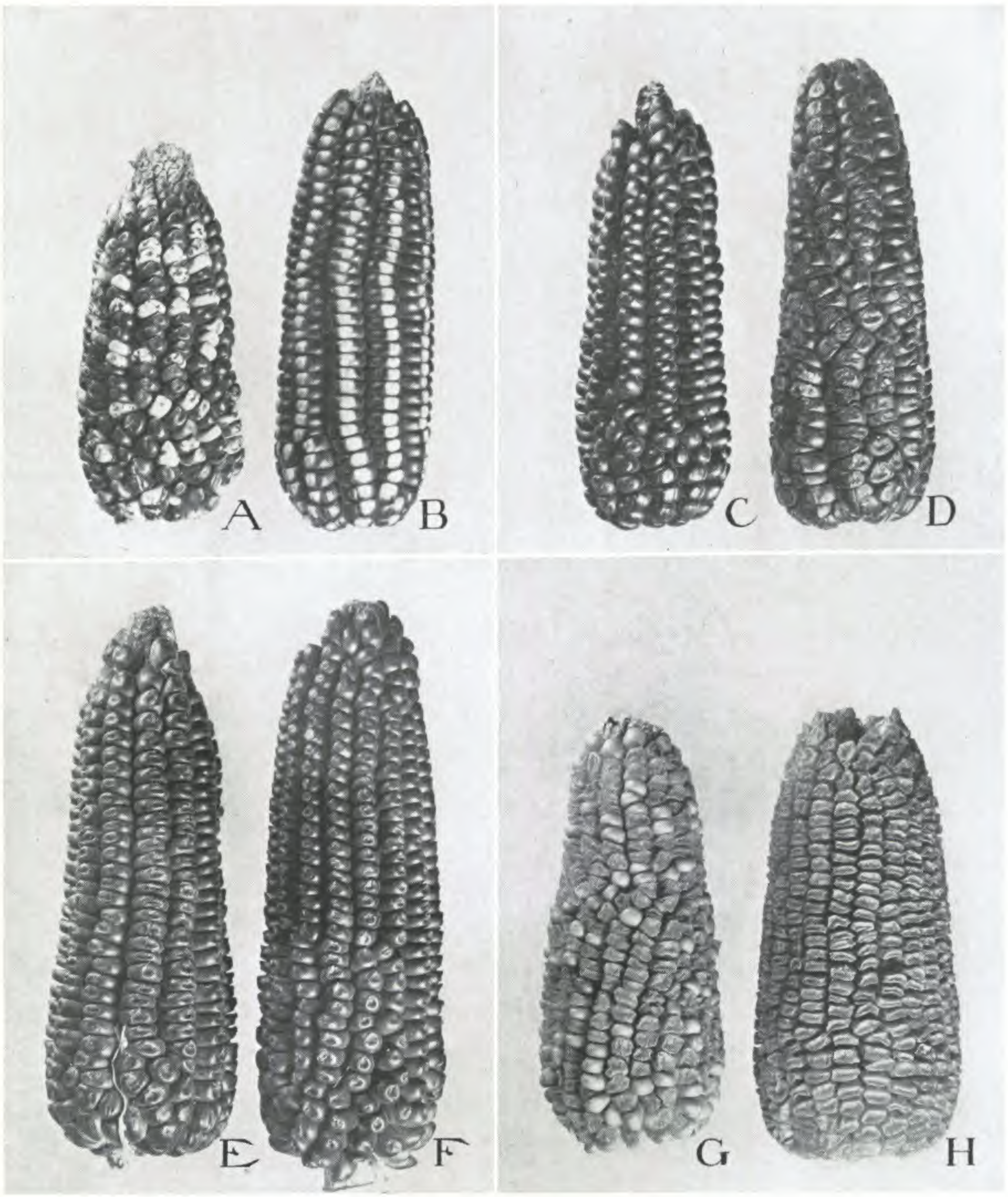


Plate XXXVI

Plate XXXVII



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RUBBER PRODUCTION IN CEARÁ, BRAZIL

BY
HUGH C. CUTLER[1]

ALTHOUGH various commissions of the American government have been investigating rubber sources in the Americas for many years, especially after measures were taken by foreign governments to control rubber production and prices, there still were rubber yielding plants, as late as 1943, which had not been adequately studied. Most of these, to be sure, had been tapped during the rubber boom years, but the rubber buyer often did not know which type of plant yielded a particular grade of rubber, or from what district it had come. In one northeastern Brazilian state alone, Ceará, nine types of trees were being tapped by the end of 1943; in many areas it was impossible to find a rubber producing tree which was not being utilized. However, little was known about the production methods which were being used or whether or not they could be improved upon. Studies of these rubber yielding plants and the methods of extraction and preparation of their rubber had been made earlier (Ule 1908, Zehntner 1914), but these were out of date by 1943.

Investigations carried on during 1943–1945 in Ceará

[1] The data for this paper was gathered during 1943–45 while the author was employed as Field Technician for the Rubber Development Corporation.

by field technicians of the Rubber Development Corporation, a United States government agency, determined the identity of the various rubber sources and disclosed that the local methods of production then in use were so well developed that only slight changes and improvements were necessary to extract the maximum amount of rubber from the available trees.

The various sources of rubber in Ceará and the methods of rubber production will be discussed in detail in this paper.

The surveys showed that in Ceará only two genera were important, *Hancornia* and *Manihot*, occurring wild with the exception of some small plantings of *Manihot* in northern Ceará made during the last rubber boom. A few isolated trees of *Castilla* (*caucho*) and two small colonies of *Hevea* were planted in damp mountains near Baturité, the Hevea seed coming from the territory of Acre. While extremely variable in yield, most of the few Hevea trees are of good quality and are now being tapped by the method used on most Eastern and African plantations (Plate XXXVIII, A) which is by means of a panel carefully cut with a jebong knife (Klippert 1942).

For several months in 1944 smoked sheets of Hevea rubber comprised the larger part of Ceará rubber exports. These were Far Eastern plantation sheets (Plate XXXVIII, B) produced under Japanese control and were being transported in German ships which were sunk near the coast by American planes and boats. Many fishermen earned more money during these months by salvaging the floating rubber than they had ever earned by fishing.

Hancornia

This genus occurs from Paraguay and Bolivia through the states of Mato Groso, São Paulo, Goiaz and Minas Gerais to Ceará, Piauí, Maranhão and Pará in Brazil

(Schery 1942). Although the genus *Hancornia* has been split into many species and varieties, the present tendency is to reduce the number. There are few herbarium specimens, and for this reason the latest review of the genus (Monachino 1944) can only be considered as a preliminary treatment. Most of the material is called *mangabeira* locally and may be classified as *Hancornia speciosa* Gomes. In Ceará (map, figure 1) mangabeira is found in small areas along the sandy coast, on the high sandy *chapada* or wooded savanna of the Serra de Araripe, and in one small isolated colony in the Serra de Ibiapaba near Campo Grande. The trees vary in size from thick-trunked, aged specimens, which resemble old apple trees,

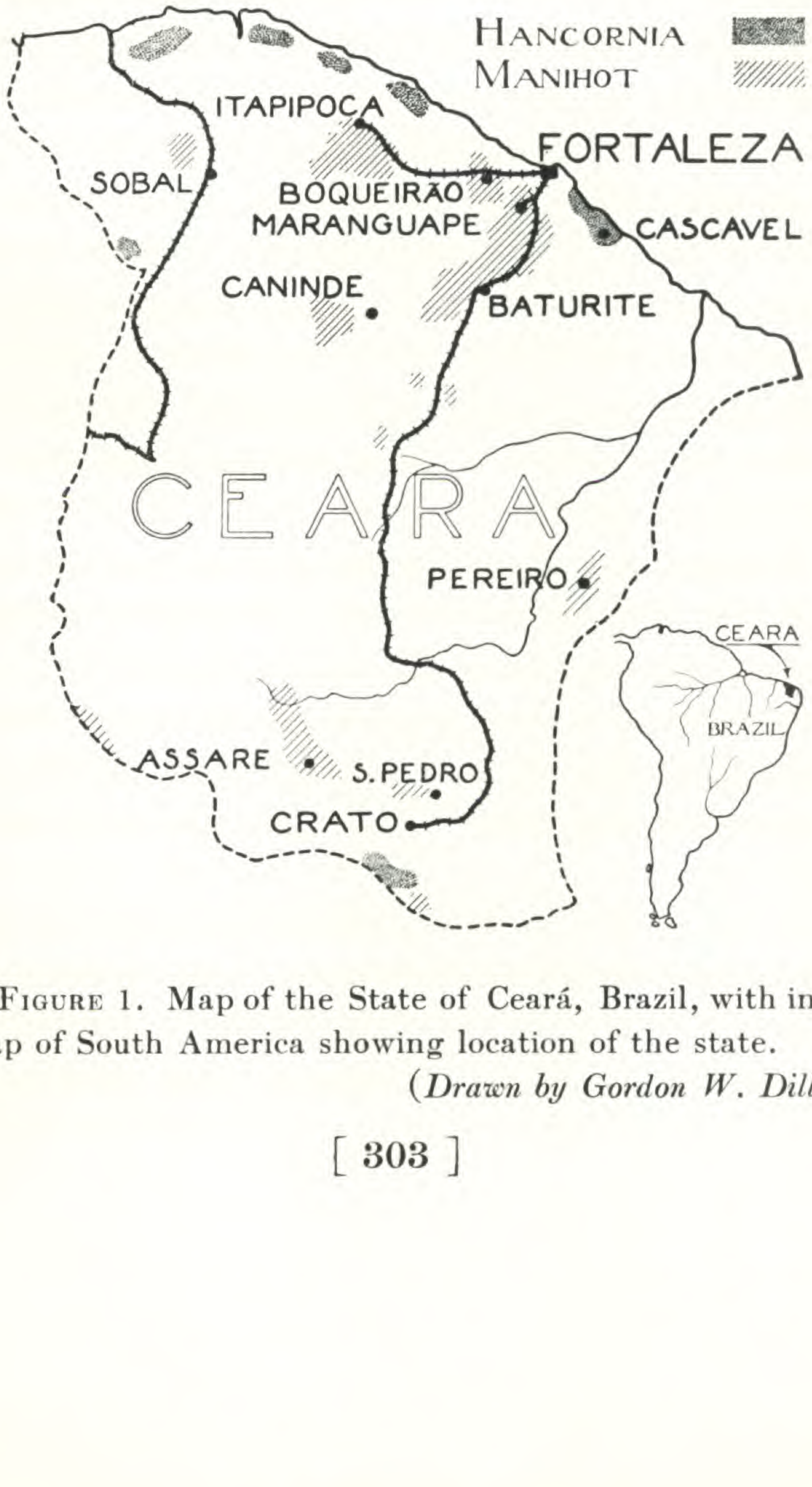


FIGURE 1. Map of the State of Ceará, Brazil, with inset map of South America showing location of the state.
(*Drawn by Gordon W. Dillon*)

to slender saplings which frequently die after the first tapping. Seedlings are absent from most areas because the local custom of burning the chapadas, even though prohibited by law, has exterminated most perennial plants which do not have a protective covering of bark or heavy leaf bases.

Only the poorest and most primitive of the Indian-White mixtures live in the areas which mangabeira prefers. These people are strongly resistant to innovations and, even where it is possible to demonstrate positive superiority of a new method, there must be an inertia-overcoming incentive before the change will even be considered. While this conservatism is characteristic of most people dependent upon the soil, and equally true of American farmers as well as Brazilian agriculturists and woods-people, this conservatism is especially evident in the Ceará coastal mangabeira areas, because most of the tapping is done by women who are even more conservative in their outlook than men. The trees are usually tapped three times each year with deep V-notches cut with a small paring knife. Because the latex flow is of short duration and cups are seldom on the tree for more than half an hour, mangabeira may be tapped throughout the year, in both the rainy and the dry season. For cups, tough and leathery *araticum* leaves (*Annona coriacea* Mart.) are folded into cones (Plate XL, A), pinned with splinters or cactus spines and slipped under a flap cut in the soft bark. If the tree yields well, the shallow cup overflows; if the wind blows, it overturns. Even though the additional latex gathered by using tin cups would pay for all the necessary cups in less than two days, only a small portion of the workers have been induced to adopt them. Yet, even leaf cups are an advance over the method which, though rare in Ceará, is common in Maranhão, a state to the north-

west. In this method, the bark is smoothed with a machete to within 4 mm. of the wood on about a third of the circumference of the trunk to a height of 70 cm. Many pricks and small cuts are made in this panel with the tip of the machete, and the latex which exudes is scraped off with a spoon and collected in a gourd. Many of the trees tapped in this manner are left with huge gaping wounds and cannot be retapped even if they survive.

The best methods of tapping mangabeira are those used in the Serra de Araripe. The workers organized to tap on the high chapada use a special knife with one end bent into a U for cutting the latex groove, the other end sharpened to a point to make an incision cutting all the latex vessels underlying this groove down to the wood. Below this V-cut a tin cup is pushed into the bark to receive the pink latex. Cuts are made at 40 cm. intervals from the ground as high up on the tree as can be reached (Plate XXXVIII, C). Even branches as small as a man's arm may be tapped and some trees support as many as twenty-five cups. When a basal cut is made before dawn, the latex may overflow a 120 cc. cup, yet the same cut made at 10 A.M. would yield only 5 cc.

A few workers in the Serra de Araripe use the same style of two-ended knife to cut a deep spiral groove on the trunk, from the highest point they can reach to the ground. Here a leaf is inserted in the cut to funnel the latex into a bottle. While there have been reports of trees which will fill a 750 cc. bottle by this method, these trees must be extremely rare, for even with cups the most skilled worker seldom secures more than 400 cc. of latex even from the rare large virgin trees. Claims of five to eight liter yields must be received with skepticism. Most trees can be tapped three times in good years, but only once if rains are scarce.

Mangabeira latex usually coagulates very slowly in

comparison with the latex of *Hevea* and manisoba (*Manihot*) which coagulates rapidly when it becomes slightly acid. Two and three months old samples of mangabeira latex may remain liquid even when they are slightly acid. The strength and vulcanization properties of mangabeira rubber are affected by the methods of coagulating the latex and handling the coagulum. It was a difficult task, second only to that of inducing the natives to tap the trees, to introduce acceptable methods for rubber preparation.

The natives have long used the dried strings of rubber found in crude cuts on the tree for making small hard balls and the latex for making waterproof sheets or shoes. In one good native recipe for coating cotton cloth a tablespoon of powdered sulfur and the white of an egg are mixed with a large cup of water, added to a liter of pure latex and spread thinly over the fabric. When dry this is placed in the sun for a day to cure.

The first mangabeira rubber produced for export was made by heating the pure latex in a bowl over a fire, adding a variable amount of salt or alum, if either were available, and removing the mass when it had coagulated. A worker can do this so that all of the original water in the latex remains entrapped in the thick soft coagulum, which then has the same 20 to 33 per cent rubber content of the original latex. The most practical method of preparing the rubber in Ceará is to add an equal amount of warm water to the latex and then a small amount of a solution of table salt. Coagulation takes place within half an hour. Locally made clay or wood basins are more satisfactory for coagulation trays than the usual kerosene cans, for the tannic acid in the latex does not then encounter rust and consequently the blue-black ink caused by the rust combining with the tannin does not stain the rubber.

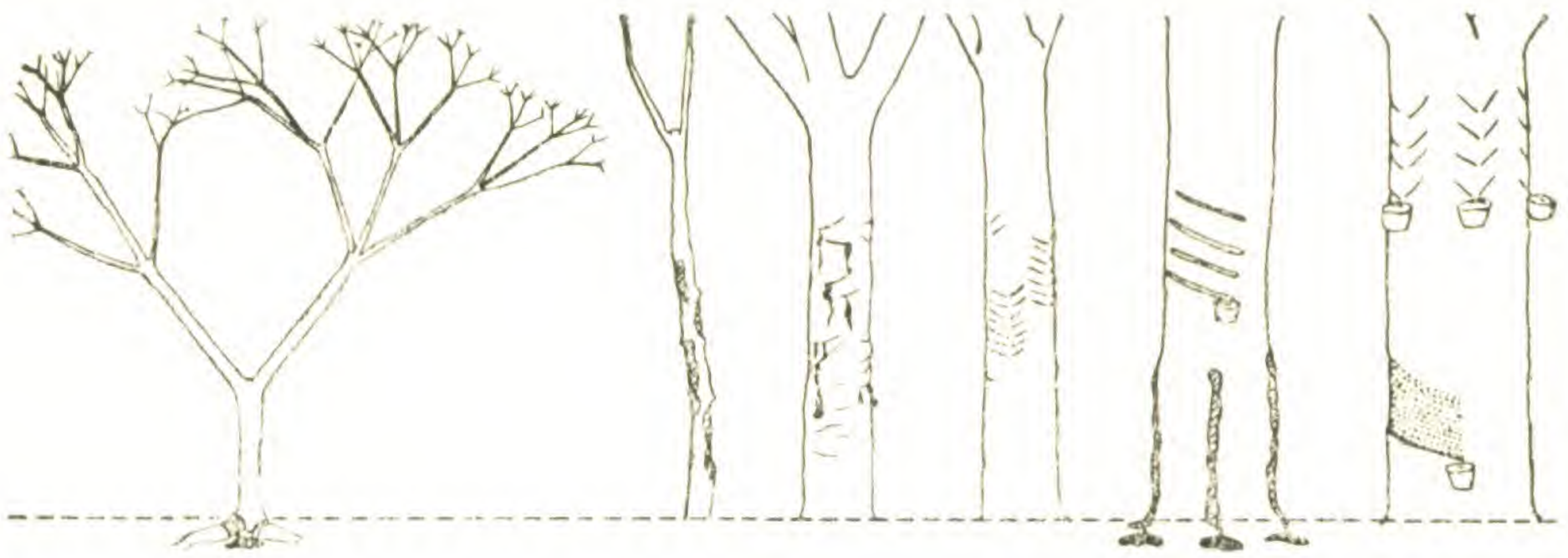
The coagulum, about 3 cm. thick, is placed on a board and rolled by hand to a sheet about 6 mm. thick, then washed in a basin with water and hung in the shade to dry. Home made rolling machines which resemble wringers with wooden rollers are used in many places to produce sheets of uniform thickness. To corrugate or to smoke the sheets is inadvisable in Ceará because prepared mangabeira rubber deteriorates rapidly, especially when nearly dry and exposed to the air.

There are better methods for the preparation of mangabeira rubber, yet none is as satisfactory for field use. By the use of exact quantities of expensive chemicals and careful heating it is possible to produce a mangabeira rubber which approaches Hevea in quality. However, the native tappers lack the skill and the careful habits necessary to accomplish this, and it was even difficult to introduce the simple scheme outlined above.

Manihot

Manihot is a large genus with its center of distribution from Ceará to central Baia, Brazil. It is best known to Americans in the form of tapioca which is obtained from *Manihot esculenta* Crantz, a species native to Brazil, and like *Hevea*, extensively grown in the East Indies. As in the genus *Hancornia* many species have been described, but the paucity of specimens in herbaria, the scanty material upon which many species were based, and the difficulties encountered in the field in ascribing many of the variable trees to a definite species suggest that a monograph of the genus based upon field study in this part of Brazil is needed.

Manihot Glaziovii Muell.-Arg., the large rubber yielding species which has been tried on plantations in Africa and the East but replaced by *Hevea*, is native to the Serras of Baturité and Maranguape, Ceará. Most of the



A B C D E F

FIGURE 2. Manisoba (*Manihot*) tree types and tapping methods in Ceará.

A. Piauí manisoba, tapped on the root with latex gathered in a dust-lined hole in the ground.

B. Serra de Uruburetama manisoba with hand-sized pieces of bark removed down to the wood. The latex dries and coagulates upon the bark and exposed wood surface in strings and globules called *choro*.

C. Low-yielding manisoba typical of region west of the Serra de Maranguape and of that about Sobral, Pereiro and Assaré. The trunk is hacked irregularly and the latex strings dry and coagulate upon the bark.

D. *Brava* manisoba which yields practically no latex, but has been hacked experimentally to see if it will yield.

E. Manisoba of the Serra do Machado, west of Canindé. Below, it has been tapped on the saliences of the trunk and the latex collected in dust-lined holes in the ground; above, it has been tapped experimentally with an Amazonas knife, a method which proved unsatisfactory for general use.

F. Manisoba of the Serras de Baturité and Maranguape. Above, it is tapped with the daily paired upward cuts and the latex flows into the tin cups; below, a panel cut with the jebong knife, a method which is excellent only if the tappers are careful and conscientious.

trees are tapped by two upward cuts with a short machete or a narrow-bladed hatchet (Figure 2 F). A tin cup is slipped under a slit in the bark directly below the vertex of the cuts (Plate XLI, A). The tapper begins each Monday inserting one to eight cups about the circumference of each tree. On Tuesday he taps about six inches below the previous cuts and affixes the same cup with its now coagulated rubber into a slit below the second tapping. This is continued until Saturday when the lumps of rubber coagulated during the week are collected and spread out to dry (Plate XLI, B). These lumps are often cut into smaller pieces to speed drying or are sold at a low price (while still fresh) to a merchant who dries the rubber to secure a higher price. Even though the latex flow increases when the rains begin, tapping is discontinued, partly because cups frequently fill with rain water before the latex coagulates, but mainly because farming is done at this time.

In the damp mountains of Baturité and Maranguape where the latex flow is greater, *Manihot Glaziovii* may be tapped by cutting with a jebong knife in a manner (Figure 2 F) similar to that used for *Hevea*. A sharp knife must be used and care taken to avoid injuring the cambium. This method was introduced on two small properties and in both cases the yield was greater per man-day, much greater per unit of trees, and, when some care was used in tapping, the trees were scarcely damaged. The method was abandoned after a few weeks, however, for the workers did not sharpen their knives and would not use care to avoid cutting the cambium, nor would they utilize the bark to greatest advantage. The narrow-bladed hatchet which is used to prune coffee trees in the mountains cuts a very small gash deep into the wood and severs only a few latex vessels in the bark. The short machete used on the mountain slopes and

plains barely cuts to the wood, but opens more latex vessels. By substituting the machete for the hatchet or inducing the producers to use wider-bladed hatchets, it was possible to decrease the damage to the trees, preserve a bark surface satisfactory for retapping, and at the same time increase the yield of rubber with no extra labor. A modified Amazonas knife to cut a deep groove was unsatisfactory because cuts which were too close together left the bark between them dry and dying, a ready shelter for termites.

In the same area, the Serras of Maranguape and Baturité, a type of manisoba tree occurs which yields practically no latex. This is called *manisoba brava*, wild manisoba (Figure 2 D). There is a complete series of intergrades between the best yielding manisoba and the driest of these wild trees. It is difficult to say whether there are two intergrading species or one variable species. Frequently one can distinguish the extremes by their bark, which is gray and thickened in the rubber-yielder, and reddish or silvery (usually smooth and thin) in the wild type. The natives believe that by hacking them regularly, it is possible to stimulate or "tame" (*amansar*) some of the wild trees so they will produce latex (Plate XLI, C). If the latex does not flow after three or four weeks of this treatment, the trees are abandoned. The basis for this belief in "taming" is a phenomenon known as wound-response. In response to the stimulation of tapping, manisoba and *Hevea* both increase their yield slowly for about three weeks when they reach a maximum at which they remain unless overtapped or injured.

West of the Serra de Maranguape the trees resemble the *brava* type, although in damp places they still yield enough latex for cup-tapping. Trees of the drier places are cut and hacked with the machete so the latex flows over the trunk (Figure 2 C) and coagulates and dries in

strings or globules which are collected two weeks later when the tree is hacked again. This type of rubber is called *choro*, or tears, and resembles the lacy strips left in cuts made by other methods and sold under the name of *sernamby*.

Still farther to the west, about the Serra de Uruburetama, excellent *choro* is produced by slicing the bark off the trunks in hand-sized patches (Plate XLI, D and Figure 2 B). After the cuts are made, the latex is allowed to drip over the trunk and dry for twelve to thirty days before it is collected and a new series of cuts made. Most of these trees are small, spindling, gnarled and scarred, like the legs of undernourished children. There are some larger trees which yield more latex and can be tapped profitably with cups, but practically all of the rubber produced in this area is *choro*. Several unsuccessful experiments were conducted to find practical methods which would yield as much or more latex than the local *choro* method and still not injure the tree. However, the large exposed surfaces of clean wood left by slicing off the bark are less harmful to the trees than the termite infested areas of dried and dead bark about the cuts made by other methods, such as those used in the Serra de Maranguape. In the Serra de Uruburetama the horny outer layer of the manisoba bark made it difficult to use the jebong or Amazonas knife, and the low yields, scattered stands, and rough terrain made it impractical to tap daily.

Even farther west, in hills near Sobral, only poor-yielding trees are found and none of the spindling but good-yielding Serra de Uruburetama trees are seen. *Choro* is produced by both of the methods described: by hacking cuts over the surface of the trunk, or by chipping away chunks of the wood.

About Assaré in southern Ceará and Pereiro in east-

ern Ceará, there are many manisoba trees which, like those near Sobral, greatly resemble *brava* trees (Figure 2 C) and like them yield a resinous, though much more abundant latex. The Assaré and Pereiro trees are hacked severely every two to four weeks. After the dried rubber is collected any part of the trunk which can be reached may be hacked again. Most of the rubber is a dark and sticky *choro*, but some of the cuts yield so much latex that globules an inch or more in diameter are frequently found. These are pressed out to form small plates about 5 mm. thick and 80 mm. long and are sold at a higher price than *choro*. These plates resemble the rubber produced in central Ceará, west of Canindé.

West of Canindé rises a low mountain range, the Serra do Machado, which is poorly represented on maps. In this area there are many trees which yield a small amount of latex. Some of the trees could be classified as *brava*, while still others have a latex flow sufficiently large to make the use of cups possible. Nearly all of the trees are tapped from a point about a meter high to the ground (Plate XL, B and Figure 2 E) by slicing away the bark on the four to eight saliences of the trunk. A small hole is dug in the ground and lined with a thin layer of dry dust (called *tabatinga*, *tauá*, or simply *pó*), which is carefully prepared by pounding up calcareous clay and sieving it. A sack of this dust is as much a part of the equipment of a good rubber gatherer (*borracheiro*) as the small tapping hatchet (Plate XXXIX, B). The latex flows over the surface of the powder which lines the holes and, like raindrops on a dusty road, does not soak in but coagulates into a small plate called *chapa*. These trees are tapped at infrequent and irregular intervals, the successive tappings merely removing a thin layer of the bark on both sides of the original vertical cut, a procedure which, although it cuts away the cambium, has much in

common with the jebong cut panel. The rubber is gathered after a few days and the tree may be tapped again, although a tree is seldom tapped more than six times in one season.

Well prepared *chapa* is a good rubber, because whatever little dirt normally adheres to it can be easily removed before selling. There are several tricks employed by the natives to add weight to the rubber. The most common of these is to turn over the coagulated latex before making a new cut and then to allow the second flow to cover the dirty surface. When this *chapa* is removed it presents two smooth and clean surfaces. A wise buyer soon learns to be suspicious of rubber which is too smooth and clean on both surfaces, so the tappers occasionally leave the first *chapa* in the hole, kick in a small amount of dirt and allow the new latex to flow in and cover the dirt with rubber. This is more difficult to detect unless the piece of rubber is suspiciously large, since one surface is smooth and the other slightly rough. Careful buyers have all the large pieces cut up because this practice not only allows them to calculate the discount which must be made for the dirt, but enables them to dry the rubber faster, sell it at a better price as a grade with higher rubber content, and reduce the freight and taxes which are based on weight.

Many property owners in the Serra do Machado are planting manisoba seeds with other crops. Snr. José Velosa of Sitio Valtiburí has planted 900 kilos, about 810,000 seeds. He plants beans, corn, cotton, mandioca, castor beans and manisoba at the same time in his field, and the harvest is made in this order. At the end of two years only a few plants of castor bean and cotton remain and the mangabeira is ready to be tapped.

Most of the rubber produced in Piauí, the state west of Ceará, is *chapa*. It is collected in a hole dug in the

ground and lined with dust, just as in the Serra do Machado. The tree and the tapping method differ. The tree is scarcely more than a large bush, branched and spreading from a short trunk (Figure 2 A and Plate XL, C). It grows very rapidly and some one year old trees which were planted on fairly good soil in northwestern Pernambuco have been tapped.

In Ceará the only native Piauí type trees are found along the southwestern margin of the state, and there are scarcely any plantings. To tap the tree the roots are exposed, a hole is dug to receive the latex, lined with tabatinga (Plate XL, D), and a groove is cut into the root down to the wood. Every three or four days the coagulated rubber *chapa* is collected and a new cut made below the old one until it is difficult to reach into the hole with the tool. At this time the tree is abandoned for the year and, since the hole is rarely ever refilled, the uncut bark frequently dries and the tree dies.

Well-prepared clean manisoba and mangabeira rubber can be used instead of Hevea in many small rubber industries. To improve low grades like *choro*, which make up the bulk of the Ceará production, washing plants have been established in northeastern Brazil. In washing, crude rubber is passed between two large rollers. These revolve at differing speeds and separate the rubber so that the streams of water which flow over the rollers can remove any dirt. If the washing is done well, the rubber leaves the rollers as a clean sheet of crêpe which needs only to be dried before it can be utilized by the manufacturers. Washing low-grade rubber is difficult and expensive. For this reason, and because of the great diversity and variability of the Ceará rubber and the unpredictable fluctuations in production, it is unlikely that exportation will increase. Ceará rubbers cannot compete in either quality or cost with the Hevea produced on

plantations during the last decade. Industry will continue to prefer the uniform reliability of cleaner and more abundant Hevea.

LITERATURE CITED

Klippert, W. E., 1942. Small-farm rubber production. Agriculture in the Americas 2: 48-53.

Monachino, Joseph, 1945. Revision of *Hancornia*. Lilloa 11: 19–48.

Schery, R. W., 1944. Some secondary rubbers in Ceará, Brazil. Mo. Bot. Gard. Bull. 32: 41–49.

Ule, Ernesto, 1908. Kautschukgewinnung und Kautschukhandel in Bahia. Notizblatt d. Königl. bot. Gart. u. Mus. Berlin-Dahlem n. 41a, Bd. 5.

Zehntner, Leo, 1914. Estudo sobre as maniçobas do Estado da Bahia, em relaçao ao problema das secas. Inspectoria Federal de Obras Contra as Secas (Brazil), Pub. 41, Ser. I, A. 115 pp.

EXPLANATION OF THE ILLUSTRATIONS

PLATE XXXVIII. A. Tapping *Hevea* with the jebong knife on Sitio Irapuru near Baturité, Ceará. This panel has been tapped for an entire season. B. Smoked sheets of oriental Hevea rubber recovered from the sea. C. Tapping *Hancornia* near Axixa, Maranhao. Even the branches are tapped and some trees support as many as twenty-five cups.

PLATE XXXIX. A. Preparing rubber from latex of *Hancornia* near Axixa, Maranhao. B. Serra do Machado workers filling their bags with the fine dust used to line the holes in which the latex is collected.

PLATE XL. A. Native women making a cup from an *araticum* (*? Annona coriacea* Mart.) leaf for gathering the latex, near Cascavel, Ceará. B. Serra do Machado manisoba tree tapped with a small hatchet on the saliences of the trunk. The latex flows into a dust-lined hole. C. One year old planting of Piauí manisoba at Belmonte, Pernambuco, ready for tapping. D. Lining a hole with dust to receive the latex flow, at Belmonte, Pernambuco.

PLATE XLI. A. Inserting a tin cup in a slit below the pair of tapping cuts in a manisoba near Maranguape, Ceará. B. Drying coagulated cup-lumps of manisoba rubber at Maranguape, Ceará. C. Brava, or wild manisoba near Maranguape, Ceará, which has been hacked to see if it will yield latex. D. Manisoba trees in the Serra de Uruburetama near Iraçuba, Ceará.

Plate XXXVIII





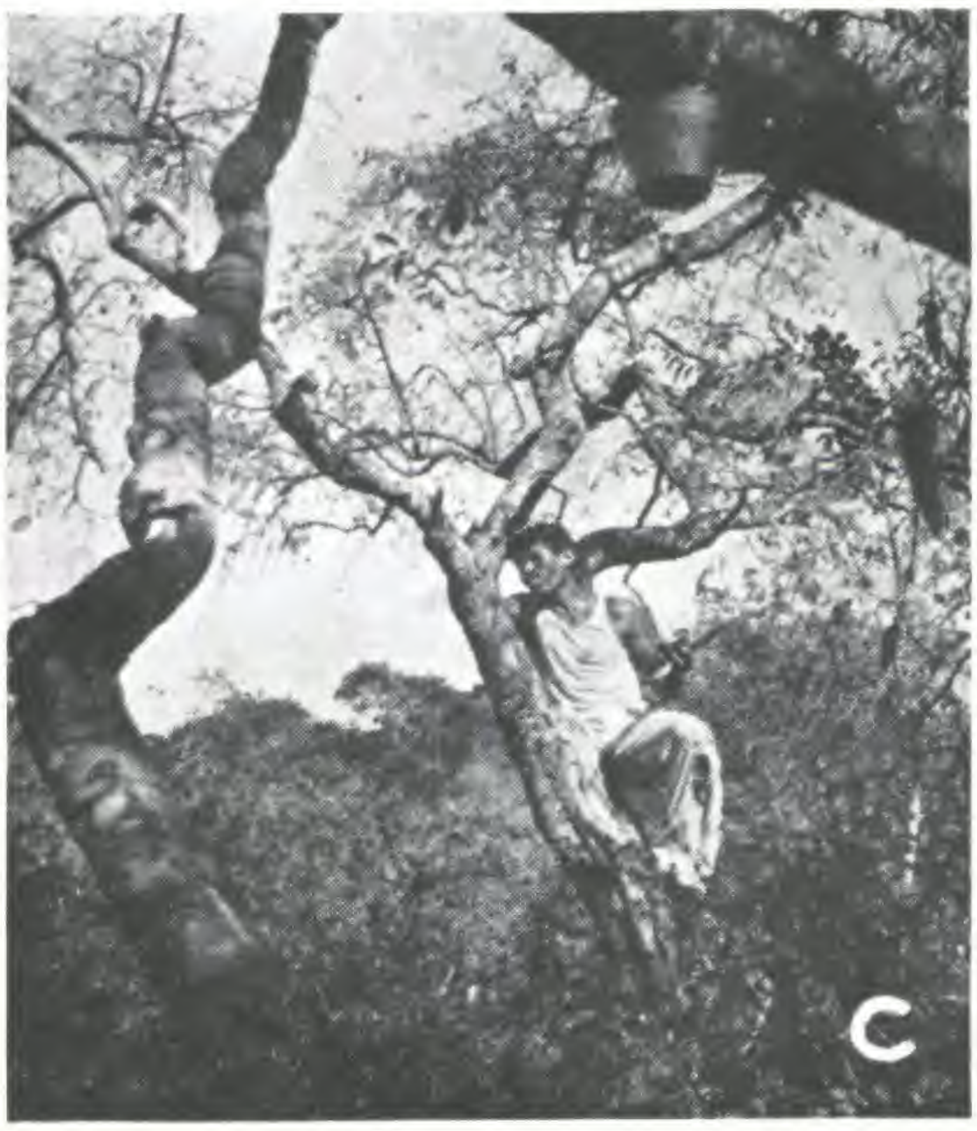


Plate XXXIX





Plate XL



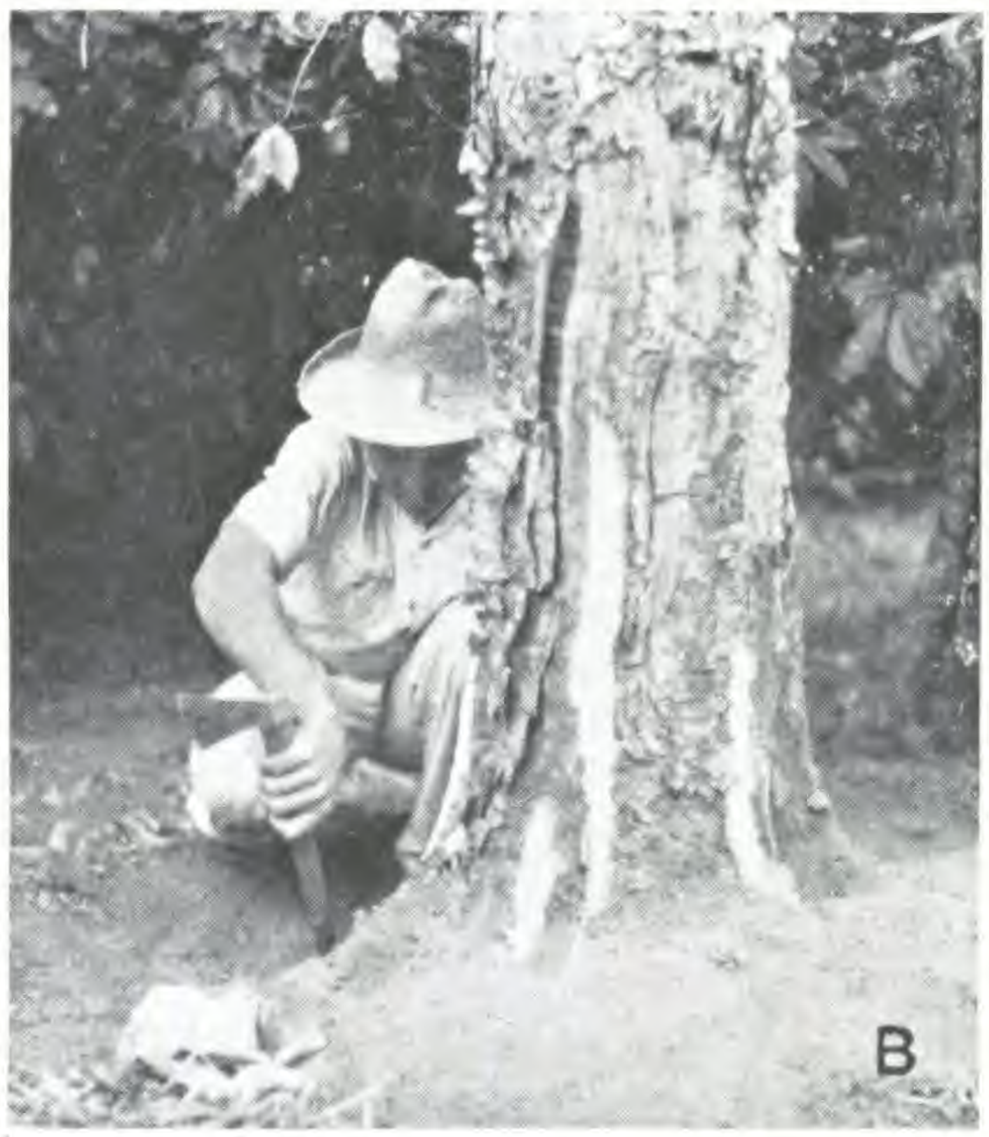
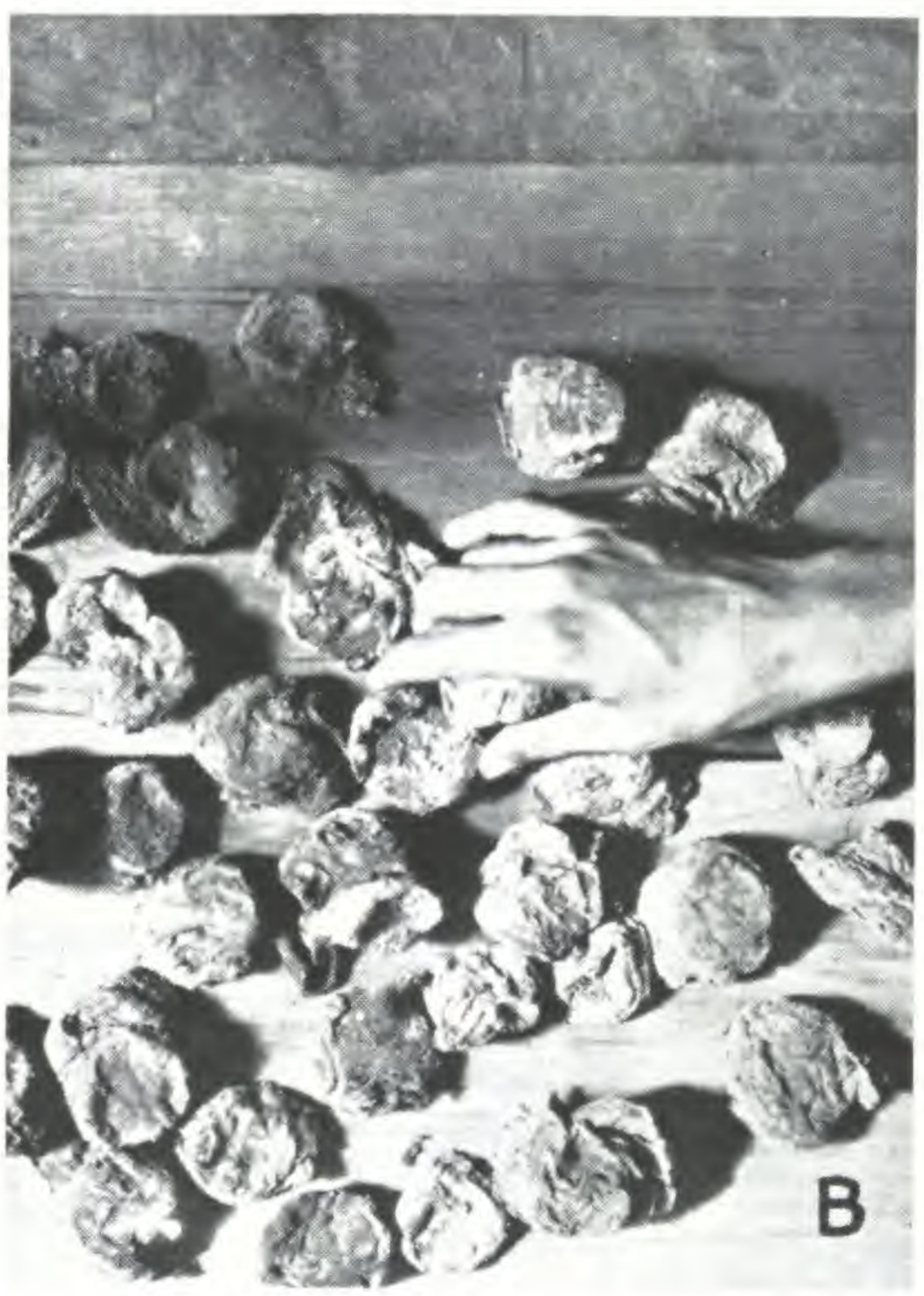






Plate XLI









A
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A CONSPECTUS OF THE GENUS CUNURIA

BY
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THE writers of the present article became interested in the euphorbiaceous genus *Cunuria* as the result of independent field studies of *Hevea*, the genus of the Pará Rubber Tree. These genera are related, and, indeed, it has been suggested (Baldwin in Journ. Heredity 38 (1947) 54; in Am. Journ. Bot., in press, "*Hevea rigidifolia*") that they possibly have hybridized. A critical classification of the several concepts of *Cunuria* and an understanding of their geographic distribution may contribute greatly to an interpretation of the complex of genera to which *Cunuria* shows affinities.

I

Cunuria belongs to the tribe *Jatropheae*. The genus appears to be related to *Micrandra*, *Hevea*, *Joannesia*, and *Nealchornia*, and has especially close affinities with *Micrandra* and *Hevea*. Bentham (in Journ. Linn. Soc., Bot. 17 (1880) 185–268) observed that the first four of

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these genera "may to a certain degree be related to each other." Huber later described the monotypic fifth genus.

Croizat, however, in a manuscript report on the *Euphorbiaceae* of the Tafelberg expedition, has stated of *Cunuria:* "This genus would seem to be improperly placed in the *Euphorbiaceae Gelonieae.* I should be inclined to think that *Garcia* Vohl, *Sagotia* Baill., *Ostodes* Bl., and *Cunuria* Baill., are not too far distantly related."

From *Micrandra, Cunuria* may be distinguished by its glandular stipules; by differences in the form of the petiole glands, as well as of the disks and staminodes; and by the number and form of the stamens. *Cunuria* is at once set apart from *Hevea* by having simple rather than compound leaves; by having stipules; and by lacking a staminate disk. It likewise differs from *Joannesia* by having entire leaves as well as by being apetalous. *Joannesia* appears to be diploid, whereas *Cunuria, Micrandra,* and *Hevea* are, in great measure, tetraploid (Baldwin in Journ. Heredity, *loc. cit.*). From *Nealchornia, Cunuria* can very readily be separated by its having a pistillate disk; by the presence of a rudimentary ovary in the staminate flower; and by differences in the form of staminodes and styles. *Cunuria,* at first considered to be completely dioecious, was recognized by Ducke (in Notizbl. Bot. Gart. Berlin 11 (1932) 586) as having monoecious representatives.

As now known and interpreted, *Cunuria* comprises four species and one variety. Two species are established in the present paper, and one concept, recently described as a species, is here reduced to varietal rank.

II

The distribution of *Cunuria* is indicated on the accompanying map (Fig. 1). Strictly speaking, *Cunuria* is not a characteristic element of the flora of the great

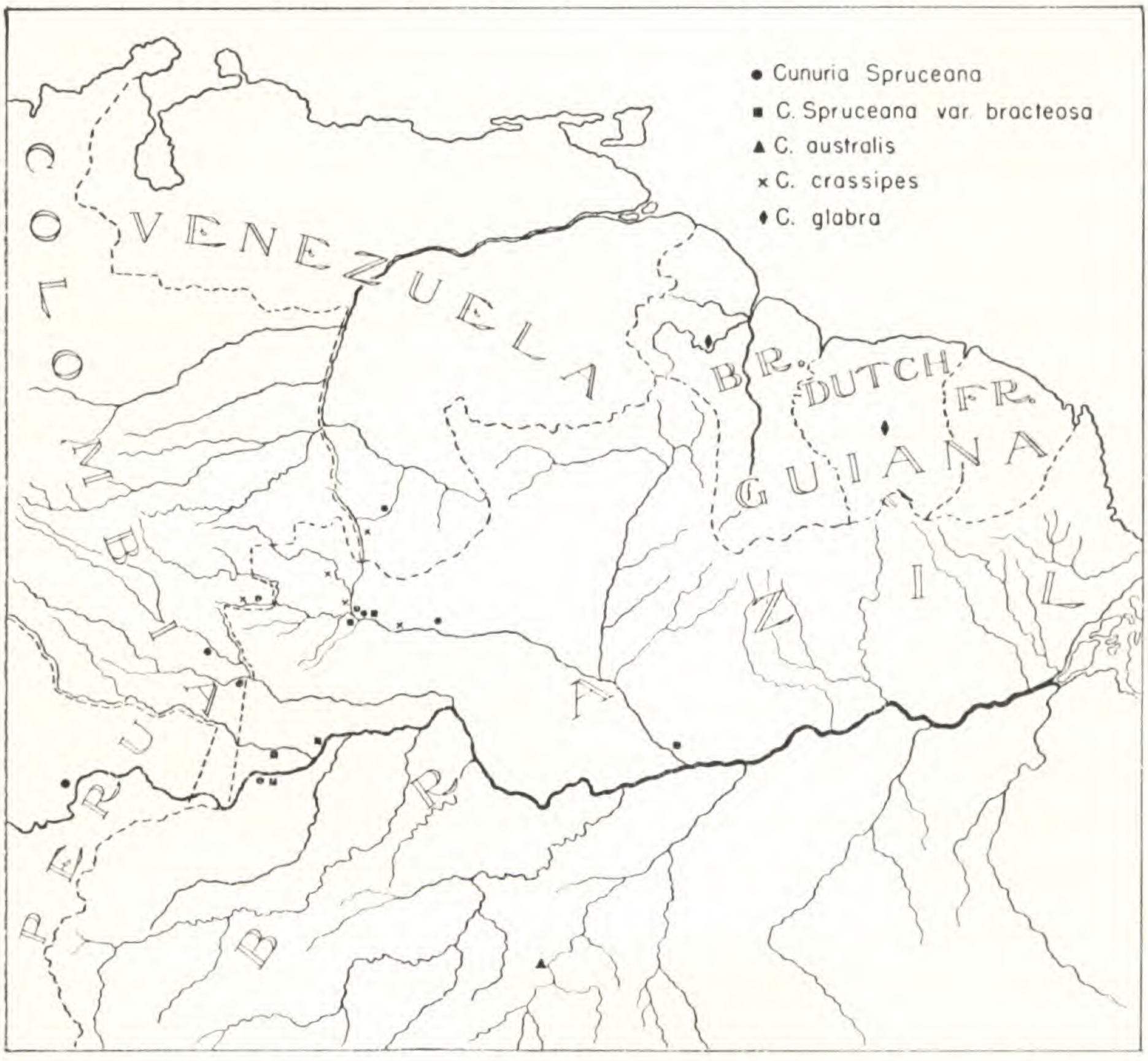


FIG. 1. Map showing the distribution of the species of *Cunuria*.

Amazonian *planada*. The genus is typical of higher elevations. It could be referred to as an element of the "upland" flora of the Amazonian region, but that expression might connote the eastern slopes of the Andes, where the genus apparently is not represented. Since *Cunuria* prefers the higher areas in the Amazonian region, it may be interpreted as a very old genus that has spread from the ancient Venezuela-Guiana land-mass. Both Schultes (in Caldasia 3, no. 12 (1944) 124–130; in Chron. Bot. 9, no. 2/3 (1945) 123–127) and Baldwin (in Journ. Heredity and in Am. Journ. Bot., *loc. cit.*) have suggested that the hills rising sharply out of the Amazonian plain in the Rio Negro–Rio Uaupés[3] area of Brazil and Colombia possibly represent a route, now discontinuous, along which plants migrated southwestward from the Venezuela-Guiana region. There may also have been another route southward from the Guianas. Baldwin (*loc. cit.* and in Am. Journ. Bot. 33 (1946) 215–216) has considered the Uaupés area to be the center of variability of both *Hevea* and *Cunuria*.

Representatives of *Cunuria* are known from the ancient mountains in southern British Guiana and Surinam. The genus is also represented in southern Venezuela along the Casiquiare. It is common along the upper Rio Negro in Brazil and along the lower Rio Uaupés in Brazil and Colombia as well as in the area around São Paulo de Olivença (one of the highest localities along the Rio Solimões) and in the vicinity of Manáos (a relatively high area near the confluence of the Rio Negro with the Solimões, with a vegetation rather like that of the region of Serra de Sapucuá, mentioned below). *Cunuria* is exceedingly abundant on the slopes of Cerro de La Pedre-

[3] The Rio Uaupés, flowing through Colombian as well as Brazilian territory, is known as the Río Vaupés in Colombia.

ra on the Río Caquetá (Japurá) in eastern Colombia. It is known from a single Peruvian locality near Iquitos in Loreto and has been collected from the high plateau between the Rio Livramento and the Rio Ipixuna, tributaries of the Madeira, in Brazil.

To these records we may add reports which suggest other areas where *Cunuria* possibly exists. South of the mountains in the Guianas where the genus has been collected, "there are some hills off the Rio Trombetas and near the Lago de Sapucuá, known as Cunurí mountains, ... probably reaching four hundred feet" (Brown, C. B. and W. Lidstone: Fifteen thousand miles on the Amazon and its tributaries (1878) 241). Since the name *cunurí* is commonly applied to various species of *Cunuria* in Brazil and since the genus often dominates the slopes of such low mountains, as observed on Cerro de La Pedrera by Schultes and at Montepelago on the Rio Uaupés by Baldwin, we presume that *Cunuria* is common on the hills designated by Brown and Lidstone. These hills are probably the ones now known as Serra de Sapucuá. In 1943, a native rubber producer wished to demonstrate to Baldwin a new kind of buttressed rubber tree which might well be a representative of *Cunuria*. In the Rio Madeira region, Schultes heard repeated references to gigantic, buttressed rubber trees which were locally known as *pae da seringueira*—"father of rubber trees." These are reputedly abundant west of Humaytá, between the Rio Madeira and the Rio Purús, and they may belong to *Cunuria*.

If the theory be accepted that an inland sea, opening westward, once covered a great part of what is known as the Amazonian *planada*, *Cunuria* might be considered to be an element of the flora of the heights fringing the shores of the sea. Accordingly, one would reasonably expect additional collections of *Cunuria* to help indicate

the limits of that sea, for which now only a hazy outline can be suggested.

III

Clavis specierum varietatisque generis Cunuriae:

A. Folia chartacea, leviter marginata. Petioli graciles, 1/3 foliorum partem aequantes vel longiores.

B. Folia circiter 2/3 lata quam longa, plerumque 11 cm. longa, 7 cm. lata, sicco brunneo-fusca, nitida sed non glauca, venis subtus elevatis, brunneis. Florum bracteae minutissimae. Stipulae usualiter caducae. Inflorescentiae saepe compactiores.
(4) *Cunuria Spruceana*

BB. Folia circiter 1/2 lata quam longa, plerumque 15–16 cm. longa, 7–8 cm. lata, sicco straminea, utrinque glauco-nitidissima, venis non elevatis, subimmersis, luteis. Florum bracteae magnae, usque ad 6 vel 7 mm. longae. Stipulae valde persistentes. Inflorescentiae saepe laxae. (5) *Cunuria Spruceana* var. *bracteosa*

AA. Folia firme coriacea, valde marginata. Petioli crassi, 1/5 foliorum partem aequantes vel breviores.

C. Petioli crassi. Capsulae parvae, usque ad 3.5 cm. longae vel breviores.

D. Folia elliptica, sicco laminis discoloribus, apice obscure acuminata, basi usualiter cuneata vel subcuneata. Venae tertiae venis secundariis paralleles, immersae.
(2) *Cunuria crassipes*

DD. Folia late ovata, sicco laminis subconcoloribus, apice abrupte acuminata, basi usualiter rotundata. Venae tertiae venis secundariis angulatim 90°, omnes elevatae.
(1) *Cunuria australis*

CC. Petioli crassissimi. Capsulae magnae, 5 cm. longae vel longiores.
(3) *Cunuria glabra*

IV

Cunuria *Baillon* in Adansonia 4 (1863–64) 287; Mueller Argoviensis in DC. Prodr. 15, pt. 2 (1866) 1123; Mueller Argoviensis in Martius Fl. Bras. 11, pt. 2 (1874) 507; Baillon Hist. Pl. 5 (1874) 190; Baillon Nat. Hist. Pl. 5 (1878) 190; Bentham et Hooker fil. Gen. Pl. 3 (1880) 289; Baillon Dict. Bot. 2 (1886) 299; Pax in

Engler & Prantl Pflanzenfam. 3, Abt. 5 (1890) 77; Pax in Engler Pflanzenr. IV. 147 (Heft 42) (1910) 16; Lemée, Dict. Genre Pl. Phan. 2 (1930) 413; Record in Trop. Woods 54 (1938) 18; Record & Hess, Timb. New World (1943) 157.

Clusiophyllum Mueller Argoviensis in Flora 57 (1864) 518.

Descriptio archetypa:

"Flores dioeci. Masc. ignoti. Foem. calyx 5-partitus, laciniis persistentibus imbricatis. Discus hypogynus (an androcaeum abortivum?) cupulaeformis glandulosus 6–8-lobus; lobis cuspidatis ovarii loculis dum 6 adsint) per paria oppositis. Ovarium liberum 3-loculare; loculis uni-ovulatis; ovulo pendulo obturato; micropyle extrorsum supera. Stylus sessilis 3-partitus; laciniis crassis 2-fidis reflexis ovario adpressis.

"Arbor ? foliis alternis, stipulis infraaxillaribus folia juniora (ut in Artocarpeis) involventibus caducis; limbo simplici basi glandulis 2 sessilibus concavis munito."

Descriptio amplificata:

Arbores magnae, elatae, parco cum succo lacteo, foliis alternis, petiolatis, stipulis infraaxillaribus folia juniora involventibus caducis. Folia integra, penninervia, coriacea vel firme chartacea, pagina supra basim biglandulosa, costis secundariis angulo amplo decurrentibus, arcuatis, tertiis reticulatis vel subparallelis. Pedunculi laterales vel axillares, foliis multo breviores, rigidi, staminati simplices vel parce ramosi, floribus in apice cymarum paucifloruum ramorum sessilibus. Flores dioeci vel monoeci, apetali. Floris staminati sepala quinque, valde imbricata, quincuncialia; discus nullus; stamina decem receptaculo elevato affixa; filamenta brevia libera; antherae dorsifixae, loculi connectivo latiusculo adnati, longitudinaliter de-

hiscentes, rudimentum ovarii tripartitum. Floris pistillati sepala quinque, laciniis eis maris similia; discus hypogynus cupuliformis, glanduloso-lobatus vel simplex, ovarium liberum triloculare, loculis uniovulatis; stylus sessilis, tripartitus cum divisionibus bifidis, crassus, reflexus, ovario adpressus. Fructus capsularis; capsula magna, subglobosa vel saepe quasi ovoidea, in coccas bivalves partiens, carnoso cum epicarpio et lignoso cum endocarpio crasso. Semina magna, ovoidea, testa crustacea et nitidissima, immaculata, ecarunculata. Albumen carnosum; cotyledones planae, latae.

Species typicus: *Cunuria Spruceana.*

Nominis generis significatio: "Cunurí" in regione typica nomen vulgare est.

V

1. **Cunuria australis** *R. E. Schultes sp. nov.*

Arbor magna, usque ad 20 m. alta. Rami robusti, cinereofusco cum cortice crasso. Ramuli aequales, subteretes, glabri, apice ipso autem cum stipulis caducissimis, minute adpresso-pubescentibus. Stipulae triangulares, minutae, 6 mm. ×2 mm. Petioli crassissimi, 30–35 mm. longi. Folia coriacea, marginata, late elliptica, apice abrupte acuta, basi rotundata, 14–16 cm. longa, 7.5–9.5 cm. lata, venis supra nitidis glabrisque, non elevatis, sicco stramineis, infra prominenter elevatis, fuscis, glandulis duabus comparate parvis, 1 mm. latis, fusco-nigricantibus limbi basi. Flores ignoti. Capsulae subglobosae, sicco usque ad 3.5 cm. longae, 3.5 cm. in diametro; epicarpio glabro, tenui, superne plus minusve 3 mm. crasso, non conspicue fibroso; endocarpio lignoso, tenui, usque ad 2 mm. crasso; valvis regularibus, dehiscentibus non contortis, 2.8 cm. longis, 1.2 cm. latis, intus aureo-brunneis et striolatis. Semina ignota.

Brazil: Estado do Amazonas—Basin of Rio Madeira, Municipality Humaytá, on plateau between Rio Livramento and Rio Ipixuna. "Tree 60 ft. high. Cipoal." *B. A. Krukoff's 5th Exped. Braz. Amaz. 7201*, November 7-18, 1934. (Typus Herb. Arnold Arb.; Herb. N.Y. Bot. Gard.; Herb. Jard. Bot. Rio.)

This is the only representative of the genus which occurs at any significant distance south of the Amazon River, a consideration which has suggested the specific epithet. This new species of *Cunuria* is of considerable interest because it has a capsule rather comparable to that of *C. crassipes*, whereas in vegetative characters it is extremely similar to *C. Spruceana*.

The petioles of *Cunuria australis* are much thicker than those of *C. Spruceana*, and the leaves appear to have been, in life, a bit more coriaceous in texture. The stipules, if indeed they are present on *Cunuria australis*, are very caducous, just as they are in *C. Spruceana*. *Cunuria australis* is probably more closely allied to *C. Spruceana* than to *C. crassipes*, and the specimens have, in the past, been identified as representing *C. Spruceana*. The ligneous valves of *Cunuria australis* apparently do not open violently, as in the other species of the genus; the lack of the characteristic twisting of the valves is interpreted as indicative of slow and gradual dehiscence. A parallel example can be cited in the case of *Hevea minor* Hemsl., the only species in the genus in which the valves open slowly, not in a violently explosive manner, and persist for some time after the seeds have dropped. The fruit of *Hevea Spruceana* (Benth.) Muell. Arg. open explosively, but the valves remain on the tree. The capsule of *Cunuria australis* is only about half as large as that of *C. Spruceana;* the woody endocarp is rather thin, and the fleshy epicarp is much thinner and measurably less fibrous. The difference in size of the fruit is so great that, even lacking the other characters of shape and

texture, it would be obvious that the Madeira collection is specifically distinct from *Cunuria Spruceana*.

One could easily suspect that the Rio Madeira material represents a combination of characters from two species, in which case there might be apprehension that a specific name is being assigned to a segregant from interspecific crossing. *Cunuria crassipes*, apparently an extremely localized endemic of the Rio Negro area, could be considered one parent of such an hypothetical hybrid, and *C. Spruceana*, also known only from a region far to the north of the Rio Madeira, the other. Possibly future exploration may turn up material of *Cunuria Spruceana* and *C. crassipes* in the Rio Madeira. These species grow in caatingas, often in association with *Hevea rigidifolia*, *H. viridis* and *H. pauciflora* var. *coriacea* (possibly correctly called *H. confusa*). All these plants, when "pure," seem to have precise ecological requirements, and these requirements are similar for each of the species cited. It is interesting, therefore, that *Hevea viridis* is known from Borba on the Rio Madeira and that *H. camporum* (which Ducke is considering as possibly a form of *H. pauciflora* var. *coriacea* and which Baldwin would refer to *H. confusa*) is known from the great plateau at the headwaters of the Rio Marmellos, an affluent of the Madeira. These localities are not distant from the general region where the type material of *Cunuria australis* was found. It would not be surprising, therefore, to discover in this area additional species of *Cunuria* or any of the already recognized species. Certainly the requisite ecological conditions exist in the Madeira Valley.

2. **Cunuria crassipes** *Mueller Argoviensis* in Martius Fl. Bras. 11, pt. 2 (1874) 510; Corrêa Diccion. Pl. Uteis Brasil. 2 (1931) 482; Pax in Engler Pflanzenr. IV. 147 (Heft 42) (1918) 17.

Clusiophyllum Sprucei Mueller Argoviensis in Flora 57 (1864) 518.

COLOMBIA: Comisaría del Vaupés—Río Papurí, vicinity of Piracuara Mission, alt. about 200 m. "Trees tall, slightly buttressed, averaging 30 m. in height and 60 cm. in diameter. Bark thin, averaging less than 1 cm. Latex yellowish, scant, coagulating to a non-elastic gum. Flowers greenish yellow. Trispermate Hevea-like capsule. Known locally as *wah-so-né-né* in Tukano." *Paul H. Allen 3068*, August 18, 1943. (Herb. Gray).

VENEZUELA: Territorio del Amazonas—"Arbor 70-pedalis. In sylvis ad basin montis Cocui," July 1853. *Spruce 3029* (Herb. Kew); "Prope San Carlos ad Rio Negro" *Spruce 3029* (*3474*) (Herb. Kew; Herb. Brit. Mus.; Herb. Univ. Cambr.); "Prope San Carlos ad Rio Negro, 1853–54" *Spruce 3473* (Herb. Brit. Mus.); "Arbor lactescens 60-pedalis. San Carlos, in sylvis." April 1854 *Spruce 3474* (Herb. Kew; Herb. Univ. Cambr.)—Río Negro, near San Carlos. *Richard Spruce 3474*, 1853–54 (LECTOTYPUS: Herb. Gray; Herb. N.Y. Bot. Gard.).—Same locality. *Richard Spruce 3029*. (Photo.spec. Hort. Berol. in Herb. Gray; Herb. Field Mus. 646435).

BRAZIL: Estado do Amazonas—Rio Uaupés, Montepelago. "In a sort of caatinga-forest. Tree to 60 ft., buttressed. Fruit cherry-colored, just as in *Hevea confusa* and in contrast to the green fruit of *C. Spruceana* and *Cunuria* sp. at Foz do Uaupés. Chromosomes: $2n=36$." Nom. vulg. *cunurí*. *J. T. Baldwin Jr.*, *3673*, March 17, 1944. (Herb. Arnold Arb.; Herb. Instit. Agron. Norte; U.S. Nat. Herb.; Herb. Kew.)—Same locality. "In a sort of caatinga-forest. Tree to 40 ft., buttressed. Latex white. Fruit flushed with cherry red. Chromosomes: $2n=36$." Nom. vulg. *cunurí*. *J. T. Baldwin, Jr. 3675*. March 17, 1944. (Herb. Arnold Arb.; U.S. Nat. Herb.)—Same locality. "Tree to 40 ft., buttressed. Fruit cherry red. In a sort of caatinga-forest. Chromosomes: $2n=36$." Nom. vulg. *cunurí*. *J. T. Baldwin, Jr. 3681*, March 3, 1944. (Herb. Arnold Arb.; Herb. Instit. Agron. Norte; U.S. Nat. Herb.; Herb. Kew.)—Foz de Uaupés. "Total height of 60 ft., buttress of 3 ft. Wood of this tree in Harvard collection. Growing not far from *C. Spruceana*, *Micrandra*, *Hevea viridis*, and *H. guianensis*. Chromosomes: $2n=36$". Nom. vulg. *cunurí da caatinga*. *J. T. Baldwin, Jr. 3698*, March 13, 1944. (Herb. Arnold Arb.; Herb. Instit. Agron. Norte; U.S. Nat. Herb.; Herb. Kew.)—Iraruca, Içana. "Árvore 15 ms., 20 cm. (diam.) Latex. Madeira dura, folhas quebradiças, verde negro no dorso; claro no ventre. *Cunurí*.

Caatinga.'' *Ricardo de Lemos Fróes 21396*, Nov. 16, 1945. (U.S. Nat. Arb. Herb. 182206.)

Enough collections of *Cunaria crassipes* are now available to assure us that this species concept is comparatively constant. Apparently the species is a very localized endemic of the upper Rio Negro area and the adjacent lower Uaupés. This region is known to have high endemism, a fact which is emphasized occasionally, as when Allen rediscovered *Cunuria crassipes*, one of the endemics which Spruce collected there almost a century ago.

No other known species of *Cunuria* has the venation of *C. crassipes*. Its coriaceous, strongly marginate leaves are supplied with a relatively strong central nerve, rather prominently elevated on the under surface but only slightly so above; eight or nine secondaries which are extremely slender and hardly elevated; and tertiaries which anastomose but which are, in general, parallel to the secondaries. In all other species, the tertiaries are set at right angles to the secondaries and are not parallel. All specimens of *Cunuria crassipes* which have been available for study have the upper and lower surface of the leaf very unequally discolored when dry, the upper usually conserving a very characteristic bluish-grey glaucescence.

The flowers of *Cunuria crassipes* are still unknown. The specimen of *Fróes 21396* in the U.S. National Arboretum Herbarium has the remnant of one flower in a poor state of preservation. It is possible to ascertain from it, however, that the flower is much larger than in *Cunuria Spruceana*.

According to the collector's notes, *Baldwin 3673*, *3675* and *3681* have a capsule with a cherry-red epicarp when ripe. *Cunuria Spruceana*, as stated on the label of *Baldwin 3673*, has a green epicarp.

Baldwin 3698, which is here included under *Cunuria crassipes*, is larger than the typical material. The collec-

tor has indicated that the tree was more robust than the other representatives of the species which he examined and that there were visible differences in wood-texture. The leaves of *Baldwin 3698* are larger and more broadly elliptic than is characteristic of the species. Furthermore, the fruit is green instead of the usual cherry-red. While it may be true that *Baldwin 3698* does not represent a "pure" line of *Cunuria crassipes*, there are no good distinguishing morphological characters to set it apart as a separate taxonomic entity, and little of a definitive nature may be stated regarding the possibility of admixture of genes—(perhaps) from *C. Spruceana*—until much more field work is carried out. It is interesting to note that *Allen 3068* very closely approaches the type in the size and shape of the leaves. The leaves of this collection are somewhat smaller than those of the Spruce material; those of the several Baldwin collections tend to be somewhat larger. In no specimens of *Cunuria crassipes* are we able to find traces of large foliaceous stipules. It is probable that these do not occur in this species, or, if they do occur, they are extremely caducous. All information indicates that the buttress roots are much smaller in *Cunuria crassipes* than they are in *C. Spruceana*, and the former is generally a much smaller tree than the latter.

The epithet *Cunuria crassipes* is being conserved, in conformity with Recommendation XIV of the International Rules of Botanical Nomenclature, over the earlier *Clusiophyllum Sprucei*. Were the indicated combination to be made, a new name would enter into the taxonomic literature. This name would be unfortunate because of its resemblance to *Cunuria Spruceana*, and endless confusion would be the result. In this connection, it should be noted that the name *Clusiophyllum Sprucei* was based upon *Spruce 3029* and *3474*. Although

these two collections were, in the early period of investigation of the genus, referred to *Cunuria Spruceana*, there is no justification for Pax's citation of *Clusiophyllum Sprucei* as a synonym of *C. Spruceana* (Engler Pflanzenr. IV. 147 (Heft 42) (1910) 16).

Little is known about the latex of *Cunuria crassipes*. In *Allen 3068*, it was "yellowish, scant, coagulating to a non-elastic gum"; while in *Baldwin 3673* and *3675*, the color of the latex is reported to be white.

In the opinion of the writers no known species of *Cunuria* appears to be promising as a commercial latex plant.

3. **Cunuria glabra** *R. E. Schultes sp. nov.*

Arbor monoecia, usque ad 75 pedes alta, radicibus cum tabularibus. Folia valdissime coriacea, perfecte ovata vel rarenter elliptico-rotundata, omnino glaberrima, in specimine typico 18–21 cm. longa, 12–13 cm. lata (in speciminibus aliis multo minora: 10–16 cm. $\times$8–11.5 cm.), apice rotundata vel rarenter obscurissime subacuminata, basi rotundata vel subcordata, valde marginata, supra brunnea vel glauco-brunnea, venis omnino (praecipue superfice inferiore) conspicue elevatis, secundariis octo arcuato-adscendentibus, sub marginem ipsum tenuiter anastomosantibus, tertiis prominentibus reticulatis subparallelis, glandulis comparate magnis. Petiolus crassissimus, sicco striato-fibrosus, 3.5–4 cm. longus, 4 mm. crassus. Inflorescentia subapicalis, laxa sed pedicellis rigidis crassisque, parce et minute adpresso-tomentellis. Flores staminati alabastro subglobosi, 2$\times$3 mm. in diametro, calycibus ovatis, usque ad 5 mm. longis, 3 mm. latis, concavis. Florum pistillatorum calyces similes sed crassiores majoresque, 6 mm. longi, 4 mm. lati. Bracteae magnae, concavae, ovatae, 6 mm. longae, 4 mm. latae. Fructus (*Pinkus 236*) vivo usque ad 5.5 cm. longus, 3

cm. latus, endocarpio tenuissimo, epicarpio tenui ut videtur, glabro, pedunculo robusto usque ad 8 cm. longo.

Dutch Guiana: Tafelberg (Table Mountain). "Common tree 25 m. tall, 40 cm. diam., rooting at base to 2 m.; scant white latex oxidizing to yellow, leaves chartaceous; fl. white; dom. high tree, north of savanna 2." *Bassett Maguire 24279*, August 10, 1944 (Typus Herb. Arn. Arb.).

British Guiana: Membaru Creek, upper Mazaruni River, "Tree in mixed forest, 70 ft. high; trunk 16 in. diam.; latex white; fruit green without, white within; seed edible." *Albert S. Pinkus 236*, February 16, 1939. (Herb. Arn. Arb.; U.S. Nat. Herb. 1776073; Herb. Mo. Bot. Gard. 1175213, 1175214; Herb. Field Mus. 1001560; Herb. N.Y. Bot. Gard.; U.S. Nat. Arb. Herb. 156385).

It would appear that *Cunuria glabra* is allied to *C. Spruceana*. Croizat (in Bull. Torr. Bot. Club 57 (1940) 289) cited *Pinkus 236* as representing *Cunuria Spruceana*. He pointed out, however, that the specimens "have slightly larger leaf blades which are truncate or fairly cordate at the base and larger capsules to 6 cm. long."

When sufficient material is amassed, it is at once evident that *Cunuria glabra* is distinct from *C. Spruceana*. Besides the size and shape of the leaves, there are important differences in the texture and margin; in *Cunuria glabra* the leaves are extremely thick, coriaceous and very conspicuously marginate. The floral bracts are relatively large in *Cunuria glabra*, the flowers are extraordinarily large, and the petioles are very thick and rigid.

4. **Cunuria Spruceana** *Baillon* in Adansonia 4 (1863–64) 288; Mueller Argoviensis in Martius Fl. Bras. 11, pt. 2 (1874) 510, t. 14; Corrêa Diccion. Pl. Uteis Bras. 2 (1931) tab. on p. 482; Le Cointe A Amazonia Bras. 3 (1934) 145.

"*Micrandra et Pogonophora ? Cunuri* H. Bn. ol. in exs. Spruce" in Adansonia 4 (1863–64) 288.

Micrandra Cunuri Baillon ex Mueller Argoviensis in DC. Prodr. 15, pt. 2 (1866) 1123.

Brazil: Estado do Amazonas—Foz do Uaupés. "*Cunurí da terra firme.* 60 ft. bole above 6 ft. buttress to crown rising 30 ft. and with 30 ft. spread. Wood fairly soft; sample of this tree in Harvard wood collection. Seeds eaten by natives; see Spruce for preparation. With *Hevea* and *Monopteryx* in unflooded forest. Chromosomes: 2 $n=36$." *J. T. Baldwin Jr. 3683*, March 13, 1944. (Herb. Gray; Herb. Instit. Agron. Norte; U.S. Nat. Herb.; Herb. Kew.)—Serra Comande, Umarituba (above Santa Isabel). "*Cunurí da terra firme.*" *J. T. Baldwin Jr. 3689*, March 22, 1944. (Spec. cum fructu unico: Herb. Arn. Arb.; Herb. Instit. Agron. Norte; U.S. Nat. Herb.)—Sao Paulo de Olivença. "Mata. Arvore grande. *Cunurí.*" *Ricardo de Lemos Fróes 20752*, April 1945 (U.S. Nat. Arb. Herb. 182190, 182204).—Porto Curucuí, Sao Gabriel, Rio Negro. "Terreno silicoso, beira rio nao inundavel." *Ricardo de Lemos Fróes 21129*, Oct. 9, 1945. (U.S. Nat. Arb. Herb. 182193, 182205).

Colombia: Comisaría del Vaupés—Río Papurí, vicinity of Santa Teresita. "Tall trees averaging 35 m. in height, and 80 cm. in diameter above the conspicuously developed and unique stilt buttresses which are produced to a height of 3–4 m. as laterally compressed board-like flanges which act as flying buttresses, the bases widely detached from the trunk, the arch often high enough for a man to walk upright beneath. Leaves simple, with two basal disk-like glands. Inflorescence of small green flowers from axillary growth. Large trispermate capsule typical of *Hevea*. Bark very thin, 6–8 mm., with scanty latex which coagulates with difficulty, producing a non-elastic gum. Seeds collected by the local Indians for food. Known as "*wah-puh*" (Tukano)." *Paul H. Allen 3063*, August 15, 1943. (Herb. Gray).

Peru: Departamento de Loreto—Mishuyacu, near Iquitos, alt. 100 m., forest. "Tree 15 m. high, fl. light yellow." *G. Klug 1312*, May–June 1930. (Herb. Field Mus. 627499).—"Tree 20 m. high; fl. yellow." *G. Klug 1325*, May–June 1930. (Herb. Field Mus. 627508).—"Tree 18 m. high; fl. white." *G. Klug 340*, October–November 1929. (Herb. Field Mus. 624153).

Venezuela: "Cunurí, ling Barré. Arbor vasta, 100–140 pedalis lactescens, in radicibus exsertis late arcuatis suffulta. Pericarpium externum subcarnosum. Ad Casiquiarem, in sylvis. Jan. 1853. Per partes superiores fluviorum Nigri et Pacimonis ut etiam per totum fluv. Uaupés vulgata." *Spruce 3299* (Herb. Kew (two specimens); Herb. Brit. Mus.; Herb. Univ. Cambr.)—"Ad flumina Casiquiari, Vasiva et Pacimoni. *Cunurí.*" *Richard Spruce 3299*, 1853–54. (Typus) (Herb. Gray; Herb. N.Y. Bot. Gard. Photo spec. Herb. Geneva).

In addition to the specimens cited above, we may refer to several collections from the Río Caquetá drainage area in eastern Colombia. These collections—*Schultes 5869* and *5989* from the slopes of Cerro de La Pedrera and *Schultes 5895* and *5932* from the Río Miritiparaná—were studied in the field, and critical notes, written in the field, were published (Schultes in Caldasia 3, no. 13 (1945) 247–249). Although the specimens, together with several hundred others from the same region, were unfortunately lost in shipment, there is no question about the identity of these four collections. The fruit was very large, 6 cm. long or longer, and was, in all specimens, a perfect match for the fruit of *Baldwin 3689*. A photograph of the typical enormous buttressed roots was likewise published (*loc. cit.* fig. p. 248). Along the lower Caquetá and Miritiparaná rivers, especially in the vicinity of the town of La Pedrera (an important Martius type locality formerly known and cited as "Cupatí"), *Cunuria Spruceana* is one of the dominant trees on high land, especially where there are rock outcrops. The Miraña Indians know the tree as *ko-nó-ko;* the Yukunas as *yé-cha*. Schultes (*loc. cit.*) reported: "Where it occurs in the lower Caquetá, Colombia, it is abundant, in some places. . . . crowding out other common forest trees and forming pockets of almost pure stands. It does not occur over wide extensions, but seems to be localized in swampy or well-watered areas where rock outcrops (sandstone as well as granite) are frequent."

Martius apparently did not collect this species in the Cupatí locality, where it is so well represented, because he happened to pass in the interim between the flowering and the fruiting season—in January and February (see Dugand in Rev. Acad. Colomb. Ciénc. Exact. Físic. Nat. 5, no. 18 (1942) 212 ff.). Ducke, who collected rather extensively in this same locality in late 1922, ap-

parently did not collect *Cunuria Spruceana*, although it should have been in flower at the time (Ducke in La Géograph. 30 (1914–15) 365–372). This serves to indicate the extremely localized and disrupted occurrence of the species, a phenomenon which has been noted in other regions for this as well as for other species of *Cunuria*.

A large tree probably representing *Cunuria Spruceana* was observed by Schultes in numerous discontinuous localities in the lower Río Apaporis in eastern Colombia (Schultes in Chron. Bot. *loc. cit.*) during a survey of *Hevea* rubber which was made along that river in 1943.

Cunuria Spruceana is an important food plant of many Indians, for the seeds, like those of *Hevea*, are a favorite food when properly prepared. Spruce (in Hook. Journ. Bot. 6 (1854) 333–337) reported that from the seeds of "*cunurí*, abundant on the Alto Rio Negro, Orinoco, Casiquiare, Pacimoni, etc. the Indians prepare a paste resembling cream-cheese in appearance and taste. The seeds are first boiled and then steeped for some days under water, after which they are broken up by the hand. In the boiling, a quantity of oil is said to be collected; . . . . it is said to be as bitter as andiroba oil, but to afford an excellent light." There is a handwritten notation on the herbarium specimen at Kew which gives much greater detail concerning the native uses of the seeds of *Cunuria Spruceana:* "On the Uaupés and around São Gabriel, a large tree, obviously allied to *Siphonia* [*Hevea*], called by the Indians *Cunurí* is frequent in the forest. It has large arched buttresses at the base, like the uacu [*Monopteryx Uaucu* Spruce ex Benth.], from which it is distinguished by milk flowing from it when wounded. I have not yet seen its flowers or fruits, but the Indians describe the latter as tricoccous, quite as in *Siphonia*, and they use the seeds in a similar manner. These being boiled 24 hours yield a small quantity

of oil, which serves for lamps. The pulpy mess into which the seeds have now fallen is packed in a basket and kept under water 3 days to sweeten; when taken out, it has a pleasant taste and no ill smell. It is eaten without the addition of anything else and may be kept a long time, but if the seeds have not been well boiled, it is a quick poison, and Indians have fallen victims to its incautious use." Schultes found the Indians of the lower Caquetá in Colombia similarly utilizing *Cunuria Spruceana* as a food, and stated (*loc. cit.*) that the seeds "apparently contain a cyanide and, according to the natives, are extremely poisonous when taken internally in the crude state." The Indians there "consume large quantities of the seeds in the form of a greyish mash which is prepared by boiling the pulp in three waters to remove the poison. This mash has a peculiar taste, somewhat like burnt potato. According to the natives, salt must not be added to this mash." Ducke reported this use for Indians of the Rio Negro (in Le Cointe *loc. cit.*). *Allen 3063* records a comparable use by the natives of the Río Papurí, an affluent of the Vaupés which forms part of the Colombo-Brazilian boundary. And, in 1944, Baldwin found the seeds used, just as reported in 1853 by Spruce, in the upper Rio Negro–Rio Uaupés region.

Cunuria Spruceana was the first species of the genus to be described. An extended description appeared in Flora Brasiliensis. The only two illustrations of *Cunuria* have been of this species; the second is a poor copy of the first which was published in Flora Brasiliensis. Probably because of this emphasis on one species, collections of *Cunuria* have almost always been referred to *C. Spruceana*. This has led to the erroneous assumption that *Cunuria Spruceana* is more widely distributed than it really is. As we interpret it, this species occurs, discontinuously, in an arc or crescent from the Casiquiare and

Rio Negro southwestward across the easternmost portion of the Colombian Amazonía to a locality near Iquitos in eastern Loreto, Peru, and to the upper Solimões in Brazil. The Peruvian specimens which are here referred to *Cunuria Spruceana* are slightly atypical in a number of minor characters of the flowers and in having stipules which are not readily caducous. In some respects, it would seem that the Peruvian specimens are somewhat intermediate between typical *Cunuria Spruceana* and *C. Spruceana* var. *bracteosa.* Until more collections are available from this westernmost station for the genus, we feel that it is unwise to interpret these variations as representing a distinct taxonomic concept.

5. **Cunuria Spruceana** *Baillon* var. **bracteosa** (*Ducke*) ***R. E. Schultes comb. nov.***

Cunuria bracteosa Ducke in Notizbl. Bot. Gart. Berlin 11 (1932) 586, *in synon.*; in Arch. Jard. Bot. Rio Janeiro 6 (1933) 57.

Brazil: Estado do Amazonas—Rio Solimoes, Sao Paulo de Olivença. "Frecuens. Silva non inundabili, saepius locis humidis vel ad rivulos. Arbor maxima, flor. albido-viridibus." *A. Ducke Herb. Jard. Bot. Rio 23519*, August 20, 1929 "florif., fructus maturi tempore pluvioso." (Typus). (U.S. Nat. Herb. 1516538, 1517678; Herb. Jard. Bot. Rio; Herb. Kew).—Rio Negro super ostium flum. Curicuriary. "Silva non inundabili. Arbor magna radicibus tabularibus magnis, flor viridibus." Nom vulg. *Cunury. A. Ducke Herb. Jard. Bot. Rio 24873*, December 24, 1931. (U.S. Nat. Herb. 1617664; Herb. Jard. Bot. Rio 24873; Herb. Kew).—Manáos, estrada do Aleixo. "Silva non inundabili, prope rivulum. Arbor magna; flores masculi albi, odore ut in *Hevea.*" *A. Ducke Herb. Jard. Bot. Rio 24874*, December 18, 1941. (U.S. Nat. Herb. 1617665; Herb. Jard. Bot. Rio 24874; Herb. Kew). —Manáos. "Matta da t. f. silicoso-humosa, loga humido perta d'um riachinho. Arv. gr. com sapupemas altas, latex branca, fl. masc. bracacenta com cheiro que lembra *Hevea.*" Nom. vulg. *cunurí. A. Ducke 77*, June 1932. (Yale School Forestry Mus. Ser. 21336; Herb. Field Mus. 657675).—Rio Negro, Sao Gabriel. "Silva non inundabili. Arbor magna flor. viridibus." Nom. vulg. *cunurí. A. Ducke 146*, February

16, 1936. (Herb. Arn. Arb.; Herb. Field Mus. 902328; Herb. Mo. Bot. Gard. 1158515; Herb. N.Y. Bot. Gard.; U.S. Nat. Herb. 1693155, 1694262; Herb. Jard. Bot. Rio 35437; Herb. Kew).—Manáos, Estrada do Aleixo. "Silva non inundabili. Arbor magna floribus albidis." *A. Ducke 848*, December 18, 1941. (Herb. Mo. Bot. Gard. 1255541; U.S. Nat. Herb. 1875676; U.S. Nat. Arb. Herb. 167007).—Manáos, Igarapé do Crespo. "Ad marginem igapo. Arbor magna floribus albidis. *A. Ducke 1087*, December 12, 1942. (Herb. Mo. Bot. Gard. 1263939; U.S. Nat. Herb. 1832363; U.S. Nat. Arb. Herb. 167008, 167009).—Tonantins. "Mata da terra firme, logar umido. Arvore muito grande; flor. brancaçenta. Arbor maxima floribus albidis." *A. Ducke 1554*, February 10, 1944. (Herb. Arn. Arb.; U.S. Nat. Herb, 1906514; U.S. Nat. Arb. Herb. 167213).—Manáos. "Arvore. Mata." *Ricardo de Lemos Fróes 20505*, Feb. 22, 1945 (U.S. Nat. Arb. Herb. 182200).—Sao Paulo de Olivença. "Mata, caatinga. Arvore." *Ricardo de Lemos Fróes 20697*, April 1945. (U.S. Nat. Arb. Herb. 182201).

Cunuria Spruceana var. *bracteosa* is one of the most widespread concepts of the genus. It is found in the upper Rio Negro in close proximity to *Cunuria Spruceana;* it is apparently frequent in the vicinity of Manáos; and it is known from the Rio Solimões. On the highland forest floor near San Pedro on the Rio Içа (Putumayo), between the Colombian boundary and the mouth of the river, Schultes, in 1946, saw fruit and seed of what apparently is *C. Spruceana* var. *bracteosa.* This is the westernmost known locality for the variety.

Cunuria Spruceana var. *bracteosa* is very easily recognized and separated from *C. Spruceana* by having remarkably large floral bracts and large foliaceous stipules which are extremely persistent. In herbarium specimens, the leaves of the variety invariably dry a glossy straw-color, while those of the species always turn a dull, dark brown. Furthermore, the nerves of the former are yellow when dry and are not elevated; those of the latter are dark brown when dry and are very prominently elevated. The capsule and seed of var. *bracteosa* are very

similar to, but always smaller than, those typical of the species itself; the capsule usually measures about 4 cm. long.

Ducke published *Cunuria bracteosa* in 1933, but a year previously he had said (in Notizbl. *loc. cit.*) that "zu dieser Art [*C. Spruceana*] gehört wohl sicher das Herbarmaterial das unter dem Namen *Cunuria bracteosa* nov. spec. von mir verteilt wurde; wahrscheinlich ist übrigens diese Gattung monotypisch." It is obvious that Ducke continued to regard his species, *Cunuria bracteosa*, as synonymous with *C. Spruceana*, because his more recent collections of the former concept have all been determined by him as representing the latter, and, in 1934, he reiterated his opinion that *C. bracteosa* should be regarded as a synonym of *C. Spruceana* (in Arq. Instit. Biol. Veget. Rio Jan. 1, no. 2 (1934) 91, footnote 1).

A letter from Ducke (April 1932) attached to *A. Ducke 23519* in the Kew Herbarium states: "I distributed the *no. 23519* with the name *Cunuria bracteosa* n. sp. (São Paulo de Olivença, Solimões River), but lately I collected similar material on the upper Rio Negro, typical region of *Cunuria Spruceana*. *Cunuria bracteosa* differs of the description of *Cun. Spruceana* by bracteae well developed and by the glandulae of the *exterior* of the male flowers receptacle, but I now presume that Spruce did not collected material in good conditions and that the *Cunuria* might be only of one single species. Still, I dare to say that the flowers as well as the capsules and seeds may vary in size on the same tree enormously. Consequently, I resolved not to publish meanwhile my supposed new species."

VI

CONCEPTUS EXCLUDENDI:

Anomalocalyx Uleanus (*Pax et Hoffman*) *Ducke*

in Notizbl. Bot. Gart. Berlin 11 (1932) 344; in Arch. Jard. Bot. Rio Janeiro 6 (1933) 60, tab. 6, fig. 8.

Cunuria Uleana Pax et Hoffman in Engler Pflanzenr. IV. 147. XIV (Heft 68 in part) (1919) 51.

When Pax and Hoffman described this concept and referred it to *Cunuria*, they had only fruiting material at hand. From flowering and fruiting material which he had collected at the type locality, Ducke described the genus *Anomalocalyx* to accommodate the concept which, up to that time, had been accepted as *Cunuria Uleana*. We are in agreement with Ducke that this genus has no relationship with *Cunuria*. A study of the remarkably complicated flowers of *Anomalocalyx Uleanus*, well figured by Ducke, indicates this fact. The structure and texture of the capsule likewise substantiates such a conclusion.

Cunuria ? casiquiariensis *Croizat* in Journ. Arnold Arb. 26 (1945) 192.

When Croizat described this concept, placing it with reservation in *Cunuria*, he stated clearly: "*Cunuria* is suggested by the intangibles of habit and the characters of the foliage, but the inflorescence is somewhat unconventional." The inflorescence would appear to diverge so widely from that which is usual for *Cunuria*, that we feel that this plant cannot be included, even provisionally, in the genus. For several valid reasons, Croizat has excluded it from *Conceveiva* and *Concevastrum*. In many respects, it suggests *Pogonophora*, but the lack of staminate flowers makes it impossible to be certain of proper generic reference. In a number of other respects, it is extremely similar to *Micrandra*.

Cunuria Gleasoniana *Croizat* in Bull Torr. Bot. Club 57 (1940) 289.

The presence of a definite caruncle on the seed of this concept renders its inclusion in *Cunuria* untenable.

VII

The authors wish to express their appreciation to the following institutions for the loan of material and for other courtesies: Arnold Arboretum, and Gray Herbarium of Harvard University; Missouri Botanical Garden; Chicago Museum of Natural History; New York Botanical Garden; Yale School of Forestry; U.S. National Herbarium and U.S. National Arboretum Herbarium. The authorities of the Jardin Botanico de Rio de Janeiro and the Herbario do Instituto Agronômico do Norte in Belem do Pará, both in Brazil; the British Museum (Natural History) and the Royal Botanic Gardens, Kew are thanked for their kindness in permitting the specimens in their care to be studied.

EXPLANATION OF THE ILLUSTRATIONS

PLATE XLII. CUNURIA AUSTRALIS *R. E. Schultes.* 1, terminal branch, one half natural size. 2, two valves of the capsule, natural size.

Drawn by G. W. DILLON

PLATE XLIII. CUNURIA CRASSIPES *Muell. Arg.* 1, terminal branch, one half natural size. 2, two valves of the capsule, natural size. 3, seed, natural size.

Drawn by G. W. DILLON

PLATE XLIV. CUNURIA GLABRA *R. E. Schultes.* 1, terminal branch, one half natural size. 2, two valves of the capsule, natural size. 3, staminate flower, four times natural size.

Drawn by G. W. DILLON

PLATE XLV. CUNURIA SPRUCEANA *Baill.* 1, terminal branch, one half natural size. 2, two valves of the capsule, natural size. 3, seed, natural size. 4, pistillate flower, four times natural size.

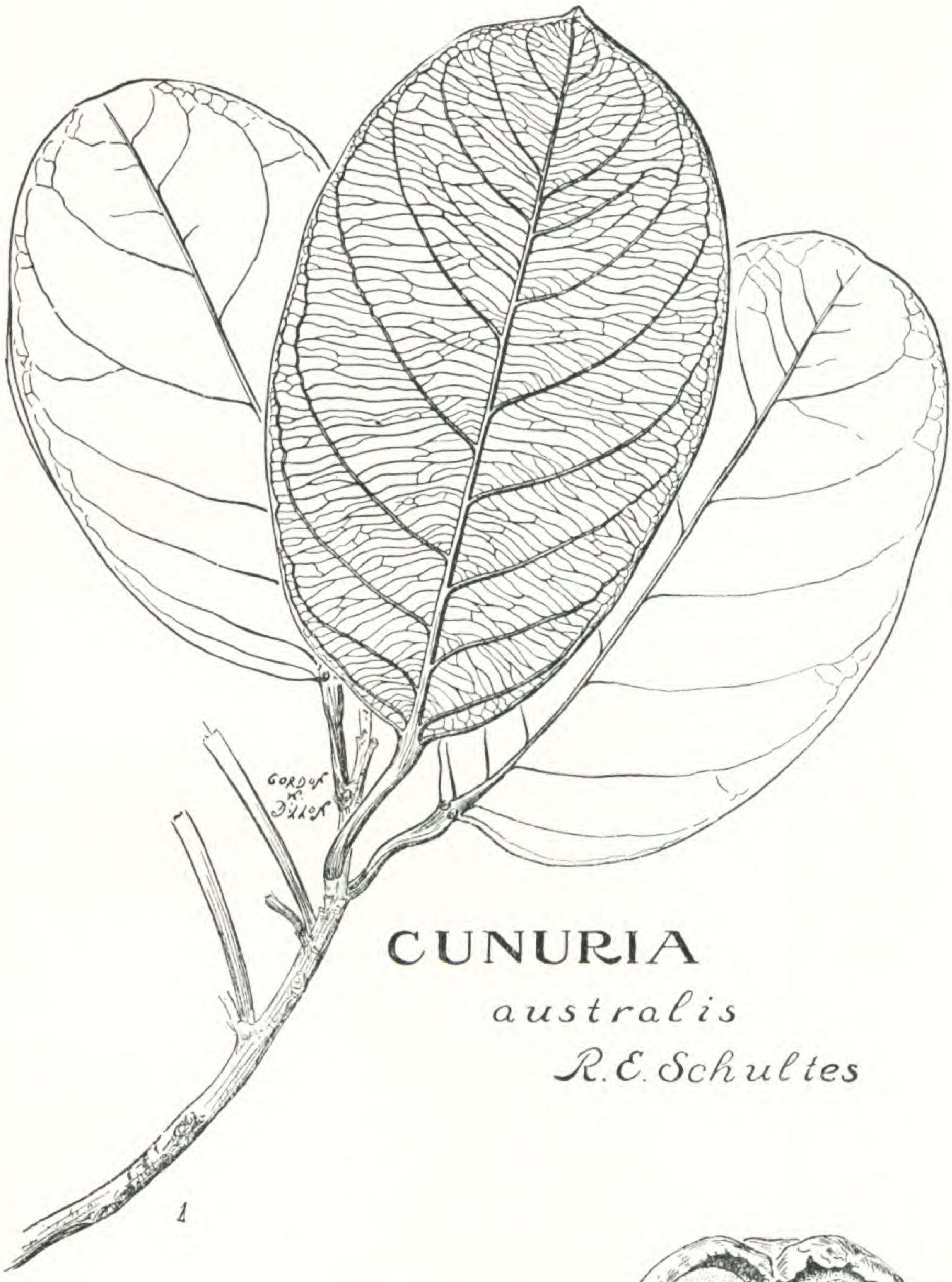
Drawn by G. W. DILLON

PLATE XLVI. CUNURIA SPRUCEANA *Baill.* VAR. BRACTEOSA (*Ducke*) *R. E. Schultes.* 1, terminal branch with inflorescence, one half natural size. 2, two valves of the capsule, natural size. 3, seed, natural size. 4, pistillate flower, four times natural size. 5, staminate flower, four times natural size.

Drawn by G. W. DILLON

PLATE XLVII. CUNURIA SPRUCEANA *Baill.* Photograph taken at La Pedrera, Colombia, showing the enormous buttress roots so characteristic of the species.

Photograph by R. E. SCHULTES



CUNURIA

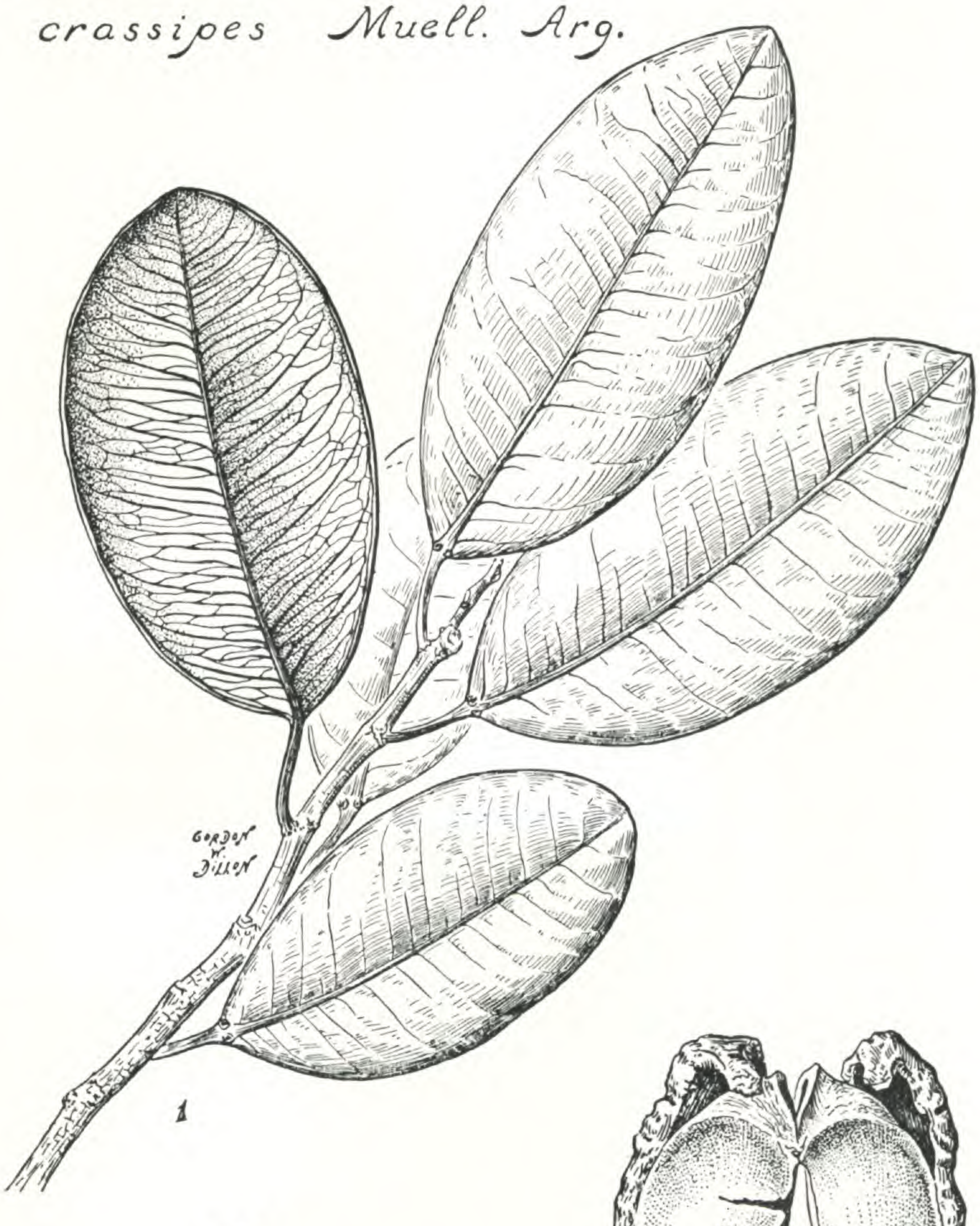
australis

R. E. Schultes

PLATE XLIII

CUNURIA

crassipes Muell. Arg.



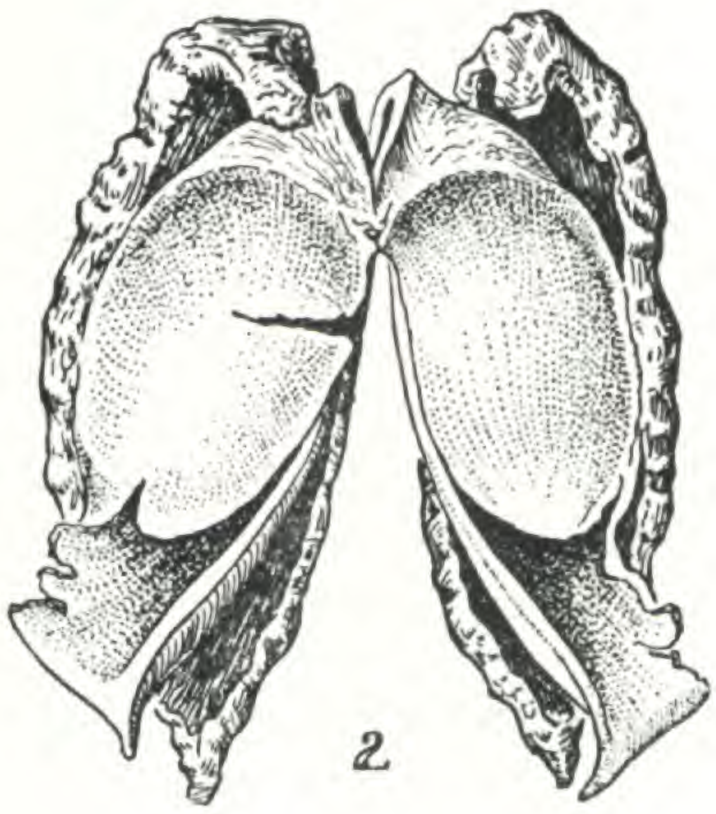
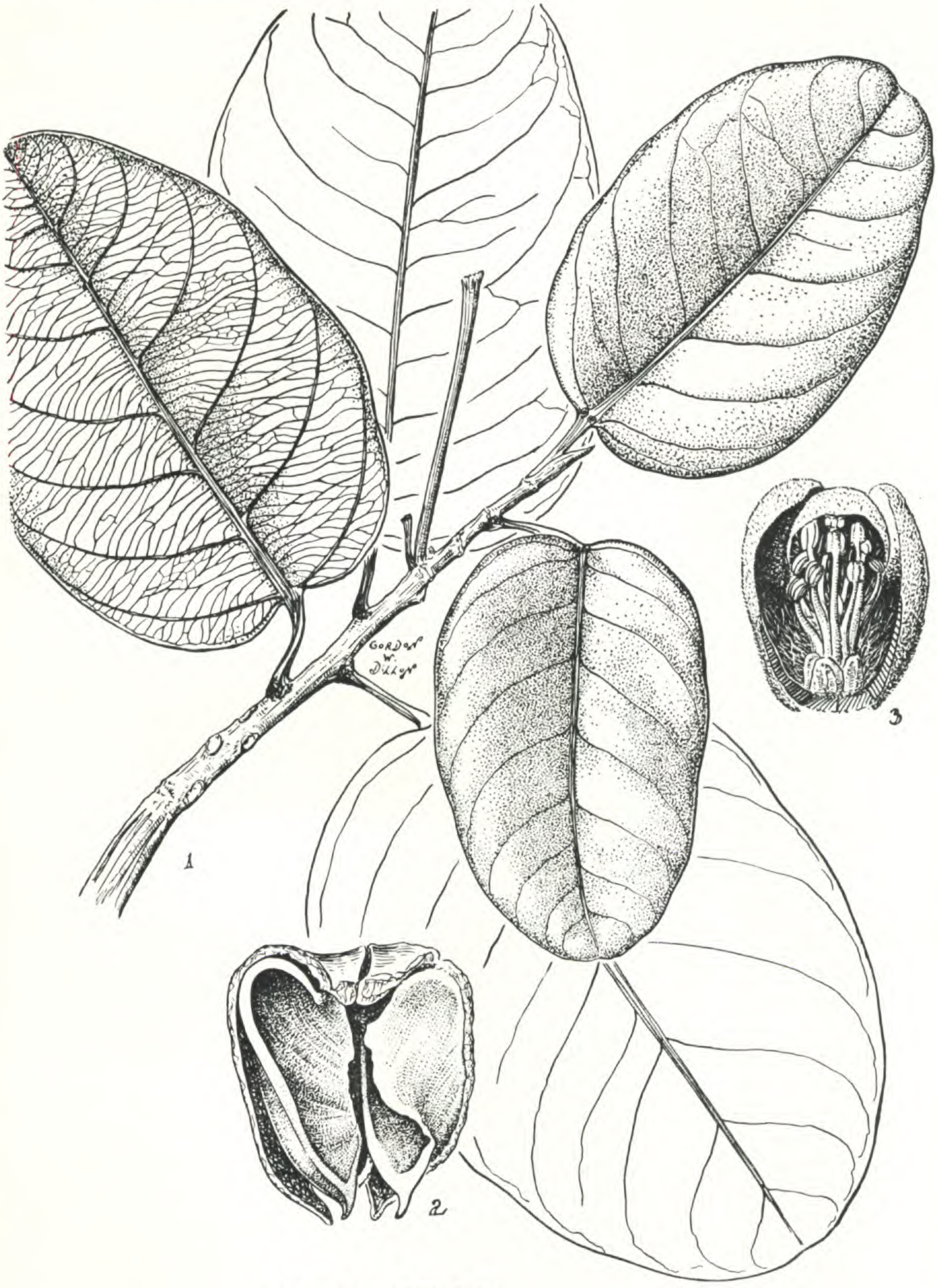




Plate XLIV



CUNURIA

glabra R.E. Schultes

PLATE XLV

CUNURIA

Spruceana Baill.

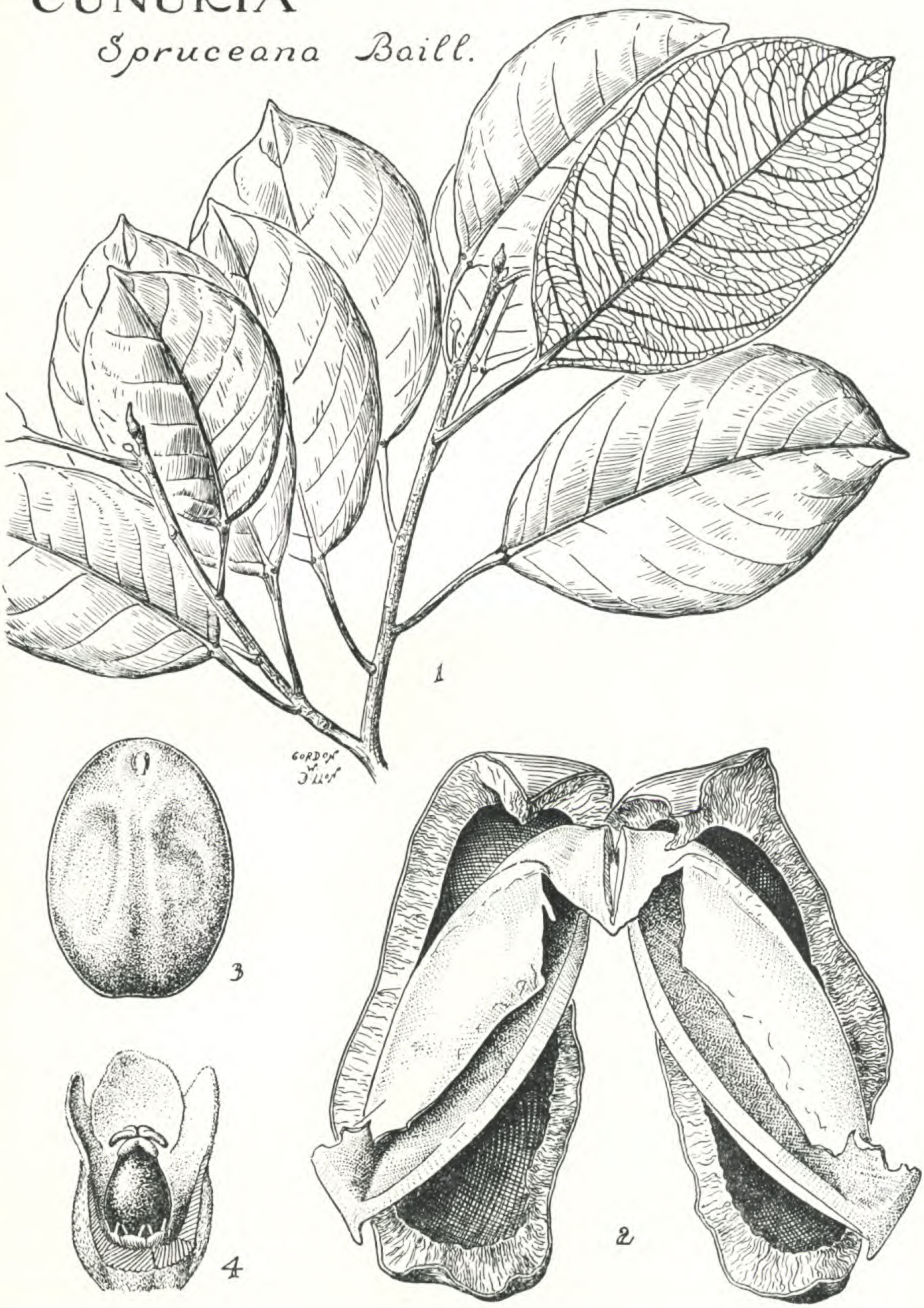
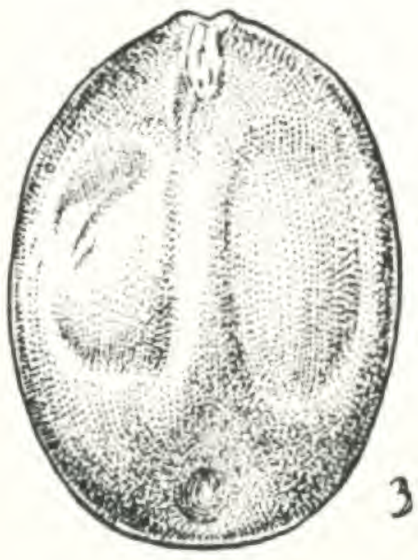


PLATE XLVI

CUNURIA

Spruceana Baill.

var. bracteosa (Ducke) R. E. Schultes



3



4

1

5

2

Plate XLVII

