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PERIODICAL SHELVES

HARVARD COLLEGE

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for pre-Premian read pre-Permian

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for alllies read allies

page 45, line 5
for ancipiti read ancipites

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for Louis read Luis

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after Univ. 1 add , no. 1

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after Sp. Pl. insert ed.

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BOTANICAL MUSEUM LEAFLETS
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CAMBRIDGE, MASSACHUSETTS, FEBRUARY 7, 1936 VOL. 4, NO. 1

TWO NEW SPECIES OF EPIDENDRUM FROM MIDDLE AMERICA

BY
OAKES AMES, F. TRACY HUBBARD
AND CHARLES SCHWEINFURTH

In recent collections from Guatemala and Panama there are two species of the genus Epidendrum which are apparently undescribed.

Epidendrum Skutchii *Ames, Hubbard & Schweinfurth sp. nov.*

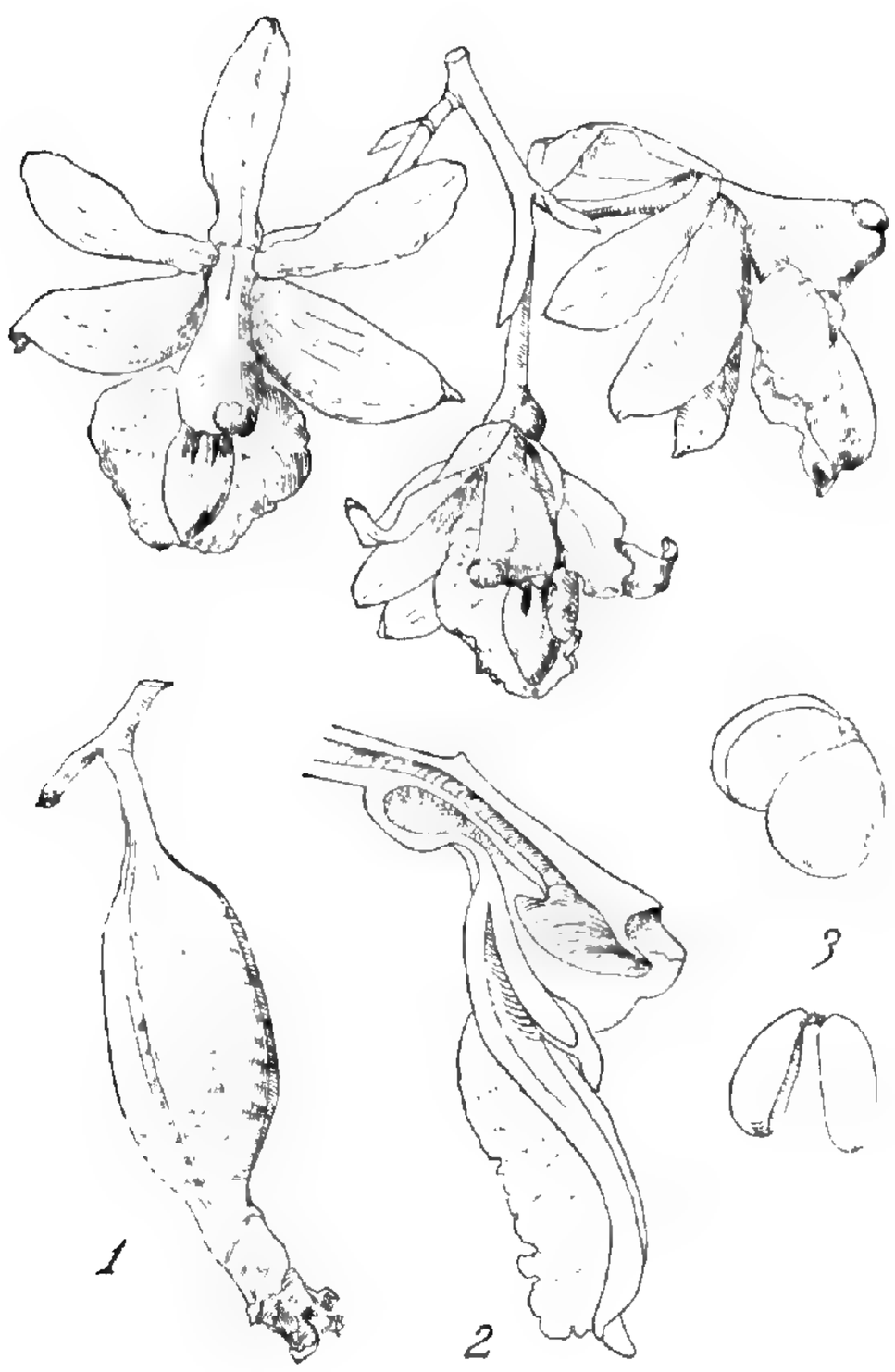
Herba fruticosa, gracilis. Radices crassae, elongatae. Folia prope ramorum apicem congesta, pauca, linearia vel lineari-lanceolata. Inflorescentiae laxae, pauciflorae, quam folia multo breviores; rhachis fractiflexa. Sepala lateralia lanceolato-elliptica vel lanceolato-ovalia, plus minusve obliqua. Sepalum dorsale oblanceolatum vel oblanceolato-ellipticum, obtusum. Petala oblanceolata vel oblongo-oblanceolata, acuta vel retusa. Labellum columnae valde adnatum, in circuitu late triangulari-ovatum, prope medium utrinque angustatum, retusum, basi cordatum, marginibus crenulatis; discus callo elliptico magno centrali basi bisulcato ornatus. Columna superne dilatata. Ovarium superne plus minusve vesiculatum.

Plant tall, much branched, "bushy," up to 120 cm. tall (fide collector). Roots fibrous, stout, elongate, sparingly branched, minutely cellular-papillose. Stems slen-

EXPLANATION OF ILLUSTRATION

EPIDENDRUM SKUTCHII drawn from alcoholic material of the type number. Flowers drawn natural size. 1, fruit natural size. 2, longitudinal section of lip showing the vesicle, enlarged. 3, the four pollinia much enlarged.

Drawn November 1935 with the aid of the camera lucida by BLANCHE AMES


1
2
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der, woody, leafless below, but concealed by close tubular whitish sheaths. Leaves two to four clustered near the end of the branches, linear to linear-lanceolate, up to 16.5 cm. long and 7 mm. wide, long-attenuate with an acute apex, subcoriaceous, slightly narrowed to a sessile base. Inflorescence racemose, few-flowered (up to five), shorter than the leaves, lax to nodding; peduncle exceeding the rachis in length, adorned below the middle with a single lanceolate-linear bract; rachis abbreviated, fractiflex. Floral bracts narrowly triangular-lanceolate, inconspicuous, membranaceous. Flowers "intricately marked with dull red on greenish-yellow background." Sepals and petals spreading and strongly revolute, with prominent nerves. Lateral sepals lanceolate-elliptic to lanceolate-oval, 11.3–11.8 mm. long, 4.1–5.4 mm. wide, dorsally carinate at the apex and usually apiculate, more or less asymmetric. Dorsal sepal oblanceolate to oblanceolate-elliptic, obtuse sometimes with a dorsal mucro at the apex, 10.5–12 mm. long, 3.5–4.2 mm. wide. Petals oblanceolate to oblong-oblanceolate, 11–12 mm. long, 3.2–4.6 mm. wide, acute to rounded and slightly retuse at the apex. Lip triangular-ovate in general outline, somewhat contracted above the middle on each side causing the lip to appear slightly trilobulate, retuse at the apex, cordate at the base, 8.1–11.2 mm. long from base of auricles to tip of lobules, 9.5–13 mm. wide below the middle, with irregularly crenulate margins except toward the base; disc with a prominent, central, fleshy, broadly clavate-elliptic callus which is deeply bisulcate at base and extends to the apex of the lip. Column adnate to the disc of the lip nearly to its apex, strongly dilated above, with an oblique retrorse tooth on either side of the apex, about 7 mm. long dorsally. Ovary with a more or less distinct vesicle at its summit under the lip.

Epidendrum Skutchii is a close ally of *E. ledifolium*

A. Rich. & Gal. and of *E. propinquum* A. Rich. & Gal., but is separable from both by the very different callus of the lip, by the broader petals and by the presence of a more or less distinct vesicle at the summit of the ovary. Great variability is shown both by the vegetative growth and floral characters in specimens of the same collection.

GUATEMALA: Department of Quiché, Nebaj. Epiphyte on mossy trunk leaning over stream. Altitude 6,200 feet. November 19, 1934. *Alexander F. Skutch 1715* (TYPE in Herb. Ames No. 41510.)

Epidendrum cocléense *Ames, Hubbard & Schweinfurth sp. nov.*

Herba epiphytica, longe scandens. Caules laxe ramosi, vaginis omnino obtecti. Folia disticha, linearilanceolata, rigida, acuminata, acuta. Inflorescentiae perbreves, 2- ad 3-florae, basi bracteis paucis imbricantibus ornatae, Bracteae florales conspicuae, convolutae, ovarium pedicellatum paulo superantes. Sepala lateralia ovato-oblonga, obliqua, apice dorso conspicue carinata. Sepalum dorsale lanceolato-oblongum, convexum. Petala lineari-oblanceolata. Labellum columnae valde adnatum, simplex, cordato-ovatum, carinis tribus medianis ornatum. Columna generis.

Plant (our specimen incomplete) scandent and up to 2.5 m. long according to the collectors. Stems sparingly branched, entirely concealed by tubular sheaths; terminal branchlets provided below with closely imbricating sheaths and above with leaves. Leaves distichous, linear-lanceolate, up to 10 cm. long and 6 mm. wide below the middle (in our specimen), acuminate, acute to apiculate, rigidly ascending, very coriaceous, with the mid-nerve more or less sulcate above and carinate beneath. Inflorescences very short, 2- to 3-flowered, subtended by two to three closely imbricating conduplicate carinate sheaths. Floral bracts conspicuous, convolute

around and surpassing the pedicellate ovary, strongly carinate above, up to 13 mm. long. Sepals and petals rigid-nervose. Lateral sepals ovate-oblong, asymmetric, about 9 mm. long and 3.5 mm. wide, acute, prominently carinate near the apex dorsally. Dorsal sepal lanceolate-oblong, 8–8.4 mm. long, about 3 mm. wide, subacute to obtuse, strongly convex, slightly carinate above dorsally. Petals linear-oblanceolate, 7.7–8 mm. long, 1.8–2 mm. wide, subacute to obtuse. Lip simple, adnate nearly to the apex of the column, cordate-ovate, obtuse, subconduplicate, 5 mm. long (from the middle of the base to the apex), about 4.7 mm. broad near the base when expanded; disc provided with three low fleshy keels of which the central keel is much more prominent, each lateral keel dilated at the base into an erect semirhombic lamina and at its apex convergent with the central keel. Column short, very stout, dilated above, crenate-dentate at the summit, 4 mm. long, slightly reflexed in the middle.

Epidendrum cocléense is an ally of *E. ramosum*, but differs in having a tricarinate lip and acuminate acute (often apiculate) leaves.

PANAMA, Province of Coclé. Lower portion of valley and marshes along R. Antón. El Valle de Antón. About 500 meters altitude. February 2, 1935. *A. A. Hunter & P. H. Allen 389* (TYPE in Herb. Ames No. 41863.)

NOMENCLATORIAL NOTES. IV.

BY

CHARLES SCHWEINFURTH

Ornithidium anceps *Reichenbach filius* Beitr. Orch. Centr.-Am. (1866) 75.

Ornithidium neglectum Schlechter in Fedde Repert. Beihefte 19 (1923) 242.

From the evidence of analytical drawings of the types of these species supplemented by the descriptions, it appears to us unwise to retain specific separation.

The leaves which are partially relied on for separation, seem identical. The flowers of *O. anceps* are described as pale ochre-colored, while those of *O. neglectum* are described as white with golden-yellow lip. The only other notable discrepancy appears to be in the callus and mid-lobe of the lip, a discrepancy which seems negligible in view of the many specimens of *O. anceps* we have examined.

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MAR 31 1936

BOTANICAL MUSEUM LEAFLETS
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CAMBRIDGE, MASSACHUSETTS, MARCH 28, 1936 VOL. 4, NO. 2

PERMIAN ELEMENTS IN THE FOSSIL FLORA OF THE APPALACHIAN PROVINCE. II.

WALCHIA

BY
WILLIAM C. DARRAH

Walchia is a synthetic genus of Paleozoic conifers. The foliage-shoots attributed to this genus are characterized by a pinnate arrangement of the ultimate branches. The small, tetragonal, crowded leaves are spirally disposed—laxly or densely. A few species have been described from shoots bearing terminal cones, but the majority are poorly defined vegetative types. *Walchia* is abundant in Permian floras and occurs less abundantly in the Upper Carboniferous (or Stephanian). It is one of the ubiquitous late Paleozoic genera.

The genus includes ten or twelve "species", following the conventional concept of Sternberg.[1] In the past decade Professor Florin[2] of Stockholm began a monographic revision of the Paleozoic conifers, and the whole group will be placed upon a satisfactory basis. Florin's results have not yet appeared in full, although he has already instituted several important new genera based upon reproductive shoots.

[1]Vers. Fl. Vorwelt. vol. 1. p. 22
[2]Proc. Int. Congr. Pl. Sci. (1926) Ithaca. pp. 401-411

The most important and widespread of the Paleozoic conifers is *Walchia piniformis* (Schlotheim) Sternberg.[3] It occurs in both Permian and Stephanian rocks of the northern hemisphere. In the vegetative condition this species is distinguished with difficulty from *Walchia hypnoides* Brongniart and *Walchia filiciformis* (Schlotheim) Sternberg. Florin[4] has created a new genus *Ernestia* for the latter species.

The present note is concerned with the occurrence of three specimens of *Walchia* from eastern North America. One is from the Stephanian ("Permian") of Prince Edward Island, and the other two from western Pennsylvania. Of these one is Stephanian and the second Permian. The three specimens fall within the range of variability of *Walchia piniformis*, although the piece from Prince Edward Island conforms also to *Walchia gracilis* Dawson. The material contains only vegetative branches, and in the absence of reproductive shoots, an assignment to these unsatisfactory species is the most convenient. A score of cellulose transfers have failed to reveal diagnostic cellular structures.

WALCHIA Sternberg 1826 Vers. Fl. Vorwelt; vol. 1. p. 22.

Walchia piniformis (*Schlotheim*) *Sternberg*

1820 *Lycopodiolithes piniformis* Schlotheim
Petrefactenkunde p. 415. pl. 23. figs. 1, 2. pl. 25. fig. 1.

1826 *Walchia piniformis* Sternberg
Vers. Fl. Vorw. vol. 1. p. 22.

1828 *Lycopodites piniformis* Brongniart
Prodrome p. 89.

1870 *Walchia piniformis* Schimper

[3] Petrefactenkunde p. 415

[4] Arkiv Bot. Bd. 21A. No. 13. 1927

Traite Pal. Veg. vol. 2. p. 236. pl. 73. figs. 1, 2?

1885 *Walchia piniformis* Renault

Cours bot. foss. vol. 4. p. 84. pl. 8. figs. 1-3.

1892 *Walchia piniformis* Zeiller

Bass. houill. Perm. Brives p. 97. pl. 15. fig. 1.

1893 *Walchia piniformis* Potonie

Fl. Rotl. Thuringen p. 218. pl. 31. figs. 4, 6.

1906 *Walchia piniformis* Zeiller

Bass. houill. Perm. Blanzy et Creusot p. 204. pl. 50. figs. 3, 5.

1908 *Walchia piniformis* Sellards

Univ. Kans. Geol. Surv. vol. 9. p. 460. pl. 66. figs. 1, 2.

1929 *Walchia piniformis* White

Fl. Hermit Shale p. 96. pl. 41. figs. 1-5. pl. 42. figs. 1-5. pl. 47. fig. 2.

There are many excellent published figures of this species. I have selected several to indicate the variety of coniferous shoots which have been included within a single "species". With the exceptions of the first three monographs, the references are generally available in large libraries.

The two specimens from western Pennsylvania are, for the present, best referred to this poorly defined species, which as White[5] says "is an aggregate of similar forms rather than a single species." One specimen is from the Clarksburg member of the Upper Conemaugh at Rennerdale, Allegheny County, Pennsylvania. The other is from the Nineveh coal group in the Greene at Mount Morris, Greene County, Pennsylvania.[6]

The specimens may be described as follows: twigs short; clothed with persistent, incurved, spirally dis-

[5]Flora Hermit Shale p. 97

[6]Penna. Top. & Geol. Surv. Bull. C-30. p. 100. 1932

posed, short, needle-like leaves, decurrent at the base; twigs depart at an angle 60°-70°, straight, tapering slightly. The leaves are fewer and more distantly placed on the Greene Specimen.

The third specimen discussed in this note is from Miminigash, Prince Edward Island. It was presented to Harvard University in 1875 by Francis Bain. Bain had identified the specimen as *Araucarites gracilis* Dawson. The specimen in our possession is from the type locality of Dawson's plant, which David White renamed *Walchia dawsoni* sp. nov.

Walchia dawsoni *White* 1929

Fl. Hermit Shale p. 99. pl. 44. figs. 1, 4, 4a. pl. 42. fig. 6? pl. 43?

1871 *Walchia (Araucarites) gracilis* Dawson

Rept. Geol. Struct. & Min. Res. P. E. I. p. 43. pl. 2. fig. 23A, nec Emmons, nec Oldham and Morris, nec Walkom.

DIAGNOSIS: (White loc. cit. p. 99.)

"Branches apparently flat, distichous, with close and slender ultimate twigs, hardly tapering until near the blunt apex; leaves close, decurrent, linear-lanceolate, dorsally carinate, curving outward, and in the upper part curving upward and inward uncinnately or more or less distinctly falcately at the rather narrowly acute apex, 3 to 6 mm. long, and broadest at the base, which is slightly carinate dorsad."

The specimen before me agrees with the figures published by Dawson from Nova Scotia and Prince Edward Island. White regarded the Nova Scotian plant as a distinct species. On this slab are branches of the diminutive size suggested by Dawson's figures and larger branches as large as those of the "typical" *Walchia piniformis*. White called attention to the close relationship between

Walchia dawsoni and *Walchia hypnoides* from Lodeve, France. Kidston remarked, "probably this species is only a smaller form of *Walchia piniformis.*"

I have compared the Prince Edward Island plant with eight specimens from Lodeve, France (five attributed to *W. hypnoides* and three to *W. piniformis*) identified by Bronn, Heer, Lesquereux, and de Koninck.

The American species is distinct "on account of the very steadily tapering and blunt appressed leaves of the plant from Lodeve, whereas the leaf of the tree from the Permian of Canada, as shown in detail by Dawson, is much more slender, tapering mainly toward the tip, which is, however, slender, acute, and more strongly upturned near the apex." (White loc. cit.).

These characters are constant in the material at my disposal, consequently I concur with the opinion of David White that is is improbable that *Walchia dawsoni* will be proven to be identical with *Walchia hypnoides.* However, Dawson's several specimens identified as *Walchia gracilis* do represent a single species, which must be known as *Walchia dawsoni* White. Recently Henry Donner has sent me a specimen of *Walchia* from the supposed Permian of Colorado. The fragment is insufficient for certain identification. It agrees well with *Walchia dawsoni* except that the needles are more robust and more distant. I doubt if this is a specific difference.

In North America, *Walchia* is abundant in the Lower Permian. Lesquereux identified several species from Fairplay, Colorado.[7] I.C. White[8] reported the genus from the Wichita (=Permian) of Texas, and David White[9] reported many specimens from Texas, Kansas, Oklaho-

[7]Acad. Geol. (4th. ed.) p. 474. fig. 159 A. 1891
[8]Bull. Geol. Soc. Am. vol. 3. pp. 217-218
[9]Proc. U. S. Nat. Mus. vol. 41. pp. 505-508

ma, Colorado, New Mexico, and Arizona. The Permian occurrences in southwestern United States are indicated by the following:

Walchia piniformis	Texas, Colorado, Arizona, Kansas
Walchia schneideri	Texas
Walchia imbricata	Oklahoma, Arizona
Walchia hypnoides	Colorado
Walchia aff. gracilis	Oklahoma, Colorado
Walchia aff. filiciformis	Kansas
Walchia sp.	Kansas

Several of Lesquereux's specimens from Colorado have been transmitted to Doctor Florin for study.

David White has also recorded *Walchia* from the Permian Hermit Flora of Arizona. He referred the material to four species: *Walchia dawsoni*, *W. gracillima*, *W. piniformis*, and *W. hypnoides*.

I. C. White noted that in the Wichita of Texas, *Walchia sp.* is found in association with a fern flora of Dunkard species.

The eastern American records are of significance because no occurrences of *Walchia* have hitherto been known except in Nova Scotia and Prince Edward Island.

Walchia makes its appearance in western Pennsylvania in rocks of Conemaugh age in the zone of *Lescuropteris*.[10] These rocks are of Stephanian age, as is evidenced by the plants associated in the same strata.

Pecopteris hemitelioides	Neurpoteris aff. ovata
Pecopteris arborescens	Neuropteris neuropteroides
Pecopteris polymorpha	Neuropteris scheuchzeri
Pecopteris feminaeformis	Odontopteris reichi

[10]Darrah, Summaries of Papers Carb. Congr. pp. 1-8. 1935

Pecopteris cistii	Odontopteris genuina
Pecopteris daubreei	Odontopteris sp. nov.
Pecopteris lamurensis	Calamites suckowi
Sphenopteris minutisecta	Annularia sphenophylloides
Dicksonites pluckeneti	Annularia stellata
Alethopteris magna	Sphenophyllum oblongifo-
Alethopteris grandini	lium
Lescuropteris moorii	Cordaianthus sp.
Zygopteris erosa	Walchia aff. piniformis

Although this same general Upper Carboniferous flora continues to populate western Pennsylvania during Monongahela and Washington time, *Walchia* has not been found in either series of rocks. It has been found in the Greene series, at Mount Morris, in the following association:

Callipteris conferta	Odontopteris pachyderma
Sphenopteris sp.	Pecopteris arborescens
Neuropteris odontopteroides	Walchia aff. piniformis

Two additional forms occur in olive shales twelve feet above:

Pecopteris polymorpha	Odontopteris cf. reichi

The Greene rocks are of lower Permian age. *Callipteris conferta*, in a small variety, is very common.

It is evident that in western Pennsylvania, *Walchia* occurs in the Upper Carboniferous as well as in the Permian. The same range has been cited for *Walchia* in Kansas,[11] and for the Cisco (=Monongahela) of Texas.

The occurrence of conifers in Prince Edward Island and Nova Scotia involves again, the relative geological age of the strata in which *Walchia* has been found. Dawson considered them to be of Permian age, and most in-

[11]Elias, XI Int. Geol. Congr. Abstracts. pp. 69, 70. 1933

vestigators have concurred in this opinion.

The specimen from Prince Edward Island, which was sent in a small lot by Bain in 1875 includes: *Callipteridium aff. pteridium*, *Pecopteris arborescens*, *Alethopteris grandini*, and *Sphenophyllum oblongifolium.*[12] Small fragments of *Walchia* are abundant. The matrix of the rock is a red micaceous sandstone of fine grain. This assemblage presents no Permian indicators but rather resembles the typical Monongahela (=Stephanian) flora of Pennsylvania.

Walchia is known to occur in the Upper Carboniferous of England,[13] Wales,[14] France,[15] and elsewhere,[16] although it is characteristic of the Lower Permian. No reliance is placed upon its presence as an indication of Permian age. However, it is a precursor of the typical Permian flora to come. In this sense its appearance is an important factor in determining the process of plant sequence in the late Paleozoic.

Walchia had been sought in Pennsylvania for fifty years without reward, but its rarity is of less importance than its presence. David White[17] believed that some physiographic or climatic barrier prevented the migration of conifers into the area of Dunkard deposition.

It is true that during the Conemaugh, orogenic movements associated with the Appalachian revolution caused many lasting changes in regions to the west in Pennsylvania. It is also true that the rapid plant evolution and floral changes in western Pennsylvania, were contemporaneous with these earth changes.

[12]Darrah, loc. cit. p. 4
[13]Crookall, Coal Meas. plants. 1929
[14]Dix, Trans. Roy. Soc. Edinb. vol. 57. p. 815. 1934
[15]Bertrand, C. R. Congr. Strat. Carb. p. 109. 1928
[16]Gothan, Carb. u. Perm. Pflanzen
[17]Personal Communication dated June 26, 1933

The beginnings of the Permian flora in Pennsylvania extend far down into the Carboniferous. Certain Permian precursors are almost coextensive with the Stephanian. The earliest appearances of Stephanian pecopterids occur in Middle Allegheny following the deposition of the Vanport marine limestone. Numerous lower Allegheny and even Pottsville plants persist, but here is the key to the whole problem. The next marine incursion eliminates the Pottsville-Allegheny complex and results in a new flow of migrants from the north-east (presumably Europe).

There are five distinct marine invasions in the Upper Pennsylvanian rocks of western Pennsylvania. Each marine invasion resulted in a local extermination of the terrestrial fauna and flora. Repopulation of the region subsequently was effected by migrants from districts nearby, where the topography had not been so seriously altered.

During the interval between the Vanport limestone (Middle Allegheny) and the Brush Creek limestone (Lower Conemaugh), the flora is essentially the *Neuropteris ovata* facies in association with Stephanian pecopterids and mariopterids of the *Mariopteris nervosa* group.

Three marine limestones occur in the middle third of the Conemaugh Series: Pine Creek, Woods Run, and Ames. The most extensive of these is the Ames limestone—a persistent bed with the following faunule: *Enteletes hemiplicatus var.*, *Spirifer cameratus*, *Ambocoelia planoconvexa*, *Chonetes granulifer*, *Productus cora*, *Lophophyllum profundum*, and a fusiline. Professor C. O. Dunbar has identified the fusiline as *Triticites collumensis* Dunbar and Condra. Among the rarer forms in this faunule, are species of *Pseudomonotis* and *Edmondia*.

With the invasion by the Ames Sea, there is a marked floral change—a change which permanently al-

tered the flora of Appalachia. The first plants to repopulate western Pennsylvania were relict survivors of the Allegheny flora: *Neuropteris ovata, Neuropteris scheuchzeri* and *Pecopteris lamurensis.* Of these only *Neuropteris scheuchzeri* regained a lasting place in the higher floras. *Neuropteris* (*Mixoneura*) *ovata* was gradually replaced by *Neuropteris* (*Mixoneura*) *grangeri* and *Neuropteris* (*Mixoneura*) *neuropteroides. Pecopteris lamurensis* was quickly eliminated. At the same time there was a steady influx of rejuvenating younger types, which were the typical Upper Stephanian and Permian plants from western Europe.

In the Upper Conemaugh *Walchia, Odontopteris, Lescuropteris,* and *Callipteridium* make their first appearances. Soon after *Taeniopteris* and *Baiera* migrated into the region of Dunkard sedimentation. The progressive change culminates in the arrival of *Callipteris.*

No marine conditions occurred in western Pennsylvania above the Ames Limestone, with the exception of two local, insignificant recurrences in the Upper Conemaugh. The reported marine limestone in the Dunkard of Ohio[18] is an unfortunate error.

It is observed then, in the type section of the Upper Pennsylvanian, how *Walchia* occurs in the normal, undisturbed, stratigraphic sequence. This coniferous genus is but one of many genera which appear in chronologic succession, precisely as in the standard floral successions of the Carboniferous and Permian in western Europe.

The occurrence of *Walchia* in the typical "coal flora" of fern-like foliage is of more than casual interest. The rarity and fragmentary nature of the two specimens from Pennsylvania indicates that they drifted into the sediments in which they became preserved. *Walchia* prob-

[18]Ohio Geol. Surv. (4th. Ser.) Bull. 22. 1920

ably grew at a higher elevation than the typical "coal-swamp" of near tide-level. This ecological difference may account for the scarcity of records in eastern North America. Nevertheless the extensive geographic distribution and relative abundance of *Walchia*, renders it one of the most useful Paleozoic plants in determining correlations and chronologies.

Two recent discoveries of *Walchia* in western American deposits indicate that the early appearance of such conifers is quite general. In Kansas *Walchia*, in a so-called Permian flora, is abundant in Conemaugh equivalents. There is no evidence of the presence of *Callipteris*, although Jongmans believed it to be common. The basis for his opinion was *Dichophyllum moorei* Elias. The Pennsylvanian age of these plants in Kansas is thoroughly demonstrated. The second occurrence of *Walchia* in supposed pre-Premian rocks is a single specimen from the vicinity of Fairplay, Colorado collected by Henry Donner. There are several determinable fragments in association, but probably not sufficient for purposes of correlation. A small fragment, which I believe is referable to *Callipteris naumanni* would seem to suggest a Permian age, but the general consensus of opinion based on invertebrate faunas in the region is that the rocks are Pennsylvanian.

Precise determinations must be based on adequate material and precise correlations are possible only by means of a reasonably large number of specimens. *Walchia* in itself cannot give us the relative age of a late Paleozoic florule. *Walchia* in company with *Taeniopteris* indicates a zone in the immediate boundary between Permian and Pennsylvanian. With this common and widespread association—at least Stephanian in age—it is possible to determine the early appearances of *Lescuropteris*, *Callipteris*, and *Sphenozamites*.

HARVARD COLLEGE
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CAMBRIDGE, MASSACHUSETTS, JULY 9, 1936 VOL. 4, NO. 3

STUDIES IN STELIS. VI.

BY
OAKES AMES

Stelis Lankesteri *Ames* in Sched. Orch. 3 (1923) 4.

AMONG MIDDLE AMERICAN species of Stelis, *Stelis Lankesteri* has the largest flowers, being approached only by *S. leucopogon* Reichb. f. It is characterized by the unequally bilabiate calyx which gives the flowers the aspect of being disepalous. The lateral sepals are coherent to the apex forming a strongly concave lamina; the petals are very fleshy, about 2 mm. long and 2 mm. wide, strongly imbricating behind the fleshy column and conspicuously thickened above the middle. The column is characterized by having the cushion-like stigmatic processes widely separated equalling the anther, with the triangular-lingulate rostellum erect between them. The labellum is about half as long as the petals and in its structure suggests the species of the group to which *S. nubis* Ames belongs.

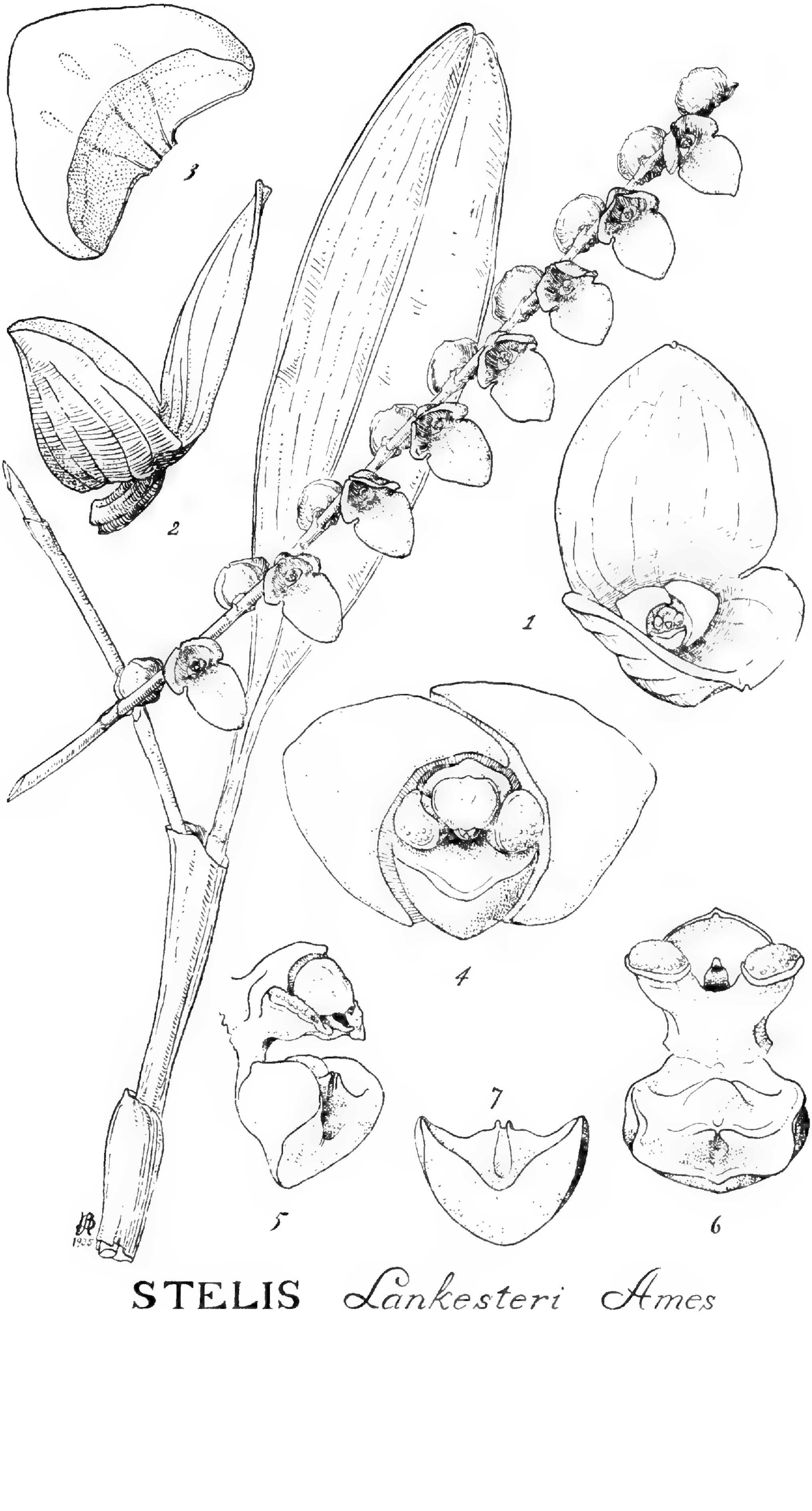
The flowers of *S. Lankesteri* are described by the collector as being vinaceous brown. When dry they are brown-purple.

Only three collections are known to me; that of the type found in the hot forest near La Florida, at an altitude of 150 meters, and two collections from Estrella de Cartago, found at an altitude of 5,000 feet. Because of the great difference in altitude between the type-locality

EXPLANATION OF ILLUSTRATION

STELIS LANKESTERI *Ames*. Plant natural size drawn from *Lankester 365*. 1, flower much enlarged showing the bilabiate aspect of the sepals and the relatively small petals, labellum and column. 2, a flower much enlarged as seen from the side. 3, a petal much enlarged. 4, petals, labellum and column as seen from above. 5, labellum and column, much enlarged. 6, labellum and column, much enlarged, the anther removed to reveal the rostellar process erect between the cushion-like stigmatic arms of the column. In this drawing the labellum is strongly deflexed. 7, the labellum much enlarged as seen in front view. Flowers and floral parts drawn from material preserved in alcohol.

Drawn in 1935 by BLANCHE AMES



STELIS *Lankesteri Ames*

and Estrella de Cartago, Mr. Lankester was of the opinion that two species might be represented and he emphasized a difference between the flowers: those from the type-locality being without the hyaline area on the sepals that is noticeable in the flowers of the plants from the higher altitude. Structurally the flowers of all the specimens examined are similar. There does not seem to be any specific difference dependent on altitude.

Costa Rica: La Florida. At 150 meters altitude in hot forest. Flowers vinaceous brown. (Blooming at Cartago under cultivation, October-November 1922). *Lankester 365*: La Estrella de Cartago. At 5,000 feet altitude. Flowers with the upper sepal vinous purple-hyaline. October 4, 1925. *Lankester 1062*; upper sepal semi-translucent maroon, lower sepal with hyaline centre. *Lankester 1017*.

A RARE VANILLA

BY

OAKES AMES

Vanilla Pfaviana *Reichenbach filius* in Gard. Chron. ser. 2, 20 (1883) 230.—l'Orchidophile 3 (1883) 758 (as *V. Pfavana*)—Hemsley in Godman & Salvin Biol. Cent.-Am. Bot. 4 (1887) 90 (as *V. pfaviana*)—R. A. Rolfe in Journ. Linn. Soc. 32 (1896) 452—Schlechter in Beihefte Bot. Centralbl. 36, Abt. 2 (1918) 426.

REICHENBACH'S DESCRIPTION of *Vanilla Pfaviana* is typical of the brief botanical characterizations appearing in the later years of the nineteenth century and is, in the absence of the type, quite inconclusive and almost useless for purposes of identification. From 1889 (the year of Reichenbach's death) until 1914, *V. Pfaviana* remained an obscure species; its identity could not be established because the type was inaccessible being a part of the Reichenbachian Herbarium in Vienna and unapproachable by the terms of Reichenbach's will during the twenty-five years following his decease.

In the original description, Reichenbach cited Mexico as the native country of *V. Pfaviana*, saying that it was found by one of Mr. Pfau's collectors, yet, what I take to be the type indicates Endres as the collector and Costa Rica as the source, the type plant being attributed to Pfau under no. 269, as if Pfau had distributed it in a series of numbered specimens.

Among the collections of orchids secured by numerous expeditions to Mexico since 1883, specimens referable to *V. Pfaviana* failed to appear prior to 1933 when plants were collected in the vicinity of Atoyac near Vera Cruz; and, notwithstanding the intensive collections made in Costa Rica in recent years, nothing answering to the original description was discovered un-

til 1936 when Alexander F. Skutch found specimens in the Province of San José. In 1935, Percy H. Gentle found specimens in British Honduras.

R. A. Rolfe, in his monograph of Vanilla, referred to *V. Pfaviana* as being known to him only from the original description. He depended on the suggestion made by Reichenbach that the flowers are terminal in the type and used this character in his key to separate the species from *V. inodora* Schiede, *V. ovata* Rolfe and *V. Methonica* Reichb.f. The specimens collected in Costa Rica by Skutch indicate that the flowers are both terminal and lateral; completely opened flowers and buds being present simultaneously on the elongated, leafy stems.

Mexico: State of Guerrero, near San Vicente, northeast of Atoyac. At 850 meters altitude in mixed oak and pine forest on trees. January 10, 1933. *Östlund 1984* (collector O. Nagel).

British Honduras: Gracie Rock, Sibun River, May 1, 1935. *Percy H. Gentle 1672.*

Costa Rica: Province of San José, vicinity of El General. At 1130 meters altitude. Herbaceous vine in forest, attached by the roots, flowering shoots pendant. Flowers green with white labellum. February, 1936. *Alexander F. Skutch 2592.*

EXPLANATION OF ILLUSTRATION

VANILLA PEAVIANA *Reichb.f.* Plant natural size drawn from *Skutch 2592*. 1, labellum, slightly enlarged, showing at the base the remains of the adnate column. 2, column, slightly enlarged, the basal portion missing. Flowers drawn from specimens of *Skutch 2592* preserved in formalin.

Drawn May 1936 by BLANCHE AMES

VANILLA *Pfaviana Reichb. f.*

1

2

A NEW PLEUROTHALLIS FROM HONDURAS

BY

OAKES AMES

Pleurothallis comayaguensis *Ames, sp. nov.*

Rhizoma repens. Caules secundarii valde abbreviati, monophylli. Folium ellipticum vel orbiculare, integerrimum, marginatum. Pedunculus elongatus, glaber, folio multo longior, prope apicem pauciflorus. Sepala lateralia in laminam orbicularem apice bidentatam cohaerentia. Sepalum dorsale valde concaviusculum, oblongum, obtusum, trinervium. Petala lanceolata, obtusa, margine glandulosa, uninervia. Labellum linguiforme, basi auriculatum, margine supra medium longe pilosum. Columna apice irregulariter fimbriata.

Rhizome branching, creeping, monophyllous at the nodes, each leaf subtended by an abbreviated root. Secondary stems up to 1 mm. long, rigid. Leaves about 3 mm. apart, up to 6 mm. long, 3–3.5 mm. wide, elliptic or lenticular, entire, conspicuously marginate, fleshy. Peduncles about 6 mm. long, borne singly in the axils of the leaves, with a tubular bract at the base, otherwise naked below the lowermost flower, glabrous. Flowers about four, opening in succession, 2 mm. long. Lateral sepals 2 mm. long, coherent almost to the tip, forming an orbicular lamina 1.5 mm. wide, strongly concave at the base, smooth. Dorsal sepal 2 mm. long, strongly concave, about 0.5 mm. wide, oblong, obtuse, 3-nerved. Petals about 2 mm. long, hardly 1 mm. wide, lanceolate, obtuse, with several elongated glandular hairs on the margins, 1-nerved. Labellum 1.5 mm. long, 0.5 mm. wide, narrowly lingulate, obtuse at the apex, margins of the basal half strongly inrolled, sometimes almost contiguous over the lower half of the disc; margins of the apical

EXPLANATION OF ILLUSTRATION

PLEUROTHALLIS COMAYAGUENSIS *Ames*. 1, part of a plant drawn twice natural size. 2, 3 and 4, flower much enlarged. 5, labellum, much enlarged, as seen from above. 6, column much enlarged with the anther removed. 7, anther. 8, pollinia much enlarged. 9, petal much enlarged. The vegetative and floral parts drawn with the aid of the camera lucida from a specimen preserved in alcohol.

Drawn in 1935 by BLANCHE AMES

PLEUROTHALLIS

comayaguensis

Ames

half deflexed, rather closely beset with elongated glandular hairs, shortly glandulose at the tip and on the depressed or canaliculate central portion of the glandulose disc, auriculate on each side at the base, the auricles rounded and curved inward. Column about 2 mm. long, dilated upward from a slender base, cucullate at the apex with the margin of the clinandrium irregularly fringed; rostellum membranaceous. Stigmatic orifice on the frontal surface.

Vegetatively this species bears a strong resemblance to *Pleurothallis Lewisae* Ames, but differs from it markedly in the structure of the flower. (cf. Bot. Mus. Leafl. vol. 1 no. 8 p. 7.) The structure of the labellum and column resembles *P. navarrensis* Ames and *P. abjecta* Ames.

Republic of Honduras: Department of Comayagua, Minas de Oro. Epiphyte in dense damp forest, at 4,000 feet altitude. Flowers very small, red. December 29, 1932. *J. B. Edwards 338.* (Type in Herb. Ames. No. 42460.)

Guatemala: District of Peten, La Libertad. March 29, 1933. *C. L. Lundell 2140*; March 30, 1933. *Lundell 2235.*

A GENERIC SYNONYM

BY

OAKES AMES

Dipodium squamatum *Robert Brown ex Lindley* Gen. & Sp. Orch. Pl. (1833) 186.

Orphrys? squamata Forster Fl. Ins. Austr. Prodr. (1786) 59, (no. 310).

Cymbidium squamatum Swartz in Kgl. Vetensk. Acad. Handl. 21 (1800) 238.

Epidendrum squamatum Poiret in Lamarck Encycl. Suppl. 1 (1810) 376.

Trichochilus neo-ebudicus Ames in Journ. Arn. Arb. 13 (1932) 142.

THE GENUS DIPODIUM, as treated by Pfitzer in his classification of the Orchidaceae in Engler and Prantl's Die Natürlichen Pflanzenfamilien, is assigned to the Acrotonae-Pleuranthae. This is a concept characterized by a laterally produced flower-shoot in contradistinction to the Acrotonae-Acranthae, a concept characterized by a terminally produced flower-shoot. *Dipodium squamatum* R. Brown and *D. punctatum* R. Brown, the Australasian species taken by Pfitzer to represent the genus Dipodium, are, as I interpret them, distinguished by a terminally produced flower-shoot and would seem properly to belong in his Acrotonae-Acranthae.

When I proposed the new genus Trichochilus, I was unmindful of Dipodium, a well-figured group with numerous specimens in my herbarium. Consequently, when the material in hand with a terminal inflorescence failed to work out as belonging to Pfitzer's Acrotonae-Acranthae, I thought I was justified in proposing a new genus.

Pfitzer briefly characterized the genus Dipodium under his Acrotonae-Pleuranthae, and made the significant

statement: "Pfl. zur Blütezeit und warscheinlich überhaupt blattlos, in ihrem Aufbau noch ungenügend bekannt." As he restricted the genus to the Australasian species, it would seem that he intended to exclude from Dipodium the Malayan species with lateral flower-shoots (plants clearly referable to the Acrotonae-Pleuranthae) and to recognize for their reception the genus Wailesia. Perhaps, as Pfitzer implied, the vegetative structure of Dipodium, as represented by *D. punctatum* and *D. squamatum*, is in need of further elucidation. However, as long ago as 1862, H. G. Reichenbach (in Xenia Orchidacea 2 (1862) 15, t. 107) attempted a classification of the then known species (taking Dipodium in its broadest sense to include Wailesia), and in his key to the genus established two groups: one characterized by a terminal inflorescence, including *D. punctatum* and *D. squamatum*; the other characterized by a lateral inflorescence, including *D. paludosum* and *D. pictum*. He published a very accurate illustration of *D. squamatum* and showed clearly what he interpreted as a terminal inflorescence.

Unfortunately the specimens of *D. squamatum* and *D. punctatum* found in herbaria are usually incomplete and appear to be broken where they emerge from the ground, yet it is difficult to understand why Pfitzer, relying on vegetative characters, should have regarded these species as members of his Acrotonae-Pleuranthae.

If Dipodium is accepted in the modern sense to include the species formerly referred to Wailesia (on floral structures it is evident that these genera are closely related and doubtfully separable) it should be emphasized that the Australasian species, *D. punctatum* and *D. squamatum*, constitute an exception to the generic characters of Dipodium based on a lateral flower-shoot and are in the same category with several other genera of the Orchidaceae, such as Dendrochilum and some of the ab-

errant species of Epidendrum which should be referred, in a key erected on vegetative characters, to both the Acrotonae-Acranthae and to the Acrotonae-Pleuranthae.

STUDIES IN PONTHIEVA

BY

OAKES AMES AND CHARLES SCHWEINFURTH

Ponthieva chuquiribambae (*Kränzl.*) *Ames & Schweinfurth, comb. nov.*

Pleurothallis Chuquiribambae Kränzlin in Ann. Naturhist. Mus. Wien 44 (1930) 327.

On receipt of habit drawings and detailed floral analyses of the type of *Pleurothallis Chuquiribambae* from the Reichenbach Herbarium at Vienna, it became very evident that this species is a typical member of the genus Ponthieva. The characteristically asymmetrical petals adnate, together with the lip, to the upper part of the column are diagnostic for Ponthieva and are quite distinct from what obtains in the very distantly related genus Pleurothallis.

This species, however, does not appear to be referable to any Ponthieva previously described. It is allied to the widespread *P. maculata* Lindl., particularly to the rather dwarf form of the plant found in Central America: but it differs in having apparently narrower connate lateral sepals and a dissimilar markedly unguiculate ovate-triangular lip. Furthermore, *Ponthieva chuquiribambae* appears to differ from the Peruvian *P. villosa* Lindl. in

the narrow connate lateral sepals, the form of the lip and the short (not elongate) rostellum.

Ponthieva parviflora *Ames & Schweinfurth, sp. nov.*

Herba elata, gracilis. Radices tuberosae. Folia basalia, rosulata, elliptico-oblanceolata vel oblanceolata, ad basim petiolatam angustata, acuta. Scapus inferne glaber, superne glanduloso-pubescens. Racemus laxiflorus. Flores parvi. Sepala lateralia oblique ovata, obtusa. Sepalum dorsale elliptico-lanceolatum, concavum. Petala sepalo dorsali valde adnata, obliquissime deltoideo-rhombica, basi cuneata. Labellum valde concavum, subsessile, apice profunde trilobatum. Columna brevis.

Plant tall, about 40 cm. high. Roots tuberous. Leaves basal, rosulate, five in this single specimen, elliptic-oblanceolate or oblanceolate, gradually narrowed into a petioled base, 13 cm. or less long, up to 2.9 cm. wide, acute, membranaceous. Stem slender, provided with eight scarious tubular acuminate sheaths of which the lowermost is 1.75 cm. long, glabrous below, finely glandular-pubescent above. Raceme loose, exceeding 10 cm. in length (incomplete), 23-flowered or more. Floral bracts lanceolate, acuminate, up to 4.5 mm. long, pubescent on the outer surface. Pedicellate ovary slender, spreading, 6 mm. or less long, glandular-pubescent. Flowers very small for the genus. Sepals sparsely glandular-pubescent near the base on the outer surface. Lateral sepals obliquely ovate, about 3 mm. long, up to 2 mm. wide, obtuse. Dorsal sepal elliptic-lanceolate, about 3 mm. long and 1 mm. wide, subacute, concave. Petals adnate to the dorsal sepal, obliquely deltoid-rhombic, obtuse or subacute, almost sessile on the column at the cuneate base, 2.9 mm. long, about 1.6 mm. wide below the middle, 1-nerved with an indistinct branch near the

base, strongly dilated on the outer margin near the base and slightly dilated on the inner margin at the middle, upper margins minutely cellular-ciliolate. Lip adnate to the column near the base of the latter, strongly concave with erect sides, nearly sessile at the solid base, about 2.7 mm. long in natural position, abruptly 3-lobed near the apex; middle lobe small, spatulate-oblong, 1 mm. long, rounded at the apex, concave, upcurved in natural position. Column very short, 2–2.5 mm. long including the terminal erect rostellar horn; clinandrium relatively long; anther oblong-cordate, stipitate.

Ponthieva parviflora is unusual in the genus in being a rather tall species with slender habit and very small flowers. It is somewhat similar to *P. parvula* Schltr., but is vegetatively much larger with dissimilar petals which are narrowed above, and with a more distinctly 3-lobed lip. It differs from *P. Brittonae* Ames in its taller habit, in its much smaller flowers, and in the venation of the petals, and in the dissimilar lip.

A sheet of the same collection bearing three plants (subsequently received from the Field Museum of Natural History) shows the following variations from the type. Plant 20–45 cm. tall. Stem with only three sheaths. Leaves elliptic, about 5–6 cm. long, 2.1 cm. or less broad. Raceme 9–15 cm. long.

YUCATAN: Tuxpeña, Campeche, January 19, 1932. *C. L. Lundell 1213.* (TYPE in Herb. Univ. Mich.).

BOTANICAL MUSEUM LEAFLETS

HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS, SEPTEMBER 18, 1936 VOL. 4, NO. 4

A NEW PLEUROTHALLIS FROM COSTA RICA

BY

OAKES AMES

THE species described below is in part characterized by the non-resupinate flowers; the connate lateral sepals being directed toward the apex of the leaf. In the collector's notes there is nothing to warrant the explanation that this condition is the result of the stems and leaves having been drooping or pendent, but it is probable that the leaves hung downward or were strongly deflexed, in which case the flowers would become non-resupinate.

Pleurothallis fantastica is without close alllies in the Central American flora. In habit it suggests *P. Tonduziana* Schltr., but in floral structure is quite distinct; furthermore, the secondary stems are less markedly ancipitous or winged below the triangular-lanceolate leaf-blade. The adnate peduncle, the conspicuously three-lobed labellum with a more or less prominent cushion-like callus on the disc at the base of the middle-lobe, and the leaves being penninerved near the base constitute the more important distinguishing characters. The column is of the type characteristic of Pleurothallis as originally defined by Robert Brown, in that the stigmas are confluent along the frontal margin of the androclinium as in *P. ruscifolia* (Jacq.) R. Br. (Cf. Bot. Mus. Leafl. Harv.

EXPLANATION OF THE ILLUSTRATION

PLEUROTHALLIS FANTASTICA *Ames*. Plant, one half of natural size, drawn from the type. 1, flower, much enlarged. 2, leaf and inflorescence, natural size. 3, labellum, enlarged, lateral lobes deflexed. 4, labellum and column (anther removed), enlarged. 5, column (anther removed) showing the triangular rostellum overhanging the stigmatic orifice. 6, pollinia, very much enlarged. Floral analyses drawn from material preserved in alcohol.

Drawn in August 1936 by BLANCHE AMES

PLEUROTHALLIS *fantastica* Ames

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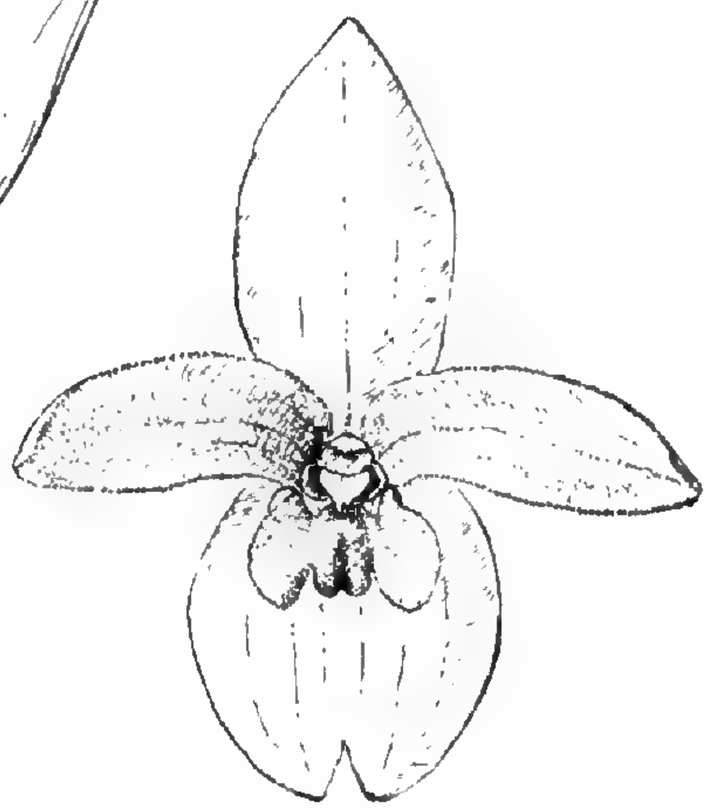

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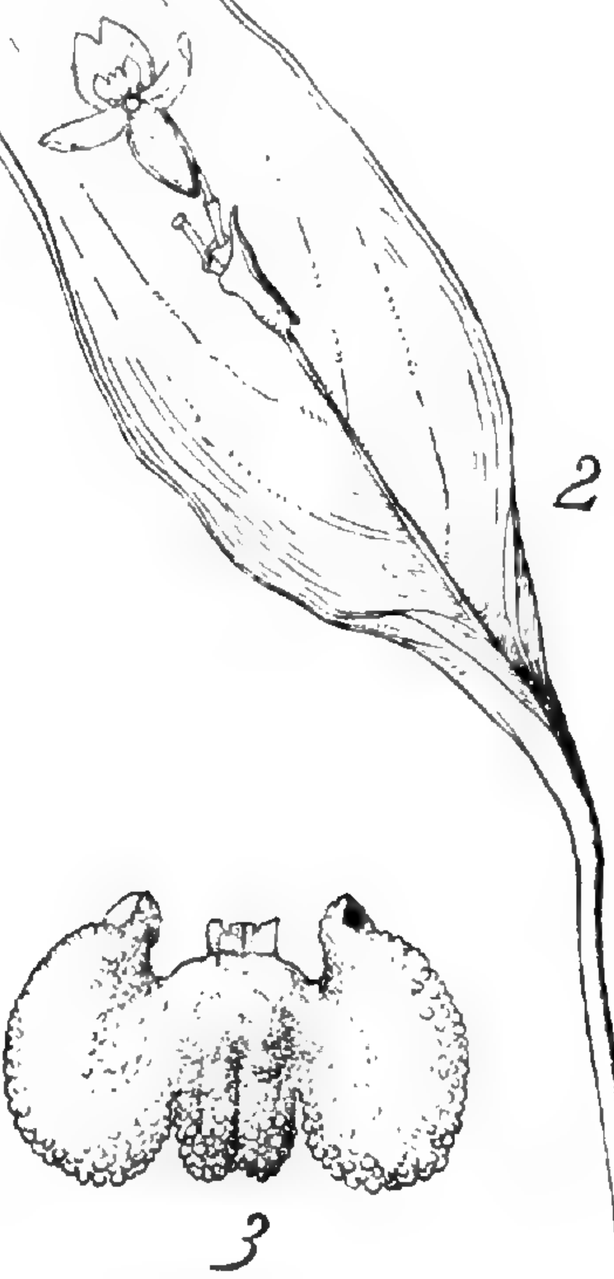

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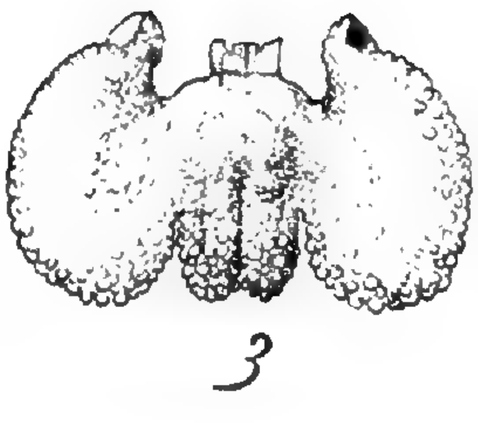

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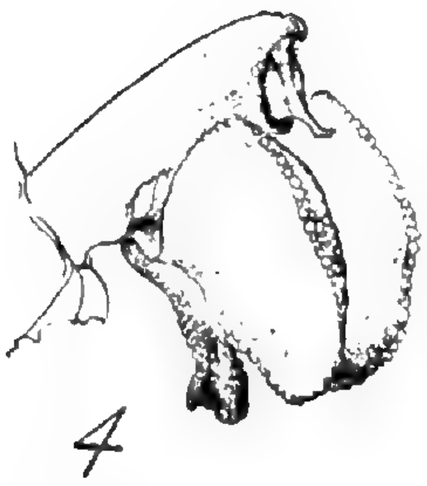

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Univ. 1, no. 9 (1933) 5, t.)

Pleurothallis fantastica *Ames sp. nov.*

Radices fibratae, albidae, glabrae. Caules secundarii congesti, valde elongati, graciles, paucivaginati, superne leviter ancipiti, monophylli. Vaginae tubulatae, valde adpressae. Folium triangulari-lanceolatum, prope basim penninervium, usque ad apicem angustatum, apice mucronatum. Pedunculi abbreviati quam folium multo breviores, folio adnati. Pedicelli fasciculati. Flores successanei. Sepala lateralia in laminam ellipticam connata. Sepalum dorsale anguste ellipticum. Petala late lanceolata, trinervia. Labellum carnosum, trilobatum; lobi laterales semiorbiculares, plus minusve erecti; lobus medius quadratus, papillosus, prope basim callo ornatus. Columna generis. Pollinia duo.

Roots fibrous, whitish, smooth, about 1 mm. thick. Secondary stems 10–20 cm. long, about 1 mm. in diameter, crowded on a creeping rhizome, ascending, slender below, becoming slightly ancipitous above, but not so conspicuously so as in the closely related *P. Tonduziana*, clothed with several closely appressed, cylindrical sheaths, monophyllous. Leaves 10–17 cm. long, 1.5–2.5 cm. wide near the base, coriaceous, tapering gradually to an acute, mucronate tip, penninerved for the length of the adnate peduncle, the basal margins more or less involute. Peduncle about 2 cm. long, completely adnate to the leaf, bearing at the free end an ample sheath which is about 6 mm. long and from which one to three or more non-resupinate flowers emerge in succession, only one flower, rarely two, being expanded simultaneously. Pedicels fasciculate, about 3 mm. long, smooth. Ovary 3.5 mm. long, jointed to the pedicel. Lateral sepals connate, forming an elliptical lamina with eight nerves, 5 mm. long, about 4 mm. wide. Upper sepal 5–6 mm. long, 3 mm. wide,

narrowly elliptical, obtuse or subacute, 3–5-nerved. Petals 5–6 mm. long, 2 mm. wide, broadly lanceolate, minutely glandulose, obtuse, 3-nerved. Labellum fleshy, adnate below to the base of the column and emerging just above its base, 2 mm. long, about 3 mm. wide, conspicuously fleshy, three-lobed with the lateral lobes semi-orbicular, about 2.5 mm. long, about 1 mm. wide, minutely glandulose, obliquely erect and more or less appressed to the column; middle lobe 1 mm. long and about 1 mm. wide, quadrate, retuse, distinctly glandulose, purplish, 3-nerved with a bilobed or retuse callus at the base. Column about 3 mm. long, narrowed toward the middle, conspicuously dilated above, minutely glandulose; rostellum broadly triangular. Pollinia two, slenderly pyriform.

Costa Rica: Province of San José, in the vicinity of El General. Epiphyte on trees by a river at 830 meters altitude. Flowers yellow. January 1936. *Alexander F. Skutch 2391.* (Type in Herb. Ames No. 43650). In the dried flowers examined the sepals and petals were yellow, the labellum purplish.

A RARE SOBRALIA FROM COSTA RICA

BY

OAKES AMES

Sobralia pleiantha *Schlechter* in Fedde Repert. 3 (1906) 79; in Fedde Repert. Beihefte 19 (1923) 81.

IN 1921, H. PITTIER discovered the type of *Sobralia pleiantha* in a forest near Boruca in southwestern Costa Rica. When Rudolf Schlechter described it, fifteen years later, he referred to the unusual nature of the inflorescence in having more than one flower expanded at a time. In Sobralia, usually, the flowers are produced singly, in succession, each flower remaining in perfection for a very few hours.

The plants attain a height of 8 decimeters or more, each slender stem bearing as many as ten elliptic-lanceolate, acuminate leaves which are articulated to elongated, closely appressed cylindrical, smooth sheaths. At the summit of the mature stems the flowers appear in an abbreviated raceme with complanate, distichous bracts. Each raceme produces as many as ten flowers. The lowermost flowers expand first and are in perfection while the terminal flowers are still in bud.

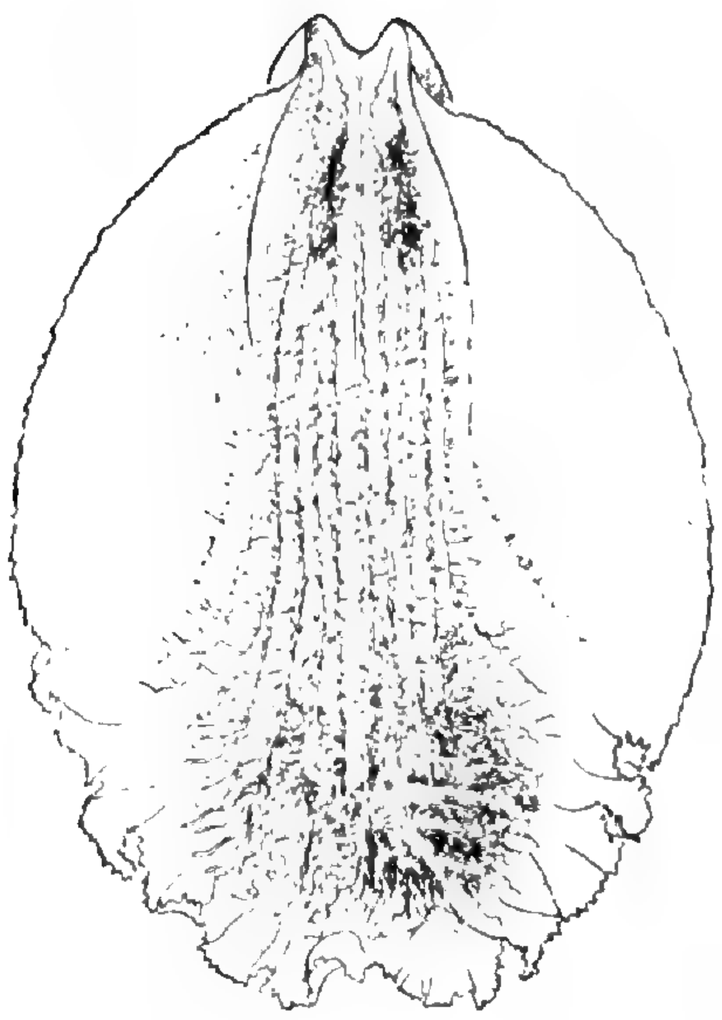
The sepals and petals are from 3–3.3 cm. long and about 1 cm. wide. The labellum, equally long, and about 2 cm. wide, is closely beset, along the central veins, with numerous, crowded, glandular processes. These processes are simple, bifurcate or several-times divided, those near the apex of the lamina being strongly complanate; those near the base being crowded into a pair of abbreviated keels; the margin of the labellum is finely denticulate almost to the base. The column is typical of the genus and attains a length of about 3 cm.

In the original description the labellum is described as being cuneate-obovate. In a drawing received from

EXPLANATION OF THE ILLUSTRATION

SOBRALIA PLEIANTHA *Schlechter*. Plant, natural size, drawn from a specimen of *Skutch 2484*. 1, labellum about twice natural size. 2 and 3, column, enlarged. Figures 1, 2 and 3 drawn with the aid of the camera lucida from flowers preserved in alcohol.

Drawn in July 1936 by BLANCHE AMES



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SOBRALIA *pleiantha* *Schltr.*

Dr. Schlechter the labellum is strongly cuneate below the middle. In the specimens from which the accompanying plate was drawn, the labellum is elliptical and not at all cuneate below the middle.

The flowers on the plants collected by Skutch are not resupinate, and it is highly probable that this condition is to be explained by the stems having been pendent rather than erect.

Costa Rica: Comarca de Puntarenas, near Boruca. In a forest, at 450 meters altitude. February, 1891. *H. Pittier 3855.* (Type in Herb. Mus. Bot. Berol. Duplicate type in U. S. Nat. Herb.): Province of San José, vicinity of El General. On trees, at 880 meters altitude. Flowers cream. January, 1936. *Alexander F. Skutch 2484.*

A NEW MACROSTACHYA FROM THE CARBONIFEROUS OF ILLINOIS

BY

WILLIAM C. DARRAH

ALTHOUGH an extensive literature concerning calamarian cones has been developed during the past fifty years, only meager information about *Macrostachya* is available. Well-preserved specimens of cones of fossil plants are rather rare, and frequently the fragmentary nature of larger forms makes investigation difficult. *Macrostachya* belongs to articulated plants remotely related to living Equisetales.

The specimen described in this study was collected in the strippings of the Wilmington mines, Will County, Illinois. These coal workings are an extension of the "Mazon Creek" beds. The specimens occur in typical iron-stone nodules. Mr. Frederick O. Thompson, the collector and donor, has presented his extensive collections to the Botanical Museum of Harvard University. Mr. Thompson has succeeded in gathering 11,000 specimens from Will County, and although calamarian cones are relatively common only two are referable to *Macrostachya*.

The complete specimen, number 15602, was first studied in the round, and then investigated by the "peel" method.

This peel method may be described briefly. The surface of the specimen is washed carefully with water and then is etched with a two percent solution of hydrochloric acid. Following the application of acid, the surface is again washed with water in order to remove excess acid and salts in solution. After the specimen is dry, a solution of nitrocellulose in butyl acetate is poured over the etched surface. Within six hours the nitrocellulose hard-

ens into a tough, pliable, permanent, transparent film. This film or "peel" is peeled away from the specimen. The dried peel contains a replica of the cellular detail which is composed of black or brown carbon from the original cellulose. Desired portions are mounted, unstained in the usual cytological method, with balsam in xylol. Such preparations may be studied with a magnification up to 1000 diameters.

Numerous peels can be made on a single specimen without destroying the specimen itself. In this study eight peels were made from the holotype.

In general practice all macrostachyan cones of large size and compact whorls are identified with *Macrostachya infundibuliformis* (Brongniart) Schimper. The species is not only poorly defined, but also so broadly interpreted that several different species are included in it. Despite this confusion it was evident at once that the specimens from Illinois were distinct. The whorls contain 30 to 36 sterile bracts, whereas *Macrostachya infundibuliformis* contains only 20. In addition, the sporangia contain large isospores, whereas *M. infundibuliformis* is believed to be heterosporous. There are other specific differences such as the shape of the bracts and the proportions of the cone. There is no reason for the establishment of a new generic designation.

MACROSTACHYA *Schimper*

Traité de Paleontologie végétale vol. 1. p. 332. 1869.

Macrostachya Thompsonii *Darrah sp. nov.*

Cone large, 210 mm. long; whorls 5–7 mm. apart, except at apex where they are compact; each whorl is composed of 30–36 bracts; there are 50–53 whorls; each bract is mucronate with 1, 2, and even 3 teeth. Sporangia are borne as in *Calamostachys*. The plant is isospo-

rous; the large spores measure 350–400 μ. in diameter; usually collapsed; smaller, undernourished spores occasionally present. Shape of the cone elongate, expanding from a pedicle 6 mm. wide, gradually to 30 mm. in the middle third, continuing until near the apex where it tapers suddenly to a rounded summit.

I have the honor to name this specimen *Macrostachya Thompsonii* in recognition of Mr. Thompson's continued interest in paleobotany and his generosity to the Botanical Museum of Harvard University.

Lesquereux believed that *Macrostachya infundibuliformis* occurs in the Mazon Creek flora. His specimen is a poorly preserved *Macrostachya Thompsonii*. Lesquereux[1] figured a specimen from Cannelton, Beaver County, Pennsylvania as *M. infundibuliformis*. It differs from Brongniart's[2] species but falls within the concept of Schimper[3]. It is probably an unnamed species. Nothing is known of its internal structure, so that a new name would not help the problem. Lesquereux also united with Schimper's *M. infundibuliformis*, *Asterophyllites tuberculata* Lesquereux[4], and *Asterophyllites aperta* Lesquereux[5]. Both of these species are probably valid.

The most comprehensive discussion of *Macrostachya*, especially *M. infundibuliformis* is to be found in the monograph on Steinkohlen-Calamarien by Weiss[6]. Figure 1 on plate VI is frequently copied by paleobotanists (Gothan[7], Scott[8]) and is considered to be the "typical" form

[1] Lesquereux: Coal Flora, p. 60. pl. 13. f. 17. 1879.
[2] Brongniart: Histoire Vég., foss. p. 119. pl. 12. f. 14–16. 1828.
[3] Schimper: Paleontologie Végétale, v. 1. p. 333. 1869.
[4] Lesquereux: Geol. Penna., p. 852. 1858.
[5] Lesquereux: Geol. Penna., p. 852. pl. 1. f. 4. 1858.
[6] Weiss: Steink. Calam., p. 71. pl. 6. f. 1–4. 1876.
[7] Gothan: Leitfossilien III, p. 117. f. 102. 1923.
[8] Scott: Studies, 3rd. Ed., v. 1. p. 65. f. 33. 1920.

of the species. On plate XVIII, figures 1, 3, and 4, Weiss illustrates a slender, lax variety called *Solmsii*. However, its reference to *Macrostachya infundibuliformis*, even as a variety is rather dubious. Certainly the robust *Macrostachya Thompsonii* with its thickened bracts is distinct.

Bischoff[9] figured a poor specimen from Bronn's collection under the name of *Equisetum infundibuliforme*. It is not referable to *Macrostachya infundibuliformis*. In the collections of the Botanical Museum, there are three specimens from Bronn's collection (number 10432). They are the type specimens.

Their identity is authenticated by the following data on Bronn's original label:

> Equisetum infundibuliforme *Bronn et Bischoff* 1827
> Steinkohlengebirge, St. Ingbert's.

As Weiss[10] suggested they belong to *Cingularia typica* Weiss. Incidently in a foot-note (loc. cit. p. 93) he says "Das Original soll mit der Bronnschen Sammlung nach dem Tode des Besitzers nach Amerika gewandert sein." Bronn's collection was purchased by Harvard University in 1859.

Brongniart[11] published a description of *Macrostachya infundibuliformis* under the name of *Equisetum infundibuliforme*. He extended Bronn's concept to include what subsequently became known as the "typical" plant. Brongniart's memoirs were widely used, while Bischoff's paper escaped the notice of most paleobotanists. Thus Brongniart's *E. infundibuliformis* is conserved, although Bronn's species has priority. Thus the correct designa-

[9] Bischoff: Krypt. Gewächse, p. 52. pl. 6. f. 4. 1828.
[10] Weiss: Steink. Calam., 1876.
[11] Brongniart: Hist. Vég. foss., p. 119. pl. 12. f. 14–16. 1828. f. 14 is a copy of Bronn's type.

tion is *Macrostachya infundibuliformis* (Brongniart, non Bronn) Schimper.

The identity of *Macrostachya infundibuliformis* is further complicated by the dual interpretation of Renault[12]. Renault figured an elongate strobilus with a typical incurved pedicle (pl. 18. fig. 2) but the detail is too poor to show any structure. He also figured and described (pl. 19. fig. 6, 7, 8) a specimen from Autun, France as *Macrostachya infundibuliformis?*. This specimen was silicified and suitable for the grinding of thin sections. From rather poor preparations he deduced that the verticils were composed of 20 bracts which are distantly placed—as much as 5 mm.—and that numerous large "macrospores" were present. Renault also included in this species numerous impressions from Permian and Upper Carboniferous deposits. There is little evidence to demonstrate that Renault's figured specimens were identical.

Renault[13] also studied carbonized cones of a *Macrostachya* found with *Calamites* stems in Autun. With unsatisfactory methods, he was able to show that the cone was heterosporous, with both microsporangia and megasporangia in the same strobilus. Renault's description and interpretation is not clear. *Calamostachys Binneyana*, although homosporous, sometimes shows abortive or undernourished spores, and may give the appearance or being heterosporous. *Calamostachys Casheana* on the other hand, is heterosporous, but even in this species the same abortion of spores occurs. A similar sacrifice of certain spores is to be observed in *Macrostachya Thompsonii.*

The occurrence of large spores in *Macrostachya Thompsonii* may indicate that the plant was heterosporous, but that the microsporangia and megasporangia

[12] Renault: Cours de Bot. foss., p. 121. 1882.
[13] Renault: Notice sur les Calamariées, pt. III. 1898.

were borne in separate cones. However, there is no evidence to support this possibility.

It will be observed that in many respects *Macrostachya Thompsonii* resembles the better-known genus *Calamostachys*. At the same time the gross appearance of the cone is very unlike the smaller, lax, not imbricated *Calamostachys*.

Huttonia spicata Sternberg[14] is in general form similar to *Macrostachya*. In its structure, however, it appears to be a typical *Palaeostachya*[15]. The resemblance of *Macrostachya* to structural plans known under other generic names, may indicate that *Macrostachya* is an unnatural group of large cones of which no structure is known. In this case, as soon as internal anatomy is known, the several species would be transferred to either *Calamostachys* or *Palaeostachya*. This is probably an extreme view which cannot be defended.

In the recent discussions of the phylogeny of the sphenopsids or articulates (Browne[16], Zimmerman[17]) no mention is made of *Macrostachya*. It will be seen from the foregoing account that *Macrostachya* in no way alters the conventional interpretations concerning the calamarian cone.

At this time it is not possible to determine the parent-plant of *Macrostachya Thompsonii*. Among the Mazon Creek plants there are many detached parts of *Calamites*. All of the calamarian cones (*Macrostachya, Calamostachys, Palaeostachya, Cingularia*) are borne by *Calamites*. The following "species" are known from the Mazon Creek flora:

[14] Hirmer: Handbuch, p. 455. 1927.
[15] Jongmans: Anleitung Bestimmung Karbonpflanzen, p. 354. 1911.
[16] Browne: Ann. Bot., v. 41. p. 301-320. 1926.
[17] Zimmermann: Phylogenie der Pflanzen, 1930.

EXPLANATION OF THE ILLUSTRATION

MACROSTACHYA THOMPSONII *Darrah*. Heliotype reproduction from a photograph of the type specimen, three fourths natural size. Number 15602 Botanical Museum Collection.

EXPLANATION OF THE ILLUSTRATIONS

MACROSTACHYA THOMPSONII *Darrah*. Figure at upper left. Heliotype reproduction of a photograph of a nitrocellulose peel from the reverse half of the type specimen, showing central axis and sterile bracts in longitudinal section at top, and numerous sporangia in the middle region. One half natural size.

Figure at lower right. Heliotype reproduction from a photomicrograph of a nitrocellulose peel from the type specimen, showing two sterile bracts and the remnants of a sporangium. Magnified 44 times.

Stems	*Foliage*	*Cones*
Calamites Suckowii	Annularia stellata	Macrostachya Thompsonii
C. carinatus	A. radiata	Calamostachys Solmsii
C. ramosus	A. sphenophylloides	C. magna
	Asterophyllites equisetiformis	C. germanica
		Palaeostachya sp.

In other words, there are three "species" of stems, four of foliage, and five of cones. The various "generic" designations indicated above are form-genera. In the study of fossil plants, the paleobotanist has to contend with fragmentary and detached specimens. Hence a cone will receive generic and specific names, as will a stem and a leaf-whorl. Ultimately the discovery of a more complete specimen may bring together these various parts under one "biological species." This may seem confusing, but in practice it has been useful and simple. The foliage of *Macrostachya Thompsonii* is an *Annularia*, because the *Asterophyllites* leaves from Mazon Creek belong to a *Calamostachys*, probably *C. magna*. The second specimen of *Macrostachya Thompsonii* (number 15608) is accompanied in organic attachment with a poorly preserved, slightly modified, *Annularia*—probably Jongman's *Annularia stellata americana*.[18]

The species here named *Macrostachya Thompsonii* is known only from the environs of Mazon Creek in Will and Grundy Counties, Illinois. It is distinct from other *Macrostochya* cones collected at Cannelton, Beaver County, Pennsylvania. The geologic age of these forms is Upper Carboniferous, Allegheny Series, Kittanning formation.

I wish to acknowledge my gratitude to Lady Isabel Browne, Professor Walter Gothan, and Professor W.J. Jongmans for their generosity in presenting to me various publications relating to this study.

[18] Jongmans and Gothan: Geol. Bur. Heerlen Jaarverslag 1933, p.36.

A RARE EPIDENDRUM FROM COSTA RICA

BY

OAKES AMES

THE IDENTITY of *Epidendrum incomptum* Reichb.f. remained obscure for many years following its publication in 1852, because in 1889 the Warscewicz type from Panama was sealed up in the Reichenbach Herbarium and remained inaccessible until 1914. Prior to 1914, the only available specimen on which to form a conception of the species was the Godman and Salvin plant collected in 1862 at Cobán in Guatemala, and preserved in the Kew Herbarium. This specimen was tentatively determined by Reichenbach as probably being referable to *E. incomptum*. The original description, aside from comparing the species with *E. arbuscula* Lindl., failed to clarify it sufficiently. We now know that *E. incomptum* is a native of Guatemala, Costa Rica and Panama, characterized by extreme rarity and sparse distribution.

Epidendrum incomptum *Reichenbach filius* in Bot. Zeit. 10 (Oct. 15, 1852) 733;—Lindley Fol. Orch. Epid. (1853) p. 87—Reichenbach filius in Walp. Ann. 6 (1862) 410; Beitr. Orch. Centr.-Am. (1866) 38—Hemsley in Gard. Chron. n.s., 11 (1879) 367; in Godman & Salvin Biol. Centr.-Am. Bot. 3 (1883) 232—Pittier in Anal. Mus. Nac. Costa Rica 1 (1887) 75—Schlechter in Beihefte Bot. Centralbl. 36, Abt. 2 (1918) 463—Ames, Hubbard & Schweinfurth Genus Epidendrum (1936) 108.

Plants much branched; conspicuously sheathed, with two to three approximate, alternate leaves on the upper part of each branch; floriferous branches 3–35 cm. long. Leaves oblong-elliptic, 8.5–12.5 cm. long, 2.5–3.2 cm. wide. Racemes terminal, lax, 4–15 cm. long, bearing from three to twenty distichously arranged, fleshy, green-

ish flowers. Lateral sepals acinaciform, 1.3 cm. long, 6 mm. wide. Upper sepal lanceolate, 1.2 cm. long, 4.5 mm. wide above the middle. Petals narrowly spathulate, 11.5 mm. long, about 1.5 mm. wide. Labellum adnate to the column, about 1.5 cm. long, free portion 7–8 mm. long, 1.3 cm. wide, about equally three-lobed with the lateral lobes divaricate, rounded; mid-lobe triangular, acute, sharply deflexed at the apex; ecallose or faintly verruculose on the mid-nerve. Column 9–11 mm. long; anther fleshy, 2-celled (each cell divided by a septum), minutely glandular-fringed in front; pollinia four, complanate.

GUATEMALA: Department of Alta Verapaz, Cobán, 1862. *Godman & Salvin 410.*

COSTA RICA: Province of Cartago, La Estrella de Cartago. Raceme pendent; flowers succulent, livid green, the lip faintly tinged with purple as is the tip of the column. 1923. *C. H. Lankester 425*: Province of San José, in the vicinity of El General, at 880 meters altitude. Flowers green; on tree over river. January 1936. *Alexander F. Skutch 2431.*

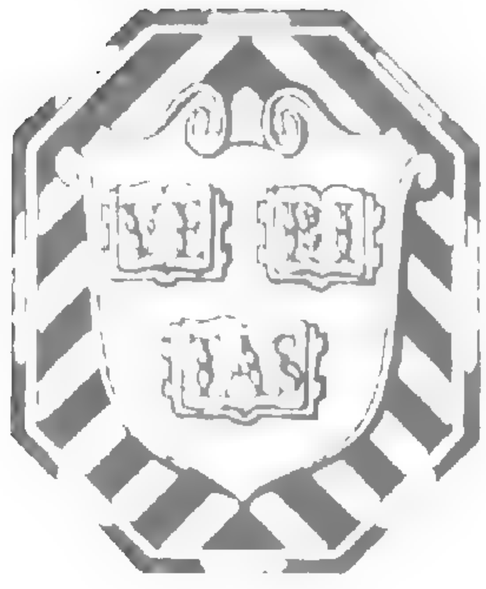
PANAMA: Department of Veragua, "on Mt. Chiriqui." *Warscewicz s.n.*

EXPLANATION OF THE ILLUSTRATION

EPIDENDRUM INCOMPTUM *Reichb.f.* Plant, one half natural size, drawn from *Skutch 2431*. 1, flower, enlarged. 2, column and labellum, enlarged. Figures 1 and 2 drawn, with the aid of the camera lucida, from specimens preserved in alcohol.

Drawn in August 1936 by BLANCHE AMES

EPIDENDRUM *incomptum Reichb. f.*



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THE PEEL METHOD IN PALEOBOTANY

BY
WILLIAM C. DARRAH

THE peel method of making microscopic preparations has become popular in many paleontological laboratories since its development ten years ago. The possibilities of diverse applications of the method have not been realized, because it has been primarily used in the study of coal-balls. Coal-balls are fossil-bearing dolomitic nodules found in association with a small number of coal beds. Professor Walton[1] devised a method of making serial sections for English coal-balls. Professor Leclercq[2] has been using the Walton method with excellent results on Belgian coal-balls. Doctor Roy Graham[3] made certain modifications in order to adapt it to Illinois coal-balls. Other investigators[4] have used Graham's procedure for calcified animal remains.

By this method successive films of nitrocellulose are peeled from a smoothed surface of a petrifaction. The fossil must first be attacked by an acid in order to remove the rock matrix and cause the carbonized cell walls to stand out in relief. Then a solution similar to collodion

[1] C. R. Congress Adv. Strat. Carb. Heerlen, pp. 749-754.
[2] Ann. Soc. Geol. Belg., vol. 52.
[3] Stain Technology, vol. 8:65-68.
[4] Am. Midl. Nat., vol. 16:410-412.

is poured over the "etched" surface and permitted to dry. The dried film is carefully peeled off. The procedure may be repeated many times.

In addition to this method of making multiple peels from one specimen, paleobotanists, since the time of Nathorst, have "transferred" various types of carbonizations and incrustations. Walton[5] has fully described this method. The thin, but nevertheless three-dimensional fossil is cemented to a glass slide with collodion or balsam. Then the glass slide is covered completely with paraffin. Finally the specimen is placed in a container of hydrofluoric or nitric acid and allowed to remain in the acid until all mineral has been removed. Obviously this process is very slow.

For the past five years various experiments have been made with the result that these two types of work can be done with one simple, time-saving technique. Improved solutions have been developed to aid in the preparation of satisfactory peels.

The possibilities of microtechnique in paleobotany have not been recognized, or even admitted by many botanists and geologists. Nevertheless, the trained paleobotanist can obtain through microtechnique the maximum available information from any specimen with preserved structure. Even the simple carbonized impression, long considered worthless as a source of biological data, may be studied without difficulty by the peel method.

The complete process of making a nitrocellulose peel involves a number of steps. These are in order: grinding, etching, drying, smearing, peeling, and care of peels.

Grinding. Any petrified specimen in which chemical replacement has occurred may be studied by the preparation of multiple peels (or serial-sections). It is necessary

[5] loc. cit.

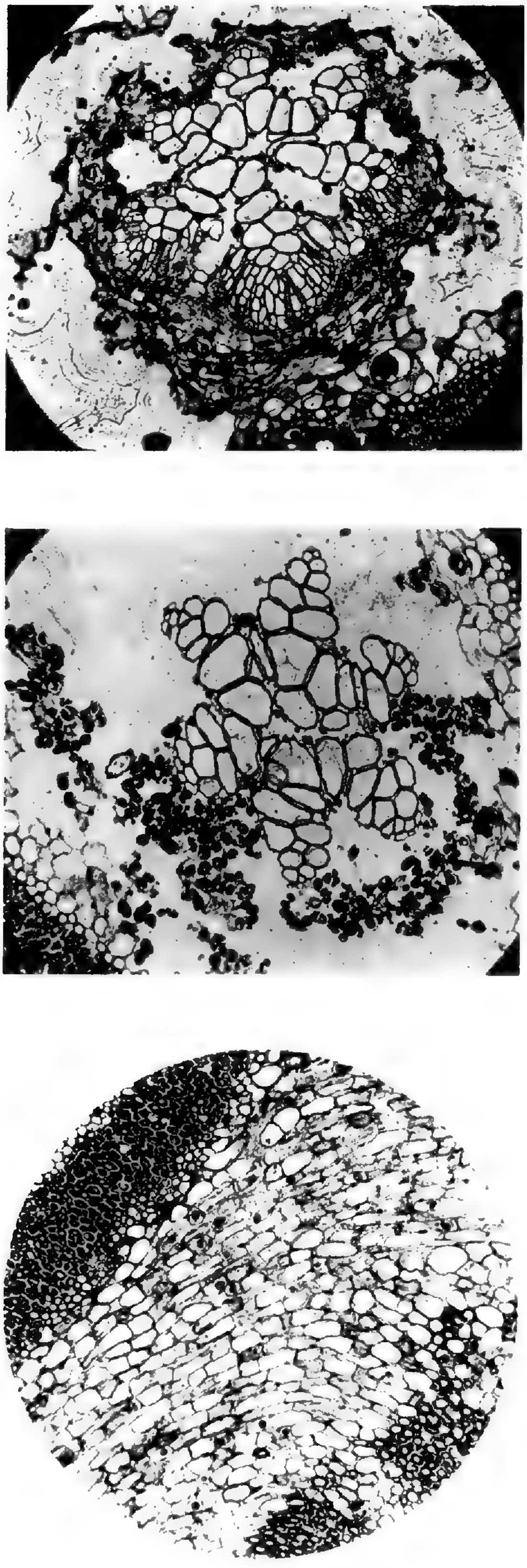
to grind a series of smooth surfaces at pre-determined intervals. It is possible to make from 250 to 500 peels per inch although such frequency is rarely desirable. The actual amount of fossil in the peel is from one to three micra in thickness. In order to guarantee uniform intervals between peels, the specimen must be calibrated. Small or fragile specimens should first be imbedded in plaster or Wood's metal. The latter is excellent but, unfortunately, expensive since several pounds are needed to imbed even a small specimen. The actual grinding is done with a fine or medium carborundum powder. Number 320 will do, 600 is better, and any size intermediate will give good results. Although grinding may be done by hand, a revolving lap is highly recommended for exact work. The abrasive powder is placed upon the lap and then moistened with water. The lap is set in motion (or the specimen is rotated by hand in one direction only) and the surface is smoothed and ground to the desired distance. The lap must be continuously moistened. If abrasive powders of different fineness are used, coarse should not be permitted to contaminate fine, otherwise deep scratches will mar both the smoothed surface and the lap surface.

Etching. Etching is the process by which the rock matrix is removed, with acid, from the carbonized structure. It is this process which may lead to success or failure, because careless etching destroys the cellular detail and frays the outline of the cell walls. It is necessary to use not only different kinds of acids but also different concentrations. Ordinary calcified specimens may be etched with a 1% solution of hydrochloric acid for 30 seconds. Dolomitic specimens which contain magnesium carbonate may require a 10% solution for one minute.

Silicified specimens must be etched with commercial hydrofluoric acid (49%) for three minutes, although sub-

EXPLANATION OF THE ILLUSTRATIONS

PSARONIUS *sp. nov.* Heliotype reproductions of photographs of nitrocellulose peels from a silicified stem. Figure at top shows the stele of a cortical root with some secondary activity. Middle figure shows a typical root with well preserved cell-walls. Lower figure shows sclerenchymatous tissue between roots. Magnified 44 times. Carboniferous: Illinois.



sequent peels may be made with a 25% solution acting for two minutes. The first etching frequently makes the specimen more susceptible to subsequent attacks.

Partially silicified specimens may be etched the first time with 25% hydrofluoric acid and thereafter by 10% hydrochloric acid for two minutes.

Hydrofluoric acid must be used with great caution because of its dangerous corrosive action, especially on the mucous membranes and on the fingernails.

Coals require special softening treatment before they can be etched. This will be discussed later.

Etching is a trial and error process. All kinds of petrifaction occur and frequent trials may be necessary before a suitable concentration is secured. Under ordinary circumstances the etched surface is carefully washed with running water in order to remove excess acid.

Drying. The etched specimen must be air-dried in a dust-free place. If one is making a number of peels, it is frequently helpful on a humid day, to set in motion an air current by means of a small electric fan. After the specimen has thoroughly dried, it is placed in a level position on plastilene bases or in a sand-box.

Smearing. The etched surface must be carefully covered with a nitrocellulose solution. The solution can be applied by two means: it may be poured gradually over the surface by a continuous slow flow from a bottle, or it may be smeared by drawing a glass stirring rod over the specimen. We pour the solution, because fewer air bubbles form on the surface. Bubbles may be punctured with a dissecting needle or removed with a scalpel. If, upon drying, the film is too thin to allow removal, additional solution may be poured on the surface and then permitted to dry.

Various kinds of solutions have been used by individual investigators. The following formula will give good

results on any type of specimen. It gives a durable, pliable, transparent film which will not "yellow" or harden with age. The consistency is viscous enough to minimize the occurrence of air bubbles.

Parlodion (Mallinckrodt) . . .	28 grams
Butyl Acetate (commercial) . .	250 cc.
Amyl Alcohol	30 cc.
Xylol (or Toluene)	10 cc.
Castor Oil	3 cc.
Ether	3 cc.

The solution should be allowed to stand a week before being used.

Parlodion is rather expensive, but the results are much superior to those obtained by guncottons (commercial nitrocellulose). We have compared a large series of nitrocellulose substances in our experiments. The majority showed a definite tendency to "yellow" and "brittle."

Chloroform may be substituted for ether. This is added to hasten hardening along the edges of the film. Castor oil makes the film pliable. Amyl acetate can be used as a substitute for butyl acetate, and in this case no amyl alcohol is needed.

Peeling. The solution dries slowly and will not be ready for removal for six or eight hours. Peels with a surface greater than 9 square inches will not dry in less than 12 hours. The surface of the specimen is "peeled" with the film, by first loosening one edge, and then carefully pulling off the whole film. We have prepared peels up to the size of eighty square inches, and such peels possess a uniform thickness and toughness. A thoroughly dried film will not wrinkle or curl after removal.

Care of Peels. Some workers prefer to file the peels in envelopes or folders. No special care is really necessary. However, one cannot subject an unmounted peel

to high magnification, and its great usefulness is not realized. With a low-power binocular microscope, one can select desirable portions of a peel for permanent mounting. Such portions are cut out and trimmed with a sharp scissors and are mounted in balsam-''damar'' (in xylol) on a glass slide of good quality (specifically, ''non-corrosive''). The peel should be covered with a number one cover-slip and weighted with a small lead block until absolutely dry. These permanent mounts are frequently capable of being magnified from 1000 to 1200 times, and 440 is average.

Occasionally so little carbon is preserved, that the peel shows only cell outline. Such a peel may be stained with any of the common biological or petrological stains, such as Light Green, Saffranin, Erosin, or Nigrosene. One is surprised to learn that it is sufficient to immerse the peel in a 2% aqueous solution of stain, and then wash out the excess dye.

The peel has tremendous advantages over the ground-section because it is thinner, more translucent, less costly and quicker to make. The peel from an incrustation or carbonization is a new departure in paleobotany and has not been reported previously.

The methods thus far described are primarily adapted to calcareous, dolomitic, and silicified specimens. We have had success with the following materials, and thus far have not experienced any failures:

Coal-balls = England, Belgium, Holland, United States.

Calcareous petrifactions = Pennsylvania, New York, England, France.

Silicified petrifactions = Rhynie (Scotland), Grand Croix (France), Psaronius from Ohio, Saxony, Illinois.

Coniferous woods from New Mexico, England,

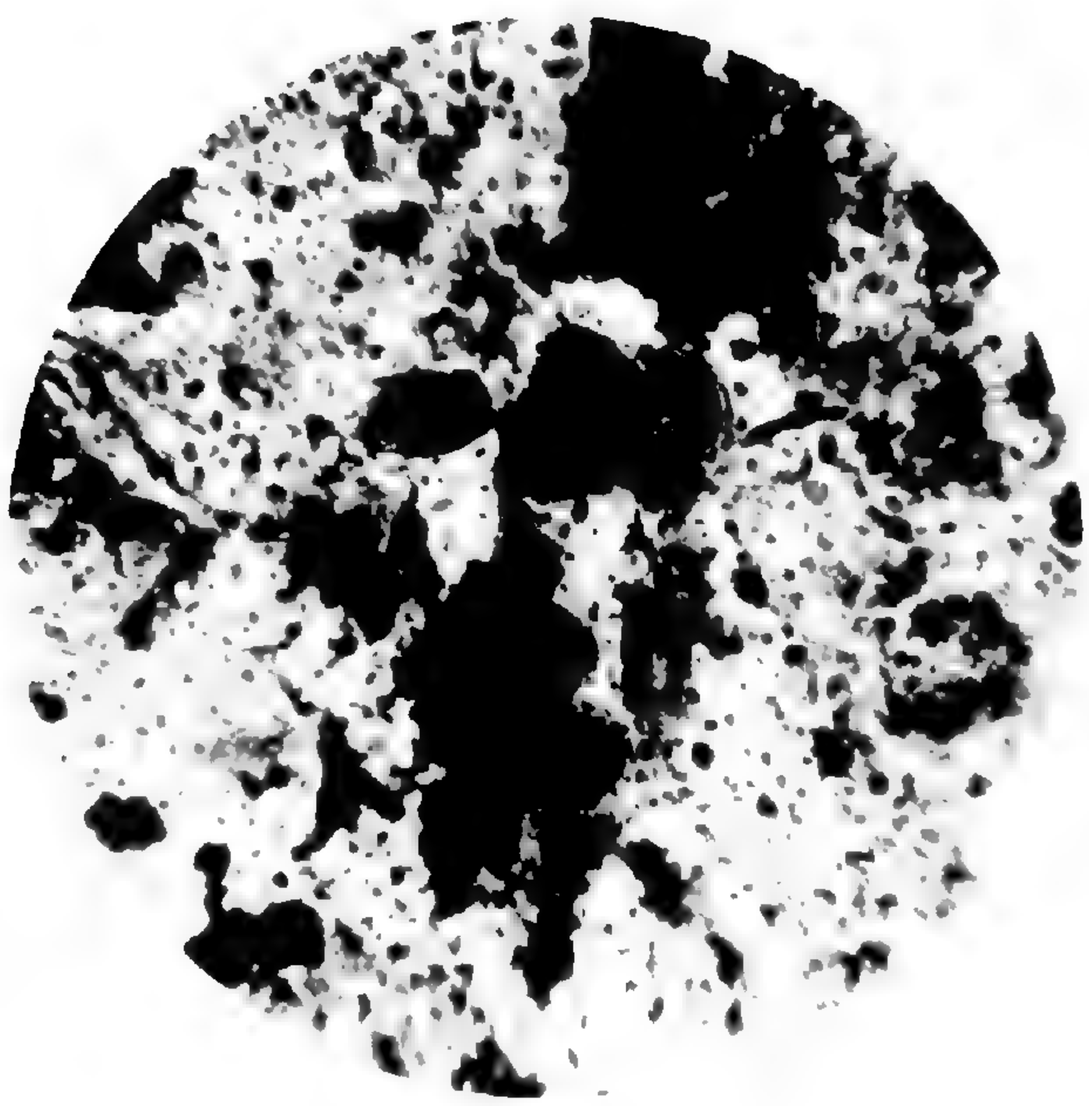
EXPLANATION OF THE ILLUSTRATIONS

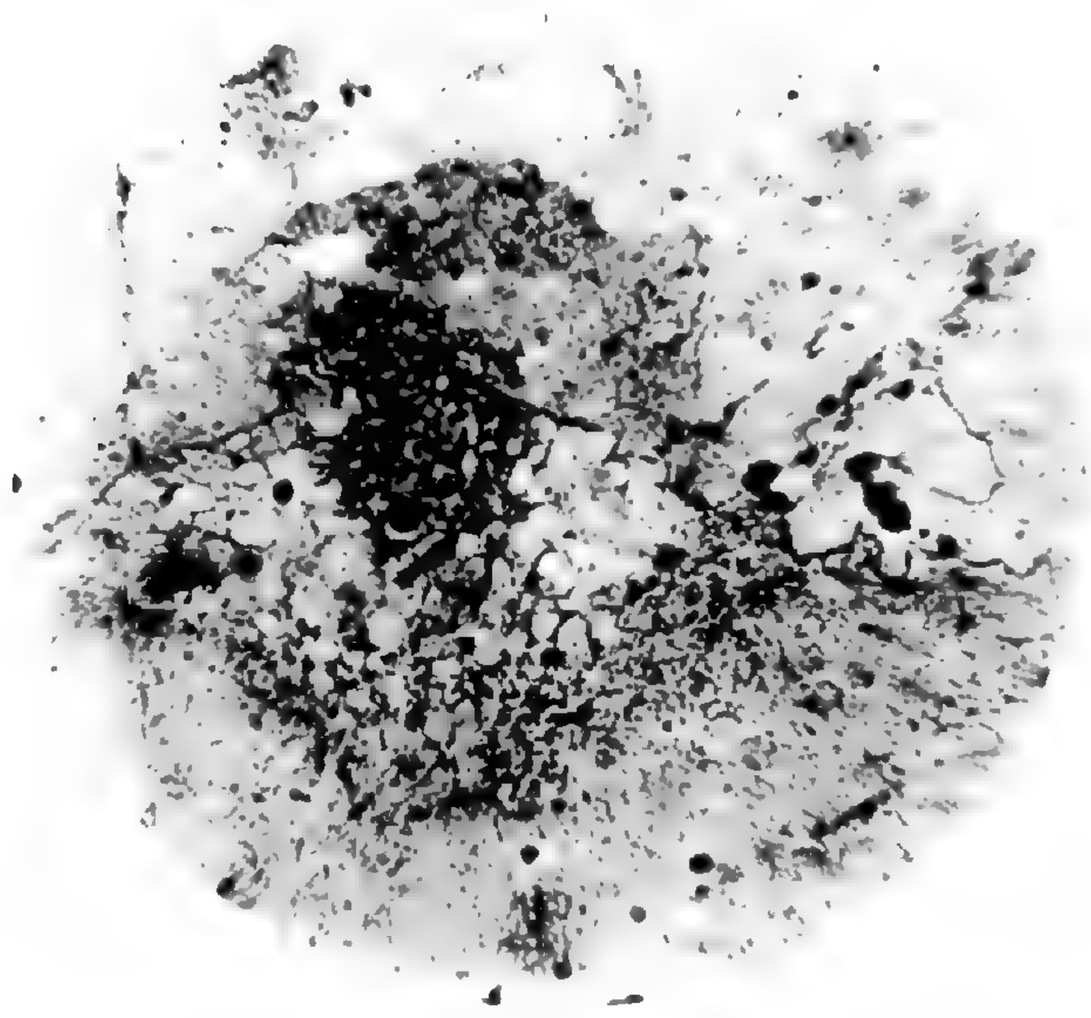
Figure at upper left. CODONOTHECA CADUCA *Sellards*. The cluster of carbonized spores has been peeled from an incrustation. Magnified 44 times. Carboniferous: Mazon Creek, Illinois. Thompson Collection.

Figure at upper right. CROSSOTHECA SAGITTATA (*Lesquereux*) *Sellards*. This peel shows a mass of spores from a carbonization. Magnified 60 times. Carboniferous: Mazon Creek, Illinois. Thompson Collection.

Figure at lower left. CORDAIANTHUS sp. The peel shows the longitudinal section through a female "flower" with sterile bracts at the base. Magnified 24 times. Carboniferous: Mazon Creek, Illinois. Thompson Collection.

Figure at lower right. PALEOMYCES sp. This peel taken from a necrotic area in a silicified stem in *Rhynia major* Kidston and Lang shows the diseased tissue and several small spores around the periphery in the "gelatinous" sheath. Magnified 60 times. Devonian: Rhynie, Scotland.





Ohio, Germany.
Nematophyton from Canada.
Carbonized impressions = Mazon Creek (Illinois), Pennsylvania, Holland, England, France, Germany, Switzerland.
Bituminous coal = Pennsylvania, Ohio, Antarctic.
Anthracite coals = Pennsylvania.

Peeling the Carbonization. This procedure is based upon the schedules used for four types of specimens: a Carboniferous calamite cone (*Macrostachya Thompsonii* Darrah) with spores, sporangia, and sporangiophores, all preserved; a Carboniferous fern fructification (*Crossotheca sagittata* (Lesquereux) Sellards) showing spores in place; a Triassic cycadean frond from which was obtained cuticles with the stomata preserved; and a Miocene leaf with basidiomycete decay spots. Before the specimen is etched, it is necessary to lay bare the sporangia with a fine chisel and a jeweler's hammer.

On a carbonization or incrustation the surface to be etched is *more or less* even. The acid solution (usually 1% to 5% hydrochloric) is carefully applied and the excess removed with water. After the specimen dries, nitrocellulose solution is poured over the surface. If the specimen is very uneven, it may be desirable to build up the peel by several layers of solution. The dried peel, after removal, should be flattened under a weight in a warm-chamber of 140° F. for an hour.

There is scarcely a limit to which this peel method may be applied in paleobotany—provided that cellular structure is preserved and that the rock can be etched or attacked with an acid. Graphitized impressions can be removed from slate, but the cell structure has been destroyed during metamorphism.

Coal. We have had some success with coal. Although improvements must and will be made, it is of

use to indicate what can be done in the study of higher rank coals. Coal by nature is a flattened mass of carbonized plant debris with a comparatively small amount of mineral in the form of ash. Coal may be studied microscopically by four methods: the ground section with transmitted light; the polished surface by reflected light (Duparque, Koopmans); the imbedded, softened, demineralized, microtome section (Jeffrey[6]); and now the nitrocellulose peel. The most superior of these is the microtome method, especially good for lignitic, bituminous, and cannel coals, but not yet adapted to anthracites. Neither the polished nor the ground section can be greatly magnified. The peel method is the only fairly quick method available, and the only method applicable to the study of anthracites.

The coal specimen must be ground smooth on the surface to be peeled. This surface must be demineralized (on the surface only) by Schultze's macerating fluid at a temperature of 180° F. This surface is washed with water and covered with a 20% solution of potassium hydroxide in alcohol. After washing again it is bathed with a 25% solution of phenol and chromic acid. With anthracite coal a 25% solution of hydrofluoric acid is used instead of chromic acid. After a thorough washing with water, the coal is dried and smeared with nitrocellulose solution.

Somewhat better peels have been made on anthracites than on bituminous coals.

It is also well to record two difficulties encountered in the nitrocellulose techniques. One is shrinkage of the peel which takes place during drying, and which is caused by the evaporation of volatile materials in the solution. This shrinkage is partially overcome by slow drying. It

[6] Sci. Conspectus, vol. 6: 71-76.

is also lessened by leaving the dry peel on the specimen as long as possible—even two days is not too long. The shrinkage of a peel 50 millimeters long is approximately 2 millimeters if drying has taken less than 12 hours. The other difficulty has been indicated before, that is the development of air-bubbles. This is chiefly overcome by mixing a slow-drying solution with Parlodion, such as that recommended, and by thoroughly drying the specimen before applying the nitrocellulose solution. It is sometimes helpful to moisten the surface with butyl acetate. Collodion and similar substances invariably develop many small bubbles, because of their rapid drying nature.

In addition to these purely paleobotanical uses of the peel technique, there are many interesting applications in other fields of work. We have tried similar methods on recent and fossil animals with calcareous parts and on anthropological material such as carbonized grains and sun-dried bricks. Some petrographic observations can be readily made with the peel technique.

To my wife, Helen Hilsman Darrah, I wish to extend thanks and to acknowledge her part in the development of various phases of this nitrocellulose peel technique.

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THE NOMENCLATORIAL STATUS OF SPIRANTHES SINENSIS

BY

F. TRACY HUBBARD

IN 1919, Professor E. D. Merrill, in the Philippine Journal of Science 15 (1919) 230, adopted the combination *Spiranthes aristotelia* (Raeusch.) Merrill in place of *Spiranthes sinensis* (Pers.) Ames. Furthermore, in 1935, in the Transactions of the American Philosophical Society n.s. 24, pt. 2 (1935) 122, he commented on the validity of this combination. Was he justified in adopting this new combination?

The earliest post-Linnean name applied to this species is *Ophrys spiralis* Georgi Bemerk. Reise Russ. Reich 1 (1775) 232, *non Linnaeus*. The specific epithet, however, is not available for two reasons, first because of the earlier *Ophrys spiralis* L. (1753) and second because of the already existing *Spiranthes spiralis* C. Koch (1849).

The second name given to the species is *Aristotelea spiralis* Loureiro Fl. cochinch. 2 (1790) 522; ed. Willd. 2 (1793) 638. The generic name is not available because of the earlier *Aristotelia* L'Hérit. (1784) and the specific epithet is not tenable on account of the combination *Spiranthes spiralis* C. Koch (1849).

The third name used was *Epidendrum Aristotelia* Raeuschel Nomencl. Bot., ed. 3 (1797) 265. The status of this combination upon which Professor Merrill based

his combination *Spiranthes aristotelia* seems open to considerable question. As published by Raeuschel it reads:

EPIDENDRUM

Aristotelia. Canto Sinar.

In a footnote the following statement is made: "Hanc [Aërides], et sex praecedentes species Celeb. Loureirus propriis generibus adscripsit: videntur vero omnia ad Linei Epidendra pertinere, hancque ob causam huic generi interim inserere, quam nova et incerta genera proponere malui."

There appear to be two reasons why the combination of Raeuschel must be considered as not in good standing. First, because according to the International Rules (Art. 44 (2)) a species is not validly published unless accompanied "by the citation of a previously and effectively published description of the group under another name;..." That this article is complied with by Raeuschel is, in the writer's opinion, open to grave doubt. No direct citation of previous publication is given and the name-bringing synonym is lacking. The only possible clue to its previous description is by inference through the footnote quoted above, which states that Loureiro in some undesignated publication described it as a separate and distinct genus.

Some botanists contend that the fact that Raeuschel's footnote states that Loureiro treated these species as genera is sufficient citation of previous publication and that it is not necessary to state where or under what name the plant was treated. Furthermore, they affirm that naturally the mention of Loureiro must be taken as a reference to his most important work, "Flora cochinchinensis."

Why should a seeker after facts be obliged to infer; why should he be required to guess what an obscure note

implies? Certainly this practice does not tend to place the proper stress upon clarity and accuracy and should be discouraged. Such halfway citation as is employed by Raeuschel seems to be far from the spirit of Article 44, and I believe that the partial reference contained in the footnote is too vague to remove Raeuschel's combination from the *nomen* category.

The second, and perhaps more weighty, reason against the use of the combination is the specific epithet *Aristotelia* used by Raeuschel. According to Art. 54 of the International Rules: "When a species is transferred to another genus (or placed under another generic name for the same genus), without change of rank, the specific epithet must be retained or (if it has not been retained) must be re-established, unless one of the following obstacles exists: (1) that the resulting binary name is a later homonym (Art. 61) or a tautonym (Art. 68, 3), (2) that there is available an earlier validly published specific epithet." Following this rule, which is clearly made retroactive, Raeuschel was obligated to use *spiralis* as the specific epithet as no previous *Epidendrum spirale* existed. The fact that a later combination *Spiranthes spiralis* C. Koch invalidates the use of *spiralis* under Spiranthes carried no weight at the time of Raeuschel's publication. His combination is not a tautonym and there was available no "earlier validly published specific epithet." The fact that Raeuschel's epithet is illegitimate is made very clear by Art. 60 of the International Rules which states: "A name must be rejected if it is illegitimate (see Art. 2). The publication of an epithet in an illegitimate combination must not be taken into consideration for purposes of priority (see Art. 45). A name is illegitimate in the following cases. (1) If it was superfluous when published, i.e. if there was a valid name (see Art. 16) for the group to which it was applied, with its peculiar circumscription,

position and rank. (2) If it is a binary or ternary name published in contravention of Art. 16, 50, 52 or 54, i.e. if its author did not adopt the earliest legitimate epithet available for the group with its particular circumscription, position and rank.'' Raeuschel's procedure fails to comply with this Article since it creates a new specific epithet and ignores a valid epithet (*spiralis*). Hence his combination is illegitimate. Consequently Raeuschel's choice of *Aristotelia* as a specific epithet is contrary to Articles 54 and 60 and has no standing.

The fourth binary combination published was *Neottia spiralis* Willdenow Sp. Pl. 4 (1805) 74. The specific epithet is unavailable for two reasons: because the species proper is not the plant under consideration and because of the *Spiranthes spiralis* C. Koch.

The fifth name applied to the species was *Neottia sinensis* Persoon Syn. Pl. 2 (1807) 511. Persoon based his plant on *Aristotelia spiralis* Lour. and gave an adequate description. Professor Ames cited *Neottia sinensis* Pers. as the name-bringing synonym when he published his combination *Spiranthes sinensis* (Pers.) Ames Orch. 2 (1908) 53, and gave full synonymy. In this procedure he fully complied with the International Rules.

In summarizing, the oldest specific epithet *spiralis* is inadmissible because of the combination *Spiranthes spiralis* C. Koch and the next proposed specific epithet *Aristotelia* is considered of no standing for the reasons stated under the discussion of *Epidendrum Aristotelia* Raeuschel. Furthermore, in consequence of the extremely dubious status of *Aristotelia* as a specific epithet, it would be most unwise to displace a combination made strictly in accordance with the International Rules by one that is certainly at variance with the spirit of Article 44 and directly contrary to the fact as stated in Articles 54 and 60.

Consequently, in my judgment, the valid name of the species is **Spiranthes sinensis** (*Pers.*) *Ames.* For a nearly complete bibliography and synonymy of the species, confer Ames Orch. 2 (1908) 53 and Ames in Merrill Enum. Philip. Flow. Pls. 1 (1924) 268. Since the issue of this last publication, a few new synonyms, which have no bearing on the nomenclatorial status of the species, have been published.

NOMENCLATORIAL NOTES ON COSTA RICAN ORCHIDS

BY

CHARLES SCHWEINFURTH

Lepanthes Wercklei *Schlechter* in Fedde Repert. 10 (1912) 396.

Lepanthes apiculifera Schlechter in Fedde Repert. Beihefte 19 (1923) 177.

The descriptions supplemented by drawings (with floral analyses) of the type specimens made from Schlechter's drawings show that these concepts are identical. The single morphological discrepancy which we can discover between them lies in the petal which is shown and described as simple in *L. Wercklei* and bilobed (with a minute apicule-like lobe) in *L. apiculifera.* Such an inconspicuous character might easily be overlooked under any but the highest magnification, and in reality all the specimens which appear as *L. Wercklei* in our herbarium show a minute more or less rounded lobule anterior to the relatively large cuneate-obovate posterior lobe. There is no sharp lobule as attributed to *L. apiculifera.*

Furthermore, the petals frequently appear to be cellular-pubescent, unlike those described in the case of both species. Other variations from the description are seen in the leaves which rarely reach a length of 5.4 cm. or a width of 6 mm. and the stems which extend to 12 cm. in length.

Maxillaria nasuta *Reichenbach filius* Beitr. Orch. Centr.-Am. (1866) 104.

Maxillaria brevipedunculata Ames & Schweinfurth in Sched. Orch. 10 (1930) 91.

The recent acquisition of drawings of *M. nasuta* from the Reichenbachian herbarium indicate that this species

includes the concept *M. brevipedunculata.*

Maxillaria Reichenheimiana *Endres & Reichenbach filius* in Gard. Chron. 1871: 1678.

Maxillaria pachyacron Schlechter in Fedde Repert. 9 (1911) 165.

The recently acquired drawings showing the habit and floral analyses of *Maxillaria Reichenheimiana* from the Reichenbachian herbarium demonstrate clearly that this species includes the concept *Maxillaria pachyacron*, as represented by similar habit and floral drawings made under the supervision of Dr. Schlechter.

The only discrepancy in these concepts that we can discover is that the lip of *M. Reichenheimiana* bears some short filiform papillae surrounding the median callus. These papillae appear to be absent in *M. pachyacron* as well as in most of the numerous Costa Rican specimens which are referable to this species.

The size and proportions of the leaf seem to constitute a variable character. The extreme length of the leaf-blade in the many Costa Rican specimens examined appears to be about 13.6 cm., while the width of some of the elliptic-ligulate leaves is about 1.2 cm. Some blades are almost subsessile, while others have a petiole up to 3 cm. long. Furthermore, the mottling of the leaf, which is a characteristic of *M. Reichenheimiana*, appears to be absent from many dried specimens from Costa Rica which are undoubtedly referable to this species. Doubtless this maculate character is observable chiefly in living specimens, as the type of *M. Reichenheimiana* consisted of garden material and as this character has been noted by the collectors in some instances.

Maxillaria ringens *Reichenbach filius* in Walp. Ann. 6 (1863) 523.

Maxillaria Türckheimii Schlechter in Fedde Repert. 10 (1912) 295.
Maxillaria Rousseauae Schlechter in Beihefte Bot. Centralbl. 36, Abt. 2 (1918) 413.
Maxillaria pubilabia Schlechter in Fedde Repert. Beihefte 17 (1922) 71.
Maxillaria Amparoana Schlechter in Fedde Repert. Beihefte 19 (1923) 54.

Maxillaria ringens, which was described from a single inflorescence, is represented in our herbarium by a tracing of the sketch of this species from the Reichenbachian herbarium. While the type description cites the source as Oaxaca (*Karwinski*) and Guatemala (*Warscewicz*), the sketch is labeled "Costa Rica, No. 42." However, the drawing of the scape and floral analysis seem to coincide well with the description. The mid-lobe of the lip is shown as rhombic-ovate.

Maxillaria Türckheimii from Guatemala, of which we have a drawing of the type made under the supervision of Dr. Schlechter, appears to be identical with *M. ringens*. While the only possible comparison is confined to the inflorescence, the only discrepancies between these species seem to be the very slightly larger flowers of *M. Türckheimii* which is credited with an oblong rather than rhombic mid-lobe of the lip and an obtuse rather than acute callus. Of course, the latter character evidently varies with drying etc. *M. Türckheimii* is described as a caespitose plant with leaves 30–40 cm. long and 3.8–4.5 cm. wide.

Maxillaria Rousseauae from Panama, represented in our herbarium by a floral analysis of *Powell 115* (not the type) made under the supervision of Dr. Schlechter, varies from *M. Türckheimii* only in its somewhat smaller vegetative proportions (the leaf being 20–25 cm. long and 2.5–3 cm. wide) and in the mid-lobe of the lip which is

described as rhombic-broadly-oval and figured as broadly obovate.

Maxillaria pubilabia from Panama, of which we have a drawing of the type made under the supervision of Dr. Schlechter, has the large vegetative proportions of *M. Türckheimii*, but the flowers are even smaller than in *M. ringens*, the sepals being cited as 2.5 cm. long. While the sepals are described as rather obtuse, they are shown in the drawing as acute or subacute and are very similar to those of the foregoing concepts. The callus of the lip is shown as obtuse and the mid-lobe subquadrate-oval.

The Costa Rican *M. Amparoana*, which is represented in our collection by drawings from the type made at Berlin, is vegetatively very similar to *M. Türckheimii*, but with narrower leaves (up to only 2.8 cm. wide) and the floral bract about twice surpasses the ovary (as is represented in the analysis of *M. ringens*). The sepals appear to be about as long as in *M. ringens*, but the callus of the lip is shown as obtuse, and the mid-lobe as obovate.

A series of collections in our herbarium extending from Guatemala to Panama shows considerable variation in vegetative characters, in the size of the flowers, in the length and shape of the mid-lobe of the lip and in the degree of pubescence on the disc of the lip.

Other species which are allied to this concept are *Maxillaria Brenesii* Schltr. and *M. Powellii* Schltr.

Maxillaria vaginalis *Reichenbach filius* Beitr. Orch. Centr.-Am. (1866) 77.

Camaridium Wercklei Schlechter in Fedde Repert. Beihefte 19 (1923) 58.

A sketch of the type of *Maxillaria vaginalis* from the Reichenbachian herbarium shows what was undoubtedly a young shoot entirely invested by distichous imbricating equitant sheaths. It shows at the summit the apical por-

tion of a conduplicate leaf, but there is no indication of a pseudobulb. However, the presence of a leaf-blade indicates the existence of a rudimentary pseudobulb concealed within the sheaths. Just such shoots are frequent among the caulescent Maxillarias, and when isolated, do not, of course, show the pseudobulb which is almost invariably present between these shoots in complete specimens.

After making due allowance for this fact, the drawing of the floral parts supplemented by the description shows that the species is conspecific with the plant described as *Camaridium Wercklei* of which we have an analytical drawing made from the type. Not only the size and contour of the dried flowers, as shown by both drawings, but especially the form of the lip and its relative proportion to the column appear to be identical in these concepts.

A collection from Santa Clara de Cartago, Costa Rica (*C. H. Lankester 563*) shows a sheathed stem closely similar to that of the typical *Maxillaria vaginalis* lacking only the terminal leaf-blade. Other fragments of this collection show sheathed stems with scattered pseudobulbs as in *Camaridium Wercklei*. The leaf-blades appear to be of exactly the form of the latter concept, but the largest one reaches a size of 19 cm. in length and 4.7 cm. in width. Its floral parts seem to be a very close approximation to those of *Camaridium Wercklei*, but while the lip is about the same size as in the latter concept, the sepals are markedly larger and range from 3.8 to 4.6 cm. in length.

It appears, therefore, that these forms are so similar that they should be regarded as representing one species.

Ornithidium Schlechterianum *C. Schweinfurth nom. nov.*

Camaridium imbricatum Schlechter in Beihefte Bot.

Centralbl. 36, Abt. 2 (1918) 415.

Since this species exemplifies our conception of the genus Ornithidium in having the base of the lip immovably joined to the base of the column, the transfer from Camaridium becomes necessary. However, the prior use of the epithet *imbricatum* in Ornithidium makes it requisite to choose another name and *Schlechterianum* is selected.

Ornithidium Wrightii (*Schltr.*) *C. Schweinfurth comb. nov.*

Camaridium Wrightii Schlechter in Fedde Repert. 16 (1920) 448.

An analytical drawing of typical *Camaridium Wrightii*, made under the supervision of Dr. Schlechter, shows that the lip is rigidly attached to the column as in the genus Ornithidium.

A large collection from Costa Rica (*Lankester 571*) is surely referable to this species. Its flowers appear to be identical with those of *Camaridium Wrightii*, except that both the sepals and petals appear to have five to seven nerves. Vegetatively, however, it is a much smaller plant. The pseudobulbs, which are ancipitously suborbicular-ellipsoid, range from 1 to rarely 2 cm. in length and the oblong-elliptic leaves (in form like the type) reach a maximum length of 7.8 cm. and a width of 1.8 cm.

Pleurothallis dentipetala *Rolfe ex Ames* in Sched. Orch. 3 (January 1923) 7—Ames in Sched. Orch. 7 (1924) 27, t. 11.

Pleurothallis stelidiformis Schlechter in Fedde Repert. Beihefte 19 (November 1923) 195.

Pleurothallis Cooperi Schlechter in Fedde Repert. Beihefte 19 (November 1923) 286.

As shown by the description of *Pleurothallis stelidi-*

formis and a drawing (with floral analysis) from the type, this concept differs from *P. dentipetala* only in its rather larger vegetative proportions (taller stems, larger leaf etc.), smaller petals and somewhat smaller lip.

However, the type of *Pleurothallis dentipetala* consists of two incomplete, obviously immature specimens; and other collections, which are apparently inseparable from that species, show vegetative proportions that even exceed those of *P. stelidiformis.* One such collection (*Brenes* (*123*) *453*) has the stems up to 24 cm. long and the leaves up to 17.6 cm. long and as narrow as 2.8 cm. wide. Another collection (*Brenes 11450*) has leaves up to 13.4 cm. long and 6.5 cm. wide. Finally, *Lankester 1042*, while vegetatively very similar to the type of *P. dentipetala*, has a slightly narrower leaf, shorter and broader perianth-segments, and a blunt lip.

Morphologically the perianth-segments of these concepts seem to be precisely similar, and the petals of all are presumably 3-nerved despite the fact that those of *P. stelidiformis* and *P. dentipetala* are described as 2-nerved.

It appears, therefore, that *P. stelidiformis* must join the formerly reduced *P. Cooperi* in the synonymy of *P. dentipetala.*

Pleurothallis segoviensis *Reichenbach filius* in Bonpl. 3 (1855) 223.

Pleurothallis Wercklei Schlechter in Fedde Repert. 9 (1911) 213.

Pleurothallis bifalcis Schlechter in Beihefte Bot. Centralbl. 36, Abt. 2 (1918) 395.

Pleurothallis Wagneri Schlechter in Fedde Repert. 17 (June 1921) 141.

Pleurothallis falcatiloba Ames in Proc. Biol. Soc. Wash. 34 (December 1921) 152.

An analytical drawing of *Pleurothallis Wercklei*, made

under the supervision of Dr. Schlechter (as well as numerous collections referred to that species) shows it to be inseparable from *P. segoviensis* Reichb.f. as recorded by a drawing of the type in Reichenbach's herbarium. Slight discrepancies from typical *P. segoviensis* appear in the somewhat less falcate petals, in the smooth claw of the lip (that of *P. segoviensis* being described, but not indicated, as "margine papilloso") and in the often prominently pilose inner surface of the sepals. Occasional specimens referred to *P. Wercklei*, however, have apparently smooth sepals, and this character appears to be of varying degree.

Pleurothallis bifalcis Schltr., also represented in our herbarium by an analytical drawing from Dr. Schlechter, appears to be only an enlarged form of *P. segoviensis*. It does not present any morphological difference from *P. segoviensis* other than in having a pubescent inner surface of the sepals. The raceme appears to be fewer-flowered (two to six) and its sepals are said to be 1.4 cm. long, whereas the largest sepals seen in the *P. Wercklei* form are scarcely over 9 mm. in length.

Pleurothallis Wagneri, of which we have a similar floral analysis made under the supervision of Dr. Schlechter, appears to be a vegetatively smaller plant than the preceding forms and to possess sepals (about 1.2 cm. long) longer than those of *P. Wercklei*, but somewhat smaller than those of *P. bifalcis*. The most striking departure from the other forms of this polymorphic species appears to lie in the abbreviated petals. However, similar petals appear in examples referred to *P. Wercklei*.

Pleurothallis falcatiloba is a concept that appears to represent the *P. Wagneri* form of this alliance.

The species appears to be very variable in the size of the plant, in the length of the leaves, in the size and color of the flowers, in the proportion of the petals to the lip

and in the degree of hairiness of the inner surface of the sepals. According to collectors' notes the flowers are transparent white with purple stripes on the sepals (*P. Wagneri* form), green with brown-purple stripes, yellow-green with purple stripes, brownish, red, dark red-purple or blackish purple. Rarely there appears in the petals a slight but abrupt narrowing above on each side or even a little tooth on one side above. Commonly the inner surface of the sepals appears to be distinctly pilose, but the hairs may be indistinct, short or lacking.

This species extends from Guatemala and Nicaragua to Costa Rica and Panama.

Other plants which form a group of puzzling allied species are *P. Aguilarii* Ames, *P. amethystina* Ames, *P. canae* Ames, *P. Johannis* Schltr., *P. pompalis* Ames and *P. vinacea* Ames. This group (together with *P. segoviensis* Reichb.f.) may, with more extensive collections, be found to represent various extremes of one polymorphic species. For the present, however, these species appear to be clearly differentiated from P. *segoviensis* by morphological characters of the lip.

Pleurothallis vaginata *Schlechter* in Fedde Repert. Beihefte 19 (1923) 197.

Pleurothallis umbraticola Schlechter in Fedde Repert. 27 (1929) 56.

A close comparison of a record of the type of the Costa Rican *Pleurothallis vaginata* with several specimens referable to that species from Costa Rica and with the type collection of the Bolivian *P. umbraticola* convinces us that these species are conspecific. The Costa Rican representatives differ from *P. umbraticola* chiefly in having more or less distinctly 3-nerved (rather than 1-nerved) petals. The degree of acuteness of the sepals in these specimens appears to be a variable character. All

the Costa Rican flowers referable to this species which we have seen differ from Schlechter's drawing of the type and from the description in having the lateral sepals semi-connate below (as in the type of *P. umbraticola*, the description notwithstanding) and in having a more or less distinctly pilose inner surface of the sepals as in *P. umbraticola*. Moreover, in all these Costa Rican specimens, as well as in *P. umbraticola*, the lip has a keel near each margin of the dilated anterior portion, a character which is not mentioned in the description of either species.

A collection from Mt. Roraima, British Guiana, is undoubtedly referable to this species, and has the 1-nerved petals of *P. umbraticola*.

Recently we have received two collections from Guadeloupe which, although the flowers were in a rather advanced stage, surely represent *P. vaginata*. They show almost entirely connate lateral sepals and traces of two lateral nerves in the petals besides the strong mid-nerve. One plant has a stem up to 29 cm. tall.

Specimens from Peru show distinctly 3-nerved petals.

A flowerless specimen (*Buchtien 5036*) from the same locality and altitude and of the same date as the type of *P. umbraticola* is almost certainly referable to this species. It has one leaf about 15 cm. long (exclusive of the petiole) and 7.8 cm. wide.

The specimens which we refer to this species have the following data:

Costa Rica, La Palma. Epiphyte, 2 to 3 dm. tall. At 1260 meters altitude. October 24, 1922. *A. M. Brenes (2) 332*; Epiphyte, 1.5–2.5 dm. tall. At 1125 meters altitude. May 22, 1923. *A. M. Brenes 586*: Pejivalle. "Flowers deep maroon. Sepals hairy on interior surface. Lower sepals connate, bifurcate at tip." *C. H. Lankester 1162*.

Guadeloupe, Forêt des Bains Jaunes. Forêt dense subéquitoriale. At 850 meters altitude. March 30, 1935. *H. Stehlé 22*; At 700 meters altitude. October 26, 193[?]. *H. Stehlé 413*.

British Guiana and Northern Brazil, Mt. Roraima. Humid temperate forest of the upper slopes, Rondon Camp. At 6900 feet altitude. December 3, 1927. *G.H.H. Tate 489.*

Peru, Department of Loreto, Pumayacu, between Balsapuerto and Moyobamba. Epiphyte in forest, flowers yellow-green and dark violet. At 600–1200 meters altitude. August-September 1933. *G. Klug 0.7.*

Bolivia, Hacienda Simaco sobre el camino a Tipuani. Región subtropical. "Auf Waldboden". At 1400 meters altitude. February 1920. *Dr. Otto Buchtien 5037* (Type of *P. umbraticola*).

Restrepia pilosissima (*Schltr.*) *Ames & Schweinfurth comb. nov.*

Pleurothallis pilosissima Schlechter in Fedde Repert. Beihefte 19 (1923) 289.

A record of the type of *Pleurothallis pilosissima* including floral analysis has recently been supplemented by a collection of this remarkable species from Costa Rica (*A. M. Brenes* (*116*) *1320*).

Evidently this species does not belong to the genus Pleurothallis, for its flowers show the clavate termination of the dorsal sepal and of the petals which is a characteristic feature of the genus Restrepia. Moreover, the lip, while somewhat more complicated than in the recorded members of Restrepia, still has the general aspect which obtains in the genus.

To be sure, the analysis of the species by Dr. Schlechter shows but two pollinia, whereas Restrepia has four pollinia. Also the Brenes collection cited above shows but two pollinia in its single available flower. However, the relatively broad, 2-chambered anther indicates that two additional pollinia were originally present.

This species is most unusual for Restrepia because of its excessively villous character throughout.

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NEW ORCHIDS FROM MIDDLE AMERICA

BY

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THE FOLLOWING ORCHIDS, which appear to be undescribed, range from Mexico, through Central America to Panama. They are chiefly taken from the extensive collections of Erik M. Östlund in Mexico, of A. M. Brenes in Costa Rica and of A. A. Hunter and P. H. Allen in Panama. From these collections, it seems evident that the vast areas of Mexico, the Republic of Costa Rica and parts of Panama (notably the Province of Coclé) are still rich in unrecorded species.

The sequence of genera follows, according to our usual practice, that of Pfitzer in Engler and Prantl's "Die natürlichen Pflanzenfamilien."

Spiranthes affinis *C. Schweinfurth sp. nov.*

Herba terrestris, gracillima, radicibus fusiformibus. Caulis glaber, vaginatus, aphyllus ut videtur. Racemus gracilis, spiralis, dense multiflorus. Flores parvi, patentes. Sepala uninervia. Sepalum dorsale elliptico-ovatum, concavum. Sepala lateralia oblongo-lanceolata. Petala late oblonga vel spathulato-oblonga. Labellum panduratosubquadratum, basi bicallosum, parte anteriore leviter undulata, apice late truncatum. Columna superne dilatata; anthera comparate magna, suborbicularis, concava.

Plant terrestrial, very slender, closely resembling *S.*

Beckii Lindl., 18.5–29.5 cm. tall, apparently leafless at flowering time. Roots stout, two to three, thick-cylindric to slender-ellipsoid, spreading. Stems slender, glabrous, provided near the apparently stouter base with numerous imbricating scarious tubular mucronate sheaths and on the upper portion with distant smaller tubular sheaths. Raceme slender, densely or subdensely many-flowered with the flowers in a single spiral, 5.7 to about 12 cm. long; rachis glabrous. Floral bracts ovate, shortly caudate, scarious, 1-nerved, little shorter than the flowers at maturity. Ovary obovoid, glabrous, very shortly pedicellate. Perianth horizontally spreading, campanulate, very small, apparently white, translucent. Dorsal sepal elliptic-ovate, concave, about 3 mm. long and 2 mm. wide, obtuse to subacute, 1-nerved. Lateral sepals oblong-lanceolate, about 3 mm. long, 1–1.2 mm. wide, obtuse or subacute with inrolled margins at the apex, 1-nerved, shortly decurrent on the ovary. Petals more or less adherent to the dorsal sepal forming a galea, broadly oblong or spatulate-oblong, little shorter than the dorsal sepal, about 1 mm. wide, slightly incurved and more or less asymmetric, rounded above with more or less irregular margins, 1-nerved. Lip pandurate-subquadrate, slightly exceeding the sepals, broadly truncate and sometimes slightly retuse at the apex, shortly unguiculate, about 3.2 mm. long, 2–3 mm. wide across the basal portion, slightly narrower across the anterior part; disc with a pair of subglobose calli at the base, 5- to 7-nerved, minutely papillose throughout the anterior half which is slightly lobulate and undulate on the margin. Column dilated above; anther conspicuous, suborbicular, concave, broadly rounded or subtruncate above.

Spiranthes affinis appears to have its nearest allies in the North American species, *S. Beckii* Lindl. and *S. gracilis* (Bigel.) Beck. It differs from both, however, in

having 1-nerved sepals and very dissimilar blunt anthers. Among Central American species, it is allied to *S. graminea* Lindl., but is distinguished from that species by its stouter roots, smooth inflorescence and smaller flowers.

Another collection, *Arsène 5476*, consists of uniformly smaller plants 11–22 cm. high and racemes 3–10 cm. long. One of its flowers shows an acute lateral sepal about 3.9 mm. long, petals which are somewhat narrowed and obtuse at the tip and a lip which is trilobulate at the truncate apex, about 3.6 mm. long and definitely shorter than the sepals. In this collection the anterior portion of the lip is more erose and crispate than in the type.

MEXICO, State of Morelos, between Tepotzlan and San Jaunico. Grassy patches between lava. At 1600 meters altitude. March 7, 1933. *Erik M. Östlund 2160* (Collector Benj. Cruz) (TYPE in Herb. Ames No. 41425): State of Michoacán, vicinity of Morelia, Jesùs del Monte. March 28, 1910. *Bro. G. Arsène 5476.* (U.S.Nat. Herb. No. 1032524).

Spiranthes albovaginata *C.Schweinfurth sp. nov.*

Herba terrestris. Radices fasciculatae, incrassatae. Caulis vaginis albo-scariosis omnino tectus. Folia marcescentia, prope plantae basim. Racemus dense multiflorus. Flores extus glandulosi; perianthium campanulatum, patens. Sepalum dorsale ovato-oblongum, concavum. Sepala lateralia oblongo-lanceolata, acuta. Petala sepalo dorsali valde adhaerentia, oblongo-linearia. Labellum oblongo-ovatum, prope apicem utrinque constrictum igitur panduratum, apice retuso-apiculatum. Columna cum acumine conspicuo.

Plant terrestrial, 55–59 cm. high. Roots fasciculate, numerous, slender-fusiform. Stem glabrous below, densely glandular near the raceme, entirely invested by scarious white green-veined sheaths which are close and bear marcescent leaves on the lower portion and which are

shorter with spreading acuminate apices above. The withered remnants of leaves indicate oblong-lanceolate blades. Raceme densely many-flowered, 8–9 cm. long, 1–(rarely) 2 cm. in diameter. Floral bracts white, translucent, thinly scarious, ovate, long-acuminate, up to 1.7 cm. long, concave below, with three green veins. Ovary densely glandular, ellipsoid in anthesis. Flowers small, horizontally spreading; perianth campanulate; sepals densely glandular on the outer surface. Dorsal sepal ovate-oblong, concave, about 6.5–6.9 mm. long and 3 mm. wide, acute, 3-nerved. Lateral sepals linear-lanceolate or oblong-lanceolate, 6.2–7.1 mm. long, about 2 mm. wide at the base, acute, 1-nerved with a less distinct supplementary nerve, asymmetric at base. Petals strongly adnate to the dorsal sepal forming a galea, oblong-linear, little shorter than the dorsal sepal, 6–7 mm. long, about 1.1 mm. wide, lightly incurved and oblique, rounded to subacute at the apex, 1-nerved. Lip oblong-ovate, panduriate, constricted near the apex, retuse and apiculate at the tip, rounded at the sessile base, about 7.2 mm. long, 3.5–4 mm. wide below the middle, anterior portion somewhat narrower and transversely oval. Column slightly dilated above, minutely papillose on the anterior surface, terminating in a triangular-lanceolate rostellar point. Anther conspicuous, broadly ovate-cordate, concave, very shortly stipitate.

Spiranthes albovaginata, while vegetatively similar to *S. Arsèniana* Kränzl., has apparently no near allies.

Mexico, near Chalma, in loamy earth under oaks. At about 2500 meters altitude. April 20, 1933. *Erik M. Östlund 2267* (Collector Juan G.) (Type in Herb. Ames No. 41427).

Spiranthes densiflora *C. Schweinfurth sp. nov.*

Herba terrestris, elata. Caulis vaginis scariosis laxis omnino obtectus. Folia marcescentia, distantia. Racemus

densissimus. Bracteae racemi scariosae, ovatae, conspicue nervosae. Flores extus valde glandulosi. Sepalum dorsale ovato-oblongum, basi valde concavum. Sepala lateralia oblongo-lanceolata. Petala elliptico-linearia, sepalo dorsali valde adhaerentia. Labellum ovatum, apice rotundatum, basi late rotundata lateribus prope medium inflexis. Anthera magna, orbiculari-cordata.

Plant terrestrial, tall, sigmoid-flexed in our specimen. Roots fasciculate, fleshy-thickened, about five in number, slender-fusiform, finely tomentose. Stem (including the raceme) about 105 cm. in length, entirely concealed below by long very loose tubular scarious leaf-sheaths and above by short loose scarious imbricating sheaths. Leaves distant, confined to the lower and middle portions of the plant, merely withered remains at flowering time, imperfect but apparently elliptic-lanceolate in our specimen. Raceme very dense, arcuate, 11.5 cm. long but very immature above, about 2–3 cm. in diameter. Floral bracts scarious, ovate, sharply acuminate, with five prominent brownish nerves. Ovary and outer surface of sepals densely glandular-pubescent. Flowers small for the plant. Dorsal sepal strongly concave at the base, ovate-oblong, about 11 mm. long, 4 mm. wide below the middle, acuminate, 1-nerved or indistinctly 3-nerved. Lateral sepals connate with the dorsal sepal at the base, oblong-lanceolate, acuminate, acute, about 10.2 mm. long, 2.7 mm. wide below the middle, slightly asymmetric at base and apex, indistinctly 3-nerved. Petals strongly adnate to the dorsal sepal, elliptic-linear, little shorter than the dorsal sepal, lightly incurved, acute, 1-nerved, about 1.5 mm. wide. Lip simple, ovate, subsessile, strongly involute on each side just above the middle, slightly undulate on the anterior margins, about 9 mm. long, 6.6 mm. wide near the base, rounded at the apex with an inconspicuous apicule, broadly rounded and obscurely bicallose at the base;

disc minutely papillose on the inner surface near the base and the apex. Column deeply 3-toothed above, the central tooth a bristle-like continuation of the rostellum. Anther relatively conspicuous, shortly stipitate, orbicular-cordate.

Another much smaller plant (which is apparently incomplete) is referable to this species. It differs from the type, however, in having on the lower part of the stem an ovate-elliptical leaf which is about 6 cm. long and 2.3 cm. wide and in having somewhat smaller flowers.

Spiranthes densiflora appears to be rather closely allied to *S. michuacana* (La Llave & Lex.) Hemsl., but differs in its much greater height, smooth floral bracts and much smaller flowers with dissimilar petals. It varies from *S. Arsèniana* Kränzl. in having very different petals and lip.

Mexico, State of Morelos, Tepeyte. At 2300 meters altitude. Flowered at Cuernavaca, October 10, 1932. *Erik M. Östlund 1513* (Collector Carbonero) (Type in Herb. Ames No. 41426): State of San Louis Potosi, Alvárez. December 1924. *C. R. Orcutt 1946* (U.S. Nat. Herb. No. 1209110).

Spiranthes obtecta *C. Schweinfurth sp. nov.*

Herba terrestris, foliis marcescentibus. Caulis vaginis albo-scariosis tubularibus lineatis omnino velatus. Racemus densiflorus; flores parvi, spirales, bracteis albo-scariosis omnino obtecti. Sepalum dorsale oblongo-lanceolatum, concavum, cum petalis adnatis galeam formans. Sepala lateralia lineari-lanceolata, acuminata. Petala elliptico-linearia, leviter sigmoidea. Labellum panduratum, prope apicem valde recurvatum, parte inferiore cuneato-rhombica, parte superiore ovata cum marginibus crenulatis involutis. Gynostemium generis.

Plant terrestrial, 25–35 cm. tall. Roots very stout, spreading, lanuginose. Leaves apparently absent at flow-

ering time, represented by remnants of very narrowly elliptic blades whose long petioles are imbricating at base. Stem flexuous or erect, terete, entirely concealed by long tubular white-scarious imbricating sheaths which are 5–6 cm. long and are marked with brownish purple longitudinal nerves. Inflorescence a dense terminal raceme, about 7–8.6 cm. long. Flowers small, spirally arranged,about thirteen to twenty, blossoming successively over a long period of time, much surpassed and mostly concealed by the scarious bracts which are ovate-lanceolate, long-acuminate, concave at base and marked with about nine prominent longitudinal nerves. Dorsal sepal oblong-lanceolate, concave, about 9.5–12 mm. long and 3.2 mm. wide, acuminate, 3-nerved, recurved at apex. Lateral sepals linear-lanceolate, 9–11 mm. long, about 1.8–2 mm. wide, acuminate, 3-nerved, recurving and "twisting to form loop which frequently holds bract of preceding flower tightly against stem." Petals strongly adnate to the dorsal sepal forming a galea, distinctly shorter than the dorsal sepal, elliptic-linear, slightly sigmoid, 8–9 mm. long and 2.3 mm. wide in the middle, subacute to obtuse, 3-nerved. Lip recurved at the apex and upcurved at the base in natural position, pandurate with a distinct rounded constriction just above the middle, 9.5–12 mm. long when expanded, about 5–6 mm. wide just below the middle and slightly narrower above; the lower portion concave in natural position, flabellate-rhombic with rounded outer angles, cuneate toward the base with more or less thickened margins; anterior portion ovate, with inrolled crenulate margins, subacute to broadly rounded at apex when expanded; disc minutely papillose. Column small, oblique at base, 5.5 mm. or less long, dilated above, minutely papillose in front, with a triangular rostellum which is abruptly contracted to a linear-ligulate point. Anther cucullate-cordate.

Spiranthes obtecta is allied to *S. eriophora* Robins. & Greenm. and to *S. velata* Robins. & Fern. From the former it differs in its densely flowered raceme, smooth rachis, much smaller flowers and narrower petals. From the latter it is distinct by reason of its quite dissimilar and less conspicuous lip.

GUATEMALA, road to Mataquescuintla about twenty miles from Guatemala City. Common. Terrestrial in open clearings. At about 8000 feet altitude, in shallow layer of topsoil (chiefly semi-decayed pine-needles). Sepals pale green; petals white; lip white with fine green mid-nerve. April 21, 1934. *Margaret Ward Lewis 101* (TYPE in Herb. Ames No. 40375).

Spiranthes sparsiflora *C. Schweinfurth sp. nov.*

Herba terrestris, hysterantha. Radices fasciculatae, crassae. Folia oblanceolata vel spathulato-oblanceolata. Pedunculus infra racemum vaginis scariosis numerosis ornatus. Racemus laxiflorus. Flores parvi. Sepalum dorsale elliptico-lanceolatum, apice cucullato-rotundatum. Sepala lateralia lineari-lanceolata, obtusa. Petala cum sepalo dorsali galeam formantia, anguste elliptico-lanceolata, falcata. Labellum in circuitu ovato-oblongum; parte inferiore subquadrato-pandurata; parte anteriore multo minore, ligulato-apiculata. Columna generis.

Plant terrestrial, about 20–22 cm. high. Roots very stout, fasciculate, thick-cylindric or fusiform, lanuginose. Leaves not present at flowering time, erect, oblanceolate or oblanceolate-spatulate; blades about 7–14 cm. long, 2.3–2.95 cm. wide, acute or acuminate, membranaceous, 7-nerved with several supplementary nerves, gradually passing into the petioles; petioles slender, about 8 cm. long or less. Scape about 20 cm. long, obviously immature in our specimen. Peduncle up to the inflorescence adorned with numerous scarious infundibuliform acuminate sheaths which are imbricating below and looser a-

bove, glabrous below, puberulent above. Raceme loosely many-flowered, about 9 cm. long; rachis puberulent. Flowers horizontally spreading. Floral bracts lanceolate, acuminate, scarious, 3-nerved. Perianth membranaceous except the lip. Dorsal sepal elliptic-lanceolate, concave, about 5.8 mm. long and 2 mm. wide, cucullate-rounded at the apex, 3-nerved. Lateral sepals linear-lanceolate, obtuse, about 6 mm. long and 1.2 mm. wide, 3-nerved, longitudinally concave. Petals adherent to the dorsal sepal forming a galea, narrowly elliptic-lanceolate, falcate, obtuse, about 6 mm. long and 1.6 mm. wide in the middle, 3-nerved through the lower half and 1-nerved throughout. Lip ovate-oblong in outline, shortly unguiculate, about 6 mm. long; lamina pandurate-subquadrate, with the apical third rather abruptly narrowed into an oblong-ligulate lobule; lower portion oblong-pandurate, about 4.3 mm. long, about 2.5 mm. wide near the base and apex, cordate at the base where are situated a pair of incurved indusium-like calli, thickened through the central portion; apical portion relatively small, 1.6 mm. long, about 1 mm. wide or more, rounded at the tip. Column about 5 mm. long, slender, pubescent on the anterior surface, extended into a short foot; anther elongate, cordate-oblong.

Spiranthes sparsiflora has a lip that suggests *S. elata* (Sw.) L.C. Rich. in its lower portion and *S. cranichoides* (Griseb.) Cogn. in its anterior portion. The leaves, however, are different from those of both species. The lip somewhat resembles that of *S. costaricensis* Reichb.f. which has very different basal calli.

MEXICO, State of Morelos, Chapultepec, "4 km. east of Cuernavaca in leafmould on rocks near brook. Fls. dingy grey-white. L-lobes yellow." At 1500 meters altitude. Leaves collected October 17, 1932; flowers (in pot) March 17, 1933. *Erik M. Östlund 1554* (Collector O. Nagel) (TYPE in Herb. Ames No. 42369).

Liparis cordiformis *C. Schweinfurth sp. nov.*

Herba terrestris, rhizomate pergracili. Caulis basi incrassatus. Folium singulum, circiter in plantae medio, suborbiculari-cordatum, acutum vel obtusum. Pedunculus filiformis. Racemus brevis, laxe pauciflorus. Flores purpurei ut videtur. Sepalum dorsale ovato-lanceolatum, trinervium. Sepala lateralia ovato-oblonga, uninervia. Petala anguste linearia, basi paulo dilatata. Labellum unguiculatum; unguis crassissimus, marginibus erectis undulatisque; lamina anguste triangulari-hastata, basi retrorse auriculata, apice conspicue mucronata; discus valde unicarinatus. Columna crassa, basi dilatata.

Plant small, up to 14 cm. high, erect or somewhat arcuate, rising from a rhizome which is very slender, long, rarely forking and terminating in an ellipsoid swelling. Stems slender, closely enveloped by the sheathing petiole of the leaf, with the swollen or lageniform base concealed by a loose scarious sheath, 2.5–5.5 cm. long. Leaf solitary, suborbicular-cordate, at about the middle of the plant, spreading from a deeply cordate-clasping base, about 2.1–4.1 cm. long from the bottom of the basal lobules to the apex, 2.1-4.1 cm. wide, acute or obtuse, membranaceous in the dried specimen. Peduncle up to the inflorescence about 1.6–5.5 cm. long, filiform, naked, glabrous. Raceme short, loosely 3- to 8-flowered; rachis up to 1.8 cm. long. Floral bracts spreading, triangular, acuminate, concave at base, membranaceous. Pedicels conspicuously surpassing the bracts, up to 10.5 mm. long in fruit. Flowers apparently wine-colored; perianth reflexed, transparent when moistened. Sepals with revolute sides, minutely cellular-papillose on the inner surface. Dorsal sepal ovate-lanceolate, about 5 mm. long and 1.9 mm. wide below the middle, narrowed to an obtuse tip, 3-nerved. Lateral sepals ovate-oblong, narrowed to an obtuse tip, 5 mm. long, 1.9 mm. wide, slightly asym-

metric, 1-nerved. Petals narrowly linear, gradually dilated at the oblique base, about 4.9 mm. long, obliquely acute, 1-nerved. Lip about 5.2 mm. long including the claw; claw conspicuous, subquadrate, very fleshy with erect undulate sides; lamina narrowly triangular-hastate, with retrorse ovate-triangular obtuse auricles, gradually narrowed above and abruptly constricted near the apex to form a prominent recurved mucro; disc with a stout fleshy keel extending nearly from the base of the lamina to the subapical constriction, 5-nerved. Column short, stout, about 1.9 mm. long, strongly dilated at base and less so above, with a pair of semiorbicular porrect wings at the apex.

Liparis cordiformis is vegetatively similar to *L. neuroglossa* Reichb.f., but has a very different lip. Apparently the closest ally of this plant is *L. fantastica* A. & S., but the latter species has much larger flowers and a dissimilar lip.

Mexico, State of Michoacán, stony lava-fields near Pátzcuaro. In leaf-mould in shady places of mixed forest on rocky slopes. At 2150 meters altitude. October 5, 1933. *Erik M. Östlund 3135* (Collector O. Nagel) (Type in Herb. Ames No. 41386).

Masdevallia tenuissima *C. Schweinfurth sp. nov.*

Herba nana. Radices fibrosae, glabrae. Caules perbreves, vaginis tubularibus obtecti. Folium singulum, lineari-ellipticum vel lineari-oblanceolatum, erectum. Scapus singulus, filiformis, folium plus minusve superans, saepissime uni- vel biflorus. Sepala connata, in caudas carnosas abrupte contracta. Sepalum dorsale ovato-suborbiculare, cucullatum. Sepala lateralia lanceolata. Petala minuta, lanceolata, apice oblique tridentata. Labellum petalis aequilongum, oblongo-lanceolatum, dimidio basali bicarinatum.

Plant dwarf, caespitose, up to 3 cm. high. Roots fi-

brous, glabrous, slender but stout in relation to the plant. Stems minute, up to 5 mm. tall, concealed by one to three scarious tubular imbricating sheaths. Leaf solitary, linear-elliptic to oblanceolate-linear, subacute to rounded and minutely tridenticulate at the apex, cuneate-narrowed at the base, up to 1.7 cm. long and 2.4 mm. wide, subcoriaceous, with the mid-nerve more or less conspicuous. Scape filiform, more or less surpassing the leaf, with a single tubular closely clasping sheath near or below the middle, arising near the base of the stem, 1- to very rarely 4-flowered. Peduncle about 2.8 cm. or less tall. Flower small, membranaceous except the sepaline tails, somewhat bilabiate. Sepals connate at base. Dorsal sepal about 5.8 mm. long, connate with the lateral sepals for about 1.1 mm., basal part of the free portion about 2 mm. long, suborbicular-ovate, 3-nerved, abruptly contracted into a fleshy linear-subclavate cauda which is about 3.7 mm. long. Lateral sepals about 7.2 mm. long, connate for 2.8 mm.; each free part ovate-lanceolate, 3-nerved, abruptly contracted into a fleshy linear cauda which is about 2.8 mm. long. Petals much smaller, lanceolate, acute, very unequally tridentate at the apex, 2 mm. long, about 0.9 mm. wide near the middle, 1-nerved. Lip minutely unguiculate, oblong-lanceolate, 2 mm. long, about 0.75 mm. wide, rounded at the apex, 3-nerved, with two intramarginal fleshy keels above the lateral nerves of the basal half, the keels extended into minute auricles. Column short, stout, terminating in a dentate wing.

Masdevallia tenuissima is allied to *M. exigua* A. & S., and the very similar *M. pygmaea* Kränzl., but differs from both in having elongate scapes, not echinate ovary, and dissimilar petals and lip.

Panama, Province of Coclé, mountains beyond La Pintada. At 400-600 meters altitude. February 17, 1935. *A. A. Hunter & P. H.*

Allen 587 (TYPE in Herb. Ames No. 42015).

Pleurothallis caudatisepala *C. Schweinfurth sp. nov.*

Herba perparva, epiphytica. Caules dense caespitosi, brevissimi, vaginis tubularibus scariosis omnino velati. Folium spathulatum vel spathulato-oblanceolatum, inferne in petiolum sensim angustatum. Flores plures. Sepala similia, lanceolata, perlonge caudata, uninervia. Petala dimidio breviora, lanceolato-acuminata, leviter falcata. Labellum minutum, elliptico-ovatum, acutum, sessile. Columna brevissima, concavo-semiorbicularis.

Plant very small, epiphytic, densely caespitose, reaching 3.5 cm. in height. Roots fibrous, flexuous, relatively stout. Stems very short, 1-jointed, up to about 5 mm. long, enclosed by two or three scarious tubular imbricating sheaths. Leaf solitary, erect, spatulate or spatulate-oblanceolate, gradually narrowed to a petiole, up to 23 mm. long including the petiole, up to 4.5 mm. wide, obtuse with a minutely bilobed and apiculate apex. Inflorescence exceeding the leaves, filiform, provided at base and below the middle with a scarious tubular sheath and at the top with two to six flowers in a loose or subumbellate raceme. Floral bracts infundibuliform, acuminate, scarious, much shorter than the pedicels. Flower (except the lip) membranaceous. Sepals lanceolate, very long-caudate, 1-nerved, apparently conduplicate. Dorsal sepal about 10.1 mm. long and 1.4 mm. wide near the base. Lateral sepals very similar, about 10.5 mm. long and 2 mm. wide near the base. Petals similar to the sepals but much shorter, oblong-lanceolate, very long-acuminate, 1-nerved, slightly falcate, about 5.2 mm. long and 1 mm. wide. Lip much smaller, subfleshy, elliptic-ovate, sharply acute, 1.5 mm. long, about 0.9 mm. wide, sessile. Column very short, concave, flabellate or semiorbicular.

Pleurothallis caudatisepala is allied to *P. propinqua* Ames, but differs in having elongate-caudate sepals and a relatively small lip.

Costa Rica, "Haies. Entre La Balsa et Cataratas de San Ramón. Alt. 800 m. 12-x-1925. Fleurs. . . jaunes-pâles brunâtre orangés, brunâtres en vieillissant, labelle pourpre." *A. M. Brenes (259) 1445* (Type in Herb. Ames No. 43773).

Pleurothallis concaviflora *C. Schweinfurth sp. nov.*

Herba parva, caespitosa. Radices numerosae, fibrosae. Caules filiformes. Folium ellipticum vel oblongo-ellipticum, sessile, apice obtuso tridenticulatum, valde coriaceum. Pedunculi fasciculati, uniflori, cum flore usque ad folii medium tendentes. Flos bilabiatus, carnosus. Sepalum dorsale ovato-ellipticum. Sepala lateralia in laminam suborbicularem connata. Petala multo minora, linearioblonga, apice crasso incurvata. Labellum profunde conduplicato-concavum, triangulari-ovatum, basi cum auriculis retrorsis et in medio callo hippocrepiformi ornatum.

Plant small, caespitose, up to 9 cm. tall, probably epiphytic. Roots fibrous, flexuous, numerous, glabrous. Stems filiform, scarcely stouter than the roots, about 3–7 cm. long, provided near the base with a close tubular evanescent sheath, slightly enlarged toward the junction with the leaf. Leaf elliptic or oblong-elliptic, sessile, about 3–3.8 cm. long and 7–11 mm. wide, minutely tridenticulate at the obtuse apex, marginate, thickly coriaceous in the dried specimen with the mid-nerve more or less sulcate above and carinate beneath. Peduncles numerous, fascicled, 1-flowered, short. Flowers small, rather fleshy. Sepals apparently closely pubescent on the inner surface. Dorsal sepal concave, ovate-elliptic when expanded, about 4–4.7 mm. long and 2.4–3.2 mm. wide, acute, 3-

nerved with the mid-nerve dorsally carinate. Lateral sepals connate into a deeply concave lamina which is suborbicular when expanded; lamina 4–5 mm. long, 4–4.4 mm. wide, acute, 4-nerved, with the inner nerves dorsally somewhat carinate below. Petals much smaller, oblong-linear, sometimes with a slightly dilated base, acute and incurved at the thickened apex, about 2.1–2.5 mm. long, up to 1 mm. wide, 1-nerved, with a prominent dorsal keel. Lip simple, deeply conduplicate-concave, triangular-ovate, with a pair of retrorse triangular-lanceolate obtuse auricles, about 2 mm. long in natural position, acute with an incurved mucronate apex; disc 3-nerved, slightly narrowed on each side below the middle, provided with a hippocrepiform callus at the base. Column very short and stout.

Pleurothallis concaviflora is apparently allied to *P. excavata* Schltr., but has longer stems, shorter leaves, almost twice smaller flowers and dissimilar petals. It is vegetatively similar to *P. Sanchoi* Ames, but has very different petals and a dissimilar lip.

Costa Rica, "Colinas de San Pedro de San Ramón. 14-xi-1927." *A. M. Brenes (134) 1668* (Type in Herb. Ames No. 43774).

Pleurothallis rotundata *C. Schweinfurth sp. nov.*

Herba parvula, caespitosa. Caules monophylli, vaginis tubularibus hispidis cum ostiis ovatis omnino tecti. Folium erectum, late ovale vel suborbiculare, apice basique rotundatum. Racemi axillares, numerosi, perbreves, biflori. Sepala anguste lanceolata vel triangulari-lanceolata, acuminata, lateralia per tertiam basalarem connata. Petala perparva, oblonga, marginibus superioribus longe fimbriatis. Labellum lanceolatum, acuminatum, trinervium, marginibus inferioribus ciliatis vel fimbriatis.

Plant small, caespitose, up to 13 cm. high to the apex of the erect leaf. Stems 2.2–10.1 cm. tall, entirely con-

cealed by four to eleven tubular sheaths which are densely hispid on the nerves and terminate in ovate marginate hispid mouths. These mouths are spreading and successively larger upward. Leaf solitary, round-ovate, round-oval or suborbicular, abruptly short-petioled; lamina 2.5–3.7 cm. long, 2–3.5 cm. wide, broadly obtuse to slightly retuse at the broadly rounded apex, subtruncate to broadly rounded at the base, subcoriaceous, the mid-nerve and commonly two other nerves more or less prominent on both surfaces. Racemes numerous, abbreviated, about 2-flowered, the flowers reaching the middle of the erect leaf. Flowers membranaceous. Dorsal sepal narrowly triangular-lanceolate, about 5.8 mm. long, 1.8 mm. wide near the base, acuminate, 3-nerved. Lateral sepals about 5.1 mm. long, connate for about the basal third; free portion narrowly lanceolate, acuminate with recurved apex, 3-nerved. Petals much smaller, oblong, somewhat broadened at the base on the anterior margin, about 2.1 mm. long and 1 mm. wide at the base, long-fimbriate above, 1-nerved. Lip simple, lanceolate, acuminate, 3 mm. long, about 1 mm. wide near the middle, 3-nerved, minutely auricled at base; the margins of the lower half irregular and fimbriate. Column very short with a fimbriate clinandrium.

Pleurothallis rotundata appears to be unique among the Central American species of the Lepanthiform section of the genus in having very broad obtuse leaves and an acuminate lip. It differs from *P. trachytheca* Lehm. & Kränzl. in lacking the distinct terminal awn to the petals and in the much shorter lip.

The flower examined was on the summit of a swollen ovary and in an advanced stage of anthesis. The specific name is in reference to the form of the leaf.

PANAMA, Province of Coclé, mountains beyond La Pintada. At

400-600 meters altitude. February 16, 17, 1935. *A. A. Hunter & P. H. Allen 561* (TYPE in Herb. Ames No. 42016).

Scaphyglottis Wercklei *Schltr.* var. **major** *C. Schweinfurth var. nov.*

A specie caulibus longioribus et foliis maxima pro parte multo majoribus et labello paulo latiori differt.

Stems narrowly cylindrical, much branched, up to 17.1 cm. long. Leaves linear-lanceolate, rigidly spreading, up to 8.5 cm. long and 8.5 mm. wide, narrowed to an abruptly obtuse tip which is minutely bilobed and apiculate. Flowers white. Dorsal sepal oblong-elliptic, about 5.1 mm. long and 2 mm. wide, acute, 3-nerved. Lateral sepals broadly oblong, very asymmetric, about 5 mm. long and 2 mm. wide, forming a distinct mentum, acute, 3- to 4-nerved. Petals linear, more or less narrowed toward the base, 4.6-5 mm. long, up to 1.1 mm. wide, obtuse, 1- or 2-nerved, or 3-nerved above the middle. Lip subparallel to the column and recurved in natural position, cuneate-flabellate in outline, gradually dilated from an unguiculate thickened base, very obscurely trilobulate at the broad apex with the broad midlobe very shallowly retuse, about 4 mm. wide near the apex. Column without angulate wings, about 4 mm. long.

The variety *major* differs from typical *Scaphyglottis Wercklei* in being a stouter plant with the lower stem-members much longer, with often much larger leaves and with a broader lip. Vegetatively it has an aspect quite different from that of *S. Wercklei*, but the flowers show its alliance to that species.

BRITISH HONDURAS, Belize District, Gracie Rock, Sibun River. Epiphyte in secondary forest. January 30, 1936. *Percy H. Gentle 1781* (TYPE in Herb. Univ. Michigan. DUPLICATE TYPE in Herb. Ames No. 43848).

Epidendrum concavilabium *C. Schweinfurth sp. nov.*

Herba epiphytica, robusta, humilis. Caules foliorum vaginis imbricantibus omnino obtecti. Folia pauca, disticha, oblongo-elliptica, apice bilobata. Inflorescentia brevis, pauciflora. Bracteae conspicuae, equitantes, patentes, dorso valde carinatae. Flores carnosi. Sepalum dorsale elliptico-ovatum, acutum. Sepala lateralia obliquissime semiorbiculari-ovata, acuta. Petala lanceolato-elliptica, obtusa. Labellum columnae apici adnatum, simplex, valde concavum, basi cordatum, apice bilobatum. Columna generis.

Plant robust, caespitose, epiphytic. Roots fibrous, numerous. Stems entirely concealed by imbricating complanate sheaths which are mostly leaf-bearing, up to 10.8 cm. long. Leaves up to five, oblong-elliptic, distichous and widely spreading, successively larger upward, up to 10 cm. long and 5.2 cm. wide, abruptly much smaller below, bilobed at the apex with rounded lobules, apparently fleshy in the living specimen. Peduncle up to the raceme very short, about 3.5 cm. long, mostly concealed by one equitant carinate spathe. Raceme short and stout, 5- to 6-flowered, about 7 cm. long and 3.5 cm. wide near the base. Floral bracts equitant, ovate when spread, deeply carinate with the keel decurrent on the rachis and peduncle, up to 2.5 cm. long. Flower, especially the sepals and lip, rather fleshy. Sepals and petals horizontally spreading or recurved. Dorsal sepal elliptic-ovate, about 12.3 mm. long and 8 mm. wide, abruptly acute with a retrorse mucro on each side of which are two minute subtriangular lamellae, 7-nerved. Lateral sepals semiorbicular-ovate, very asymmetric with the posterior margin nearly straight and the anterior margin strongly convex, about 13 mm. long and 9.2 mm. wide near the middle, acute, mucronate with a short dorsal dentate keel, about

8-nerved. Petals lanceolate-elliptic, obtuse or rounded at the apex, about 12 mm. long and 6 mm. wide in the middle, 3-nerved with the lateral nerves branching. Lip adnate to the apex of the column, simple, strongly concave, cordate at the base, bilobed at the apex, about 13.6 mm. long from the tip of a basal auricle to the tip of an apical lobule and 15 mm. wide when expanded, the three central nerves slightly and shortly carinate-thickened near the base and the central one conspicuously thickened above, the margins irregularly crenulate. Column short and very stout, 8 mm. long measured dorsally.

Epidendrum concavilabium suggests *E. coriifolium* Lindl. and *E. nitens* Reichb.f., but differs from both species in having a dissimilar lip and broader petals.

Costa Rica, Colinas de San Pedro de San Ramón. "14-xi-1927." [*A.M. Brenes*] *(119) 1660* (Type in Herb. Ames No. 43877).

Maxillaria appendiculoides *C. Schweinfurth sp. nov.*

Herba epiphytica. Caules elongati, sine pseudobulbis, foliorum vaginis imbricantibus omnino obtecti. Folia disticha, numerosa, late patentia. Inflorescentiae breves, axillares, uniflorae. Flos parvus, membranaceus. Sepalum dorsale ovato-lanceolatum, longe acuminatum, valde concavum. Sepala lateralia lanceolata vel ovato-lanceolata, valde obliqua, complicato-acuminata. Petala elliptico-linearia, falcata, acuta. Labellum in circuitu rhomboideum, obscure trilobatum, antice truncatum, basi cuneatum; discus parte inferiore callo crasso oblongo ornatus. Columna arcuata, in pedem producta.

Plant epiphytic. Stem elongate, flexuous or arcuate, sparingly branched, without pseudobulbs, entirely concealed by distichous imbricating leaf-sheaths, about 5 mm. wide or less across the sheathed stems, at rare intervals producing a few fibrous roots. Leaves articulated,

those present confined to the upper portion of the stems, numerous, distichous, horizontally spreading, ovate-oblong or elliptic-oblong, about 2.4 cm. long or less, up to 8 mm. wide (the larger and the smaller blades interspersed), rounded at the apex with slightly unequal lobules separated by an apicule, deeply clasping at the base, with the mid-nerve conspicuously sulcate above and carinate beneath. Inflorescences scattered on the upper part of the plant, short, axillary, solitary, 1-flowered, about equaling the leaves. Peduncle adorned with one or two scarious erect acute sheaths. Flower small, membranaceous. Dorsal sepal strongly concave, when expanded ovate-lanceolate, long-acuminate, about 7.9 mm. long and 3.2 mm. wide below, 3- or less distinctly 5-nerved. Lateral sepals obliquely lanceolate or ovate-lanceolate, about 7 mm. long and 2.8–3 mm. wide, long-acuminate with infolded margins, 3- or indistinctly 5-nerved. Petals falcately elliptic-linear, about 6.5 mm. long and 1.2 mm. wide in the middle, complicate-acute, 3-nerved through the lower portion and 1-nerved throughout. Lip rhomboid in outline, subsimple or indistinctly 3-lobed above the middle, 6 mm. long, about 3.7–4 mm. wide across the middle, cuneate toward the base, with the anterior portion subquadrate or subquadrate-ovate, broadly truncate at the apex in the center of which is a dorsal thickening; disc with a fleshy oblong callus extending from near the base to the middle. Column short, abruptly arcuate and somewhat dilated above, 3.2–3.9 mm. long, extended into a foot which is about 2.8 mm. long. Anther conic-hemispherical; pollinia four.

Another collection, *(Brenes 182) 1378*, differs from the type in having larger leaves which extend to about 3.2 cm. in length and 1.1 cm. in width, also in having slightly smaller flowers. It shows a pollen-mass consisting of two pairs of complanate-obovoid pollinia attached

to a very short stipe.

This species has much the habit of *Camaridium dendrobioides* Schltr., but has very dissimilar floral segments. It is apparently allied to *Maxillaria linearifolia* A. & S., but differs in having short blunt leaves and much smaller flowers.

Costa Rica, "Bois. Collines de San Pedro de San Ramon. Alt. 1100 m. 20-ix-1925." *A. M. Brenes (239) 1427.* (Type in Herb. Ames No. 43846); "8-viii-1925. Fleurs. . . en couleur jaune verdâtre pâle. . . le calle de labelle. . . pourpre violacé foncé. Cultivé chez moi." *A.M.Brenes (182) 1378.*

Ornithidium sigmoideum *C.Schweinfurth sp. nov.*

Herba robusta, sparsissime ramosa. Caules vaginis conduplicatis imbricantibus lanceolatis omnino celati, pseudobulbos perdistantes ferentes. Pseudobulbi complanato-ellipsoidei, monophylli. Folia oblongo-elliptica, cum petiolo distincto. Flores mediocres. Sepalum dorsale oblongo-lanceolatum, concavum. Sepala lateralia oblongo-lanceolata. Petala oblonga. Labellum inferne profunde saccatum, valde sigmoideum, superne trilobatum cum lobis lateralibus semicuneatis erectis et lobo terminali parvo ovato conduplicato. Columna gracilis.

Plant robust, about 45 cm. tall. Roots fibrous, flexuous, numerous. Stem stout, very sparingly branched, about 5 mm. in diameter in the dried specimen, entirely invested by distichous imbricating shining sheaths which are conduplicate, triangular-lanceolate, deeply carinate, mucronate and slightly incurved in natural position, but are evanescent on the lower portion of the stem, bearing pseudobulbs at intervals of 25 cm. more or less. Pseudobulbs complanate-ellipsoid, 2.3 cm. long or more, monophyllous, shining, surrounded and surpassed by a pair of distichous leaf-bearing sheaths. Leaves oblong-elliptic, petioled; blade up to 15 cm. long and nearly 4 cm. wide, acute or acuminate, chartaceous, with the mid-nerve

somewhat sulcate above and carinate beneath; petiole distinct, conduplicate, long or very short, up to 4 cm. in length. Inflorescences short, 1-flowered, solitary, in the axils of the imbricated sheaths of the stem. Peduncles concealed by several conduplicate lanceolate or ovate-lanceolate imbricated acuminate bracts. Flowers medium-sized. Dorsal sepal elliptic-lanceolate or oblong-lanceolate, strongly concave, about 14.9–16 mm. long and 5–6 mm. wide, complicate-acute, 7- to 9-nerved, dorsally carinate toward the apex. Lateral sepals oblong-lanceolate, acute or subacute, somewhat asymmetric, about 13.5–15 mm. long, 4.5–5 mm. wide near the base, 6- to 7-nerved. Petals oblong, acute, about 12–14 mm. long, 3 mm. wide, acute, 5-nerved, with a slight concavity near the apex on the posterior margin. Lip rigidly attached to the column-foot, sigmoid-curved below, about 11.5–12.8 mm. long in natural position, deeply 3-lobed about one third the length from the apex, with the basal portion (about 5 mm. long) deeply saccate, the sac porrect and almost contiguous to the abruptly reflexed central portion; lateral lobes erect, spreading, semicuneate, with a straight anterior margin, free portion about 2.5 mm. wide; mid-lobe small, strongly conduplicate, concave at the base, broadly ovate when expanded, complicate-acute, about 4–5 mm. long; disc with a small fleshy oblong-ovate sulcate callus which extends from the sinus of the lateral lobes as a free projection above the lower portion of the mid-lobe. Column slender, about 8–8.9 mm. long, slightly arcuate, extended into a short foot forming a mentum with the lateral sepals.

Two additional collections bearing the imperfect remains of the perianth at the summit of enlarged ovaries show larger leaves than the type. In *Standley 33065* the longest leaf is 18 cm. in length, while in *Standley 33058* the broadest leaf is about 4.9 cm. in width.

Ornithidium sigmoideum appears to be most closely allied to *O. Wrightii* (Schltr.) C. Schweinf., but differs strikingly in the details of the lip and in the relatively elongate column.

The specific name is in allusion to the lip.

Costa Rica, Cerro Gallito. At 2000 meters altitude. December 20, 1927. *M. Valerio 72* (Type in Herb. Ames No. 33641): Province of San José, La Palma. Epiphyte on mossy tree trunk. At about 1600 meters altitude. February 3, 1924. *Paul C. Standley 33058, 33065.*

Telipogon parvulus *C. Schweinfurth sp. nov.*

Herba nana. Caulis vaginis foliorum distichorum omnino tectus. Folia linearia vel lineari-oblonga, coriacea. Inflorescentiae axillares, laxe pauciflorae. Flores pro genere parvi. Sepala anguste ovata, breviter acuminata, concava, nervo medio conspicuo. Petala multo majora, elliptico-ovata, acuta. Labellum perlate rhombico-ovatum, latius quam longius, apice rotundato subacutum. Columna velutina, antice in callum compresso-ovatum extensa.

Plant dwarf, about 7 cm. tall (stem incomplete at base). Roots fibrous, flexuous, glabrous, numerous. Stem short, entirely concealed by the imbricating leaf-sheaths. Leaves linear or linear-oblong, coriaceous in the dried specimen, rounded at the apex with an apiculate tip; blades up to about 15 mm. long and 2 mm. wide. Inflorescences axillary. Peduncles below the raceme up to 3.2 cm. long, filiform, glabrous, with a single infundibuliform spreading sheath enclosing what appears to be an incipient branchlet. Raceme loosely 5- to 7-flowered, suberect or arcuate; rachis more or less fractiflex. Floral bracts spreading, infundibuliform. Pedicellate ovary filiform, elongate, about 11 mm. long. Flower small for the genus. Dorsal sepal very similar to the lateral sepals, but

slightly larger. Lateral sepals narrowly ovate, about 6.7 mm. long and 3 mm. wide, short-acuminate, concave, 1-nerved or very indistinctly 3-nerved, carinate near the apex with the keel extended into a short apicule. Petals much larger than the sepals, elliptic-ovate, about 10 mm. long and 7 mm. wide, acute, 9-nerved shortly above the minutely papillose base, minutely ciliolate, without reticulated veins. Lip very broadly rhombic-ovate, 14-nerved without reticulations, rounded or subacute at the apex, about 7.2 mm. long and 9.8 mm. wide near the base, minutely ciliolate, very minutely papillose at base. Column short, velutinous, extended in front into a fleshy compressed-ovate velutinous callus which is long-setose on each side at the base. Pollinia four, complanate-pyriform, in two unequal pairs.

Telipogon parvulus is remarkable for its small size throughout. It differs from *T. gracilipes* Schltr. in its much lower stature, smaller leaves and dissimilar fewer-nerved lip which is decidedly broader than long.

Costa Rica, Cerca de "La Holanda." Fecha. September 29, 1934. *M. Valerio 971* (Type in Herb. Field Mus. Nat. Hist. No. 753912).

Ornithocephalus cochleariformis *C. Schweinfurth sp. nov.*

Herba parvula, caespitosa, flabelliformis. Radices fibrosae, glabrae. Folia anguste elliptico-oblonga vel oblongo-lanceolata, equitantia, ad vaginas imbricantes articulata. Racemi arcuati vel reflexi; rhachis dense glanduloso-pubescens. Sepala flabellato-suborbicularia, extus glandulosa. Petala similia, obovata vel cuneato-obovata. Labellum simplex, ovatum, apice acuto valde involuto; discus inferne incrassatus, basi subcordatus vel truncatus. Columna rostello lineari-lanceolato decurvato ornata.

Plant small, caespitose, up to 8 cm. high to the tip

of the leaf. Roots fibrous, slender, glabrous, numerous. Leaves seven to eight, equitant, narrowly elliptic-oblong or narrowly oblong-lanceolate, up to 5 cm. long and 1 cm. wide, acute, spreading, articulated to oblong sheaths which are up to 2.4 cm. long, equitant, imbricating, and have scarious upper margins. Racemes reflexed or arcuate, up to 9 cm. long, sublaxly flowered nearly to the base; rachis densely glandular-pubescent, with the internodes more or less fractiflex. Floral bracts widely spreading, broadly ovate to suborbicular, glandular-ciliate. Flowers small. Sepals thickly beset with stout glands on the outer surface and glandular-ciliate on the margin, flabellate-suborbicular, 1-nerved; the lateral sepals slightly oblique and carinate with a lacerate keel on the outer surface, about 3 mm. long and equally broad above the middle. Petals similar, broadly obovate or cuneate-obovate, about 3.3 mm. long and equally broad above the middle, finely and irregularly ciliate, 1-nerved and carinate with a lacerate keel on the outer surface. Lip simple, ovate, strongly concave above the middle with an involute tip, about 4.2 mm. long when expanded, about 3.2 mm. wide below the middle, truncate or subcordate at base, acute, 5- to 7-nerved; disc fleshy-thickened and shortly papillose across the lower half, with the thickened margins of the basal half extending onto the lamina as a keel to a point slightly above the middle on each side. Column short, with a prominent recurved linear-lanceolate rostellar process.

A collection recently acquired from Mrs. Purdom is referable to this species. It differs from the type in having the shorter leaves ranging from asymmetrically ovate to elliptic-lanceolate. One flower shows a triangular-linear stipe bearing four subglobose pollinia at its dilated summit.

Ornithocephalus cochleariformis appears to be allied to

O. tripterus Schltr., but differs markedly from that species in having smooth roots, densely glandular rachis and very dissimilar sepals and petals.

PANAMA, Province of Coclé, lower portion of valley and marshes along Rio Antón, El Valle de Antón. "Petals white, lip green." At about 500 meters altitude. February 2, 1935. *A. A. Hunter & P. H. Allen 383* (TYPE in Herb. Ames No. 42017): Valle de Antón, rim. At 2500 feet altitude. February 1936. *Mrs. M. A. Purdom s.n.*

NOTES ON EPIDENDRUM

BY

CHARLES SCHWEINFURTH

Epidendrum microbulbon *Hooker* in Icon. Pl. 4 (1841) t. 347.

A recently acquired collection referable to this species is somewhat at variance with the diagnostic characters cited in the key in Ames, Hubbard and Schweinfurth: The Genus Epidendrum in the United States and Middle America (1936) 17, 18, 19. The leaves in all of the plants of this collection are several times to many times shorter than the inflorescence; two of the plants have 1-leaved pseudobulbs and the tips of the lateral lobes of the lip are not scaly as is the mid-lobe.

MEXICO, State of Sonora, Tepopa, Rio Mayo. June 2, 1936. *H.S.Gentry 2214.*

Epidendrum pseudo-Wallisii *Schlechter* in Fedde Repert. Beihefte 19 (1923) 124.

In a large collection of specimens received from Costa Rica, a plant referable to this species has been recognized. As in recent years only this single specimen of *E.pseudo-Wallisii* has been found among the large collections received for study, it is evident that the species is among the outstanding rarities of the orchid flora of Middle America. At the base of the stem there is present a single fibrous, stout, branching root. The leaves differ from those described and from the ones represented in a drawing from the type in being longer and more narrowly elliptic-oblong, 10.3–12.2 cm. long and only about 2 cm. wide. A still more striking discrepancy from the typical form appears in the inflorescence which is not properly a terminal raceme, but consists of a series of short lateral 2-flowered racemes arising opposite the upper leaves. The

petals are rather cuneate-spatulate than obovate-spatulate as characterized in the original description. The lip appears to be about 2.2 cm. long rather than 2.7 cm. long as described and the pedicellate ovary is more than twice shorter than in the type.

Costa Rica, "Cataratas (Los Angeles) de San Ramón. 17-18-19-iv-1935." *A. M. Brenes* (Herb. Brenes No. 20529).

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PEYOTE AND PLANTS USED IN THE PEYOTE CEREMONY

BY

RICHARD EVANS SCHULTES

I. Economic Importance of Peyote.

PEYOTE, (*Lophophora Williamsii* (Lem.) Coult.), a small, grey-green, narcotic cactus of the Rio Grande region of the United States and Mexico, is the centre of an elaborate religious ceremony common to more than thirty American Indian tribes. The peyote-cult, incorporated into the Native American Church, has been given a charter by the State of Oklahoma. Inasmuch as this cult, practically unknown in the United States before 1885, yet numbering 13,300 members in 1922,[1] is rapidly increasing[2] in the face of intense opposition from missionary groups, the following observations should prove botanically and ethnologically interesting.

Peyote is also an important article of commerce. It grows in a limited area close to the Rio Grande in Texas and in scattered places throughout the states of Aguas

[1]There is great need for a new and exact census. No later statistics are available from the Bureau of Indian Affairs of the United States Department of the Interior. The number of communicants at the present time is, without doubt, far in excess of this figure for 1922.

[2]See "Secretary Ickes Moves to Protect Minority Religious Group at Taos Pueblo", *Indians at Work*, November 15, 1936, pp. 8-13; Office of Indian Affairs, Washington, D.C.

Calientes, Chihuahua, Coahuila, Durango, Hidalgo, Jalisco, Neuvo Léon, Querétaro, San Luis Potosí, Tamaulipas, and Zacatecas in Mexico. The practice of sending pilgrims to gather it in the field has grown up among the Indians of the southern plains of the United States, following the long established custom of all the peyote-using tribes of Mexico. The pilgrims from this country use automobiles and bring back trailers full of peyote.

The more northern tribes, however, are forced to procure their supply of peyote (the dried heads of the cactus, usually called mescal buttons) through the mail from merchants in Laredo, Texas. This is permitted, since *Lophophora Williamsii* is not a narcotic under Federal regulation. Neither is it restricted in Mexico. However, the states of Colorado, North and South Dakota, Kansas, Montana, Nevada, Oklahoma and Utah have taken legal action to prohibit the use, transportation and possession of peyote. This action was subsequently repealed in Oklahoma. However, in the enforcement of legal restrictions difficulties have been encountered.

Several business establishments in Laredo, Texas deal exclusively in mescal buttons *(9)*[3]. The annual variation in price usually ranges from $2.50 to $5.00 a thousand buttons. I find that, for small amounts, the present price is $6.00 a thousand. The Laredo establishments supply most of the peyote used by tribes from Iowa north to the Canadian border. Some of the peyote used in Oklahoma and neighboring states is also supplied from Laredo.

Independent gatherers average about two hundred heads a day in October. The heads are cut off, leaving the root in the ground to send forth new shoots. The financial returns of independent gatherers are meager unless the sales are made to peyote-seeking pilgrims who

[3]Italic numbers in parentheses refer to Bibliography.

pay from four to six cents a pound for the newly cut heads.

The peyote industry is not an insignificant business, in spite of the fact that it is little known outside of Texas. It is said *(9)* that inhabitants of the small town of Neuvo Laredo, on the Mexican side of the Rio Grande, derive their livelihood almost exclusively from the peyote trade. In Ward County, Texas, the town of Peyote takes its name from the trade in mescal buttons gathered in Ward and Winkler Counties. From the following evidence, the economic and cultural importance of peyote in Mexico can be clearly seen. The town of Hikuli in the state of Sonora derives its name directly from the Tarahumare word for the cactus. A village in the state of Jalisco is called Peyotan. A mission in the state of Durango bears the name El Santo Nombre de Jesus Peyotes on account of the abundance of the plant in the surrounding hills.

No statistical data regarding the extent of this industry are available. However, assuming a price of $4.00 a thousand buttons and a per capita consumption of six buttons once a week,[4] $20,000 seems a very conservative estimate of the actual annual commercial transactions involved north of the Rio Grande. This estimate would be greatly modified were it possible to include in it the great amount of peyote used in Mexico where most of the supply is collected by the Indians themselves.

Peyotism was embraced over ten years ago by a group of negroes in Oklahoma *(16)*, but no records of the present state of this branch of the peyote-cult are available.

[4]Meetings are often held more than once a week, and the per capita consumption is, no doubt, much higher as *every* participant eats at least four buttons, and some consume upwards of thirty in a single meeting. Add to this the large amount used medicinally, and the extreme conservatism of this estimate, based on figures for 1922, will be evident.

It apparently ceased to exist after the death of its leader in 1926 *(16)*. It would not be surprising, however, if groups of non-Indians near the reservations use peyote.

It has been stated from time to time by investigators, and the statement has often appeared in the newspapers, that the use of peyote has spread to France (the alkaloid mescaline sulfate usually being used instead of the crude drug) and that the Paris press has waged a vigorous campaign to stop its use and spread. Reko writes *(12)* on this point: "In Paris (und übrigens auch in anderen Städten) existieren geheime Gemeinden von Peyote-Essern, deren Mitgliederzahl von Kundigen vorsichtig auf etwa 10000 geschätzt wird." If this statement is correct, the Texas peyote trade may be of much greater proportions than are suggested above. It has not been possible, however, to verify this statement as to the number of peyote users in France.

II. Peyote and Its Use.

Peyote is eaten in the dried form (less often fresh) because of the sense of ease and well-being that it induces and, in some cases, because of the psychological effects (the chief of which is the kaleidoscopic play of richly colored visions) often experienced by those who indulge in its use. Peyote is considered divine, a "messenger" enabling the individual to communicate with God without the medium of a priest. By some of the adherents of the peyote-cult the drug is believed to be the incarnation of the Holy Ghost.

Correlated with its use as a religious sacrament is its supposed value as a medicine. By some Indians it is claimed that if peyote is used correctly, all other medicines are unnecessary. The supposed curative properties of peyote are responsible probably more than any other attribute for the rapid diffusion of the peyote-cult in this

country. The emphasis on the therapeutic and pseudo-therapeutic use of the plant is great among the Plains Indians even today; it is regarded as a physical and spiritual panacea.

There are few diseases known to the Indians for which peyote is not believed to be a cure. Among the many diseases listed by my Indian informants were tuberculosis, pneumonia, influenza, intestinal ills, scarlet fever, diabetes, rheumatic pains, colds, and especially grippe; some even included venereal diseases. A Shawnee informed me that peyote tea was a very good antiseptic wash for wounds and bruises and a soothing liniment if applied warm to an aching limb. Partly masticated mescal buttons, packed around an aching tooth, are said to bring relief.

Peyote is used freely as a medicine and tonic in daily life "as white man uses aspirin," according to the statement of a Kickapoo. This common use of the drug has led foes of the peyote-cult to make the accusation that the Indians become "addicted" to it, but, in my field-investigations, no habitual use of peyote was noted. The statement that peyote is an aphrodisiac has been disproved, since investigation has shown it to possess definite anaphrodisiac properties.

Although it is still a question whether or not peyote is harmful, the usual absence of uncomfortable effects following its use, even among beginners, combines with many other considerations to support the view that it is morally and socially safe, and productive of little physical harm.

In the United States, peyote is ordinarily taken in the dried form. In Mexico, fresh peyote is ground on a metate and the resulting thick, brown liquid is drunk *(4)*; it may also be added to fermented fruit juices to render the resulting alcoholic beverages more intoxicating *(4,*

12), a fact which probably has led to the unfortunate confusion of peyote or mescal buttons with the alcoholic "mescal" or agave-brandy distilled from the juice of *Agave spp.* In many places peyote tea may be used in preference to the dry buttons, the tufts of hair of which often cause nausea if not removed. The use of this tea is very common when a patient is being treated during a peyote ceremony.

There are nine "anhalonium" alkaloids. Eight[5] of these may be found in *Lophophora Williamsii*: Mescaline, Pellotine, Anhalonidine, Anhalonine, Lophophorine, Anhalamine, Anhalinine, and Anhalidine. Of these, the first five are sedative in physiological action; anhalamine is an excitant. Anhalinine and Anhalidine have only recently been isolated and in amounts too minute to be of use in physiological tests. Anhalonine and Pellotine hydrochlorides find minor use in insomnia, neurasthenia, and hysteria; the latter is analgesic, though not to the extent of morphine. Mescaline, the vision-producing alkaloid, is used (as the sulfate) for this purpose in psychological investigation and is valuable to the psychopathologist in investigating mental derangements. All of these alkaloids can be synthesized.

In the isolation of the alkaloids from the plant material, a residue that is said to consist of a waxy substance and "two resinous bodies" *(13)* is obtained. This has not been investigated thoroughly either chemically or physiologically; it has been suggested that it may be physiologically active, but present indications are that it is not.

The ninth "anhalonium" alkaloid, Anhaline,[6] is ob-

[5]The number and relative proportions of these alkaloids in *Lophophora Williamsii* vary greatly with seasonal and environmental changes; any number from four to eight may be present.

[6]Anhaline, isolated from *Ariocarpus fissuratus* (Engelm.) K.Schum. in Engler and Prantl Natürl. Pflanzenfam. III. 6. a. (1894) 195, is identical with hordenine found in *Hordeum spp.*

tained from several species of *Anhalonium*, with which genus *Lophophora Williamsii* was formerly identified.

In Mexico, the term *peyote* or *peyotl* refers to plants other than *Lophophora Williamsii*. This has been the source of much confusion.

A representative list of Mexican "peyotes", all of which are either narcotic or medicinal, would include: among the *Cactaceae: Ariocarpus fissuratus* (Engelm.) K.Schum., *Astrophytum myriostigma* Lem. *(11)*, and *Astrophytum asterias* (Zucc.) Lem., *Pelecyphora aselliformis* Ehrenb., and *Strombocactus disciformis* DC. *(2)*; among the *Crassulaceae: Cotyledon caespitosa* Haw. *(4)*; among the *Compositae: Senecio calophyllus* Hemsl., *S. Hartwegii* Benth., *S. ovatifolius* Sch. Bip. *(4)*, and *S. Petasitis* DC. *(11)*, as well as several species of *Cacalia*, especially the supposed aphrodisiac and sterility cure obtained from *Cacalia cordifolia* HBK. *(13)*; among the *Leguminosae: Rhynchosia longeracemosa* Mart. & Gal. *(11)*; and among the *Solanaceae: Datura meteloides* DC. ex Dunal *(11)*.

Under the diminutive term *peyotillo* are included the cactuses *Dolichothele longimamma* Britton & Rose and *Solisia pectinata* Britton & Rose *(4)*.

Peyote (*Lophophora Williamsii*) is often confused with the intoxicating Mexican seed *ololiuqui*, the botanical identification of which still seems to be uncertain. Specimens received from Mexico under this name have been identified at the Gray Herbarium as *Rivea corymbosa* (L.) Hall.f. A narcotic drink prepared from these seeds is called *piule;* it is without doubt this name that has caused confusion *(10)*.

The application of the name *peyote* to so many widely different plants cannot be satisfactorily explained by assuming successive borrowings. Turning to etymology, it is found that Safford *(13)* holds to the old theory that

the word *peyote* comes from the Aztec *peyutl* (a silky cocoon) and was applied to *Lophophora Williamsii* and the several species of *Cacalia* because certain parts of these plants were velvety or silky (the tufts of hair of the cactus, the soft tuberous roots of the composites), resembling caterpillar cocoons. Although generally accepted, this etymology does not seem to explain the application of the same name to the great array of plants which possess no soft or silky parts whatsoever. As far as the botanical evidence is concerned, the etymology *(10)* which derives *peyote* from the Aztec prefix *pi* (small) and *yautli* or *yolli* (herb with narcotic odor or action) seems more probably correct. Thus, in this broad sense (a small, narcotic herb), the word could have been and was applied to scores of Mexican plants. There may be some doubt as to the validity of this etymology in the minds of American Uto-Aztecan linguistic experts, but the botanical evidence seems to support it as a more logical origin of the term.

Unfortunately for the botanist and anthropologist, *teonanácatl* ("flesh of the gods") has, in recent years, become a common name for mescal buttons in America. This is the result of an erroneous identification by Safford *(13)* of peyote with the sacred, intoxicating mushroom of the Aztecs. Failing to find a fungus possessing narcotic properties in Mexico, and noting that the dried head of *Lophophora Williamsii* resembles "a dried mushroom so remarkably that at first glance it will even deceive a mycologist", Safford concluded that the two (mescal buttons and the sacred mushrooms) were identical *(13)*.

It is to be regretted that the misapplication of this Aztec word *(teonanácatl)* to peyote had established itself so firmly before a correction was forthcoming. Inasmuch as refutation of this has not been made by English authors, the following contradiction made by Reko *(12)*

may prove significant and end confusion: "Dem [the Safford identification] muss widersprochen werden. Die Nanácates sind Giftpilze, die mit Peyote nichts zu tun haben. Seit alten Zeiten ist es bekannt, dass ihr Genuss Rauschzustände, Extasen und Geistesstörungen hervorruft, aber trotz ihrer Gefährlichkeit hat man sie überall, wo sie vorkommen, wegen ihrer berauschenden Eigenschaften bis auf den heutigen Tag geschätzt." Reko also states *(12)* that, today, in the provision markets of Mexico, certain mushrooms the exact names of which are not known are called *nacátl* and classes *Amanita mexicana* Murrill as one of the *nanácatls*. In connection with this refutation, it should be remembered that the Spanish historian, Sahagun, writing in the sixteenth century, carefully distinguished between *teonanácatl*, the sacred mushroom, and *peiotl*, the earth-cactus. The intoxicating *Basidiomycetes*, species of *Amanita* (especially *Amanita muscaria* (L.) Pers.), are so well known in so many places that it is difficult to understand how Safford's identification was accepted so readily. Although little is known about intoxicating mushrooms in Mexico, nevertheless Safford's identification was not based on substantial evidence. Intensive research work relating to this important problem is being done in Mexico and should result in definite information concerning the "sacred mushroom" of the Aztecs.

In an unpublished manuscript: "Was bedeutet das Wort *Teonanácatl*?", Reko points out philologically that the name applies to "divine" food of a soft or fleshy nature; in this light, it is difficult to see how the term could ever have referred to the corky, though succulent, peyote, much less to hard, brittle mescal buttons.

III. Plants and the Peyote Ceremony.

In the peyote ceremony, there are additional plants

that play somewhat lesser roles. With few exceptions, these are local plants of the Plains. Among the American Indians, their use is remarkably constant. The following account with regard to the plants used may be considered applicable to any American peyote-ceremony and is based on my personal investigation among the Kickapoo, Kiowa, Quapaw, Shawnee and Wichita, and is supplemented by the observations of R. W. LaBarre among the Caddo, Comanche, Delaware, Osage, Oto, Pawnee, Ponca, and Southern Cheyenne.

Peyote (señi),[7] sage (tägyi), cedar (k'okiädlä), hay, oak leaves, corn shucks, tobacco (täbä), various woods, the gourd, mescal beans (k'awn-k'odl) and fruits are always used; the practice of painting the face, still common with some of the older leaders, calls for any of a dozen berries or roots as well as for certain "earths" of which the use is subject to regional and tribal variation.

The ceremony begins with a prayer, for which each member rolls and smokes a cigarette. The tobacco is always Bull Durham; it is kept in a cotton bag which is passed around the circle of worshippers. The cigarettes are never rolled in paper; the use of corn shucks (*Zea Mays* L.) or the leaf of the black-jack oak (*Quercus nigra* L.) for this purpose is more in keeping with the old tradition which the peyote-cult strives to preserve. The leader may, according to a Kiowa statement, hand a consumptive patient a few dried sumac (mokola) leaves (*Rhus glabra* L.) for mixing with the tobacco. This is believed to make the tobacco-smoke more potent as a purifying agent; neither the sumac nor the tobacco, however, are considered to be medicinal when used in the peyote ceremony. This blending of sumac and tobacco is so well liked

[7]Inasmuch as the Kiowa tribe has been one of the most, if not the most, active in the diffusion of the cult, all native names are given in Kiowa.

by men and women generally that it is common in every-day social smoking.

The cigarette is lighted from a glowing "smoke-stick" of Cottonwood (*Populus spp.*) or other soft wood removed from the altar-fire and handed around the circle (Figure I). Among the Oto, whose cult is organized into the Church of the First Born, tobacco has no part whatsoever in the ceremony.

Cedar incense (*Juniperus virginiana* L.) is next sprinkled on the fire by the leader; the participants reach out their hands and waft the fragrant smoke towards their bodies, rubbing the chest and face. The cedar is considered a purifying agent and is used at intervals during the all-night ceremony before or after prayer. The paraphernalia are thrust into the smoke occasionally during the ceremony.

The cotton or beaded-chamois bag containing the peyote supply is reverently passed around, each person taking four buttons without further ceremony. The "Father Peyote" is either an exceptionally large and beautiful plant or a button handed down from some great leader of the past;[8] this is placed in the centre of the crescent-shaped altar on a cross or rosette of sage leaves. Prayers are addressed to God through this Father Peyote.

Meanwhile, each participant is given or removes, from the hay serving as a cushion under the blankets, a sprig of sage (*Artemisia vulgaris* L.). In localities where sage is plentiful, the cushion may be entirely of sage instead of hay mixed with sage; the Wichita near Anadarko, Oklahoma, follow this procedure. Rolled between the palms, the sage is rubbed all over the body as a purifying agent. It is also used for this purpose in the sweat-house

[8]One Kiowa peyote-leader treasured a Father Peyote given to him by the great Comanche chief and peyote-leader, Quanna Parker.

and in other rituals. Some may chew a few leaves before eating the peyote buttons.

Peyote and a cigarette may be called for at any time during the night unless some special rite, such as Midnight Water is in progress. When the bag of mescal buttons has made its first circuit, the leader begins to sing, shaking for accompaniment with his right hand a gourd rattle (*Lagenaria spp.*); a companion beats time on a small kettle-drum made from an iron pot covered with buckskin. The drumstick is usually made of maple (*Acer spp.*), but the finest ones are of true South American mahogany (*Swietenia Mahogani* Jacq.).

Each male worshipper sings four songs and passes the instruments on to his neighbor. Together with the musical instruments are used a staff made of bois d'arc or Osage orange-wood (*Maclura pomifera* C. K. Schneider) and a fan of eagle or pheasant feathers. The staff is held upright in front of the singer with the feathers of the fan hiding his face; a sprig of sage that was started on its round from the leader's place is usually held with the fan.

The wood for the fire must be slow-burning; other than this, there are no rules governing its selection. Black-jack oak (tdok-a-di-awng) is most preferred, but other woods are used: Red oak (*Quercus borealis* Michx. var. *maxima* Sarg.), Hackberry (*Celtis occidentalis* L.), Redbud (*Cercis canadensis* L.), Box-elder (*Acer Negundo* L.), and Cottonwood make excellent substitutes for black-jack. Mulberry (*Morus rubra* L.), Elm (*Ulmus spp.*), and Osage orange are never used, as they crackle and throw off sparks while burning. (The framework of ceremonial tepee is of Cottonwood.)

Some leaders of the ceremony wear, hanging across the chest from the left shoulder, a string of mescal beans (*Sophora secundiflora* (Orteg.) Lag. ex DC. *(1, 3, 14, 15, 17)*, a native of Mexico, Texas and New Mexico). These

beans, usually red in color, are not eaten in the ceremony; they serve merely as symbolic ornaments. The symbolism of the beads is very vague, but is probably associated with the fact that *Sophora secundiflora* is one of the most conspicuous plants growing near the places where the very inconspicuous peyote is found. The Kickapoo say that the mescal-bean shrub shades and protects peyote in the field, and that the beans are worn when peyote is eaten because of the protection it gave the sacred plant. In view of the uses mentioned below concerning the wide use of this bean in the pre-peyote Plains rites before the introduction of peyote, it seems probable that it is a survival from the past. A Kiowa leader wore several beans on the lower part of the leggings of his buckskin peyote-uniform as a safeguard against stepping on menstrual blood; Skinner *(15)* also reports this use among the Ioway.

The Kiowa, and probably also most Plains Indians, believe the beans to be alive. Some Kiowa prefer to own a string of light, yellowish-red mescal-beans (Figure 11); others would rather have them of a deep red color. The variation in color may be due to different stages of maturity when gathered, or the yellowish tinge may be brought on by gentle heating *(14)*, a custom common among the Ioway Indians in preparing the mescal-bean for brewing in the old Red Bean Dance.

Important as this article is in peyote worship, no reference to the mescal-bean necklace has been found in the extensive literature which has been published concerning the cult.

In addition to the use of mescal-beans in the peyote-cult, these beans are interesting from several other points of view. It is said that about fifty years ago it was the custom in parts of Texas to use long strings of *Sophora* beans for barter. Mescal-beans are poisonous to cattle

EXPLANATION OF THE ILLUSTRATION

Figure I. Heliotype reproduction of a Shawnee smoke-stick of cottonwood (*Populus balsamifera* L.). The charred end was kept glowing at the altar-fire for lighting cigarettes before prayer. The use of certain Christian elements in this aboriginal cult is strikingly shown by the presence of the cross and the word *Christ* associated with the crescent-shaped altar, its peyote, and the water-bird. Smoke-sticks are not always so elaborate. Collected at McCloud, Oklahoma, June, 1936. Harvard Botanical Collection (Economic Botany) No. 5025.


CHRIST.

when eaten in large amounts *(1)*. They contain the alkaloid sophorine (cytisine) *(18)* which causes death by asphyxiation *(5)*. It has been stated that one bean is sufficient to kill a man *(7)*, but this certainly must be an exaggerated statement. A Wichita informed me (his statement being corroborated by several Kiowa and Kickapoo) that members of his tribe ate one bean before a foot-race to prevent panting afterwards. A Kickapoo stated that a decoction made by boiling the ground beans in water and strained through a cloth was employed to cure earaches. Similarly, LaBarre reports that the Cheyenne value it as an "eye-water." The beans are used as an intoxicant in the form of a tea by the Indians of San Antonio, Texas, and of northern Mexico; the intoxication is said to be marked by an initial period of stimulation followed by a deep sleep of long duration *(8)*. Skinner, quoting Harrington, states *(15)* that the Ioway Indians use the mescal-bean[9] as an intoxicant in their Red Bean Dance; the beans are "killed" (crushed) and brewed with herbs (unfortunately not enumerated) which are said to make the tea milder. "Everything looks red to the drinker for a while, then he vomits and evacuates the bowels, which the Indians say, cleans out the system and benefits the health, even in the case of children." *(15)*

Mescal-beans were usually included in the War Bundles of the Indians of the southern plains. The Ioway Red Bean War Bundle is considered a fetish, protecting

[9]Skinner reports *(15)* the mescal-bean as *Erythrina flabelliformis* Kearn. Inasmuch as the seeds of the two legumes (*Erythrina* and *Sophora*) are easily confused, and as *Erythrina* seeds are *not* narcotic, this is palpably an error, and the seed indicated must have been that of some *Sophora*. Safford states *(14)* that Erythrina seeds are often contained in the same package with the narcotic *Sophora secundiflora* beans sold in Mexican drug markets, but that, inasmuch as the two plants are not at all similar, the adulteration is intentional.

the members of the Red Bean Dance from the dangers of war and bringing them luck in all enterprises, especially in horse racing and formerly in the buffalo hunt.

The beans were once widely used as adulterants for the alcoholic agave-brandy or mescal, making the drink more intoxicating *(14)*. This use of the seeds is the reason for the name *mescal bean* which has been extended and wrongly applied to the dried heads of *Lophophora Williamsii*. Although the term, thus misapplied, has acquired wide usage in anthropological literature, it is *never correctly* employed to designate peyote buttons.

Mescal-beans are also called coral beans and *frijolillo;* the Mexican name is *tolesclo.*

The peyote ceremony ends at about six o'clock in the morning, when a dawn feast is brought into the tepee by the wife or sister of the leader. This consists of bread, parched corn, meat, and sliced canned fruits; sometimes candy is added. The fruit is purchased at nearby stores and is the ordinary "fruit salad" used so widely in this country. The participants have little hesitation in using commercial preparations in the meeting, although, in general, plants and preparations rooted in past tradition still claim precedent. The tobacco is always the same commercial brand, but the cigarette papers supplied with the tobacco are discarded in favor of the more traditional leaf wrappings.

With the end of the dawn feast, the ceremony comes to a close. The members lounge about until noon, when a second and much larger feast is prepared by the host. This is not a part of the ceremony itself, and the menu varies. Meat is usually the most important food at the noon meal.

IV. Importance of Plants to the Ceremony.

The underlying causes of the rapid spread and tenacity

of the peyote-religion are many and are complexly interrelated. Among the most obvious, and those most often listed, are: the ease in obtaining the narcotic; the lack of Federal restraint; the cessation of intertribal warfare; reservation life with its consequent intermarriage and peaceful exchange of social and religious ideas; the ease of transportation and postal communication; and the general attitude of resignation towards the encroaching culture of the white race.

From the Father Peyote down to the cigarette wrappings, the peyote service is a form of worship expressed through the use and symbolism associated with articles of nature—both animal and vegetable. It is obvious to any student of peyote that perhaps one of the greatest factors to which is attributable the diffusion and tenacity of the cult is its appeal to the aboriginal mind, in the face of rapid culture changes.

Of the plants used in the ceremony, only peyote is new to the Plains Indians. Its remarkable physiological and psychological effects have caused it to become dominant in this new complex of traditional ceremonial plants. Peyote has become dominant in the daily life of the Indian as well as in the ceremony, for its use as a therapeutic agent and general tonic is now widespread. In fact, the medicinal powers attributed to the peyote are responsible probably more than anything else for the wide and rapid distribution of the peyote-cult. It still holds its place in Indian life as a physical and spiritual panacea.

Peyote and the plants associated with it embody so much of the traditional that is of prime importance to Indian religion and enough of the new that the peyote-cult has been enabled to withstand persistent opposition. The peyote-religion will doubtless successfully resist disintegration for many years because of its remarkable adaptability to the changing life of the Indian.

EXPLANATION OF THE ILLUSTRATION

Figure II. Heliotype reproduction of a Kiowa mescal bean necklace. The beans (*Sophora secundiflora* (Orteg.) Lag. ex DC.) are strung on buckskin. Attached to the string are several personal trinkets: a piece of red ribbon, beaver fur, a child's ring, a lace handkerchief with a bundle of dried beaver muscle "medicine" under the ring. All the necklaces are similar, but the personal trinkets vary with individual tastes and are thought to have symbolic meaning. Collected at Anadarko, Oklahoma, July, 1936. Harvard Botanical Collection (Economic Botany) No. 5026.

BIBLIOGRAPHY

(1) Boughton, I.B. and Hardy, W.T. "Mescalbean *(Sophora secundiflora)* poisonous for livestock" Texas Agric. Exper. Sta. Bull. no. 519, December, 1935.

(2) Britton, N.L. and Rose, J.N. "The Cactaceae" Vol. III, Carnegie Institution of Washington, Washington, D.C. 1922.

(3) Dayton, William C. "Important western browse plants" U.S. Dept. Agric. Misc. Publ. no. 101, Washington, D.C., July, 1931.

(4) Diguet, Léon "Les cactacées utiles du Mexique" Archives d'Histoire Naturelle, IV, Société Nationale d'Acclimation de France, Paris, 1928.

(5) Hare, R.A.; Caspari, Charles and Rusby, H.H. "National Dispensatory" ed. 2 (1908), p. 905.

(6) Havard, V. "Drink plants of the North American Indians" Bull. Torr. Bot. Club, Vol. 23, p. 33, 1896.

(7) Kew Bulletin (1892) pp. 216-217

(8) Kew Bulletin (1896) p. 231.

(9) Newberne, Robert E.L. "Peyote, an unabridged compilation from the files of the Bureau of Indian Affairs" Washington, D.C., 1922.

(10) Reko, Blas P. "Das Mexikanische Rauschgift Ololiuqui" El Mexico Antiguo, Vol. III, no. 3-4, Tacubaya, D.F. December, 1934.

(11) Reko, Victor A. "Was ist Peyote?" Zeitschr. f. Parapsychologie, Vol. IV, pt. 7, Leipzig, July, 1929.

(12) Reko, Victor A. "Magische Gifte—Rausch- und Betäubungsmittel der Neuen Welt" Stuttgart, 1936.

(13) Safford, William E. "An Aztec narcotic" Journ. Hered., Vol. VI, no. 7, Washington, D.C., July, 1915.

(14) Safford, William E. "Narcotic plants and stimulants of the ancient Americans" Smithson. Rept. for 1916, pp. 387-424, Washington, D.C., 1917.

(15) Skinner, Alanson "Ethnology of the Ioway Indians" Bull. Public Museum City Milwaukee, Vol. 5, no. 4, June 12, 1926.

(16) Smith, Mrs. Maurice G. "A negro peyote cult" Journ. Wash. Acad. Sci., Vol. 24, no. 10, Washington, D.C., October 15, 1934.

(17) Standley, Paul C. "Trees and shrubs of Mexico" Contrib. U.S. Nat. Herb., Vol. 23, p. 435, Washington, D.C., 1922.

(18) Wood, H.C.; Remington, J.P.; and Sadtler, S.P. "Dispensatory of the United States of America" ed. 18 (1899), p. 1797.

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CODONOTHECA AND CROSSOTHECA: POLLENIFEROUS STRUCTURES OF PTERIDOSPERMS

BY

WILLIAM C. DARRAH

THE PTERIDOSPERMS or seed-ferns are of especial evolutionary significance because in a number of structures they foreshadow the cycads and higher seed-plants. The main interest in the pteridosperms centers in their mode of fructification which is generally considered to be non-strobiloid, having true seeds and typical archi-gymnospermous pollen in sacs borne on pinnatified branches of fern-like habit.

One of the important and meagerly known microsporangiate form-genera is *Codonotheca* which belongs to the medullosan seed-ferns.

Halle *(7)*[1] has published the only comprehensive survey of pteridosperm fructifications and has given direction to the interpretations concerning the polleniferous structures.

It was Sellards' *(14)* opinion that *Codonotheca* was the polleniferous structure of *Neuropteris decipiens* Lesquereux *(11)*. I am inclined to this opinion because of the similarity of cuticlar and stomatal structures of *Codonotheca* to those of *Neuropteris decipiens*. There is also some resemblance of its cuticle to that of *Neuropteris rariner-*

[1]Italic numbers in parentheses refer to Bibliography.

EXPLANATION OF THE ILLUSTRATION

CODONOTHECA CADUCA *Sellards*

Upper figure: A cluster of synangia showing their paired arrangement. Carboniferous: Allegheny Formation. Mazon Creek, Illinois. Four fifths natural size. Harvard Botanical Museum (Paleobotany) No. 24991 (F.O.Thompson Collection).

Figure at lower left: Photograph of a nitrocellulose peel from one synangium. Note the orientation of the many small dark "granules." These granules are pollen-grains. Twice natural size. Mazon Creek, Illinois. Peeled from specimen No. 5033 Harvard Botanical Museum (Paleobotany) (Lesquereux Collection).

Figure at lower right: A single synangium natural size. Mazon Creek, Illinois. Harvard Botanical Museum (Paleobotany) No. 5026 (Lesquereux Collection).

vis Bunbury *(3)*. It is well to note that Stockmans *(15)* identifies the Mazon Creek representatives of *Neuropteris rarinervis* with *Neuropteris attenuata* Lindley and Hutton. However, I am inclined to dismiss *Neuropteris attenuata* as of no more than varietal importance.

In the Lesquereux collection there are one hundred and thirty specimens of *Codonotheca caduca* which were identified as *Equisetites occidentalis (11)*. Since there are certain calamarian leaves also included in the type series of Lesquereux, Sellards' name should stand and no attempt should be made to reinstate Lesquereux's specific name. There are sixty-two specimens of *Codonotheca caduca* in the F.O.Thompson collection.

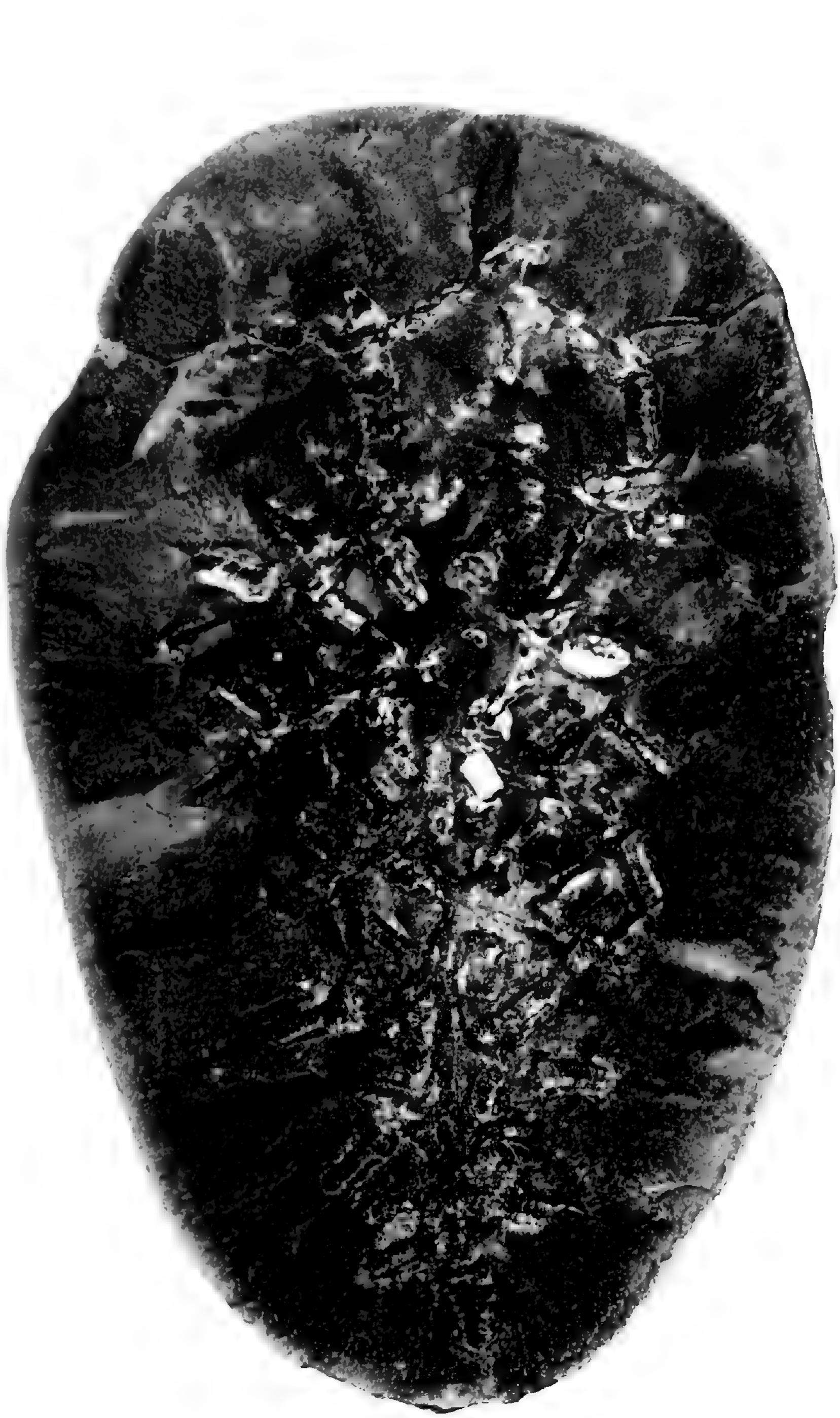
Sellards had to deal with detached fructifications from which no evidence concerning arrangement could be obtained. I have illustrated in the first figure how the terminal sporangiate structures are borne pendulously on pinnatified branches. There are four pairs of synangia arranged almost opposite. Several other smaller and more fragmentary branches are known, but these show the same opposite, pendulous and paired arrangement.

Each campanulate staminate structure has six long tubular sporangia filled with large pollen-grains imbedded in the tissue. In this respect, *Codonotheca* belongs to the same group as *Whittleseya*. Halle *(7)* interprets *Codonotheca* as follows: "Specimens of *Codonotheca caduca* of average size are stated to be 3–5 cm. long and 1½ cm. wide at the top. The segments are free for about half of the length of the specimen, or somewhat less. The spores are described as forming long and narrow groups which extend from the tip to the base of each segment and lie in more or less well-marked depressions occupying one half or two thirds of the width of the segment. Sellards states that there is nothing to indicate the location of the sporangia, but he evidently thinks that each group of

EXPLANATION OF THE ILLUSTRATION

CROSSOTHECA SAGITTATA *(Lesquereux) Sellards*

A specimen of a pinna, showing the typical sagittate form of the "sporophyll." Carboniferous: Allegheny Formation. Mazon Creek, Illinois. Three fourths natural size. Harvard Botanical Museum (Paleobotany) No. 19703 (F.O.Thompson Collection).



spores represents several sporangia 'more or less completely immersed in the tissue'. He discusses, however, a second possibility, namely that the segments themselves are enormous sporangia united at the base. This interpretation he rejects because of the great size of the segments and especially because of the vascular strands which are stated to run through them. In the light of the information which has now been gained regarding the structure of *Whittleseya*, *Goldenbergia* and *Aulacotheca*, I believe that this alternative interpretation is more probably the right one. The unusual size and shape of the spores and their aggregation in very long and narrow groups which form a uniseriate whorl round a central cavity are features characteristic of the three genera named, and if the sporangia, as believed by Sellards, are really immersed in the tissue, this would be yet another point of agreement." *Whittleseya* is a misunderstood form despite the lucid description given by Halle *(7)*.

Recently Wodehouse *(17)* has revived the obsolete and erroneous opinion that *Whittleseya* is a ginkgoalean. *Whittleseya elegans* Newberry is the staminate fructification of *Alethopteris grandifolia* Newberry, *(12)* which Arnold has shown to bear *Trigonocarpus*-like seeds. *Whittleseya* is a pteridosperm of the order *Medullosae*.

The spores of *Codonotheca* are very large, elongate-elliptical bodies 0.28–0.32 mm. long and 0.18–0.20 mm. wide. They retain a yellow resinous color sometimes obscured by reddish-brown stain. The spores usually contain two rather large dense structures which may represent nuclei. There are also present smaller irregular masses of a black substance which Sellards regards as the remnants of the original food supply. The pollen-grains of *Codonotheca caduca* resemble those of *Dolerotheca fertilis (7)* in size, shape and ornamentation.

Sellards described (p. 89) the spores of *Codonotheca*

as having a single longitudinal "slit". Misinterpretation of the material led him to this conclusion. It will be observed in the accompanying figures that *Codonotheca* spores have two furrows as have all other members of the *Whittleseyineae*. Halle remarks (p. 11) that these furrows "might be supposed to mark the junction between the part of the wall facing outwards in the tetrad and the two radial walls."

Codonotheca caduca Sellards seems to be restricted to the environs of Mazon Creek. It has been found at Mazon Creek, Braidwood, Wilmington and Morris. Somewhat similar, but not sufficiently preserved, specimens have been collected in the Upper Allegheny formation of Ohio and western Pennsylvania. Turner *(16)* has figured pollen grains found in the flame-etched surface of polished anthracite coal from the Ross coal of Nanticoke, Pennsylvania. The Ross coal is of Middle Allegheny age. It is impossible to identify this pollen specifically with that of *Codonotheca*, but there is no doubt that the pollen belongs to one of these medullosan fructifications.

Recently Chamberlain *(4)* has described *Neuropteris decipiens* as bearing *Trigonocarpus* seeds. He was led to this opinion by the celebrated reconstruction in the Field Museum of Natural History in Chicago. Professor Noe informs me that unfortunately the seeds have not been found in attachment. It is probably true that *Neuropteris decipiens* is a pteridosperm, that it bore polleniferous structures of the *Codonotheca* type and that it had seeds of a *Neuropterocarpus* of *Rhabdocarpus* shape and structure.

Crossotheca, unlike *Codonotheca*, is widely distributed and has figured prominently in phylogenetic speculations on the seed-forms. In addition, there are a number of points involved which stimulate reasonable doubt regarding the pteridospermous nature of at least a few species of *Crossotheca*.

Crossotheca is a spore-bearing form-genus defined by Zeiller in 1883, *(18)* and regarded by him to be filicinean. *Crossotheca* became known as the polleniferous member of the pteridosperms because a structure referable to *Crossotheca* was found in organic attachment with a frond type known to be seed-bearing. Within the past few years Crookall *(5)* has revived a long-standing controversy over this case, but before I discuss the issue it would be well to give a description of a typical species of *Crossotheca* for which the sterile form is also known.

Sellards *(13)* has described the attachment of *Crossotheca sagittata* (Lesquereux). The detached fructification had been named *Sorocladus sagittatus* by Lesquereux *(11)*. For the sterile frond, Sellards cites the name *Pecopteris fontainei* Lesquereux MS., which was published without valid description by Lesley *(10)*.

The small sagittate "sporophylls" bear 12 free, pendulous sporangia. These rather large sporangia have a length of 3–5 mm. and a width of 0.5–0.75 mm.

There are probably 128 spores to the sporangium (the lowest count in twenty-five well-preserved sporangia was 46, the largest 106). The spores are large, spherical bodies with a diameter ranging from 0.050–0.060 mm. All bear the typical tri-radiate scar, which in itself is not allowable as evidence in determining relationship. Sellards *(13)* states that the thick exospore is marked by minute warty thickenings. The spores in our preparations are almost smooth. Maceration methods used by Sellards may have slightly roughened (swelled) the exine, but this is not to be interpreted as a difference in opinion.

Crossotheca sagittata is borne on foliage of the *Pecopteris* type, long regarded to be true-fern. *Pecopteris fontainei*, the sterile form, belongs to the *miltoni-abbreviata* group, which finds a curious paradox in its known fructifications. The usual fertile form is *Asterotheca*, a typical

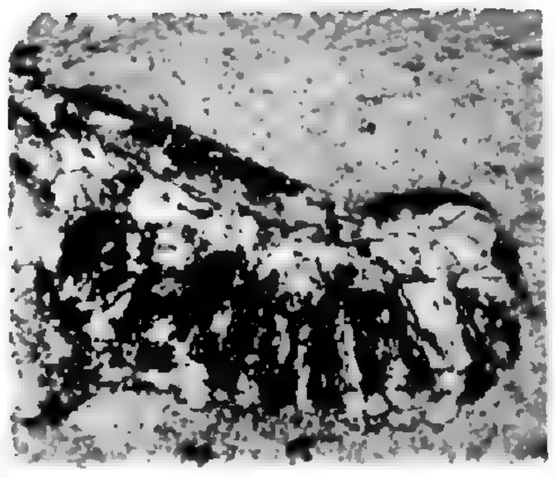
EXPLANATION OF THE ILLUSTRATION

CROSSOTHECA SAGITTATA *(Lesquereux) Sellards*

Upper figure: A small specimen from Mazon Creek, Illinois. Natural size. Harvard Botanical Museum (Paleobotany) No. 9748 (F.O.Thompson Collection).

Middle figure: "spores," somewhat collapsed, taken from the specimen shown in the upper figure. Photograph of a nitrocellulose peel. Magnified 75 times.

Lower figure: Photograph of a nitrocellulose peel showing a cluster of sporangia with the typical epaulette shape. Twice natural size. Mazon Creek, Illinois. Peeled from specimen No. 12192 Harvard Botanical Museum (Paleobotany). (Lesquereux Collection).



eusporangiate sorus with a prodigious production of very small ellipsoidal spores (0.012 mm. $\times$0.015 mm.). Those species bearing *Crossotheca* fructifications have large spherical spores. Recently Halle *(6)* has found a species which he named *Pecopteris wongii* from the Permo-Carboniferous of Shansi Province of China. This species, clearly referable to the *miltoni-abbreviata* group, may prove to be seed-bearing. At least one specimen seems to have a single smooth rhabdocarp-like seed attached laterally. Halle is unwilling to accept this evidence without reservation.

The real reason why *Crossotheca* is held to be phylogenetically important is because it is believed to be the pollen-bearing structure of certain pteridosperms. To be specific, the microsporangiate fructification of the classic *Lyginopteris oldhamia* was believed by Kidston *(9)* to be a *Crossotheca*. Miss Benson *(2)* at once challenged this contention by showing how *Telangium* could as well be the microsporangiate structure of *Lyginopteris*.

Actually, Miss Benson has called attention to the weakest point in the argument, because the structure found by Kidston, though a true *Crossotheca*, does not belong to *Lyginopteris oldhamia*. The species has been renamed *Crossotheca kidstoni* by Crookall, *(5)* but it probably belongs to another lyginopterid.

It is interesting to note that *Telangium* shows a definite resemblance in structure to certain members of the *Whittleseyineae*. However, the evidence indicates that the synangium is bilaterally symmetrical.

Crookall *(5)* has shown that *Crossotheca* fructifications are borne on foliage of both the *Pecopteris* and *Sphenopteris* types, but he cites an opinion of Mr. Hemingway that in every case where proof of attachment can be obtained, this attachment has been pecopterid.

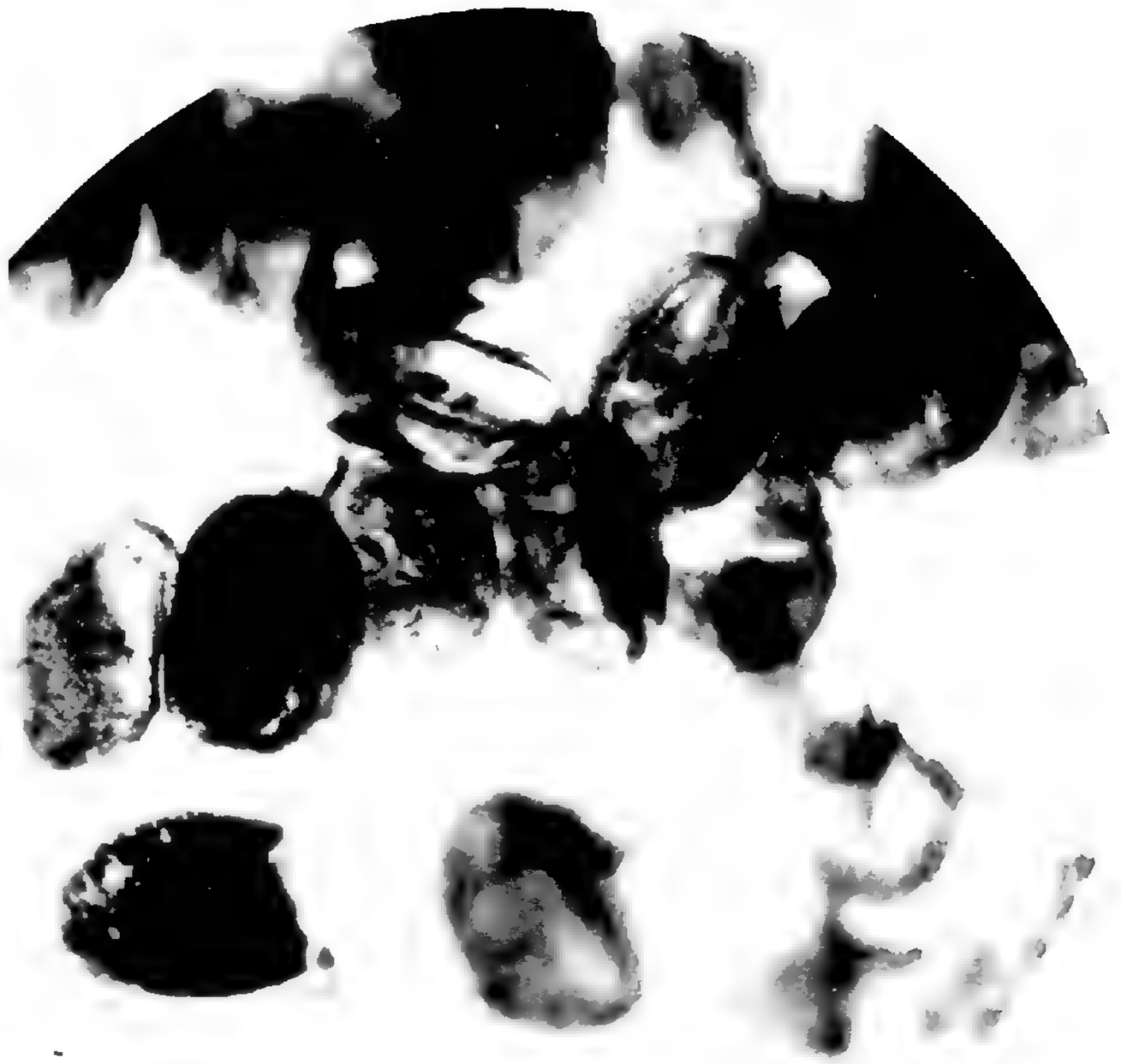
Hirmer *(8)* has arranged what he considers to be a

EXPLANATION OF THE ILLUSTRATION

CODONOTHECA CADUCA *Sellards*

Upper figure: Photograph of a nitrocellulose peel showing pollen-grains with the two furrows and the two dark bodies which bear some resemblance to nuclei. Peeled from specimen No. 5033. Photographed with a red filter.

Lower figure: Photograph of the same peel photographed without filters, showing apparently a single furrow.



phylogenetic series of micro-sporangiate structures beginning with the typical *Asterotheca*, then through *Asterotheca truncata* to *Crossotheca pinnatifida* to the typical *Crossotheca* to the *Whittleseyineae.*

It is not clear, however, whether this is only an implied transition from a typical fern synangium through pendulous encapsulated sporangia to the typical radial structure characteristic of the *Whittleseyineae*, or whether it is a genetically related series.

Thus we come to a brief consideration of the two genera under discussion: *Codonotheca* and *Crossotheca.*

Codonotheca is known to be a pteridosperm, its "pollen" (=microspores) are typically cycadean, and it belongs clearly to the *Whittleseyineae.*

Crossotheca is probably pteridospermous, but there remains the possibility that at least some of its species are filicinean. In *Crossotheca sagittata*, we may be dealing with a fern whose spores are typically pteropsid and are apparently unicellular.

The difference in spore structure may not be serious, for *Crossotheca* is attributed to the *Lyginopterideae*, the most primitive group of pteridosperms, while *Codonotheca* belongs to the later-derived medullosans.

A careful investigation into the phylogeny and relationships of the seed-ferns reveals at once the scarcity of precise data. The order *Medullosae* is characterized by large ellipsoidal pollen borne in elongate, tubular sporangia, which may be fused into a seed-like synangium. On the other hand, from a survey of the available data and materials, it is not possible to circumscribe the limits of the *Lyginopterideae*, nor even to recognize with certainty the nature of their microsporangia. *Crossotheca*, although probably referable to the lyginopterids, may yet prove to be filicinean.

BIBLIOGRAPHY

(1) Arnold, C.A. 1935 Contrib. Mus. Paleont., Univ. Mich. 4: 279-282.

(2) Benson, M. 1904 Ann. Bot., 18: 161.

(3) Bunbury, C. 1847 Quart. Journ. Geol. Soc., 3: 425.

(4) Chamberlain, C.J. 1935 Gymnosperms, p. 24.

(5) Crookall, R. 1930 Ann. Bot., 44: 621-637.

(6) Halle, T.G. 1929 Kungl. Svensk. Vetensk. Handl., Bd. 6 No. 8.

(7) Halle, T.G. 1933 Kungl. Svensk. Vetensk. Handl., Bd. 12 No. 6.

(8) Hirmer, M. 1932 Palaobotanik, Fortschritte der Botanik, Bd. 1.

(9) Kidston, R. 1905 Proc. Roy. Soc. B. 76: 358-360

(10) Lesley, J.P. 1889 Dictionary of Fossils of Pennsylvania p. 606.

(11) Lesquereux, L. 1880 Coal Flora Vol. 1.

(12) Newberry, J.S. 1860 Geol. Rept. Ohio, Paleont., 6: 384.

(13) Sellards, E.H. 1902 Am. Journ. Sci., 14: 196-198.

(14) Sellards, E.H. 1903 Am. Journ. Sci., 16: 87-95.

(15) Stockmans, F. 1933 Mem. Mus. Roy. Hist. Nat. Belg. No. 57, p. 22.

(16) see, Twenholfel, W. 1932 Treatise on Sedimentation (Rev. Ed.) p. 360.

(17) Wodehouse, R.P. 1935 Pollen Grains p. 227.

(18) Zeiller, R. 1883 Ann. Sci. Nat. (Bot.), ser. 6, Vol. 16.

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THE NOMENCLATURE OF THE CULTIVATED SORGHUMS

BY

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THE CULTIVATED SORGHUMS in the United States may readily be separated into four cultural groups: (1) the grass sorghums, which include Johnson grass, Sudan grass and Tunis grass; (2) the sweet or saccharine sorghums, commonly known as sorgos; (3) the grain or non-saccharine sorghums, which comprise durra, feterita, hegari, kaoliang, milo and shallu; and (4) the broomcorns.

The determination of the taxonomic identity of these plants, however, is a difficult matter, and their nomenclature has long been in an unusually chaotic state. In consequence, the greater part of the literature dealing with sorghums in the United States has made little or no reference to the scientific names.

Several causes have been responsible for this state of affairs. The normally complicated nomenclature of any group with numerous horticultural forms has, in this instance, been further confused by the fact that the sorghums have been referred at various times to at least three distinct genera: *Andropogon*, *Holcus* and *Sorghum*. There has also existed a considerable difference of opinion among taxonomists as to whether the several races should be accorded a varietal or a specific status. Finally the identity of certain of the forms has been in

doubt. This has been particularly true in the case of milo and kaoliang, which are not listed in such authoritative manuals as Bailey *(1)* and Hitchcock *(2)*.

Within the last few years considerable progress has been made toward a better and more accurate understanding of the group. The typification of the generic name *Holcus* by *H. lanatus* L., in accordance with the rules of the Sixth International Botanical Congress, has rendered the generic name *Sorghum* available for the cultivated sorghums. This eliminates the confusion which arises when these plants are considered as species and varieties of *Holcus*.

In 1935, J. D. Snowden published a classification of the cultivated sorghums *(3)* and followed this, in 1936, by an exhaustive monograph *(4)* dealing with all the cultivated races of sorghum. In this latter work the author discusses the taxonomic position and botanical history of the various types in great detail, and gives, as well, much valuable information in regard to the cultural features of the plants concerned. Snowden, following the European custom, considers the chief groups of *Sorghum* to be distinct species, and lists some 31 species, 158 varieties and 524 unnamed forms. Probably few American botanists will care to adopt this treatment, preferring to treat the majority of the cultivated forms as varieties of a single polymorphic species. Snowden, nevertheless, has made a distinct contribution and one that should be acceptable to everyone, in that he makes clear the identity of all the larger groups, indicating their nomenclatorial history and citing full synonymy as well. As a result of his work one can now list the American sorghums more completely and more accurately than has hitherto been possible.

The object of this paper is to assign names to those sorghums which are not treated in Bailey or Hitchcock,

and to indicate a few changes in the citation of authorities as well. No attempt will be made to reconcile all the kinds of sorghum grown in this country with one or another of Snowden's species or varieties; nor to discuss the several nomenclatorial changes which he proposes.

For the sake of clarity all the larger groups of American Sorghums will be listed below, irrespective of whether or not any nomenclatorial changes are herein indicated. With the exception of the grass sorghums, they will be treated as varieties of *Sorghum vulgare* Pers., following the custom usual in this country. The several grass sorghums, on the other hand, will be considered as distinct species, a practice rather generally adopted in the United States as well as in Europe.

The Cultivated Sorghums in the United States.

1. **Sorghum halepense** *(L.) Persoon* Syn. Pl. 1 (1805) 101. Johnson grass.

   Holcus halepensis Linnaeus Sp. Pl. (1753) 1047.

2. **Sorghum sudanensis** *(Piper) Stapf* in Prain Fl. Trop. Afr. 9 (1917) 113. Sudan grass.

   Andropogon Sorghum Brot. var. *sudanensis* Piper in Proc. Biol. Soc. Wash. 28 (1915) 33.

   Holcus sudanensis L. H. Bailey Gentes Herb. 1 (1923) 132.

   Sorghum vulgare Pers. var. *sudanense* (Piper) Hitchcock in Journ. Wash. Acad. Sci. 17 (1917) 147.

3. **Sorghum virgatum** *(Hack.) Stapf* in Prain Fl. Trop. Afr. 9 (1917) 111. Tunis grass.

   Andropogon Sorghum Brot. subsp. *halepensis* Hack. var. *virgatus* Hackel in DC. Monogr. Phan. 6 (1889) 504.

   Holcus virgatus L. H. Bailey Gentes Herb. 1 (1923) 132.

4. **Sorghum vulgare** *Persoon* Syn. Pl. 1 (1805) 101. Sorghum.

Holcus Sorghum Linnaeus Sp. Pl. (1753) 1047.
Andropogon Sorghum Brotero Fl. Lusit. 1 (1804) 88.

var. **bicolor** *(L.) Persoon* Syn. Pl. 1 (1805) 101. Gooseneck sorgo.

Holcus bicolor Linnaeus Mant. Alt. (1771) 301.
Sorghum bicolor Moench Meth. Pl. (1794) 207.

var. **caffrorum** *(Retz.) Hubbard & Rehder* in Bot. Mus. Leaflets Harv. Univ. 1 (1932) 10 (Published as var. *caffrorum (Thunb.)* Hubbard & Rehder). Kafir.

Panicum caffrorum Retzius Obs. Bot. 2 (1781) 7.
Holcus caffrorum Thunberg Prod. Pl. Cap. (1794) 20.
Sorghum caffrorum Beauvois Agrost. (1812) 131, 178.
Holcus Sorghum L. var. *caffrorum* L. H. Bailey Gentes Herb. 1 (1923) 133.

In addition to the various kafirs, Snowden includes hegari and several of the sweet sorghums, such as Orange Sorgo and closely related types, in this variety.

var. **caudatum** *(Hack.) A. F. Hill comb. nov.* Feterita.

Andropogon Sorghum Brot. subsp. *sativus* Hack. var. *caudatus* Hackel in DC. Monogr. Phan. 6 (1889) 517.
Sorghum caudatum Stapf in Prain Fl. Trop. Afr. 9 (1917) 131.
Holcus Sorghum L. var. *caudatus* L. H. Bailey Gentes Herb. 1 (1923) 133.

var. **cernuum** *(Ard.) Fiori & Paoletti* Icon. Fl. Ital. (1895) 14. White durra.

Holcus cernuus Arduino in Saggi Sci. e Lett. Padova 1 (1786) 128, t. 3, figs. 1 & 2.

Sorghum cernuum Host Gram. Aust. 4 (1809) 2, t. 3.

Snowden clearly indicates that the White durra or Jerusalem corn belongs to a different race from the Brown durra (var. *Durra*).

var. **Drummondii** *(Nees) Chiovenda* in Result. Sci. Miss. Stefan.-Paoli. Somal. Ital. 1 Coll. Bot. (1916) 224. Chicken corn.

Andropogon Drummondii Nees in Steud. Syn. Pl. Glum. 1 (1854) 393.

Sorghum Drummondii Nees ex Steudel Syn. Pl. Glum. 1 (1854) 393 in synon.—Millspaugh & Chase in Publ. Field Columb. Mus. Bot. 3 (1903) 21.

Holcus Sorghum L. var. *Drummondii* Hitchcock in Proc. Biol. Soc. Wash. 29 (1916) 128.

Sorghum vulgare Pers. var. *Drummondii* (Nees) Hitchcock in Amer. Journ. Bot. 21 (1934) 139.

This variety is not grown at the present time and is of historical interest only.

var. **Durra** *(Forsk.) Hubbard & Rehder* in Bot. Mus. Leaflets Harv. Univ. 1 (1932) 10. Brown durra.

Holcus durra Forskal Fl. Aegypt.-Arab. (1775) 174.

Sorghum Durra Stapf in Prain Fl. Trop. Afr. 9 (1917) 129.

Holcus Sorghum L. var. *Durra* L. H. Bailey Gentes Herb. 1 (1923) 132.

var. **nervosum** *(Besser ex Schult.) Forbes & Hemsley* in Journ. Linn. Soc. Bot. 36 (1904) 368. Kaoliang.

Sorghum nervosum Besser ex Schultes in Roem. & Schult. Syst. Veg. Mant. 3 (1827) 669.

var. **nigricans** *(Ruiz & Pav.) A. F. Hill comb. nov.* Sumac sorgo.

Milium nigricans Ruiz & Pavon Fl. Peruv. et Chil. 1 (1798) 47.

Sorghum nigricans (Ruiz & Pav.) Snowden in Kew Bull. (1935) 244.

var. **Roxburghii** *(Hack.) Haines* Bot. Bohar. & Orissa, pt. 5 (1924) 1034. Shallu.

Andropogon Sorghum Brot. subsp. *sativus* Hack. var. *Roxburghii* Hackel in DC. Monogr. Phan. 6 (1889) 510.

Sorghum Roxburghii Stapf in Prain Fl. Trop. Afr. 9 (1917) 126.

Holcus Sorghum L. var. *Roxburghii* L. H. Bailey Gentes Herb. 1 (1923) 132.

Sorghum vulgare Pers. var. *Roxburghii* (Stapf) Haines of Hitchcock's Manual.

var. **saccharatum** *(L.) Boerlage* in Ann. Jard. Bot. Buitenzorg 8 (1890) 69. Sorgo.

Holcus saccharatus Linnaeus Sp. Pl. (1753) 1047, emend. Sp. Pl. 2 (1763) 1484.

Sorghum saccharatum Moench Meth. Pl. (1794) 207.

Holcus Sorghum L. var. *saccharatus* L. H. Bailey Gentes Herb. 1 (1923) 132.

Holcus dochna Forskal Fl. Aegypt.-Arab. (1775) 174.

Sorghum dochna (Forsk.) Snowden in Kew Bull. (1935) 234.

The sorgos are a much more heterogeneous group than the other sorghums and are referred by Snowden to several varieties. Many of them, particularly the Amber and Honey sorgos, belong here; other types are referred to var. *bicolor*, var. *caffrorum*, or var. *nigricans*.

For various reasons Snowden considers *Holcus saccharatus* L. to be a *nomen dubium*, and takes up instead Forskal's name for this plant.

var. **subglabrescens** *(Steud.) A. F. Hill comb. nov.* Milo.

Andropogon subglabrescens Steudel Syn. Pl. Glum. 1 (1854) 393.

Sorghum subglabrescens Schweinfurth & Ascherson in Schweinf. Beitr. Fl. Aethiop. (1867) 302, 306.

var. **technicum** *(Koern.) Fiori & Paoletti* Fl. Anal. Ital. 1 (1896) 46. Broomcorn.

Andropogon Sorghum Brot. var. *technicum* Koernicke in Koern. & Wern. Handb. Getreidebau 1 (1885) 308.

Sorghum technicum Battandier & Trabut Fl. Algér. Monocot. (1895) 128.

Sorghum vulgare Pers. var. *technicum* (Koern.) Jávorka Magyar Fl. 1 (1924) 63 according to Hitchcock's Manual.

Holcus Sorghum L. var. *technicus* L. H. Bailey Gentes Herb. 1 (1923) 132.

Sorghum dochna (Forsk.) Snowden var. *technicum* (Koern.) Snowden in Kew Bull. (1935) 235.

Broomcorn is considered to be a variety of Sorgo by Snowden and several other taxonomists.

BIBLIOGRAPHY

(1) Bailey, L. H. Manual of Cultivated Plants. The Macmillan Co. New York. 1925.

(2) Hitchcock, A. S. Manual of the Grasses of the United States. U.S. Dept. Agric., Misc. Publ. 200. Washington. 1935.

(3) Snowden, J. D. A Classification of the Cultivated Sorghums. Kew Bulletin (1935) 221-255.

(4) —— The Cultivated Races of Sorghum. Adlard and Sons, Ltd. London. 1936.