

Vol. 8 MARCH · 1945 No. 1

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ZOOLOGICAL GARDEN 466

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LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

The Genus Chlorotettix (Homoptera-Cicadellidae) in Mexico

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BOOK NO. 1086

Several species of Chlorotettix have been described from Me Central American material, but no attempt has previously bee bring together the species occurring in that country and to ex type material, dissect the genital structures and establish the morphological characters for these and other tropical species, thereby determining the authenticity and synonymy of the group of species previously described. In view of the fact that most species have variable or no definite color markings and resemble each other very closely superficially, and that certain species may vary greatly in the intensity of color markings, it is logical that synonymy would occur easily unless the genital structures were used in formulating these descriptions. Furthermore, certain of the types have not been available for efficient study or dissection and this has further confused the problem of the species of this genus. In addition to the subtropical and exotic types in the author's collection, the type material in the collections of Professor Herbert Osborn, the National Museum, the California Academy of Science and the Carnegie Museum have been of particular value in this study.

Ten species previously described—*scutellatus*, *minimus*, *curvidens*, *vividus*, *tethys*, *emarginatus*, *lebatus*, *necopinus*, *nudatus* and *vittatus* are treated in the following pages. Seventeen species are described as new which occur in Mexico, Central America or Brazil. Twelve species which occur either in the southwestern United States along the Mexican border, in the southeastern Gulf States and Texas or in Central or South America but which have not yet been found in Mexico have also been included in this discussion. They are *orbonatus*, *vividus*, *lucidus*, *nigromaculatus*, *aberrans*, *bakeri*, *breviceps*, *delicatus*, *luteolus*, *truncatus*, *floridanus* and *aurum*.

The synonomy which has been established in the present paper shows *pallidus* Brown = *scutellatus* Osborn; *lineatus* Osborn = *minimus* Baker; *serratus* DeLong = *curvidens* Osborn; *dilutus* Osborn = *bidentatus* De Long = *tethys* V.D.

With few exceptions the known Mexican species of Chlorotettix are tropical in distribution and occur at fairly low altitudes. The four species—*vittatus* Osborn, *viridius* V.D., *nudatus* Ball and *minimus* Baker have been taken only at altitudes of a few hundred feet. Several others have a greater range in altitude as tropical forms. *C. tethys* V.D., *emarginatus* Baker and *bipartitus* DeLong have been collected near sea level at El Mante, Tamps., other low altitude localities and up to some 2500 feet at Igula, Gro. Three species, *necopinus* V.D., *curvidens* Osborn, and *scutellatus* Osborn, are undoubtedly tropical but vary in elevation from near sea level to some 3000 to 3500 feet. A species described at this time, *nigrolabes*, has been found as low as 300 feet elevation in Guerrero and as high as 5000 feet at Lake Chapala and Guadalajara in Jalisco. Three species particularly, *lobatus* Osborn, *striatus* DeLong, and *redimiculus* DeLong seem to be at the upper limit of the tropical range occurring only at elevations of 3000 to 3500 feet. Further collecting may show these to have a much wider range in altitude. Another group of species represented by *venosus* DeLong, *brunneus* DeLong, *subfuscus* DeLong and *obscurus* DeLong are apparently neotropical forms and occur entirely in that zone at elevations of from 4000 to 5000 feet. These occur in the pine association and some of them have been collected only from pine. Few species seem to occur at or be limited to high altitudes. *C. inscriptus* DeLong has been taken at an elevation of 7500 feet at Mexico City but also as low as 3500 feet at Orizaba. The only species which seems to be limited to an alpine habitat is *C. pinus* DeLong occurring on pines at 10,000 feet.

KEY TO SPECIES OR GROUPS OF SPECIES OF CHLOROTETTIX*

1. Color some shade of green, yellow or white without distinct dark color markings 2
1′. Dark brown or smoky, or pale with distinct dark color markings 5
2. Smaller in size, not exceeding 5.5 mm. in length 3
2′. Larger, 6 mm. or more in length 4
3. Vertex distinctly angled and produced ..... *vividus, lucidus*
3′. Vertex bluntly or broadly rounded, not angled ..... *tethys, minimus, beeryi, variabilis* (in part), *truncatus, delicatus, aberrans, orbonatus, bakeri, undatus.*
4. Vertex broadly rounded, scarcely produced at middle ..... *viridius, spinosus, breciceps.*
4′. Vertex produced, blunt, rounded at apex or bluntly angled ..... *nudatus, bipartitus, emarginatus, floridanus, aurum.*
5. Dark brownish green, smoky or brown 6
5′. Usually paler with distinct dark markings 11
6. Brownish green without distinct markings 7
6′. Brownish green or brown with transverse markings on vertex 9
7. Two proximal dark spots on anterior margin of pronotum ..... *venosus.*
7′. Without a pair of dark spots on anterior margin of pronotum 8
8. Small in size female 6 mm. in length ..... *obscurus*
8′. Larger in size female 8 mm. in length ..... *subfuscus*
9. With a faint transverse line between ocelli and a dark brown spot on either side at base ..... *pinus*

* The key is based upon the more common or conspicuous color markings. A detailed key based upon the genital characters seems unnecessary since the illustrations of these characters are included.

9'. A dark transverse line just above vertex margin between ocelli 10
10. Vertex angled, transverse line pale ..... *brunneus*
10'. Vertex broadly rounded, transverse line broad and black ..... *bicoloratus*
11. A dark brown stripe along commissure of elytra ..... *variabilis* (in part)
11'. Without dark coloration along commissure of elytra 12
12. Vertex with a distinct, but often narrow transverse brown band between eyes 16
12'. Vertex without distinct transverse makings between the eyes 13
13. White or yellow with distinct oblique lines on elytra 14
13'. Yellowish or green without oblique lines 15
14. White—scutellum with dark brown spots in basal angles ..... *vittatus*
14'. Yellow—basal angles of scutellum not dark ..... *luteolus*
15. Vertex with two round black dots at base ..... *nigrolabes*
15'. Without black spots on base of vertex, basal angles of scutellum with dark spots ..... *striatus, curvidens*
16. Size not exceeding 7 mm. in length 17
16'. Size 7.5 to 8 mm. in length 20
17. Not exceeding 5.5 mm. in length 18
17'. From 6 to 7 mm. in length 19
18. A pair of large, round, black spots on rounded margin just below ocelli ..... *nigromaculatus*
18'. Without black spots on margin of vertex ..... *recurvatus*
19. Basal angles of scutellum dark brown to black without definite markings on pronotum ..... *scutellatus*
19'. Basal angles not dark brown, a transverse row of brown spots across middle of pronotum ..... *inscriptus*
20. Transverse band between eyes narrow, basal angles of scutellum with dark spots ..... *lobatus latocinctus*
20'. Transverse band between eyes broad, basal angles of scutellum without dark spots ..... *necopinus redimiculus*

CHLOROTETTIX NECOPINUS V.D.

Chlorotettix necopinus V.D. Can. Ent. **25**: 282, 1893.

A large species with a broad black band between the eyes. Length 7.5–8 mm.

Vertex broad, blunt, scarcely angled, a little longer at middle than next the eyes, more than twice as wide between eyes at base as median length.

Color pale, marked with brown and black. Vertex dull yellow with a broad transverse black band between the anterior portion of the eyes. Pronotum dull brown with an irregular row of darker spots almost parallel to and not far posterior to anterior margin. Scutellum pale with a triangular dark spot in each basal angle and a median dark stripe in center. Elytra brownish veins paler. Face pale brown with short dark arcs on each side of middle.

Genitalia: Female last ventral segment with lateral angles strongly produced and rounded. Posterior margin broadly deeply excavated more than halfway to the base. The sides of the V-shaped excavation concavely rounded with a short produced tooth at apex. Male plates, short, broad, convexly rounded and constricted before apex to form a thick finger-like tip. Style broad at base, rather short, apical third rapidly tapered to a pointed apex. Aedeagus gradually widened from connective to truncate apex. In lateral view it appears narrowed to apex, the ventral portion is

convexly rounded. At the apex a long blade-like structure extends dorsally and a very short blade extends ventrally.

Specimens are at hand from Valles, S. L. P., elevation 312 ft. December 1, 1938 and September 24, 1941; Santa Engracia, Mex., elevation 1050, November 11, 1938; Tamazunchale, S. L. P., elevation 687 ft., November 15, 1938 and September 25, 1941 and Fortin, Ver., elevation 3281 ft., October 9, 1941, all collected by J. S. Caldwell, E. E. Good, C. C. Plummer, and the author.

Chlorotettix inscriptus n. sp.

Resembling *necopinus* superficially but with a more angled vertex and a more narrowed dark band between the eyes. Length 6.5–7 mm.

Vertex produced and bluntly angled, about one-third longer at middle than length next the eyes, more than twice as wide between eyes at base as median length.

Color pale brown with dark brown markings. Vertex with a narrow black band extending between anterior margins of the eyes, which is bent forward at the middle. Pronotum mottled with darker brown. Scutellum with a short transverse line at middle and two round dots just anterior to it. Elytra brownish subhyaline with paler veins. Face with conspicuous dark arcs either side of middle.

Genitalia: Female last ventral segment with lateral angles produced and rounded to concavely excavated posterior margin. The central fourth of margin is slightly produced and feebly notched. About two-thirds of the margin is embrowned. Male plates long, apices broad and rounded. Style tapered from a broad base to a bluntly pointed apex. It is slightly abruptly narrowed at about four-fifths its length on the outer margin. Aedeagus curved with the basal and apical portions extending dorsally. The apical portion is notched forming a pair of short terminal spines and just below these is a pair of short lateral processes. The pygofer is convexly rounded to ventral margin and bears a short spine on apex of ventral margin and a pair of spines at about middle of apical portion.

Holotype male, allotype female and paratype female collected at Mexico City, D.F., elevation 7500 ft., September 1 to 5, 1939, by C. C. Plummer and the author. Female paratype collected at Zimapan, Hidalgo, elevation 6000 ft., September 26, 1941, by Good and DeLong. Male paratypes from Orizaba, elevation 3500 ft. Ver., October 17, 1941, by Plummer, Good, Caldwell and DeLong. Paratype male collected at Jacala, Hidalgo, September 26, 1941, by Caldwell, Good and the author.

Chlorotettix redimiculus n. sp.

Resembling *necopinus* in form and coloration but with a blunter head and distinct genitalia. Length 8 mm.

Vertex bluntly angled, almost rounded, slightly longer at middle than

next the eyes and two and one-half times as wide between eyes at base as median length.

Color: Dull yellow with black and brown markings. The extent and intensity of the markings are variable. Vertex with a broad black transverse band between the anterior portion of the eyes. The entire basal two-thirds of the vertex is often black. Pronotum with anterior marginal third pale, the posterior portion black. Scutellum pale to dark brown. Elytra brown to black, veins pale. Face pale brown with traces of dark arcs on each side.

Genitalia: Female last ventral segment with strongly produced lateral angles which are rounded at apex. Posterior margin forming a broad, deep, U-shaped notch which extends halfway to the base of the segment and bears a conspicuous short tooth at its apex. Male plates concavely narrowed on apical half to form blunt pointed apices which curve to inner margin. Style long, broad at base tapered to a blunt pointed apex. Aedeagus broad and thick directed caudally notched at middle of apex forming a rather broad lobe on either side. Pygofer with a long rather narrow spine extending from the dorsal apical portion to ventral apical margin where it is sharp pointed.

Holotype male, allotype female and male and female paratypes collected at Orizaba, Ver., elevation 3500 feet, October 8, 1941. Male and female paratypes from Cordoba, Ver., elevation 3000 feet, October 8, 1941; Fortin, Ver., October 9, 1941, all collected by J. S. Caldwell, C. C. Plummer, E. E. Good and the author.

Superficially this species can scarcely be distinguished from *necopinus* and if it were not for the distinct male genital structures it might be considered as a color variation of *necopinus*.

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Chlorotettix latocinctus n. sp.

Resembling *necopinus* in general appearance but with distinct coloration and genitalia. Length 7.5 mm.

Vertex broadly rounded, scarcely produced, a little longer at middle than next the eyes, almost three times as wide between eyes at base as median length.

Color yellow to pale brown. A pale brown band on vertex margin and a darker transverse band just above margin between ocelli. Anterior portion of pronotum yellow with brownish spots. Posterior portion dark brown. Scutellum yellow with a central dark brown stripe and basal angles with dark brown spots. Elytra smoky, veins pale, brown margined. Face with dark arcs either side of median pale area.

Genitalia: Female last ventral segment strongly produced and rounded on anterior margin to a central notch at apex which is short and narrow. Male plates narrowed at about half their length on outer margin, apices

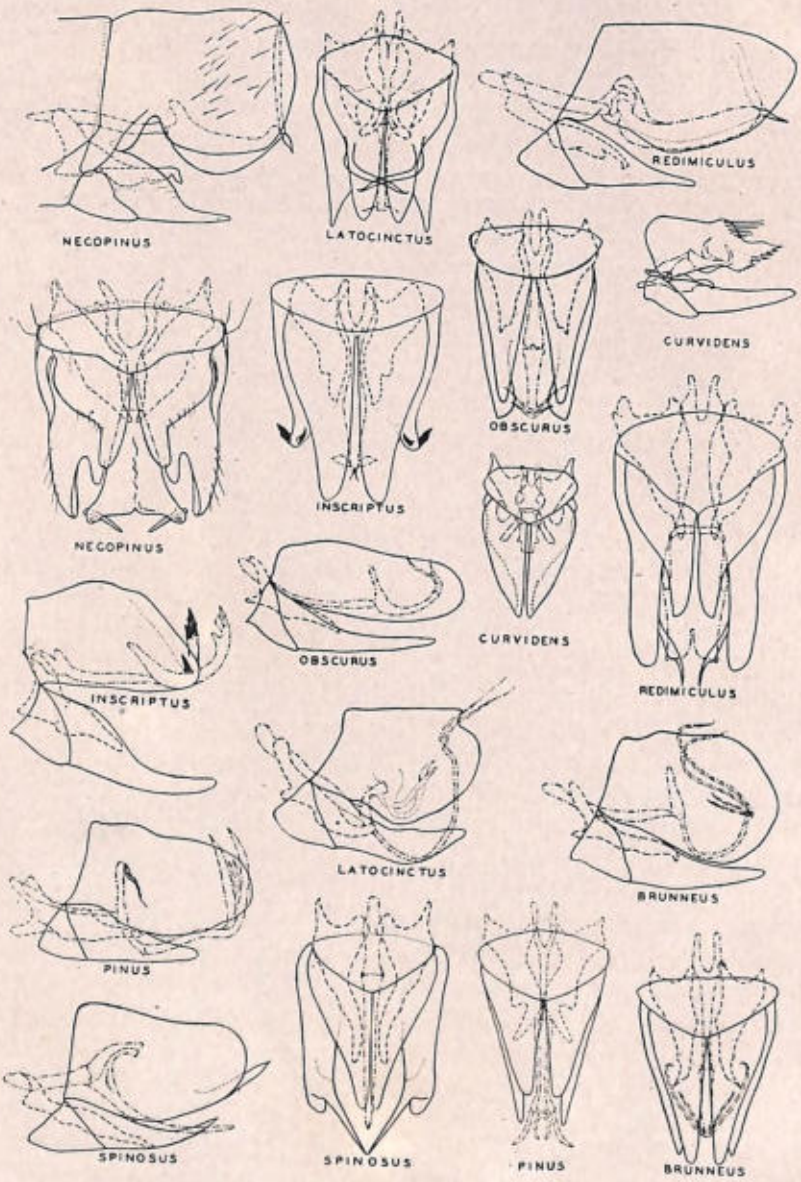


PLATE 1.—Lateral and ventral views of male genital structures in normal position, of species as labeled.

bluntly angled. Style broad at base, rapidly narrowed and produced as a narrow outwardly curved apex which is blunt at the tip. Aedeagus long and slender. The basal portion extends dorsally. The apical third is bifid forming two long slender apical processes which extend dorsally and caudally. A conspicuous pygofer spine arises at about middle of pygofer curves ventrally then inwardly crossing the median line.

Holotype male, allotype female and male and female paratypes collected at Vicosa, Brazil, in November 1929, by Edson Hambleton.

Chlorotettix bicoloratus n. sp.

Resembling *latocinctus* in form and general appearance but with distinct color markings and genitalia. Length 8 mm.

Vertex broadly rounded, scarcely produced; length at middle equalling length next the eyes. More than three times as wide between the eyes at base as median length.

Color: Vertex black with a pale transverse band on base, broken at middle and not quite reaching to the eyes. Ocelli pale. Pronotum with anterior one-third pale with black spots on the middle third. Posterior two-thirds black. Scutellum with anterior half black and posterior half white, with four white spots about equally spaced along anterior margin. Elytra dark, smoky, veins paler. Face black with short pale arcs either side of middle. Ventral abdomen orange yellow, last ventral segment and pygofer black.

Genitalia: Female last ventral segment with produced rounded lateral angles. Posterior margin broadly excavated about half way to the base. The apex of the notch with two small black approximate teeth.

Holotype female collected at Vicosa, Brazil, November 1929, by Edson Hambleton.

Chlorotettix obscurus n. sp.

Resembling *tergatus* in general form and color but smaller and with distinct genitalia. Length 5.5–6 mm.

Vertex broad, bluntly angled and produced about two-thirds its length before the anterior margins of the eyes. About one-third longer at middle than next the eyes and more than twice as wide between eyes at base as median length.

Color brown tinged with green, the vertex paler than pronotum and scutellum. Face greenish with darker arcs either side of a median longitudinal band.

Genitalia: Female last ventral segment with lateral angles broadly rounded to posterior margin forming a broadly rounded lobe either side of a median V-shaped notch reaching about half way to base of segment. The

apex of notch is narrow and brown margined. Male plates long, tapered to blunt apices. Style broad, rather short, apical half narrowed to a blunt apex with a pointed tooth on outer apical margin. Aedeagus rather short, broadly U-shaped with the basal portion curved dorsally and the apical portion curved dorsally and forming four conspicuous apical processes. The outer pair are longer than the inner pair and all extend dorsally.

Holotype male, allotype female and male and female paratypes collected at Carapan, Michoacan, elevation 5000 ft., October 2, 1941, by E. E. Good, J. S. Caldwell, C. C. Plummer and the author.

Chlorotettix pinus n. sp.

Resembling *tergatus* in form and coloration but much smaller in size and with distinct genitalia. Length 6.5 mm.

Vertex broadly rounded, length at middle not exceeding length next the eyes, appearing parallel margined.

Color pale brownish with dark brown markings. Vertex with a pale line between the ocelli and a dark brown spot on either side at base. Pronotum with dark brown mottled spots on the anterior half and posterior half dark brown. Scutellum pale with basal angles dark brown and a pair of small round brown spots at middle. Elytra brownish subhyaline the veins inconspicuous. Face with a row of dark brown arcs either side of a broad middle pale area.

Genitalia: Female last ventral segment with lateral angles broadly rounded to posterior margin forming a rounded lobe either side of a rather broad V-shaped median notch which extends to base of segment and is embrowned at apex. Male plates long, triangular, apices blunt, rounded. Style rather broad, deeply notched on outer margin at two-thirds its length so as to form an outwardly curved fingerlike apex curving from the inner margin. Aedeagus long and rather slender curving dorsally to form a long erect processs at base and curving dorsally at apex and forming four terminal processes. The outer pair are longer, heavier and divergent; the inner pair are shorter, more slender and convergent.

Holotype male, allotype female and male and female paratypes collected at an elevation of 10,000 feet from pine 43 kilometer south of Mexico City, September 5, 1939, by C. C. Plummer and the author. Male and female paratypes were collected from pine near the same locality at LaGuardia, Mor., October 26, 1941, by E. E. Good and the author. Types in author's collection.

Chlorotettix subfuscus n. sp.

Resembling *tergatus* in general appearance and coloration but with distinct genitalia. Length female 8 mm.

Vertex produced and bluntly angled, one-third longer at the middle than

length next eyes, more than twice as wide between eyes at base as median length.

Color brown tinged with green, veins pale.

Genitalia: Female last ventral segment long. Posterior margin broadly rounded either side of a broad, shallow median V-shaped notch about half the width of the segment and extending only a small portion of the distance to base.

Holotype female and female paratype collected at Carapan, Mich, Mexico, elevation 5000 ft., October 2, 1941, by Plummer, Caldwell, Good and DeLong.

Chlorotettix venosus n. sp.

In general appearance resembling *nudatus* but with distinct markings and genitalia. Length 7.5–8 mm.

Vertex produced, broad and bluntly angled, only slightly longer at middle than next the eyes and almost three times as wide between eyes at base as median length.

Color pale brown with darker markings. Vertex with pale ocelli. A pale waved line just beneath ocelli and a brown waved line passing through ocelli just above the pale line. Pronotum with irregular brown mottling. Basal angles of scutellum with dark brown spots. Veins of elytra pale margined with brown. Face pale with darker arc on either side of a central longitudinal band. Three small black dots arranged in a triangle just beneath apex of vertex. A heavy black quadrate spot just back of eye on lateral margin of pronotum.

Genitalia: Female last ventral segment with produced rounded lateral angles between which the posterior margin is broadly deeply notched, about two-thirds the distance to the base. A black spot on each side of the V-shaped notch at base. Male plates long, tapered to a blunt, rounded apex. Style with central portion narrowed. Outer margin conspicuously notched near apex, inner margin strongly curved, forming a blunt pointed apex which is bent outwardly. Aedeagus rather long and slender. The basal portion is long and erect. The apex is composed of four long slender processes. The two outer processes are longer than the inner pair and all extend dorsally.

Holotype male, allotype female and male and female paratypes collected at Tuxpan, Michoacan, Mexico, elevation 4002 ft., October 5, 1941. Paratype male collected at Zamora Michoacan, elevation 5140, October 2, 1941, by C. C. Plummer, E. E. Good, J. S. Caldwell and the author.

Chlorotettix brunneus n. sp.

Resembling *venosus* in general form and appearance but with more produced head and distinct genitalia. Length 7 mm.

Vertex produced and bluntly angled, about twice as long at middle as length next eyes. More than twice as wide between eyes at base as median length.

Color pale brown. A darker line just above vertex margin between ocelli. Pronotum brown, somewhat mottled. Scutellum with basal angles dark brown. Elytra brownish subhyaline, veins pale margined with brown.

Genitalia: Female last ventral segment with lateral angles produced and rounded forming a broad lobe either side of a broad deep excavation on the posterior margin at the bottom of which is an almost truncate, brown margined, median third which is slightly notched at middle. Male plates rather long, tapered to blunt rounded apices. Plate broad at base tapered to a narrow apex which appears almost truncate but slopes to a sharp point on the outer margin. Aedeagus narrow forming a V-shaped loop. The base is thickened and is erect. The apex is composed of four narrow terminal processes. Two are rather short and the other two are three times as long. All four are directed dorsally and anteriorly.

Holotype male, allotype female and male paratypes collected at Chilpancingo Guerrero, Mexico, elevation 4488 feet, October 25, 1941, by E. E. Good and the author.

CHLOROTETTIX VIRIDIUS V.D.

Chlorotettix viridius V.D. Psyche 6: 309, 1892.

A small species with broadly rounded head, apple green in color and with distinct genitalia. Length 6–6.5 mm.

Vertex broadly rounded, scarcely longer at middle than next the eyes and more than two and one-half times as wide between eyes at base as median length.

Color bright apple green, eyes usually dark.

Genitalia: Female last ventral segment with lateral angles produced and angled. The posterior margin forming a broad V-shaped notch with a prominent rounded tooth at about the middle on either side. Male plates short and broad, convexly rounded to form bluntly pointed apices. Style broad at base, constricted between base and a slightly widened, truncate apex. Aedeagus in lateral view curved upwardly at apex and appearing excavated at middle. The tip is narrow and bifid forming a pair of short, pointed teeth.

Specimens are at hand from Laredo, Nuevo Leon, elevation 600 ft., December 6, 1938 (Caldwell), and Loma Bonita, Oaxaca, June 8, 1937 (M.F. 6070A), collected by Dampf. It is undoubtedly more widely distributed than these records indicate.

Chlorotettix spinosus n. sp.

Resembling *viridius* in form but smaller with rounded head and distinct genitalia. Length male 6 mm.

Vertex broadly rounded scarcely produced, length at eyes almost as great as length at middle, more than twice as wide between eyes at base as median length.

Color yellowish tinged with green.

Genitalia: Male plates elongate, triangular, with narrow, pointed apices. Style long, broad at base, narrowed at one-third its length and tapered to blunt pointed apices. Aedeagus thickened at base with a conspicuous dorsally curved portion. It tapers from the base to a slender pointed apex which extends caudally. The pygofer bears a long heavy spine on the ventral margin near the apex which extends dorsally and caudally.

Holotype male and paratype male collected at Buena Vista, Guerrero, Mexico, elevation 3400 ft., October 23, 1943, from meadow grasses by E. E. Good and the author.

CHLOROTETTIX ABERRANS Osb.

Chlorotettix aberrans Osb. Anns. Carn. Mus. **15**: 72, 1923.

A small blunt headed yellowish species. Length 5.5 mm.

Vertex blunt but somewhat produced at middle, one-fourth longer at middle than length next eyes.

Color: Yellowish without definite markings.

Genitalia: Male plates medium in length, convexly rounded to broad, blunt, rounded apices. Style long, broad at base, gradually tapered to bluntly pointed apices. Aedeagus short, thick. In lateral view appearing rounded ventrally and bearing a long, curved, tapering process extending from the anterior ventral portion and directed caudo-ventrally. A long curved pygofer spine arises on the caudo ventral margin each side and curves anteriorly then dorsally and the sharp pointed apex extends caudally.

This small species was described from a holotype male from Januaria, Brazil. The type has been used to prepare the illustrations. No Mexican records are available at this time.

CHLOROTETTIX DELICATUS Osb.

Chlorotettix delicatus Osb. Anns. Carn. Mus. **15**: 73, 1923.

A produced but blunt head species. Length 4.5–5 mm.

Vertex produced, blunt at apex but only slightly longer at middle than at eyes due to the strong curvature of the basal portion next the pronotum. Vertex produced about one-half its length before the anterior margin of the eyes.

Color yellowish with green tinge, without definite markings.

Genitalia: Male plates long, broad at base, apices broad and rounded. Style tapered from base to near apex where it is broadened and almost truncate. The outer apical margin is rounded and the inner margin bears a sharp-pointed tooth. Aedeagus bearing a dorsal process not far from

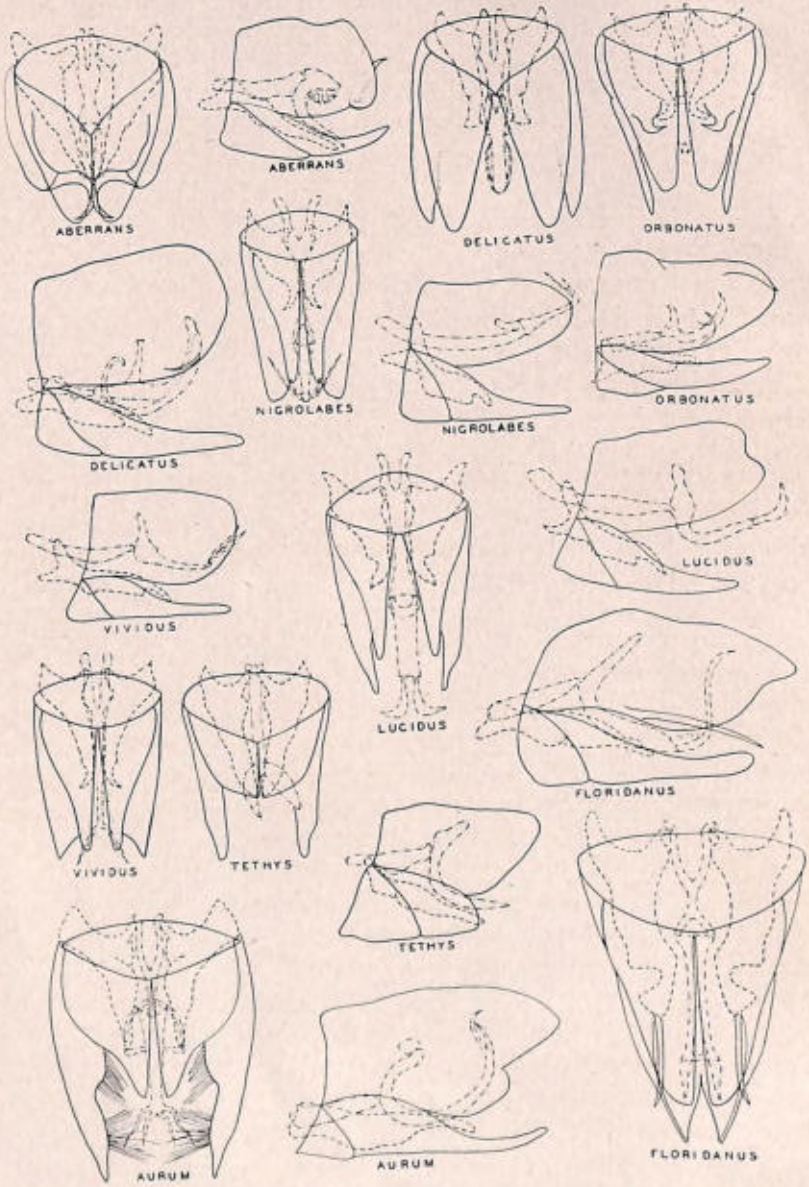


PLATE 2.—Lateral and ventral views of male genital structures in normal position, of species as labeled.

base which is long and straight. The apical third is curved dorsally and bears a slender process either side which extends cephalad. A portion of the body of the aedeagus curves ventrally beneath the straight portion bearing the dorsal process.

The type series contained specimens from Brazil and Bolivia. It has not been found in Mexico to date.

CHLOROTETTIX TRUNCATUS Osb.

Chlorotettix truncatus Osb. Anns. Carn. Mus. **15:** 75, 1923.

A small pale blunt headed species. Length 4.7 mm.

Vertex bluntly angled, one-fourth longer on middle than length next the eyes.

Color pale yellow, elytra appearing whitish.

Genitalia: Female last ventral segment with posterior margin appearing truncate.

The female holotype was described from Bolivia and apparently is a distinct species. The male allotype as designated is the male of *minimus* Baker and no male has been found which is thought to belong with the female as here described. No records are at hand for Mexico.

Chlorotettix orbonatus (Ball)

Thamnotettix orbonatus Ball, Can. Ent. **35:** 229, 1903.
Chlorotettix productus S. & DeL. Anns. Ent. Soc. Am. **12:** 236, 1919.

A small wedgeshaped species with a rounded vertex and distinct genitalia. Length 5 mm.

Vertex roundedly produced, appearing almost parallel margined, slightly longer on middle than next the eyes, about twice as wide as long.

Color: Dull yellowish green without definite markings.

Genitalia: Female last ventral segment with lateral angles rounded to posterior margin which is concavely sinuate either side of a slightly produced median third which is slightly notched at middle. Male plates elongate, triangular, concavely rounded on outer margins, apices blunt. Style narrow, strongly excavated on outer margin just before apex forming a short thick finger-like tip. Aedeagus short, narrow, broadly U-shaped in lateral view. Apex narrowed and cleft. Pygofer process arising at about middle of ventral portion, very short, with a sharp pointed apex.

This is one of the smallest species of the group and was described from Florida specimens. It has since been collected in Virginia, North Carolina, Georgia, Mississippi, Louisiana and Texas. It will probably be found along the Gulf coast in Mexico.

CHLOROTETTIX VIVIDUS Crumb

Chlorotettix vividus Crumb, Anns. Ent. Soc. Am. **8**: 197, 1915.

A small species, green tinged with brown and with distinct genitalia. Length 5.5–6 mm.

Vertex produced and distinctly angled, slightly conical, more than one and one-half times as long on middle as next the eye.

Color: Almost uniform brownish green, elytra subhyaline with more of a green tinge and with apical portion distinctly brown.

Genitalia: Female last ventral segment with posterior margin broadly, triangularly notched halfway to base of segment, with narrow apical notch. Male plates almost as broad as long, gradually, convexly narrowed three-fourths their length then produced to the same length as pygofer with margins almost parallel. Male plate long, triangular, narrowed before apex so as to form a long narrow tip. Style long, excavated on outer margin just before apex forming a long slender finger-like tip which curves outwardly. Aedeagus rather short, tapered from base to apex which bears a pair of short divergent processes.

This is one of the smaller species of the genus and is found in all of the Gulf states of the southeastern United States and is also reported for Arizona. It should occur in Mexico but no records are available at this time.

CHLOROTETTIX LUCIDUS Baker

Chlorotettix lucidus Baker, Psyche **7** (Suppl. 1): 12, 1895.
Chlorotettix delta Ball, Ent. News **27**: 205, 1916.
Chlorotettix acus DeL. & Dav. Jour. N.Y. Ent. Soc. **42**: 223, 1934.

A small species with a distinctly angled vertex. Length 4.5 mm.

Vertex strongly produced and angled, apex conical. One-third longer at middle than next the eyes. About one and one-half times as wide between eyes at base as median length.

Color: Pale green, apex of vertex and tips of elytra slightly tawny. Eyes dark.

Genitalia: Female last ventral segment with produced, rounded, lateral angles. Posterior margin broadly angularly excavated, the V-shaped notch extending about one-third the distance to base. Male plates long, slender, concavely rounded on outer margins. Apices narrow. Style broad at base gradually tapered to a shallow concave notch on outer margin just before apex. Tips sharply pointed. Aedeagus erect and enlarged at base, curved ventrally and extending caudally. Apex composed of a pair of short blade-like processes which curve outwardly and have pointed apices.

This is probably the smallest species of the genus occurring in the southwest and is known to be in southern California, Arizona and New Mexico and undoubtedly occurs in that portion of Mexico adjoining these states.

CHLOROTETTIX TETHYS V.D.

Chlorotettix tethys V.D. Buffalo Soc. Nat. Sci. **8**: 71, 1907.
Chlorotettix bidentatus DeL. Jour. Dept. Agri. Porto Rico **7**: 264, 1923.
Chlorotettix dilutus Osb. Anns. Carn. Mus. **15**: 73, 1923.

A small green species with distinct genitalia. Length 5 mm.

Vertex produced and bluntly angled, almost twice as long at middle as length next the eyes, less than twice as wide between eyes at base as median length.

Color: Pale to dark green usually washed with yellow and often without markings. In well marked specimens with five brown spots on each elytron. A round spot on corium, a similar spot on outer claval vein, anterior to the spot on corium. A spot along commissure at about its middle, another just outside apex of clavus and the fifth is on the base of the long middle anteapical cell.

Genitalia: Female last ventral segment with produced lateral angles between which the posterior margin is broadly concavely rounded. At the middle of the concavity is a slightly produced portion bearing two slightly produced proximal teeth. The median margin of the segment heavily embrowned. Male plates short, broad, apices almost truncate, sloping from outer curved margins to straight inner margins. Style long, rather broad at base, gradually narrowed to rather wide, bluntly angled spices. Aedeagus long, rather slender, curved. In lateral view the basal half appears erect and the apical half curves ventrally and extends caudally. In ventral view the aedeagus is always tilted with the apical portion to the right.

A large series of specimens have been examined from Iguala, Gro., elevation 2398, September 11, 1939 and October 10, 1941; Mexcala, Gro., elevation 1706 ft., October 22, 1941; Tehuantepec, Oaxaca, elevation 328 ft., October 13, 1941 and Santa Engracia, Tamps., elevation 1050 ft., November 3, 1928, collected by Caldwell, Good, Plummer and DeLong. Specimens at hand from El Mante, Tamps., elevation 264 ft., August 9, 1930 (M.F. 1734) Carbel, Ver., August 3, 1932 (M.F. 2656) Santa Lucia, Chiap., July 29, 1926 (M.F. 1055); Chiapode, Corza, Chiapas, July 26, 1926 (M.F. 1047); Arcelia, Gro., August 17, 1930 (M.F. 1766) Parra; Pungarabato, Gro., August 22, 1930 (M.F. 1769); San Feronimo, Gro., August 30, 1930 (M.F. 1787); Huetamo, Mich., elevation 1100 ft., August 22, 1933 (M.F. 3100); Nainari, Sonora, August 12, 1927 (M.F. 1285) were collected by Dampf and Parra.

The holotype female specimens of *dilutus* Osb. from Columbia has been examined and cannot be distinguished from *bidentatus* DeL. which in turn is considered as a synonym of tethys. Allotype male from Iguala, Guerrero, September 11, 1939.

Chlorotettix nigrolabes n. sp.

In general appearance resembling tethys but with distinct markings and genitalia. Length 5.5–6 mm.

Vertex bluntly angled and produced at least half its length before the anterior margins of the eyes, but only slightly longer on middle than next

the eyes due to strong curvature of pronotum. More than twice as wide as median length.

Color varying from apple green to pale brownish with darker markings. The greenish specimens usually have only the two round black spots on the basal margin of the vertex. The brownish specimens have the two black spots, a faint marginal line between ocelli another pale line just posterior to it between anterior margins of the eyes, the disc of scutellum brown, and brown basal angles of the scutellum. Elytra with dark brown spots along commissure and on disc.

Genitalia: Female last ventral segment with lateral angles produced and rounded. Posterior margin broadly, rather deeply notched, about half way to base. Apex with a black spot on each side. Male plates long, slender, concavely rounded on outer margins, apices narrow, bluntly rounded. Style broad at base deeply concavely excavated at two-thirds its length to form a narrow, sharply pointed, outwardly curved apex. Connective almost twice as long as aedeagus. The aedeagus is narrow, curved dorsally near apex and with four terminal processes two of which are longer than the other pair.

Holotype male, allotype female and male and female paratypes from Jiutepec, Morelos, elevation 3500 ft. September 6, 1939, by Plummer and DeLong. Male and female paratypes collected at Iguala, Guerrero, September 11, 1939, and October 25, 1941; Acapulco, Guerrero, elevation 328 ft., September 10, 1939; Tepotzlan, Morelos, September 11, 1941; Cuernavaca, Morelos, elevation 4921 ft., October 21, 1941; Lake Chapala, Jalisco, elevation 5000 ft. October 3, 1941; Guadalajara, Jalisco, elevation 5000 ft., October 3, 1941 and August 23, 1937 (Stone) collected by Caldwell, Plummer, Good and the author.

CHLOROTETTIX AURUM DeLong

Chlorotettix aurum DeL. Ohio Jour. Sci. 38: 218, 1938.

Resembling *suturalis* in general form and appearance but smaller with notched pygofer and four shorter terminal processes on oedagus. Length 7 mm.

Vertex roundedly produced, only slightly longer on middle than next the eye, about twice as broad as median length.

Color: Yellow, unmarked, elytra pale subhyaline, slightly darker along commissural line. Yellow beneath.

Genitalia: Male plates long, gradually tapered to rather acutely pointed apices. A brown mark in center of either plate at base as in *suturalis*. Male styles long and slender, apical half gradually tapered to blunt apices. Oedagus in lateral view curved, basal and apical ends directed dorsally. Pygofer notched on caudal margin, the portion dorsal to notch strongly

pointedly produced. Two pairs of brushes of heavy spines extend from wall of pygofer into genital chamber and almost obscure apex of oedagus. Two of these are attached just below the notch on ventral apical portion and two are attached to dorsal wall above and anterior to notch.

This is a low coastal species described from Carolina Beach, North Carolina. It may be found in the Gulf Coastal area of Mexico but has not been taken to date.

CHLOROTETTIX FLORIDANUS DeLong

Chlorotettix floridanus DeL. Jour.N. Y. Ent. Soc. **32**: 66, 1924.
Chlorotettix rubidus Brown, Univ. Kan. Sci. Bul. **21**: 246, 1933.

Resembling *galbanatus* in size and general appearance with vertex more rounded and genitalia different. Length 6 mm.

Vertex bluntly rounded, a little longer at middle than next the eyes and more than twice wider between eyes than length at middle. Pronotum more than twice as long as vertex. Elytra long, greatly exceeding abdomen.

Color bright green with a brownish iridescent tinge especially on elytra. Often washed with yellow.

Genitalia: Female last ventral segment twice as long as preceding, lateral margins roundingly produced from half their length to form a broad rounding lobe either side of a broad median somewhat U-shaped notch extending two-thirds the distance to base. The sides of the notch convexly rounded almost to apex where an abrupt broad V-shaped notch is formed. Notch at base broadly embrowned. Male valve almost twice as long as preceding segment, more than twice wider than long, almost rounded at apex. Plates exceeding valve by more than twice its length, gradually sloping almost to apex where they are convexly rounded to form rather blunt appressed apices. Styles long, rather broad, deeply roundedly notched on outer margin just before apex, forming a broadened, truncate apex which is curved outwardly. Aedeagus in lateral view broadly U-shaped with a long erect basal portion and the apical third forming a pair of long slender processes which extend dorsally. A straight heavy spine arises on the middle of the ventral caudal edge of pygofer.

This species was described from specimens collected in the coastal area of Florida. It has since been collected in Mississippi, Louisiana and Texas and probably occurs along the Gulf area of Mexico.

Chlorotettix bipartitus n. sp.

A species with a bluntly produced head, resembling *galbanatus* in general appearance. Length 6.5–7 mm.

Vertex produced, bluntly angled, less than twice as long at middle as length next the eyes, more than one-half as long at middle as basal width between the eyes.

Color: yellowish green without markings.

Genitalia: Female last ventral segment with produced lateral angles which are rounded to the posterior margin forming a rather broad lobe either side of the broadly deeply concavely rounded posterior margin. The median portion is slightly produced, black in color and has a small V-shaped notch at middle. Male plates short, broad, concavely emarginate near apex forming short blunt tips. Style broad at base, decidedly constricted and narrowed at less than its length, broadly, concavely notched just before truncate apex forming a pointed tooth on outer margin. Aedeagus long and slender. The base is thickened and erect. The apex forms two long slender processes which extend dorsally and laterally. Pygofer with a long straight spine extending from near middle to apical ventral margin at the apex of which is a short, dorsally curved hook.

Holotype male, allotype female and male and female paratypes collected at Iguala, Guerrero, elevation 2398 ft., October 25, 1941, by Good and DeLong. El Mante, Tamaulipas, elevation 264, October 26, 1930, Dampf (M.F. 1775); Santa Lucia, Chiapas, July 29, 1936, Dampf (M.F. 1055); Balsas, Guerrero, August 7, 1930, Dampf (M.F. 1754); Cocula, Guerrero, August 6, 1930 Dampf (M.F. 1753).

CHLOROTETTIX EMARGINATUS Baker

Chlorotettix emarginatus Bak. Can. Ent. **30**: 219, 1898.

A yellowish, blunt headed species resembling *galbanatus* in general appearance but with distinct genitalia. Length 7.5–8 mm.

Vertex produced and bluntly angled more than twice as long at middle as length next eyes and more than twice as wide between eyes at base as median length.

Color straw yellow tinged with green often with a minute, darker spot either side on base. Elytra pale subhyaline usually with brown spots along commissural line.

Genitalia: Female last ventral segment with lateral angles produced forming long narrow finger-like processes between which the posterior margin, which is half-way to base, is roundedly excavated either side of a pair of median, rounded, prominent teeth which are separated by a short "V"-shaped notch. Male plates rather long, broad, scarcely narrowed to apices which are broadly rounded. Style short, broad at base, abruptly narrowed at about three-fourths its length then produced to form bluntly pointed apices which are bent inwardly. Aedeagus in lateral view thickened at middle and tapered at both ends. The anterior is narrow and bluntly rounded. The posterior end is elongated, tapered and divided, forming two slender terminal processes which curve dorsally and anteriorly. Pygofer with a long, heavy strongly curved pygofer spine which arises on the ventro caudal margin curving caudally, dorsally then anteriorly.

A large series of specimens are at hand collected at Iguala, Gro., September 11, 1939, and October 25, 1941, by Plummer, Good and DeLong. From Vergel, Chiap., elevation 3000 ft. June 4, 1935 (M.F. 4431); Santa Lucia, Chiap., July 29, 1926 (M.F. 1055); El Mante, Tamps., elevation 264, October 26, 1930 (M.F. 1775); Pandancuareo, Gro., August 28, 1930, (M.F. 1785) collected by Dampf.

CHLOROTETTIX NUDATUS Ball.

Chlorotettix nudatus Ball. Can. Ent. **32**: 340, 1900.

Resembling *gallanatus* in general appearance but with distinct genitalia. Length 6–6.5 mm.

Vertex produced and bluntly angled, one-third longer on middle than length next eyes, less than twice as wide between eyes at base as median length.

Color yellowish green without markings.

Genitalia: Female last ventral segment with produced lateral angles which are rounded to posterior margin forming a broad deep V-shaped notch reaching almost to base. The caudal portion is broad with the sides concavely rounded, the cephalad portion is narrowed to a brown bordered slit. Male plates broad at base tapered to sharp pointed apices. Style long, bent sharply inwardly at two-thirds its length, apex bluntly pointed. Aedeagus short and thick with a basal, slender, dorsally produced portion. In lateral view the dorsal surface seems deeply narrowly excavated just before the apex. In ventral view the apex is bifid with a short process curving laterally on each side. Pygofer with a long narrow spine arising on ventral margin just beyond the center and extending ventrally and caudally.

One male specimen was collected at Finca, Esperanza, Chiapas, Mexico, June 23, 1938, by Nettel (M.F. 6934) and a female collected at Valles, S. L. P., Mexico, September 24, 1941, by Good, Caldwell and DeLong.

CHLOROTETTIX LOBATUS Osb.

Chlorotettix lobatus Osb. Ohio State Univ. Bul. **23**: 17, 1919.

Resembling *emarginatus* in general appearance but with distinct genitalia and a less produced vertex. Length 7.5–8 mm.

Vertex bluntly angled, only slightly longer at middle than length next the eyes, more than twice as wide between eyes at base as median length.

Color pale yellow to pale brown with distinct or slight markings. The vertex has a dark brown narrow transverse line between anterior margins of the eyes. Pronotum with a series of dark brown irregular spots just posterior to anterior margin. Scutellum with a median anterior brown spot and a spot on each basal angle. Elytra pale brown subhyaline, with darker brownish markings along commissural line and with brownish spots on corium. The veins of second wing brown often visible through the elytra. Face with darker arcs either side of a pale median area.

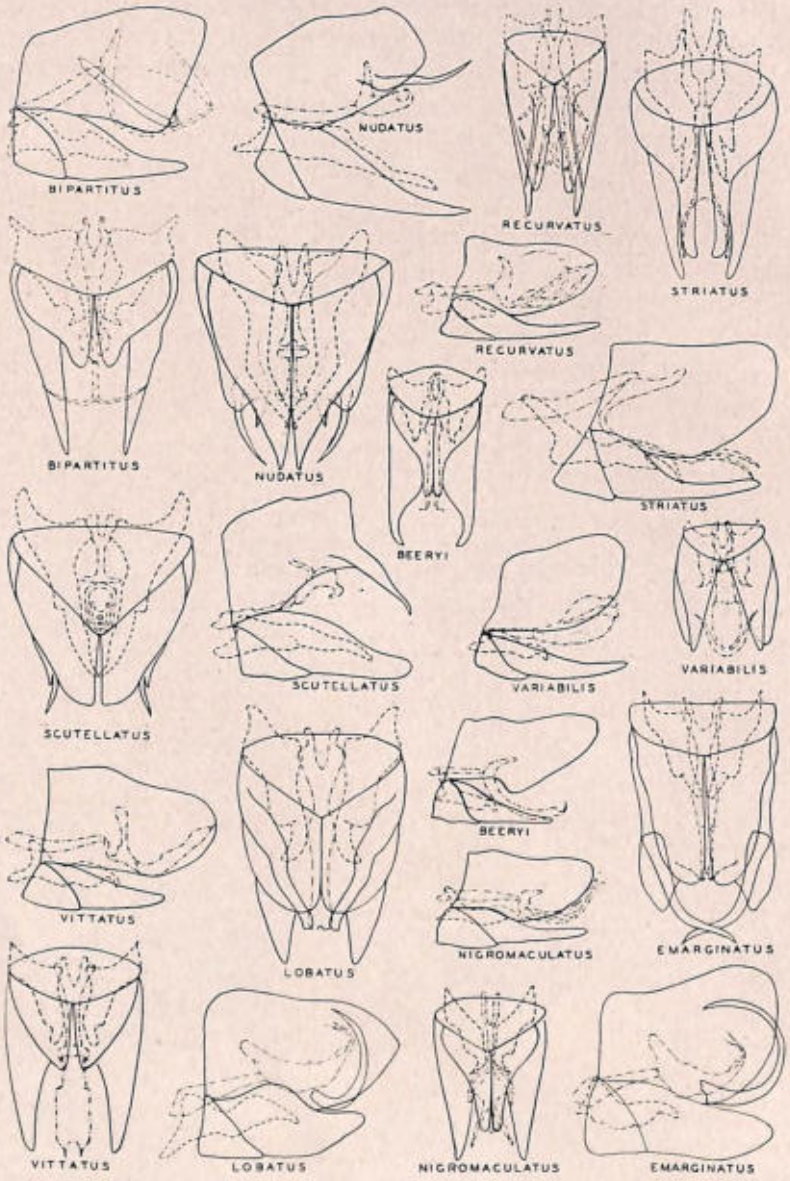


PLATE 3.—Lateral and ventral views of male genital structures in normal position, of species as labeled.

Genitalia: Female last ventral segment produced, forming a broad lobe either side of a median U-shaped notch the sides of which are almost straight. The lobe is longest on the outer rounded angle, then slopes slightly anteriorly to the sides of the notch. Male plates convex on outer margin broadly rounded at apices. Style broad at base abruptly narrowed on outer margin at three-fourths its length and produced on inner margin to form rather long thick finger-like processes. Aedeagus in lateral view appearing convexly rounded on ventral margin somewhat concave on dorsal margin, narrowed just before apex and with a bifid apex. A slender pygofer process arises at two-thirds its length on ventral portion and curves caudally and dorsally almost to dorsal margin. Pygofer rather long, bluntly angled.

This species was described from a single female specimen collected at Gualan, Guatemala and the male is described here for the first time. Male allotype taken at Fortin, Ver., Mexico, October 9, 1941, by Good, Plummer, Caldwell and the author. Specimens are at hand from Fortin, elevation 3281, and Cordoba, elevation 3060, Ver.; Tierra Blanca, Vera Cruz, July 29, 1932 (M.F. 2655) Dampf. Vergel, Chiapas, May 16, 1935 (M.F. 4193) elevation 3000 ft.; Finca Prusia, Chiapas, December 5, 1932 (M.F. 2869); Jalapa de Diaz, February 16, 1932, Oaxaca (M.F. 2267); San Miguel, Chimalapa, Oaxaca (M.F. 2509); Pungarabato, Guerreo, August 22, 1930 (M.F. 1769); Buerna Esperanza, Guatemala, December 14, 1925 (M.F. 898) and Cantetul, Guatemala, Dec. 11, 1925 (M.F. 878).

CHLOROTETTIX CURVIDENS Osb.

Chlorotettix curvidens Osb. Ohio State Univ. Bul. **23**: 16, 1919.
Chlorotettix serratus DeL. Ent. News **48**: 52, 1937.

A rounded headed species with few color markings. Length 6.5 mm.

The vertex is scarcely longer at middle than next the eye.

Color: Straw yellow to yellowish green with a pale brown line on each basal angle of scutellum and brown spots along posterior margin of elytra on clavus. Some specimens are pale without markings.

Genitalia: Female last ventral segment with lateral angles strongly produced and bluntly angled. Between these the posterior margin is strongly, broadly notched forming a V-shaped notch almost to base. A brown coloration at about half its length causes it to appear notched on each side. Male plates long, gradually tapered to pointed apices. Style broad at base, constricted at middle and deeply narrowly notched at two-thirds its length to form a narrow terminal portion which is truncate at apex and slopes obliquely outwardly from center. Aedeagus short, thickened at base; apical half narrowed, the tip in the form of a hook which curves dorsally.

It was taken in abundance at Tamazunchale, S. L. P., elevation 687 ft. August 29, 1939 and September 25, 1941; Valles, S. L. P., elevation 312, September 25, 1941; Jesus Carranza, Ver., October 14, 1941 and Suchilapa, Oax., October 11, 1941, by Plummer, Caldwell, Good and DeLong. Specimens are also at hand from Tierra Blanca, Ver., July 29, 1932 (M.F. 2655); La Forestal, Veracruz, Ver., October 14, 1926 (M.F. 1066); Vergel, Chiap., elevation 3000 ft., May 28, 1935 (M.F. 4321); Finca Esperanza, Chiap., August 2, 1939 (M.F. 6811); Yetla, Gro., August 11, 1930 (M.F. 1756); Cuantla, Mor., elevation 2500 ft., September 2, 1937 (M.F. 6259); Frontera, Tabasco, June 9, 1928 (M.F. 1357) by Dampf.

CHLOROTETTIX SCUTELLATUS Osb.

Chlorotettix scutellatus Osb. O.S.U. Bull. **23**: 18, 1919.
Chlorotettix pallidus Brown, Univ. Kan. Sci. Bull. **21**: 245, 1933.

A species variable in color, with a slightly produced vertex and distinct genitalia. Length 6–6.5 mm.

Vertex bluntly produced, about one-fourth longer at middle than length next eyes.

Color: Well marked specimens are pale brown with a narrow brown line between the anterior margin of the eyes. A dark brown longitduinal band forming an elongated spot on each basal angle of the scutellum and extending under the pronotum to about its middle, visible through the pronotum. Elytra pale brownish subhyaline, with darker brownish markings along the commissural margin on clavus. In pale specimens the color is greenish yellow without markings.

Genitalia: Female last ventral segment with the lateral margins produced forming bluntly rounded lateral angles between which the posterior margin is broadly angularly excavated with the apex rounded. Male plates rather broad, convexly rounded on outer margin, apices broad convexly rounded to inner margin. Style long, gradually tapered from broad base to narrow pointed apex except for a slight abrupt narrowing on outer margin at more than half its length. Pygofer with a long tapering spine on caudoventral margin directed caudoventrally. Aedeagus short, convexly rounded caudally to produce a short curved process on ventral caudal portion which curves anteriorly and is pointed at apex.

Pallidus is undoubtedly a pale form of scutellatus because the male and female genitalia are identical.

Specimens have been examined from Santa Engracia, Tamps, elevation 1050 ft. November 8, 1938 (Caldwell); Valles, S. L. P., elevation 312, November 7, 1941; Cuantla, Mor., elevation 3500 ft., September 9, 1937 (M.F. 6289) Dampf; Matamoras, Tamps, July 21, 1930 (M.F. 1772) Dampf; Montemorelos, N. Leon., June 3, 1930 (M.F. 2022) Dampf.

CHLOROTETTIX VITTATUS Osb.

Chlorotettix vittatus Osb. Ohio Naturalist **9**: 465, 1909.

A white to cream yellow species with brown oblique vittae on the elytra. Length 7–7.5 mm.

Vertex broad, rounded, only slightly produced. About one-fourth longer at middle than length next eyes almost twice as wide between eyes at base as median length.

Color white to cream, vertex and pronotum with darker areas but without definite markings. Scutellum with a large dark brown spot on each basal angle and a median longitudinal brown stripe. Elytra white with four or five oblique or longitudinal brown stripes. Two oblique lines are on

the clavus; another oblique line extends from the corium to the cross vein of the third apical cell. A short line parallel to the costa on the anterior portion of the elytron is on the anterior branch of the first sector. Two short lines on the posterior portion, which are sometimes faint or missing, extend across the first and second anteapical and apical cells.

Genitalia: Female last ventral segment broadly shallowly concavely rounded between the produced lateral angles. The central third of the margin embrowned. Male plates short, triangular with bluntly pointed apices. Style broad at base, narrowed to half its basal width at one-third its length and slightly notched on outer margin, just before the rounded apex. Aedeagus narrow at base with a long conspicuous dorsal process near base. Apical portion thickened, curved dorsally, the apex notched by a U-shaped excavation so as to form a pair of pointed terminal teeth.

Specimens are at hand from Jesus Carranza, Ver., elevation 200 ft., October 14, 1941, collected by Plummer, Good, Caldwell and DeLong; and from Veracruz, Ver. during November and December, 1926 (M.F. 1112 and M.F. 1117). Collected by Dampf. This species has been found only in the low altitude tropical vegetation.

Chlorotettix striatus n. sp.

A blunt headed species resembling diminutive specimens of *vittatus* but with distinct genitalia. Length 5.5–6 mm.

Vertex blunt, rounded, scarcely longer at middle than length next the eyes and produced about one-half its length before the anterior margins of the eyes.

Color pale brown with darker mottling on the anterior margin of pronotum and basal angles of scutellum with dark brown spots. Elytra with pale veins giving them a distinctly striated appearance.

Genitalia: Female last ventral segment almost truncate slightly produced to middle where it is notched more than halfway to base with a narrow V-shaped notch. Male plates long, broad at base strongly convexly narrowed at half their length and produced as slender almost parallel sided tips to the rounded apex. Style long bent inwardly at middle and rather deeply narrowly notched at three-fourths its length to form a narrow apical finger-like tip which is sharp pointed. Pygofers exceeding plates.

Holotype male collected at Vergel Chiapas, elevation 3000 ft., May 17, 1935 (M.F. 4196) by Dampf. Allotype female collected at Tolosa, Oaxaca, January 1, 1932 (M.F. 2512) by Parra.

CHLOROTETTIX LUTEOLUS Baker

Chlorotettix luteolus Baker, Phillip. Jour. Sci. **30:** 347, 1926.
Chlorotettix luteus Osb. Ann. Carn. Mus. **15:** 425, 1924.

A yellow species with brownish markings and a rounded vertex. Length 6.5–7 mm.

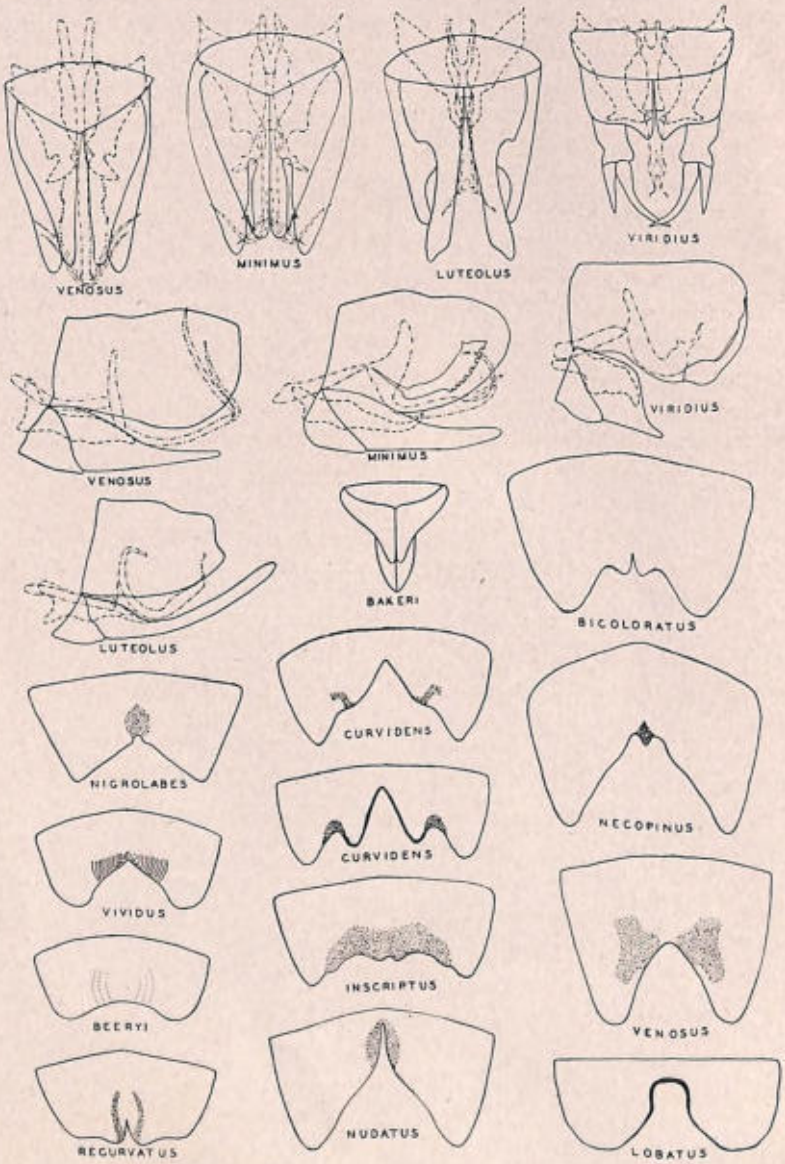


PLATE 4.—Upper portion—lateral and ventral views of male genital structures in normal position, of species as labeled. (Central figure of bakeri is ventral view of external male plates.) Lower portion—ventral views of last ventral segments of females as labeled.

Vertex broad, almost rounded, produced about half its length before the anterior margins of the eyes, scarcely longer at middle than next the eyes, more than twice as wide between eyes at base as median length.

Color pale yellow, pronotum with some darker longitudinal markings which appear as a continuation of the spots on basal angles of scutellum. Elytra yellow with a black mark on commissure just beyond the apex of clavus. Pale brownish markings along commissure on clavus, an oblique brown line between claval veins at base and one along claval suture. A pale brown line extends from base to apex about equidistant between claval suture and costal margin. A shorter, paler line is often between this and costa. Face with faint traces of darker arcs.

Genitalia: Female last ventral segment with produced rounded angles, posterior margin appearing shallowly excavated with a short rounded lobe either side of a shallow, V-shaped median notch. Male plates long, convexly rounded to one-third their length then broadly convexly emarginate forming narrowed apical portions which are longest on outer margin forming blunt apices which slope to inner margin. Style long, tapering to blunt apex which slopes inwardly. Aedeagus bent upwardly at base, apical portion notched forming a filamentous process each side which extends dorsally.

This small species was described from Uruguay and has since been collected in Brazil. It has not been taken in Mexico. The allotype female as described at this time is from Vicosa, Brazil, collected in November, 1929, by Edson Hambleton.

CHLOROTETTIX NIGROMACULATUS DeL. & Wolcott

Chlorotettix nigromaculatus DeL. & Wolc., Jour. Dept. Agr. Porto Rico 7: 265, 1923.

A short round headed species, yellowish green with brown markings. Length 4.5 mm.

Vertex rounded, scarcely produced, slightly longer on middle than next the eyes and almost twice as wide between eyes at base as median length.

Color: Vertex yellowish green, ocelli large, reddish, a transverse brown band just above ocelli. A pair of large round black spots on rounded margin just below ocelli. Face yellowish with slight traces of arcs. Pronotum yellowish unmarked. Scutellum with a large, triangular dark brown spot in each basal angle which extends under the pronotum. Elytra white, hyaline, nervures white, two oblique brown stripes on inner clavus between veins and a broader one between claval vein and corium.

Genitalia: Female last ventral segment with lateral angles produced, posterior margin shallowly concavely rounded and slightly notched at middle. A median brown stripe extends to base of segment. Male plates long, concavely rounded on outer margins, apices narrow, rounded at tip. Style distinctly excavated on outer margin just before apex forming a

pointed tip which is bent outwardly. Aedeagus with a short erect basal portion. The ventral portion bears a central process and a pair of longer processes which are divergent and appear twisted near the end.

The species was described from a female from Porto Rico and the male allotype described at this time is from Panama, Canal Zone. No definite records for Mexico are at hand but it should occur either in the state of Chiapas, Oaxaca or Guerrero.

Chlorotettix berryi n. sp.

A small species resembling *vacunus* in general appearance but with distinct genitalia. Length 5.5 mm.

Vertex bluntly angled one-third longer at middle than length next eyes, more than half as long at middle as basal width between the eyes.

Color dull yellow, unmarked.

Genitalia: Female last ventral segment roundedly emarginate on central half of posterior margin. Male plates concavely rounded to form narrow apices which are rounded at tips. Style short, broad at base and with narrow blunt apex. Aedeagus rather narrow, curved, in lateral view with the basal end curved upward. The apex is notched so as to form a pair of short slender terminal processes which are tapered to pointed apices and curve dorsally and laterally.

Holotype male and allotype female collected at Santarem, Brazil, October, 1942, by Laurence Berry. I take pleasure in dedicating this species to Mr. Berry who has collected many interesting species in Brazil.

CHLOROTETTIX MINIMUS Baker

Chlorotettix minimus Baker, Can. Ent. **30**: 220, 1898.
Chlorotettix lineatus Osb., Ohio State Univ. Bul. **23**: 5, 1919.

A small blunt headed species with distinct male and female genitalia. Length 4.5–5.5 mm.

Vertex bluntly angled, scarcely produced, a little longer at middle than length next the eyes.

Color dull yellowish slightly tinged with smoky.

Genitalia: Female last ventral segment somewhat variable. The posterior margin with a deep narrow notch reaching almost to base, either side of which is a rather sharp produced tooth. The lateral angles are produced and rounded to the gently sloping posterior margin which is slightly emarginate either side of the produced teeth. Male plates almost as long as pygofer, triangular, convexly rounded on outer margin. Style elongate, deeply, convexly emarginate on outer margin near apex, forming a narrow sharp-pointed apex which is curved sharply outwardly. Aedeagus with four slender processes at apex; two are short and straight and two are longer,

curved outwardly and dorsally, and the apices are bent cephalad. A conspicuous pygofer process arises near base and extends caudodorsally. The ventral margin is serrate.

This is a low altitude tropical species. Specimens taken in Mexico are at hand from Tierra Blanca, Ver., July 29, 1932 (M.F. 2655); and Loma Bonita, Oax., June 8, 1937 (M.F. 6070A). It is common in Brazil, through most of Central America and authentic records show it occurs in Florida.

Chlorotettix variabilis n. sp.

Resembling *minimus* in size and general appearance, with distinct genitalia. Length 3.5–4 mm.

Vertex bluntly angled, more than one-half wider between eyes at base than median length.

Color yellowish green. Certain specimens are conspicuously marked with dark brown or black on central half of pronotum, scutellum and on elytra along commissure to apex of clavus.

Genitalia: Female last ventral segment with lateral angles produced between which the posterior margin slopes basally to a rather broad, short truncated median tooth which is produced to about the length of the lateral angles. Male plates long, narrowed on apical half to narrow blunt apices. Styles rather short, slightly concavely excavated on outer margins just before apex to form a sharply pointed tip on outer margin. Aedeagus short, broad, in lateral view appearing inflated with a pair of long apical processes arising on ventral side and extending basally on each side.

Holotype male collected at Pcvicuc, Tab., June 16, 1938 (M.F. 6566). Allotype female collected at Frontera, Tab., June 7, 1928 (M.F. 1357). Male and female paratypes from same localities and from Zapata, Tab., July 1938 (M.F. 6859); Yaqin Valley, Sonora, Mex., Nov. 19, 1935 (M.F. 3980); Pandancuareo, Gro., August 28, 1930 (M.F. 1785); and San Jose, Guat., Nov. 14, 1925 (M.F. 801) all collected by Dampf and his co-workers.

Chlorotettix recurvatus n. sp.

Resembling *minimus* in general form and appearance but with dark band across vertex and with distinct genitalia. Length 4.5 to 5.5 mm.

Vertex blunt, rounded, one-fourth longer than length next eyes, more than twice as wide between eyes as median length.

Color yellowish marked with pale brown. A transverse brown band on vertex just above ocelli. Elytra with pale veins, margined with brown, giving the elytra a striped appearance. Face yellowish with pale brownish arcs one either side of middle.

Genitalia: Female last ventral segment almost truncate on posterior margin with a short narrow incision at middle reaching about one-fourth

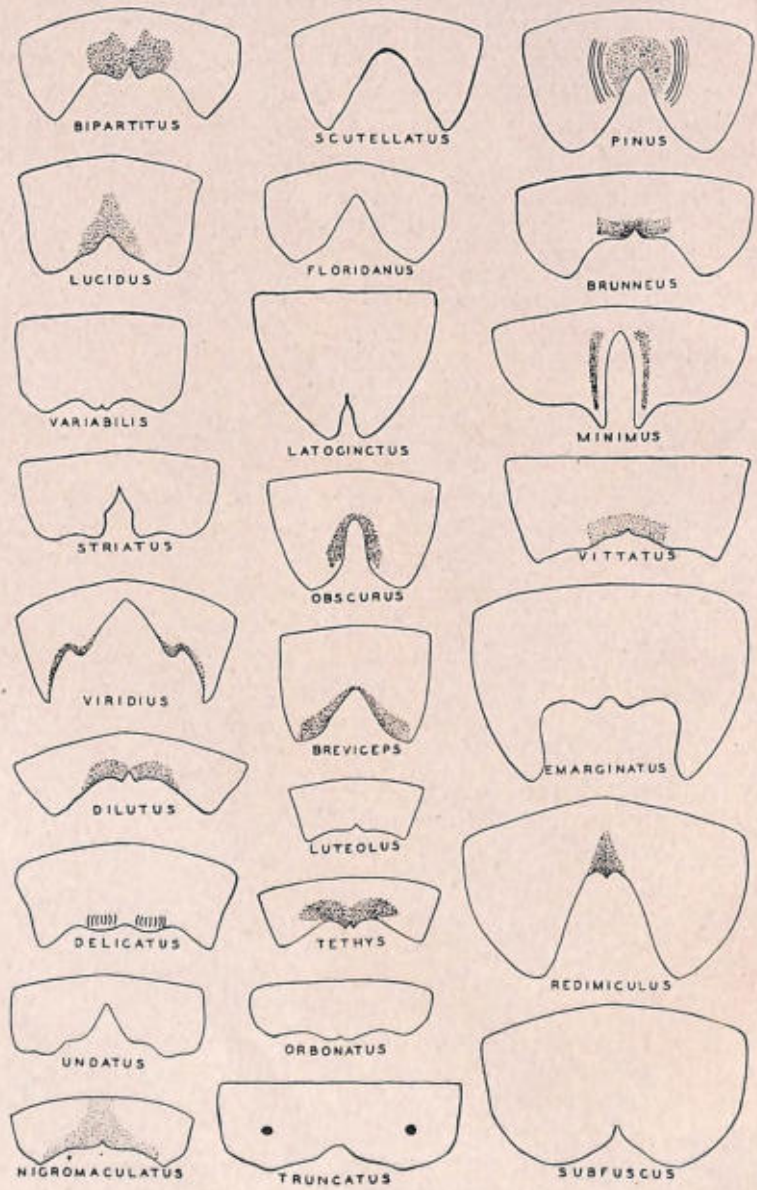


PLATE 5.—Ventral views of last ventral segments of females as labeled.

the distance to base. Male plates long, gradually narrowed to a rounded apex. Style abruptly deeply excavated just before apex forming a long slender pointed outwardly bent apex. Aedeagus with an erect swollen basal portion at the ventral end of which the apical three-fourths is bent caudally. A pair of straight processes arise, one on either side, and extend caudally. The apex of the aedeagus is bifid, forming two long slender processes which curve dorsally then anteriorly. A long straight pygofer process arises near the base and extends to the end of pygofer.

Holotype male and allotype female collected at Loreta Mission, Argentina, December, 1931, by A. A. Ogoblin.

Chlorotettix undatus n. sp.

Resembling *minimus* in general appearance but with distinct female genitalia. Length female, 5.5 mm.

Vertex blunt, rounded, only slightly longer at middle than length next the eyes and more than twice as wide between eyes as median length.

Color yellowish green unmarked.

Genitalia: Female last ventral segment with a rather broad V-shaped median notch extending about two-thirds the distance to base. Posterior margin with a slight excavation on either side of notch, lateral angles rounded.

Holotype female collected at Loma Bonita, Oaxaca, June 8, 1937 (M.F. 6070A). Paratype females from Tierra Blanca, Ver., July 29, 1932 (M.F. 2655) all collected by Dampf. This is apparently a low altitude species.

CHLOROTETTIX BAKERI Sand. & DeL.

Chlorotettix bakeri Sanders & DeL., Proc. Ent. Soc. Wash. **24**: 97, 1922.

Resembling *minimus* in size and general appearance but with distinct male genitalia. Length 5 mm.

Vertex scarcely longer at middle than next the eyes and two and one-half times as broad between eyes at base as median length.

Color: Yellowish green without markings.

Genitalia: Female last ventral segment with lateral angles broadly rounded to posterior margin which is broadly and roundedly notched one-third the distance to the base. Male valve broadly and evenly rounded, plates about four times as long as valve, broad at base, tips narrow and rounded.

The holotype male and allotype female labeled "Columba, Brazil, May" are in the National Museum. This species has not been taken in Mexico.

CHLOROTETTIX BREVICEPS Baker

Chlorotettix breviceps Baker, Can. Ent. **30**: 220, 1898.

A broad, rounded headed species without color markings. Length 6.25 mm.

Vertex broadly rounded, parallel margined, almost four times as broad between eyes at base as median length.

Color pale brownish with two longitudinal white lines on scutellum.

Genitalia: Female last ventral segment with rather prominent lateral angles between which the posterior margin is broadly notched about one-half the distance to base. Margins of notch heavily embrowned especially next lateral angles.

This species is known by two female type specimens collected at Chapoda, Brazil. No specimens have been collected in Mexico.

The Russulaceae of Yunnan[1]

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The earliest records of the family Russulaceae from this country were made by Patouillard and Baccarini on collections of Souli and Giraldi (J. Bot. **7**: 343–344, 1894; App. al. Nuovo Giorn. Bot. Ital. n.s. **22**: 689-698, 1905). Four species, *Russula alutacea*, *Lactarius laccatus*, *L. pallidus* and *L. torminosus* were reported. From 1932 to 1939 S. C. Teng recorded twenty-four species of *Russula* and six species of *Lactarius* from the southeastern provinces such as Kiangsu, Chekiang, Anhwei and Fukien (A Contribution to Our Knowledge of the Higher Fungi of China, Academia Sinica, 1939). In northern China, C. H. Chow recorded three species, *Russula delica*, *R. adusta* and *Lactarius obliquus* (Bull. Fan. Mem. Inst. Biol. **6**(2): 31, 1935). F. L. Tai also enumerated three species *Russula emetica*, *Lactarius deliciosus* and *L. indigo* from Nanking (Sci. Rept. Tsing Hua Univ. S. B. **2**: 326; 393, 1937).

Of the fungous collections made by Handel-Mazzetti in the Northwest of Yunnan and the Southeast of Hunnan eighteen species of *Russula*, including three new species, *R. cernohorsky* Sing., *R. Handelii* Sing. and *R. punctipes* Sing., and twenty-four species of *Lactarius* were reported (Symbolae Sinicae **2**, 1937). The determination of many of these species has been considered as doubtful by Singer himself.

In this paper species of the family Russulaceae, which have so far been collected by the writer and his colleagues in Yunnan, are described. Thirty-one species of *Russula* and nineteen species of *Lactarius*, of which three of *Russula* and five of *Lactarius* are considered new species, have been studied. Many of these species are new records to China.

Genus LACTARIUS (Gray) Fr.
Section GLUTINOSI Quél.
Subsection GLABRATI Bat.
Dapetes Fr.
LACTARIUS DELICIOSUS (L.) Fr.

Fig. 1

Pileus 2.5–8 cm. in diameter, convex, umbilicate, "light ochraceous salmon,"[2] tinged pinkish somewhere, turning greenish when bruised,

[1] Paper no. 18, Plant Pathology Division, Institute of Agricultural Research, Tsing Hua University.

The writer is indebted to Prof. F. L. Tai for valuable suggestions and help in the preparation of the manuscript.

Received for publication from the Division of Cultural Relations, Department of State.

[2] See Ridgway: *Color Standards and Nomenclature*, 1912.

inconspicuously zonate, somewhat viscid when young; margin at first involute, becoming straight with age, usually striate. Gills "Saffrano's pink," becoming "livid pink," greenish with age or where bruised, free to short decurrent or sinuate, close, alternated with shorter blades, up to 5 mm. broad. Stipe 2–6×0.7–2 cm., cylindrical, usually tapering downward slightly, "Saffrano's pink," turning "livid pink" with age, greenish where bruised. Flesh whitish, becoming "Claret brown"; glandules "Claret brown" in color, dotted over the cutting surface. Milk "Claret brown," copious. Taste mild. Odor pleasant.

Spores elliptical, punctate or reticulate, 8–9.5×6–7 (8.5×6)μ. Basidia 40–50×8.5–9.5μ. Cystidia fusiform 65–100×7–8μ.

May 11, 1941, W. F. Chiu, Wangchiachou, Kunming, 8136[3]; Aug. 24, 1940, F. L. Tai, Tapugi, Kunming, 5637, 8140; July 4 to 8, 1942, W. F. Chiu, at the same locality, 8137, 8138, 8139. Under *Pinus yunnanensis*.

LACTARIUS SANGUIFLUUS (Paul.) Fr.

Pileus 3–3.5 cm. in diameter, convex, slightly depressed in the center, "Coral pink," "Grape pink" or "Salmon' color, glabrous, more or less viscid; margin incurved when young. Gills concolorous with the cap, decurrent, up to 3 mm. broad, close to subclose. Stipe 2.5–4×0.8–1 cm., cylindrical, equal, concolorous but paler, hollow. Milk blood red.

Sept. 15, 1940 from Kiangpu, Kiangsu by Mr. Ching (color drawings and notes only).

This is one of the famous edible mushrooms in the Kiangsu province and known as "Peach-blossom" mushroom or "Pig-blood" mushroom on account of its pink color and red milk. *L. subpurpureus* Pk. is considered a synonym of this species. Thanks are due to Prof. Y. Chen for his kindness in forwarding to me Mr. Ching's color drawings and notes and informing me of its economical value.

Immutabiles Kon.

LACTARIUS ZONARIUS (Bull.) Fr.

Fig. 2

Pileus 4.5–6.5 cm. in diameter, depressed, "Cadmium yellow," with concentric zonation, slightly viscid when moist. Gills white becoming "pale buff," short decurrent, close, forked either behind or in the middle, up to 3 mm. broad. Stipe 3.5–4×0.8–1 cm., cylindrical, subequal, or slightly tapering downward, glabrous, "light ochraceous buff." Flesh "light ochraceous buff," spongy then hollow in the stipe. Milk white. Taste acrid.

[3] This refers to Plant Pathology Herbarium number, Tsing Hua University.

Spores subglobose to short ellipsoid, punctate and reticulate, 7–9.5×6–7μ. Basidia 25–30×5–6μ. Cystidia not observed.

Aug. 7, 1942, W. F. Chiu, Miaokaotze, Kunming, 8115, 8116.

The Yunnan plant fits the description of *L. insulus* Fr. (sec. Coker) of America. *L. insulus* Fr. (sec. Quél.) is also a synonym.

Lactarius zonarius (Bull.) Fr. var. insulus (Fr.) Rom.

Fig. 3

Pileus 5–13 cm. in diameter, convex, umbilicate or deeply depressed, "Ochraceous buff," floccose-squamulose, concentrically zonate, viscid when moist; margin wavy. Gills brittle, "light buff," short decurrent, close, forked behind or anastomosed with cross veins, 7 mm. broad. Stipe 3–3.5×1–2 cm., dead white, pruinose, stout, slightly tapering downward. Flesh white, slightly brownish under the cuticle of the cap, sometimes hollow in the stipe. Milk white, watery. Taste very acrid.

Spores globose, hyaline or slightly yellowish under the microscope, partially or completely reticulate, 8–10 (11)×8.6–9 (11×9)μ. Basidia 20–25×5–6 μ. Cystidia fusiform 30–35×6–6.5μ.

July 14, 1942, W. F. Chiu, Tapugi, Kunming, 8142. Under *Quercus*.

Lactarius zonarius (Bull.) Fr. and *L. insulus* Fr. might be the same species. The characters used by many authors to distinguish these two species are the shape and size of the spores. Lange stated that "the bisporid and tetrasporid forms occur in *L. insulus* Fr." and that "if further investigations should lead to uniting the two forms as being only a bisporid and tetrasporid variety of the same species, the name *L. zonarius* should be preferred . . ." (Studies in the Agarics of Denmark **5**(5): 30–31, 1928). In Yunnan both large spored and small spored forms have been collected. Although the writer is not prepared to say that the large spored and small spored forms correspond to bisporid and tetrasporid forms, he is of the opinion that, since these two forms are macroscopically indistinguishable, the larger spored form should be considered a variety of the smaller. The writer agrees therefore with Romagnesi in reducing *L. insulus* Fr. to a variety.

Lactarius cinereus Peck

Pileus 3–4 cm. in diameter, convex or slightly umbilicate, "Avellaneous," paler toward the margin, glabrous; margin involute when young. Gills whitish, short decurrent, close, alternated with shorter blades, up to 3 mm. broad. Stipe 2.5–4×0.7–0.9 cm., cylindrical, subequal, "pale cinnamon pink" or subconcolorous, subglabrous, stuffed, spongy, then hollow. Flesh pale pinkish to brownish. Milk white. Taste acrid.

Spores globose to subglobose, warted or ridged, 8–9.5×6.5–7 (8×6.5)μ.

Basidia 20–25×4.5–5μ. Cystidia ventricose-rostrate to fusiform, 30–35 ×3.5–5μ.

July 14, 1942, W. F. Chiu, Tapugi, Kunming, 8118. Under *Quercus*.

The stipe of the Yunnan plant tends to be of a pink shade which is not the case in the American form.

Lactarius castaneus sp. nov.

Fig. 5

Pileo 4 cm. lato, plano-convexo, leniter papillato, "Cinnamon brown," glabro, nitido; lamellis albis, 3 mm. latis, breviter decurrentibus, confertis; stipite 6 cm. longo, 0.9 cm. circ. crasso, subaequali, concolore; carne alba, immutabili, stipiti cavo; lacte albo, immutabili; sapore leviter acri. Sporis albis, globosis v. subglobosis, punctatis, 9–13×8–9 (10×8)μ; basidiis 18–20×6.5–7μ; cystidiis clavatis v. fusiformibus 70–110×10–12μ.

Pileus 4 cm. in diameter, plane-convex, slightly papillate, "Cinnamon brown," glabrous, shining. Gills white, 3 mm. broad, short decurrent, close. Stipe 6×0.9 cm., cylindrical, subequal, concolorous with the cap, subglabrous. Flesh white unchanging, usually hollow in the stipe. Milk white, unchanging. Taste slightly acrid.

Spores white globose to subglobose, punctate and reticulate 9–13×8–9 (10×8)μ. Basidia 18–20×6.5–7μ. Cystidia clavate to fusiform 70–110× 10–12μ.

Aug. 30, 1938, C.C. Cheo, Chunghotze, Tali, 8144. Type.

Macroscopically this fungus is quite like *L. Chichuensis* except that it has white unchanging gills and flesh. Microscopically this plant has larger and reticulate spores.

Section VELUTINI Quél.
Subsection ALBATI Bat.
LACTARIUS SUBVELLEREUS Peck

Fig. 6

Pileus 6–9 cm. in diameter, depressed, dull white, maculate yellowish when old and dry, tomentose; margin involute. Gills white, becoming "Light buff," decurrent, close, repeatedly forked, 5 mm. broad. Stipe 4–7×1.5–2 cm., cylindrical, equal, dull white, maculate yellowish with age, pubescent. Flesh whitish, becoming yellowish, compact. Milk white unchanging. Odor none.

Spores globose to subglobose, punctate 6–8×6–6.5 (7×6)μ. Basidia 15–20×3.5μ. Cystidia subfusiform to fusiform, 25–30×3–4μ.

Aug. 7, 1942, W. F. Chiu, Miaokaotze, Kunming, 8132. Mixed woods. Aug. 10, 1942, W. F. Chiu, Shishan, Kunming, 8131; Aug. 26, 1938, Chunghotze, Tali, 8133.

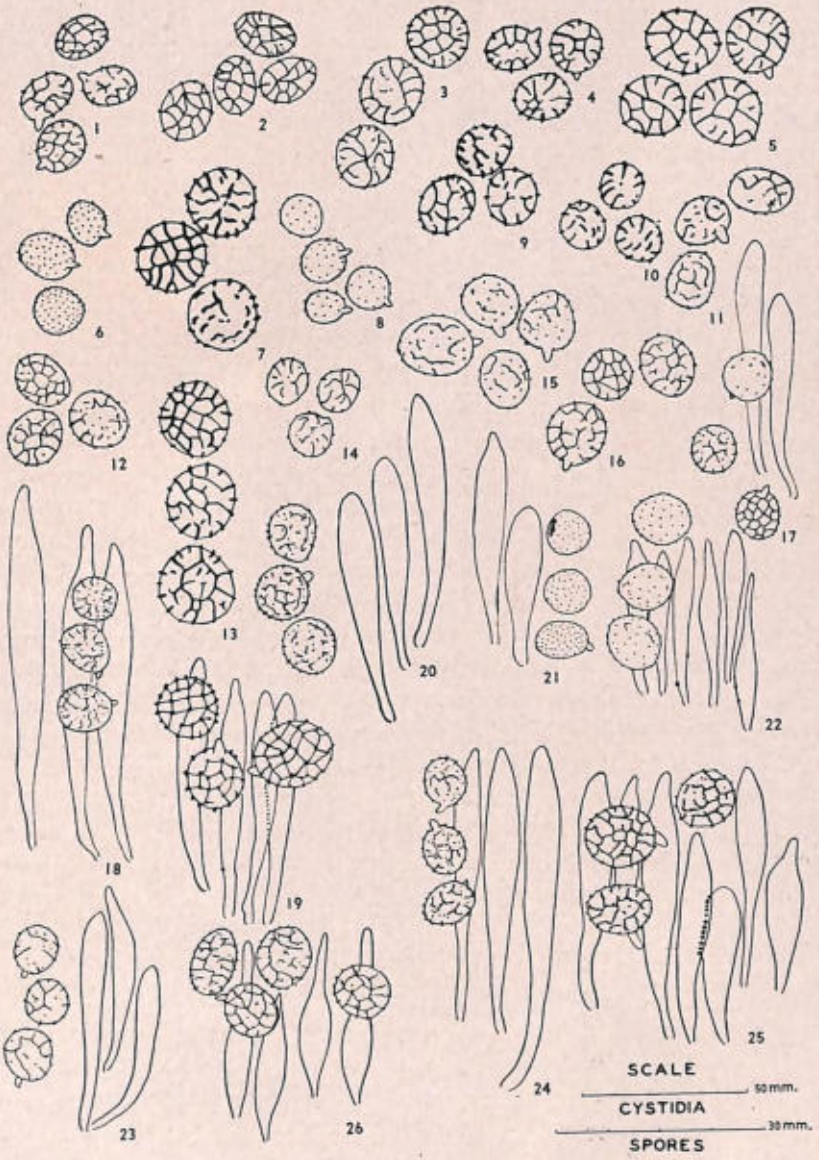


PLATE 1.—1. *Lactarius deliciosus* (L.) Fr., spores. 2. *L. zonarius* (Bull.) Fr., spores. 3. *L. zonarius* var. *insulus* (Fr.) Rom., spores. 4. *L. cinereus* Peck, spores. 5. *L. castaneus* sp. nov., spores. 6. *L. subvellereus* Peck, spores. 7. *L. lignyotus* Fr. f. *gracilis* Bres., spores. 8. *L. atroviridis* Peck, spores. 9. *L. rufus* var. *exumbonatus* Boud., spores. 10. *L. chichuensis* sp. nov., spores. 11. *L. cinnamomeus* sp. nov., spores. 12. *L. hygrophoroides* B. et C., spores. 13. *L. corrugis* Peck, spores. 14. *L. subserifluus* Longyear, spores. 15. *L. lignicolus* sp. nov., spores. 16. *L. camphoratus* (Bull.) Fr., spores. 17. *Russula nigricans* (Bull.) Fr., spores and cystidia. 18. *R. albonigra* (Krombh.) Fr., spores and cystidia. 19. *R. delica* Fr., spores and cystidia. 20. *R. mustelina* Fr., spores and cystidia. 21. *R. heterophylla* Fr., spores and cystidia. 22. *R. cyanoxantha* var. *variata* (Bar n. ap. Pk.) Sing., spores and cystidia. 23. *R. flavida* Frost et Peck, spores and cystidia. 24. *R. virescens* (Schaeff.) Fr., spores and cystidia. 25. *R. lepida* Fr., spores and cystidia. 26. *R. unciali s* Peck, spores and cystidia.

Subsection COLORATI Bat.

Fuliginosi Kon.

LACTARIUS LIGNYOTUS Fr. f. GRACILIS Bres.

Fig. 7

Pileus 5 cm. in diameter, convex-plane, papillate, black, rugose, tomentose. Gills white, decurrent, subclose, alternated with shorter blades. Stipe 7×0.7 cm., subequal, concolorous with the cap, minutely tomentose. Milk watery, changing to reddish. Flesh white, changing to brownish red.

Spores olivaceous under microscope, globose, warted to completely reticulate, 11–12×9–11 (12×11)μ.

Aug. 30, 1938, C. C. Cheo, Chunghotze, Tali, 8128.

Constantes Kon.

LACTARIUS ATROVIRIDIS Peck

Fig. 8

Pileus 4–7.5 cm. in diameter, convex, umbilicate or depressed with age, "bottle green," "sea green," concentrically zoned with floccose and squamules sometimes azonate; margin involute. Gills subconcolorous with the cap, up to 4 mm. broad, subclose to distant, long decurrent. Stipe 2.5–5×0.8–1.4 cm., cylindrical, tapering downward, "zinc green," pruinose, usually hollow. Flesh "light buff," "light mustard gray," milk white, changing "sea green" when exposed to the air.

Spores globose, minutely punctate 6.5–7×5–6μ.

July 27, 1938, C. C. Cheo from Kunming market, 8117.

The cap of the Yunnan plant is more or less zonate which is not the case in the American form.

LACTARIUS RUFUS (Scop.) Fr. var. EXUMBONATUS Boud.

Fig. 9

Pileus 1.5–4 cm. in diameter, convex to plane, slightly umbilicate to minutely papillate, "Hay's russet," fading to ferroginous, somewhat rugose, minutely pubescent; margin incurved when young. Gills "pale vinaceous tawny," becoming subconcolorous, close, subdecurrent, sometimes forked, up to 3 mm. broad. Stipe 2–6×0.5–1 cm., cylindrical, equal, concolorous with the cap, subglabrous, minutely fibrillate, stuffed then hollow. Flesh brownish. Milk white, copious, unchanging. Taste acrid.

Spores globose to subglobose, warted to reticulate, 8–9.5×6.5–8μ. Basidia 20–35×5–5.5μ. Cystidia not seen.

Aug. 6, 1938, C. C. Cheo, Haiyuentze, Kunming, 8123; Aug. 1939, Kunming, 8126; July 22, Aug. 10, 1942, W. F. Chiu, Shishan, Kunming, 8124, 8125.

LACTARIUS AURANTIACUS (Fl. Dan.) Fr.

Pileus 4.5 cm. in diameter, convex, "salmon orange," minutely tomentose; margin more or less involute. Gills "maize yellow," short decurrent, about 4 mm. broad, close, alternated with shorter blades in the front, rarely forked behind. Stipe 3×1.5 cm., equal, whitish becoming yellowish, minutely pubescent to subglabrous, compact, solid. Flesh whitish, changing yellow in the stipe and purplish in the cap. Milk white. Taste mild.

Spores not seen. Basidia 18–21×4–5μ. Cystidia subfusiform, more or less encrusted, 35–65×5–6.5μ.

The present plant is a rather young fruiting body of *L. aurantiacus*. It differs from the maturing sporophore in the minutely tomentose cap, the pale stipe and the purplish flesh in the cap. The measurements of the basidia and of the cystidia are smaller than those of mature ones.

Aug. 7, 1942, W. F. Chiu, Miaokaotze, Kunming, 8129. Mixed woods.

Lactarius omeiensis sp. nov.

Fig. 48

Pileo 3–7 cm. lato, convexo dein plano-convexo, interdum leviter depresso, "Saccardo umber," minute "Sepia"-squamuloso; lamellis albis, adnato-decurrentibus, distantibus; stipite 3–5 cm. longo, 0.7–1.6 cm. crasso, concolore, subglabro v. fibrilloso, saepe deorsum attenuato, farcto dein cavo, centrico v. excentrico. Sporis albis, globosis v. breviter ellipsoideis, reticulatis, 8–10×7–8.8 μ. Lacte albo, copioso.

Pileus 3–7 cm. in diameter, convex then plane-convex, sometimes slightly depressed in the central portion, "Saccardo umber," covered with minute "Sepia"-squamules. Gills white, broadly adnate and decurrent, alternated with narrower free blades, distant, very brittle. Stipe 3–5×0.7–1.6 cm., cylindrical, slightly tapering downward, concolorous with the cap, subglabrous or fibrillate, stuffed then hollow, central or excentric. Latex white, copious.

Spores white, globose to short elliptical, reticulate 8–10×7–8.5μ.

July 27, 1938, W. F. Chiu, Mt. Omei, Szechwan, 8292, Chiu 105.[4] Type. Under conifers.

This is a very distinct species among the Constantes. The angular attachment of the gills is very characteristic. It seems to be close to *L. umbrinus* (Pers.) Fr., but its gills are never tinged yellowish and its flesh never changes to brown on exposure to the air.

[4] Specimens are deposited in the Plant Pathology Herbarium of the University of Nanking.

Section PRUINOSI Quél.
Subsection PIPERATI Pon.

Lactarius chichuensis sp. nov.

Fig. 10

Pileo 5 cm. lato, depresso, "Tawny," glabro; lamellis liberatis v. breviter decurrentibus, subconcolore, pubescenti; carne spongiosa, brunneola; lacte albo; sapore acri. Sporis hyalinis v. pallidiore olivaceis, globosis v. subglobosis, verrucosis, 6–8×6–7 (6.5×7) μ. Basidiis 30–35×5–6μ.

Pileus 5 cm. in diameter, depressed, "Tawny," glabrous. Gills free to short decurrent, subconcolorous with the cap, up to 5 mm. broad, close. Stipe 5.5×0.8 cm., equal, subcolorous with the cap, pubescent. Flesh spongy, brownish. Milk white, watery. Taste acrid.

Spores hyaline to pale olivaceous under microscope, globose to subglobose, warted or with short parallel ridges, 6–8×6–7 (6.5×7)μ. Basidia 30–35×5–6μ.

Sept. 8, 1938, C. C. Cheo, Mt. Chichu, Pinchuan, 8135. Type.

The smaller spores with typically parallel ridged ornamentation distinguish it among the *Piperati*.

Lactarius cinnamomeus sp. nov.

Fig. 11

Pileo 7 cm. lato, depresso, "light ochraceous salmon" v. "Cinnamon," glabro, leniter rugoso; margine striato; lamellis "light ochraceous salmon," breviter decurrentibus, retrorsum furcatis, subconfertis, usque 5 mm. latis; stipite 8 cm. longo, 1 cm. circ. crasso, basi leniter ventricoso, "vinaceous tawny," supra pubescenti, infra villoso, cavo; carne brunneola; lacte albo; sapore acri. Sporis subglobosis v. breviter ellipsoideis, punctatis v. imperfecte reticulatis, 7.5–8×6–7.5μ; basidiis 30–40×7–10μ; cystidiis fusiformibus 70–80×8.5–12 μ.

Pileus 7 cm. in diameter, depressed, "light ochraceous salmon" to "Cinnamon," glabrous, slightly rugose; margin more or less striate. Gills short decurrent, "light ochraceous salmon," rarely forked behind, subclose, profusely alternated with short blades, up to 5 mm. broad; edge of blades slightly wavy. Stipe 8×1 cm., cylindrical, slightly ventricose at the base, "vinaceous tawny," pubescent above, villose below, hollow. Flesh brownish. Milk white, watery. Taste very acrid.

Spores subglobose to short elliptical, punctate, ridged to partially reticulate, 7.5–8×6–7.5μ. Basidia 30–40×7–10μ. Cystidia fusiform 70–80×8.5–12 μ.

Aug. 7, 1942, W. F. Chiu, Miaokaotze, Kunming, 8122. Type.

The present plant is close to *L. volemus* except the acrid taste and the

pale cinnamon color. Among the *Piperati* this species is somewhat related with *L. platyphyllus* Pk., but differs from the latter in the pubescent and villose stipe and the brownish flesh.

Subsection DULCES Kon.

Volumi Kon.

LACTARIUS HYGROPHOROIDES B. et C.

Fig. 12

Pileus 2.5–9 cm. in diameter, "vinaceous rufous," becoming paler with age, convex, depressed, minutely tomentose, more or less rugose; margin irregular, wavy. Gills whitish, short decurrent, rather distant, forked and anastomosed, up to 7 mm. broad; edge of blades slightly wavy. Stipe 2.5–5×1–3 cm., cylindrical, subequal or slightly tapering downward, "pale yellow orange," "Capucine buff" to "light ochraceous Salmon," sometimes tinged with yellow, spongy or hollow, central or excentric. Flesh white, unchanging. Taste mild.

Spores subglobose to short elliptical, punctate to partially or entirely reticulate, 8.5–10×7–8 (8.5×7) μ. Basidia 20–25×4–5μ; cystidia scarce.

July 6, 1938, from Kunming market; Aug. 6, 1938, C. C. Cheo, Haiyuantze Kunming (colored drawings and notes only); Aug. 11, 13, 1942, W. F. Chiu Shishan, Kunming 8111, 8112, 8141.

This species differs from the American form in the pale yellow orange stipe.

LACTARIUS CORRUGIS Peck

Fig. 13

Pileus 3.5–8 cm. in diameter, convex to plane convex, depressed, becoming infundibuliform with age, "liver brown," "cinnamon brown," velvety, minutely rugose, especially near the margin. Gills "Antimony yellow" to "yellow ocher," close, decurrent, up to 4 mm. broad, usually narrow. Stipe 3–5×1.5–2 cm., equal or slightly tapering upward, stuffed, "apricot buff" to subconcolorous, subglabrous to minutely velvety. Flesh white, becoming brownish. Milk copious, white, becoming brownish with age. Taste mild.

Spores globose, warted and reticulate, 10–12×8.5–12 μ. Cystidia abundant, fusiform, 36–65×4–5μ.

June 26, 1938, W. F. Chiu, Nanpu, Szechwan, Chiu 65; Sept. 8, 1938, C. C. Cheo, Mt. Chichu, Pinchuan, 8113, 8114. An edible species in Szechwan.

The cap of the Szechwan collection is less rugose while that of the Yunnan plant is distinctly rugose especially near the margin.

Subdulces Bat.

LACTARIUS SUBSERIFLUUS Longyear

FIG. 14

Pileus 1.7 cm. in diameter, convex, papillate, "Brazil red," glabrous. Gills "pinkish cinnamon," sinuate, close, 2 mm. broad. Stipe 2.5×0.6 cm., subequal, concolorous with the cap, but paler, glabrous. Flesh white, unchanging, hollow in the center of the stipe. Milk watery white.

Spores globose, punctate and slightly ridged, 6.5–7×6–6.5 (6.5×6.5) μ. Basidia 35–55×6–9μ. Cystidia not seen.

This plant is a small form of *L. subserifluus*. As far as the description is concerned, Murril's *L. alachuana* seems to be identical with this plant.

Lactarius lignicolus sp. nov.

FIG. 15

Pileo 3.2–4.5 cm. lato, depresso v. infundibuliformi, "cinnamon buff," leniter zonato, margine azonato; lamellis "yellow ocher," decurrentibus, confertis, furcatis, usque 3 mm. latis; stipite 1.5–4 cm. longo, 0.5–1 cm. crasso, aequali, saepe compresso, minute pubescenti v. subglabro, cavo; carne "light buff," firma; lacte albo v. albido, flavescente; sapore amarulo. Sporis globosis v. subglobosis, punctatis, rare anastomosantibus, 8–9.5 ×6.5–9.5 (8×9)μ; basidiis 20–35×5–8μ. Cystidiis invisis.

Pileus 3.2–4.5 cm. in diameter, depressed to infundibuliform, "cinnamon buff," slightly concentrically zonate in the center, azonate at the margin; margin more or less wavy. Gills "yellow ocher," decurrent, close, forked, up to 3 mm. broad. Stipe 1.5–4×0.5–1 cm., equal usually compressed, concolorous with the cap, minutely pubescent to subglabrous, hollow in the center of the stipe. Flesh "light buff," firm. Milk white to whitish, changing to yellowish with age. Taste bitterish. Odor none.

Spores globose to subglobose, punctate, rarely ridged, 8–9.5×6.5–9.5 (8×9)μ. Basidia 20–35×5–8μ. Cystidia not seen. Lacticiferous hyphae abundant.

July 31, 1938, C. C. Cheo, Chunchutze, Kunming, 8127. On decaying woody seed coat.

This plant is close to *L. mutabilis* Pk., but the color is quite different. The habitat of this species is also outstanding among the *Subdulces*.

Olentes Bat.

LACTARIUS CAMPHORATUS (Bull.) Fr.

Fig. 16

Pileus 2–3.5 cm. in diameter, depressed or more or less infundibuliform, dry, "vinaceous cinnamon," concentrically zoned with "Hay's russet"-squamules, fading to "Hazel"; margin involute when young. Gills whitish

or "light buff," becoming reddish brown, short decurrent, close, forked either behind or in the front, 3 mm. broad. Stipe 2–5.5×0.5–1 cm., cylindrical, subequal or slightly tapering upward or downward, "Congo pink," becoming "testaceous" or concolorous with the cap, hollow, central or more or less excentric. Flesh spongy, brownish, becoming "light grayish vinaceous." Milk white, watery. Taste mild. Odor very strong but pleasant.

Spores globose to subglobose, punctate, ridged and reticulate, 7–9×6–8 (8.5×8)μ. Basidia 30–40×10–12μ. Cystidia subfusiform 60–65×7.5–8μ.

July 31, 1938, C. C. Cheo, Chunchutze, Kunming, 8119; Aug. 15, 1938 T. H. Hwang, Simatang, Wenshan, 8121; Aug. 1941, Tapugi, Kunming, 5472; July 8, 1942, W. F. Chiu at the same locality, 8120, 8125.

L. camphoratus (Bull.) Fr. is described by European writers as more or less zonate, whereas by Americans as azonate. The Yunnan plant is distinctly zonate, yet its color is close to the American description. Moreover, the degrees of zonation of the Yunnan form vary much and the azonate form has never been found.

Genus RUSSULA Fr.

Section COMPACTAE Fr.

Subsection NIGRICANTINAE M-Zw.

RUSSULA NIGRICANS (Bull.) Fr.

Fig. 17

Pileus 8–14 cm. in diameter, depressed, "snuff brown," becoming darker or "Sepia" then black, minutely pubescent; margin smooth. Stipe 2–4×4–6 cm., subequal, white becoming brownish and finally black, subglabrous. Gills brittle, white becoming grayish and finally deep ochraceous, turning "apricot orange" then black when bruised, acute at both ends, ventricose, up to 10 mm. broad, free from the stipe, subdistant, here and there anastomosing with transverse veins. Context grayish, changing immediately to "apricot orange," turning purplish and finally blackish, usually paler along the rind, firm, compact and solid.

Spores globose to subglobose, punctate and sometimes anastomosing to form inconspicuous partial reticulation, 6–6.5×7–8μ. Basidia 6–9×25–40μ. Dermatocystidia absent, epicuticular hyphae usually 6–8μ in width, but sometimes swelling to 11–17μ. Cystidia in hymenium usually clavate, 50–80×6–8μ.

July 16, 1942, W. F. Chiu, Tapugi, Kunming, 7971. Under *Quercus*.

RUSSULA ALGONIGRA (Krombh.) Fr.

Fig. 18

Pileus 14 cm. in diameter, concave or deeply depressed, white, immediately changing to grayish brown then black, subglabrous; margin smooth,

usually wavy. Stipe 4×8 cm., cylindrical, subequal, white then grayish, quickly turning blackish. Gills whitish, becoming grayish, finally turning black, acute at both ends, decurrent, rather narrow, up to 5 mm. broad. Context immediately changing grayish brown and finally black, firm, solid.

Spores globose to subglobose, sometimes elliptical, very minutely punctate and reticulate, sometimes nearly smooth, 6–7×7–8μ. Basidia 30–50×7–8μ. Dermatocystidia absent, epicuticular hyphae 4–5μ in width. Hymenial cystidia subfusiform to ventricose-rostrate, 86–118×9–12μ.

Aug. 7, 1942, W. F. Chiu, Miaokaotze, Kunming, 8000. Mixed woods.

Subsection DELICINAE M-Zw.

RUSSULA DELICA Fr.

Fig. 19

Pileus 5–10 cm. in diameter, deeply depressed or convex-umbilicate, whitish to "warm buff," darker with age, dry, slightly rugose; margin smooth, usually incurved. Stipe 1.5–3×2–3 cm., short cylindrical, slightly tapering downward, central or excentric, white, minutely rugose, becoming grayish or ochraceous when dried. Gills white to whitish, slightly greenish with age, sharp in the front, decurrent behind, up to 5 mm. broad, sometimes anastomosing with transverse veins, rather close. Context white, unchanging, solid. Odor very unpleasant. Spore mass white.

Spores globose to subglobose, strongly warted and reticulate, 8–9×7–8μ. Basidia 38–45×8–9μ. Dermatocystidia none. Primordial hyphae 4–5μ in width. Hymenial cystidia subfusiform, ventricose-rostrate, 55–70×8–9μ.

Sept. 17, 1938, H. S. Yao, Gintingtze, Mt. Chichu; July 8, 1942, W. F. Chiu, Tapugi, Kunming, 7976, 7975, 7968. Under *Quercus*.

This fungus usually bursts out from the earth and therefore is covered with soil particles. The Australian species *R. erumpen* of Cleland seems to be a synonym of *R. delica* Fr. (?).

Section GRATAE M-Zw.

Subsection HETEROPHYLLINAE Fr.

RUSSULA MUSTELINA Fr.

Fig. 20

Pileus 4–10 cm. in diameter, convex, umbilicate when young, becoming depressed, "tawny," minutely areolate and tomentose in the center, dry, dull; margin smooth, entire. Stipe 4–6×1.5–2 cm., subequal, whitish then brownish or subconcolorous with the cap, glabrous. Gills ochroleucous when fresh, becoming dark ochraceous when dried, acute at both ends, short decurrent, up to 6 mm. broad, close, forked repeatedly and profusely.

Context brownish, changing slightly grayish, solid, compact. Taste mild. Spore mass ochroleucous.

Spores usually subglobose, punctate and partially reticulate, 7–8.8 ×6–8μ. Basidia 30–50×8–9μ. Dermatocystidia absent. Epicuticular hyphae 6–11μ in width. Hymenial cystidia usually clavate, rarely subfusiform, 55–70×9–11μ.

Aug. 13, 1942, W. F. Chiu, Shishan, Kunming, 7967, 7970.

This species is very close to the Compactae. The interpretation of this fungus varies according to author, but that of J. Schaeffer (Ann. Mycol. **31**, 1933) seems to be the most satisfactory.

Russula heterophylla Fr.

Fig. 21

Pileus 5 cm. in diameter, convex, becoming depressed, "Scheele's green," more or less silky, glabrous when dried; margin smooth, not striate, cracked with age. Stipe 7×1.2–1.5 cm., subequal, whitish, glabrous. Gills white, ochraceous when dried, more or less round at both ends, slightly ventricose in the middle, up to 6 mm. broad, subclose, forked only behind. Context white, firm and compact, hollow. Spore mass white. Taste mild.

Spores globose to ellipsoid, sparsely punctate (vesca-type), 6–6.5–(7)×5–6μ. Basidia 30–40×6–8μ. Dermatocystidia absent. Epicuticular hyphae about 2μ in width, rarely 6μ. Hymenial cystidia, subclavate to fusiform, 50–60×8–9μ.

Aug. 28, 1938, C. C. Cheo et H. S. Yao, Chunghofung, Tali, 7978.

The figure given by Gillet in his Atlas Hymenomycetes IV of *R. furcata* Fr. is identical with the present specimen. The vesca-type of the spores of these two species indicates their close affinity. This species is a green form of *R. heterophylla*. No brown form has been collected.

Russula cyanoxantha (Schaeff.) Fr. var. variata (Bann. ap.Pk.) Sing.

Fig. 22

Pileus 3–8 cm. in diameter, convex becoming depressed, "light brownish olive," "vinaceous purple," even pale green in tint, paler toward margin, subglabrous when moist, slightly shining when dried; margin smooth, never striate. Stipe 2–6×1–2 cm., subequal or tapering downward, pure white, glabrous. Gills white becoming cream-colored, more or less acute in front, decurrent, up to 3 mm. broad, close, forked either behind or in the middle. Context white, firm, mild, then slightly acrid. Spore mass white.

Spores globose to subglobose, sparsely punctate, 7–8–(9.5)×6–7–(8)μ.

Basidia 25–30×6–8μ. Dermatocystidia absent, primordial hyphae about 3μ in width. Hymenial cystidia cylindrical, clavate, ventricose-rostrate or fusiform, 38–55×5–7μ.

July 16 and 22, 1942, W. F. Chiu, Tapugi, Kunming, 7988, 8007. Under *Quercus* only.

The variation of the coloration of the cap is quite typical. Singer has restudied the specimens of the American *R. variata* Bann. ap. Peck and thereupon reduced it to a variety of *R. cyanoxantha* (Schaeff.) Fr. (Ann. Myc. **33**: 315, 1935).

RUSSULA FLAVIDA Frost et Peck

Fig. 23

Pileus 1–3.5 cm. in diameter, hemispherical when young, becoming convex then plane and slightly depressed, "Cadmium yellow," pruinose, dry; margin smooth. Stipe 1.5–3×0.6–1.4 cm., subequal, white and floccose at apex, "Cadmium yellow," pruinose downward, concolorous with the cap, subexcentric. Gills white, slightly ochroleucous when dried, up to 5 mm. broad, free to short decurrent, subclose, usually forked behind. Context white, unchanging, brittle, spongy in the stipe. Spore mass whitish.

Spores globose to ellipsoid, punctate and ridged or partially reticulate, 6–8–7.5×6–6.8μ. Basidia 28–35×8–11μ. Dermatocystidia absent. Primordial hyphae containing yellow pigment, septate, 3–5μ in width, very long. Hymenial cystidia not numerous, cylindrical, clavate or more or less ventricose-rostrate, 40–55×6–8μ.

June 25, 1942, W. F. Chiu, Miaokaotze, Kunming, 7987. Mixed woods.

This is the only species of *Russula* which has a beautiful yellow cap and yellow stipe. The original description of this species was given by Frost and Peck (Bull. N. Y. Stat. Mus. **2**: 32; Bull. N. Y. Stat. Mus. **105**: 38–39), but Schaeffer's Russula monograph should be consulted for a more detailed description (Ann. Myc. 1933).

Subsection GRISEINAE Schaeff.
RUSSULA VIRESCENS (Schaeff.) Fr.

Fig. 24

Pileus 3.5–9.5 cm., convex, umbilicate, then plane, depressed, "Pale lumiere green" to "Bice green," dry, areolately squamulose, sometimes turning "Congo pink" in the center with age; margin striate. Stipe 3.5–6×1.5–2 cm., subequal, white fibrillate. Gills white, becoming ochroleucous when dried, more or less acute at both ends, slightly ventricose, up to 8 mm. broad, short decurrent, forked behind or in the middle, close. Context white, unchanging, compact, firm, solid, becoming spongy with age. Taste mild. Spore mass white.

Spores globose to subglobose, minutely punctate or warted, sometimes

fused into ridges, 6–7×5–6μ. Basidia 35–50×6–11μ. Dermatocystidia none. Primordial hyphae 4–5μ in width. Hymenial cystidia clavate or subfusiform, 60–100×8–11μ.

July 22, 1942, W. F. Chiu, Shishan, Kunming. Mixed woods. Aug. 2, 1942, from Kunming market, 7965, 7966.

This is a well known edible mushroom in Kunming as well as in Szechuan. Its local name in Kunming is "Tsingtaojium" or green head mushroom. The spore measurement of the present collection is smaller than those hitherto recorded.

Subsection LEPIDINAE M–Zw.

RUSSULA LEPIDA Fr.

Fig. 25

Pileus 3–6 cm. in diameter, convex becoming depressed, "Nopal red" to "Dragon blood red," partially or entirely fading to "Pinkish cinnamon," more or less viscid when moist, glabrous when dry, dull or slightly shining especially at the margin, somewhat farinaceous in the center; margin smooth, not striate. Stipe 3–4.5×0.8–1.7 cm., subequal, glabrous, white or partly rose-colored which disappears when dried. Gills white, becoming yellowish, ochraceous when dried, obtuse at both ends, broader in the front, up to 5 mm. broad, short decurrent, close, forked repeatedly. Context white, unchanging, firm, often tunneled by worms. Spore mass whitish. Taste slightly bitterish.

Spores subglobose to ellipsoid, punctate and warted, usually forming partial reticulation, 8.5–9.5×7–8.5μ. Basidia 30–38×8–12μ. Dermatocystidia present 6–8μ in width. Epicuticular hyphae 4–5μ in width, some inflated hyphae up to 9–11μ in width. Hymenial cystidia varying from clavate to fusiform, even to ventricose-rostrate, 46–90×9–12μ.

July 8, 1942, W. F. Chiu, Tapugi, Kunming, 8005. Under *Quercus*.

The fading of the color on the cap is rather characteristic. The illustration given in Gillet's Atlas Hymenomycetes IV is identical with our collection.

RUSSULA UNCIALIS Pk.

Fig. 26

Pileus 3.5–8 cm. in diameter, pulvinate, convex becoming depressed, "La France Pink," "Nopal red" or fading to pale rose or whitish somewhere, more or less pruinose, becoming subglabrous at the margin; margin slightly wavy, more or less striate. Stipe 1.5–6×0.5–2 cm., subequal, "La France pink," subglabrous, central or subexcentric. Gills whitish becoming ochroleucous when dried, more or less obtuse in the front, slightly ventricose, 5 mm. broad, short decurrent or free, close forked behind. Context

white, fragile, usually becoming spongy or hollow in the stipe. Spore mass white. Taste mild.

Spores globose to subglobose, occasionally elliptical, punctate and minutely warted, even reticulate, 6.7–8–(9)×(5)–6–7μ. Basidia 25–30×9–11μ. Dermatocystidia not observed. Primordial hyphae thickened, inflated and suddenly slendered at some portions, quite cystidium-like. Common epicuticular hyphae about 5μ in width, while inflated ones 7–11μ. Hymenial cystidia numerous, usually ventricose below and lanceolate above (a cucurbiliform with aculeate tip), 45–60×8–9μ.

July 14 and 20, 1942, W. F. Chiu, Tapugi, Kunming, 7989, 7990. *Quercus* woods.

The figures given in Mycologia **4**, plate 76:6 do not correspond very well with the original description, since the gills appear too ochraceous in shade. According to Kauffmann, the gills of this species are always pure white, although according to Peck's description they may turn ochroleucous later.

Russula taliensis sp. nov.

Fig. 27

Pileo 5 cm. lato, plano-convexo, depresso, albo, "Begonia rose"—tomentoso, sicco; margine levi; stipite 5.5 cm. longo, 1–1.5 cm. crasso, subaequali, supra albo, infra "La France pink," glabro; lamellis albis, aetate ochraceis, usque 6 mm. latis, liberatis, subconfertis; carne firma, alba, aetate leniter grisea, stipiti cavo; sapore molli. Sporis globosis v. subglobosis, punctatis et minute verrucosis, 7–9–(10)×6–7–(8)μ; basidiis 25–30×6–8μ; dermatocystidiis (?) 2–3μ latis. Hymenocystidiis saepe clavatis, raro ventricoso-rostratis, 35–45×11–12μ.

Pileus 5 cm. in diameter, plane-convex, depressed, white with "Begonia rose" tomentum, dry; margin not striate. Stipe 5.5×1–1.5 cm., subequal, white above, "La France pink" below, glabrous. Gills white, ochraceous when dried, more or less obtuse in the front, about 6 mm. broad, free behind, subclose. Context firm, white, slightly grayish with age, hollow in the stipe. Spore mass whitish. Taste mild.

Spores globose to subglobose, sparsely punctate and warted, rarely anastomosing, 7–9–(10)×6–7–(8)μ. Basidia 25–30×6–8μ. Dermatocystidia (?) numerous, rigid, cylindrical, erect 2–3μ broad. Some epicuticular hyphae thickened to 7μ. Hymenial cystidia usually clavate, rarely ventricose-rostrate, rather thick and short 35–45×11–12μ.

Sept. 17, 1938, C. C. Cheo from Tali, 7995.

Macroscopically this plant resembles in many ways *R. punctata* (Gill.) Mre., but the spores of the former are never reticulate.

Subsection LILACINAE Schaeff.

RUSSULA AZUREA Bres.

Fig. 28

Pileus 4.5 cm. in diameter, plane-convex, slightly depressed, "light glaucous blue," subglabrous; margin smooth, not striate. Stipe 4×0.7–1.2 cm., slightly tapering upward, white, glabrous. Gills white, more or less obtuse in the front, about 4 mm. broad, free or short decurrent, close, forked and anastomosing repeatedly. Context white, unchanging, firm, solid. Spore mass white.

Spores subglobose, punctate and minutely warted, ridged or partially reticulate, 7–8.5–(9)×6.5–7μ. Basidia 30–35×9–11μ. Dermatocystidia absent but long primordial hyphae abundant, septate and encrusted, 5–6μ in width. Hymenial cystidia clavate to subfusiform, 40–55×8–9μ.

Sept. 17, 1938, H. S. Yao, Gintingtze, Mt. Chichu, 7979.

Our collection compares in every respect with the figures given in Cook's British Fungi no. 1088.

RUSSULA PSEUDOLEPIDA Sing.

Fig. 29

Pileus 4–8 cm. in diameter, pulvinate, convex to strongly depressed, dark "Nopal red," purplish when dried, fading to "yellow ochre" in the center, minutely velute, never shining; margin smooth, not striate. Gills white, becoming cream-colored when dried, more or less acute in the front, about 6 mm. broad, short decurrent, close, forked behind. Stipe 3–7×1–1.8 cm., subequal or slightly ventricose, white, very occasionally pinkish at the base, glabrous, central to excentric. Context white, firm, unchanging. Taste at first mild, turning slightly acrid. Spore mass cream-colored.

Spores globose to subglobose, punctate and warted, usually forming partial reticulation 7–8×6–7μ. Basidia 30–40×8–9μ. Dermatocystidia absent. Primordial hyphae ranging from 3–5μ in width. Cystidia numerous, cylindrical, tapering downward, rarely very acuminate at the apex (ventricose-rostrate), 50–55×11–12μ.

July 20, 1942, W. F. Chiu, Tapugi, Kunming, 8008. Under *Quercus*.

This species is very close to *R. lepida*, but differs from the latter in microscopic characters.

Subsection PALUDOSINAE Schaeff.

RUSSULA PURPURINA Peck ap. Kauffmann

Fig. 30

Pileus 3–4 cm. in diameter, plane or slightly depressed, "Nopal red," "Indian Lake," "dark vinaceous purple" in the center, glabrous, more or less shining, margin smooth. Stipe 3–4×0.5–1 cm., subequal, "Jasper pink"

to "old rose," fibrillate under hand lens. Gills white, becoming ochroleucous when dried, somewhat obtuse in the front, narrower behind, 6 mm. broad, subclose to subdistant, rarely forked, nearly of equal length. Context white, unchanging, brittle, spongy in the stipe. Spore mass white. Taste mild.

Spores globose to subglobose, sparsely punctate and warted; warts up to 0.5μ in height, (9)–10–11.5×(7)–9–10μ. Basidia 30–40×9–12μ. Dermatocystidia absent. Primordial hyphae 3–6μ broad. Hymenial cystidia clavate, fusiform or subventricose 60–70×9–12μ.

Aug. 28, 1938, H. S. Yao, Simatang, Tali, 7985.

The spore size of this species seems variable. According to Burlingham the measurement is 4–8μ, whereas Kauffman encountered a species with larger spores. The spores of the present collection are even larger than those measured by Kauffmann. The ornamentation of the spore of this species varies also. Burlingham described it as finely warted, while Kauffmann observed partial reticulation. In short, the spores of the present plant approach those of Burlingham's collection in ornamentation but Kauffmann's in size. Singer, after restudying the microscopic characters of this species, suggested that *R. perplexa* Burl. might be a synonym. But, so far as we know, the color of the gills of *R. purpurina* is, nevertheless, different from that of *R. perplexa*.

Russula humidicola Burl.

Fig. 31

Pileus 5–8 cm. in diameter, convex then plane, usually depressed, "Acajou red" when young, fading to "Eugenia pink" with age, usually paler toward margin, becoming "Chateny pink," subglabrous; margin striate even when young. Gills white, ochroleucous or buff when dried, slightly ventricose, about 6 mm. broad, subclose, free, rarely forked. Stipe 4–6.5×1–1.5 cm., cylindrical, equal, white, glabrous, spongy then hollow. Context white, unchanging. Taste acrid. Spore mass buff.

Spores globose to subglobose, strongly warted, 7.5–10×6.5–8μ. Basidia 30–35×5–6μ. Dermatocystidia absent. Epicuticle hyphae 1.5–4.6μ in width. Hymenial cystidia numerous ventricose-rostrate, 85–90×10–12μ.

Sept. 3, 1943, W. F. Chiu, Shishan, Kunming, 8282. Mixed woods.

Subsection Russulinae Schaeff.

Russula integra (L.) Fr.

Fig. 32

Pileus 5.7–10.5 cm. in diameter, plane-convex, depressed, "Brazil red," sometimes fading to "Buff yellow" in the center, glabrous, slightly viscid when moist, shining when dried; margin striate. Stipe 5–10×1.5–2 cm., cylindrical, slightly tapering downward, usually widened at the apex, dull white, fibrillate. Gills white, turning ochraceous when dried, slightly ob-

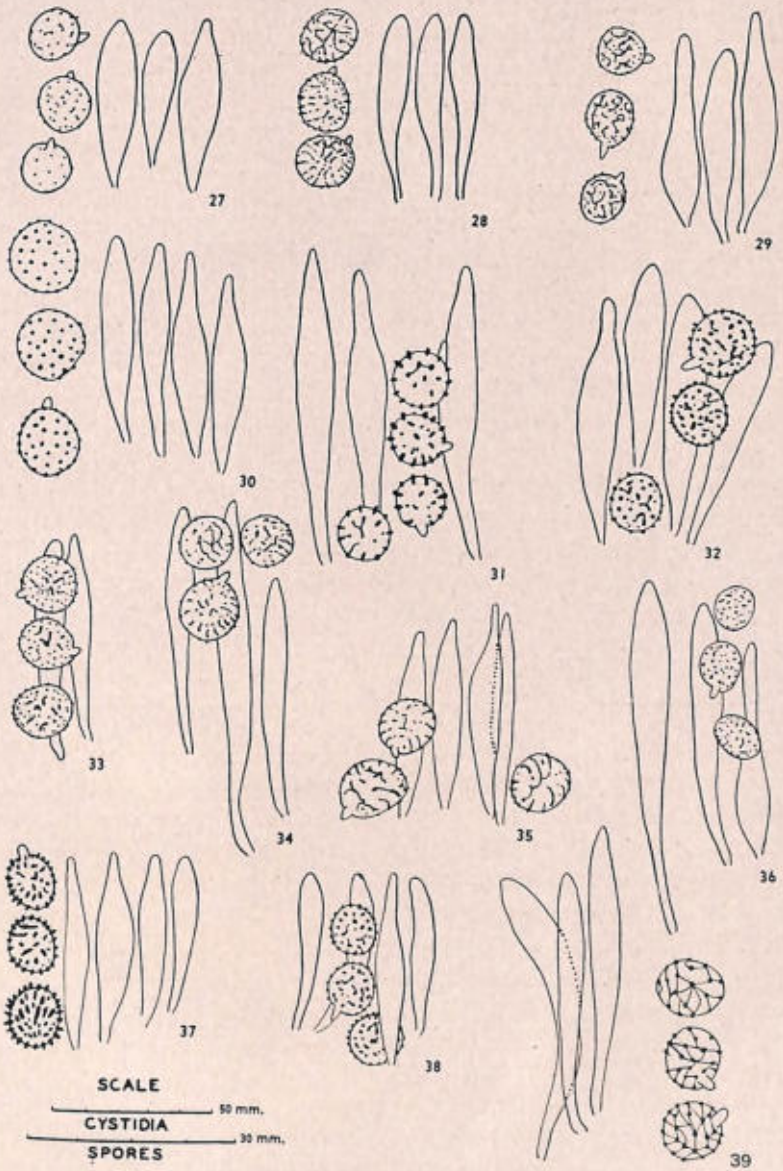


PLATE 2.—27. *R. taliensis* sp. nov., spores and cystidia. 28. *R. azurea* Bres., spores and cystidia. 29. *R. pseudolepida* Sing., spores and cystidia. 30. *R. purpurina* Pk. ap. Kauffm., spores and cystidia. 31. *R. humidicola* Burl., spores and cystidia. 32. *R. integra* (L.) Fr., spores and cystidia. 33. *R. borealis* Kauffm., spores and cystidia. 34. *R. xanthophaea* Bourd., spores and cystidia. 35. *R. pseudoviolacea* Joachim, spores and cystidia. 36. *R. farinipes* Rom., spores and cystidia. 37. *R. foetens* Pers., spores and cystidia. 38. *R. consobrina* var. *soraria* (Larb.) Fr., spores and cystidia. 39. *R. emetica* Schaeff., spores and cystidia.

tuse in the front, up to 7 mm. broad, narrower behind, short decurrent, close, of nearly equal length, rarely forked. Context white, firm, becoming spongy in the stipe. Spore mass not observed. Taste milk.

Spores globose to subglobose, warted, rarely anastomosed; warts up to 1μ in height, 8.5–10–(11)×7–8–(9)μ. Basidia 30–40×8.6–11μ. Dermatocystidia present, narrow and long, sometimes septate, 5–8μ in width. Hymenial cystidia clavate to ventricose-rostrate, numerous, 60–70×9–16μ.

July 18, 1938, C. C. Cheo, Shihan, Kunming, 7999, 8002.

This species can not be confused with *R. lepida*, since the latter never has a shining cap. In his notes on *R. integra* M. M. Josserand illustrated spores with isolated echinules and stated: "ornées d'une échinulation assez marquée, bien régulière; dépourves non seulement de crêtes vraies mais même de pseudo-crêtes, donc du type purément échinulé" (B. S. M. Fr. **46**: 280, 1930). But according to Singer, the spores of his Integrinae should belong to his spore type II, and according to Schaeffer, anastomosis between echinules may be present (B. S. M. Fr. **51**: 281, 1935 and Ann. Myc. **31**: 403, 1933). The types of dermatocystidia and of hymenial cystidia figured by Josserand, however, agree with those of the Yunnan plant.

Russula borealis Kauffmann

Fig. 33

Pileus 10 cm. in diameter, convex, slightly depressed, "Ox-blood red," evenly colored, becoming much darker when dried, subglabrous or minutely pubescent, usually glabrous at the margin; margin smooth, not striate. Stipe 4×11 cm., cylindrical, equal, rather thick and compact, white, glabrous. Gills yellowish, dark ochraceous when dried, obtuse in the front, free, 10 mm. broad, close, forked behind. Context white, unchanging, firm, compact, solid. Taste acrid.

Spores subglobose, sparsely punctate, 7.5–9.5×7–8μ. Basidia 8–11×30–40μ. Primordial hyphae 3–5μ in width. Hymenial cystidia ventricose-rostrate or subfusiform, 60–80×8–12μ.

Sept. 1, 1938, S. T. Chao from Kunming market, 7981.

Russula xanthophaea Bourd.

Fig. 34

Pileus 6–8 cm. in diameter, convex, becoming plane, slightly viscid when moist, somewhat shining when dried; margin beadedly striate. Stipe 6–7×1.5–2.5 cm., cylindrical, subequal, white, fibrillate. Gills whitish then buff, becoming ochraceous when dried, obtuse in the front, 10 mm. broad, narrower behind, subclose, forked, free. Context white, spongy in the stipe. Taste very acrid. Spore mass buff.

Spores globose, minutely punctate and warted or ridged, 9–10×8.5–10μ.

Basidia 35–45×8–11μ. Dermatocystidia absent. Primordial hyphae 3–5μ in width. Hymenial cystidia abundant, clavate to subfusiform, 60–100×8–9μ.

July 22, 1942, W. F. Chiu, Shishan, Kunming, 7904. Mixed woods.

By the lack of the typical pectinoid odor this species is readily distinguishable from *R. pectinata*.

Russula pseudoviolacea Joachim

Fig. 35

Pileus 6–10 cm. in diameter, convex becoming plane, usually umbilicate or depressed, "Deep Hellebore red" to "Corinthin purple," glabrous, becoming darker when old, slightly shining when dried; margin smooth when young, striate with age. Gills "light buff," becoming "warm buff" or even darker, broader in the front and narrower behind, 10 mm. broad, usually forked behind, free or attached to the stipe with a short tooth. Stipe 5–7× 1.5–2.5 cm., cylindrical, tapering either upward or downward, white, somewhat fibrillate, hollow. Context white, unchanging, not compact but firm, spongy or hollow with age. Spore mass slightly yellowish. Taste mild.

Spores subglobose to ellipsoid, punctate to minutely warted, sometimes with parallel ridges, 8–9×(6.5)–7–8μ. Sterile basidia 23–30×6–8μ. Maturing basidia 30–40×8–10μ. Dermatocystidia clavate, usually septate, up to 11μ in width, normally 5–8μ. Hymenial cystidia cylindrical, tapering toward both ends, usually acuminate at the apex, 54–60×6–9μ.

July 22, 1942, W. F. Chiu, Shishan, Kunming, 7974, 7998. Mixed woods.

This species is very close to *R. atropurpurea* Kromb., but differs from it in many ways. Joachim stated that "*R. atropurpurea* Kromb. a les spores blanches, de même grandeur, mais les aiguillons plus dense, les lignes plus abondantes, les dermatocystides beaucoup plus robustes." Superficially *R. atropurpurea* v. *depallens* Mre. can easily be confused with this plant. But according to Zvara the former is identical with *R. brunneo-violacea* Craws., which differs from the present fungus in the coloration of the stipe and the flesh (B. S. M. Fr. **47**: 257, 1931).

The position of the present plant seems to be close to Emeticinae. On account of its mild taste it is provisionally included in this section.

Section Ingratae M–Zw.
Subsection Foetentinae M–Zw.
Russula farinipes Rom.

Fig. 36

Pileus 5.5–8 cm. in diameter, convex, plane convex, usually slightly depressed, white, somewhat dirty yellow or brownish at the center, becoming

unicolor when dried, very viscid when moist, glabrous; margin striate, *foeten*-like. Stipe 4–8×1.5–2.5 cm., equal, white, fibrillate or glabrous. Gills white becoming ochraceous when dried, more or less acute at both ends, 5–7 mm. broad, close, forked behind, free. Context white, unchanging, firm and hard, solid at first, spongy or hollow with age. Spore mass yellowish.

Spores subglobose, minutely and sparsely punctate, scarcely ridged, 7–(8)×5–6.5μ. Basidia 25–30×8–9μ. Dermatocystidia none, epicuticular hyphae 4–5μ in width. Hymenial cystidia usually clavate, rarely cucurbiliform, 50–120×8–11μ.

Sept. 15, 1938, C. C. Cheo et H. S. Yao, Mt. Chichu, Pinchuan, 7972, 7973.

This plant can easily be confused with *R. foetens* except that it has a very weak odor and its spores are of the vesca-type.

RUSSULA FOETENS Pers.

Fig. 37

Pileus 3.5–10 cm. in diameter, pulvinate, then convex, becoming plane or slightly depressed, whitish or more or less "Honey yellow" when young, "Auburn" in the center, paler toward the margin, very viscid and glutinous when moist, glabrous, shining when dried; margin beadedly striate. Stipe 3.5–9×1.5–3 cm., usually tapering upward or subventricose and slightly constrict at the apex, white, brownish fibrillate with age. Gills whitish, more or less acute in the front, short decurrent, 5 mm. broad, subclose to subdistant, usually forked behind, rarely anastomosing with transverse veins. Context white, changing to dirty brownish, spongy then hollow in the stipe. Taste very acrid. Spore mass whitish.

Aug. 1938, W. F. Chiu, Shishan, Kunming; July 1942, W. F. Chiu, Tapugi, Kunming, 7994, 8004.

The color of the cap varies considerably in different collections. The writer is of the opinion that environmental factors may influence the coloration of the cap to a certain extent.

RUSSULA CONSOBRINA Fr. var. SORARIA (Larb.) Fr.

Fig. 38

Pileus 3–6 cm. in diameter, pulvinate when young then plane-convex and depressed, "Buffy brown" or "Raw umber," darker when dried, soapy feeling when flesh, glabrous; margin striate, usually beadedly striate. Stipe 5–8×1.2–2.5 cm., subequal or tapering upward or downward, white, turning grayish, slightly floccose. Gills white becoming grayish, fragile, acute in the front, ventricose, 5 mm. broad, free. Context white, changing gray-

ish, usually spongy in the stipe. Taste acrid. Odor strong typically pectinoid. Spore mass buff.

Spores globose to subglobose, sparsely echinulate or warted; warts up to 1μ in height, 6–7–(8)×5–6μ. Basidia 30–40×9–11μ. Dermatocystidia absent; primordial hyphae punctate, 5–9μ in width. Hymenial cystidia ventricose-rostrate to subfusiform 38–50×6–9μ.

June 27 and July 14, 1942, W. F. Chiu, Tapugi, Kunming, 7976, 7977, 7880. Under *Populus* and *Quercus*.

This plant is very close to *R. consobrina* and *pectinata*, but it differs from *R. consobrina* in the beadedly striate margin and from *pectinata* in the usually "raw umber" even "Sepia" color of the cap. Schaeffer's monograph of *Russula* (Ann. Myc. **31**, 1933) includes both *consobrina* and *soraria* as two distinct species. But the writer agrees with Rea and others in considering *soraria* a variety.

Subsection EMETICINAE M–Zw.

RUSSULA EMETICA Schaeff.

Fig. 39

Pileus 4.5–6.5 cm. in diameter, convex to plane-convex and depressed, "Geranium pink" to "La France pink," usually fading to very pale even white toward margin, but remaining pink in the center, viscid or not when moist, glabrous; margin faintly striate or smooth. Stipe 3–4×0.7–1.7 cm., uniformly white, glabrous, stuffed or hollow. Gills pure white, subclose, round at both ends, free, 7 mm. broad, rarely forked. Context white, unchanging, very acrid. Spore mass white.

Spores globose to subclose, coarsely warted and finely reticulate, 8.5–11×6.5–9.5μ. Basidia 18–20×3–5μ. Dermatocystidia abundant clavate, 6–8μ in width. Hymenial cystidia clavate 78–90×7–10μ.

July 2, 1943, W. F. Chiu, Tapugi, Kunming, 8283. Under pines. July 8 1943, W. F. Chiu at the same locality, 8212. Under *Quercus*.

Singer excluded all *emetica*-species except those living in coniferous habitats which he referred to *R. emetica*. The writer has collected this species both under pines and *Quercus*, and cannot find out any significant difference between these two collections. It seems to be unreasonable to limit the *emetica*-species to those with coniferous habitat.

RUSSULA CORALLINA Burl.

Fig. 40

Pileus 2–6 cm. in diameter, hemispherical when young becoming plane or slightly depressed, "Brazil red," becoming "Peach red" with age, sometimes fading to ochraceous in the center, somewhat hygrophanous and viscid, minutely rugose; margin smooth when young, striate with age. Gills white, ochroleucous when dried, more or less obtuse in the front, narrower

behind, up to 4 mm. broad, short decurrent, close, mostly forked behind. Context white, brittle, becoming hollow or spongy in the stipe. Taste bitterish. Spore mass white.

Spores globose to subglobose, punctate and warted; short ridged; warts up to $\frac{3}{4}\mu$ in height, 8–8.6–(9)×(6)–6.5–7μ. Basidia 25–30×8–9μ. Dermatocystidia not obesrved. Primordial hyphae 4–6μ in width. Hymenial cystidia cylindrical, clavate, fusiform and ventricose-rostrate, 35–46×9–17μ.

Aug. 11, 1942, W. F. Chiu, Shishan, Kunming, 7996.

The original description given by Burlingham did not list microscopic characters in detail. It was not until 1939 that Singer studied it again. The Yunnan plant differs from the American form in the glabrous and striate cap.

RUSSULA FRAGILIS (Secr.) Fr.

Fig. 41

Pileus 3–6.5 cm. in diameter, pulvinate then plane and depressed, "Nopal red," "Geranium pink," usually darker in the center and fading to ochroleucous toward the margin, slightly viscid when moist, subglabrous when dried; margin smooth. Stipe 2.5–6×1–2 cm. subequal, white, fibrillate, subexcentric. Gills white, becoming ochroleucous, more or less obtuse in the front, slightly ventricose but narrower behind, 5 mm. broad, subclose, usually forked behind, free. Context white, unchanging, very fragile, hollow in the stipe, very acrid. Spore mass white.

Spores subglobose to ellipsoid, punctate and minutely warted, usually reticulate 8–9–(11)×6–8–(9)μ. Basidia (25)–30–35×(7)–8–(11)μ. Dermatocystidia numerous, clavate, long, 5–8–10μ in width, the refraction of the granular cytoplasmic substance rendering the appearance as if rugose. Hymenial cystidia clavate to ventricose-rostrate, possessing granular substance, 55–80×8–11μ.

June 11, 20, 1942, E. F. Chiu, Tapugi, Kunming, 7992, 7997. Under *Quercus*.

Singer has reduced *fragilis* to a subspecies of *R. emetica*. Although these two species are in many ways alike, the size and ornamentation of the spores are quite different. In general the spores of *fragilis* are usually finely warted, reticulate and smaller, whereas those of *emetica* are coarsely warted and larger.

RUSSULA VISCOSA P. Henn.

Fig. 42

R. fallax Craw.

Pileus 2.5–3.5 cm. in diameter, convex, usually umbilicate, "light grayish vinaceous," "livid brown" in the center, glabrous; viscosity not determined; margin inconspicuously striate, very thin. Stipe 2.5–4×0.7–1 cm.,

subequal, white, glabrous. Gills buff or whitish becoming ochraceous buff when dried, acute in the front, broadest in the middle, 4 mm. broad, free, subclose, forked behind, fragile. Spore mass whitish. Context white, fragile, usually spongy in the stipe. Taste acrid.

Spores ellipsoid, sparsely punctate, 8–9×5–8μ. Basidia 25–30×8–9μ. Dermatocystidia clavate 6–8μ in width. Some epicuticle hyphae swelling to cucurbiliform, often strangulated, 38–55×6–8μ.

July 8, 1942, W. F. Chiu, Tapugi, Kunming, 7983.

Hennings first described this species from Java, but his description is not very complete. Crawshay's *R. fallax* is identical with it. Crawshay did not mention the viscosity of the cap and in the case of the Yunnan plant the viscosity remains to be determined.The smaller size of the plant and the vesca-type of the spores are very characteristic.

Russula punicea sp. nov.

Fig. 43

Pileo 2.5–6 cm. lato, plano-convexo v. depresso, "Shrimp pink" et "Begonia rose," minute farinaceo; margine levi; lamellis albis, 5 mm. latis, confertis, post furcatis; carne alba, immutabili, firma, aetate cava; stipite 1–3 cm. longo, 1.2–2.5 cm. crasso, conico v. bulboso, curto, candido v. leniter puniceo, glabro; sapore acri. Sporis flavidis, globosis v. subglobosis, punctatis v. reticulatis 6.5–7–(8)×5–6.5μ; basidiis 30–40×7–11μ; dermatocystidiis clavatis v. fusiformibus, ventricoso-rostratis v. -lanceolatis, strangulatis, 6–9μ latis; cystidiis clavatis v. ventricoso-rostratis 45–60×9–12μ.

Pileus 2.5–6 cm. in diameter, plane-convex to depressed, "Shrimp pink" and "Begonia rose," minutely farinaceous, usually darker in the center; margin smooth, never striate, more or less wavy. Stipe 1–3×1.2–2.5 cm., conical or bulbous, very short, dull white or slightly pinkish when young, glabrous. Gills white becoming ochroleucous, acute in the front, narrower behind, 5 mm. broad, close, usually forked behind. Content white, unchanging, firm, stuffed, spongy or hollow with age. Taste acrid. Spore mass slightly yellowish.

Spores globose to subglobose, punctate or reticulate or ridged, 6.5–7–(8)×5–6.5μ. Basidia 30–40×7–11μ. Dermatocystidia numerous, clavate, fusiform, ventricose-rostrate or -lanceolate, strangulated, 6–9μ in width. Hymenial cystidia clavate or ventricose rostrate, 45–60×9–12μ.

July 12, 1942, W. F. Chiu, Tapugi, Kunming, 7991. Under *Quercus*.

The short conical and bulbous stipe of this species is outstanding in Emeticinae. This species seems to be close to Murril's *R. roseitincta* but the latter has ellipsoid spores and a rosy-avellaneous-isabelline cuticle. Besides the short conical stipe, the type of dermatocystidia can also serve to separate it from the other rose-colored Russulae.

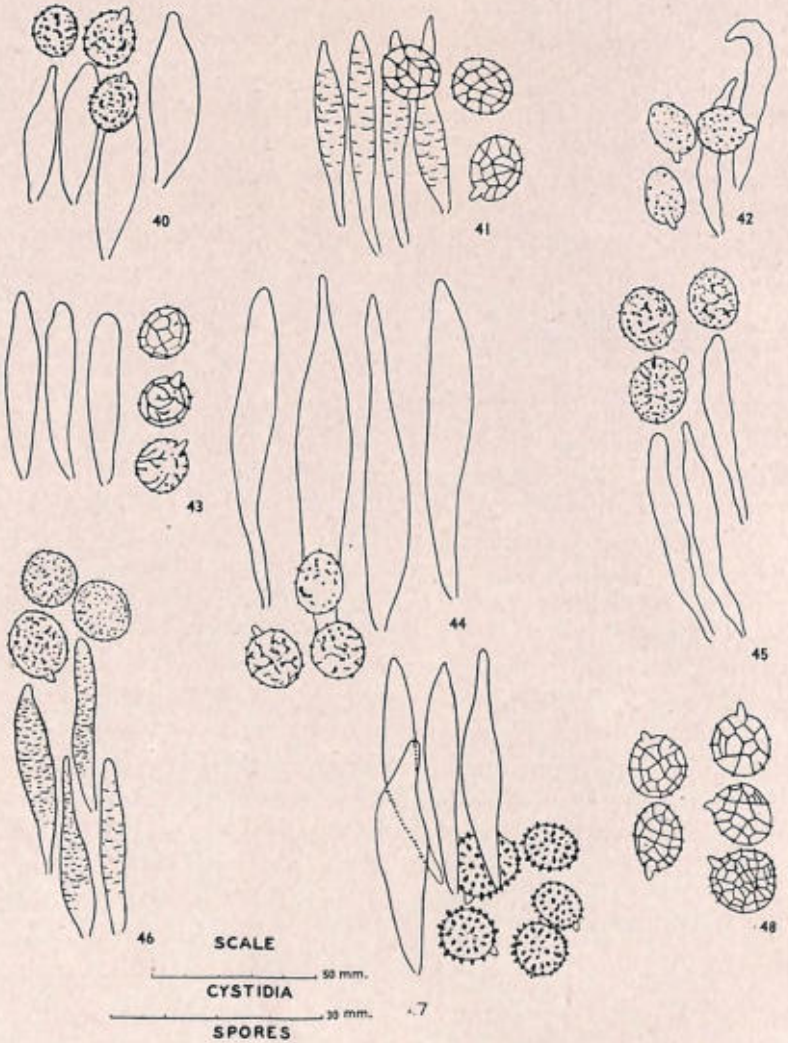


PLATE 3.—40. *R. corallina* Burl., spores and cystidia. 41. *R. fragilis* (Secr.) Fr., spores and cystidia. 42. *R. viscosa* P. Henn., spores and cystidia. 43. *R. punicea* sp. nov., spores and cystidia. 44. *R. chichuensis* sp. nov., spores and cystidia. 45. *R. sanguinea* (Bull.) Fr., spores and cystidia. 46. *R. pseudoaurata* sp. nov., spores and cystidia. 47. *R. rubra* (Krombh.) Bres., spores and cystidia. 48. *Lacterius omeiensis* sp. nov., spores.

Russula chichuensis sp. nov.

Fig. 44

Pileo 9 cm. lato, plano-convexo, leniter depresso, "Coral red," "Salmon orange," "yellow orange," ad marginem pallidiore; margine plus minusve striato; lamellis albis, 6 mm. latis, confertis, liberatis; stipite 7.5 cm. longo, 2 cm. circ. crasso, aequali, flavido v. puniceo, basi brunneolo, glabro; carne alba, immutabili, spongiosa; sapore acri. Sporis albis, globosis v. subglobosis, verrucosis v. echinulatis, imperfecte reticulatis, (7)–8–9×(6)–7μ; basidiis 25–30×8–9μ; dermatocystidiis nullis; dermatohyphis 3–5μ latis; cystidiis clavatis, ventricosis v. apice rostratis, interdum fusiformibus 86–110×12–16μ.

Pileus 9 cm. in diameter, plane-convex, slightly depressed, "Coral red" and "Salmon orange" in the center, "yellow orange" or paler toward margin, glabrous; margin somewhat striate. Stipe 7.5–2 cm., equal, yellowish tinged with pinkish shade, brownish at the basal portion, glabrous. Gills white, obtuse in the front, 6 mm. broad, close, free. Context white, unchanging, spongy. Taste acrid. Spore mass white.

Spores globose to subglobose, warted and echinulate, ridged to partially reticulate (7)–8–9×(6)–7μ. Basidia 25–30×8–9μ. Dermatocystidia absent. Primordial hyphae 3–5μ broad. Hymenial cystidia cylindrical, clavate, ventricose-rostrate, sometimes subfusiform, 85–110×12–16μ.

Sept. 10, 1938, C. C. Cheo, Mt. Chichu, Pinchuan, 7982, Type.

Macroscopically this species is close to *R. decolorans*, but it has white spores and unchanging flesh. The large cystidia of this species are also very characteristic.

Subsection SANGUININAE M–Zw.

RUSSULA SANGUINEA (Bull.) Fr.

Fig. 45

Pileus 4.5–10 cm. in diameter, convex, plane to depressed, "Carmine," slightly tinged purplish when dried, minutely tomentose or pruinose; margin smooth. Gills whitish becoming cream-colored with age, grayish ochraceous when dried, acute in the front, 5 mm. broad, decurrent, close, of nearly equal length, forked mostly behind. Stipe 4–8×1.5–2 cm., subequal or somewhat claviform, usually colored "Jasper pink," "orange yellow" at the base, sometimes entirely white, minutely pruinose under hand lens, central or excentric. Context white, solid, firm, unchanging, slightly acrid. Spore mass yellowish.

Spores globose to subglobose, punctate and minutely warted; warts here and there anastomosed but rarely forming reticulation, usually less than 0.5μ in height, 8.5–9.5×(7)–7.5–8.5μ. Basidia 26–30×6–8μ. Dermatocystidia numerous, cylindrical to fusiform 6–8μ in width. Cystidia numerous, cylindrical, clavate and fusiform, usually strangulated, 45–61×8–9μ.

Aug. 1938, F. L. Tai from Kunming market; June 25, 1942, W. F. Chiu, Miaokaotze, Kunming, 7984, 8001, 8000. Under *Quercus*.

This species can be readily distinguished from *R. rubra* by its pink stipe, narrower gills and especially its finely warted or punctate spores. Some collections of this species are tinged yellow orange at the base which is not, however, a constant character.

Russula pseudoaurata sp.nov.

Fig. 46

Pileo 5 cm. lato, convexo-pulvinato, "old rose," ad marginem "light orange yellow," glabro; margine levi; lamellis "pale lemon yellow" 4 mm. latis, confertis, liberatis, post furcatis; stipite 4 cm. longo, 1 cm. cir. crasso, subaequali, "Empire yellow," glabro; carne flavida, firma; sapore acri. Sporis globosis, punctatis, 8–9×7–8μ; basidiis 25–30×6–7μ; dermatocystidiis clavatis v. ventricoso-rostratis, crustatis, 40–55×8–9μ.

Pileus 5 cm. in diameter, convex-plane (rather irregular in form), "old rose" in the center, "light orange yellow" toward margin, glabrous; margin smooth, hanging downward at least when young. Stipe 4×1 cm., subequal, "Empire yellow," glabrous. Gills pale "lemon yellow," acute in the front, free, 4 mm. broad, close, forked behind. Context yellowish, reddish under the cuticle, firm. Spore mass yellowish. Taste acrid.

Spores globose, sparsely punctate, 8–9×7–8μ. Basidia 25–30×6–7μ. Dermatocystidia abundant, cylindrical, clavate and ventricose, sculptured with transverse lines (encrusted ?) 8–11–(13)μ in width. Hymenial cystidia subfusiform, cucurbiliform to ventricose-rostrate, sculptured as dermatocystidia; 40–50×8–9μ.

Sept. 10, 1938, C. C. Cheo, Mt. Chichu, Pinchuan, 7986. Type.

R. aurata has reticulate and strongly warted spores and no dermatocystidia; that is not the case in this species. The sculptured cystidia and the acrid taste make this plant more outstanding.

Russula rubra (Kromb.) Bres.

Fig. 47

Pileus 8–9 cm. in diameter, convex, plane then slightly depressed in the center, "Nopal red" becoming darker or paler or tinged with purplish with age, usually fading to pale rose or ochraceous either in the center or toward the margin, minutely tomentose or becoming glabrous; margin inconspicuously striate, sometimes not; the striation hardly distinguishable when young. Gills "warm buff," becoming darker when dried, broader in the front, 7 mm. broad, close to subclose, usually forked behind, free or short decurrent with the stipe. Stipe 6–8×1.5–2.5 cm. subequal or slightly tapering downward, white, fibrillate, (occasionally tinged with a little rose at the basal portion or on one side) at first firm. Context whitish (to

yellowish with age) becoming spongy or hollow in the stipe. Spore mass buff. Taste acrid.

Spores globose to subglobose, strongly warted and echinulate; the echinules usually 0.5–1μ in height; anastomoses between warts rare; 7–8–(10)×6.5–7–(8)μ. Basidia 30–35×8–9μ. Dermatocystidia club-shaped 7–11μ in width. Primordial hyphae ranging from 4 to 5μ in width. Cystidia cylindrical, tapering toward both ends (fusiform), ventricose-rostrate, 69–80×9–16μ.

July 22, 1942, W. F. Chiu, Shishan, Kunming, 8005.

This is an edible mushroom of China and famous especially in Fukien, where it is known as "Hungu" or Red mushroom. Specimens from Fukien have been collected by the writer at Wangli, Ingan, Aug. 28, 1941. The Fukien plant is no doubt *R. rubra*. S. C. Teng reported a red *Russula* from Fukien, *R. rosacea*, which according to his description seems to be the same species.

Physiological Studies on Some Members of the Family Saprolegniaceae IV. Carbohydrate Requirements*

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INTRODUCTION

It is now well established that carbon along with various other elements is indispensable for the growth of fungi and that different organisms show a differential utilisation of various carbon compounds. Glucose, fructose or sucrose provides an excellent source of carbon for many fungi (Young and Bennet 1922, Leonian 1924, Kögl and Fries 1937, and Robbins and Kavanagh 1938) while glucose is valueless for others like *Sphaeonema fimbriatum* (Weimer and Harter 1921) and *Fusarium lini* (Tochinai 1926). Lockwood (1933) reports that growth of *Penicillium javanicum* is poor on sucrose.

Very few studies have been made on the suitability of different carbon compounds for the members of the family Saprolegniaceae. The author has not come across any account describing the relative utilisation of carbon compounds in a quantitative manner. Pieters (1915) reported that *Achlya racemosa*, *A. prolifera*, *Saprolegnia ferax* and *S. monoica* were unable to utilise sucrose. Volkonsky (1933, 1934) investigated the nutritional requirements of a number of fungi belonging to this family and mentioned some compounds suitable as source of carbon for these fungi. Later Moreau and Moreau (1936 a, b) studied the action of glycerine and some sugars on the growth and reproduction of *Achlya colorata*. Edgecombe 1938), while studying the effect of galactose on some fungi, found that it was a poor source of carbon for *Saprolegnia ferax*.

The results of investigation described in the following pages throw some light on the relative value of various carbon compounds in the nutrition of *Achlya* sp., *Brevilegnia gracilis* v. Eek, *Isoachlya anisospora* (deBary) Coker var. *indica* Sak. et Bhar., *Saprolegnia delica* Coker and *S. monoica* Pringsh.

METHODS

The methods and technique employed in this investigation were the same as described in an earlier paper (Bhargava 1944). The basal medium, which will afterwards be referred to as medium A, consisted of 0.5 gm. each of KH_2PO_4 and $MgCl_2 \cdot 6H_2O$, 2 gms. of NH_4NO_3, 0.17 gm. of Na_2S and 1000 c.c. of double distilled water. In the case of *Brevilegnia gracilis* the sulphur in the basal medium was supplied in the form of K_2SO_4, the amount being 0.5 gm. per litre. Unless otherwise stated carbon, from what-

* Part of thesis approved for the degree of Doctor of Philosophy in the University of Allahabad.

ever source, was introduced in quantities so as to give a concentration equivalent to 2000 mgs. of carbon per litre. A few of the compounds (viz., dextrin, glycogen, inulin and soluble starch) were taken equal in weight of glucose because of their unknown constitution.

In one series of experiments the sugars were further extracted by the "acetone-alcohol-ether" method used by Corum (1942) and briefly described below:—

5 gms. of sugar were extracted and stirred twice with 25 c.c. of acetone, and then stirred vigorously with 25 c.c. of absolute alcohol. The mixture was filtered with suction on a Buchner funnel, and washed again with 25 c.c. of alcohol. The sugar was then removed from the funnel, placed in a large beaker and stirred with 25 c.c. of ether, filtered and dried till the odour of the ether was removed.

EXPERIMENTAL

Series 1.—To the basal medium A, the following carbon compounds were added singly, before autoclaving. Medium A alone served as control

Carbohydrates:

Monosaccharides;
Pentoses—Arabinose, rhamnose and xylose.
Hexoses—Galactose, glucose, laevulose and mannose.
Disaccharides; Lactose, maltose and sucrose.
Trisaccharides; Raffinose.
Polysaccharides; Dextrin, glycogen, inulin and soluble starch.

Glucosides: Amygdalin.
Alcohols:

Trihydric—Glycerine.
Tetrahydric—Erythrite and mannite.
Hexahydric—Dulcite and sorbite.

Various media thus obtained were inoculated with five fungi under investigation. The results are summarised in table 1.

Table 1 shows that there was no growth on the basal medium which was lacking in source of carbon.

None of the pentoses tried, supported the growth of any of the fungi.

Among the hexoses, glucose and laevulose proved to be very favourable sources of carbon. Mannose was utilised by *Saprolegnia monoica* and *Brevilegnia gracilis*, while galactose served as a source of carbon for *B. gracilis* only.

Of the three disaccharides, maltose supported good growth of all the fungi. Sucrose produced negligible growth in each case except in *B. gracilis*. Lactose was valueless as a source of carbon but *B. gracilis* showed good growth on it; similar was the case with raffinose, a trisaccharide.

Three polysaccharides (dextrin, glycogen and starch) were excellent for the growth but inulin was utilised feebly by *B. gracilis* only.

Amygdalin, a glucoside, proved to be a good source of carbon supply for the fungi.

Alcohols in general did not support good growth. Glycerine and sorbite were utilised to some extent. Mannite produced slight growth in the case of *B. gracilis* only. Others were quite valueless.

Series 2.—To minimise the risk of various carbohydrates being hydrolysed in the presence of the basal medium during autoclaving, various

TABLE 1. *Dry weight (in mgs.) of the fungal colonies grown on basal medium A to which various carbohydrates and alcohols were added singly.*

Period of incubation = 21 days.

Compounds	*Achyla* sp.	*B. gracilis*	*I. anisospora* var. *indica*	*S. delica*	*S. monoica*
Arabinose	..	..	..	..	..
Rhamnose	..	..	..	..	..
Xylose	..	..	..	..	..
Galactose	..	28.3	..	..	..
Glucose	13.3	33.0	17.0	14.0	18.3
Laevulose	14.0	26.6	15.7	14.3	27.0
Mannose	..	31.0	..	..	25.3
Lactose	..	20.0	..	..	..
Maltose	15.7	29.0	20.0	15.0	25.0
Sucrose	3.0	27.3	2.0	2.0	2.5
Raffinose	..	25.0	..	..	..
Dextrin	10.0	28.3	12.0	12.0	13.5
Glycogen	13.0	25.0	15.0	13.0	15.0
Inulin	..	13.3	..	..	..
Soluble starch	14.0	25.0	16.0	14.0	17.0
Amygdalin	13.0	17.6	16.0	13.5	14.0
Glycerine	3.0	28.3	5.6	2.0	5.0
Erythrite	..	..	..	..	..
Mannite	..	17.3	..	..	..
Dulcite	..	..	..	..	..
Sorbite	4.0	29.3	6.2	4.0	5.0
Basal medium (Control)	..	..	..	..	..

carbohydrates and the basal medium were autoclaved separately and mixed together after cooling. The flasks were then incubated for 72 hours, and uncontaminated ones were inoculated with the fungi. The results obtained were practically the same as described above.

Series 3.—*Saprolegnia delica* was not included in this series, since it has already been dealt with in an earlier paper (Saksena and Bhargava

1941). Various nitrogenous substances were added singly (in 0.1% concentration) as sources of carbon to the basal medium. Of the various substances tried good growth of the fungi was obtained on peptone, phenylalanine, leucin, glutamic acid and histidin. Alanin, asparagin, tyrosin, tryptophane, cystin and cystein hydrochloride supported a fair amount of growth but were not as favourable as the above mentioned substances. Only a trace of growth resulted when *Achlya* sp., *Isoachlya anisospora* var.

TABLE 2. *Dry weight (in mgs.) of fungal colonies grown on media containing extracted and unextracted carbohydrates.*

Period of incubation = 10 days.

Compounds		*Achlya* sp.	*B. gracilis*	*I. anisospora* var. *indica.*	*S. delica*	*S. monoica*
Glucose	Extracted	2.8	15.6	5.7	3.8	8.0
	Unextracted	3.0	16.6	6.0	4.0	8.3
Laevulose	Extracted	3.2	13.7	5.5	4.5	15.0
	Unextracted	3.5	13.0	5.7	4.3	16.0
Maltose	Extracted	4.3	16.8	7.6	4.9	20.1
	Unextracted	4.5	17.3	8.0	5.0	19.0
Galactose	Extracted	..	15.6	..	..	..
	Unextracted	..	16.6	..	..	..
Mannose	Extracted	..	16.7	..	..	13.0
	Unextracted	..	17.0	..	..	13.5
Lactose	Extracted	..	11.6	..	..	..
	Unextracted	..	11.3	..	..	..
Raffinose	Extracted	..	9.4	..	..	..
	Unextracted	..	10.6	..	..	..

indica and *Saprolegnia monoica* were cultured on asparatic acid, while glycin, valin, acetamide, urea and trihydroxytriethylamine did not supply the necessary carbon for growth. *Brevilegnia gracilis* behaved somewhat differently in its ability to utilise glycin and valin which supported good growth; similar was the case with asparatic acid and asparagin. Tryptophane was found valueless for this fungus.

Series 4.—To the basal medium A were added some carbohydrates singly (glucose, laevulose, maltose, galactose, mannose, lactose and

raffinose) which had been extracted according to the "acetone-alcohol-ether" method of Corum (1941). Unextracted carbohydrates as such served as control in each case. The various media thus obtained were inoculated with the fungi and dry weight of the colonies was taken after 10 days' incubation period. The results are summarised in table 2.

The results obtained in table 2 show that the difference in growth on extracted and unextracted carbohydrates is negligible.

DISCUSSION

The utilisation of various carbohydrates seems to depend either on the ability of the fungus to utilise certain of the simpler carbon compounds directly or on its ability to convert more complex carbohydrates into such simpler compounds as can be used directly. In the former case the molecular configuration (structure) of the carbon compound would presumably be the most important determining factor while the production and the activity of the enzymes associated with the fungus would be of equal importance in the latter case.

Pentoses (arabinose, rhamnose and xylose) have generally been reported as poor sources of carbon. Farries and Bell (1930) found that these three sugars did not supply carbon for *Spermaphthora gossypii*, *Nematospora corylii* and *N. gossypii*. Saksena (1940) reported similar results with some species of *Pythium*.

Of all the hexoses employed, glucose and laevulose are good sources for *Achlya* sp., *Isoachlya anisospora* var. *indica*, *Saprolegnia delica* and *S. monoica*, and mannose for *S. monoica* only, while galactose does not support growth in any of the above named fungi. Since glucose, laevulose and mannose have the same enolic form and produce the same hexose phosphate (Armstrong and Armstrong 1934), their utilisation by *S. monoica* can be correlated with their chemical similarity. Galactose differs from these three sugars, and its different chemical configuration and properties prevent it from being a readily available carbon source. On the basis of our present knowledge it is impossible to offer an adequate explanation for the difference of results obtained with mannose in respect of *Achlya* sp., *Isoachlya anisospora* var. *indica* and *Saprolegnia delica*, though it may be due to their differential physiological characters. In the case of *Brevilegnia gracilis* apart from these three sugars galactose also provides a good source. It has already been observed by many workers that glucose and laevulose provide an excellent source of carbon while galactose is generally a poor source, though with a few exceptions. Galactose has been clearly demonstrated as a poor source of carbon by Horr (1936) in cases of *Aspergillus niger* and *Penicillium glaucum*, by Kinsel (1937) in *Diplodia Zeae*, by Edgecombe (1938) in *Phytophthora cactorum*, *Saprolegnia ferax* and some other fungi and by Saksena (1940) in some species of *Pythium*. Galactose as

a good source of carbon has been shown for *Trichophyton* (Mosher *et al.* 1936) and *Ceratostomella ulmi* (Ledeboer 1934). Utilisation of laevulose in the present case is in accord with the earlier findings (Saksena and Bhargava 1941) but is contrary to the results of Volkonsky (1933) for some members of the family Saprolegniaceae.

Of the three disaccharides tested, maltose serves as a good carbon source for all the fungi. This specificity in utilisation depends on the ability of the organisms to digest or hydrolyse maltose into monosaccharides. It has been shown earlier (Bhargava 1943) that maltase is secreted by all these fungi. Only a trace of growth is obtained when the fungi used are cultured with sucrose; *Brevilegnia gracilis*, however, shows a fair amount of growth. This ability of *B. gracilis* is due to its being able to secrete invertase (Bhargava 1943). The scanty utilisation by other fungi can be assumed to be due to the presence of assimilable sugar or sugars as impurities in the sucrose used. Lactose provides a good carbon source only in the case of *B. gracilis*, probably due to its ability to secrete lactase. Lactose has been reported to be a poor carbon source by earlier workers (Moore 1937, Ezekiel *et al.* 1934, Saksena 1940 and others).

Raffinose, a trisaccharide, supports no growth. This is in full accord with the earlier observations of the author (Bhargava 1943) that raffinase is not secreted by these fungi. The presence of a slight growth obtained in the case of *B. gracilis* indicates that probably a slight breakdown occurs with the resulting availability of one or more simpler sugars, or it may be that some raffinose is hydrolysed by the sucrase secreted by *B. gracilis*. This is not impossible as has been observed by Blank and Talley (1941) in the case of *Phymatotrichum omnivorum*.

The utilisation of starch can be attributed to the secretion of diastase which has already been reported to be excreted by these fungi (Bhargava 1943). It is highly probable that the growth of fungi on dextrin and glycogen is dependent to a large extent on the production of enzymes.

Of the alcohols glycerine and sorbite are slowly hydrolysed by all the fungi but mannite is utilised by *B. gracilis* only. Glycerine has been found to be assimilated by *Pythium debaryanum* (Volkonsky 1933) and some other species (Saksena 1940), while it is of no value in *Saprolegnia*, *Aphanomyces* (Volkonsky 1933) and in *Phymatotrichum omnivorum* (Ezekiel 1934). Mannitol is unsuitable for the growth of *Agaricus campestris* (Styer 1930) and five species of *Pythium* (Saksena 1940) but is a favourable source of carbon for *Phymatotrichum omnivorum* (Blank and Talley 1941).

The availability of amygdalin can be attributed to its hydrolysis by the enzyme glucosidase, which is secreted by the fungi under investigation (Bhargava 1943).

Since the capacity of a fungus to utilise carbohydrates as sources of carbon depends on their configuration and also on the specific enzymes se-

creted by the organism, the results of the nutritional requirements reported by various investigators vary a lot.

The experiments of series 2 indicate that autoclaving has no marked effect on the hydrolysis of the various carbohydrates in a neutral medium.

That these fungi are capable of utilising carbon from nitrogenous substances, such as amino acids or proteins, is clearly shown by the experiments described under series 3.

Recently Corum (1941) has reported that sugars used by him contained traces of vitamin B_1 which retards the growth of *Rhizopus suinus*. But the results of experiments reported under series 4 indicate that the growth substances are either absent in the sugars used by the author or, if present, they neither retard nor accelerate the growth of the organisms.

SUMMARY

The growth of *Achlya* sp., *Brevilegnia gracilis*, *Isoachlya anisospora* var. *indica*, *Saprolegnia delica* and *S. monoica* on different carbohydrates and alcohols was measured under controlled conditions. The fungi did not grow on media lacking carbon. Glucose, laevulose, maltose and starch were found to be the best carbon sources. Mannose also served as an equally good carbon source for *S. monoica* and *B. gracilis*. The utilisation of polysaccharides was correlated with the ability of the organism to hydrolyse them.

These fungi were also able to utilise carbon present in some amino acids and proteins, some of which were valueless as sources of carbon.

Growth substances are either absent in the sugars used, or, if present, have no marked effect on the growth of the organisms.

The studies reported in this paper were completed under the direction of Dr. R. K. Saksena who suggested the problem and to whom the writer wishes to express his gratitude for the many helpful suggestions made and the keen interest shown during the progress of the work. His grateful thanks are due to Prof. J. N. Couch, of the University of North Carolina, U. S. A. for his critical reading of the manuscript. He also wishes to express his indebtedness to Dr. G. Watts Padwick, Imperial Mycologist, New Delhi; Prof. S. R. Bose, Carmichael Medical College, Calcutta, and Dr. B. B. Mundkur, New Delhi for making suggestions and supplying the literature.

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Vol. 8 JUNE · 1945 No. 2

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

SYMPOSIUM
on
Age of the Distribution Pattern of the Gene Arrangements in *Drosophila pseudoobscura*

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Introduction

ERNST MAYR

In March, 1944, Carl Epling published[1] the results of his researches which led him to the conclusion of a great antiquity of the gene arrangements in the third chromosome of *Drosophila pseudoobscura* and *D. persimilis*. A considerable private correspondence ensued between C. Epling, L. Stebbins, E. Mayr, E. Colbert, C. Hubbs, and others as to whether or not Epling's interpretation of the evidence was compelling. This is a question of major importance in view of the central position in the study of evolution occupied by *Drosophila* studies. Part of this correspondence is contained in Bull., No. 4 (Nov. 3, 1944) of the Committee on Common Problems of Genetics, Paleontology, and Systematics (National Research Council), but since this bulletin is not generally available, it was urged by friends of the writers to make the results of their correspondence public.

[1] Epling, Carl. 1944. Contributions to the Genetics, Taxonomy, and Ecology of *Drosophila pseudoobscura* and its relatives. III. The Historical Background. Carnegie Institution of Washington Publication **554**: 145–183.

Some Evidence in Favor of a Recent Date

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In spite of the wealth of knowledge that has accumulated concerning the genetics of *Drosophila*, next to nothing is known about the evolutionary history of this genus. This situation is much regretted by students of evolution. Whereas mammals, reptiles, and many invertebrates are abundantly preserved as fossils, only specifically unidentified fossil Drosophilae have yet been discovered in Baltic amber. They shed little light on the history of the genus, in view of the great similarity of many of the living species. To overcome at least partly this handicap, Carl Epling has recently applied indirect methods in a most ingenious analysis of the chromosome arrangements of the species *Drosophila pseudoobscura* and *D. persimilis*.

It would lead too far to repeat in detail all of Epling's evidence and we must refer to the original work (Epling 1944). In short, the facts are as follows: In the third chromosome of *Drosophila pseudoobscura* a number of inversions of chromosome sections have occurred, which have produced a set of gene arrangements, usually named for the localities where they were first found, like *Estes Park*, *Pikes Peak*, *Hidalgo*, and so forth (Fig. 1). The genetic evidence is very strong that all existing chromosomes with a given gene arrangement are descendants of a single original chromosome. Furthermore, the sequence of the occurrence of the various arrangements can be established accurately. This permits the determination of the phylogeny of the gene arrangements. Epling points out the important fact that the 15 accurately described arrangements belong to groups named after the basic or primary arrangements, the *Standard* and the *Santa Cruz* phylads. A postulated intermediate between *Standard* and *Santa Cruz*, named *Hypothetical*, has not been found in nature (Fig. 1).

After a painstaking analysis of the geographical and ecological factors involved in the distribution of the various arrangements, with special emphasis on discontinuities in their present ranges, Epling came to the conclusion "that not only *Santa Cruz*, but also its derivatives of the second and third degree were in existence during Miocene time or perhaps earlier." Obviously, this conclusion is based on indirect evidence, on the more or less subjective evaluation of data, on the application of analogies, in short on methods which permit divergent results. Epling is fully aware of this: "We advance this [theory of the Mid-Tertiary origin of the chromosome arrangements] as an hypothesis and from it suggest a tentative history of the species. This hypothesis and history may be very far from the truth. It is possible, as originally implied by Dobzhansky and Sturtevant (1938), that the present distribution of gene arrangements took place in relatively recent time, perhaps Pleistocene or post-Pleistocene.

I, too, have come to the conclusion that the data presented by Dobzhansky and Epling are consistent with a hypothesis of recent origin of the distribution of the gene arrangements. This divergence of view is of considerable interest because of its bearing on many questions of evolutionary rates, paleoclimatology, and biogeographic methods. A presentation of the reasons for my dissent seems therefore justified.

A few additional well established facts must be presented before the controversial questions can be considered. Epling points out that aside from some exceptions, the arrangements of the *Standard* phylad have a

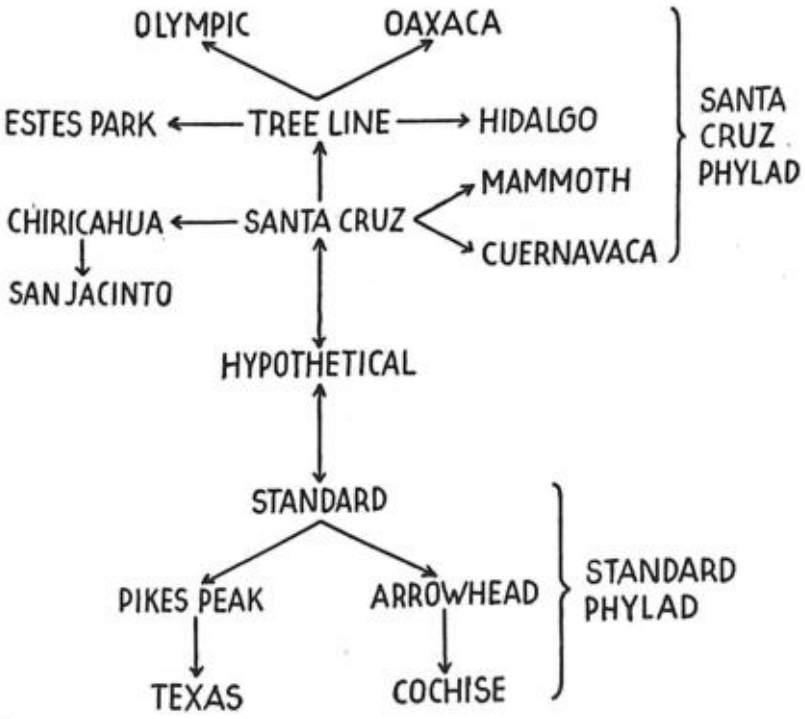


FIG. 1

different geographical distribution from those of the *Santa Cruz* phylad. The difference is as follows: *Standard* phylad has its center of abundance in the United States, extending eastward to the border of the range of the species on the eastern slopes of the Rocky Mountains (Nebraska, Colorado, Texas), barely reaching Mexico in the south. *Santa Cruz* phylad has its center of abundance in Mexico, extending southward to Guatemala and northward to the Pacific coast and the Rocky Mountains. Three of the northward ranging arrangements (*Olympic*, *Tree Line*, and *Santa Cruz*) have a discontinuous range, being absent from the arid belt formed by the

Colorado Desert and the Intermontane Plateau (between the Sierras and the Rocky Mountains). *Chiricahua* is the only arrangement of the *Santa Cruz* phylad found in this arid belt. On the whole the range of the *Santa Cruz* phylad is thus associated with a milder and more humid climate, that of the *Standard* phylad with a drier and more continental climate. From these facts Epling draws the conclusion with which I am in complete agreement that the inversion giving rise to the *Santa Cruz* phylad occurred most likely in a population of *Drosophila pseudoobscura* living in a maritime climate, while the inversion leading to the *Standard* phylad occurred in a drier part of the range with a more continental climate. I am convinced of the validity of this conclusion.

On the other hand, his further conclusion, that even the tertiary arrangements of the *Santa Cruz* phylad, like *Olympic* and *Oaxaca*, "were in existence during Miocene time or perhaps earlier," with the implication that the secondary arrangements originated even earlier, and that the separation of the *Standard* from the *Santa Cruz* phylad, and of the species *pseudoobscura* from *persimilis* may date back perhaps to early Tertiary, has failed to convince me. The reasons for this are at least four sets of data which are interpreted differently by Epling and by myself.

I. THE VALIDITY OF CONCLUSIONS RESTING ON ANALOGIES

Epling quotes reliable evidence proving great age of certain species of trees (*Sequoia*, *Cupressus*, and others). It must, however, be noted that trees are evolving at notoriously slow rates, and as Babcock has shown for *Crepis* (1945) and Elias (1942) for grasses, there has been a considerable amount of evolution in species of herbaceous plants since Miocene and even Pliocene. Likewise, Cockerell's reference to the "essentially modern" composition of the fauna of Baltic amber (Oligocene), refers mainly to macrotaxonomic units and not to subdivisions of the species. Amber insects are in the majority of cases specifically and frequently generically different from the living forms. Petrunkevitch (1942), for example, states with reference to the spider fauna of the Baltic amber: "My study fully confirms Koch's conclusions. [Koch had stated as early as 1854, (1) that all species of spiders found in the amber are extinct, (2) that many genera are quite analogous to the recent ones while other are extinct, and (3) that some of the genera survive at present only in the tropics.] Not one of the species described below can be placed in any of the recent species. Most of the extinct genera are distinct from recent ones, yet closely related to them." He then lists the current geographical distribution of many amber genera which form "a sufficient array of facts establishing the exotic relationship of the Baltic amber spider fauna." Of the several hundred genera of spiders now found in Europe only nine are also found in the Baltic amber. Of the 62 genera described in the work of Petrunkevitch, 50 are

extinct, representing 80.6 per cent of the total. "The percentage of extinct genera is probably even greater owing to the fact that some species were described under recent genera because of poor preservation preventing clear recognition of generic characters." All this indicates a considerable evolutionary change since the Oligocene. The evolution of insects during the same period of time closely parallels that of the spiders, to judge from the rather scattered literature on the subject.

However, as Simpson (1944) stresses, rates of evolution are so different in different phyletic lines that analogous conclusions are not permissible. This works, of course, both ways, and the rapid evolution in certain mammalian genera can not be cited as proof for the recent origin of all species, including *Drosophila pseudoobscura* and *D. persimilis*. The existence of endemic genera and species of insects on young oceanic islands of volcanic origin and on recent coral atolls, indicates that evolution can be very rapid under favorable circumstances (Zimmerman 1942).

It is likewise dangerous in the case of discontinuities to rely too much on analogy. Not being a botanist this writer is unable to judge the significance or age of the discontinuities found in *Symplocarpus*, *Cypripedium arietimum*, *Polygonum arifolium*, and others. However, many discontinuities in the animal kingdom, that look very old, like that between the South American and the Indian tapirs, are geologically speaking quite young. This might seem unbelievable if it were not for a complete geological record to prove it. Every discontinuity has a history of its own, a history depending on many factors, most of them unknown to us. Hence the danger of proving anything in this field "by analogy." Seeing how closely the geographic distribution of the *Santa Cruz* gene arrangement in *Drosophila pseudoobscura* parallels that of certain plant species, like *Mahonia fascicularis* and *Chimaphila umbellata*, it seems quite legitimate to assume that the ecological requirements of *Santa Cruz* must be the same as that of the two mentioned species of plants, and hence the history of their distribution. This conclusion may prove to be fallacious for two entirely different reasons, either because the means of dispersal of the two forms are quite different, or because the geological period at which the adaptation to this set of ecological factors was acquired was different (let us say Miocene in the case of *Mahonia*, and post-Pleistocene in the case of *Santa Cruz*).

II. GENE ARRANGEMENTS AND SELECTION

Epling brings out very clearly the important fact that the center of distribution of the arrangements of the *Santa Cruz* phylad is in a different (milder) climate than that of the *Standard* phylad. He explains this, as seems to me quite correctly, by assuming that each gene arrangement is associated with different gene contents, adapted for different climates. ["The areas in which the gene arrangement of wider distribution are

dominant in frequency correspond generally to the principal physiographic, climatic, and biotic subdivisions of the specific area." (p. 147)].

However, throughout his discussion he repeatedly neglects this important fact in his conclusions. On p. 147 he states that "the gene arrangements are attributes which are equal in selective value." This is an ambiguous statement, which might easily be misunderstood and become the source of confusion. The statement may mean either one of two things, (a) that the inversion does not cause any position effects, or (b) that the amount of crossing-over in the inverted section is not reduced. As far as (a) is concerned, no evidence either pro or contra is available. However, if present at all, position effect is likely to be of very minor importance. It might affect a few loci in the immediate neighborhood of the breaks. The implication (b), however, is definitely wrong. In view of the unavoidable association of each gene arrangement with specific gene contents, it would be more nearly correct to say: "Each gene arrangement, such as *Santa Cruz*, *Standard*, *Chiricahua*, and the others, may have different selective values at each locality." This is a consequence of the fact that the reduction of crossing over in the inverted sections prevents the free recombination of genes.

This is obviously of decisive importance, particularly where short inversions are involved. Proof for the correctness of this assertion is supplied by experimental studies on crossing-over, but also by the present distribution pattern of the various arrangements of *D. pseudoobscura*. The fact that regular clines exist in the relative frequency of the various gene arrangements and that in the dry belt of the Southwest certain arrangements reach a peak in frequency (like *Chiricahua*) while others seem to be rare or completely absent in this zone (like *Santa Cruz*) proves that the inversions have become locally associated with gene complements of specific survival values.

The gene contents of every gene arrangement are the result of a number of conflicting forces: the conservative influence of the inhibition of gene exchange by crossing over on one side, and the evolutionary influences of mutation pressure and selection on the other. It is therefore misleading to speak of the interrupted range of "the *Santa Cruz* arrangement." In spite of the monophyletic origin of the chromosomes with the *Santa Cruz* gene arrangement, it might be better to speak of the two ranges of *Santa Cruz* arrangements. This wording is preferable because there is every reason to believe that the gene contents of the two sets of *Santa Cruz* arrangements are quite different and that *as far as survival and geographic range are concerned the gene contents are the important factor and not the accidental position of the breakage points of the inversion* which caused the gene arrangement. In view of the frequency of crossing over it is possible that the gene contents of different gene arrangements from one locality are more alike than

of the same arrangement in different localities. It is, for example, probable that *Tree Line*, *Standard*, and *Santa Cruz* of northern California are more similar to each other in gene contents than *Santa Cruz* of California, *Santa Cruz* of Michoacan, and *Santa Cruz* of Guatemala. Furthermore, the inverted section, in which the amount of crossing over is reduced, is only a part of the third chromosome. On the other hand, it is probable that all chromosomes with the same gene arrangement, let us say *Santa Cruz*, share some common property which is absent in all other chromosomes.

A gene arrangement which owing to its superior selective qualities has recently spread over a wide area, can be expected to carry gene contents considerably different from those of the gene arrangements with which it has come in contact in newly colonized areas. Since "the natural populations of *Drosophila pseudoobscura* are panmictic" (p. 110), and since there is no discrimination against heterozygotes, the gene contents of the indigenous and the newly arrived gene arrangements will tend to become equalized in the course of time. Crossing over between the arrangements of the *Standard* phylad and of the *Santa Cruz* phylad must have gone on ever since the geographical ranges of the two phylads started to overlap. The more recently we assume this to have taken place the more likely it seems to me that any genetic differences are left. This consideration favors a comparatively recent origin of the arrangements.

It seems probable that a new gene arrangement has a chance to survive and to spread, only if it contains a particularly successful combination of genes. The selective advantage, which the new arrangement gives to its bearers, permits it to spread until it reaches an environment where some other gene arrangement is locally superior. This describes the situation purely from the point of view of a given gene arrangement. From the point of view of populations, a dynamic balance of various arrangements in a single population seems to be most advantageous. Otherwise one would expect more populations with a 90–100 per cent prevalence of a single arrangement. This occurs only rarely, for example, in *D. pseudoobscura* (*Arrowhead* is several places in the southwest) and in *D. persimilis* (*Klamath* in Washington and Oregon). In most other cases, two, three, or more arrangements are fairly numerous in a given population.

It seems to me that local selective inferiority of some of the arrangements has not been given sufficient weight by Epling in some of his discussions. For example, on p. 152, he reasons that winds could not be an essential factor in the dispersal of the gene arrangements because, "if *Chiricahua* and *Standard* could be carried eastward [from California into the Great Basin], why not *Santa Cruz*, which is an arrangement perhaps as ancient as *Standard* and certainly older than its derivative *Chiricahua?*" My answer to this question would be that *Santa Cruz* flies have probably been carried eastward as often as *Standard* and *Chiricahua* flies but have not

succeeded in establishing themselves, because they lack something in their gene complement which would permit them to compete in this area successfully with *Chiricahua* and *Standard*. This assumption is quite reasonable since we know that even single genes sometimes control such important ecological factors as temperature tolerance and food utilization. The effect of a balanced combination of many genes, such as might be temporarily stabilized in inversions, should be even greater. These differences in the selective values of the gene arrangements are the reason why their distributions are not correlated with the direction of the prevailing winds. Epling is surprised (pp. 151–152) at the many exceptions from an expected west to east distribution in the United States and a southeast to northwest distribution in Mexico. All of the questions asked by Epling on pp. 152–153 can be answered without much difficulty if one assumes different selective values for the gene contents of the various arrangements. I have failed to find any reference in Dobzhansky's and Epling's work to experiments which would prove the assertion that all gene arrangements "have been found equally viable wherever they have been tested" (p. 158). The distributional phenomena clearly indicate the opposite.

My conclusions concerning this problem are as follows: Each gene arrangement has at each given locality gene contents of specific selective value. The interference with crossing over (caused by the inversions) tends to preserve the gene combinations which have local selective advantages. Whenever crossing over does occur it tends to equalize the gene contents of various arrangements found in the same population, particularly if long periods of time are available. It is, however, probable that chromosome parts adjacent to the loci of the breaks never undergo crossing-over. The present information does not permit to decide how extensive these sections are. Cytological identity (in regard to the position of the breakage point) of chromosomes found in populations distant in time or space, indicates genetic similarity of only very limited extent.

III. DISPERSAL

Epling's chronology, in particular his placing the origin of *Santa Cruz*, *Cuernavaca*, *Tree Line*, and other arrangements in the middle Tertiary, can be maintained only if dispersal is a negligible factor. This is clearly realized by Epling himself and several reservations concerning this factor are found in his discussions. For example: "If we believe that aerial transport has not been a factor in producing the pattern of its [=*Santa Cruz* phylad] distribution, then it follows . . . " (p. 176), or: "We cannot exclude the possibility that wind has caused the present distribution pattern in recent time. But the only tenable conclusion seems to be that, if such is the case, the factors are so variable in effect, that a consistent explanation is impossible at present" (p. 153). Denying *Drosophila* the ability to jump across

more than very narrow gaps between suitable territories, Epling is forced to postulate that all discontinuous ranges in the gene arrangements must have been continuous at one time.

The vulnerability of this assumption is particularly obvious in the discussion of the role of the isthmus of Tehuantepec as a dispersal barrier (p. 174). "The isthmus, which separates the now disjunct populations of the highlands of central Mexico and of Guatemala . . . is an area of low rounded hills less than 800 feet above sea level, covered with a tropical lowland vegetation. . . . It interposes a climatic barrier which, it would seem, is completely impervious to the migration of *D. pseudoobscura*, barring aerial transport. . . . From [geological] evidence it appears that the isthmus has been an area of low relief since the Middle or Lower Miocene. During part of this time . . . the land was submerged. . . . In the late Pliocene and Pleistocene the isthmus was raised above the sea. There is no evidence to suggest that his elevation was very much greater than at present, and . . . was seemingly insufficient to permit a free migration of the temperate biota between these regions." Epling therefore advances the hypothesis (p. 176) "that not only *Santa Cruz*, but also its derivatives of the second and third degree, *Tree Line*, *Cuernavaca*, *Olympic*, and *Oaxaca*, were in existence during Miocene time or perhaps earlier." If we follow Epling's interpretation, this "earlier" is obviously the time when the isthmus was passable for a temperate zone biota. If I understand the evidence of the geologists correctly, the isthmus of Tehuantepec was submerged during most of the middle and early Tertiary and was definitely tropical in the periods during which it was raised above sea level. Unless one wants to go back to earlier cool periods, such as the Triassic or the Permian, which is obviously absurd, one must accept a second alternative. This is that individuals of *Drosophila pseudoobscura* were able to cross the isthmus of Tehuantepec by aerial transport in periods when it was either tropical or submerged.

I can see no valid objections to such an assumption, in fact the weight of recent evidence has become increasingly strong in favor of the universal occurrence of long distance dispersal. Incontrovertible proof for this can be found in the biotas of the islands of the eastern Pacific, from Samoa to Hawaii. The geological evidence is in this case quite unambiguous (Zimmerman 1942). However, the same is true for any region with discontinuous ranges (Gulick 1932, Darlington 1939). As far as *Drosophila* is concerned, there is good evidence (Glick 1939), as quoted pertinently by Epling, that they are a regular component of the aerial plankton. Far more effective than ordinary wind drift is probably the carrying power of occasional storms as pointed out by numbers of recent authors. The gap between the Mexican and the Californian ranges of *Santa Cruz* could easily be bridged by a ten-hour drift of a gravid female during a heavy storm.

The colonizing ability of *Drosophila* is perhaps best illustrated by the rich fauna of Drosophilidae found on the West Indian Islands and particularly on Hawaii. The oceanic character of the faunas of these islands is admitted by most modern students of zoogeography. If species of *Drosophila* have been able to span the wide gaps between the mainland and those islands, how much more easily should they be able to overcome the narrow gaps between the discontinuous ranges of the gene arrangements.

The ability of insects to overcome geographical barriers is well documented in the entomological literature. For example, there is a surprisingly strong recent Holarctic element in the Temperate Zone and Paramo insect faunas of the South American Andes. This can have reached South America only by jumping successively one after the other of the tropical barriers (of which the Panama barrier is perhaps the widest) between northern Mexico and the Andes. Recent holarctic insects and plants in the high mountains of New Guinea and even of New Zealand are additional manifestation of the same phenomenon. Cases of conquest of geographical barriers by long distance dispersal are so frequent that almost any modern zoogeographic study could be quoted if further illustrations were needed. Botanists seem to be less prepared to accept the importance of long distance dispersal, if the two recent summaries of Steenis (1934–1935) and of Cain (1944) reflect the majority opinion.

Colonization flights into territories previously unoccupied either by the species *D. pseudoobscura* or by a particular gene arrangement occur probably with such frequency as to make transport as such a negligible factor in the distribution pattern. Actually it is not the ability to get there which counts, but rather the ability to get established and to survive. The chance is rather small that on its first colonization flight a gene arrangement becomes established in a region where it was previously absent. Competition with other gene arrangements that are adapted to the specific local condition of such an area is likely to be fatal. Individuals that arrive in areas in which the species was previously absent are probably subjected to far less severe competition. However, this does not eliminate the possibility that one in a thousand or one in a million of such colonization flights is successful, because the bearer of the arrangement happens to settle in a very localized, but eminently suitable niche. Numerous cases in the zoogeographical literature indicate that this is exactly what happens. Furthermore, there is always the possibility that a gene recombination which is inferior at its place of origin is "preadapted" in the sense of Davenport and Cuénot for life at a different geographical locality.

If one compares the equivalent biotas of two long isolated areas, like temperate zone Guatemala and the Mexican plateau, one finds that many species (better, phyletic lines) are represented on both sides of the gap. In some cases they seem completely identical, in others they are subspe-

cifically distinct, and in others specifically. In the case of some other gaps (Hawaii-North America), the level of taxonomic divergence may have reached generic level. This can be interpreted as indicating different evolutionary rates, but in some cases it appears highly probable that it indicates different colonization periods (Mayr 1943).

The Guatemalan population of *Drosophila pseudoobscura* agrees in the composition of its gene arrangements extremely well with that of south-central Mexico (Michoacan). In view of the easy dispersal of insects this proves to me not a high age of these gene arrangements, but the recent arrival in Guatemala of flies with the arrangements *Santa Cruz*, *Cuernavaca*, *Tree Line*, and *Oaxaca*. It may be significant in this connection, that so far not a single arrangement is known that is restricted to Guatemala. If the Guatemalan population of *Drosophila pseudoobscura* had been separated from the Mexican one since Miocene or even since early Pleistocene one would expect a much stronger difference in the chromosomal composition.

Epling's discussion (pp. 151–160) implies that he rules out—as factor important for the explanation of the distribution pattern of the gene arrangements— not only passive long distance dispersal but also active migration. Experimental data prove that the recorded dispersal tendencies of *Drosophila pseudoobscura* are more than sufficient, to fill all the existing gaps in the ranges of the gene arrangements in less than a thousand years, if one assumes that all the arrangements are everywhere "of equal viability." Dobzhansky's and Wright's (1943) work has shown that the mean dispersal of a *Drosophila pseudoobscura* population is easily one kilometer per year. This is an averaged distance, "and some individuals will undoubtedly move farther and others much less far from one starting point." If all gene arrangements were of equal selective value, each should spread at the rate more or less of one kilometer per year over areas suitable for the species.

Passive aerial dispersal together with the active dispersal tendency exert a tremendous expansion pressure against the border of the distribution of each arrangement. Only the continuous elimination by selection of less well adapted gene arrangements (outside their normal range) is able to maintain the status quo of the distributional borders of the arrangements. In this respect there is a basic difference betsween the dispersal of species and of gene arrangements. If an individual of a species crosses beyond the border of the normal range of the species it colonizes completely new territory and is fully exposed to the forces of selection. However, if a fly with the *Santa Cruz* arrangement ventures into the gap between the Californian and the Mexican *Santa Cruz* areas, it will become a member of a population of flies with *Standard*, *Arrowhead*, *Pikes Peak*, and *Chiricahua* arrangements, all of which are viable in heterozygotes with the *Santa Cruz*

arrangement. The gap in *Santa Cruz* is thus by no means completely analogous with that found in the ranges of humidity-loving species of plants, like *Chimaphila umbellata* or *Mahonia fascicularis*. Potential mates are scattered through the entire area of disjunction in the case of *Drosophila pseudoobscura*. A slight change of ecological conditions will permit rapid colonization by a gene arrangement, which during the previously existing ecological conditions was eliminated by selection. This consideration is extremely important in connection with the question of past climates.

IV. THE STABILITY OF PAST CLIMATES

In order to determine the period at which the discontinuity between the two *Santa Cruz* arrangements developed, Epling undertakes a survey of the paleoclimatic history of the American West. This valuable review of the widely scattered literature on this subject is interesting reading even for those who are not concerned with the gene arrangements of *Drosophila*. The main conclusion of this study is that the climate of the Southwest has changed only insignificantly during the Pleistocene, in fact since the Miocene. For example, "even during the pluvial periods [of the Pleistocene] the biota of the Pacific coast was separated from that of the Rocky Mountains by a relatively arid Basin and Range Province." Epling documents this conclusion well, but does not entirely answer the question, how arid is "relatively arid." There can be no doubt that the central basin has been less humid than the coast ever since the rise of the Sierras. However, can a period be called arid during which muskox lived in the Guadeloupe Mountains and tapirs in Arizona?

The Pleistocene, like all other geological periods, had a fluctuating climate. Arid cycles followed such with a more humid climate. It is conceivable that the intermontane region was impassable for certain gene arrangements of *Drosophila pseudoobscura* during the arid phases of the Pleistocene (except for occasional long distance transports). The decisive point, however, is whether or not this area was equally impassable during more humid spells. If I understand Meinzer correctly (whom Epling quotes extensively), the relative aridity of certain areas of the Southwest was not so much due to lack of rainfall, as to the "great increase in temperature and evaporation" in the lowlands. Even so the climate of "the region of southwestern New Mexico and southeastern Arizona in the Pleistocene is apparently comparable to [the climate of] southern Oregon at present." It seems to me that this is a sufficient climatic change to permit wide reaching range dislocations. It is obvious that the gap betweeen the two areas of *Santa Cruz* must have been much narrower at that time, if not completely eliminated.

Epling reasons against the existence of a former continuity of *Santa Cruz* (or other now disjunct gene arrangements) during one of the pluvial pe-

riods, because in such a case one would "expect traces in this intervening region of a previous continuous population of *Santa Cruz* if it had existed in such a Pleistocene woodland, or even more humid forest. It would also seem reasonable to suppose that a Pleistocene connection of the Californian and Mexican populations by way of the Rocky Mountains would have left some trace. None has been found" (p. 169). Actually only few of the temperate forests on the mountains of the intervening area have been explored thoroughly enough to prove the absence of *Santa Cruz*.

Furthermore, Epling's reasoning is based on the assumption of equal selective value of all gene arrangements. There is no reason why a gene arrangement should "have left traces" of its former occurrence in an area which has become uninhabitable due to a change of climate. The elimination of an unfavorable gene arrangement would probably happen very rapidly in a species with the tremendous annual fluctuation and population turnover so typical for *Drosophila*, certainly much faster than the extermination of a poorly adapted species.

CONCLUSION

The means of dispersal of *Drosophila pseudoobscura*, both active and passive, are sufficient to allow a rapid spread of all the gene arrangements. The problem of the discontinuities in the geographical range of some of the arrangements is therefore not, how did these discontinuities arise, but how are they maintained? The absence of a phylogenetically old gene arrangement from a certain region indicates that this gene arrangement is not provided with gene contents of favorable survival value in that region. Climatic changes, a certain amount of crossing over and occasional mutations are the reason for never-ending shifts in the distribution pattern of the arrangements. The pattern, as found today, is a clue to environmental conditions existing today, it has only a limited value as a key to the past.

The fact that the configuration of the distributional areas of the gene arrangements may be of very recent origin does not necessarily mean that the arrangements themselves are recent. To be sure, highly localized gene arrangements, such as *Hidalgo*, *Cochise*, *Texas*, and *San Jacinto*, are probably so new that they have had no time as yet to spread (age and area principle). On the other hand, the distribution gives no clue whether such widespread arrangements as *Standard*, *Tree Line*, and *Santa Cruz* originated 1,000 years ago or in mid-Pleistocene or in mid-Tertiary. The only clue as to the age of the "old" arrangements that I can perceive, is the fact emphasized by Epling that the *Standard* arrangement is found both in *Drosophila pseudoobscura* and in the closely related species *D. persimilis*. This indicates that this arrangement is older than the split of the *pseudoobscura-persimilis* ancestor into two species. However, this is a rather barren discovery since we have no information whatsoever on the date at

which this split took place. My own guess would be not earlier than late Pliocene or early Pleistocene.

One additional problem requires solution, namely the manner by which the *Standard* phylad became separated from the *Santa Cruz* phylad, or for that matter how any gene arrangement can develop from an ancestral one. As stated above, *Standard* has a gene complex adapted for a cooler, more arid and more continental climate, *Santa Cruz* has a gene complex adapted for a warmer, more humid and more equable climate. It might be expected that the two arrangements originated in areas that differed climatically in a similar manner. As Epling says (p. 158): "The possibility still exists that the various arrangements may have arisen in populations which were already differentiating with respect to different genes or gene frequencies which might restrict the population to certain habitats, or permits it to expand into others." It is conceivable that a geographically and ecologically marginal population would contain the genic material to permit the origin of a rather distinct new arrangement. That the change can be rather drastic and that it can occur without geographical isolation is indicated by *Chiricahua*. This arrangement, which differs from *Santa Cruz* by a single inversion (Fig. 1), has been able to occupy the greater part of the rather arid Basin and Rocky Mountain regions, which are inaccessible to the other arrangements of the *Santa Cruz* phylad.

The real significance of the inversion types lies to me in a field quite different from that which Epling has emphasized. To me they are, in a way, comparable to the ecotypes found in plants and in particular in apomicts and polyploids. The chromosomes of sexually reproducing animals are subjected to a continuous reshuffling of their gene contents. A particularly viable and advantageous combination of genes is likely to be destroyed through recombination (including crossing over) during the formation of the germ cells. Inversion gives an opportunity to preserve some of these combinations. Carriers of the inversion are able to occupy ecological niches that are inaccessible to other members of the ancestral population. This is apparently the reason why *Chiricahua* can enter the arid belt where the parental arrangement *Santa Cruz* cannot survive. It would lead too far to discuss at this occasion all the evolutionary implications of the stabilization of gene complexes through inversion, but one aspect must be emphasized. The flies with *Santa Cruz* or *Standard* do not form "*races*." Wherever carriers of the gene arrangements are found, they are members of populations, interbreeding with other gene arrangements. In fact the great majority of the arrangements are found in heterozygous conditions. Thus it is always only a small section of the inverted chromosome which is withdrawn from the reshuffling process of recombination. The danger of evolutionary stagnation which is so apparent in apomicts and many polyploids is thus largely avoided.

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Evidence for Abnormally Slow Rates of Evolution, with Particular Reference to the Higher Plants and the Genus Drosophila

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The problem of rates of evolution is of great importance both to those who are studying the recorded history of life in the fossil record, and to those who are attempting a causal analysis of evolutionary phenomena by studies of the dynamics of evolutionary processes taking place in existing organisms. At our present state of knowledge, however, there lies a great gulf between the factual record of evolutionary progress which paleontologists have pieced together in certain groups and the information which geneticists, studying the processes now at work in other, unrelated organisms, have obtained on evolutionary dynamics as they operate in the extremely short periods of time during which they can be observed. This gulf exists both because none of the modern representatives of groups well represented in the fossil record have been studied genetically, chiefly because they are unsuitable, and because fossil remains of the ancestors of the animals and plants known genetically are scarce or absent. Obviously the ideal way to bridge this gulf would be to discover a group of organisms well represented in the fossil record of which the modern representatives could easily be studied genetically, but no such group seems available at present. A substitute bridge, however, would be provided by fragmentary fossil evidence about groups well known genetically or by indirect evidence concerning the past evolution of such groups.

Slowly evolving evolutionary lines in the higher plants

One source of such indirect evidence is provided by the patterns of geographic distribution of certain existing organisms which can be explained most logically on the assumption of dispersals during certain periods of past geological time. The value and the pitfalls of this type of evidence have long been recognized by plant geographers. Their faith in it has repeatedly been strengthened by the subsequent discovery of fossil evidence supporting the hypotheses originally proposed solely on the basis of distributional evidence.

The classic example of such verification is that of the similarity between the floras of Eastern North America and Eastern Asia. This subject has been thoroughly reviewed by Fernald (1929, 1931) and Cain (1944) and the statement need only be made that the similarity between the modern floras of these two regions is due to the fact that they are segregates from a continuous holarctic forest flora which existed during the early part of

the Tertiary period. This is amply demonstrated by fossil evidence in regard to the woody members of this flora. By analogy, one would expect the herbaceous genera and species which are common to Eastern America and Eastern Asia but absent in the intervening area to be descendants also of common ancestors dating back to middle or early Tertiary time, and this supposition is supported by further indirect evidence. In the first place, the distance between the two areas—nearly half way around the globe—is far too great to allow for dispersal of plant seeds from Asia to Eastern America without the establishment of numerous colonies in the intervening area. And the absence of such intermediate "way stations," as well as the ecology of the species themselves, makes such accidental long distance dispersal in recent time highly unlikely if not impossible. In both Asia and America the species concerned occur exclusively within the ranges of the deciduous trees which are known to have constituted the bulk of the Holarctic Tertiary forest, and many of them thrive only on the humus provided by this type of forest.

The significance of this example to the student of evolutionary rates lies in the fact that many of the members of these derived Tertiary floras are so similar in Asia and America that the difference between them consists of only a few minor morphological characters, or is actually non-existent. In case of the woody species the representatives in Asia and America are nearly always different enough morphologically, so that they are classed by systematists as distinct species. But even in such cases where cytogenetic evidence is available, as in *Rhododendron* (Sax 1930), *Campsis* (Sax 1933) and *Catalpa* (Smith 1941) this evidence indicates that the divergence has been entirely morphological, without the appearance of barriers of physiological isolation which would keep the species separate if they should occur together naturally in the same area. Among the herbaceous species, however, there are those such as *Cypripedium arietinum* R. Br., *Symplocarpus foetidus* (L.) Nutt, and *Polygonum arifolium* L. (Fernald 1929), which are morphologically identical in Eastern Asia and Eastern America. The case of *Polygonum* is particularly significant, since *P. arifolium* is an annual, so that the assumption of identity between the modern species and its tertiary Holarctic ancestor implies that *P. arifolium* has passed through at least 20 to 30 million generations without undergoing any evolution whatsoever. Furthermore the genus *Polygonum* is a large one, with about 275 species, many of which (*P. aviculare*, *P. lapathifolium*, *P. persicaria*) are highly variable weeds of disturbed soil, which have clearly been evolving rapidly in relatively recent times. A parallel case to *P. arifolium* is that of *Brachyelytrum erectum* (Schreb.) Beauv., a grass species common in woodlands of Eastern America, which was recently found in the mountains of central China.

In relation to this example, we have fossil evidence (Elias 1942) that a

related genus, *Stipa*, evolved very rapidly during the latter part of the Tertiary period. Furthermore the genus *Muhlenbergia*, which is so close to *Brachyelytrum* that the two are united by some botanists, is represented in western North America by a far larger and more complex series of both widespread and narrowly endemic species than is *Stipa*, and so has probably been evolving even more rapidly. We therefore have no reason to assume that there is anything inherent in the germ plasm of *Brachyelytrum* or of the other species mentioned which would cause them to cease evolution, and we must seek other causes for their stagnation.

This evidence for very rapid and very slow evolution in closely related lines would be hard to believe were it not for the fact that abundant paleontological evidence for slow evolution has recently been compiled on the basis of a statistical study of the most complete fossil records known to us. Dr. G. G. Simpson (1944, chap. IV) has shown that in such totally different animals as carnivorous mammals and pelecypod molluscs there exist side by side rapidly and slowly evolving lines. Furthermore, although the modal rate of evolution is much higher in the Carnivora than the Pelecypoda, the distribution of the genera about their respective modes is the same in the two groups. In both groups there is a small percentage of genera which have evolved much more slowly than their relatives, and in the case of the Pelecypoda, some of these are more than four hundred million years old. Simpson has considered this phenomenon of slow evolution to be of such importance that he has coined for it the term bradytely. Although he gives a careful analysis of bradytelic genera only in the Pelecypoda, he cites examples from throughout the animal kingdom; the opossums and armadillos among mammals, crocodiles and *Sphenodon* among reptiles, coelacanths among fishes, limulids and cockroaches among arthropods, and lingulids among brachiopods. A survey of paleobotanical literature (Seward 1931, Chaney 1936) reveals a similar series in the plant kingdom; *Thyrsopteris* among ferns, *Ginkgo*, *Araucaria* and many others among gymnosperms, as well as *Magnolia*, *Cercidiphyllum*, and *Platanus* to mention a few of the angiosperms. The writer shares the opinion of most paleobotanists and geographers that the absence of herbaceous seed plants from this list is due only to the fact that such types very rarely enter the fossil record in an identifiable condition. The plant record, therefore, fully supports Simpson's conclusion (1944, p. 127) that patterns of evolution involving bradytely are standard ones, "essentially the same for many, probably for all taxonomic units. . . ."

The cause of bradytely, according to Simpson (1944, pp. 137–142) is not inherent in the genetic makeup of the individuals of a slowly evolving line, but is primarily a result of the structure of its populations, the type of environment to which it is adapted, and the nature of this adaptation. Most bradytelic lines (1) have large interbreeding populations, (2) are "highly

and particularly adapted to some ecological position or zone with broad but rather rigid selective limits," (p. 140), and (3) "are so well adapted to a particular, continuously available environment that almost any mutation occurring in them must be disadvantageous" (p. 141). Such groups are usually found in the ocean or its shores, in rivers, or if terrestrial in the great forest belts. My own experience with the variability between and within populations of plant genera recognized to be old and stable suggests that they are not lacking in mutability, and recent correspondence with Prof. Dobzhansky, published in Bulletin no. 3 of the Committee on Common Problems of Genetics, Paleontology and Systematics (National Research Council) has tended to strengthen my previous inclination to believe that rates of evolution are largely independent of mutation rates.

If, therefore, abnormally slow evolution depends upon such factors as population structure, habitat, and adaptation, rather than on cessation of mutation then this phenomenon should exist with respect to every category, from the genus to the phylum. We should find not only bradytelic families within certain orders and bradytelic genera within families, but also bradytelic subgenera and species within certain genera. The eastern American-eastern Asiatic species of plants mentioned above all appear to be good examples of bradytelic genera or subgenera, and nearly all have the characteristics listed by Simpson. *Symplocarpus* and *Cypripedium* are recognized by all students of their groups to be relatively primitive in the Araceae and Orchidaceae respectively, and as compared with their strictly tropical relatives, these genera have produced rather few species. They are both forest dwellers. *Symplocarpus* exists in large interbreeding populations and is admirably adapted for life in swampy deciduous forests, such as have existed continuously on the margins of streams in the temperate zone ever since the Cretaceous period. *Cypripedium arietinum* is at present very rare and apparently poorly adapted to modern conditions; it appears to be on the verge of extinction, like such bradytelic animals as *Sphenodon*. *Brachyelytrum* is certainly a bradytelic genus, as indicated above. It also exists in large populations and is excellently adapted to the broad ecological niche of well-drained soil under deciduous trees. The subgenera *Tovara* (*P. virginianum* sens. lat.) and *Echinocaulon* (*P. arifolium* and *P. sagittatum*) of *Polygonum* appear to be bradytelic subgenera, and both contain few species. The habitat and frequency of the former is similar to that of *Brachyelytrum*, that of the latter to *Symplocarpus*. In contrast, the much larger and more diversified subgenus *Persicaria* seems to be modal, or horotelic for this genus, while subg. *Avicularia*, with its abundance of highly variable species living largely in weedy, newly available sites is evolving particularly rapidly, and can be considered a tachytelic line in Simpson's sense. In the genus *Crepis* (Hawk's Beard) the exhaustive systematic, distributional and cytogenetic monograph by Babcock (1945) has

shown that while the majority of its approximately 200 species are Pleistocene or recent, and many appear to be actively evolving at present, 21 of the most primitive species have changed but little since the middle of the Miocene period. With respect to the evolution of *Crepis* as a whole, therefore, these latter must be considered as bradytelic species.

EVOLUTIONARY RATES IN THE GENUS DROSOPHILA

The gulf between paleontological and genetic knowledge about evolution might be partially bridged by studying intensively the genetics and ecology of the presumably bradytelic species of herbaceous seed plants just mentioned. An even firmer link between the two fields would, however, be forged by acquring an understanding of the probable past history of the genus of organisms best known genetically, namely *Drosophila*. It is in this connection that the hypothesis of Epling about the possible age of *D. pseudoobscura* assumes great importance. But before discussing the validity of his evidence for this hypothesis, it would be well to consider some facts about the genus as a whole, in comparison with other genera of animals and plants. In the first place, *Drosophila* is an exceptionally large. genus, and one in which intensive study, particularly from the cytogenetic viewpoint, has always tended to increase the number of known species over that previously recognized by purely morphological taxonomic studies. This is in striking contrast to the situation in many other groups, such as Lepidoptera, various groups of fishes, ducks, pheasants, and such mammals as the Canidae, in which cytogenetic studies have demonstrated the weakness of genetic barriers between forms judged on morphological grounds to represent different species, subgenera, or even genera, and have led many geneticists to believe that the morphological taxonomists have been recognizing too many species, rather than too few, as in *Drosophila*. This would lead one to suspect that the modal rate of speciation in *Drosophila* is high. Nevertheless, the presence of *Drosophila* in the Baltic amber (Handlirsch 1908, p. 1029) shows that this genus has existed since early Tertiary time, and the abundance and ubiquitousness of its modern species indicates that it will continue to exist for many millennia. We might therefore expect to find in *Drosophila* a distribution of species groups as to age corresponding with that illustrated by Simpson (1944) for the Pelecypoda and Carnivora (Fig. 18), and said by him (p. 127) to be "a standard pattern of survivorship that is essentially the same for many, probably for all taxonomic units." Although the fossil record of *Drosophila* is extremely scanty, we can get a probable minimum estimate of the age of the genus from Handlirsch. In this compilation (pp. 1026–1029) are listed 21 Oligocene genera of Borboridae, the "family" (now considered a group of families) in which *Drosophila* is placed. Nineteen of these, or 90 per cent, are modern genera. This fact, which agrees with our knowledge of early

Tertiary insect genera in other families and orders, (Cockerell 1917) enables us to assume safely that *Drosophila* arose not later than the beginning of the Oligocene period, and therefore has a minimum age of 30 million years (cf. Simpson 1944, table 5).

Judging from the fact that 120 species are known from North America alone (Patterson 1943), the total number of its species can be estimated at a minimum of 400. If the curve of extinction of its species is similar to that for genera of Pelecypoda (Simpson, Table 6 and Figs. 5, 18), then we should expect 2%, or 8 existing species, of *Drosophila* to be essentially unchanged since the end of the Oligocene and 28%, or 112, to be survivors from some part of the Miocene. If *Drosophila* is actually older than its recorded appearance in the Oligocene, then the number of Oligo-Miocene species still existing would be expected to be much larger.

If, therefore, Simpson's law of survival rates applies to *Drosophila*, Epling's conclusion that *D. pseudoobscura* is a survivor from Mid-Miocene is quite a reasonable one. Further evidence that this is true for the *obscura* group and some other species groups of *Drosophila* is provided by the geographic distribution of the genus, which has recently been given a thorough and discerning analysis for North America by Patterson and Wagner (1943). These authors found 5 species groups, containing a total of 33 species in North America, to be definitely represented also in temperate Eurasia. One of these, the subgenus Hirtodrosophila, has primarily the distribution Eastern America-Eastern Asia, and consists of fungus feeders inhabiting deciduous forests. Its distribution, therefore, corresponds closely to that of the plant genera mentioned above, and by analogy we should expect it to be early Tertiary in origin. The *obscura* group (sensu Patterson) has one representative, *D. athabasca*, extending north to Alaska and perhaps continuously distributed into Asia, but this species belongs to a different subgroup from *D. pseudoobscura*, the *affinis* subgroup of Patterson (1943), or the *affinis* group of Dobzhansky and Epling (1944). According to these latter authors, the area of the *obscura* group sensu stricto (*pseudoobscura* subgroup of Patterson) is (p. 17) "sharply discontinuous in the temperate and subtropical regions of North America and Eurasia." Mayr, to be sure, has in the preceding discussion questioned the validity of bihemispheric discontinuities as indicating anything about the age of a group citing as evidence the "quite recent" origin of the pantropical distribution of the tapirs. I am not a vertebrate paleontologist, and therefore not in a position to criticize Mayr's statement authoritatively, but my interpretation of the history of the tapirs as summarized by Matthew (1939, pp. 70–72) and Simpson (1944, p. 39) does not lead me to this viewpoint. Matthew's map (fig. 19) indidates a large discontinuity in the known Pleistocene distribution of tapirs, and he states that during the Pleistocene "they inhabited the Sonoran region . . . and the marginal parts of the Palearctic

region." Tertiary records of tapirs in the New World appear to be scanty, but since the genus *Tapirus* (s. l.) already existed in the Miocene, its dispersal from the Old World to the New during this epoch seems not unlikely. At any rate, the distribution of tapirs seems to be determined by that of forested areas (Matthew p. 72) and no continuous forests have existed along the Siberian-Alaskan land bridge since the Miocene epoch or earlier (Chaney 1936). For plant groups, the presence of a discontinuous distribution in the forests of the Old and New World segments of temperate Holarctica has been recognized by all phytogeographers as indicating at least a Mid-Tertiary age for the groups concerned, and in all groups in which fossil evidence is available, this assumption is fully confirmed (Cain 1944). Similar conclusions have been independently drawn by students of insect distribution (Van Dyke 1919, 1929). Since the *Drosophila* species concerned are plant feeders, and have the relatively low ability for individual migration characteristic of plants, in contrast to the wide ranging, warm blooded mammals and birds, we should expect that the significance of distribution patterns in *Drosophila* would be more like that in plants than that in these higher animals. An additional reason for supporting Epling's (1944, pp. 174–175) conclusion that the *D. pseudoobscura* subgroup is of Tertiary age is that its center of distribution, i.e. the area within which all three of its component species are found, is the Pacific Coast forest area from Vancouver Island to central California (Dobzhansky and Epling 1944, fig. 1). This has been termed the Vancouveran faunal region by Van Dyke (1919) and he writes of its insect fauna as follows: "This fauna has existed in approximately its present territory from the Tertiary period and no doubt from well back in that period, being in fact a Tertiary fauna which has come down to us in a pure state." The fact that this statement has gone unchallenged for 26 years indicates that entomologists in general, at least those who have studied distribution, are in agreement with it.

Thus we have two a priori reasons for believing that *Drosophila pseudoobscura* is of Mid-Tertiary age. The first is the age of the genus *Drosophila* and the probable rate of evolution of its species, and the second is the most logical and generally accepted interpretation of the known distribution of the species group to which *D. pseudoobscura* belongs. A third reason for the belief that *D. pseudoobscura* is one of the probable 10 or 20 species of the genus which have existed since the beginning of the Miocene epoch is that it has all of the characteristics which Simpson (1944, pp. 138–142) postulates for bradytelic lines. Since "in the forested zone of the western United States *D. pseudoobscura* is by and large the commonest species of the genus" (Dobzhansky and Epling 1944, p. 15) its interbreeding populations are relatively large. It is highly adapted to an ecological zone—that part of the temperate and subtropical regions which contains woody plants —which has broad but rather rigid selective limits. Thirdly the species appears so well adapted to this environment, which has been continuously

available since the Cretaceous period, that the vast majority, if not all, of the mutant types occurring in nature are lethal, semilethal, or at least of a definitely lower selective value (Dobzhansky, Holz and Spassky 1942).

THE PROBLEM OF THE INVERSION TYPES OF DROSOPHILA

When these a priori reasons are considered, Epling's (1944) brilliantly conceived and carefully worked out hypothesis of a Mid-Tertiary origin for some of the inversion types of *D. pseudoobscura* seems wholly plausible. Furthermore, I believe that a careful consideration of the evidence presented by him as compared with that advanced for the two alternate theories of a recent or a Pleistocene dispersal of the inversion types leads inevitably to the conclusion that in the present state of our knowledge Epling's hypothesis has the greatest degree of probability.

First, let me say that I disagree with both Epling, as his original argument has been interpreted, and Mayr as to the relation between the two questions of the origin of the observed discontinuities in distribution, and their maintenance at the present time. Epling, by devoting all of his attention to their origin, has led some readers to believe that he considers the maintenance of the discontinuities to be independent of the selective activity of the environment. Mayr, on the other hand, believes that the only problem is the maintenance of the discontinuities under modern conditions. This he attributes to an association between the inversion types and certain gene combinations which have a selective advantage under certain ecological conditions, an assumption for which Dobzhansky (1944, p. 118) has obtained some indirect evidence. I agree with Mayr that even under the assumption that the populations are highly sedentary, the maintenance of any distribution pattern over periods of thousands or millions of years would be improbable unless the dispersal of the various chromosomal types were restricted by the selective activity of the environment. I therefore agree with Mayr that the discontinuity in the range of the Santa Cruz phylad is maintained under modern conditions because of certain similarities between the climates of coastal California and central Mexico, and because the different climates of the intervening area are inhospitable to flies with chromosomes of these types. Epling (in litt.) has stated that he now holds the same belief.

On the other hand, I cannot conclude with Mayr that "the means of dispersal of *Drosophila pseudoobscura*, both active and passive, are sufficient to allow a rapid spread of all gene arrangements." Whatever might be the potential dispersal rates under abnormal conditions, the actual situation in the modern continental populations, as it has been determined by Dobzhansky (1944, p. 119) after many years of careful study of large samples, is that they are "in fact relatively sedentary, and that transport over appreciable distances, whether active or passive, is negligible."

Mayr cites as evidence for passive long distance dispersal chiefly the

examples of colonization of oceanic islands, particularly Hawaii. There are, however, two factors which make extremely dangerous the analogy between such transoceanic dispersals and any transcontinencal migration. In the first place, it is a commonplace meteorological fact that winds of high velocity, while frequent over some parts of the ocean, rarely if ever carry for long distances overland, particularly over mountainous terrain (cf. Petterssen 1941). Secondly, any individual of *D. pseudoobscura*, even if blown for several hundred miles without being killed, would find upon arrival an area already densely populated with well adapted members of its own species, and would therefore face not the exploitation of a new area, as in the first colonization of an island, but the most intense form of competition. I believe that Mayr is right that the first colonization of Guatemala by *D. pseudoobscura* was probably by aerial transport across most or all of the 100 mile wide lowland barrier of the Isthmus of Tehuantepec. But to believe that the 500–800 mile gap from Central Mexico to Northern Lower California was "bridged by a ten-hour drift of a gravid female during a heavy storm" is quite another matter. Such storms are unknown in this region, and the possibility that the female in question, after travelling ten hours at 60 miles an hour, would still be alive and vigorous enough to lay her eggs is in itself hard to believe. Then the resulting larvae would have to adjust themselves to new food plants and an entirely different climatic cycle, in strong competition with the population already existing. The adults, if any should survive, would have to mate and leave offspring in sufficient numbers so that the gene arrangement which they bore would not be exterminated, but would spread eventually to fly populations 900 miles still farther away. Such a succession of highly improbable events adds up nearly to complete impossibility.

Furthermore, the present composition of the entire series of inversion types in the populations of Coastal California and Central Mexico is such that its explanation by chance long distance dispersal in modern times is, as Epling points out, highly improbable. If one should postulate that Santa Cruz originated in California and was blown to Central Mexico, then why was Standard not blown there too? The Standard arrangement accompanies Santa Cruz in all of the California localities where the latter is found, and in fact Standard is in every case more common and presumably better adapted to prevailing ecological conditions. Conversely, if Santa Cruz was transported from Central Mexico to Lower California or California, why not Cuernavaca? If the records for central and southern Mexico (cf. Dobzhansky 1944, Table 2, p. 89) are grouped together, the chromosomes containing Santa Cruz are only 8.1% of the total, while 47% contain the Cuernavaca arrangement. The only region in which Santa Cruz is known to be the dominant one in several populations is Guatemala, at the extreme southeastern edge of the range of the species. The explanation of the present distribution pattern of the gene arrangements on the basis of long dis-

tance passive dispersal in modern times is thus beset with so many improbabilities that it could be believed only if all other hypotheses were also almost incredible, a situation which I am attempting to show is by no means the case. The possibility of active dispersal in short stages of Santa Cruz *under modern climatic conditions* is ruled out, since this hypothesis offers no possible explanation for the observed discontinuities.

We are thus led to accept as much more probable the hypothesis that the present discontinuous distribution of Santa Cruz and related gene arrangements, although it is maintained under modern conditions primarily by the selective activity of the enrivonment, nevertheless is a relict distribution, and indicates more or less continuous occurrence of these types from California to Mexico, or their existence as a continuous population in some intermediate area, some time in the past. As Epling has shown by his careful analysis of past climatic conditions in western North America, the only two times during which conditions could possibly have been favorable for the above mentioned continuous or intermediate distribution were first, the pluvial periods of the Pleistocene epoch, and second, the period of widely distributed mild and moist climates which existed throughout the early part of the Tertiary period, and ended early in the Miocene epoch. Before deciding which of these two times is the more probable for the continuous dispersal of the Santa Cruz inversion phylad, I should like to review briefly the evidence presented by Epling and certain additional facts about the ecological conditions now prevailing in the two disjunct areas now occupied by Santa Cruz and its descendants.

At the outset I must say that I agree perfectly with Mayr's statement that the populations of Drosophila carrying certain inversion types are roughly comparable to the ecotypes found in cross-breeding plant species, though hardly to the specialized situations occurring in apomicts and polyploids. The inversions themselves are selectively neutral characters, similar to the neutral diagnostic characters found associated with many plant ecotypes, such as petal color in *Potentilla glandulosa* (Clausen, Keck and Hiesey 1940). Such neutral characters have definite geographic distribution patterns which often involve discontinuities. These patterns are maintained through the more or less permanent association of the neutral character with gene combinations that possess definite selective values. This association is maintained partly by linkage and partly by the sedentary nature of the populations, limiting cross breeding between populations occupying widely different habitats, and producing the phenomenon of "isolation by distance" (Wright 1943). There is every reason to believe that an association between the neutral inversion types and certain adaptive gene combinations could similarly be maintained in fly populations, and this would be aided, as Mayr points out, by the effect of the inversions in suppressing crossing over in the heterozygous condition.

The decision between a Pleistocene and an early Tertiary dispersal of

the ecotypes bearing Santa Cruz and its derivatives should be based on as careful a consideration as possible of the ecological conditions of the regions in which they now occur, and of the available evidence concerning the probable nature of the climate in the intervening area during the two past geological times in question. Epling points out that both the California coast and the highlands of central Mexico have climates which are "relatively mild, humid, and equable," compared to the intervening territory. When we analyze these factors we find that at least in the California coast area the mild, equable character of the climate is more important in determining the frequency of Santa Cruz than the amount of precipitation. The rainfall in the southern end of this narrow coastal strip, namely Cedros Island, is less than 10 inches per year, while at its northern end, in Sonoma County, California, the mean annual precipitation is 50–60 inches. Along the coast from Monterey southward the annual precipitation is actually less than in the mountains of Arizona and northern Mexico, but the presence of summer fogs and maritime conditions probably keep the level of atmospheric humidity higher than that of the interior for most of the year. To the north of Sonoma County the humidity increases, yet the Santa Cruz arrangement drops out in favor of Standard, Arrowhead, and *D. persimilis*. This suggests that, as is true of many other ecotypes, the Santa Cruz ecotype of *D. pseudoobscura* demands a balance of temperature and humidity conditions, which affect it not directly, but indirectly. As a plant feeder, this species is no doubt strongly dependent on the growth cycle of the vegetation. Now an important feature of the woody vegetation within the California range of Santa Cruz is that activity and growth are more or less continuous, with no marked periods of dormancy, either in winter or in summer. Hence *Drosophila* larvae could have abundant food at any season of the year, and the great fluctuations in population size which Dobzhansky and Epling (1944, pp. 34–38) record for various interior localities would not be expected to occur. As a working hypothesis, therefore, I shall offer the following suggestion. The gene combination or combinations predominantly associated with Santa Cruz are such that they give flies bearing this arrangement a selective advantage over arrangements like Arrowhead and Chiricahua when food is continuously available and fluctuations in population size are relatively slight, while flies bearing Santa Cruz are at a great disadvantage where because of unfavorable conditions of food or temperature at certain seasons the fluctuation in population size is great. Indirect evidence favoring this hypothesis is provided by the high frequency of the Santa Cruz arrangment at Camino (Dobzhansky 1944, p. 83). This, the only locality in the Sierra Nevada in which more than an occasional Santa Cruz chromosome has been found, is the site of a large sawmill, where fermenting pine sap is continuously present in large quantities, and lumber sheds would provide protection in winter.

With this hypothesis in mind, we can examine the evidence presented by Epling and others on climatic conditions in the Pleistocene. Epling has fully recognized the fact that during this epoch the climates varied a great deal, and has confined his attention to the moister, pluvial parts of the epoch. Based largely on the evidence of Meinzer, he concluded that even during these periods the climate of Arizona and Northern Mexico was more arid than that of the California coast at present. This conclusion, however, does not seem fully justified, particularly in view of the fact that precipitation is at present greater in the southern Arizona mountains than in the southern part of coastal California. More important is the fact that the scanty evidence available indicates that in this entire region the climate of the last pluvial period was cooler as well as moister than at present. Meinzer (cf. Epling 1944, p. 163) suggests a Pleistocene pluvial climate in southeastern Arizona similar to that now found in southern Oregon, while Hubbs (1945) states that "during late Glacial time the whole western region was . . . cold (not warm) and moist. . . . " The only scrap of paleobotanical evidence available points in the same direction. In the Wilcox Playa, a late glacial lake bed near Tucson, Arizona, has been found wood of *Carya* (Sayles and Antevs 1941), a genus not now known west of central Texas. The hickory at present occurs exclusively in regions with cold winters, and is strongly adapted to winter dormancy. Antevs therefore rightly considers this fossil as supporting his conclusion, based on other evidence, that the climate of southern Arizona during the last pluvial period was colder as well as moister than at present. The *Drosophila* populations now occurring in the range of *Carya* lack completely the Santa Cruz arrangement, and consist mainly of Pike's Peak and Arrowhead, plus the related species *D. affinis*. This evidence, coupled with the fact that the Santa Cruz arrangement at present drops out in the moister but colder parts of northern and eastern California, suggests that conditions in southern Arizona and northwestern Mexico during the last pluvial period of the Pleistocene were perhaps less favorable for the Santa Cruz arrangement than at present. An alternative route of Pleistocene migration might be suggested, namely down the peninsula of Lower California, with a subsequent long distance jump from the tip of this peninsula 400 miles to central Mexico. Epling, however, has pointed out that at present most of Lower California is excessively dry, and the evidence of Mason and Miller (cf. Epling 1944, pp. 163–164) does not suggest that conditions moist enough to support continuous active growth of woody plants could have existed more than 250 miles farther south than at present. This would be sufficient to extend conditions favorable to Santa Cruz south along the now arid coast as far as Cedros Island, and so link up the now probably isolated occurrence of the arrangement on Cedros with its range in California, but no further southward migration would be likely. There is also the possibility that earlier

pluvial periods of the Pleistocene were warmer than the last one, but we have no evidence on that point. Furthermore the present relation between the floras of central California and central Mexico, as will be pointed out below, speaks against this possibility. I believe with Epling, therefore, that while it is possible that flies with the Santa Cruz arrangement migrated from California to Mexico or vice versa during the Pleistocene, nevertheless present evidence is definitely against the probability of such an event.

It must be noted here that the evidence presented above does not apply to the derivatives of Santa Cruz, namely Tree Line, Olympic, and Estes Park. These arrangements are in general most common at high altitudes and more northerly latitudes, so that their dispersal during the latter part of the Pleistocene is a reasonable hypothesis. This corresponds with their relatively younger age.

There remains, therefore, Epling's hypothesis of the dispersal of the Santa Cruz inversion type during the Miocene or Oligocene epoch. As pointed out above, this hypothesis is fully in accord with our knowledge of the age of the genus *Drosophila*, and with the estimate of the age of *D. pseudoobscura* that results from applying to it Simpson's explanations of slow evolutionary rates. It also agrees, as Epling pointed out, with the most logical interpretation of the age of certain patterns of plant distribution involving coastal California and central Mexico. In addition to the examples of *Cupressus* and *Mahonia*, which he cites, there are some other species pairs, species groups, genera, or subfamilies which are found predominantly in coastal California and central Mexico, and are absent in part or all of the intervening territory. Those known to me are as follows, the data having been obtained from Jepson (1925) and Standley (1923), as well as Barkley (1937) for *Rhus* and Ownbey (1940) for *Calochortus*, and Epling (in litt.) for *Stachys*, and having been personally verified by examination of herbarium specimens.

GROUP	COASTAL CALIFORNIA	CENTRAL MEXICO
Cupressus	*C. macrocarpa* Hartw. *C. Goveniana* Gord. *C. pygmaea* Sarg.	*C. Benthamii* Endl. et aff.
Calochortus sect. *Cyclobothra*	subsect. *Weediani* Ownbey	subsect. *Ghiesebrechtiani* Ownbey subsect. *Barbati* Ownbey subsect. *Purpurei* Ownbey
Berberis	*B. pinnata* Lag.	*B. pinnata* *B. moranensis* Roem. et Schult.
Ribes	*R. quercetorum* Greene *R. leptanthum* Gray	*R. microphyllum* H.B.K.

Group	Coastal California	Central Mexico
Rhus	*R. ovata* Wats. *R. integrifolia* (Nutt.) Benth. et Hook. *R. Lentii* Kellogg	*R. Muelleri* Standl. & Barkl. *R. Standleyi* Barkley
Ceanothus	*C. thyrsiflorus* Esch. et aff.	*C. coeruleus* Lag.
Sterculiaceae tribe Fremontieae	*Fremontia* (3 spp.)	*Chiranthodendron pentadactylon* Larr. (monotypic genus)
Gaultheria	*G. Shallon* Pursh.	*G. odorata* Willd. et aff.
Comarostaphylis	*C. diversifolia* Greene	12 spp. (entire genus except for *C. diversifolia*)
Vaccinium	*V. ovatum* Pursh.	*V. confertum* H.B.K. *V. cordatum* Hemsl.
Stachys	*S. stricta* Greene	*S. globosa* Epling *S. exilis* Epling *S. collina* Brandegee
Baccharis	*B. pilularis* DC.	*B. conferta* H.B.K.

The species on this list represent only a small fraction of the flora of their respective areas, so that the coastal Californian-central Mexican affinity is not one of whole floras, like that between Eastern Asia and Eastern America, but of certain floral elements. Furthermore the Californian and Mexican representatives of these groups are in general well differentiated from each other, so that only *Berberis pinnata* is common to the two areas. Since fossil evidence indicates that even in the Pliocene the woody species of the California flora were essentially the same as the modern ones (Axelrod (1937), it is highly improbable that any of the common ancestors of the species groups or species pairs mentioned above migrated from California to Mexico or vice versa during the Pleistocene and acquired their present high degree of distinctness in the relatively short period since then. They are much more likely relicts of an early Tertiary forest element that existed in the intervening area before the climate there acquired its present continental character. If one accepts Simpson's principles, one can readily see how the plants of these regions have evolved considerably since Oligo-Miocene time, while *Drosophila pseudoobscura*, although it has passed through a hundred or more times as many generations, has remained the same. *D. pseudoobscura* has a range of climactic tolerance far greater than that of any single species of seed plants. It is apparently physically impossible for any plant species to evolve some ecotypes adapted to the winter rainfall cycle of California and others to the summer rainfall conditions of Mexico. *Drosophila*, however, is not so directly dependent on rainfall, so that in *D. pseudoobscura* this is possible. If the flies can be active at any

season of the year, as is apparently the case in the two regions concerned, then one might even suppose that the same genetic type could survive under summer rainfall as under winter rainfall conditions. In that case, a species could pass from an original region having a climate with essentially uniform seasonal rainfall into one with either summer rain or winter rain without being subjected to great selection pressure, as would inevitably be exerted on plant species under such circumstances. The corresponding response of the organisms would be relatively great evolutionary modification in plants and little or none in the flies.

The botanical evidence, therefore, is entirely against the hypothesis that a climate similar to that which now supports the Santa Cruz arrangement and its plant associates has existed in Arizona, central and southern Lower California, or northern Mexico at any time since the Miocene or Oligocene epoch. It therefore supports entirely the hypothesis that no active migration of Santa Cruz flies between their present disjunct areas has taken place since that time.

Another reason for assuming that the present peripheral distribution of the Santa Cruz arrangement is an old, relict one is that it agrees with the hypothesis of Matthew (1939) on the peripheral distribution of old members of a group. Furthermore the other primitive arrangement, Standard, is also peripheral, since it occurs in high concentrations only along the Pacific Coast (Dobzhansky 1944, pp. 119–132) and the center of the range of *D. pseudoobscura*, namely Utah, Arizona, New Mexico and Chihuahua, is occupied almost entirely by the derivative arrangements Arrowhead, Pike's Peak, and Chiricahua. On the basis of the ecotype hypothesis of the relation between chromosomal arrangements, one can assume that there has been extensive intraspecific evolution in *D. pseudoobscura*. This has not led to the differentiation of distinct species, with the probable exception of *D. persimilis*, or even to recognizably different morphological types, but has produced physiologically different genotypes, adapted to the colder, drier and more continental climatic conditions which have arisen in western North America during late Tertiary and Quaternary time. In this connection, it must be noted that both of the rare, phylogenetically terminal arrangements in the Standard phylum, namely Cochise and Texas occur in areas with a dry continental climate, and near the center of the range of the species. This is less evident in the Santa Cruz phylum, but three out of four of the rare, phylogenetically terminal arrangements of this phylum found in the United States, namely Estes Park, Olympic, and Mammoth occur in areas that are colder and drier than those in which their parent arrangements are the most common. Thus in both phylads of *D. pseudoobscura* the progression of inversion types appears to accompany the adaptation of the flies to successively colder and drier habitats. The correlation of this progression with the known changes of climate toward

cold and dryness during the latter part of the Tertiary period (Chaney 1936) is fully in accord with the hypothesis of Epling and the writer. Similar tendencies, though less marked, can be seen in *D. persimilis*. Thus in the southern Sierra Nevada the moister western slope has a relatively high concentration of flies with the Standard arrangement, while in the dry eastern slope, which is subject to extreme temperature fluctuations, the derived arrangement Whitney is the most common. Also in the extreme northern part of the range of this species, with a relatively cold climate, the predominant gene arrangements are the derived ones Klamath, Cowichan, and Whitney. The fact that Standard of *D. persimilis* is found predominantly in a cooler, drier climate than is Standard of *D. pseudoobscura*, suggests that *D. persimilis* arose from its more widespread relative some time in the latter part of the Tertiary period.

SUMMARY AND PREDICTIONS

The arguments presented in favor of the present hypothesis may be summarized as follows:

(1) Evidence from discontinuous distributions of plant species and genera, involving principally the temperate floras of the Old World and the New, indicates that a number of genera or species of seed plants have evolved little or none since the middle of the Tertiary period, while others, in related groups, have been evolving much more rapidly.

(2) The characteristics of population size, ecological distribution and degree of adaptation found in these species agree with those postulated for slowly evolving, or bradytelic, lines by Simpson, who based his principles on a study of fossil animals of all available phyla. Hence they indicate a close agreement between the paleontological evidence in animals and the distributional evidence in plants bearing on rates of evolution.

(3) The scanty fossils available, as well as the more ample distributional evidence, both point to the probability that the genus *Drosophila* existed, and that the *obscura* species group acquired its now disjunct holarctic distribution, during the first half of the Tertiary period.

(4) *D. pseudoobscura* has all of the characteristics postulated by Simpson for bradytelic lines. The hypothesis of a Tertiary age for this species therefore brings into perfect agreement the evidence on evolutionary rates derived from paleontology, phytogeography, insect distribution, and from the biology of *Drosophila*.

(5) The maintenance under modern conditions of the discontinuity in the distribution of the Santa Cruz phylad is best explained on Mayr's hypothesis of an association between the chromosome arrangements and gene combinations which have local selective advantages. The particular gene combination associated with the Santa Cruz arrangement in both California and Mexico may be one which gives the flies a selective advantage under

relatively uniform seasonal conditions, with consequent slight fluctuations in population density, and a disadvantage in regions where seasonal periods of unfavorable temperature or food conditions produce marked fluctuations in the population.

(6) The origin of the present distribution pattern by means of long distance passive dispersal in modern times is highly unlikely on the basis of meteorological and ecological evidence, and the analogy between this example of transcontinental dispersal and the population of oceanic islands is very hazardous. The evidence from the composition of the modern populations both as to inversion types and recessive genes, is also against the hypothesis of accidental passive dispersal.

(7) Such evidence as is available on the climate of the southwestern United States and northern Mexico during the later pluvial period of the Pleistocene epoch indicates that it was colder as well as more humid than at present. Such a climate would be no more favorable to the Santa Cruz arrangement than the present one, since at present Santa Cruz occurs almost entirely in regions which are mild and equable as well as moderately humid. The derivatives of Santa Cruz, namely Tree Line, Olympic and Estes Park, may have been dispersed during the Pleistocene.

(8) There is no paleobotanical evidence to indicate that a continuous belt of vegetation consisting of types adapted to a mild, subhumid climate has extended from coastal California to central Mexico at any time since the beginning of the Miocene epoch. The evidence from the distribution of modern floras is definitely against this possibility.

(9) The combined evidence from all sources therefore indicates that the essential part of the Epling's hypothesis, namely that *Drosophila pseudoobscura*, as well as the primitive inversion type Santa Cruz, was already in existence at the beginning of the Miocene epoch, and was a part of the generalized Arctotertiary biota, offers the most probable explanation of the sum total of data at present available.

In the case of such necessarily indirect evidence as this, however, any hypothesis must be looked upon merely as the one which has the greatest degree of probability, rather than one which is wholly possible or impossible. The value and probability of such an hypothesis, therefore, will depend to a considerable degree on how many verifiable predictions one may make on the basis of it. I shall venture, therefore, to make such predictions, in hopes that future research will either verify them or not.

In regard to points 1 and 2 of the summary, further examples showing a correlation between paleontological and phytogeographical evidence bearing on Simpson's postulates about bradytelic lines of evolution would automatically increase the probability that this type of evolution exists in *Drosophila*. In regard to point 3, fossil evidence if obtainable would of course be decisive. But further evidence from distribution might also be

highly significant. In particular, study of *Drosophila* populations in eastern Asia should reveal the presence of members of both the *affinis* and *obscura* species groups, and these forms should be more closely related to those in North America than are the European *D. obscura* and its relatives. The significance of point 4 will be greatly increased if other species of *Drosophila* can be identified on the basis of distributional or other evidence as representing rapidly evolving lines, and if the characteristics of populations and adaptation in these are the opposite of those in *Drosophila pseudoobscura*. In regard to point 5, a technique or techniques of determining the ecological requirements of gene combinations in *Drosophila* would make possible a testing of the writer's hypothesis on the nature of adaptation in flies bearing the Santa Cruz arrangement. If sufficiently refined, it could provide direct evidence on the possibility of long distance dispersal in modern times by determining whether or not Santa Cruz flies from California are ecologically different from those from Mexico, and therefore whether or not transmigration and establishment would be prevented by adverse selection. The force of the arguments in point 6 depends on whether the discontinuity is actually as large as it appears on the basis of present evidence. The discovery of high concentrations of Santa Cruz in the Mexican provinces of Lower California, Sonora, and Sinaloa would reduce considerably the force of the whole argument based on the discontinuity of the inversion types, although it would not affect the validity of the other evidence as to the age of the *obscura* species group. In regard to point 7, further paleobotanical and paleoclimatological evidence should continue to point against the assumption of a milder climate than the present during the moist pluvial periods of the Pleistocene.

In any case, I believe that the evidence for slow evolution in certain *Drosophila* species is so strong that it should be taken into account in any discussion of evolutionary dynamics. If further evidence from this and other rapidly reproducing, genetically analyzed groups continues to point in the same direction, certain general principles on the causes of evolutionary progress will automatically emerge. Viewed in this light, the bold and imaginative concept of Epling assumes major significance.

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Evidence from Fossils and from the Application of Evolutionary Rate Distributions

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The immediate point involved in this discussion, the age of *Drosophila pseudoobscura* and of certain of its gene arrangements, has been so fully discussed by Epling (1944), Mayr (1945), and Stebbins (1945) that there is little to add on this specific question. The fact that these students disagree after so thorough a review of the evidence suggests that the evidence is inadequate and induces in at least one neutral observer an attitude of suspended judgment. The problem is of great importance, but still more important are the general interpretive principles involved. On this score a note of caution seems to be in order, particularly as regards the arguments used by those who seek to establish a relatively great age for the species *D. pseudoobscura* and for gene arrangements that evidently arose after the species as such. Their conclusions may prove to be correct, but some of the reasons given for considering this as probable seem to me not only to go beyond the evidence but also to involve interpretive procedures of dubious validity.

The only direct evidence would, of course, be provided by fossils, but such data are as yet scanty and equivocal, to say the least. Stebbins (in the paper accompanying this note) cites Handlirsch (1908) to the effect that *Drosophila* occurs in the Baltic amber, usually considered early Oligocene in age. The citation is a second-hand authority based on the work of Löw in 1850—nearly a century ago. But even Löw (e.g. 1864) did not consider this as a positive datum. He explicitly excluded the Drosophilidae from the roster of dipteran families certainly present in the amber. It may be concluded *a fortiori* that the presence of the genus *Drosophila*, itself, is uncertain. My knowledge of the later literature is incomplete, but I have not been able to find any positive and first-hand identification of this genus in the Tertiary (see, e.g., Handlirsch, 1921; Ander, 1942, and his extensive bibliography). Some of the amber dipterans have been given thorough modern study (e.g., Tipulidae, Empididae) but the Drosophilidae and their allies, poorly represented in the Oligocene, seem to have been neglected, an unfortunate lacuna in view of the great interest attaching to these forms in recent biology. As far as I have been able to learn the only evidence now available is negative. There is no trustworthy fossil evidence as to the age of *Drosophila*.

It is curiously difficult to find really reliable figures for extinction of genera and species of Diptera in the Tertiary. The recent tabulations by Ander (1942) are completely misleading from this point of view because he

enters as extinct not all the genera and species that no longer exist as such, the definition of "extinct" necessary for our problem, but only the much smaller number that do not, in his opinion, have geographic affinities in the recent fauna. There is, however, some reason to believe that Stebbins' figure of 10% extinction for Oligocene "borborid" genera, based on Handlirsch, 1908, will prove to be much too low. Handlirsch's work was compendious but notoriously uncritical and his sources for this group were in part quite unreliable and all very old, dating from a time when genera of fossil insects were defined in a much broader way than they are now. Generic distinctions are, even now, more difficult to observe in fossils, and the samples involved were too small to yield reliable inferences as to the Oligocene population.[1] Some evidence on this last point is given by the fact that a later compilation by Handlirsch (1921) shows that more than 15% of the genera of "Borboridae" known as fossils of any age are extinct. Since very few known fossil "Borboridae" are older than the Baltic amber and the majority are younger, many Pleistocene or sub-Recent, the percentage of extinction since the deposition of the amber will, when adequately known, almost surely prove to exceed this figure. In dipteran families more adequately studied and with larger samples from the amber, the percentage of extinct genera in the amber is higher than 15%. For instance in the well-studied and abundant Tipuloidea (see Alexander, 1931), 24% of the genera are extinct. The percentage of extinction is still higher among other dipterans of the Baltic amber (e.g., Mycetophilidae and Empididae) and so, it seems, is the average generic extinction for insects in general (bees, 100%; Trichoptera, 46%; etc.; see, e.g., Alexander, 1931).

More pertinent, because the question is the age of *D. pseudoobscura* and not immediately that of *Drosophila*, are figures for specific extinction and survival. When studied by Löw, 100% of the known Baltic amber species of Diptera were listed as extinct. As far as I can learn, no well-established exception to this generalization has since been found. Again the abundant and carefully revised tipuloids provide a check, and Alexander (1931) confirms that all amber species are extinct. Moreover, this appears to be the rule even for the Miocene flies. Few Miocene allies of *Drosophila* are known (only 6 species of "Borboridae" in Handlirsch, 1908), but these are all extinct species. Among tipuloids, better known here as they are in the Oligocene, Scudder (1894) found that more than half the genera and 100% of the species from the rich Miocene Florissant deposit are extinct. On the face of the evidence, the tipuloids would appear to be the more ancient and conservative group and it is reasonable to assume that drosophilid

[1] It may also be noted that early work on amber insects not infrequently confused Oligocene inclusions in amber with Pleistocene and Recent inclusions in copal, and also that spurious specimens, made by enclosing recent materials in gums of various sorts, were rather extensively manufactured.

speciation was at least as rapid.[2] The evidence is not conclusive, but it has some value and it definitely suggests that *no* species of *Drosophila* is likely to be of Miocene, or, still more, of Oligocene, age. At least it throws the burden of proof on those who would establish such antiquity on other and even less direct evidence.

Aside from the fossil evidence, such as it is, two others of Stebbins arguments may be briefly reconsidered: first, that *D. pseudoobscura* has the characteristics of a bradytelic group (and so is likely to have evolved slowly or to be of great age), and, second, that standard evolutionary rate distributions suggest that a considerable number of the living species of *Drosophila* date from the mid-Tertiary. Here, too, I conclude (with real reluctance) that the arguments are without force as applied in this way and to the data in hand.

The argument regarding bradytely (see Simpson, 1944), as applied to *Drosophila*, leads to some logical difficulties. The existence of bradytely is recognized because of the long survival of some genera with little evolutionary change, i.e. with demonstrable exceptionally low evolutionary rates. The evolutionary rate could be just as low and the genus (or other group) just as truly bradytelic even though it had arisen at a recent date, but in that case direct observation of the bradytely would probably be impossible. Before becoming bradytelic the group may have evolved at a rapid rate; indeed there is some evidence that this is normal. In other words, only old bradytelic groups have as yet been surely recognized as such, but a bradytelic group is not necessarily old and may be of quite recent origin. Hence evidence that a group fulfills all the conditions for bradytely is not *ipso facto* evidence that the group is old.

Another difficulty is that the conditions involved in bradytely as discussed by me and summarized by Stebbins are empirical generalizations regarding groups considered bradytelic on other more direct evidence. It does not follow, unless separately demonstrated, that groups fulfilling these conditions are therefore (without direct evidence as to rate) bradytelic. A proposition in the form "most *a* is *b*" cannot be inverted and applied in the form "all (or most) *b* is *a*."[3]

The validity of application of extinction or survival curves to any given

[2] As Stebbins notes, in the accompanying paper, recent *Drosophila* suggests that the rate of speciation in that genus is high. His contrary evidence, that *Drosophila* is recorded from the early Oligocene, has been shown above not to be established as to fact, and would not be conclusive as to the age of living species even if it proved to be true.

[3] Another minor misunderstanding is involved in Stebbins' citing me (Simpson, 1944, p. 127) as authority for the statement that patterns of evolution involving bradytely are standard and essentially the same for many or all taxonomic units. I apparently failed to make clear that the standard distribution here under discussion *excludes* bradytely. I consider bradytely as involving a separate, non-standard rate distribution, and I have stressed the necessity of distinguishing bradytelic from slow standard, or horotelic, rates (ibid., p. 133). It has not been demonstrated that true bradytely occurs in most groups of animals. It likely does not.

group, in the way that Stebbins proposes to apply them to species of *Drosophila*, depends on several conditions that have not, I suggest, been met in the present instance. In the first place, these curves differ markedly according to whether bradytelic lines occur in the group in question and are included in the data summarized in the curve. (Note strong contrast between the broken and continuous curves in the upper graph of Simpson, 1944, fig. 5; the broken line includes bradytelic groups and the solid line probably does not.) We do not know whether *Drosophila* includes bradytelic species or not, or, if it does, what proportion of the species are bradytelic or when they arose. The relatively uniform horotelic distributions (ibid, fig. 18) are not applicable to the living fauna unless bradytelic groups are absent or can be eliminated from the data. That such a curve, based on genera of molluscan and mammalian orders, applies also to species of an insect genus is not yet demonstrated. It is my personal belief that it will prove to do so (all other conditions being met), but it must be recognized that this is somewhat speculative and that a secondary inference based on this undemonstrated generalization begins to be rather hazardous.

The gravest difficulty of all, in application of these curves to the present problem, is that their constancy (only relative) is a matter of general form, not of absolute values. As exemplified in Simpson, 1944, the evolutionary rates involved, and their mean and extreme values, may be highly different in two distributions even though the forms of the distributions are approximately the same. In order, then, to apply the curve to estimating the ages of various percentages of species in a group, as Stebbins does, we need to have beforehand some estimate of average rates in that group. Otherwise the curve can tell us nothing as to the absolute age of the lines included. The mean survivorship in *Drosophila* might be under 100,000 years, with no living species older than the Pleistocene, or it might be 25,000,000 years, with some living species survivors from the Mesozoic, and still the horotelic rate distribution could have precisely the same form. There is danger of assuming a mean survivorship value and then using it to argue for the antiquity of species in the genus, which is a completely circular argument. What little evidence there is seems to me to suggest that the mean survivorship was greater than 100,000 years and less than 25,000,000 years, but probably much nearer the smaller figure. Even if *Drosophila* arose not later than the beginning of the Oligocene, which is Stebbins' assumption but which lacks a factual basis as I have shown, it still would not follow that any living species arose in the Oligocene or even in the Miocene. It does not follow, but on the contrary is most unlikely, that any living species is comparable to the genus in age.

Thus it does not appear that the fossil evidence or the tentative laws of

rate distribution and survivorship really support a Miocene age for *Drosophila pseudoobscura*.

Without going into further detail, it may not be amiss to express general skepticism regarding the attempt to infer the age of this species from its recent geographic distribution. We are dealing here with minor taxonomic units covering a relatively quite small area. There is evidence that both large and small units (although seldom as small as a species) have sometimes changed little in distribution since the Oligocene or Miocene. There is also abundant evidence that other groups have undergone the most radical geographic changes in that time, involving relatively enormous areas and movements of intercontinental scope. (Examples of both sorts based on insects are given by Ander, 1942.) The distribution of *Drosophila pseudoobscura* involves no great geographic change, such as the rise or sinking of a land bridge, and no barrier of major importance seems to occur even now, although there are various minor barriers, The general impression given (to me, at least) by the arguments on both sides is that time is not really the crucial factor in this instance and that the recent distribution could have occurred quite recently, even within the last few hundred or thousand years, or could be rather ancient, depending on other factors mainly biotic and evolutionary, that are imperfectly known, unknown, or indeterminate, as has been sufficiently emphasized by Mayr.[4]

In conclusion, the age of *Drosophila pseudoobscura* and of its gene arrangements seems to be indeterminate on the basis of the evidence (all indirect) so far at hand. Perhaps too much space has been devoted to this negative conclusion, but even negative conclusions have some value. Although Epling and Stebbins have properly qualified their positive conclusion, the absence of published dissent might, as experience has painfully shown, have led to the use of their hypothesis by other authors as a basis for other inferences still more circumstantial and still farther removed from any objective support. It is also to be feared that generalizations and interpretive principles, sound as proposed and within their limitations, may fall into disrepute, or into too uncritical use, if they are misapplied or applied

[4] A parenthetical comment on the evolution of tapirs may be added, as this group has been mentioned in the discussion in a slightly inaccurate way. Tapirs are not abundant fossils, but a fairly continuous series has been found both in the Old World and the New. There were at least two and perhaps more migrations of tapirs between the two land masses. The genus *Tapirus*, itself, using this to include the living tapirs of Asia and South America, is not surely known from the Miocene but does occur in the Pliocene of Europe and Asia. It was probably present in the Pliocene of North America but is not yet known here in beds earlier than the Pleistocene. It entered South America probably in the early Pleistocene. The evidence is strong that discontinuity between Old and New World forms is not as old as the Miocene. It apparently dates from the Pliocene, at earliest, and perhaps from the Pleistocene. Thus the tapirs do not support the view that discontinuities in a biotic complex of forests and forest-dwelling mammals and insects between America and Asia must be pushed back into the middle or early Tertiary.

without the restriction of their limitations. In criticizing the conclusion reached by Epling and supported by Stebbins, it is proper to call attention to the great interest and value of many of the data presented by them and to the stimulating effect of their work in a field of study with great promise for the future.

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A Revision of Ambelania, Inclusive of Neocouma (Apocynaceae)[1]

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INTRODUCTION

Conspectus.—In the following preliminary study the two species described in Neocouma are transferred to Ambelania, resulting in the new combination *A. ternstroemiacea* and the new name *A. Markgrafiana*. *A. Sagoti* and *A. tenuiflora* are placed in synonymy under *A. acida*. Ambelania is regarded as containing the most heterogeneous specific elements in all the genera of Carisseae in America, but nevertheless as displaying sufficient unity and integration of its components to be maintained as a single comprehensive genus. A systematic treatment of the group is presented, with key, short descriptions, and bibliography.

Literature.—The present article is the only integral work on the taxonomy of Ambelania, besides that of Mueller Argoviensis (24) who in Martius' Flora Brasiliensis describes six species, five of them under the genus and one as *Tabernaemontana* (?) *ternstroemiacea*. Five of these were original and all except one are still valid, *A. tenuiflora* being placed here in synonymy under *A. acida*. K. Schumann (33) gives some short differential characters for six species, and like G. Bentham (5), he suggests that *A. tenuiflora* and *A. Sagoti* are conspecific with *A. acida*. J. Miers (23) describes four species, one of them original and three in new combinations under Rhigospira, but he makes only incidental mention of *A. laxa* and Aublet's type of *A. acida*. H. Hallier (13) discusses the systematic position of Ambelania as known to him only from literature. F. Markgraf (20 & 21) describes three original species, and in Pulle's Flora of Surinam presents his concept on the differences between *A. acida* and *A. Sagoti*, two species which are here considered synonymous. In the treatment of individual species, F. Aublet (1) gives a good account of *A. acida*, as J. Huber (14), in addition to giving valuable notes on the Brazilian plants of *A. acida*, does of his *A. grandiflora;* L. Pierre (27), in an interesting discussion, introduces the genus Neocouma for *A. ternstroemiacea*. S. J. Record (29) places *Ambelania acida* and Neocouma in his key based upon wood anatomy, and Record & Hess (30), in Timbers of the New World, present some gross wood properties of *A. laxa*, *A. acida*, and Neocouma.

Abbreviation of herbaria and acknowledgments.—In order to conserve space, no place of deposit is indicated when a particular collection is represented either in the Britton Herbarium or in the Krukoff Herbarium at the

[1] This contribution is made possible by the financial support of the Chicle Development Company.

New York Botanical Garden, except when it is a type collection. Otherwise the depository is thus abbreviated: A—Arnold Arboretum, Jamaica Plain; CGE—Botanical Museum and Herbarium of the University, Cambridge, Mass.; F—Field Museum of Natural History, Chicago; G—Gray Herbarium, Cambridge; M—Missouri Botanical Garden St. Louis; NY—New York Botanical Garden, New York; US—United States National Herbarium, Washington; Y—Yale School of Forestry, New Haven. Acknowledgment is here made to the directors and curators of the institutions listed for their generous loans of herbarium material, and my particular gratitude is expressed for the aid rendered me by Mr. B. A. Krukoff and Mr. E. J. Alexander, Drs. H. A. Gleason and H. N. Moldenke.

SYSTEMATIC TREATMENT

AMBELANIA Aubl., Pl. Guian. **1**: 265. Pl. 104. 1775.

Willughbeja Scop., in Schreb. Gen. **1**: 162. 1789.—pro parte. Non *Willughbeia* Roxb., Pl. Coromandel **3**: 77. Pl. 280. 1819.
Bentheca Neck., Elem. **2**: 54. 1790. Non *Benteca* Adans., Fam. **2**: 166. 1763.
Rhigospira Miers, Apocyn. S. Am. 67. 1878.—pro parte.
Neocouma Pierre, Bull. Soc. Linn. Par. (N. Sér.) **1**: 33. 1898.

Tribe *Carisseae* (5, p. 684); shrubs or small trees of diverse habits, up to 25 m. high, the trunk up to 50 cm. diam., unarmed, sometimes swollen, the white latex abundant, non-poisonous, sweet or bitter, the wood moderately heavy to very light; branchlets slender to thick and fistulose, 2–15 mm. diam., flattened or terete to bluntly or very sharply quadrangular, usually grooved, shining or dull brown or becoming grey, glabrous (sometimes sparsely and minutely puberulent), smooth to very densely and minutely verruculose, marked with an interpetiolar line which is sometimes fringed with minute processes or glands, the pith white or brown, the vegetative axillary buds inconspicuous; *leaves* opposite, essentially uniformly spaced, the petioles 0.5–4 cm. long, deeply canaliculate on upper side, ridged, sometimes with minute axillary glands, glabrous (rarely sparsely and minutely puberulent), the blades lanceolate to elliptic to obovate or oblanceolate, 6–30 cm. long and 1.5–17 cm. broad, acute or sharply cuneate to rounded at base, short acuminate and blunt to broadly obtuse or rounded at apex, the margins inrolled, the tissue more or less coriaceous, sometimes rigidly so at maturity, drying greenish grey or brownish or yellow, the upper surface dull to nitidous, the under surface usually paler, subnitidous to very opaque, usually dotted with minute, scattered, sometimes numerous dark points and also thickly beset with microscopic white atoms imbedded within tissue, smooth or scrobiculate-rugulose, the midrib impressed to markedly raised on upper surface and raised on lower surface, the principal secondaries (secondary or lateral veins) 17–30 pairs with an average distance of 3–30 mm. apart near middle, somewhat impressed to markedly raised on upper surface, raised on

lower surface, slightly arcuate, simple or branched, connected by a marginal nerve (which is sometimes hidden underneath the inrolled leaf-margin or is obscure), the minor secondaries in between principal ones sometimes present, the tertiaries obscure to numerous and raised on upper surface, sometimes visible on under surface, oblique and branched, the reticulation sometimes evident on upper surface, raised and irregular, open or very close; *inflorescences* axillary or terminal, densely crowded to lax, sometimes glutinous, 2–60 flowered, the infl. axis 0.5–8 cm. long, the peduncle to first pair of bracts up to 6 cm. long or completely reduced, the pedicels very short or up to 7 mm. long, the bracts and bracteoles small scale-like and inconspicuous to large oblong-lanceolate, up to 10 mm. long and 6 mm. broad, often caducous, glabrous; *calyx* 1.5–7 mm. diam. below lobes, obtuse or rounded at base, the calyx-tube very short, the calyx-lobes quincuncial, ovate, 1–6.5 mm. broad and 1–13 mm. long, obtuse to acute at apex, rounded at base, glabrous, dorsally thickened or flattened or sometimes slightly keeled, sometimes with minute resinous granules or pustules, the glands within often inconspicuous, sometimes evident, in one or several ranks, wedge-like and minute to linear, up to 0.48 mm. long; *corolla* white to orange, hypocrateriform, the corolla-tube 3.5–30 mm. long and 1.5–7 mm. diam., usually swollen at region of insertion of stamens and somewhat constricted at throat, glabrous outside, glabrous inside or pilose with linear to clavate hairs, the corolla-lobes more or less elliptic-oblong, mostly approximately the length of the corolla-tube, 7–45 mm. long and 2–15 mm. broad, pilose at base inside or glabrous, spreading at maturity, sinistrorsely contorted (viewed externally), twisted either strongly to the right or to the left or only slightly twisted; anthers located below middle of corolla-tube, subsessile (filament short but evident) or firmly sessile, pubescent at point of attachment or completely glabrous, lanceolate, 2–9 mm. long, sagittate at base, the lobes close together or spreading, blunt or somewhat acute, the apex extending into a non-polleniferous acute appendage 0.16–1.2 mm. long, the loculi polleniferous their entire lengths or the pollen lacking or not developed, reduced, amorphous and agglutinated in basal lobes; *ovary* syncarpous, superior, ovate to oblong, generally about 1.5–2 mm. long, glabrous, usually grooved, without disk or glands, conical or truncate at apex, unilocular with the two placentas each in cross section in shape of a T and almost touching (as in species of Couma, Parahancornia, and Lacmellea[2] or two-celled, ovulate to base or the base of ovary on a sterile podium up to 0.5 mm. long, the ovules numerous, in 2–10 series, seen in longitudinal view generally as irregular polygons arranged in honeycomb-like mosaics; style at maturity about 0.3–8 mm. long up to ring, more or less angled or fluted, glabrous, the ring incrassate, sometimes with a thin

[2] See author's treatment of these genera in Lloydia, 1943 (Vol. 6, p. 230) & 1944 (Vol. 7, p. 277).

undulate or lobed rim, about 0.6–2.5 mm. broad, the crested capitulum usually 5-lobed, composed of fibrous tissue, 0.3–1.3 mm. long and 0.4–2 mm. broad, sessile on ring or stalked, the stalk up to 0.32 mm. long, the stigma-apiculi 0.2–1.9 mm. long, cleft into two parts or apparently united, acute at apex, glabrous; fruit a berry, oblong to elliptic in longitudinal section and circular to elliptic or star-like pentagonal in cross section, up to 15 cm. long, narrowed to pointed or blunt at apex, narrowed to truncate at base, sometimes stalked, yellowish to brown or orange, verrucose to smooth, usually two-celled; seeds numerous elliptic, up to 15 mm. long and 8 mm. broad and 4 mm. thick, flattened or concave on placental side and convex or bluntly tricostate on opposite side, grey to brownish, minutely pitted, smooth or roughened with protuberances, the hilum small, elliptic, located a little below center; embryo about length of seed, the cotyledons small, about $\frac{1}{3}$ length of the cylindrical radicle.

Types species.—*Ambelania acida* Aubl.

Scopoli proposed Willughbeja to embrace both Ambelania Aubl. and Pacouria Aubl., two genera that are amply distinct from each other; his concept was adopted by Gmelin (11). Willughbeia Roxb., which is typified by *W. edulis* Roxb. and which has been recommended for conservation by M. L. Green (Kew Bulletin **1935**: 541. 1935), is applicable only to certain Asiatic species of scandent Carisseae. The Compositae genus Willughbaeya Neck. (Elem. **1**: 82. 1790) is on the list of nomina rejicienda in the International Rules, Mikania Willd. being conserved against it.

Necker proposed Bentheca in place of Ambelania without offering any justification for the substitution, and he apparently extracted his diagnosis wholly from Aublet's Pl. Guian. On the other hand, Adanson's Benteca (or Benteka, as spelled in the index of Adanson's book) refers to the Teckenkour tree figured in Rheede's Hortus Malabaricus, a plant which obviously is not apocynaceous. Kasailo Dennst. Schluess. Hort. Malab. 30 (1818), listed in Index Kewensis in synonymy under Ambelania, also refers to this Malabar tree.[3]

Miers proposed Rhigospira to embrace three species of Ambelania and four species of Macoubea. These two latter genera, although very closely allied, I nevertheless maintain distinct.

Neocouma was founded by Pierre on basis of *Tabernaemontana* (?) *ternstroemiacea* Muell. Arg. Markgraf added a second species to this genus, *N. Duckei*, a plant which has a striking similarity in habit, foliage and fruits to the type species of Neocouma; but, on the other hand, contrasts with it in its small axillary inflorescences, much smaller bracts and calyx-lobes with inconspicuous glands inside, smaller corolla and strongly sinistrorsely twisted corolla-lobes. Both of these species are well within

[3] Don (8) lists "Fagraea species, Willd." in his synonymy under Ambelania. However, Willdenow does not include any Abelania species under Fagraea in Species Plantarum.

the Ambelania generic concept as formed by the remainder of the group. Florally they differ from each other about as much as they differ from *Ambelania acida;* and they are both in harmony with this species more than *A. acida* is with *A. laxa* and its relatives, or *A. laxa* is with *A. quadrangularis*. Again, the two species described in Neocouma differ in no important respect from either these three or any other species in the genus, and they are so intimately involved in the group that separate treatment for them is inadvisable.

As noted by Ducke (9, p. 239), Ambelania[4] has a close generic kinship to Macoubea. It is of deep interest, furthermore, in that it displays an unmistakable affinity to the extra-Carisseae genera, such as Tabernaemontana sensu latiore, as observable in its styles and stigmas, and in the numerous intra-calyx glands in *A. ternstroemiacea*. Ties outside of Carisseae are suggested particularly by the shape of the anthers and the dimorphic pollen in the Laxae group. It is noteworthy that not only did Mueller place *A. ternstroemiacea* doubtfully in Tabernaemontana, but also that Miers (23, p. 67), in proposing Rhigospira for this species and also several other species of Ambelania and Macoubea, implied that Rhigospira is related to Anacampta.

The species of Ambelania recognized in this paper are amply distinct, and can be separated even on foliage characters without the least difficulty. (Sterile material of *A. Markgrafiana* might be confused with that of *A. ternstroemiacea*. See discussion under the former species.) It is not desirable to recognize formal sections in Ambelania, as the various species-groups in this small genus have either a single or only a few representatives and have no clearly definable segregation limits. Some of the morphological distinctions observed, however, are as outstandingly marked as in species of Tabernaemontana sensu latior, and were Ambelania as large a group as the latter there might be strong argument in favor of sectional treatment, although I could hardly reconcile myself to generic segregations here as Markgraf has done so ably with Tabernaemontana (Notizblatt des Botanischen Gartens und Museums zu Berlin-Dahlem **14**: 151–184. 1938). The sections I should then recognize for the available species are as follows: 1. ACIDAE. Inflorescence axillary; anthers subsessile, fertile to base or nearly so; petiole not deeply fossate at axil, the blade with obscure tertiaries. *A. acida*, *A. Duckei*, *A. cucumerina* (?). 2. NEOCOUMAE. Anthers subsessile, fertile to base or nearly so; petiole deeply fossate at axil, the blade with numerous faint oblique tertiaries showing, drying yellowish; fruit not angulate. Neocoumae might be divided into two subsections: 2a. NEOCOUMAE-

[4] The original spelling is Ambelania. Don in A General History of the Dichlamydeous Plants, p. 102, and Miers in Apocynaceae of South America, pp. 6, 11, 13, 18, 19, 68, 265, and plate 1, spelled it Ambellania. Except for rare instances (e.g., Teixera da Fonseca), the original spelling has been adopted by authors.

MARKGRAFIANAE. Inflorescence axillary; calyx-lobes small, without conspicuous glands inside; corolla-lobes strongly twisted sinistrorsely. *A. Markgrafiana*. 2b. NEOCOUMAE-TERNSTROEMIACEAE. Inflorescence terminal; calyx-lobes very large, with conspicuous several ranked glands inside; corolla-lobes little twisted. *A. ternstroemiacea*. 3. QUADRANGULARIAE. Inflorescence terminal; anther subsessile, fertile to base or nearly so; ovary truncate at apex, the style very short; branchlets very sharply quadrangular; leaf-blades with close reticulation on upper surface. *A. quadrangularis*. 4. LAXAE. Inflorescence terminal; anthers firmly sessile, the basal lobes spreading, the pollen dimorphic, that in the basal lobes not developed. *A. zschokkeiformis* (?), *A. cuneata*, *A. laxa*, *A. macrophylla*, *A. grandiflora*.

The species of Ambelania do not present a clear serial interrelationship, but diverse disjuncted affinities, so that a straight accurate taxonomic alignment is not possible here as it has been in Lacmellea (=Zschokkea). The two obvious major divisions in the genus are the group of species with axillary inflorescences and that with terminal inflorescences. The two members of Neocouma, here included in Ambelania, bridge this division and thereby help cast doubt on the naturalness of such a segregation. Neither are the two more natural divisions based on the pollen morphology of the anther-loculi complete proof against integration and heterogeneity. True that the species with pollen dimorphism form a closely knit natural group; but, as is obvious from the sectional-like categories sketched above, the species having uniform pollen within their entire loculi fall into at least four divisions.

A. acida and *A. Duckei* are very closely interrelated, the foliage differences affording the easiest characters for their separation. The axillary flowers and their general structure, the anthers, the shape of the fruits of *A. cucumerina*, as illustrated, place this species near *A. acida;* the globose stigmas described and figured for it, however, are unique in the genus, as all members of Ambelania examined by me have styles terminating in acute apiculi above the crested capitulum. Florally, *A. Markgrafiana* presents a contrast to *A. ternstroemiacea* of almost a sectional magnitude; but the striking vegetative and fruit similarity of the two species leaves no doubt as to their comparatively strong affinity. These two species not only bridge the axillary and the terminal flowered members of Ambelania but also demonstrate, by their actual affinity notwithstanding the apparent floral difference (the flowers are alike in essential morphology), the futility of sectional treatment in this group. The sharply quadrangular branchlets of *A. quadrangularis* are unique in the genus. Its ovary is abruptly truncate at the apex, and this feature, in addition to the very short style, the anthers pubescent at the point of attachment, and the terminal inflorescences, suggests that *A. quadrangularis* is the closest link in the generic tie between Ambelania and Macoubea. If the anthers of *A. zschokkeiformis*

are as described, it should be removed from the Laxae group, which it otherwise suggests, particularly in its terminal inflorescences, slender branchlets and small leaves with the venation raised on their upper surface. Essentially, it has a good measure of individuality in itself. With the possible exception of *A. zschokkeiformis*, the four remaining species in Laxae form a very closely knit unit; *A. cuneata* with *A. laxa*, and *A. macrophylla* with *A. grandiflora* are, respectively, the two closest sets within the group.

All the described species of Ambelania are represented in the Amazon Valley, and only *A. acida*, known from Teffé to Belém on the Amazon, extends beyond this area, reaching in eastern South America northerly into the three Guianas and southerly into the Maracassumé River region of the state of Maranhão in Brazil. (The nomen nudum *A. camporum* Glaziou is for a plant reported from Minas Geraes!) *A. cucumerina*, *A. ternstroemiacea*, *A. cuneata* and *A. macrophylla* are known from only the upper Rio Negro, while *A. Markgrafiana* has been collected also in São Paulo de Olivença, *A. quadrangularis* on the Rio Solimões and Rio Madeira, and *A. laxa*, which is not rare on the upper Rio Negro, is also reported from the shores of Rio Cotinga and Rio Branco. *A. Duckei* has been collected only in the vicinity of Manáos. *A. Zschokkeiformis* is represented by two collections from the southeastern section of the state of Amazonas in Brazil. *A. grandiflora* is rather frequent in Pará. The species of Ambelania are found growing in diverse habitats, from inundated lands (*A. laxa*[5] and *A. grandiflora* are reported growing in water) to dense forests, low bush or sand hills, and caatingas on terra firma, usually in the proximity of water courses.

The local names of Ambelania species, referable to the regions from which they are reported, are as follows:—BRAZIL, AMAZONAS: *Boia* (*A. zschokkeiformis;* Rio Madeira), *Gogo de Guariba* (*A. ternstroemiacea;* São, Gabriel), *Goiaba d'Anta* (*A. quadrangularis;* São Paulo de Olivença), *Jaquitaque* (*A. Markgrafiana;* São Paulo de Olivença), *Molongó* (*A. laxa;* upper Rio Negro), *Paroa-papo* & *Paroa-papo do Terra Firma* (*A. ternstroemiacea;* São Gabriel), *Pepino* (*A. Duckei;* Prainha), *Pepino do Mato* (*A. acida;* Borba. *A. cucumerina;* Manáos), *Sorva da Catinga* (*A. ternstroemiacea;* Cucuhy), *Sorva du Cutia* (*A. Markgrafiana;* Rio Negro), *Uarina Gogo* (*A. ternstroemiacea;* São Gabriel). BRAZIL, PARÁ: *Acucena d'Aqua* (*A. grandiflora;* Belém), *Angelica do Igapó* (*A. grandiflora;* Belém to Bragança), *Molongó* (*A. grandiflora;* Breves; Gurupá), *Pepino do Mato* (*A. acida;* Arama; Breves; Obidos; Rio Branco). BRAZIL, MARANHÃO: *Pepino do Mato* (*A. acida;* Maracassumé River region). BRAZIL, RIO DE JANEIRO:

[5] From consideration of botanical affinity and what is known about the general distribution habits in the genus, it seems likely that the entire Laxae group is found in Igapó. All the other species are reported from uninundated lands.

Pepino do Matto (*A. macrophylla;* Quinta da Boa Vista, São Christovão; Cult.; fide Glaziou). COLOMBIA, AMAZONAS: *Do-Ko-Gay* & *Juansoco* & *Palo de Leche* (*A. Markgrafiana; Schultes 3877*). FRENCH GUIANA: *Ambelani* & *Paraveris* & *Quienbiendent* (*A. acida*). DUTCH GUIANA: *Ambararie* & *Bat Batti* or *Bati Bati* & *Makoriro* or *Makurriro* & *Mampa* or *Mapa* (*A. acida*). BRITISH GUIANA: *Makurriro* (*A. acida*).

The latex of Ambelania, unlike that of Couma or Lacmellea (=Zschokkea), does not seem to show promise as a basic material in the manufacture of chewing gum. *A. cucumerina* is described as having copious viscid sweet milk. The latex of *A. acida* is mixed with balata in Surinam. The fruits of this species have an agreeable acid taste, after being macerated and soaked in water. The preserves of the decorticated fruits are described as refreshing, while those of the unskinned ones are said to be a little purgative; they are recommended in the cure of dysentery. Le Cointe and Teixeira da Fonseca, referring to the Brazilian plants of *A. acida*, report that the fruits are used in coughs, as well as eaten after being pounded. The fruits of *A. quadrangularis* are also reported edible. Spruce writes that the sarcocarp of *A. cucumerina* smells like a ripe apple when cut across and is sweet tasting. Ducke, however, notes that the fruits of *A. grandiflora* "ont un goût très désagréable," and those of *A. Duckei* are described as bitter. The wood of *A. laxa*, because of its excessive lightness, is used locally for various purposes instead of cork. Record states that the timber of the Neocoumae is suitable for the same purposes as soft kinds of Pine, but is neither utilized nor is it of any commercial possibilities.

KEY TO THE SPECIES OF AMBELANIA

(Characters in italics not found in species other than where designated. Species followed by an asterisk not seen.)

1. *Inflorescences axillary;* anthers subsessile, fertile to base or almost so; corolla-tube 8–16 mm. long, pubescent inside ..... 2.
   2. Leaf-blades *markedly scrobiculate-rugose*, opaque and furfurescent-like on under surface, the principal secondaries 17–20 pairs, the tertiaries obscure ..... 1. *A. acida.*
   2. Leaf-blades not scrobiculate-rugose on under surface ..... 3.
      3. Corolla-lobes twisted to the right or only slightly to the left; tertiaries of leaf-blades obscure ..... 4.
         4. Principal secondaries about 20 pairs with an average distance of about 10 mm apart near middle of blade; leaf-blades subnitidous on under side as well as above; latex bitter ..... 2. *A. Duckei.*
         4. Principal secondaries about 30 pairs with an average distance of about 4 mm. apart near middle of blade; leaf-blades opaque on underside; latex sweet; stigma-apiculi described as *subglobose* ..... 3. *A. cucumerina.**
      3. Corolla-lobes *twisted strongly to the left;* petioles 1.5–4 cm. long; blades drying yellowish, 17–30 cm. long, typically very short acuminate at apex, the faint oblique tertiaries evident ..... 4. *A. Markgrafiana.*
1. Inflorescences terminal; leaf-blades with tertiaries evident on upper surface ..... 5.
   5. Anthers subsessile, fertile to base or almost so (?*A. zschokkeiformis*) ..... 6.
      6. Calyx-lobes 5.5–6.5 mm. broad and 10–13 mm. long, with numerous *several ranked conspicuous glands* at base inside; corolla-lobes 25–28 mm. long; branchlets thick, *7–15 mm. diam.;* leaf-blades drying yellowish, typically rounded at apex ..... 5. *A. ternstroemiacea.*

6. Calyx-lobes 1–2 mm. broad and about as long, the glands in one rank and often obscure or lacking: corolla-lobes less than 10 mm. long.....7.
   7. Branchlets very *sharply quadrangular*, about 4–5 mm. diam.; ovary abruptly truncate at apex, the style very short (about 0.3 mm. long); *filaments pubescent* at attachment of anthers; leaf-blades densely minutely rugulose-reticulate on upper surface.....6. *A. quadrangularis.*
   7. Branchlets terete or flattened, about 2 mm. diam.; leaf-blades 6–11 mm. long, the secondaries strongly raised on upper surface and branched, the reticulation not close.....7. *A. zschokkeiformis.*
5. Anthers firmly sessile, the pollen undeveloped in their basal lobes, the lobes spreading (*?A. zschokkeiformis*).....8.
   8. Corolla-tube less than 15 mm. long, *glabrous inside;* entire flower less than 30 mm. long.....9.
      9. Reticulation open, indefinite, present on both surfaces of leaf-blade; blades lanceolate to elliptic; corolla-tube less than 5 mm. long; style up to ring about 0.63 mm. long.....7. *A. zschokkeiformis.*
      9. Reticulation close, prominent on upper surface of leaf-blade, not evident on under surface; style up to ring more than 0.8 mm. long.....10.
         10. Leaf-blades *obovate to oblanceolate, sharply cuneate at base and rounded at apex;* calyx about 1.5–2 mm. diam. below lobes, the lobes 1–1.2 mm. broad and 1–1.6 mm. long.....8. *A. cuneata.*
         10. Leaf-blades elliptic, typically short acuminate at apex; calyx about 2.5–3 mm. diam. below lobes, the lobes 1.5–2.5 mm. broad and about as long .....9. *A. laxa.*
   8. Corolla-tube more than 15 mm. long at maturity, pilose inside; leaf-blades lanceolate, 10–19 cm. long and 4–7 cm. broad, the reticulation close.....11.
      11. Flowers up to 35 mm. long. (Upper Rio Negro.).....10. *A. macrophylla.**
      11. Flowers more than 50 mm long. (Pará.).....11. *A. grandiflora.*

1. AMBELANIA ACIDA Aubl., Pl. Guian. **1**: 265. Pl. 104. 1775.

Willughbeia acida J. F. Gmel., Syst. **2**(1): 434. 1791.
Ambelania Sagoti Muell. Arg., Linnaea **30**: 389. 1860.
Ambelania tenuiflora Muell. Arg., in Mart. Fl. Bras. **6**(1): 16. Pl. 3. 1860.
Ambelania tenuiflora β. tenuiramea Muell. Arg., loc. cit.

Branchlets about 3 mm. diam.; petioles 0.7–1.7 cm. long; leaf-blades lanceolate to elliptic or oblong, 10–24 cm. long and 3.5–8.5 cm. broad, generally short acuminate at apex, dull to subnitidous on upper surface, dull and pale on under surface and minutely scrobiculate-rugose, the principal secondaries 17–24 pairs with an average distance of 7–14 mm. apart near middle, the tertiaries obscure; inflorescences axillary, 2–10 flowered, the peduncle to first pair of bracts very short or lacking, up to 10 mm. long, the pedicels up to 3 mm. long; calyx about 3 mm. diam. below lobes, the calyx-lobes 1–2 mm. broad and 1.5–2.8 mm. long; corolla-tube 10–15 mm. long, pubescent inside from below level of insertion of stamens to throat, the corolla-lobes 10–12 mm. long and 2–2.5 mm. broad, glabrous or slightly pubescent at base inside; anthers subsessile, 2.6–3 mm. long, polleniferous to base or nearly so, the acumen 0.3–0.5 mm. long; style up to ring about 2 mm. long, the apiculi 0.9–1.2 mm. long; fruits oblong-elliptic, sessile, up to 7 cm. long and 4 cm. diam., strongly angulate.

Type.—"in sylvis Caïennae & Guianae."

Illustrations.—Type (1); a flowering branch in leaf, an analysis of the flowers, and fruits. Ambelania (17); a copy of the preceding. *Ambelania acida* (7); a colored copy of the preceding. *Ambelania tenuiflora* (24, pl. 3); a flowering branch in leaf and an analysis of the flowers.

Distribution.—Wide-spread from British Guiana to the Rio Maracassumé region of the state of Maranhão in Brazil and up the Amazon valley up to or beyond Teffé, rather common throughout (reported frequent in the vicinity Belém, Bragança and Breves), growing in diverse habitats from low bush to dense forests on terra firma.

Specimens examined.—Brazil, Amazonas: *Ducke 212* (Rio Madeira, Borba; July, fl.); *Killip & Smith* 30007 (Manáos, Agricultural Experiment Station; cult. ?); *Kuhlman 21875* (Barro Alto, Paraná do Ramos; March, fl. & fr.; US); *Poeppig 2604* (type coll. of *A. tenuiflora β. tenuiramea;* F; photo, NY). Brazil, Maranhão; *Froes 1956* (Rio Maracassumé region, Estrada da Feitoria; Oct., fl.). Brazil, Pará: *Ducke 10899* (Rio Cuminá, east of lake Salgado; Aug., fl.; US). French Guiana: *Sagot 393* (type coll., photo). Dutch Guiana: *Forest Bureau 4713* (Tree No. 1653; Wahamiri; July, fr.), *4907* (Tree No. 686; Kaboerie; Nov., fl.), *5932* (Tree No. 686; Kaboerie; US). British Guiana: *J. S. De La Criz 3068* (Waramuri Mission, Moruka Rv., Pomeroon District; Oct., fl.), *4423* (Kaieteur Falls, Potaro Rv.; Oct.–Nov., fr.); *A. C. Persaud 150* (Hyde Park; Sept., fr.); *Sandwith 465 & 537* (Essequibo Rv., Moraballi Creek, near Bartica; Oct., fl.); *A. C. Smith 2581* (basin of Kuyuwini Rv., Essequibo tributary, about 150 miles from mouth; Nov., fl.).

The cotypes of *A. Sagoti* are cited as follows: "Guyana gallica ad Acarouany (*Sagot 393* in hb. DC; specimen incompletum); in Guyana absque loci designatione (*Poiteau* in hb. Berol. et Petrolpo.)." No material of Aublet's plant being available to him, Mueller described *A. Sagoti* as a new species distinct from *A. acida* on faith of the collector's observation, that it was by the "Indi 'Ambelani' vocant sed Ambelania Aublet alia species." Markgraf (22, p. 6) accepted the validity of *A. Sagoti*[6] and contrasted it with *A. acida* with the following key characters:

"*a.* Leaves remotely nerved (1 cm. of distance), rounded at base, not acuminate at the top. Corolla tube shorter (1 cm. long) ..... 1. *A. acida.*

b. Leaves densely nerved (½ cm. of distance), roundly narrowed at the base shortly acuminate at the top. Corolla tube longer (1½ cm.) ..... 2. *A. Sagotii.*"

In synonymy under *A. Sagoti*, furthermore, he lists "*A. acida* ex Pulle in Rec. Trav. Bot. Néerl. **6** (1909) 285." From Markgraf's statements one gathers that the only material of *A. acida* available to him was a single uncertainly determined specimen with unripe fruits collected in Surinam, a drawing of a leaf of Aublet's type made by Dr. Baker of the British Museum, and Dr. Baker's statement that the leaves of a specimen of *A. Sagoti* sent to him by Markgraf "do not exactly match those of Aublet's *acida* type because of their nervation and outline." I find the Ambelania material of the Guianas to be conspecific and the characters presented in Markgraf's key to be of a variable nature, intergrading in a way that makes it impossible to recognize clear delimitations. *Persaud 150*, collected in British Guiana, I find to be a perfect match for *Sagot 393*, whose photo I

[6] The original spelling of the species is *Sagoti*. Markgraf, however, spelled it *Sagotii*.

have examined; this specimen has its secondary veins more closely set than any other in the series of *A. acida* collections available to me, rather outstandingly so; but in view of the variable nature of this feature and its lack of coherence in itself or correspondence with any other diagnostic character, the scanty material representing this extreme, and the absence of geographical segregations of any forms in the specimens from the Guianas, I am unwilling to place any specific importance on Persaud's plant.

The cotypes of *A. tenuiflora* are cited as follows: "Habitat secus flumen Amazonum in silivis primaevis prov. Paräensis: *M.;* ad Borba: *Riedel 1368.;* in campis ad Villam Novam da Rainha [Parintins or Villa Bella da Imperatriz] s. Topinambarana prov. do Alto Amazonas: *M.*" The type of the variety *β. tenuiramea* is: "in silvis obscuris ad Ega prov. do Alto Amazonas: *Pöpp. 2604.*" Mueller notes that *A. tenuiflora* has a habitat similar to that of *A. acida* and *A. Sagoti* but differs in its corolla and calyx. I have examined representative material of *A. tenuiflora* and the type collection of *A. tenuiflora β. tenuiramea*, and find them to fit fairly well within the species concept of *A. acida* as formed by the Guianas plants. The corollas of the Brazilian material, however, tend to be somewhat longer than those of the Guianas' representatives, and it is possible that *A. tenuiflora* might eventually be given a varietal status when a long series of flowering collections from the two areas is accumulated. Bentham (5, p. 694) was the first botanist to express doubt as to the specific distinction of these two Mueller species from Aublet's plant, and Schumann (33, p. 124) stated that they are synonymous with *A. acida.*

Index Kewensis lists *Benteca odorata* Raf. (Sylva Tellur. 13. 1838) as synonymous with *Ambelania acida.* This Rafinesque name, on the contrary, refers to the Teckenkour tree figured on Rheede's Hortus Malabaricus, a plant which is obviously not apocynaceous.

2. AMBELANIA DUCKEI Markgraf, Notizb. Bot. Gart. Berlin **12**: 296. 1935.

Branchlets about 4 mm. diam.; petioles 1–1.5 cm. long; leaf-blades elliptic to lanceolate or oblanceolate, 9–20 cm. long and 4–8 cm. broad, generally short acuminate at apex, subnitidous on upper surface, pale on under surface but smooth, not scrobiculate, dotted with numerous minute scattered brownish points, the principal secondaries sometimes obscure, about 15–20 pairs with an average distance of about 10 mm. apart near middle, the tertiaries obscure; inflorescences axillary, glutinose, about 5 flowered, the peduncle to first pair of bracts very short or lacking, up to 5 mm. long, the pedicels about 3 mm. long; calyx about 2.5 mm. diam. below lobes, the calyx-lobes 1.5–2 mm. broad and 1.5–1.8 mm. long; corolla-tube about 11 mm. long and 3 mm. diam., pubescent inside from below level of insertion of stamens to throat, the corolla-lobes about 10 mm. long and 4

mm. broad, glabrous; anthers subsessile, polleniferous to base or nearly so, about 3 mm. long, the acumen 0.5 mm. long; style up to ring about 1.5 mm. long, the apiculi 1.1–1.3 mm. long; fruits described as oval, stalked at base, up to 15 cm. long and 9 cm. diam., longitudinally rimose; seeds subpyramidal; elliptic, plano-convex, convex-tricostate on back, 12 mm. long and 7 mm. broad and 4 mm. thick, the testa fuscous-cineraceous, lepidote, the endosperm corneous and oily, the embryo cylindrical, erect, 8 mm. long and 1 mm. broad, the cotyledon 1 mm. long.

Type.—"Brasilien: Staat Amazonas, Manáos, bei Estrada do Aleixo, im humosen, feuchten, aber nicht überschwemmbaren Urwald (blühend und fruchtend 2. November 1929—*Ducke 22422*)."

Distribution.—Known at present only from the vicinity of Manáos, growing on terra firma.

Specimens examined.—Brazil, Amazonas: *Ducke 451* (*H.J.B.R. 35153;* Manáos; March, fl.); *Froes 12004/5* (Prainha).

A. Duckei is unqestionably very closely related to *A. acida*. It is none the less easily separated from the latter species in the smooth shining non-scrobiculate appearance of the under sides of its usually more coriaceous leaves. The inflorescences of *A. Duckei* are, moreover, much more resinous than those of *A. acida*, and the corollas are thicker in proportion to their lengths. Markgraf states that *A. tenuiflora* [=*A. acida*] differs from *A. Duckei* in its fruit which is long-cylindric in shape, not bitter, and is divided completely into two cells by a true placenta, whereas in *A. Duckei* the placenta apparently tears apart after anthesis and remains only in the form of two partitions; in addition, the corolla-lobes of *A. tenuiflora* are strongly twisted to the right, whereas in *A. Duckei* faintly to the left. No fruit of *A. Duckei* has been available to me. Although I observe the degree of torsion in the flowers of Ambelania to be somewhat variable and not altogether to be relied upon for specific differentiation, the condition in *A. acida* and *A. Duckei* seems to be as stated by Markgraf.

Besides an expression of a close affinity, no opinion on the precise relationship of *A. Duckei* with the following species, *A. cucumerina*, is here ventured without authenticated material of the latter. It is noteworthy that *A. cucumerina* was reported by Spruce from Manáos, which is the same type locality as that of *A. Duckei*, and that both *A. cucumerina* and *A. Duckei* and probably also *A. acida* are there given the local name "Pepino."

3. AMBELANIA CUCUMERINA Spruce ex Miers, Apocyn. S. Am. 13. Pl. 1, fig. B. 1878.

Described as a tree 3–10 m. high; petioles about 7 mm. long; blades elliptic-oblong, 11–14 cm. long and 4.5–7 cm. broad, short acuminate at apex, green and dull on upper surface, paler and very dull on under surface

and dotted with numerous minute points, the principal secondaries about 30 pairs with an average distance of about 4 mm. apart near middle, the tertiaries obscure; inflorescences axillary, few flowered, the peduncle to first pair of bracts about 10 mm. long, the pedicels up to 3 mm. long; calyx about 3 mm. diam. below lobes, the calyx-lobes ovate, about 2 mm. broad and 1.5–2 mm. long; corolla-tube about 8 mm. long, pubescent inside, the corolla-lobes about 7 mm. long and 2.5 mm. broad; anthers subsessile, polleniferous to base or nearly so, about 2.5 mm. long; ovary conical at apex and merging into style, the style up to ring about 2 mm. long, the apiculi "globose," resting in an indusium, about 0.5 mm. long; fruit yellowish, elliptic, about 11.5 dm. long and 4.5 cm. diam., stipitate, obtuse, with five ribs alternating with calyx-lobes, rugose and sparingly muricate, two celled, about 60 seeded; seeds brown, oval, plano-convex, about 6 mm. long and 4 mm. broad, the testa thick, hard and scrabrid, marked by a small hilum; embryo nearly as long as the horny albumen, the cotyledons short, roundish, the radicle long, about three times as long as cotyledons, fusiform-terete.

Type.—"In Brasilia: pl. sicc. in hb. Hook., fructus in Mus. Kew., Panurè, Rio Negro (*Spruce 2413*)." The collector, Spruce (34), gives the following distribution: "Barra [Manáos]; dense shady forest."

Illustration.—Type (23, pl. 1); a flowering branchlet in leaf, an analysis of the flowers, and seeds, and a fruit.

Distribution.—Reported only from the original collection in Panuré (S. Jeranimo) on the Rio Vaupés, near the Brazilian-Colombian border, or from Manáos.

Miers presents a good illustration of the flowers of *A. cucumerina* and describes them in detail. The only collection of the species that Miers examined was *Spruce 2413*, and the implication therefore is that this collection contained flowering material. Besides mentioning his shipment of the leaves and the pickled fruit, the only account Spruce gives of this plant is a description in Hooker's Journal of Botany (34). It is incomprehensible that Spruce in this description, although dwelling elaborately on both the leaves and the fruits of his Pepino do Mato, fails to mention anything whatsoever about either its inflorescence or flowers. This seeming negligence is the more surprising since Spruce listed the plant as questionably in Ambelania, and suggested that it might represent a genus distinct from any described in Apocynaceae. On the other hand, if Spruce saw the tree while it was only in fruit and not in flower, the problem is raised as to where Miers obtained the flowering material for his description and what collection the material represents.

The globose stigmas described and depicted for *A. cucumerina* and the absence of a crested podium below the stigma-apiculi are characters which conflict with those of all the other members of the genus examined

by me.[7] Otherwise, the description is in harmony with Ambelania, and suggests that *A. cucumerina* has close relationship with *A. acida* and *A. Duckei*.

Miers credits the binomial *Ambelania cucumerina* to Spruce, but there is no published evidence that the name did not originate with Miers alone. Spruce's description of this plant in Hooker's Journal of Botany is under "Ambelania?"

4. **Ambelania Markgrafiana** Monachino, nom. nov.

Neocouma Duckei Markgraf, Notizb. Bot. Gart. Berlin **11**: 337. 1932.

Branchlets mostly 6–7 mm. diam.; petiole 1.5–4 cm. long, deeply fossate and with an elevated rim at axil; leaf-blades elliptic to lanceolate or oblanceolate, 17–30 cm. long and 7–15 cm. broad, generally very short acuminate at apex, subnitidous on upper surface, dull and pale on under surface and dotted with few, if any, scattered brownish points, the principal secondaries 16–20 pairs with an average distance of 13–20 mm. apart near middle, the tertiaries faint but numerous on both surfaces, connecting the secondaries obliquely, often branched; inflorescences axillary, glutinose, few flowered, the peduncle to first pair of bracts very short or lacking, up to 4 mm. long, the pedicels up to 7 mm. long; calyx about 3.5–4 mm. diam. below lobes, the calyx-lobes 2–2.8 mm. broad and 2–2.6 mm. long; corolla-tube about 15 mm. long and 3.5 mm. diam., pubescent inside from below level of insertion of stamens to throat, the corolla-lobes about 11 mm. long and 3.5–4 mm. broad, pubescent at base inside; anthers subsessile, polleniferous to base or nearly so, 3.6–3.8 mm. long, the acumen 0.4–0.6 mm. long; style up to ring about 2.5–3 mm. long, the apiculi 1.4–1.9 mm. long; only fragments of fruit seen, not angulate or grooved, the shell orange, minutely rugulose and obscurely blistered.

Type.—"Nordbrasilien: Staat Amazonas, Fontebôa, im nicht überschwemmbaren Wald (blühend 5. September 1939—*Ducke 22418*)."

Distribution.—Known from the upper Rio Negro, São Gabriel in the state of Amazonas in Brazil and probably in adjacent Venezuela, Vaupés and Caqueta in Colombia, south to São Paulo de Olivença and east to Rio Madeira (Borba) or beyond in Amazonas, scattered or gregarious, growing on terra firma.

Specimens examined.—Brazil, Amazonas: *Ducke 320* (Yale Ser. No. 34084; Borba, Rio Madeira; July, fl.), *30103* (Borba, Rio Madeira; July, fl.; prob. Herb. Jard. Bot. Rio Jan. number for *Ducke 320;* US); *Froes 280* & *282* (Rio Solimões, municip. São Paulo de Olivença, Rio Tonantins; Aug., fl.), *548* (Rio Negro, municip. São Gabriel, Macubeta), *825* (Rio Negro, municip. São Gabriel, Lago do Dodona, Rio Uenuichy); *J. C. Stout 700* (Rio Negro; Aug., fl.). Colombia: *Cuatrecasas 7129* (Vaupés, Pucaron, Oct., fl.; US); *Schultes 3877* (Caqueta, between El Encanto and La Chorrera; May–June, fr.; CGE).

[7] The crested capitulum present in Ambelania appears in longitudinal view more or less globose, however, and in the oversight of the apiculi it might have been interpreted as described for *A. cucumerina*.

The present species and the one following are the only two members of Ambelania examined by me that might be confused with each other in sterile condition, notwithstanding that they are easily and decisively differentiated in the presence of flowers. *A. Markgrafiana* is, however, not reported growing in caatinga; its branchlets are far more slender than those of *A. ternstroemiacea;* leaf-blades usually short acuminate at apex (only rarely rounded), the secondaries 16–20 pairs, crowded towards the leaf summit, and the upper surface is more rugulose than that of the latter species. Contrariwise, *A. ternstroemiacea* is reported only from caatinga; its branchlets are the thickest in the genus; leaf-blades rounded at apex (rarely obscurely acuminate), the secondaries 6–13 pairs, little crowded towards the leaf summit, and the upper surface is smoother and more shining than that of *A. Markgrafiana.*

This species is given a new name as the combination *Ambelania Duckei* is preoccupied.

5. **Ambelania ternstroemiacea** (Muell. Arg.) Monachino, comb. nov.

Tabernaemontana (?) ternstroemiacea Muell Arg., in Mart. Fl. Bras. **6**(1): 88. 1860.
Rhigospira ternstroemiacea Miers, Apocyn. S. Am. 71. 1878.
Neocouma ternstroemiacea Pierre, Bull. Soc. Linn. Par. (n. sér.) **1**: 33. 1898.

Branchlets mostly 7–15 mm. diam., subquadrangular to angled-terete; petioles 1–3 cm. long, deeply fossate and with a greatly elevated rim at axil; leaf-blades broadly elliptic, 15–30 cm. long and 8–17 cm. broad, rounded or rarely obscurely acuminate at apex, nitidous on upper surface, dull and pale on under surface and dotted with numerous scattered brownish points, the principal secondaries 6–13 pairs with an average distance of 15–30 mm. apart near middle, the tertiaries faint but numerous on both surfaces, connecting the secondaries obliquely, often branched; inflorescences terminal in convex cymes, rather crowdedly 8–20 flowered, the peduncle up to first pair of bracts 1–4.5 cm. long, the pedicels up to 7 mm. long, the bracts numerous, some simulating calyx-lobes and subtending them, early deciduous leaving elevated scars; calyx about 5–7 mm. diam. below lobes, the calyx-lobes 5.5–6.5 mm. broad and 10–13 mm. long, the glands inside at base very numerous, in about four series of different sizes, 0.19–0.48 mm. long; corolla-tube 11–12 mm. long and 5 mm. diam., pubescent inside below level of insertion of stamens, the corolla-lobes 25–28 mm. long and 9–13 mm. broad; anthers subsessile, polleniferous to base or nearly so, about 4 mm. long, the acumen 0.5 mm. long; style up to ring about 4.5 mm. long, the apiculi 0.5–0.6 mm. long; fruits elliptic, up to 8 cm. long and 4 cm. diam., not angulate or grooved, the shell orange or yellowish, black-tuberculate or merely obscurely blistered.

Type.—"prope S. Carlos ad Rio Negro: *R. Spruce 3035.*"

Distribution.—Known from only the upper Rio Negro, scattered or gregarious, sometimes rather common, growing on caatinga.

Specimens examined.—Brazil, Amazonas, upper Rio Negro, municip. São Gabriel: *Ducke 220* (Yale Ser. No. 31947; Cucuhy; Sept., fl.), *22417* (Camanáos; Nov., fl.; US); *Froes 360* & *368* (Cucuhy, Ca-te-Espera; Nov., fl.), *416* & *425* & *431* (Yuco, Rio Xié; Dec., fl.), *443* & *444* (Santa Ana on Rio Içana; Dec., fr.), *471*, *475*, *477* (Acara; Jan., fr.), *499* & *502* & *503* (Rio Vaupés, Corôcôro; Jan., fl. & fr.), *539*, *540*, *541* (Macubeta on Rio Marié), *882* (Rio Vaupés, Bela Vista; May, fl.). Venezuela, Amazonas: *Spruce 3035* (type coll., F; photo).

This species has vegetative similarity to the preceeding, *A. Markgrafiana*. For comments helpful in separating sterile material of the two see notes under the latter. The striking floral differences between *A. ternstroemiacea* and *A. Markgrafiana* are remarked upon in the discussion under the genus.

6. AMBELANIA QUADRANGULARIS Muell. Arg., in Mart. Fl. Bras. 6(1): 18. 1860.

Hancornia? macrophylla R. Spruce, mss. pl. Rio Negro n. 3026, ex Muell. Arg., loc. cit.
Rhigospira quadrangularis Miers, Apocyn. S. Am. 68. 1878.

Branchlets mostly 4–5 mm. diam., sharply quadrangular; petioles 1.5–2 cm. long; leaf-blades broadly elliptic, 8–14 cm. long and 6–8 cm. broad, short acuminate at apex, nitidous on upper surface and duller on lower surface, the principal secondaries about 13 pairs with an average distance of 15–20 mm. apart near middle, the tertiaries numerous and conspicuous on upper surface of mature leaves, intricately branched, the raised reticulation resulting in a minutely rugulose leaf surface; inflorescences terminal in broad cymes, many flowered (flowers about 60), the peduncle up to first pair of bracts about 5–6 cm. long, the pedicels up to 6 mm. long; calyx about 2 mm. diam. below lobes, the calyx-lobes 1.2–1.6 mm. broad and about as long; corolla-tube about 10 mm. long (flowers not mature), pubescent inside from level of insertion of stamens to throat, the corolla-lobes about 7 mm. long and 2.7 mm. broad; anthers subsessile, pubescent at point of attachment, polleniferous nearly to base, about 2.5 mm. long; the acumen 0.16 mm. long; ovary abruptly and markedly truncate at apex, the style up to ring 0.3 mm. long, the apiculi 0.5–0.8 mm. long.

Type.—"prope San Carlos ad Rio Negro: *R. Spruce 3026*."

Illustration.—*Rhigospira quadrangularis* (23, pl. 10); leaf on branchlet, an inflorescence, and an analysis of the flowers.

Distribution.—Known from San Carlos on the upper Rio Negro to Borba on the Rio Madeira and Vargem Grande on the Rio Solimões, growing on terra firma.

Specimens examined.—Brazil, Amazonas: *Ducke 471* (Borba, Rio Madeira; April, fl.), *22419* (São Paulo de Olivença; Aug., fl.; US), *35159* (prob. H. J. B. R. no. for *471;* Borba, Rio Madeira; April, fl.; US); *Froes 12153/63* (Vargem Grande, Rio Solimões). Venezuela, Amazonas: *Spruce 3026* (photo; type).

A. quadrangularis is striking in its ovary conspicuously truncate at the apex, and unique in its sharply quadrangular, almost alate, branchlets.

7. AMBELANIA ZSCHOKKEIFORMIS Markgraf, Notizbl. Bot. Gart. Berlin **12**: 295. 1935.

Branchlets mostly 2 mm. diam.; petioles slender, 1.2–1.5 cm. long; leaf-blades lanceolate to elliptic, 6–11 cm. long and 1.5–4 cm. broad, nitidous on upper surface and duller on lower surface, the principal secondaries about 15 pairs with an average distance of 5 mm. apart near middle strongly raised on upper surface and frequently branched, the tertiaries not numerous or conspicuous, the reticulation open and indefinite; inflorescences terminal, contracted, the peduncle to first pair of bracts about 1 cm. long, the pedicels up to 3 mm. long; calyx about 2 mm. diam. below lobes, the calyx-lobes about 1.6 mm. broad and 2 mm. long; corolla-tube 3.5–5 mm. long and 1.5–2 mm. diam., glabrous inside, the corolla-lobes about 6 mm. long and 3 mm. broad; anthers (incomplete) probably firmly sessile, 2 mm. long; ovary truncate-depressed at apex, the style up to ring about 0.63 mm. long, the apiculi about 0.2 mm. long; fruits (mature?) oblong-elliptic, 3.5 cm. long and 1 cm. diam., obtuse at apex and truncate at base, grooved, the shell fragile, light-brown.

Type.—"Brasilien: Staat Amazonas: Maués, im Sumpf des Rio Maués-mirim (blühend und fruchtend 4. Oktober 1929—*Ducke 22421*)."

Distribution.—Known at present from only the south-eastern sector of the state of Amazonas in Brazil, growing probably in inundated land.

Specimens examined.—Brazil, Amazonas: *Krukoff 5822* (Rio Madeira, on shore of lake near Rio Mamellos; Nov., fr.).

A. zschokkeiformis suggests relationship with *A. laxa* in its terminal inflorescences, and perhaps also somewhat in its slender branchlets and small leaves. Its trunk is described incrassate at base, as it is reported for *A. laxa* ("spongy incrassate"). Furthermore, unlike all the previous species accounted for in this article, it possibly shares with *A. laxa* a habitat in inundated land. (The type was collected in a swamp, and *Krukoff 5822* on the shore of a lake.) I have seen only fragmentary flowers of *A. zschokkeiformis*. Although in the original description the anthers of this species are reported to be subsessile and fertile almost to the base ("subsessilia, usque ad basin fertilia"), I suspect that *A. zschokkeiformis* belongs to the Laxae group and I anticipate that upon examination of good material its anthers will be found firmly sessile with the spreading basal lobes lacking developed pollen. Markgraf compares *A. zschokkeiformis* with *A. acida*.

8. AMBELANIA CUNEATA Muell. Arg., in Mart. Fl. Bras. **6**(1): 17. 1860.

Branchlets mostly 2–3 mm. diam.; petioles about 1 cm. long; leaf-blades obovate to oblanceolate, 6–9 cm. long and 2.5–4.5 cm. broad, sharply cuneate and strongly decurrent on petiole at base, rounded to round-obtuse at apex, nitidous on upper surface and duller on lower

surface, the principal secondaries about 20 pairs with an average distance of 3 mm. apart near middle, frequently branched or with minor secondaries in between, the tertiaries numerous and raised on upper surface of mature leaves resulting in an irregular minute reticulation; inflorescences terminal, more congested and fewer (4–10) flowered than in *A. laxa*, the peduncle to first pair of bracts 1.5–2 cm. long, the pedicels to about 4 mm. long; calyx about 1.5–2 mm. diam. below lobes, the calyx-lobes 1–1.2 mm. broad and 1–1.6 mm. long; corolla smaller than in *A. laxa*, glabrous inside; anthers firmly sessile, 2.5–3 mm. long, without developed pollen in their basal lobes, the lobes spreading; style up to ring about 1 mm. long (flower not mature), the apiculi 0.31 mm. long.

Type.—"ad Rio Negro prope ostium fluminis Casiquiari: *R. Spruce 3528.*"

Distribution.—Known from only the type locality, near S. Carlos in the territory of Amazonas in Venezuela.

Specimens examined.—Venezuela, Amazonas: *Spruce 3528* (type coll.; G. photo, NY).

As noted by Mueller, *A. cuneata* is closely allied to *A. laxa*. It is easily distinguished from the latter species, however, not only by the oblanceolate-cuneate shape of its leaves but also by its flowers which are much smaller in all their parts.

9. AMBELANIA LAXA (Benth.) Muell. Arg., in Mart. Fl. Bras. **6**(1): 17. 1860.

Tabernaemontana laxa Benth., in Hook. Journ. Bot. **3**: 244. 1841.
Hancornia laxa A. DC., Prodr. **8**: 326. 1844.

Branchlets 2–3 mm. diam.; petioles 0.5–1 cm. long; leaf-blades elliptic, 4–10 cm. long and 2–4 cm. broad, round-obtuse to obscurely acuminate at apex, subnitidous to dull on upper surface and duller on lower surface, the principal secondaries about 20 pairs with an average distance of 3 mm. apart near middle; frequently branched or with minor secondaries in between, the tertiaries not distinct but an irregular minute reticulation present on upper surface of mature leaves; inflorescences terminal, becoming lax and spreading, 3–18 flowered, the peduncle to first pair of bracts 3–6 cm. long, the pedicels up to 5 mm. long; calyx about 2.5–3 mm. diam. below lobes, the calyx-lobes 1.5–2.5 mm. broad and about as long; corolla-tube 8–9 mm., glabrous inside, the corolla-lobes about 12 mm. long and 4 mm. broad; anthers firmly sessile, 3–3.6 mm. long, without developed pollen in their basal lobes, the lobes spreading; style up to ring 1.5–2 mm. long, the apiculi 0.2–0.31 mm. long, fruits (not seen at maturity) elliptic, somewhat falcate, attenuate at apex and narrowed towards base, grooved, dark colored.

Type.—"On the Rio Negro. [*R. H.*] *Schomburgk 919.*"

Illustration.—Specimen cited in Flora Brasiliensis (24, pl. 4); a flowering branch in leaf, and an analysis of the flowers.

Distribution.—Known only from the upper Rio Negro and also reported by Richard Schomburgk from the shores of Rio Cotinga and Rio Branco, growing on inundated land.

Specimens examined.—Brazil, Amazonas, upper Rio Negro: *Ducke 44* (Rio Curicuriary; Oct., fl.), *163* (Yale Ser. No. 22623; Oct., fl.; A, F, Y), *22420* (Rio Curicuriary; Nov., fr.; US); *Froes 491 H* (municip. São Gabriel, Rio Cubaté; Jan., fl. & fr.); *Spruce 2445* (near Panuré, Rio Vaupés; 1852–Jan. 1853). Venezuela, Amazonas: *Spruce 2445* (on Rio Casiquiare, Vasiva and Pacimoni; 1853–4).[8]

Mueller, who transferred *Tabernaemontana laxa* to Ambelania, cites as examined by him both the type collection and *Spruce 2445*. I have examined the Spruce material. A tree from the upper Rio Negro, *Parahancornia negroensis* Monachino (see author's A Revision of Couma and Parahancornia. Lloydia **6**: 244. 1943), which sometimes grows in association with Schomburgk's plant, and like it, is called Molongó and has light weight wood, can be easily distinguished without technical analysis from *A. laxa* by the many-flowered lax inflorescence of the latter. In the wedge shaped configuration of its leaves *Parahancornia negroensis* more nearly simulates *A. cuneata* but the leaf venation of the two species is altogether different, as it is obvious from an examination of even the photo of *Spruce 3528*.

The close affinity of *A. laxa* to *A. cuneata* is clearly evident. It has a more remote relationship to *A. grandiflora* (and presumably to *A. macrophylla*, a species which I have not seen).

10. AMBELANIA MACROPHYLLA Muell. Arg., in Mart. Fl. Bras. **6**(1): 18. 1860.

Hancornia macrophylla Spruce, mss., ex Muell. Arg., loc. cit.
Rhigospira venulosa Miers, Apocyn. S. Am. 68. 1878.

Described as having terete branchlets; petioles 1–1.5 cm. long, "deeply fossate at base, with a hooded margin"; blades ovate-lanceolate, 12–15 cm. long and 4–6 cm. broad, acuminate at apex, the secondaries prominulent, "more than 50 pairs" and very closely set, simple or branched, anastomosing towards the margins, the fine reticulation evident; inflorescences terminal, about 15 flowered, the peduncle 1.5 cm. long, the pedicels about 6 mm. long, flowers similar to those of *A. laxa* but larger in all their parts, up to 3.5 cm. long, the corolla-tube about 18 mm. long, densely pilose inside for $\frac{2}{3}$ its length from throat, the corolla-lobes about 8 mm. long; stamens inserted at base of pilose ring.

[8] *Spruce 2445* apparently consists of two separate collections given the same numbers. That Spruce observed *Ambelania laxa* in at least two different localities is evident from his description of the vegetation of the shores of the Rio Vaupés (35): "Another great ornament to the banks is a small Apocyneous tree with odoriferous white flowers, which I was assured is the true Mulongo of which corks, etc., are made. It proved to be the same as a species I had gathered near São Gabriel (*Hancornia laxa* A.D.C.)."

Type.—"ad Panure fluv. Uaupes prov. do Alto Amazonas: *R. Spruce 2483* in hb. Mart., ubi rara dicitur."

Distribution.—Reported from the original collection in Panuré (S. Jeranimo) on the Rio Vaupés, near the Brazilian-Colombian border. Glaziou (11) claims that the species is cultivated in the Quinta da Boa Vista, São Christavão, Rio de Janeiro.

The generic name Rhigospira is untenable (see discussion under genus). Miers proposed the specific name *venulosa* in place of *macrophylla* in order to avoid confusion in the two different species named *Hancornia macrophylla* by Spruce. Spruce's name originally appeared as a chironym and was later printed in synonymy under both *Ambelania quadrangularis* and *A. macrophylla* by Mueller. As "*Hancornia* (?) *macrophylla*" was never validly published and as there is no doubt concerning the application of *Ambelania macrophylla*, there is no justification for any change in the specific name of this plant.

The greater portion of the description of *A. macrophylla* appearing in this paper was extracted from Miers' diagnosis. Mueller states that the calyx, corolla, ovary and style of this species are like those of *A. laxa* but a little larger in all parts.

11. AMBELANIA GRANDIFLORA Huber, Bol. Mus. Para. **3**: 444. 1902.

Branchlets mostly 4–5 mm. diam.; petioles 1–1.5 cm. long; leaf-blades lanceolate to elliptic, 10–19 cm. long and 4–7 cm. broad, usually short acuminate at apex, subnitidous on upper surface and paler on under surface, the principal secondaries 18–22 pairs with an average distance of 6–8 mm. apart near middle, the tertiaries distinct on upper surface, connecting secondaries obliquely and interjoined by numerous veinlets forming a prominulose irregular reticulation; inflorescences terminal, in convex showy cymes, 9–15 flowered, the peduncle up to first pair of bracts 1–2.5 cm. long, the pedicels up to 12 mm. long; calyx 5–7 mm. diam. below lobes, the calyx-lobes 4.5–5 mm. broad and 4–5 mm. long; corolla-tube 25–30 mm. long and about 6 mm. diam., pubescent inside from about middle up to throat, the corolla-lobes 30–45 mm. long and 11–15 mm. broad; anthers firmly sessile, 8.5–9 mm. long, without developed pollen in their basal lobes, the lobes spreading; style up to ring 7–8 mm. long, the apiculi 0.3–0.5 mm. long; fruits elliptic, about 6 cm. long and 3.5 cm. broad; seeds irregularly elliptic or oblong, 11–12 mm. long, 4–6 mm. broad, and about 2 mm. thick, strongly roughened with numerous protuberances, minutely pitted; embryo about 7 mm. long and 0.7 mm. broad, the cotyledons 1.6 mm. long, the radicle terete.

Type.—"Aramá. beira do rio, frequente ([*Huber*] *1836*)."

Distribution.—Known from the state of Pará in Brazil, frequent particularly in the eastern sector, growing on inundated land.

Specimens examined.—Brazil, Pará; *Francis Drouet 1949* (municip. Belém, Lagoa Agua Preta; June, fl.; F, G, M); *Ducke 1254* (Belém; May, fl.; US), *11357* (Rio Ariramba; Dec., fl.; US), *15820* (Belém; Feb., fl. & fr.; US); *Huber 769* (Rio Capim; leaf & photo; F), *1836* (type coll.; leaf & photo, F; photo, NY); *Ynes Mexia 5982a* (district Acará, Thomé Assu, up Rio Acará ½ km; July, fl.; M).

As stated by Huber, *A. grandiflora* is similar to *A. macrophylla* but has larger flowers. Since *A. macrophylla* was described from a single plant with its flowers not fully mature there is some doubt as to the measurement given for this species. The distinction of *A. grandiflora* in Pará, however, makes it very unlikely that it is the same species as *A. macrophylla* which was reported from the Vaupés (upper Rio Negro).

DOUBTFUL OR EXCLUDED PLANTS

AMBELANIA CAMPORUM Glaziou, Bull. Soc. Bot. France **57** (mém. 3e): 449. 1910.—nomen nudum. Type.—"Entre Barbacena et Queluz, dans le campo, Minas, *No. 15222*. Frutescent, fl. jaunatres. Octobre-Novembre. C. In herb. Pairs., Berol., Kew., Genev., etc." Glaziou lists *A. camporum* as questionably a new species of Ambelania. No description of this plant has been published, nor have I seen its type collection. From considerations of the distribution of the genus it should appear probable that it represents a new species, provided the plant is truly an Ambelania. From the same geographical considerations, I might add, the report of an Ambelania so far removed from the rest of the group should be regarded with some suspicion.

Schomburgk 779. Bentham (4, p. 250) writes of this Robert Herman Schomburgk collection from the Canaku Mts. in British Guiana: "A shrubby Apocyneous plant, perhaps an Ambelania, but of which, without the fruit, I am at present unable to determine the genus." The collection has not been seen by me, nor has research discovered any further data concerning it.

Ducke 14972, at first given an unpublished herbarium name as a new species of Ambelania by Huber, was subsequently cited as a cotype for Ducke's *Zschokkea aculeata* [*Lacmellea aculeata* (Ducke) Monachino].

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The Synchytria of India

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The genus *Synchytrium* was represented in India by three species: *Synchytrium collapsum* Sydow, *Synchytrium Gei* Padwick and *Synchytrium Rytzii* Sydow. Three other species also occur, *Synchytrium aecidioides* (Peck) Lagerheim, *Synchytrium Dolichi* (Cooke) Gäumann and *Synchytrium Puerariae* (P. Henn.) Miyabe but in Butler and Bisby (1931) they are shown under *Woroninella*, a genus now proved to be a synonym of *Synchytrium* by Gäumann (1927). As there is no further justification to retain that genus, six species of *Synchytrium* should be considered as occurring in India. Specimens of *Synchytrium aecidioides* and *Synchytrium Puerariae* are not available in the *Herb. Crypt. Ind. Orient.* or other Indian Herbaria and Sydow (1914) who recorded them for India does not state where and by whom they were collected.

The hosts of *Synchytrium collapsum* and *Synchytrium Gei* are *Clerodendron infortunatum* and *Geum elatum* respectively. *Synchytrium Rytzii* was originally described on *Anisomeles ovata* but the *Synchytria* on *Peristrophe*, *Justicia* and *Leucas* have also been named *Synchytrium Rytzii* by Sydow and Butler (1912), for they were not certain whether the differences in sporangial measurements which they found, were or were not within the range of variability of those of *Synchytrium Rytzii*. The other collections are either placed in *Synchytrium Rytzii* or left unnamed. An attempt has now been made to identify all of them as accurately as possible.

The genus *Synchytrium* does not have many structures of diagnostic value other than the sporangia and hypnospores on whose colour, shape, size and epispore markings much reliance is placed. It was separated from the other genera of Chytridiales on the basis of the mode of development of those structures and the habit of its species attacking land plants on which they formed minute galls. There is no mycelium and the thallus becomes recognizable when the plasma bodies, which are the zoospores, emerge from the germinating sporangia and enter the epidermal cells of the particular host as naked, hyaline, yellow or red, spherical initials. They gradually get enveloped by a membrane, complete their maximum growth and more or less fill the host cells.

The parasite causes an irritation to the host cells leading to the formation of warts, calluses or disc-like crusts. The fully grown plasma body within the cells may, after the formation of the cell-wall, either develop into a resting spore or break up into several sporangia, by cleavage and formation of fissures. The sporangia mature immediately and are released by the disintegration of the host tissue. They then germinate in the presence of moisture forming numerous zoospores. The resting spores, also known as

hypnospores, occur singly in a host cell. They are usually spherical, ellipsoidal, sometimes polygonally flattened, with thick brown epispore and a tender hyaline endospore. The contents of the host cell may sometimes be deposited on them in the form of a thick, horny, brown crust. The hypnospores germinate after a long period of rest, forming numerous swarmspores indistinguishable from those produced by sporangia.

In establishing species of *Synchytrium*, several assumptions have been made. According to Farlow (1885) the same *Synchytrium* can attack plants belonging to different families and orders. On the other hand species have also been established assuming host specificity and over seventy five species are enumerated in Saccardo's *Sylloge Fungorum*.

Pathogenic fungi, especially obligate parasites, are assumed to attack only one host or to be limited in their pathogenicity to closely related species. Species among them are often established on the basis of physiological selection of host plants rather than on distinct morphological characters.

Species of *Synchytrium* are obligate parasites with restricted host range, although *Synchytrium aureum* Schroeter is stated to attack 130 species of plants belonging to several different orders and families. Rytz (1907) showed that the fungus attacking these plants does not represent one species. He established six species to take care of some of the forms which until then had been included under *Synchytrium aureum*. However, Rytz's conclusions were based on observations made on them in their natural habitats rather than on carefully planned laboratory experiments. More precise tests were carried out by Lüdi (1901 and 1902) who investigated *Synchytrium Taraxaci* de Bary and showed that this fungus is restricted to the genus *Taraxacum* and, actually, to a few species within that genus. McMurphy (1913) found a *Synchytrium* on *Amsinckia intermedia* growing in close proximity of *Erodium cicutarium* which was attacked by *Synchytrium papillatum* Farlow. In carefully conducted experiments he noted that the zoospores of the latter were unable to attack *Amsinckia* and *vice versa*. Indeed *Synchytrium papillatum* did not infect orher closely related species of *Erodium cicutarium*, viz., *Erodium botrys* and *Erodium moschatum*, the zoospores apparently not attacking these plants which can be differentiated only by specialists.

There are no other accounts reporting experiments on the pathogenicity of *Synchytrium* spp.; or their having been transferred from one species to another under laboratory conditions. Since the discovery of *Synchytrium endobioticum* (Schilb.) Percival attempts have been made to determine the host range of this very destructive parasite of potatoes in several European countries. While it is known to attack species of nine or ten genera of the family Solanaceae it has not been reported to attack members of other orders or families.

In this investigation, the specificity of a species to a host and its close

relatives within the family or order, is assumed. If however there are two forms attacking species of the same family but showing clear morphological differences, then independent specific rank has been given to them.

Prior to the discovery of potato wart in Central Europe, the species of this genus were not considered to be of much importance economically. That no longer holds true. Potato wart does not occur in India but another plant of economic importance is attacked by a species belonging to this genus. Fruit and leaves of *Trichosanthes dioica*, a cucurbit of much importance as a vegetable in India, are attacked by *Synchytrium Trichosanthidis*. The diseased fruits become prematurely yellow and lose flavor which affects their quality and market value. Other Indian species attack, however, only wild plants growing in marshy places.

The specimens of species reported in this paper are deposited in the *Herb. Crypt. Ind. Orient.* of the Imperial Agricultural Research Institute, New Delhi.

SYNCHYTRIUM De Bary and Woronin

1. SYNCHYTRIUM ANEMONES (DC.) Woronin in *Bot. Ztg.* xxvi, p. 100, 1868; Saccardo, *Syll. Fung.* vii, p. 288, 1888; v. Minden, *Kryptogamenfl. Brandenburg*, v, p. 304, 1911; Tobler-Wolff, *Arch. Protistenk.* xxviii, p. 193, 1913.

Leaves covered with minute galls, rusty in appearance. Galls dark brown with violet ring, 0.2 to 0.3 mm. in diameter. Resting spores one in each host cell, spherical, smooth, very dark brown, measuring 73–120μ in diameter with thick, reddish-brown wall.

On leaves of *Anemone* sp. Kashmir, July, 1937 (C. C. Burt).

2. SYNCHYTRIUM ATYLOSIAE (Petch) Gäumann in *Ann. Mycol.* xxv, p. 174, 1927.

Syn. *Aecidium Atylosiae* Petch in *Ann. Roy. Bot. Gdns. Peradeniya*, iv, p. 302, 1909.

Leaves and stems covered with orange red, globose, cupulate galls deeply sunken in host tissue and covered by epidermal hairs; hypophyllous, measuring 0.2 mm. in diameter. Sporangial masses smooth, globose, hyaline to orange, granular, with thin epispore and orange-yellow contents, measuring 170–220μ in diameter, each sporangium being 17–21μ in diameter.

On leaves of *Atylosia* sp. Malleswaram (Mysore), 29-10-43 (Thirumalachar). The sporangia have been germinated by Thirumalachar who observed 32–48 uniciliate zoospores, confirming that the fungus is not a rust but a *Synchytrium*.

3. SYNCHYTRIUM COLLAPSUM Sydow in Sydow and Butler, *Ann. Mycol.* v, p. 510, 1907; Saccardo, *Syll. Fung.* xxi, p. 839, 1912; Tobler-Wolff, *Arch. Protistenk.* xxviii, p. 204, 1913; Butler and Bisby, *Sci. Monogr. Coun. Agric. Res. India*, 1, p. 1, 1931.

Host surface covered with numerous, tiny reddish-brown, crust-like cupulate, single or compound galls measuring 0.2 to 0.3 mm. in diameter. Resting spores one in each cell, spherical, globose to ellipsoidal, smooth, orange brown, 3–6μ thick epispore, 3–5μ thick endospore, 72 to 129μ in diameter.

On leaves and stems of *Clerodendron infortunatum* Gaertn. Assam, 18-4-1907 (Butler No. 654), type; Anandsar Degi, Comilla (Bengal), 10-8-1913 (Butler); Pusa (Bihar), 6-12-1914.

4. **Synchytrium Cyperi** Mundkur and Mhatre, sp. nov.

Hospitae plantae facies cooperta gallis multis, magnis, firmis, canescentibus, magnitud. 0.2–3.3 mm. diam. Hypnosporae magnae sphaericae, leves, fusco-brunneae, magnitud. 210–240μ diam., episporio oleaceo, crasso, singulae in singulis soris.

Typus lectus in culmis *Cyperi flavidi* Retz. in Tejpur (Birjanj in Nepalia), 28-11-1907 (I. H. Burkill).

Host surface covered with numerous, large, hard, stone-grey galls measuring 0.2 to 0.3 mm. in diameter. Resting spores one in each cell, large, spherical, smooth, dark-brown, measuring 210–240μ in diameter with olive-coloured, thick epispore.

On the stems of *Cyperus flavidus* Retz. Tejpur (Birganj in Nepal), 28-11-1907 (I. H. Burkill), type.

5. SYNCHYTRIUM DOLICHI (Cooke) Gäumann in *Ann. Mycol.* XXV, p. 172, 1927.

Syn. *Aecidium Dolichi* Cooke in *Grevillea*, x, p. 127, 1882.
Woroninella Dolichi Sydow in *Ann. Mycol.* xii, p. 484, 1914: Saccardo, *Syll. Fung.* xxiv, p. 17, 1928: Butler and Bisby, *Sci. Monogr. Coun. Agric. Res. India*, 1, p. 2, 1931.

Leaves and stems covered with circular, irregular, rust-coloured crateriform galls, measuring 0.3 to 0.7 mm. in diameter. Resting spores none. Summer sporangia forming large sori each 297–700μ in diameter; each sporangium 17–30μ in diameter, irregular in shape, light yellow, smooth.

On *Glycine javanica* L. Bangalore (Mysore), November, 1943 (Thirumalachar); on leaves of *Dunbaria ferruginea* W. and A. Runnymeade (Madras), 17-12-1912 (McRae).

6. SYNCHYTRIUM GEI Padwick in Ocal. Papers Imperial Mycological Institute, 1945, in press.

Resting sporangia thickly crowded on the leaf and petiole but causing only slight gall formation, sepia in mass; single in a host cell, subglobose or globose 51–94μ in diameter, mostly 64μ; epispore many coloured, contents sepia.

On living leaves and petioles of *Geum alatum* Wall., Aru (Kashmir), 23-6-1941 (G. Watts Padwick).

7. **Synchytrium Lagenariae** Mhatre and Mundkur, sp. nov.

Gallae minutae, squalidae, crustae similes, pallide brunneae, aliquotiens cupulatae, magnitud. 0.2–0.4 mm. diam. hospitae plantae texturam cooperientes. Hypnosporae citrinae tenuibus parietibus praeditae, magnitud. 39–86 diam., singulae in singulis soris, globosae.

Typus lectus in foliis *Lagenariae vulgaris* Ser. in loco Pusa (Bihar), 31-8-1916 (L. S. S. Mony).

Host tissue covered with minute, dirty white, crust-like, light brown, sometimes cupulate galls measuring 0.2 to 0.4 mm. in diameter. Resting spore one in each cell, globose, smooth, lemon yellow, thin-walled, measuring 39–86μ in diameter.

On the leaves of *Lagenaria vulgaris* Ser. Pusa (Bihar), 31-8-1916 (L. S. S. Mony), type.

8. **Synchytrium Lepidagathidis** Mundkur and Mhatre, sp. nov.

Gallae in foliis atque culmis, minutae, pallide brunneae, rotundae, cupulatae, magnitud. 0.1–0.4 mm. diam. Hypnosporae singulae in singulis soris, sphaericae, leves, fusco-brunneae magnitud. 57–129μ diam. episporio crasso, oleaceo-brunneo.

In foliis atque culmis *Lepidagathidis cristatae* Wall. Yeshwantpur (Mysore), 28-10-43 (Thirumalachar), typus; Plantae hospitae aliae: *Lepidagathis* sp. Dehra Dun (U.P.) 26-9-1914 (P. C. Kar); *Dicliptera* sp. Dehra Dun (U.P.), 26-9-1914 (P. C. Kar); *Peristrophe* sp. Pusa (Bihar), 24-10-1910 (Butler No. 1381); Baijnath (Punjab), 6-9-1910 (J. H. Mitter); *Justicia procumbens* L. Pusa (Bihar), 16-9-1913 (Butler); *Justicia* sp. Aitampudi (Madras), 1-12-1910 (L. S. S. Mony); Nagpur (C.P.), 10-10-1908 (P. A. Pandit No. 1382); Samalkota (Madras), 21-11-1910 (F. J. Shaw).

Galls on leaves and stems, minute, light brown, round, cupulate, measuring 0.1 to 0.4 mm. in diameter. Resting spores one in each host cell, spherical, smooth, dark brown, measuring 57–129μ in diameter, with thick olive brown epispore.

On leaves and stems of *Lepidagathis cristata* Wall. Yeshwantpur (Mysore), 28-10-1943 (Thirumalachar), type; *Lepidagathis* sp. Dehra Dun (U.P.), 26-9-1914 (P. C. Kar); *Dicliptera* sp. Dehra Dun (U.P.), 26-9-1914 (P. C. Kar); *Peristrophe* sp. Pusa (Bihar), 24-10-1910 (Butler No. 1381); Baijnath (Punjab), 6-9-1910 (J. H. Mitter); *Justicia procumbens* L. Pusa (Bihar), 16-9-1913 (Butler); *Justicia* sp. Aitampudi (Madras), 1-12-1910 (L. S. S. Mony); Nagpur (C.P.), 10-10-1908 (P. A. Pandit No. 1382); Samalkota (Madras), 21-11-1910 (F. J. Shaw).

9. **Synchytrium Physalidis** Mhatre and Mundkur, sp. nov.

Gallae minutae, singulae vel aggregatae, totam hospitae plantae faciem cooperientes, pallide brunneae, cupulatae, 0.25 mm. diameter. Hypno-

sporae sphaericae, leves, palliae vel fusce brunneae, magnitud. 43–82μ diam., parietibus crassis, fusco-brunneis; singulae in singulis soris vel 2–4 acervatim coactae.

In foliis atque culmis Physalidis sp. Dhalghat, Chittagong (Bengal), 12-9-1911 (R. Sen), typus.

Galls minute, solitary or in groups, covering the entire host surface, light brown, cupulate, 2.25 mm. in diameter. Resting spores one in each cell, or 2 to 4 in groups, spherical, smooth, pale to dark brown, measuring 43–82μ in diameter, with thick, dark brown spore wall.

On leaves and stems of *Physalis* sp. Dhalghat, Chittagong (Bengal), 12-9-1911 (R. Sen), type.

10. **Synchytrium Piperi** Mundkur and Mhatre, sp. nov.

Gallae ut minutae maculae in Piperi texturis subimpressae, epiphyllae. Hypnosporae sphaericae, leves, tenuibus parietibus ornatae, pallide brunneae, magnitud. 30–38μ diam., singulae in singulis soris.

In foliis *Piperi Betle* L. Sassona, Alibag (Bombay), 24-5-1921 (B. R. Tonapy), typus.

Galls as minute, white dots on leaves, epiphyllous, somewhat deep-seated; resting spores one in each cell, spherical, smooth, thin-walled, light brown, measuring 30–38μ in diameter.

On leaves of *Piper Betle* L. Sassona, Alibag (Bombay), 24-5-1921 (B. R. Tonapy), type.

11. SYNCHYTRIUM RYTZII Sydow in Sydow and Butler, *Ann. Mycol.* v, p. 510, 1907; Saccardo, *Syll. Fung.* xxi, p. 840, 1912; Tobler-Wolff, *Arch. Protistenk.* xxviii, p. 214, 1913; Butler and Bisby, *Sci. Monogr. Coun. Agric. Res. India*, 1, p. 1, 1931.

Galls singly or in groups on host surface, spherical, light brown measuring 0.1 to 0.3 mm. in diameter. Resting spores one in each sorus, round, smooth, dark brown, 50–148μ in diameter, with thick light brown walls.

On leaves and stems of *Anisomeles ovata* Br. Dehra Dur (U.P.), 2-11-1903 (Butler No. 653); type Pusa (Bihar), 15-4-1908 (Chibber); *Leucas aspera* Spreng. Pollachi (Madras), 25-8-1912 (McRae); *Leucas* sp. Benares (U.P.), 27-9-1911 (L. S. S. Mony No. 1379).

12. **Synchytrium Trichosanthidis** Mhatre and Mundkur, sp. nov.

Gallae crustae similes, minutae, aliquotiens cupulatae, albae, magnitud. 0.1–0.3 mm. diam., hospitae plantae textus cooperientes. Hypnosporae leves, sphaericae, oleaceo-brunneae vel fusco-brunneae, magnitud. 64–95μ diam., parietibus crassis, roseo-brunneis, singulae vel binae in singulis soris.

Typus lectus in foliis, culmis atque fructibus *Trichosanthidis dioicae* Roxb., in loco Pusa (Bihar), 19-8-1931 ab Azmatullah Khan; lectus quoque

in foliis *Citrulli vulgaris* Schrad. in loco Pusa, 27-8-1931 ab Azmatullah Khan; lectus etiam in foliis atque culmis *Cephalandrae* sp. in loco Pusa, 31-8-1931, ab eodem Azmatullah Khan.

Host surface covered with crust-like, minute, sometimes cupulate, white galls measuring 0,1 to 0.3 mm. in diameter. Resting spores one to two in each cell, smooth, spherical, olive brown to dark brown, measuring 64–95μ in diameter, with reddish-brown thick wall.

On leaves, stems and fruits of *Trichosanthes dioica* Roxb. Pusa (Bihar), 19-8-1931 (Azmatullah Khan) type; on leaves of *Citrullus vulgaris* Schrad. Pusa (Bihar), 27-8-1931 (Azmatullah Khan); on leaves and stems of *Cephalandra* sp. Pusa (Bihar), 31-8-1931 (Azmatullah Khan).

13. SYNCHYTRIUM VULGATUM Rytz. in *Zbl. Bakt.* 2. Abt. xviii, p. 805, 1907; Saccardo, *Syll. Fung.* xxi, p. 842, 1912; Tobler-Wolff, *Arch. Protistenk.* xxviii, p. 185, 1913.

Host surface covered with numerous, small glistening white, round, cupulate galls, measuring 0.1 to 0.3 mm. in diameter. Resting spores spherical, smooth dark brown, one spore per cell, 86–129μ in diameter with thick reddish-brown wall.

On leaves of *Launea asplenifolia* Hooker f. Pusa (Bihar), Oct. 1932 (Azmatullah Khan); on leaves and stems of *Conyza* sp. Saranath (U.P.), 24-10-1917 (N. N. Mukerjee).

SPECIES REPORTED FROM INDIA BUT NOT SEEN

14. SYNCHYTRIUM AECIDIOIDES (Peck) Lagerheim.

Syn. *Uredo aecidioides* Peck in *24. Report, N. Y. State Mus.* 1870, p. 88, 1872.
Synchytrium decipiens Farlow in *Bot. Gaz.* x, p. 240, 1895.

On leaves of *Amphicarpaea Edgeworthii* Benth. Simla (Punjab).

15. SYNCHYTRIUM PUERARIAE (P. Henn.) Miyabe in *Bot. Mag. Tokyo*, xix, p. 199, 1905; Saccardo, *Syll. Fung.* xxi, p. 839, 1912; Tobler-Wolff, *Arch. Protistenk.* xxviii, p. 211, 1913.

Syn. *Aecidium Puerariae* P. Hennings in *Engler's Bot. Jb.* xv, p. 6, 1892.
Woroninella Puerariae Sydow in *Ann. Mycol.* xii, p. 486, 1914: Butler and Bisby, *Sci. Monogr. Conn. Agric. Res. India*, 1, p. 2, 1931.

On leaves and stems of *Pueraria hirsuta* Kurz and *Pueraria* sp. in India.

SUMMARY

An attempt has been made to identify the different collections of *Synchytrium* collected in India at various times, on the basis of the morphology of the galls, resting spores and sporangia where present. Of the fifteen species that are now reported to occur in India, three are new records and six are proposed as new species.

ACKNOWLEDGMENTS

We wish to place on record our deep debt of gratitude to Miss Sushila Rani Tombat who had done considerable preliminary work on the genus. We also desire to thank Rev. Father Santapau S.J., Head of the Department of Biology, St. Xavier's College, Bombay, for translating the diagnoses into Latin and to Dr. M. J. Thirumalachar for specimens.

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New Genera of Fungi-II*

ROLF SINGER

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The following genera are based on known species that had originally been forced into one of the genera of the schemes of Fries and Saccardo. These species have been studied by the writer in authentic dried material or fresh material collected by himself and compared with the respective types.

1. **Scytinopogon** Sing. gen. nov.

Clavariinearum genus; carpophoris ramosis, subcarnoso-tenacibus, glabris levibusque, trunco plerumque obsoleto, pigmento nullo vel haud copioso; sporis ellipsoideis vel oblongo-subangulatis, asymmetricis, luteis, inamyloideis, verrucoso-echinatis; basidiis pro ratione exiguis, breviusculis; cystidiis et gloeocystidiis nullis; hyphis inamyloideis, fibuligeris, membrana subtenui vel moderate crassa instructis.

The type species is **Scytinopogon pallescens** (Bres.) comb. nov. (*Pterula pallescens* Bres.; *Lachnocladium pallescens* Bres.)

This genus belongs in that group of basidiomycetous genera which appears to be intermediate between the Phylacteriineae and the Clavariineae, probably being close to the common phylogenetic starting point of both these suborders of the Aphyllophorales. It is not congeneric with *Pterula* because of the different consistency, the echinate, yellow spores, and some minor characters. It is also not congeneric with *Lachnocladium* if the writer's suggestion (Mycologia **36**: 553. 1944) is approved, i.e., to consider *Lachnocladium brasiliense*, one of the original species of the genus, as the *typus generis*. It seems that the remaining species of *Lachnocladium* (with the exception of the group *L. semivestitum* which approaches what Patouillard used to call *Thelephora*—not *Thelephora* in the accepted sense) will have to be transferred, eventually, either to *Pterula* or *Scytinopogon*.

The spores of the type species were found to be 5–6.8×3.5–4μ; mature basidia are often attenuate upwards, or clavate, with 4–5 (usually 4) apical sterigmata which are 4μ long; some of them are at times aborted; the entire size of the basidia averages about 27×6.7μ. The hyphae of the apices of the branches are thin with rounded tips in the terminal members, with scattered septa, the clamps large; these hyphae form the surface of the branches at some places since the hymenium is not continuous everywhere and the basidia are scattered at places; the hyphae of the context beneath are subparallel, little interwoven, hyaline, 4–8.5μ thick, with thin walls in some, with moderately thick (0.7μ) walls in others. with rounded, rarely even subclavate ends, not exceptionally dense but touching each

* The first part of this paper appeared in Mycologia **36** (4): 358–368. 1944.

other and not gelatinous. When fresh, this plant is "rather soft, white, and has a peculiar odor of iodoform." (Singer, *l.c.*)

The type of *Lachnocladium aciculare* Lév. has spores of a similar kind but much larger (15–16×9–11μ), with spines 1.5–3.5μ high. It is probable that this belongs in the same genus, *Scytinopogon*.

2. **Gloeocantharellus** Sing. gen. nov.

Cantharellacearum genus; *Cantharello cibario* et affinibus speciebus similis in characteribus externalibus, sed sporis verrucosis, basidiis typi *Gomphorum* et praesentia gloeocystidiorum differt; a genere *Gompho* hymenophoro haud reticuloso, magis lamelliformi et praesentia gloeocystidiorum differt.

The type species is **Gloeocantharellus purpurascens** (Hesler) Sing. comb. nov. (*Cantharellus purpurascens* Hesler). Authentic material of this interesting species has kindly been sent to the writer by Dr. L. R. Hesler, University of Tennessee. The cystidia described by Hesler in his original account turned out to be gloeocystidia since they have the same kind of contents as those of *Favolaschia*. This is proved by the fact that their contents turn an intense blue in sections treated with brilliant cresyl blue. The spores have an homogeneous yellowish wall which is, however, uneven and warty, much in the manner of the spore wall of the Gomphi; it is non-amyloid. The hyphae are also non-amyloid, thin-walled, and show numerous clamp-connections. The basidia are moderately long, 4-spored with four thin, long, rather straight apical sterigmata. The trama is hyaline and consists of intricately interwoven hyphae.

Considering the fact that the gloeocystidia are not the only character distinguishing *C. purpurascens*, we think that it fully deserves generic rank. Gloeocystidia have, as far as we know, never been observed in this group of genera (Cantharellaceae). The species with verrucose spores and moderately long 4-spored basidia (such as *Gomphus clavatus*, *G. crassipes*, **G. Bonarii** (Morse) Sing. = *Cantharellus Bonarii* Morse, **G. floccosus** (Schw.) Sing. = *Cantharellus floccosus* Schwein., **G. viridis** (Pat.) Sing. = *Neurophyllum viride* Pat., **G. ochraceus** (Pat.) Sing. = *Neurophyllum ochraceum* Pat.) usually have rather deeply colored spores and the longitudinal veins with, at least in a certain zone of the hymenophore, concentric (though irregularly arranged) connecting veins that project to about the same height as the longitudinal veins they cross, thus forming a venose reticulation. In *Cantharellus*, the spores are smooth in all species known to me, and the veins are somewhat higher or lower (to lacking) but never connected to a network by concentric veins. Our new genus *Gloeocantharellus* is exactly intermediate between the genera *Cantharellus* and *Gomphus*, as far as the characters of the hymenophore and the spores are concerned, and, in addition, it has the unique character of the gloeocystidia.

The genera belonging to the Cantharellaceae which family is linked with the rest of the suborder Clavariineae by the genera *Ramaria* and *Clavariadelphus* (both close to *Gomphus*) can be distinguished in the following way:

A. Cantharelloideae: Spores smooth; basidia very long (stichobasidia in the species studied).
  B. Context thin, subcartilaginous ..... *Craterellus* Fr.
  B. Context thick, fleshy ..... *Cantharellus* Ad. *ex* Fr.
A. Gomphoideae: Spores warty or with ridges; basidia moderately long (chiastobasidia in the species studied)
  C. Gloeocystidia not differentiated; hymenophore venose-ramose-subreticulate.
    D. Carpophores multipilous ..... *Polyozellus* Murr.
    D. Carpophores unipilous ..... *Gomphus* S. F. Gray
  C. Gloeocystidia present; hymenophore longitudinally (radially) venose-sublamellate; anastomoses inconspicuous ..... *Gloeocantharellus* Sing.

3. **Diacanthodes** Sing. gen. nov.

Aphyllophoralium poriferorum genus; ab *Abortiporis* sporis echinatis et pilei superficie rugosissima vel dentata differt; a *Bondarzewiis* sporis haud amyloideis nec non crescendi modo subsolitario differt. Polypori pileati, stipitati, intus albi, sporis echinatis, hyphis partim tenuitunicatis, partim crassotunicatis vel solidis, haud amyloideis, fibuligeris; terrestres, tropicales vel subtropicales.

The type species is *Daedalea philippinensis* Pat. which is here transferred to **Diacanthodes philippinensis** (Pat.) Sing. The genus *Daedalea* in the sense of Patouillard is identical with the genera *Heteroporus* Laz. *sensu* Donk and *Abortiporus* Murr. It is therefore not surprising to see that Murrill who collected the same species in Florida called it *Abortiporus subabortivus* Murr. We have collected fresh material of this species in South Florida in tropical hammock. It is fleshier, and in its whole habit more like a *Scutiger* than an *Abortiporus*. Actually, however, its anatomy is more like that of an *Abortiporus*, and it seems to us that it deserves to be considered as belonging in a separate but related genus, *Diacanthodes*.

We have recently found more material among undetermined specimens sent to the Farlow Herbarium by J. Rick from Brazil. It appears that this fungus, collected but four times in scattered localities of the tropics and subtropics, is a widely distributed but rare species.

The genus *Diacanthodes* represents, in our opinion, a link between the genera *Abortiporus* and *Bondarzewia*. It may now be preferable to take *Abortiporus* out of the Polyporaceae proper, and to place it in the Scutigeraceae along with *Bondarzewia* and *Diacanthodes*.

4. **Leucocortinarius** (Lange) Sing. stat. nov. (*Cortinarius* subgen. *Leucocortinarius* Lange).

Tricholomatacearum genus; pileo stipiteque cortina connexis; stipite bulbo marginato instructo; sporis hyalinis, sat crasso-tunicatis (membrana

0.5–1.0μ crassa) sed semper simpliciter homogeneo-tunicatis; cystidiis nullis; cuticula pilei ex hyphis intertextis, ipsam superficiem versus magis parallelis; hyphis coloratis pigmento intracellulari haud incrustante gaudentibus; subhymenio cellulari; tramate in lamellis regulari, in carne pilei intertexto; neque hyphis nec sporis amyloideis; fibulis numerosis praesentibus.

This monotypic genus was formerly called *Cortinellus*. However, in the sense of Roze, *Cortinellus* would not include this particular species but rather a mixture of *Tricholoma* (the tomentose species of the *Tricholoma vaccinum* group) and *Tricholomopsis* (the species of the *Tricholomopsis rutilans* group). The emendation by N. Patouillard, favored by other French authors and also by this writer, is, therefore, as was pointed out by Miss Wakefield (Trans. Brit. Myc. Soc. **23**: 230. 1939), invalid since the type concept has been accepted in the International Rules (1935) unless the genus is conserved in the sense of Patouillard (1900). However, we do not think that it is the policy of the nomenclatorial commissions to conserve genera of little importance with only one known representative. We therefore take advantage of the existence of a rather descriptive name introduced by Lange which we propose to raise to generic rank.

Leucocortinarius differs from *Cortinarius* in simple, smooth spore walls and quite different color of the spores. It differs from *Tricholoma* in the presence of the cortina *and* clamp connections at the same time; in *Tricholoma*, even a spurious cortina would never be found in a specimen whose hyphae have clamp connections. Furthermore, in *Tricholoma*, the pigment of these species would be intercellular rather than intracellular. *Leucocortinarius* differs from *Tricholomopsis* in the absence of the characteristic cheilocystidia of the latter and in subfusoid-ellipsoid instead of globulose-ellipsoid spores; aside from all this, *Leucocortinarius* is distinguished from all the above mentioned genera except *Cortinarius* by the marginate bulb.

The new combination **Leucocortinarius bulbiger** (Alb. & Schw.) Sing. (*Agaricus bulbiger* A. & S. ex Fr.; *Armillaria bulbigera* Quél.; *Tricholoma bulbigerum* Ricken; *Cortinellus bulbiger* Konr. & Maubl.; *Cortinarius bulbiger* Lange) is proposed.

5. **Rajapa** Sing. gen. nov.

Tricholomatacearum genus; cuticula pilei ex hyphis jacentibus, parallelis, longis, filiformibus, hyalinis; septis defibulatis; lamellis subliberis vel rarius subadnatis; sporis in massa roseolis, albido-cremeo-carneis, etc., sub microscopio haud voluminosis, hyalinis, sat tenuiter tunicatis, haud amyloideis, levibus; cystidiis praesentibus; tramate hymenophorali paene regulari; carne tenaci-carnosula, in stipite sat tenaci; stipite e pseudorhiza conspicua nascente, plerumque fasciculariter crescente; hyphis haud

fibuligeris, haud amyloideis (sed nonnullis nonnunquam subpseudoamyloideis); velo interdum praesente. Typice in termitum nidis habitat.

The type species is the well known Asiatic termite fungus, *Agaricus eurhizus* Berk. which Hoehnel tried to place in *Collybia*. However, the clampless septa, the cystidia, and the potential veil show that it cannot be considered as a *Collybia* unless the old broad conception of this genus in the sense of Fries and Saccardo is maintained.

Fayod has described the genus *Schinzinia* from Africa which according to the diagnosis might be suspected of being congeneric with the termite fungus. However, a closer examination of the excellent drawing published by Fayod (Verh. Bot. Ver. Brandenburg **31**: 227, pl. 3. 1890) makes it more than probable that Fayod had—as I have suggested in a previous paper—a leucocoprinaceous species, close to *Schulzeria* and *Leucocoprinus*.

The termite agaric is an important edible mushroom in the regions where it occurs, especially on Ceylon, according to Petch, and is called "rajap" in Malay (hence the generic name).

Our notes on material from the Hoehnel Herbarium: spores in print about "light pinkish cinnamon" (Ridgway), hyaline under the microscope, non-amyloid, smooth, with rather thin walls, with a slight suprahilar depression or applanation, ellipsoid; basidia 25–30×7–(10)μ, 4-spored; some pseudoparaphyses of about the same size and shape; cystidia 37–47×13–21μ, hyaline with rather thin walls, fusoid-ventricose with the thickest part above the middle, the apex attenuate but rounded; trama consisting of two kinds of hyphae (regular-subintermixed); none of them diverging and not bilaterally arranged, some of these hyphae rather broad and strongly contracted at the septa, rather strictly axillarily arranged, slightly pseudoamyloid; another type of hyphae of the trama is characterized by a smaller diameter, equal breadth at the septa; these latter hyphae are non-pseudoamyloid, and run towards the edge of the lamellae as well as in other directions; they are connected with each other by numerous hyphal bridges; cuticle of the pileus consisting of an hypodermium of very broad, repent hyphae which are contracted at the septa, and an epicutis of parallel, thin, filiform, strictly cylindric, smooth hyphae; dermatocystidia none.

The new combination **Rajapa eurhiza** (Berk.) Sing. is proposed.

6. **Podabrella** Sing. gen. nov.

Tricholomatacearum genus; carpophoris mycenoideis vel collybioideis; epicute ex hyphis tenuibus, jacentibus, parallelis consistente; hypodermio ex hyphis crassioribus ad septa plus minusve contractis, hyalinis, elongatis consistente; lamellis subliberis vel adnatis, tenuibus, intermixtis; sporis in cumulo (in specie typica) pallide roseolis, sub microscopio hyalinis, par-

vulis, inamyloideis, sat tenuiter tunicatis, levibus, poro germinativo destitutis, ellipsoideis vel ovatis; basidiis haud voluminosis, tetrasporis; cystidiis nullis; stipite nullo, solido, haud tenaci, ex hyphis haud amyloideis, elongatis, fibulis destitutis consistente.

The type species is *Collybia microcarpa* (Berk. & Br.) Hoehn. sensu Hoehn. (according to Hoehnel the same as *Agaricus microcarpus* Berk. & Br., *Entoloma microcarpum* Sacc., etc.). I have no reason to doubt Hoehnel's identification; yet, I feel that it is better to be specific since I have not personally studied the type at Kew.

This genus differs from its closest relatives of the Tricholomataceae, subfamily Marasmioideae, in having no clamp connections, no pseudorhiza no hymenial cystidia nor dermatocystidia of the pileus, no thickened hyphal walls, and no or almost no pigment. It may be compareed with *Tricholoma* but it does not show the typical emarginate-sinuate attachment of the lamellae to the stipe, not to mention the entirely different mycenoid habit and the pinkish spores. The genus *Omphalina* (*Omphalia sensu* Sing.) differs in its external appearance, concave or umbilicate pileus and deeply decurrent lamellae, and white, larger spores. *Callistosporium* which may be its closest relative, is nevertheless easily recognized by abundant pigmentation, especially the pigment bodies in the spores or in the basidia. *Rajapa* differs in having a pseudorhiza and hymenial cystidia. *Mycena* and *Hemimycena*, in which the species of *Podabrella* would most probably be placed according to their external appearance, are both amply different chemically and anatomically. *Mycena* differs in having amyloid spores, or at least amyloid hyphae, mostly diverticulate epicuticular hyphae, and always either cheilocystidia or cystidia; the latter two characters are also valid for *Hemimycena*. No species in *Hemimycena* or in *Mycena* are known to have pinkish spore prints.

The new combination **Podabrella microcarpa** (Berk. & Br. *sensu* Hoehn.) Sing. (*Agaricus microcarpus* Berk. & Br. *sensu* Hoehn.) is proposed. On the basis of a large number of specimens collected by the writer in Florida and determined by Alexander H. Smith as *Collybia alba*, this latter species, the type of which Smith has examined at Albany, has the same essential characters as *Podabrella microcarpa*. The exact color of the spore print is not yet known but even if it should not be pinkish, the similarities are significant enough to justify a transfer of this species from *Collybia* where it is quite isolated, to *Podabrella*, as **Podabrella alba** (Peck) Sing. comb. nov. (*Collybia alba* Peck).

Vol. 8 SEPTEMBER · 1945 No. 3

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

Some Comparisons of Chemical Ontogeny with Chemical Phylogeny in Vascular Plants

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There are resemblances between certain characters in the embryos of higher animals and corresponding stages in the embryos of lower animals. This is most plausibly explained by the assumption that they have descended from the same ancestors and that their common structures are embryonic survivals (Morgan, 1925). Perhaps then in some cases chemical ontogeny is to a certain extent an epitome of chemical phylogeny and vice versa. If this holds even partially true in plants, then we have a pattern which may aid in the phylogenetic classification of plants on the basis of their chemical products; a method to aid in the discovery of "missing links" in the formation of certain compounds along the phylogenetic chain; as well as a pattern for the study of chemical ontogeny through the study of chemical phylogeny.

THEORY OF RECAPITULATION IN ZOOLOGY

The theory of recapitulation was first considered in relation to animals. In some such sense as stated in the preceding paragraph it was early suggested in the writings of Meckel (1821), von Baer (1828) and Louis Agassiz; but it was first clearly formulated by F. Müller in 1863, and received its most sweeping applications in the works of E. Haeckel (1866). [For a good summary of instances in the animal kingdom see Jordan and Kindred (1930)].

Although the theory of recapitulation was formulated in general terms which could include both the animal and plant kingdoms, it owed its origin to the facts of animal life. For a long time it depended almost entirely for support on zoological evidence. However, it might be expected that if this fundamental biological principle holds true in the case of animals it should likewise apply to the plant kingdom.

THEORY OF RECAPITULATION IN BOTANY

As Sahni (1924) says the animal kingdom appears to afford many more instances of probable linear genetic series than are found among plants. But even the most convincing of them would be a very incomplete picture of the racial history. A comparative morphologist cannot hope to discover more than the general evolutionary tendencies, and the most that can be reasonably claimed for ontogeny is a recapitulation of those tendencies. It would be useless to expect to find among the developmental stages of a plant or an animal the specific characters of an actual series of ancestors. The potter, states Sahni (1924), molds his lump of clay successively into shapes less and less generalized until the desired specific type of vessel appears. He may, of course, stop at any stage of the process, to produce a vessel of a simpler, more generalized type. But to give it a specific character he must put in the finishing touches (color, ornamentation and glaze) which characterize it as distinct from a mere stage in the creation of a more elaborate form.

Therefore recapitulation seems to be a much more vague and uncertain phenomenon than some have considered it to be. Despite this vagueness it still remains a splendid conception. In many instances it may be mere recapitulation of the grades of differentiation. But in its fundamental aspects evolution itself is only progression through successive grades of differentiation.

Consequently on its fundamental basis as expressed in the familiar words "ontogeny tends to recapitulate phylogeny" the principle of recapitulation seems to stand on firm unassailable ground.

In an illuminating historical account of the early attempts to extend the theory to plants, Bower (1908) draws attention to certain important differences which most higher plants show in their mode of development from those seen in the majority of animals.

The common occurrence in plants of the sessile habit and particularly the fact that plant tissues are made up of walled cells have involved important peculiarities in the manner of growth and development that are rarely encountered in the animal kingdom. For instance, the botanist has no fine display of larval or embryonic types to show as the ancestral forms of sporophytes, as the zoologist has for crustaceans, echinoderms, molluscs, and even vertebrates. Development in animals is usually a process of transformation where earlier stages in the life-history are replaced by later ones. Only in exceptional cases does an animal retain any trace of its juvenile condition. Such instances are found in the growth of the shells of foraminifera and molluscs. In the higher plants replacement is the exception. In the higher plants each organ as it is formed, retains its position and as the plant develops, becomes a permanent feature of the anatomy. Consequently the adult plant contains a more or less complete record of

the life-history. Therefore, as stated by Sahni (1924), the primary development of the plant may thus be compared, although in a crude way, to the erection of an edifice. From the aspect of development alone, as apart from growth, it can be said in a general way that while the majority of animals unfold their life-history only in time, most plants do so in both space and time.

Incidentally, this difference is advantageous to the botanist, because in favorable instances the examination of a single specimen may reveal the entire sequence of development. This fact has been used with remarkable success by Chandler (1905) in his study of fern "seedlings" and by Gwynne-Vaughan (1903) in tracing the ontogeny of *Alsophila excelsa* and other ferns.

Atavism.—In the study of plant evolution, it was natural to consider the plants of the great coal producing period during the Paleozoic. These plants first received attention because of their importance in connection with the search for productive coal veins. In more recent years the plants of the Mesozoic, which is of the greatest interest in relation to the appearance of our modern types, have been studied more intensively.

Knowlton in 1898 compared the leaves of the fossil *Populus eotremuloides* Kn. with those of the living *P. tremuloides*. He found the equivalent of the fossil leaves in those of a young seedling collected in Utah. One small difference was noted, namely, that the leaf margin of the living species is toothed from apex to base while that of the fossil species is entire at the base. Knowlton states, "The leaves of this seedling differ somewhat from the normal mature leaves of the species, but it would seem, in view of their evident relationship to the fossil leaves, that they represent a reversion to an ancestral type, or perhaps rather a survival of this type, which disappears in the mature plant." It is believed, therefore, that these seedling leaves are atavistic. In like manner, the fossil leaves greatly resemble the majority of second leaves formed on mature trees of *P. tremuloides*, which are also believed to be atavistic. The first leaves were severed from the trees about May 28 and the new leaves which appeared had the characters of *P. eotremuloides*.

It is generally known that if the leaves of trees or shrubs are destroyed, after a time new leaves appear which do not exhibit the characteristics of the normal leaf. In like manner, leaves of adventitious shoots and very young sprouts exhibit atypical leaves. It is believed that such leaves represent a reversion to an ancestral type ("memory leaves"). With this in mind, leaves of *Populus tremuloides* Michx., *Corylus americana* Walt., *Tilia americana* Linn., *Ulmus americana* Linn., and *Platanus occidentalis* Linn., were collected and studied by Oliver (1903). In each case the normal leaf form was determined and the amount of variation typical of the normal leaf noted. Then atypical leaves were studied and compared with fossil

species, Cretaceous through Tertiary in age. Pleistocene species were regarded as too recent for such comparisons.

Seedlings.—The seedlings of many plants produce leaves of a different kind than are borne on older plants. Generally the difference is merely one of size and shape, but in some cases the juvenile leaves are quite unlike those of the adult foliage.

Since the very early stages of seed plants are sheltered under uniform conditions throughout, during their embryonic or intraovularial phases, the complications of development known as larval stages in animals do not occur. In this respect, as in many others, the higher plants prove to be superior material to animals for the investigation of general biological principles on the basis of inductive reasoning. Accordingly, in the case of the seed plants, the process of events is not obscured or confused by any larval mask and it is apparently rather easy to interpret the facts of development and history. The situation is enhanced by the presence of many adaptations to actual environment which plants have developed in the course of time, as it seems by reason of their sedentary life which differs so greatly from the generally mobile existence of animals.

Xerophytes.—A very striking mode of adaptation in the case of plants is found in connection with growth during which the water relations for one reason or another are unfavorable. An excellent and familiar illustration of this condition is supplied by the cactus family. Although in *Peireskia* normal leaves are developed, many of the other genera are leafless except in their early seedling stages, in which they usually develop more or less normal seed leaves or cotyledons. The genus *Cereus* is interesting because in some of its species it does not even develop cotyledonary leaves. It is not improbable that related genera such as *Echinocactus*, *Melocactus*, *Anhalonium*, etc., may also lack seed leaves or cotyledons. Preliminary investigations carried on in Jeffrey's (1924) laboratory show that in a number of these more highly specialized cactaceous genera even the vessels which so uniformly characterize angiospermous seed plants are absent. The presence of cotyledons in cactaceous genera, which lack leaves in the adult vegetative condition, can only be interpreted as the occurrence of an ancestral structure in the seedling, which has completely disappeared in the adult; in other words, as an example of the validity of the principle of recapitulation.

There are numerous parallel instances among species inhabiting dry or poisonous soils. For example, we have in North America many species of *Veronica*, whose leaves have a normal development and a very characteristic form. But in certain exotic Veronicas the leaves are very small and confluent with the surface of the stem. While young these xerophytic Veronicas have, however, leaves precisely like other Veronicas. The same condition is exemplified by the nearly leafless *Rubus* species of the "Malle

Scrub" of Australia, which in its seedling condition has leaves like other raspberries.

Interesting examples are also found in other Australian xerophytes. The continent of Australia, unlike the continents of the northern hemisphere, did not undergo an ice age with its concomitant destruction of plants but in many areas underwent a prolonged change from mesophytic to xerophytic conditions. Consequently, many Australian plants which are now xerophytes have seedlings that demonstrate these changes. For instance, in the Proteaceae the seedlings of *Hakea* show transitional stages from entire leaves to the much divided leaves common in the genus. Of the Australian Myrtaceae the *Eucalyptus* seedlings often have opposite leaves as first formed which are also dorsiventral, the later ones are alternate and isobilateral, more suited to the present drier climate of Australia. The water content of the dorsiventral *Eucalyptus* leaves is higher than that of the isobilateral (Shilling, 1939). The tropical American coral plant *Russelia juncea* Zucc. (Scrophulariaeceae) an often cultivated xerophyte with much reduced leaves and pendulous green stems has shoots sometimes under cultivation with broad leaves. These are perhaps a reversion to an ancestral type. In the European heath plant, *Ulex europaeus* L., the leaves are reduced in size and many branches are reduced to green spines. In germination the seeds of this xerophyte show interesting transition stages from the usual compound leaves seen in legumes to the needle leaves of the mature plant.

Examples of this kind could be multiplied indefinitely and all show clearly that the young of desert plants show organization resembling that found in allied species growing under a normal water supply. Since the young are absolutely under the same conditions of environment as the adults, the differences of nepionic or seedling organization are rationally explained as the persistence of a tendency to grow like the ancestral mesophytic forms from which the xerophytic or desert inhabiting modifications were originally derived.

The seedlings of plants which have become adapted to a dry or desert habitat accordingly supply an extremely good illustration of the principle of recapitulation, since in their first development they manifest peculiarities which are only explainable as the persistence of a tendency to grow like nearly related forms living under more normal conditions of water supply.

Similar conditions are supplied by plants provided with flattened stems or phylloclades, or by that abnormal type of leaf known as the phyllode. In their seedlings these forms usually show the type of organization characteristic of the more normal nearly related species or genera. Innumerable similar examples could easily be supplied of angiosperms showing marked adaptations to special conditions of existence in the adult, which go through a normal development in the young state and thus supply evidence in favor

of the validity of the doctrine of recapitulation.

Attention may now be turned advantageously to the conifers, a group of very special interest in the present connection on account of their great geological age. Although the group as a whole is evergreen and has obviously been so for many thousand of years, there are deciduous genera such as the larch (*Larix*) and the Chinese larch (*Pseudolarix*) which regularly shed their leaves in the autumn. Interestingly enough the seedling of the North American larch is evergreen for a few years. Since it grows under precisely the same conditions as the adult, this striking deviation in habit can only be explained as a persistence of an ancestral feature, namely, the typical coniferous evergreen habit in the young individual and at the same time an exemplification of the validity of the biogenetic principle. Another of our commonest and at the same time most interesting conifers is the pine. This is characterized by having its leaves attached to the stem in clustered fascicles, which in modern species are from two to five in number. In the first year's development, the leaves occur singly and directly attached to the stem, which is obviously the harking back to an ancestral condition. In many of our higher conifers, the leaves are small and more or less confluent with the surface of the stem. This condition, for example, is found in certain junipers, in the arbor vitae, the big tree, the incense cedar, etc. In the seedling all these forms have quite normal free leaves, the presence of which is explainable on the basis of the principle of recapitulation. The Japanese umbrella pine, *Sciadopitys*, which in the adult bears only needles comparable to those of a two-leaved pine, but fused together, in the seedling condition, for a short time, produces normal leaves. In certain conifers now confined to the southern hemisphere and belonging to the genus *Phyllocladus*, the branches are flattened to resemble leaves and the real foliar organs are rudimentary. In the seedling normal leaves and stems always are present for a time.

Phylloclades are found also in other plants beside conifers. For instance, at least three genera of the Leguminosae have them. In the Leguminosae nearly all members have pinnately divided leaves. Of the many species of *Acacia*, some are characterized by bipinnate leaves, often with many pairs of small leaflets, while others bear phyllodia. In some species of *Acacia* having phyllodia, the first leaves borne on the seedling are bipinnate. Then leaves of intermediate character appear, and finally only phyllodia are produced (Goebel, 1900). Thus there is a recapitulation during early development of the ancestral condition.

Several xerophytic species of *Bossiaea* have flattened green stalks (phylloclades) with minute scaly leaves as in *Acacia*. Seedlings of these *Bossiaea* show transitions from leaves to phylloclades. Another xerophytic leguminous genus of the antipodes *Carmichalia* has flat green stems (phylloclades) and no green leaves.

In the Oxalidaceae some species of *Oxalis*, e.g., *O. bupleurifolia* A. St. Hil., have phyllodes in place of ordinary leaves.

The growth of ferns furnish striking examples of recapitulation. The ferns begin with a germinating spore, then resemble a green alga.

RECAPITULATION—BOTANY—INTERNAL FEATURES

All of the above illustrations of the exemplification of the principle of recapitulation have reference to external organization. Attention can now be directed to important internal structures and fossil forms.

Perhaps no better examples of the theory of recapitulation are to be seen in the plant kingdom than those offered by the Filicales. Ferns may be broadly classified according to their stelar anatomy into three groups: the protostelic, solenostelic and dictyostelic. This classification refers to the type of stele found in the main axis of the adult plant, without regard to the condition in the juvenile plant. The study of the development of many ferns has resulted in the well established fact that, in general, even in the dictyostelic fern the vascular stem consists initially of a protostele which gives off simple traces to the juvenile leaves. The protostele expands like a funnel as the plant grows, and soon acquires a pith and traces are now given off in a typical solenostelic manner. Finally the change is made into the final or adult phase. The leaves are now more crowded and fully developed and the solenostele telescopes into a dictyostele.

In a similar way the solenostelic ferns are not solenostelic at the beginning, but pass through a transient protostelic phase.

In the protostelic ferns the juvenile type of structure persists throughout the life of the plant.

There is also a fourth type of structure, namely the "Lindsaya type." This structure is intermediate between the proto and the solenostelic types. It is characterized by a core of internal phloem but lacks a true pith. Here likewise the juvenile state is protostelic.

It may safely be deduced that the protostele, solenostele, and dictyostele are progressive stages in an evolutionary sequence. This conclusion can be made on evidence that is separate from the facts of ontogeny. However, the ontogenetic sequence normally runs parallel to this evolutionary sequence. It is, therefore, not unnatural that this ontogenetic sequence should be considered, in a general way, as recapitulation of the ancestral history. It is important to point out that it is only in a general way recapitulative. This is necessary for it is known from the study of individual life histories that the recapitulation is neither complete nor specific. For instance, Gwynne-Vaughan has worked out the anatomy of *Alsophila excelsa* and thus demonstrated one of the clearest instances of recapitulation in plants; nevertheless, it would be a hopeless task to reconstruct from however complete a knowledge of the ontogeny, the actual pedigree of this

plant. In a similar manner no one could seriously maintain that the genus *Lindsaya* is in direct line of descent of all ferns, the stelar anatomy of which passes through the so-called *Lindsaya* phase. However, it is evident that the *Lindsaya* phase does represent a tendency which is more obvious in the solenostelic ferns and which may have been an important factor in the evolution of the vascular system of the ferns.

However, the developing embryo may also be considered from a causal viewpoint as shown by Lang (1915). The increasing resources in the matter of constructive materials in the young sporophyte is accompanied by a gradual progression from the simple to the elaborate vascular system. This change, therefore, is not necessarily a case of phyletic recapitulation. As the material accumulates in the young plant the diameter of the stem gradually increases and consequently is able to support larger and larger leaves. This increase in axis diameter is accompanied by a change from the solid to the medullate stele.

Tansley (1907) and Bower (1920) take a similar position to that of Lang (1915) in regard to the origin of the medullate condition of the stem. According to Tansley and Bower the peripherally inserted leaves on a stem of increasing thickness cause its medullation. They maintain that unless the diameter of the stele is less than a definite variable minimum the demand for water by the leaf traces would be met entirely by the peripheral xylem. Such a condition would cause little or no water to be drawn from the central tracheids. Consequently the central tracheids would be reduced to that of a water-storing tissue. There is no antagonism between the phyletic and the causal points of view. The phyletic reveals certain facts such as parallelism between ontogeny and phylogeny while the causal viewpoint seeks to explain these facts through physiology.

Parallel evolution.—According to some investigators parallel evolution appears to offer difficulty in regard to a phyletic interpretation of ontogeny. Striking illustrations of this are found in the vascular systems of the Filicales. As illustrations one may cite polycycly and dictyostely which occur in separate and distinct circles of affinity and therefore are quite likely to have arisen independently more than once in the history of the group. These occurrences might have a causal interpretation. Nevertheless they are not inconsistent with the recapitulation theory. This consistency is shown by the fact that each ontogeny, as far as stelar structure is concerned, is still a more or less abbreviated recapitulation of its own phyletic line.

Similar arguments would also apply to some other familiar facts of ontogeny which likewise may be placed under the general head of parallel developments. These facts deal with parallel developments within the limits of one species or in an individual plant. For example, plants grown from adventitious buds, bulbils, etc., during their development repeat

more or less closely the normal ontogeny of the parent plant which has been produced from an embryo. Among numerous instances may be mentioned *Psilotum*, *Tmesipteris*, *Asplenium*, *Adiantum*, *Woodwardia* and many more proliferating ferns.

Furthermore, we know from the work of Stengel, Gwynne-Vaughan, Mettenius and others (summarized by Sahni, 1917) that branches may develop in a similar manner, partcularly when produced from small-sized dormant buds. Very good examples of this are found in *Alsophila excelsa*, *Aspidium speciosum*, *Struthiopteris germanica* and the stoloniferous species of *Nephrolepis*.

It has been found that variations in the conditions of nutrition may affect the faithfulness with which the development of the branch conforms with the ontogeny of the parent axis. A remarkably clear instance occurs in *Nephrolepis cordifolia* where a comparison may be made between a branch produced from a stolon and a plant grown from a prothallus. Here we compare the slow development of a plant from the small beginning of a fertilized egg, which elaborates its meagre resources as it grows with a stoloniferous branch which has already available through an efficient channel the fully developed resources of the mother plant. This branch rapidly attains maturity and in doing so omits some of the transitional stages which may have been important stages in the phylogenetic history of the species (Sahni, 1915). As Heilbronn (1910) points out, it is significant that although there is a marked difference in the rate of progress in the life cycle, there is no deviation from the normal track. This example serves as an interesting botanical parallel to the development of the West Indian frog *Hylodes*. This frog develops from an egg especially rich in food yolk. As a result it hatches directly without a free-living tadpole stage intervening.

From studies of the vascular anatomy of the stem, it seems evident that recapitulation is of frequent occurrence in the ferns. For instance the leaf-trace develops in a partially independent line of evolution somewhat parallel to that of the axial cylinder. During the ontogeny of the fern an increased elaboration in the vascular supply takes place in each successive leaf. This elaboration is accompanied in the stem by the stelar advance. It is of interest to note that in some cases in the development of the individual adult leaf a similar sequence occurs to that in the stem. This sequence is in a more or less complete form. Gwynne-Vaughan (1903) noticed such a sequence in *Dicksonia* (*Cibotium*) *Barometz* where the leaf-trace at its origin has a simple C-shape which distally divides into a number of distinct strands. These strands are arranged in the shape of an arc.

Recent research in paleobotany has produced considerable evidence to show the phylogenetic significance of the various changes undergone by the leaf-trace as it extends through the cortex of the stem and through the

petiole. The principle of recapitulation, of course, is shown most completely in those instances where the leaf-trace acquires a number of different shapes before it eventually reaches its definitive form. Bertrand (1911) deduced that the successive transitory forms of the leaf-trace are to be considered as resembling, to a certain extent at least, the permanent form of the trace in a line of ancestors. The work of Kidston and Gwynne-Vaughan, Bertrand, and Gordon demonstrates the sound basis for Bertrand's conclusion even though the actual ancestors may not have been found.

If there is any justification for the principle of recapitulation we have here an outstanding instance of ontogenetic recapitulation. In the process of growth in both the fern leaf and fern stem development proceeds by successive intercalations behind an apical growing point. We are justified in assuming therefore that different parts of the fossil fern leaf represent stages in its ontogeny. Kidston and Gwynne-Vaughan (1909) have found in *Thamnopteris Schlechtendali* that the simple mesarch leaf-trace passes from the axial xylem in a protostelic manner. As it continues through the cortex an island of parenchyma appears, adaxially to the protoxylem. The protoxylem ultimately divides first into two and later into additional bundles while the accompanying island of parenchyma first enlarges and later opens out to form an adaxial bay. The elliptic mesarch leaf-trace is consequently first converted into a closed ring and lastly changed to an open arc with several endarch protoxylem groups. Such is the series of changes undergone by the individual leaf-trace as it passes obliquely upward in the cortex of an "adult" type of leaf. This likewise must have been its ontogenetic sequence. In *Thamnopteris* a single cross section through the stem provides the total leaf-trace series needed for ontogenetic sequence. This is due to the fact that in this genus the leaf-traces ascend nearly vertically in the cortex and the mature leaves are crowded around an erect axis. Kidston and Gwynne-Vaughan (1908) maintain that this leaf-trace sequence indicates the changes occurring in the ontogeny and phylogeny and consequently supply useful and dependable suggestions in regard to the origin and derivation of the adaxially curved leaf-trace so commonly found in the Filicales.

According to Sahni (1924) the mesarch condition may be considered as an ancestral character. This is based on the study of Gwynne-Vaughan (1911) of the genus *Osmunda* where some of the juvenile leaves were found to be furnished with a solid mesarch strand. In later leaves the trace was found to be curved and endarch at its origin.

An allied group to the Osmundaceae which is also of interest in relation to the recapitulation principle is the Zygopterideae. The Zygopterideae comprise a notable series of extinct ferns remarkable for the extremely varied shapes of the vascular bundles in their petioles. The cross sections of these bundles comprise extraordinary shapes, decidedly distinct from any found elsewhere among any living or fossil ferns.

For instance in the Clepsydroideae the characteristic shape of the trace may be compared in the various species to such objects as a pair of spectacles (*Clepsydropsis australis*), an hourglass (*C. antiqua*), a double-bladed battle ax (*Asterochlaena Williamsoni*), a double anchor (*A. bibractensis*), the letter A (*A. Grayi*), and a dumb-bell (*A. laxa, Ankyropteris corrugata*). However, Bertrand's (1909) research shows all of these different types that extend from the Devonian to the Permian are all variants of a single underlying plan. All of these traces are related to the simple form of trace of *Clepsydropsis*. As *Clepsydropsis* is likewise the oldest geologically it may be considered as the ancestor for all the Clepsydroideae.

In addition to the Clepsydroideae the Zygopterideae contain another group of great interest and importance in regard to the recapitulation principle. This group or series is the Dineuroideae and is notable for having quadriseriate "pinnae." The foliar trace acquires some of the most complex and curious shapes ever discovered in the bundle of a filicinean petiole. Among the various forms are the X-shaped pincer- or claw-like forms with five-pointed "antennae" of *Diplolabis zygopteris*. Other forms are variants of an H-shaped form found in *Elapteris*. Of these the vertical arms may be either clumsy or thick as in *E. tubicaulis* or pointed and slender as in *E. diupsilon*, or bent inwards and gradually enlarging toward their free ends into four club-shaped processes as in *E. Scottii* and *E. Lacattei*. Another form in the *Stauropteris* has the four rays of its "star" generally separated from each other in the middle. At the bottom of the entire series is the simple elliptic trace of the genus *Dineuron* in the Lower Carboniferous. This basic genus has a position corresponding to that of *Clepsydropsis* in the Clepsydroideae.

According to Sahni (1924) we are still far from knowing the actual interrelationships in the Zygopterideae. However more work can still be done on petiolar anatomy to determine its reliability as an index of affinities in this family. From evidence so far discovered it seems quite apparent that the two series (Clepsydroideae and Dineuroideae) are composed of progressively differentiated genera that diverged from a common ancestor. Simplicity of form in the leaf trace may here be considered as indicating relative primitiveness. It would appear that the common ancestor or prototype of the Zygopteridae had a simple elliptic foliar bundle with a protoxylem near each end. Presumably this bundle had its origin in one of the circular mesarch type, the *Urform* of the leaf trace of the Filicinaceae. Apparently an unimportant detail is the presence or absence of parenchyma in association with the protoxylem.

The ontogeny of the leaf trace as shown by a series of cross sections may now be considered.

To demonstrate the ontogeny of the leaf trace in the Clepsydroideae, those of three genera will be considered. In *Asterochlena* the leaf trace originates as a circular strand containing a single protoxylem in the center.

This may be taken as the primitive filicinean leaf trace. The protoxylem divides in half as the trace ascends the cortex and as this takes place the trace also flattens tangentially. Such may be considered the primitive zygopteridean type of leaf trace. This stage in development is of short duration as the trace soon becomes constricted in the middle. Besides the median constriction other changes take place which result in the transformation of the bundle into the final somewhat clepsydroid or dumb-bell-like shape. In *Clepsydropsis* parenchyma and protoxylem are intermixed from the start, the original circular mesarch bundle becomes flattened tangentially, and finally a median constriction completes the typical clepsydroid or spectacle-like shape. A similar development is found in the genus *Ankyropteris* (Sahni, 1924), especially if no attention is given to the so-called axillary branch which is adnate to the petiole. There is the separation of a circular mesarch bundle containing "mixed" protoxylem. There is likewise the tangential flattening and later a median constriction along with the bisection of the protoxylem. It seems quite probable that *Ankyropteris* is a further evolved genus than *Clepsydropsis* as the clepsydroid or dumb-bell-like formation is superseded in *Ankyropteris* by an antero-posterior extension of the peripheral loops. This extension is more noticeable in some species and when associated with other changes results in such shapes as a double anchor in *A. bibractensis*, a double hatchet in *A. Williamsonii* and the letter H in *A. Grayi*.

In the Dineuroideae, another group of the Zygopterideae, data from two genera are available, i.e., *Metaclepsydropsis* and *Diplolabis*. Gordon (1911) showed that in *Metaclepsydropsis* the leaf trace at its origin is an elliptic bundle with two protoxylems. As development continues an island of parenchyma is noticed in association with the protoxylem at each end of the ellipse and as a result the trace acquires a form identical with the completely developed leaf bundle of *Dineuron* (Scott). As the trace ascends the petiole it gradually acquires the typical shape of the genus. Likewise in *Diplolabis*, Gordon (1911) has found transient phases at successive levels. These phases are similar to (1) the elliptic trace with two protoxylems primitive for the entire family, (2) the *Dineuron* type, ancestral for the Dineuroideae, and (3) the *Metaclepsydropsis* type which is not as complex as that of *Diplolabis* as it has shorter "antennae" and a thicker "waist."

From the foregoing analysis it is evident that in several genera of the Zygopterideae the leaf trace passes through a series of similar stages. Sahni (1924) maintains that although these series of forms from simple to complex may not constitute actual phyletic lines, nevertheless it is highly probable that they do reveal certain evolutionary tendencies which are recapitulated in the ontogeny.

Our attention may now be turned to a consideration of some other vascular cryptogams. The work of Holloway (1917) shows in *Tmesipteris* that

while a mature stem is traversed by a ring of bundles the stem of a young sporophyte is traversed by a solid protostele. However, the two different conditions have not thus far been seen in different parts of the same stem. Apparently the stems with solid protostele continue to keep their juvenile structure all their lives. Other branches succeeding from the rhizome may develop the siphonostelic anatomy.

In continuance of Halloway's investigation Sahni (1923) discovered in another species of *Tmesipteris* that the lower or first formed portion of the stem had a certain amount of cauline medullary xylem, while in later formed, more distal, portions of the same shoot this undoubtedly primitive tissue was absent. Sahni considered this New Caledonian species, *T. Vieillardi*, as in all probability the most primitive member of the genus.

In the study of the phylogeny of the lycopods the work of Treub (1890) is important especially in regard to his ingenious theory of the protocorm. The protocorm of *Lycopodium cornuum* was considered by Treub as a degenerate organ of great antiquity. It was regarded by him as the forerunner of the leafy shoots in ancestral Pteridophytes. Generally the protocorm is a small transient organ whose function is not clear. However, in *Phylloglossum* it is important as the means of its perennial existence. Holloway (1916) has observed in some other species of *Lycopodium* it functions as a rhizome for an entire season. In these it has been known to branch and reproduce itself by means of bulbils. Until lately opinion differed as to its phylogenetic significance. The work of Kidston and Lang (1921) however has shown Treub's theoretical assumptions to hold true when they discovered an actual group of archaic Pteridophytes, the Psilophytales, in which the protocorm or an organ very similar persisted in the mature plant, as it is found to do in the living Psilotaceae.

Phylloglossum is a sort of "adult seedling" according to Treub's theory and consequently comparable in animals to the Mexican Axolotl which breeds in the larval state. *Phylloglossum* like *Welwitschia* in addition to some short-lived angiosperms grown under adverse conditions are required to flower in the seedling stage.

In the genus *Lycopodium* xylem and phloem are arranged in two different patterns. When xylem and phloem occur in alternate horizontal plates (*Cernua* and *Clavata*) the condition is considered as ancestral to the radially arranged stele (*Selago*). Holloway (1915) found that "seedlings" of these species have radially arranged steles. This fact says Sahni (1924) may have phylogenetic significance even though this same structure may occur again in the final branches.

Gymnosperms.—The application of the principle of recapitulation, as we have seen, holds true in the internal structure of some of the cryptogams and it is of interest to determine its fitness in the gymnosperms. It will be of interest in this connection to examine how certain well-known living

conifers compare anatomically with their extinct ancestors and what basis they supply for the validity of the principle. The genus *Pinus* is a very ancient one, and extends back in substantially its present form at least as far as the middle of the Mesozoic period (Jurassic). In its earliest occurrence *Pinus* was different in certain notable respects from its living representatives, and like the cycads, was represented by many more species than at the present time.

The earliest pines, instead of having two or five needles in a cluster, as our present pines have, had many leaves in a fascicle. Another feature of interest in the primitive pines was the fact that the leaf wood began its growth towards the upper surface of the leaf as in the case of the earliest known gymnosperms. The anatomical structure of the wood varied from that of our living pines in several ways. For instance, in our existing pines, the rays of the wood are accompanied by horizontal tracheids or water-conducting elements. These structures are absent in the earliest pines. Even at the beginning of the Cenozoic, as shown by the pines of the Baltic amber deposits, the horizontal or ray tracheids only made their appearance after the branch had grown for a number of years.

In the late Mesozoic (Cretaceous) marginal ray tracheids have been found in certain American species, investigated in Jeffrey's (1924) laboratory, but their appearance was deferred even later than in the pines of the Baltic amber deposits. In our living pines the tracheids are late in appearing in the seedling, and in the root, which is the most conservative of all plant organs, it is often many years before the ray tracheids make their appearance along the margins of the rays in the wood. In the cone or reproductive axis, which has from two to three annual rings, marginal or ray tracheids are usually quite absent. Longley (1924) has made some very interesting observations on the effect of injury on the wood of the pine. He has discovered that even in the old stem the wood formed after injury is without marginal ray tracheids for several years. It is obvious from the above statements that the oldest pines were entirely without ray tracheids in their wood and that after these structures made their appearance they were at first greatly delayed in the late Mesozoic and less so in the early Cenozoic of the Baltic amber pines. In the adult stem of living pines they appear at once in the first year's growth, but they are delayed in the seedling in accordance with the principle of recapitulation. Interesting subsidiary principles to that of recapitulation are exemplified by the old and interesting genus *Pinus*, unquestionably the most ancient surviving tree of our northern forests. In accordance with the principle of retention of ancestral conditions in conservative organs, we find a similar delay to that exemplified by the seedling of the pines in the roots and cone in the appearance of the marginal tracheids. Further, as a result of injury the formation of marginal tracheids may be inhibited for several years and the structure of

the wood thus reverts to the ancient condition of organization.

The principle of recapitulation is consequently admirably illustrated by our ancient but still living genus *Pinus*, as becomes clear from a comparison of its younger organization with that of the extinct species of earlier geological times. Further the evidence derived from a detailed comparison of root and cone or reproductive axis shows that these two organs likewise present features of resemblance to the seedling stem. In other words, root and stem of the adult are conservative organs. These conditions Jeffrey (1924) has described as illustrative of the principle of retention of ancestral structures by conservative organs and in the course of his anatomical investigations on other groups of plants from the Calamites upwards found them to be of wide validity. A very important general principle is that of reversion to extinct types as a result of injury. This condition exemplified by *Pinus* is of special importance because the reversionary reaction is often the most persistent indicator of former conditions, since it makes itself felt when all other indications of ancestral organization have become obliterated by time. The comparison of living pines with their extinct forbears of Mesozoic and Cenozoic periods consequently supplies us with three useful working principles. These are, first, recapitulation, which is clearly and strongly supported by the data supplied by living and extinct pines. Second, is the principle of retention or principle of conservative organs. Finally, we have the principles of reversion as a result of injury.

Another example of reversion through injury is shown in the higher members of the Abietineae such as *Cedrus*, *Abies*, and *Tsuga*. These trees are in general without normal ligneous resin canals except in the root. When any of these three genera has its wood injured, traumatic resin canals are formed, vertically only in *Tsuga* and *Abies*, but both horizontally and vertically in *Cedrus*. The rational as well as the natural explanation of these conditions is that the three genera in question have come from *Pinus* by reduction and that they revert under conditions of injury.

REVERSION TO A MORE JUVENILE FORM

Many plants are able to return to their juvenile form. This may be called "reversion" in an ontogenetic sense and is of course of special interest in regard to the principle of recapitulation. It has been observed that these phenomena of reversion occur differently even in species of the same genus. They may appear in one species under definite conditions while they will not do so in another. Their occurrence is sometimes limited to certain regions of the plant body, or to a certain stage of development, which when once passed, the capacity for "reversion" is lost.

External.—In aquatic and marsh monocotyledonous plants a reversion to the primary leaves may occur in plants whose vegetation is unfavorably influenced. For example, specimens of *Eichhornia azurea* which had win-

tered as land plants, produced reversion shoots with ribbon-like primary leaves (Goebel, 1900). Like occurrences have been seen in *Hydrocleis Humboldti*, *Potamogeton natans*, *Sagittaria* spp., etc.

In dicotyledons reversions have been caused in a similar way. For instance, in *Acacia verticillata*, a species that produced phyllodes. The young plant of this species as in other *Acacia*, develops bipinnate foliage leaves which gradually change to phyllodes (Goebel, 1900). In young plants that had already formed a large number of phyllodes and which were made feeble by growth in a dry chamber, reversion shoots with bipinnate foliage leaves appeared. The New Zealand species of *Veronica* and the myrtaceous *Melaleuca micromera* have ordinarily a xerophilous habit resembling that of the Cupressineae. When grown in a moist chamber or under unfavorable conditions these plants produce spreading stalked flat primary leaves in place of the depressed scale-like ones. In the Cactaceae reversions likewise often occur.

In general reversion shoots are formed at definite places—usually near the base of the plant. In this manner are found juvenile shoots on Eucalyptus trees in California and Italy. Likewise a similar phenomenon occurs in *Callitris*, *Colletia*, *Cruciata* and others.

Internal.—Lang's (1915) studies on *Helminthostachys* have shown that a rhizome after having once reached its adult (medullate) stele in a normal manner may revert temporarily to the juvenile protostelic state.

Gwynne-Vaughan (1914) noticed the formation of scattered xylem elements in the pith of a wounded specimen of *Osmunda regalis*. This is essentially a case similar to *Helminthostachys*.

Previously in this paper examples of reversion through injury have been given for *Pinus* and higher members of the Abietineae.

The fact that reversions to the juvenile condition occur is not inconsistent with the general recapitulative nature of ontogeny. It is a truism that the structure of an organism at all phases of its existence is a reflection of its past and present experiences. It thus represents a combination of characters acquired both in a general way (i.e., from foregoing generations) and from its present environment. It is significant that when an upset in normal equilibrium is caused by unfavorable conditions an adjustment is sometimes obtained by a reversion to the surer basis of past experience. As Sahni (1924) says, "We may liken such cases to the retreat of an army in the face of a strong adversary, a retreat along the old lines of communication being naturally preferred to a doubtful escape by an unfamiliar path."

SOME LIMITATIONS IN THE APPLICATION OF RECAPITULATION

The principle under consideration has many illustrations in the vascular plants, but on the whole it cannot be said to have as great a validity as among the higher animals.

Plant structures are much more uniform than those of animals, and it is hardly possible to establish such definite major divisions as are recognized in the animal kingdom. Where specialized tissues like the woody, skeletal structures of the higher plants are found, they are much less constant than those of animals, so that they are less reliable indicators of genetic relationship. The higher plants are also less individualized than are most animals. An oak, for example, is a colony of potential independent plants rather than a true individual (Campbell, 1942).

The higher plants in general, are more conservative than are the higher animals. Thus many existing genera of flowering plants, e.g., sassafras and poplar, are represented by fossil species at a period when the modern families of birds and mammals had not come into existence.

It is further necessary to note in the present connection that the absence of a given structure in young individuals is by no means evidence of its absence in the ancestral forms from which they have descended. For example, there is good evidence that the cycadean gymnosperms have come from ancestors possessing concentric bundles and centripetal wood, yet the seedlings of cycads in general do not support this conclusion by their anatomical organization. The principle of recapitulation is of value, accordingly, when it presents positive evidence from the seedling for the ancestral occurrence of a given feature of organization; but negative testimony from this standpoint must be estimated as having little or no value. A failure to realize this situation has been responsible for much fallacious biological reasoning.

The stem in that region devoted to the function of reproduction has figured strikingly in connection with the theory of conservative organs. For instance, the peduncle or base of the cone in certain cycadales furnishes a clear example of the persistence of an ancestral structure in the reproductive axis which has quite disappeared in the ordinary vegetative state. However, the value of the anatomy of reproductive axes cannot be estimated so highly in the case of the angiosperms, since the relatively slight development of fibrovascular structures in flowers and inflorescences leaves less scope for the appearance of phylogenetically significant structures. Clearly in this instance only structures are significant which find adequate development in the somewhat slender annual woody cylinder of the flowering parts of perennial dicotyledons. In the monocotyledons the restrictions on interpretation are still greater because of the usual absence of secondary growth in this great division of the angiosperms.

CHEMICAL ONTOGENY AND PHYLOGENY

Carbohydrate-Fat Ontogeny.—It is now a well known fact that in the formative development of seed, carbohydrate is changed to a fatty oil or oils. At first the saturated oil (or oils) is predominant while later the less saturated oil (or oils) makes up the larger portion. If chemical ontogeny is

a recapitulation of chemical phylogeny, then one might apply this test to the monocotyledons, and dicotyledons to determine which group was first to originate. Such a test might also be applied to Archichlamydeae and Sympetalae.

The taxonomic distribution of oil and starch in seeds has already been tabulated (McNair, 1930). These data may be reclassified (Table 1) as to the percentages of starchy and oily embryos in the seeds of the monocotyledons, Archichlamydeae and Sympetalae. The percentages of starchy and oily embryos in these groups have also been determined as well as the nature of the total seed contents.

TABLE 1. *Percentages of families that have starchy or oily embryos, albumen and general contents.*

Plant Group	Embryos		Albumen		General Contents Oily
	Starchy %	Oily %	Starchy %	Oily %	%
Monocotyledons	4/ 33=12	15/ 33=45	19/ 33=57	9/ 33=27	5/ 33=15
Archichlamydeae	21/137=15	62/137=45	23/137=16	43/137=30	69/137=50
Sympetalae	4/ 42= 9	18/ 42=42	1/ 42= 2	17/ 42=40	23/ 42=54

An examination of the data in Table 1 shows a definite increase in the percentages of families with oily embryos, oily albumen, and oily general contents in the series beginning with the monocotyledons, through the Archichlamydeae to the Sympetalae. There is a corresponding decrease in the starchy contents. The monocotyledons also have less saturated seed oils than those of the Archichlamydeae and Sympetalae (McNair, 1935). From these results one can deduce that the monocotyledons in their present chemical development are more primitive than the dicotyledons. Therefore the monocotyledons may have originated before the dicotyledons or as an early branch from primitive dicotyledons[1]. As a result of a similar deduction one can say that the Archichlamydeae are more primitive, chemically at least, than the Sympetalae.

In a study of tropical angiosperm seed oils (glycerides) (McNair, 1934) it was found that the higher the tropical plant family is in evolutionary development the greater will be its tendency to produce fatty oils of large average iodine numbers. That is, the higher in evolutionary position the greater is the tendency for unsaturated fatty oil production (and also the lower will be their melting points.)

This tendency has also been noticed within angiosperm families, e.g., in the Leguminosae (McNair, 1929).

Small Molecules vs. Larger Molecules.—Besides the increase in unsatura-

[1] From an anatomical standpoint monocotyledons cannot be derived from herbaceous dicotyledons. Bailey, I. W. 1944. The development of vessels in angiosperms and its significance in morphological research. Amer. Jour. Bot. 31: 425.

tion in fatty oils with the increase in evolutionary position, it has been noticed that the molecules of the fatty acids used in the composition of these fatty oils increase in size in angiosperm seed fats with an increase in phylogenetic position (McNair, 1941).

Phylogenetic Increase in the Number of Fatty Oils.—It has also been observed in angiosperm seed fats that there is a tendency for the number of component fatty acide to increase with an increase in phylogenetic position (McNair, 1941).

Volatile Oils, Ontogeny.—Chemical ontogeny finds a splendid example in the seedlings of the Eucalyptus. It has been found that volatile oil from the younger Eucalyptus seedlings contains more hydrocarbon (d-pinene) and less hydrocarbon oxidation product (cineole, an oxidation product of pinene) than does the volatile oil from saplings two or three years old, and that the maximum cineole content is reached in oil from leaves collected from older trees. This is true also for the leaves which are reproduced from lopped old trees, as the volatile oil from the seven months' "suckers" contains less pinene and more cineole than does that from twelve months old seedlings. The volatile oil from fifteen months old "suckers" contains less pinene and more cineole than the oil from two and one-half years old seedlings.

Volatile Oils—Phylogeny—Eucalyptus.—Baker and Smith (1902, 1920) after thirty years' work classified the genus Eucalyptus both chemically and phylogenetically. Eucalyptus oils were divided into seven chemical groups. When these chemical groups are considered in relation to the Baker and Smith phylogenetic tree, it becomes apparent that each chemical group represents a horizontal cross section of the phylogenetic tree (McNair, 1942). Consequently, these groups sometimes include heterogeneous species which are products of different branches of descent (not natural groups or genetic sequences) and sometimes include reversions. In other words, each Baker and Smith group represents a stratum or phase in the evolutionary development of the genus. Consequently, these plants may sometimes combine advanced systematic characters with more primitive chemical characteristics and vice versa. But in general, a plant in an advanced chemical group also has advanced systematic characters.

By chemical analysis it has been found that the number and variety of oxidation products increase with advance in evolutionary position in the genus (Table 1, McNair, 1942).

In the genus Eucalyptus morphological and chemical ontogenies are thus found to have their counterparts in phylogeny.

Hall (1914) from his study of the seedlings of nearly 150 species of *Eucalyptus* was able to trace the development of the higher from the more primitive forms. It was found that a very interesting and instructive classification of seedlings could be made according to the size and shape of the

cotyledons. The differences in the cotyledons appear to be a response to Australian xerophytic conditions, and indicate that the species with simpler, entire cotyledons are those of the more primitive type; while those, with emarginate cotyledons, are of the more evolved and developed type, and this arrangement follows certain morphological and chemical lines.

The large entire reniform cotyledons of the "Bloodwood" or *E. corymbosa* type are the most primitive. There is next a group, like *E. marginata* with large emarginate cotyledons; then the peppermint group with smaller cotyledons, slightly or hardly at all emarginate; then a large collection of species, all more or less emarginate, but with cotyledons gradually diminishing in size, until we get the almost minute ones of *E. rostata* and *E. viridis;* and finally, the extremely bifid species of the *E. squamosa* type. Accompanying these changes in the cotyledons there has been a change in the volatile oils. The *corymbosa* type is associated with the pinene oil without eucalyptol (cineol). That of the peppermint group is associated with eucalyptol, phellandrene and piperitone in varying proportions. In the emarginate *E. globulus* type of cotyledon there is a general reduction in size. This is mainly associated with a eucalyptol-pinene oil, and in its reduced form aromadendral frequently appears. Finally, the Y-shaped extremely bifid cotyledon is also usually associated with eucalyptol, pinene, and aromadendral.

Volatile Oils—Phylogeny—In General.—In the case of angiosperm tropical volatile oils scatter diagrams may be made with their specific gravities as one coordinate and the botanical positions of the producing plant families as the other coordinate. The resulting trend is upward in accordance with the increase in specific gravity and the increase in plant evolution (McNair, 1934).

Another scatter diagram for tropical volatile oils may be made in which one coordinate is the refractive index and the other is the producing family's evolutionary position. The trend of this arrangement is down and coincides with the results obtained from the use of the specific gravity, for a low index in refraction carries with it a concomitant increase in specific gravity (McNair, 1934).

It can therefore be concluded that the volatile oils of the families highest in evolutionary development have constituents with a large number of double bonds (low saturation), more aromatic compounds, or more sulphur and nitrogen compounds with small amounts of substances of low molecular weight or small quantities of terpenes or bodies of the fatty series (McNair, 1934).

The heat of combustion of the acids contained in the tropical volatile oils increases with the increase in the average systematic position of the families producing them. This coincides with the findings obtained from the study of the specific gravity and refractive index of volatile oils (McNair, 1934).

The heats of combustion of the alcohols which are constituents of the tropical volatile oils increase with the increase in the average systematic position of the families producing them. This result likewise agrees with and confirms the findings obtained from the study of the specific gravities and refractive indices of volatile oils (McNair, 1934).

Alkaloids—Phylogeny.—No cases of alkaloid ontogeny are known but work has been done on alkaloid phylogeny. Tropical alkaloids may be arranged in a scatter diagram with the average molecular weights and the botanical position of the containing plant families as coordinates. When this is done, the straight line trend produced indicates that the higher the plant family in evolutionary progression, the more likely it is to produce alkaloids of high molecular weight (McNair, 1934).

Likewise, it is shown that alkaloids which are formed by more than one family when first separated as to climate assume positions in the evolutionary scale proportional to their average molecular weights (McNair, 1934).

Cyanogenetic Glucosides—Ontogeny.—It has been shown above in some species of *Acacia* which have phyllodia that the first leaves borne on the seedling are bipinnate. Then leaves of intermediate character appear, and finally only phyllodia are produced. Cyanogenetic glucosides have been found in the following species of *Acacia* which have bipinnate leaves (Steyn 1935, Steyn and Rimington 1935): *A. giraffae* Willd., *A. lasiopetula* Olw., *A. litakunensis* Burch. *A. robusta* Burch, and *A. stolonifera* Burch. Negative tests were obtained from the following bipinnate leaved species: *A. arabica* Willd., *A. karro* Hayne, and *A. permixta* Burtt-Davy. Therefore, of the above eight species of bipinnate leaved *Acacia*, 5 or 60 per cent gave positive tests for the presence of cyanogenetic glucosides. The following four species of phyllode producing *Acacia* were all found to form cyanogenetic glucosides (Finnemore and Gledhill, 1928): *A. cheelii* Blakely, *A. cunninghamii* H.K., *A. doratoxylon* A. Cunn, and *A. glaucescens* Willd. From these tests it is apparent that cyanogenetic glucosides are more likely to be produced in the phyllode bearing that is the *Acacia* of more advanced evolutionary position than in the more primitive or bipinnate leaved species. Phyllode and bipinnate determinations were made for the author by E. H. Walker of the Smithsonian Institution in 1942.

Cyanogenetic Glucosides—Phylogeny.—If the occurrence of cyanogenetic glucosides in the angiosperms be considered, it is found that these substances occur more generally in the more advanced of the older groups and also in the more advanced families of the different orders. For instance, in the monocotyledons, they have not been found in 1. Pandanales, 3. Triuridales, 5. Principes, or 6. Synanthae. However, they do occur in the 2. Helobiae, 4. Glumiflorae, 7. Spathiflorae, 8. Farinosae, 9. Liliiflorae, 10. Scitamineae, and 11. Microspermae. In the Archichlamydeae of the dicoty-

ledons cyanogenetic glucosides have not been found the first eleven orders (which consist mostly of woody plants). They have been found in nearly all of the remaining 19 orders. These orders are 12. Urticales, 13. Proteales, 14. Santalales, 17. Centrospermai, 18. Ranales, 19. Rhoeadales, 20. Sarraceniales, 21. Rosales, 23. Geraniales, 24. Sapindales, 26. Malvales, 27. Parietales, 29. Myrtiflorae, and 30. Umbelliflorae. In the highest group of the dicotyledons, namely the Sympetalae, six orders (60 per cent) out of ten form cyanogenetic glucosides. These six are: 1. Ericales, 4. Ebenales, 5. Contortae. 6. Tubiflorae, 8. Rubiales, and 10. Campanulatae.

As to the occurrence of cyanogenetic glucosides in the more advanced families of the various orders the following examples may be considered as indicative. In the Rosales the substances mentioned are found in the: 4. Crassulaceae, 6. Saxifragaceae, 14. Platanaceae, 16. Rosaceae, and 18. Leguminosae. In the Parietales the containing families are: 17. Winteranaceae, 19. Flacourtiaceae, and 23. Passifloraceae. In the Myrtiflorae the producing families are: 9. Lecythidaceae, 14. Myrtaceae, 15. Melastomaceae, 16. Onagraceae, and 17. Haloragidaceae.

SUMMARY

It is considered that chemical ontogeny is at least partially the epitome of chemical phylogeny in plants. If this be true then we have a pattern which may aid in the phylogenetic classification of plants by their chemical products; a method to aid in the discovery of "missing links" in the formation of certain compounds along the phylogenetic chain; as well as a pattern for the study of chemical ontogeny through the study of chemical phylogeny.

The most that can be expected is that ontogeny proves to be a recapitulation of evolutionary tendencies.

The common occurrences of the sessile habit in plants involves important differences in growth and development from those of animals. In the higher plants each organ as it is formed retains its position and becomes a permanent feature of the anatomy. While the majority of animals unfold their life history only in time, most plants do so in both space and time. Examination of a single plant may therefore, in favorable instances, reveal the entire sequence of development.

The equivalents of fossil leaves have been found in those of young seedlings, and in second leaves which have replaced severed first leaves.

In many xerophytes the seedlings exhibit ancestral mesophytic development, e.g. Cactaceae, *Veronica*, *Rubus*, *Eucalyptus*, *Ulex*, etc.

The ancestral evergreen state in the young of *Larix*, *Pseudolarix*, etc. is replaced in the adult by a deciduous condition.

In the early years of growth in *Pinus* leaves occur singly and directly attached to the stem (as in ancestral species) and not in clustered fascicles as in the adult.

In the genus *Acacia* the first leaves are bipinnate (indicative of an ancestral mesophytic habit) to be replaced later, in many species, by phyllodia.

In the Filicales it is shown that the protostele, solenostele and dictyostele are progressive stages in an evolutionary sequence. The ontogenetic sequence normally runs parallel to this, e.g., in *Alsophila excelsa*.

Parallel evolution or development may be considered as an example of recapitulation, e.g., polycycly and dictyostely in Filicales; plants grown from adventitious buds, bulbils, etc. during their development repeat more or less closely the normal ontogeny of the parent plant which has been produced from an embryo, e.g., *Psilotum*, *Woodwardia;* in ferns the leaf trace trace develops in a partially independent line of evolution somewhat parallel to that of the axial cylinder, e.g., *Dicksonia*.

In the lycopods the protocorm has been shown to be the forerunner of the leafy shoots.

In *Lycopodium* the xylem and phloem occur in alternate horizontal plates, a seedling condition considered ancestral to the radially arranged stele (*Selago*).

In the living pines the tracheids are late in appearing in the seedling. In the root, which is the most conservative of all plant organs, it is often many years before the ray tracheids make their appearance along the margins of the rays in the wood. The oldest fossil pines were entirely without ray tracheids in their wood.

Reversion through injury is also an important example of recapitulation, e.g., the traumatic resin canals in *Tsuga*.

Reversion to a more juvenile form can likewise be considered as supporting evidence for recapitulation. This occurs in both external and internal anatomical change.

The absence of a given structure in young individuals is by no means evidence of its absence in the ancestral forms from which they have descended. The principle of recapitulation is of value when it presents positive evidence from the seedling for the ancestral occurrence of a given feature of organization.

The carbohydrate-fat ontogeny is shown to have parallel phylogenetic representation. From this analysis monocotyledons are more primitive than dicotyledons and Archichlamydeae more primitive then Sympetalae.

Volatile oil ontogeny and phylogeny show hydrocarbons to precede their oxidation products, low specific gravities to precede high specific gravities, high refractive indices to precede low refractive indices, and low heats of combustion to precede high heats of combustion.

Alkaloid phylogeny shows low molecular weights to precede high molecular weights.

Cyanogenetic glucoside ontogeny and phylogeny show cyanogenetic glucosides more abundant in phyllode producing *Acacia* and therefore of

more recent evolutionary appearance both ontogenetically and phylogenetically in *Acacia*. The occurrence of cyanogenetic glucosides is more prevalent in the angiosperms in the more advanced of the older groups and also in the more advanced families of the different orders.

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The Laschia-Complex (Basidiomycetes)

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The efforts of modern taxonomists are aimed at a better knowledge of fungi presumably well studied and frequently collected in order to rearrange them along new and more natural lines. This work is being carried on with fair success and at a growing pace in some groups of fungi. These studies are based on analyses of the type collections in North America and intended to continue the French and Swedish tradition. Many errors, more or less understandable at the time they occurred, have been brought to light, and numerous involved questions concerning temperate species have been solved by coordinating field work and herbarium studies. Difficult as this task may seem, it is nothing compared with the chaos awaiting the taxonomist who endeavors to organize and classify the tropical fungi. Petch (24) has given a vivid picture of the difficulties of work on tropical fungi, and the following notes on the species of *Laschia* will illustrate this situation well enough.

The genus *Laschia* and all other groups confused with it are entirely tropical. It has to be kept in mind that none of the important authors of genera, sections, and species in this complex group, i.e., neither Montagne, Berkeley, Patouillard, Bresadola, nor Hennings, has ever seen a *Laschia*, or what they used to call so, in living condition. At best, what they saw were dried, or—still worse—alcohol material, revived in water. The first authors who revised individual species critically on the basis of observations in nature were Höhnel (7), who studied *Filoboletus mycenoides*, and Petch (25), who worked on two Ceylon "Laschias." Rick saw many fresh specimens, but used Lloyd's data on the dried ones when publishing (27). Van Overeem (21) based his publications partly on fresh material, collected by himself between 1921–1923.

While collecting fungi in tropical South Florida, I observed, among other laschioid species, two fairly common holobasidial forms and studied them extensively in fresh condition. They were, as I would now call them, *Favolaschia sabalensis* (Charles) Sing., and *Filoboletus gracilis* (Klotzsch ex Berk.) Sing. Characteristically, the problem of naming these specimens correctly was extraordinarily difficult. Yet the determinations were unsatisfactory, since these species, so distinct in appearance and anatomy, were supposed to belong to the same old phantom genus *Laschia* (by Lloyd, for instance), and both generic and specific names were different in either case, depending on whether Lloyd's or Patouillard's views were accepted. Patouillard listed the one species which I thought was an agaric, as be-

longing to *Polyporus* (*Leucoporus*), whereas he referred the other, which did not look like an agaric to me, to the Marasmioideae (agarics).

This situation became more complicated and embarrassing the more specimens and literature I consulted. This situation prompted me to restudy all available types of any consequence. The result of my studies does not seem to be in complete accord with the findings of other authors and, therefore, this paper was prepared in order to facilitate future monographic work. Although by no means a monograph of the Laschias, this contribution constitutes an attempt to redefine the various groups and dispose of them within the framework of a natural classification of the Basidiomycetes.

HISTORY OF THE GENUS LASCHIA

The genus *Laschia* Fr. (1830), together with the genera *Favolaschia* (Pat.) Henn. (1895), *Campanella* Henn. (1895), *Filoboletus* Henn. (1899), *Porolaschia* Pat. (1900), *Mycenoporella* Van Overeem (1926), and *Poromycena* Van Overeem (1926) form what may be called "the *Laschia*-complex," i.e., a group of fungi with alveolate, poroid, sublamellose-anastomosing, or venose-anastomosing hymenophores and, supposedly or actually, entirely or partially, more or less gelatinous trama. Being close to one of these, at least two more genera will be involved in the *Laschia*-complex: *Leptotus* Karst. (1879), and *Dictyopanus* Pat. (1900).

In attempting to reclassify the pore-bearing Basidiomycetes in 1941 (1), we left the genus *Laschia* as well as its satellites out of consideration with the statement: "As for the *Laschia*-complex, we paid no attention to this problem because of lack of good material" (p. 46). This omission was of no consequence at all since the Laschias, as will be shown in this paper, are not Polyporineae as we understand this group, and therefore their classification has no effect on the systematics of the Polyporineae.

But this does not mean that the Laschias are not interesting structually and taxonomically. On the contrary, their characters as far as they were known previous to these studies, were extremely fascinating as has been emphasized by Lloyd who studied them with remarkable zeal especially between 1916 and 1919. As will be seen later, the use of certain dyes and reagents adds to the abundance of interesting features known in Laschias, especially in *Favolaschia*.

The genus *Laschia* was described by Fries (3). The species of this genus, as understood by Fries, are known to be phragmobasidial and belong to the section *Auriculariella* Sacc. which was subsequently transferred to *Auricularia*.

Later Junghuhn (10) described a new genus *Laschia*—having no knowledge of the existence of the Friesian genus. His genus, a homonym, consists of two species, one now called a *Hymenogramme* (a substitute for

Laschia sensu Jungh.), or *Poria* (according to Bresadola), the other now considered to be *Favolus spathulatus* (Jungh.) Lév. Actually, *Laschia crustacea* Jungh. which I have not studied, has cystidia according to Bresadola, and probably belongs to one of the modern segregates of the ancient form-genus Poria. *Laschia spatulata* Jungh. which is frequent in tropical Asia, is, as most species of *Favolus* sensu aut., non Murr. nec Jungh., a *Polyporus* with rather elongated pores. *Laschia spatulata* is the same as *Favolus multiplex* Lév., *F. tener* Lév., and *Hexagona pertenuis* Murr., but neither epithet can be used in *Polyporus* without forming a homonym of an already existing combination. However, Bresadola indicates *Polyporus vibecinus* Fr. as a synonym of his combination *Favolus spathulatus* (Jungh.) Bres., and this, if correct, would mean that the legitimate name for *Laschia spatulata* Jungh. is *Polyporus vibecinus* Fr. (fide Bres.).

Later authors, especially Montagne and Berkeley, used the Friesian name *Laschia* in a much broader sense, including homobasidial fungi with more or less favoloid or merulioid to sublamellose hymenophores, such as *Laschia auriscalpium* Mont., and *L. agaricina* Mont., and even centrally stipitate agaric-like forms such as *Laschia caespitosa* Berk. and *L. viridula* Berk. ex Cooke.

Patouillard, in 1887, started his studies with a survey of the Laschias (22), referring the original species for the first time to the Auriculariaceae where they actually belong, and dividing the remaining and, as he then thought, polyporaceous group in three sections: *Laschia* proper, or section *Eu-Laschia*, section *Porolaschia*, and section *Favolaschia*, describing a typical species for each of these sections. Eight years later, Moeller (20) showed that Patouillard should have buried the genus *Laschia* for good, once its identity with *Auricularia* was established. Certainly this procedure would have immensely simplified the *Laschia*-problem. But Moeller no doubt went too far in suggesting that *Laschia delicata* Fr. is not merely an *Auricularia* but a synonym of *Auricularia auricula-Judae* (though most of the observers of the tropical Auriculariaes agree that the configuration of the hymenophore varies considerably.)

In 1895, Hennings, starting his somewhat superficial studies on Cameroun fungi (5), recognized Patouillard's *Favolaschia* as an independent genus, and described a new genus, *Campanella*. Its type species, *C. Buettneri* Henn., is, according to Lloyd, identical with or close to *Campanella cucullata* (*Merulius Junghuhnii*) which in reality belongs to Patouillard's section *Eu-Laschia*. Hennings somewhat later described another genus novum, species nova: *Filoboletus mycenoides* Henn. (6) which he thought to be intermediate between *Laschia* and *Boletus*. Höhnel recollected and redescribed it (7) and his well preserved dried material and slides have been studied by the writer. It appears to belong to Patouillard's section *Porolaschia*.

Patouillard, however, changed his mind on the whole *Laschia*-problem before publishing his Essai (1900). As a consequence we find his former sections now, scattered and partly changed, as independent genera in various groups of Basidiomycetes. And among these, *Porolaschia* (Pat.) Pat. has been redefined in order to exclude the species closest to what Hennings called *Filoboletus*, and restricted to accommodate but forms of the type *Laschia Sprucei* Berk. The *Filoboletus*-like species were transferred to *Leucoporus* (corresponding to our genus *Polyporus* sensu stricto) as section III: *Gelatinosi* Pat. *Favolaschia* and *Porolaschia* were taken to the agarics while the section *Eu-Laschia*, now genus *Laschia* Pat. non Fr. was considered to belong to the Cantharellaceae. Since *Laschia* Pat. is the same as *Campanella* Henn., we have to use Henning's name, if, of course, the genus is to be maintained. Since the meaning of the *Porolaschia*-group has been changed when it became a genus, excluding *Filoboletus*, the latter is a valid genus, if it has to be maintained.

Patouillard is, up to this day, the only author who realized the affinity of *Filoboletus* and *Leucoporus* sect. III *Gelatinosi*, making *Filoboletus* the fourth, i.e. subsequent section of *Leucoporus*.

When revising Henning's genera, Höhnel (8) identified *Campanella* Henn. with *Dictyolus* Quél. (i.e. *Leptotus* Karst.). This is an error resulting from Hennings' claim that his fungus is not gelatinous, a statement which had also caused Patouillard to recognize Hennings' genus as a section of his genus *Laschia* Pat. non Fr., while actually *Laschia* Pat. non Fr. and *Campanella* are plain synonyms. Killermann (11) identified *Campanella* with *Arrhenia*, probably for the same reason.

Lloyd (14), under the heading "The mesopodial Laschias" listed three species of *Filoboletus*, but without reference to this latter genus, and without any further discussion of their affinities. He considered this group, I take it, as but a section of what he called *Laschia*, and what is neither *Laschia* of Fries, of Patouillard, nor of Junghuhn, but the same as *Favolaschia* (Pat.) Henn. In some later notes (16, 17), Lloyd gave his opinion on *Favolaschia* and *Campanella* in the following way: *Campanella* and *Laschia* Pat. are considered to be the same, and the former name is adopted; this group is, in accord with Hennings' original disposition, listed as a genus of the agarics. "*Laschia*" Lloyd, i.e., *Favolaschia* (Pat.) Henn. is considered to be a "poroid" genus, meaning it belongs to the Polyporaceae. As for the original *Laschia* Fr., Lloyd refers all species of this to *Auricularia delicata*.

The three basic groups of Laschias which we find in Lloyd's treatment, namely the "Mesopodial Laschias," the genus *Campanella*, and *Laschia* sensu Lloyd, are, essentially, good, natural groups as will be shown in the next chapter. Aside from this, Lloyd (13) was, as far as I know, the first to show that several species had been "dumped" in the genus *Laschia*, one of them, *Laschia guaranitica* Speg. being a form of *Polyporus pusillus*,

or *P. rhipidium*, or *P. subpulverulentus*, a fungus which has been made the type of the genus *Dictyopanus* Pat. (24).

Van Overeem (21) described two genera of what he calls Mycenaceae, both considered to be close to each other as well as to *Mycena*. These genera are *Poromycena* and *Mycenoporella*. I have not seen the type specimens but the descriptions, accompanied by good illustrations in color, can be determined, without running too much risk, as a segregate of *Mycena* in one case (*Poromycena*), and as a synonym of *Filoboletus* in the other (*Mycenoporella*).

THE AUTHOR'S VIEW

When using Melzer's reagent as a medium for spore and tissue study, the writer has been able to distinguish some of the holobasidial groups maintained by the authors cited above, by the reaction of the spore and hyphal walls with iodine:

(1) Spores amyloid, trama non-amyloid: *Favolaschia*, *Porolaschia*, *Filoboletus*, *Dictyopanus*.
(2) Spores and tramal hyphae non-amyloid: *Campanella*.
(3) Spores non-amyloid, hyphae amyloid: *Poromycena*.

In group 1 with amyloid spores, the genera *Dictyopanus*, *Filoboletus*, and *Favolaschia* are very different from each other, in every other respect, and only *Porolaschia* seems to come too close to *Favolaschia* because of the iodine-reaction. Actually, as it seems to the writer after careful study of the types, *Porolaschia* and *Favolaschia* cannot be generically separated. Among the holobasidial Laschias, the iodine reaction, therefore, confirms the following elementary genera: *Campanella*, *Poromycena*, *Favolaschia*, *Filoboletus* and *Dictyopanus*. This takes care of the delimitation of the subdivisions of the *Laschia*-complex. But it does not give a solution as for the very contradictory statements concerning the affinities of the groups involved.

THE RELATIONSHIPS OF FAVOLASCHIA

When comparing the type material of many species of the largest genus, *Favolaschia*, the author was impressed by the characteristic sterile hymenial and cuticular bodies in *F. cinnabarina* (B. & C.) Pat. and similar species. When observed superficially and with a generalizing mind, they will certainly suggest the Marasmioideae of the Agaricineae, especially if the new additional character of the amyloid spores is considered. But the irregular shape of the spores of some species and the cup-like, distant young pores in others remove it from all genera of agarics where a tendency toward a poroid hymenophoral structure has been observed. And while all the agarics which may seem to be related to *Favolaschia* (such as *Marasmius*, according to Patouillard) belong to the Marasmioideae rather than to the Pleurotoideae, the habit and development of the Favolaschias and

other so-called Laschias would make them comparable with the Pleurotoideae rather than with any other agarics. Furthermore nobody ever observed anything that might be interpreted as a transitional formation between the rather constant honey-comb-pores of the Favolaschiae and the lamellae of the Agaricineae; at least such formations were never observed in *Marasmius*, or any related group of Marasmioideae.

When the sterile bodies of *Favolaschia* were more closely compared with the broom-like cells and hairs, and the so-called diverticulate hyphae of the agarics, the writer found them to belong to different types. The only type of sterile bodies they entirely match is the dendrophysis of *Aleurodiscus*, and of some Corticieae. *Aleurodiscus* is a genus of the Coticiaceae according to the majority of authors, yet, it belongs to the Cyphellaceae according to Patouillard (1900) and Gäumann (1926).

Dendrophyses are likewise found in the outside of the cups of *Cyphella*. Here and also in *Aleurodiscus* where they intrude into the hymenium, they usually are narrower than the dendrophyses of *Favolaschia*, but in this latter genus a slender kind is also observed, especially in the hymenium of the hymenenophore, while in *Aleurodiscus* and *Corticium* broader dendrophyses also occur but are described by Bourdot and Galzin (2) as "sterile basidia," if they are devoid of crested spines, and, instead, appear more nodulose to ramose, or entire. The nodose type however is better known under the term of "pseudophysis" (a rather unfortunate word). We realize that in some cases dendrophyses may be connected with pseudophyses by transitional formations. Of *Aleurodiscus apricans* Bourd., for example, Bourdot says that "toward the margin almost all organs terminate with an appendage which is ovoid and thorny with obtuse teeth." This coincides with our observation that dendrophysoid formations, i.e. broad, crested, erect hyphae, are practically confined to the margin, pore-edges, and sterile surfaces of the Favolaschias, and are only exceptionally found in the pores (sides of the dissepiments) while smooth bodies, and thin ramose bodies, both more or less pseudophysoid, are equally numerous in the interior of the pores of some species. In *Cyphella*, the marginal hairs may, if crested, well be compared with the narrower types of dendrophyses though not tending to become constantly erect.

In some species of *Favolaschia*, a cuticular formation can be observed that seems to be more primitive than the dendrophyses, and can also be derived from the crested hairs of the *Cyphella*-cups. It is the cuticular layer of diverticulate but horizontal, repent, not individualized hyphae which is so familiar in *Mycena*, and in the section *Rameales* of *Marasmius*. It occurs in *Favolaschia rubra* (Bres.) Pat., *F. pezizaeformis* (B. & C.) Sing., and *F. minima* (Jungh.) Sing. Yet, it is more than probable that this structure originated independently in *Favolaschia* and in the Marasmioideae (*Mycena*, *Marasmius*, etc.) as in *Mycena* the diverticulate hyphae

represent the epicutis covering a well developed subcutis while in the three Favolaschias such a differentiation is not present.

The superficial similarity of the structure of *Favolaschia* and the Marasmioideae becomes still more apparent when characters other than the above mentioned sterile bodies are compared. When searching for Lloyd's "color glands" in the Favolaschias, the writer was surprised to discover typical gloeocystidia, pigmented in some species, pigmentless in others. They are quite different from the colored cheilocystidia of *Mycena crocea*, *Pluteus atromarginatus* (Sing.) Kuhn, etc. How could it happen that no author compared these bodies—provided he saw them—with the gloeocystidia of the Corticia? I do not know. But the fact remains that they are gloeocystidia. Even the colored type ("color glands") is frequently met with in *Corticium* and *Peniophora*, e.g., *P. lutea*. It is irrelevant whether or not this species is really a *Peniophora*, but its cystidia were no doubt correctly described as gloeocystidia by Bourdot and Galzin (2).

The anatomical details discussed here and used in the keys and descriptions were obtained after reviving the dried mtaerial in a 15% KOH-solution, and staining the sections by adding a watery phloxine solution, or, after washing out the alkali, and staining with brilliant cresyl blue. Other portions of the washed out material were treated with Melzer's reagent in order to obtain the data on amyloidity, reported above.

The metachromatic stain obtained with cresyl blue is recommended for all observations concerning gloeocystidia. This dye brings about a bright blue discoloration of the normally hyaline or yellow contents of gloeocystidia, not only when these contents are coarsely granose and evident without any coloring matter, but even in cases where the contents are structureless and colloidally dissolved. At the same time, the walls are put in striking contrast with the contents, appearing lilac in cresyl blue. This method of staining helps to reveal gloeocystidia and their basal proliferations in the trama in cases where they do not show up clearly in other dyes or water. The best test of the usefulness of cresyl blue is the way it stains the basidiomorphous gloeocystidia of *Favolaschia pezizoidea* (B. & C.) Sing.

In absence of better dyes for the walls of the elements of the carpophores, cresyl blue is still the best dye for most of them. The dendrophyses assume a pale lilac tinge localized in the wall; when the immersion objective is focussed at the echinulation of the upper side of the dendrophyses (i.e. nearer to the observer), the spines are well contrasted appearing deep lilac on pale lilac ground. The real wall of the dendrophyses is differentiated from a sometimes strongly developed pseudomembrana agglutinated at the inside of the wall, probably gelatinized matter. Likewise, one can observe a hyaline space between the upper end of the contents and the tip of the wall of the gloeocystidia. All these secondary or false walls remind

one of the pseudo-membrana in the cystidia of some species of *Inocybe*. If stains other than cresyl-blue are used, such a acid fuchsin solution, the incorrect impression may be obtained that the walls of these bodies are thick, like the wall of the *Peniophora*-cystidium, or the cystidium of *Campanella* and *Geopetalum* (see p. 180). The metachromatic stain also reveals that the gloeocystidia, when old, are gradually dissolving or breaking down their walls, eventually becoming naked masses of contents which, however, in most cases retain their original shape for a long time. The contents are seen to be of many kinds: either homogeneous-colloidal, or consisting of individualized bodies from extremely faint fibrillae to coarse subglobose granulae, usually densely packed.

As we have seen, the dendrophyses do not differ fundamentally from the pseudophyses which, by the way, also occur in *Favolaschia*, especially numerous and well developed in *F. pustulosa* (Jungh.) Sing. and *F. rubra* (Bres.) Pat. The same is true as regards the dendrophyses on one hand and the gloeocystidia on the other. In *F. sabalensis* (Charles) Sing. occur empty globose bodies on the pore edges and the sterile outside of the pileus. These spherocysts can be explained in two ways. They are either empty gloeocystidia, or smooth dendrophyses. In *F. saccharina* Pat. we find a characteristic loose mealy covering (hence the name "sugary") consisting of cells which clearly represent a combination of both dendrophyses and gloeocystidia. They are globose cells separated from each other, containing the contents of a gloeocystidium, but having the crested-echinulate wall of a dendrophysis.

Unlike similar elements in the Marasmioideae, all the elements mentioned do not form a continuous epicutis, but rather a discontinuous floccosity. They are irregularly intermixed and juxtaposed without forming a true palisade and, in this connection, rather recall the epicutis of some Russulaceae or, in the case of *Favolaschia saccharina*, remind one of the surface layer of *Cystoderma*, *Phaeolepiota*, and some Coprini.

It is true that there is, in agarics, another type of deep-rooting obviously excretive and contents-bearing hymenial elements. Since they are merely the hymenial proliferations of the laticiferous system, they have been called pseudocystidia by Kühner. It is interesting to compare typical pseudocystidia such as found in *Russula* with the gloeocystidia, staining both with brilliant cresyl blue. No metachromatic phenomena are observed in the pseudocystidia (commonly described as cystidia) of *Russula emetica*, and the contents do not become vividly bright blue and thus contrast with the walls. Instead, the walls of the pseudocystidia stain as much as the least susceptible basidial walls of the same mount. Unless other types of pseudocystidia, not examined by the author, show more analogy with the gloeocystidia, pseudocystidia and gloeocystidia are to be considered as different types of cystidia.

While typical gloeocystidia are not observed in agarics, they have been observed in *Aleurodiscus*. Furthermore, in this latter genus, Bourdot and Galzin list several species with amyloid spores, and the author has found the trama non-amyloid in these same forms. In some species of *Aleurodiscus* and *Corticium* we find exactly the same types of sterile bodies as in Favolaschias: pseudophyses, dendrophyses, and gloeocystidia, all together in one individual. It will be remembered that the margin of some species of *Aleurodiscus* is turned up, and the base slightly elevated what gives them the shape of a *Cyphella*. Whether Patouillard's and Gäumann's classification of *Aleurodiscus* in the same group with *Cyphella* is correct or not, it seems to us that these genera are related, since the marginal hairs of some Cyphellae correspond surprisingly well to the dendrophyses of some Aleurodisci. It may be supposed that both *Cyphella* and *Aleurodiscus* were derived from a common ancestor. However this may be, what really matters, as far as the *Laschia*-complex is concerned, is the fact that in *Aleurodiscus*, a genus undoubtedly related to *Cyphella*, all the chemical and anatomical particularities of *Favolaschia* can likewise be observed.

If there is a relationship between *Cyphella* and *Aleurodiscus*, the explanation of the peculiar hymenophore of *Favolaschia* becomes very simple. Some species of *Cyphella*, e.g. *C. conglobata* Burt, grow in dense clusters, and offer the aspect of a wide-pored "Poria." When this attachment becomes very intimate and obligatory, in other words, when a multitude of individuals becomes a single individual fruit body, the resupinate *Favolaschia* has originated. It is quite understandable that the mutual pressure of the cup walls provokes their becoming angular. Aside from this, the polygonal, especially hexagonal arrangement is more economic for the proportions between hymenium surface obtained and the amount of tissue used. The hairs of the sterile outside of the Cyphellaceae would thus be confined to the surface of the pileus or/and the margin of the pores where in *Favolaschia* all the dendrophyses are found. The stipe would be a secondary formation of the confluent cup-bases, and this is not without precedent: The type species of the genus *Rimbachia* Pat., *R. paradoxa* Pat., referred to the agarics for no apparent reason by Patouillard, Hennings and Lloyd, has been studied by the writer (see descriptive part, p. 186) and found to be a long-stipitate cyphelloid fungus. If this stipe is formed laterally instead of basally, i.e. only the outer cups of one side participating in its formation, and the combined cups, now forming the "pileus," are bent over, the "pileus" becomes laterally stipitate and the hymenium inferior. That is what has occurred in *Favolaschia*. The question of whether this bending over has at some time actually taken place, can be answered affirmatively, since the individual cup of other stipitate fungi belonging to the Cyphellaceae such as "*Merulius*" *pezizoideus* Speg. is distinctly bent over like a bell flower, and during the individual development of some

specimens of *Favolaschia*, this phase should be easy to demonstrate since no other transformation from the original subresupinate stage to the eventual pileate-stipitate stage can be conceived.

This explanation is not as extraordinary and audacious as it may seem at the first glance. It is not without parallel either. Several authors [Lohwag (18), Gäumann (4), and Lohwag and Follner (19)] have shown with a number of good reasons in their favor that poroid fungi such as *Porothelium*, and especially *Fistulina*, are closer to the Cyphellaceae than to any other aphyllophoraceous group, and the interpretation of the pores of these genera, as given by the above authors, is essentially the same as the explanation given here in the case of *Favolaschia*. The main difference between these cases consists in the degree of development of the stromatic portions. In the Fistulinaceae, these are developed much stronger than in *Favolaschia*. It is of interest to follow the development of such species as *Favolaschia pezizaeformis* (B. & C.) Sing. where the very young hymenophore is flat and shows round pits widely separated from each other with the layer of basidioles and the subhymenium forming a definitely limited circle at the mouth of each. These pits widen gradually and, once mature, the hymenium covers real tubes. The initial pitted depressions are now larger in diameter than the wall separating them, and the latter is of about equal diameter everywhere. As a consequence, the pores are now angular-polygonal. On the basis of the available facts one is led to assume that *Favolaschia* is a pore-bearing member of the suborder Cyphellineae with some features reminiscent of *Aleurodiscus*. As for the remaining genera with amyloid spores, their characters seem to suggest quite different affiliations which will be discussed later (p. 183).

THE RELATIONSHIPS OF CAMPANELLA

A situation comparable though not identical with the one discussed in *Favolaschia* may be noted in *Campanella*. A superficial evaluation, based on the lamellose arrangement of the hymenophore and the "pleurotoid" habit of these species, will certainly tend to support the view of Hennings and Lloyd who refer this genus to the agarics. It must be admitted that a more profound study of the anatomy of various species of *Campanella* and of pleurotoid agarics makes this view more plausible than the traditional classification of *Favolaschia* in the polypores. The cuticular layer of *Campanella* shows more or less definitely the so-called *Asterostromella*-structure, i.e. thin and branched hyphae, so-called dichophyses, usually branching at right angles, the branches being rather short and obtuse, sometimes crowded, or nodose. This structure, formerly known only in the genus *Vararia*, has recently (28) been found also in a genus of Pleurotoideae, i.e., in the agarics, namely *Asterotus dealbatus* (Berk.) Sing. *Geopetalum* Pat., another agaricaceous genus, frequently shows gelatinous layers, a

structure which does not exactly equal the tramal structure of *Campanella* but is no doubt comparable. *Geopetalum carbonarium* (A. & S.) Pat. even shows venose lamellae comparable though not too similar to the hymenophore of *Campanella*. And this is not all. In one species of *Campanella*, *C. simulans* (Pat.) Sing., cystidia are observed which very frequently resemble closely the cystidia of *Geopetalum*. Yet it cannot be claimed that they belong to the same type of cystidia, since they are smaller, and have a less stratified and less heavy wall in *Campanella*. They may or may not be an indication of relationship between *Campanella* and *Geopetalum*.

It must, however, be remembered that in the polypores (in the broader sense of the word) all characters mentioned are also present in one or another genus: gelatinous layers in *Gloeoporus*, asterostromelloid structure in *Vararia luteopora* (Bond.) Sing., and cystidia like those of *Campanella simulans* in many genera of the Polyporineae. In view of the presence of the above characters, *Campanella* can probably be considered to be "related" to almost any group of basidiomycetes. It should not be forgotten that *Campanella* shares two of the characters mentioned here with certain species of *Favolaschia*, and that to this day it has been considered congeneric with these by the majority of authors. The asterostromelloid structure has been observed by the writer in *Favolaschia vararioiecta* Sing., and in a less obvious form in other species. The trama of all Favolaschias is strongly gelatinous as in *Campanella*. There remains the question of the cystidia. We have seen that *Favolaschia pezizoides* (B. & C.) Sing. has thick walled marginal hairs which are exactly cystidioid and sometimes approach the cystidia of *Campanella simulans* in shape although they are much more variable. It may be assumed that these bodies are of the same origin.

On the other hand, it seemed necessary to find out just how far the analogy of the cystidia of *Campanella simulans* and the species of *Geopetalum* goes. I tried, therefore, to stain them according to the same method of using cresyl blue and adding some ammonium hydroxide to the watery medium. The different behavior of the two types of cystidia in cresyl blue is apt to discourage all speculations regarding their similarity. In *Campanella* they stain less readily becoming pale lilac to pale blue than do the basidia, which become deep lilac or violet. The metachromism in **Geopetalum angustatum** (Berk.) Sing. comb. nov. (*Panus angustatus* aut.) is almost exactly opposite: the basidia are violet-blue while the cystidia stand out beautifully in a deep rich lilac since the entire wall stains this color.

It seems, therefore, reasonable to assume that a genus, close to *Favolaschia* in many important characters, especially in the histology of all its organs (hymenophore, trama, and cortical layers), and also in appearance, ecology, and geographical distribution, such as *Campanella*, should have

similar affinities. *Campanella*, in the author's opinion, is still closer to *Cyphella* than *Favolaschia* (which is about equally close to *Cyphella* and *Aleurodiscus*). The non-amyloid spores, constant absence of gloeocystidia and dendrophyses, the more irregular and simpler structure of the cuticle, and the more irregular structure of the hymenophore point to a less developed organism, a more primitive position. Actually, some species of *Cyphella* (such as *C. laeta* Fr.) have a venose disk instead of a smooth one, and the basal attachment to the substratum is not central-inferior but lateral, and even extended into a small stipe, as shown in Patouillard (23), p. 55, fig. 38, 6.1900. These forms are astonishing in their resemblance of *Campanella*. *Cyphella muscigena* Fr. sometimes forms stipitate-spathulate carpophores which are said (Bourdot & Galzin, 2; also Killermann, fide Bresadola, 11) to be the same as *Arrhenia auriscalpium* Fr., the type of the genus *Arrhenia* according to Patouillard (23). *Arrhenia cupularis* (Wahl.) Fr., however, does not seem to be generically different from *Plicatura* (Meruliaceae).

The Arrhenia-forms of *Cyphella* come close not only to *Campanella* but also to another supposedly cantharelloid or even agaricoid genus, *Leptotus* Karst. (*Leptoglossum* Karst., *Dictyolus* (Quélet). In fact, Quélet as long as 70 years ago, stated (26) that the group of fungi which he later called *Dictyolus*, i.e., *Leptotus* Karst., "is similar to the Cyphellae." The hymenophore in *Leptotus* is still more gill-like, though mostly venose or at least with obtuse edges and sometimes anastomosing, than in *Campanella*, and the trama is definitely not gelatinous. Ecologically they appear to be different, too, with *Leptotus* growing on living mosses while *Campanella* grows on dead wood.

It seems therefore logical to refer both *Campanella* and *Leptotus* to the Cyphellineae rather than to the Cantharellaceae. The latter family, consisting mainly of the genera *Cantharellus* and *Craterellus*, is much closer to *Dentinum repandum* (L. ex Fr.) S. F. Gray and the Clavariaceae. It differs from *Leptotus* in many ways, having colored instead of white spores, being entirely different in consistency, size and shape, with larger, especially longer stichobasidia instead of medium sized chiastobasidia, the basidia being different even if the more *Clavaria*-like chiastic genus *Gomphus* is included. These cantharellaceous genera are also different chemically, physiologically, and ecologically. The traditional classification of many true agarics (*Trogia*, *Nyctalis*), a boletineous genus (*Hygrophoropsis*) and a genus of the Meruliaceae (*Plicatura*), all within the same family or subfamily respectively, is merely due to the similar appearance of the hymenophore, a character of the utmost flexibility, and not practicable for the characterization of the basic groups of the basidiomycetes. For the same reason *Campanella* and *Leptotus* have been assigned to the Cantharellaceae aut., though there actually is not the slightest affinity be-

tween these genera and those referred there by Patouillard, Hennings and others.

RELATIONSHIPS OF DICTYOPANUS AND FILOBOLETUS

The remaining groups of the *Laschia*-complex, *Filoboletus* and *Dictyopanus* are according to the authors of these names, boletes or agarics respectively (Cantharellaceae). I am inclined to think, however, that both are agarics. They have exactly the habit and manner of growth of agaricaceous fungi to which they are related: *Filoboletus* reminds one of *Marasmius* or *Collybia*, or *Mycena*, or *Omphalia* in most external characters; *Dictyopanus* is, as has been claimed rightly by Patouillard, like a *Panellus* but with often gelatinous trama of the hymenophore and densely alveolately connected lamellae, giving them the appearance of Polypore-pores, or "Favolus"-alveolae.

Filoboletus with its radially elongated, and in some cases lamellosely arranged pores which, near the point of attachment to the stipe, usually assume clearly lamellose character—much as in *Boletinus* and *Phylloporus* among the Boletaceae—thus reveals its affinities with the Agaricales, and especially the Marasmioideae. The more or less gelatinized hyphae of the trama are also observed in the genus *Micromphale* (*Heliomyces* sensu Sing., Mre., non Lév.). The combination of amyloid spores and non-amyloid trama is observed in the marasmioid genera *Omphalopsis* Earle (*Xeromphalina* Kühn. & Mre.), *Hydropus* (Kühn.) Sing., and *Fayodia* Kühnar. Cystidia like those found in *Filoboletus mycenoides* are common in *Mycena*. In *Filoboletus gracilis*, the author observed a peculiar differentiation in the cuticular layer, a large-celled subcutis, and a poorly developed, but indubitable epicutis of thin repent smooth hyphae. This structure is not uncommon in the Marasmioideae. A tendency toward anastomosing gills is frequently found in the Marasmioideae, e.g. in *Marasmius magnificus* (Henn.) Sing. (see p. 218). While there is, in the agarics, no intermediate formation between the hymenophore of *Favolaschia* and true gills, there certainly is a series of morphologically connecting formations between the pores of *Filoboletus gracilis* (Kl. ex B.) Sing., and **Micromphale foetida** (Sow. ex. Fr.) Sing. comb. nov. (*Marasmius foetidus* aut.). We shall see later that a series of forms connects the extreme types of the hymenophore in the genus *Poromycena*, reaching the poroid form with even pores the radial walls of which, however, are arranged to form straight lamella-like ridges revealing their virtually lamellose structure. The same structure of the hymenophore can be seen in a species of *Filoboletus* from the Philippines determined "*Porolaschia ?Staudtii* Henn." by Patouillard (see also p. 217). Within the intraspecific variation of this latter form, there are both forms with lamellosely arranged pores as mentioned above for

Poromycena and *Filoboletus*, and also pores without any trace of a lamellose arrangement as known in *Filoboletus mycenoides*, and illustrated in *Filoboletus luteus* (Van Ov.) Sing. in Van Overeem and Weese (21).

In the case of *Dictyopanus*, the poroid condition of the hymenophore does not strictly separate it from *Panellus*. A rarely occurring poroid condition of the normally truly lamellose hymenophore of *Panellus stypticus* (Bull.) Karst. has been observed by Patouillard, and also once by the writer. Gelatinous trama of the hymenophore also does not seem to be extraordinary in the Pleurotoideae.

If *Dictyopanus* and *Filoboletus* would be retained in the Polyporineae, the only genus in which they could be placed, would be *Polyporus* sensu stricto. However the amyloid spores would not fit in this case. There is only one genus of polyporoid Aphyllophorales having amyloid spores, i.e., *Bondarzewia* Sing. But the spores in this genus are of an entirely different type, with a strongly amyloid perisporium of the kind observed in the Russulaceae, and, according to Bondarzew & Singer (1), not belonging in the Polyporineae, but rather in the Scutigeraceae Bond. & Sing. which are closer to some amyloid-spored "Hydnaceae" than to the rest of the polypores. This excludes the only chances of reuniting the genera *Filoboletus* and *Dictyopanus* with any known group of polypores, even if their evident affinity with the agrics were ignored.

If, on the other hand, *Dictyopanus* and *Filoboletus* were retained with *Favolaschia* and *Campanella* in the Cyphellineae, their structural peculiarities and all the external analogies with agarics would have to be entirely disregarded, or it would be necessary to operate on the hypothesis that the link originally connecting the cyphellaceous "Laschiae" with the agaricaceous "Laschiae" has either disappeared, or has not yet been discovered.

This disposition of *Filoboletus* and *Dictyopanus* should be regarded as a suggestion concerning the possible relationships existing between these genera and the large, established groups of agarics as presently conceived. It is possible that future discoveries or new data on described species, and as yet unknown characters will furnish the facts needed to fill the gaps between some genera now considered to be true agarics, and the Cyphellineae of the *Favolaschia*- and *Campanella*-type. If this should be the case, some genera of the Tricholomataceae will have to be excluded from the Agaricales and transferred to the Cyphellineae or, more specifically, to the Leptotaceae, just as *Lenzites* and "*Lentinus*" cyathiformis (Schaeff.) Bres. have been shown, years ago, to belong to the Polyporineae rather than to the Agaricales. The group to be transferred eventually to the higher Cyphellineae is likely to include *Geopetalum*, *Scytinotopsis*, *Calathinus*,

Asterotus, *Panellus*, and, of course, *Filoboletus* and *Dictyopanus*, as well as some others.*

At present, any transfers advocated on the grounds of these speculations would be premature and even dangerous, to say the least.

RELATIONSHIPS OF POROMYCENA

Among the Marasmioideae, poroid transformations of the hymenophore are not restricted to the previously discussed genera. We have mentioned the poroid Mycenae of the *Poromycena*-group. These on one hand approach *Mycena*, section *Janthinae* (*M. pura* and related species), having ordinary lamellae, connected by a trivial low irregular venosity (in *P. pseudopura*), frequently met with in true agarics, while on the other hand, these anastomoses may be developed so strongly that they form genuine pores arranged radially (in *P. decipiens*) in a way described above for the *Filoboletus* spec. ("*Porolaschia ?Staudtii* Henn." Pat.). In between the extremes are species with strongly anastomosing but not yet quite poroid lamellae: *P. anastomosans* Sing., and *P. viridula* (Berk. ex Cooke) Sing. (*Laschia viridula* B. ex Cke.). They differ from the rest of *Mycena* in having non-amyloid spores. They differ from *Marsmius* in having smooth repent epicuticular hyphae. Besides, what appears to be a poroid *Marasmius* of the section *Globulares* Kühn., probably identical with *Marasmius polyporoides* Murr., was first described under the name *Laschia* (?) *magnifica* Henn.

In concluding this survey of the *Laschia*-complex, we state the amazing fact that, even if erroneous determinations are entirely left out of consideration, the old genus *Laschia*, as successively compiled by Saccardo, reaches from *Auricularia* to *Mycena*, with affinities, or assumed affinities in nearly all major divisions of the Basidiomycetes. And among the scores of Laschias and so-called Laschias, there is only one lonely species, corresponding to the initially intended meaning of the genus *Laschia: Auricularia delicata* (Fr.) Henn.

The following key should express our conclusions in a condensed form:

KEY TO THE GENERA OF THE LASCHIA-COMPLEX

A. Basidiospores formed on phragmobasidia....AURICULARIA Bull. ex Fr. (fam. Auriculariaceae)
B. Basidiospores formed on holobasidia.
  I. Spores amyloid.
    a. Stipe not central, nor elongate, nor cespitose. If there is a stipe, it is lateral (though

* D. H. Linder who has monographed the genus *Schizophyllum* in the Western Hemisphere, tends towards the belief that *Schizophyllum*, too, is derived from the Cyphellaceae (oral communication to the author, and Linder's courses in mycology). Lohwag's thesis whereby *Schizophyllum* is derived from *Skepperia* is, in contrast to Linder's opinion, highly improbable. *Skepperia convoluta*, type species of this genus, has been studied extensively by the author, not only in consideration of Lohwag's hypothesis but in view of Patouillard's treatment of *Skepperia* as a close relative of *Marasmius*. In the author's opinion, the anatomical characters of *Skepperia* do not justify any comparison with either *Schizophyllum*, or *Marasmius*, *Skepperia* being a spathulate stereaceous genus.

sometimes attached to the deepest point of a sinuosity of the margin of the pileus, thus feigning a mesopodial attachment), never beset with floccules other than those made up by hyphae, dendrophyses, gloeocystidia, pseudophyses, or dichophyses.

1. Spores broadly cylindric, and then rather broad and large (more than 9μ long), or mostly ellipsoid to globose; dendrophyses and gloeocystidia either absent, or present, and, if both of these are absent, the cuticular layer of the pileus and stipe made up of diverticulate hyphae or dichophyses, or pseudophyses; hyphae of the trama usually very gelatinous all through the pileus.....
FAVOLASCHIA (Pat.) Henn., see also supplementary-key, p. 195 (subord. Cyphellineae)
2. Spores small (less than 6μ long), and ellipscid to cylindric; dendrophyses, gloeocystidia, pseudophyses never occurring; hyphae strongly gelatinized only in the tube trauma, or not at all.....
....DICTYOPANUS Pat., see also supplementary key, p. 222. (subord. Agaricineae)

b. Stipe central, elongate, often cespitose, usually more or less floccose because of more of less scattered dermatocystidia which however are not dendrophysoid, gloeocystidioid, or pseudophysoid; cuticular layers never approaching Asterostromella-structure, i.e., devoid of dichophyses.....
....FILOBOLETUS Henn., see also supplementary key, p. 214. (subord. Agaricineae)

II. Spores non-amyloid.

a. Hyphae non-amyloid.

1. Hymenium turned upside in a stipitate cup, only slightly venose-rugulose or smooth; stipe longer than the diameter of the cup..RIMBACHIA Pat. (subord. Cyphellineae)
2. Not as above.

α. Hyphae gelatinois.....
CAMPANELLA Henn., see also supplementary key, p. 190. (subord. Cyphellineae)
β. Hyphae not gelatinous.....LEPTOTUS Karst. (subord. Cyphellineae)

b. Hyphae amyloid.

1. Epicutis of the pileus of smooth, repent, thin, hyaline hyphae.....
.....POROMYCENA Van Ov., see supplementary key, p. 219. (subord. Agaricineae)
2. Epicutis not as above..*Marasmius magnificus* (Henn.) Sing. (subord. Agaricineae)

Descriptive Notes on Selected Species of the Laschia-Complex

CYPHELLINEAE

CYPHELLACEAE

CYPHELLA CONGLOBATA Burt, Ann. Missouri Bot. Gard. 1: 375, pl. 19, fig. 15, 1915.

The microscopical characters of the type and an identical collection by Jackson from Bell's Lake, Ontario, Canada, are:

Spores hyaline, cylindric or suballantoid, smooth, most of them with a pluriguttulate content, with or without a slight suprahilar depression, non-amyloid, 7–10.5×2.8–3.2μ; basidia clavate, not very thick and medium long, with four straight and rather long sterigmas, 35–39×6–6.5μ; pigmented hyphae of the outer surface of the cups not or little gelatinized, with crested-echinulate diverticulation and a brown membrana-pigment, more or less interwoven, irregularly and obliquely erect, thin: about 2–3μ thick, with clamp connections, imbedded in a gelatinous mass and very loosely arranged, non-amyloid, smooth.

These characters certainly tend to confirm the impression obtained from the macroscopical features: *C. conglobata* is, in a certain sense, a prototype

of the laschioid Cyphellineae, i.e., *Campanella* and *Favolaschia*. Burt (l.c.) says: "One might regard this fungus as the type species of a new genus distinct from *Cyphella* or *Solenia* by the common central mass on which the individual cups are born. . . ." He is probably right in this though we would prefer to delay the proposal of a new generic name for this group until the Cyphellaceae are reorganized more logically than they are now.

The macroscopical description given by Burt does not need any emendations.

RIMBACHIA PARADOXA Pat., Bull. Soc. Myc. Fr. **7**: 159, pl. 11, fig. 1. 1891.

This species is macroscopially much like Patouillard's figures. It evidently grows on dead fragments of mosses, and is said to be white when fresh. The stipe is long and conspicuous.

Material in Patouillard's Herbarium shows non-amyloid spores which are smooth, applanate on their inner longside, hyaline and thin walled, 10.5–11×3.8–6μ; hymenium on the upper side of the cup shaped structure on the top of the stipe, consisting of rather small basidia: 26–28×6.3–6.8μ; sterigmata four; trama non-amyloid.

Arrhenia pezizoidea (Speg.) Pat., Herb., comb. nov. ad inter.

Syn.: *Merulius pezizoideus* Speg., Acad. Nac. Cienc. Cord. **11**: 455. 1889.
Campanella pezizoidea Lloyd, Myc. Not. 3, letter **27**: 4. 1910.
Rimbachia pezizoidea Lloyd, Myc. Not. **5**: 817. 1919.

Carpophores calyciform-stipitate, the hymenium superior in the concave side of the cup, the apex of the stipe however usually bent over and then the side of the cup which is nearer to the stipe often lower or very low, the carpophore thus appearing spathulate as in *Arrhenia auriscalpium;* cup white, 5–18 mm. in diameter and thin, membranaceous: about 0.25 mm. thick; sterile outer surface white and glabrous according to Spegazzini, sordid and subpubescent in the dried specimens; hymenophore pallid, becoming almost fulvous, irregularly reticulate because of small veins radiating and ramosely anastomosing from the center; the alveoli thus formed 0.1–0.5 mm. in diameter; stipe rather rigid, concolorous with the outside of the cup, subpubescent in dried material, 5–25 mm. long, 0.3–0.8 mm. thick, subequal or slightly thickened (1 mm.) at base.

Spores (5) 5.5–7.7 (8.7)×(3.7) 4.2–5.5 (6.3)μ, short ellipsoid, without suprahilar depression, thin walled, the wall later becoming thicker and an arcuate septum sometimes developing, hyaline, non-amyloid; smooth; basidia (25) 27–28×5.2–7μ; basidioles narrower, subfusoid or filamentous; other sterile bodies none; subhymenium distinct, of very thin, closely interwoven hyphae, denser than the trama of the cup which appears to be gelatinous, consisting of very loosely arranged, easily separating, wavy-irregular, thin walled slender (1–4μ in diameter) hyphae; hyphae of the

stipe parallel; hyphae of the cuticular layer of the outside of the cup much denser than the trama, not gelatinized, somewhat interwoven but all repent, large elongate hyphae mixed with very thin ones, the former 15–18μ in diameter, the latter not more than 1.5–2.2μ thick; hyphae near the line separating the cuticular layer from the trama often thick walled; some thick walled hyphae occasionally reaching the surface of the outside of the cup or its margin, and rarely assuming the shape of cystidia; all hyphae non-amyloid and with clamp connections.

Habitat: On logs in gardens, etc. Gregarious.

Distribution: Tropical South America.

Observations: The genera *Rimbachia* and *Arrhenia* seem to be very close to each other and to *Cyphella*, possibly too close to the latter, as long as it is treated in the broader sense of Bourdot & Galzin, and others. Having little personal experience with the classification of *Cyphella*, I am unable to suggest any solution at present. But it seems that the generic names *Rimbachia* and *Arrhenia* will be needed as soon as a reclassification of the Cyphellaceae is possible.

As for *Arrhenia pezizoidea*, I do not believe that this fungus belongs to *Merulius* as Spegazzini thought. It is included in these studies because it has a hymenophore and a trama much like *Campanella*, and therefore has been compared with "*Laschia*" in the literature. The structure of the cuticular layer and the pezizoid habit, however, distinguish this species from *Campanella*. Unfortunately, I have never had a chance to study *Arrhenia auriscalpium* in Europe and do not know the latter well enough as far as its anatomy and variable habits are concerned to accept its identity with *Cyphella muscigena*, proposed by several authors. It seems to me, however, that this identity is very uncertain. Nevertheless, there appears to exist a group of Cyphellae, among them *C. muscigena*, which seems to deserve generic rank. Both Fuckel's and Burt's collections of *C. muscigena* do not show clamp connections, and have no marginal hairs, but are different from each other. They can however not be congeneric with *Arrhenia pezizoidea*. If the latter actually is an *Arrhenia* as Patouillard thought (who by the way *knew A. auriscalpium*), it must be assumed that *Arrhenia auriscalpium* is different from both Fuckel's and Burt's material of what they called *Cyphella muscigena*, and must have clamp connections as *Arrhenia pezizoidea*. The whole problem is much too complicated, and no facts about the types of the European species are known. Under these circumstances, the value of the genus *Arrhenia* can not be determined, and the combination *Arrhenia pezizoidea* is proposed only "ad interim" and "fide Patouillard." Should *Arrhenia* eventually turn out to cover this species if used in the sense of Patouillard (1900), i.e., granting that *A. auriscalpium* to be the type species, and assuming that this species has the same essential characters as the tropical species, the genus *Arrhenia* would

have to be considered intermediate between *Cyphella* and *Campanella* or the Cyphellaceae and the Leptotaceae.

There is in Curtis' Herbarium at Farlow Herbarium a species of *Laschia*, labeled under an unpublished name, which is most certainly congeneric and close to *Arrhenia pezizoidea*, but which differs in being larger and the spores being narrower: 6.3–9×4.2–5μ. The specimens from Venezuela are *very large*, the ones from Cuba are smaller but still larger than the usual *Arrhenia pezizoidea*. There are, however, no notes on the fresh fungus, and a posthumous publication of Berkeley's and Curtis' herbarium name does not seem to be urgent without such notes. Another closely related species, macroscopically identical, with much smaller basidia but without spores in the type material (immature ?) is the African *Rimbachia camerunensis* Henn. And finally *Rimbachia cyphelloides* Lloyd, judging from the photograph, may belong in this small group of tropical Arrhenias.

Lloyd (15) thinks that *Arrhenia pezizoidea* is a *Rimbachia*, and that *Rimbachia paradoxa* Pat. is identical with it. This, however, is an incorrect statement as far as the identity of the species goes, and in regard to the generic position of the latter. I have shown that this is still an open question.

My description of *Arrhenia pezizoidea* is based on dried material, collected by Rick in South Brazil, and by R. T. Thaxter in Grenada, West Indies (det. R. Singer); some data are taken from Rick (color, etc.).

Leptotaceae R. Maire em. Sing.

Syn.: *Dictyolaceae* Gäumann

This family, here used in a wider sense, to include *Favolaschia* and *Campanella*, and, at the same time, in a narrower sense to exclude *Geopetalum* Pat. (Agaricineae, Tricholomataceae) and *Hygrophoropsis* R. Maire (Boletineae, Paxillaceae), has the following characters:

Pileus eccentrically or laterally stipitate or sessile to resupinate with a definite margin, small, usually diaphanous and radiately or tesselately striatulate or tesselately pustulate, corresponding to the walls or the lamellae of the hymenophore. Hymenophore inferior, consisting of alveolate tubes, or veins or obtuse lamellae with or without connecting veins and anastomoses. Cuticle either not differentiated, or with a simple cuticular layer, in the latter case with dense or regular diverticulate hyphae or with asterostromelloid structure, or with dendrophyses, or with pseudophyses and sometimes with conidia-bearing hyphae. Trama gelatinous or not. Hyphae with clamp connections, non-amyloid. The hyphae of the hymenophore trama interwoven or very loosely arranged and wavy-subirregular in a gelatinous mass. Spores medium to rather large (longer than 5μ, and up to about 16μ), broadly cylindric or, more often, ellipsoid, or subglobose, hyaline, smooth, amyloid or non-amyloid, asymmetric with

continuous, simple, thin wall. Basidia uni-cellular, of medium volume, sometimes rather long, sometimes short and thick, 2- or 4-spored, probably always chiastic. The sterile bodies of the cuticular layer sometimes entering the hymenium (pseudophyses, dendrophyses, etc.) which is continuous on the hymenophore, some cystidoid elements occasionally forming hymeniform patches or intermixed in the basidia; gloeocystidia frequently present in species with amyloid species; they are either hyaline or colored (mostly yellow), and sometimes connected with gloeo-vessels in the trama, not always reaching the surface of the hymenium or cutis. Habitat: The species of the temperate zones mostly on living mosses, the species of subtropical and tropical zones mostly on dead wood.

Genus LEPTOTUS Karst., Hattsv., p. xvii. 1879.

Syn.: *Corniola* S. F. Gray, Nat. Arr. 1: 637. 1821; not Corniola Adans. 1763.
Leptoglossum Karst., Hattsv., p. XVII. 1879.
Dictyolus Quél., Enchir., p. 139. 1886.
Cantharellus sect. *Resupinatus* Fr., Epicr., p. 368. 1838.

Spores non-amyloid; trama not gelatinous; gloeocystidia, dendro-, pseudo-, and dichophyses absent. On living mosses. Other characters as in family. Type species: *Leptotus retirugis* (Bull. ex Fr.) Karst.

LEPTOTUS RETIRUGIS (Bull. ex. Fr.) Karst., Hattsv. 1: 243. 1879.

Syn.: *Helvela retirugis* Bull., Herb. Fr., p. 289, pl. 498, fig. 1. 1789.
Merulius retirugis Pers., Syn., p. 494. 1799.
Cantharellus retirugis Fr., Syst. 1: 324. 1821.
Dictyolus retirugis Quél., Enchir., p. 104. 1886.
Leptoglossum retirugum Ricken, Blätterp. 1: 6. 1910.

Carpophore pileate-sessile or subsessile, or with slightly extended pseudostipe, definitely margined, sordid pale grey, about 10 mm. in diameter: sterile surface glabrous, azonate, slightly white fibrillose near the point of attachment to the substratum, smooth; hymenophore consisting of low, obtuse, radiating veins which are connected by narrower, or equally narrow, usually rather scattered anastomosing veins, distant; context soft-membranaceous.

Spores 7.5–10.5×5–7μ, the inner longside mostly concave, the apical half attenuate but with rounded apex, wall thin, hyaline, non-amyloid, smooth, with an asymmetrically attached hilar appendage; basidia 29–45×7–8.5μ, 4-spored, rarely with a few 1- to 3-spored ones intermixed, not granulose in aceto-carmine; sterigmata rather long; cystidia none; hyphae of the trama of the hymenophore rather strongly interwoven, subintermixed, not gelatinous, with clamp connections; hyphae of the very thin pileus trama about 4μ thick, not gelatinized, thin walled, with clamp connections; hyphae of the cuticular layer not differentiated except for the very minutely roughened wall of the outermost repent hyphae, the rough-

ening apparently resulting from an incrusting brown pigment as also found in some tramal hyphae; hyphae of the white felt involving the moss thallus seem to be incrusted by crystals or amorphous masses but otherwise not remarkable.

Habitat: On mosses (*Hypnum uncinatum*). October (practically producing fruit bodies the year around).

Distribution: Circumpolar.

Observations: This description was drawn from good material collected and determined by Farlow at Shelburne Bassins, Shelburne, N. H. in 1898, and preserved at Farlow Herbarium. A very similar plant, also determined as above by Hesler, from the Great Smoky Mts., has narrower spores: 8.5×4.2μ.

Genus CAMPANELLA Henn., Engl. Botan. Jahrb. **22**(1): 95. 1895.

Syn.: *Laschia*, sect. *Eulaschia* Pat., Journ. d. Botan. **1**: 231. 1887.
Laschia, sect. *Campanella* Pat., Essai Hymen., p. 129. 1900.
Laschia Pat. l.c. 1900, non Fr. nec Jungh. nec Lloyd.
Laschia, sect. *Laschiella* Henn. in Engl. & Prantl. Nat. Pfl. Fam. I, 1**, p. 186. 1900.

Spores non-amyloid. Trama strongly gelatinous. Gloeocystidia, dendro- and pseudophyses absent, but dichophyses on sterile surfaces forming a more or less conspicuous asterostromelloid structure; cystidia sometimes present. On dead wood and on culms of bamboo, and leaves of palms.

Type species: *Campanella Büttneri* Henn.

KEY TO THE SPECIES STUDIED

A. Cystidia none.
  I. Spores small, not longer than 7.6μ ..... *C. caerulescens* (B. & C.) Sing.
  II. Spores large: longer than 7.6μ.
    a. Spores 8.5–10×4.8–7.3μ, distinctly ventricose in the lower half in both longside-outlines when seen frontally, and in the outer longside only, if seen in profile. Tropical North America ..... *C. alba* (B. & C. sensu Pat.)Sing.
    b. Spores normally and evenly ellipsoid, 7.7–9×4.2–5μ. Tropical Asia ..... *C. Junghuhnii* (Mont.) Sing.
B. Cystidia present ..... *C. simulans* (Pat.) Sing.

Campanella caerulescens (Berk. & Curt.) Sing. comb. nov.

Syn.: *Laschia caerulescens* Berk. & Curt., Linn. Soc. Journ., Bot. **10**: 323. 1869.

Carpophore suborbicular-conchoid, astipitate, attached to the substratum at the center or at some eccentric point of the sterile surface, thin, 6–10 mm. broad in dried condition, white or yellowish, turning to dull bluish purple; sterile surface glabrous, smooth, opaque; hymenophore more favose and almost merulioid near the point opposite to the point of attachment, frequently merulioid all over, but sometimes more radiately lamellose and anastomosing near the margin, the resulting compound pores up to 0.6 mm. wide, but extremely irregular and the edges of the walls on very different levels, the radial lamellose ridges usually highest and in large specimens surpassing 1 mm. in height.

Spores 5.2–5.7×4–4.5μ subglobose with rounded angles, hyaline, the walls smooth, non-amyloid; basidia 19×5.5μ; cystidia and other sterile bodies none; trama gelatinous: cuticle little individualized, consisting of pseudophysoid, i.e., nodose, usually irregularly branched hyphae forming a very poorly developed asterostromelloid structure, but probably partly destroyed in the material available, due to gelatinization.

Habitat: On the bark of erect dead trunks of fondose trees. Gregarious and sometimes crowded.

Distribution: West Indies. I have seen material from Cuba (Wright, type and authentic material), and from Grenada (coll. R. Thaxter, det. R. Singer).

Observations: Some of the individuals examined, especially from Wright's material, strongly suggest *Merulius* rather than *Campanella*. This fact is supported by the characteristic change in color, as indicated by the collector, and still more by the small basidia and spores. On the other hand, the subglobose spores and the typical loosely arranged and imbedded-gelatinous hyphae, as well as the shape of the carpophore which is not as in most pileate Merulii laterally reflexed, and not as in most resupinate Merulii, merely narrowly free on the very margin, separate it from *Merulius*. Nevertheless, *Campanella caerulescens* is the one species within the *Laschia*-complex, suggesting a close relationship with the Meruliaceae, possibly the kind of relationship existing between Cyphellaceae and *Aleurodiscus*. See also Lloyd apud Stevenson & Cash, Bull. Lloyd Library No. 35, Myc. Ser. No. 8: 150. 1936, for notes on *Campanella resupinata*.

Lloyd thinks that *Laschia purpurea* Berk. & Curt., *Laschia subcaerulea* Berk. & Curt., and *Laschia pensilis* Berk. & Curt. are all identical with the above species. I have not studied them anatomically, but macroscopically they look somewhat different. *Dictyolus boninensis* Ito & Imai, Trans. Sapporo Nat. Hist. Soc. **16**(1): 1939, also seems to belong to this group.

Campanella alba (Berk. & Curt. sensu Patouillard) Sing. comb. nov.

Plate 3, Fig. 1

Syn.: *Laschia alba* Berk. & Curt. sensu Pat., Essai Hymen., p. 129. 1900.

Carpophore suborbicular to subreniform or conchoid, astipitate, or more rarely with a short lateral stipe, attached at one point of the sterile surface, or, if stipitate, the stipe is recurved and attached to the substratum above the sinuate side of the pileus, 4–12 mm. broad, white, becoming somewhat cremeous when old; sterile surface convex or irregularly flat, more or less pustulose, glabrous; hymenophore consisting of 2–7 radiating lamellae which concur at almost equal breadth at a central or eccentric point and which are forked and connected by veins which run transversally, and sometimes cross each other to form small, areolate-poroid spaces, the lamel-

lae up to 1.2 mm. broad, distant; stipe, if present, subequal and up to 3×1 mm. large.

Spores 8.5–11×4.8–7.3μ, with a ventricose outline on both sides near the base when seen frontally, and tapering toward the rounded apex, but when turned around their axis 90°, the outline is inequilateral, with a ventricose lower outer portion and a slightly convex to subapplanate inner side, hyaline, smooth, thin walled, non-amyloid; basidia clavate, with (2)–4 medium sized sterigmata, 28–38×7.5–8.8μ; cystidia none; trama decidedly gelatinous; hyphae non-amyloid, with numerous clamp connections; numerous dichophyses on the sterile surface form a cuticle with asterostromelloid structure.

Habitat: On dead wood of various kinds (in two cases of *Chusquea* in Ecuador), on small twigs as well as on stumps and trunks, old logs etc. The year round.

Distribution: Tropical America.

Observations: The species is represented in the Curtis Herbarium by an extremely poor collection. If there is no better material at Kew, it may be permissible to use Patouillard's conception of this species. Neither the type specimen, nor the original description furnish any character not in agreement with Patouillard's idea of the plant as here adopted. I do not know any other white Campanellae which occur in tropical America and am of the opinion that this interpretation is likely to be correct. When Patouillard received this species without stipe, he designated it as above. Stipitate specimens, however, were determined by him as *Laschia agaricina*=*Exidia agaricina* Mont.; but this can hardly be correct, since Montagne says that his plant is orange while Lagerheim, the collector of one of Patouillard's stipitate specimens, notes clearly enough: "Fungus totus albus." Besides, he collected the stipitate and the resupinate forms the same day and at the same place, near Quito. Both forms are microscopically identical. Rick distributed the stipitate form as "*Laschia agaricina* Pat.," obviously relying upon Patouillard's determination (Rick, Fungi Austro-Americani, no. 234, São Leopoldo 1907). *Laschia lamellosa* Pat. is probably the astipitate form of the same species but the type from the Orinoco River basin, the only material in existence, consists of two tiny black specimens which have been in alcohol, and can hardly furnish reliable characters.

Campanella Junghuhnii (Mont.) Sing. comb. nov.

Syn.: *Cantharellus Junghuhnii* Mont., Ann. Sc. Nat. 2me sér. **16:** 318. 1841.
Merulius cucullatus Jungh., Praem. Flor. Crypt. Jav., p. 76. 1838, non Brond. (1828).
Laschia cucullata Bres., Ann. Mycol. **8:** 587. 1910.
Campanella cucullata Lloyd, Mycol. Not. **5:** 815, fig. 1358. 1919.
Merulius cuticularis Lév. in Zoll., Syst. Verz. Ind. Arch. Jap., p. 17. 1854.
Laschia celebensis Pat., Journ. de Bot. **1:** 227, pl. 4, figs. 1–4. 1887.

Carpophore suborbicular to reniform, astipitate, or very rarely with a very short lateral stipe, usually laterally attached or attached at an eccentric point, 3–12 mm. broad, white to pale brownish yellow or cinereous-pale-yellow, probably changing so when old; sterile surface convex, somewhat diaphanous to very transparent but smooth and glabrous; hymenophore consisting of 2–7 radiating lamellae which concur at an eccentric point or in the center whereby they are narrowed when meeting, forking and connected by reticulate veins which thus form small areolate-poroid spaces, the lamellae up to 1 mm. broad, distant; stipe, if present, minute.

Spores 7.7–9×4.2–5μ ellipsoid (not as in *C. alba*), hyaline, wall non-amyloid, smooth, often with a central oil-droplet; basidia 18–34×6–9μ; cystidia none; trama distinctly gelatinous; hyphae non-amyloid, slender, thin walled, imbedded in a gelatinous mass, with clamp connections; cuticular layer with numerous crowded dichophyses forming a well developed asterostromelloid structure.

Habitat: On dead culms of bamboo and on other dead parts of monocotyledons. Throughout the year.

Distribution: Eastern Asia: Java, Celebes, Tonkin, Philippines. Probably also in Japan, and Australia.

Observations: This species is not very easily separated from the preceding one, if only macroscopical characters are used. The oriental species, *C. Junghuhnii*, seems to become more discolored than the American plant, the lamellae are more narrowed at the point of concurrence, and the habitat is usually on dead parts of bamboo. But the difference in spore shape should distinguish them best, even if the habitat and origin are unknown. Thus it is easily understood that Lloyd (17), having a tendency to combine rather than to separate, and having, as he admits himself, not correctly observed the spores of this species, thought that *C. alba* and other collections from tropical America were the same as the Asiatic fungus. *Campanella Büttneri* Henn. which he first indicated as identical with *C. cucullata*, was later declared different in general appearance and size (Myc. Not. **6**: 1096, 1921, commenting on material from Japan which I have not seen). It may be that *C. Büttneri* is a third species of this same group.

In Patouillard's Herbarium there are five collections of *C. Junghuhnii*. Two are labeled as a new species of *Laschia*, and came from Bon who collected them in Tonkin; the type of *Merulius cuticularis* with Léveillé's own handwriting, and a specimen from the Philippines, determined "*Laschia cuticularis* Lév. (*Merulius*)." The latter two specimens are on the same sheet with the type of *Laschia celebensis* and all considered to be identical. I have not studied the types of Junghuhn, but Bresadola and Lloyd have done so, and found much smaller spores and basidia, but at least Lloyd corrected himself later. I take it, therefore, that Lloyd's conception of Junghuhn's plant is correct. I have not checked Lloyd's state-

ments concerning the identity of *Favolaschia javanica* Holterm. (1898), and *Marasmius campanella* Henn. apud Holterm. (1898). Holtermann's descriptions are rather obsolete (9).

Campanella simulans (Pat.) Sing. comb. nov.

Plate 3, Figs. 2–4

Syn.: *Laschia simulans* Pat., Leafl. Philipp. Botan. 6(104): 2252. 1914.

Carpophore reniform or orbicular-lobate, attached to the substratum directly either laterally at the deepest point of the concave side, or at or near the center of the sterile surface, resupinate-pendulous, pale alutaceous in the center and whitish near the margin in dried condition, probably white when fresh, 5–10 mm. in dried condition; sterile surface transparently reticulate from the veins of the hymenophore, more or less pustulate, glabrous, somewhat pruinose under a lens; hymenophore alveolate-favose behind and lamellate toward the margin, the lamellae connected by low, anastomosing veins, or else, entirely lamellate and with many faint transversal anastomoses, and then attenuate to an eccentric smooth point, up to 1 mm. broad; stipe none.

Spores (7.8) 8.5–10.8×4.7–7.5μ, very variable in shape, ellipsoid as in *C. Junghuhnii*, or very asymmetric as in *C. alba*, the apex often truncate, usually with one central oil-droplet, or multi-guttulate, hyaline, wall smooth, thin, non-amyloid; basidia 29–35×8–8.5μ, 4-spored; cystidia 39–50×11–14.5μ, fusoid, often with crystals on the tip as in *Geopetalum*, the walls not pseudoamyloid, not strongly colored by cresyl blue, thickened in the upper half, gradually thinner toward the base, hyaline in ammonia, 1.5–2μ thick above, very few occasionally thin walled, scattered on edge and sides of the lamellae and on the veins, moderately numerous; ramose pseudomyloid bodies sometimes observed on the surfaces; trama more or less gelatinous, its hyphae interwoven, but loosely arranged, thin, non-amyloid, with clamp connections; cuticular layer of the sterile surface showing distinct asterostromelloid structure, the dichophyses-branchlets often short and nodose.

Habitat: On fallen branches and rotten wood. June to July, but probably fruiting during a longer period.

Distribution: Pacific Islands: Philippines. Samoa.

Observations: This species is well defined by its cystidia. The type, and authentic material (coll. Lloyd, det. Patouillard, from Samoa), and a much better collection in Hoehnel's Herbarium (coll. K. Rechinger, det. Singer) were studied by the author, and the above description is the result. Patouillard compares his species with *Laschia candida* A. L. Smith (Journ. Linn. Soc., Bot. **39**: 198. 1909) for which **Campanella candida** (A. L. Smith) Sing. comb. nov. is proposed, since this species is definitely congeneric with *C. simulans*. Patouillard points out that the spores are much

smaller in *C. candida* (subglobose, 4–5μ), though I think that Smith's measurements ought to be checked on the type material which was not available to the author. *C. candida* is described from the Fiji Islands, and is said to have two-spored basidia. Another species of *Campanella*, said to have cystidia is **Campanella Eberhardtii** (Pat.) Sing. comb. nov. (*Laschia Eberhardtii* Pat., Bull. Soc. Mycol. Fr. **25**: 8. 1909, from Tonkin) which, however, looks decidedly different, and is described as 3 cm. large and of a pale aerugineous color. I have not studied the anatomy of the type specimens.

Genus FAVOLASCHIA (Pat.) Henn., Engl. Bot. Jahrb. **1**: 231(1): 93. 1895.

Syn.: *Laschia* sect. *Favolaschia* Pat., Journ. de Bot. **1**: 231. 1887.
Porolaschia Pat., Essai Hymen., p. 138. 1900.
Laschia Lloyd, Myc. Not. **5**: 831. 1919; non Fr. nec Jungh. nec Pat.

Spores amyloid. Trama gelatinous. Gloeocystidia, dendro-, pseudo-, and dichophyses frequently present. On dead wood, bark, fallen palm leaves and culms of *Bambusa*. Other characters as in family.

Type species: *Favolaschia Gaillardii* Pat.

KEY TO THE SPECIES STUDIED

A. Gloeocystidia not (or poorly) differentiated.
  I. Dendrophyses not distinct, i.e., erect echinate sterile bodies covering the whole or parts of the pore edges and the sterile surface of the pileus, absent.
    a. Carpophore decidedly red, and remaining so in the herbarium if properly dried..... ..... *F. rubra* (Bres.) Pat.
    b. Carpophore not red.
      1. Surface of the pileus characterized by a poorly or well developed layer of dichophyses, forming a typical or a depauperate Asterostromella-structure, or by irregular hyphae and pseudophyses, or by a superposed layer of conidiophorous hyphae; spores 5μ broad or broader.
        α. Cystidioid pseudophyses either none or scarce; spores 8.8–12.5×7–9.5μ..... ..... *F. tonkinensis* (Pat.) Sing.
        β. Cystidioid pseudophyses forming hymeniform layers near the margin of the pileus; spores 6.5–10×5–7μ..... *F. pustulosa* (Jungh.) Sing.
      2. Surface of the pileus characterized by repent hyphae which are warty-diverticulate like the hyphae of the epicutis of *Mycena*. Spores 5.5μ broad, or narrower.
        α. Carpophores cup shaped, like a sessile *Helotium*, yellowish when dried..... ..... *F. pezizaeformis* (B. & C.) Sing.
        β. Carpophores attached laterally with or without a short, oblique stipe, vinaceous when dried, or, at least, not yellowish.... *F. minima* (Jungh. sensu Hohn.) Sing.
  II. Dendrophyses rather distinct, well developed. (See under B, II; *F. pezizoidea*.)
B. Gloeocystidia large and broad, very prominent and numerous.
  I. Dendrophyses none; gloeocystidia smooth.
    a. Stipe short and inconstant; cuticular layer of the sterile surface of the pileus consisting of a very particular kind of dichophyses, forming a non-gelatinized cuticle of definite asterostromelloid structure; many branchlets of the dichophyses are echinulate-crested, thus resembling very slender dendrophyses..... *F. varariotecta* Sing.
    b. Stipe well developed; cuticular layer of a different structure. *F. Sprucei* (Berk.) Sing.
  II. Dendrophyses well developed and numerous, or else, gloeocystidia crested.
    a. Gloecystidia crested; pigment none; carpophore white when dry... *F. saccharina* Pat.
    b. Gloecystidia smooth, only the dendrophyses crested; carpophores yellowish-orange to orange red when fresh, not white nor pallid when dried though frequently bleaching to yellowish white on drying or in the herbarium.

1. Pigment not localized in the gloeocystidia; carpophores sessile, subresupinate, and never bleaching to yellowish white when dry.
   α. Carpophore distinctly red if recently and properly dried; dendrophyses distinctly filled with a chrome yellow sap; spores large, 8.5–12.8×6.7–11μ..... *F. cinnabarina* (B. & C.) Pat.
   β. Carpophore not red when dried; microscopical characters not combined as above.
      * Gloeocystidia large, striking..... *F. Gaillardii* (Pat.) Pat.
      ** Gloeocystidia basidiomorphous and inconspicuous unless treated with a metachromatic stain..... *F. pezizoidea* (B. & C.) Sing.
2. Pigment localized in the gloeocystidia; carpophores not sessile but laterally stipitate, or at least potentially stipitate (and then yellowish white when dried properly).
   α. Carpophore yellowish white when dried properly; stipe not always present; dendrophyses cylindric, a minority vesiculose-fusoid-clavate; basidia (constantly?) 2–3-spored..... *F. sabalensis* (Charles) Sing.
   β. Carpophores yellow with a slight orange hue when dried; stipe always distinct; dendrophyses vesiculose-fusoid-clavate, sometimes a minority narrowly cylindric; basidia 4-spored..... *F. Thwaitesii* (B. & Br.) Sing. (cf. also observations sub *F. sabalensis*).

FAVOLASCHIA RUBRA (Bres.) Pat., Essai Hymen., p. 141. 1900.

Syn.: *Laschia rubra* Bres., Hedwigia **35**: 285. 1896.

Carpophore subreniform to suborbicular and laterally stipitate, decidedly red in fresh and in dried condition; sterile surface transparently tessellate but almost smooth, glabrous or subglabrous, between "brick red" and "Pecan brown" (Ridgway) when dried, 1–2 mm. broad; hymenophore initially distantly pitted, later polygonally tubulose with thick dissepiments and narrow lumen even when old, somewhat paler than the sterile surface in dried material; stipe well developed, laterally attached at a right angle, rarely in young specimens very eccentrically, almost laterally attached, subpruinose, 1–3×0.2×0.2–0.3 mm. in dried condition, subequal or more frequently slightly thickened toward the base, insiticious.

Spores 6.3–7.5×4.5–5μ in the 4-spored form, 7.7–10×6.3–7.7μ in the type, i.e., the 2-spored form, short ellipsoid without any suprahilar depression, wall thin, smooth, hyaline, amyloid; basidia (25) 30×(7) 7.7μ and 2-spored, or about as large and 4-spored; gloeocystidia none; dendrophyses none; pseudophyses present on the edge of the pores and on the sterile surface, very versiform, at places fasciculate, lacerate, angled, nodose, subdiverticulate, or ramulose, hyaline to yellowish, e.g., 22×9μ, also present on the surface of the stipe but much shorter there, so, that the superficial repent hyphae of it seem to be strongly diverticulate; hyphae of the trama gelatinous and loosely arranged, non-amyloid, parallel in the stipe, with clamp connections, but not all septa with clamps.

Habitat: On the bark of fallen dead trees, evidently of dicotyledonous genera only.

Distribution: South America: Brazil, British Guiana.

Observations: The type which is 2-spored, has been collected by Möller in Brazil. This and a *f. tetraspora* from British Guiana (coll. D. H. Linder,

det. Weir) are identical in all other regards, and have been used for the above description. This is the only *Favolaschia* which faintly reminds one of *Filoboletus*, especially *F. mycenoides*, since some of the pseudophyses are reminiscent of the dermatocystidia of the latter, and the rarely observed eccentric stipes of *F. rubra* may seem to approach the centrally stipitate habit of *Filoboletus* rather than the strictly laterally stipitate or

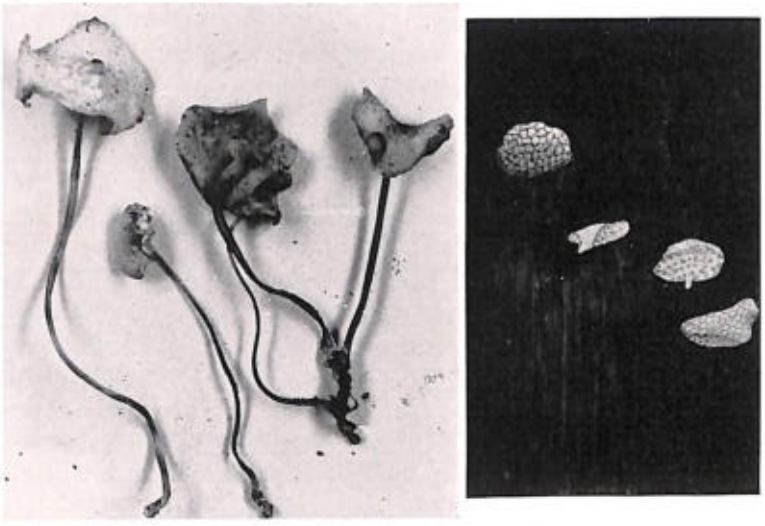


PLATE 1.—Fig. 1. *Filoboletus gracilis* (Kl. ex Berk.) Sing. Dried material from Florida, natural size. Phot. D. H. Linder.—Fig. 2. *Favolaschia tonkinensis* (Pat.) Sing. Photographic reproduction of a painting of fresh authentic material from Tonkin, executed by Nguyen Manh Hoan, and preserved in Demange's "Champignons de Tonkin" (ined.), approved by N. Patouillard.

sessile carpophores of the other Favolaschias; besides, the red color, of course, makes this slight similarity seem more striking.

Favolaschia tonkinensis (Pat.) Sing. comb. nov.

Plate 1, Fig. 2

Syn.: *Laschia tonkinensis* Pat., Journ. de Bot. **5**: 313. 1891.
Porolaschia tonkinensis Pat., Essai, p. 138. 1900.
Favolaschia Frieseana Henn., Engl. Bot. Jahrb. **22**: 94. 1895.
Laschia Frieseana Sacc., Syll. **14**: 197. 1899.

Carpophores conchoid, subreniform, or orbicular, suddenly attenuate behind and attached laterally; younger carpophores resupinate and attached to the substratum by a small spot of the sterile surface, or attached by a short stipe, white, becoming pale melleous when (old ? and) dried, 2–20 mm. in diameter; sterile surface convex, tesselate-pustulate, glabrous; hymenophore consisting of pores which are at first round but soon become polygonal and with thick or rather thin dissepiments, up to 1.5 mm. in

diameter when mature, rarely larger; stipe subequal, up to 7×1.5 mm., laterally attached at an obtuse angle with the pileus, oblique, glabrous, smooth.

Spores 8.8–12.5×7–10μ ellipsoid or short-ellipsoid, sometimes with irregular small sinuosities or spurs, hyaline, wall thin, amyloid, smooth; basidia 35–37×7.8–12μ, 4-spored; cystidia and other sterile bodies in hymenium none; cuticle not well differentiated, rather rudimentary, at places formed by tender irregular hyphae, some of which are transformed into pseudophyses, at other places a layer of interwoven very thin hyaline hyphae is often superposed; these hyphae of about 1μ diameter, are conidia-bearing; conidia about 4–6×3–4μ, smooth; trama very gelatinous, its hyphae with clamp connections, wavy-irregular and very loosely arranged, non-amyloid, imbedded in a gelatinous mass, subregular but distant in the dissepiments of the tubes, some, especially near the surface, having wavy-nodose walls.

Habitat: On various parts of *Bambusa* spp. In Africa in February and March, in Eastern Asia from June to October, Usually gregarious.

Distribution: Probably originally Asiatic, but now possibly pantropic, or nearly so.

Observations: *F. Frieseana* Henn. is the same species as *F. tonkinensis*, as the comparison of the dried specimens shows. Lloyd described a "*Laschia Friesiana*," a misspelling initiated by Hennings himself. But this species is obviously quite different from Hennings' species. It is said to have "crested cells" i.e., dendrophyses, and "color glands," i.e., gloeocystidia, but none are found in the specimens seen. The carpophores are yellow when fresh, and the spores are indicated as measuring 10–14×6μ. These characters were probably obtained from Brazilian material mentioned by Lloyd, which in turn seems to belong to a South American plant here described (p. 000) as *F. Thwaitesii* subsp. *Selloana* (Henn.). However, Lloyd's photograph of *L. tonkinensis*, l.c., p. 835, fig. 1394, is probably correct.

Favolaschia pustulosa (Jungh.) Sing. comb. nov.

Plate 3, Figs. 5–7

Syn.: *Favolus pustulosus* Jungh., Praem. Flor. Crypt. Jav., p. 73, fig. 38. 1838.
Laschia pustulosa Sacc., Syll. 6: 410. 1888.

Carpophores narrowly resupinate with a broad, free, pileate, reflexed, conchoid main portion, or conchoid to subreniform or suborbicular and merely laterally attached, or with a lateral stipe, pure white, but somewhat discoloring on drying, 5–25 mm. broad; sterile surface tessellate-pustulate, slightly transparent, glabrous; hymenophore polygonally-poroid, the pores wider in the middle of the carpophore and smaller toward the margin; stipe usually none, but sometimes a majority of specimens of a population is stipitate, the stipe being variable in size, up to 4.5–0.8 mm. in dried condition.

Spores 6.5–7.5×5–5.8μ, more rarely up to 10μ long, and up to 7μ broad, short-ellipsoid, hyaline, wall thin, smooth, amyloid; basidia 23–28×7–8μ, 4-spored; sterigmata 6.3–7μ long; cystidiform pseudophyses present and crowded at certain places near the margin of the pileus, extremely versiform, hyaline, thin walled, smooth, often ventricose, capitate or twice capitate, divided into small branchlets at the apex, or simply appendiculate, 35–53×7–12.5μ; gloeocystidia and dendrophyses none; the cuticular layer of the pileus of more densely arranged interwoven hyphae, many of them pseudophysoid, branched and nodose, occasionally with a slight tendency to asterostromelloid structure; trama of imbedded, irregularly wavy hyphae with clamp connections, non-amyloid, gelatinous, loosely arranged; conidia-bearing tissue on the surface of the pileus rarely seen, and never covering large surfaces.

Habitat: On dead wood of all kinds; gregarious. Apparently mostly from July to December.

Distribution: South Eastern Asia and Oceania: Java, Borneo, Philippines, probably Samoa.

Observations: This species is macroscopically very similar to *F. tonkinensis*. No wonder, therefore, that it was determined *L. tonkinensis* by Lloyd (Flora of British North Borneo, No. 2191, coll. M. Ramos) when stipitate, and *L. pustulosa* when sessile. Actually, the relative frequency of pseudophyses and the size of the spores are much better characters by which to distinguish these species. I have not seen Junghuhn's type but there seems to be general consent in referring his specimens to this species. In fact, his description is rather good and does not suggest any other species but this, Patouillard's (in herbario) and Lloyd's views therefore are accepted. "*Laschia*" *Holtermannii* (Henn. ap. Holterm.) is said to be the same (Lloyd, l.c.), and so is *L. papulosa* (Cesati), collected by Beccari at the same place where our Borneo material came from but, probably erroneously, described as ochraceous-fulvous. Lloyd's photograph, p. 834, fig. 1393 is probably correct.*

Favolaschia pezizaeformis (Berk. & Curt.) Sing. comb. nov.

Syn.: *Laschia pezizaeformis* Berk. & Curt., Proc. Amer. Acad. 4: 123. 1858.
Hologloea pezizaeformis Pat., Essai Hymen., p. 86. 1900.

I have nothing to add to the macroscopical description given by the authors of this species. The following microscopical data have been taken from the part of the type which is preserved in the Curtis Herbarium.

Spores 7.7–8.5×4.5–5.5μ, the outer side strongly ventricose, the inner side without depression, hyaline, wall easily collapsing, smooth, thin, amyloid; basidia about 27×8.7μ, relatively short and broad; gloeocystidia and dendrophyses none; pseudophyses none, or not conspicuous; hyphae of the surface layer near the margin of the pileus repent, hyaline, not gelat-

* Except for the fact that it is not natural size as indicated by Lloyd, but enlarged.

inized, distinctly diverticulate by echinate warts, recalling the epicuticular hyphae of *Mycena;* trama gelatinous.

Habitat: On dead petioles and rachis of *Livistona boninensis* (palm), and *Alsophila Martensiana* (fern) in November (according to Itao & Imai).

Distribution: Bonin Islands.

Observations: This fungus has been recollected several times by Japanese botanists (see Ito, S. & Sanshi Imai, Fungi of the Bonin Islands, V., Trans. Sapporo Nat. Hist. Soc. **16**(3): 124. 1940), but all citations from the American tropics are erroneous, based on the misdetermination of a different species from Venezuela which is preserved in Curtis' Herbarium, labeled "comp. *Laschia pezizaeformis* B. & C." by Berkeley. It was collected by Fendler and is reminiscent of *Favolaschia pezizaeformis*, although macroscopically, by color and habit, it also suggests *F. sabalensis*. My notes on the microscopical characters of this specimen follow here: Spores 8.5–11×5–7μ, otherwise as in *F. sabalensis* (see p. 207); gloeocystidia prominent but rather narrow in most instances, smooth, yellow, many proliferating into the trama of the tubes and filling the latter with a regular structure of parallel gloeo-vessels as in *F. saccharina* (see p. 203); dendrophyses on the sterile surface forming a layer of more or less erect, now indistinct and mostly collapsed, very thin walled, hyaline, vesiculose-ventricose to subglobose, minutely asperulate-roughened sterile bodies; trama gelatinous, non-amyloid; number of the sterigmata not seen. The presence of gloeocystidia and dendrophyses in the American material excludes any relationship with *F. pezizaeformis*. It is rather close to *F. pezizoidea* and *F. sabalensis*. More exact statements about this fungus will have to wait till better material becomes available. Another collection labeled *L. pezizaeformis* by Farlow does not belong to either of the previously mentioned species but is a new species, *F. vararioiecta* Sing. (see p. 201). Consequently, *F. pezizaeformis* has not been found in the Western Hemisphere and probably never will.

Patouillard combines this species and a large Mexican polypore in one genus, *Hologloea* Pat., Essai Hymen., p. 85. 1900; I consider *H. microspora* Pat. as the type of the genus *Hologloea; F. pezizaeformis* which does not show the slightest similarity with this species must be included in *Favolaschia* and excluded from *Hologloea*.

Favolaschia minima (Jungh.) Sing. comb. nov. (sensu Hoehnel, Herbarium).

Syn.: *Polyporus minimus* Jungh., Praem. Plor. Crypt. Jav., p. 64. 1838. (Probably).
Laschia minima Sacc., Syll. **6**: 409. 1888.

Carpophores elliptic to mostly reniform in outline, 1–2.5 mm., broad stipitate, probably white when young and fresh, but said to be "pallide gilvus" by Junghuhn, assuming an unmistakable pink to vinaceous tinge

("light vinaceous fawn," "vinaceous fawn," sometimes "Pecan brown" Ridgway) when dried, especially on the hymenophore, less strongly on the sterile portions; sterile surface subglabrous, smooth, convex to nearly plane; hymenophore consisting of very minute round pores which later become somewhat polygonal, separated by a very thick, later moderately thick wall, 7 pores pro mm.; stipe attached to the sterile surface or the margin at the base of the sinus, forming a right angle with the substratum, forming varying angles with the pileus depending on the position of the substratum, up to 1×0.3 mm.

Spores 7.5–9×4.2–5μ, ellipsoid, hyaline, wall thin, smooth, amyloid; basidia 27×7.5μ, 2- to 4-spored; basidioles or cystidioles fusoid, of varying size and contents; gloeocystidia and dendrophyses none; tramal hyphae non-amyloid; clamp connections present; cuticular layer on the sterile side of the pileus consisting of repent but sometimes almost cellular, short hyphae, and filamentous hyphae, usually about 1.5–2μ, more rarely up to and more than 4μ thick, beset with spines of 1–3.7μ in length, and if the spines are long, they approach asterostromelloid structure.

Habitat: On dead parts of various kinds of Monocotyledones, e.g. Scitamineae (Junghuhn), and palms, etc. July (Junghuhn). Gregarious.

Distribution: Java (Mt. Kedang, Buitenzorg, Tjibodas).

Observations: Junghuhn's diagnosis perfectly fits the two collections in Hoehnel's Herbarium which I have studied, one under the name *Laschia minima*, the other under the incorrect name *Laschia pustulosa*. Hoehnel's notes seem to indicate that he thinks *Laschia calamicola* Henn. is the same species. I know only Saccardo's compilation of Hennings' diagnosis, and Hoehnel has seen the specimens from Berlin (Java, on *Calamus* spec.); I can see no reason why they should not be identical with *Favolaschia minima*. Both species have been indicated from the Philippines by Graff (Phil. Journ. Sc. **9**: 243. 1914, and Bull. Torr. Club **49**: 229. 1922), but in one case the carpophores were averaging larger (2.5–5 mm. in diameter) than in the Javanese material.

Favolaschia vararioteca Sing. spec. nov.

Carpophoris orbicularibus, vertice vel margine ad substratum affixis, rarius lateraliter stipitatis, flavido-albidis in siccis, verosimiliter luteis vel aurantiacis in vivis, 1 mm. cc. in diam.; superficie sterili tessellata, subglabra oculo nudo; hymenophoro poris pro ratione latis, angulatis formato in speciminibus maturis; stipite admodum exiguo vel nullo.

Sporis 6–6.5×4.5–5.5μ magnis, ellipsoideis vel globosis, paucis in speciminibus nostris, amyloideis, tenui-tunicatis, levibus; pseudophysibus sparsis, tenuibus, ramosiusculis, inter basidia interspersis; gloeocystidiis numerosis, luteis, 18–45×5–13μ metientibus, fusoideis vel clavatis, in speciminibus nonnullis basidiomorphis, vasculis gloeoferis communicanti-

bus; vasculis gloeoferis in tramate tubulorum hyphis parallelis, cylindraceis, 3–5μ crassis, sparsis; tramate gelatinoso, hyphis haud densis; strato corticali e dichophysibus consistente, quarum ramusculi extremi dendrophysum modo echinato-spinosi sunt ita ut variationem structurae *Vararíae* generis efficiant; dendrophysibus nullis.

Habitatio: Ad folia palmarum delapsa, emortua. Novembri mense.

Area geographica: Grenada insula.

Observations: Two collections of this interesting new species were made by R. Thaxter at Grand Etang, British West Indies. It is one of the smallest known. It suggests *F. pezizaeformis* when dry and was so determined in one case. The type collection is preserved at Farlow Herbarium.

Favolaschia Sprucei (Berk.) Sing. comb. nov.

Syn.: *Favolus Sprucei* Berk., Hook. Journ. Botan. & Kew Misc. **8**: 237, pl. 5, fig. 8, 1856.
Porolaschia Sprucei Pat., Essai Hymen., p. 138, 1900.
Laschia Sprucei Bres., Ann. Mycol. **9**: 270. 1911.
Laschia decurrens (Berk. & Curt. ex) Cooke, Grevillea **19**: 105. 1891.

Carpophores flabelliform to orbicular with a more or less conspicuous depression on the side where the stipe is inserted, 10–50 mm. broad, white, often becoming pale yellow in the herbarium; sterile surface convex, subtessellate-rugose; hymenophore of 10–40 angular pores which suggest either *Hexagona*, or the favoloid Polypori, always wide: 0.5–2 mm. in diameter, rather shallow in comparison with their width, broadly adnate to decurrent on the apex of the stipe; stipe consistently well developed, lateral, 2–25×0.5–3 mm., subequal or slightly thickened toward the base, forming a more or less right angle with the pileus.

Spores 10.5–14.5×7–9μ, short ellipsoid, or rarely ellipsoid-suboblong, without suprahilar depression, hyaline, wall rather thin to very thin, fragile, amyloid, smooth, contents guttulate; gloeocystidia with vesiculose upper portion, with contents, yellow, approximately 28–40×14–26.5μ, but very variable, sometimes imbedded in the trama, but many reaching the hymenium near the pore edges or the cuticular surface; cuticular layer of denser hyphae which are repent, filamentous and, toward the outside mostly beset with 1–2μ high diverticulae; trama gelatinous; tramal hyphae thin walled, but also some thick walled ones observed; dendrophyses none; on the surface of good material, loose, smooth, hyaline, short ellipsoid (e.g. 30×22μ), subglobose, or globose spherocysts are usually found, and these cells form loose cumuli of floccons not visible without a lens; they sometimes contain some contents but do not suggest gloeocystidia (not blue with cresyl blue), though they tend to collapse, and for that reason may be old or modified gloeocystidia.

Habitat: On dead wood.

Distribution: Venezuela to Brazil, probably in most South American countries.

Observations: This species is the largest known in this genus. In habit, it suggests a favoloid *Polyporus*, perhaps a small *Polyporus dermoporus* Pers. (*Favolus brasiliensis* Fr.), such as found at some places in Florida, U.S.A., especially on fruits of *Carya megacarpa*, but also on small logs, and then called *Hexagona floridana* Murr.; but, of course, these polypores are not related to *F. Sprucei*. I have studied *Laschia decurrens* Cke. (part of type preserved in the Curtis Herbarium) and find that it is identical, as previously stated by Lloyd who also thinks that *Laschia Moelleri* Bres. is identical. But material collected by R. Wettstein in Brazil and determined by Hoehnel as *L. Moelleri*, is different.

FAVOLASCHIA SACCHARINA Pat., Bull. Herb. Boissier **3**(2): 54. 1895.

Syn.: *Laschia* (*Favolaschia*) *saccharina* Sacc. & Syd., Syll. **14**: 197. 1899.
Laschia gemma Hoehnel in Schiffner, Denkschr. k. Akad. Wiss. Wien, Math.-Nat. Kl. **83**: 11. 1907.

Carpophores usually reniform or orbicular-reniform, horizontal, attached to the substratum by an extremely minute, lateral stipe, all included 0.2–2 mm. broad, pure white but on drying becoming somewhat discolored on the hymenophore; sterile surface smooth, more or less pruinose-pulverulent; hymenophore consisting of 3–19 distant and round, later angular and not quite so distant pores with a diameter of about 0.2 mm. and rather thick to very thick, obtuse dissepiments which are also pruinose at their edges; stipe curved, terete, pruinose, up to 1×0.4 mm.

Spores 7–7.5 (9.5)×5.3–5.6 (7)μ, short ellipsoid; basidia clavate, none seen with countable sterigmata; sugary pulverulence due to an accumulation of short and thick cells, usually subglobose, with echinate-crested, rarely smooth walls, and coarse contents as in gloeocystidia rarely empty, thus a minority of these cells representing either dendrophyses or gloeocystidia, probably originating on the outermost layer of the sterile surface but disintegrating by successive production of more cells, the majority combining the contents of the gloeocystidia and the crested walls of the dendrophyses; these cells are hyaline, 16–35×10–20μ large; gloeo-vessels abundant in the trama of the dissepiments and in the subhymenium, arranged regularly and nearly parallel, cylindric, mostly hyaline, but in some cases bright yellow.

Habitat: On stalks of *Chusquea*, *Bambusa*, and other dead woody parts of Monocotyledones. Gregarious.

Distribution: Tropical America: Ecuador, Brazil, etc.

Observations: This species is very characteristic because of the peculiar pulverulence of the surface, consisting of "dendro-gloeo-cysts" (which would be an appropriate term) which have become disconnected from the hyphal and gloeo-system of the carpophore.

I am almost sure that *Laschia intermedia* Berk. & Curt. is exactly the same species, but there are no types, in fact, no material at all, in Curtis' Herbarium, and if there is none at Kew, it will be hard to prove the identity. *L. intermedia* came from Wright who collected it on palm petioles in Cuba, but the species is not represented in Wright's Fungi Cubenses either. Lloyd says that *Laschia pulverulenta* Henn. from Brazil is the same as *L. saccharina*, and this appears highly probable when Hennings' diagnosis is compared. I have, however, not seen the types which are said to be in Berlin. Lloyd's own species *Laschia longicellulis* Lloyd does not seem to be different from *F. saccharina*, at least this is the impression one has when reading the short description (l.c. p. 837). The author has studied the type of *Laschia gemma* Hoehn. and finds it to be the same as *F. saccharina*. Lloyd published a photograph of *F. saccharina* (l.c., p. 837, fig. 1397–1398), and Patouillard (Essai, p. 141) a schematic drawing.

FAVOLASCHIA CINNABARINA (Berk. & Curt.) Pat., Essai Hymen., p. 141. 1900.

Plate 2

Syn.: *Laschia cinnabarina* Berk. & Curt. Journ. Linn. Soc., Botany **10**: 322. 1869.

Carpophores orbicular or conchoid, laterally attached and sessile, sometimes slightly attenuate behind, but never stipitate, when young and growing on the lower surface of the substratum, the carpophore usually is marginate all around and attached to the substratum with a point of the sterile surface, 0.5–3.3 mm. broad when fresh or preserved in alcohol, "capucine yellow" or "cadmium orange" to "flame scarlet" (Ridgway) when fresh, becoming more yellow in alcohol, becoming more cinnabarinous ("Nopal red" or "English red" of Ridgway) when dried; sterile surface convex, slightly pustulate and transparently tessellate, macroscopically glabrous; hymenophore faveolate, the pores (3) 9–22, wide: 0.3–0.6 (1.0) mm. in diameter; stipe none.

Spores 7.5–12.8×6.7–11μ, short ellipsoid to subglobose, many of them rounded-angular, or with strange, irregular excrescences or sudden small depressions, asymmetric, hyaline, the wall thin, smooth, amyloid; basidia 26–28×8–8.5μ; gloeocystidia hyaline, some lemon yellow, globose with a small stipe, or clavate-vesiculose, filled by a resinous-looking mass of angulate refringent bodies which more or less completely disappear in Melzer's reagent, 20–56×8–32μ; dendrophyses on sterile surfaces and edges of pores, piriform to bullate-clavate, very few cylindric-elongate, many filled with a deep orange pigment solution which, however, in some of the older collections is not quite satisfactorily restored, only the walls showing a yellow color, the stipe itself smooth, all the rest echinate as usual, 14–29 ×10–24μ; trama consisting of intricately interwoven, loosely arranged,



PLATE 2.—*Favolaschia cinnabarina* (B. & C.) Pat. Material from British Guiana, on its natural habitat. Phot. D. H. Linder. The millimeter scale at the right side of the plate is enlarged exactly as much as the specimens.

gelatinized hyphae which are slender, thin walled, with clamp connections, and not amyloid.

Habitat: On dead bark of dicotyledonous trees (e.g. *Nectandra*), and on dead lianes. October to December. Gregarious.

Distribution: Tropical America: Brazil, British Guiana, Cuba, South Florida.

Observations: D. H. Linder's excellent material from Bartica, B. G., determined as *Laschia cinnabarina* by Weir, and my own collections from Miami, Fla., on *Nectandra coriacea*, were the main sources of information used in the above description. These materials were compared with authentic and type material from Cuba; another collection, made by Noack at Araraquara, Brazil, and preserved in Patouillard's Herbarium, is identical.

FAVOLASCHIA GAILLARDII (Pat.) Pat., Essai Hymen., p. 141. 1900.

Syn.: *Laschia Gaillardii* Pat., Journ. de Botan. 1: 228, pl. 4, fig. 3–5. 1887.

I can add nothing to Patouillard's description of the macroscopical characters; the type specimens are now about 2.5 mm. large and still yellow.

Spores 7–9×5.5–6.5μ, smooth, amyloid; basidia about 31–33.5×7–7.6μ; trama gelatinous but hyphae rather agglutinate in the type; gloeocystidia yellow, numerous, smooth, e.g. 35×12μ; dendrophyses 17–28×11.5–15.5μ. vesiculose-balloon-shaped, cristate all over except on their small stipe; these crested echinulae about 2μ high, cylindric; the cell sap of the dendrophyses colored by a dissolved yellow pigment, more rarely hyaline.

Habitat: On fallen dead branches and stumps. May. Gregarious.

Distribution: Venezuela.

Observations: Rick (27) considers *Laschia Gaillardii* Pat. a synonym of *L. cinnabarina*. It is true that these species are very closely allied but since they differ in spore size, in carpophore-size, and in color, I would rather consider them as two different species.

Favolaschia peziozidea (Berk. & Curt.) Pat. in Herb. comb. nov.

Plate 3, Figs. 8–10

Syn.: *Laschia pezizoidea* Berk. & Curt., Journ. Linn. Soc., Botany 10: 322. 1869.

I have to add nothing to Berkeley and Curtis' description, except for the following microscopical data:

Spores 7.7–10×6.3–7.7μ, short-ellipsoid, wall amyloid, smooth; basidia few among the gloeocystidia, about 28–31×7μ, 4-spored; gloeocystidia basidiomorphous, covering most of the hymenial layer, yellowish, not striking, but very numerous, 36–58×4–10.5μ, their contents a rich blue when dyed with cresyl blue, the bases proliferating downward, in many cases, into gloeo-vessels which are not as crowded as in *F. saccharina* but

also run perpendicularly to the basidia; dendrophyses balloon shaped with a short smooth stipe, 14–35×11–21.5μ, yellowish; the occasional thick walled pseudophyses near the margin extremely variable in shape, sometimes with finger-like appendages, strongly ventricose, or fusoid, e.g. 65×12μ, not stained by cresyl blue; trama gelatinous.

Habitat: On herbaceous stems, according to Berkeley and Curtis; on woody stick, as seen in the herbarium. Gregarious.

Distribution: The only material I have studied was from Cuba (authentic), but the species may be occurring in most of tropical America.

Observations: Lloyd, l.c., published an enlarged photograph of *Laschia pezizoidea* (p. 836, fig. 1396) but does not indicate which collection this is. He identifies *L. pezizaeformis* which is incorrect, and *L. Goetzei* (Henn.), a species I have never seen.

Favolaschia sabalensis (Charles) Sing. comb. nov.

Syn.: *Laschia sabalensis* Charles, Mycologia **34**(3): 238. 1942.

Carpophores conchoid to suborbicular or reniform, sessile or short stipitate, 1–4 mm. in diameter, "carnelian red," becoming "rufous" then "apricot orange" (Ridgway), pale yellow or yellowish white when dried; sterile surface macroscopically glabrous, reticulate, the lines of the reticulation corresponding to the dissepiments of the hymenophore; hymenophore consisting of 3–8 (–20, according to V. K. Charles) pores which are little or not elongated and 3- to 6-angled, the pore layer up to 1 mm. thick; stipe either present or absent, more frequently present in small specimens, lateral, or attached at an eccentric point of the sterile surface, in Florida up to 2 mm. long and 1 mm. thick, in Trinidad usually of the same size but the length occasionally reaching 5 mm.

Spores 9–15.5×4.2–11μ, hyaline, ellipsoid and often somewhat angular with the angles rounded, also slightly sausage shaped, piriform, etc., frequently with small irregularities such as small depressions and hooks, especially on and near the apex; oil drop usually present, central, globose; wall smooth, thin, amyloid; basidia 33–36×8.5–8.8μ, clavate, (1-)2(-3)-spored; sterigmata very long and rather straight; cystidia none; gloeocystidia on the pore edges and on the sterile surface numerous, yellow, globose to clavate, often narrowed in the middle, broadly rounded above, thin to moderately thick walled, very numerous in the trama and there not always reaching the surface, smooth, rarely very slightly and incompletely warted, sometimes also occurring on the inner sides of the tubes (so in Trinidad); dendrophyses on the pore edges and on the sterile surface of the pileus, of two types, either cylindric or subcylindric, and measuring 12–56×7–11μ, or ampullaceous to vesiculose, and then measuring up to about 35×15μ, densely and regularly beset in their upper halves or thirds or more frequently down to the stipe, with 2μ long thorns, always and in all

parts hyaline, without contents and not colored blue in cresyl blue; pseudophyses moderately frequent, occasionally seen among basidia, not very striking, smooth, or very rarely spinose or warty at the tip, hyaline; empty spherocysts among the gloeocystidia and dendrophyses usually present in large numbers, not bluing with cresyl blue, mostly thin walled, rarely thick walled, about 28μ in diameter; trama gelatinous, non-amyloid as are all elements of the carpophore except the spores, consisting of very wavy, irregularly arranged, imbedded hyphae with thin walls, about 2.5–3.5μ thick; clamp connections present.

Habitat: On leaves and petioles of *Sabal palmetto*, and on an indetermined palm, after they fall to the ground and decay in the wet atmosphere of a low hammock or swamp, usually very gregarious on the lower side of the substratum, August and September, also collected by C. L. Shear and V. K. Charles in November, December, and March which would indicate that it is not, as most Agaricales are, confined to certain of the very distinct Florida seasons; collected in April in Trinidad.

Distribution: Florida, U.S.A., and Trinidad.

Observations: This species has been collected by the writer at the type locality in fresh condition and in large numbers. The above emended description is the result of studies of these collections with additional data taken from R. Thaxter's Trinidad material which differs only in having larger spores and gloeocystidia in the tubes of the hymenophore. As for the specific name, I hesitated a long time to accept the epithet proposed by Miss Charles. If Lloyd is right about the anatomical characters of the original *Laschia auriscalpium* Mont., this latter species must be extremely close to *F. sabalensis*. We have noticed that Central and South American material, determined as *Laschia auriscalpium*, has not only a more conspicuous stipe, but also a color quite similar to that of the forms of *F. Thwaitesii* though it was not very carefully prepared. However, Lloyd's indication of an astipitate form of his *L. auriscalpium* in Brazil, and the chance that the difference in color may be due to different methods of preparing and preserving the material, makes it rather uncertain whether these characters are worth anything at all for comparison of *L. auriscalpium* sensu Lloyd and *F. sabalensis*. I have not tried to go deeper into this question since the decisive material, Montagne's types, are not available at present; they are probably still in Paris, or somewhere in France. Even so, I am ready to venture the opinion that Lloyd is hardly right assuming that "it is not an orange species as they seem to think at Berlin." The pigmentation of Lloyd's and our species seems to be about the same in so far as the gloeocystidia contain all the pigment (in NH_4OH). Since the Florida material fades out to yellowish white or pale yellow even when dried carefully, or maybe, especially when dried carefully, the pallid color given in Montagne's diagnosis (Ann. Sc. Nat. Quatrième sér. Botan. 1: 137. 1854) does

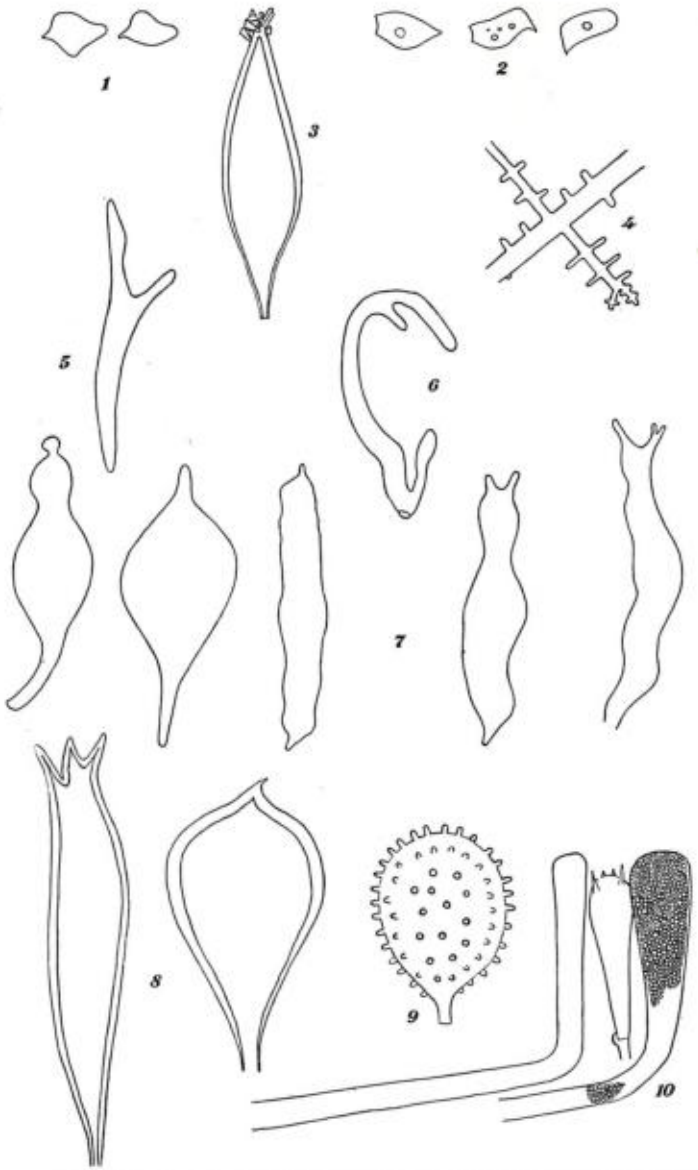


PLATE 3.—Fig. 1. *Campanella alba* (B. & C.) Sing. Spores, seen frontally (left) and in profile (right); ×1000.—Fig. 2. *Campanella simulans* (Pat.) Sing. Cystidium; ×1000.—Fig. 3. *Campanella simulans* (Pat.) Sing. Spores; ×1000.—Fig. 4. *Campanella simulans* (Pat.) Sing. Dendrophysis of the sterile surface of the carpophore; ×1000.—Figs. 5–6. *Favolaschia pustulosa* (Jungh.) Sing. Pseudophyses of the sterile surface; ×1000.—Fig. 7. *Favolaschia pustulosa* (Jungh.) Sing. Five cystidioid pseudophyses of the fertile surface; ×1000.—Fig. 8. *Favolaschia pezizoidea* (B. & C.) Pat. Two thick walled cystidioid pseudophyses; ×1000.—Fig. 9. *Favolaschia pezizoidea* (B. & C.) Pat. Dendrophysis; ×1000.—Fig. 10. *Favolaschia pezizoidea* (B. & C.) Pat. Elements of the hymenium. From left to right; gloeocystidium with homogenous contents, proliferating into the gloeo-vessels of the trama; a basidium with four sterigmata; another gloeocystidium with guttulate-granulose contents, rare in this species; ×1000.

not prove anything. The stipe as described by Montague is considerably smaller than the largest stipes seen in *F. sabalensis*. The spherocysts observed by us on the sterile surface and the spores, have been observed by Montagne 90 years ago. So, nothing tends to exclude Montagne's species *a priori*, and if the types should turn out to be the same as the species described above, the somewhat embarrassing Latin of the name adopted here would disappear in the obscurity of synonymy. Miss Charles published a good photograph (l.c., p. 239, fig. 1), showing enlarged carpophores from the fertile side.

Favolaschia Thwaitesii (Berk. & Br.) Sing. comb. nov.

Syn.: *Laschia Thwaitesii* Berk. & Br., Journ. Linn. Soc., Botany 14: 58. 1875.

General description of the complex: Carpophores pileate, stipitate, orange to orange red, not strongly fading on drying, medium sized; sterile surface tessellate, glabrous to pruinose; hymenophore of round or polygonal, small to wide pores; stipe conspicuous, constant, lateral. Spores 7–13×4.2–8μ amyloid, smooth, thin walled; basidia 4-spored; gloeocystidia and vesiculose hyaline dendrophyses present on pore edges as well as on the sterile surfaces. Habitat: On dead wood.

Subspec. TYPICA:

Carpophores reniform, stipitate, up to 9×6 mm. large, entirely orange-red or orange, margin and stipe sometimes paler; sterile surface slightly convex or plane, pruinose, margin repand and crenate when old; hymenophore of circular 0.3–0.4 mm. wide, rather distant pores with thick dissepiments; stipe lateral or seemingly eccentric, attenuated upward, translucent, pulverulent, solid, up to 15 mm. high, 1 mm. thick; context wholly subgelatinous.

Spores short cylindric or ellipsoid to (mostly) short ellipsoid, 8.8–11 (13, according to Petch)×6.3–8μ; gloeocystidia with coarse contents; dendrophyses moderately numerous, clavate to vesiculose, sometimes branched and fasciculate, combining the characters of dendrophyses and pseudophyses; trama of thin hyphae, imbedded in a gelatinous mass.

Habitat: On dead wood. Cespitose or scattered.

Distribution: Ceylon.

Observations: Lloyd indicates as synonyms: *Laschia congolensis* (he means *Favolus congolensis* De Seynes, but this is rather a subspecies of *F. Thwaitesii*, see observations on ssp. *Dybowskyana* Sing.); *L. lateritia* (which is very probably the same as our ssp. *Zenkeriana*, see there); *L. sanguinea* (Henn., a nomen dubium, since it is, according to Lloyd, based on a drawing only); *L. coccinea* (W. G. Smith, adventitious in a warm house in England the type of which I have not seen).

The description of the type subspecies is partly drawn from Petch's good account of the plant, and partly from my own notes on the type.

Subspec. **Dybowskyana** Sing. ssp. nov. Poris in centro latis, ad marginem angustioribus differt; sporis 8.5–12.5×4.2–6.3μ.

This subspecies differs macroscopically from the type only in few characters: pores wide and angular in the middle, narrower on the margin.

Spores broadly ellipsoid to cylindric, often with refringent yellow contents, easily collapsing, 8.5–12.5×4.2–6.3μ; basidia 30–40×8.5–9.5μ; gloeocystidia yellow, with contents; some similar but empty bodies observed at the pore edges: 22–53×7–23μ; dendrophyses very variable in shape, but always hyaline, from balloon shaped to narrowly cylindric, usually clavate to elongate-clavate, e.g. 35×9μ; pseudophyses crowded at places, extremely variable; trama gelatinous; hyphae interwoven, non-amyloid; subhymenium denser than in the trama, not otherwise differentiated.

Habitat: On dead wood.

Distribution: French Congo, and Uganda Protectorate, tropical Africa.

Observations: This is *Laschia congolensis*, as represented in Patouillard's Herbarium, collected by Dybowsky, but not the type of *Favolus congolensis* de Seynes (Rech. Champ. Cong. Fr., p. 28, pl. 1, figs. 27–31. 1897). It is highly probable that De Seynes' fungus is the same, since Patouillard probably compared the types, but what Lloyd saw at Paris was, I suppose, nothing else but Patouillard's specimens. De Seynes says that his fungus is not gelatinous, but I would rather doubt the truth of this statement. Thus, at present, his species may be considered to be probably the same as our subspecies which however has been based on Patouillard's specimen in order to avoid further confusion. Neither did I use the name *Favolaschia Volkensii* (Bres. ap. Henn. in Engl., Pflanzenwelt Ost-Africa's 1, C: 58. 1895; Henn., Fung. Cam. 1: 93. 1895) since the types are not available at present, and without studying them thoroughly, the identity can not be established though it is most probable. The above description results from the study of the type (Dybowsky-Patouillard) and identical material, collected by R. A. Dummer, in the Uganda Protectorate at 4000 ft. altitude near the Tropical Institute at Mulange, determined *Laschia Volkensii*, and described as "orange" (Co-type).

Subspec. **Zenkeriana** ssp. nov. Poris latissimis differt neque non stipite breviore; sporis 7–10×6–7μ.

Macroscopically, this subspecies differs from the type only in few characters: Hymenophore consisting of very wide, polygonal pores, even slightly lamelloid, but not of the *Campanella*-type, not wider in the center;

stipe very variable in length, 4 mm. long as an average, i.e. shorter than in the type subspecies; color of the entire fruit body "salmon orange" (Ridgway) when fresh.

Spores 7–10×6–7μ, ellipsoid, or short ellipsoid, hyaline, but sometimes some filled with a yellow sap, with a central oil-droplet, or with coarse oily contents; basidia 35–55×7–10.5μ; gloeocystidia yellow, numerous in the hymenium near the margin and the pore edges, and on the sterile surfaces of pileus and stipe, vesiculose, smooth, some (in the hymenium) basidiomorphous, 20–77×5.5–31μ; dendrophyses scattered or in fascicles, not always erect, sometimes repent or ascendant, the thorns scattered to mostly dense, occasionally in rows, the outline clavate to saccate, or even narrowly fusoid to cylindric, not very numerous; pseudophyses very variable in shape, rather frequent on the surfaces among the bunches of gloeocystidia and dendrophyses; trama gelatinous; hyphae thin, thin walled and clamp-bearing in the pileus, parallel and with slightly thickened walls (0.5–0.7μ) and only moderately gelatinized in the stipe, of variable diameter, non-amyloid.

Habitat: On rotting limbs, fallen branches. August, probably also in March, etc. Gregarious.

Distribution: Liberia, and probably in nearby regions farther to the East (Camerouns).

Observations: This description was drawn from D. H. Linder's notes on the fresh material, and my own notes on the dried specimens collected by him in Liberia, at Oulah, and Firestone #3 Du River, both in August 1926. The Oulah specimen is the type. Though I am almost sure that *F. lateritia* Henn., Fung. Camer. I, Engl. Bot. Jahrb. **22**(1): 93. 1895, is the same thing, I do not dare use his name, because in Laschias more than anywhere else it is impossible to rely on incomplete descriptions or the macroscopical impression a specimen made on some other student. Lloyd has seen the type, and he thinks that *F. lateritia* and *F. Thwaitesii* are the same.

This subspecies differs from the type subspecies as indicated above, from subspecies *Dybowskyana* in having equally wide, even extremely wide pores, and slightly different spores, also somewhat shorter stipe. Subspecies *Zenkeriana* seems to occupy the northern part of tropical Africa, or at least the Northwestern part of it while subspecies *Dybowskyana* is found in the Central portion; this geographical differentiation may be quite ficticious, since comparatively few collections have come to the authors attention. The following subspecies is South American.

Subspec. **Selloana** (Henn.) Sing. comb. nov.

Syn.: *Favolaschia Selloana* Henn., Hedwigia **36**: 203. 1897.
Laschia Selloana Sacc. & Syd., Syll. **14**: 199. 1899.

This subspecies differs from the type but in few characters: Pores con-

siderably wider in the middle and rather narrow at the margin; stipe, and sometimes also the pileus larger than in the type subspecies, up to 17 mm. in diameter, and stipe 20–30×1–2 mm., according to Hennings.

Spores 9.7–10.7 (12.5)×4.2–5.2μ, ellipsoid-oblong, or subcylindrical, usually at least one side applanate but without any depression, wall thin, fragile, hyaline; gloeocystidia yellowish, with coarse contents, fusoid when pressed between the basidia, 33–55×9–12.5μ and versiform (clavate, fusoid-vesiculose, subglobose) in other positions, and then measuring 15–74×10–20μ, numerous; dendrophyses rather numerous, fusoid or clavate, more rarely subcylindric, or narrowed between an enlarged tip and a ventricose middle portion, or vesiculose, subacute, or more often broadly rounded at the apex, with 2.5μ long spines which are cylindric or subsubulate, spiny about one third to two thirds from above, often conglutinate and then hard to observe; trama gelatinous, consisting of non-amyloid, slender hyphae.

Habitat: On dead branches and rotten trunks. September.

Distribution: Brazil.

Observations: I did not see the type specimen but additional material from the same collector (E. Ule, Herbarium Brasiliense, no. 2704), has been examined, and it seems rather safe to suppose that these collections are all the same form. This subspecies differs from the others in having narrower spores, and in being the largest macroscopically. It is the only form definitely belonging to *F. Thwaitesii* sensu lato, and occurring in South America. But there are other species which I have not been able to investigate thoroughly enough and which may possibly belong here. It is not certain that there is no broad-spored subspecies in South America.

Lloyd (16) thinks that *Favolaschia Selloana*, as well as *F. brasiliensis* Henn. (l.c., same page), are "surely" the same species as *Laschia papulata* Mont. (in Gay, Hist. Fis. Pol. Chile, Botan. 7: 367. 1850.). This can not be proved but on the contrary, it seems to me that Montagne's species described from Chile, is different from any of the subspecies described above, including ssp. *Selloana*, because of the color "de un blanco sucio" which is neither true for the fresh plant nor for the dried specimens, and the pores are "constantly rounded or oblong, and never become polygonal," characters which are not found in the South American material of orange species that I have seen. Lloyd says about *L. papulata:* "Microscopical characters not known." The relation between *F. Thwaitesii* and *F. papulata* will not be clarified unless these characters *are* known.

F. Thwaitesii ssp. *typica*, ssp. *Dybowskyana*, ssp. *Zenkeriana*, and ssp. *Selloana* differ only in minor characters and clearly form a group of very closely related forms. As it looks at present, these forms are most probably geographic races.

AGARICINEAE Roze
TRICHOLOMATACEAE Roze em. Heim
MARASMIOIDEAE Sing.

Genus FILOBOLETUS Henn., Monsunia 1: 146. 1900.

Syn.: *Laschia* sect. *Porolaschia* Pat., Journ. de Botan. 1: 231. 1887, p.p.
Leucoporus Quél. sect. *Gelatinosi* Pat., sect. *Filipedes* Pat., Essai, p. 82. 1900.
Mycenoporella Van Overeem in Van Overeem & Weese, Icon. Fung. Mal., Heft 14–15, p. 2, pl. 15. 1926.

Agarics with marasmioid appearance, or suggesting *Omphalia*, or *Mycena*, often cespitose-subfasciculate; hymenophore poroid; spores ellipsoid-oblong to globose, smooth, amyloid, white in print, small to medium; cystidia in the pores none, but occasional cheilocystidia, and also dermatocystidia in some species well developed, basidiomorphous but with finger-like or club-like proliferations above, or with branchlets at the tip, forming a faint floccosity; hyphae of the epicutis thin, smooth, repent, with clamp connections, subcutis denser than the trama; hyphae of both trama and subcutis irregular, interwoven or wavy, non-amyloid, with clamp connections; habitat: on wood; all species tropical or subtropical. Type species *Filoboletus mycenoides* Henn.

KEY TO THE SPECIES STUDIED

A. Pileus colored, though rather pale, when fresh. In tropical Asia.....*F. mycenoides* Henn.
B. Pileus white or pallid when fresh. Pantropical species.
I. Pores very long.....*F. manipularis* (Bk.) Sing.
II. Pores very short.....*F. gracilis* (Bk. ex Kl.) Sing.

FILOBOLETUS MYCENOIDES Henn., Monsunia 1: 146 (:48 reprint), pl. 5, fig. 2. 1900.

Pileus pale pink, somewhat darker and floccose with small reddish floccons in the center, smooth but transparently tessellate, convex with applanate or depressed center, (1) 2–3.25 mm. broad, up to 1 mm. high; hymenophore tubulose, almost white, pores 0.2–0.3 mm. wide, 0.8–0.9 mm. deep, walls about 0.05 mm. thick, pores rounded-subpolygonal, or somewhat radially elongated but not showing a lamellose tendency, slightly smaller toward the margin, or almost equal, tubes adnate to the apex of the stipe; stipe a very pale pink, beset with small reddish floccons, filamentous, smooth, hollow, fragile, slightly thickened at the base, central, 15–29×0.2–0.3 mm., at base up to 0.8 mm. thick, insiticious; context gelatinous, tender.

Spores 7–7.7×3.5–4.5μ, ellipsoid, with the inner side applanate, asymmetric, contents and wall hyaline, wall smooth, amyloid, thin; basidia 16.4–21×8μ, 4-spored; cystidia none; floccons on the surfaces consisting of clavate bodies with broom-like multi-appendiculate apex, the appendages usually claviculate, about 3.5–4.5×1.5–2μ, total length of the dermatocystidioid bodies 14–21μ, total diameter: 7–10.5μ; hyphae of the gelatinous

trama non-amyloid, with clamp connections, hyaline or slightly colored, in the pileus interwoven, parallel in the stipe; epicutis not clearly visible in the preparations available, the outermost hyphae extremely slightly roughened; gloeocystidia, dendrophyses, pseudophyses, dichophyses none.

Habitat: On fallen leaves.

Distribution: Java.

Observations: The above description has been drawn from my own notes on Hoehnel's material, a well dried carpophore, and permanent mounts which were opened, stained, and remounted, and also from Hoehnel's notes in his herbarium which were later published in "Fragmente" (7). The fungus impresses one as an agaric, and its name *F. mycenoides* is well chosen.

Another colored species but differing in being much larger and yellow instead of pink, is **Filoboletus luteus** (Van Overeem) Sing. comb. nov. (*Mycenoporella lutea* Van Overeem in Van Overeem & Weese, l.c.), type species of the genus *Mycenoporella*.

Filoboletus manipularis (Berk. fide Lloyd) Sing. comb. nov.

Syn.: *Favolus manipularis* Berk., Hooker's Journ. Botan. **6**: 229 (:5 reprint). 1854.
Porolaschia manipularis Pat., Essai Hymen., p. 138. 1900.
Favolus caespitosus Berk., Journ. Linn. Soc., Bot. **13**: 167. 1873.
Laschia caespitosa Berk. *var.* Berk. & Br., Journ. Linn. Soc., Bot. **14**: 58. 1875.
Laschia caespitosa Berk. & Br., Linn. Soc. London **2**(2): 62. 1883.
Laschia caespitosa var. *gogolensis* Henn., Engl. Bot. Jahrb. **18**(3): 33. 1894 (e descr.)
Polyporus mycenoides Pat., Bull. Soc. Myc. Fr. **3**: 169, pl. 17, fig. 1. 1887.
Laschia Lauterbachii Henn., l.c. (e descr. & fide Lloyd).

Pileus pallid to brownish when dried, probably whitish when fresh, subrugulose-reticulate, or folded when dried, probably smooth and transparent when fresh, campanulate-conic to semiglobose, 2–10 mm. in diameter, 5–6 mm. high, the disk sometimes applanate to subumbilicate, the margin sometimes narrowly sterile; hymenophore tubulose, concolorous, flatly adnate, tubes long: 3–6 mm., but also longer or shorter than this, according to the shape of the pileus, pores narrow, inequal, somewhat rounded-angular, 0.2–0.9 mm. in diameter; stipe concolorous or tending to become reddish brown, subfilamentous, centrally attached, subglabrous, but tomentose at the base, 10–60×1–2 (4) mm.

Spores 5.5–7×4–5.3μ, ellipsoid to short-ellpisoid, hyaline in NH_4OH, wall smooth, thin, amyloid; hymenium destroyed in the specimen studied; hyphae of the epicutis minutely punctulate; trama somewhat gelatinous; gloeocystidia, dendrophyses, pseudophyses, dichophyses none.

Habitat: On decayed wood, cespitose or fasciculate in dense clusters.

Distribution: Type from Australia, also in Ceylon. New Guinea, and New Caledonia; also reported from the Philippine Islands.

Observations: This species has been adopted in the sense of Lloyd. The diagnoses of the species he cites as synonyms, seem to support his views

very well; the reader is referred to Lloyd's good photographs published, l.c., figs. 921–922. The original data which were added here to the description given by the various authors are taken from my notes on the type specimen of *Polyporus mycenoides* Pat.

Filoboletus gracilis (Klotzsch ex Berk.) Sing. comb. nov.

Plate 1, Fig. 1

Syn.: *Polyporus gracilis* Klotzsch ex Berk., Ann. & Mag. Nat. Hist. **3**: 384. 1839.
Polyporus flexipes Fr. *var. gracilis* Sacc., Syll. **6**: 69. 1888.
Leucoporus gracilis Pat., Essai Hymen., p. 82. 1900.
Laschia clypeata Pat., Journ. de Botan. **1**: 229. 1887.
Leucoporus clypeatus Pat., Essai Hymen., p. 82. 1900.
Polyporus obolus Ellis & Macbride apud Ellis & Everh., Bull. Lab. Nat. Hist. University Iowa **4**: 68. 1896.

Pileus initially white, then becoming "light pinkish cinnamon" (Ridgway), finally often with "burnt umber" to "Vandyke brown" (Ridgway) stains, hygrophanous, hyaline to pale grey when very wet and fresh, delicately transparently reticulate near margin, rugose-venose on the disk, convex to almost flat, very frequently umbonate, 9–30 mm. in diameter; hymenophore tubulose, white, becoming pale incarnate-white when old not showing any signs of lamellose arrangement in typical specimens, pores 0.5–3 mm. deep, with thin waved dissepiments, the diameter of a pore betweeen 0.2 and 0.6 mm., usually about 8 pores pro 5 mm. tangential distance in the middle between the center and the margin in large mature specimens, the outline of the pores round, rounded-angular, or polygonal; stipe "smoke grey," "light drab," "drab," "hair brown" (Ridgway) when young and fresh, turning to "Vandyke brown" or "burnt umber" (Ridgway) when old, white fibrillose or white pruinose, and therefore usually appearing whiter than indicated above, hollow, equal or tapering upward, central, 24–70×1–3 mm.; context white or hyaline, fleshy-membranaceous, becoming fleshy-cartilaginous and somewhat tough but not leathery, inodorous, mild with a raphanaceous taste.

Chemical reactions. $FeSO_4$ and KOH no reaction; methylparamidophenol little reaction; phenol with the context and the surface of the pileus becoming chocolate.

Spores 6.3–7.7×5–6.3μ, short-ellipsoid, hyaline, guttulate and granulate inside, asymmetric, wall smooth, thin, amyloid; basidia 25–30×6.3–7.7μ, 2- to 4-spored; cystidia none; basidioles or cystidioles as in *Marasmius*, or *Collybia*, fusoid; cheilocystidia not distinctly differentiated, but the sterile basidia have a tendency to form sterigma-like excrescences from 1 to 5 at a time which are either globose and look like sessile spores, or clutch-like, or they recall cheilocystidia of *Conocybe* but usually with 2 instead of one stipitate globule, about 23–26×8.5μ, globules 3.5μ in diameter, its stipe 2μ long; trama of the pileus consisting of irregular (in size, shape, diameter, and direction) hyphae which are, when revived in KOH, imbedded in a

gelatinous mass; a subcuticular layer, differing from the trama only in consisting of in average larger, thicker, less (but still) gelatinized, and denser hyphae; epicutis present in well preserved material, but rather inconspicuous, consisting of hyaline, gelatinized, thin, thin walled, long-cylindric, filamentous, strictly repent hyphae of 3–5.3μ diameter; all hyphae non-amyloid, and usually with numerous clamp connections.

Habitat: On fallen trunks of frondose trees (e.g., *Quercus virginiana*) but only in a rather decayed and weathered stage, very cespitose, and some more or less fasciculate, gregarious in tropical hammocks, woods, and plantations. May to November.

Distribution: Tropical and subtropical America, and also in West Africa: Florida, West Indies, Venezuela, Brazil, etc.; Liberia.

Observations: The type from the West Indies has not been studied by the author, but it is the unanimous conviction of all mycologists who have worked on this problem, that Berkeley's *Polyporus gracilis* belongs in this group; and since the species described above is the only representative of this genus in the American tropics, it may be concluded that they are identical. This species has an interesting history. Klotzsch did not publish it in his own paper because of Fries' advice that it was only a variety of *Polyporus flexipes* Fr., but Berkeley, not knowing this fact, published it on the basis of Klotzsch's herbarium name. I do not think that *P. flexipes* is closely related to *F. gracilis* as far as the short diagnosis can reveal anything about this relation. I have examined the types of *Laschia clypeata* Pat. as well as numerous collections sent by Rick and Noack from Brazil under the name of *Polyporus clypeatus* and later *Polyporus gracilis;* I have also studied the type of *P. obolus* Ell. & Macbr. ap. Ell. & Everh., and good material from Liberia (coll. D. H. Linder, det. R. Singer); my own Florida collections were the main basis for the above description. As for additional illustrations see Patouillard, l.c., and Lloyd, l.c. fig. 923.

Favolaschia Staudtii Henn., Engl. Bot. Jahrb. **23**: 544, was described from the Camerouns, West Africa, but similar specimens were collected by the writer in Florida, and by T. Callado in the Philippines; a part of Noack's material determined as *Laschia clypeata* (forma caespitosa, poris majoribus, and var. poris majoribus) by Patouillard also suggests *F. Staudtii*. In the Philippine material, the pores are arranged in lamellate rows; they resemble Van Overeem's picture of *Poromycena brunnea* Van Ov. in Van Ov. & Weese (l.c., pl. 14, fig. 2). The spores are amyloid, smooth, short ellipsoid, 5.5–7.5×4.5–5.5μ. Though I have seen all these collections, I still hesitate to refer them to *F. Staudtii*, and to transfer this species to *Filoboletus*. I am not sure that there are not several distinct forms hidden in the collections mentioned above and, even if all were identical, it would still be hard to decide whether they constitute an autonomous species or a variety of *Filoboletus gracilis*. Further studies would be desirable.

Among the specimens referred to *Laschia clypeata* by Patouillard in his herbarium are others called *Polyporus gracilis*, all on the same sheet; it does not seem that Patouillard himself thought them very different. One of the specimens in his herbarium (*"Polyporus gracilis"*), however, is quite different. It comes from Pointe Noire (No. 56), and grew on a decayed trunk of *Cedrela odorata* at a very humid place. It has the same spores and the same general appearance and characters as the type specimens of *Polyporus stipitarius* Berk. & Curt. in the Curtis Herbarium which do not differ from several collections in Wright's Fungi Cubenses (No. 88, 182, 183) called *Polyporus tricholoma* Mont. or *P. tricholoma* Mont. *var.* by Berkeley and Curtis. All these fungi, *Polyporus tricholoma*, *P. stipitarius*, and the above-mentioned misdetermined *Polyporus gracilis* are the same, and do not belong in the genus *Filoboletus*, but are actually Polypori (i.e., *Polyporus* sensu str. Donk, Bond. & Sing.). Their spores are small, smooth, ellipsoid to ellipsoid-cylindric, hyaline, non-amyloid, 6–7×3μ. The external appearance of these polypores may, in the field, resemble *F. gracilis*, but they are not in the least related to each other.

Lloyd (14) states under *Laschia gracilis* (p. 647): " . . . Murrill discovered it to be a "new species," and called it *Polyporus Cowellii*." The microscopical examination of the type at New York Botanical Garden did not confirm this statement. *Polyporus Cowellii* Murr. has non-amyloid, cylindric spores (6.3–7×3.2μ) which are slightly applanate or subdepressed above the hilar apiculus, and is very closely related to *Polyporus tricholoma* Mont. (*P. stipitarius* Berk. & Curt.)

Genus MARASMIUS Fr.

Marasmius magnificus (Henn.) Sing. comb. nov.

Syn.: *Favolaschia? magnifica* Henn., Hedwigia **36**: 203. 1897.
?Laschia (Favolaschia) magnifica Sacc. & Syd., Syll. **14**: 199. 1899.
Marasmius polyporoides Murr., N. Am. Fl. **9**(4): 266. 1915.

I cannot add anything to the macroscopical description of this species except that it instantly and strongly suggests *Marasmius*.

Spores not found; trama strongly amyloid; epicutis hymeniform, of elements with broom-like appendages.

Observations: As for *Marasmius polyporoides* Murr. see A. H. Smith, Contrib. U. Mich. Herb. No. 1: 22, pl. 1, fig. 5, 6, 8. 1939. My determination of *F. magnifica* is based not on the type but on a later collection by Ule, Herbarium Brasiliense No. 2699 which, I hope, is the same as the type collection of Sello's.

Genus POROMYCENA Van Overeem in Van Overeem & Weese, Icon. Fung. Malay., **14–15**: 4. 1926.

Agarics with marasmioid appearance, reminiscent of the Mycenae of the

section *Pelianthinae* with which they are related, but showing, at least in the tropics and subtropics, an unusually strong tendency to form conspicuous anastomoses, leading in some forms to radially arranged pores; spores oblong-ovoid to ellipsoid, non-amyloid (in contrast to *Mycena* where they are amyloid in nearly all species as in the section *Pelianthinae*); cystidia none; cheilocystidia well developed; epicutis of filamentous, hyaline, smooth, thin, repent hyphae; subcutis of subcellular, pigmented (pigment dissolved in the cell-sap) hyphae; tramal hyphae not gelatinized, amyloid, with or without clamp connections. Type species: *Poromycena decipiens* Van Ov. in Van Ov. & Weese.

KEY TO THE SPECIES OF POROMYCENA

A. European species. Clamp connections in epicutis none, according to Kühner; lamellae merely slightly anastomosing by low veins, not porous..... *P. pseudopura* (Cooke) Sing.
B. Tropical and subtropical species. Clamp connections numerous; lamellae with strong concentric anastomoses which in many cases make the hymenophore decidedly porous.
  I. Lamellae greenish or grey; many or all anastomoses between the lamellae lower than these. Species occurring in tropical and subtropical America or on Madagascar.
    a. Lamellae greenish; low veins, and anastomoses of full lamella-height both occurring in the same carpophore; spores 7–7.8–4.2–4.8μ..... *P. viridula* (Berk. ex Cooke) Sing.
    b. Lamellae greyish; all veins lower than the radial lamellae; spores 7.3–10×3.5–4.5μ.
      1. Base of the stipe with pale yellow setae; lamellae broad (up to 3.5 mm.), arcuate-decurrent and continued on the apex of the stipe. On inhabited ant-hills on Madagascar..... *P. myrmecophila* (Heim) Sing.
      2. Base of the stipe not markedly setose; lamellae moderately broad, adnate to subdecurrent. On foliage and palm débris, etc., in hammocks in Florida..... *P. anastomosans* Sing.
  II. Lamellae whitish in the center, more pink toward the margin; most or all anastomoses of equal height with the radial lamellae. Species occurring in tropical Asia (Java)..... *P. decipiens* Van Ov. in Van Ov. & Weese

Poromycena pseudopura (Cooke) Sing. comb. nov.

Syn.: *Agaricus* (*Mycena*) *pseudopurus* Cooke, Grevillea **10**: 147. 1882.
Mycena pseudopura Sacc. **5**: 257. 1887.

Kühner published an excellent description (Le Genre Mycena, p. 451. 1938) and Cooke gave a good colored picture in his Illustrations of British Fungi, pl. 220 (158).

Poromycena viridula (Berk. ex Cooke) Sing. comb. nov.

Syn.: *Laschia viridula* Berk. ex Cooke, Grevillea **19**: 105. 1891.

Pileus fuliginous according to Cooke, glabrous, about 10 mm. broad; hymenophore lamellose-porous, consisting of radial lamellae which are connected by concentric lower veins and lamellae of equal height, more regular in the center, more irregular and merulioid near the margin, bluish-green accordingto Fendler, the collector; stipe concolorous according to Cooke, central, 10 mm. or more in length.

Spores 7–7.8×4.2–4.8μ, ellipsoid, hyaline, wall smooth, non-amyloid; cystidia none; cheilocystidia present, not clearly discernible in the type;

trama not gelatinous, hyphae with clamp connections, amyloid; epicutis destroyed in the material available.

Habitat: On wood.

Distribution: Venezuela.

Observations: The above species is represented in both Berkeley's and Curtis's herbarium, but, as it seems, under different though similar names; I studied Fendler No. 64 in Curtis Herbarium. This is most probably a part of the type. Lloyd (16) lists it under species dubiae where the "types . . . either do not exist or are too fragmentary. . . . " Actually the specimens are in comparatively good shape, and leave no doubt about their affinities.

Poromycena myrmecophila (Heim) Sing. comb. nov.

Syn.: *Omphalia myrmecophila* Heim, Bol. Soc. Brot. **13** (II): 46. 1938.

This species has been carefully described by H. Heim (l.c.) though the iodine reaction of the spores and the hyphae and the presence of clamp connections are not mentioned. Considering, however, the doubtlessly strong affinity between this and the following species, I do not hesitate to transfer it to *Poromycena*.

Poromycena anastomosans Sing. spec. nov.

Fig. 1

Pileo obscure sordideque lilaceo, in vetustis fuligineo ("pale brownish drab" Ridgwayi) prope marginem, "deep brownish vinaceous" (R.) in disco speciminum juvenilium vivorum, aut omnino "deep brownish vinaceous" (R.), glabro, sulcato ad marginem, e campanulato convexo vel subapplanato, centro interdum subumbonato, umbone obtuso vel centraliter umbilicato praedito, 10–15 mm. lato; hymenophoro lamelloso-poroso, lamellis initio sordide lilaceis ad aciem vel totis unicoloribus, mox grisellis vel griseolo-pallidis, dein cinereis vel griseis, ad aciem concoloribus vel obscure brunneolo-vinaceis ("deep brownish vinaceous" R.), moderate latis, brevioribus intermixtis, venis anastomosantibus altioribus in centro, angustioribus ad marginem, conspicuissimis ita, ut visae verticaliter porosae appareant, poris plus minusve 0.5 mm. in diametro, radialiter dispositis, subdecurrentibus vel adnatis; stipite concolori vel pallidiore, haud viscoso, glabro, subaequali, 25–40×1–2 mm.; carne tenui, subconcolori vel pallida, inodora (odore raphanico constanter destituto), haud lactiflua.

Sporis 7.3–10×3.7–4.2μ, subellipsoideis, hyalinis, inamyloideis, levibus; basidiis circa 26–27×7–8μ; cystidiis nullis; cheilocystidiis numerosis, hyalinis, saepissime nonnullis succo cellulari sordide violaceo vel vinaceo impletis, integris, versiformibus, plerumque autem vesiculoso-fusoideis vel vesiculoso-ampullaceis, saepius crassis, rarius gracilibus elongatisque (i.e.,

plus minusve 50×5.5μ), 24–51×5.5–14μ metientibus; hyphis tramalibus majusculis, regulariter dispositis, haud gelatinosis, fibuligeris, amyloideis; strato cuticulari e subcute et epicute consistente; hyphis subcuticularibus pigmento sordide vinaceo, dissoluto pigmentatis, subcellulari; hyphis epicuticularibus hyalinis, tenuissimis, jacentibus, haud diverticulatis, levibus, paucis semi-erectis et subpiliformibus, omnibus filamentosis, longis, tenui-tunicatis.

Habitatio: Ad fragmenta palmigena delapsa putrescentia nec non ad folia vel humum silvarum frondosarum typi "hammock" mesophytici vel inferioris. Julio-Septembri mensibus. Plerumque duobus tribusque speciminibus congregatis at haud caespitose crescentibus.

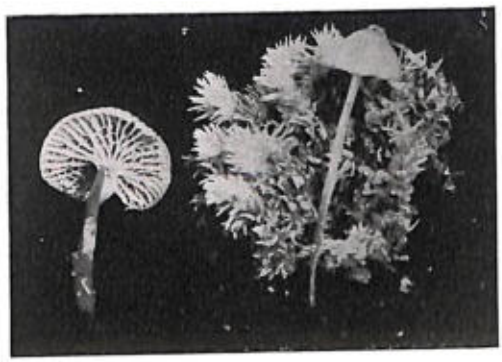


FIG. 1. *Poromycena anastomosans* Sing., fresh carpophores from Highlands Hammock State Park, Fla. Phot. Singer.

Area geographica: Florida, U. S. A. (Highlands Co. et Alachua Co.)

Observations: This species is in the configuration of the hymenophore intermediate between *Poromycena pseudopura* and *P. viridula*. It differs from both these species in being consistently inodorous. It is distinguished from *P. pseudopura* in having clamp connections, and from all species but *P. myrmecophila* in the color of the lamellae. *P. myrmecophila* appears to be closest, and may be distinguished by the characters pointed out in the key. The type specimen of *P. anastomosans* was collected in Highlands Hammock State Park, the co-type in Kelley's Hammock near Gainesville; both are preserved at the Farlow Herbarium.

POROMYCENA DECIPIENS Van Overeem in Van Overeem & Weese, Icon. Fung. Malay. **14–15**: 1, pl. 14, fig. 1. 1926.

The author of this species gives a fairly clear description of his material and a good colored illustration representing fresh specimens. For this reason the species can be included in the key.

PLEUROTOIDEAE Sing.

Genus DICTYOPANUS Pat., Essai Hymen., p. 137. 1900.

Agarics with pleurotoid appearance resembling species of *Panellus* with which they are related, but showing a strictly and consistently poroid-favoloid configuration of the hymenophore rather than a lamellose one, and the trama of the pore dissepiments is in one species gelatinous; spores ellipsoid to ellipsoid-cylindric, hyaline, amyloid, smooth, small; basidia small to medium; trama non-amyloid; cystidia none; epicutis of the pileus and stipe and of the edges of the pore walls with strongly diverticulate hyphae, sometimes assuming an asterostromelloid structure. On dead wood and dead grasses. Predominantly tropical, but also in temperate North and South America. Type species *Dictyopanus rhipidium* Berk., i.e., *D. pusillus* var. *rhipidium* (Berk.) Sing.

KEY TO THE SPECIES AND VARIETIES STUDIED

A. Pileus 2–3 mm. broad; stipe longer than the pileus; spores 6.8–7.8×3.5–4.2μ, ellipsoid; tube trama not gelatinized ..... *D. Copelandii* Pat.
B. Pileus 3–32 mm. broad; stipe shorter than the pileus; spores 3.5–5×1.5–2.5μ; tube trama more or less gelatinized.
  I. Pileus 3–14 mm. broad, rarely broader and then deeply lobed-flabellate; stipe usually equal; growing singly or gregariously. In the tropics and subtropics ..... *D. pusillus* (Lév.) Sing. (var. *typicus*)
  II. Pileus 12–32 mm. broad; stipe usually dilatate either at the apex or at the base; growing in clusters. Temperate form ..... *D. pusillus* var. *rhipidium* (Berk.) Sing.

DICTYOPANUS COPELANDII Pat., Leafl. Bot. **6**: 2254. 1914.

Pileus flesh-white, whitish, smooth, pruinose when seen under a lens, suborbicular or reniform in outline, the margin somewhat coarsely short-radially furrowed, or smooth, laterally umbonate in most specimens just above the point of insertion of the lateral stipe which thus is seemingly separated from the pileus behind, but pileus not actually marginate all around; hymenophore resembling a small "*Favolus*," i.e., as in *Polyporus* but with pores that are strongly radially elongate and angular, sometimes more irregular, and some individual pores may be elongated tangentially, not actually lamellose except at the stipe where the pores form a short, decurrent zone of lamellae, reddish, dissepiments (lamellae) very thick, medium thick in old specimens, sometimes showing a separating line of white pubescence running along the middle of the edges, diameter of the pores 60–180μ, diameter of the dissepiments 40–70μ, depth of the pores 120–180μ; stipe lateral but sometimes seemingly eccentric, straight or flexuose, thin, elongate, slightly pruinose under a lens, smooth, terete, 3–6×0.18–0.24 mm.

Spores 6.8–7.8×3.5–4.2μ, hyaline, inner side applanate, ellipsoid when seen frontally, wall smooth, thin, amyloid; basidia 28×7.5μ, 4-spored; basidioles as in *Marasmius*, fusoid; cystidia none; trama hyaline, now

staining fuliginous with KOH (visible even macroscopically) because of a dark fuliginous precipitation of pigment in the hyphae, nowhere gelatinous when revived in KOH or even when boiled in it, the hyphae very coherent, very irregularly interwoven, parallel in the stipe, thin walled in the pileus, thin and thick walled in the stipe, always non-amyloid and with clamp connections, occasionally with very slightly gelatinizing (?) walls if these are thick, and then becoming eroded-wavy; sterile surface of the pileus consisting of intricately interwoven hyphae which are strongly warted or spiny, and short-branched, some of these dichophyses could be called dendrophyses if it were not for the branching whereby a layer with astero-stromelloid structure is formed; this same layer is present on the edges of the pore dissepiments.

Habitat: On dead culms and leaves of grasses, gregarious. July.

Distribution: Philippine Islands.

Observations: The above description is the result of a study of the type specimens. When comparing this description with Patouillard's, it will be noted that he gives very different measurements of the spores and basidia, so different indeed, that I first thought that this species belongs to *Favolaschia* rather than to *Dictyopanus*. Only a revision of the microscopical characters of the type convinced me that Patouillard was right in considering it a *Dictyopanus*. The structure of the covering layer on the pileus and the dissepiment-edges is likewise wrongly described by Patouillard who attributed it to short hairs which are more or less granulose, and incrusted by mineral matter.

The existence of a species with a combination of characters as given above is, it seems to me, the strongest argument in support of the hypothesis that a group of agarics, especially *Panellus*, is actually related to the Leptotaceae. As we have seen in the case of the genus *Campanella*, a parallel genus with non-gelatinous trama and somewhat different ecological particularities was discovered in *Leptotus*. The idea that *Dictyopanus Copelandii* might represent an analogous case in regard to the genus *Favolaschia* can scarcely be rejected by any argument based on striking distinctive characters. The spores of *D. Copelandii* are shorter and larger and the basidia more voluminous than in *D. pusillus* as well as in *Panellus stipticus*, thus being intermediate between *Favolaschia* and *Dictyopanus*. The presence of dichophyses has been observed in several Favolaschiae, though, of course, also in agarics; the favoloid hymenophore suggests *Dictyopanus pusillus* rather than the Favolaschias. However *Favolaschia Sprucei* has a very similar hymenophore except for the lack of a lamellose attachment to the stipe which is so well developed in *D. Copelandii*. This latter has also an incurved margin in young stages, thus resembling *D. pusillus* and *Panellus stypticus*. For further discussion of this problem see p. 183.

Dictyopanus pusillus (Lév.) Sing. comb. nov.

Syn.: *Gloeoporus pusillus* Lév., Ann. Sc. Nat. 3me sér. **2**: 195. 1844.
Polyporus pusillus Pers. ex Lloyd, Myc. Mot. **7**: 1238. 1924, non al.
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Polyporus Rhipidium forma *pusillus* S. Ito & Imai, Trans. Sapporo Nat. Hist. Soc. **16**(3): 121. 1940.
Polyporus rhipidium Berk., Decad. 11, Lond. Journ. Botan. **6**: 319 (8, reprint pagination). 1846, a variety, and sensu lato.
Favolus Rhipidium Sacc., Syll. **6**: 397. 1888.
Gloeoporus rhipidium Speg., Bol. Acad. Nac. Cienc. Cordoba **11**: 74 (reprint). 1889.
Dictyopanus Rhippidium Pat., Essai Hymen., p. 137. 1900.
Polyporus subpulverulentus Berk. & Curt., Journ. Linn. Soc., Bot. **10**: 306. 1869.
Dictyopanus subpulverulentus Pat., Essai Hymen., p. 137, 1900.
Favolus Rhipidium var. *subpulverulentus* Sacc., Syll. **6**: 397. 1888.
Laschia guaranitica Speg., Ann. Soc. Cient. Argent. 1884, p. 70 (1884).
Gloeoporus guaraniticus Speg., Bol. Acad. Nac. Cienc. Cordoba **11**: 74 (reprint). 1889.
?Polyporus diminutus Mass., Journ. Bot. **34**: 153, pl. 357, fig. 17–18. 1896 (no type preserved).

Pileus white, becoming fulvous to red in the herbarium and sometimes when old, glabrous or pubescent, smooth, or with 1–2 concentric slight furrows, slightly convex, subreniform, not marginate behind, the stipe when seen from above merely a proliferation of the pileus which is 3–14 mm. in diameter; hymenophore porous, pores concolorous with the pileus, and discoloring even faster than the latter, not showing lamellose arrangement but distinctly radially elongate in most specimens, 2.5–5 pro 1 mm. tangential distance in the middle between the stipe and the margin which is slightly incurved when young, tubes up to 1 mm. long, mouths angular; stipe concolorous, and discoloring like the pileus, subequal, lateral, but the apex often three quarters surrounded by the hymenophore though the upper surface of the stipe not different from the surface of the pileus and both surfaces running into each other, but well differentiated from below, always inserted at the deepest point on the rear sinus in the circumference of the pileus, horizontal or obliquely ascendant, rarely suberect, 1.5–6×1–2 mm.; context white, inodorous, mild, almost fleshy, soon becoming tough.

Spores oblong elliposid to ellipsoid-cylindric, 3.5–5×1.5–2.5μ, wall rather thin, hyaline, smooth, distinctly amyloid; basidia about 20×4.5μ, 4-spored; occasional thin cylindric or nodose cheilocystidia present; cystidia none; trama of the tube dissepiments gelatinous, the hyphae imbedded, their walls wavy and eroded at many places, subparallel to interwoven, regularly arranged, not amyloid; subcutis dense, of closely interwoven hyphae; epicutis irregular, of hyaline, semi-erect or repent rather thin walled, filamentous hyphae which are diverticulate either on one side only or on all sides, the diverticula 1–4μ long, but not in very regular arrangement, and wanting in some of the epicuticular hyphae, the whole epicuticular layer not always clearly discernible in old material, though when well developed, the epicutis resembles the asterostromelloid structure of *Asterotus* or the diverticulate epicuticular hyphae of most Mycenas;

hyphae of the pileus and stipe trama not gelatinized, not amyloid, with clamp connections.

Habitat: On fallen branches, on logs, stumps, and trunks of all kinds, but only on dead, usually well decayed matter, on hosts as different as the following, indicated on, or determined from material preserved in the Farlow Herbarium: *Antirhoea acutata*, *Araucaria* spec., *Caryota urens*, *Eucalyptus capitellata*, *Ilex dioica*, *Meriania leucantha*, *Quercus virginiana*, *Sterculia caribaea*, *Xylosma martinicense*. Fruiting bodies are produced practically throughout the year; they grow densely gregarious.

Distribution: Tropical and subtropical America, Oceania, Australia, South-Eastern Asia, not known from Africa.

Observations: *Dictyopanus pusillus* is a very common plant within its area and, as such, rather variable in several regards. In some forms the reddish color does not show in many years (*L. guaranitica*), in others it is replaced by a yellow discoloration. In other forms the epicuticular layer is very strongly developed and macroscopically visible as a subfurfuraceous pulverulence (*D. subpulverulentus*). The most remarkable variation is observed in regard of the shape and size of the carpophores. The usual tropical form, as described above, is replaced in temperate North America and probably also in the temperate regions of South America by a larger variety or subspecies, the original *Polyporus rhipidium* Berk., later used by Berkeley himself in a wider sense as to include the small tropical plant. **Dictyopanus pusillus** var. **rhipidium** (Berk.) Sing. comb. nov. has the pilei about 12–32 mm. wide, the stipes 7–12×1.5–5 mm., usually more thickened below or above than in the type, and growing in denser clusters, or at least with some individual carpophores in a population connected at the bases. The microscopical features are the same. In the tropics, exceptionally large single carpophores or occasionally concrescent individuals usually are deeply lobate or flabellate. Var. *rhipidium*, first discovered in Ohio, has since been found in New York, North Carolina, etc. The material from Florida, however, as collected by Lloyd (No. 4839), myself (Alachua Co., Dade Co.), and also by Murrill and West in North Florida, represents the typical tropical form.

The similarity of this fungus with *Panellus stipticus* impressed Berkeley who, when commenting on the affinities of *Polyporus rhipidium* (i.e., *Dictyopanus pusillus* var. *rhipidium*), said: "This curious species exactly resembles *Panus stipticus* with the exception of the hymenium. I know of no species to which it has a close affinity." Spegazzini mentions a feature of his Brazilian specimens which make the difference in the shape of the hymenophore appear even less important. He observes that the marginal pores especially are almost radiato-lamellose. I have not observed this in other materials, but there is no reason to believe that Spegazzini's observation is incorrect.

The original inclusion of this fungus in *Polyporus*, or *Favolus* is quite understandable, as long as the amyloidity of the spores was unknown. It took Patouillard's characteristic sense for natural affinities to remove this species from the polypores and place it right beside *Panellus*. Léveillé's and Spegazzini's suggestion to refer it to *Gloeoporus* is, from a purely schematical point of view, correct, but a comparison with true Gloeopori shows just how much this *Dictyopanus* is out of place among them. The shape of the carpophores and pores, the anatomy of the cortical layer and the chemistry of the spore wall tend to separate it from *Gloeoporus conchoides* and its allies.

The description of the typical tropical form as given above is the result of the study of numerous collections, fresh as well as dried, including authentic material of *Polyporus rhipidium* Berk., the type of *Polyporus subpulverulentus* Berk. & Curt. and material collected by Lloyd. This fact is important since Lloyd who had an excellent knowledge of this species, the tropical as well as the temperate form, is the only author who has studied *Polyporus pusillus* of Persoon's Herbarium, the type of the species. Lloyd is fully convinced and undoubtedly right, that *Polyporus pusillus* Pers. Herb., represents the tropical form of the species in question. As for *Laschia guaranitica* Speg., it is clear from its author's own words that it is the white form of *Dictyopanus pusillus*, whereas Spegazzini's *Gloeoporus rhipidium* is unquestionably the reddening form.

Under the name of *Polyporus subpulverulentus* B. & C. several collections are found in the Farlow Herbarium, all of which were determined by Farlow and collected by Wight and others in the West Indies, for example on Jamaica. These collections are decidedly different from the type of *P. subpulverulentus*. They belong to *Porodisculus pendulus* (Schw.) Murr. (*Polyporus pocula* (Schw.) aut.). They have, however, the asterostromelloid structure of the general covering and also the shape and approximate size of the basidia (17.5×4.2μ, 4-spored) characteristic of *Dictyopanus pusillus;* the trama is here non-gelatinous, even in the hymenophore, as is the case in *D. Copelandii*, and the shape of the carpophores is the well known, peculiar pendulous cup which characterizes this species so well macroscopically. The fact that Farlow who knew *Porodisculus pendulus* from the U. S. A., confused it with *P. subpulverulentus*, shows that there must be some similarity in the external appearance of these fungi. If we consider all these facts, there seems to be reason to suspect that *Porodisculus* Murr. (and *Porodiscus* Murr.) is congeneric with *Dictyopanus*, and that *P. pendulus* is a third species of this small genus. However, after several futile efforts to obtain my own data on the spore characters, I was able to find some spores in a carpophore collected by Peck on oak, in Orange Co., N. Y. (Bartholomew Herbarium, Farlow Herbarium), still connected with the sterigmata. They were cylindric-allantoid, smooth, hyaline, non-

amyloid, 4.2–4.8×1.5–2μ. It is obvious that Cooke's indication was an error, unfortunately copied without indication of the source by Murrill and cited by Overholts. Since the spores are not amyloid, I consider *Porodisculus* as an independant genus of unknown affinities.

CONCLUSIONS

1. The genus *Laschia* Fr. is a synonym of the genus *Auricularia* Bull.
2. The genus *Laschia* sensu Pat. non Fr., as outlined in Essai . . . (1900) is a synonym of the genus *Campanella* Henn.
3. The genus *Laschia* sensu Lloyd non Fries corresponds to *Favolaschia* (Pat.) plus *Filoboletus* Henn.
4. The genus *Laschia* Junghuhn consists of a *Poria*-like fungus and *Polyporus vibecinus* Fr.
5. The genus *Porolaschia* Pat. 1900 is a synonym of *Favolaschia* (Pat.) Henn.
6. The genus *Mycenoporella* Van Overeem is a synonym of the genus *Filoboletus* Henn.
7. The genera *Leptotus*, *Campanella*, *Favolaschia* belong to the family Leptotaceae Maire. The family Leptotaceae belongs to the suborder Cyphellineae Bond. & Sing.
8. The genera *Dictyopanus*, *Filoboletus*, and *Poromycena* are agarics (Agaricineae).
9. The iodine reaction of the spore and hyphae walls is an excellent character for the delimitation of the genera within the *Laschia*-complex.
10. Many species of *Favolaschia* have gloeocystidia which are best stained with brilliant cresyl blue.
11. There is a possibility that some genera of the Agaricineae-Pleurotoideae, and maybe also Marasmioideae, will have to be separated from the agarics, and combined with the Cyphellineae.
12. Asterostromelloid structure is rather frequently observed in certain organs of representatives of the *Laschia*-complex as well as in agarics and polypores.

ACKNOWLEDGMENTS

A Fellowship awarded to the author by the Guggenheim Memorial Foundation made it possible for him to study representatives of the *Laschia*-complex in living condition in the only tropical territory within the Continental U. S. A., South Florida. The author also wishes to acknowledge his indebtedness to Dr. David H. Linder, Curator, Farlow Herbarium, for his efforts in producing valuable material, for his kindness in reading the manuscript, and for his technical help and advice in many instances.

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Polyporus Farlowii and Its Rot

W. H. Long*
(*Albuquerque, New Mexico*)

For several years I have been finding a large number of shade trees in the southwest, seriously attacked by a common heart rot which resembles the rot caused in the eastern states by *Polyporus hispidus* (Bull.) Fries. After a careful study of Lloyd's (1915) figure and description of his *Polyporus farlowii*, I decided, tentatively, that the sporophores associated with this heart rot were those of *P. farlowii*, pending an opportunity to examine the type material; recently a portion of the type has been examined and my tentative conclusion that the fungus is *P. farlowii* was confirmed.

The sporophores of *P. farlowii* are very variable in size and shape depending apparently upon the size of the host, the time of year they are formed and whether the season is a wet or dry one. Many have thickened bases (Fig. 1) resembling those of *P. rheades* but without a gritty core. They usually develop near the base of the host, but are sometimes found 15–20 feet from the ground. They are usually imbricated (Fig. 2) and are often solitary. Sometimes a badly diseased tree trunk will have 8–10 groups of sporophores attached to dead areas of the sapwood, or forming from broken limbs or issuing from knot holes. The sporophores when fresh are hairy on top, but as they weather these hairs either become more or or less agglutinated or they may wear off leaving the surface of the pileus glabrous. The lower pilei that are imbricated usually have their tops colored a rusty brown, due to the large number of spores which have been discharged. These spores remain upon the surface for a long time even after several months of exposure to winds and rains.

The spores, when they germinate, enter the trees either through wounds which reach to the heartwood or through dead branches; apparently they enter mainly through wounds. After the spores germinate the mycelium gradually extends down the heartwood of the wound until it reaches the main heartwood of the tree where it grows both upward and downward; the rapidity of this growth depends upon the character of the host and to a considerable extent upon the amount of air which the growing fungus can obtain.

The shape of a rot lesion in the heartwood of living trees depends upon the special means by which the fungus enters the host, and the character

* I am under many obligations to Dr. David H. Linder for the loan of valuable material; to Mr. John A. Stevenson for loan of material and for photograph of figure 4; to Dr. J. L. Mielke of the office of Forest Pathology, Bureau of Plant Industry at Albuquerque for the privilege of examining the specimens in the herbarium here, and for the photographic prints from which figures 1 and 2 were made; also to Mrs. Bessie E. Etter of the same office for valuable assistance in compiling the data on distribution.

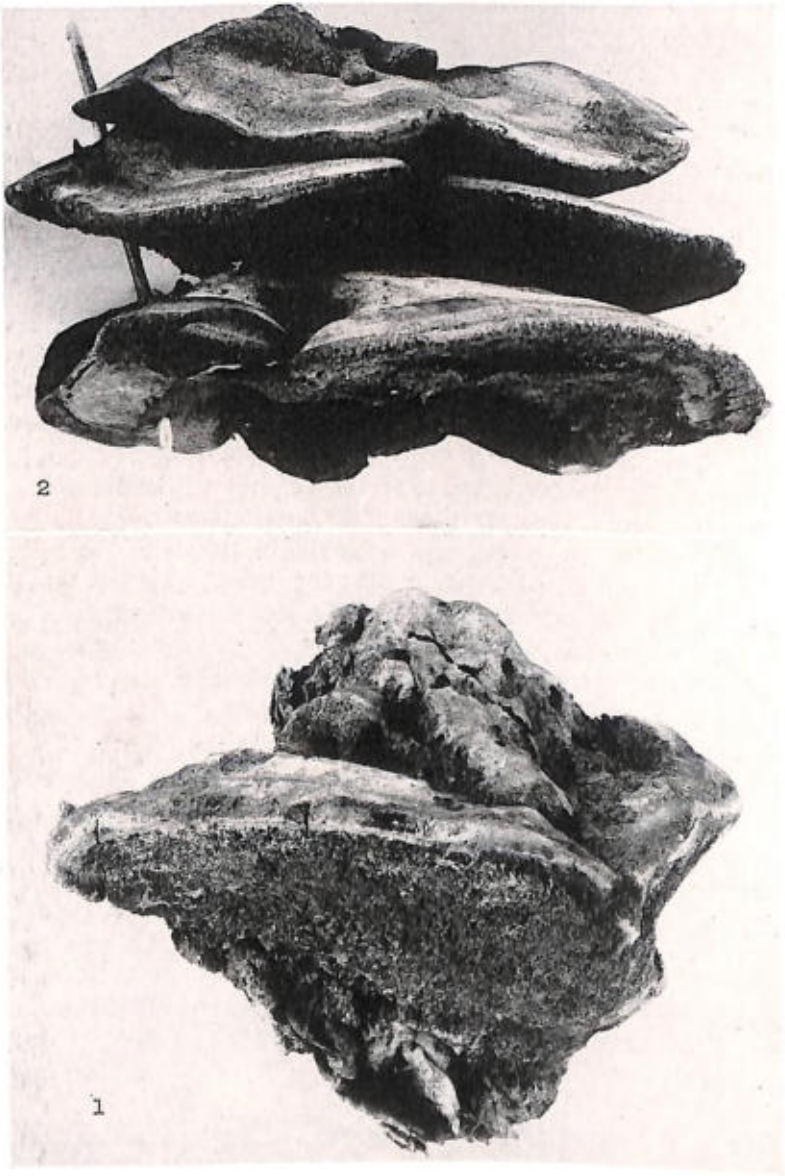


FIG. 1. *Polyporus farlowii* on *Schinus molle*. FIG. 2. *P. farlowii* on *Populus italica*.

of the fungus itself. If the wound is a large one, the fungus will of course attack that side of the heartwood first, thus producing a one sided lesion at this point. Later, however, as the fungus grows in both directions from this point the normal shape of the lesion will begin to develop. In some fungi this rot lesion will take the shape of an acute double cone, in other

cases it will be a very obtuse cone, while in a few instances it will be in the shape of a cylinder or paraboloid.

The special shape that a rot lesion will assume depends upon the relative rapidity with which the mycelium moves longitudinally in the heartwood

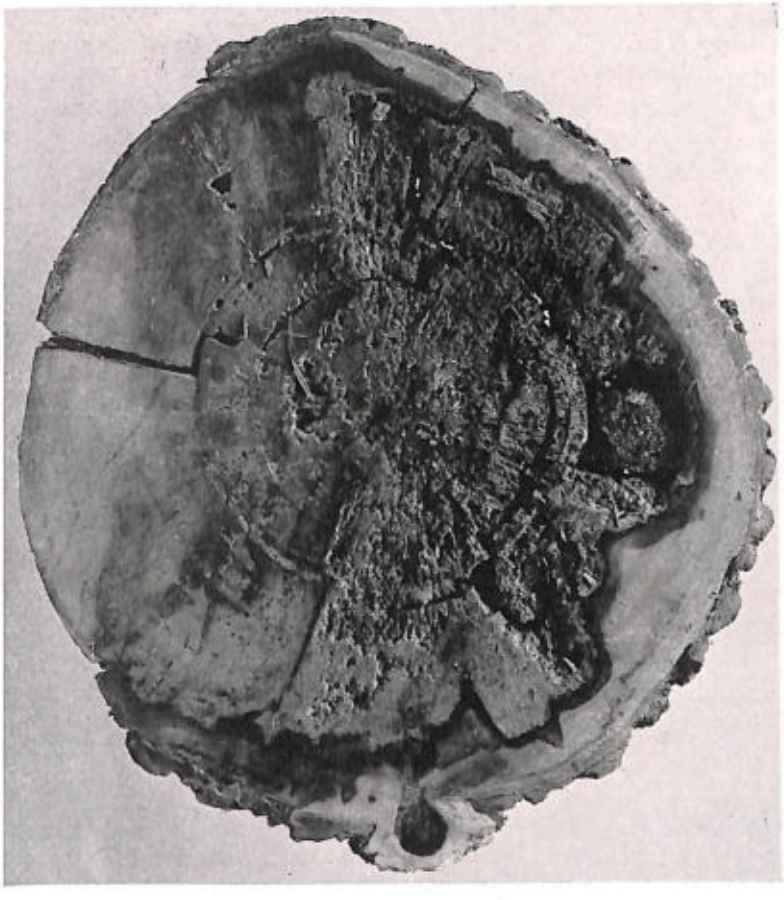


FIG. 3. *Polyporus farlowii*, heart rot in *Acer negundo*.

compared to its rate of movement laterally. If the longitudinal movement is very rapid compared to its lateral movement the rot lesion will assume the shape of an actute cone. If the longitudinal movement is slow compared to the lateral we have the obtuse cone. If the two movements grow at about the same rapidity we will have a cylindrical or paraboloid shape.

The rot caused by *Polyporus farlowii* is of the cylindrical type and extends entirely to the sap wood in the majority of cases, so that any light wind or unusual strain may cause the branches to break off or the trunks

to split. This fungus does not entirely destroy all of the heartwood but forms a rot which the writer has heretofore called indeterminate (Fig. 3), that is, the texture and color of the wood has not been appreciably changed although there have been material changes in the structure of the cells and vessels thus weakening the strength of the heartwood.

The distribution of this fungus is very peculiar. It seems to be limited to the dry semi-arid and hot portions of the United States, since as we go east into a wetter and colder climate the fungus disappears. Its northern boundary is northern New Mexico, its eastern limit west Texas, its southern limit has not been defined, while its western range extends to the Pacific Ocean. If one will examine the area roughly outlined above, they will find that this region includes the semi-desert and hotter regions of the southwest. This indicates that this fungus is xerophyte.

In Phoenix, Arizona, all kinds of ornamental trees with probably the exception of the elms and ashes are found badly damaged by this heart rot. This is especially true of the pepper trees (*Schinus molle*), cottonwoods, willows, box elders, elders and mulberries. The pepper tree seems to be peculiarly susceptible to the inroads of this organism. Why this should be is difficult to understand. It is probably due to the nature of the heartwood of this species which furnishes favorable ground for the growth of this heart rotting organism. The next most susceptible tree is the Mexican elder (*Sambucus mexicana*). Usually every bush of this species which has reached a diameter of 4 inches at the ground has its heartwood destroyed by this fungus. The rot even extends into the small branches if they contain any heartwood.

It was very difficult to find any evidence of this rot in the pepper trees in Los Angeles, California, although the climatic conditions, as far as moisture and temperature are concerned, would seem to favor the development of this disease. After several days' search a few pepper trees with the sporophores of *P. farlowii* on them were found in an old cemetery; also near Elysian Park an occasional pepper tree was attacked by this heart rot. Just why this fungus should be so rare in Los Angeles where there are thousands of pepper trees is hard to explain, unless the climatic conditions are too damp.

Remedies: There is no remedy for this disease after the heartwood of the tree has been invaded to any considerable extent. The real remedy is to prevent the entrance of this fungus by removing the dead limbs and by protecting the trees against wounds which penetrate to the heartwood. After a wound has already been made on the tree the injured bark should be cut from around the wound, and the exposed surface painted with shellac or some good paint made of white lead.

Long & Harsch (1918)[1] have grown eighteen strains of *P. farlowii* from 10 different hosts on artificial media. In all of these cultures the characters

[1] Pure Cultures of Wood Rotting Fungi on Artificial Media. Jour. Agri. Res. 12: 33–82.

of the growth of each strain on a given medium was practically identical. There were a few minor differences due, apparently, to the host from which the strain came. This fungus produces sporophores readily on various kinds of artificial media. The sporophores produced in the test tubes have no pilei but are otherwise normal. An abundance of spores is discharged in the test tubes after the pores have once started. If the test tube is reversed the spores fall upon the inside of the glass tube opposite the slanted agar. These spores when plated are easily viable. They also have the typical color, shape and size of spores produced in the open, thus proving that the sporophores formed in the test tubes are normal in every way except for the absence of a pileus. This fungus also, when grown on artificial media in test tubes produces sporulating sporophores in absolute darkness. This is very unusual, since normally sporophores of wood rotting fungi do not develop in absolute darkness but require at least some light and in some instances quite a large amount of light for sporophore formation.

The formation of sporophores on artificial media did not occur on all of the media tested but were found on the following five agars: prune, malt, cornmeal, parsnip, and beet. Only 10 agars have been tested so far, namely: carrot, malt, cornmeal, beet, celery, prune, potato, bean, alfalfa and parsnip.

The following is a more technical description of the fungus and details on its distribution:

POLYPORUS FARLOWII Lloyd, C. G. Myc. Writ. **4**: Ap. 363, 1915.

1922 *Polyporus munzii*, Lloyd, C. G. Myc. Writ. **7**: 1163.
1930 *Inonotus schini*, Brown, J. G. Timber Rot of the Pepper tree, *Schinus molle*, University of Arizona, Bulletin 132.

Sporophore annual, spongy, and watery when fresh becoming firm and rigid when dry, single or imbricated, ungulate and dimidiate or irregular, 4–22 cm. side to side by 4–18 front to back by 1–13 cm. thick. *Surface* strongly hispid when fresh often becoming glabrous with age, upper surface chestnut brown from the dense hirsute pubescence, azonate, margin thick or thin, obtuse or acute. *Sterile* zone 1–6 mm. wide, 1–2 cm. thick sometimes thicker. *Context* hazel; *tubes* avellaneous to tawny, angular, oval or irregular, 1–20 mm. long; *setae* usually present, brown, straight or cat-claw shaped, 8–10 by 20–30μ. *Pores* angular at maturity, 4–6 sided, 2–4 per mm. *Spores* smooth, oval, light brown, 6–10 by 4–7μ.

Habitat: heart rot in ornamental and shade trees in the southwest.

Type locality: Arizona, probably Phoenix on *Sambucus mexicana?*

Distribution: ARIZONA, Cochise County; in Coronado National Forest, *M. Averett* on *Populus* sp. F.P. 18666. Coconino County; Indian Springs, in Oak Creek Canyon, *W. H. Long* on *Acer negundo*, F.P. 89059. Graham County; Safford, *W. H. Long & David J. Stouffer*, on *Acer negundo*, F.P. 89613; *L. N. Goodding*, on *Populus* sp., F.P. 26803; *W. H. Long & David J. Stouffer*, on *Populus* sp., F.P. 89583; *David J. Stouffer*, on *Populus* sp. F.P. 89584; *H. T. Pinto*, on *Salix nigra*, F.P. 89116; Maricopa County; Phoenix, *W. H. Long*, on *Acer negundo*, F.P. 89158, on *Ficus carica*, F.P. 21106, F.P. 26799; *L. N. Goodding*, on *Melia azedarach*, F.P. 21967; *W. H. Long*, on

Morus alba, F.P. 12325, F.P. 19920; *L. N. Goodding*, on *Morus alba*, F.P. 21968; *W. H. Long*, on *Populus McDougalii*, F.P. 33194; F.P. 26800, F.P. 21113, F.P. 33195, F.P. 26707, on *Sambucus mexicana*, F.P. 18625, F.P. 26605, F.P. 12306, 21108, F.P. 33186, F.P. 26984, on *Schinus molle*, F.P. 12311, F.P. 12328, F.P. 18329, F.P. 19117, F.P. 19918, F.P. 21103, 33182, F.P. 33079, F.P. 33183, F.P. 33184, F.P. 33185, F.P. 89160; Mohave County; Kingman, *L. N. Goodding*, on *Salix nigra*, F.P. 33027, Pima County; Tucson, *W. H. Long*, on *Morus alba*, F.P. 21999, on *Populus* sp. 21057; *L. N. Goodding*, on *Salix nigra*, F.P. 21798, *W.H. Long*, on *Salix nigra* 26700, on *Sambucus mexicana*, F.P. 26601, on *Schinus molle*, F.P. 12835, F.P. 26600. Pimal County; near Sonora, *Dr. G. W. Goldsmith*, on *Salix* sp. F.P. 89580. Santa Cruz County; near Nogales, *L. N. Goodding*, on *Sambucus mexicana*, F.P. 21984. Yuma County; near Yuma, *W. H. Long*, on *Salix* sp. F.P. 21111.

CALIFORNIA: Los Angeles County; Los Angeles, *W. H. Long*, on *Schinus molle*, F.P. 30520; *Bessie E. Etter*, on *Schinus molle*, F.P. 33074, F.P. 33077; San Bernardino County; Barstow, *W. H. Long*, on *Salix* sp. F.P. 68983, F.P. 68988, on *Schinus molle*, F.P. 30515, F.P. 30923; Needles, *Bessie E. Etter*, on *Schinus molle*, F.P. 33072, F.P. 33072, F.P. 33076, *W. H. Long*, on *Schinus molle*, F.P. 30923.

NEW MEXICO: Bernalillo County; Albuquerque, *W. H. Long*, on *Acer negundo*, F.P. 12001, F.P. 12285, F.P. 12615, F.P. 21149, F.P. 21591, F.P. 30682, F.P. 89702, on *Ailanthus glandulosa*, F.P. 33377, on *Populus italica*, F.P. 12635, F.P. 19643, F.P. 21315, F.P. 21402, F.P. 30684, F.P. 30685, on *Populus wislizenii*, F.P. 12947, F.P. 21400, F.P. 36969. Socorro County; San Marcial, *W. H. Long*, on *Populus wislizenii*, F.P. 21994. Grant County; Silver City, *W. H. Long*, on *Populus angustifolia*, F.P. 18538; Sierra County; Hillsboro, *C.S. Llewellyn*, on *Populus angustifolia*, F.P. 21979.

TEXAS: Bexar County; San Antonio, *J. B. Hayes*, on *Salix* sp. F.P. 21955; *W. H. Long*, on *Salix* sp. F.P. 30570; Cameron County; Brownsville, *W. H. Long*, on *Salix* sp. F.P. 30566; Colorado County; Eagle Lake, *J. B. Hayes*, on *Salix* sp. F.P. 30505. Travis County; Austin, *W. H. Long*, on *Salix* sp. F.P. 12029; Webb County; Laredo, *W. H. Long*, on *Celtis missippiensis*, F.P. 33321; Val Verde County; Del Rio, *W. H. Long*, on *Acacia farnesiana*, F.P. 21683, on *Morus alba*, F.P. 21682, on *Populus italica*, F.P. 89528, on *Populus* sp. 33394, on *Salix* sp. F.P. 33396.

All of the collections listed are deposited in the Forest Pathology Herbarium of the Bureau of Plant Industry at Albuquerque, New Mexico; also the accession numbers of the specimens are those of the Forest Pathology Herbarium.

DATA ON THE TYPE OF POLYPORUS FARLOWII LLOYD

This species was based on material collected by Dr. E. Palmer somewhere in Arizona (locality, date and host not given) and sent to Dr. Farlow at Harvard University. Later Dr. Farlow divided it and retained part for his herbarium sending the remainder to M. C. Cooke at Kew for identification, who called it *Polyporus endocrocinus*, Berk, an eastern species which is now recognized as a synonym of *P. dispidus*.

When Lloyd examined this material at Kew, he decided it was a new species and called it *Polyporus farlowii* (l.c.). He published a photograph of the type material at Kew (Fig. 4) and a description of the species in his Mycological Writings.

Recently through the kindness of Dr. Linder I have been able to study that portion of the type material (co-type) retained by Farlow in his herbarium. This material evidently was collected "green" and before full maturity as shown by the paucity of spores present and the over-running of the pore surface by a honey yellow layer of mycelium, which is not uncommon with this species when collected before maturity and dried while still watery.

The material evidently came from near the ground as it is overrun by a moss that is rather common in Phoenix on the ground and extending some 12 inches up the bases of shrubs and trees located in damp areas where there



FIG. 4. *Polyporus farlowii*, photograph of type at Kew by C. G. Lloyd.

are leaky water mains and hydrants. This moss is shown even in Lloyd's photograph of the type.

The small size of the sporophores and the presence of this moss is a strong indication that the type material grew at the base of the Mexican Elder since this tree was rather common in such locations in Phoenix, especially on the Court House and City Hall grounds.

Polyporus munzii Lloyd (1922) was based on material from the C. F. Baker Herbarium of Pomona College, Plants of Southern California, collected on *Salix* sp. by P. A. Munz & D. D. Keck (No. 5304) April 9–12, 1922, in the vicinity of Corn Springs, Chuckwalla Mountains, Colorado Desert. I have examined this type material (Lloyd Catalog No. 18867) and find that it is typical *Polyporus farlowii*. The name is *nomen nudum* since Lloyd did not give any figure or adequate description that would identify the species.

Higher Fungi of the Panjab Plains. IV

SULTAN AHMAD
(Government College, Rohtak, India)

THE GENUS ITAJAHYA ALFR. MOELLER

The genus *Itajahya* was established by Alfred Moeller in 1895. It consisted of one species from Brazil, *I. galericulata*, to which were added by transfer *Albofiella argentina* Speg. from Bolivia and Argentina, and *Phallus roseus* Delile from Egypt and Palestine. The distinctive characters of the genus are the pseudoparenchymatous veins traversing the gleba and a pseudoparenchymatous cap at the apex of the stipe. The two species, *I. galericulata* and *I. rosea*, recognised at present resemble each other except in colour, the former being white and the latter rosy. The curious geographical distribution has also been taken into account for differentiating the two species. This is quite evident from Fischer's (1929) statement regarding *Phallus roseus* (=*I. rosea*) "Wenn man dies alles in Betracht zieht, so ergibt sich, dass *Phallus roseus* zu *Itajahya* gestellt werden muss. Doch möchte ich ihn trotz der grossen Übereinstimmungen einstweilen nicht mit der Spezies *I. galericulata* identifizieren, einmal wegen der geographischen Verbreitung und anderseits wegen der Rosafarbe seines Receptaculums." But later on Fischer (1933) remarks "vielleicht mit vorigen (*I. galericulata*) in eine Art zu vereinigen."

The writer has been conducting observations on a species of *Itajahya* which is very common in the Panjab Plains and which was reported by him (1940) as *I. galericulata*. These observations show that though the stipe is generally orange pink (R) or orange buff (R), white stemmed forms are by no means rare. It follows that too much stress should not be laid on colour difference as it varies in individuals of the same species found in the same locality. This conclusion is supported by Lloyd's (1909) statement about the colour of Phalloids, "there are only three colours known in the phalloids: red, yellow, and white . . . the yellow and red phalloids seem quite distinct, and do not run into each other, but the red species are apt to have white forms." That geographical distribution, another criterion used for erecting new species, is of no value is evident from the fact that a large number of fungi whose distribution was once regarded as more or less localized has proved to be of cosmopolitan range. This is amply borne out by the study of the fungus flora of the Panjab Plains which reveals such interesting species as *Protubera maracuja*, *Phallus celebicus*, *Lycoperdon echinella*, *Queletia laceratum* and a host of others. "When the subject (of phalloid distribution) is well known," says Lloyd (1909) "I think, it will be found that several species are of very wide distribution, but at present we know only two." Such has indeed proved to be the case.

After a four years' study I am convinced that only one species of the genus *Itajahya* can be found in different parts of the world. It should be given the older name *Itajahya rosea* (Delile) Fischer, whereas *I. galericulata* Alfr. Moeller should be reduced to a synonym.

ITAJAHYA ROSEA (Delile) Fischer

Figs. 1–3

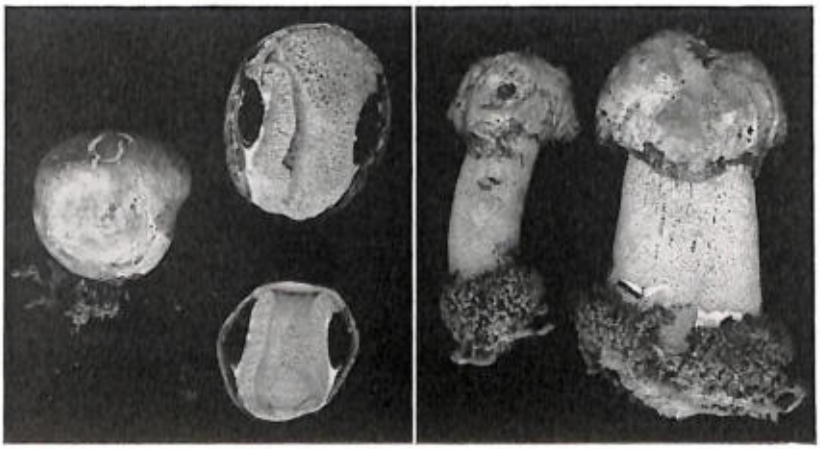
This is a very common phalloid found in the Panjab Plains. It has so far been collected from Rohtak, Lahore, Gujranwala, Sheikhupura and Bahawalpur State. It is interesting to note that the plant thrives equally well in the Bahawalpur State which is practically a desert with an average annual rainfall of five inches. It is found only during the monsoon months i.e., July–September, and not throughout the year as observed by Moeller (1895) in Brazil. It occurs in groups near the bases of *Zizyphus jujuba* and *Salvadora oleoides* trees, where the soil is particularly rich in humus (fig. 1). The mycelium seems to be perennial since, once established in a particular spot, it comes up regularly year after year without interruption.

The eggs are rarely solitary and perfectly globose, but frequently clustered and flattened on the sides. They measure from 2.5–8 cm in diameter, white on emerging from the soil, becoming dirty white on contact with the air, turning brownish when handled roughly or when bruised. The brown colour is soluble in alcohol. The eggs develop on thick and profusely branched mycelial strands which ramify in the soil at various depths and are occasionally seen penetrating dead pieces of buried wood and dead roots of grasses. They show the same colour changes as the eggs. A large number of eggs arise from a common mycelial strand.

When the eggs are mature the middle jelly layer deliquesces and they become flaccid. If the weather remains sufficiently wet for a long period the volva ruptures at the apex in a stellate manner directly exposing the upper surface of the cap. But when a heavy rainfall is followed by a long dry period, as is generally the case in the Panjab Plains, the volva invariably ruptures in a circumscissile manner the upper half being carried with the pileus. After the rupture of the volva the stipe begins to elongate due to the stretching of the originally closely packed chambers of the wall. The time required for this process is not necessarily long as pointed out by Moeller. It all depends on the environmental conditions, especially on suitable temperature and the amount of available water. If the rupture of the volva is followed by dry weather, the stipe takes 5–6 hours to reach its maximum length. Under exceptionally moist conditions the stipe attains a length of about 12 cm. in 3–4 hours. The elongation of the stipe is uniform throughout and not as stated by Moeller from above downwards. The length of the stipe varies from 6.5–17 cm. and the thickness below the



FIG. 1. *Itajahya rosea*. Photographed in situ.



FIGS. 2 (left) and 3 (right). *Itajahya rosea*.—2. A complete egg; two eggs in section, the upper showing an unequal development due to pressure and the lower showing normal development of the various parts.—3. Two expanded plants showing the prominent apical collar after the cap has fallen.

pileus from 2.5–4.5 cm. The stipe tapers downwards but broadens towards the apex where it is bent outwards to form a very prominent collar.

The stipe is orange pink (R) or orange buff (R) in colour, but sometimes perfectly white stemmed individuals are found. The exact environmental conditions which prohibit the development of the pigment in some plants could not be ascertained. In any case the white colour is not due to the washing off of the pigment by rain, since some plants had white stipes when hatched from eggs in the laboratory under moderately moist conditions. The wall of the stipe is 5–6 chambered, the chambers are large and closed internally, becoming smaller towards the periphery where they open on the surface in the form of numerous labyrinthiform pores. Seen in section the chambers are filled with very loose white hyphal threads. The cavity of the stipe widens towards the apex in the form of a funnel.

The stipe bears at its apex a globose head. Before the deliquescence of the gleba the outer ends of the pseudoparenchymatous veins filling the glebal chambers appear strikingly conspicuous against the dark olive green background. The pileus is continuous for some distance with the stipe becoming free lower down. The lower free margin is hidden below the gleba which covers the downwardly directed pseudoparenchymatous veins.

At the apex of the plant there is a very prominent pseudoparenchymatous cap, varying in form and size in different individuals. After the elongation of the stipe it curves upwards and falls on the ground, thus exposing the wide opening at the apex of the stipe.

The ripe plants emit a strong odour like that of a flowering *Acacia leucophloea*.

PHALLUS CELEBICUS P. Henn.

This species was described by Hennings (1900) from Celebes. It belongs to the section "Rugulosae" of the genus *Phallus* characterised by a granular pileus, but differs from all th other species of the section in having "goldgelb" colour. At first it was included by Fischer (1900) in "ungenügend bekannte *Ithyphallus* Arten" but later (1933) without any obvious reason was put under *Phallus aurantiacus* Mont. as a synonym.

A *Phallus* species reported (1940) from the Panjab Plains as *Ithyphallus rubicundus* resembles this species in colour. The white colour described there is a mistake, arising from observation of specimens preserved in alcohol and unaccompanied by field notes. The plant has been collected several times since then and the colour always noted as bright yellow. The eggs are white but on sectioning reveal the characteristic colour of the species. The white mycelial threads ramify in all directions and generally penetrate the dead roots of grasses.

AURICULARIA POLYTRICHA Mont.

This species resembles *A. auricularis* (S. F. Gray) Martin, the common Jew's Ear, in colour, consistency and habit, but is distinguished by the long coarse hairs on the upper surface of the pileus and the slightly more purplish hymenium.

Jaggatpur, Gurdaspur Dist.—On dead branches of *Ficus bengalensis*, August 20, 1941 (No. 427). Very common.

AURICULARIA PELTATA Lloyd

Resupinate, gelatinous when fresh, forming small circular fruitbodies in the beginning, becoming confluent and covering the surface over large areas, attached to the wood by white mycelial hairs that exceed and form a narrow margin; rarely reflexed with a slightly developed pileus strigose on the upper surface; hymenial surface even or wrinkled, drab or hair brown (R), substance consisting of two kinds of hyaline hyphae embedded in a gelatinous matrix; thick straight hyphae 3.5μ and very thin hyphae 1.5μ with a wavy outline or sometimes spirally coiled, with some kind of granular substance in them; basidia slender, cylindric, curved, 4-septate, 35–38×3.5–4.2μ, forming a dense brown palisade layer; spores white in spore print, hyaline, cylindric curved or flattened on one or both sides, 5.5–7×9.5–11.5μ.

Gujranwala, August 25, 1941 (No. 422); Ladhar, Sheikhupura Dist., Sept. 12, 1940 (No. 351), Sept. 20, 1941 (No. 431) and August 20, 1942 (No. 592) On bark and dead stumps of *Zizyphus jujuba;* Rohtak, on dead wood of *Cordia myxa*, Nov. 8, 1942 (No. 655); on dead wood of *Jacaranda mimosaefolia*, Feb. 27, 1943 (No. 677).

This species is so far known from the Philippines from specimens sent to C. G. Lloyd. The basidia and the spores were not observed in the original collection, so it was fortunate to get fully mature plants from which very good spore prints could be obtained. The species is exceptional in the colour, resupinate habit, and rarely has a slightly reflexed strigose pileus.

GUEPINIA SPATHULARIA (Schw.) Fries

A common species of the tropics known from America, Pacific Islands, Australia, Africa and India. It is of frequent occurrence in the Panjab Plains but has not been collected by any mycologist from this part of the country. It is found growing on dead decaying wood in the form of small pale yellow simple or branched spathulate lobes. On drying it becomes cartilaginous and the colour changes to apricot orange (R) or almost black in old specimens. The plants form a network of compressed branches below the few outer layers of the decaying wood. Spores light ochraceous

buff (R) in spore collection, very pale yellow under the lens, elliptic to kidney shaped, 4–5.2×7.4–10μ, the mean being 4.8×8.5μ.

Jaggatpur, Gurdas Dist. August 12, 1941 (No. 430); Gujranwala, October 1937 (No. 372); Ladhar, Sheikhupura Dist., Sep. 20, 1944 (No. 950).

Solenia candida Persoon

This is the first record from India of the species reported to be common in Europe, America, and Ceylon. The fruitbody is cylindrical, 0.5–3.5 mm. in height, pure white; basidia 18.5×4.5μ; spores white in spore collection. globose or subglobose, hyaline, 3.2–4.5μ. It is generally gregarious, very rarely solitary.

Ladhar, Sheikhupura Dist. August 31, 1944 (No. 951). On dead leaf bases of *Saccharum munja*. Very common.

Mucronella aggregata Fries

Subiculum absent; spines 1–3.5 mm. in length, subulate, entire, acute gregarious, in groups sometimes actually fasciculate, curved in drying, white when fresh but yellowish with slightly brownish tips on drying; hyphae 1.5–2μ in diameter, thin-walled, with clamp connections and numerous crystals; basidia 20–25×6.5–7μ; spores 3.0×7.5μ, elliptic, smooth, hyaline.

Rohtak, on dead branches of *Salvadora oleoides*, Nov. 8, 1942 (No. 657) and Nov. 15, 1943 (No. 799).

The occurrence of fasciculate spines in addition to the gregarious habit supports Miller and Boyle's (1943) statement that *M. ramosa* Lloyd is not sufficiently distinct from *M. aggregata* to justify specific recognition. This is the first record of this fungus from India.

Lopharia mirabilis (Berk. & Br.) Patouillard

It occurs in the form of large white resupinate patches with a narrow reflexed margin. The hymenium lines narrow distant ridges which also bear numerous hyaline, pointed cystidia, densely encrusted with a crystalline substance, 110×8.5μ, projecting about 90μ above the surface; spores globose or subglobose, hyaline, 7.5×9.95μ.

Jaggatpur, Gurdaspur Dist., on dead branches of *Ficus bengalensis*, Sep. 10, 1941 (No. 428).

There are only two other species of the genus described, viz., *L. lirellosa* from Africa and *L. javanica* from Java. According to Lloyd (1917) these are merely hymenial variations of this species.

Polyporus pusillus Persoon

A very small species, 0.5 cm. in size, attached by a lateral stem, white when fresh but turning red in the herbarium, spores 5.5–5.8μ. This is a

very widely distributed species reported from North America, Paraguay, Australia, Bonin Island, Ceylon, Brazil, Cuba, Venezuela, Mexico, New Zealand and West Indies. At first it was regarded as a small tropical form of *Polyporus rhipidium* Berk. but as Lloyd (1923) remarks "it is so constant and common in the tropics and does not occur in the temperate regions from where the large plant comes originally, we feel now the little tropical plant should be called *Polyporus pusillus* as originally named in Persoon's herbarium."

Jaggatpur, Gurdaspur Dist., on dead leaf bases of *Saccharum munja* Roxb., Sep. 20, 1941 (No. 509).

ARRHENIA CUCULLATA (Jungh.)

This is a very common species reported from Samoa, N. S. Wales, Java, New Zealand, Australia, and Florida, but this is the first time that it has been collected in this country. Lloyd (1919) has presented a detailed account and a beautiful photograph of the fungus as *Campanella cucullata* Jungh.

Jaggatpur, Gurdaspur Dist., On dead leaves of *Saccharum munja* Roxb., Sep. 15, 1941 (No. 508).

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Vol. 8 DECEMBER · 1945 No. 4

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

Studies of Types and Authentic Specimens of Hypoxylon—I

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The writer has accumulated a considerable number of notes during the past 50 years based upon his studies of type and authentic material representing most of the species of *Hypoxylon* of the older authors and many of the more recent ones.

Slides from this material and other specimens examined are deposited in the Mycological Collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering at Beltsville, Maryland. Among the principal authors whose types have been studied are the following: Berkeley, Berkeley and Curtis, Berkeley and Ravenel, Cesati, Cooke, De Notaris, Earle, Ellis, Ellis and Everhart, Fuckel, Karsten, Lloyd, Montagne, Nitschke, Peck, Spegazzini, and Wallroth. Special attention has been given to the species of Persoon, Fries, and Schweinitz. The descriptions of these older authors were usually brief and gave no measurements. As spore characters are of fundamental importance in the identification of species in this group, it is necessary to make microscopic examination of type or authentic specimens in order to determine them with certainty. In many cases the current concept of the older species has been based on tradition or incorrect interpretation of the original descriptions, rather than a study of the original or authentic specimens. Unfortunately some of the earlier writers on this group such as Bulliard, Tode, and Hoffman did not preserve their type material or else it has been lost and we must rely on the descriptions and the interpretations of subsequent authors for the application of their names. In such cases a neotype which would represent the best current concept of the species should be selected as a substitute for the original specimen; such specimens if possible should be selected from some published exsiccati available in most of the large herbaria.

The older authors, working on a fundamentalist instead of an evolutionary basis had no such concept of species and types as is current today. Fries did speak of types, but this concept seems to have been that they were the ideal models the Creator had in mind in making each species.

The nomenclatorial type of modern botanists is a particular specimen which an author used as the basis for the original description of his species. This specimen may not be and often is not the biological type or a typical specimen of the species, as may be later shown by comparison with other collections and species belonging to the genus. The type specimen, though it may not be typical, gives one a tangible, concrete basis from which a more definite concept of the species as a whole can be formed. Since the older mycologists did not realize the importance of designating a particular specimen as the type and as they sometimes had more than one specimen before them when the original description was made, it is necessary to decide which most nearly agrees with the description and should therefore be regarded as the type.

In Persoon's case, his species are represented by very few specimens and in many instances only one. Where more than one is present it is usually possible to tell the original from the data regarding locality, host, and collector or its agreement with the original description. In Schweinitz' case, the problem is more difficult as has already been shown elsewhere. (Endothia parasitica and related species. U. S. Dept. Agric. Bull. 380: 6–8. 1917.) Due to his habit of mixing in the same packet various specimens of different dates and collectors which frequently represent different species, it is often difficult to tell which is the original from which the description was drawn. Much confusion has arisen in the interpretation of his species by various authors who have based their opinions on examination of specimens of Schweinitz found in his herbarium or distributed by him or later by others (Torrey and Curtis, etc.) to various mycologists in Europe and America. Many of these, as has been shown, are not parts of the original but later gatherings erroneously identified by the author. Having had an opportunity to examine most of his specimens to be found in Europe and in this country, we have been able to decide in most cases upon which the original description was based and should therefore be accepted as the true type.

Study of material in the C. G. Lloyd Herbarium has made it possible to determine the identity and synonymy of many of the species which he discusses and also to examine bits of types of other authors which are found in his herbarium.

There is no general agreement among mycologists at present as to the generic limitations in *Hypoxylon* and its near relatives. The material now available in our herbaria shows conclusively that there are no distinct boundary lines to be found between *Rosellinia*, *Hypoxylon*, *Nummularia*, *Ustulina*, *Penzigia*, and *Xylaria*. Generic segregation must be a matter of individual judgment, which should be based largely on considerations of convenience and conservatism. Too much splitting of genera serves no useful purpose.

HYPOXYLON AENEUM Nits. Pyren. Germ. 47. 1867.

The type specimen of this species found on beech wood near Münster, Germany, (Fig. 1) which I have examined, has spores, according to Nitschke's label 20×7–8μ. A slide from this specimen, however, shows spores only 15.5–18×6–7.5μ, mostly 16 to 17×6–7μ. This specimen agrees



FIG. 1. *Hypoxylon aeneum*. A portion of the type collection in the Nitschke herbarium. ×12.

very well in general appearance with Persoon's type of *H. serpens*, the spores of which are 15–18×6–8μ. Miller (in Chardon and Toro, Myc. Expl. Venezuela, 206. 1934) cites this as a synonym of *H. serpens*, but according to Nitschke's description the conidia in *H. serpens* are "subglobosa *minutissima*" while the conidia in *aeneum* are 4–5×3–4μ. It appears evident in this case as well as in some other species in this group, that one cannot be sure of the identity and synonymy of the different species involved until the conidial forms have been found and compared.

HYPOXYLON AFFLATUM (Schw.) Curt. Cat. No. Car. Pl. p. 140. 1867.

Sphaeria afflata Schw. Schr. Nat. Ges. Leipzig 1: 34. 1822.

Schweinitz' type of this species has been shown by the writer (Mycologia 33: 330. 1941), to be a species of *Melanomma* (*M. afflatum* (Schw.) Shear).

HYPOXYLON ALBOCINCTUM Ell. & Ev. Proc. Acad. Nat. Sci. Phil. **43**: 229. 1890.

This species clearly belongs to the *H. serpens* group. The type specimen in the Ellis herbarium is A. P. Morgan's No. 884 on dead *Crataegus*, collected at Preston, Ohio. The date of collection according to the original description (l.c.) was January, 1890, but the specimen of this number in the Ellis herbarium has the date 1889. It agrees entirely with the description. The spores as described by Ellis and Everhart are 7–8×3.5–4μ. According to our measurements they are 7–9×3.5–4.5μ. This species, while resembling *H. serpens* macroscopically, differs entirely in spore measurements from that species, the spores of which are 15–18×6–8μ and it is evidently distinct. It is found on *Crataegus* and *Cornus* in the southeastern United States. Miller reports it from Georgia (Plant Disease Rept. Supp. **131**: 57. 1941) on old *Poria punctata*. I have specimens on *Cornus florida* from Vienna, Virginia (Shear 3246).

HYPOXYLON ALBO-STIGMATOSUM Speg. Anal. Soc. Cient. Argentina **18**: 271. 1884.

The type specimen of this species, No. 2765, as cited in the original description is now lacking in Spegazzini's herbarium at the University of La Plata. In its place Dr. J. Lindquist, the curator, sent No. 2781 of Balansa's Fl. Parag. (Spegazzini No. 1676) for study and as an authentic specimen it should be accepted as a substitute type. It resembles closely *H. fuscopurpureum* (Schw.) Curt., the form of *H. rubiginosum* with irregular, dark red surface which is found on bark of *Fraxinus*, but until a more satisfactory limitation of that species is reached, *H. albostigmatosum* may be retained. Our spore measurements are 9–12×4–6μ. Portions of the original Balansa collection of 2781 from the Paris museum and the Ellis herbarium were also studied and found to be identical.

HYPOXYLON ALLANTOSPORUM Berk. & Curt. Jour. Linn. Soc. **10**: 385. 1869.

"836. *H.* (Effusae) *allantosporum*, B. & C. Peritheciis parvis inumeris dense catervatis obovatis fuscis; ostiolo papillato; sporidiis allantiformibus magnis (334)."

"On dead bark. Sporidia. .002 inch long." [Cuba].

A specimen so labelled by Curtis was found in the herbarium of the Museum in Paris with the additional note "N. Pac. Exploring Expedition 1853–1856, Wright Coll." There is no such species mentioned in Berkeley and Curtis' list of fungi of the North Pacific Exploring Expedition, and no evidence that any fungi were collected in Cuba by that expedition. It would, therefore, seem that there is some error in the label on the Paris specimen. The specimen is old and shows but few asci with five or six free

dark brown, muriform spores, somewhat collapsed, 36–45×10–12μ. Two brown thick-walled 5-septate spores, 18–30×7μ, were found also, which resembled *Sporodesmium*. The ascospores found evidently belong to the Cucurbitariaceae. It is difficult to understand how Berkeley and Curtis came to refer such a fungus to *Hypoxylon*.

Cooke (Grev. **11**: 128. 1883) says "1498 *Hypoxylon allantosporum* B. & C. not *Hypoxylon*. Sporidia 5-7-septate." This statement is presumably based upon Cooke's examination of a Kew specimen. Dr. J. H. Miller has written me as follows concerning this species:

" . . . in regard to *Hypoxylon allantosporum* B. & C. On the Kew specimen is the meager data—'*Hypoxylon allantosporum* B. & C. No. 334 Cuba, C. Wright.' There was only the one specimen and it should be the type. I mounted and recorded the spores, but did not save any as it was not a *Hypoxylon*. I found the spores several septate and some appeared to have longitudinal walls also, which would make them muriform."

It appears from this that the Paris specimen I examined is the same as Berkeley's type at Kew, but the spores are muriform, and as the perithecia are numerous and aggregated in dense masses as per the original description, the species should be referred to *Cucurbitaria*.

HYPOXYLON AMORPHUM Ell. & Ev. in herb.

This appears to be an unpublished name. There are 3 specimens so labelled in the Ellis Herbarium at the New York Botanical Garden which were collected by Langlois in Louisiana. They all look alike except for slight differences in size and shape of the stromata, some of them reaching a width of 2 inches and up to ½ inch thick. A note by Ellis on the label of No. 2167 says "Sec. Cooke, this is the ordinary type form of *Hypoxylon broomianum* B. & C." The spores are 10–14×4–5μ according to Ellis. These specimens clearly belong to *H. sclerophlaeum* Berk. & Curt. and not to true *H. broomianum* which is a *Nummularia*. Cooke's statement concerning these specimens apparently misled Ellis in his interpretation of *H. broomianum* as expressed in his description in North American Pyrenomycetes (628. 1892).

HYPOXYLON ANNULATUM (Schw.) Mont. in Gay, Fl. Chil. p. 445, pl. 10, f. 3. 1853.

Sphaeria annulata Schw. Jour. Phil. Acad. Sci. **5**: 11, pl. II, f. 8. 1825.
Sphaeria annulata depressa Fr. Elen. Fung. **2**: 64. 1828.
Sphaeria marginata Schw. p.p. Syn. Fung. Am. Bor. 190. 1832.
Sphaeria truncata Cke. Grev. **15**: 80. 1886. Not Schw.
Hypoxylon truncatum Miller p.p. Trans. Brit. Myc. Soc. **17**: 130. 1932. Not Schw. 1822.
Sphaeria truncatula Miller Mycol. **32**: 182. 1940. Not Schw.

Schweinitz' original description and type specimen of this species clearly include what is here shown to be two distinct species, *H. annulatum* and

H. marginatum. His illustration shown in our Fig. 2 and the part of his original specimen agreeing with it should be accepted as representing the type of *H. annulatum*. Schweinitz sent specimens of this to Fries who described it (l.c.) as a variety, *S. annulata depressa*. The specimens sent to Fries and labeled by Schweinitz, "*Sphaeria annulata*, Salem," consist of four pieces, two on bark and two on bare wood, all evidently oak. From slides and photographs of these pieces kindly sent by Dr. Nannfeldt of Uppsala, I find that the two specimens on bark (Fig. 3A) are typical small stromata of *S. marginata* Schw. It will be noted on the photograph that Starbäck also examined the two pieces on bark and properly labeled them *H. marginatum*. The spores are inequilateral, 9–12×4–5μ. One of the specimens

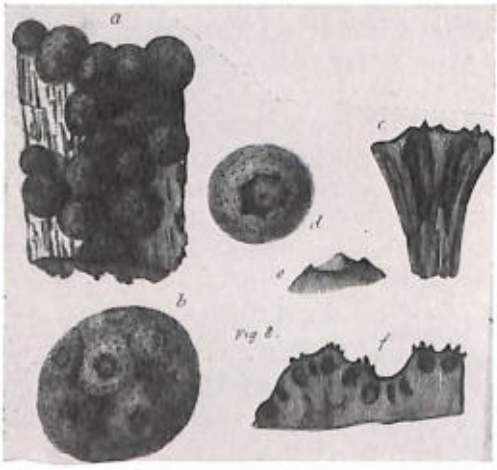


FIG. 2. *Hypoxylon annulatum*. Schweinitz' original illustration of his *Sphaeria annulata* in Jour. Phil. Acad. Sci. **5**, pl. II, fig. 8.

(Fig. 3x) on bare wood is typical *H. annulatum* as I interpret it and as illustrated by Schweinitz (l.c.). The spores are 7–9×3–4μ and the stromata are much smaller and the perithecia much more elevated and erumpent than in *H. marginatum*. This specimen should be accepted as the type of *H. annulatum*. The other piece of bare wood (Fig. 3y) shows only the basal portion of a stroma without perithecia.

It is evident from his descriptions and these mixed specimens that Schweinitz thought this collection represented but one species. Later (Syn. Fung. Amer. Bor. 190. 1832) he substituted the name *S. marginata* for *S. annulata*. In his description of *S. marginata* he cites Pl. II, f. 8, which he had already named *S. annulata* seven years earlier and which is typical *H. annulatum* as generally understood. He adds "affinis *S. multiformis*, sed major," which does not apply to his figure. As *S. annulata* is not mentioned in his Synopsis of North American Fungi (l.c.) he appar-

ently intended *S. marginata* to include both species. Why he substituted "*marginata*" for "*annulata*" is not clear. I have found no earlier use of the name under *Sphaeria*.

I was in error in my statement (Mycologia **20:** 94. 1938) in saying that



FIG. 3 A. *Hypoxylon marginatum*. x and y. *Hypoxylon annulatum*. Photograph by Nannfeldt of specimen sent by Schweinitz to Fries.

H. annulatum is an effuse form of *H. marginatum*. In the study and observation of many gatherings of these two species since through the eastern and southern United States, I have never yet found any intermediate forms connecting the two species. The differences in size and shape of the stromata and perithecia and in the size of the spores appear to be very constant.

Lloyd's interpretation of *H. annulatum* which is the same as mine is shown by his excellent illustration (Myc. Writings **7**: 1351, fig. 3145. 1925).

The following specimens in the Mycological Collections of the Bureau of Plant Industry are typical *H. annulatum:* Ellis and Everhart, North American Fungi, Nos. 472, 2553 a and b; Rehm, Ascomycetes, No. 1594 (collected by Kellerman in Ohio); Rabenhorst-Winter, Fungi Europaei, No. 3668 (collected by Demetrio in Missouri); J. H. Miller, No. 1672, on *Quercus alba*, Athens, Georgia.

The first use of the combination *Hypoxylon annulatum* was made by Montagne as cited. His specimen from Chile shows both the effuse and glomerate forms as illustrated in his plate (l.c.). The spores in the effuse form of Montagne's specimen (var. *depressum* Fr.) are 10–12×5–6μ and the perithecia and annulus are slightly larger than in Schweinitz' type. This seems to be true of all the specimens examined from the tropics, Japan, China and South America. Since Montagne's specimens differ so little from Schweinitz' they may be regarded as the same until more evidence to the contrary can be found.

It is now generally recognized except by Miller that *S. annulata* and *S. marginata*, which Schweinitz substituted for it, includes two distinct species. How should the names be applied? If we are willing to accept usage, which has been fairly uniform since Montagne's application of the name *annulata* to the part of Schweinitz' specimen illustrated by him with his original description (l.c.) and the name *marginata* to the species which was referred to *Hypoxylon marginatum* (Schw.) by Curtis (Cat. No. Car. Plants, 140. 1867) and most other more recent mycologists, it would seem to be the most satisfactory solution of the case. The combination *H. marginatum* is usually attributed to Berkeley (Outl. Brit. Fung. 357. 1860), but Miller says (Trans. Brit. Myc. Soc. **17**: 130. 1932) Berkeley's specimen is not this species, but *Hypoxylon stygium* Lév.

The name *Sphaeria marginata* had already been used by two different authors before Schweinitz, 1832. Sowerby (Eng. Fung. Pl. 372, f. 7. 1809) applies the name to a plant which Fries (Syst. Myc. **2**: 387, 1828) says is his *Sphaeria leucostoma* (*Valsa* of recent authors).

Fries (Elen. Fung. **2**: 69, 1828) describes *Sphaeria marginata*, which according to his description is a species of *Nummularia*. Saccardo and also Ellis refer to it as *N. discreta* (Schw.) Tul. According to the rules Fries' *marginata* would have priority over Schweinitz' name of 1832, but to avoid any further confusion in the application of the name, *marginata* should be retained as applied here. The photograph of Schweinitz' specimen sent Fries (Fig. 4) is a good illustration of the species *Hypoxylon marginatum* (Schw.) Curt. Figs. 3146 and 3147 Lloyd Myc. Writings **7**: 331 are also typical.

Sphaeria truncata Schw. Syn. Fun, Car., 44 No. 174, 1822 has been stated by Cooke (Grev. **15**: 80, 1886) and Miller (Trans. Brit. Myc. Soc. **17**: 13, 1932 and Mycol. **32**: 182, 1940) to be the same as *H. annulatum* and *marginatum* as they apply the name. Cooke says (l.c.) that according

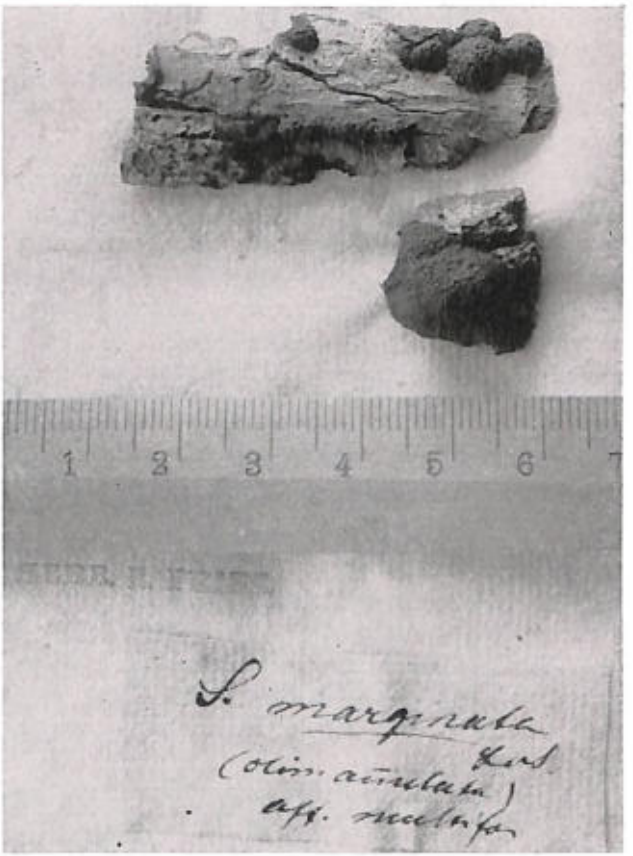


FIG. 4. *Hypoxylon marginatum*. Photograph by Nannfeldt of specimen sent by Schweinitz to Fries.

to an authentic specimen this is *H. marginatum* in its scattered condition.

This species was described by Schweinitz (l.c.) as follows:

"S. simplex subconfluens bysso fusco involuta, sphaeria aterrima oblonga apice truncata marginata.

Elegans species rariuscula in lignis. Primum bysso involuta; demum aterrima, nitens, dolioli forma, apice truncata, margine annulata, ostiolo papillato conico assurgit, tum ad dimidium bysso orbatur, qua initio etiam ostiolum tegitur."

He sent part of his type specimen of this from Salem to Fries who described it in Syst. Myc. **2**: 442, No. 282, 1823 as follows:

"282. *S. truncata*, peritheciis solitariis truncatis papillatis atris, primo involutis tomento fusco, in subiculum subrotundum confluens expanso.

S. truncata. Schweinitz (l.c.) Syn. Fun. Car. p. 44, n. 174.

Elegans, praecedentibus similis, sed omnino simplex est, nisi subiculum breve byssaceum basin peritheciorum cingens primumque undique involvens cum affinibus confluat, unde oriuntur maculae nigrofuscae, 2–3 lin. latae. Perithecia magna, demum glabra, nitida, 'oblonga dolioli-forma, margine annulata,' ostiolo conico. *In corticibus Carolinae.* (v.s.)" It will be noted that Fries' description is practically the same as that given by Schweinitz (l.c.).

I have examined authentic specimens as follows: An autographed specimen from Schweinitz to Fries which he described, as quoted above and which is evidently a part of the original specimen upon which Schweinitz based his description of *S. truncata* in Syn. Fun. Car. No. 174, 1822. Both these descriptions and the specimen sent Fries clearly belong to *Rosellinia corticium* (*R. aquila* of most American authors). Both Schweinitz and Fries place *S. truncata* near *S. byssiseda* (*Rosellinia aquila*), indicating clearly its relationship. The reference in both descriptions to a byssoid subiculum could not apply to *Hypoxylon annulatum* Schw. or to *H. marginatum* to which Curtis, Cooke and Miller have applied this name. Later collections which Schweinitz put in his original packet of this species and which he evidently confused with his type collection, belong to these latter species. As for example an autographed specimen in the Collins Herbarium at Philadelphia, which is typical *H. annulatum* on oak, and has spores 8–10 $\times$3.5–4μ. He also had in the same packet according to the upper piece of a specimen in his mounted collection at Philadelphia, a specimen which is clearly *H. cohaerens*.

Specimen No. 1501 of Schweinitz' North American Fungi, labelled *S. truncatula* in the Michener Herbarium on a piece of oak bark, has ascospores 8–10$\times$3–4μ and is typical *H. annulatum*. The Collins' specimen is labelled "*Sph. truncata* L.v.S. and Fr. Beth." in Schweinitz' hand and is evidently a part of the specimen he collected in Pennsylvania (*H. annulatum* with spores 9–10$\times$3.5μ) and which he then confused with his original *S. truncata* from North Carolina. The lower piece of Schweinitz' specimen No. 1501 in the mounted collection at Philadelphia is typical *Rosellinia corticium* Schw. and has spores 21–27$\times$9–11μ, agreeing entirely with his original specimen in Fries' Herbarium.

Miller (Trans. Brit. Myc. Soc. **17**: 13, 1932, and Mycol. **32**: 182, 1940) has decided, apparently on the basis of an examination of Schweinitz' specimen at Kew, the one referred to by Cooke, that Schweinitz' original

truncata, as described by him and also by Fries, was *Hypoxylon annulatum* (Schw.) Mont. and therefore makes *H. truncatum* a synonym of *H. annulatum*. Ellis follows Cooke and puts *S. truncata* as a synonym of *marginatum* in North American Pyrenomycetes, p. 640, 1892.

The Kew specimen referred to by Cooke and Miller as the type of *truncata* is evidently part of Schweinitz' later gatherings which he mistook for *truncata* and mixed with the type.

Sphaeria truncatula Schw. Syn. Fun. Am. Bor. 210, 1832, which Miller (l.c.) cites as a synonym of *Hypoxylon annulatum*, was proposed as follows "1501. 356. *S. truncatula*, L.v.S., Syn. Car. 174, F. 282, et in Pennsylv."

This name was substituted by Schweinitz l.c. for his *S. truncata* which was published in Syn. Fun. Car. No. 174, 1822, which he cites by number only. Evidently the change was made because there was already a *Sph. truncata* of Fries (1823) to which he farther on in North American Fungi 1598 referred a specimen on *Rhododendron*, which is a pyrenomycete with small gregarious perithecia and is neither *Hypoxylon* nor *Rosellinia*.

In the Index to Syst. Myc. (1832) Fries lists *S. truncatula* and cites **2:** 468, 1823 where we find "S. truncata (Hyst. truncatum? Pers.)" which is an entirely different fungus. This is the plant Fries substituted *truncatula* for and not Schweinitz' plant.

There were already two other species named *S. truncata* in the literature. The first, by Bolton, Fun. Halif. **3:** Pl. 127. 1789, which equals *Poronia punctata* (L.) Fr. and the other just cited from Fries as the *Hysterium* of Persoon which according to Sacc. is *Lophiostoma truncatum* (Pers.) Sacc.

There is another autographed specimen of Schweinitz labelled "*Sph. truncatula* L.v.S. Beth. 1" in Greville's Herbarium at Edinburgh. This is typical *H. annulatum* Schw. apparently on white oak bark. Curtis in his copy of Schweinitz' North American Fungi No. 1501 says "*Var. truncatula*."

Cooke (Grev. **15:** 80, 1886) says of *S. truncata* "from authentic specimen this is the same as *Hypoxylon marginatum* in its scattered condition, a form by no means uncommon." This also is typical *H. annulatum*. This evidently was also one of Schweinitz' Bethlehem specimens entirely different from his type from North Carolina. Here we have another example of the confusion caused by mixing different collections in the same original packet as was Schweinitz' unfortunate custom.

As *truncatula* was simply a substitute for *truncata* it would have the same type specimen which is the autograph specimen from Salem sent to Fries and as cotype the lower piece of the specimen in the mounted collection of Schweinitz at the Philadelphia Academy of Science.

As indicated above Schweinitz' *truncatula* was preceded by Fries' application of the name to another fungus.

HYPOXYLON ANTHOCHROUM Berk. & Br. Jour. Linn. Soc. Bot. 14: 122. 1875

In the original description of this species two specimens, Nos. 160 and 269 are cited. A part of No. 160 in the New York Botanical Garden Hebarium sent to Ellis by Cooke shows small, pulvinate, dark purple stromata. The spores are 10–12×4–5μ. Cooke (Grev. 11: 124, 1883) gives them as 10×4μ, while in the original description they are described as .0004 in. long. Petch (Ann. Royal Bot. Gardens Peradeniya 8: 158. 1924) states, "Spore measurements on the type specimen give 13–14×6–7 and 10–14 ×5–7μ. In recent collections they are 10–12×5–7 and 8–12×5–6μ."

This species belongs to the *rubiginosum-pulvinatum* group and the synonymy cannot be determined until the types and more material of the other species of this group have been more carefully studied and compared. Miller (in Chardon and Toro, Myc. Expl. Venezuela, 204. 1934) considers this a synonym of *H. rubiginosum*.

HYPOXYLON APIAHYNUM Speg. Bol. Acad. Mac. Cien. Cordoba 11: 506 (128 in reprint.) 1887.

A bit of the type of this species collected by Puiggari at Apiahy, Brazil (his No. 1655 in Spegazzini's herbarium and Spegazzini's No. 1678) was old and no spores could be found. The original description gives the spores as 8–9×4μ. The part of the type examined consisted of a small, closely aggregated group of perithecia united on a thin black stromal base penetrating the bark and blackening the under side. Three quarters of the upper parts of the perithecia, which are smaller and thinner walled than those of *H. annulatum* (Schw.) Mont. are free from each other, and these portions were mostly broken off, leaving only cup-like bases. Some of the ostioles showed slightly flattened disks as in *H. annulatum*. A collection by H. E. Thomas (No. 26) from Consumo, Puerto Rico is very similar, except that the perithecia of the Puiggari specimen are somewhat smaller and with a less evident disk about the ostiole. Theissen (Ann. Myc. 6: 538, 1908) says this species is the same as *H. annulatum* (Schw.) Mont., but Montagne's original specimens collected by Gay in Chile have much larger perithecia and annuli than in Spegazzini's type of this species. This name may be retained until we have a better knowledge of the annulate species.

HYPOXYLON APOENSE P. Henn. Hedw. 47: 259. 1908. = *H. globosum* (Spreng.) Mont.

A specimen under this name in the New York Botanical Garden, which is a part of the type collection gathered by E. B. Copeland (No. 1073) on dead trunks on Mt. Apo, Davao, Philippine Islands, April 1904, as cited by Hennings has small globose, nearly sessile stromata. It appears identical with globose, nearly sessile specimens of *Hypoxylon globosum* (Spreng.) Mont. which we have studied from the Hawaiian Islands and other

tropical regions. The spores were found to be 30–36×12–15μ and those in the type of *H. globosum* 22–34×8–12μ. *H. apoense* is surely only a small form of the extremely variable *H. globosum*.

HYPOXYLON ARGILLACEUM (Pers.) Berk. Outlines Brit. Fungi, 387. 1860.
Sphaeria argillacea Pers. Ann. der Bot. 3: 23. 1794.

Persoon described this species first in 1794 (l.c.) and again in 1797 (Tent. Disp. Meth. Fung. p. 49). A further note concerning it was given in 1801 (Syn. Meth. Fung. 1: 10) and he illustrated it in his Icon. Pict. Rar. Fung., pl. III, figs. 1–3, 1808. He says that it is subglobose and occurs rarely on dried trunks and branches of *Fraxinus*.

We found in Persoon's herbarium only one specimen labelled *argillaceum* in his hand without a question mark. This is marked "Gallia," is

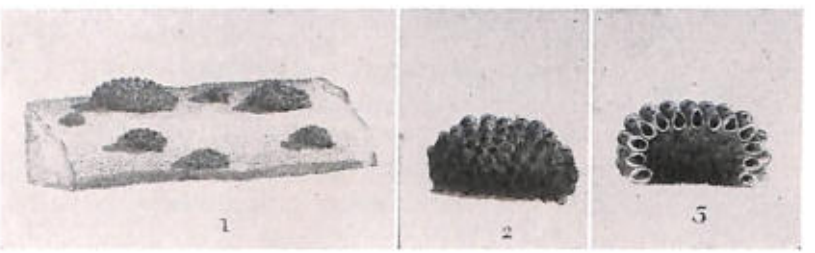


FIG. 5. *Hypoxylon argillaceum*. From Persoon's Icones pictae specierum rariorum fungorum, pl. 3, figs., 1, 2, 3.

possibly on *Fraxinus*, and might be regarded as the type. It consists of small subglobose reddish stromata, which have the general form of *H. coccineum*, but are much smaller. The specimen is apparently immature since neither spores nor perithecia could be found. There is another specimen labeled by Persoon "prope Parisios" but it has a question mark and "cohaerens junior" added. The substratum is apparently *Quercus* and the fungus too young for positive identification. There are also two other specimens from North America so labeled. One, No. 58, sent by Mühlenberg from Pennsylvania was labeled "Argillacea" by him but not by Persoon. This is on *Quercus* and is not Persoon's species, but perhaps *H. fuscum*. The other specimen (without number) although appearing the same and labeled *S. argillacea* by Persoon is not this species. "Am. Bor." was added to the label and the specimen is apparently also from Mühlenberg, although no collector is cited. The fungus is on *Alnus* and has confluent stromata. Miller (Trans. Brit. Myc. Soc. 15: 148, 1930) cites Persoon's type as "No. 911. 18–199." We do not know which of the specimens mentioned above bears this number as his specimens have been numbered since we examined them.

Persoon's illustration as cited shows apparently typical specimens of this species, but none showing good perithecia as illustrated, could be found in his herbarium. If spore measurements are not available from his collection some other specimen should be substituted as a neotype. Fries misunderstood this species and referred to it two specimens one of which is *H. coccineum* and the other a *Melogramma*, according to Nannfeldt as cited by Miller (Trans. Brit. Myc. Soc. **15**: 148, 1930). Miller found the spores 17–20×8–10μ in a specimen collected by Berkeley in England. There is also a specimen on *Fraxinus* issued as No. 6839 in Roumeguère's Fungi Selecti Exsiccati which is typical of this species. The spore measurements in this specimen range from 16.4–20.1×9.3–10.5μ. Specimens in Tulasne's herbarium in Paris on *Fraxinus* also appear typical and he cites specimen No. 247 in Rabenhorst's Herb. Myc. (Ed. III, 1869) as representing this species.

The best description is that of Nitschke (Pyren. Germ. 29–31, 1867). He gives spore measurements 22–24×10–12μ and conidia oval, about 6–7μ long. He found it only on *Fraxinus* and that has been our experience as well as that of Mason and other English mycologists. The reports of its occurrence on *Fagus*, *Betula* and other hosts by Albertini and Schweinitz and Fries have been found to be due to misidentification of the species. It has not been positively identified as occurring in this country until recently. Schweinitz' specimens so recorded, so far as I have examined them, are young *H. coccineum* on *Fagus*. I have collected typical specimens on *Fraxinus* in three localities in New York and one in Virginia and Miller, who is well acquainted with the species, reports it from Georgia. Fig. 5 is a copy of Persoon's (l.c.) plate 3, figs. 1, 2, and 3 and shows a typical specimen. It is easily separated from *H. commutatum* and *H. coccineum* with which it has been confused, by its much larger spores.

The following specimens are found in the Mycological Collections of the Bureau of Plant Industry: England, Shear and Mason, Mickleham, Sept. 21, 1930; E. W. Mason, Petersfield, May, 1920, No. 115; and Shear, Harking, Aug. 10, 1930. The United States, Shear, Saw Kill, N. Y., June 13, 1914, same locality, Mason, Aug. 8, 1931; Shear, Stony Clove, N. Y., Sept. 4, 1925; Labrador Lake, N. Y., June 22, 1932; and Price Fork, Va., April 16, 1933. All are on *Fraxinus* spp.

HYPOXYLON ?ATROFUSCUM (Berk. & Curt.) Ell. & Ev. Jour. Myc. 4: 111. 1888.

Sphaeria atrofusca Berk. & Curt. in sched. nec Schw. nec Fr.
Fuckelia atrofusca Berk. & Curt. in herb. Berk. apud Cooke Grev. **12**: 51. 1883.
Melogramma atrofusca Cke. Grev. **13**: 108. 1885.
Anthostoma atrofuscum Berl. & Vogl. in Sacc. Syll. Fung. additamenta 46. 1886.
Rosellinia atrofusca Starb. Bihang till K. Svenska Vet.—Acad. Hand. **19** (III): 23. 1894.

The type of this species was described by Cooke (l.c.) as follows:

"*Fuckelia atrofusca* Berk. & Curt. in herb. Berk., 9004, Erumpens, pustulis minimis (vix ½ mm.) ellipticis, cortice marginatis. Peritheciis inaequaliter in stromate atro depresso congestis. Ascis cylindricis, stipitatis, sporidiis ellipticis, fuscis (.013×.007 mm.) on bark of *Rhus glabra*, Virginia Mountains, U.S.A."

According to Curtis' original label the particular locality was Staunton, Virginia. The species was referred to *Hypoxylon* with doubt by Ellis and Everhart, as cited above and a translation of Cooke's description given. A part of the original specimen from Curtis in Michener's herbarium has spores 15×9μ and in the Berkeley specimen we find them 13–15×6–9μ. This is doubtfully distinct from *Lopadostoma turgidum* (Pers.) Trav., which has spores 8–12×6–8μ, according to Traverso (Flor. Ital. Crypt. **2**: 169. 1906).

HYPOXYLON ATROPUNCTATUM (Schw.) Cke. Grev. **13**: 15. 1889.

Sphaeria atropunctata Schw. Schr. Nat. Ges. Leipzig **1**: 31. 1822.
Diatrype atropunctata Berk. Trans. Linn. Soc. **22**: 269. Pl. 46, fig. 70. 1858.
Anthostoma atropunctata Sacc. Syll. Fung. **1**: 295. 1882.
Nummularia atropunctata Hoehn. Ann. Myc. **16**: 219. 1918.
Nummularia cinerea Rehm. Ann. Myc. **16**: 219. 1918.
Numulariola atropunctata House N. Y. State Mus. Bull. **266**: 49. June 1925.
Albocrustum atropunctatum Lloyd Myc. Writ. **7**: 1353. Fig. 3167, 3168. July 1925.

There is a specimen of this species in Persoon's herbarium labeled "Sphaeria dealbata Amer. Sept." in his handwriting. This was probably sent by Mühlenberg, who made one of the earliest collections of Pyrenomycetes in this country, and who is known to have sent specimens to Persoon.

The type of *Nummularia cinerea* Rehm was collected on oak by Brenckle at Kulm, No. Dak., Feb. 1915, and distributed by Rehm as No. 2150 in his Ascomycetes Exsiccati. It is typical *N. atropunctata* (Schw.) Hoehn., the name we have adopted for the plant.

HYPOXYLON ATROPURPUREUM Fr. Summa Veg. Scand. 384. 1849.

Sphaeria atropurpurea Fr. Obs. Myc. **1**: 174. 1815.
Hypoxylon multiforme Fr. Syst. Myc. **2**: 334. 1822.

Whether this is the *Sphaeria atropurpurea* of Tode (Fungi Meckl. **2** 32, 1791) is uncertain, as no authentic specimen of his species is known. The type of the species should be Fries' specimen of his No. 75, Scleromycetes Sueciae. A specimen of this number in Schweinitz' herbarium has spores 11.5–13×4.5–6μ. The substratum is apparently decorticated beech as given in the original description and the fungus is clearly an effuse form of *H. multiforme*. I have the same thing (Shear No. 2878) on *Alnus* gathered by myself near Stockholm in 1912. This form is apparently scarce

in this country. It is most likely to be found in the northwest Pacific Coast region where the pulvinate form of the species is common on *Alnus*, *Salix* and *Betula*.

Schweinitz' own specimens labeled *S. atropurpurea* are not this species. They include apparently two or three different things, one in the Collins collection seems to be *Nummularia*, and others in Michener's herbarium belong to the *serpens* group near *H. investiens* Schw. and *H. colliculosum*. It is possible that not all the specimens of Fries' exsiccata issued as number 75 are the same species. A specimen of this number in Greville's herbarium in Edinburgh which we examined is not *Hypoxylon*, but some other old pyrenomycete with large buried perithecia and erumpent rough ostioles. A specimen labelled as *S. atropurpurea* by Persoon in his herbarium is the same as Fries' No. 75.

HYPOXYLON ATRORUFUM Ell. & Ev. No. Amer. Pyren. p. 742. 1892.

The type of this species was collected by G. H. Hicks (No. 165) on beech bark in Michigan, January 1892. The substratum is given as "oak?" in the original description, but the type specimen in the herbarium of the New York Botanical Garden is clearly on *Fagus*. The specimen is somewhat immature, which accounts for the reddish-brown color of the stroma, a recognized character of *H. cohaerens*, of which species this specimen is typical. The spores were described by Ellis as 6–7×3μ, but our measurements made from the type are 9–12×4–6, mostly 10×4.5μ, which is unusual since our measurements usually agree rather closely with those of Ellis.

HYPOXYLON ATROVIRIDE Ell. & Ev. Acad. Nat. Sci. Phil. 1894, 346. 1895.

As has been previously noted (Mycologia **30**: 586, 1938) this species is synonymous with *Camarops tubulina* (Alb. & Schw.) Shear.

HYPOXYLON AVELLANA Ces. Att. Real Accad. Sci. Fis. e Mat. **8**: 18. 1879.

Fragments of the type specimen of this species collected by Beccari in Sarawak and deposited in the C. G. Lloyd herbarium (No. 11234) show spores 20–30×9–11μ. The stromata are subglobose, smooth, black without and white within, varying in diameter from 7–10 mm. The species is related to *H. berteri* Mont., but the spores are about twice the size of those of that species. Cooke sec. Sacc. Syll. Fun., **1**: 373, 1882, gives the spore measurements from a Cesati specimen at Kew as 35×10μ, the original description says 8–10×3μ. However, those who have examined Cesati's specimens have found that his measurements are all incorrect. Petch states that they are one-half the real size, but in this case they are evidently only about one-third the true size. In other species I have found his measure-

ments only one-fourth of the actual size, indicating that there was no uniformity in his measurements.

H. avellana belongs in the genus *Penzigia* Sacc. as emended by Petch (Ann. Royal Bot. Garden Peradeniya **8**: 138. 1924), and Miller (in Chardon and Toro, Myc. Explor. Venezuela, p. 210. 1934). Whether *Penzigia* deserves generic rank is doubtful.

HYPOXYLON BALANSAE Speg., Fungi Guaranitici. Anal. Soc. Cient. Argentina **26**: 30–31. 1888.

The type of this species, No. 3978 of Balansa (No. 1681, Herb. Speg.) shows small, circular, effuse stromata on decorticated wood, which suggest *H. serpens*, but the stromata are more circular in outline, and the perithecia smaller and more crowded in Spegazzini's species than in *serpens*. A part of the same number 3978 in Herb. Paris is identical in appearance. Spores from the type are 9–12×3–5μ (Spegazzini says 8–12×4–5μ) oblong, obtuse and much too small for *H. udum* (P). The spores are more uniformly equilateral and obtuse than in typical *serpens* which also has larger spores. It agrees entirely with the type of *H. caries* (Schw.) to which it should be referred.

HYPOXYLON BAMBUSICOLUM (Speg.) Sacc. Syll. Fung. **14**: 511, 1899.
=*H. culmorum* Cke. q.v.

HYPOXYLON CULMORUM Cke. Grev. **7**: 51. 1878.

Auerswaldia ? bambusicola Speg. Anal. Soc. Cien. Argentina **19**: 246. 1885.
Hypoxylon bambusicolum (Speg.) Sacc. Syll. Fung. **14**: 511. 1899.

I have not seen the type of Cooke's species which was collected by Ravenel (No. 2505) on *Arundinaria*, Darien, Georgia; but an authentic specimen collected and distributed by him from the same host and locality as No. 351 in his Fungi Americani Exsiccati agrees very well with the original description. It has spores 15–19×6–9μ and in the type according to Cooke they are 15–18×6μ. Forms are found with scattered perithecia suggesting close relationship with *Rosellinia*.

The type of Spegazzini's species is lacking in his herbarium at La Plata according to the Curator, but a specimen of Balansa's No. 3499, which is cited by Spegazzini as the type collection, was found in the Paris museum. It agrees in every way with the original description except spore size. The spores are 15–19×8–10μ in the Paris specimen of No. 3499 instead of 12–13×5μ as per Spegazzini's description. The macroscopic characters as well as the spores are very variable. The perithecia are frequently separate and scattered. Spegazzini in his account of the fungus suggests that in the effuse form the structure is dothideaceous; but Theissen and Sydow (Ann. Myc. **13**: 300. 1915) say it belongs to *Hypoxylon* and is near, if not identical with, *H. culmorum* Cke. to which it should be referred as a synonym.

HYPOXYLON GLOMIFORME Berk. & Curt. Grev. 4: 49. 1875.

?Hypoxylon marginatum (Schw.) Curt.

"Gregarious, hemispherical, nearly $\frac{1}{4}$ inch wide, at first clothed with ferruginous powder, then black and shining, even perithecia hidden without any external trace of ostiola; stroma dark brown." On bark of *Quercus nigra*, Connecticut, C. Wright No. 5632.

The spores of this species according to Cooke (Grev. **11**: 123. 1883) are $14–15 \times 3.5\mu$. A Connecticut specimen in the Peck Herbarium from Curtis, which appears to be part of the type collection of Wright as well as one in the herbarium at Strassburg, communicated by Farlow, are young and without spores or perithecia. They have the appearance of young abnormal forms of *H. marginatum*. If Cooke's spore measurements are correct, however, this species cannot be referred to *H. marginatum* as indicated by Miller (Myc. **32**: 182, 1940); since in the latter species, the spores are $7–10 \times 3–5\mu$. There may be a mistake in Cooke's measurements and until they are verified it should be regarded as a doubtful synonym of *marginatum*.

The writer wishes to express here his great indebtedness and gratitude to Mr. J. A. Stevenson and Miss Edith K. Cash for assistance and editorial help in preparing this paper and its illustrations for publication.

More Florida Fungi

WILLIAM A. MURRILL
(Herbarium, Florida Agricultural Experiment Station, Gainesville, Fla.)

The specimens here cited are in the Station Herbarium. While the nomenclature is that used in "North American Flora," at the close of the paper certain species are transferred to genera found in Saccardo.

Mycologists of the present day, with their cars and modern equipment, can little appreciate the difficulty of collecting fleshy fungi a half century or more ago. A glance at the list of Cuban fungi collected by Charles Wright shows very few strictly fleshy species of any considerable size. Ravenel visited Gainesville, Fla., and carried away a marasmius. Small saw myriads of mushrooms in Florida but what could he do with them? If he had succeeded in drying them they would probably have molded, and without notes the best of them would have had little value.

The pioneer mycologist was usually a good walker and after spending a hard day collecting he had to work far into the night making notes and drying the specimens. Colors and minor characters do not show up well under a dirty oil lamp, especially when the eyes are tired and heavy with sleep. A day off could hardly be afforded with mushroom seasons so uncertain and so much to be done; so he kept on day after day and night after night, doing his best to meet the issue and justify the expense.

Collecting mushrooms is not always a fair-weather proposition; often it is done in the rain. Then both the collector and the specimens become sopping wet, and remain so for a long time. Imagine trying to make good notes on a wet mushroom, and drying it so as to look like anything! There are several regions I could name where there are no mushrooms until it begins to rain and no knowing when the rain will stop. One must be hardy and bold to pioneer in such places.

After the specimens had been collected, noted and dried the problem was to get them back to civilization unbroken, unmolded and uneaten by insects. The final task was to amplify the notes, add microscopic characters and compare with described species. If one had to work in order to eat he may have had to do all this with an eye on the door and an ear pointed at the telephone. Berkeley and Bresadola assumed heavy clerical responsibilities, while Patouillard often had to stop in the middle of a description to fill out a prescription.

Russula albiclavipes sp. nov.

Pileo e convexo explanato-depresso, 8 cm. lato, glabro, testaceo, grato; lamellis adnatis, 1 cm. latis, venoso-conjunctis, cremeis; sporis ellipsoideis, praeechinulatis, hyalinis, 8.5×6.5μ; stipite cavo, albo, glabro, 8×2–4 cm.

Pileus convex to fully expanded, slightly depressed, solitary, 8 cm.

broad; surface slightly viscid when wet, smooth, glabrous, testaceous, disk pale-latericious, margin cremeous-testaceous, even, entire, straight, peeling readily; context fragile, thin, white, unchanging, mild; lamellae adnate, few forked at base, not inserted, close, 1 cm. broad, not tapering at ends, strongly interveined, entire, cremeous; spores ellipsoid strongly echinulate, hyaline, about 8.5×6.5μ; cystidia not projecting beyond basidia; stipe clavate, hollow, smooth, glabrous, white, unchanging, 8×2–4 cm.

Type collected by W. A. Murrill in leaf-mold under a laurel oak in a high hammock at Gainesville, Fla., Mar. 21, 1944 (*F 18457*). Colors little changed in drying. Stipe greatly inflated below, as in *R. praeclavipes* Murr., but taste mild and cap very differently colored.

Russula australirosea sp. nov.

Pileo convexo-expanso, subdepresso, 4 cm. lato, viscido, glabro, subroseo, grato; lamellis adnatis, confertis, albis; sporis ellipsoideis, echinulatis, albis, 8×6μ; stipite glabro, albo, 3.5×1 cm.

Pileus convex to expanded, slightly depressed, about 4 cm. broad; surface viscid, smooth, glabrous, subroseous, margin even, entire, peeling readily; context thin, white, unchanging, odorless, mild; lamellae adnate, many forked at base, plane, close, 4 mm. broad, entire, white, unchanging; spores ellipsoid, conspicucusly echinulate, white in mass, about 8×6μ; stipe subequal, stuffed, smooth, glabrous, white, unchanging, about 3.5×1 cm.

Type collected by W. A. Murrill under live-oak near Newnan's Lake, east of Gainesville, Fla., June 18, 1944 (*F 38859*). Mature caps on drying become subavellaneous with a rosy tint, while younger caps change from pink to purplish-incarnate. Sterile cells are scarce or wanting.

Russula brunnescens sp. nov.

Pileo convexo-subdepresso, 7.5 cm. lato, glabro, viscido, subroseo, substriato, grato; lamellis adnatis, furcatis, latis, cremeis; sporis ellipsoideis, echinulatis, albis, 8×6μ; cystidiis longis, fusiformibus; stipite glabro, albo, 5×1–1.5 cm.

Pileus slightly depressed, solitary, 7.5 cm. broad; surface smooth, glabrous, distinctly viscid, pale-rose with a lilac tint, brown when dry, margin entire, slightly striate; context very thin, white, unchanging, odorless, mild; lamellae adnate, several forked at base, close, 1 cm. broad, entire, cremeous, mostly gray when dry; spores ellipsoid, distinctly and densely echinulate, amyloid, white, about 8×6μ; cystidia rather abundant on gill-edge, fusiform, long-projecting; stipe tapering downward, smooth, glabrous, white, brown when wounded or dried, 5×1–1.5 cm.

Type collected by W. A. Murrill in a road through red-oak woods 7 mi.

west of Gainesville, Fla., July 23, 1944 (*F 24505*). Very rare and without near relatives.

Russula cremeirosea sp. nov.

Pileo convexo-subdepresso, 7 cm. lato, glabro, roseo cremeoque, grato; lamellis adnatis, subconfertis; sporis globosis, spinulosis, stramineis, 6–8μ; stipite glabro, albido, roseitincto, 5×1.7 cm.

Pileus convex to slightly depressed, solitary, 7 cm. broad; surface smooth, glabrous, rose and cream, margin even, entire, incurved on drying; context thin, white, unchanging, odorless, mild; lamellae adnate, mostly equal, some forked, rather narrow, subcrowded, yellow at maturity; spores globose or subglobose, densely spinulose, stramineous, 6–8μ; stipe equal, smooth, glabrous, white with a faint pink blush, somewhat discolored on drying, 5×1.7 cm.

Type collected by W. A. Murrill under oak at Newnan's Lake, near Gainesville, Fla., July 9, 1938 (*F 9326*). The pileus is slightly sticky when moist. After prolonged drying it assumes a uniform, dull, old-rose color. There are no cheilocystidia. Near *R. xerampelina* Fr.

Russula cremeirubra sp. nov.

Pileo depresso, 7 cm. lato, glabro, cremeo rubroque, striato, grato; lamellis adnatis, latis, subdistantibus, stramineis; sporis ellipsoideis, echinulatis, subflavis, 9×7μ; cystidiis brevibus, apiculatis; stipite glabro, albo, 5×1.5 cm.

Pileus depressed, solitary, 7 cm. broad; surface smooth, glabrous, pale-cream suffused with pale-red, margin subentire, pectinate-striate; context thin, white, unchanging, odorless, mild; lamellae adnate, few inserted, broad, ventricose, rather distant, straw-colored, entire; spores ellipsoid, densely and distinctly echinulate, pale-yellow, about 9×7μ; cystidia rather abundant on gill-edge, inflated, short, abruptly apiculate; stipe equal, solid, smooth, glabrous, white, unchanging, 5×3.5 cm.

Type collected by W. A. Murrill in turkey-oak woods at Arredonda, near Gainesville, Fla., Aug. 22, 1943 (*F 12100*). A rare species with peculiar coloring.

Russula fragiloides sp. nov.

Pileo convexo-plano, 2.5–3 cm. lato, viscido, glabro, rubro, piperato; lamellis adnatis, confertis, angustatis, albis; sporis ellipsoideis, echinulatis, albis, 7–8×5–6μ; stipite albo, glabro, 3.5×0.5–0.7 cm.

Pileus convex to plane, scattered, 2.5–3 cm. broad; surface viscid when wet, smooth, glabrous, ruber, margin entire, even to slightly striate; context very thin, white, unchanging, odorless, very acrid at once; lamellae

adnate, few inserted, narrow, crowded, entire, white, pallid on drying; spores broadly ellipsoid, white, distinctly short-echinulate, about 7–8×5–6μ; sterile cells abundant, fusiform, abruptly apiculate, about 60×10μ, confined to the edges of the lamellae; stipe increasing below, smooth, white, glabrous, about 3.5×0.5–0.7 cm.

Type collected by W. A. Murrill in leaf-mold in laurel-oak woods at Gainesville, Fla., Apr. 13, 1944 (*F 18001*). Closely resembling *R. fragiliformis* Burl. but with smaller, more elongate spores. Bresadola describes the spores of that species (*R. fragilis* Pers.) as globose or subglobose, 8–10×7–9μ. I am aware that the form of my specific name is old-fashioned but I use it intentionally to suggest the close relationship.

Russula inconstans sp. nov.

Pileo convexo-plano, gregario, 4–5 cm. lato, glabro, flavo roseoque, grato; lamellis adnatis, confertis, albis, isabellescentibus; sporis globosis, echinulatis, albis, 7μ; stipite aequali, glabro, albo, 3×0.6–0.9 cm.

Pileus convex to plane, gregarious, 4–5 cm. broad; surface slightly viscid, smooth, glabrous, yellow and pink, margin peeling readily, entire, slightly striate with age; context very thin and fragile, white, unchanging, odorless, mild; lamellae adnate, plane close, medium broad, milk-white, unchanging when bruised but dark-isabelline when dry, entire; spores globose or subglobose, amyloid, distinctly echinulate, white, about 7μ; cystidia very few on gill-edge, projecting, pointed; stipe equal, smooth, glabrous, milk-white, unchanged when bruised or on drying, about 3×0.6–0.9 cm.

Type collected by W. A. Murrill at the edge of low mixed woods by a lake near Gainesville, Fla., Sept. 15, 1943 (*F 18105*). The specific name refers to the decided change in the color of the gills on drying while that of the stem remains constant.

Russula levisporiformis sp. nov.

Pileo convexo-subdepresso, 6 cm. lato, glabro, stramineo ochraceoque, subfelleo; lamellis adnatis, basifurcatis, latis, albis; sporis globosis, subtuberculatis albis, 7–8μ; stipite aequali, glabro, albo, 5×1.2 cm.

Pileus convex to slightly depressed, 6 cm. broad; surface slightly viscid, smooth, glabrous, stramineous with ochraceous areas, margin even, entire, not peeling readily; context 3 mm. thick, white, unchanging, odorless, slightly acrid and bitter; lamellae adnate, many forked at or near base, none inserted, plane, 8 mm. broad, close, entire, not fimbriate, white; spores white in mass, globose or subglobose, minutely tuberculate, 7–8μ; cystidia none; stipe equal, solid, smooth, glabrous, white and unchanging except at the ochraceous base, 5×1.2 cm.

Type collected by W. A. Murrill under a laurel oak at Gainesville,

Fla., July 13, 1944 (*F 24504*). Suggesting *R. levispora* Murr. but having white spores and a paler yellow cap. Rare.

Russula lutescentifolia sp. nov.

Pileo convexo-subdepresso, 5–5.5 cm. lato, glabro, subflavo et testaceo, felleo; lamellis adnatis, confertis, albis ad luteis; sporis subglobosis, levibus, 9–10×7–8μ; cystidiis fusoideis, 60–70×10–15μ; stipite aequali, glabro, albo, 4–4.5×1.5 cm.

Pileus convex to slightly depressed, scattered, 5–5.5 cm. broad; surface slightly viscid when wet, smooth, glabrous, pale-yellow with some testaceous spots, margin even, entire, not peeling readily; context thin, firm, white, unchanging, odorless, somewhat bitter; lamellae adnate, plane, few inserted, few forked at base, close, narrow, entire, white, unchanging when cut but becoming luteous on drying; spores subglobose, smooth, 1-guttulate, about 9–10×7–8μ; cystidia abundant, fusoid, about 60–70×10–15μ; stipe equal, solid, smooth, glabrous, white, unchanging, the base spotted with isabelline and dark-red, 4–4.5×1.5 cm.

Type collected by W. A. Murrill under a laurel oak in Gainesville, Fla., June 11, 1944 (*F 38839*). The spores and gills are milk-white but the latter turn egg-yellow when dried. The cap also is usually a deeper yellow after drying.

Russula mutantipes sp. nov.

Pileo convexo-depresso, 4.5 cm. lato, roseo-isabellino, disco latericio grato; lamellis adnatis, albis, 7 mm. latis; sporis ellipsoideis, echinulatis albis, 8×6μ; stipite glabro, albo, glaucescenti, 3×1–1.5 cm.

Pileus convex to somewhat depressed, solitary, 4.5 cm. broad; surface dry, the cuticle finely checked, center latericious, margin rosy-isabelline, even, entire to undulate; context thin, white, unchanging, odorless, mild; lamellae adnate, thick and firm, few inserted, ventricose, moderately close and medium broad, about 7 mm., entire, white; spores ellipsoid, distinctly echinulate, 1-guttulate, white, about 8×6μ; stipe tapering downward, smooth, glabrous, white, glaucous when dry, 3×1–1.5 cm.

Type collected by W. A. Murrill under a live-oak in Sugarfoot Hammock, near Gainesville, Fla., July 23, 1944 (*F 17921*). The changing color of the stipe suggests *R. glaucescentipes* Murr. but otherwise the two plants are quite different.

Russula ochroleuciformis sp. nov.

Pileo convexo-subexpanso, subdepresso, 8 cm. lato, subviscido, glabro, sulphureo-cremeo, grato; lamellis adnatis, 6 mm. latis, albis; sporis ellipsoideis, albis, reticulatis, 8–9×6–7μ; stipite albo, glabro, 5×1.5 cm.

Pileus convex to subexpanded, very slightly depressed, solitary, 8 cm. broad; surface viscid when wet, smooth, glabrous, cream with a sulfur tint,

ochraceous at the very center, margin white, thin, peeling, entire, deflexed, very slightly striate; context 5 mm. thick, white, unchanging, odorless, mild; lamellae squarely adnate, plane, 6 mm. broad, close, few forked at base and few at middle, few inserted, entire, white, unchanging, pale-cream when dried; spores broadly ellipsoid, white, reticulate, 8–9×6–7μ; stipe equal, solid, smooth, glabrous, white, unchanging, 5×1.5 cm.

Type collected by W. A. Murrill in sandy soil in a high hammock at Gainesville, Fla., Apr. 21, 1944 (*F 17250*). Suggesting *T. ochroleuca* Pers. but mild and with different spores. The sterile cells on the edges of the gills are few, clavate, and project well beyond the basidia. Some of them are abruptly apiculate. On some of the spores there seemed to be small tubercles, as well as reticulations.

Russula partirosea sp. nov.

Pileo depresso, 9 cm. lato, glabro, partim roseo, striato, subgrato; lamellis adnatis, confertis, latis; sporis ellipsoideis, tuberculatis, ochroleucis, 8×6μ; cystidiis inflatis, apiculatis, 20×10μ; stipite solido, glabro, albo, 8×2.5 cm.

Pileus convex to depressed, solitary, about 9 cm. broad; surface slightly viscid, glabrous, roseous with white and cream areas, margin scarcely peeling, short-striate, undulate; context reaching 1 cm. thick, white, unchanging, odorless, very slightly astringent and bitter; lamellae adnate, slightly rounded behind, 1 cm. broad, close, few inserted, entire, white to yellow; spores ellipsoid, distinctly tuberculate, ochroleucous in mass, about 8×6μ; cystidia inflated, hyaline, abruptly long-apiculate, projecting about 20 ×10μ; stipe slightly enlarged below, solid, smooth, glabrous, white within and without, unchanging, about 8×2.5 cm.

Type collected by W. A. Murrill on a lawn near laurel oak in Gainesville, Fla., Sept. 20, 1944 (*F 19157*). Frequent in this locality during the summer rainy season. The cap is never entirely roseous but has white and cream areas, giving it a mottled appearance. Cystidia are common on the gill-edges and their shape is rather peculiar.

Russula pervirginea sp. nov.

Pileo convexo-subdepresso, 5–6 cm. lato, glabro, albo, grato; lamellis latis, albis; sporis echinulatis, albis, 9×7μ; stipite solido, albo, glabro, 3×1–1.5 cm.

Pileus convex to slightly depressed, scattered, 5–6 cm. broad; surface very slightly viscid, smooth, glabrous, milk-white, yellowish-brown when dried, margin even, entire, peeling readily; context thin, white, unchanging, odorless, mild; lamellae adnate, plane, crowded, broad, white, yellowish when dried, entire; spores broadly ellipsoid, strongly echinulate, pure-white in mass, about 9×7μ; sterile cells inflated with shriveled tip, pro-

jecting about 5μ; stipe equal, solid, smooth, glabrous, white and unchanging without and within, about 3×1–1.5 cm.

Type collected by W. A. Murrill in open, wet, slash-pine flatwoods just east of Gainesville, Fla., Feb. 3, 1944 (*F 17266*). Suggesting *R. lactea* Pers., which has a very different habitat. The entire hymenophore, including the spores, is milk-white and the taste mild.

Russula praefragilis sp. nov.

Pileo convexo-depresso, 5–7 cm. lato, viscido, cremeo roseoque, substriato, grato, anisato; lamellis adnatis, basifurcatis, confertis, albis; sporis globosis vel subglobosis, praeechinulatis, cremeis, 7–8×6–8μ; stipite glabro, albo, 4–6×1–2 cm.

Pileus convex to depressed, scattered, 5–7 cm. broad; surface viscid, glabrous, cream and pink, margin readily peeling, becoming striate at times, entire to undulate; context very fragile, rather thick, white, unchanging, mild, with a slight anise odor; lamellae adnate, many forked at base, close, medium broad, very fragile, entire, white to cream; spores globose or subglobose, uniguttulate, conspicuously echinulate, cremeous in mass, 7–8×6–8μ; cystidia none; stipe equal or enlarged below, solid or hollow, smooth, glabrous, white and unchanging without and within, 4–6×1–2 cm.

Type collected by W. A. Murrill in white sand among dwarf evergreen oaks in thin longleaf pine flatwoods just east of Gainesville, Fla., Mar. 12, 1944 (*F 19866*). Suggesting *R. praepalustris* Murr. but growing in higher ground and being much larger, with many forked gills and more globose spores. The color of the cap varies with the weather, especially if rainwater collects in its depressed center. It is one of the most fragile species I know.

Russula praepalustris sp. nov.

Pileo convexo-depresso, 3.5 cm. lato, subviscido, glabro, grato, roseo, disco atrotestaceo; lamellis adnatis, latis; sporis ochroleucis, tuberculatis, 9×7μ; stipite glabro, albo, 2×0.7 cm.

Pileus convex to depressed, 3.5 cm. broad; surface slightly viscid, smooth, glabrous, roseous with dark-testaceous disk, margin even, entire, not peeling; context white, unchanging, 1–3 mm. thick, odorless, mild; lamellae plane, adnate, neither inserted nor forked, close, broad, entire, fragile, soon yellow; spores ochroleucous in mass, broadly ellipsoid, densely tuberculate, about 9×7μ; sterile cells inflated, scarcely projecting; stipe equal, solid, smooth, glabrous, white and unchanging within and without, about 2×0.7 cm.

Type collected by W. A. Murrill in wet ground in open low slash-pine flatwoods just east of Gainesville, Fla., Feb. 3, 1944 (*F 22480*). A rare, neat

species remarkable for its marshy habitat. The colors are little changed in drying.

Russula rimosa sp. nov.

Pileo convexo-plano, 6 cm. lato, sicco, roseo-livido, demum radiato-rimoso, grato; lamellis adnatis, confertis, albis; sporis ellipsoideis, levibus, albis, 5–6×4μ; stipite aequali, glabro, albo, solido, 5×1.5 cm.

Pileus convex to plane, slightly depressed at the center, solitary, 6 cm. broad; surface dry, pale rosy-livid, cuticle becoming radially cracked on the broad entire margin; context thin, white, unchanging, odorless, mild; lamellae adnate, very few inserted, close, medium broad, some forked near the margin, entire, white, unchanging, isabelline when dried; spores broadly ellipsoid, smooth, chalk-white in mass, about 5–6×4μ; sterile cells scarce, ventricose, abruptly apiculate, moderately projecting, hyaline; stipe equal, solid, smooth, glabrous, white, unchanging, white when dried; 5×1.5 cm.

Type collected by W. A. Murrill under laurel oak in Gainesville, Fla., May 11, 1944 (*F 32888*). The cuticle is very delicate, soon becoming minutely checked, and with age or on drying splitting radially 1–2 cm. on the margin as in some species of *Inocybe*.

Russula subcarnicolor sp. nov.

Pileo subdepresso, 3.5 cm. lato, subsquamuloso, roseo lilacinoque, striato, grato; lamellis adnatis, basifurcatis, distantibus, albis; sporis ellipsoideis, echinulatis, albis, 7×5μ; stipite albo, glabro, 3×0.7 cm.

Pileus slightly depressed, solitary, 3.5 cm. broad; surface dry, minutely appressed-scaly from the rupture of the cuticle, rose and lilac, margin not peeling readily, widely striate, undulate or split; context 3 mm. thick, white, unchanging, odorless, mild; lamellae adnate, many forked at and near base, not inserted, distant, ventricose, 5 mm. broad, entire, white; spores white in mass, ellipsoid, finely echinulate and reticulate, about 7×5μ; cystidia none; stipe smooth, glabrous, white, equal below the enlarged apex, 3×0.7 cm.

Type collected by W. A. Murrill under a laurel oak at Gainesville, Fla., July 17, 1944 (*F 24507*). Suggesting a pale form of *R. carnicolor* Bres. but not viscid and having ellipsoid spores. Also related to *R. variicolor* Murr. Very rare.

Russula subcremeiceps sp. nov.

Pileo convexo-subdepresso, 6 cm. lato, glabro, cremeo, grato; lamellis confertis, adnatis, albis; sporis globosis, ochroleucis, echinulatis, 6–7μ; stipite aequali, albo, glabro, 5×2 cm.

Pileus convex to shallowly depressed, solitary, 6 cm. broad; surface slightly viscid when wet, glabrous, pale-cream or cream, faintly pseudo-

striate, margin thick, entire, not peeling readily; context firm, 3 mm. thick, white, unchanging, odorless, mild; lamellae squarely adnate, very few inserted, not forked, ventricose, 5 mm. broad, close, entire, not fimbriate, white to pale-yellow; spores globose or subglobose, pale-yellow in mass, densely echinulate, 6–7μ; cystidia none; stipe equal, solid, smooth, glabrous, white, unchanging, 5×2 cm.

Type collected under a laurel oak in Gainesville, Fla., June 28, 1944 (*F 38929*). A rare species resembling *R. albidicremea* Murr. but with closer, unforked gills and rounder spores.

Russula subfloridana sp. nov.

Pileo convexo-subexpanso, depresso, 6 cm. lato, purpureo-rubro, glabro, grato; lamellis adnatis, confertis, albis; sporis ellipsoideis, echinulatis, albis, 10×8μ; stipite glabro, subroseo, 5×1.7 cm.

Pileus convex to subexpanded, centrally depressed, solitary, 6 cm. broad; surface slightly viscid when wet, smooth, glabrous, uniformly purplish-ruber, margin even, entire, not peeling; context firm, 2 mm. thick, white, unchanging, odor pleasant, taste mild; lamellae plane, adnate, few forked at the base, none inserted, firm, 6 mm. broad, crowded, entire, white, unchanging when bruised but ochroleucous when dried; spores broadly ellipsoid, distinctly echinulate, white, about 10×8μ; sterile cells inconspicuous, clavate; stipe equal, solid, smooth, glabrous, pale-roseous, unchanging, 5×1.7 cm.

Type collected by W. A. Murrill under red oak 11 mi. northwest of Gainesville, Fla., Apr. 16, 1944 (*F 18067*). A beautiful species suggesting *R. floridana* Murr. but with pink stem, smaller spores and even margin.

Russula subpavonina sp. nov.

Pileo convexo-depresso, 6.5 cm. lato, sicco, glabro, sublivido, grato; lamellis adnatis, furcatis, confertis; sporis subglobosis, echinulatis, ochraceis, 7–9μ; cystidiis apiculatis; stipite glabro, roseo, 7.5×1–1.5 cm.

Pileus convex to depressed, solitary, 6.5 cm. broad; surface dry, smooth, glabrous, uniformly pale-livid, margin even, entire, not peeling readily; context medium thick, white, unchanging, odorless, mild; lamellae adnate, forked at base, not inserted, interveined, crowded, rather narrow, entire, rosy near margin, becoming ochraceous; spores subglobose or broadly ellipsoid, echinulate, ochraceous, 7–9μ; cystidia inflated, abundant on edge of gill, of medium length and abruptly apiculate; stipe enlarged downward, smooth, glabrous, roseous, unchanging, 7.5×1–1.5 cm.

Type collected by W. A. Murrill under a hop hornbeam in a high hammock at Gainesville, Fla., June 6, 1943 (*F 32995*). Suggesting a purple form of *R. alutacea* Fr. but the gills are adnate and forked at the base. Rare and beautiful.

Russula testaceiceps sp. nov.

Pileo convexo-subexpanso, depresso, gregario, 4.5–6 cm. lato, viscido, testaceo, glabro, grato; lamellis adnatis, confertis, albis; sporis subglobosis, cremeis, echinulatis, 10×9μ; stipite albo, glabro, 4×1–1.5 cm.

Pileus convex to subexpanded, centrally depressed, gregarious, 4.5–6 cm. broad; surface viscid when wet, smooth, glabrous, testaceous, partly fading to cream, margin even, entire, not peeling; context thick, firm, white, unchanging, odorless, mild; lamellae adnate, plane, none inserted, few forked, medium broad, close, entire, white, unchanging when bruised, ochroleucous when dried; spores subglobose, pale-yellowish, 1-guttulate, distinctly echinulate, about 10×9μ; sterile cells few, fusiform, projecting only slightly beyond the basidia; stipe equal, stuffed, smooth, glabrous, white, unchanging, about 4×1–1.5 cm.

Type collected by W. A. Murrill under red oak 11 mi. northwest of Gainesville, Fla., Apr. 16, 1944 (*F 15916*). Young sporophores are testaceous over the entire surface, but older ones fade out at the center, where water may collect, or even over areas of the margin.

Russula tricolor sp. nov.

Pileo convexo-depresso, 6–8 cm. lato, subviscido, glabro, rubro cremeoque, grato; lamellis adnexis, latis, ventricosis; sporis ochraceis, echinulatis, 8×6μ; stipite glabro, albo, 3.5×2–2.5 cm.

Pileus convex to expanded and shallowly depressed, scattered, 6–8 cm. broad; surface slightly viscid when wet, smooth, glabrous, ruber and cream, margin obtuse, fertile, red, even, entire, not peeling; context thick, white, unchanging, odorless, mild; lamellae adnexed, very few inserted, broad, ventricose, crowded, entire, soon deep-yellow; spores broadly ellipsoid, ochraceous, distinctly short-echinulate, about 8×6μ; sterile cells clavate, abruptly apiculate, projecting well beyond the basidia; stipe subequal, solid, smooth, glabrous, white, unchanging, about 3.5×2–2.5 cm.

Type collected by W. A. Murrill under red oak 11 mi. northwest of Gainesville, Fla., Apr. 16, 1944 (*F 18066*). A striking species with red cap, ochraceous gills and white stem. The creamy areas on the cap were probably red at first. The taste is mild but after some time becomes slightly disagreeable. The stipe is distinctly shorter than that of *R. alutacea*, while the spores are ellipsoid rather than subglobose. Suggesting *R. Romellii* Maire but not striate.

Russula venusta sp. nov.

Pileo convexo-subexpanso, depresso, 11 cm. lato, sicco, incarnato, glabro, grato; lamellis adnatis, confertis, integris; sporis ellipsoideis, echinulatis, cremeis, 8–9×6–7μ; stipite glabro, albo, 6–7×1.5–2 cm.

Pileus convex to subexpanded, centrally depressed, scattered, up to 11

cm. broad; surface dry, smooth, glabrous, incarnate, margin concolorous, even, entire, deflexed on drying; context thin, white, unchanging, sweet; larmellae plane, adnate, inserted, few forked at base, rather narrow, crowded, entire, soon cremeous, isabelline in the herbarium; spores broadly ellipsoid, distinctly echinulate, cremeous, about 8–9×6–7μ; stipe smooth, glabrous, white, unchanging, about 6–7×1.5–2 cm.

Type collected by W. A. Murrill in thin woods near a live-oak east of Gainesville, Fla., July 11, 1943 (*F 17836*). A very beautiful species.

Clitocybe praefellea sp. nov.

Pileo convexo-plano, 4 cm. lato, albo, glabro, felleo; lamellis adnatis, confertis, sublatis, albis; sporis ellipsoideis, levibus, albis, 8×4μ; stipite bulboso, solido, glabro, albo, 5–6×1 cm.

Pileus convex to very slightly depressed, solitary, about 4 cm. broad; surface smooth, glabrous, milk-white, unchanged, margin even, entire; context soft, white, unchanging, 5–7 mm. thick near the center, odorless, very bitter at once; lamellae adnate with decurrent tooth, inserted, close, 5–7 mm. broad behind, narrow in front, entire, white, unchanging, dirty-pallid when dry; spores ellipsoid, smooth, 1-guttulate, about 8×4μ; cystidia none; basidia 4-spored; stipe bulbous, solid, smooth, glabrous, white, unchanging, about 5–6×1 cm.; bulb ovoid, white, 1.5–1.8 cm. thick.

Type collected by W. A. Murrill on an exposed lawn near a laurel oak in Gainesville, Fla., Jan. 15, 1944 (*F 17980*). Having the appearance of *Tricholoma* but gills not sinuate. It belongs in the group with *C. candicans* Pers.

Marasmius callicarpellus sp. nov.

Pileo convexo-subexpanso, gregario, 1.5 mm. lato, glabro, ochraceo-isabellino, membranaceo; lamellis adnatis, albis; sporis globosis, levibus, 2μ; stipite glabro, albo fulvoque, 1 cm. longo.

Pileus convex to subexpanded, closely gregarious, about 1.5 mm. broad; surface dry, smooth, glabrous, ochraceous-isabelline, margin entire, even, becoming rugose-sulcate on drying; context membranous, pallid; lamellae adnate, inserted, medium broad, rather close, entire, white, discolored when dry; spores globose, smooth, hyaline, about 2μ; cystidia none; stipe capillary, smooth, glabrous, white above, dark-fulvous below, whitish-mycelioid at the base, about 1 cm. long.

Type collected by E. West and W. A. Murrill on small dead fallen twigs in woods at Gainesville, Fla., Nov. 8, 1932 (*F 9926*). Minute but attractive.

Marasmius octifolius sp. nov.

Pileo hemisphaerico, papillato, gregario, 2–3 mm. lato, subbadio, glabro; lamellis adnatis, latis, albis; sporis ellipsoideis, 5–6×4μ; stipite glabro, subnigro, 1 cm. longo.

Pileus hemispheric, papillate, gregarious, 2–3 mm. broad; surface pale-bay, sulcate, glabrous, with a small black papillae at the center, margin entire, concolorous; context membranous, pallid; lamellae adnate, broad, entire, white, neither inserted nor interveined, eight in number; spores broadly ellipsoid, smooth, 5–6×4μ; stipe equal, smooth, glabrous, shining, blackish, capillary, about 1 cm. long.

Type collected by Dr. G. F. Weber on the leaf-sheaths of dead sugarcane at Gainesville, Fla., Sept. 19, 1942 (*F 17859*). Suggesting *M. minutus*, *M. Hiorami* and certain other small species.

Marasmius pallidiceps sp. nov.

Pileo convexo-plano, gregario, 8 mm. lato, glabro, pallido, membranaceo; lamellis adnatis, confertis, pallidis; sporis globosis, levibus, 2–3μ; stipite subtomentoso, 2×0.05 cm.

Pileus convex to plane, gregarious, about 8 mm. broad; surface dry, smooth, glabrous, pallid to isabelline, margin even, entire, straight; context membranous, white, unchanging, odorless; lamellae adnate, inserted, narrow, crowded, entire, pallid to isabelline; spores globose, smooth, hyaline, 1-guttulate, 2–3μ; cystidia none; stipe equal, subtomentose, white above, discolored below, about 2×0.05 cm.

Type collected on dead fallen oak leaves, moist and partly shaded, seven miles west of Gainesville, Fla., Sept. 26, 1943 (*F 17771*). Suggesting *M. Olnei* but quite distinct.

Marasmius pruinosipes sp. nov.

Pileo convexo, 6 mm. lato, rugoso, isabellino; lamellis decurrentibus, latis, distantibus, albis; sporis globosis, levibus, 3μ; stipite albo, pruinoso, 2.5×0.1 cm.

Pileus convex, not fully expanding, 6 mm. broad; surface dry, subglabrous, rugose, isabelline, margin deflexed, becoming sulcate; context membranous, white, unchanging, odorless; lamellae decurrent, few, distant, broad, entire, white, unchanging, yellowish when dried; spores globose, smooth, hyaline, about 3μ; cystidia none; stipe equal, white, unchanging, pale-umbrinous below, pruinose, much twisted when dry, 2.5 ×0.1 cm.

Type collected by W. A. Murrill attached to a small dead root on an exposed bank in Gainesville, Fla., July 17, 1938 (*F 8346*). Suggesting *M. pruinosulus* Murr., described from Cuba, but differing in color and length of stem.

Marasmius stenophylloides sp. nov.

Pileo convexo, umbonato, 1.5 cm. lato, albo, subtomentoso, lobato; lamellis adnatis, furcatis, albis; sporis globosis, levibus, 4μ; stipite albo, subtomentoso, discoideo, 1×0.12 cm.

Pileus convex, not fully expanding, umbonate, gregarious, 1.5 cm. broad; surface dry, milk-white, nearly smooth, minutely tomentose, margin incurved, even, lobed; context thin, white, unchanging, odorless; lamellae adnate or slightly decurrent, arcuate, inserted, forked, narrow, rather distant, notched, white, yellowish when dry; spores globose, smooth, hyaline, about 4μ; stipe equal, smooth, white, minutely tomentose, with a white mycelial disk at the base, 1×0.12 cm.

Type collected by W. A. Murrill on a fallen frondose stick in dry woods in Gainesville, Fla., Sept. 6, 1939 (*F 9920*). Suggesting *M. substenophyllus* Murr., but tomentose with adnate, forked gills.

Melanoleuca calceifolia sp. nov.

Pileo convexo-subexpanso, 6 cm. lato, sicco, albido, farinaceo; lamellis sinuatis, latis, praealbis; sporis ellipsoideis, levibus, 3×2μ; stipite solido, glabro, albo, 5×0.8–1.2 cm.

Pileus convex to subexpanded with broad umbo, solitary, 6 cm. broad; surface dry, white with avellaneous tint, drying grayish, slightly silky, shining, margin very thin, even, subfimbriate, undulate to splitting; context very thin, white, unchanging, with distinct farinaceous odor and taste; lamellae sinuate, inserted, broad, close, chalk-white, unchanging, undulate; spores ellipsoid, smooth, hyaline, about 3×2μ; stipe slightly enlarged above, solid, smooth, glabrous, white and unchanging without and within, 5×0.8–1.2 cm.

Type collected by W. A. Murrill in leaf-mold under a laurel oak at Gainesville, Fla., Apr. 9, 1944 (*F 19948*). Remarkable for its chalk-white gills and small spores. Young caps are avellaneous and innate-fibrillose.

Melanoleuca lasciviformis sp. nov.

Pileo convexo-depresso, 9 cm. lato, glabro, fulvo, grato; lamellis sinuatis, confertis, albis; sporis ovoideis, levibus, albis, 6–8×3–4μ; stipite aequali, albo, 4×1–1.5 cm.

Pileus convex to depressed, gregarious, to 9 cm. broad; surface smooth, glabrous, fulvous, margin even, entire to lobed and split; context about 3 mm. thick, white, unchanging, odorless, nutty; lamellae sinuate, inserted, close, medium to broad, white, unchanging, fragile, entire; spores ovoid, smooth, 1-guttulate, hyaline, 6–8×3–4μ; cystidia none; stipe equal, white, fibrillose, about 4×1–1.5 cm.

Type collected by W. A. Murrill in leaf-mold in a high hammock at Gainesville, Fla., Aug. 11, 1944 (*F 32726*). Both the cap and the gills are considerably duller in dried specimens than when fresh.

Melanoleuca melaleuciformis sp. nov.

Pileo convexo-depresso, gregario, 4–5 cm. lato, sicco, glabro, umbrino ad

atro-avellaneo, grato; lamellis emarginatis, distantibus, latis, albis; sporis levibus, 6×3μ; stipite glabro, avellaneo, 5–6×0.5–1 cm.

Pileus convex to deeply depressed, gregarious, 4–5 cm. broad; surface dry, smooth, glabrous, shining, uniformly umbrinous to dark-avellaneous, margin deflexed when young, even, entire to slightly undulate or rimose; context very thin, pallid, unchanging, 1 mm. or less thick, odorless, mild; lamellae emarginate with broad adnate base, plane, inserted, distant, 1 cm. broad, entire, white to pallid; spores oblong-ellipsoid, smooth, hyaline, white in mass, about 6×3μ; cystidia none; stipe fleshy, hollow, subequal, smooth or slightly furrowed, glabrous, shining, white at the apex, avellaneous below, 5–6×0.5–1 cm.

Type collected by G. F. Weber in a dried-up cypress pond in the Cary Forest, east of Gainesville, Fla., Jan. 18, 1944 (*F 17233*). Suggesting *M. melaleuca* but the spores are smooth and much smaller. Depauperate specimens were collected at the same time on a sandy roadside nearby.

Melanoleuca microsperma sp. nov.

Pileo convexo-plano, umbonato, 4–5 cm. lato, subtomentoso, avellaneo, disco fumoso, farinaceo; lamellis confertis, angustatis, albis; sporis ellipsoideis, levibus, 4×2μ; stipite albo, glabro, 3–4×1 cm.

Pileus convex to plane with broad umbo, gregarious, 4–5 cm. broad; surface dry, finely tomentose, smooth, avellaneous with fumose disk, margin even, concolorous, entire to undulate or slightly rimose; context very thin, white, unchanging, with farinaceous odor and taste, not becoming bitter or acrid; lamellae sinuate, inserted, close, narrow, pure-white, unchanged on drying, edges entire to somewhat split; spores ellipsoid, smooth, hyaline, about 4×2μ; stipe equal, solid or slightly hollow, smooth, glabrous, white, unchanging, about 3–4×1 cm.

Type collected by G. F. Weber on an open grassy lawn near water oaks in Gainesville, Fla., Jan. 16, 1944 (*F 18641*). Suggesting *Cortinellus multiformis* but having very small spores and fine tomentum. The gills when dry are chalk-white, as in *M. melaleuca*.

Melanoleuca ustaliformis sp. nov.

Pileo convexo-plano, 6–7 cm. lato, purpureo-avellaneo, disco fuligineo, glabro, farinaceo; lamellis adnexis, confertis, pallidis; sporis ovoideis, levibus, 5×3.5μ; stipite albo, solido, 4–5×1.5–2 cm.

Pileux convex to plane, 6–7 cm. broad; surface slightly viscid when fresh, shining, purplish-avellaneous with fuliginous disk, smooth, glabrous, margin even, entire; context white, unchanging, 1 cm. thick toward the center, very thin at the margin, with strong farinaceous odor and taste; lamellae adnexed, rounded behind, ventricose, medium broad, crowded, white-ciliate, dirty-white, subfulvous in the herbarium after several years;

spores ovoid, smooth, hyaline, mostly about 5×3.5μ, some larger; stipe subequal, smooth, white without and within, solid, finely white-scaly at the apex, 4–5×1.5–2 cm.

Type collected by W. A. Murrill under turkey oak at Gainesville, Fla., Jan. 10, 1941 (*F 19488*). Also collected later in the vicinity under laurel oak. What appears to be a form of the same thing was collected by the author in a high hammock at River Rise, Alachua Co., Dec. 31, 1939 (*F 18486*). It was pallid to fulvous, with sinuate gills and ellipsoid spores about 6×4μ. I at first referred it to *M. transmutans* Pk., because the gills became stained. See note by Singer in Lloydia **5**: 116. 1942.

Omphalina bicolor sp. nov.

Pileo umbilicato, 8–15 mm. lato, subtomentoso, avellaneo, grato; lamellis decurrentibus, confertis, albis; sporis ellipsoideis, levibus, 5×3μ; stipite albido, pruinoso demum glabro, 1.3–1.5×0.1 cm.

Pileus deeply umbilicate, gregarious, 8–15 mm. broad; surface dry, minutely tomentose, uniformly avellaneous, margin even, entire to undulate, upturned at times in age, incurved when young; context membranous, flexible, white, unchanging, odorless, mild; lamellae decurrent, inserted, narrow, close, entire, white, isabelline when dry; spores ellipsoid, smooth, hyaline, about 5×3μ; cystidia none; stipe equal above the slightly enlarged base, fistulose, pruinose to glabrous, whitish, about 1.3–1.5×0.1 cm.

Type collected by W. A. Murrill in open short grass at Gainesville, Fla., June 15, 1944 (*F 38850*). Typical of the genus, with avellaneous cap and white gills.

Omphalina pervirginea sp. nov.

Pileo convexo, umbilicato, caespitoso, 1.5–2 cm. lato, albo, grato; lamellis subdistantibus, albis; sporis ovoideis, 5–6×3–4μ; stipite albo, 1–1.5 ×0.2–0.4 cm.

Pileus convex, umbilicate to infundibuliform, not fully expanding, cespitose, 1.5–2 cm. broad; surface smooth, pruinose to glabrous, uniformly white, margin even to very slightly striate, incurved when young, entire to lobed; context thin, white, unchanging, mild, odorless; lamellae arcuate-decurrent, inserted, some forked, rather narrow, subdistant, thin with blunt edges, entire, white, unchanging; spores ovoid, smooth, hyaline, 1-guttulate, 5–6×3–4μ; cystidia none; stipe tapering downward, cartilaginous, solid or with small pith, pruinose to glabrous, smooth, white, 1–1.5 ×0.2–0.4 cm.

Type collected by W. A. Murrill in open sandy soil among low shrubs and wiregrass in longleaf pine flatwoods just east of Gainesville, Fla., Mar. 19, 1944 (*F 21539*). Suggesting *O. buccinalis* (Batsch) Murr., but much larger, cespitose, and having distant gills. It is clear-white like melting snow throughout when fresh, becoming chalk-white on drying.

Omphalina subfloridana sp. nov.

Pileo umbilicato, 8–10 mm. lato, glabro, albo, grato; lamellis decurrentibus, angustatis, albis; sporis ovoideis, levibus, 4×2μ; stipite aequali, glabro, albo, 1–1.5×0.05–0.1 cm.

Pileus umbilicate, gregarious or scattered, 8–10 mm. broad; surface smooth, glabrous, white, margin even, entire, incurved when young; context membranous, white, odorless, mild; lamellae short-decurrent, several times inserted, sinuous, rather close, narrow, entire, white, unchanging; spores pip-shaped, smooth, hyaline, about 4×2μ; cystidia none; stipe equal, smooth, glabrous, white, 1–1.5×0.05–0.1 cm.

Type collected by W. A. Murrill in open turkey-oak woods west of Gainesville, Fla., July 23, 1944 (*F 32937*). Related to *O. floridana* Murr. and *O. scyphoides* Fr. White throughout, unchanged on drying.

Omphalina subumbratilis sp. nov.

Pileo convexo, umbilicato, gregario, 1.5–2 cm. lato, glabro, striato, umbrino demum nigro; lamellis distantibus, latis, pallidis; sporis oblongo-ellipsoideis, 5×2.5μ; stipite aequali, pruinoso, umbrino, 2–3×0.1–0.15 cm.

Pileus convex, umbilicate, gregarious, about 1.5 to 2 cm. broad; surface hygrophanous, smooth, glabrous, umbrinous, black when dry, faintly multistriate, margin entire, incurved when young; context membranous, odorless, mild; lamellae arcuate, short-decurrent, inserted, subdistant, broad, ventricose, entire, white to dirty-white, darker when dry; spores oblong-ellipsoid, flat on one side, granular, hyaline, about 5×2.5μ; sterile cells present on gill edges; stipe equal, pruinose, smooth, umbrinous, 2–3×0.1–0.15 cm.

Type collected by W. A. Murrill on a rotten pine log in low woods south of Newnan's Lake, near Gainesville, Fla., June 25, 1944 (*F 32943*). Dried specimens are colored like *O. umbratilis*.

Prunulus subfloccipes sp. nov.

Pileo conico, 1.5 cm. lato, sicco, glabro, substriato, atro-isabellino; lamellis adnatis, confertis, integris, albis; sporis ellipsoideis, 4–5μ longis; cystidiis ventricosis; stipite glabro, albido, 4×0.2–0.3 cm.

Pileus conic, not fully expanding, solitary, 1.5 cm. broad; surface dry, glabrous, striate under a lens, dark-isabelline, margin entire, concolorous; context very thin, white, unchanging; lamellae adnate, inserted, narrow, crowded, entire, white, unchanging; spores ellipsoid, smooth, hyaline, 4–5μ long; pleurocystidia ventricose, somewhat thick-walled; stipe twisted, short-radicate, equal, smooth, dry, glabrous, whitish, 4×0.2–0.3 cm.

Type collected by W. A. Murrill in leaf-mold in a high hammock at Gainesville, Fla., June 30, 1942 (*F 22485*). Prof. A. H. Smith examined the type and reported it near my *P. atribrunneus*, described from N. Y., but

distinct by its ellipsoid spores and more ventricose, thicker-walled pleurocystidia.

Entoloma felleum sp. nov.

Pileo convexo-plano, gregario, 5–8 cm. lato, glabro, subvirgato, avellaneo, felleo; lamellis adnexis, albis; sporis angulatis, 5μ; stipite albo, glabro, 7–10×1.5–2 cm.

Pileus convex to plane or slightly depressed, gregarious, 5–8 cm. broad; surface dry, glabrous, subvirgate, avellaneous, often darker on the disk, margin concolorous, entire, sometimes splitting with age; context thin, white, unchanging, bitter, not farinaceous, with a faint pleasant odor; lamellae adnexed, rounded behind, slightly ventricose, about 1 cm. broad, inserted, rather crowded, entire, white to pink; spores subglobose in outline, decidedly angular, apiculate, with one large gutta, pink, about 5μ; cystidia none; stipe subequal, hollow, smooth, glabrous, white, unchanging, 7–10×1.5–2 cm.

Type collected by G. F. Weber in a dried-up cypress pond in Cary Forest, ten miles east of Gainesville, Fla., Jan. 18, 1944 (*F 22493*). Suggesting *E. Grayanum* in form but bitter instead of farinaceous and becoming murinous when dried. About two dozen hymenophores were collected.

Entoloma pallidiceps sp. nov.

Pileo convexo-expanso, umbonato, 4.5 cm. lato, pallido, sericeo, grato; lamellis adnexis, ventricosis, confertis, erosis; sporis angulatis, 9×7μ; stipite aequali, albido, 7×0.4 cm.

Pileus convex to expanded with a distinct conic umbo, solitary, 4.5 cm. broad; surface dry, pallid, shining, finely appressed-silky, margin even, entire to undulate; context very thin, white, unchanging, not farinaceous but odor pleasant and taste mild; lamellae adnexed, inserted, ventricose, rounded behind, 6 mm. broad, close, dirty-pink, undulate to distinctly eroded; spores broadly ovoid in outline, distinctly irregularly angular, mostly pentagonal, usually 1-guttulate, about 9×7μ; cystidia none; stipe equal, solid, smooth, shining, subglabrous, pallid, 7×0.4 cm.

Type collected by Prof. J. R. Watson in rich soil under a magnolia in Prairie Hammock, southeast of Gainesville, Fla., May 7, 1944 (*F 32987*). Suggesting *E. albidiforme* Murr. but pallid instead of avellaneous, with crowded eroded gills and equal stipe. Evidently rare. When I first saw it I thought of volvaria but found no volva, and the spores turned out to be angular. Mr. Watson was only a few feet from me, raking the magnolia for catocalas, when he discovered it.

Pleuropus entoloma sp. nov.

Pileo convexo-expanso-depresso, 1.5–2 cm. lato, glabro, umbrino, grato;

lamellis decurrentibus, distantibus, latis, albis; sporis angulatis, 8–10μ: stipite albo, glabro, 2×0.2–0.3 cm.

Pileus convex to expanded and slightly depressed, gregarious, 1.5–2 cm. broad; surface not viscid, smooth, glabrous, umbrinous, disk darker, margin even, entire, upturned with age; context very thin, pallid beneath the dark cuticle, odorless, pungent but not acrid; lamellae short-decurrent, inserted, distant, ventricose, very broad, entire, white to pink; spores angular, mostly pentagonal, 1-guttulate, 8–10μ; cystidia none; stipe enlarged downward, smooth, white, glabrous, 2×0.2–0.3 cm.

Type collected by W. A. Murrill in rich soil under a laurel oak in Gainesville, Fla., Apr. 14, 1944 (*F 17948*). Suggesting *Entoloma muriniforme* Murr. but the gills are adnate with a short decurrent tooth. Although allied to species of *Entoloma* it must be placed in *Pleuropus* because the gills are decurrent rather than sinuate.

Volvariopsis griseiceps sp. nov.

Pileo convexo-plano, 2 cm. lato, griseo, radiato-lineato, disco atrogriseo, margine pallido; lamellis liberis, latis, albis; sporis ellipsoideis, roseis, 7×4; cystidiis nullis; stipite albo, glabro, 2×0.2 cm.; volva lobata, avellanea, glabra, 6×6 mm.

Pileus convex to plane, solitary, 2 cm. broad; surface dry, dark-gray at the center with radiating gray lines, margin paler, entire; context thin, white, odorless; lamellae free, inserted, medium distant, broad, ventricose, not tapering at ends, slightly eroded, white; spores ellipsoid, smooth, 1-guttulate, pink, about 7×4μ; cystidia none; stipe slightly tapering upward, smooth, white, glabrous, 2×0.2 cm.; volva lobed, dark-avellaneous, glabrous, about 6×6 mm.

Type collected by W. A. Murrill in grass under a palmetto at Gainesville, Fla., Sept. 12, 1944 (*F 19951*). Suggesting *V. villosovolva* Lloyd but volva glabrous and spores ellipsoid. The coloring of the cap resembles that of *V. fuscidula* Bres. A very rare and dainty little species.

Cortinaria albidiformis sp. nov.

Pileo convexo-plano, 3–6 cm. lato, subviscido, glabro, albo vel pallido, grato vel raphanico; lamellis adnatis, confertis; sporis oblongo-ellipsoideis, levibus, flavis, 6–9×4–5μ; cortina evanida; bulbo albo, marginato, 2 cm. lato.

Pileus convex to slightly depressed, gregarious, about 3–6 cm. broad; surface viscid, smooth, glabrous, white or pallid, margin even, entire; context thick, white, unchanging, mild or with taste of radishes; lamellae adnate, inserted, rather narrow, much crowded, entire, soon rusty; spores oblong-ellipsoid, smooth, pale bright-yellowish under the microscope, about 6–9 ×4–5μ; cystidia none; stipe equal or tapering upward above the large bulb,

white, smooth, glabrous, about 1.5–3×0.7–1 cm.; cortina copious but evanescent; bulb obovoid, white, margined, reaching 2 cm. broad.

Type collected by G. F. Weber in sandy soil under scrub oaks east of Gainesville, Fla., Dec. 27, 1942 (*F 19208*). Suggesting *C. albida* Pk., described from New York, but the gills are adnate and the spores smaller.

Cortinaria amarissima sp. nov.

Pileo convexo-plano, 6–7 cm. lato, sicco, pallido, glabro, praefelleo; lamellae sinuatis, latis; sporis oblongo-ellipsoideis, levibus, 11×6μ; stipite bulboso, glabro, lilacino, 1.5–2×1 cm.; bulbo marginato, 2 cm. lato; cortina evanida.

Pileus convex to plane, solitary, about 6–7 cm. broad; surface dry, pallid, umbrinous when dried, smooth, glabrous, margin even, entire; context very thin, pallid, odorless, very bitter and astringent, lamellae sinuate, rather close, broad, ventricose, inserted, entire, soon fulvous; spores oblong-ellipsoid with rounded ends, smooth, ferruginous, about 11×6μ; cystidia none; stipe short, equal above the bulb, smooth, glabrous, lilac, about 1.5–2×1 cm.; cortina evanescent; bulb short, pale, margined, about 2 cm. broad.

Type collected by W. A. Murrill under a live-oak near Keystone Heights in Putnam Co., Fla., Jan. 26, 1941 (*F 19482*). Also collected by me under a live-oak in Sugarfoot Hammock, near Gainesville, Dec. 17, 1941 (*F 19593*). The flesh is very bitter and astringent.

Cortinaria citriniceps sp. nov.

Pileo convexo-plano, 7–8 cm. lato, praeviscido, citrino, grato; lamellis adnexis, latis; sporis amygdaliformibus, tuberculatis, ferrugineis, 10×5μ; stipite sicco, citrino, 2–3×1–1.5 cm.; bulbo marginato, 2.5–3 cm. lato; cortina copiosa, evanida.

Pileus convex to plane, gregarious, 7–8 cm. broad; surface slimy-viscid, smooth, glabrous, lemon-yellow, margin even, entire; context thin near the margin, lemon-yellow, odorless, mild; lamellae adnexed, broad, crowded, soon bay, entire; spores amygdaloid, rough, deep-ferruginous, about 10×5μ; no cystidia; stipe dry, short, bulbous, solid, lemon-yellow, about 2–3×1–1.5 cm.; cortina copious, evanescent; bulb short, margined, about 2.5–3 cm. broad.

Type collected by W. A. Murrill at the edge of laurel-oak woods near Lake Wauberg, Alachua Co., Fla., Jan. 14, 1921 (*F 22463*). A very attractive species suggesting *C. Davisii* Murr. in some ways but yellow instead of pale-lilac. When dried the cap and stem became dirty-bay, while the cap is lustrous with its coating of dried gluten. In *C. citrinella* Kauffm. the stipe is much longer and the spores much broader.

Cortinaria cylindrispora sp. nov.

Pileo convexo-subexpanso, 2–4 cm. lato, sicco, glabro, fulvo, grato; lamellis adnatis, confertis, angustatis; sporis levibus, pallidis, 11×3μ; stipite aequali, glabro, pallido, 4–5×0.5–0.7 cm.; cortina evanida.

Pileus convex to subexpanded, gregarious, 2–4 cm. broad; surface dry, smooth, glabrous, uniformly fulvous or ferruginous-fulvous, margin even, entire, strongly deflexed on drying; context thin, white, odorless, mild; lamellae adnate, inserted, close, narrow, entire, soon fulvous; spores rusty in mass, cylindric, smooth, uniguttulate, very pale yellowish-brown, about 11×3μ; cystidia none; stipe slender, equal, not bulbous, smooth, glabrous, hollow, shining, pale violet-white, about 4–5×0.5–0.7 cm.; cortina evanescent.

Type collected by W. A. Murrill under pines northwest of Gainesville, Fla., Jan. 10, 1940 (*F 22512*). Also collected by G. F. Weber in dry mixed woods east of Gainesville, Dec. 27, 1942 (*F 18334*). Well characterized by its cylindric spores, as is *C. squalidiformis* Murr. In *C. heterospora* Bres. the spores are also elongate but sinuate, golden-yellow and slightly punctate.

Cortinaria equestriformis sp. nov.

Pileo convexo-subexpanso, 4–5 cm. lato, viscido, glabro, citrino ad fulvo, grato; lamellis adnatis, confertis, integris, flavis; sporis amygdaloideis, levibus, 10×5μ; stipite citrino vel subfulvo, glabro, 2×1.5 cm.; cortina alba, evanida; bulbo 1.5×2 cm.

Pileus convex to subexpanded, gregarious, about 4–5 cm. broad; surface viscid, smooth, glabrous, citrinous to fulvous, margin inflexed at first, entire, even, sulfur-yellow; context 2 cm. thick near center thinning toward margin, citrinous, unchanging, mild, earthy; lamellae adnate, close, 5 mm. broad behind, entire, bright-yellow, rusty at maturity; spores pip-shaped, smooth, clear bright-ferruginous, 1-guttulate, about 10×5μ; stipe solid, citrinous within, equal above bulb, citrinous or subfulvous, smooth, glabrous, about 2×1.5 cm.; cortina white, evanescent; bulb abrupt, not margined, 1.5 cm. high and 2 cm. broad.

Type collected by W. A. Murrill in short grass under a live-oak on a lawn in Gainesville, Fla., Jan. 20, 1944 (*F 19626*). Suggesting *Tricholoma equestre* when young, both in form and coloring, but related to *C. fulmineus* Fr. var. *sulphureus* Kauffm. Typical *C. fulmineus* is squamulose and Kauffman says his variety sometimes has spotlike scales on the disk.

Cortinaria hebelomoides sp. nov.

Pileo convexo-plano, 4 cm. lato, viscido, glabro, roseo-avellaneo; lamellis sinuatis, confertis; sporis subellipsoideis, subtuberculatis, ferrugineis,

8–9×5–6μ; stipite alboviolaceo, glabro, 3×0.8 cm.; cortina evanida; bulbo pallido, non marginato, 1.5 cm. lato.

Pileus convex to plane, solitary, 4 cm. broad; surface viscid, shining, smooth, glabrous, pale rosy-avellaneous, margin even, entire; context thin, white, unchanging; lamellae sinuate, rounded behind, close, inserted, medium broad, entire, soon fulvous; spores subellipsoid, slightly tuberculate, bright pale-ferruginous, about 8–9×5–6μ; cystidia none; stipe equal above bulb, smooth, glabrous, pale-violaceous, about 3×0.8 cm.; bulb large, onion-shaped, whitish, not margined, 1.5 cm. thick; cortina evanescent.

Type collected by W. A. Murrill under a laurel oak at Gainesville, Fla., Jan. 12, 1940 (*F 22466*). Also collected by Watson and Murrill in a live-oak hammock at Arredonda, west of Gainesville, Jan. 21, 1940 (*F 22473*). Suggesting *Hebeloma* when viewed from above.

Cortinaria perviolacea sp. nov.

Pileo convexo-subexpanso, 1.5 cm. lato, alboviolaceo, grato; lamellis emarginatis, ventricosis, violaceis; sporis subglobosis, levibus, ferrugineis, 7×6μ; stipite glabro, aequali, alboviolaceo, 2.5×0.2 cm.; bulbo nullo; cortina evanida.

Pileus convex to subexpanded, gregarious, about 1.5 cm. broad; surface smooth, subfibrillose, pale dull-violet, the center becoming isabelline, margin even, entire; context pale-violet, unchanging, 1 mm. or less thick, odorless, mild; lamellae emarginate, inserted, ventricose, 3–4 mm. broad, subdistant, entire, violet; spores subglobose, smooth, 1-guttulate, ferruginous, about 7×6μ; cystidia none; stipe smooth, glabrous, shining, stuffed, pale-violet, equal, about 2.5×0.2 cm.; cortina evanescent, leaving a few fibrils on the margin and more scattered along the stipe.

Type collected by W. A. Murrill in moist ground at the edge of mixed woods near Gainesville, Fla., Sept. 24, 1944 (*F 32992*). Suggesting *C. fuscoviolacea* Pk. but quite distinct. A very small, rare species, pale-violet throughout when young but becoming isabelline on the disk with age.

Cortinaria squalidiformis sp. nov.

Pileo convexo-plano, subcaespitoso, 3–4 cm. lato, glabro, subbrunneo, grato; lamellis adnatis, confertis; sporis cylindricis, levibus, pallidis, 6–9×3–4μ; stipite subaequali, glabro, pallido-violaceo, 3×0.3–0.6 cm.; cortina evanida.

Pileus convex to plane or slightly depressed, gregarious to cespitose, 3–4 cm. broad; surface slightly viscid, smooth, glabrous, shining, uniformly brownish and drying fuliginous, margin even, entire to undulate or rimose; context very thin, pallid to brownish, odorless, mild; lamellae adnate, medium broad, close, entire, soon fulvous-umbrinous; spores cylindric,

smooth, very pale yellowish-brown, about 6–9×3–4μ; cystidia none; stipe subequal, not bulbous, smooth, glabrous, shining, pale-violet, about 3×0.3–0.6 cm.; cortina evanescent.

Type collected by W. A. Murrill in open mixed woods on the river flat northwest of High Springs in Columbia Co., Fla., Dec. 14, 1941 (*F 16534*). Suggesting *C. squalida* Smith but with spores much like those of *C. cylindrispora* Murr. In Smith's species they are pip-shaped. *C. uracea* Fr. is similar in appearance but more umbonate.

Cortinaria subcamphorata sp. nov.

Pileo convexo-expanso, 5–6 cm. lato, viscido, glabro, ferrugineo, non grato; lamellis adnatis ad sinuatis, confertis, latis; sporis amygdaliformibus, punctatis, ferrugineis, 10–12×5–6μ; stipite solido, clavato, subviolaceo, 3.5×1.5 cm.; cortina copiosa, evanida; bulbo immarginato, 2 cm. lato.

Pileus convex to expanded, gregarious, 5–6 cm. broad; surface viscid, smooth, glabrous, uniformly ferruginous, margin even, entire; context thick near center, white, unchanging, odor strong, taste mawkish, oily and slightly radishy; lamellae adnate, becoming sinuate, broad, close, entire, soon rusty; spores amygdaloid, rough, deep-ferruginous, 10–12×5–6μ; stipe solid, white within, smooth, glabrous, equal above the bulb, partly violet, about 3.5×1.5 cm.; cortina copious, evanescent; bulb clavate, not marginate, about 2 cm. broad.

Type collected by W. A. Murrill on a shaded bank in low frondose woods at River Rise, Alachua Co., Fla., Jan. 12, 1941 (*F 21789*). Suggesting *C. camphorata* but differing in several ways.

Cortinaria subfimbriata sp. nov.

Pileo convexo-plano, 4 cm. lato, glabro, subochraceo, grato; lamellis sinuatis, integris, fulvis; sporis ellipsoideis, ferrugineis, subpunctatis, 8×5μ; stipite albo, glabro, 2–3×0.6–1 cm.; cortina evanida; bulbo subgloboso, non marginato.

Pileus convex to plane, gregarious, 4 cm. broad; surface slightly viscid, smooth, glabrous, pale-ochraceous, shining and rugose when dried, margin even, entire, concolorous; context white, unchanging, odorless, mild, 1 cm. thick near center; lamellae sinuate, rounded behind, medium broad, medium close, entire, fulvous at maturity; spores ellipsoid, 1-guttulate, slightly roughened, clear bright-ferruginous under the microscope, fulvous in mass, about 8×5μ; stipe slightly enlarged at the base, stuffed, dull-whitish within, smooth, glabrous, shining, white, 2–3×0.6–1 cm.; cortina evanescent; bulb subglobose, not margined.

Type collected by G. F. Weber in his yard at Gainesville, Fla., Jan. 16,

1944 (*F 15995*). Suggesting *C. fimbriata* Murr. but smaller and with different spores.

Gymnopilus flavifolius sp. nov.

Pileo convexo, gregario, 2.5–3 cm. lato, umbrino, imbricato fibrillosoque, grato; lamellis decurrentibus, flavis; sporis ochraceis, 9–12×3–4μ; stipite aequali, fibrilloso, 3–3.5×0.5 cm.

Pileus convex, not fully expanding, very slightly depressed, gregarious, 2.5–3 cm. broad; surface dry, uniformly umbrinous, imbricate on the disk, radiate-fibrillose toward the margin, which is incurved when young, even, entire, concolorous; context very thin, stramineous, unchanging, odorless, mild; lamellae short-decurrent, medium distant, 5 mm. broad, few inserted, flavous, edges white and minutely eroded; spores elongate with rounded ends, smooth, ochraceous, 9–12×3–4μ; stipe equal, flavous at the apex, yellowish below with furrows and brown fibrils, solid, 3–3.5×0.5 cm.

Type collected by W. A. Murrill in short grass under young slash pines in Gainesville, Fla., Jan. 20, 1944 (*F 22500*). The cap suggests *Inocybe*, the gills are bright-yellow, and the spores are unusually long and slender for the genus. The long needle-like fibrils on the stem appear to originate from the splitting of the cuticle, which is grooved longitudinally.

Gymnopilus Weberi sp. nov.

Pileo convexo-plano, 4–5.5 cm. lato, viscido, luteo, praefelleo; lamellis sinuatis, latis, pallidis; sporis ellipsoideis, levibus, 7×5μ; stipite bulboso, albo, sicco, 6×1 cm.

Pileus convex to plane, 4–5.5 cm. broad; surface slimy-viscid, smooth, glabrous, luteous, margin even, entire, concolorous; context thin, watery-pallid, odorless, very bitter at once; lamellae sinuate, inserted, close, broad, entire, pallid to pale-isabelline; spores ellipsoid, smooth, uniguttulate, ochraceous, about 7×5μ; cystidia none; stipe bulbous, stuffed, smooth, white, glabrous, dry, about 6×1 cm., bulb onion-shaped, up to 1.7 cm. broad.

Type collected by G. F. Weber under laurel oaks at Gainesville, Fla., Jan. 16, 1944 (*F 22492*). A rare species characterized by its luteous, slimy cap; white stem, which is not viscid; and very bitter flesh.

Hebeloma atrifulvifolium sp. nov.

Pileo convexo-plano, 3–4 cm. lato, viscido, rosei-isabellino, grato; lamellis sinuatis, latis, fimbriatis; sporis subovoideis, levibus, ochroleucis, 13–18×5–8μ; stipite albo, 4–6×0.6–1 cm.

Pileus convex to plane, gregarious, 3–4 cm. broad; surface viscid, smooth, glabrous, rosy-isabelline, darker on the disk, margin paler, even, entire; context very thin, white, unchanging, odorless, mild; lamellae sinuate, inserted, close, 1 cm. broad, ventricose, pallid to dark-fulvous, white-

fimbriate; spores oblong-subovoid, smooth, ochroleucous under the microscope, 13–18×5–8μ; cystidia none; stipe enlarged upward, hollow, not bulbous, white and unchanging within, fibrillose, furrowed, shining-white when young, slightly discolored when older, chaffy at the apex, 4–6×0.6–1 cm.

Type collected by G. F. Weber in a shaded alley in Gainesville, Fla., Jan. 24, 1944 (*F 20151*). Suggesting *H. subfastibile* Murr. but the gills become dark-fulvous.

Hebeloma levyanum sp. nov.

Pileo convexo-plano, 4 cm. lato, roseo-isabellino, grato; lamellis sinuatis, latis, confertis; sporis subovoideis, levibus, pallidis, 8×5μ; stipite aequali, pallido, floccoso, 3.5×0.4–0.5 cm.

Pileus convex to plane, solitary, 4 cm. broad; surface viscid, uneven, glabrous, rosy-isabelline with darker reddish disk, margin even, entire; context thin, white, odorless, mild; lamellae sinuate, inserted, broad, close, pallid to fulvous, white-fimbriate; spores subovoid, obliquely apiculate at the base, smooth, very pale yellowish, not guttulate, about 8×5μ; stipe equal, not bulbous, pallid with a slight violet tint, white-floccose, especially above, 3.5×0.4–0.5 cm.

Type collected by Watson and Murrill under hardwoods at Gulf Hammock, Levy Co., Fla., Jan. 14, 1940 (*F 22488*). Not found elsewhere.

Hebeloma lucidum sp. nov.

Pileo convexo-subexpanso, 2 cm. lato, viscido, glabro, pallido, subamaro et subraphanico; lamellis sinuatis, praelatis, pallidis; sporis subovoideis, levibus, 11×6μ; stipite clavato, pallido, lucido, 4×0.4–0.7 cm.

Pileus convex to subexpanded, slightly depressed at the center, solitary, 2 cm. broad; surface viscid, smooth, glabrous, shining, pallid to slightly isabelline, margin even, entire; context thin, white, odorless, slightly bitter and with a slight flavor of radishes; lamellae sinuate, inserted, very broad, rounded behind, medium close, pallid to dark-isabelline, white-fimbriate; spores subovoid, obliquely apiculate at the base, smooth, 1-guttulate, bright-ochraceous under the microscope, about 11×6μ; stipe equal above the clavate base, smooth, whitish, shining, pruinose at the apex, 4×0.4–0.7 cm.

Type collected by W. A. Murrill under a camphor tree in Gainesville, Fla., Jan. 21, 1944 (*F 20056*). Characterized by a shining cap and stem and broad gills.

Hebeloma praeviscidum sp. nov.

Pileo convexo-subexpanso, 4 cm. lato, praeviscido, roseo-ochraceo, grato;

lamellis adnexis, latis; sporis subovoideis, levibus, ochraceis, 10–12×6–7μ; stipite sicco, albo, 6×0.7–0.9 cm.

Pileus convex to subexpanded, solitary, 4 cm. broad; surface slimy-viscid, smooth, glabrous, uniformly pale rosy-ochraceous, margin incurved at first, even, entire; context 1–5 mm. thick, watery-pallid, odorless, mild; lamellae adnexed, rounded behind, inserted, close, broad, entire, pale clay-colored; spores subovoid, smooth, 1-guttulate, ochraceous, 10–12×6–7μ; cystidia none; stipe subequal, white, dry, shining, slightly grooved and fibrillose, 6×0.7–0.9 cm.

Type collected by G. F. Weber in laurel-oak woods at Gainesville, Fla., Jan. 16, 1944 (*F 10116*). The furrowed cuticle of the stipe splits into long, slender, hairlike threads. The pileus is unusually slimy and becomes very rugose when dried.

Hebeloma subaustrale sp. nov.

Pileo convexo-expanso, 3–4 cm. lato, subviscido, glabro, pallido-roseo, raphanico; lamellis sinuatis, latis, confertis; sporis subovoideis, pallidis, levibus, 8–10×4–4.5μ; stipite aequali, pallido, 3×0.5 cm.

Pileus convex to expanded, gregarious, 3–4 cm. broad; surface somewhat viscid, smooth, glabrous, uniformly pale-pinkish, margin entire, even; context thin, white, with the odor and taste of radishes; lamellae sinuate, inserted, broad, close, fragile, pallid to isabelline, white-fimbriate; spores subpipshaped, smooth, obliquely apiculate at the base, 1-guttulate, very pale, 8–10×4–4.5μ; stipe equal, smooth, pallid, about 3×0.5 cm.

Type collected by Dr. G. F. Weber on a shaded lawn in Gainesville, Fla., Oct. 30, 1941 (*F 19345*). Suggesting *H. australe* Murr. but differing in odor and spore characters.

Hebeloma subvatricosoides sp. nov.

Pileo convexo-expanso, 4 cm. lato, viscido, glabro, pallido, disco aurantio; lamellis emarginatis, confertis, latis, pallidis; sporis subovoideis, 11×5.5μ; stipite aequali, bulboso, pallido, 4×0.6 cm.

Pileus convex to expanded, solitary, 4 cm. broad; surface viscid, smooth, glabrous, pallid, with orange disk, margin even, entire; context thin, pallid; lamellae emarginate with long decurrent tooth, broad, ventricose, crowded, inserted, pallid to isabelline, white-fimbriate; spores subovoid, obliquely apiculate at the base, pointed, 1-guttulate, pale-yellowish, about 11×5.5μ; stipe equal above the bulbous base, pale clay-colored, fibrillose, conspicuously ridged above, about 4×0.6 cm.

Type collected by Watson and Murrill in deep leaf-mold in a climax hammock on the old Micanopy road south of Gainesville, Jan. 21, 1940 (*F 22508*). Suggesting *H. vatricosoides* (Pk.) Murr., described from N. Y., but having different spore characters.

Atylospora floridana sp. nov.

Pileo convexo, umbonato, 5–10 mm. lato, striato, atomaceo, avellaneo-isabellino, grato; lamellis adnatis, ventricosis, fimbriatis; sporis ellipsoideis, levibus, 6–8×4–5μ; stipite 2–2.5×0.1–0.15 cm.

Pileus convex with slight umbo, gregarious to cespitose, 5–10 mm. broad; surface dry, dull, striate, atomaceous, avellaneous-isabelline, margin appendiculate; context very thin, isabelline, unchanging, odorless, mild; lamellae adnate, rounded behind, 3 mm. broad, ventricose, inserted, medium distant, white-fimbriate and slightly dentate; spores ellipsoid, smooth, 1-guttulate, purplish-brown, 6–8×4–5μ; stipe somewhat hollow, slightly enlarged below, smooth, glabrous, clear pale rosy-isabelline, tinged with reddish-brown below, white-chaffy at the apex, 2–2.5×0.1–0.15 cm.

Type collected by W. A. Murrill on an open grassy lawn inGainesville, Fla., Feb. 19, 1944 (*F 32844*). Rare in the vicinity. Very small with slender stem.

Atylospora subaustralis sp. nov.

Pileo convexo-expanso, umbonato, 3 cm. lato, avellaneo-isabellino, striato, grato; lamellis adnatis, integris; sporis ellipsoideis, 8×4μ; stipite albo, glabro, 4×0.3–0.4 cm.

Pileus convex to expanded with a small mammillate umbo, about 3 cm. broad, surface dull, smooth, avellaneous-isabelline except the umbrinous umbo, becoming finely radiate-striate when expanded, margin slightly undulate or split at times; context thin, white, unchanging, odorless, mild; lamellae adnate with decurrent ridges, inserted, 5 mm. broad, subdistant, entire, pallid to blackish; spores purple-brown, ellipsoid, smooth, usually 1-guttulate, about 8×4μ; stipe equal, hollow, smooth, white, glabrous, about 4×0.3–0.4 cm.

Type collected by G. F. Weber on trash in a dried-up cypress pond in Cary Forest, east of Gainesville, Fla., Jan. 18, 1944 (*F 15900*). Suggesting *A. australis* Murr. but having adnate instead of adnexed gills.

Coprinus subroris sp. nov.

Pileo campanulato-expanso, margine revoluto, gregario, 5–10 mm. lato, radiato-sulcato, griseo, furfuraceo, membranaceo; lamellis angustatis, liberis; sporis ellipsoideis, opacis, 11×8μ; stipite albo, glabro, 3–5 cm. longo.

Pileus campanulate to expanded, gregarious, 5–10 mm. broad; surface radiate-sulcate, furfuraceous, pale-grayish, isabelline at the center, margin entire, revolute with age; context membranous; lamellae free, narrow, subdistant, soon black; spores ellipsoid, smooth, chocolate, about 11×8μ; stipe capillary, smooth, white, shining, glabrous, about 3–5 cm. long.

Type collected by W. A. Murrill on a rich open grassy lawn in Gaines-

ville, Fla., May 25, 1944 (*F 38819*). Suggesting *C. Wrightii* B. & C. and *C. roris* Quél. in some ways. Very dainty and delicate.

Ceriomyces sordidiformis sp. nov.

Pileo convexo, 7 cm. lato, avellaneo, acidulo; tubulis 1.5 cm. longis, 2–3 per mm., ochroleucis, glaucescentibus, demum castaneis, hygrosopicis; sporis 10–13×4–5μ; stipite glabro, albido et roseo-isabellino, 4.5×2.5–3 cm.

Pileus convex, not fully expanding, solitary, 7 cm. broad; surface dry, minutely tomentose under a lens, avellaneous, bay when bruised, margin entire, fertile; context to 1.5 cm. thick, mild with acid odor, white to glaucous and then partly pale-bay when cut; tubes depressed and elongate behind, ventricose, 1.5 cm. long, gradually changing to bay or chestnut when cut; mouths thin-walled, angular, about 2–3 per mm., ochroleucous to slightly glaucous, becoming castaneous where bruised, hygroscopic when dried; spores oblong-fusiform, smooth, yellowish-brown, about 10–13 ×4–5μ; stipe slightly smaller at the middle, solid, smooth, glabrous, whitish mottled with cream and rosy-isabelline, 4.5×2.5–3 cm.

Type collected by W. A. Murrill on a grassy lawn partly shaded by longleaf pine and laurel oak at Gainesville, Fla., Sept. 26, 1944 (*F 20460*). Suggesting *C. sordidus* and *C. porphyrosporus*. The fresh tubes form a glutinous mass in water and after drying are very hygrosopic, soon becoming moist and emitting a strong, persistent, disagreeable acid odor.

Suillellus luridiceps sp. nov.

Pileo convexo-subexpanso, 11 cm. lato, subtomentoso, umbrino-fulvo; tubulis 1 cm. longis, 2 per mm., subflavidis, poris atrobadiis, fulvescentibus; sporis pallidis, 11×3μ; stipite glabro, citrino, umbrinescenti, 7–8 ×2.5–3.5 cm.

Pileus convex to subexpanded, scattered, reaching 11 cm. broad; surface subtomentose, uniformly umbrinous-fulvous, margin even, entire; context 2 cm. thick behind, whitish, becoming caesious at once when cut, mild, with pleasant odor; tubes plane, slightly depressed at the stipe, circular, 2 per mm., 1 cm. long, dull-yellowish within, becoming dull-bluish at once when bruised, mouths when young dark-bay, becoming dull dark-fulvous when mature; spores cylindric, smooth, pale, about 11×3μ; stipe ventricose or tapering downward, solid, smooth, glabrous, citrinous, becoming umbrinous and red-blotched below with age, whitish within, becoming slightly caesious when cut, 7–8×2.5–3.5 cm.

Type collected by W. A. Murrill under a laurel oak at Gainesville, Fla., July 13, 1944 (*F 32942*). The spores are paler and much slenderer than those of *S. luridus* Auct. Am. or of *S. vermiculosus* (Pk.), matching those of *B. speciosus* Pk. as figured by Coker. The young hymenium looks almost

black but at maturity it is dark-fulvous; while the context is whitish, becoming pale-blue when broken.

NEW COMBINATIONS

For those using Saccardo's nomenclature the following species are recombined:

Atylospora floridana = Psathyra floridana
Atylospora subaustralis = Psathyra subaustralis
Ceriomyces sordidiformis = Boletus sordidiformis
Gymnopilus flavifolius = Flammula flavifolia
Gymnopilus Weberi = Flammula Weberi
Melanoleuca calceifolia = Tricholoma calceifolium
Melanoleuca lasciviformis = Tricholoma lasciviforme
Melanoleuca melaleuciformis = Tricholoma melaleuciforme
Melanoleuca microsperma = Tricholoma microspermum
Melanoleuca ustaliformis = Tricholoma ustaliforme
Omphalina bicolor = Omphalia bicolor
Omphalina pervirginea = Omphalia pervirginea
Omphalina subfloridana = Omphalia subfloridana
Omphalina subumbratilis = Omphalia subumbratilis
Pleuropus entoloma = Clitopilus entoloma
Prunulus subfloccipes = Mycena subfloccipes
Suillellus luridiceps = Boletus luridiceps
Volvariopsis griseiceps = Volvaria griseiceps

A Revision of Macoubea and the American Species of Landolphia (Apocynaceae)[1]

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Conspectus.—In the following preliminary study Macoubea is considered as a member of the Tabernaemontaneae, although allied to the Carisseae, with which it is linked through Ambelania. The entities are found to be very closely interrelated and displaying strong tendencies towards intergradation. Only two are credited with specific rank. *Macoubea paucifolia* is reduced to a variety of *M. Sprucei*, while *M. sinuosa* is placed in the synonymy of *M. Sprucei* var. *paucifolia*. A new variety is described from Peru, *M. guianensis* var. *pubiflora*.

In the second portion of this paper a rather complete history of the American species of Landolphia is presented. The genus has the largest number of representatives of any Carisseae in Africa and is of some economic importance, but it is very poorly known in the Western Hemisphere, from where only three species have so far been described. The taxonomic treatment is almost entirely confined to the genus as it is represented in South America. An attempt is made to summarize all the available information on the New World species of Landolphia.

In the Appendix evidence is presented for the African origin of several plants reported to have been collected by Perrin in the West Indies. The Perrin collections cited by Sprengel in Neue Entdeckungen are discussed. A species described in Tetracera is transferred to Ochna.

Bibliographies for Macoubea and the American species of Landolphia, under separate headings for each genus, are appended at the end of this paper.

Abbreviation of herbaria and acknowledgments.—In order to conserve space, no place of deposit is generally indicated when a particular collection is represented in the Britton Herbarium or in the Krukoff Herbarium at the New York Botanical Garden, except when it is a type collection. Otherwise the depository is thus abbreviated: A—Arnold Arboretum, Jamaica Plain; B—Forest Department of British Guiana, Mazaruni, British Guiana; F—Field Museum of Natural History, Chicago; M—Missouri Botanical Garden, St. Louis; Mich—University of Michigan, Ann Arbor; NY—New York Botanical Garden, New York; US—United States National Herbarium, Washington. Acknowledgment is here made to the directors and curators of the institutions listed for their generous loans of herbarium material, and my particular gratitude is expressed for the aid rendered to me by Mr. B. A. Krukoff and Miss E. C. Hall, Drs. H. A. Gleason and H. N. Moldenke.

[1] This contribution is made possible by the financial support of the Chicle Development Company.

MACOUBEA

Literature.—Markgraf's revision of Macoubea, Die amerikanischen Tabernaemontanoideen, is quite satisfactory in all important taxonomic features. In this monograph the genus is classified in its correct position in the Tabernaemontaneae, treated in a key alongside its immediate generic relatives, and a complete survey of all the species, together with a key to those recognized by Markgraf as distinct entities, is presented. Markgraf's analysis stemmed from Pulle's study, Neue Beiträge zur Flora Surinams III, where for the first time *M. guianensis* was aptly and elaborately described, as well as illustrated, and its connection with the Brazilian species, then known under Tabernaemontana, was observed. Ducke's description of Macoubea in Archivos do Jardim Botanico do Rio de Janeiro, and the excellent illustration of *M. guianensis* appearing therein, also deserve the highest praise. In the same class belongs Hoehne's description and discussion of the "Pequiá" or *M. guianensis* from Bahia, published in Annaes da Academia Brasiliera de Sciencias; the plate presented here is of particular importance, not only because of its elaborate delineation of Macoubea in general but especially because it figures a typical specimen of *M. reticulata*. The remaining species of Macoubea are described in the section Stenocephalium of Tabernaemontana by Mueller in Flora Brasiliensis. *M. Sprucei* is figured in plate 27, fig. 1, in this work.

Mier's Apocynaceae of South America is of secondary importance. Here Macoubea was first definitely placed in Apocynaceae; a close relationship between the Brazilian species of Macoubea and Ambelania (under the genus Rhigospira) was indicated, and the two cotypes of *Tabernaemontana Sprucei* were segregated to establish two different entities. Markgraf's treatment of Apocynaceae in Pulle's Flora of Surinam and his comments in Recueil des Travaux Botaniques Néerlandais also deserve particular notice. Aublet's original description and illustration represent the type of the genus. The remaining works listed in the bibliography are of minor interest.

Local names.—The vernacular names of species or varieties of Macoubea, referable to the region from which they are reported, are as follows:—BRITISH GUIANA: *Mapa* or *Mappa*, *Rokko-Rokko*, *Warapa*. DUTCH GUIANA: *Liekapatoe*, *Sokko-Sokko*. FRENCH GUIANA: *Macoube*. BRAZIL: *Macucú* (fide Saldanha da Gama), *Molongó* (fide Record). BRAZIL, PARÁ: *Amapá Dóce*, *Sorva* (confusion with Couma?). BRAZIL, AMAZONAS: *Amapá* (São Gabriel; Humaytá), *Amapá Branco & Gogo de Guariba* (São Gabriel). BRAZIL, MARANHÃO: *Amapá*. BRAZIL, BAHIA: *Pequiá*, *Virote Brabo*. PERU, LORETO:[2] *Chicle* (fide Williams), *Huapu-Caspi*.

[2] Williams, in Woods of Northeastern Peru, gives the native appellation "Yako-Sanango" for Macoubea. Record (Timbers of the New World) and Herrera (Catalogo Alfabetico) follow this usage. "Yako-Sanango" was based upon the sterile specimen *Williams 1103*, which I identify as Tabernaemontana.

Uses.—Macoubea exudes copious latex, which is reported as more or less bitter by Froes, but as sweet by Williams (the tree is called "Amapá Dóce" in Pará, Brazil). An annotation on the herbarium sheet of *Froes 1795* (Maranhão) states that the latex is used for pulmonary diseases.

Markgraf in the Flora of Surinam states that the mericarps are woody and not edible, whereas Williams in Woods of Northeastern Peru claims that the fruits contain an edible pulp. "Comestivel" is noted on the label of *Silva 26472* (Bahia), and according to the collector, Dr. Pirajá da Silva (15, p. 17), the fruits upon maturity seem like gourds filled with honey.

To a limited extent the timber is used locally for interior construction and carpentry, but is quickly perishable when exposed. It is said to be fetid or smelling almost like naphthaline when dry.

MACOUBEA Aubl., Pl. Guian. **2** (Suppl.): 17. pl. 378. 1775.

Tabernaemontana sectio *Stenocephalium* Muell. Arg., in Mart. Fl. Bras. **6** (1): 86. 1860.—pro parte.

Rhigospira Miers, Apocyn. S. Am. 67. 1878.—pro parte.

Macoubea belongs to the tribe Tabernaemontaneae. Unarmed trees sometimes exceeding 30 m. in height and 80 cm. diam., the bark light grey, smooth, fairly thick, fissured vertically and horizontally, exuding a copious white latex; branches subterete, grey, marked with an interpetiolar line, becoming fistulose, the young growth compressed, glabrous or puberulent, sometimes verruculose; LEAVES opposite, isophyllous, the petioles 1.5–2.5 cm. long, glabrous or puberulent, fossate at axil and with an elevated hood which is conjoined across node by a transverse ridge, sometimes resinous at axil, the minute axillary glands or processes numerous, sometimes hidden; blades variable in outline, suborbicular to elliptic, 8–22 cm. long and (4–)6–15 cm. broad, rounded to acutely cuneate at base, rounded or slightly retuse to short-acuminate and blunt at apex, glabrous to softly short-pilose on under surface, the leaf-margins flattened or becoming involute, the tissue subcoriaceous, the veins impressed on upper surface and lightly raised on lower surface, the principal secondaries (secondary or lateral veins) well-spaced, generally 1–1.5 cm. apart near middle of blade, somewhat arcuate, 10–15 pairs, faintly connected at margins, the tertiaries and reticulation evident; INFLORESCENCE terminal, dichasial, corymbose, many branched, bracteate, relatively numerously flowered (flowers 20–100), puberulent, the common peduncle 1.5–5 cm. long to first pair of bracts, the pedicels short, rarely up to 6 mm. long, striate, puberulent, bracteolate; CALYX persistent, 2–4 mm. diam., obtuse or rounded at base, the calyx-tube very short, the calyx-lobes quincuncial, ovate to broadly oblong, 2–3.3 mm. broad and 2–3.2 mm. long, rounded to obtuse at apex, rounded at base, glabrous to densely hirtellous outside, glabrous

inside except at base, well-ciliate with short hairs, flattened or slightly keeled, with glands at base inside, the glands minute (up to 0.16 mm. long), scale-like to peg-like, in 1–3 series; COROLLA white, sweet-scented, conical in bud, a little swollen above throat, the corolla-tube 4–8 mm. long and 1.5–2.5 mm. diam. at maturity, cylindric, slightly dilated at region of stamens and constricted below, pubescent to glabrescent outside, pubescent inside below stamens with linear hairs and with linear to slightly clavate hairs at throat, corolla-lobes narrowly ligulate to broadly elliptic-oblong, asymmetrical, sinistrorsely contorted (viewed externally), twisted slightly to strongly dextrorsely, usually surpassing length of corolla-tube, 8–15 mm. long and 2–7 mm. broad, glabrous to densely hirtellous outside, pubescent inside towards base and glabrous to sparsely pubescent above, ciliate, spreading at maturity; STAMENS inserted about ¼ from base of corolla-tube, the anthers firmly sessile, sagitate-lanceolate, reaching up to about throat of corolla, 2.8–5.3 mm. long, gradually extending into a sharp straight non-polleniferous appendage or acumen (about 0.3–0.4 mm. long) at apex, the loculi strongly spreading and sterile at base; OVARY apocarpous, the two single-celled carpels very tightly pressed together and appearing as one two-celled ovary, superior, ovate to cylindric, about 1–2 mm. long and 1 mm. diam., truncate-depressed at apex, somewhat quadrate and with numerous furrows on sides, densely pubescent (the hairs very minute and obscure at inner faces of carpels), without disk or glands, ovulate to base, the ovules numerous, in about 8 series in each cell; STYLE very short, 0.3–1 mm. long up to ring, striate, glabrous, the ring incrassate, about 0.8 mm. diam., lightly undulate, the crested capitulum usually 5-lobed, about 0.8–1 mm. long, the stigma-apiculi separating, very sharp pointed, about 0.4–0.7 mm. long; FRUIT usually of only one mericarp, globose, about 6–8 cm. diam. at maturity, obscurely 3-ribbed, asymmetric and sometimes umbonate or otherwise marked at one side at base, brown or orange, punctate, the shell thick and woody, up to 7 mm. thick; SEEDS attached to wall of mericarp, elliptic-oblong, about 2 cm. long, 6 mm. broad and 2 mm. thick, becoming curved, conspicuously vermicular-pitted throughout, longitudinally linear-incised on side of attachment, the hilum located near end (about ¼ up from end), the surface seen upon cross-section of seed to be composed of ends of numerous strands very compactly crowded together.

Type species.—*Macoubea guianensis* Aubl.

Macoubea's place in close relationship with Tabernaemontana sensu latiore is undoubted. But as it is easily distinguished in its totality of characters, and is characteristic in many features, Macoubea[3] is best main-

[3] The genus is spelled "Macubea" by St.-Hilaire in Exposition des Familles Naturelles (Vol. 2. 1805. p. 29), and also by Post & Kuntze in Lexicon (1904. p. 346).

tained in the generic status. In the development of usually but one carpel into a large globose fruit, it is outstanding. Markgraf (18) associates Macoubea with his Tabernaemontana segregates Peschiera (DC.) Mfg. and Stenosolen (Muell. Arg.) Mgf. Miers proposed Rhigospira to embrace three species of Ambelania and four species of Macoubea, two incongruous genera.

Macoubea was placed with the Guttiferae by some early writers.[4] Miers (1878), who was first to recognize the genus in its correct family, associated it with the apocynaceous tribe Carisseae.[5] However, he grouped *Rhigospira paucifolia*, *R. reticulata*, *R. Sprucei* and *R. sinuosa*, which are species of Macoubea, under the tribe Tabernaemontaneae. It should also be noted that he merged *Ambelania* (=*Neocouma*, =*Tabernaemontana*) *ternstroemiacea* with Rhigospira. *Tabernaemontana reticulata*, described by De Candolle (1844), was accepted in this genus by Mueller (1860) who, in addition, described *Tabernaemontana Sprucei* and *T. paucifolia*. He placed these under his Tabernaemontana sectio Stenocephalium, with the addition of *Tabernaemontana* (=*Ambelania*) *ternstroemiacea*. All of these, except *A. ternstroemiacea*, are undoubtedly species of Macoubea. Their congenerity with Aublet's *M. guianensis* was first ascertained by Pulle (1912), who moreover was the first clearly to define the genus. Pulle transferred Aublet's species to Tabernaemontana. On the other hand, Ducke (1922) adhered to the genus Macoubea for *M. guianensis*, noting concerning it: "Floribus generi *Ambelania* affinis at tubo brevi, fauce pilosâ, antheris longis, stigmata crasso fere subsessili diversa, fructus structurâ singulari inconfundibilis est." Markgraf (1925) concurred with Ducke in maintaining Macoubea, and affirmed Pulle's observation in associating it with *Tabernaemontana Sprucei*, *T. reticulata* and *T. paucifolia*. In the Flora of Surinam (1932) he rejected Pulle's *Tabernaemontana Aubletii* in favor of the original *Macoubea guianensis*. Finally, in his monograph of this genus and other related genera in the "Tabernaemontanoideen" (1938), Markgraf struck the happy medium: he maintained Macoubea as a valid genus, placed here several species hitherto described in Tabernaemontana, and emphasized the intimate kinship between Macoubea and Tabernaemontana (or his segregates from this genus). For further remarks on the taxonomic relationship of Macoubea to the related genera, and this group to other members of the Apocynaceae, see Markgraf's revision in Notizblatt.

As seen from the above discussion, Miers, Mueller, and Ducke recognized a close relationship between species of Ambelania and Macoubea.

[4] J. St.-Hilaire (1805), Mirbel (1806), Jussieu (1813), Choisy (1822). Macoubea was classed as a doubtful genus in Guttiferae by Choisy in De Candolle's Prodromus (1824), and removed from this family by Cambessedes (1828), Planchon & Triana (1862), and Bentham (1862). Schumann (1895) noted Macoubea as possibly apocynaceous.

[5] This disposition was followed by Baillon.

For my previous comments on this affinity see A Revision of Ambelania, Inclusive of Neocouma (Lloydia **8:** 109–130. 1945). Macoubea is a tabernaemontanaceous connecting link with the Carisseae through Ambelania. The two genera stand at the juncture between the extra-Carisseae and the Carisseae.

The species of Macoubea are very closely interrelated. The most important differences discernible in the diverse elements are based on the proportions and sizes of flowers and foliage, but are by no means constant.

There are in the genus only two entities which in typical specimens are clearly definable, *M. guianensis* and *M. Sprucei*. Intermediate between the two, *M. Sprucei* var. *paucifolia* sometimes too closely simulates either the one or the other. Hoehne (15, pp. 16, 12) apparently regarded *M. guianensis*, *M. reticulata*, and *M. Sprucei* as synonymous, or, in other words, Macoubea as a monotypic genus.

Even an examination of the meager material available at present proves that the floral characters in Macoubea grade gradually from species to varieties and from one specimen to another within the same variety. Individual leaves of *M. guianensis* and *M. Sprucei* var. *paucifolia* are not always distinguishable either in shape, size or nervature. The undersides of the leaf-blades of authenticated (flowering) specimens of *M. Sprucei* var. *paucifolia* are glabrous, whereas those of the typical variety are hirtellous; however, the constancy of this difference is dubious. The feature of leaf-pubescence sometimes strikingly contrasting in forms of *M. guianensis* is not correlated either with other morphological characters or geographical distribution.

Macoubea is confined to South America. Representatives of the genus have been collected in the three Guianas, the states of Pará, Amazonas, Maranhão, and Bahia in Brazil, and in the department of Loreto in Peru. They probably grow also in the adjacent districts of Venezuela and Colombia. Macoubea is reported not rare in the environs of Belém in Pará, and fairly abundant in the basin of the upper Rio Negro (abundant in the region of upper Rio Marié, São Gabriel), and also fairly common in the upper Nanay in Peru. It prefers woodlands or forests on swampy humid terra-firma (non-inundated land) in the vicinity of streams. Its habitat has been described by such terms as "campinarana," "restinga," and "catinga." In British Guiana *M. guianensis* is reported growing in alluvial clay, and in Bahia side by side with the Mucugé (*Couma rigida*). Naturally, Macoubea is associated with other arborescent Apocynaceae like Tabernaemontana, Ambelania, Couma, Parahancornia, and Lacmellea.

KEY TO THE SPECIES AND VARIETIES OF MACOUBEA

(Characters difficult to define and variable; entities separated by concurrence of features.)

1. Leaves typically broadly elliptic to suborbicular, the ultimate reticulation fine and evident on mature leaves; corolla-tube 4–5 mm. long; corolla-lobes 2–4 mm. broad; anthers about 2.8–3.5 mm. long. (Distribution range of the genus.) 2

2. Calyx and corolla slightly pubescent outside; corolla-lobes generally 3–4 mm. broad, little twisted; anthers 3–3.5 mm. long; ovary about 1.5 mm. long. . 1. *M. guianensis* (typical var.)
2. Calyx and corolla densely pubescent; corolla-lobes about 2 mm. broad, strongly twisted; anthers 2.8 mm. long; ovary about 1 mm. long. . . . . 1a. *M. guianensis* var. *pubiflora*

1. Leaves typically elliptic, about twice or more as long as wide, the ultimate reticulation generally becoming obscured; corolla-tube 4–8 mm. long; corolla-lobes 4–7 mm. broad; anthers 4–5 mm. long. (Amazon and Peru.) 3
3. Corolla-tube 5–8 mm. long; corolla-lobes 5–7 mm. broad; anthers 4.5–5 mm. long. . . . . 2. *M. Sprucei* (typical var.)
3. Corolla-tube 4–5 mm. long; corolla-lobes 4–5 mm. broad; anthers about 4 mm. long. . . . . 2a. *M. Sprucei* var. *paucifolia*

1. MACOUBEA GUIANENSIS Aubl., Pl. Guian. 2 (Suppl.): 18. pl. 378. 1775.

Tabernaemontana reticulata A. DC., Prodr. **8**: 366. 1844.
Rhigospira reticulata Miers, Apocyn. S. Am. 69. 1878.
Tabernaemontana Aubletii Pulle, Recu. Trav. Bot. Néerl. **9** (2): 157. pl. 3. 1912.

Description.—Pulle (*Tabernaemontana Aubletii*, 22); Markgraf (17); Ducke (11 & 12); Hoehne (15); Mueller (*T. reticulata*, 20). Young branchlets usually speckled; leaf-blades 9–25 cm. long and 6–18 cm. broad, entirely glabrous to densely hirtellous on under surface; inflorescence profusely flowered.

Type.—*Aublet s.n.* "in sylvis Caux," French Guiana.

Illustrations.—Type (1): a leafy branch; fruit; seeds. *Tabernaemontana Aubletii* (22): a flowering branch with leaves; flower and flower analysis; fruit showing double carpels; seed and longitudinal section of seed. *Macoubea guianensis* (11 & 12): pl. 17, a flowering branch with leaves; pl. 18, a longitudinal section of fruit showing seeds; pl. 22, flower analysis and seeds. Pequiá (15): typical specimens of *M. reticulata* (*Pirajá da Silva* coll.); branch with leaves and inflorescence; flower analysis; cross-section and outline diagram of fruit; seeds. (18): flower analysis. *Tabernaemontana reticulata* (20): fig. 2, flower analysis.

Distribution.—Throughout the range of the genus.

Specimens examined.—British Guiana: *Alston 460* (Anandabaru, Kopinang Rv.), *Forest. Dept. Brit. Guiana 936* (Yampari Creek, 20 mi. S.W. of Georgetown; May, fl.), *2406* (Field No. D410; Mazaruni Station; Jan., fl.; B.) Dutch Guiana: *Forest Bureau 62* (Sectie o), *2939* (Brownsberg; Oct., fl.), *3591* (Sectie o), *5563* (Sectie o; Feb., fr.; US). Brazil, Pará: *Ducke 15354* (Belém; July, fl.; US), *15521* (Belém; Oct., fr.; US), *17185* (Jurupá; Aug., fl.; US); *C. W. Smith 12589/39* (Municip. Santarém, Nocurí, Rio Arapiums). Brazil, Amazonas: *Ducke 21611* (Tonantins, Rio Solimões; US); *Froes 365* & *545* & *860* & *887* (Municip. São Gabriel, upper Rio Negro; Cucui & Macubeta & Busseh Cussi & Bela Vista); *Krukoff 7046* (Municip. Humaytá, basin Rio Madeira, between Rio Livramento & Rio Ipixuna; Nov., fr.). Brazil, Maranhão: *Froes 1795* (Maracassumé Rv. region; July, fr.). Brazil, Bahia: *Blanchet 2336* (photo; cotype of *Tabernaemontana reticulata*); *Froes 1062* (basin Rio Una, near Bela Vista), *1089* (basin Rio St. Ana, Bom Gosto), *2004* (basin Rio Acarahy); *Pirajá da Silva 26472* (Camami).

The cotypes of *Tabernaemontana reticulata* are: "prov. Bahiae (*Blanch.* ! *2336*), et in Guyanâ gall. (ex spec. Mus. par. comm.)." Besides the descriptions of this species in Prodromus and Flora Brasiliensis, a photo of the

Bahia cotype was available to me. In addition, I studied the flowering material of *Pirajá da Silva 26472*, which must surely be placed with the Blanchet plant, and I also examined three other Bahia collections in a sterile condition. *M. reticulata* falls well within my species-concept of *M. guianensis*, any observable minor differences from the Guiana plant hardly entitling it to an infra-specific distinction.

Markgraf recognizes *M. reticulata* as a valid species. In Recueil (16, p. 378) he states that the Martin collection from Cayenne [French Guiana], which was deposited in the Berlin Herbarium and was cited as a cotype of the species in the original description, belongs rather with *M. guianensis*.

Pulle, in transferring Macoubea to Tabernaemontana, created a new name, *Tabernaemontana Aubletii*, because *T. guianensis* was preoccupied.

1a. **Macoubea guianensis** var. **pubiflora** Monachino, var. nov.

Haec varietas a forma typica speciei calcibus corollisque densiore pubescentibus et lobis corollae angustioribus (ca. 2 mm. latis) valde contortis differt.

Tree 20 m. high; leaf-blades 7–10 cm. long and 5.5–7 cm. broad (in type coll.), hirtellous on under surface; inflorescence profusely flowered; calyx densely hirtellous outside, about 2.5–2.6 mm. long and 2 mm. diam. below lobes, the calyx-lobes 2 mm. long and about as broad, the glands within in one (or tending towards two) series; corolla-tube 4–5 mm. long and 1.5 mm. diam., densely hirtellous on upper portion outside; corolla-lobes linear-oblong, about 9 mm. long and 2 mm. broad, more or less pubescent throughout, strongly twisted in bud (about 7 spirals showing); anthers 2.8 mm. long; ovary 1 mm. long, the style 0.3 mm. long, the clavuncle 0.8 mm. long, the apiculi 0.5 mm. long.

Type.—*G. Klug 596;* Peru, dept. Loreto, Mishuyacu, near Iquitos, alt. 100 m., forest; Oct.-Nov. 1933. (Deposited in Britton Herb. NY).

Distribution.—Known at present only from the type collection.

Specimens examined.—Peru, Loreto: *Klug 596* (Type coll.; Oct.-Nov., fl.; NY, US).

2. MACOUBEA SPRUCEI (Muell. Arg.) Mgf., Notiz. Bot. Gart. Mus. Ber.—Dah. **14** (122): 179. 1938.

Tabernaemontana Sprucei Muell. Arg., in Mart. Fl. Bras. **6** (1): 86. pl. 27, fig. 1. 1860.
Rhigospira Sprucei Miers, Apocyn. S. Am. 70. 1878.

Description.—Mueller (20). Young branchlets not speckled; leaf-blades 7–17 cm. long and 3.5–8.5 cm. broad, hirtellous on under surface; inflorescence sparsely flowered; first pair of bracts on peduncle broadly ovate and blunt; corolla-tube glabrescent to puberulent on upper portion outside; style up to about 1 mm. long.

Lectotype.—"prope Panuré ad Rio Uaupès: *R. Spruce 2594*."

Illustration.—*Tabernaemontana Sprucei* (20): fig. 1, a branch with leaves and inflorescence.

Distribution.—The typical variety is known definitely only from the state of Amazonas, Brazil.

Specimens examined.—Brazil, Amazonas: *Spruce 2594*(type coll.; NY); *Ducke 9* (Manáos, Pensador; Aug., fl.), *227* (Yale Ser. No. 31954; Manáos, Pensador; Aug., fl.), *21604* (Manáos, prope cataractas fluminis Tarumá; Oct., fl., US); *Krukoff 7924* (Manáos, along road to Aleixo; Aug.-Sept., fl.).

Spruce 2594, which I accept to typify *M. Sprucei* (typical variety), is obviously the basis for the original description of *Tabernaemontana Sprucei*, at least for the greater part, and is the plant illustrated for the species in Flora Brasiliensis. This collection was selected by Miers to typify *Rhigospira Sprucei*, in forming this new combination, the other specimen (*Spruce 3693*) cited by Mueller for the species being chosen for his proposed novelty *R. sinuosa*.

The typical material of *M. Sprucei* is easily distinguished from *M. guianensis*, but is separated with great difficulty but from some specimens of *M. Sprucei* var. *paucifolia*. *Spruce 3693*, cited by Mueller and Markgraf as cotype of *Tabernaemontana Sprucei*, and by Miers and Markgraf as the type of *Rhigospira sinuosa*, is here placed with var. *paucifolia*.

2a. **Macoubea Sprucei** var. **paucifolia** (Spruce ex Muell. Arg.) Monachino, stat. nov.

Tabernaemontana paucifolia Spruce ex Muell. Arg., in Mart. Fl. Bras. **6** (1): 87. 1860.
Rhigospira paucifolia Miers, Apocyn. S. Am. 69. 1878.
Rhigospira sinuosa Miers, loc. cit. 70.
Macoubea paucifolia Markgr. ex L. Williams, Field Mus. Nat. Hist. Pub. Bot. **15**: 422. 1936.
Macoubea sinuosa Markgr., Notiz. Bot. Gart. Mus. Ber.—Dah. **14** (122): 178. 1938.

Description.—Mueller (*Tabernaemontana paucifolia*, 20); Miers (*Rhigospira sinuosa*, 19). Young branchlets sometimes speckled; leaf-blades glabrous; infloresence profusely to sparsely flowered; first pair of bracts on peduncle lanceolate and pointed; corolla-tube hirtellous on upper portion outside.

Type.—"ad Rio Uaupès prope Panuré: *R. Spruce 2564*."

Distribution.—The variety *paucifolia* is known definitely only from the state of Amazonas, Brazil; sterile material, possibly of this variety, is available from Loreto, Peru.

Specimens examined.—Brazil, Amazonas: *J. T. Baldwin Jr. 3586* (São Felippe, upper Rio Negro); *Ducke 1006* (Borba, circa Campo Grande; Aug., fl.; US); *Froes 473* (Municip. São Gabriel, Acara, Cubaté), *536* & *542* (Municip. São Gabriel, Macubeta on Rio Marié); *Spruce 2564* (type coll. *Tabernaemontana paucifolia;* fl.), *3693* (cited as cotype *T. Sprucei* in Mart. Fl. Bras.; fl.). Peru, Loreto: *L. Williams 938* (Timbuchi on Rio Nany; F, M).

The collections for which flowers are not noted above are either sterile

or bear only immature flowers. These specimens are therefore doubtfully determined as to variety.

The binomial appearing in Williams' Woods of Northeastern Peru, 1936, is: "Macoubea paucifolia (Spreng.) Markgr., ined."[6] The parenthetical citation "Spreng." is an error for Spruce. No synonymy is presented by Williams. The description is confused (cites *1103*, which is not a Macoubea but a Tabernaemontana) and erroneous ("long yellow staminal filaments").

Although in 1925 (Recueil Trav. Bot. Néerl. **22**: 377) Markgraf regarded *Tabernaemontana paucifolia* Spruce as related with *Macoubea guianensis*, in the 1938 revision of the genus in Notizblatt he placed *T. paucifolia* Spruce ex Muell. Arg. in synonymy under *M. guianensis*. It is clear therefore that Markgraf, upon matured judgment, never intended publishing the binomial *Macoubea paucifolia*. My accreditation of the transfer to Markgraf is thus to be accepted with all due reservation.

The authority citation for *T. paucifolia* in Fl. Bras. is: "Müller (R. Spruce)." In his treatment of the Apocynaceae Mueller never presented double citations (in the sense of indicating transfers); moreover, whenever he proposed to render credit to a single authority he indicated that authority alone after the botanical name. In this case the reference "Müller (R. Spruce)" suggests therefore equal accreditation to both botanists, and is interpreted as "R. Spruce ex Muell. Arg." This treatment agrees with that of Markgraf in Notizblatt.

The type of *Rhigospira sinuosa* is *Spruce 3693*, collected "prope S. Carlos ad Rio Negro," and consists of branchlets with leaves and flowers. The type collection was examined by me and found to be identical with the type coll. of *Macoubea paucifolia* in all significant characters. *Spruce 3693* was cited by Mueller as a cotype of *Tabernaemontana Sprucei*. Markgraf, in his monograph (18), due to some confusion, cites this collection both for *Macoubea Sprucei* (page 179) and *M. sinuosa* (p. 178).

M. Sprucei var. *paucifolia* is intermediate between *M. guianensis* and *M. Sprucei* (typical variety), inclining more towards the latter. It is conceivable that when extensive material of both varieties is accumulated the two may prove identical. Markgraf placed *Tabernaemontana paucifolia* in synonymy of *M. guianensis*, not without reason.

THE AMERICAN SPECIES OF LANDOLPHIA

Literature.—Published information on the American species of Landolphia is very meager. After the original description of Pacouria by Aublet (30) the only concrete advance in our understanding of that Guiana plant

[6] The designation, as quoted, is found in Herrera's Catalogo Alfabetico (p. 352), as well as in the Gray Cards. No other reference to this name has been found.

was the publication by Pulle (59). During the long period elapsing between 1775 and 1906 there appeared only trivial remarks concerning the species, or, at best, only profound conjectures such as that of Bentham (34), which was based solely on the original description written over a century ago, or the single-sentence statement by Hiern in 1898 (see History, below) which, notwithstanding its bare laconic character, implies that he had actually compared several African representatives of Landolphia with Aublet's type in the British Museum and found them sufficiently similar to enable him to publish transfers from Landolphia to Pacouria. Of these earlier works, the résumé presented by Hallier (41 & 42) and the unconfirmed report of *Pacouria guianensis* from British Guiana by Schomburgk (63) deserve particular notice. The substance of most of the remaining articles listed in the Bibliography is presented in the historical discussion appearing below.

Shortly after Pulle had clarified the status of Aublet's plant, Huber, (45) discovered in 1910 a second New World Landolphia, *L. paraënsis*. Finally, Markgraf (51) in 1925, placed the American representatives in the section Ancylobotrys, as Schumann had first suggested; and also, in the following year, described an additional species, *L. boliviensis*.

By comparison, the literature on the African members of Landolphia is extensive; mention is here made only of several works that might have indirect bearing on the American plants. Stapf's treatment in Thiselton-Dyer's Flora of Tropical Africa (70, pp. 29–60, 26. Addenda, pp. 589–594), Hallier's Ueber Kautschuklianen und andere Apocyneen (41, pp. 19–98), and Dewèvre's Les caoutchouc africains, étude monographique des lianes du genre Landolphia (37, pp. 3–80) are foremost. Dewèvre's publication has a particularly excellent generic description of Landolphia, in which the vegetative and floral variations of the genus are presented comprehensively with specific examples, and also contains a table conveniently illustrating the distribution of the African members then known. É de Wildeman, in Mission Émile Laurent (1905–1907, vol. 1, pp. 453–495, vol. 2, pls.), presents good photos illustrating the physiological-botanical aspects of Landolphia species, such as close-ups of stems and their cross sections, fruits, tap-root, habitats, etc.; the second volume of this work contains 10 excellent plates.

History.—During the long period dating from 1775, when Aublet described Pacouria, until 1906, when Pulle ascertained that Pacouria was congeneric with Landolphia, the history of the former genus has been largely one of conjectures and nomenclatural vacillation. In 1777 Scopoli renamed Pacouria as Alstonia, without submitting any reason for the change, and Necker (1790) simply accepted this name substitution. Jussieu, 1789, stated that the stigma of Pacouria was like that of Ambelania, and queried: "an Ambelaniae cogener?" Shreber, 1789, admitted both

Pacouria and Ambelania under Willughbeja Scop.; and Gmelin, 1791, and Raeuschel, 1797, in agreement with this view, transferred the species *gujanensis* and *acida* to this genus. Willdenow, 1797, while maintaining *Willughbeja acida* for the species of Ambelania, gave the name *Willughbeja scandens* for *Pacouria gujanensis*. In the same year, Lamark figured both Vahea and Pacouria on the same plate, but made no note of their affinity. Augier, 1801, erected the family "Pacourides," which apparently derived its name from the genus Pacouria. In 1805 Palisot de Beauvois described Landolphia based on an African plant—and nothing was said concerning the relationship of this genus with Pacouria until 1876. Roemer and Schultes, 1819, placed *Willoughbeja scandens* in synonymy under *Pacouria gujanensis*, and also reverted Ambelania to a valid generic status. Steudel, 1821, preferring Willdenow's treatment, placed *Pacouria guianensis* (together with *Willughbeia guianensis*) and *Ambelania acida* in synonymy under *Willughbeia scandens* and *W. acida*, respectively; in the 1841 edition of Nomenclator Botanicus, however, Steudel placed *Willughbeia scandens* after *Pacouria guianensis*, apparently in synonymy. Again, Sprengel in 1825 accepted *Willughbeia scandens* for *Pacouria guianensis* and *W. acida* for *Ambelania acida*, and furthermore associated the two American species with two Old World plants, *W. edulis* and *W. zeylanica*. In 1831 F. Hamilton (Wallish's Numerical List, no. 4465) determined *Willughbeia edulis* as a Pacouria, *P. Gudara;* and Kosteletzky, 1834, also recognized Pacouria in this species, placing *W. edulis* parenthetically after his new combination *Pacouria Roxburghii*. A. De Candolle in Prodromus, 1844, hinting at a possible tie between Pacouria and Vahea, noted of the former genus: "forsan Vaheae et Ambelaniae propior." In 1848 appeared a significant statement by Schomburgk in his report of *Pacouria guianensis* as being found on the banks of the Essequibo, Pomeroon and Demarara rivers in British Guiana; the species had hitherto been known only from the original collection in French Guiana, nor was it subsequently reported until Pulle's Enumeration in 1906. The next important note to appear regarding Pacouria is one which initiated a true understanding of the genus: Bentham, 1876, placed both Vahea and Pacouria under Landolphia; of Pacouria he stated: "ex sola icone et descriptione auctoris nota, nec characteres nec habitum praebet quibus a *Landolphia* distinguas. An *Landolphiae* species ex Africa tropica in Guianam introducta?" And this remark by Bentham was the key-note of a discussion which followed until the plant's rediscovery in 1906. F. von Mueller, 1878, accepted Bentham's merging of Vahea and Landolphia, but thought the former to be the valid genus because of priority, and acting on this concept transferred several African species of Landolphia to Vahea; in 1883 he took up the problem of Pacouria, which antedates Vahea, but suggested that even if both Pacouria and Vahea should prove congeneric it would be best to adhere to Vahea because of the existence of the Compositae genus Pacourina.

Baillon, 1891, following Mueller's understanding on the priority of Vahea, placed Landolphia under this genus; he also noted Pacouria as doubtfully synonymous with it. Schumann, 1892 and 1895, discussed the possible identity of Pacouria and Landolphia, and gave his opinion on the suggestion which had been made regarding the introduction of Aublet's plant into French Guiana from Africa. In Pflanzenfamilien, 1895, he summarized his impressions in the following words: "Dass *Pacourea guianensis* Aubl. eine *Landolphia* ist, scheint mir zweifellos, sie ist nahe verwandt mit *L. comorensis* (Boj.) K. Sch., *L. Petersiana* (Kl.) Dyer etc., ist aber wahrscheinlich nach Amerika eingeführt worden." Dewèvre, 1895, alluded to Schumann's treatment, and added that the known characters of Pacouria suggest Landolphia. Hiern, 1898, after stating "The type of Aublet's genus is in the British Museum herbarium" then proceeded to place the genera Alstonia Scop., Vahea, and Landolphia in synonymy under Pacouria and transferred four African species to Aublet's genus. Pierre, in the same year expressed his objection to considering Landolphia congeneric with Pacouria. Hallier, 1899, after quoting Stapf's then unpublished remark that Pacouria is a Landolphia belonging in the group of *L. owariensis*, and after a long discussion on the opinions presented by Bentham, Schumann, and Pierre, concluded that Pacouria either belongs in a new section of Landolphia native to America or is a distinct genus related to Landolphia. Dalla Torre & Harms, 1900, placed Pierre's Dictyophleba and Ancylobothrys, as well as Vahea and Pacouria, in synonymy under Landolphia, but questioned its natural distribution in Guiana. Stapf, 1902, stated: "Pacouria is very probably a species of Landolphia, § Ancylobotrys. It was found in French Guiana by Aublet, but has never been collected again, and is perhaps not indigenous there." In the Lexicon, Kuntze & Post, 1906, referred Landolphia to "Pacouria." Then, in the same year, all these discussions and conjectures were brought to a conclusive end; all doubts were eliminated as to the existence and character of Landolphia in America by the publication in 1906 of Pulle's An Enumeration of the Vascular Plants known from Surinam, in which three collections of *Landolphia guianensis* are cited and an excellent description together with an illustration of the species are presented. And to clinch matters, shortly after, 1909, a second American species of Landolphia, *L. paraënsis*, was described by Huber from Belém.

These additional notes might be inserted here, giving the final stage in the history of the American Landolphia: Chevalier, 1912, stated that he examined the type of *Pacouria guianensis* and did not hesitate to identify it with the genus Vahadenia created by Stapf, and decided also that *L. paraënsis*, of which he had seen specimens in the Rubber Exhibition of London in June 1911, belonged within the group. Hallier, 1918, after alluding to Pulle's elucidation of the status of Pacouria, noted his discovery amongst Splitgerber's undetermined plants of *Splitg. 833* which Rendle

compared with Aublet's type and reported them to agree "admirably," and then, taking cognizance of *L. paraënsis*, concluded by conceiving these American species of Landolphia as representatives of the flora which inhabited the prehistoric land or island bridge connecting South America and tropical Africa. Markgraf, 1925, recalled remarks made by Schumann, Pierre, Hallier, and Chevalier concerning the section of Landolphia in which the American species belong, and submitted his opinion that they fall into the section Ancylobotrys, being related to such Guinea species as *L. ferruginea* and *L. pyriformis*. In the following year Markgraf described the third species of American Landolphia, *L. boliviensis*, suggesting for it also the section Ancylobotrys. In 1932, in presenting a description of *L. guianensis* while treating the Apocynaceae in Pulle's Flora of Surinam, Markgraf published the latest reference available to me on the genus in America.

Local names.—The only local names available for the American species of Landolphia are: "Pacouri-rana," recorded by Aublet as the Caribbean Indian name (gallicized to "Pacourier") for *L. guianensis*, and "Bejuco Negro," cited by Markgraf as the Spanish name for *L. boliviensis*.

Uses.—Several African species of Landolphia are well-known rubber plants of economic importance. They are known also for their pleasantly acidulous edible fruits, those of *L. senegalensis* being sometimes sold in markets in western Sudan; the fruit-pulp of *L. owariensis* is reported used to season food, and that of both this species (in Senegal and the upper Nile land) and *L. Heudelotii* to prepare a beverage (a fermented drink or native beer). The fresh seeds of *L. florida* are used medicinally for colic in Northern Nigeria, while its roots, along with other substances, are taken as a remedy for gonorrhoea. Like that of *L. florida*, the latex of *L. leonensis* is used as a bird lime in Liberia, and, in addition, this latter species is recommended as a remedy for mumps (mixed with the bark of *Fagara angolensis*, it is applied to the swellings). According to Dr. Kersting, the leaves, flowers and twigs of *L. florida* are used in the preparation of a blue dye in Togo. The twigs of *L. owariensis* are employed in the Gold Coast as chew-sticks.

In regard to the adaptation of the African Landolphia to American soil, J. H. Hart (in Bailey, Cyclopedia of American Agriculture. Vol. 2, 1907, p. 559) notes that they do not respond readily to cultural treatment,[7]

[7] I have examined the following flowering specimens of African Landolphia cultivated in America: *L. florida* var. *leiantha* Oliver; Trinidad (Botanic Gardens), *Broadway 4065* (M). *L. Kirkii* Dyer; Jamaica (Castleton Gardens), *W. Harris s.n.* (4 Nov. 1902); Trinidad (Botanic Gardens), *Broadway s.n.* (1 July 1922, 27 April 1929, 27 Sept. 1929; F & M, M & US, F); British Guiana, *Jenman 2118* (Cult.?). *L. Klainei* Pierre; Trinidad (St. Clair Exp. Station), *Broadway 2894*. Material of two other collections of Landolphia cultivated in Jamaica, inadequate for satisfactory determination, were available to me: a sterile sample named *L. Heudelotii* A. DC. (*Collins 145*, Castleton Gardens; US) and a single fruit of "*L. senegalensis* Kotschy & Peyr." (*Mrs. N. L. Britton 3433*, Hope Gardens).

and adds: "It may be assumed with some certainty that Landolphias are unlikely to compete with Hevea, Ficus, Castelloa or Manihot." Of the species native to America, Aublet writes that the latex of *L. guianensis* is strongly viscose and the fruits have on maturity an agreeable odor; Planchon reports its latex as producing rubber and its fruits as being edible (Dragendorff characterizes the fruits as purgative). The latex of *L. paraënsis*, Huber notes, contains rubber but of an inferior quality.

LANDOLPHIA Pal. de Beauv., Fl. d'Owar. **1**: 54. pl. 34. 1805. (*nom. conser.*)

Pacouria Aubl., Pl. Guian. **1**: 268. pl. 105. 1775. (*nom. rejic.*)
Alstonia Scop., Introd. 198. 1777. (*nom. rejic.*). Non *Alstonia* R. Br., Mem. Wern. Soc. **1**: 75. 1809.
Willughbeja Scop., in Schreb. Gen. **1**: 162. 1789.—pro parte. Non *Willughbeia* Roxb., Pl. Coromandel **3**: 77. pl. 280. 1819.
Vahea Lam., Illust. Gen. Pl. 169. 1797; in Poiret, Dict. Encycl. Suppl. **5**: 409. 1817. (*nom. rejic.*)
Landolfia D. Dietr., Syn. Pl. **1**: 561, 625. 1839.
Faterna Noronha ex A. DC., in DC. Prod. **8**: 327. 1844.
Ancylobothrys Pierre, Bull. Soc. Linn. Paris, nouv. sér. **11**: 91. 1898.
Dictyophleba Pierre, loc. cit. 92.
Pacuria O. Kuntze & Tom von Post, Lex. Gen. Phanerogam. 412. 1904.

For a general description of Landolphia see Stapf's Apocynaceae in Flora of Tropical Africa (70, pp. 30–31) and Dewèvre's monograph (37, pp. 7–13). The American species are large lianas, the stems terete, marked with an interpetiolar line, the axillary glands or processes linear, numerous; LEAVES opposite; petioles 3–7 mm. long; blades ovate-elliptic to elliptic-oblanceolate, 10–16 cm. long and 5–10 cm. broad, rounded and apiculate to short-acuminate at apex, acutely narrowed to cordate at base, glabrous to pubescent on maturity, dull or nitidous, the midrib impressed on upper surface and raised on under surface, the secondaries (secondary or lateral veins) arcuate and distantly spaced, about 10–13 principal pairs with frequent minor ones in between, connected near leaf-margins by light arches, the tertiaries conspicuous on under surface, the reticulation closely intricate or becoming obscured; INFLORESCENCES terminal (and pseudo-axillary), the axis usually very long and tendriliform, pinnately branched above the elongated naked portion, the branches subtended by small lanceolate bracts (6 mm. long or less), up to 3.5 cm. long, shortened towards apex of rhachis, recurved; FLOWERS numerous in dense subcapitate clusters on ends of infl. branches, cymose on almost entirely reduced rusty-tomentose obscure peduncles, the bracts minute, the pedicels up to 2 mm. long or completely reduced; calyx about 1.5–2 mm. diam. below lobes, the lobes eglandular, ovate to lanceolate, about 1.4–2 mm. long and 1.3 mm. broad, obtuse to acute at apex, pubescent outside and glabrous inside, thick; COROLLA greenish white to yellowish, the corolla-tube cylindric, a little swollen at region of anthers, 6–11 mm. long, glabrous to densely

tomentose outside with minute hairs, pilose inside, the corolla-lobes narrowly oblong or elliptic, about as long as tube or longer, 9–14 mm. long, glabrous or sparsely tomentulose near base outside, glabrous inside, sparsely short-ciliate on edges or the left edge (seen from within) conspicuously and densely pilose-ciliate with soft long hairs (about 1.3 mm. long) which are pointed downward in bud and spread at anthesis; FILAMENTS evident, 0.5–1.0 mm. long, inserted below middle of corolla-tube; ANTHERS lanceolate, 1.5–2 mm. long, sharp-pointed at apex and rounded at base, the sterile point 0.10–0.15 mm. long, the loculi polleniferous to base; OVARY syncarpous, superior, rounded and pubescent at apex, unilocular, the placentas two, the ovules numerous, the style either shorter or obviously longer than calyx-lobes, the clavuncle (sensu Miers, 19, pp. 2 & 3) a spindle-shaped swelling, the apiculi two.

Type species.—*Landolphia owariensis* Pal. de Beauv.,[8] Fl. d'Owar. **1**: 54. pl. 34. 1805.[9]

That *Pacouria*[10] *guianensis* correctly belongs amongst the African species generally referred to as Landolphia is clear from Pulle's description. However, Landolphia is a complex genus and even when adopting a conservative attitude it must be regarded as comprising several diverse species-groups. Five sections are recognized by Stapf. The American material of the genus examined by me falls into Ancylobotrys. Pierre had raised this section to a distinct genus, spelling it Ancylobothrys, and H. Hua (Bull. Mus. Hist. Nat. Par. **5**: 186. 1899) seems to have accepted the generic segregate. The type species of Landolphia does not belong in Ancylobotrys, but in section Eulandolphia.

The name Alstonia was introduced by Scopoli in substitution for Pacouria. "Pacuria" and "Landolfia" are merely orthographic variants of Pacouria and Landolphia. "Faterna Noronha mss." appears in Prodromus as a synonym under Vahea.

Vahea was considered congeneric with Landolphia by Bentham, and this disposition was adopted by Schumann, Dewèvre, Hallier, Stapf (who based a section on this genus), and others. L. Radlkofer (Ein Beitrag zur africanischen Flora. Abhandlungen des Naturw. Vereines in Bremen. Bd. VIII. 1883. Pp. 394–399) contested the merging of the two genera, asserting that he could separate Vahea from Landolphia on morphological and

[8] This species is named *Paederia owariensis* by Sprengel, in Syst. (69, p. 669). The genus Paederia belongs to the Rubiaceae.

[9] The date appearing on the title page of the first volume of Flore d'Oware et de Benin is "Ann XII.—1804." Hallier (41, p. 67) notes, however, that the year is 1805 for the 1–6 parts comprising the first 60 pages and 1–36 plates. According to Hiern (Journ. of Bot. **36**: 495. 1898) plates 37–42 were published in 1806. Jackson in the Index Kewensis, Briquet in the International Rules, and several other authors cite 1806, while other authorities (e.g., Durand, Schumann) cite 1804, as the year of publication of *L. owariensis*.

[10] J. D. Hooker (Fl. Brit. India **3**: 624. 1882) spelled the genus "Pacourea" (sphalm.); Schumann in Nat. Pfl. (67, pp. 128, 130) did likewise.

anatomical bases. Hallier (41, p. 20) and Schumann (67, p. 452) discussed Radlkofer's claim, but decided to maintain Landolphia and Vahea as congeneric. Sprengel (69, p. 639) placed *Vahea gummifera* Lam. in synonymy of *Tabernaemontana squamosa* Sm.; otherwise, Vahea is almost universally considered either as a Landolphia or a genus of Carisseae close to it, never a Tabernaemontana (the Mauritian plant is referred to *T. mauritiana* Poir. by De Candolle, Baker, and others).

Pierre, in the progress of his study of the "Landolphieés," segregated two genera from Landolphia, Ancylobothrys, based on *L. Petersiana* and others, and Dictyophleba, based on *L. lucida*, of which only the leaves and very young flowers were known to him. The former genus was lowered to the status of a section by Stapf, while *L. lucida* was placed by him with the imperfectly known species.

Scopoli proposed Willughbeja to embrace both Ambelania Aubl. and Pacouria Aubl., two incongruous genera.[11] This concept was adopted by Sprengel (69), who moreover listed under Willughbeia Scop. the type species of two additional genera, Willughbeia Roxb. and Fagraea Thunb. Fagraea belongs in the Loganiaceae, whereas Willughbeia Roxb. is applicable only to certain Asiatic species of scandent Carisseae having axillary inflorescences. Nonetheless, Willughbeia Roxb. is closely allied generically with Landolphia (= Pacouria) and might be visualized as its Asiatic representative. It is perhaps significant of this relationship that Klotzsch (in Peters, Reise Mossamb. Bot. 1: 281–283. 1862) applied Roxburgh's genus for Landolphia from Mossambique; and Kosteletzky (47) published *Pacouria Roxburghii* for *W. edulis*, the type species of Willughbeia Roxb., while Hamilton (ex Wallich's Numerical List. No. 4465. 1831) suggested *Pacouria Gudara* for that Asiatic species.

Stapf (in Thist.-Dyer's Flora of Tropical Africa 4(1): 29–30. 1902) characterized his new genus Vahadenia as follows: "Allied to the sections *Mesandroecia* and *Ancylobotrys* of Landolphia, but differing from all the species of this genus in the large, persistent, ultimately reflexed or spreading sepals, the very numerous intracalycular glands, the stout, fleshy corolla and the woody pericarp." The genus is based on *Landolphia Laurentii* De Wild. Up to date only three species have been placed in Vahadenia, one of which, *V. Talbotii* Wernham, is relegated to synonymy of *V. Caillei* (A. Cheval.) Stapf in Hutch. & Dalz. Fl. W. Trop. Afr. Although it is altogether beyond the scope of the present paper to evaluate closely the African species of Landolphia, particularly in view of the very scanty material available to me, it appears from the description of Vahadenia that this genus is best incorporated within a sectional category in Landol-

[11] See previous remarks by the author in his A Revision of Ambelania, inclusive of Neocouma (Apocynaceae). LLOYDIA 8: 109–130. 1945.

phia. It is noteworthy that the feature of intracalycular glands[12] adduced as one of the salient distinctions for Vahadenia has an analogy in the intra-axillary glands of the leaves in Landolphia, which, however, are either absent or present, minute and obscure or subulate to filiform, and not of any generic importance. De Wildeman (Notes sur Quelques Apocyn. Lactif. 61. 1903) in referring to the characters employed by Stapf in erecting Vahadenia states that they do not seem sufficient to permit the creation of a genus, for if they are admitted, all the subgenera of Landolphia should be elevated to generic rank, as Pierre had already proposed elsewhere.

Chevalier (35) wrote: "En examinant, au British Museum, le type du *Pacouria guyanensis* Aublet, nous avons reconnu qu'il présentait les plus grandes analogies avec le genre *Vahadenia* et nous n'hésitons pas a identifier le genre *Pacouria* au genre créé par Stapf." Associating *L. paraënsis* with Pacouria, he suggested that these species belong in a section of Landolphia very closely related to Ancylobotrys. Markgraf (51) expressed disagreement with Chevalier's view. It is quite apparent from Stapf's diagnosis of Vahadenia, quoted above, that the American species of Landolphia do not belong in the same species-group with this genus, notwithstanding the probability of congenerity between Vahadenia and Landolphia.

Landolphia in Africa is marked by its extreme heterogeneity, comprising about 50 species of various habits and floral characters, ranging from giant lianas to dwarf shrubs; leaves of varying sizes, the secondary nerves usually distantly spaced but rarely very close, the axillary glands absent or minute and obscure, or evident and filiform; inflorescences often characteristically elongated tendriliform with the flowers in little clusters spaced far apart, or sometimes subsessile and consisting of many-flowered dense corymbs; flowers diversified in size and pubescence, 0.5–5 cm. long, usually white or yellowish, rarely drying dark reddish, glabrous to densely fulvous-tomentous outside; corolla-tube sometimes constricted at throat by a callous ring, the corolla-lobes sometimes much shorter than or sometimes surpassing the corolla-tube, conspicuously villose-ciliate with long hairs on one edge or minutely sparsely ciliate on both edges or entirely eciliate and completely glabrous; stamens inserted near base, middle or throat of tube; ovary truncate to conical at apex, densely hirsute to completely glabrous, the style shorter than calyx or obviously surpassing it; fruits variable, 1–25 cm. long, glabrous or pubescent, sometimes pruinose, smooth or wrinkled,

[12] The author of this paper has had previous experience with the presence of conspicuous multiseriate intracalycular glands as an insufficient character for maintaining generic segregation in Carisseae, i.e., subsection Neocoumae-ternstroemiaceae in Ambelania. The problem here, however, involved a genus of only eleven species. See Monachino, A Revision of Ambelania, Inclusive of Neocouma. LLOYDIA 8: 119–130. 1945.

the rind soft or hard, with or without a sclerenchymatous layer, the seeds 1–60, about 0.8–4 cm. long.

Notwithstanding the diversity of morphological characters in the African species of Landolphia, as illustrated above, none of these features is confined to any single group and also sufficiently correlated with other features to warrant recognition of generic segregates. As has already been suggested, the American species of Landolphia are best placed in the section Ancylobotrys (Pierre) Stapf. This disposition is in agreement with that of Schumann, Stapf, and Markgraf. *L. paraënsis* presents a slight disparity in the section as defined by Stapf; its style, otherwise than "very slightly exceeding the calyx," is longer, obviously surpassing the tips of the calyx-lobes.

L. paraënsis and *L. boliviensis* are evidently very closely related. *L. guianensis*, as described, seems to diverge from these in the lack of conspicuous long cilia on the edge of its corolla-lobes, since its lobes are only sparsely minutely ciliate.

Within the large area in South America where Landolphia is represented, discovery of several additional rare new members of the genus is anticipated. Judging from the experience with the group in Africa, morphological variability and probably varieties in the species are to be expected.

Landolphia in America is known from the Guianas, Amazonian Brazil and Bolivia. *L. guianensis* is distributed in the French and Dutch Guianas, and it is reported by Schomburgk from British Guiana. *L. paraënsis* has been collected only at Belém in the state of Pará, Brazil. *L. boliviensis*, originally described from the headwaters of the Rio Mamoré, in the department of Sta. Cruz in Bolivia, has been discovered also on the Rio Madeira, state of Amazonas, Brazil; it is to be expected elsewhere in the Amazon. The species are reported growing on the banks of rivers. Judging merely from the material collected, representatives of Landolphia seem to be nowhere common in the New World, notwithstanding the fairly widespread distribution of the genus.

Key to the American Species of Landolphia

1. Corolla-lobes inconspicuously and sparsely minutely ciliate with short hairs on both edges; corolla-tube glabrous outside; leaf-blades obtuse or rounded at base. (Guianas) ..... 1. *L. guianensis*

1. Corolla-lobes conspicuously and densely villous-ciliate with long hairs on one edge (and minutely ciliate on the other) 2

2. Young stems hirsute with spreading long hairs as well as pubescent with short crisped hairs; leaf-blades cordate to rounded at base, dull on the upper surface; calyx-lobes ovate, obtuse at apex; corolla-tube about 11 mm. long, sparsely pubescent outside; ovary hirsute at apex. (Pará) ..... 2. *L. paraënsis*

2. Young stems with only short crisped adpressed hairs; leaf-blades narrowed to acute at base, nitidous on upper surface; calyx-lobes ovate-lanceolate, subacute at apex; corolla-tube about 6 mm. long, densely tomentose outside; ovary finely tomentose at apex. (Amazonas and Bolivia) ..... 3. *L. boliviensis*

1. LANDOLPHIA GUIANENSIS (Aubl.) Pulle, Enum. Pl. Surinam 379. pl. 16. 1906.

Pacouria guianensis Aubl., Pl. Guian. 1: 269. pl. 105. 1775.
Willughbeja gujanensis J. G. Gmel., L. Syst. Nat. 2: 434. 1791.
Willughbeja scandens Willd., L. Sp. Pl. 1: 1231. 1797. Non *Willoughbya scandens* Kuntze, Rev. Gen. Pl. 1: 371. 1891.

Stems brown-hairy when young, glabrescent in age, brown, closely spotted with lenticels; blades ovate-elliptic or elliptic, 12–15 cm. long and 6–7 cm. broad, somewhat narrowed and shortly acuminate at apex, obtuse or rounded at base, glabrous, the secondaries 12–13 principal pairs; inflorescence-axis brown-hairy; calyx about 2 mm. long, the lobes hirsute outside, subacute (?) at apex; corolla-tube 11 mm. long, glabrous outside, the corolla-lobes narrowly oblong, 14 mm. long and 2 mm. broad, sparsely minutely ciliate; ovary hirsute, the style not surpassing calyx, about 3.5 mm. long to tips of the apiculi; fruit large, yellow, the seeds many, angled (Boon's material contains an unripe fruit, quite glabrous, 8 cm. diam., thinly blue-hoary, with about 12 seeds, the seeds 1.5 cm. long and 1 cm. thick).

Type.—*Aublet s.n.* "ad ripam amnis Galibiensis."

Illustrations.—Type (30 & 50): stem with leaves and infloresences; fruits; seeds. *Pacourea guyanensis* (co-basis of Pulle's *Landolphia guyanensis*, 59): stem with leaves and inflorescences; analysis of flower.

Distribution.—Known from the French and Dutch Guianas. Schomburgk (63) reports it from British Guiana: "An den Ufern des Essequibo, Pomeroon und Demarara. Blüht im April und Mai."

Besides the literature on *Landolphia guianensis*,[13] the only material available to me in reference to this species is a *Perrin s.n.* plant collected in the "West Indies" and named "*Willughbeia scandens*" by Sprengel. The data on the sheet appear in John Torrey's handwriting. It is evident from his Systema that Sprengel applied the name *Willughbeia scandens* Willd. for *Pacouria guianensis* Aubl. Moreover, in the Systema appears the distribution "Brasil" for the species, as well as Aublet's original Guiana report; and in view of another example (*Torreya paniculata*) in which Perrin's "West Indies" collection was cited as from Brazil by Sprengel, it is suspected that this hitherto unreported Brazilian record for Pacouria might be based upon the Perrin specimen in question. Unfortunately my *Perrin s.n.* is sterile (a detached young fruit is available). It is correctly placed in Landolphia. However, I do not believe the species is correctly identified with Aublet's plant, notwithstanding my lack of either authenticated *Landolphia guianensis* or good African material of the genus for

[13] The specific name is spelled "*guianensis*" in the text of Aublet's publication, whereas it appears as "*guyannensis*" under the plate. Pulle spells it "*guyanensis*."

comparison. I believe Perrin's Landolphia originated in Africa.[14] In its vegetative characters it corresponds very closely to Stapf's description (70, pp. 44, 45) of *L. scandens* Didr. (and *L. Tayloris* Stapf). It differs from *L. guianensis* in its smaller leaves (7.5–9.5 cm. long, 3–4 cm. broad) with the secondaries straight and diverging perpendicularly from the midrib (not arcuate, not ascending).

Several inaccuracies found in the original description of *Pacouria guianensis* have misled certain earlier writers (e.g., Pierre and Hallier). Aublet characterized the inflorescences in his plant as axillary, and the anther as having "deux boirses écartées par le bas, & ressemble à un fer de flèche." Consequently, Pierre (57, p. 94) noted that Pacouria, considering the form of its anther, could not be a Landolphia. It is noteworthy that while Aublet makes a similar statement in regard to the anthers of *Ambelania acida*, i.e., their being arrow-head shaped, the present author found the anthers with their basal lobes conspicuously diverging only in the Laxae[15] section of the genus, but not in *A. acida*.

2. LANDOLPHIA PARAËNSIS Hub., Bol. Mus. Goeldi **6**: 88. 1910.

Stems lightly striate, densely pale-rusty hirsute with spreading long hairs (about 0.07 mm. long) as well as pubescent with short crisped hairs, the buds densely hirsute; petioles thick, hirsute; blades broadly elliptic to elliptic-oblanceolate, 10–16 cm. long and 7–10 cm. broad, rounded and apiculate to short-acuminate and acute at apex, cordate or rounded at base, the upper surface densely hirsute on midrib, secondaries, and near margins when young, pubescent only on midrib and near margins in age, somewhat bullate, dull, the under surface densely pubescent with erect curved hairs when young, becoming glabrescent except on midrib in age, the secondaries about 10 principal pairs, about 1.5 cm. apart near middle, the reticulation close and finely intricate, the tissue subcoriaceous at maturity; inflorescence-axis hirsute like the stem; calyx about 2 mm. diam. below lobes, the lobes ovate, about 1.4 mm. long and 1.3 mm. broad, obtuse at apex, tomentose outside; corolla fragrant, the corolla-tube 10–13 mm. long, sparsely pubescent outside, the corolla-lobes narrowly oblong, about as long as tube, glabrous except for left edge (seen from within) conspicuously and densely pilose-ciliate, the right edge merely sparsely ciliate with short hairs; ovary densely hirsute at apex, glabrous and shallowly undulate for about 0.3 mm. from base, the style surpassing calyx, 3–4 mm. long, lightly striate-angulate, the clavuncle about 0.7 mm. long, papillose, the apiculi oblong-lanceolate, about 0.7 mm. long, microscopically papillose; fruit described as "globose, up to 18 cm. diam., glabrous,

[14] For evidence that certain other plants reported collected by Perrin in the West Indies must have originated from Africa see discussion in the Appendix.

[15] See Monachino, A Revision of Ambelania, Inclusive of Neocouma (Apocynaceae). LLOYDIA 8: 119–130. 1945.

seeds immersed in its pulp, subglobose-compressed (their largest diameter 25 mm.), albumen abundant, corneous."

Type.—"ad ripas rivulorum prope Pará, et in Horto botanico Musei Goeldiani culta. I V 1908 (*H. A. M. G. 9341*)."

Distribution.—Known only from Pará, Brazil.

Specimens examined.—Brazil, Belém: *Ducke 16187* (June 1916, fl.; US); *Huber 9341* (type coll.; hort. bot.; F; photos, F, NY).

3. LANDOLPHIA BOLIVIENSIS Mgf., Notiz. Bot. Gart. Mus. Berlin **9**: 1041. 1926.

Stems lightly striate, rusty-pubescent with short crisped, more or less adpressed hairs, becoming inconspicuously puberulent in age; petioles tomentose when young, becoming sparsely pubescent in age; blades elliptic-oblanceolate, 10–16 cm. long and 5–9 cm. broad, broadly short-acuminate (sometimes rounded or retuse) at apex, narrowed at base, often acute, somewhat decurrent on petiole, the upper surface densely tomentose with crisped hairs on midrib and secondaries when young, becoming glabrous, smooth and nitidous, the under surface densely tomentose on midrib and secondaries when young, becoming glabrescent on maturity, glaucesent-dull (constant?), the secondaries about 12 principal pairs, about 1.5 cm. apart near middle, the reticulation close and finely intricate (becoming obscured in extremely old age?), the tissue subcoriaceous (or coriaceous?) at maturity; inflorescence-axis puberulent like the stem; calyx about 1.5 mm. diam. below lobes (variation?), the lobes ovate-lanceolate, 1.5–2 mm. long and 1–1.3 mm. broad, subacute at apex, tomentose outside, ciliate, spreading, persistent; corolla-tube 6 mm. long and 1.5 mm. diam. (flowers not mature), densely minutely tomentose outside, sparsely pilose inside, the corolla-lobes narrowly elliptic, about 9 mm. long (and 1.5 mm. broad in type), sparsely tomentulose outside near base, glabrous inside, the left edge (seen from within) conspicuously and densely pilose-ciliate, the right edge merely puberulent-ciliate; ovary densely tomentose with very short hairs at apex, glabrous below, the style 1.6 mm. long (not mature), the clavuncle about 0.4 mm. long, the apiculi narrowly lanceolate, about 0.6 mm. long, microscopically papillose; fruits spheroid, about 2.5–3 cm. diam.

Type.—"Ostbolivia (Regenwaldgebiet): Wald am Flusse Surutú, Prov. Sara, Dep. Sta. Cruz, 400 m ü. d. M. (Blühend 2. October 1924—*Steinbach 6537.*)"

Distribution.—Known at present only from the type, district of Rio Mamoré in Bolivia, and *Krukoff 6640*, basin of Rio Madeira in Brazil.

Specimens examined.—Brazil, Amazonas: *Krukoff 6640* (Munic. Humaytá, near Livramento, on Rio Livramento, terra firma; 16 Oct. 1934, fr.; Mich, NY, US). Bolivia, Santa Cruz: *Steinbach 6537* (type coll.; A; photo, NY).

APPENDIX

Interpretation of specimens reputedly collected by Perrin in the West Indies and South America has frequently led to grave difficulty. It is suspected that this difficulty has been due to the fact that the true origin of certain of these plants is African rather than American.

An attempt to obtain information in literature regarding Perrin's botanical itinerary bore hardly any pertinent results besides the citations of Perrin as a collector by Sprengel in Neue Entdeckungen im ganzen Umfang der Pflanzenkunde, Vol. 2 (1821): 121, 126, 127, 128, 139, 143, 154, 160, 161, 164, and Vol. 3 (1822): 11, 35.

With the exception of *Smithia spicata* (page 160, "Senegambia"), all the plants described on these pages were originally reported collected in the New World, and *S. spicata* is repudiated from the African flora by the manuals. Eleven species were referred to as new by Sprengel. I am in a position to comment only on several of the citations presented:

P. 121.—"*Torreya paniculata** . . . Brasilia." The place of collection appearing in Torrey's handwriting on the Perrin sheet is "West Indies (probably Guadeloupe)." About a decade after Sprengel described Torreya, G. A. W. Arnott pointed out the identity of this plant with Clerodendrum (Ann. Nat. Hist. 1: 126–128. 1838): "but I have seen no species that agrees with it . . . . It approaches most to one in Sir W. J. Hooker's herbarium from the east coast of South Africa." H. N. Moldenke annotated the *Perrin s.n.* sheet, deposited in the N. Y. Bot. Gd., as *Clerodendrum volubile* P. Beauv.; moreover, he refers *Torreya paniculata* Spreng. to this species of Clerodendrum in An Alphabetic List of Invalid and Incorrect Scientific names Proposed in the *Verbenaceae* and *Avicenniaceae*, 1942, p. 44. In The Known Geographic Distribution of the Members of the *Verbenaceae* and *Avicenniaceae*, 1942, p. 73, Moldenke cites *C. volubile* as cultivated in Guadeloupe. While this record was derived from the label on the Perrin sheet, the species is listed in Prestoe's Plants in the Royal Botanical Gardens (Proceedings of the Scientific Association. Part 6. 1869. p. 307) and List of Duplicate Plants in the Government Botanic Gardens, Trinidad (1874. p. 7). *C. volubile* is native to tropical Africa.

P. 126.—"*Polymeria pusilla* R. Br. . . . America forte meridionali." The genus Polymeria is Australian. The Perrin plant was examined by me and determined as *Evolvulus nummularius* L., a species which is frequent in the New World tropics and is also found in tropical Africa.

P. 127.—"*Cordia portoricensis** . . . Portoricco." The type was probably examined by Urban (Symb. Ant. Fl. Ind. Occ. 4 (3): 519. 1910) who cites "*Cordia portoricensis* Spreng.!" under *Cordia cylindrostachya*, a species widespread in the American tropics.

P. 139.—"*Mocinna brasiliensis** . . . E. Brasilia." This name is placed

in synonymy under *Calea pinnatifida* (R. Br.) Less. by Lessing (Linnaea **1830**: 158. 1830), De Candolle (Prodr. **5**: 674. 1836), Baker (Fl. Bras. **6** (3): 263. 1884), and Cabrera (Notas Mus. La Plata **2**: 102. 1937). In none of these instances, however, is the actual Perrin collection cited. *Calea pinnatifida* is reported only from South America.

P. 154.—"*Casearia punctata** . . . Portoricco." Urban (Symb. Ant. Fl. Ind. Occ. **4** (3): 422. 1910) places this name in synonymy under *Casearia sylvestris* Sw. He does not cite the Perrin collection. *C. sylvestris* occurs rather generally in the American tropics.

P. 160.—"*Smithia spicata** . . . forte in Senegambia." Baker (in Oliver, Fl. Trop. Afr. **2**: 154. 1871) writes that the plant published under this name "from Senegambia, according to Dr. Torrey was a compound of the flowers of a Cassia, with the fruit of *Mimosa pudica* or *sensitiva*, and was procured by Perrin from a garden in Guadeloupe.' Three sheets of the Perrin collection are available in the herbarium of the N. Y. Bot. Gd. One of these is labeled "Guadeloupe?" in Torrey's handwriting; this sheet contains an admixture of a fruiting fragment of *Mimosa pudica* L. The remaining material is conspecific and correctly determined in Smithia. The species is fairly adequately described by Sprengel (legume 2-jointed; corolla wings 3–4 mm. long; floral bracts about 3.5 mm. long and 2.5 mm. broad, not caudate at apex; leaves 3–5 cm. long, the leaflets up to 20 pairs, 0.6–1 cm. long); the publication of *Smithia spicata* is not antedated by any earlier one. Smithia is a moderately large genus in tropical Africa, but is not known from the New World.

P. 161.—"*Galega Perriniana** . . . America forte meridionali" and "*Indigofera Perriniana** . . . America forte meridionali." Both species are now referred to Tephrosia. The latter was given a new name, *Cracca hypoleuca*, by Rydberg, who had access to the Perrin collection. Rydberg (N. Am. Fl. **24** (3): 180. 1923) notes that the type locality is given as "West Indies" on the label and adds "Known only from the type collection." *Indigofera Perriniana* is still known only from the type collection. The genus Tephrosia is abundantly represented in both America and Africa (where more than 60 species are known).

P. 164.—"*Tetracera Perriniana** . . . America forte meridionali." The Perrin type collection was examined by me and belongs to the genus Ochna. The plant therefore needs a new name:

Ochna Perriniana—(Spreng.) Monachino, comb. nov.
Tetracera Perriniana Spreng., Neue Entdeck. **2**: 164. 1821.

A short emended description might be desirable: Leaf-blades 7–8 cm. long and 3.5–4 cm. broad, sparsely serrulate, the principal secondaries about 9 pairs, the reticulation faint; inflorescences about 5 cm. long, terminal on short branches, marked at base by numerous annular scars left

by the caducous bracts; flowers 12–15 in each infl., racemose, singly disposed, the pedicels 1.5–2.5 cm. long, jointed at base; sepals 4, suborbicular to broadly elliptic, about 8 mm. long; petals 4, broadly spatulate, clawed, about 11 mm. long and 7 mm. broad; filaments about 3 mm. long, the anthers about 2.2 mm. long, caducous; carpels 8.

Of all the species described previous to *Tetracera Perriniana*, our plant is most closely related to *O. multiflora* DC. (Ann. Mus. Par. **17**: 398. 1813. pl. 3). *Ochna Perriniana* is easily separated from *O. multiflora*, as described, in the obscure reticulation of its leaves and markedly clawed petals.

Ochna is well represented in Africa, but is not native to America.

From the above discussion of Sprengel's Torreya (p .121), Smithia (p. 160), and Tetracera (p. 164), in addition to my comments on *Willughbeia scandens* Willd. presented in the systematic treatment under *Landolphia guianensis*, it appears certain that at least several plants supposedly collected by Perrin originated in Africa and most probably have never been cultivated in America.

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LLOYDIA

A Quarterly Journal of Biological Science

THEODOR JUST, *Editor*
JOHN H. HOSKINS, *Associate Editor*

Vol. 8, Nos. 1-4, 1945

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Editorial Office—309 W. Court St., Cincinnati, Ohio

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Dates of Publication

Volume 8, 1945

Number 1, March ..... June 21, 1945
Number 2, June ..... August 17, 1945
Number 3, September ..... November 6, 1945
Number 4, December ..... February 10, 1946

Vol. 9 MARCH · 1946 No. 1

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

Brazilian Chytrids. VIII. Additional Parasites of Rotifers and Nematodes

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In a previous contribution relating to aquatic fungi of the Amazon Valley in Brazil, the author (1944) described three new *Lagenidium* species which parasitize the eggs, embryos and adults of rotifers. Species of this genus are characterized by biflagellate zoospores and therefore belong to the family Lagenidiaceae. Since that time several additional fungous parasites of the same hosts and nematodes have been found in the soil and water samples collected in Brazil in 1943. The latter group of parasites, on the other hand, have posteriorly uniflagellate zoospores and, accordingly, relate to the order Chytridiales.

The first two chytrids are internal holocarpic parasites of rotifer eggs and adults and belong in the genus *Olpidium*. However, their identity and relationship to other known *Olpidium* parasites of rotifers are not certain because the latter group of species are poorly known and have not been fully described. Up to the present time, approximately twelve species of this genus have been described as infecting nematodes, rotifers, monads and other microscopic animals. Of these only two species, *O. gregarium* and *O. macrosporum*, and one variety, *O. entophytum* var. *intermedium*, have been reported as parasites of rotifers. *Olpidium gregarium* (Nowakowski, 1876) Schroeter appears to be the most common and widely distributed and has been reported from Germany, England, Denmark, India, Japan and the U.S.A. It is characterized by sporangia with short broad exit tubes, spherical, 2.5–3μ, zoospores which contain a conspicuous hyaline refractive globule, and by large brown resting spores. *Olpidium macrosporum*, on the other hand, has been reported only once and is a very doubtful species. It is distinguishable by unusually large, ellipsoid, $6 \times 10\mu$, zoospores which are optically homogeneous and lack refractive globules, and by sporangia with greatly elongate tortuous exit tubes. Nowakowski (1876) did not observe flagella on the zoospores and described the appearance of the protoplasm and the method of cleavage as being similar to

those of saprolegniaceous fungi. It is quite probable, therefore, that this species does not relate to *Olpidium* at all. *Olpidium entophytum* var. *intermedium* Constantineanu (1901) is so little known that no definite conclusion can be drawn about its relationships. Constantineanu found neither zoospores nor resting spores, and the long undulating exit tube which he described resembles that of *O. macrosporum*. It is not improbable therefore, that his fungus may relate to the latter species.

The *Olpidium* parasites found by the author in Brazil differ primarily from those noted above by the size, shape and appearance of the zoospores and resting spores. The more commonly occurring one, illustrated in figs. 1 to 13 and 16 to 18, has spherical 3.5–4.5μ, zoospores which are slightly larger than those of *O. gregarium*, have an unusually long, 38–45μ, flagellum, and lack a conspicuous refractive globule. Instead, they contain numerous minute granules which are not very refringent. The exit tubes of the sporangia, however, are relatively broad and short like those of *O. gregarium*. On the other hand, its resting spores are hyaline in contrast to the brown color of the spores of *O. gregarium*. The presence or absence of a conspicuous refractive globule in zoospore are specific characters which seldom vary in chytrids, and primarily for this reason the writer does not believe that his species is identical to *O. gregarium* or to any of the other known *Olpidium* parasites of rotifers. In the lack of a refringent globule and the presence of numerous minute granules, the zoospores of the author's species resemble those of *O. Vampyrellae* (Scherffel, 1926), but the latter's zoospores are slightly smaller in size and oval in shape and have a shorter flagellum. Accordingly the Brazilian parasite is regarded as a new species and described below.

The second *Olpidium* species, illustrated in figs. 19 to 34, parasitizes the eggs and adults of *Monostyla* and *Distyla*, and is characterized by larger, oblong, 3–3.5×6–7μ, zoospores, which contain one or two small elongate lateral refractive globules and have a relatively short, 12–14μ, flagellum, and by hyaline, oval to spherical resting spores. By these characters it differs from the other known parasites of rotifers and is therefore diagnosed as a new species and described below.

In addition to these species several monocentric rhizidiaceous species and one polycentric chytrid have been found in rotifers and nematodes in Brazil. Three of the monocentric species, *Rhizophydium gibbosum*, *R. zoophthorum*, and *Endochytrium operculatum*, and the polycentric member, *Catenariu Anguillulae*,[1] are fairly well known and have been reported several times from various parts of the world. A fourth monocentric species was found on the eggs and adults of nematodes which relates to the genus *Phlyctochytrium* and appears to be new. It is the only known species of this

[1] Since this paper went to press, Couch (1945, Mycologia **37**: 187) has established a new family for this species and transferred it to the Blastocladiales.

genus which parasitizes microscopic animals, and inasmuch as the author has been unable to transfer it to algae and other hosts he regards it as a new species.

Olpidium granulatum, sp. nov.

Sporangiis hyalinis, laevibus, ovalibus, 7–26×12–44μ, subsphaericis 8–50μ diam., in unum brevem, latum, 3.5–5×6–10μ tubulum exeuntibus, Zoosporis sphaericis, 3.5–4.5μ, dense minuteque granulosis; flagello 38–45μ longo. Sporis perdurantibus, hyalinis, laevibus sphaericis vel ovalibus, 14–22μ diam. Germinatione ignota.

Sporangia, hyaline, smooth, oval, ellipsoid, 7–26×12–44μ, usually numerous, up to 16 in a cell, subspherical, 8–50μ diam., with one, 3.5–5μ wide by 6–10μ long, exit tube which usually does not extend far beyond the surface of the host cell. Emerged zoospores forming a globular mass at the exit orifice before dispersing; spherical, 3.5–4.5μ, with numerous minute granules and a 38–45μ long flagellum. Resting spores hyaline, smooth, spherical or oval, 14–22μ; germination unknown.

Parasitic in rotifer eggs, San Carlos, Matto Grosso, Brazil.

This species developed very quickly and abundantly in watered soil cultures and soon attained epidemic proportions in the eggs of *Distyla* sp. In one mount measuring 24 mm. square, four hundred and thirty-two infected eggs were found. However, the epidemic of infection began to subside within three weeks and after two months no evidence of the parasite was to be found. As in *O. gregarium* the sporangia are usually quite numerous (fig. 1) and as many as sixteen may often occur in one egg. On the other hand, a single large sporangium which almost fills the entire egg is not an uncommon occurrence in this species. The size and shape of the sporangia are usually correlated with the number present. When numerous sporangia are present they are usually small, crowded and even somewhat angular in shape, whereas, when only one to two occur, they almost fill the egg and may be oval to subspherical in shape.

Infection of the egg is readily observable, particularly when the content of the egg is contracted as in fig. 2. The zoospore comes to rest on the surface, round up, and after a dormant period of 1½ to 3 hours forms a germ tube which penetrates the wall. In cases where the host protoplasm is contracted and enveloped by a membrane (fig. 2) the germ tube may become relatively long. After it has entered the host its tip apparently deliquesces and the spore plasm slowly flows into the egg, leaving the empty spore case behind. Fig. 3 shows an infected egg with four small parasites within and a fifth one in the process of entering. In these early stages no well-defined walls are visible around the parasites, but the fact that the protoplasts of host and parasite are immiscible indicates that some type of delimiting membrane is present around the latter. No marked antagonism between the two protoplasts is visible at first, but within a short time the host pro-

toplasm begins to retract from the wall and becomes more and more vacuolate (fig. 3). As the parasites grow in size the host protoplasm aggregates around them and is gradually absorbed, so that very little is present in the egg but sporangia by the time the latter are mature.

In the young stages the protoplasm of the parasite appears to be very hydrated or watery with a few suspended discrete bodies. Well-defined vacuoles soon develop into the cytoplasm (figs. 5, 6) which usually fuse later (fig. 7) to form one or more larger central ones. This phase is followed by progressive cleavage (figs. 8, 9) and maturation of the cleavage segments. At maturity the tip of the relatively short exit tube deliquesces and the zoospores emerge singly and in quick succession (fig. 1-A). They form a globular mass at the orifice and are embedded in a slimy substance which apparently dissolves and disperses in a very short time, for within a minute after emerging the zoospores begin to separate. By the time a minute and a half has elapsed, they begin to shake violently and within two minutes they swim away. The first swimming movement is quite uneven, and the zoospore appears to shake and vibrate as it moves along. Later the movement becomes more regularly darting or hopping.

As was noted earlier the zoospores lack a conspicuous refractive globule and contain instead numerous minute granules which are more or less evenly distributed (figs. 10, 12). They are further distinguishable from those of *O. gregarium* by the possession of an unusually long flagellum. With the view of emphasizing these differences more objectively, I have presented in figs. 14 and 15 zoospores of *O. gregarium* as they were drawn by Nowakowski (1876) and Butler (1907). The zoospores of *O. granulatum* may often become slightly amoeboid in shape (fig. 12) and creep around with the long flagellum trailing behind. The motile period lasts from twenty-five to seventy minutes after which the zoospores come to rest and round up (fig. 13). Some of them may remain in this state for several hours and often have the appearance of minute cystospores. Those which fail to reach the host eventually disintegrate. Occasionally, cleavage in the sporangia is incomplete or unequal with the result that large zoospores are formed. Fig. 11 shows an unusually large, 11μ in diam., abnormal zoospore with six long flagella.

The resting spores of *O. granulatum* are hyaline, smooth, oval to spherical in shape (figs. 16–18), 14–25μ, and lie in thin-walled hyaline vesicles which vary from 22 to 33μ in diameter. The content of the spores is at first coarsely granular and refractive, but as time goes on the refractive material accumulates in the form of large globules (figs. 17, 18). Germination of the spores has not been observed. Similar spores were found by Butler (1907) and Sparrow (1936) in *O. gregarium*, but these were brown instead of hyaline in color. Butler believed that the surrounding vesicles were the remnants of the cleavage segments of the egg which had become

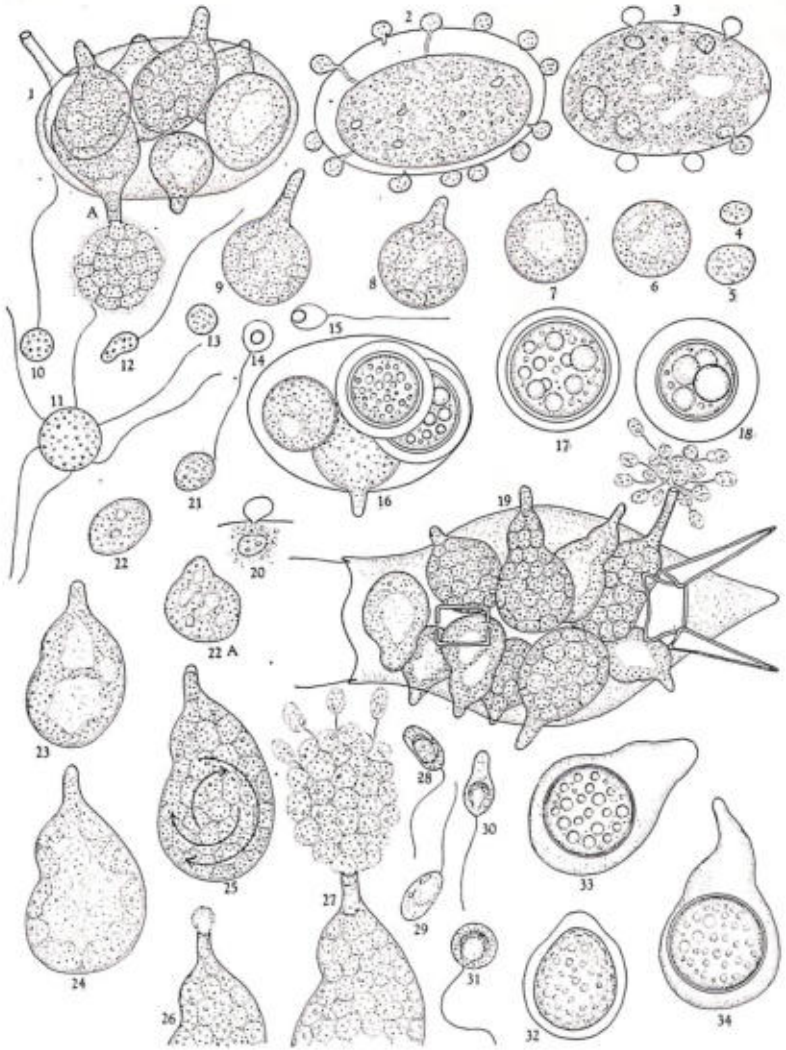


PLATE 1. Figs. 1–18.—*Olpidium granulatum*. 1. Rotifer egg with eight sporangia of parasite. 2. Infection of rotifer egg. 3. Egg with four minutes parasites; a fifth one in the process of entering; empty spore cases attached to surface of egg. 4–9. Successive developmental stages of thallus and sporangium. 10–13. Spherical abnormal multiflagellate, amoeboid, and quiescent zoospores, respectively. 14, 15. Zoospores of *O. gregarium* after Nowakowski (1876) and Butler (1907), respectively. 16. Rotifer egg with two sporangia and two resting spores. 17, 18. Resting spores in vesicles. Figs. 19–34.—*O. rotiferum*. 19. Adult rotifer with ten parasites, 20–22 A. Infection of egg and successive developmental stages of a thallus. 23–27. Developmental stages, cleavage, internal swarming of zoospores, deliquescence of exit papilla, and discharge of zoospores from a pyriform sporangium. 28, 29. Oblong zoospores with a dense central region and two refractive globules. 30, 31. Zoospores near end of motile period; densé nuclear cap around nucleus. 32–34. Stages in resting spore formation.

infected. Sparrow (1943) concurred with this belief, but the present writer is not certain that this is true of the vesicles in *O. granulatum*.

Olpidium rotiferum, sp. nov.

Sporangiis hyalinis, laevibus, pyriformibus, 12–40×20–70μ, ovalibus, 10–20×15–35μ, subsphaericis, 15–40μ, in unum brevem latum, 4–6×5–12μ, tubulum exeuntibus. Zoosporis oblongis, 3–3.5×6.5–7μ; flagello 12–14μ longo. Sporis perdurantibus, hyalinis, laevibus, ovalibus, 12–14×15–17μ, sphaericis, 10–15μ. Germinatione ignota.

Sporangia gregarious, up to 15 in a cell, hyaline, smooth, predominantly pyriform, 12–40×20–70μ, oval, 10–20×15–35μ, subspherical 15–30μ, with one short broad, 4–6×5–12μ exit tube. Zoospores swarming in sporangium before emerging; later forming a globular mass at exit orifice; oblong, 3–3.5×6.5–7μ, with one or two small lateral, elongate refractive bodies; flagellum 12–14μ long. Resting spores hyaline, smooth, oval, 12–14×15–17μ, spherical, 10–15μ; germination unknown.

This species parasitizes eggs and adults of rotifers but occurs most commonly in the adult bodies. Like *O. granulatum* it attained epidemic proportions for a short time but disappeared from the cultures within two months. In severe cases of infection (fig. 19) the rotifer body may become filled with sporangia, and in a few instances as many as 15 parasites were found in one host. Infection of mature rotifers was not observed but in the case of eggs the method is fundamentally the same as was described for *O. granulatum*. The zoospore comes to rest on the host cell and develops a penetration tube through which the protoplasm flows into the egg (fig. 20). The mature rotifer does not appear to suffer any ill effects at first from the presence of the parasite and may continue to feed normally for a time. However, as the parasites increase in size it becomes sluggish and ceases feeding and by the time the parasites are half grown it is usually dead. The content of the rotifer body is gradually absorbed so that when the sporangia are mature scarcely anything but the shell remains. The changes produced in the eggs are much the same as those induced by *O. granulatum*.

Successive developmental stages of a thallus are shown in figs. 20 to 22-A and 23 to 27, which indicate that *O. rotiferum* develops in the same manner as the previous species. However, just before the exit tube deliquesces the zoospores begin to swarm in the sporangium (fig. 25). As is indicated by the arrows, the whole mass rotates for ten to ninety seconds in much the same fashion as Miss Waterhouse (1940) and the author (1942) have described for *Rozellopsis* and *Rozella*. As the tip of the exit tube deliquesces a small globular mass of hyaline slime exudes, (fig. 26) after which the zoospores swarm out. The first spores to emerge form a globular or irregular mass at the exist orifice, but they disperse before most

of the spores are discharged. Those within the sporangium continue to swarm, emerge singly and dart directly away. In large sporangia complete discharge of the zoospores may require up to ninety seconds.

As was noted elsewhere the zoospores are oblong to elongate in shape and have a comparatively short flagellum (figs. 28–31). Near the base and slightly towards the side lies one or two small oblong refractive bodies which may change in position as the zoospore swims or creeps about. The lower central portion of the spore is occupied by a globular denser mass which appears to be the nucleus. It becomes more optically heterogeneous and well-defined as the zoospore comes to rest, and in many cases observed it was surrounded at the upper end by a denser layer which resembles the nuclear cap of other simple fungi. Near the end of the motile period, which lasts from forty to seventy-five minutes, the zoospores become pyriform in shape (fig. 30) with a tapering anterior end, and by the time they have come to rest they are usually spherical (fig. 31).

The resting spores usually developed in abundance as the cultures became old. As was described in the diagnosis above, they are hyaline, smooth, oval or spherical in shape with a coarsely granular and refractive content (figs. 32–34). As they mature the refractive material usually accumulates in the form of numerous small globules. Like those of *O. gregarium* and *O. granulatum* the resting spores of *O. rotiferum* lie in hyaline vesicles, but in this species the vesicles are the walls of its own partly empty and unopened sporangia or thalli instead of cleavage segments of the host. The durable spores are formed by the contraction and encystment of the protoplasm in thalli or incipient sporangia in the same fashion described by Buckley and Clapham (1929) and the author (1944) for *Catenaria Anguillulae* and *Lagenidium parthenosporum*, respectively. Numerous successive stages of this process were observed which left no doubt about the origin, identity and nature of the vesicles. Figures 33 and 34 are particularly significant, because they show resting spores in incipient sporangia which had developed to the stage of exit tubes before their protoplasm contracted and encysted. The discovery that these vesicles relate to the fungus instead of the host suggests that those described above for *O. granulatum* also may be of the same nature, and for this reason the author is reluctant to regard them as infected and modified cleavage segments of the host. The walls of the sporangia, and resting spores of *O. rotiferum* and *O. granulatum* show no positive cellulose reaction when tested with chloriodide of zinc.

Phlyctochytrium nematodeae, sp. nov.

Sporangiis extramatricalibus, hyalinis, laevibus, sphaericis, 16–24μ, ovalibus, 15–18×19–22μ, rare urceolatis, 10–16×18–26μ, uno aut multis papillis instructis. Zoosporis ovalibus, 2.5–3μ, unguiculatis; flagello 12μ

longo. Sporis perdurantibus, extramatricalibus, hyalinis, laevibus, ovalibus sphaericis, 7–10μ. Germinatione ignota.

Sporangia usually numerous, extramatrical, hyaline, smooth, spherical, 16–24μ, oval, 15–18×19–22μ, rarely slightly urceolate, 10–16×18–26μ, with one to five low exit papillae. Apophysis oval, subspherical, 4–7μ in diameter. Rhizoidal system richly branched. Zoospores oval, 2.5–3μ, with a .5 to 1μ in diameter refractive globule, and a 12μ long flagellum. Resting spores extramatrical, hyaline, smooth, oval to spherical, 7–10μ, with one large and several small refractive globules; germination unknown.

Parasitic in adults and eggs or cysts of nematodes in soil samples from San Carlos, Matto Grosso, Brazil.

This species was found several times on eggs or cyst and thrice on adult nematodes. It appears to be a virulent parasite of eggs but whether or not it is capable of killing active adults is uncertain. All of the infected nematodes were dead at the time they were found, and it is not certain whether they had been killed by *P. nematodeae* or by some other agent. So far, this chytrid has not been found on rotifer eggs, and all attempts to infect algae with it have failed.

The development of this species is so similar to that of other known members of the genus that it is unnecessary to describe it in detail. The zoospores (fig. 35) emerge from one (fig. 37) or two deliquesced papilla and form a globular mass at the exit orifice. However, this mass becomes dispersed before all of the spores have emerged, so that those remaining in the sporangium escape singly and dart immediately away. They remain motile for twenty to fifty minutes and often become intermittently amoeboid (figs. 35 a, b). After coming to rest on the host (fig. 36) they form a short penetration tube which branches and develops into the intramatrical rhizoidal system and apophysis, while the zoospore body enlarges and develops into the extramatrical sporangium as in other species of *Phylctochytrium*. So far only a few resting spores have been found. These develop extramatrically (fig. 38) like the sporangia up to a certain stage and then accumulate numerous refractive globules. As the wall begins to thicken the globules coalesce to form one or more larger ones (fig. 38 b).

Rhizophydium gibbosum and R. zoophthorum

Among the numerous species of *Rhizophydium* found in Brazil were two which occurred on eggs of rotifers in watered soil samples from San Carlos, Matto Grosso. The first of these is characterized primarily by irregular gibbose sporangia and minute zoospores which contain one or more small globules. By these characters it is identical to the species found by Zopf (1888) on various desmids and rotifer eggs in Germany, which he named *Rhizophyton gibbosum*. This species was subsequently transferred to *Rhizophydium* by Schroeter (1889) and has since been known as *R. gib-*

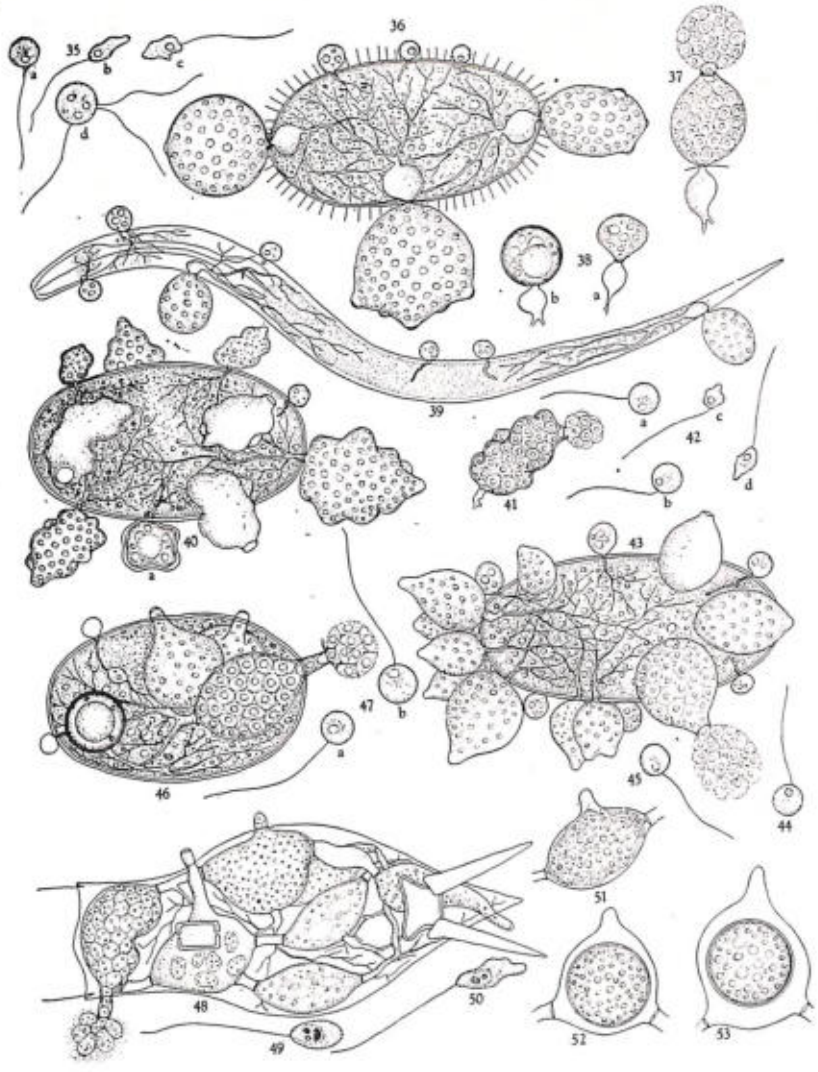


PLATE 2. Figs. 35–38.—*Phlyctochytrium nematodeae*. 35 a, b, c, d. Spherical, amoeboid, and abnormal multiflagellate zoospores, respectively. 36. Greatly enlarged nematode egg with six parasites. 37. Discharge of zoospores from sporangium. 38 a, b. Stages in resting spore development. 39. Mature nematode with seven parasites. Figs. 40–42.—*Rhizophydium gibbosum*. 40. Rotifer egg with nine sporangia and one resting spore. 41. Discharge of zoospores. 42 a, b, c, d. Spherical and amoeboid zoospores. Figs. 43–45.—*Rhizophydium zoophthorum*. 43. Rotifer egg with seventeen parasites. 44, 45. Zoospores. Fig. 46, 47.—*Endochytrium operculatum*. 46. Rotifer egg with four thalli and one resting spore. 47. Zoospores. Figs. 48–53.—*Catenaria anguillulae*. 48. Adult rotifer with internal rhizomycelium. 49, 50. Zoospores. 51–53. Stages of the development of resting spores.

bosum. The method of development, size and shape of the sporangia (fig. 45), branching of the rhizoids, method of zoospore discharge (fig. 41), as well as the appearance, size, shape and behavior of the zoospores (fig. 42) in the Brazilian material are similar to those described by Zopf, and no fundamental differences have been found. However, a few resting spores developed as the cultures became old. These occurred extramatrically (fig. 40 a) and are irregular in shape, 6 to 12μ in diameter, hyaline and smooth with one to several large refractive globules in the cytoplasm. So far germination has not been observed.

The second species, illustrated in figs. 43 to 45, is characterized by pyriform or oval sporangia with a prominent tapering apex and by a fairly stout branched rhizoidal system. The sporangia are usually closely crowded on the surface of the egg and sometimes become angular in shape because of mutual contact and pressure. In these characteristics as well as methods of zoospore discharge, size, shape, appearance and behavior of the zoospores, it is identical to *Rhizophydium zoophthorum* which Dangeard (1887, 1889) first found on rotifer eggs in France more than fifty years ago. Resting spores are unknown in this species, and none were found in the Brazilian material.

Endochytrium operculatum

This intramatrical operculate chytrid occurs normally as a soprophyte in decaying vegetation in water (Karling, 1937), but it may occasionally attack the cysts and eggs of microscopic animals. It was found on numerous occasions in rotifer eggs from soil samples collected at San Carlos, Matto Grosso and near Manaus, Amazonas in Brazil. Figure 46 shows an infected egg from San Carlos with three mature sporangia, one resting spore and a very young developing thallus. The sporangia, resting spores and zoospores of the Brazilian specimens are similar in every respect to those described by the author (1937) from the U.S.A., and there is no doubt that they relate to *E. operculatum*. In this connection it may be noted that Sparrow (1933) described *E. oophilum* as a parasite of rotifer eggs in New York. Since he found no rhizoids, he assigned his fungus provisionally to *Endochytrium*. As the present writer pointed out previously (1937) if *E. oophilum* actually belongs in *Endochytrium* it is doubtless identical to *E. operculatum*, because the latter species will readily infect microscopic animals as well as plant hosts.

Catenaria anguillulae

This polycentric species was found on several occasions in the body of adult rotifers in watered soil cultures collected on the banks of the Rio Madeira at Porto Velho, Amazonas. All of the infected rotifers were dead at the time of discovery, so that it is not certain that they had been killed

by this fungus or some other agent. Since *Catenaria anguillulae* may grow readily as a saprophyte in dead plant tissues (Karling, 1934) and on synthetic agar media (Butler and Humphires, 1932) it is possible that the thallus shown in figure 48 was a secondary invader. The sporangia, zoospores and resting spores of the South American specimens were similar to those reported from Europe and North America, and no outstanding differences were found. Resting spores occurred sporadically, and these were formed in the same manner described by Buckley and Clapham (1929). The content of thallus segments or incipient sporangia contracts (fig. 51), encyst (fig. 52) becomes enveloped by a thick hyaline wall (fig. 53) and lies free in the surrounding vesicle. Buckley and Clapham found that the spores germinate within the vesicles and give rise directly to exit tubes and posteriorly uniflagellate zoospores, but no germination stages have yet been seen in the Brazilian material.

SUMMARY

Two new species of *Olpidium*, *O. granulatum* and *O. rotiferum*, were found parasitizing rotifer eggs and adults collected at San Carlos, Matto Grosso, and Manaus, Amazonas in Brazil. *Olpidium granulatum* is characterized by small spherical zoospores which contain numerous minute granules and by hyaline oval or spherical resting spores, whereas *Olpidium gregarium* is distinguishable by large oblong zoospores. In addition to these chytrids a new species of *Phlyctochytrium*, *P. nematodeae*, was found parasitizing eggs and adult nematodes. It is the only known species of this genus which attacks animals and apparently does not infect algae. It is characterized by minute zoospores, spherical, oval or slightly urceolate sporangia, and oval or spherical, hyaline, smooth resting spores. *Rhizophydium gibbosum*, *R. zoophthorum*, *Endochytrium operculatum* and *Catenaria Anguillulae* were also found on and in rotifer eggs and adults in Brazil.

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Physiological Studies on Some Members of the Family Saprolegniaceae. V. Growth Substances*

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INTRODUCTION

The importance of growth substances in the metabolism and growth of plants and animals has now been well established. Many fungi, for instance, can grow on a medium containing some minerals as well as suitable carbon and nitrogen sources, out of which they can manufacture the growth substances required for their normal and perhaps optimal growth. Such species do not need an external supply of growth substances. There are other species which are unable to grow without an extraneous supply of growth substances, which they are incapable of synthesizing themselves. The third category consists of organisms which grow slowly in the absence of an external supply of growth substances, but more rapidly if these are added to the medium. Such organisms are capable of manufacturing their own growth substances, but do so at a sub-optimal rate. In such cases the deficiency of growth substances acts as a limiting factor and their addition results in a marked acceleration of growth. The organisms belonging to the first category described above are called "autotrophic" species while the other two types are referred to as "heterotrophic" species. Some of the latter forms have a "complete deficiency" for one or more vitamins, while others suffer from "partial deficiencies."

During the last few years a great amount of precise work has been done in this connection. Unfortunately, too many terms have been introduced to designate growth substances such as accessory growth factors, auximones, auxithals, ergones, growth activators, growth factors, nutrilites, plant hormones and vitamins. The literature about growth substances is now so extensive that it is neither possible nor advisable to include a review of it in this paper. For comprehensive surveys of the literature concerning the role of growth substances, the reader is referred to Went (1935), Bonner (1937), Robbins and Kavanagh (1941, 1942), Carroll (1943), and Schopfer (1943).

Yet very little work has been done on the effects of various growth promoting substances on the members of the family Saprolegniaceae. Leonian and Lilly (1937) found that *Plectospira gemmifera* and *Saprolegnia diclina* did not grow on a medium consisting of KH_2PO_4, $MgCl_2$, $MgSO_4$, NH_4NO_3 and dextrose. Addition of heteroauxin caused no response but

* Part of thesis approved for the degree of Doctor of Philosophy in the University of Allahabad.

good growth was obtained with the addition of yeast extract. Wolf (1937) reported that a definite inhibition of growth occurred in *Achlya bisexualis* and *Saprolegnia ferax* following the addition of alphanaphthalene acetic acid in concentrations 1:1,000,000 or higher. Leonian and Lilly (1938) also tested the effect of thiamin on *Achlya conspicua*, *Aphanomyces camptostylus*, *Isoachlya monilifera*, *Saprolegnia parasitica* etc. without obtaining positive results. Murdia (1939) studied the effect of β-indolyl 3-acetic acid and phenyl acetic acid on the growth of some saprolegniaceous fungi. *Thraustotheca clavata* was listed as a biotin deficient organism by Leonian and Lilly (1940). Saksena and Bhargava (1941) studied the effect of vitamin B_1 on the growth of *Saprolegnia delica*.

Achlya sp., *Brevilegnia gracilis* v. Eek, *Isoachlya anisospora* (de Bary) Coker var. *indica* Sak. et Bhar. and *Saprolegnia monoica* Pringsh. have been used in the present investigation which deals with (1) the synthesis of growth substances, (2) the effect of light on the yield of thiamin, and (3) the effect of vitamins B_1, B_2, C thyroxin and β-indolyl 3-acetic acid on the growth of these organisms.

METHODS

Since growth substances are effective only in most minute amounts and are widely distributed in the products of natural origin, much emphasis has been laid on the details of techniques used in experimental work dealing with these substances. These methods have been thoroughly discussed by Peskett (1933), Koser and Saunders (1938) and Robbins and Kavanagh (1938c, 1942), and the important precautions pointed out by them have been closely followed in these experiments.

The following nutrient media were prepared:

Medium A containing 0.5 gm. each of K_2HPO_4, $MgCl_2 \cdot 6H_2O$, 2.0 gms. NH_4NO_3, 0.05 gm. cystin, 5.0 gms. pure dextrose and 1000 cc. double distilled water.

Medium B containing all the ingredients of medium A but in place of 0.05 gm. cystin, there was 0.5 gm. K_2SO_4.

Medium C containing 0.5 gm. each of K_2HPO_4, $MgCl_2 \cdot 6H_2O$ and K_2SO_4, 1.0 gm. NH_4NO_3, 1.0 gm. purified asparagin, 5 gms. pure dextrose and 1000 cc. double distilled water.

Medium D containing all the ingredients of medium C but double distilled water was only 250 cc.

For the solidification of media Difco bacto agar was used.

Throughout the entire investigation only Pyrex glassware was used. The apparatus was thoroughly cleaned and washed several times with distilled water. Only guaranteed reagents (*proanalysi* of Merck or Analar of British Drug House) were used. Thiamin was vitamin B_1, vitamin B_2 was lacto-

flavin and vitamin C was ascorbic acid of Hoffmann-Roche (Switz.). Thyroxin and β-indolyl 3-acetic acid (heteroauxin) were obtained from British Drug House. Solutions of these substances were prepared so as to give 25 international units per 1 cc. of the solution. The unit of vitamin chosen is the same as that employed by Robbins and Kavanagh (1938c) and is equal to 10^{-9} mole of the compound. These substances were added to the solutions before autoclaving.

Asparagine was purified by repeated precipitations with alcohol and the purification of agar was carried on by treatment with pyridine and alcohol (Robbins and Ma 1941, p. 448).

Various media were sterilized in an autoclave for 15 minutes at 15 pounds pressure. All cultures were grown in triplicate. The temperature, unless otherwise stated, was 25°C. For sterile filtration Seitz sterile filter was employed.

Achlya sp., *Brevilegnia gracilis*, *Isoachlya anisospora* var. *indica*, *Saprolegnia monoica* and the test fungi used, i.e., *Phytophthora erythroseptica* Pethy. and + strain of *Phycomyces blakesleeanus* Burgeff, were maintained on oatmeal agar.

The known methods for quantitative determination of thiamin can be found in books by Williams and Spies (1938) and by Harris (1938). A very sensitive and simple test involves the use of the fungus *Phycomyces blakesleeanus*, growth of which is controlled largely by the amounts of thiamin (Schopfer 1934) or its components supplied in culture media (Robbins and Kavanagh 1937, 1938a, b). This method measures the cumulative activity of thiamin, its two components and cocarboxylase. Since some unidentified substances may stimulate somewhat the growth of the fungus in the presence of thiamin (Robbins and Hamner 1940), this method gives only an approximation of thiamin and related compounds. *Phytophthora erythroseptica* was also employed in the assay method.

EXPERIMENTAL

Series 1.—Media A, B and C were inoculated with *Phytophthora erythroseptica* and *Phycomyces blakesleeanus*, but there was no growth in any case. These two fungi responded if thiamin was added to these media.

Series 2.—*Achlya* sp., *Isoachlya anisospora* var. *indica* and *Saprolegnia monoica* were grown on medium A and *Brevilegnia gracilis* on medium B. The fungi showed good growth and were indefinitely transferable on the media.

Series 3.—Flasks containing 60 cc. of medium A were inoculated with *Achlya* sp., *Isoachlya anisospora* var. *indica* and *Saprolegnia monoica*, whereas flasks containing 60 cc. of medium B were inoculated with *Brevilegnia gracilis*. One set of cultures was kept in total darkness and the other was subjected to constant light at laboratory temperature (20°–22°C.) for

14 days. It was noticed that the colonies of fungi ramified in the medium.

(a) In each case the mycelium was removed from the three flasks of each set, and washed well in distilled water which was changed several times. It was ground and added to 200 cc. of medium C which was then heated in an autoclave for 5 minutes at 5 pounds pressure, filtered sterile and poured in five sterilized flasks. These were then incubated for 3 days at 30°C. The uncontaminated ones were inoculated with the test fungi.

(b) In each case 25 cc. of medium D was added to 125 cc. of the staled medium from which the mycelium was removed as described under series 3 a. The pH of the medium was adjusted to 7 by N/10 KOH solution and the medium was then filtered sterile, and poured in five sterilized flasks. The flasks were then incubated for 3 days at 30°C. The uncontaminated ones were inoculated with the test fungi. The period of incubation was 15 days at 25°C.

TABLE 1. *Dry weight (in mgs.) of the test fungi grown for 15 days on media used in Series III a and b. Temperature = 25°C.*

	Phytophthora erythroseptica				*Phycomyces blakesleeanus*			
	Medium D +staled medium		Medium C +mycelial extract		Medium D +staled medium		Medium C +mycelial extract	
	Light	Darkness	Light	Darkness	Light	Darkness	Light	Darkness
Achlya sp.	6.0	14.0	5.0	8.3	14.3	29.5	7.0	12.5
B. gracilis	12.5	34.0	14.3	43.3	12.0	28.0	11.0	35.0
I. anisospora var. *indica*	7.5	19.0	5.5	13.3	13.0	35.0	9.0	23.0
S. monoica	10.3	23.2	6.0	16.3	12.0	30.0	7.5	26.5

It was found that the test fungi gave appreciable growth in all experiments in the case of each fungus (Figs. 1–8). Dry weight of the colonies obtained is given in table 1.

The results tabulated in table 1 indicate that the test fungi gave more growth when they were grown on medium D containing the staled medium than on those containing the mycelial extracts of *Achlya* sp., *Isoachlya anisospora* var. *indica*, and *Saprolegnia monoica*, but reverse results were obtained in the case of *Brevilegnia gracilis*. Another important conclusion derived is that the growth of the test fungi was greater on media obtained from the set of cultures kept in total darkness than from those kept in light.

Series 4.—Media A and B were supplemented with various growth substances in different concentrations (5, 50 and 100 units per 25 cc. of the medium) singly and experiments were performed in Petri dishes and flasks.

TABLE 2. *Diametric spread (in cms.) of the fungal colonies on solidified medium A and B with and without growth substances. Temperature 25°C.*

Fungi	At the end of (hrs.)	Without growth substances	Supplemented with vitamin B_1, each dish containing (units)			Supplemented with vitamin B_2, each dish containing (units)			Supplemented with vitamin C, each dish containing (units)			Supplemented with thyroxin, each dish containing (units)			Supplemented with indolyl acetic acid, each dish containing (units)		
			5	50	100	5	50	100	5	50	100	5	50	100	5	50	100
Achlya sp.	24	1.5	1.6	1.5	1.5	1.5	1.6	1.5	1.5	1.4	1.5	1.5	1.4	1.4	1.5	1.5	1.3
	48	2.7	2.7	2.8	2.7	2.8	2.8	2.6	2.6	2.7	2.7	2.7	2.5	2.5	2.6	2.6	2.3
	72	3.7	3.7	3.7	3.6	3.8	3.7	3.5	3.5	3.5	3.4	3.7	3.5	3.1	3.5	3.2	3.2
B. gracilis	24	5.9	6.1	6.1	6.2	6.1	6.1	6.2	6.0	6.2	6.0	6.1	6.2	5.9	6.0	5.8	5.7
	48	11.5	11.5	11.5	11.4	11.5	11.5	11.6	11.4	11.5	11.0	11.5	11.6	11.5	11.5	11.2	11.0
I. anisospora var. *indica*	24	3.4	3.4	3.5	3.5	3.3	2.9	2.8	3.1	2.9	2.7	3.3	3.4	3.2	3.2	2.7	2.5
	48	5.5	5.5	5.6	5.4	5.3	5.1	4.9	5.1	4.8	4.7	5.4	5.5	5.2	5.0	4.8	4.5
	72	7.6	7.6	7.7	7.5	7.4	7.2	7.0	7.2	6.9	6.8	7.4	7.5	7.2	7.5	6.9	6.5
S. monoica	24	1.5	1.5	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.3	1.5	1.4	1.3	1.5	1.3	1.2
	48	2.6	2.6	2.5	2.4	2.5	2.6	2.6	2.6	2.4	2.3	2.6	2.5	2.1	2.4	2.2	2.0
	72	3.6	3.6	3.3	3.0	3.5	3.5	3.4	3.6	3.4	3.2	3.6	3.5	3.2	3.2	3.1	3.0

Media A and B served as control. The inoculum was cut off from the margin of the young colony maintained on solid medium A or B in each case. The results are summarized in tables 2 and 3.

The results obtained above indicate that the growth of the fungi on media supplemented with different doses of thiamin was nearly the same as that on the control. Vitamins B_2, C and β-indolyl 3-acetic acid have similar effects when supplied in lower doses (i.e., 5 and 50 units per 25 cc. of

TABLE 3. *Dry weight of mycelium (in mgs.) of the fungi grown for 14 days in flasks on medium A and B with and without growth substances. Temperature=25°C.*

Growth substances		*Achlya* sp.	*B. gracilis*	*I. anisospora* var. *indica*	*S. monoica*
Name	Amount in each flask (in units)				
B_1	5	48.3	33.6	35.0	43.6
	50	45.0	31.6	32.6	43.6
	100	48.0	34.5	29.3	38.8
B_2	5	47.6	32.0	32.3	38.5
	50	41.0	31.6	30.0	36.6
	100	40.0	30.3	26.6	34.3
C	5	42.0	34.0	33.3	40.0
	50	42.3	33.5	31.6	36.0
	100	37.3	29.6	30.6	32.0
Thyroxin	5	43.3	32.0	34.0	36.6
	50	38.3	30.3	31.0	35.3
	100	38.0	27.6	31.0	30.0
Indolyl acetic acid	5	42.3	34.0	32.6	36.0
	50	40.0	31.6	31.0	35.0
	100	35.6	26.0	28.6	30.0
Control	0	44.0	35.0	36.0	40.0

the medium). Higher concentrations (100 units per 25 cc. of the medium) of these three substances retarded the growth of the organisms. Thyroxin was harmful when supplied in 50 and 100 units per 25 cc. of the medium.

Series 5.—The fungi were grown on Difco bacto agar, purified Difco bacto agar and purified bacto agar supplemented with agar extract. It was found that *Brevilegnia gracilis* was able to grow on all three media but *Achlya* sp., *Isoachlya anisospora* var. *indica* and *Saprolegnia monoica* grew only on Difco bacto agar and purified bacto agar supplemented with agar extract. The latter did not grow on purified bacto agar alone.

DISCUSSION

Since *Achlya* sp., *Isoachlya anisospora* var. *indica* and *Saprolegnia monoica* were able to grow and were transferable on medium A and *Brevilegnia gracilis* was able to grow on medium B (Series 2), both of which were free from the significant amounts of thiamin and its components (Series 4), it is clear that these fungi do not require thiamin from an external source for their growth.

It is now well established that the growth of *Phytophthora erythroseptica* and *Phycomyces blakesleeanus* is controlled by thiamin or its components respectively, and it has been demonstrated above that they did not grow on media A, B, C and D. Since these two fungi grew well on the media used in series 3a and b, it can be safely assumed that the required thiamin and probably its intermediates were present in the extracts of the mycelium (Series 3a), and that part of the synthesized vitamin was also given off by the mycelium into the solution (Series 3b). These species behave like *Cunninghamella blakesleeana* Lender (Leonian and Lilly 1938, p. 540), *Saprolegnia delica* Coker (Saksena and Bhargava 1941) and some species of *Pythium* (Saksena 1941) which synthesize their own thiamin from the ingredients of the nutrient medium.

From the results summarized in table 1, it is clear that the yield of growth substance in cultures kept in total darkness is greater than that in cultures subjected to constant light. Robbins and Kavanagh (1941, p. 496) have reported that many plants (bacteria and fungi) which lack chlorophyll synthesize thiamin in the dark. On the other hand Thimann and Dolk (1933) obtained data indicating higher yield of growth substance in illuminated cultures than in those kept in the dark. Occasionally they too got higher value for cultures kept in the dark. Later they (Thimann and Dolk 1933, p. 60) remark, "The data we have obtained are, however, far from conclusive . . . . It is hoped to carry out conclusive experiments at a later date."

Results of experiments carried on as series 4 and tabulated in tables 3 and 4 indicate that the addition of thiamin has no marked effect on the growth of these fungi. The differences which appear are within the limits of experimental error, and are therefore, not significant. In this respect these fungi resemble *Agaricus campestris* Linn., *Absidia glauca* Hagem, *Basidiobolus ranarum* Eidem, *Cunninghamella* sp. no. 102, *Mucor circinelloides* v. Tiegham (Robbins and Kavanagh 1938), *Saprolegnia delica* Coker (Saksena and Bhargava 1941) and some species of *Pythium* (Saksena 1941). These results also indicate that these fungi synthesized the required quantity of thiamin and, therefore, an external dose of thiamin did not increase their growth.

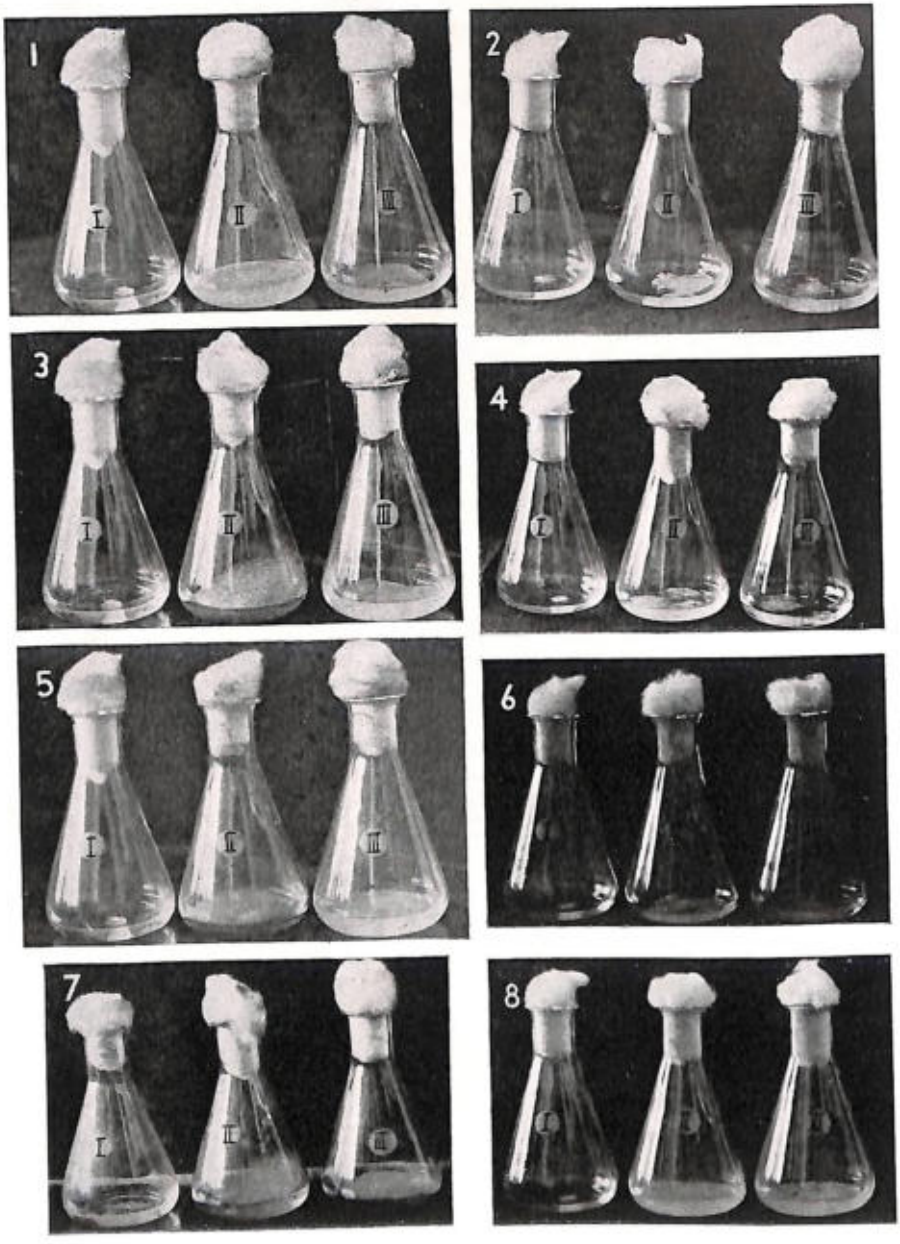


FIG. 1. Growth of *Phycomyces blakesleeanus* on medium C (I), staled medium (II) and mycelial extract (III) of *Achlya* sp. FIG. 2. Growth of *Phytophthora erythroseptica* on media used in Fig. 1. FIG. 3. Growth of *Phycomyces blakesleeanus* on medium C (I), staled medium (II) and mycelial extract (III) of *Isoachlya anisospora* var. *indica*. FIG. 4. Growth of *Phytophthora erythroseptica* on media used in Fig. 3. FIG. 5. Growth of *Phycomyces blakesleeanus* on medium C (I), staled medium (II) and mycelial extract (III) of *Saprolegnia monoica*. FIG. 6. Growth of *Phytophthora erythroseptica* on media used in Fig. 5. FIG. 7. Growth of *Phycomyces blakesleeanus* on medium C (I), mycelial extract (II) and staled medium (III) of *Brevilegnia gracilis*. FIG. 8. Growth of *Phytophthora erythroseptica* on media used in Fig. 7.

Addition of vitamin B_2 (lactoflavin) does not improve the growth of the fungi. In higher concentration (100 units per 25 cc. of the medium), however, it has a tendency towards retardation of growth.

Ascorbic acid (vitamin C), though occurring abundantly in plants, appears to be without any growth promoting effect. In the present case, it too has a tendency towards retardation of growth. Kögl and Haagen Smit (1936) also report that ascorbic acid appears to be without a growth promoting effect. Das Gupta and Guha (1941) report that the addition of ascorbic acid to the nutrient medium in a concentration of 1/50,000 produces stimulation of growth of *Aspergillus niger*, *A. oryzae* and *Saccharomyces cerevisiae* etc. in the beginning, which later becomes roughly equal to that of the controls. It has an inhibitory effect on their growth in a concentration of 1/10,000.

Thyroxin and β-indolyl 3-acetic acid are without effect in low concentration but in higher doses they retard the growth. Leonian and Lilly (1937) report that low concentrations of heteroauxin do not induce any stimulation and higher concentrations are toxic to the growth of *Plectospira gemmifera* and *Saprolegnia diclina*. For heteroauxin they (1937, p. 139) remark, "heteroauxin is a growth-inhibiting rather than a growth promoting substance. It may be possible that acting like a powerful stimulant or irritant, it induces the formation, the transportation to, and the concentration in the invaded region of large quantities of the growth substances of the plant. This constant drain may eventually lead to weakening and ultimate death unless the foreign substance is removed or neutralized." Murdia (1939) reports that β-indolyl 3-acetic acid is of no value as a growth stimulant. It rather inhibits the growth in higher concentrations in the case of *Achlya dubia*, *Aphanomyces camptostylus*, *A. cladogamus*, *Pythiopsis intermedia* and *Thraustotheca clavata*.

Robbins and Ma (1941, p. 461) have reported that extraction of agar with aqueous pyridine removed all or almost all of biotin. The results of experiments described under series 5 indicate that *Achlya* sp., *Isoachlya anisospora* var. *indica* and *Saprolegnia monoica* may be biotin deficient organisms, being incapable of growing on purified Difco agar but showing growth with the addition of agar extract to the purified Difco agar. Leonian and Lilly (1940) listed *Thraustotheca clavata* a related genus, among biotin deficient organisms.

A reasonable objection can be raised here that the absence of growth of the organisms on purified Difco agar may be due to the removal of necessary minerals during the process of purification. Since *Brevilegnia gracilis* is capable of growing on purified Difco agar it is assumed that the necessary amount of minerals is retained by the agar even after purification. In spite of best efforts the author failed to procure mineral salts and sugars free from biotin to add to the purified agar. Therefore it cannot be said with certainty that they are biotin deficient organisms.

SUMMARY

Achlya sp., *Brevilegnia gracilis*, *Isoachlya anisospora* var. *indica* and *Saprolegnia monoica* are capable of unlimited growth on a nutrient medium which does not contain any appreciable amount of thiamin or its components. They synthesize their own thiamin from the ingredients of the nutrient solution and some of the thiamin thus manufactured is also given off by the mycelium into the solution.

The amount of thiamin manufactured is greater in cultures kept in total darkness than in those exposed to constant light.

The addition of vitamins B_1, B_2, C, thyroxin and β-indolyl 3-acetic acid in low concentrations has no marked effect on the growth of these organisms. Higher concentrations of vitamins B_2, C, thyroxin and β-indolyl acetic acid retard their growth.

The experimental results indicate that *Achlya* sp., *Isoachlya anisospora* var. *indica* and *Saprolegnia monoica* may be biotin deficient organisms whereas *Brevilegnia gracilis* does not require an external supply of biotin.

ACKNOWLEDGMENT

I wish to express my gratitude to Dr. R. K. Saksena, who suggested the problem to me and whose criticism has been invaluable during the progress of the work. My grateful thanks are expressed to Prof. J. N. Couch, University of North Carolina, U. S. A. for his kindness in going through the manuscript and making useful suggestions. I have also great pleasure in acknowledging my indebtedness to Dr. G. Watts Padwick, Imperial mycologist, New Delhi; Prof. S. R. Bose, Calcutta; and Dr. B. B. Mundkur for helping me with relevant literature.

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Nuclear Cycle and Life History of a New Species of Doassansia (Ustilaginales)

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The diagnostic characters of the genus *Doassansia* Cornu (1883) are the presence of spore balls which are permanently embedded within the host tissues with a cortex of sterile cells. Only three species are reported from India (Mundkur 1940), viz. *Doassansia Nymphaeae* Syd. known only from the type collection made by Chibber on *Nymphaea stellata*, *D. Alismatis* (Nees) Cornu on the leaves of *Alisma plantago* collected by Butler in Kashmir and *Doassansiopsis Martianoffiana* (Thüm) Diet. also collected by Butler in Kashmir. None of the three above mentioned species has so far been reported from southern India. While collecting smuts near Nandi Hills, the writer came across a leaf smut of *Hygrophila* species growing in marshy places which on examination proved to be an unrecorded species of *Doassansia*. The details of the nuclear cycle and the life-history of the smut have been worked out and are here presented together with the description.

Material for cytological study was fixed in formalin acetic alcohol, and the microtome sections were stained with Heidenhain's iron-alum hematoxylin as well as Newton's iodine gentian violet. For the germination of the spores, the host tissue containing the sori was teased out. The spores separated from the spore balls were germinated and stained by the method suggested by the author (1940).

The smut is foliicolous and only once has it been observed on some of the calyx lobes. The first indication of the presence of the fungus is the appearance of circular pale-yellowish spots on the lower surface of the leaves. These spots gradually enlarge in width becoming orange-yellow in color on account of the spread of the mycelium within the host tissue. The sori begin their development in the center, whence they gradually expand concentrically in a centrifugal manner. The spore balls which are embedded within the host tissue, can be observed macroscopically as minute pustulate specks. In later stages the entire infection patch dries up and crumbles away leaving a circular pore resembling shot holes.

Sections through a young infection spot reveal the mycelium which is hyaline and which traverses the intercellular spaces. The host cells in the neighborhood lose their cell contents and turn orange-yellow in color. The hyphae are septate, thin-walled and distinctly binucleate. The fundaments of the spore balls are formed by the grouping of the hyphae which branch repeatedly intertwining with one another and forming a spherical mass. Many of the hyphal cells begin to round off and later on develop into spores

(Fig. 4). This process is accompanied by the gelatinization of the walls. In a young sorus, the spores are compactly arranged; they are somewhat polygonal as a result of lateral compression. There is no indication of the presence of any unaltered hyphae surrounding this spore mass as noticed by Setchell (1892) in *D. Alismatis* (Nees) Cornu. The sterile cortical layer is formed by the transformation of the outermost layer of spores. The cells of the outermost layer enlarge and later on elongate in a radial direction. The nucleus degenerates and the cytoplasm becomes pressed to the margin, being replaced by large vacuoles. In the meanwhile, the two nuclei in the young fertile spores fuse to form a single fusion nucleus. The mature spores (Fig. 2) are hyaline, pale cinnamon yellow, thin-walled, polygonal and measure 10 to 15μ. The cells of the sterile cortex are of a slightly deeper shade and measure 16.5–25×9–15μ. The mature spore balls (Fig. 1) are large, subspherical or ovate to polygonal, occupying sometimes the entire mesophyll tissue between the upper and lower epidermis. Coalescence of several spore balls developing in close proximity has been noticed in many cases. The fertile spores entirely fill the space in the center conforming to the subgenus *Eudoassansia* of Setchell (1892). Except for minor variations, the type of development of the spores agrees in all respects with that given by Fisch (1884), Setchell (1892), Dangeard (1894) and others for the species of *Doassansia*.

The spores germinate readily without a period of rest being necessary. When sufficient moisture becomes available, the spores swell slightly and the germ tube extrudes after bursting the spore coat (Fig. 3). The fusion nucleus migrates into the aseptate promycelium thus formed, and in almost all cases observed, undergoes three successive divisions resulting in the formation of 8 free nuclei. When the promycelium has reached its full length (which at this stage is broader at the base and gradually tapers into a point), small papillate projections which are in fact the rudiments of sporidia, are differentiated at the tip. These elongate gradually until the mature sporidia, from 5 to 7 in number, are formed in a whorl at the tip. The sporidia are inserted equidistant from each other and spread out in a radiating manner. Each sporidium receives a single nucleus, and in those cases where only 5, 6 or 7 sporidia are formed, the supernumerary nuclei 3, 2 or 1 respectively as the case may be, are left in the promycelium (Fig. 7). Like conditions have been described by Rawitscher (1922) for *D. Sagittariae* (West) Fisch, Biraghi (1934) for *Urocystis Tritici* Koern., and probably occurs also in *D. Alismatis* (Lutman 1910). This clearly indicates that of the 8 sporidia which develop normally, only 5, 6 or 7 sporidia are actually produced. During the course of sporidial development, usually the cytoplasm is not used up entirely and a small quantity is thus left behind the promycelium. Following the depletion of the cytoplasmic contents, vacuoles appear in the promycelium and as the contents are with-

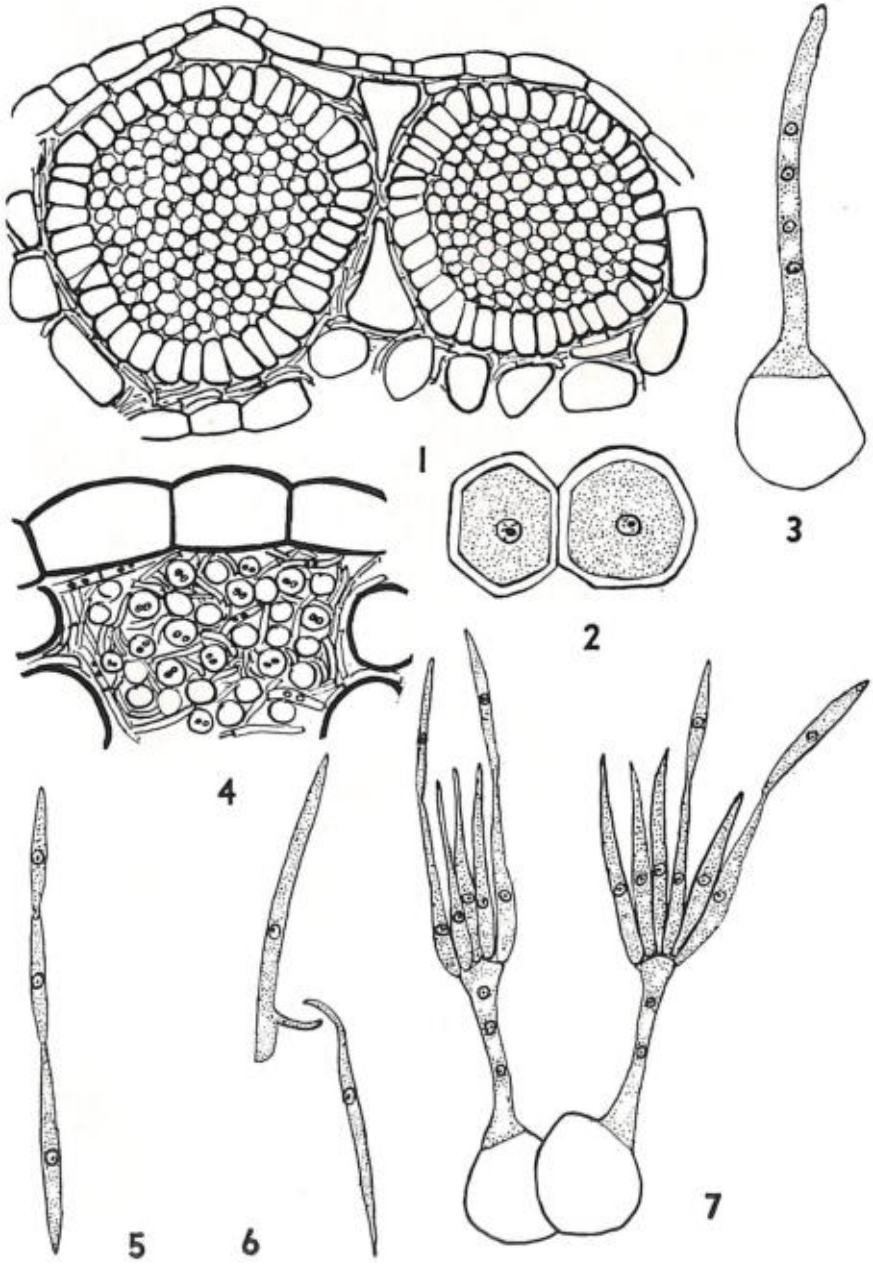


FIG. 1. Showing the spore balls within the host tissue, ×200. FIG. 2. Mature spores, ×800. FIG. 3. Germinating chlamydospore, ×900. FIG. 4. Section through a young sorus, ×1800. FIG. 5. Development of secondary and tertiary sporidia, ×900. FIG. 6. Early stage in the formation of conjugation tubes. ×1000. FIG. 7. Germination of chlamydospores, ×900.

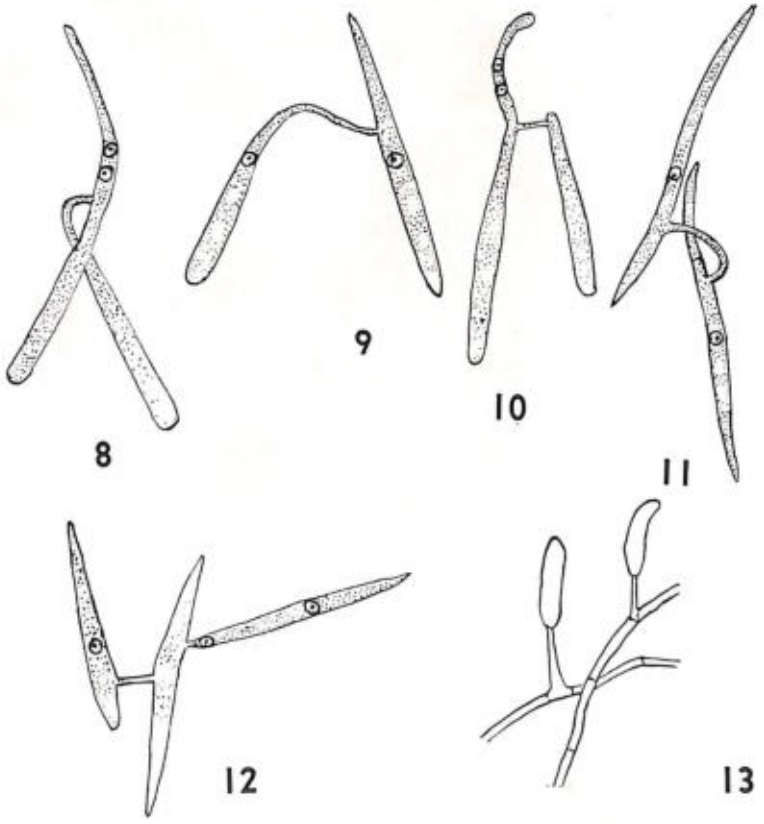
drawn towards the apex, one or rarely two septa are formed in the promycelium. This feature has been noticed by Setchell (1892) in many of the species of *Doassansia* studied by him.

Mature sporidia are fusiform, thin-walled, broader at the base than at the apex, slightly asymmetric, uni-nucleate and measure 14–16×1–1.2μ. The sporidia do not show any signs of conjugation, but get readily separated from the promycelieum. In many cases the formation of secondary sporidia (Fig. 7) even while still attached to the promycelium, and the formation of tertiary sporidia (Fig. 5) have been observed. The secondary and tertiary sporidia so formed are always developed in catenations acrogenously and never in whorls as in *D. obscura* Setchell. The secondary sporidia resemble the primary ones in all respects.

The sporidia begin to conjugate after separation from the promycelium. On the slides over which the spores were germinated, one could observe large numbers of conjugating sporidia floating in water. Though experimental evidence is still lacking, sporidia from the same promycelium apparently do not conjugate. On the other hand, sporidia derived from separate chlamydospores appear to conjugate after they get loosened from the promycelium and have come in contact with one another. In some cases in which single chlamydospores had germinated far apart, with their sporidial mass separated and lying close by, no sporidial fusions were observed, probably because they all belonged to the same chlamydospore. On the other hand, Setchell (1892) has shown that the sporidia of *D. Alismatis* develop conjugation tubes while still attached to the promycelium; however, conjugation has not been observed in *D. Sagittariae* which, according to Rawitscher (1922) and others, resembles *Ustilago Zeae* in the type of diploidization.

Prior to conjugation, each of two sporidia closely situated to one another develops a small recurved process (Fig. 6). These processes meet and fuse thereby establishing a direct connection. They can develop from any part of the sporidia, either at the apex or at the sides (Figs. 8 to 11). After conjugation, the nuclei of the two sporidia pass into the infection hyphae which become septate and prominently show the binucleate condition. In those cases in which the conjugation processes are formed from the equatorial region of the sporidia, an H-shaped connection is established as in many *Tilletia* species and the infection hypha is developed from the conjugation tube. On the other hand, when the sporidia fuse by their terminal ends, the nucleus and cytoplasm from one sporidium completely migrate into the other. In rare instances, the conjugation of more than two sporidia has also been observed. In one case, three sporidia had conjugated with one another, but the infection hyphae that had formed possessed only two nuclei, while the nucleus of the third sporidium was lagging behind and probably became non-functional (Fig. 12).

Germinating spores were used for inoculating the leaves of *Hygrophila* sp. in petri dishes according to the method adopted by Clinton and McCormick (1924). The leaves could be maintained in the dishes only for 12 to 15 days. However within that time, the inoculated leaves showed the infection spot gradually expanding into a yellow patch, resembling in all respects those which occur in naturally infected leaves. In artificial inocu-



FIGS. 8–12. Conjugation of sporidia, ×1000. FIG. 13. Development of conidiospores on the secondary mycelium, ×1800.

lation experiments, stages up to the development of the spore balls could not be followed, because the vigor of the host leaves gradually diminished.

In some of the germinating spores, the infection hyphae developing after sporidial conjugation had produced limited branching hyphae. It was observed that some of these had formed laterally somewhat allantoid to arcuate spores. These are probably (Fig. 13) of the same nature as the falcate conidia borne on the secondary mycelium of species of *Tilletia*. This type of conidia has, as far as the author knows, not been described for any

of the species of *Doassansia*. Further studies are being made to eludicate the nature of these secondary spores.

The structure and development of the sori indicate that the species of *Doassansia* under consideration belongs to the subgenus *Eudoassansia* of Setchell. Among the species of *Doassansia* found on various Sympetalae with which the present species could be compared might be mentioned *Doassansia Downingiae* Liro on *Downingia elegans* (Lobeliaceae) described by Liro (1935) and *D. Rhianthi* Lagerh. described recently by Zundel (1944) on *Rhianthus* (Scrophulariaceae). Comparative studies indicate that the two smuts referred to above are quite different from the species occurring on *Hygrophila*. The dark brown opaque spore balls with reddish-brown sterile cortex of *D. Rhianthi* and the thick-walled yellowish sterile cortex with punctate walls of *D. Downingiae* clearly differentiate them from the *Doassansia* species on *Hygrophila*. Furthermore, the spore measurements also show considerable variation, and there is little doubt that the *Doassansia* species on *Hygrophila* is new to science.

Doassansia Hygrophilae, sp. nov.

Sori foliicolous, forming yellow spots gradually enlarging into orange-yellow patches, spots circular to irregular, 8 to 12 mm. wide, with minute pustulate specks arranged concentrically indicating the position of the spore balls. Spore balls permanently embedded in the mesophyll tissue, occupying the entire space between the upper and lower epidermis, globose to polygonal due to pressure against one another, often confluent, 120 to 200μ in diam. Cortex distinct, cortical cells conspicuous, radially elongate, 16.5–25$\times$9–15μ; rounded at both ends, cinnamon-yellow, smooth and vacuolate; spore mass completely filling the interior, individual spores loosely packed, pale cinnamon-yellow, subglobose to angular on account of lateral compression, thin-walled, smooth, 10–15μ in diam. with a mean of 12.2μ. Spores germinating with one or rarely two-septate promycelia bearing a terminal whorl of 5 to 7 sporidia, spreading out in a radiating manner; mature sporidia fusiform, broader at the base than at the apex, asymmetric, measuring 14–16$\times$1–1.2μ, forming secondary sporidia acrogenously, and conjugating after separation from the promycelium.

Habitat: On the leaves of *Hygrophila* sp. Nandi Hills, Mysore State, India, 5-11-1944, leg. M. J. Thirumalacher; type deposited in the Herb. Crypt. Ind. Orient., New Delhi and at the Imperial Mycological Institute, Kew, England.

Sori foliicoli maculas luteas gradatim crescentes in aurantiaco-luteos textus plus minus circulares vel irregulares 8–12 mm. diam. formantes pustulis minutis concentrice dispositis atque sporarum positionem indicantibus. Sporarum sphaericae massae permanenter in mesophyllo infixae, simul aggregatae, totum spatium inter superiorem et inferiorem foliorum

faciem occupantes, globosae vel angulares, saepe confluentes, 120-200μ diam. Cortex distinctus; cellulae corticales conspicuae, radialiter elongatae, 16.5–25×9–15μ diam., in utroque apice rotundae, cinnamomeo-luteae atque laeves. Sporae totum spatium occupantes, haud arcte aggregatae, pallidae cinnamomeo-luteae, subglobosae vel angulares, tenuibus parietibus praeditae, laeves, 10–15μ diam. (med. 12.2μ). Sporae efformato promycelio 5–7 sporidiis verticillatis radialiter divaricatis germinantes; matura sporidia fusiformia, basi latiora quam apice, asymmetrica, 14–16×1–1.2μ, secundarium vel tertiarium sporidium acrogene efformantia, atque bina post separationem ex promycelio conjugantia.

Habitat: in foliis *Hygrophilae* sp., Nandi Hills, in regione Mysore, 5-11-1944, legit M. J. Thirumalachar. Typus positus in Herb. Crypt. Ind. Orient., New Delhi atque in Imperial Mycological Institute, Kew, Anglia.

The writer wishes to express his indebtedness to Dr. B. B. Mundkur, Imperial Agricultural Research Institute, New Delhi, to Dr. L. N. Rao, Professor of Botany, University of Mysore, for helpful suggestions and encouragement, and to the University of Mysore for the award of the Research Fellowship. Rev. Father Dr. H. Santapau, Ph.D., S.J., Professor of Botany, St. Xavier's College, Bombay, kindly rendered the diagnosis of the new species into Latin.

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Four Marine Algae from Australia and New Zealand[1]

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The four species of marine algae treated in the following pages are represented among the collections made by Professor J. E. Tilden and a group of graduate students (South Pacific Plants, Series II, 1934–1935). Two of them, *Acrosorium uncinatum* and *Phitymorphora imbricata*, have been known for years, but are included here, because additional information and accurate figures seem desirable. The other two, *Ceramium nanum* and *Ectocarpus Warnocki*, are described as new.

The author takes this opportunity to express his gratitude and indebtedness to Dr. H. Kylin, Sweden; Dr. H. E. Petersen, Denmark; and the late Professor R. M. Laing, New Zealand, for needed reprints; to Dr. Juergens, Germany; and Dr. H. A. Hill, California, for transcriptions from books otherwise inaccessible; and, finally, to Professor J. E. Tilden, not only for the plant material here described, but also for whatever knowledge he possesses of marine algae.

ACROSORIUM UNCINATUM (J. Ag.) Kylin

Acrosorium uncinatum (J. Ag.) Kylin, Studien Deless. 78, fig. 61. 1924; *Nitophyllum uncinatum* (Turn.) J. Ag. Spec. gen. et ord. alg. **2** (2): 654. 1852; *Cryptopleura lacerata* var. *uncinata* Kuetz. Tab. phyc. **16**: 10. pl. 25e. 1866; *Areolaria cristata* Schousboe, Bornet Les alg. de P. K. A. Schousboe, 294. 1892.

Acrosorium uncinatum, long known as *Nitophyllum uncinatum*, is a truly cosmopolitan plant. It has been reported from Great Britain (Cotton, Newton); the Mediterranean coasts of France, Italy and Spain, and the Atlantic coasts of France and Great Britain (J. Agardh); Tanger Bornet); Cape of Good Hope (De-Toni); New Zealand (Cotton, Laing); Australia (Harvey, Lucas, Wilson); Dutch East Indies (Weber van Bosse); and is widely distributed on the Pacific coast of Japan (Okamura, Takamatsu). In the United States it has only been reported from San Diego and San Pedro in California, sometimes in such quantities as to "clog the nets of fishermen" (Nott). G. M. Smith informs me[2] that the University of California possesses herbarium specimens from several other localities, all of them lying in the algal area that Setchell designated as subtropical. He also states that, at La Jolla, the plant is a very common epiphyte on *Gelidium*, *Pterocladia*, and various other algae, especially late in the summer.

[1] Excerpts from a thesis presented to the Graduate School of the University of Minnesota under the title "Some Contributions to the Knowledge of the Marine Algae of Australia and New Zealand."

[2] Personal communication, June 21, 1944.

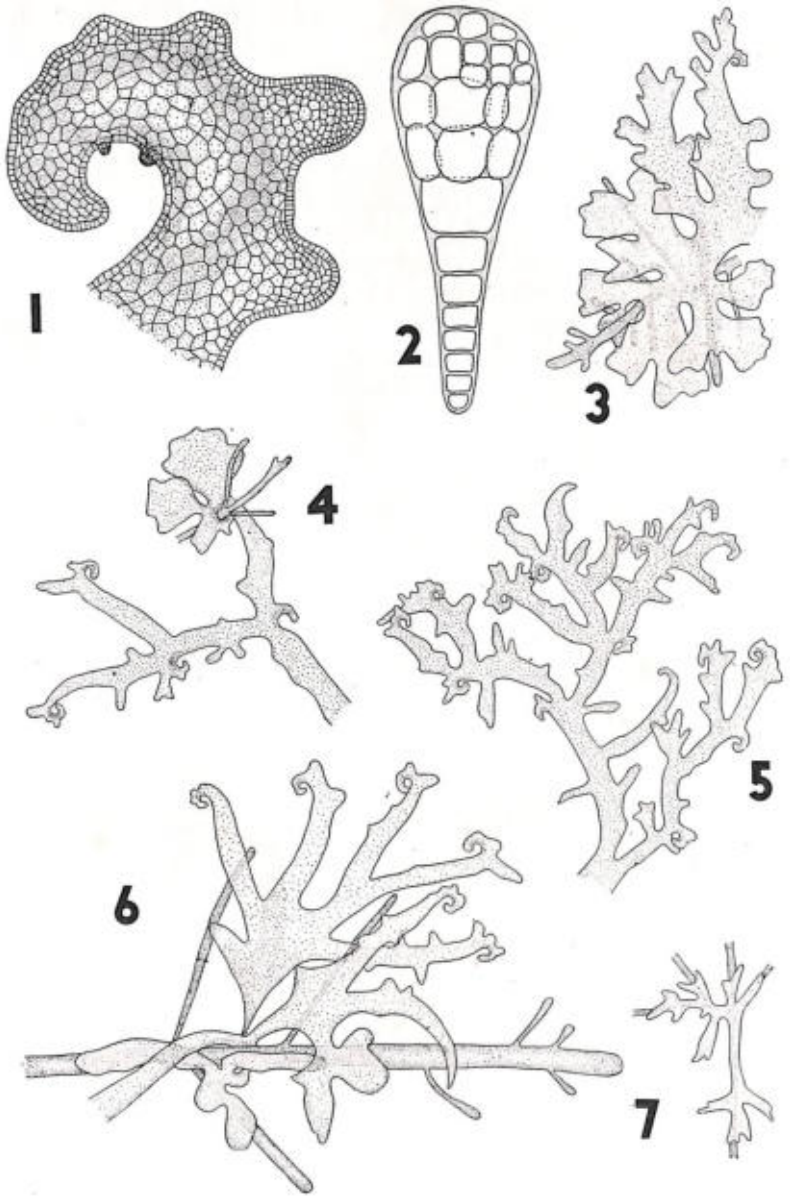


PLATE 1. *Acrosorium uncinatum*. 1. Surface view of hook (magnified). 2. Cross section through hook (magnified). 3. Thallus of expanded growth upon Gelidium capillaceum, one edge showing formation of hook (×1). 4. Portion of plant showing wedge-shaped segments. 5. Thallus consisting entirely of hooked formations (×1). 6. One hook clasped a Gelidium branch; some segments growing in hooked formation, others in linear form along the Gelidium. 7. Portion of thallus of very small size (×1). (Figs. 1–7 after Nordhausen; all others original)

This cosmopolitan distribution may account for the great variability in the vegetative structure of the plant. Nott's detailed synopsis shows this to be true for the Californian plants. Nordhausen, who made a detailed study of the growth habits of the Mediterranean plants (Figs. 1–7), concluded that, in extreme cases, it is rather difficult to draw a sharp line of demarkation between this and other species of *Nitophyllum* (to which genus the plant was referred in his days). And Kylin[3] believes that at least the individuals from the Mediterranean, from California and Australia, are distinct varieties of *Acrosorium uncinatum*.

The plants collected by I. B. Warnock at Point Lonsdale, Victoria, Australia, agree well with the general descriptions of Nott and Nordhausen. The fronds are all of the erect type. The sessile portion of the thallus is small and almost disk-like. From it arise two or three linear branches which, in turn, give rise to new segments. The whole thallus is delicately membranaceous and consists, except in the veins, of a single layer of cells. Neither a midrib nor conspicuous veins are present. But delicate, microscopic veins extend throughout the entire frond, branch freely though irregularly in a dichotomous manner, and frequently anastomose. They arise through subsequent divisions of regular thallus cells into 3–5 daughter cells, all lengthened in longitudinal direction and lying parallel to the surface. They do not project above the surface, and in the hooked segments they terminate as described by Nordhausen (Fig. 10). Apical growth is similar to that described by Kylin for *Cryptopleura lacerata*, and by Papenfuss for *Acrosorium acrospermum* (Fig. 12). But since other marginal cells may also develop into secondary initial cells, the manner of apical growth gradually becomes obscured (Fig. 20).

Rhizoids were observed only in the hooks, where they occur in clusters and in an immature condition (Fig. 10). All specimens were free from epiphytes and parasites, and sterile. Nott seems to be the only one to have found specimens with cystocarps, while J. Agardh was the first to report sporangia. But neither of these authors furnished drawings. Most collectors state that their specimens were sterile. Hence, Nott may be right when he says, "there is a strong probability that the plant propagates itself largely, if not entirely, by vegetative means."

The color of those specimens that have been kept away from the light (all of them preserved in formalin solution) is a bright rosy-red tint. The height of the fronds varies from 2–4 cm. Other collectors indicate greater variability, ranging between 2–6 cm. Mazza (1908) found that young plants varied from a few millimeters to 2 cm., and that several adult plants measured as much as 8 cm. Nott states that the fronds may attain a length of 10–15 cm.

The material was collected November 28, 1934. The attached label car-

[3] Personal communication, June 19, 1945.

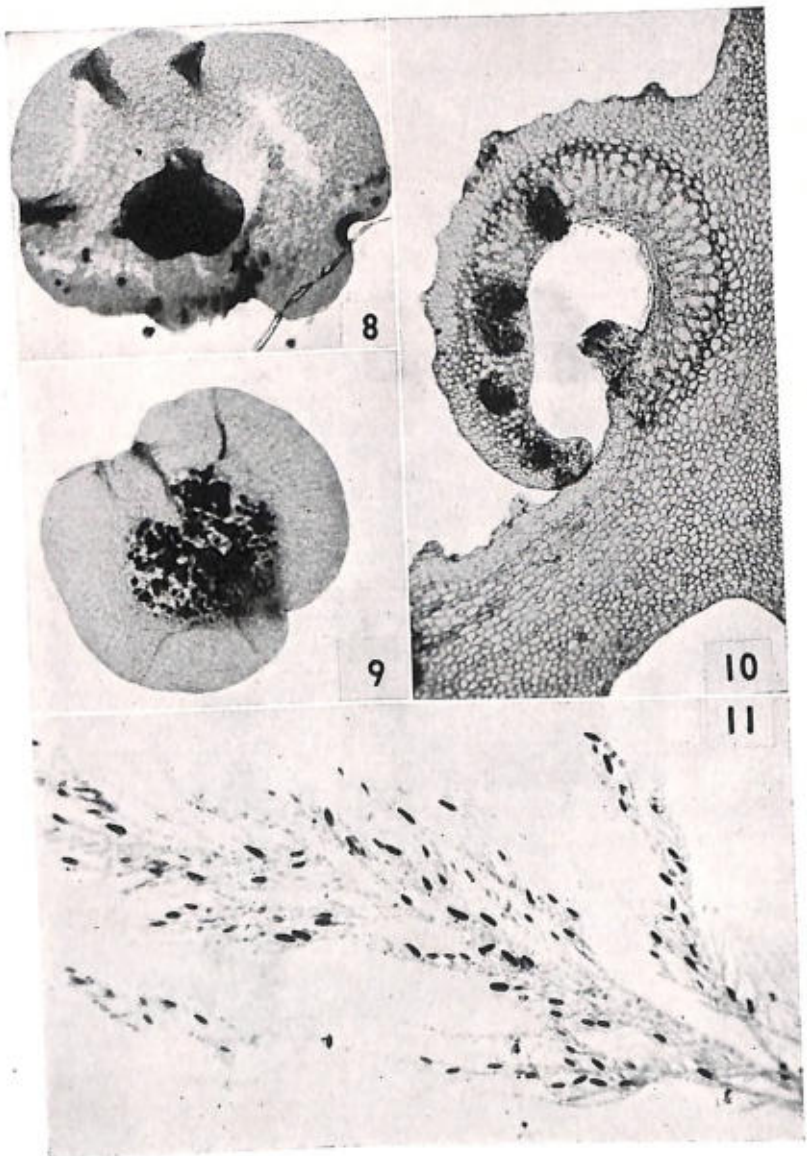


PLATE 2. *Phitymorphora imbricata*. 8. Very young portion of thallus (×33). 9. A sporophyll (×33). *Acrosorium uncinatum:* 10. Hook, showing thickened inner half, bundles of rhizoids, microscopic veins (×20). *Ectocarpus Warnocki:* 11. Portion of thallus (×33).

ries the following note, "First zone of transect line (about as far out as one can get at low tide period), attached to coralline algae and eelgrass." It may be added that the oldest authors are satisfied with merely stating that the plant is epiphytic upon other algae (Bertoloni). Later ones mention definite substrata, such as *Zostera* (Ardissone, Mazza), *Gelidium* (De-Toni, Nordhausen), *Bryopsis* and *Corallina* (Nordhausen), and *Phyllospadix* (Nott). The corallines, by reason of their jointed structure and rough surfaces, seem to furnish an excellent habitat.

PHITYMORPHORA IMBRICATA (Aresch.) J. Ag.

Phitymorphora imbricata (Aresch.) J. Ag. Spec. gen. et ord. alg. **3** (3): 170. 1898; *Delesseria imbricata* Aresch. Phyc. novae. 346. 1854; *Delesseria rigida* Harvey Alg. exsicc. No. 276; *Chauvinia imbricata* Harvey Phyc. austr. Syn. cat. xxxi and pl. 240. 1862; *Delesseria amansioides* Sonder, Kuetz. Tab. phyc. **19**: 4, 1868.

The primary frond is 8–12 cm. long and 4–4½ mm. wide, slightly stipitate, strictly linear, with an acute base and obtuse apex, the margin entire and more or less wavy, and with conspicuous midrib, but no lateral veins. From both sides of the midrib there arise, at brief but irregular intervals, secondary fronds of similar structure, which in their turn bear similar but smaller fronds (Fig. 13). This mode of ramification is repeated several times until there results, in the words of Harvey (1862), who had seen specimens in living condition, "a nearly globose, excessively compound general frond, whose leaflets are closely *imbricated* one on another." The primary frond is gradually changed into a compressed stem, consisting essentially of the thickened midrib. Dimensions of the larger secondary fronds 76–127×12–19 mm.

As to the cellular structure, the fronds, with the exception of the midrib, when viewed superficially, seem to be made up of three layers. The middle layer consists of large, irregularly polygonal cells (Fig. 8), whereas the outer layers of smaller cells exhibit 8–12 of the latter to one of the former (Figs. 14, 17). Near the edge the fronds become reduced to a single layer of elongated cells. The midrib, of more than three layers, terminates in a single apical cell, from which cells are cut off transversely (Fig. 14). In the sporophylls the middle layer seems to be entirely wanting.

Since only dried material was available, it was impossible to study the internal structure of the fronds in detail. The structure of the disk has been described by Mazza (1922).

Sporangia are borne on special minute sporophylls which are round or slightly obovate in shape and 2–4 mm. in diameter. Like the proliferations the sporophylls arise from the midrib. The sporangia are not scattered over these minute leaflets, but aggregated into sori, which develop on each side of the midrib and gradually cover the greater part of the sporophyll surface (Fig. 9). The collection did not contain specimens with cystocarps.

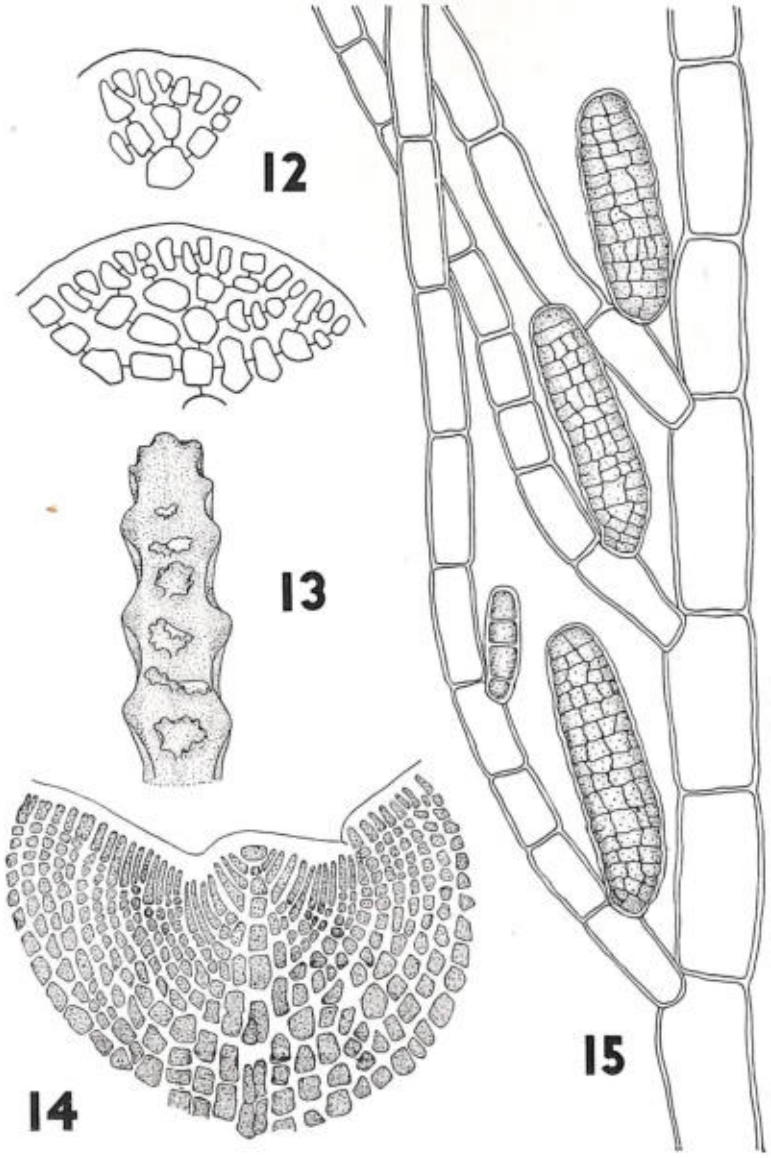


PLATE 3. *Acrosorium uncinatum.* 12. Manner of apical growth (×500). *Phitymorphora imbricata:* 13. Portion of linear frond, bearing six rounded leaflets (×5). 14. Tip of small frond, showing definite mode of growth (×400). *Ectocarpus Warnocki:* 15. Plurilocular reproductive organs (×400).

Harvey informs us that the cystocarps are likewise produced on the midribs of special minute leaflets, and are "hemispherical, thick-walled, containing a nearly globular tuft of moniliform sporethreads."

The specimens (South Pacific Plants, II, No. 99) were collected by Miss C. M. Crosby at Point Lonsdale, Victoria, Australia, November 20, 1934. They were dark or blood red in color when alive and became darker in drying. In the dry state they do not adhere to the paper. *Phitymorphora imbricata* is not only a strictly Australian, but also highly localized species, having thus far been reported only from Port Phillips Heads and vicinity. Another species, *Ph. linearis*, is endemic in New Zealand.

NOTE ON A NEW SPECIES OF CERAMIUM

The genus *Ceramium* was established by C. A. Agardh in 1817; but already in 1849 Harvey (Ph. Brit. **2**: 181) was forced to admit, "the *Ceramia* are almost as unsatisfactory to the Botanists as the *Rubi*, and their varieties quite as numerous." To a large extent this difficulty was due to the fact that the species constituting the modern genus *Ceramium* were distributed among several other genera. J. Agardh (1894) tried to remedy this confusion by collecting all forms under the single generic term *Ceramium*, grouping them into various tribes and using the old generic names for this purpose.

The measure, however, proved only partially successful, and the genus is taxonomically as difficult as ever. Many early accounts are of very little value because of inadequate descriptions or uncertain synonymy. Sometimes, too, drawings are either entirely wanting or so poorly executed as to be of little help. The added fact that, in several instances, the type material can no longer be located, easily explains why taxonomists hesitate to create new species.

In spite of this, the *Ceramium* collected at the Bay of Islands, New Zealand, is here described as new. The verticillate arrangement of the sporangia places it in Agardh's series *Periclinia;* its corticated zone, a definite ring with no apparent growth from either the upper or lower margin, in the tribes *Leptogonia* or *Brachygonia*. The fact that the lower portion of the sporangium remains immersed in the cortical zone and only the upper protrudes, limits it to the last named tribe. In the structure of its cortication it agrees well with that of *C. diaphanum* as shown by Petersen (1911, fig. 1); but differs from it in all other respects. Thus its apices are straight, not hooked; the involucral ramuli surrounding the cystocarps are long; the filaments are considerably narrower toward the base; the corticated zones are not as high as broad. Similar differences exist also between the new species and others belonging to this tribe.

Ceramium nanum, sp. nov.

Fronde pusilla, 5–10 mm. longa; regulariter dichotoma, ramis lateralibus e zonis surgentibus rare instructa; apice simplici, rarius bifurcato (in ramellis juvenilibus); setis et pilis copiosis; filamentis inferne 150–180μ latis, gradatim sursum angustioribus; cellulis superne paule altioribus quam latis, ad basim vix aeque altis ac latis; interstitiis ad apicem valde angustis, ad basim circiter aeque altis ac zonis; corticatione zonis interrupta; zona corticale latiore quam alta, 2–3 series cellularum rotundato-angulatarum irregulariter positarum gerente; sporangiis in ramulis superioribus ad genicula verticillatim numero vario dispositis, ellipticooblongiis, superiore sua parte fere ex toto emergentibus nudis, strato hyalino circumdatis, triangule divisa, circiter 28–33×40–65μ (membrana 5–7μ exclusa); cystocarpiis rotundatis, singulis, nonnumquam 2–3, 196–259μ latis, in ramis superioribus sessilibus; involucri ramellis pluribus, 3–5, cystocarpium longe superantibus.

Frond small, 5–10 mm. high; branching regularly dichotomous; lateral branches rarely arising from the nodes; apices simple, rarely forcipate (in branchlets); setae and hairs abundant; filaments 150–180μ broad near base, becoming gradually more narrow above; axillary cells somewhat longer than broad near the apex, scarcely as high as broad near the base; cortication restricted to nodes; corticated zones broader than high, composed of 2–3 layers of irregularly placed, roundish-angular cells; sporangia verticillate in nodes of upper branches, elliptical or oblong, with upper portion almost entirely extruding, surrounded by a hyaline membrane 5–7μ in thickness, 28–33×40–65μ (exclusive of membrane); cystocarps round, single, sometimes 2–3, 196–259μ broad, on upper branches, surrounded by 3–5 very long involucral branches.

On flat rocks. Oneroa, near Russell, Bay of Islands, New Zealand. Jan. 25, 1935. Collector Irl B. Warnock. (South Pacific Plants, II. No. 485.)

To the above description the following remarks may be added. The dichotomous ramification produces a more or less bilateral, somewhat dorsiventral thallus, whose apices are generally straight (Figs. 21, 22). The cortical cells are arranged in definite layers (2–3) at the nodes. The outer layer consists of small, roundish or angular cells. The inner is composed of angular cells, larger and less numerous than those of the outer layer (Fig. 23). The nodes, of which there are 4–6 in each ramification, are always wider than high, and commonly only slightly protruding.

Delicate hyaline hairs, 250–400μ long, are plentiful. Setae are found on all corticated zones, arising only from the upper margin of each zone (Fig. 22). They are less than 64μ in length, and not more than 3.5μ in width.

The specimens were abundantly fructiferous. The sporangia form a whorl in the corticated zones of the upper, but not ultimate branches (Figs.

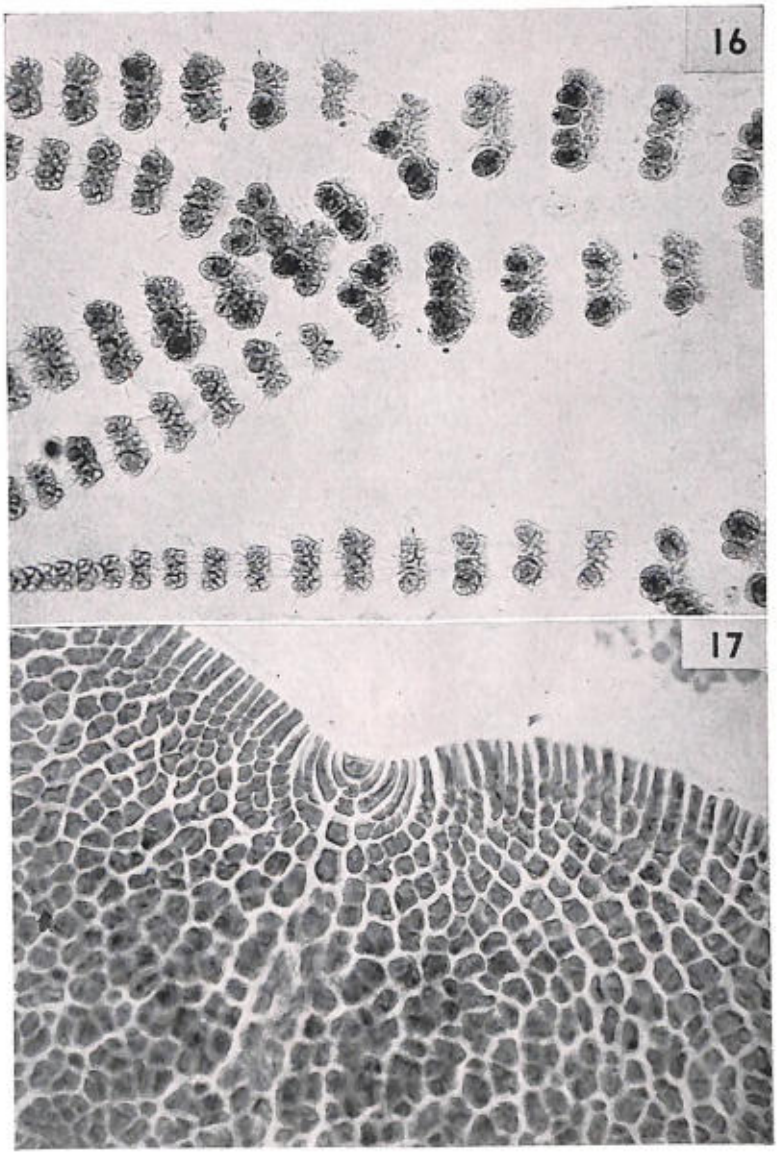


PLATE 4. *Ceramium nanum*. 16. Portion of sporophyte (×93). *Phitymorphora imbricata:* 17. Apical portion of frond (×381).

16, 19), and are surrounded by a conspicuous hyaline membrane. The cystocarps are sessile at the nodes of the upper branches (Pl. 6) and surrounded by 3–5 elongated unbranched involucral ramuli (Fig. 23). There were only fragments of spermatangial specimens. The spermatangia occur in patches of various sizes at the nodes (Fig. 18).

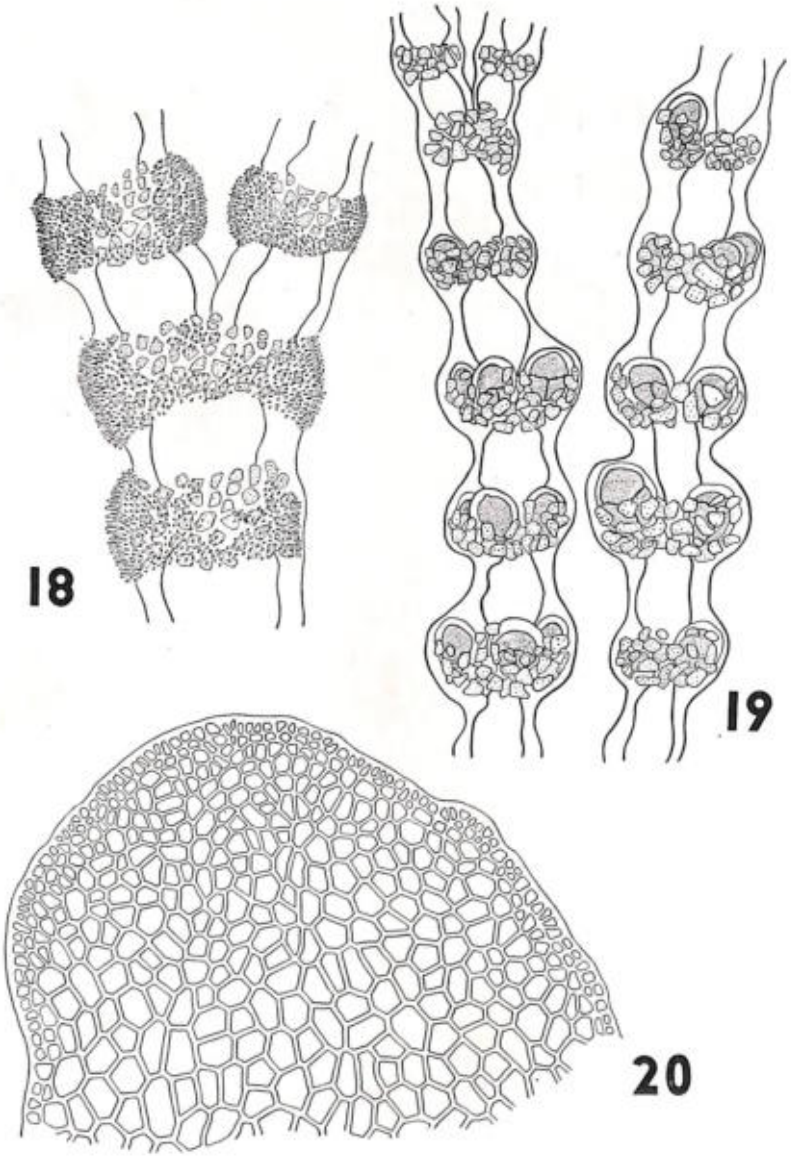


PLATE 5. *Ceramium nanum*. 18. Portion of male gametophyte; only upper layer of cortication shown (×200). 19. Portion of sporophyte (×200). *Acrosorium uncinatum*. 20. Tip of frond (×200).

NOTE ON A NEW SPECIES OF ECTOCARPUS

Among the plants collected at the Bay of Islands, New Zealand, an *Ectocarpus* was found growing intermingled with *Ceramium nanum*. In the size and structure of the plurilocular reproductive organs it agrees quite

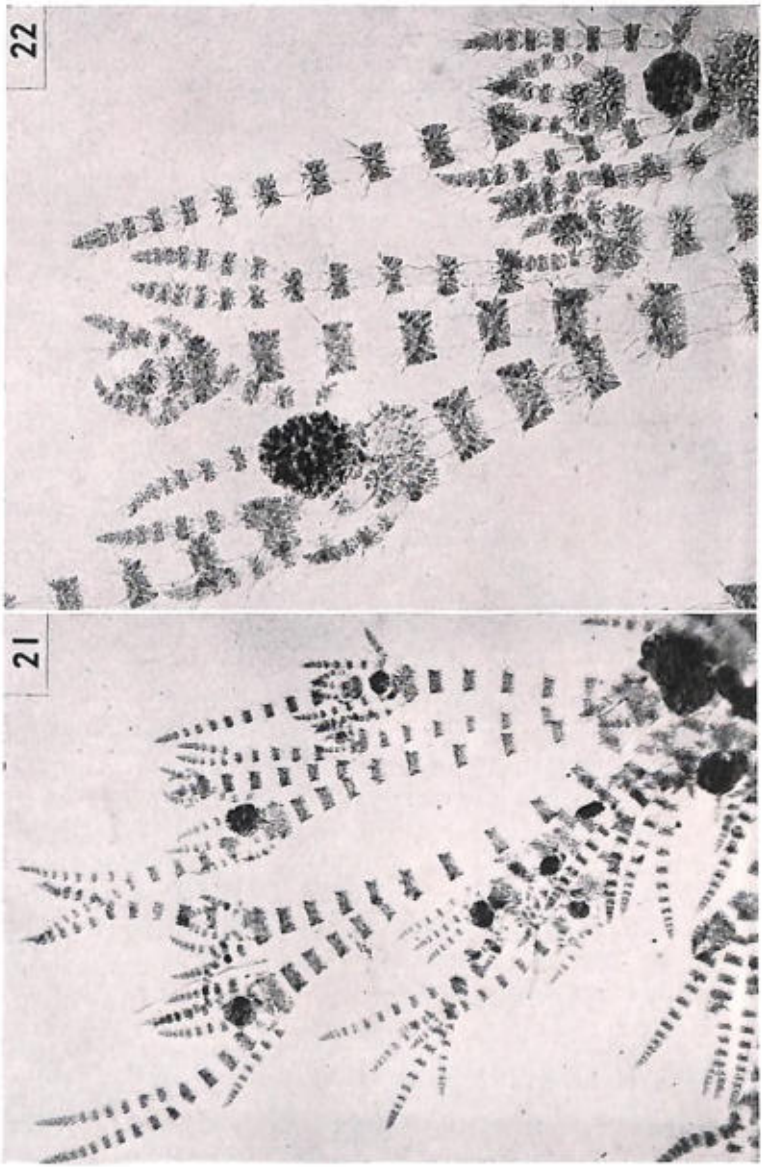


PLATE 6. *Ceramium nanum*. 21. Portion of female gametophyte (×33). 22. Section of the previous, enlarged to show setae and hyaline hairs (×93).

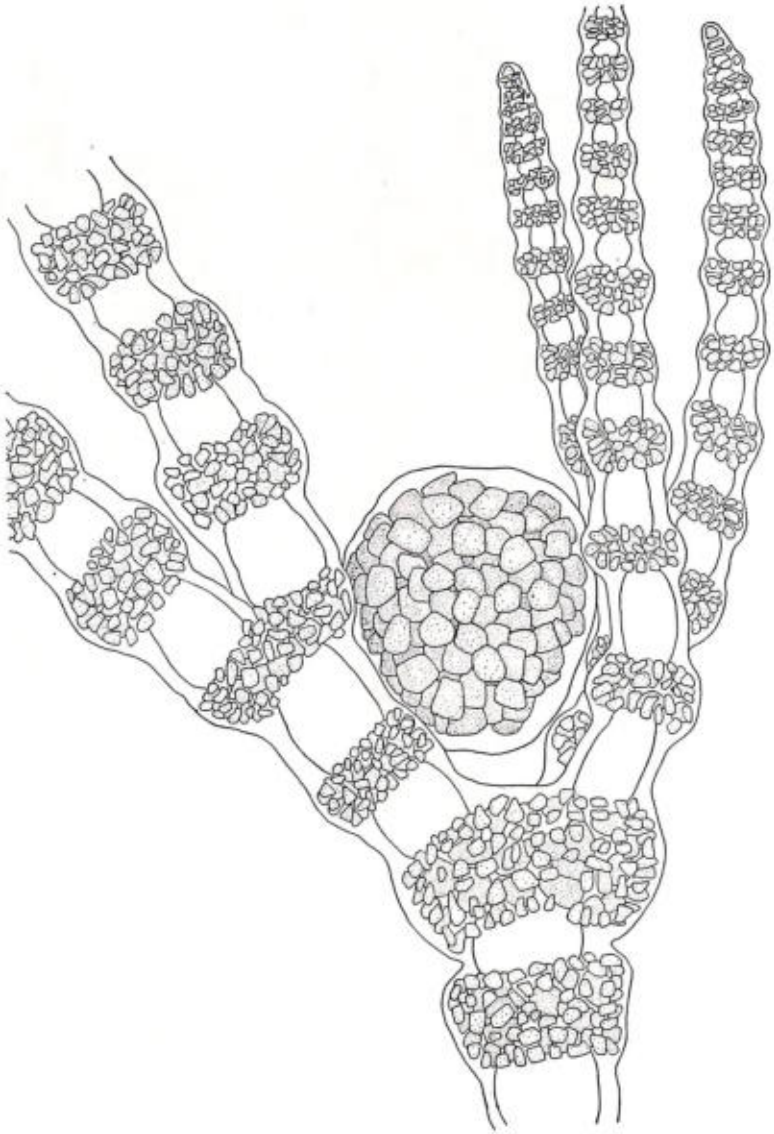


PLATE 7. *Ceramium nanum*. 23. A cystocarp with its involucral ramuli (×200).

well with that found in Australia and described and figured by Askenasy (1894) as *Ectocarpus Indicus* Sonder. In the size of the thallus, however, it differs considerably. Sonder's diagnosis states "bipolicaris vel ultra," and Askenasy's specimens were up to 2 cm. long. The plant in question, however, is only minute. Of course, such a difference might perhaps be ascribed to the geographic remoteness and somewhat different climatic conditions

of New Zealand. But there is also the added difference in the general manner of branching. According to Askenasy and De Toni (1895) *E. indicus* branches irregularly in all directions. In the New Zealand specimens the branching is mostly subsecund.

A search through the literature has failed to reveal any other species to which the plant might be referred. Differences are not only to be found in the general growth habits of the thallus and the size and shape of the chromatophores, but especially in the size and shape of the reproductive organs. The plant is therefore described as new, since it was also found in intimate association with another new species, *Ceramium nanum*.

Ectocarpus Warnocki, sp. nov.

Fronde caespitosa, 6–10 mm. alta; filis primariis usque ad 35–42μ latis; fronde, basi modice ramosa, superne ramosissima; ramis subsecundis, nonnumquam alternis, saepe in pilum abeuntibus; articulis cylindraceis, ad genicula leviter constrictis; chromatophoris discoideis; gametangiis numerosis, cylindraceis, 17–32×37–147μ, sessilibus, secundatim in ramis superioribus dispositis.

Frond caespitose, 6–10 mm. high; main axis up to 35–42μ broad; frond sparsely branching in lower portion, profusely in upper, in a subsecund, sometimes alternate manner; branches often terminating in a hair; cells cylindrical, slightly constricted at transverse walls; chromatophores discoid; plurilocular reproductive organs numerous, cylindrical, 17–32×37–147 mic., sessile, secund on upper branches.

On flat rock. Oneroa near Russell, Bay of Islands, New Zealand. Jan. 25, 1935. Collector, Irl B. Warnock. (South Pacific Plants, II. No. 485.)

The plant (Fig. 11) was found growing on rocks, attached by means of rhizoids. These, however, are only poorly developed. A main axis may be distinguished. It is about 12–18μ broad near the base, and rapidly increases in thickness to about 35–42μ. Branches do not arise from every cell. Generally, several cells forming branches are followed by a longer or shorter row of cells without branches. Most branches terminate in a hair; that is, in a row of elongated empty or colorless cells. The cells are cylindrical and slightly constricted at the transverse walls (Fig. 15). In the main axis their length is 1–2 times their width. In the branches the cells are generally slightly longer than broad near the stem, but gradually increase in length and decrease in width (especially in the hairs). The chromatophores are discoid, small and numerous. They are to be found in all cells, except those constituting the hairs.

All specimens were abundantly fructiferous. The plurilocular reproductive organs are sessile and secund on the upper branches, cylindrical and very variable in size (Fig. 15).

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The Taxonomy of Godoya R. and P., Rhytidanthera van Tieghem, and Cespedezia Goudot (Ochnaceae)

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In two recent papers dealing with the tribe Luxemburgieae[1] I pointed out that the following genera: *Godoya* R. and P., *Rhytidanthera* van Tieghem, *Cespedezia* Goudot, *Krukoviella* A. C. Smith, *Blastemanthus* Planchon, and *Luxemburgia* St. Hil. form a complex within the tribe, suggesting that of this group the first four genera exhibit even a more striking alliance. I propose here to discuss the taxonomy of the first three of these allied genera,[2] having already treated the genus *Krukoviella* in a separate paper. The species of *Godoya*, *Rhytidanthera*, and *Cespedezia* are arboreal, with the exception of one species of *Rhytidanthera*, *R. sulcata* van Tieghem, which is described as a shrub. The eleven species of this trio of genera are all confined to tropical America. Structural similarities between the genera are especially manifest in their bracts, flowers, and fruits. In the *Fleurydora* paper cited below I stated that " . . . the sepals of *Rhytidanthera*, the only pinnately-leafed genus of the Ochnaceae, are the prototypes of those of *Godoya* in every detail. This character, as well as less obvious characters, demonstrate the close relationship existing between *Godoya* and *Rhytidanthera*. Both of these are closely allied with the genus *Cespedezia* Goudot principally on the basis of the following characters: the fimbriate appendages (glands?) located at the proximal and inner surface of the bracts and sepals, the coriaceous and estylate and pentacarpellate pistil with intrusive T-shaped parietal placentae and with sessile radiating stigmas, and lastly the distinctly alate seeds." *Rhytidanthera* is readily distinguished from *Godoya* and *Cespedezia* by its compound leaves while *Godoya* and *Cespedezia* are easily separable, the former genus having 10 stamens and deciduous stipules, the latter having very numerous stamens and persistent stipules.

USES AND NATIVE NAMES

In his treatment of the genus *Godoya* Planchon notes that *G. antioquiensis* is called "Counso" and *G. obovata* R. and P. is known commonly as

[1] *A Discussion of the Ochnaceous Genus Fleurydora* A. Chev. *and the Allied Genera of the Luxemburgieae*. Bull. Torrey Club **71**: 175–178. 1944. *The Taxonomy of the Genus Krukoviella*. Torreya **45**: 69–72. 1945.

[2] This paper represents a segment of a thesis on the *American Genera of the Tribe Luxemburgieae* (Ochnaceae), submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Biological Laboratories, Fordham University Graduate School, New York, N. Y.

"Laupe," both species supplying very durable wood. Archer on his collection *305* of *G. antioquiensis* records the common name "Caunce." *Rhytidanthera magnifica* (Gleason) Dwyer and *R. sulcata* van Tieghem provide wood suitable for axles and gears, the former species, according to a notation on the type collection, being known locally as "Asuseno." Little information concerning the uses and native names of the six species of *Cespedezia* has been compiled. Goudot states that his species *C. Bonplandi* (=*C. spathulata* (R. and P.) Planch.) is known to the inhabitants of Colombia as "Lingua de Vaca" (Cow's tongue) or "Lingua de Buey" (Bull's Tongue), the descriptive names referring to the characteristic shape of the leaf-blades. On his collection *6357* (US) of *C. spathulata* from San Lorenzo, Esmeraldas, Ecuador, Little appends two local names: "Sajo," and "Pacora," while Gill records the name "Amarron-Gaspi" on two sterile collections (*39* and *40*) of probably *C. spathulata*, made at Napo Pastaza, Oriente, Ecuador. According to Gill's label this species is used in this area as an emetic in malaria therapy. Lawrance notes on his collection *618* of *C. repanda* from the El Humba region of Colombia that its local name is "Polbillya." In British Guiana, according to notations made on several collections *C. spathulata* is known as "Ariwa," "Hooboodiballi," and "Mungwagwa."

ACKNOWLEDGEMENTS

Specimens cited in this paper are deposited in herbaria of the institutions listed below, the customary symbol being employed in designating the particular institution.

Chicago Natural History Museum (F)
Gray Herbarium (G)
Royal Botanic Garden (K)
New York Botanical Garden (NY)
Museum d'Histoire Naturelle, Paris (P)
United States National Herbarium (US).

Throughout the paper an additional symbol *s. no.* is used in citing specimens bearing no collection number. I wish to express my appreciation to the directors of the above institutions who by their cooperation made this study possible. Special thanks are due to Dr. A. C. Smith of the Arnold Arboretum for his assistance and to Mr. Charles Gilly who prepared the plates and offered valuable advice.

KEY TO THE GENERA

Leaves Simple
- Stipules of leaves deciduous; sepals large, unequal; stamens 10 ..... 1. *Godoya.*
- Stipules of leaves persistent; sepals small, subequal; stamens 50–75 ..... 3. *Cespedezia.*

Leaves compound ..... 2. *Rhytidanthera.*

1. GODOYA R. and P. Fl. Per. Prodr. 1: 58. 1794.

Godovia R. and P. Per. Syn. 1: 467. 1805.

Trees; leaves sessile, simple, persistent at apices of branches, the secondary veins parallel and oblique-ascending, the tertiary veins perpendicular to secondary veins, dense, irregular, evanescent; stipules deciduous; inflorescences racemose or paniculate, the rachis terminal or axillary, the bracts with small basal and adaxial appendages, the latter gradually deciduous, the flowers solitary or fasciculate, the pedicels short, scarcely articulate; sepals 5, unequal, imbricate, spirally arranged, bearing small adaxial appendages at base; petals 5, bright yellow, distinctly unequal or subequal, exceeding sepals in length; stamens 10 in a single whorl around pistil, the anthers linear or narrow-elliptic, 4-celled, dehiscing by two terminal pores, the filaments short, almost as wide as anthers; pistil secund at anthesis, pentacarpellate, one-celled, short-stipitate, the stigmas 5, sessile, radiating, spongy, the ovary fusiform, the ovules very numerous, imbricate and in several rows on 5 intrusive T-shaped parietal placentae; fruit capsular, dehiscing septicidally, the margins of carpels separating from placentae, the latter filamentous, rough with persistent funiculi, the seeds oblong, transparent-winged, the wing subequal or obviously unequal at each end (Fig. 1.).

Type species: *Godoya obovata* Ruiz and Pavon.

KEY TO THE SPECIES

Secondary veins of leaf-blades 0.9–1.4 cm. apart; leaf-blades usually drying lustrous orange-brown; petals 3.5–5 cm. long; Dept. Antioquia, Colombia ..... 1. *G. antioquiensis.*
Secondary veins of leaf-blades 0.3–1.0 cm. apart; leaf-blades usually drying dull brown above; petals 2–3 cm. long; Peru and Bolivia ..... 2. *G. obovata.*

1. GODOYA ANTIOQUIENSIS Planch. Lond. Jour. Bot. 5: 598. 1846.

Trees up to 10 m. high, the trunk simple, densely branched at crown; leaf-scars large, fosseate, subrotund, 2.5–5 mm. long, about 5 mm. wide; leaf-blades lustrous-green, drying lustrous orange-brown, coriaceous, widely obovate-oblong, 8.5–17 cm. long, 3.5–8 cm. wide, obtuse to vaguely triangular at apex, cuneate at base, the margin vaguely serrate, the teeth minute, up to 0.3 mm. long, 0.2–1.3 cm. apart, the costa subplane above and below (except at base), up to 3.5 mm. wide, tapering and usually irregular at apex, the secondary veins 14–17 (rarely 19), 0.9–1.4 cm. apart, subprominent above, prominent beneath, simple or bifurcating in middle or close to margin, parallel-ascending, spreading from costa at 65°–70° angle; stipules deciduous; flower buds 2–3 cm. long, 0.8–1.3 cm. wide; inflorescence terminal, paniculate, the flowers solitary or frequently 2–3 per fascicle, the rachis 10–20 cm. long, usually exceeding uppermost leaves at anthesis, the pedicels stout, 0.6–2 cm. long, the articulation stalk 0.2–0.5 cm. long, the disc prominent; sepals unequal, concave, coraceous, strigose,

oblong-rotund, oblong or subrectangular, 1.0–2.2 cm. long, longer than wide, wide-triangular or obtuse at apex, often splitting irregularly, the sinuses 0.3–1 cm. deep, the margin entire, subinvolute; petals bright yellow, unequal or subequal, wide-oblong or oblong-rotund, 3.5–5 cm. long, 2.2–3.5 cm. wide, triangular or subobtuse at apex, obtuse to spatulate at base, the filaments 1–3 mm. long; ovaries smooth or striate, narrowly fusiform, 1.5–2 cm. long, the stigmas 5; capsules smooth, the lobes distinct, coriaceous, drying dark-brown, linear-falcate (here indehiscent), up to 7 cm. long, 0.45 cm. wide, the seeds about 2 mm. long, up to 0.65 mm. wide, the wings unequal, 3.7–4.7 mm. long (Fig. 1, *g*, *h*).

Type locality: High Mountains, Dept. Antioquia, Colombia.

Illustration: Planch. Lond. Jour. Bot. **5**: *pl. 21–22*, 1846.

Distribution: Known only from the Dept. of Antioquia, Colombia.

COLOMBIA: Without locality: *Mutis 2473* (US); Antioquia: *Triana* s. no. (F, photo of type of *G. antioquiensis*); *Kalbreyer* s. no. F, G, photo, K); 1000 m. alt., *Lehman 4087* (K, US), *4271* (F, US); Rio Negro and Medellin, *Jervise* s. no. (K); *Purdie* s. no. (K); *Triana* s. no. (F, photo, K, NY, P); Rio Negro, 2100 m. alt., *W. A. Archer 305* (US); Santuario, *Daniel 466* (NY, US); Medellin, *Toro 710* (NY).

This species is readily distinguished from *G. obovata* on the following characters: its obovate-oblong and usually larger leaves, with more widely spaced and more prominently disposed secondary veins, and its much larger flowers. Although information obtained from labels is scarce, *G. antioquiensis* seems to be a smaller tree than *G. obovata*, reaching 10 m. in height. Its leaves are thicker and preserve their lustre in drying. Almost every sheet of *G. obovata* shows the leaves drying a dull yellow-brown or black. Further confirmatory evidence of the separability of the species is in its limited distribution in the Dept. of Antioquia, Colombia. Like *G. obovata*, it is restricted to high altitudes.

According to Purdie's field label the local name of the species is *Counso;* this, however, may be a mispelling for *Caunce*, annotated by Archer on his respective collection. The wood of *G. antioquiensis* is extremely durable, being used for axles and cogs.

2. GODOYA OBOVATA R. and P. Fl. Per. Prodr. **1**: 58. 1794.

Trees up to 25 m. high; lenticels scattered; leaf-scars compressed-rotund or inversely triangular, 2.5–3.5 mm. long, 2–4.5 mm. wide; leaves thin-coriaceous, drying a dull lustrous brown or black above, obovate, 6.5–13 cm. long, 3–6.5 cm. wide, triangular or obtuse at apex, cuneate at base, the margin serrate (except 2–3 cm. from base), the teeth minute, 3–7 mm. apart, the costa subprominent above, plane beneath, 1.5–2 mm. wide at base, slender and evanescent at apex, the secondary veins 3–10 mm. apart, parallel-ascending, spreading from costa at 65°–70° angle, simple or infrequently bifurcating at middle or near margin, plane above and below;

stipulates fugacious; flower buds glandular-shiny, up to 2.5 cm. long, 1.1 cm. wide; inflorescence racemiform, the rachis terminal or axillary, up to 20 cm. long, the bracts (on immature rachises) whorled, imbricate, thin-coriaceous, striate, oblong-rectangular, up to 2 cm. long, obtuse and often retuse at apex, the subannular scars up to 3 cm. apart; the pedicels lignose, terete, 0.5–2 cm. long, 0.2–0.3 cm. wide, the articulation stalks 0.4–0.8 cm. long; sepals rectangular to oblong, 0.6–1.5 cm. long, 0.3–0.5 cm. wide, widely triangular or obtuse at apex, often retuse or split to middle,

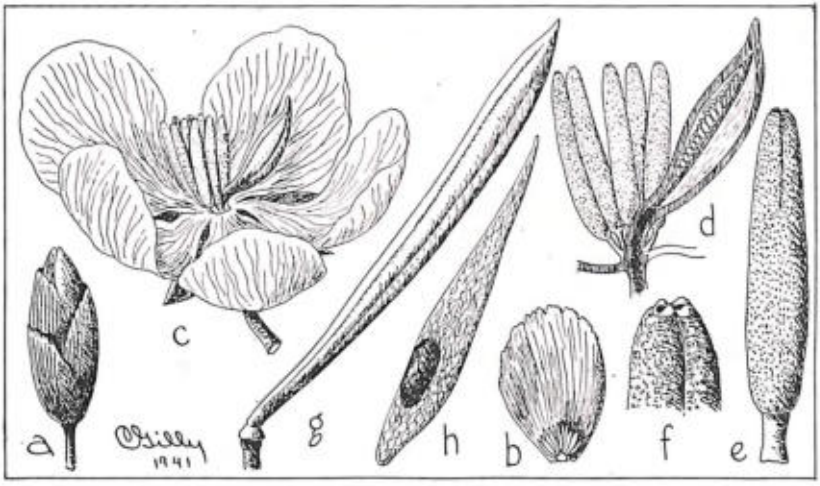


FIG. 1. GODOYA R. and P.—*G. obovata* R. and P.: a—bud (×1); b—sepal, ventral view, showing the inflated and gland-like cilia at the base (×1); c—flower (×1); longitudinal section through flower, showing half of the stamens in position (×2); e—stamen dorsal view (×4); f—apical portion of anther, showing the dehiscence pores (×8). (a, drawn from *Ruiz* and *Pavon 1634;* b–f, drawn from *Poeppig 1286.*)

G. antioquiensis Planch.: g—fruit, perhaps immature (×1); h—seed (×5). (Drawn from *Toro 710.*)

obtuse at base, the margin entire; petals bright-yellow, unequal, obovate or elliptic, 20–30 mm. long, 17–20 mm. wide, round-obtuse and retuse at apex, constricted below middle or scarcely tapering, the veins flabellate, often distinct; anthers smooth, often slightly inflated, often seemingly 2-lobes, linear or narrow-elliptic, rotund-obtuse at apex, vaguely bilobed at base, the filaments 0.1–0.2 mm. long, almost as wide as base of anther; ovaries coriaceous, black or brown, smooth or striate, linear-fusiform, 15–20 mm. long, 1.5–2 mm. wide at base, 2.5–2.8 mm. wide at apex, the stigmas usually distinct, the ovules oblong, about 0.4 mm. long, 0.25 mm. wide, the terminal wing about 2 mm. long; fruit not seen (Fig. 1, *a–f*).

Type locality: Peru.

Distribution: Peru and Bolivia.

PERU: *Barbey* (?) s. no. (K); *Lambert* s. no. (K); *Ruiz* s. no. (K); *Ruiz* and *Pavon 13164* (F); Pinto Bamba (?), *Pearce* s. no. (K); Cuchero (?), *Poeppig 1286* (F, G, P); Lima: *Ruiz* and *Pavon* s. no. (K, type collection ?); Huánuco: Chincao, *Ruiz* and *Pavon 95* (K); *Sawada 92* (F). BOLIVIA: La Paz: Mapiri Basin, Parannani, 1000 m. alt., *Buchtien 1774* (NY, US).

The specimen cited above as having been probably collected by Barbey has larger leaves and somewhat wider-spaced secondary veins; the shape of the lamina is much like that of the leaf-blade of *G. antioquiensis*. In other respects, however, it matches the other specimens of *G. obovata*. Anthers dissected from flowers of *Buchtien 1774* and *Sawada 92* were found to be inflated. The limited number of flowers available for dissection made a thorough study of this interesting condition impossible.

2. RHYTIDANTHERA van Tieghem, Ann. Sci. Nat. VIII. **19**: 43. 1904.

Godoya subgen. *Rhytidanthera* Planch. Lond. Jour. Bot. **5**: 599. 1846.

Shrubs or trees; lenticels minute; leaves pinnate, the leaflets 8–10, borne on short petioles, unequal, odd-pinnate, the lateral leaflets paired, the margin serrate or doubly serrate, the teeth minute, the costa prominent above and below, the secondary veins well-spaced, oblique and parallel-ascending; stipules deciduous; inflorescence terminal, patent-paniculate, the flowers solitary or fasciculate, the bracts amplexicaul, subcoriaceous, strigose, concave, erose-marginate, with minute appendages adaxially and proximally, the pedicels stout, coriaceous, articulate at base; flower-buds elliptic; sepals 4–5, unequal, fugacious, subcoriaceous, concave; petals 5, white, unequal or subequal, thin-carnose, longer than sepals, the veins parallel-ascending, flabellate toward margin; stamens 20–50, encircling pistil, deciduous at anthesis, the anthers bright-yellow, incurved, linear, dehiscing by two terminal pores, attached basally, the filaments shorter than anthers; pistil secund at anthesis, pentacarpellate, one-celled, short-stipitate, the stigmas 5, sessile, radiating, spongy, the style short, subfalcate, the ovary narrowly fusiform, the ovules very numerous, imbricate and in several rows on 5 intrusive T-shaped parietal placentae; fruit capsular, dehiscing septicidally, the margins of carpels separating from placentae, the latter filamentous, rough with persistent funiculi, the seeds imbricate, oblong, conspicuously and unequally winged at the ends, the wing exceeding body of seed in length (Fig. 2).

Type species: *Godoya splendida* Planch.

Van Tieghem, although devoting little discussion to generic relationships in the Luxemburgieae, segregated this remarkable pinnate-leafed group of plants, localized in Colombia, as a distinct genus. This leaf condition is unique not only in the tribe Luxemburgieae but also in the entire family Ochnaceae.

Previous workers have linked this group to *Godoya* but have failed to realize its closer relationship to *Cespedezia* with which it agrees in the fol-

lowing important characters: numerous stamens, linear anthers with elongate slender filaments, paniculate and strictly terminal inflorescence, and imbricate, appressed, amplexicaul, and frequently persistent bracts. Its relationship with *Godoya*, on the other hand, is especially manifest in the general structure of the sepals. Little attention has been directed to flower-color which is known to be white in two of the three species. This color has not been reported in the species of *Godoya*, *Cespedezia*, and *Krukoviella*.

KEY TO THE SPECIES

Petals oblong-rotund; stamens about 50; capsules 3.5–5.5+ cm. long ..... 1. *R. sulcata.*
Petals obovate-spatulate; stamens 18–20; capsules 1.5–1.8 cm. long
Leaf-blades 2–5 cm. wide; flowers solitary in a terminal raceme; petals 1.5–2 cm. long ..... 2. *R. splendida.*
Leaf-blades 5–6 cm. wide; flowers both solitary and fasciculate in a terminal raceme; petals 2.5–3.5 cm. wide ..... 3. *R. magnifica.*

1. RHYTIDANTHERA SULCATA van Tieghem, Ann. Sci. Nat. VIII. **19**: 44. 1904.

Rhytidanthera fragrans van Tieghem, Ann. Sci. Nat. VIII. **19**: 44. 1904.

Shrubs 2–3 m. high; stems erect, simple, branching at apex, about 4 cm. (+?) in diameter; leaves well spaced along twigs, somewhat pendent, the petioles 20–30 cm. long, the leaflets 8, lateral, one terminal and free (or the uppermost pair fused for a short distance at base), those paired alternate or subopposite, 4.5–6.5 cm. apart, obovate-oblong to oblong, 12–14 cm. long, 5.5 ± cm. wide, the lowest pair shorter, 6.8–10.5 cm. long, 4–5.5 cm. wide, subobtuse at apex, often splitting along costa, flat-obtuse or vaguely cordate at base, the costa prominent above, very prominent beneath, the secondary veins 17–20, 4–7 mm. apart, immersed above, prominent beneath, the margin doubly serrate, the teeth 4–9.5 mm. apart; stipules deciduous; inflorescence extending (here) a half meter above uppermost leaves, about as wide as long, the branches almost horizontal, the flowers solitary at apices of branches, fasciculate toward base, the bracts appressed, imbricate, shield-shaped, entire or retuse (often split) at apex, ovate-triangular, 2–8 mm. long, a little longer than wide, often enclosing small buds, the pedicels about 1.5 cm. long, 0.15–0.2 cm. wide toward base, 0.3–0.4 cm. wide and clavate at apex; sepals unequal, imbricate, glandular-lustrous, strigose on outside, concave, oblong-rotund or oblong, 8–11 mm. long, 5–8 mm. wide, splitting freely at apex; petals white, oblong-rotund, 3–3.5 cm. long, about 2 cm. wide; stamens about 50, the anthers smooth (here in bud), up to 11.5 mm. long, 0.8 mm. wide, the filaments about 2.5 mm. long; pistil crassate, narrow-fusiform, up to 13 mm. long, narrowing toward apex, the style indeterminate, the stigmas 5, sessile, radial; capsules minute-rugose, narrowly subfalcate, 3.5–5.5 cm. long, the median vein of each carpel subplane and evanescent, the seeds (here immature)

oblong, about 0.7 mm. long, the wing about 3× length of body of seed (Fig. 2 *h, j*).

Type locality: Dept. Santander, Colombia.

Distribution: Known only from the eastern cordillera of Colombia.

COLOMBIA: Santander: Mesa de los Santos, 1500 m. alt., *Killip and Smith 15217* (G, F, NY); Santander: Socorro: *Linden 765* (F, photo of type of *R. sulcata*); Ocaña: *Schlim 1144* (K, type collection of *R. fragrans*).

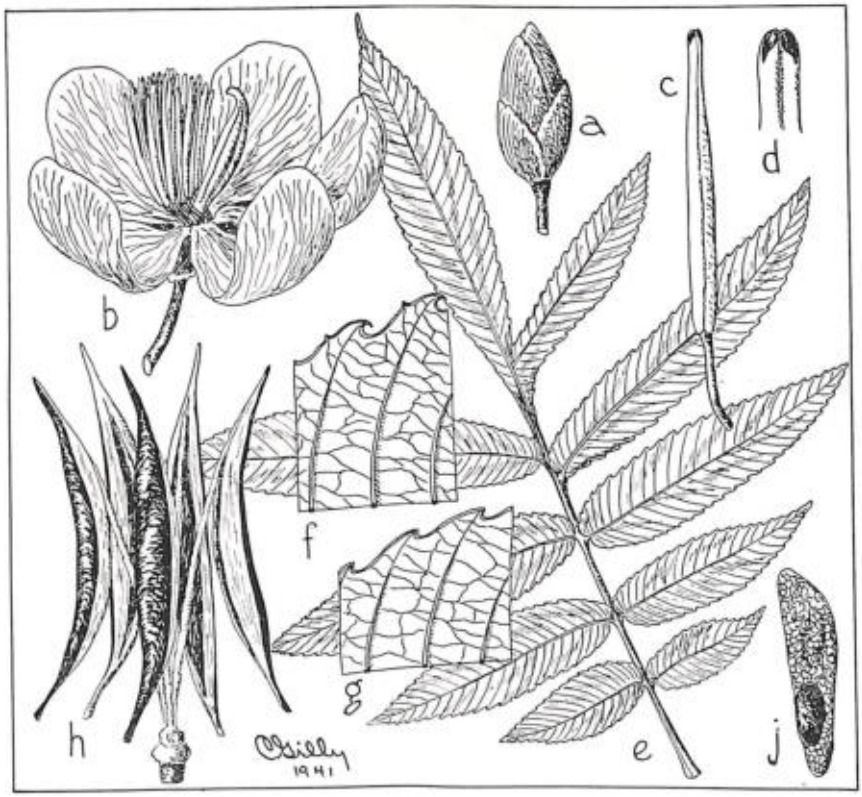


FIG. 2. RHYTIDANTHERA van Tieghem.—*R. magnifica* (Gleason) Dwyer: a—bud (×1.5); b—flower (×1.5); c—stamen, dorsal view (×4); d—apical portion of anther (×8); e—leaf (×0.25); f, g—portions of leaflet edge showing venation and the two types of marginal teeth (×2). (Drawn from *Lawrence 509*, TYPE.)

R. sulcata van Tieghem: h—capsule, after dehiscence, (×1); j—seed (×5). (Drawn from *Killip* and *Smith 15217*.)

Van Tieghem's "descriptions" of *R. sulcata* and *R. fragrans* are simply notations of the differences between his species and the type species of the genus, *R. splendida*. He makes no attempt to compare or contrast his new species with the type species. From an examination of the type collection

of *R. fragrans* deposited in Kew Gardens and the photo of the type of *R. sulcata* in the Field Museum I have been unable to find characters worthy of separating the two collections as species.

2. RHYTIDANTHERA SPLENDIDA (Planch.) van Tieghem, Ann. Sci. Nat. VIII. **19**: 44. 1904.

Godoya splendida Planch. Lond. Jour. Bot. **5**: 599. 1846.

Trees; petiole of leaves up to 45 cm. long, the leaflets 9, sessile, those lateral paired, 5.3–7.3 cm. apart, oblong, 13–18.5 cm. long, 5–6 cm. wide, triangular-acute at apex, obtuse at base (flat-obtuse in the 4 basal leaflets) or the three terminal leaflets fused at the base in a cuneate fashion with the apex of the petiole, the costa prominent above and below, the secondary veins 20–25, somewhat prominent above and below, 6–10 mm. apart, slightly arcuate-ascending, the marginal teeth minute, 5–10 mm. apart, often with a minute median tooth; stipules deciduous; inflorescence paniculate, the rachis exceeding the leaves in length, terete at base, about 7 mm. wide, becoming angular and somewhat contorted toward apex, bearing thin, transverse, and circular bract scars, the basal branches elongate, up to 25 cm. long, the upper branches shorter, the pedicels stout, lignose, 8–9 mm. long, clavate at apex, 1–1.5 mm. wide at base in flower, 2 mm. wide at apex, about 2 mm. wide at base in fruit, 3 mm. wide at apex, articulate on a thick terete oblique projection of the rachis; flower buds not seen; sepals subcoriaceous, strigose, unequal, the outer obovate, about 5 mm. long, 4 mm. wide, the inner oblong, longer, up to 1.5 mm. wide, subacute at apex; petals unequal, obovate-spatulate, 2.5–3.5 cm. long, 1.4–1.6 cm. wide, round-obtuse and slightly inequilateral at apex, spatulate or narrow-cuneate at base; stamens 18–20, the anthers subequal, incurved, transversely rugose, exceeding filaments in length, about 0.7 mm. wide, the filaments about 3 mm. long; pistil secund at anthesis, black, smooth, the ovary linear-fusiform, about 10 mm. long at maturity, constricted at apex into a short subfalcate style about 4 mm. long; capsule (here immature) 1.5–1.8 cm. long, acute, the seeds obovate or oblong, about 0.7 mm. long, the terminal wing wider than seed, about 0.3 mm. long.

Type locality: Dept. of Magdalena, La Cruz, Mompos, Colombia.

Illustration: Planch. Lond. Jour. Bot. 5: *pls. 19–20.* 1846.

Distribution: Known only from the type locality.

COLOMBIA: Magdalena: Mompos, La Cruz, *Purdie* s. no. (K, type collection of *G. splendida*).

3. **Rhytidanthera magnifica** (Gleason) Dwyer, comb. nov.

Godoya magnifica Gleason, Phytologia **1**: 27. 1933.

Trees 15–20 m. high; petioles of leaves 15–17 cm. long, the leaflets 9–10, minutely rugose, sessile, paired, the pairs 3–3.5 cm. apart, narrowly or

widely lanceolate, 6–17 cm. long, 2–5.3 cm. wide (the basal pair obviously opposite, 6.5–7 cm. long, 2–3 cm. wide), acute at apex, inequilateral and flat-obtuse at base (or the basal lamina of the 2 terminal leaflets often fusing cuneately with the apex of petiole), the costa prominent above, subprominent below, evanescent toward apex, the secondary veins slender, 20+, plane above, prominent beneath, arcuate-ascending, 4–8 mm. apart, the margin coarsely and doubly dentate, the teeth incurved, minute, 0.4–1.3 cm. apart, the intermediate teeth smaller; inflorescence terminal, patent, paniculate, the flowers solitary, 15–20 per branch, the pedicels 1–1.2 cm. long, 0.1–0.15 cm. wide at base, 0.3–0.35 cm. wide above; flower-buds up to 1.5 cm. long, about 1 cm. wide; sepals 4–6, unequal, concave, often dorsally carinate, the outermost the smallest, ovate-rotund, 0.75–1.4 cm. long, 0.7–0.9 cm. wide, the inner larger, oblong, 1.1–1.5 cm. long, 1–1.1 cm. wide, obtuse obtuse and often deeply fissured at apex, the margin entire; petals white, unequal, oblong or obovate-oblong, 1.6–2.1 cm. long, 0.8–0.95 cm. wide, rotund and often inequilateral at apex, spatulate or obtuse at base; stamens 40–50, the anthers often transverse-rugose, 0.95–1.1 cm. long, 0.75 mm. wide at base, the filaments about 0.3 cm. long, 0.03 cm. wide; ovary fusiform, about equal to stamens in length, tapering gradually into a crassage style about 0.2 cm. long, the stigmas 5, sessile, radical; fruit not seen.

Type locality: El Umbo Region, Dept. Boyacá, 1200–1500 m. alt., Colombia.

Distribution: Known only from the type locality.

COLOMBIA: Boyacá: El Umbo Region, *Lawrence 599* (G, F, NY, type collections of *C. magnifica*).

R. magnifica is readily distinguished from the two other species of the genus by its narrower leaflets which taper toward the base, its constantly non-fasciculate flowers, and longer petals. The number of the stamens and the length of the pedicels point to it being more closely related to *R. sulcata*. Although both of these species have white flowers, the importance of this character as indicating close relationship between the two species is uncertain, since there is no record of the color of the petals of *R. splendida*. Fruiting material of *R. magnifica* is desirable for comparative study. "Asuseno" is the native name given to the durable wood of this species. According to the collector it is used for making gears for sugar mills.

3. CESPEDEZIA Goudot, Ann. Sci. Nat. III. **2**: 370. 1844.

Godoya R. and P. Fl. Per. Prodr. **1**: 58. 1794. In Part.
Fourneiria van Tieghem, Ann. Sci. Nat. VIII. **19**: 58. 1904.

Large trees; branches whorled and clustered at apices of trunk; petioles of leaves short; leaf-blades simple, glabrous, the costa prominent above and below, the secondary veins arcuate-ascending, the margin sinuate, the

marginal teeth minute; stipules persistent, densely imbricate, and appressed at base of crowded leaf-blades, entire, bearing minute appendages on the basal and adaxial margin; inflorescence patent, terminal, paniculate, the flowers in fascicles, the basal branches arcuate-ascending, the pedicels short-articulate at base, the bracts deciduous, bearing minute appendages on the basal and adaxial margin; flower buds obovate or oblong; sepals 5, subequal or obviously unequal, imbricate at base and united into a short cup, coriaceous, dorsally marcescent and carinate, ventrally smooth, bearing minute appendages on the basal and inner margin; petals 5, yellow, equal, the veins flabellate; stamens 50–80, in several rows encircling the pistil, the anthers soon deciduous, 4-celled, opening by two oblique and terminal pores, the filaments slender, often longer than anthers; pistil stipitate, secund, the ovary 1-celled, 5-carpellate, the ovules borne in several series on intrusive T-shaped placentae, the style short, the stigmas 5, spongy, radial; fruit capsular, dehiscing septicidally, the carpels coriaceous, the placentae at dehiscence separating from the margins of carpels, the seeds imbricate, long-winged, the wings subequal, scarcely wider than the body of the seed (Fig. 3).

Type species: *Godoya spathulata* R. and P. Fl. Per. Prodr. 1: 58. 1794.

KEY TO THE SPECIES

Sepals entire at apex; petals 1–2 cm. long
- Leaf-blades coriaceous
  - Lateral veins on underside of leaf-blade prominent and ridge-like ..... 1. *C. macrophylla.*
  - Lateral veins plane or prominulous on underside of leaf-blade
    - Leaf-blades flat obtuse at apex; petioles plane above at distal end ..... 2. *C. excelsa.*
    - Leaf-blades acuminate or obtuse at apex; petioles terete at distal end
      - Leaf-blades narrow-obovate; secondary veins in middle of the blades 1.5–2.5 cm. apart; pedicels at anthesis 0.7–1.2 cm. long; petals 1–1.5 cm. long ..... 3. *C. repanda.*
      - Leaf-blades oblanceolate or spatulate; secondary veins in middle of blade 0.7–1.5 cm. apart (only in larger leaf-blades up to 2 cm. apart); pedicels at anthesis 1.3–2 cm. long; petals 1.4–2 cm. long ..... 4. *C. spathulata.*
- Leaf-blades membranaceous ..... 5. *C. scandens.*

Sepals retuse at apex; petals 2–2.5 cm. long ..... 6. *C. braziliana.*

1. CESPEDEZIA MACROPHYLLA Seem. Bot. Voy. Herald 97. 1853.

Large trees up to 15 m. high, with aerial roots and buttresses; leaf-scars compressed-rotund, fossulate, up to 1.3 mm. wide, about 1 mm. long; petioles about 1 cm. long, plane above; leaf-blades coriaceous (or subpapyro-membranaceous), obovate or obovate-elliptic, 45–75 cm. long, 18–25 cm. wide, obtuse, often retuse above, cuneate at base, the costa prominent and carinate above, prominent beneath, up to 0.4 cm. wide, the secondary veins 1–2 cm. apart in middle, prominent above and below, ascending from costa at a 50°–60° angle, the tertiary veins subimmersed above and below, the margin widely sinuate, the cilia minute, falcate, up to 3.5 cm. apart; stipules thin-coriaceous, dense, imbricate, appressed, linear-rectangular, up to 7 cm. long, up to 1.3 cm. wide, obtuse above, tending

to split, the basal and adaxial appendages up to 1 cm. long; inflorescence paniculate, the flowers fasciulate, the rachis exceeding uppermost leaves, the pedicels angular, 1.3–1.5 cm. long, the flower-buds elliptic, up to 2 cm. long; sepals subequal, nonimbricate at anthesis, coriaceous, dome-shaped, about as long as broad, up to 2.3 cm. long, the margin with irregular and glandular teeth up to 0.1 cm. long; petals yellow, obovate,

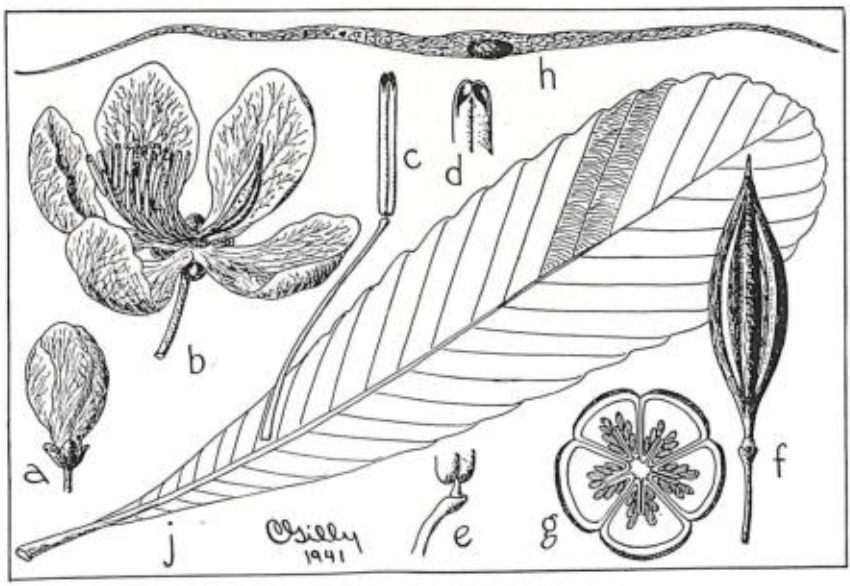


FIG. 3. CESPEDEZIA Goudot.—*C. spathulata* (R. and P.) Planch.: a—bud (×1.5); b—flower (×1.5); c—stamen (×4); d—apical portion of anther (×8); e—basal portion of anther, showing detail of filament attachment (×8). (Drawn from *Ducke 12241*.)

C. repanda (Kunth) van Tieghem: f—capsule (×1); g—diagrammatic cross-section of pistil, showing placentation; h—seed (×5); j—leaf, the secondary venation shown only in part (×0.17). (Drawn from *Bonpland* s. no. TYPE.)

up to 1.8 cm. long, 1.1 cm. wide, tapering cuneately or obtusely toward base; stamens 80±, the anthers about 0.95 cm. long, 0.5 mm. wide, the filaments up to 1.2 cm. long, scarcely swollen above; pistil usually striate, narrow-oblanceolate, stipitate, up to 0.7 cm. long, the ovules numerous, about 0.3 mm. long, about 0.1 mm. wide; fruit (here immature) linear-falcate, up to 6.5 cm. long, 0.7 cm. wide, the seeds angular, 0.1–0.13 cm. long, each wing about 0.8 cm. long.

Type locality: Bay of Utria, Panama.

Distribution: Limited to Nicaragua, Costa Rica, Panama, Canal Zone, and Colombia.

NICARAGUA: Braggman's Bluff, *Englesing 274* (F). COSTA RICA: Suerre de Santa Clara, 300 m. alt., *J. D. Smith 6460* (US). PANAMA: Gatum, *Hayes* s. no. (K); Penome, *Williams 424* (NY, US); Obalida, San Blas, *Piltier 4340* (F, G, NY, US); Changuinola Valley, *Cooper* and *Slatter 121*

(F, US); Bay of Utria, *Seeman* s. no. (G, K, type collection of *C. macrophylla*). CANAL ZONE: Barro Colorado Island: *Kenoyer 665* (NY); *Shattuck 791* (F); *Wilson 155* (F); *Woodworth* and *Vestal 411* (F). COLOMBIA: El Chocó: Rio Condoto and Rio San Juan, *Killip 35102* (US); Narino: Gorgona Island, *Killip* and *Garcia 33100* (US).

Although *C. macrophylla* shows much diversity in leaf-shape, it is readily recognized by the secondary veins of the leaf-blade which are prominent beneath. The papyro-membranaceous leaf-blades of *J. D. Smith 6460* are probably immature. As in *C. spathulata* (R. and P.) Planch. the leaves vary from being subacute to flat-obtuse at the apices.

2. CESPEDEZIA EXCELSA Rusby, Mem. Torrey Club **6**: 17. 1896.

Trees up to 20 m. high; petioles stout, plane (or concave) at distal end above, up to 0.8 cm. wide; leaf-blades thin-coriaceous, obovate-spatulate, 40–100 cm. long, 12–18 cm. wide, flat-obtuse at apex, cuneate at base, the costa prominent and ridge-like above, tapering toward apex, scarcely prominent below, up to 0.5 cm. wide in middle, the secondary veins prominent and ridge-like above, sub-plane beneath, spreading from costa at 50°–65° angle, 1–2 cm. apart in middle, the margin sinuate, entire toward proximal end, the teeth minute, 0.5 mm. long, 1.5–3 cm. apart, located at base of sinuate lobe (rarely in middle); stipules thin-coriaceous, narrowly rectangular to square, up to 6 cm. long, up to 1.5 cm. wide at base, obtuse above and below, the margin tending to split, often with deep sinus at apex; inflorescence patent-paniculate, the flowers mostly 3 per fascicle, the rachis smooth below, becoming contorted above, up to 1.5 cm. wide at base, the basal branches arcuate-ascending, up to 25 cm. long, 6–7 cm. apart, the uppermost branches shorter, the first fascicle on uppermost branch 4–8 cm. from base, the pedicels lignose, 0.9–1.3 cm. long, sharply ascending, the flower buds obovate, up to 2.2 cm. long, 0.9 cm. wide; sepals subequal, thick-coriaceous (especially outer sepals), imbricate at base, ovate-rotund, about one-seventh length of petals, up to 3.5 mm. long, obtuse-rotund at apex, obtuse to subauriculate at base, the outer surface vague-marcescent, the margin entire or with minute blunt ascending teeth; petals yellow, obovate, up to 18 mm. long, about 8 mm. wide, erose-marginate at apex, the veins frequently indistinct; anthers linear-falcate, up to 6 mm. long, the filaments unequal, 0.5–0.95 cm. long, narrow-clavate at apex; ovaries linear-elliptic, up to 12 mm. long, the stigmas distinct; capsule minutely glandular-rugose, linear-fusiform before dehiscence, falcate or suberect, up to 3 cm. long (immature here), 0.4 cm. wide, when dehiscent up to 6 cm. long, the carpels black except on margins, silver-gray within, the seeds linear, 2 mm. long, 0.25 mm. wide, the wings about 5.5 mm. long.

Type locality: Between Tipuani and Guaiana, La Paz, Bolivia.

Distribution: Known only from several collections in Bolivia.

BOLIVIA: La Paz: Tipuani-Guaiana, *Bang 1723* (NY, type collection of *C. excelsa*, with distributional numbers *1652* or *1658* a (G, F, US); Mapiri, *Buchtien 1724* (G, NY, US), *Buchtien 2045* (NY, US); Larecaja, Copacabana, *Krukoff 11232* (NY).

3. CESPEDEZIA REPANDA (HBK) van Tieghem, Ann. Sci. Nat. VIII. **19**: 50. 1904.

Godoya repanda H. B. K. Nov. Gen. et Sp. **7**: 277. 1825.

Trees up to 30 m. high; petioles 3–4 cm. long, 0.5 cm. wide distally, the costa of blade carinate proximally, the leaf-blades narrow-obovate, 35–65 cm. long, 8–15 cm. wide, obtuse at apex, cuneate at base, the margin subserrate toward base, widely undulate above, the marginal teeth about 0.5 mm. long, 2–4.5 cm. apart, often with smaller cilia along the margin, the costa carinate above, subplane and conspicuous beneath, the secondary veins prominent above, subplane beneath, 1.5–2.5 cm. apart in middle of blade, leaving costa at 45°–50° angle; stipules striate, oblong-rectangular or obovate-oblong, 1.7–2 cm. long, 1.2 cm. wide; inflorescence patent-paniculate, the flowers fasciculate along upper two-thirds of branches, the rachis elongate, exceeding uppermost leafblades, up to 1.8 cm. wide at base, subterete, the basal branches elongate, arcuate-ascending, the pedicels lignose, slender, 0.7–1.2 cm. long, about 0.8 mm. wide in middle; flower buds narrow-obovate, up to 1.2 cm. long; sepals subequal, marcescent outside, reflexed at anthesis, ovate or compressed-rotund, 2–3 mm. long, 2–2.5 mm. wide, obtuse at apex, the margin entire or with small obtuse teeth, the latter usually crowded at base; petals bright yellow, subcarnose, narrowly obovate, 10–15 mm. long, 0.65–0.75 cm. wide, obtuse at apex, tapering below; stamens 55 or more, the anthers linear-falcate, about 4 mm. long, the filaments about same length; pistil linear-elliptic, about 10 mm. long, 16 mm. wide, the style short and rostrate; capsule (indehiscent here) linear, the seeds subplane, oblong, about 1 mm. long, 0.3 mm. wide, each wing linear-subulate, 2.8–5.5 mm. long (Fig. 3, *f–h, j*).

Type locality: Mariquita, Tolima, Colombia.

Distribution: Distributed throughout Colombia and Peru.

COLOMBIA: Without locality, *Mutis 4456* (US); Boyacá: El Humba, *Lawrance 618* (F, US); Tolima: Mariquata, *Bonpland* s. no. (P, type of *C. repanda*); *Triana* s. no. (K, NY); El Chocó: Timbio, *Woronow 6990* (F). PERU: Without locality, *Poeppig* s. no. (P).

Goudot (Ann. Sci. Nat. III. 370. 1844) cites *Godoya repanda* HBK as a synonym of his species *C. Bonplandi*, apparently without having examined the type material of this species. A study of the type collections indicates that *C. repanda* is valid while *C. Bonplandi* is a synonym of Ruiz and Pavon's *C. spathulata*. Comparing equally sized leaf blades of both species one finds that the secondary veins of *C. repanda* are obviously more widely spaced than in *C. spathulata*. Other differentiating characters are the shorter petals and pedicels of *C. repanda*.

4. CESPEDEZIA SPATHULATA (R. and P.) Planch. Lond. Jour. Bot. **5**: 647. 1846.

Godoya spathulata R. and P. Fl. Per. Prodr. **1**: 58. 1794.
Cespedezia Bonplandi Goudot, Ann. Sci. Nat. III. 370. 1844.
Cespedezia Sprucei van Tieghem, Ann. Sci. Nat. VIII. **19**: 50. 1850.
Cespedezia amazonica Huber, Bot. Mus. Goeldi **7**: 302. 1913.

Large trees up to 25 m. high; petioles of leaves 1–3 cm. long, plane above; leaf blades coriaceous, oblanceolate-spatulate, up to 80 cm. long, up to 26 cm. wide, tapering acutely above, subobtuse to distinctly obtuse at apex, cuneate at base, the costa prominent and ridge-like above, scarcely prominent or distinctly so beneath, 0.18–0.4 cm. wide in middle, the secondary veins prominent above, subplane beneath, 0.7–2 cm. apart, somewhat arcuate-ascending at 50°–65° angle, the tertiary veins distinctly or vaguely immersed above, immersed beneath; stipules thin-coriaceous, short-rectangular or narrow-elliptic, 1–3.5 cm. long, 0.9–1.7 cm. wide, the smaller often as broad as long, retuse or tending to split at apex; inflorescence terminal, paniculate, the rachis smooth, usually contorted toward apex, up to 60 cm. long, the basal branches up to 40 cm. long, the flowers mostly 3 per fascicle, the pedicels usually slender, 1.3–2 cm. long, short articulate at base, the flower buds oblong, 1.2–1.5 cm. long; sepals subequal, thick-coriaceous, imbricate, dorsally marcescent, fused into a small cup at base, ovate-rotund, compressed-rotund to almost square (rarely broader than long), 1.7–3 mm. long, obtuse and entire at apex, subauriculate at base, the margin with minute obtuse teeth; petals carnose, obovate or narrow-obovate-oblong, 14–20 mm. long, up to 9 mm. wide, tapering obtusely at base; stamens up to 100, the filaments up to 8 mm. long, usually twice length of anthers, the anthers 3.5–5.5 mm. long; pistil linear-oblong, about 10 mm. long; fruits (before dehiscence) linear-subulate, smooth, drying purple-brown, linear, often falcate, acute, up to 7 cm. long, up to 0.4 cm. wide, the dehiscent fruit 4.5–7.5 cm. long, the seeds oblong, about 0.1 cm. long, 0.05 cm. wide, the wings transparent, 0.85–1.5 cm. long (Fig. 3, *a–e*).

Type locality: Peru.

Distribution: British Guiana, Colombia, Brazil, Peru, and Ecuador.

BRITISH GUIANA: Demarara, Yampari Creek, Georgetown, *Davis 930* (K); Demarara, *Hohenkerk 814* (K); Demarara River *Jenmann 2444* (K, NY, US); *4168* (K, NY); Upper Kamuni, Demarara River, *Anderson 153* (K); COLUMBIA: Vaupes: De Cupati, Rio Yapura, *Ducke 12241* (P, US, type collection of *C. amazonica*). PERU: Without locality, *Fox 120* (K); Huánuco: Chincnao, *Ruiz* and *Pavon* s. no. (K, type collection of *Godoya spathulata ?*); Mat. Campana, Tarapoto, *Spruce 4831* (F, G, K, NY, type collection of *C. Sprucei*); Amazonas: Rio Santiago, *Tessmann 4178* (NY); San Martin: Zepalacio, *Klug 3428* (F, G, NY, US); Lamas, *Llewelyn Williams 6460* (F, G, US); Loreto: Mishuyacu, *Klug 124* (F, NY, US); Junín: La Merced, *Killip* and *Smith 23888* (NY). ECUADOR: Qualaquiza, *von Hagen 290, 291, 293* (NY); Esmeraldas: San Lorenzo, *Little 6357* (US). BRAZIL: Amazonas: São Paulo de Olivacenca, *Ducke 20707* (F); Matto Grosso: Serra do Chapadá, *Riedel 1194* (?) (NY).

According to Little's (*6357*) label this species is known as "Sajo" and "Pacora" in the vicinity of San Lorenzo, Esmeraldas, Ecuador.

5. **Cespedezia scandens** (van Tieghem) Dwyer, comb. nov.

Fourniera scandens van Tieghem, Ann. Sci. Nat. VIII. **19**: 58. 1904.

Vine?; petioles of leaves about 1.5 cm. long; leaf-blades membranaceous, oblanceolate, 30–60 cm. long, 9–16 cm. wide, acute at apex, often acuminate, cuneate at base, the costa thin, ridge-like above, widening and often striate proximally, the secondary veins prominent above, subplane beneath, 1–1.2 cm. apart, ascending at a 60°–65° angle from costa, the margin widely undulate, the lobes 0.7–2 cm. long, the teeth wanting or 1–3 on margins of lobes, ascending, uncinate, up to 0.05 cm. long; stipules linear-lanceolate, up to 4.5 cm. long, subauriculate at base, the margin entire or often splitting; inflorescence paniculate, terminal (?), the rachis angular, finely striate, the fascicles of flowers alternate, paired, each pair 1–4 cm. apart below the middle of the branch, the pedicels stout, lignose, up to 1.3 cm. long at anthesis, deciduous, leaving stout and circular scars 1–1.8 mm. wide, the bracts of pedicels ovate-lanceolate, up to 0.25 cm. long, the marginal cilia few and short; sepals thick-coriaceous, unequal, imbricate at base, ovate-oblong, about one-fifth the length of petals, dorsally marcescent, the veins prominent on outside, obtuse to subacute at apex, obtuse to subauriculate at base; petals subequal, subcarnose, obovate, up to 20 mm. long, the veins well spaced, flabellate, branching above middle; stamens 70+, the filaments narrow-ligulate at apex, 10.5–12 long, about 0.25 mm. wide at apex, the anthers up to 6 mm. long, about 0.5 mm. wide; capsule (immature here) fusiform-falcate, 1.4 cm. long, 0.4 cm. wide.

Type locality: Chontales, 600 m. alt., Nicaragua.

Distribution: Known only from the type locality.

NICARAGUA: Chontales: *Levy 467* (F, photo of type; K type collection of *F. scandens*).

The single collection of this species is noted by van Tieghem in his original description as a vine. Since there is no indication of the habit of the plant on the label of the Kew material or on the photograph of the type, we have no way in which we might check on the accuracy of his statement. It is noteworthy that the five other species of the genus are trees of considerable height. Whether the membranaceous leaf-blades of this collection are mature is important as membranaceous leaf-blades are not found in any other species of *Cespedezia*. Since the material cited above has a piece of the obviously mature inflorescence, we may infer that these are mature.

C. scandens is related to *C. macrophylla* Seem., the only other species collected in Nicaragua. The differences between the species are manifest

in the texture, size apex, and disposition of the secondary veins of the leaf-blades, and in the habits of the plants.

6. CESPEDEZIA BRAZILIANA van Tieghem. Ann. Sci. Nat. VIII. **19**: 51: 1904.

Trees; petioles up to 1.5 cm. long or absent, plane or subconcave on upper surface; leaf-blades whorled, narrowly elliptic-lanceolate up to 70 cm. long, 13 cm. wide, subacute to acute at apex, narrow-cuneate at base, the costa prominent, striate, ridge-like above, the secondary veins prominent above, subplane below, arcuate-ascending, spreading from costa at a 50°–60° angle, 1–1.7 cm. apart in middle, the tertiary veins plane above, immersed beneath, the margin sinuate, the lobes 1–3 cm. apart, the marginal teeth ascending, falcate, about 0.1 cm. long; stipules thin-coriaceous, densely imbricate, linear-elliptic or narrow-rectangular, 2–2.5 cm. long, slender-striate on outside, obtuse at apex, often splitting at apex; inflorescence a patent terminal panicle, the rachis angular, smooth, up to 35 cm. long, the branches elongate, arcuate-ascending, those at base up to 20 cm. long, the flowers usually three per fascicle, the pedicels lignose, expanding distally at anthesis, 1.8–2 cm. long, about 0.1 cm. wide in middle, the articulation-stalks up to 0.6 cm. long, the flower buds obovate, up to 2.2 cm. long, up to 1.1 cm. wide; sepals unequal, imbricate at base, subcoriaceous or subscarious, vaguely marcescent or smooth, carinate on outer surface, obcordate to rotund, 3–4, 5 mm. long, 2.5–3.5 mm. wide, often wider than long, retuse at apex, the sinus up to 1 mm. deep; petals subequal, obovate, 23–25 mm. long, 13–17 mm. wide, cuneate or tapering obtusely at base, obtuse and retuse at apex, the veins well-spaced, flabellate, branching freely toward apex; stamens 70±, the filaments slender, up to 13 mm. long, the anthers linear-falcate, up to 7 mm. long; capsule (immature here), linear-falcate, 18 mm. long.

Type locality: State of Santa Catherina, Brazil.

Distribution: Known from the States of Matto Grosso and Santa Catherina, Brazil.

BRAZIL: Matto Grosso: *Collennette 123* (K); Santa Catherina: *Weddell 3027* (P, type of *C. braziliana*, F, frag.).

The sepals of *C. braziliana* provide the strongest distinguishing characters. Unlike the other species of the genus these are frequently scarious in texture, at least being obviously thinner than those of the other species of *Cespedezia*. The conspicuously retuse condition of the apex of its sepals and their obcordate shape stand in sharp contrast to the remainder of the genus.

Supplementary Notes on the American Species of Strychnos—II

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Extensive collections of *Strychnos*, largely from Brazil, Colombia, Surinam and Venezuela, recently became available to us. We have also been able to examine specimens deposited in the three European herbaria mentioned below. The collections examined extend our knowledge of certain species previously known to us from incomplete material or only from descriptions; extensions of ranges are noted for a considerable number of species; one species, *Strychnos Duckei*, is described as new, and another new species, *S. pachycarpa*, recently described by Ducke (1), is reviewed by us.

The species noted in this supplement are arranged in the same order, and the place of deposit of specimens is shown by the same abbreviations, as in our previous papers on *Strychnos* (2, 3). The following additional abbreviations are used:

G: Conservatoire et Jardin Botanique, Geneva
P: Museum d'Histoire Naturelle, Paris
R: Secçaõ do Botanico do Museu Nacional, Rio de Janeiro
S: Naturhistoriska Riksmuseet, Stockholm

2. Strychnos ramentifera Ducke.

Brazil: Para: *Ducke 1658* (A, F, NY).

This collection of the species is the second known to us. Ducke notes on the label: "ad viam ferreani km. 18, silva non inundabili. Frutex robustissimus altissimi scandens."

In his recent paper under this species (1, p. 11) Ducke states: "Cipó robusto, frequente na mata da terra firme dos arredores de Belem do Para. Notavel pelos frutos que são tão volumosos como os de *Str. pachycarpa*, embora de estrutura diferente."

3. Strychnos asperula Sprague & Sandw.

Brazil: Territory of Acre: Basin of Rio Acre, *Ule 9838* (G).

We now have examined the type collection of the species. In the previous paper our description was taken from the original description of it by Sprague and Sandwith. The following changes in the key to the species of *Strychnos* appear to be necessary (2, p. 262):

1. The sentence: "Anthers 1.75–2.75 mm. long and acuminate at base; corolla-tube glabrous and not papillose without, not pilose within" should read: "Anthers 1.75–2.75 mm. long and acuminate at base; corolla-tube

glabrous and not papillose without, not pilose within, corolla-lobes sparsely pilose within near sinuses."

2. In the sentence: "Filaments not distinct, anthers over 2 mm. long; corolla-tube about 1.5 cm. long or longer, corolla-lobes sparsely pilose within near sinuses"—the last part, namely "corolla-lobes sparsely pilose within near sinuses," should be deleted.

3. In the sentence: "Filaments distinct but short, anthers about 1.75 mm. long, glabrous; corolla-tube about 0.85 cm. long, corolla-lobes glabrous within"—the last part, namely "corolla-lobes glabrous within," should be deleted.

In the same paper (2, p. 266), in the description of the species, the sentence: "corolla-lobes about 2.5 mm. long, glabrous without, cinereous-papillose within, especially toward margins and apex" should read: "corolla-lobes about 2.5 mm. long, glabrous without, papillose and glabrous within except for sparse long hairs near sinuses."

4. STRYCHNOS RONDELETIODES Spruce.

VENEZUELA: Amazonas: Cassiquiare, *L. Williams 15612* (US, Ven). BRAZIL: Amazonas: Basin of Rio Tonantins, *Ducke s. n.* (Jan. 31, 1944); Basin of Rio Negro, *Ducke s. n.* (*H. J. B. R. 23936*) (S).

Local names: Curare de pava (Venezuela).

The Williams specimen is the first record of the species from Venezuela.

4a. STRYCHNOS MACROPHYLLA Barb. Rodr.

BRAZIL: Amazonas: Basin of Rio Negro, *Herb. Est. do Amazonas 754* (19/7–1941) (M).

Dr. Ducke states on the label: "Manaos, Igarape do Crispo, silva non inundabili, loco humido."

5. STRYCHNOS BARNHARTIANA Krukoff.

BRAZIL: Amazonas: Basin of Rio Tonantins, *Ducke 1483* (A, F, NY), *1484* (A, F, NY).

The first record of the species from the basin of Rio Tonantins. Ducke states on the label: "fructibus maturis aurantiacis."

7. STRYCHNOS HACHENSIS Karst.

In a private communication to us Dr. A. Dugand of Universidad Nacional, Instituto de Ciencias Naturales, Bogota, Colombia, writes as follows concerning the type locality for the species: "Tomarazon is not near Santa Maria, but about 40 miles due south of Riohacha formerly called Rio de la Hacha or Rio Hacha. The correct spelling is 'Tomarrazón.'"

8. STRYCHNOS TRINERVIS (Vell.) Mart.

BRAZIL: *Frölich s.n.* (S); *Museu Nacional 41612* (R), *41616* (*Barb. Rodr. 12*) (R), *41642* (*Riedel*, Serra da Guarida) (R). Minas Geraes: *Museu Nacional 41639* (*Regnell—III—182*; Caldas) (R); *Regnell—III—182* (1834–44) (S). Rio de Janeiro: *Mosén 2531* (Corcovado) (S); *Glaziou s.n.* (S); *Museu Nacional 41632* (*Lad. Netto 102*) (R), *41633* (*Netto s.n.*; Sta. Theresa) (R),

41636 (*Lad. Netto s.n.*) (R), *41634* (*Lad. Netto s.n.*, Jurujuba) (R), *41618* (*Glaziou s.n.;* Praia Grande) (R), *41637* (*Freire 596;* Restinga de Crumarí) (R), *41644* (*Saldanha & Schwacke s.n.;* Fazenda Sobral, Paraiba do Sul) (R); *Weddell s.n.* (G), *404* (G); *Richard s.n.* (G); *Glaziou 9521* (G); *Freire Allemão s.n.* (G). Parana: *Museu Nacional 41656* (*Schwacke—II—28;* Antonina) (R); *Dusen 10395* (Jaguariahyva, in silvula) (S), *11973* (Antonina, in capueirão) (S). Santa Catarina: *Museu Nacional 41617* (*Fritz Muller 198;* Itajahy) (R).

The collections from Paraná are our first record of the species from that state.

9. STRYCHNOS PANAMENSIS Seem.

COLOMBIA: Basin of the Atrato river, Truando, *A. C. V. Schott s.n.* (Dec. 1857).

This plant is cited as "Cinchonaceae #1" in J. Torrey's manuscript copy of Schott's Atrato Plants. "Cinchonaceae #2," collected in the same region and also available to us, has been determined as *Malouetia guatemalensis* (Muell. Arg.) Standley. Torrey's manuscript is deposited in the Library of the New York Botanical Garden.

12. STRYCHNOS MEDEOLA Sagot.

SURINAM: Basin of the Coppename River, Raleigh Valley, *Geijskes s.n.* (June 10, 1944). FRENCH GUIANA: *Sagot 398* (P, S). BRAZIL: Para: *Museu Nacional 41658* (*Jobert & Schwacke 868;* Santarem, Serra) (R), *41657* (*Schwacke 145;* Rio Capim, ad Pacoval) (R).

This is the first record of the species from Surinam.

14. STRYCHNOS TOMENTOSA Benth.

BRAZIL: Para: Near Catú, *Ducke 1645* (A, F, NY).

This is the first specimen of the species examined by us from the State of Para.

15. STRYCHNOS DIABOLI Sandw.

BRAZIL: Amazonas: Basin of Rio Negro, *Ducke s.n.* (2/3–45).

This is the first specimen of the species examined by us from the basin of Rio Negro.

16. STRYCHNOS JAVARIENSIS Krukoff.

BRAZIL: Amazonas: Basin of Rio Javary, *Ducke 1770.*

With the collection of *Ducke 1770*, flowering material of *S. javariensis* is now available. The flowers of *S. javariensis* are essentially like those of *S. diaboli*, except that the calyx-lobes (1.5 mm. long), corolla-lobes (1.8 mm. long), and anthers (0.8 mm. long) are somewhat shorter. In *S. diaboli* they are 2 mm., 2.5 mm., and 1.1 mm. long respectively. The two species are best distinguished in their vegetative characters.

In the key to the species in our previous paper (2, p. 262) *S. javariensis* should now be placed next to *S. diaboli* and the key should read as follows:

Corolla-tube glabrous and papillose without; calyx-lobes about 1 mm. long, glabrous without.. ..... 5. *S. Barnhartiana.*

Corolla-tube conspicuously strigose without; calyx-lobes 1.5 or 2 mm. long, pubescent without.

Lobes of corolla densely bearded at base within; calyx-lobes densely subsetulose without; pedicels short or none.

Leaf blades with secondaries and reticulation faint, 5–15 cm. long, 3–9 cm. broad 15. *S. diaboli.*

Leaf blades with prominent rib-like secondaries beneath and deeply impressed reticulation above, 13–19 cm. long, 5–12 cm. broad..... 16. *S. javariensis.*

Lobes of corolla glabrous within; calyx-lobes sparsely subsetulose without; pedicels up to 3.5 mm. long..... 6. *S. brachiata.*

18. STRYCHNOS JOBERTIANA Baillon.

PERU: Loreto: near Pongo de Manseriche, *Tessmann 4722* (S). BRAZIL: Amazonas: Basin of Rio Solimoes, *Museu Nacional 41651* (*Schwacke s.n.;* Alto Amazonas, Calderão) (R); Basin of Rio Tonantins, *Jobert s.n.* (type coll., P).

The Tessmann specimen is the first record of the species from Peru

19. STRYCHNOS PSEUDO-QUINA A. St. Hil.

BRAZIL: Goyaz: *Glaziou 21761* (G, S); *Museu Nacional 41643* (*Ule 464;* "nos cerrados perto de Mossamedes") (R). Matto Grosso: *Museu Nacional 41645* (*Mello s.n.;* Cuiabá) (R). Minas Geraes: *Malme 2411a* (Santa Ana da Chapada) (S); *Lindman A.2515* (Palmeiras, in dumetis campi aprici) (S), *A.3073* (Rio Jocuára, in campis glareosis) (S); *Weddell 1866* (G); *Claussen 135* (G); *Museu Nacional 41629* (*Mello Barreto 5195;* in "cerrado" near Lagoa Santa, munic. Santa Luzia) (R), *41638* (*Regnell—III—179;* Uberaba) (R), *41614* (*Sampaio 6718;* Sta. Luzia, Serra Serra do Cipó) (R), *41635* (*Lad. Netto 104*) (R). São Paulo: *Museo Nacional 41641* (*Regnell—III—179*) (R, S); *Mosén 1474* (Mogy-mirim in campo secco) (S). Rio de Janeiro· *Glaziou 14094* (G).

The Glaziou specimen is the first record of the species from the State of Rio de Janeiro.

20. STRYCHNOS XINGUENSIS Krukoff.

According to Ducke (1, p. 14) the cotypes of this species known up to the present time only from the type collection are available at the Botanical Garden at Rio and in Kew Gardens.

21. STRYCHNOS AMAZONICA Krukoff.

BRAZIL: Amazonas: Basin of Rio Negro, *Ducke s.n.* (12/4/45), *s.n.* (27/2/45).

22. STRYCHNOS PECKII B. L. Robinson.

VENEZUELA: Amazonas: Basin of the Upper Orinoco, island Solitaria, between Tamatama and Esmeralda, *L. Williams 15241.* COLOMBIA: Valle del Cauca: *Cautrecasas 17447.* BRAZIL: *Museu Nacional 41628* (*Luetzelburg 23957;* Rio Papori-Japú-Cachoeira-17/XII-928) (R). Amazonas: Basin of Rio Tonantins, *Ducke s.n.* (Febr. 2, 1944); Basin of Rio Negro, *Ducke s.n.* (July 6, 1943).

Local names: Cúpira (Baniba Indians, Venezuela).

The Williams specimen is the first record from Venezuela, whereas one of the Ducke specimens is the first record of the species from the basin of Rio Tonantins. The Luetzelburg specimen likely is a new record of the species for the State of Ceara or Rio de Janeiro. Outside of the basin of the Amazon in Brazil the species was known up to the present time to occur only in the States of Maranhão and Bahia. We have been unable to

ascertain in what State the Luetzelburg specimen was collected. The Cuatrecasas specimen is the first record of the species from Colombia. It was collected at "costa del Pacifico, Rio Cajambre, silva, 5–80 met. alt."

24. STRYCHNOS ERICHSONII Rich. Schomb.

VENEZUELA: Boliver: Basin of the Upper Paragua, *Felix Cardona 1228*. BRITISH GUIANA: *Schomburgk 981* (G).

Local names: Uruichá (Arekuna, Venezuela).

Cardona's specimen was obtained on Rio Karún, 350 met. (Guayana); it is the first record of the species from Venezuela.

25. STRYCHNOS GARDNERI A. DC.

BRAZIL: Ceara: *Museu Nacional 41620* (*Freire Allemão e M. de Cysneiros 1006*) (R). Goyaz: *Gardner 3890* (type coll., P). Rio de Janeiro: *Museu Nacional 41619* (*Glaziou 12691;* Serra do Tinguá) (R). São Paulo: *Mosén 3217* (Santos, ad rivulum umbrosum) (S).

This is the first record of the species from the State of Ceara.

26. STRYCHNOS PUBIFLORA Krukoff.

BRAZIL: Minas Geraes: *Museu Nacional 41630* (*Mello Barreto 8919; Jard. Bot. Belo Horizonte 25907*) (R, type coll.).

27. STRYCHNOS PEDUNCULATA (A. DC.) Benth.

BRITISH GUIANA: Essequibo: Kamuni creek, *Maguire* & *Fanshawe 22875, 22929*.

In his recent paper (1, p. 23) Dr. Ducke makes a very interesting observation: "Este espécie coletada em varios lugares da Guiana britânica e na Venezuela não parece habitar Trinidad, apesar de ter por sinônimo *St. trinitensis* Griseb., atribuida à flora daquela ilha. Sandwith e Krukoff relatam que as etiquetas do tipo de *trinitensis* e de um outro espécimen, ambos do herbario do Jardim Botânico de Trinidad, indicam "Caura," como localidade de coleta; êsse nome refere-se evidentemente ao Rio Caura, afluente da margem direita do baixo Orinoco, no Estado de Bolivar, Venezuela."

28. STRYCHNOS MITSCHERLICHII Rich. Schomb.

BRITISH GUIANA: Essequibo: Potaro River Gorge, *Maguire* & *Fanshawe 23503*. SURINAM: Bakhuis mountains, *Geijskes 1035*. BRAZIL: Para: Near Catú, *Ducke s.n.* (Sept. 26, 1944). AMAZONAS: Basin of Rio Tonantins, *Ducke s.n.* (Febr. 17, 1944), *1485* (A, F, NY). COLOMBIA: Valle del Cauca: *Cautrecasas 15811, 16617, 17310*.

The Cuatrecasas specimens are the first record of the species from Colombia. Cuatrecasas *#17310* was collected at "Costa del Pacifico, Rio Cajambre, San Isidro, 5–100 met. alt."; *Cuatrecasas #15811*—at "Costa del Pacifico, Rio Yurumangui, Veneral, bosques, 5–10 met. alt.," and *Cuatrecases #16617*—at "Rio Calima (Regiòn del Chocó), La Trojita, 5–50 met. alt."

29. STRYCHNOS DARIENENSIS Seem.

COLOMBIA: Valle del Cauca: *Cuatrecases 17673*.

The Cuatrecasas specimen is the first record of the species from Colombia. It was collected at "costa del Pacifico, Rio Cajambre, Silva, 5–80 met. alt."

30. STRYCHNOS GUIANENSIS (Aubl.) Mart.

VENEZUELA: Amazonas: Basin of the Upper Rio Negro, *L. Williams 14813, 14883*. BRITISH GUIANA: *Schomburgk s.n.* (G). Essequibo: Potaro River Gorge, *Maguire & Fanshawe 23496*. Surinam: Basin of the Coppename River, *Geijskes 1015, 1032, s.n.* (Dec. 17, 1943). FRENCH GUIANA: *Poiteau s.n.* (G); *Leprieur 243* (G). BRAZIL: Matto Grosso: Juruena, *Museo Nacional 41615* (*Hoehne V/909*) (R). Para: Basin of Rio Tapajos, *Museo Nacional 41665* (*Jobert & Schwacke 867;* Santarem, Serra) (R); Basin of Rio Capim, *Museo Nacional 41660* (*Schwacke 159;* Putirytá) (R). Amazonas: *Ducke 1699* (A, F, NY); Basin of Rio Negro, *Ducke s.n.* (2/3-45).

Local names: Cúpira (Baniba Indians, Venezuela).

The Hoehne specimen cited above is the first record of the species from the State of Matto Grosso, whereas *Ducke 1699* is the first record from the basin of Rio Tonantins, Amazonas.

In his recent paper Dr. Ducke (1, pp. 19 & 20) makes an interesting observation: "A presença de *St. guianensis* em Minas Geraes parece-me carecer de confirmação por novas coleçoes. *S. oblonga* Gilg, da coleção Glaziou, e, segundo a etiqueta, procedente de Minas, foi reconhecida por Krukoff como co-específica com *S. guianensis;* no entanto, em mais de uma das numerosas plantas distribuidas por Glaziou, as localidades indicadas nas etiquetas foram encontradas errôneas."

Ducke s. n. (21/9–45), collected from a giant bush-rope of the forest of terra firma near Catú, Para, is placed by us with the collections that we discuss in remarks in our previous paper (2, p. 297).

31. STRYCHNOS SUBCORDATA Spruce.

BRAZIL: Amazonas: *Museu Nacional 41613* (collector undesignated; Vale do Rio Canumarí) (R), *41652* (*Schwacke s.n.;* Manaos) (R), *41653* (*Schwacke s.n.;* Manaos, 1877) (R), *41661* (*Schwacke s.n.;* Manaos, 15/IV-82) (R).

The collector note on *Museu Nacional 41653* reads: "Urary—uva . . . contendo o principio venenoso agita como o *Strychnos Castelnaei* Wedd. como a differencia de ser menos efficaz."

32. STRYCHNOS BICOLOR Prog.

BRAZIL: São Paulo: *Hemmendorff s.n.* (Santa Rita do Passa Quatro) (S); *Mosén 1475* (Mogymirim in campo secco) (S).

33. STRYCHNOS PANURENSIS Sprague & Sandw.

COLOMBIA: Chocó: *Cuatrecasas 16918*. Venezuela: Bolivar: *Killip 37285*.

This is the first record of the species from the "Intendencia del Chocó," Colombia, and the State of Boliva, Venezuela.

33a. **Strychnos Duckei** Krukoff and Monachino, sp. nov.

Frutex volubilis magnus; laminis foliorum macroscopice glabris, in siccitate flavescentibus, reticulo venarum utrinque crasso et valde prominente; inflorescentiis elongatis minute hirtellis; lobis calycis ovato-lanceolatis ca. 1.3 mm. longis glabris vel extus sparse hirtellis; lobis corollae intus toto lanatis; antheris ca. 0.8 mm. longis; ovario styloque glabris.

Macroscopic: petioles about 3–6 mm. long; blades lanceolate, about 10–11 cm. long, 3.5–4 cm. broad, rounded to obtuse at base, acuminate at apex, somewhat shining on upper surface, duller beneath, drying an olive-ocher yellow with dark petioles, subcoriaceus, 3-plinerved with the inner pair subopposite and diverging at about 4 mm. from base, reticulation coarse and prominent on both surfaces. *Microscopic:* branchlets puberulent with minute adpressed or ascending hairs; petioles very sparsely puberulent with adpressed hairs; blades beneath with inconspicuous atomic dots, universally puberulent with very short adpressed hairs, above occasionally sparsely puberulent on midrib near base, otherwise glabrous.

Inflorescences in elongated thyrses (about 7 cm. long) with nodes of opposite branches along rachis distant, puberulent with pale-brown straight very short adpressed or ascending hairs, bracts lanceolate, sometimes subfoliaceous, pedicels up to 2 mm. long; calyx-lobes ovate-lanceolate, about 1.3 mm. long, acute or acuminate at apex, spreading, glabrous or very sparsely hispidulous without, ciliate; corolla-lobes densely lanate on the whole face within; anthers about 0.8 mm. long; ovary and style glabrous. Fruits not seen.

Type locality: Amazonas (Tabatinga, Marco), Brazil.

Distribution: Known only from the type collection.

Brazil: Amazonas: basin of the Upper Solimoes, *Ducke 1771* (NY, Type).

S. Duckei is closely related to *S. panurensis* but easily distinguished from it. In place of "Plant macroscopically glabrous; leaf-blades 5–20 cm. long, etc.," 19th line from bottom of page 295 in our first paper on *Strychnos* (**2**: 295) substitute the following key:

Plant macroscopically glabrous; leaf-blades with reticulation prominent on both surfaces; infl. generally compound and elongated, many-flowered.

Leaf-blades with fine closely intricate reticulation, the ultimate areolae being microscopic, drying greyish; anthers about 1.6 mm. long; calyx-lobes about 1 mm. long, strongly papillose or grey papillose-puberulent without.....33. *S. panurensis.*

Leaf-blades with coarse reticulation, the ultimate areolae being rather open, drying yellowish; anthers about 0.8 mm. long; calyx-lobes about 1.3 mm. long, glabrous or sparsely hispidulous with pale-brown hairs without.....33a. *S. Duckei.*

The collector notes: "Silva non inundabili. Frutex robustus alte scan-

dens floribus albis Jasminum fortiter redolentibus." No tendrils are present in the available material.

34. STRYCHNOS HIRSUTA Spruce.

BRAZIL. Amazonas: Basin of Rio Madeira, *Ule 6105* (G).

The corolla of this species was not previously seen by us. Corolla-lobes are lanate on the lower half within, the upper half is papillose but glabrous.

35. STRYCHNOS COGENS Benth.

VENEZUELA: Amazonas: Basin of the Upper Orinoco, between Tamatama and Esmeralda, *L. Williams 15230* (Ven).

This is the first record of the species from Amazonas, Venezuela.

36. STRYCHNOS MELINONIANA BAILLON.

SURINAM: Basin of the Upper Coppename, *Geijskes 1040*.

This is the first record of the species from Surinam.

38. STRYCHNOS CASTELNAEANA Wedd.

BRAZIL: Amazonas: Basin of Rio Solimoes: *Museu Nacional 41664* (*Schwacke 806;* Alto Amazonas, Calderão) (R).

This specimen is of a historical interest. It was collected by Schwacke on his and Jobert's visit to Calderão in Sept. 1877, at which time they witnessed the Curare manufacture by the Tecuna Indians. Schwacke notes on the label: "la base du curare des Indiens Tecunas." The herbarium label of "Herb. J. de Saldanha" attached to this collection reads: "Plantes du Curare des Indiens Tecunas, mission de Calderão, Alto Amazonas:

(1) casca—*Strychnos Castelnaei* Wedd. —"guure" (la base),
(2) casca—*Anomospermum grandifolium* Eichl.* —"icú,"
(3) caule—Aglaonema —"taja,"
(4) folhas—Petiveria —"yone,"
(5) casca da raiz—Piper —"obue,"
(6) casca da raiz—Artanthe —"aeruma"

39. STRYCHNOS RUBIGINOSA DC.

BRAZIL: Piauhy: *Museu Nacional 41662* (*Schwacke 455;* Oeiras) (R). Ceara: *Museu Nacional 41624* (*Freire Alemão s.n.*) (R). Bahia: *Blanchet 2918* (type coll, P). PARAHYBA: *? Museu Nacional 41625* (*Jayme Vasconcelos s.n.;* Areias) (R). RIO DE JANEIRO: *Glaziou 4883* (São Christavão, Morro de telegraphos) (type coll. of *S. fulvotomentosa*, S).

* For a discussion of the botanical identity of this plant, see remarks under *Elissarrhena grandifolia* and *Chondodendron limaciifolium* in paper by B. A. Krukoff and H. N. Moldenke entitled "Studies of American Menispermaceae, with Special Reference to species used in Preparation of Arrow-poisons" (Brittonia **3**: 1–74. 1938). For the other botanical ingredients used by the Tecunas in Curare manufacture see the paper by B. A. Krukoff and A. C. Smith entitled "Notes on the Botanical Components of Curare" (Bull. Torrey Bot. Club **64**: 401–409. 1937).

The specimens from the States of Ceara and Parahyba are the first record of the species from these two States.

42. STRYCHNOS PARVIFOLIA DC.

BRAZIL: Ceara: *Lofgren 561* (Serra Araripe) (S); *Museu Nacional 41623* (*Freire Allemão s.n.*) (R), *41621* (*Freire Allemão* e *M. de Cysneiros 1007*) (R), *41622* (*Freire Allemão* e *M. de Cysneiros 1008*) (R). RIO DE JANEIRO: *Museu Nacional 41627* (*Rangel s.n.*; Estação do Commercio) (R). PARAGUAY: *Rojas 1536a* (*Herb. Corn. Osten 8404*) (S); *Fiebrig 303* (G).

43. STRYCHNOS GRAYI Griseb.

CUBA: Oriente: *Ekman 1874* (S), *2739* (S), *3406* (S), *6129* (S). HAITI: *Ekman H. 6757* (Santo Domingo, Cordillera de Bahoruco, prov. de Barahona, Sierra de los Comisarios, between Banane and Gros-Figuier, limestone, 400 m.) (S).

43a. STRYCHNOS PACHYCARPA Ducke, Boletim Técnico do Instituto Agronômico do Norte **3**, 1945: 15. 1945.

Macroscopic: petioles 5–10 mm. long; blades orbicular-ovate to elliptic or oblong-ovate, 5–9 cm. long, 3.5–6 cm. broad, subcordate to rounded at base, usually abruptly acuminate at apex, shining on upper surface and somewhat duller beneath, membranaceous to chartaceous, 3–5-plinerved with the inner pair subopposite and diverging at 2–11 mm. from base, reticulation moderately prominent on both surfaces. *Microscopic:* branchlets and petioles puberulent with short erect greyish hairs, glabrescent or glabrous; blades beneath sparsely puberulent on principal nerves of essentially glabrous, above sometimes puberulent on midrib, otherwise glabrous.

Inflorescences in paniculate cymes, usually hemispheric and many-flowered, puberulent with short, erect hairs, bracts lanceolate and long-acuminate to ovate, ciliate, otherwise glabrous or sparsely puberulent, peduncles flattened, 7–21 mm. long and about 1 mm. wide, pedicels shorter than calyx; calyx-lobes ovate, about 1 mm. long, acute at apex, ciliate, otherwise glabrous; corolla-tube manifestely longer than calyx, about equal to or slightly longer than corolla-lobes, 1.6–2.3 mm. long, glabrous both without and within (microscopically papillose); corolla-lobes about 2 mm. long, obscurely papillose without, long-bearded near middle within along an upwardly convex arc, otherwise papillose and glabrous; anthers glabrous; ovary and style glabrous. Fruits (ex descrip.) 6–9 cm. in diam., shell 9–10 mm. thick, seeds about 8, with pale-fulvous fibrous (finally easily removable) covering, 3-sided suborbicular with two faces plane and the remaining face rounded, up to 25 mm. long, glaucous-black, rugulose on surface, stony; fruit-pedicels about 10 mm. in diam.

Type locality: Amazonas (near Manaos), Brazil.

Illustrations: Boletim Técnico do Instituto Agronômico do Norte #3. 1945: pl., fig. 1–5. 1945.

Distribution: Known only from the type collection.

BRAZIL: Amazonas: Basin of Rio Negro, *Ducke 1403* (type coll., A, F, NY).

S. pachycarpa is anomalous in *Breviflorae* because of its relatively long corolla-tube, otherwise in all other features it falls well within the section. The corolla-tube is manifestly longer than the calyx and somewhat longer than the corolla-lobes, but the size of the flower as a whole suggests *Breviflorae*, in which section the species is in harmony in both external and internal floral characters, inflorescence and vegetative habit.

In the key to the species in our previous paper (2, p. 305) *S. pachycarpa* should be placed next to *S. Castelnaeana* under the division "Leaf-blades less than 15 cm. long," etc., and distinguished as follows:

Corolla-tube manifestly longer than calyx, equal to or longer than corolla-lobes, indumentum of greyish puberulence or none .....43a. *S. pachycarpa*.
Corolla-tube shorter than calyx, manifestly shorter than corolla-lobes.

Furthermore, the proper exception introduced by the long corolla-tube of *S. pachycarpa* should be noted in the key to the sections (2, p. 261) and the description of the section *Breviflorae* (2, p. 305).

In the systematic arrangement of the species *S. pachycarpa* belongs with *S. brachistantha* and *S. nigricans*, to which it bears a general resemblance in many respects.

Ducke writes the following field description of the plant: "Frutex robustus altissime scandens, cortice trunci crassi in laminulas parvas soluto, inermis, cirrhifer, ramulis cinereo-brunneis dense pallido-lenticellosis, novellis subtetragonis." He also states: "Os frutos atingem até 9 cm. em diâmetro, tamanho alcançado somente pelos de *St. ramentifera*, do Pará, e de *St. hachensis* Karst., do Colômbia; êles cáem durante a estação chuvosa, e os que não se partem pela queda permanecem na chão, inalterados, durante muito tempo. Eles lembram, em forma e côr, laranjas de regular tamanho, ficando, no entanto, enegrecidos depois de algum tempo; a casca lustrosa, lenhoso-suberosa, é dura e espessa, porém quebradiça; a polpa branca é doce e será sem dúvida comida por animaes da mata, mas aparentemente só é aproveitada nos frutos quebrados na ocasião da queda. Notáveis são as sementes, grosseiramente fibrosas, que diferem muito das sementes sedosas ou felpudas das outras espécies que pude obter. A planta, atí agora só observada num unico exemplar, na mata das terras altas ao Nordeste de Manaos, é um cipó robusto, ramificado nas copas de varias árvores altas."

45. STRYCHNOS NIGRICANS Prog.

BRAZIL: cult. Museu Paraense, Belem, *Ducke 1613* (A, F, NY). Amazonas: Basin of Rio Negro, *Ducke s.n.* (12/4-45). Minas Geraes: *Esc. Sup. Agr. & Vet. 1515; Museu Nacional 41650* (*Schwacke s.n.*, Serra da Cayana) (R).

This is the first record of the species from the State of Minas Geraes. Ducke states on the label (*Ducke 1613*): "Belem, Museu Paraense culta,

a J. Huber e medio Rio Purus introducta. Frutex alte scandens fructibus aurantiacis."

48. STRYCHNOS TARAPOTENSIS Sprague & Sandw.

COLOMBIA: Cundinamarca: between Tocaima and Pubenza, *? Killip, Dugand & Jaramillo 39309* (US).

The specimen is sterile and we are unable to identify it with any certainty.

49. STRYCHNOS BRASILIENSIS (Spreng.) Mart.

BRAZIL: Minas Geraes: *Regnell* III-*183* (29/10-1847) (S), III-*183* (Pedra Branca, 1854–1858) (S), III-*183* (15/1-1864) (S), II-*137* (10/11-1846) (S), II-*137* (30/4-1869)(S); *Mosén 623* (Caldas, in campo umbroso) (S), *4251* (S); *Widgren s.n.* (S), *s.n.* (1845) (type coll. of *S. macroacanthos*, S); *Weddell 881* (G); *Museu Nacional 41631* (*Mello Barreto 11022*, Poços de Caldas—Cascata das Antas) (R), *41640* (*Regnell* III-*183*, Caldas) (R). RIO DE JANEIRO: *Glaziou 6047* (Serra dos Orgãos, Therezapolis) (S); *Museu Nacional 41647* (*Schwacke s.n.*, Fazenda Sobral do Dr. Viriato de Medeiros, Paraiba do Sul) (R). São Paulo: *Mosén 1472* (Serra de Caracol) (S), *1473* (S); *Heiner s.n.* (Campinas;1904–1906) (S), *258* (Campinas, prope Ponte Preta) (S). PARANÁ: *Dusen s.n.* (Itararé, in silvula; 7/11-1910) (S), *s.n.* (Therezina, in capueira; 20/1-1911) (S), *1252a* (Villa Velha, in silvula; 4/11-1914) (S), *8010* (Capão Grande, in silvula) (S), *8784* (Jacarehý, in silva primaeva) (S), *11245* (Therezina, in capeuira) (S); *Jöhnsson 818a* (Jacarehý, in silva primaeva) (S); *Museu Nacional 41655* (*Schwacke 11–23*, Antonina) (R). SANTA CATARINA: *Museu Nacional 41626* (*Hetschko* Col. IV, Blumenau) (R), *41648* (*Schwacke s.n.*, Joinville) (R). RIO GRANDE DO SUL: *Lindman A. 1487* (Santa Maria in silvulis dumetisque) (S); *Malme s.n.* (17/4-1893) (S), *474* (Porto Alegre, pr. Menino Dues) (S). PARAGUAY: *Hassler 9645* (G); *Balansa 2049* (G), *2050* (G); *Balansa 2049* (Villa Rica) (S). ARGENTINA: Misiones: Posadas, *Ekman 1393* (S), *1442* (S).

The specimen *Glaziou 6047* is cited by Gilg under *S. Sellowiana* Gilg in Bot. Jahrb. **25**, Beibl. 60: 41. 1898.

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Vol. 9 JUNE · 1946 No. 2

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

The Adoxa Type of Embryo Sac: a Critical Review

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I. INTRODUCTION

For many years the Adoxa type was considered the commonest of the tetrasporic embryo sacs, in which all four megaspore nuclei take part in the development. In this type there is only one division following megasporogenesis giving rise to an eight-nucleate embryo sac which organizes typically to form an egg apparatus of three cells and a group of three antipodal cells, leaving two free nuclei to function as polars. It was described almost simultaneously by Jönsson (1879/80) in *Adoxa moschatellina* and

Treub and Mellink (1880)in *Lilium* and *Tulipa*. Later, it was reported in a large number of other plants, belonging to various families of the Dicotyledons as well as Monocotyledons.

Bambacioni's (1928, a, b) researches disclosed, however, that the embryo sacs of *Lilium* and *Fritillaria* followed an entirely different mode of development. She found that immediately after the reduction divisions the megaspore nuclei take up a 1+3 arrangement, in which one nucleus lies at the micropylar end of the cell and three at the chalazal. In the next division, the three chalazal spindles fuse resulting in a second four-nucleate stage with two haploid nuclei at the micropylar end and two triploid ones at the chalazal. One more division follows, resulting in eight nuclei of which the four micropylar are haploid and the four chalazal are triploid.

This mode of development, characterized by the presence of four nuclear divisions between the megaspore mother cell stage and the mature embryo sac and the interpolation of a secondary four-nucleate stage, came to be known as the Fritillaria type. Subsequent work done by Bambacioni and several other embryologists in various parts of the world (see Maheshwari, 1946, for a full bibliography) showed that a number of plants, formerly supposed to have the Adoxa type of development, really belong to the Fritillaria type. Due to these corrections and transfers, the Fritillaria list gradually increased, while the Adoxa list continued to diminish, until it now contains only four genera.

II. Known Distribution of the Adoxa Type

Adoxa.—Jönsson's original account of *Adoxa moschatellina* was confirmed in 1909 by Lagerberg and again in 1938 by Fagerlind. The four megaspore nuclei, produced as a result of the reduction divisions, show varying positions with respect to each other but eventually arrange themselves in two pairs at opposite ends of the embryo sac with a large vacuole occupying the space in the center. All of them divide once again. During this division the two polar spindles, one at each end, are oriented obliquely to the longitudinal axis of the embryo sac and are situated very close to the poles. The remaining two spindles, one at the chalazal and the other at the micropylar end, are in a direction more or less parallel to the longitudinal axis of the sac. As a result of this division there arise two very small nuclei at the micropylar pole and two similar ones at the chalazal, with two other pairs of larger nuclei, situated closer to the center. The two small ones at the micropylar end form the synergids, and of the larger, one becomes the upper polar and the other organizes into the egg cell; at the chalazal end the two small nuclei and one of the larger two give rise to the antipodals while the remaining nucleus functions as the lower polar. Sometimes the lowest chalazal nucleus of the four-nucleate stage is unable to complete its division so that there is a seven-nucleate embryo sac with only two antipodal cells.

Sambucus.—Lagerberg (1909) reported the same type of development in *S. racemosa*. This has now been confirmed by Fagerlind's (1939) study of *S. canadensis* and *S. ebulus*. A peculiarity in this case is the early vacuolation which is appreciable even at the megaspore mother cell stage, although in most other cases it commences only after megasporogenesis is completed.

Erythronium.—In 1901, Schaffner reported that in *Erythronium albidum* and *E. americanum* the four megaspore nuclei were not separated by walls and divided just once to produce an eight-nucleate embryo sac of the Lilium type[1] (=Adoxa type in present terminology.) On the basis of Hrubý's (1934, 1938) work on *E. dens canis*, which indicated the occurrence of the Drusa or Fritillaria type in this genus, Schaffner's account was considered somewhat doubtful (Maheshwari, 1937; Fagerlind, 1938, 1939). However, Cooper (1939) has recently confirmed the occurrence of the Adoxa type at least in *E. albidum*. He counted twenty-two pairs of chromosomes at the diakinesis stage as well as the heterotypic metaphase. The two nuclei formed as a result of the division had 22 chromosomes each. The spindles of the homotypic division were oriented obliquely to the longitudinal axis of the cell. After the formation of the four megaspore nuclei the cell was found to grow in size and elongate to a considerable extent becoming four times longer than broad and the cytoplasm in the middle region became highly vacuolate. The two micropylar nuclei and the upper chalazal nucleus divided normally and 22 chromosomes were agian counted on each equatorial plate. Only the nucleus nearest to the chalazal end was observed to undergo a more or less abortive division. Four nuclei were nevertheless formed at each pole of the embryo sac which organized in the usual fashion, viz., an egg apparatus of three cells, a group of three antipodal cells and two polar nuclei.

Referring to Schaffner's (1901) statement that "the egg apparatus is not very definitely organized,"[2] Cooper (1939, p. 865) says that in his material also a definite organization of the embryo sac was seen only for a short time and, if fertilization failed to take place, the membranes delimiting the cells broke down and all the eight nuclei became free. Such aborting embryo sacs were quite frequent. It is interesting to note that the polar nuclei and the nuclei of the egg and synergids were found to undergo a considerable increase in size before their final disintegration.

It is now probable that Schaffner (1901) was also correct in his account of *E. americanum*, but this needs confirmation.

Tulipa.—A very peculiar type of development has been described in *T. sylvestris* (Bambacioni-Mezzetti, 1931). Vacuolation frequently com-

[1] The designation "Lilium type," so common in older literature, has now been abandoned, as the embryo sac of *Lilium* has a different mode of development called the "Fritillaria type."

[2] Schaffner (1901, p. 380) considers this lack of organization of the egg apparatus as the usual thing in Liliaceae, but there seems to be no evidence in favor of such a supposition.

mences even at the megaspore mother cell stage and all four megaspore nuclei gather at the micropylar end of the cell, where they divide to give rise to a group of six cells (one of which is to be interpreted as the egg) and two free nuclei.

T. tetraphylla is essentially similar (Romanov, 1938) although in this case vacuolation commences after the four megaspore nuclei have been formed. Three of these gather in the micropylar part leaving only one in the chalazal (a reversal of the situation occurring in the Fritillaria type). All divide once again so that there are six daughter nuclei in the upper part of the sac and two in the lower. Cell-plates are laid down at the conclusion of the division, resulting in the formation of five cells at the microyplar end and one at the chalazal, leaving two free nuclei (the polars) in the center. Of the five micropylar cells one is the egg; the single antipodal cell soon degenerates.

In *T. ostrovskiana*, also investigated by Romanov (1938), some of the ovules show the same type of development as that described above for *T. tetraphylla* but usually the megaspore nuclei arrange themselves in two pairs, one at the micropylar end and the other at the chalazal. The next division gives rise to two quartets which organize into a three-celled egg apparatus, a group of three ephemeral antipodal cells and two polar nuclei.

The unipolar development seen in *T. sylvestris* and *T. tetraphylla*, belonging to the Eriostemones section of the genus *Tulipa*, is designated by Romanov as the Eriostemones Form of the Adoxa type.

III. Irregular Occurrence of the Adoxa Type

The four genera, discussed above, i.e., *Adoxa*, *Sambucus*, *Erythronium* and *Tulipa*, are the only ones in which the Adoxa type is now known to occur with certainty but not even all species of the last two genera follow this mode of development. Thus, *Erythronium helneae*, *E. tuolumnense* and *E. japonicum*[3] definitely come under the Fritillaria type (see Maheshwari, 1946, for fuller information). *Tulipa maximoviczii*, *T. gesneriana*, *T. praecox* and *T. "Inglescomb Yellow"* belong to the Fritillaria type; and *T. rosea* to the Drusa type (Romanov, 1939a, b).

We shall now consider certain species in which the Adoxa type occurs sporadically in a small percentage of the ovules, although they usually follow some other type of development.

Ulmus.—This genus shows a considerable variability regarding the development of the embryo sac. Shattuck (1905) reported the Adoxa type in

[3] In another species, *E. dens canis*, investigated by Hrubý (1934, 1938), the position is not yet clear. In all probability, it follows the Fritillaria type, but Hrubý saw one stage showing two nuclei at the micropylar end and six at the chalazal. If another division took place in such an embryo sac, the development would be of the Drusa type, similar to that reported in *Majanthemum bifolium* by Stenar (1934).

U. americana but observed that "in very many cases" there seemed to be a further nuclear division. He frequently saw as many as 12 nuclei (occasionally more) evenly distributed and very similar in appearance. Later, a number of embryo sacs were found having four nuclei in the micropylar and eight or more in the chalazal end of the sac. Therefore, he concluded that the embryo sac of *Ulmus americana* was in some ways intermediate between "the regular eight-nucleate angiosperm type and the sixteen-nucleate sac of Peperomia." Leliveld (1935), who investigated *U. hollandica belgica*, *U. wilsoniana* and *U. pumila*, believed the development to be of the Adoxa type "with the restriction that the number of antipodal cells has augmented." Similarly, Miss Walker (1938) reported the Adoxa type in *U. fulva* but noted having seen 12 nuclei in one embryo sac.

Fagerlind (1938) saw a young embryo sac of an undetermined species of *Ulmus* with two nuclei at the micropylar end and six at the chalazal, and several mature ones with always more than three antipodals. He therefore interpreted the embryo sac to be fundamentally sixteen-nucleate although admitting the possibility of some reduction owing to a failure of some of the divisions at the chalazal end.

Ekdahl (1941) studied *Ulmus glabra* and figured a complete series of stages supporting Fagerlind's interpretations. The megaspore nuclei show a 1+3 arrangement, followed after the next division by a 2+6 stage. In the fourth and the last division the two lowest nuclei at the chalazal end remain quiescent so that the mature embryo sac has only 14 nuclei, four at the micropylar and ten at the chalazal. Very often the latter degenerate so that the mature embryo sac has only two to four antipodal cells. Those, which do remain however, enlarge and frequently assume an egg-like appearance, also observed by Shattuck (1905) and Leliveld (1935), sometimes even giving rise to embryos. In certain other cases the egg apparatus was seen to consist of more than three cells which may be due either to a secondary division of one of the original cells or to an abnormal distribution of the nuclei so that more than four came to lie at the micropylar end (Ekdahl, 1941, p. 153).

D'Amato's (1940) work on *U. campestris* revealed a somewhat different condition. He found that the megaspore nuclei may take up either a 1+3 or a 2+2 arrangement. The former condition was the more common (occurring in 65% of the ovules), and in this case the egg apparatus differentiated after four divisions of the megaspore mother cell (Drusa type) with some reduction in the number of nuclei at the chalazal end (10, 12 and 14 nuclei were counted in mature embryo sacs). When the latter condition occurred (35% of the ovules), there were only three divisions and the embryo sac was eight-nucleate (Adoxa type).

This is an interesting observation which helps us to understand the divergent reports of Stattuck, Leliveld and Walker on the one hand, and of

Fagerlind and Ekdahl on the other. It now seems that in this genus the Drusa form of development is the rule but that the Adoxa type also occurs quite frequently. Accordingly, the earlier authors were at least partially correct, although further work is of course necessary to clear this point.

Tamarix.—Mauritzon (1936a) reported the Adoxa type in six species of this genus, namely *T. tetrandra*, *T. aestivalis*, *T. africana*, *T. gallica*, *T. odessana* and *T. pentadra*. Later workers (Joshi and Kajale, 1936; Sharma, 1936) demonstrated that in the species studied by them development follows the Fritillaria type. Subsequent investigations by Puri (1939) on *T. chinensis*, Pároli (1940) on *T. gallica* and Battaglia (1941) on *T. africana* have shown however that while development is usually of the Fritillaria type, deviations are possible and the Adoxa type also occurs in a certain percentage of the ovules. Mauritzon does not seem to have been aware of Bambacioni's (1928a) work on *Fritillaria* at the time of writing his paper and his statement, that in the species studied by him the antipodals were sometimes ephemeral but on other occasions quite large and persistent, may perhaps find an explanation in the two different modes of development occurring in this genus. If the development is of the Fritillaria type, the antipodal cells will be triploid and are then likely to be better developed and more resistant to decay than in those cases in which it follows the Adoxa type and the chromosome number remains unchanged. However, this is only a possible interpretation and a reinvestigation is necessary to confirm it.

Armeria.—All species of this genus, which have so far been investigated, have a Fritillaria type of embryo sac. In *A. vulgaris*, D'Amato (1940a) has found that in approximately 3% of the ovules the development may proceed according to the Adoxa type.

Leontodon.—Bergman (1935) found some very interesting embryological variations in *Leontodon hispidus*. One individual designated as 1931:123 was found to be partially apomictic. The second (1931:123x) was found to have a multicellular archesporium and a large complex of embryo sacs of monosporic origin which penetrated deep into the chalaza and had a variable number of nuclei lacking any regular arrangement or organization. The third (1931:284) showed weakly developed somatic apospory. In this case, microspore formation was usually seen to proceed normally, but in more than half the ovules the walls separating the four megaspores became mucilaginous and dissolved away so that the nuclei came to lie in a common cavity. Only one more division took place giving rise to the eight nuclei of the mature embryo sac. Under such conditions the development would be of the Adoxa type.

However, several deviations from this method were also observed. Thus, some embryo sacs were found to have as many as 14 nuclei. Bergman believes that in such cases there was a fourth division but the dissolution of

the wall between the third and the fourth megaspore and consequently the incorporation of the lowest megaspore nucleus were delayed until the upper three megaspore nuclei had already undergone one division. This gave a seven-nucleate stage which by further division formed a 14-nucleate embryo sac.

In certain other cases diploid embryo sacs were found to originate by a dissolution of the wall separating the dyad cells and the formation of a restitution nucleus. A full discussion of these events is outside the scope of this paper.

Rudbeckia.—Most of the species, belonging to this genus, show the Fritillaria type of embryo sac but Rosén (1944) has recently reported the occurrence of the Adoxa type in one form of *R. laciniata*, collected in the Botanical Garden at Gothenburg. Another form of the same species showed the Fritillaria type. Fagerlind (1944, p. 30), on the other hand, reports the possibility of the formation of restitution nuclei. Further work is necessary to clear up the development of the embryo sac in *R. laciniata*.

IV. Excluded and Doubtful Cases

We now proceed to consider those cases which were formerly believed to have an Adoxa type of embryo sac but which must now be deleted from that list either because of recent reinvestigations or because of other indirect and circumstantial evidence. Of special interest in this connection is the paper by Fagerlind (1939), comprising a critical review of the older literature on this subject and a fresh study of some doubtful species. In the following pages frequent reference will be made to this contribution as well as some others (Fagerlind, 1938, 1944; Maheshwari, 1937, 1941). Before discussing individual cases of this type, it is necessary however to call attention to some general characteristics of the Adoxa type of development which serve to distinguish it from the other types with which it has been most frequently confused. This will enable the reader to appreciate some of the points which are bound to come up quite frequently during the present discussion.

Since the Fritillaria type has often been mistaken for the Adoxa type owing to the fact that in both cases the final stage is eight-nucleate, it may be pointed out that the former is characterized by two four-nucleate stages. In the first or *primary* stage all nuclei are of approximately the same size and in the next or *secondary* stage the two chalazal nuclei are triploid and therefore of a much larger size.[4,5] In the Adoxa type, on the

[4] In certain exceptional cases, the three chalazal nuclei of the primary four-nucleate stage are reduced in size from the very beginning and therefore the secondary four-nucleate stage does not show the usual size difference between the micropylar and chalazal nuclei (for literature and details, see Maheshwari, 1946).

[5] Occasionally, there is also a secondary two-nucleate stage. In such cases the fusion of the

other hand, only one four-nucleate stage is present and typically all nuclei are approximately of the same size and shape.

In other cases, the four nucleate stage of a monosporic embryo sac has been mistaken for the same stage of a tetrasporic one. This is possible when the dyad and tetrad stages of the monosporic type are entirely overlooked due to inadequate material or hasty observation. In some cases the remains of the three degenerating megaspores, characteristic of a monosporic embryo sac, become absorbed and obliterated at a very early stage and increase the chances of error. Nevertheless, a careful observer has another test at his disposal. During the meiotic divisions and up to the formation of the megaspores (or megaspore nuclei) the cytoplasm of the cells concerned (i.e., the megaspore mother cell or its derivatives) exhibits a more or less homogeneous structure with only small and inconspicuous vacuoles. It is only after the completion of megasporogenesis that a conspicuous vacuolation is discernible. For this reason, the two- and four-nucleate stages of a monosporic embryo sac always show a large central vacuole, while this is hardly ever the case in tetrasporic embryo sacs where vacuolation typically commences only when the four-nucleate stage is passing into the eight-nucleate (Fig. 1).

We shall now deal with those cases whose embryo sac development was incorrectly interpreted as following the Adoxa type, or is open to question on very valid grounds.[6]

PIPERACEAE

In two genera of this family, *Piper* and *Heckeria*, Johnson (1902, 1910) reported the development of the embryo sac to be of the Adoxa type. The writer (Maheshwari, 1937) reinterpreted his illustrations in the light of the newly discovered Fritillaria type and further investigations made since then on several species have fully justified the opinions expressed at that time (see Maheshwari, 1946, for additional references). The only exception is an undetermined species of *Piper* (*Piper* sp. Bogor Nr. IV C 45) recently studied by Fagerlind (1939) which behaves differently in that two of the megaspore nuclei degenerate, and the remaining two alone divide to give rise to an eight-nucleate embryo sac. Nuclear fusions of the Bambacioni type are absent and, strictly speaking, the embryo sac is bisporic. Palm's (1915) fig. 10a of *Piper subpeltatum* is also interpreted by Fagerlind in the same way; (the two prominent nuclei, separated by a large vacuole, are

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three chalazal megaspore nuclei occurs before they have progressed beyond the prophase stage of the next division.

[6] In the following treatment, the families have been arranged according to the system given by Engler (1936). This is done purely for the sake of convenience, and the writer does not necessarily endorse all their views regarding the inter-relationships of individual orders and families?

considered to be the surviving megaspore nuclei left over after the other two have degenerated and disappeared).

It would be of interest to investigate other species of these two genera, keeping in mind the possibilities of such variations. Meanwhile, no species of either *Piper* or *Heckeria* is now known to have the Adoxa type of embryo sac.

SALICACEAE

Chamberlain (1897) studied five species of *Salix*, particularly *S. petiolaris* and *S. glaucophylla*. He reported (p. 6) that "almost always" the

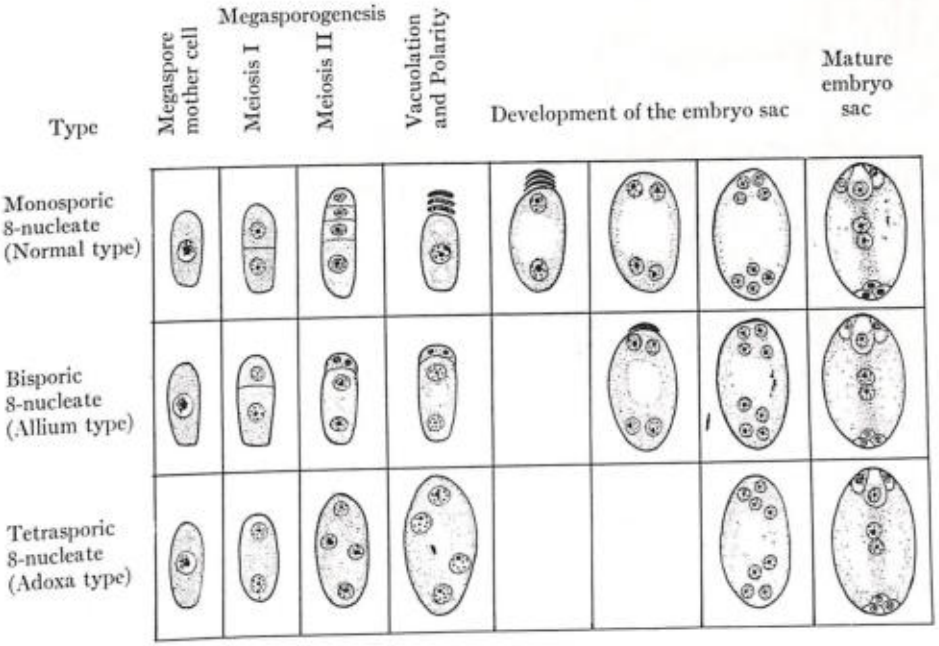


FIG. 1. Diagram to show stage at which vacuolation begins in the development of monosporic, bisporic, and tetrasporic embryo sacs. Note the difference between the two- and four-nucleate stages of the monosporic and terasporic embryo sacs.

megaspore mother cell "divides into two cells, a smaller one nearer the micropyle, and the larger one which becomes the fertile macrospore. The smaller cell either undergoes one transverse division, thus giving rise to two potential macrospores, or it does not divide at all. In a case like fig. 17 there is a possibility that the two smaller cells may have been cut off in succession from the larger cell, but as no mitotic figures were found in this stage this question cannot be settled." Elsewhere he says: "Sometimes the macrospore mother cell does not divide but develops directly into the

macrospore. If any potential macrospores have been cut off, they are crowded and absorbed by the growing fertile macrospore until nothing remains of them but a refractive cap, and even this soon disappears."

The picture that one gets from these vague statements is that the embryo sac may develop in any one of three possible ways: Normal type, Allium type and Adoxa type. Earlier, Jönsson (1879/80) reported Normal type in *S. fragilis* and *S. aurita*, and Håkansson (1929) confirmed this in *S. viminalis* and *S. caprea*. Fagerlind (1938, p. 465), who has discussed this question in detail, believes that the development follows the Normal type and that the occurrence of the Allium and Adoxa types has not been established in any species of *Salix*. I am in agreement with him and wish to point out that Chamberlain's fig. 17, interpreted by him as a functioning dyad cell with two degenerating cells on top (products of division of the upper dyad cell, according to him) probably shows instead the degenerating upper dyad cell and the two megaspores derived from the lower dyad cell of which the chalazal one is enlarging. Or perhaps, the tetrad was T-shaped and one of the megaspores was lying in an adjoining section so that only a row of three cells was visible. From Chamberlain's statements it appears that he did not consider it to be of much importance to establish whether the embryo sac developed by one method or the other. Incidentally, another point which deserves further study, is his statement (p. 172) that "in a few cases the synergids were observed to persist until the embryo was almost in the cotyledon stage."

JUGLANDACEAE

Karsten (1902) studied a number of plants belonging to this family, viz., *Juglans nigra*, *Pterocarya fraxinifolia*, *Carya amara* and *C. tomentosa*, but was apparently unable to decide whether the development follows the Normal or Adoxa type. At one place he writes (p. 318): "diese (i.e., the megaspore mother cell) wird ohne weitere Zelltheilungen und Verdrängungen direct zum Embryosack," but soon adds: "In anderen Fällen war aber auch eine eingetretene Theilung der Embryosackmutterzelle nachzuweisen, so dass drei oder vier Tochterzellen entstanden. Die beiden oberen habe ich niemals sich weiterentwickeln sehen, die beiden unteren schienen ziemlich gleiche Chancen zu besitzen." He also states that in *J. nigra* there is no fusion of the polar nuclei, or that if it does occur it is only at a very late stage.

Since then it has been shown, however, that the embryo sac is of the Normal type; see Nawaschin and Finn (1913) on *J. regia* and *J. nigra;* Langdon (1934) on *J. mandschurica* and *Carya glabra;* Nast[7] (1935) on *J. regia;* and Woodroof (1928) and Shuhart (1932) on *Hicoria pecan*.

[7] In Figs. 16 and 17 of Nast (1935), the cell considered to be a "macrospore" is more likely the megaspore mother cell in the meiotic prophase.

FAGACEAE

Conard (1900) investigated *Quercus velutina* Lam. (=*Q. coccinea tinctoria* Gray). His account is quite confused when he comes to the stages leading to megaspore formation and he regards all archesporial cells as "potential megaspores." Presumably he made no distinction between 'megaspore mother cell' and 'megaspore.' Fagerlind (1938, p. 465; 1939, p. 4) therefore remarks that "die Entwicklung des Embryosackes ist hier ganz unbekannt." In my opinion, however, Conrad's fig. 29 gives sufficient indication, that the development is of the Normal type. It shows two cells in the metaphase stage which could hardly be anything but the two dyad cells in the second reduction division. A two-nucleate stage is not figured but the prominent vacuolation seen at the four-nucleate stage (see figs. 30 and 31) strengthens the view that the embryo sac is monosporic and not tetrasporic.

SANTALACEAE

Thesium.—The exact mode of development of the embryo sac of *Thesium* remained unknown for a long time. Jönsson's (1879/80) work on *T. intermedium* (now *T. linophyllon*) does not give anything clear or definite about the process of megasporogenesis. Guignard (1885) reported Normal type in *T. divaricatum*. Modilewski (1928), who investigated *T. intermedium*, apparently considered the development to be of the Adoxa type. Schulle (1933) said the same for *T. montanum* (now *T. Bavarum* Schrank): "Die Makrosporenmutterzelle wird ohne Teilung direkt zum Embryosack. Seine Bildung erfolgt nach dem *Lilium*-Typus."

None of the above investigators considered this point in detail, however. Rutishauser (1937) showed a normal tetrad of megaspores in *T. rostratum* with the chalazal megaspore functioning. Fagerlind (1939) found the same in *T. montanum* (=*T. Bavarum* Schrank). Further development is also normal except that there may be some reduction in the number of nuclei at the chalazal end owing to the inability of one of the nuclei in this region to divide after the four-nucleate stage; a noteworthy feature is the formation of an embryo sac caecum or haustorium which pushes onward leaving the antipodals in a lateral position.

More recently, L. N. Rao (1942) has investigated four Indian species of the Santalaceae: *Santalum album*, *Thesium wightianum*, *Osyris arborea* and *Scleropyrum wallichianum*. In every case a normal megaspore tetrad is formed with the only difference that in *Santalum* and *Scleropyrum* it is the micropylar megaspore which functions and not the chalazal. No member of the family Santalaceae is therefore now known to have an Adoxa type of embryo sac.[8,9]

[8] See also, in this connection, Schaeppi's (1942) work on *Thesium*.

[9] See p. 84.

LORANTHACEAE

Billings (1933) investigated two species of *Phoradendron: P. villosum* and *P. flavescens* var. *macrophyllum*. There are two archesporial cells which function directly as the megaspore mother cells and the first division is heterotypic. No mention is made of the two- and four-nucleate stages but (p. 267) "after completion of the four-nucleate stage within the placenta, each embryo-sac develops what appears to be a haustorial growth, tubular in form, that passes laterally outwards, or else downwards, the direction depending on the depth of the space between the placental base and the carpels. After passing under this space, the growth turns sharply upwards within the tissue of the carpel." Two of the four nuclei accompany the outgrowth, keeping just back of its tip. Of these the upper is said to give rise to four daughter nuclei, which organize the egg and *three* synergids. The second nucleus divides to form two polar nuclei. These with the two nuclei which remain behind in the placental portion of the embryo sac form the eight nuclei of the mature embryo sac. Occasionally, however, the two placental nuclei also divide, in which case the embryo sacs are ten-nucleate.

The author (p. 266) concludes that *Phoradendron* belongs to the Lilium (=Adoxa) type of embryo sac development "in the main," "though the origin of the primary endosperm nucleus is different."

Maheshwari (1937) listed *Phoradendron* as one of the doubtful cases. Fagerlind (1939) is in agreement with this view but concedes nevertheless that the embryo sac is of a tetrasporic type: "In Billings Arbeit fehlen jedoch sichere Beweise dafür, dass der Embryosack wirklich tetrasporisch ist. Ich halte dies aber für so gut wie sicher, da nur in diesem Fall die Anzahl Teilungsschritte mit den bei früher bekannten Fällen (*Tanacetum*, *Crucianella*, *Ulmus* and *Limnanthes* have been mentioned) vorkommenden übereinstimmt und da der vierkernige Embryosack gar kein Vakuolisierung aufweist."

I am inclined to think, on the other hand, that the development is *not* of the tetrasporic type and Billings' account is questionable for the following reasons:

a. The embryo sac development in the other Viscoideae, so far investigated (for literature see Maheshwari, 1937, 1941), is of the Allium type with the upper dyad cell functioning.

b. Billings does not figure or describe the stages intervening between the

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[9] It might be noted here that Rao (1942) supports the old view that the ovules of the Santalaceae are naked, that "definite seed coverings are not produced," and that the micropyle is a narrow passage through the nucellus. Judging from Schulle's and Fagerlind's figures, however, this view seems to be untenable. An integument *is* present although the nucellus is extremely reduced and soon becomes unrecognizable.

megaspore mother cell and the four-nucleate embryo sac and it seems quite possible that he missed some of them altogether.

c. His account of the origin of the last stage (eight- or ten-nucleate embryo sacs) is also doubtful, particularly in regard to the occurrence of three synergids and the peculiar mode of origin of the secondary nucleus.

Regarding Fagerlind's interpretation of the number of megaspore nuclei taking part in the formation of the embryo sac, it may be said that the lack of vacuolation seen in Billings' fig. 8 of the four-nucleate stage of *P. villosum* cannot be considered as an indubitable proof of its tetrasporic nature, for it is difficult to apply the usual criteria to a family like the Loranthaceae in which the embryo sacs often have an extremely abnormal and weird organization. In *Korthalsella dacrydii* also (Rutishauser, 1935), which has an Allium type of embryo sac, there is no appreciable vacuolation at the newly formed four-nucleate stage (see his figs. 7c, 8a, and 8b, embryo sac on left). Besides, the only four-nucleate stage figured by Billings for *P. flavescens* (see his fig. 10) does show very prominent vacuolation.

Balanophoraceae

Helosis.—Umiker (1920) thought that *H. guyanensis* (now *H. cayennensis*) is an apomict and described the development as of the Adoxa type (without the occurrence of any reduction in the chromosome number). Fagerlind (1938a) has shown that he was mistaken in both respects, that reduction and fertilization occur normally and the development is of the Allium type. After the eight nuclei have been formed, the micropylar quartet gives rise to an egg apparatus and the upper polar nucleus. From the chalazal quartet, as a rule, two nuclei move up and fuse with the upper polar nucleus, and the remaining two form a single binucleate antipodal cell or two uninucleate ones. Sometimes, when there are only two polar nuclei, all three antipodals are formed.

Balanophora.—This genus has received the attention of several authors: Hofmeister (1858), Lotsy (1899), Treub (1898), Van Tieghem (1896, 1907), Ernst (1914), Kuwada (1928), Ekambaram & Panje (1935), Zweifel (1939), and Fagerlind (1945).

Of the older contributions, that of Ernst on *B. globosa* and *B. elongata* is the most important. He considered the development to be of the Adoxa type but figured some stages to show that under exceptional conditions the megaspore mother cell divides into two dyad cells of which one gives rise to the embryo sac, i.e., the development is then of the Allium type. After the two-nucleate stage the embryo sac undergoes a bend and assumes a horseshoe-shaped form with one pair of nuclei at each end. The next division gives rise to two quartets of which the one formed at the lower end (which, however, is now situated at a higher level) gives rise to the egg apparatus and upper polar nucleus.

In *B. dioica*, Ekambaram & Panje (1935) found that the first division of the megaspore mother cell results in the formation of a small lower dyad cell and a larger upper one. In the second division the two spindles are more or less at right angles to each other, that of the upper cell lying in the long axis of the cell. The result is a tetrad of megaspores of which the uppermost cell is the largest and gives rise to the embryo sac while the basal three soon begin to degenerate, although their remains are distinguishable for some time afterwards. According to these authors, therefore, the development is of the monosporic type. Their account is nevertheless confused by a later statement (p. 540): "It must, however, be pointed out with equal emphasis that one now and then comes across a more or less fully developed embryo-sac with no evidence of degenerating megaspores at its base. . . . These instances, by no means to be overlooked, make it impossible to assert that megaspore formation is an essential part of the development. . . . "

An interesting feature noted in the Indian species is the fusion of the nuclei of the chalazal quartet followed by a degeneration of the fusion nucleus so that neither antipodals nor a lower polar nucleus are present.

Recently, Zweifel (1939), a pupil of A. Ernst, studied *B. abbreviata* and *B. indica*. In his account of the first species he says (p. 275): "Fast immer unterbleibt die Zellwandbildung nach der ersten und zweiten Teilung, und die vier frei im Plasma liegenden Kerne liefern durch eine weitere Teilung den achtkernigen Embryosack. Die Embryosackmutterzelle funktioniert also direkt als Makrospore. . . . " He does not deny the possibility of an Allium type of development, however, and says that in some cases the embryo sac arises from the upper dyad cell: "Eine einzige Teilung derselben (this means the megaspore mother cell) und Entstehung des Embryosacks aus der oberen Tochterzelle, wie sie von den genannten Forschern an *B. elongata* und *B. globosa* teilweise beobachtet wurde, und auch von Kuwada für *B. japonica* beschrieben wird, konnte ich in meinen Präparaten ebenfalls feststellen. Die erste Teilungsspindel der Makrosporenmutterzelle liegt dann immer an der Zellbasis und von den gebildeten beiden Zellen wird die kleinere basale bald verdrängt. Solche Zellteilungen liegen in meinen Präparaten aber nur äusserst selten vor."

Unlike the conditions described for *B. dioica* (Ekambaram and Panje, 1935), Zweifel notes that in *B. abbreviata* the nuclei at the antipodal end of the embryo sac do not fuse or degenerate but remain in a healthy condition and may even undergo some further divisions so that sometimes as many as six nuclei are seen in this region. One of these moves up and fuses with the upper polar nucleus.

In *B. indica*, too, Zweifel found an Adoxa type of embryo sac, but here again deviations were noted and the author draws two figures to show the possibility of tetrad formation. In these the lower dyad cell has divided

anticlinally to form two megaspores, but in the upper, which is considerably larger, there is no wall separating the two nuclei. The author states however that a wall is to be laid down later and eventually the uppermost cell will give rise to the embryo sac. Here then, the development would correspond to the Normal type as described for *B. dioica* by Ekambaram & Panje (1935).

The latest contribution (Fagerlind, 1945) deals with *B. elongata*. He shows very clearly that the first as well as the second reduction division is followed by wall formation (cf. *B. dioica*, investigated by Ekambaram & Panje) resulting in a normal tetrad of megaspores. The micropylar megaspore is the largest; the three chalazal ones are small and not always easily distinguishable from the adjacent somatic cells. It appears that due to this difficulty previous workers were led to erroneous interpretations of the development of the *Balanophora* embryo sac. It seems fairly certain now that no species of this genus belongs to the Adoxa type and probably none even to the Allium type. A reinvestigation of *B. abbreviata* and *B. indica* would be welcome but the likelihood is that these will be found to have embryo sacs of the monosporic type.

Rhopalocnemis.—Lotsy (1901), who studied *R. phalloides*, considered the development to be of the Adoxa type. As Fagerlind (1938, p. 468) remarks, however, it is more likely that it is of the Allium type, similar to *Helosis*. A reinvestigation is desirable.

Hydnoraceae

Dastur (1922) reported Adoxa type in *Hydnora africana*. Fagerlind (1938, p. 470) has discussed this case in sufficient detail and I am in agreement with his view that Dastur's interpretation is incorrect (see also Maheshwari, 1937, p. 396). It is more likely that the development is of the Normal or the Allium type. A reinvestigation is desirable.

Aizoaceae

In a paper dealing chiefly with the morphology and anatomy of *Mesembryanthemum pseudotruncatellum*, Schmid (1925) says that the embryo sac arises directly from the megaspore mother cell. He gives no figures to support this statement however, and it seems certain that this is a hasty conclusion (see also Fagerlind, 1938, p. 469; 1939, p. 14). Other plants of the family have a monosporic eight-nucleate embryo sac.

Caryophyllaceae

Gibbs (1907) reported that in *Stellaria media* the embryo sac develops according to the Adoxa type. Rocén (1927), who made a comparative study of several members of the family Caryophyllaceae and the order Centrospermales in general, criticized this observation and regarded the embryo

sac as normal. P. C. Joshi (1936) renewed this controversy by saying that the further development of the megaspore mother cell was "variable." He reports that he never came across a row of three or four megaspores and only in a few cases did he see the mother cell give rise to two superposed cells with a transverse or oblique wall between them. This would give the impression that the development is usually of the Adoxa type but sometimes of the Allium type. Joshi does not seem to be quite certain however and confuses the issue by adding that "this does not preclude the possibility that the two megaspores[10] may give rise to three or four megaspores."

In reviewing this work some years ago (Maheshwari 1937, p. 394), I suggested that the row of three cells shown in his figure 35 and the four cells arranged in the form of a 'T' in figure 36 indicated that the embryo sac is monosporic.

Since then Fagerlind (1939, p. 14) has also commented on P. C. Joshi's observations and agrees with me that the latter's interpretation of the occurrence of the Adoxa type in this species is "äusserst unbefriedigend" and that "irgendwelche Gründe dafür bei *Stellaria media* an eine Entwicklung nach dem *Adoxa*-Schema zu glauben, liegen demnach nicht vor."

CAPPARIDACEAE

A remarkable anomaly has been reported by Billings (1937) in *Isomeris arborea*, a xerophytic plant, collected from the Colorado and Mohave deserts, California. There is a tendency towards degeneration in the anthers as well as ovaries and only a small proportion of the flowers set fruit.

The first division of the hypodermal archesporial cell is periclinal, "resulting in an outer parietal and an inner sporogenous cell." "The primary parietal cell now initiates a series of periclinal divisions by which daughter cells are formed that overlie the sporogenous cell by a group from two to six cells in thickness, though the prevailing number, by far, is 3."

"An examination of much material in the sporogenous cell stage, and following, plainly indicates that the cell typically develops directly into the embryo sac without the formation of megaspores. A single instance was observed, however, in which they were present, and their position and appearance was quite in accord with what would have been expected in such an instance."

In the majority of cases the first division of the megaspore mother cell is said to give rise to the binucleate stage, in which the two nuclei are always separated by a central vacuole. In the next stage the primary micropylar nucleus alone divides and we thus get a three-nucleate stage after which as a rule there are no further divisions. "The typical definitive embryo sac in *I. arborea* has three nuclei which are organized into what seems

[10] These must be the dyad cells.

to be an egg apparatus. The two upper, of pyriform shape with their associated cytoplasm, resemble synergids and are doubtless truly such. The lower nucleus may appear like an egg but perhaps more like an endosperm nucleus. There is a complete absence of polar nuclei and antipodals." The author tries to compare the embryo sac of *Isomeris* with that of *Plumbagella* (as originally described by Dahlgren, 1916) but concludes that "the embryo sac of this species (i.e., *Isomeris arborea*) doubtless belongs to an entirely new type, as it does not find a parallel in any listed by Schnarf (1929) nor in the literature issued since the publication of his book."

Regarding later stages, the author summarizes the situation in the following words (p. 325): "A pollen tube may enter the micropyle and form a bulbous terminus in the embryo sac. It does not discharge its contents, but instead develops a thickened wall and remains intact during the earlier stages of endosperm development. The synergids generally disintegrate at the beginning of endosperm development, but one of a pair occasionally continues activity, becomes richly protoplasmic, and by cell division forms a cell row that extends a short distance downward from the micropylar end of the embryo sac. This activity seems to serve no important useful purpose. Endosperm begins as a free-cell formation but afterwards exhibits two definite types of structure, a nodular type consisting of circumscribed masses of coarsely granular cytoplasm containing free nuclei; a cellular type consisting of vacuolated cells in the form of a tissue. The nodular type does not extend into the short arm of the J-shaped embryo sac. The embryo arises by a direct outgrowth of an endosperm nodule which is generally located near the base of the convex curve of the sac. In one instance an embryo was found developing from a nodule in the micropylar region."

Five years ago (Maheshwari, 1941, p. 223) I commented upon this account as follows: "Several of the above statements appear to be of a doubtful nature. To mention a few instances, fig. 19 which would ordinarily be interpreted as a clear tetrad of megaspores of which the lowest is dividing, is regarded by him as showing 3 wall cells and an embryo-sac mother cell. Similarly fig. 18 in which the axial row clearly consists of one wall cell and 4 megaspores, of which the lowest has enlarged, is regarded as composed of 4 parietal cells and 'a vacuolated sporogenous cell.' Various other ingenious interpretations have been offered which cannot be considered here in detail. It is sufficient to state that the illustrations entirely fail to support the conclusions based upon them."

My recent study of the work of Billings makes me feel even more doubtful than I did previously about the validity of his conclusions. So far as the development of the embryo sac is concerned I would interpret it as of the usual monosporic type although the frequent occurrence of degenerations may at times obscure the real picture. The post-fertilization stages

need careful study to see whether the embryo arises from the egg (as is more probable) or from the endosperm.[11] It would also be of interest to compare the behavior of *I. arborea* with that of the other species belonging to this genus.

CRASSULACEAE

D'Hubert (1896) considered the embryo sac of *Sedum* to be of the Adoxa type. He said: "La cellule mère donne directement le sac embryonnaire." Mauritzon (1933) has shown, however, that it is of the Normal type.

SAXIFRAGACEAE

Elst (1909) reported Adoxa type in *Philadelphis coronarius*. Gäumann (1919) and Mauritzon (1933, p. 109) have found this to be incorrect. Tetrad formation occurs normally and the development is of the Normal type.

LEGUMINOSAE

Guignard (1881) in *Medicago arborea* and *Lupinus polyphyllus*, and Young (1905) in *Melilotus alba*, considered the development to be of the Adoxa type, but this is certainly incorrect. Reeves (1930), Cooper (1936), and Farley and Hutchinson (1941) have shown that it is of the Normal type in *Medicago:* and the same is true of *Melilotus* (Cooper, 1933). In a recent paper Markowa (1944) states that in the tribe Vicieae the genus *Cicer* is an exception, having an embryo sac of the Adoxa type and a long and cellular suspensor, and that it should therefore be placed in a new tribe Intermediae, between the Trifolieae and Genisteae. The author does not give any convincing illustrations, however, to support the occurrence of the Adoxa type in *Cicer* and it seems likely that on reinvestigation this will be found to have a Normal type of embryo sac as in the other Leguminosae.

RUTACEAE

Mauritzon (1935) stated that in *Xanthoxylum* spp. the development could be of the Normal, Allium or Adoxa types. As Fagerlind (1939) points out, the peculiar appearances seen by him are no doubt due to the occurrence of apospory and it is surprising that Mauritzon did not take this possibility into consideration. Fagerlind concludes: "Das *Adoxa*-Schema liegt kaum hier vor."

EUPHORBIACEAE

Modilewski (1910) investigated the embryo sac of *Euphorbia hetero-*

[11] Tischler (1943, pl 617) comments as follows: "Die Angabe von Billings (1937), dass die Capparidacee *Isomeris arborea* haploidparthenogenetisch sei und dass der Embryo aus dem unbefruchteten Endosperm entsteht, ist, so lange keine Bestätigung von anderer Seite vorliegt, m. E. völlig unglaubwürdig."

phylla and reported a Normal type of embryo sac in this and several other species of the genus. Sanchez (1938), on the other hand, found in *E. heterophylla* an Adoxa type of embryo sac. Since his figures and descriptions were not very convincing, I was prompted to reinvestigate it (Maheshwari, 1942) and can definitely say that the development is not of the Adoxa type but of the Normal type as originally reported by Modilewski.

Limnanthaceae

The embryo sac of *Limnanthes douglasii* has been investigated by four different workers but without any complete agreement regarding the exact mode of its development. Leaving aside Hofmeister's (1858) work, which was done with free hand sections, we come to Stenar (1925a), who reported an Adoxa type of embryo sac in this plant but noted the reduction in size of the chalazal nuclei of the embryo sac. Following him, Eysel (1937) investigated some material of the same species, obtained from the Botanical Gardens of the Universities of Marburg, Bonn and Edinburgh, and confirmed Stenar's observations in most respects. He found however an occasional reduction in the number of nuclei at the chalazal end of the embryo sac owing to a failure of the lowest nucleus of the four-nucleate stage to undergo the last division. An interesting observation made by him is the frequent disappearance of the wall separating the megaspore mother cell from the nucellar cell situated directly below it and the subsequent incorporation of the latter into the embryo sac. One embryo sac showed nine nuclei, seven of which had organized into cells at the micropylar end of the embryo sac (four looking like synergids; two looking like egg cells; two 'polar' nuclei; and the nature of one cell remained undecided). No antipodal cells or nuclei were seen in this case.

Fagerlind (1939) had apparently no knowledge of Eysel's work as he does not refer to it in his paper. His material, which was collected in the Botanical Gardens, Stockholm, has been interpreted differently. The first division of the megaspore mother cell gives rise to two nuclei which become separated by a large vacuole. The lower of these usually degenerates right away and forms just a densely staining homogeneous blob which lies close to the bottom of the embryo sac and takes no part in further development. The upper nucleus now divides to give rise to two nuclei of which the lower (this will be designated hereafter as the middle nucleus) has the same fate as the primary chalazal nucleus mentioned above. After the meiotic divisions are over, we thus have a three-nucleate stage in which the micropylar nucleus alone retains the capability of further division. This gives rise to a quartet which produces the egg apparatus and a polar nucleus. Of the two degenerating nuclei, one may be considered as an antipodal and the other as the lower polar.

There are other methods of development, however. After the three-

nucleate stage arising as a result of the meiotic divisions, the uppermost nucleus alone divides in the next stage. The middle one does not degenerate, however, as in the first case but remains quiescent for a time and reawakes to take part in the fourth division. We thus come to have a seven-nucleate embryo sac in this instance with two antipodals instead of one.

A further step in the "gesteigerte Vitalität" of the nuclei is seen when the middle nucleus of the three-nucleate stage divides synchronously with the micropylar nucleus, but only one of its daughter nuclei divides again with the result that this time the embryo sac is eight-nucleate.

Still other variations are mentioned by Fagerlind (1939) and the diagram given by him on page 27 of his paper seems to include all the possibilities that one can think of. The multiplicity of these variations nevertheless calls for a further study of this plant, based on material collected from its native habitat. It may be that at least some of these abnormalities are due to greenhouse or garden conditions. Eysel's work does not mention the possibilities visualized by Fagerlind, and the latter in his turn does not consider the possibility of the incorporation of a nucellar cell into the embryo sac as noted and figured by Eysel.

It seems difficult for the present to assign *Limnanthes* to any of the usual types of embryo sac development. According to Fagerlind (1939) the egg apparatus is separated from the megaspore mother cell stage by four nuclear divisions and not three, and if this is correct, the development is not of the Adoxa type where only three nuclear divisions intervene between the megaspore mother cell and the egg.

THEACEAE

Cavara (1899) stated that in *Thea sinensis* the development is of the Normal type and the embryo sac arises from the micropylar megaspore, whereas Cohen-Stuart (1916) believed it to be of the *Adoxa* type. Fagerlind (1939, p. 17) finds both of them to be wrong; the embryo sac is of the Allium type.

TAMARICACEAE

The genus *Tamarix* has already been dealt with on page 78. Frisendahl (1912) reported an Adoxa type of embryo sac in *Myricaria germanica*, but his figures, which are remarkably clear and faithful, gave good indications that the development was really of the Fritillaria type (see Schnarf, 1931, p. 94). Zabban (1936) actually proved it by demonstrating the chalazal fusions and the triploid nature of the nuclei in the chalazal half of the embryo sac. Battaglia (1942) has confirmed this.

CARICACEAE

Heilborn (1921, 1928) reported that in *Carica papaya* and some other

species of this genus, wall formation does not occur during megasporogenesis and that all four megaspore nuclei lie free in the mother cell. Only one nucleus at the micropylar end now divides again so that the mature embryo sac is five-nucleate. His results are however at variance with those of other workers. Agharkar & Banerji (1930), who investigated some material of *Carica papaya* from India, find that tetrad formation takes place in the usual way and the mature embryo sac is eight-nucleate. They conclude that "it is not possible to account for his (Heilborn's) results except on the supposition that the Equadorian species of *Carica* differ from the rest in their gametophytic development." More recently, Fagerlind (1939) and L. T. Foster (1943) have also observed a Normal type of embryo sac and Heilborn's supposition that *C. papaya*, being a cultivated plant, has several races behaving differently, no longer seems plausible. There is hardly any doubt now that the other species investigated by him (*C. candamercensis*, *C. chrysopetala* and *C. pentagona*) and reported to have tetrasporic embryo sacs of the Adoxa type will also turn out to be normal.

Mention may also be made here of the contributions of Usteri (1907) and Kratzer (1917). These authors agree that the embryo sac is monosporic and eight-nucleate. But while Usteri thought it was the micropylar megaspore which gave rise to the embryo sac, Kratzer is less sure of that point. He writes (p. 306): "Ebenso wird nicht immer dieselbe Zelle zum Embryosack. Ich konnte unzweideutig feststellen, wie sich bald die oberste, bald die unterste dazu entwickelt."

Cactaceae

D'Hubert (1896) considered the embryo sac of *Phyllocactus* sp. to be of the Adoxa type. He says: "Quand l'ovule est complètement developpé, la cellule sous-épidermique donne le sac embryonnaire par 3 bipartitions successives de son noyau. Le sac embryonnaire provient donc directement de la cellule sous-épidermique axile du nucelle." The central vacuole seen by him at the two-nucleate stage, coupled with the fact that other Cactaceae so far studied (see Mauritzon, 1934; Neumann, 1935) have a normal type of embryo sac, make it seem fairly certain however that he was wrong in his interpretation. Further work on the embryology of this family would of course be welcome as it has not received adequate attention in this respect.

Myrtaceae

Pijl (1934) reported a five-nucleate embryo sac in *Eugenia jambos* and *E. bancana*. After reduction division, only the micropylar megaspore nucleus divided again and gave rise to the egg and one synergid, the second micropylar nucleus functioned directly as a synergid, and the two chalazal nuclei as the polars. His figures, which are entirely diagrammatic, are quite

inadequate to substantiate this story and it seems likely that a reinvestigation of *Eugenia* will show the occurrence of a monosporic eight-nucleate embryo sac with the possible difference that the antipodals may be of an ephemeral nature.

HYDROCARYACEAE

Gibelli and Ferrero (1891) reported an embryo sac of the Adoxa type in *Trapa natans*, but Ishikawa (1918) saw regular tetrad formation in this species and Maheshwari (unpublished) has confirmed it in *T. bispinosa*. There is no doubt therefore that the development is of the Normal type. Fagerlind (1939, p. 20) also writes: "Hier liegt sicher der Normal-typ vor. Diese Auffassung wird durch Maheshwaris Nachweis dieser Entwicklungsart bei *Trapa bispinosa* bekräftigt."

PLUMBAGINACEAE

Dahlgren (1916) had reported Adoxa type in *Armeria alpina*, *A. plantagineae*, *A. vulgaris*, *Statice bahusiensis*, *S. gmelini* and *S. macroptera*. Subsequent work has shown however that in *Armeria* the development is of the Fritillaria type (Fagerlind, 1939a; D'Amato, 1940a), and in *Statice* some species follow the Fritillaria type and others the Penaea type (Fagerlind, 1938, 1939a).

OLEACEAE

Billings (1901) wrongly interpreted the embryo sac of *Forsythia suspensa* to be of Adoxa type. Andersson (1931, p. 52) showed that the development is normal.

FOUQUIERIACEAE

Johansen (1936) reported a peculiar type of development in three species of *Fouquieria*: *F. splendens*, *F. peninsularis*, and *F. burragei*. According to this account the embryo sacs are tetrasporic but may have eight, six, or only five nuclei. Mauritzon (1936), who made an independent study of *F. splendens*, found a Normal type of embryo sac. Johansen (1936) seems to have missed some stages between his figs. 1 and 2 of *F. splendens* (see Fagerlind, 1939, p. 15; and Khan, 1943).

SOLANACEAE

Nanetti (1912) reported that the development of the embryo sac in *Solanum muricatum* followed the "tulip" type. He saw nothing to indicate the formation of a tetrad of megaspores nor did he note any degenerating megaspores on top of the young embryo sac. Young (1923, p. 330), who studied *S. tuberosum*, also made a vague statement saying that the archesporial cell grows rapidly and "at this stage it may be regarded as a megaspore; further development is delayed for a time." Elsewhere he says: "In

a few instances a row of two or three sporogenous cells was found in the axis of the ovule, suggesting a transverse division of the original archesporial cell, though it is apparent that this is not the ordinary method of megaspore formation."

Since then, Rees-Leonard (1935) and Lamm (1937) have shown that *S. tuberosum* follows the Normal type and there is no doubt that *S. muricatum*, like other species of this genus (Krüger, 1932; Bhaduri, 1932) will be found to be similar.

Gesneriaceae

Cook (1907, p. 180) makes a very brief statement on the development of the embryo sac in *Rhytidophyllum crenulatum* and *R. tomentosum:* "The single archesporial cell elongates without division, in the antipolar direction, the new part being smaller in diameter than the older part. This cell then elongates very rapidly, and forms the two- and four-nucleate stages of the embryo-sac. At this time the sac is usually about twice as long as wide. Without further enlargement of the sac the nuclei now divide, thus forming the eight-nucleate stage." From this one would conclude that the development is of the Adoxa type. The author noted one instance however in which the archesporial cell had divided into two 'megaspores."[12] This and the fact that the two-nucleate stage (his fig. 5) shows prominent vacuolation make it difficult to lay much confidence in Cook's account and a reinvestigation is necessary. All other members of the Gesneriaceae, so far studied, have a Normal type of embryo sac.

Acanthaceae

Karsten (1891), who investigated the embryo sac of *Acanthus ilicifolius*, stated that as far as he could ascertain the megaspore mother cell grew directly into the embryo sac without undergoing any cell divisions. Gigante (1929) has shown however that the development is of the normal type.

Myoporaceae

In *Myoporum humile*, David (1938) has recently described a vacuolated megaspore mother cell which is said to give rise to a Lilium (=Adoxa) type of embryo sac. She writes (p. 681): "Da ich überdies nirgends Kappen über der Embryosackmutterzelle beobachtete, entwickelt sich hier der primäre Embryosack offenbar ohne vorherige Tetradenbildung (*Lilium-Typ*)." The considerable gap between her figs. 1 and 2, the presence of a distinct vacuolation at the uninucleate stage and the further appearance of a large central vacuole at the two- and four-nucleate stages leaves no doubt however that she entirely missed the stages in megasporogenesis and the embryo sac is really of the monosporic eight-nucleate type. Fagerlind (1939, p. 46) says: "Eine Nachuntersuchung ist notwendig."

[12] These must be the dyad cells.

COMPOSITAE

Ward (1880) thought that the development of the embryo sac of *Pyrethrum balsaminatum* corresponded to the Adoxa type. Fagerlind (1939, figs. 10, 11) studied some specimens growing in the Stockholm Botanical Garden and made the observations summarized below.

As in other Compositae, the nucellus is of the reduced type. The archesporium is usually two-celled but sometimes three cells are seen and occasionally only one may be present. As a result of the first meiotic division, two nuclei are formed of which the uppermost soon increases in size as compared to the lower. Both of them undergo the second division and the resulting four nuclei take up a 1+3 arrangement. The micropylar nucleus is the largest and functions while the chalazal nuclei soon begin to degenerate. Vacuolation takes place at this stage and is followed by the appearance of a lateral bladder-shaped outgrowth which assumes a tubular form and gradually makes its way upwards into the micropyle. The functioning megaspore nucleus, which has by this time moved into the apex of this tube, divides to form two nuclei and then four. The latter lie in two pairs, one at each end of a large vacuole. The next division gives rise to eight nuclei, of which the upper four form the egg apparatus and the upper polar nucleus, and the lower four the three antipodal cells and the lower polar nucleus. The lowest antipodal cell forms the connection between the 'bladder' and the body of the old megaspore mother cell in which the three degenerated megaspore nuclei are sometimes still distinguishable. The nuclei of the antipodal cells undergo some divisions but the daughter nuclei fuse once again to form a single lobed nucleus.

As Fagerlind points out, Ward seems to have completely overlooked the three degenerated megaspore nuclei and thus considered the development to be of the Adoxa type. It is now clear that five divisions actually take place, between the megaspore mother cell and the mature embryo sac, as in the Normal type.

TYPHACEAE

Schaffner (1897) reported that in *Typha latifolia* "the macrospore mother cell develops directly into the fertile macrospore without any division," i.e., the embryo sac is tetrasporic. But Dahlgren (1918) demonstrated that megaspore formation takes place normally and the chalazal cell of the tetrad functions to give rise to an eight-nucleate embryo sac.

ALISMACEAE

All members of this family so far investigated have been shown to have an embryo sac of the Allium type with a tendency towards some reduction in the chalazal end.

Alisma.—Ward (1880), who was the first to investigate *A. plantago*,

claimed that the megaspore mother cell divides into two cells, of which the upper divides once, but the daughter cells thus formed quickly degenerate. The nucleus of the lower cell divides thrice to give rise to the embryo sac. In the same year Fischer noted that the upper cell remains undivided and soon degenerates while the lower behaves as described by Ward. Schaffner (1896) interpreted the degenerating cell as a parietal cell and thought the development was of the Adoxa type. Sometimes he saw only two nuclei (instead of four) at the chalazal end of the embryo sac but believed that he had perhaps missed the others. Nitschke (1914) disagreed with all of these workers and reported that the megaspore mother cell produced four free nuclei, three of which were cut off at the top by a wall while the remaining nucleus divided thrice to give rise to the embryo sac. According to him the development is therefore of the Normal type. The correct interpretation was finally given by Dahlgren (1928) who showed clearly that there is a hypodermal megaspore mother cell which divides into two dyad cells, of which the lower gives rise to the embryo sac. Since the two chalazal nuclei of the four-nucleate stage do not undergo further division, the mature embryo sacs are six-nucleate. Of the two nuclei at the chalazal end, one functions as an antipodal and the other as a lower polar nucleus. Johri (1936b) confirmed Dahlgren's account and found another species, *A. plantago-aquatica*, to behave similarly. He noted however that in certain cases the chalazal nuclei were able to complete the last division and the embryo sacs could occasionally have more than six nuclei.

Sagittaria.—Schaffner (1897) investigated *S. variabilis* and reported the embryo sac to be eight-nucleate but was unable to follow the earlier development. A few years later, Cook (1907), working on *S. lancifolia*, wrote that it was similar to *S. variabilis* but that the antipodals were ephemeral. Dahlgren (1934) traced the whole development in *S. sagittifolia* and showed that the embryo sac arises from the lower dyad cell and is therefore bisporic. This was confirmed by Johri (1935a & b; 1936b) for this, as well as three other species, viz., *S. guayanensis*, *S. latifolia* and *S. graminea*, although he found that occasionally seven- or eight-nucleate embryo sacs are also formed as in *Alisma*.

Butomaceae

Hall (1902) investigated *Limnocharis flava* (now *L. emarginata*) and reported the development to be of the Adoxa type. On the other hand, Nitschke (1914) claimed that the embryo sac was formed from the third megaspore of a T-shaped tetrad. Johri (1938) showed however that the development is really of the Allium type, the embryo sac arising from the lower dyad cell. After the two-nucleate stage the primary chalazal nucleus quickly degenerates and is cut off by a thin membrane from the rest of the embryo sac. The primary micropylar nucleus divides twice and

produces the egg apparatus and upper polar nucleus. The mature embryo sac is thus usually five-nucleate but occasionally the primary chalazal nucleus may divide or undergo fragmentation resulting in six-, seven-, or even eight-nucleate embryo sacs. It now appears that Hall misinterpreted the upper dyad cell as the primary parietal cell.

GRAMINEAE

Miller (1919) thought that all four megaspore nuclei enter into the formation of the embryo sac of *Zea mays*, so that the development is of the Adoxa type. Weatherwax (1919) and Cooper (1937) have shown that a tetrad of megaspores is formed as usual and the lower of these functions to give rise to an eight-nucleate embryo sac.

PALMAE

Cocos.—Working on *C. nucifera*, Quisumbing and Juliano (1927) write: "The nucleus of the megaspore mother cell of the embryo sac next divides into two, more or less unequal in size, without wall formation. . . . In the coco palm the formation of the tapetal cell and the four megaspores is eliminated, the two daughter nuclei lying side by side." It seems, however, that the authors missed all stages of megasporogenesis. The chromosome condition of the two nuclei in fig. 9 appears to indicate that they are the nuclei of two megaspore mother cells lying obliquely oriented with respect to each other so that the separating wall was entirely overlooked. Besides, the two nuclei are quite equal and similar and not "unequal" as stated in the text. In an earlier paper, Bauch (1911) mentions the occasional occurrence of two megaspore mother cells and he also noted the presence of degenerating megaspores. It seems very likely therefore that the embryo sac of *Cocos* is of the Normal type. A reinvestigation is desirable.

Chamaerops.—In *C. humilis*, Gioelli (1930) reported a modified Adoxa type. According to his statements there is no wall formation after the first division of the megaspore mother cell and the two nuclei move apart to the opposite poles. Only the micropylar divides again, first to form two, and then four nuclei, the chalazal nucleus remaining undivided. The mature embryo sac is thus five-nucleate. Gioelli's figures and descriptions are however so unsatisfactory that little reliance can be placed on his observations. In his fig. 3 he shows a large central vacuole at the two-nucleate stage, which would indicate that the development is not of the Adoxa type but of the Normal type.

ARACEAE

Homalonema.—In a contribution dealing with the embryology of 11 aroids, none of which however seems to have been satisfactorily investi-

gated, Gow (1913) states that in *Homalonema argentea* the primary archesporial cell "divides once transversely, and of the two resultant cells the outer one functions, the inner one being broken down and absorbed." The author says that "whether the latter is to be regarded as one of a 'row of two' or as a vestigial tapetum is purely an academic question." He thus attached no importance whatever to the morphological nature of these cells nor does he mention the intervening stages leading to the eight-nucleate embryo sac. The plant needs a fresh study.

Richardia.—Gow (1913, p. 136) is less vague though not more correct in his account of *Richardia africana* and says: "No primary parietal cell is formed. The primary archesporial cell is in this species, the spore mother cell, and develops directly into an embryo sac without the previous formation of a row of megaspores." The two- and four-nucleate stages figured by him nevertheless show the vacuolation characteristic of a monosporic embryo sac and Michell (1916) has actually demonstrated that a tetrad of megaspores *is* formed. According to her "in no case is there anything to lead one to suppose that the embryo sac has originated directly from the megaspore mother cell."

Aglaonema.—Gow's (1908) work on *A. versicolor* is of such a fragmentary nature that it is mentioned here only for the sake of completeness. He was unable to trace the precise development and showed only a two-nucleate and a four-nucleate stage of the embryo sac.

In a paper entitled "The embryo sac of *Aglaonema*," Campbell (1912) states that in *A. simplex* and *A. modestum*, investigated by him, the four megaspore nuclei were not separated by walls; after this stage only one of the micropylar nuclei divided again and this division gave rise to the two synergids; the second undivided nucleus functioned as the egg and the two chalazal nuclei as the polars. This would seem to indicate that one of the megaspore nuclei functioned directly as the egg and two as the polars —a condition once reported in *Plumbagella* but now proved to be incorrect.

Apart from the unsatisafctory nature of Campbell's observations, none of the Araceae so far investigated (see Jüssen, 1928) has been found to have a tetrasporic embryo sac. Fagerlind (1939, p. 44) remarks briefly and well: "Diese Angabe, die wohl als falsch anzusehen ist, hat kaum jemals Glauben gefunden."

All of Campbell's material was collected from plants growing under more or less artificial conditions and it may be well to reinvestigate the embryo sac of *Aglaonema* from material collected in its natural habitat.

Acorus.—Although Mücke (1908) reported the embryo sac to be of the Adoxa type, Jüssen (1928) and Buell (1938) have shown that it is really of the Normal type.

Anthurium.—Campbell's (1905) account of *A. violaceum* var. *leucocar-*

pum is unsatisfactory in several respects. In 1937, I remarked: "Needs reinvestigation." Fagerlind (1939) concurs with this view and says: "Der *Adoxa*-Typ ist hier wenig wahrscheinlich."

LEMNACEAE

According to Caldwell (1899, p. 57), in *Lemna minor*, "the primary sporogenous cell seems to develop directly into the megaspore, and as such undergoes a long period of rest." A careful study of his figures seems to indicate however that he missed several stages in the early development of the embryo sac. A reinvestigation is desirable in view of the fact that *L. trisulca* (Jönsson, 1879/80) and *Wolffia arrhiza* (Gupta, 1935) have embryo sacs of the Allium type.

COMMELINACEAE

In a recent study of the development of the embryo sac in *Commelina angustifolia*, McCollum (1939) remarks: "It seems quite certain that all the four nuclei resulting from the meiotic divisions of the megaspore mother cell, enter into the structure of the embryo sac. The lack of any evidence of walls separating the nuclei, also the lack of any evidence of disintegration of any of these nuclei points definitely to the same conclusion."

In spite of this categorical statement, McCollum's figures seem to indicate that he missed all stages in megasporogenesis and his interpretations are therefore incorrect.

In another species of the genus, *C. benghalensis*, investigated by Maheshwari & Singh (1934), the embryo sac is monosporic and eight-nucleate.

CYNASTRACEAE

According to C. E. Fries (1919) the embryo sac of *Cynastrum johnstonii* is of the Adoxa type, but this is certainly incorrect, since the two- and four-nucleate stages show the central vacuole characteristic of monosporic embryo sacs. Stenar (1937) and Nietsch (1940) have demonstrated the Normal type.

LILIACEAE

Aloe.—Several species of this genus (*A. arborescens*, *A. caesia*, *A. ciliaris*, *A. lodari* var. *praecox* and *A. varvari*) were investigated by Gioelli (1930a) who reported that the development was of the Adoxa type. This was criticized by Maheshwari (1937), who interpreted Gioelli's fig. 9 of *A. caesia*, supposedly showing a four-nucleate embryo sac, as a T-shaped tetrad of megaspores. Joshi (1937), and Schnarf and Wunderlich (1939), have shown since then that megaspore formation takes place as usual and the embryo sacs are monosporic and eight-nucleate.

Camassia.—Leffingwell (1930) figured a few stages in the development of *C. quamash* and concluded that the development is of the Adoxa type. However, the large central vacuole seen at the two-nucleate stage did not support this interpretation and Fagerlind (1941) has actually shown that in this species as well as in *C. esculenta* and two other undetermined ones the development is of the monosporic eight-nucleate type. F. H. Smith (1942) has done the same for *C. leichtlinii*.

Convallaria.—One species of this genus, *C. majalis*, has attracted much interest. Wiegand (1900) reported that the first division of the megaspore mother cell gives rise to two dyad cells of which the outer is the larger. The next division is not accompanied by wall formation. Instead, the four nuclei, two in each cell, divide simultaneously, and as the partition wall between the upper and lower quartets breaks down, the development may be designated as of the Adoxa type.

Schniewind-Thies (1901), on the other hand, reported that the megaspore mother cell produced a row of four cells, only one of which functioned to produce the embryo sac while the remaining three degenerated, i.e., the embryo sac is of the monosporic type.

Stenar (1941) has reinvestigated the problem, basing his studies on material fixed from plants growing in their natural habitat. He has shown that the first division of the megaspore mother cell is followed by wall formation and results in the formation of two dyad cells, but the walls laid down after the second division are very thin and ephemeral so that we once again get the original dyad cells each of which contains two nuclei. The micropylar dyad cell is at first larger and more vacuolated than the chalazal, but gradually the latter increases in size and acquires the more dominant position. The two nuclei of this cell divide to form four and then the eight nuclei of the mature embryo sac. The development is therefore of the Allium type, the interesting point being that it starts like a monosporic form but is actually bisporic due to the early dissolution of the cell walls in the dyad cells.

Fritillaria.—As mentioned in the introductory part of this review, *Fritillaria* and *Lilium* were originally supposed to have an Adoxa type of embryo sac. Investigations carried out during recent years by Bambacioni (1928, a, b) and Cooper (1935) have shown that both these genera have an entirely different type of embryo sac in which four divisions take place between the megaspore mother cell stage and the formation of the eight-nucleate embryo sac.

Gagea.—Stenar (1927) reported Adoxa type in *G. lutea*. Since then several species of this genus have been shown to follow the Fritillaria type (Romanov, 1936) and it seems probable that *G. lutea* will be found to be similar. Fagerlind (1939, p. 39) says: "Der Fritillaria-Typ kann hier als so gut wie sicher festgestellt betrachtet werden." Of course, in exceptional cases all

four megaspore nuclei may divide just once to produce an eight-nucleate embryo sac of the Adoxa type as noted even by Romanov (1936) in *G. graminifolia*.

Medeola.—McAllister (1909) reported Adoxa type in *M. virginica* but as I pointed out previously (Maheshwari, 1937) his figs. 40 and 41 of the four-nucleate stage show a marked difference of size between the micropylar and chalazal nuclei and indicate that the Fritillaria type is more likely. Fagerlind (1938, p. 483; 1939, p. 38) is in agreement with this opinion.

Majanthemum.—McAllister (1914, p. 140) found that in *M. canadense* the first and second divisions of the megaspore mother cell are followed by the formation of cell membranes resulting in four fully separated cells which may be arranged either in an axial row, or, more frequently, in a more or less bilateral fashion. Later the partition membranes degenerate, thus giving rise to a tetranucleate cell whose nuclei undergo one further division to form the eight-nucleate embryo sac. Stenar (1934) has shown that in *M. bifolium* the embryo sacs are 16-nucleate (Drusa type) although they may appear eight-nucleate in later stages owing to an early degeneration of some of the antipodals. *M. canadense* thus needs to be reinvestigated.

Smilacina.—McAllister (1909, 1914) investigated several species of this genus. He reports that in *S. sessilifolia* and *S. stellata* the four nuclei resulting from the first two divisions of the megaspore mother cells are at first separated by cell membranes but they soon disappear and the development takes the course laid down for the Adoxa type. Stenar (1934) suspects that they would turn out to be similar to *Majanthemum*. Fagerlind (1938, p. 483; 1939, p. 38) is in agreement with this view. A reinvestigation is necessary to determine whether the development is of the type seen in *Majanthemum* or *Fritillaria*.

Tulipa.—Early reports (Ernst, 1901; Guignard, 1900; Newton, 1927) of the occurrence of the Adoxa type in several species of this genus are now regarded as doubtful in the light of the investigations made by Bambacioni-Mezzetti (1931) and Bambacioni and Giombini (1930). The Adoxa type does not occur in any of the species belonging to the section Leptostemones. A modified Adoxa type, noted in members of the section Eriostemones, has already been described on page 76.

AMARYLLIDACEAE

Amaryllis, Buphane, Nerine.—Schlimbach's report (1924) on *Amaryllis belladonna, Buphane disticha* and *Nerine curvifolia* is extremely brief and unillustrated. All of these plants should be reinvestigated.

Cooperia.—Church (1916), working on *C. drummondii*, says: "Megaspore formation takes place in the way usual for the Liliaceae. The archesporial cell becomes directly the one-celled stage of the embryo sac." She com-

pares her observations with those of Treub and Mellink (1880) on *Lilium* and *Tulipa*, and of Schaffner (1901) on *Erythronium* and concludes: "We may for the present assume that the reduction division occurs with the division of the one-celled stage and is completed when the four-nucleate embryo sac is formed." A study of her figs. 3 and 4 seems to indicate however that she missed several stages between the megaspore mother cell and the two-nucleate embryo sac. A reinvestigation will probably show that the embryo sac is not of the Adoxa type but of the Normal type.

Crinum.—Schlimbach (1924) reported Adoxa type in *C. asiaticum* without offering any illustrations to support his statement. On the other hand, Stenar (1924) and Tomita (1931) found Allium type in certain species of this genus. The latter condition seems more likely, but a reinvestigation is necessary.

Cyrtanthus.—Farrell (1914), who investigated "the ovary and embryo of *C. sanguineus*," does not figure any stages in embryo sac development but merely writes that "some of the ovules which were killed in the early stages were examined and found to contain an embryo sac of the lily type." Stiffler (1925), working on *C. parviflorus*, supports this statement and states (p. 212): "The product of the heterotypic division is the 2-nucleate embryo sac with a large vacuole in the center between the nuclei. . . . The homotypic division forms the four-nucleate stage, with two nuclei occupying each end of the sac." The fact that a large central vacuole is seen at the two- and four-nucleate stages, together with certain other considerations, makes it almost certain that these investigators were mistaken and the development is really of the Normal type (see also Fagerlind, 1938, p. 484; 1939, p. 39).

Haemanthus.—Schlimbach (1924) and Stenar (1925) found that in *H. catharinae* the development of the embryo sac corresponded to the Normal type. Woycicki (1928), on the other hand, considered it to be of the Adoxa type. As Fagerlind (1938, p. 484) points out, the presence of a large central vacuole at the two-nucleate stage indicates that the earlier observations of Schlimbach and Stenar are more likely to be correct. In a later paper (Fagerlind, 1939, p. 39) he says: "Der Normal-Typ ist hier so gut wie sicher" and I am in agreement with this opinion.

ZINGIBERACEAE

Humphrey (1896, p. 22) writes of a species of *Costus:* "The mother cell of the embryo sac enlarges as the ovule grows but does not divide further and thus becomes itself the definitive embryo sac." This is supported by Mauritzon (1936, p. 28) who states: "Ich habe viel Zeit darauf verwendet, die Embryosackentwicklung bei *Costus igneus* zu studieren and hierbei meine Präparate nur in der Weise deuten können, dass oben zitierte Darstellung auch ganz auf diese Art passt." He notes however that the

development does not entirely agree with that in other forms showing the *Adoxa* type, for in these vacuolation commences only after the megaspore nuclei have been formed. "Bei *Costus* dagegen wächst die junge Embryosackmutterzelle zuerst lange und wird vacuolisiert, bevor der Kern sich ohne darauf folgende Wandbildung teilt."

The irregular vacuolation observed by Mauritzon seems to indicate that he missed the stages in megasporogenesis and misinterpreted the functioning megaspore as the megaspore mother cell. Since then Banerji & Venkateswarlu (1936) have found a Normal type of embryo sac in *C. speciosus* and Fagerlind (1939) has done the same in *C. cylindricus*.

ORCHIDACEAE

Epidendrum, Bletia.—In *Epidendrum variegatum* and *Bletia shepherdii*, Sharp (1912) reports that, although the embryo sac usually develops according to the Normal type, sometimes wall formation between the megaspores is partially or completely absent and the embryo sacs may be bi- or tetrasporic. Since these differences are probably due to environmental factors, no great importance need be attached to this abnormality.

Epipactus.—In *E. pubescens*, according to Brown and Sharp (1911), "in most cases, the megaspore mother cell divides to two unequal daughter cells, the chalazal one again dividing to form two megaspores. The innermost megaspore then gives rise to the embryo sac." In certain other cases, however, "the fate of the megaspore mother cell is quite different." "After enlarging somewhat the nucleus divides, the spindle lying at about the center of the cell, so that the thin wall formed upon the fibers separates the mother cell into two nearly equal daughter cells. The wall, however, soon disappears, leaving the two nuclei in a single cell cavity which is to form the embryo sac. Between the nuclei vacuolation occurs, so that the center of the sac comes to be occupied by a single large vacuole, the two nuclei taking up positions at opposite ends of the sac, where the greater part of the cytoplasm lies." These nuclei are now said to form four and then eight, so that in such cases the development is to be considered as of the Adoxa type. While such a variation is possible, a reinvestigation of *Epipactis* would be useful.

Gyrostachys.—In 1914 Pace published a paper on two species of *Gyrostachys* (=*Spiranthes*) named *G. gracilis* and *G. cernua*. She says that "the embryo sac is very irregular in its development. Sometimes it develops from the mother cell, sometimes from the daughter cell (she evidently means a dyad cell) and at others from either of the megaspores. The sac may contain four, five, six or eight nuclei, the six-nucleate sac resulting from a lack of one mitosis in the chalazal end of the sac being the usual one in my material."

Pace's illustrations seem to convey the impression however that the

embryo sac is as a rule monosporic and not bi- or tetrasporic as she often believed it to be. The two-nucleate stage shown in her fig. 4 has such a large and typical central vacuole that its direct origin from the megaspore mother cell appears to be highly improbable. It seems more likely that she occasionally missed some of the degenerating megaspores and thus arrived at different interpretations. In an Indian species of *Spiranthes*, which I have investigated from material growing under natural conditions (observations unpublished) the embryo sac is clearly monosporic and I have found no evidence of its being occasionally bi- or tetrasporic.

The four-nucleate condition of the embryo sac, reported by Pace in certain instances, is also doubtful. As she herself admits (p. 10), this condition "may be due to the decay of some of the chalazal nuclei." The other alternative of course is that she missed some of the chalazal nuclei as in the *Cypripedium* spp. investigated by her in 1908 (see Maheshwari, 1937, p. 374).

V. Conclusion and Summary

The Adoxa type of embryo sac, formerly called "Lilium type" is characterized by the occurrence of a single nuclear division following the formation of the megaspore nuclei; the mature embryo sac is eight-nucleate and is organized into a normal egg apparatus of three cells and a group of three antipodal cells, leaving two free nuclei which function as polars. The name "Lilium type" is no longer applicable to this mode of development, as *Lilium* conforms to the Fritillaria type where we have a fusion of three of the megaspore nuclei and the interpolation of a secondary four-nucleate stage.

Up to the present, the Adoxa type is known with certainty in relatively few species: *Adoxa moschatellina*, *Smabucus racemosa*, *S. canadensis*, *S. ebulus*, *Erythronium albidum* and *Tulipa ostroviskiana*. In *T. sylvestris* and *T. tetraphylla*, which may provisionally be included here, the development follows a somewhat peculiar course: The megaspore nuclei take up a 3+1 position, so that after the next division six nuclei are seen at the micropylar end and two at the chalazal. In *T. sylvestris* the egg apparatus consists of six cells leaving two free nuclei to function as polars; in *T. tetraphylla* there are five cells at the micropylar end and one at the chalazal, and two free nuclei.

In a few genera, viz., *Ulmus*, *Tamarix*, *Rudbeckia*, *Armeria* and some others, the development is ordinarily of the Fritillaria type, but the Adoxa type also occurs in a small percentage of the ovules. In one individual of *Leontodon hispidus*, the development showed a deviation from the usual monosporic type in more than 50% of the ovules. Here the partition walls laid down between the megaspores became mucilaginous and dis-

solved away leaving all four nuclei in a common cavity. Only one further division occurred giving rise to the eight nuclei of the mature embryo sac.

In the past, several genera were reported to have an embryo sac of the Adoxa type. These must now be transferred elsewhere either because a reinvestigation has shown the previous results to be incorrect or because there is strong evidence of an indirect nature to warrant such removals.

Species of *Piper, Heckeria, Myicaria, Armeria, Statice* (except *S. Eu-Limonium* in which Penaea type has been reported), *Fritillaria, Lilium, Gagea, Cardiocrinum* and *Tulipa* (Sect. Leptostemones) have embryo sacs of the Fritillaria type. It is possible that *Medeola* and some species of *Smilacina* may also belong here.

Helosis, Thea, Alisma, Sagittaria, Limnocharis and *Convallaria* have been shown to have bisporic embryo sacs of the Allium type and probably the same will also be found to be true of *Phoradendron, Rhopalocnemis, Lemna* and *Crinum*. The last four need further study, however.

Reports of the occurrence of the Adoxa type in the following genera are considered incorrect or extremely doubtful: *Salix, Juglans, Thesium, Hydnora, Balanophora, Mesembryanthemum, Stellaria, Isomeris, Sedum, Philadelphus, Medicago, Lupinus, Melilotus, Cicer, Euphorbia, Carica, Phyllocactus, Eugenia, Trapa, Forsythia, Fouquieria, Solanum, Rhytidophyllum, Acanthus, Myoporum, Typha, Zea, Cocos, Chamaerops, Homalonema, Aglaonema, Acorus, Commelina, Cynastrum, Aloe, Agave, Cooperia, Amaryllis, Buphane, Nerine, Cyrtanthus, Haemanthus, Costus, Epidendrium, Bletia, Epipactis,* and *Gyrostachys*. It seems likely that in all of these the development is really of the monosporic eight-nucleate type. Further confirmatory evidence is desired however in a few cases: *Isomeris, Cicer, Cocos, Homalonema* and *Aglaonema*.

The embryo sac of *Limnanthes douglasii*, according to the latest account of Fagerlind (1939), shows an extraordinary variability in its development and does not seem to agree with any of the well-known types of development. Four nuclear divisions intervene between the megaspore mother cell and the formation of the egg apparatus and the number of nuclei in the mature embryo sac varies from nine to five, owing to the failure of some divisions at the chalazal end.

In *Pyrethrum balsaminatum* also, the embryo sac is not of the Adoxa type as once reported by Ward. Fagerlind has shown that after the meiotic divisions are over, the three chalazal megaspore nuclei do not take any further part in the development and it is the micropylar nucleus alone which undergoes three divisions to give rise to the eight nuclei of the mature stage. It is a matter of opinion whether such an embryo sac should be regarded as tetrasporic or monosporic. Since the degenerating megaspore nuclei are not cut off from the embryo sac by a wall, Fagerlind is of the opinion that it should be included under the tetrasporic types.

VI. ACKNOWLEDGMENTS

The writing of this paper was begun several years ago in India, continued at Harvard University, Cambridge, Massachusetts, and completed at the University of Notre Dame, Notre Dame, Indiana. I have pleasure in offering my sincere thanks to Profs. R. H. Wetmore and Theodor Just for the assistance which they rendered in its preparation. I am indebted to Miss Joann Walsh, Notre Dame, for the willingness and care with which she typed the manuscript.

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Type Studies on Agarics-II[1]

ROLF SINGER

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This is a continuation of the studies on type and authentic specimens preserved in the herbaria of this country. While most of the types examined in part I came from the Herbarium of the New York Botanical Garden, the present part deals with specimens preserved at the Farlow Herbarium (Curtis Herbarium, Patouillard Herbarium, Höhnel Herbarium, etc.) and at the Herbarium of the Agricultural Experiment Station of the University of Florida (FLAS.)

Fam. TRICHOLOMATACEAE

TRICHOLOMA LACTESCENS Pat., Bull. Soc. Myc. Fr. **23**: 59. 1917. (Type, and color-plates.)

The type has a pinkish spore print like that of *Collybia butyracea;* the spores are smooth to distinctly though very minutely rough, thin-walled, without suprahilar depression, non-amyloid, hyaline, 5–5.5×3.2–4μ; basidia and cystidia none seen, the hymenium of the type being partly destroyed; laticiferous hyphae present but not predominant; gill trama regular, consisting of rather parallel, hyaline hyphae which have rather thin, non-amyloid walls, a diameter of 3–10μ, and clamped septa.

This species is illustrated by two excellent plates in V. Demange's unpublished Album in the Farlow Library. It has all the characters of a *Rhodopaxillus,* and therefore the name **Rhodopaxillus lactescens** (Pat.) Sing. comb. nov. is proposed.

AERUGINOSPORA SINGULARIS Hoehn., Sitz.-ber. k. Akad. Wiss. Wien **117**: 1012, 1908. (Type.)

The spores of this species are non-amyloid, thin-walled, pore-less; the hyphae are non-amyloid, the septa clampless; the basidia are medium sized, 27×6.5μ, and 4-spored. The external appearance of the dried carpophores is that of a *Clitocybe.* There is no spore print preserved, together with the specimens, and the lamellae are now grayish.

These additional characters prove that *Aeruginospora* has neither any relationship to the other green-spored agarics (provided it is, itself, really green spored which has been doubted), nor is it congeneric with *Clitocybe.* I am inclined to think that *Aeruginospora singularis* is a tropical species of *Armillariella,* in which case the short spores, clampless septa, decurrent lamellae, and slightly colored spore print would fit into the generic diagnosis.

[1] Cf. Singer, Rolf. Type Studies on Agarics. Lloydia **5**: 97–135. 1942.

AGARICUS (COLLYBIA) BORYANUS Berk. & Mont., Ann. Sc. Nat. III. 11: 235. 1849. (Authentic[2].)

These specimens darken much more in the herbarium than do those of *Lentinus cubensis* and—although the microscopical characters are not easily ascertained in the specimens available—the general appearance, shape, and color of the carpophores is too different to allow one to synonymize these species. The writer has found a species very similar to the Cuban specimens of *Agaricus Boryanus* which will be described in a later paper. However, I want to emphasize that they are not identical with what Murrill has called *Armillaria Boryana* (Berk. & Mont.) Murr. The latter is, as I have been able to find out by comparison and by observation of living plants, the same as *Lentinus cubensis* Berk. & Curt. (see Lloydia 5: 130. 1942): about this latter species, see p. 124 of the present paper.

AGARICUS (MYCENA) IOCEPHALUS Berk. & Curt., Ann. Mag. Nat. Hist. II. 12: 420. 1853. (Type and fresh material compared with the type.)

Pileus "Aconite violet" to "light Perilla purple," margin becoming "light purplish lilac" or even paler, center sometimes becoming as deeply colored as "dark Perilla purple," somewhat hygrophanous, paler when dry, radially striate to sulcate, convex, later flattened or irregular, rather thin, glabrous, non-viscid, 12–45 mm. broad.—*Lamellae* between "pale vinaceous lilac" and "light vinaceous lilac," subdistant to distant, narrow, 1–2 mm. broad, free to adnexed; spore print almost pure white, much paler than in *C. butyracea*.—*Stipe* white when quite young, soon becoming "pale vinaceous lilac" to "light purple drab" above, the base "tilleuil buff" or sordid, the very base reaching "clay color" and coarsely strigose-tomentose, often the entire stipe pilose with white hairs, more often glabrous at the apex, tapering upwards, 35–60×1.5–5 mm.—*Context* subconcolorus-paler; odor of sauerkraut (disagreeable); taste not distinctive.

Spores 7.5–8×3.5–4μ, elongate-ellipsoid, with the whole inner side more or less applanate, smooth, non-amyloid, hyaline; *basidia* 4-spored; *cystidia* none; *cheilocystidia*-like bodies on the partly sterile edge not forming a continuous hymenium; *hyphae of the cuticle* filamentous, lilac with dissolved pigment turning blue in alkali, repent; all hyphae non-amyloid, with clamp connections.

The color of the pigment as found in nature is due to a slightly acid reaction of the cell sap; it becomes "roselline purple" with strong acids (HNO_3), and "Delft blue" with alkali (e.g., NH_4OH). This blue reaction is still distinct in dried material.

On fallen leaves characteristic of southern low hammock vegetation, preferring leaves of *Liquidambar styraciflua* but also on leaves of *Quercus nigra*, *Pinus palustris*, *Ostrya virginiana*, *Acer rubrum*, *Nyssa sylvatica*,

[2] Material in the Curtis Herbarium and in Wright's Fungi Cubenses (det. Berkeley).

fruiting in June, July and August. From New York to North Florida and west to Alabama.

The pigment reacts as an indicator in a manner comparable to the reaction of the pigment of *Lactarius turpis*. The anatomical data given above prove that this species has nothing in common with *Mycena*, nor is it a *Marasmius* as Pennington and others thought, but that it belongs to *Collybia*. The combination **Collybia iocephala** (B. & C.) Sing. comb. nov. is proposed.

AGARICUS (COLLYBIA) LUTEOOLIVACEUS Berk. & Curt., Ann. Mag. Nat. Hist. III. 4: 286. (Type, and fresh material compared with the type.)

Pileus uniformly yellowish-melleous with sometimes umbrinous hues, hygrophanous, "Isabella color" when wet, "chamois" to "honey color," or "cartridge buff" when dry, occasionally "olive ocher" on the disc, long but faintly transparently striate when wet, smooth when dry, glabrous, becoming copper red ("liver brown," "carob brown" at the darker places, as pale as "walnut brown" on the lighter colored places) where it has dried out completely and in the herbarium, campanulate or more often convex, umbilicate, becoming subumbilicate, when dried with depressed center, with projecting margin, sometimes becoming flattened in age, the cuticle not gelatinized, even when quite wet, 12–26 mm. broad.—*Lamellae* concolorous with the pileus in fresh as well as in dried condition, or "buff yellow," sometimes paler than the pileus in youth, close to crowded, with entire and concolorous edge, or sometimes somewhat eroded, moderately broad, or sometimes narrow, adnate to subdecurrent, or emarginate-adnexed, separating on drying; spore print white when fresh.—*Stipe* concolorous with the pileus or lamellae, excepting the pure white and unchanging mycelial tomentum which is always well developed, somewhat pruinate, then glabrous, smooth, often slightly compressed, opaque, equal or very slightly tapering upwards, fleshy-cartilaginous, solid, or hollow in age, 22–55×1.5–5 mm.—*Context* concolorous with the surface, fleshy-fibrous, soft, later rather somewhat tough, but fragile when fresh, rather thin; odor none; taste disagreeable, styptic, more or less bitter.

Spores 4.5–6.2×3.2–4μ, ellipsoid, smooth, thin-walled, non-amyloid, non-pseudoamyloid, without germ pore, hyaline or more rarely with a rosy-vinaceous cell sap, the majority with vinaceous red oil droplet or red pigment precipitation along the inside of the wall or with red intracellular crystals, at least in dried material, and older spore prints; *basidia* 16.5–27×(4)–4.5–6.5μ, with or without deep red guttulae or amorphous or crystalline bodies, at least in herbarium material, 4-spored; *cystidia* and cheilocystidia none; *cystidiols* (or basidiols as for some of them) fusiform or basidiomorphous, or fusoid-lageniform, very sparse to rather numerous along the edges of the gills, always hyaline, also often filamentous-sub-

flexuous, or subcapitate at times, 16–28×1.5–4.8μ; *edge* homomorphous; *trama* regular, consisting of subparallel-subinterwoven to parallel, moderately thick hyphae, sometimes with some of the red pigment found in the spores and basidia, septa moderately distant, without clamps; *cuticle* of repent hyphae; *epicutis* little differentiated. The reddening of the carpophore can also be induced by various reagents. On stumps, logs, and trunks of oak, birch, and pine (e.g. *Pinus glabra*), gregarious, fruiting from June till October. From New England to North Florida and west at least to Tennessee.

This species varies to a certain degree in certain particularities, and this being a rather rare species, its identification with extreme forms is not always easy. Even so, the microscopical characters of the dried plant are so striking that it would not have been difficult to determine our first specimens (*C. psilocybe* Murr. & Sing.) as *Collybia luteoolivacea* (Berk. & Curt.) Sacc. if the latter had been known and described adequately. It was necessary to restudy the types of the Curtis Herbarium in order to establish the identity of both of these species. I think that *Agaricus coloreus* Peck and *A. rubescentifolius* Peck too belong to this species. It is, however, a mistake to identify these fungi with the European *Agaricus exsculptus* Fr. which is evidently nothing but a yellow form of *Collybia dryophila*. *Callistosporium* does not occur in Europe. I propose the new combination **Callistosporium luteoolivaceum** (Berk. & Curt.) Sing.

COLLYBIA IRRORATA Pat., *in* Duss, Enum. Champ. Guadel., p. 49. 1903.

The type and two additional collections, with drawings are preserved in the Patouillard Herbarium (FH). To the characters already indicated by Patouillard, I want to add several more.

Spores ellipsoid, thin-walled, these as well as the hyphae non-amyloid; cystidia very thick-walled, with a hood of calcium oxalate; hyphae partly thick-walled, partly thin-walled, they have few septa and these are very difficult to observe. I think, however, I have seen at least three good clamp connections, and several more septa without clamps, thus, the clamp connections appear to be scattered and not constant in the tissue; the cellular cuticle consists of spherocysts filled with dark brown pigment; the material is outwardly in very good condition but there is *Actinomyces* in most of it. For more details see Patouillard's diagnosis, l.c.

This species seems to be rather closely related to *Pseudohiatula Cyatheae* (Sing.) Sing. (*Mycena Cyatheae* Sing.) which Kühner thought might be included in *Marasmius*. Whether this group of fungi, perhaps including the clampless species *Marasmius esculentus* and *"Collybia" conigenoides*,[3] is

[3] I have studied the type and numerous other collections, and there is no doubt about its position in the immediate neighborhood of *M. esculentus*. The host is a *Magnolia* sp. Clamp connections are absent.

considered as belonging to *Marasmius*, or to a genus by itself, depends entirely on the definition of the genus. In my opinion, *Pseudohiatula*, though undoubtedly related to *Marasmius*, sect. *Alliacei*, is as good a genus as is now generally admitted in botany, and, therefore, the combination **Pseudohiatula irrorata** (Pat. *in* Duss) Sing. comb. nov. is proposed for *Collybia irrorata* Pat.

Murrill synonymizes this species with *Gymnopus nigritus* (Berk. & Curt.) Murr. However, the type of *Agaricus* (*Collybia*) *nigritus* Berk. & Curt. is identical with *Hydropus fuliginarius* (Batsch ex Fr.) Sing. (see below).

OMPHALOPSIS PERNIVEA Murr., Proc. Fla. Acad. Sc. **7**: 113. 1944 (publ. 1945).

The type consists of a scanty collection from sandy soil under a palmetto palm in Gainesville (North Florida). It has dermatocystidia of 15–22×6.7–11.3μ which are numerous on the pileus, clavate balloon-shaped, and on the stipe there are similar, more irregular and narrower bodies; the hyphae of the stipe are strongly parallel; on and very near to the edge of the lamellae, I found cheilocystidia of the same general shape as the dermatocystidia of the pileus; basidia 20–26×6.3–6.7μ, mostly 4-spored; all hyphae were non-amyloid. The spores which were seen by Murrill as well as by me, were narrowly oblong, subcylindric, about 8×3.3μ or still narrower, non-amyloid, smooth.

If these spores belong to the specimen, then, Murrill's plant is different from an otherwise very similar species (described below), and does not even belong in the same genus. However, the near-identity of the anatomical characters and the very suggestive habitat (though on the base of the palms instead of on the trunk) brings up the question whether *Omphalopsis pernivea* is a different species, or a *nomen ambiguum* in which the sterile portions and the basidia belong to the following species (*Hydropus Sabalis*) while the spores are foreign (which often happens when small agarics are left near or under other fungi with which they have been collected or studied). There are other slight differences between the palm *Hydropus* and Murrill's plant in the macroscopical description, but they would hardly be important enough to warrant separation if the matter of the spores had not been discovered. I therefore feel that the common and interesting palm inhabiting fungus of South Florida with short and broad amyloid spores should here be described, for comparison, as a new species of *Hydropus* (Kühn.) Sing.

Hydropus (Kühn.) Sing. stat. nov. (*Mycena* sect. *Hydropus* Kühn., Mycen., p. 531, 1938) with the following species: *H. marginellus* (Pers. ex Fr.) Sing.; *H. fuliginarius* (Batsch ex Fr.) Sing. (type of the genus; syn.: *Agaricus nigritus* B. & C.); *H. africanus* Sing.; **H. atriceps** (Murr. as *Gymnopus*) Sing. comb. nov.; **H. translucens** (Murr. as *Camarophyllus*)

Sing. comb. nov.; *H. Sabalis* Sing. spec. nov. (see below), and *H. oculatus* (Murr.) Sing.

H. Sabalis Sing. nov. sp. Pileo albo, glabro, striato, umbilicato, 12–25 mm. lato; dermatocystidiis numerosis vesiculosis. Lamellis albis, sublatis, arcuatis, decurrentibus, sat distantibus; sporis albis, s.m. hyalinis, amyloideis, breviter ellipsoideis vel subglobosis, levibus, 6.5–7.5×5.3–6μ; cheilocystidiis 20–66×6.8–17μ; tramate haud amyloideo. Stipite albo, fistuloso, glabro, 15–37×1–3 mm. Carne alba; odore nullo; sapore miti. Hyphis fibuligeris.

Pileus white, hygrophanous, non-viscid, glabrous, naked, transparently striate when wet, convex with depressed center or umbilicate, later concave with the margin sometimes strangely uplifted, 12–25 mm. broad.—*Lamellae* white, medium broad, more rarely broad (2–3 mm.), arcuate, eventually strongly descendant, always deeply decurrent, rather distant, entire, intermixed with lamellulae; spore print white.—*Stipe* white, glabrous, naked, smooth, but the base white strigose, fistulose, equal, or thickened upwards or downwards, 15–37×1–3 mm.—*Context* white, thin, fragile and fleshy; odor none; taste mild.

Spores 6.5–7.5×5.3–6μ, short ellipsoid to subglobose, smooth, without suprahilar depression, amyloid; *basidia* 20–25.5×6.2–6.8μ, 4-spored; *cheilocystidia* on or near the edge, 20–66×6.8–17μ, vesiculose to clavate-balloon shaped, sometimes minutely mucronate at the apex with a apiculate papilla on the tip, or acuminate at the tip, rarely capitulate, thin-walled, easily collapsing, hyaline; *cystidia* none; *trama* regular but the outermost layer (nearest the hymenium) distinctly though slightly diverging without being otherwise differentiated from the mediostratum, but becoming quite regular in mature specimens, consisting of hyaline, non-amyloid hyphae of variable length and diameter; *hyphae of the pileus* rather irregularly interwoven, more parallel-prostrate in the hypodermium where some occasional laticiferous hyphae are intermixed, rather filiform and thin; *epicutis* consisting of occasionally interrupted fascicles or groups of dermatocystidia, especially near the margin of the pileus where they have the same appearance and shape as the cheilocystidia; the same *dermatocystidia* on the stipe are, however, often more irregular and narrower; hyphae of the interior of the stipe-context strictly parallel; all *septa* with clamp connections.—$FeSO_4$ negative.

This is the most specialized of the smaller, non-symbiotic agarics in Florida. It occurs only on living trunks of *Sabal palmetto*, gregarious, sometimes associated with *Mycena chlorinosma* Sing.[4] which has a preference for palmetto. Fruiting from July till November. South Florida, in the

[4] This was discovered in a greenhouse of the Botanical Garden in Leningrad. It was an exciting experience for this writer to find this species in the hammocks of South Florida from where it must have been introduced to Europe.

tropical and subtropical zones, common in Highlands Hammock State Park and in and around the Fairchild Tropical Garden, rarely found on other palms related to *Sabal palmetto*, in gardens, alleys etc.

This species is most closely related to *H. translucens* (Murr. Mycologia **35**: 424. 1943) Sing. which differs in having still more distant lamellae than our species, smaller [in the type specimen (FLAS) 5.5–6.5×4–4.8] spores, and the habitat on earth under hardwood; the dermato- and cheilocystidia, the iodine reaction, the lack of pigment, and many other features are the same in this as well as in our species.

MARASMIUS SEMIUSTUS Berk. & Curt.. Journ. Linn. Soc., Bot. **10**: 295. 1868. (Type and various additional collections, also fresh, and compared with the type.)

Pileus white, subglabrous, radially sulcate and slightly grooved, convex, then flat, more or less umbilicate, 7–22 mm. broad, rarely broader.—*Lamellae* white, medium broad to rather broad (1–2.8 mm.), distant (8–15 through-lamellae), not or slightly ventricose, adnexed to adnate, more rarely somewhat subdecurrent, lamellulae 0—many, in 1–3 tiers, spore print white.—*Stipe* white, subglabrous, curved, rarely straight, attached to a somewhat pruinate pedestal (or insiticious, the lower part frequently becoming brownish in old and long-stemmed forms), tapering upwards or downwards, or equal, eccentric, rarely central, 3–20×0.2–2 mm.—*Context* white, thin, submembranaceous, not fragile. Odor none.

Spores (6)–7–10.8×(4)–4.5–6μ, non-amyloid, smooth, hyaline, without suprahilar depression, sometimes even convex on the inner side, ellipsoid to ellipsoid-oblong; *basidia* 21–35×5.5–9.5μ, 4-spored, basidioles fusoid; *cheilocystidia* 21–30×6–10μ, but also smaller or larger than this, very variable in shape and size, clavate with nodulose or capitate subsessile appendages all over, or vesiculose and echinate-appendiculate, sometimes with not more than one oblique appendage, more frequently with innumerable appendages either concentrated near the tip, or equally dense on the sides, the appendages sometimes branched, the whole cheilocystidiam also often branched, and the branches lacerate-digitate, numerous; *edge* of gills heteromorphous; *subhymenium* of thin and short, strongly interwoven hyaline hyphae forming a thick layer; *trama* regular, consisting of interwoven, hyaline, slightly thick-walled, non-amyloid hyphae; *hyphae* of the pileus somewhat thick-walled, irregular, less thick-walled, and less irregular in the hypodermium; the *epicutis* strongly differentiated, consisting of strongly diverticulate hyphae, some of them branched nearly rectangularly, the branches also diverticulate and, if erect, assuming the character of dermatocystidia which are entirely analogous to the cheilocystidia of the lamellae; all *hyphae* with clamp connections and nonamyloid; *surface of the stipe* also more or less diverticulate.

On various Cormophyta, e.g., *Caryota mitis* (Fla.), *Saccharum officinarum* (La.); *Pithecolobium samon* (Cuba), etc. on dead as well as living material, roots, wood, vines, especially bark, often in large quantity climbing up the trunks in the tropical forests, 6–10 ft. from the ground, fruiting from May until September.

Material studied: CUBA (Fungi Cub. Wright and Curtis Herb., FH, type); Soledad, Cienfuegos, *W. L. White, 470* (FH); *D. H. Linder*, on sugar cane (FH).—FLORIDA: Miami, *R. Singer F 1500* on *Caryota* (FH).—LOUISIANA: Lobdell, *H. R. Fulton*, on sugar cane (FH), also St. Delphine, La. (FH).

When growing on sugar cane, it often causes root disease in the Americas (in Asia, the disease seems to be mostly caused by a similar species, known as *Marasmius plicatus* or *M. Sacchari*, and phytopathologists frequently determine the American root disease erroneously under these names). It is "omnivorous" and will probably be found to cause damage also on crops other than sugar cane. Its taxonomic position is, together with a series of other species, ambiguous between *Marasmius*, section *Rameales* Kühner, and *Hemimycena*, sect. *Pseudoconidiophorae* Sing. In fact, these tropical species seem to make impossible the clear separation of *Hemimycena* and *Marasmius* on this level. It would in my opinion be best to remove the whole section *Rameales* from the *Marasmii* and incorporate them in *Hemimycena*.

Murrill identifies *M. semiustus* with *M. stenophyllus* Mont. the type of which I have not studied. However, the description, if it is anywhere near the facts, excludes such a synonymy (lamellae foldlike in Montagne's species). Otherwise, his description (North Am. Flora **9**: 262. 1915) comes rather close to my own in some items. I have seen the specimens on banana trash, mentioned by Murrill but have not studied them. They probably belong here. *M. hyperellus* Fr. cannot be considered as belonging here unless there are specimens that, in spite of the description, prove their identity with *H. semiusta*.

PANUS CANTHARELLOIDES Mont., Ann. Sc. Nat. IV. **1**: 120. 1854. Type.
MARASMIUS PURPURASCENS Berk. & Curt., Journ. Linn. Soc., Bot., **10**: 296. 1868. (Type.)
LENTINUS SCYPHOIDES Pat., Bull. Soc. Myc. Fr. **15**: 195. 1899. (Type.)
LENTINUS SUBSCYPHOIDES Murr., Mycologia **3**: 34. 1911. (Authentic material.)

Aside from the above indicated types and authentic material, the writer has studied large numbers of fresh specimens, and compared them with the types. These species are definitely identical. The following revised description is based on the data obtained.

Pileus "raw umber" with pallid margin, the margin which is involute

often colored "dull lavender" on the lower side, more rarely lavender colored also on the upper surface, or not infrequently the entire pileus similarly colored, the lavender tinge gradually disappearing, especially in old carpophores that have been dried out and revived by weather conditions several times, glabrous or faintly fibrillose-subtomentose, non-viscid, subhygrophanous, infundibuliform from the beginning, with an orbicular or irregular outline, often splitting radiately more or less deeply, or lobed, but more frequently entire if normally developed, 10–45 mm. broad.—*Lamellae* usually "dull lavender," becoming tan color, deep descendant-decurrent, somewhat arcuate in most specimens, the lavender color sometimes lacking from the beginning in the inner (rear) half of the hymenophore, usually eventually disappearing everywhere, very narrow (1 mm.), forking, close to usually crowded, rather thin, with acute edges when mature.—*Stipe* either flushed with lavender like the lamellae at the apex, or unicolorous, tan color all over, often with grayish fibrillosity, solid, eventually often hollow, often broadened into a discoid socle at the base, sometimes tapering from the base to the apex, simple, rarely once branching, central or eccentric, 17–40×1.2–4 mm.—*Context* dirty lavender violet all over, becoming tan color, or tan color from the beginning, or partly so, rather tough but very flexible, tougher in the stipe, reviving when wetted; thin; odor farinaceous, but rather weak; taste more or less bitter.

Spores (3.3)–3.5–6×2.5–3.5–(4)μ, short-ellipsoid to ellipsoid-oblong, non-amyloid, smooth, hyaline; *basidia* (1- 2-) 4-spored, 21–25×3.5–6.3μ; cystidia none or few, with the walls very slightly tough, noticeably thicker than in the basidia (about as thick as in the hyphae); cheilocystidia scattered, little differentiated, very versiform, inconspicuous; *gill-trama* regular, consisting of subparallel-subinterwoven, non-amyloid hyphae with a diameter of about 2–2.2μ, with very slightly thickened walls (0.5–0.7μ); they are somewhat irregularly interwoven and partly pigmented with a melleous, dissolved, intracellular pigment; *epicutis* formed by a trichodermium consisting of clavate or subclavate terminal hyphae, 15–32×3–9μ, mostly about 28×6–7μ (wall 0.5–0.7μ thick); *hyphae* of the stipe essentially longitudinally arranged but interwoven, hyaline, smooth, with 0.4–0.8μ thick walls, 2.5–5.5μ in diameter; all hyphae with clamp connections, hyaline to yellowish in iodine.

On logs of frondose trees such as *Nectandra coriacea*, *Theobroma cacao*, *Psidium guava*, *Cecropia peltata*, *Quercus virginiana*, etc. in tropical hammocks and plantations, gregarious, fruiting from September until December, possibly also earlier in the year, according to the rainy seasons, common everywhere within the area; Florida (tropical zone); Cuba, and through the Caribbean area to the Guianas and south to Brazil.

Material studied: FLORIDA: Dade Co., *R. Singer F 987, F 926, F 761*, etc. (FH); *R. Thaxter*, det. Singer (FH).—GUADELOUPE: type and authentic material of *L. scyphoides* (FH); Pointe

Noire, 2 collections in the Patouillard Herbarium (FH).—CUBA: Josephina, *Wright, 44*, type of *Marasmius purpurascens* (FH); *165* (FH).—PUERTO RICO: *J. R. Johnson, F 18715*, authentic material of *L. subscyphoides* Murr.[5] (FLAS).—TRINIDAD: Port of Spain, on old termite nests, *R. Thaxter*, det. R. Singer, (FH).—FRENCH GUIANA: *Leprieur 1041*, type of *Panus cantharelloides* (FH).—BRAZIL: Rio Grande do Sul, Serro Azul, *J. Rick, 402*, det. Singer (FH).

The oldest of the above species is *Panus cantharelloides* Mont. which was transferred by Patouillard to *Trogia*, by Murrill to *Panellus*. Though this may fit into the Earle-Murrill conception of *Panellus* which is artificial, it does not agree with the characters of *Panellus* Karst. as outlined by the writer. The spores are non-amyloid and the stipes are more vertical and elongated than in *Panellus*. I accept Patouillard's transfer as correct, since *P. cantharelloides* has all the important characters of a group of agarics one of which appears to be the type of the genus *Trogia*. Other species of *Trogia* are *T. buccinalis* (Mont.) Pat. from South America, with less crowded lamellae; *T. discopoda* (Pat.) Pat., and *T. violaceogrisea* (Henn.) Pat. from the Congo to Liberia and Cameroun; also *T. aplorutis* (Mont.) Fr. and *T. infundibuliformis* Berk. & Br., and others.

Trogia cantharelloides (Mont.) Pat. is the first species of *Trogia* discovered on the North American continent (see Singer, Mycologia **36**: 554. 1944). The type is strongly split and lobed, and rather large in size while the Brazilian specimens are also large but have an entire margin; the majority of the specimens from the Antilles and Florida are moderately large and entire. Neither these small differences nor the presence and extent of the lavender color have the slightest taxonomic importance.

Trogia, as a genus, differs from *Lentinus* (to which Patouillard referred most of the species in the beginning, transferring them gradually after 1900 and especially after 1914) in the absence of strongly thickened hyphal walls and in the non-cylindric shape of the spores, or at least a large number of spores in each preparation, in the constantly entire, forking lamellae, in the slender shape of the carpophores, and to a certain degree, in the structure of the cuticle. It differs from *Panus* in the absence of thick-walled cystidia, in thinner context, a different structure of the cuticle, and forked lamellae; it is distinguished from *Clitocybe* in the constantly rather tough, revivescent context and in the periodical formation of spores evidenced by the frequency of sterile hymenophores in the *Trogiae*. It differs from *Nothopanus* in the colored hymenophores which are much narrower, more forked, decurrent, and in the presence of a much more well-developed stipe in all specimens, also in the presence of a trichodermium on the pileus.

The lamellae of *Trogia*, above the point where they join in forking, are so

[5] I have not studied or compared with my fresh material the type of *L. subscyphoides* but a macroscopical check made in 1943 (NY) revealed specimens of the general external appearance of *Trogia cantharelloides*, exactly as described above.

close to each other in many instances that they appear to be broadened along the edge, and obtuse, or even canaliculate as described and illustrated by Montagne for *Cantherellus aplorutis* Mont. This condition has nothing to do with the reticulate venation of the hymenophores in the chiastobasidial Cantharellaceae (*Gomphus*, etc.) which are fundamentally different in their biology (humicolous and non-revivescent vs. lignicolous and revivescent), color of the spores (yellow to green vs. white), size of the spores and basidia (voluminous against small), diameter of the hyphal wall when compared with the diameter of the hyphae (large against small), consistency (soft-fleshy and thick against tough and thin), and the volume of the carpophores (large against small). There is not the slightest relation between any representative of the Cantharellaceae and the Trogias. They must be transferred to the Tricholomataceae, where they are closest to *Lentinus* and *Panus*, perhaps *Clitocybe*. They should not be confused with the meruliaceous genus *Plicatura*.

LENTINULA DETONSA (Fr. ?) Murr., Mycologia **3**: 28. 1911. (Authentic material.)

ARMILLARIA BORYANA Murr., Bull. Torr. Bot. Cl. **66**: 31. 1939, (*non* Berk., *Agaricus*). (Authentic material.)

ARMILLARIA RAPHANICA Murr., Mycologia **35**: 422. 1943. (Type.)

GYMNOPUS ALLIACEUS Murr., Mycologia **35**: 425. 1943. (Type.)

All the above named species are identical with each other, and at the same time, with *Lentinus cubensis* Berk. & Curt. *L. detonus* Fr. which would be the oldest of the names available, is very doubtful as far as the description is concerned, and if good type specimens do not exist, this name has to be abandoned.

Lentinus glabratus Mont., Pl. Cell. Cuba, p. 424, 1842 would also antedate *L. cubensis*, but the type at Paris "resembles *Lentinula detonsa* but differs in having decurrent gills and brown marginal hairs" (Murrill). Authentic material at Kew "seems referable rather to *Lentinula detonsa*" (Murrill). On the basis of this material, Berkeley determined a Cuban agaric, now found in Wright's Cuban Fungi (FH), as *Lentinus glabratus* Mont. The same species is also found in the Curtis Herbarium (FH). An analysis of these specimens shows that they are not *L. cubensis*, nor a *Lentinus* at all, but *Oudemansiella Canarii* (Jungh.) Höhn.

Consequently, I am using the name *Lentinus cubensis* B. & C. for the plant described below, on the basis of my own collections in Florida as well as of the types studied.

Pileus white, glabrous and smooth, or very minutely diffract to rimulose-subsquamulose on the disc, remaining glabrous and white on the margin, otherwise inclined to turn pale buff or pale tan in age, sometimes with 1–2 concentric zones, sometimes with fine ferruginous spots like those of

Collybia maculata, with a circular or ellipsoid outline, convex, then usually flat, eventually often depressed in the center, with initially incurved to subinvolute margin, occasionally with velar appendages, 50–80 mm. broad.—*Lamellae* white, whitish when fresh, often somewhat discolored in age or on drying, close to crowded, sinuate-adnexed to adnate, never distinctly decurrent, sometimes rounded-adnexed, and in age usually tending to separate from the apex of the stipe, arcuate-linear, narrow (2.5–3 mm. broad), entire to eventually often perpendicularly splitting with the edges, consequently appearing toothed; spore print white.—*Stipe* pale pinkish cinnamon, white at the apex, eventually concolorous, the base often darker brownish in age, subglabrous at apex, subsquamulose below, with 0–3 "velar" belts similar to those of *L. tigrinus*, curved, more rarely straight, central to eccentric, equal or enlarged at the apex, or tapering downwards, the apex often short-striate in continuation of the lamellae, 22–50×4–10 mm.—*Context* white, unchanging when broken, rather tough fleshy when quite fresh, especially in stipe, softer in pileus but becoming almost leathery in age; taste of garlic; odor none, or slightly alliaceous.

Spores (4.2)–5.5–6×2–2.8μ, smooth, hyaline, non-amyloid, cylindric; *basidia* 17–25×3.5–4.5μ, 4-spored; basidiols (cystidiols?) fusoid; *cystidia*, pseudocystidia etc. none, but sometimes some hypha-like bodies are found projecting between the basidia (16–24×3–4.5μ); *trama* of lamellae regular, homogeneous, consisting of non-amyloid, smooth, filamentous, hyaline, somewhat interwoven hyphae; their walls 0.6–1.8μ thick; their septa with clamps; *cuticle* dense, consisting of hyphae with very variable diameter, intricately interwoven.

On logs of *Quercus laurifolia*, *Q. Catesbaea*, *Sloanea Massonii*, *Freziera undulata*, *Morisonia americana*, *Daphnopsis caribaea* etc. Gregarious to subcespitose. Fruiting from April until October. From Florida to Louisiana, and West Indies.

Material studied: FLORIDA: Gainesville, *W. A. Murrill* (F 17944, etc.) (FLAS); *R. Singer (F 2188*, FH), also numerous other collections at FLAS from Alachua, Columbia, Marion Co., Fla.—LOUISIANA: *Langlois*, comm. Lloyd (FH).—CUBA: Numerous collections, among them the types of *L. cubensis* and *L. proximus* (FH).—MARTINIQUE: det. Patouillard, *477* (FH).—GUADELOUPE: det. Patouillard, *33P*, *55P*, *58P*, *666* (FH).

Fam. AMANITACEAE

AMANITA MAGNIVELARIS Peck, Ann. Rep. N. Y. State Mus. **50**: 96. 1898. (Type, and numerous fresh collections.)

Pileus white, inclining to yellowish when dried, more rarely with a pale alutaceous disc, subviscid when wet, shining to subopaque when dry, with subacute to obtusely rounded margin which is split radially at times (in dry weather), convex, very often with a broad, low, very obtuse umbo, later almost flat, smooth and glabrous everywhere, without remnants of

the universal veil, 40–95 mm. broad, up to 27 mm. high.—*Lamellae* pure white, varying slightly orange-pallid, rather broad, sometimes partly serrulate at edges, quite free to sinuate-free with faint decurrent lines, medium broad to rather broad (3–7 mm.). with the lamellulae either suddenly emarginate (the shorter ones), or gradually attenuate (especially the longer ones), subclose to crowded; spore print pure white when fresh. —*Stipe* pure white, or in age with yellowish stains, subglabrous to entirely white fibrillose-flocculose, solid, sometimes finely banded in lower half, with a slight elongated or subglobose bulb or without it (25–35 mm. in diameter if present), equal or slightly tapering upwards, with distinct annulus and volva, 60–150×11–20 mm. (not counting the volva); annulus attached 6–11 mm. from the very apex of the stipe, fimbriate at the margin, tender-membranaceous, white, distant and pendulous (shirt-like), tending to stain yellowish in age, somewhat striate above; volva white to whitish, well developed, loosely saccate with broad free or applicate upper portion, firmly attached below, large (25–75×25–35 mm.), somewhat fragile above but not friable, rather thin in upper third.—*Context* pure white, unchanging on bruising; odor somewhat of old wine barrels or lye, or carpenter's glue, or Camembert cheese, or chloride of lime.

Spores medium-sized and neither oblong-cylindric, nor globose-subglobose, amyloid, smooth, 8–12×6.2–8.8μ ($\frac{8-8.2-9.3-9.5-10-10-11-11-12}{6.5-6.2-6.5-7.2-7-8-7.5-8.8-8}$ μ), *basidia* 32–41×12–14μ, 4-spored; *cheilocystidia* vesiculose, 17–22×10–19μ; *trama* of lamellae bilateral in youth, rather intermixed in age; *hyphae* without clamp connections.

KOH, immediately "amber yellow," "wax yellow," "strontian yellow" on context and all surfaces, especially on the stipe and annulus; positive even in carefully preserved not too old specimens in the herbarium.—Methylparamidophenol, negative, only interior of the base sordid drab.—Phenol and formaline, negative.

On poor, sandy or rocky soil under *Pinus* (*P. strobus*, *P. taeda*, etc.), *Quercus*, or *Betula* (various species), fruiting from April until October, in the northern part of the area mostly from June until September. Eastern United States from New England to North Florida, rather common.

This is often determined as *A. verna* (Bull. *ex* Fr.) Pers. *ex* Secr. and not admitted (listed as doubtful) by Murrill in North America Flora (1914), although admitted for Florida (1938); evidently the specimens referred there were correctly determined. In the writer's opinion, this is definitely different from anything he has seen in Europe, and not closely related to the *Phalloides*-group. This opinion can now easily be checked, since we have a very selective and simple chemical test for this species. I do not

know any other *Amanita* that reacts equally fast and strongly yellow with KOH.

VENENARIUS SUBMUTABILIS Murr., Mycologia **35**: 428. 1943. (Type, and authentic material.)

Pileus white, rarely slightly palest cream color in age, subviscid or viscid in wet weather, smooth except for a 2–10 mm. broad marginal zone which is sometimes indistinctly striate in age, often faintly warty-rugose on the disc, sometimes naked but usually with very thin, rather few, broad, membranous but not friable white to palest pinkish-grayish white patches from the universal veil, with subobtuse to broadly rounded margin, convex, eventually rather flat, (40)–60–100 mm. broad.—*Lamellae* white, with flocculose edges, rather broad to very broad (up to 14 mm.), ventricose, close to crowded, deeply sinuate with decurrent, linear sooth or completely free; spore print pure white when fresh.—*Stipe* white, solid, eventually partially hollow, about as long or longer than the diameter of the pileus, (40)–60–130×11–20 mm. (breadth measured just above the bulb which is up to 30 mm. in diameter), usually equal above the bulb, annulate, volvate; annulus white, pendulous, persistent, striatulate above, attached 5–20 mm. from the very apex of the stipe; volva thick and cup-shaped-saccate, deeply attached at the base, somewhat thinning in the free upper portion which therefore may eventually disappear leaving a bulb of the appearance of that of *Amanita citrina*, but not friable as in *A. chlorinosma*. —*Context* white, turning a beautiful intense pink ("thuilite pink" Ridgway, in *A. mutabilis* to "Eugenia red") when bruised; odor usually none (so in most of the hundreds of specimens I have tested in all ages as long as they are quite fresh, slight and pleasant of *Suillus variegatus* or "oily" according to Beardslee for *A. mutabilis*).

Spores 10.5–13.7×6.5–7.5μ, hyaline, amyloid; *basidia* 43–46×10.5–11μ.

KOH, formaline, and aniline: negative.—Methylparamidophenol, negative.—Phenol accelerates the change to pink.

Under *Pinus palustris*, and *P. taeda* on moist sandy ground, also under *Quercus*, on sandy ground, fruiting from July till October. From North Carolina to extratropical South Florida, probably also west to Alabama.

This species is common in Highlands Hammock State Park, Fla., and rather frequent in and around Gainesville. Neither the spores nor any other character I could discover separate this species from *A. mutabilis* Beardslee. *V. submutabilis* is a synonym of *A. mutabilis*.

Fam. CORTINARIACEAE

MARASMIUS SQUAMOSIDISCUS Murr., Bull. Tor. Bot. Cl. **67**: 151. 1940. (Type, and fresh material.)

LENTODIUM FLORIDANUM Murr., Mycologia **35**: 426. 1943. (Type.)
ARMILLARIA ALACHUANA Murr., Mim. Contr. Herb. U. of Fla. Agr. Exp. Sta., p. 12. 1938 *nom. nud.* (Type, and authentic materials.)

All these materials are identical with each other and, in addition, with an unpublished species of *Lepiota* (FLAS, coll. & det. W. A. Murrill). *Lepiota* may be the first genus that this species suggests when seen in the woods; there is, however no similarity with *Marasmius* or *Lentinus*, or *Armillaria*. As the following complete description shows, this has some characteristics of *Ripartites*. Consequently the combination **Ripartitella squamosidisca** (Murr.) Sing. is proposed. The other species become synonyms of it.[6]

Pileus white or whitish, the disc with suberect rusty to reddish brown, acute, later appressed squamulae which are then extremely like those of *Crepidotus calolepis*, non-viscid, the scales detersible, washed off by heavy rains, the margin glabrous and naked except for occasional traces of the veil, smooth, convex, eventually flat with the center often depressed, or shallowly umbilicate, with suborbicular outline, or sometimes lobed, diameter 20–50 mm.—*Lamella* white, eventually sordid white, entire, intermixed with lamellulae (polydymous), squarely adnate, to adnexed-subfree, never quite free, often with an adnate-decurrent tooth, or sinuate-emarginate, narrow (2.5–3 mm.), close to crowded, sublinear; spore print white.—*Stipe* on whitish ground whitish to whitish-brownish-squamulose to flocculose, the scales or floccons transversely elongated, minute to medium sized, the whole surface becoming eventually pale brown in the lower part of the stipe, naked and glabrous above the annular zone, straight or somewhat curved, central or frequently slightly eccentric, equal or slightly tapering upwards, or downwards, solid, then hollow, 15–40×2–5.5 mm.; base connected with thin, white, rhizomorphal strands. —*Context* white, unchanging, thin, inodorous, mild.

Spores 4–5×3.5–3.8μ, finely echinulate, broadly ellipsoid, non-amyloid,

[6] If it is possible, for an experienced observer, to "deposit," in a classification based on the Friesian macroscopical characters, a single species in four different genera in the herbarium, publish them in two different genera, and then have them all transferred to a genus belonging to a different family as soon as microscopical characters are used, it appears that that classification, aside from being the opposite of natural, is not practical at all, as it has been claimed to be. Similarly bewildering cases can be enumerated without limit (see our comments on *Oudemansiella Canarii*, and the list of synonyms, Mycologia **37**: 436. 1945; also *Rhodophyllus Farlowii* Sing., Farlowia **2**: 50. 1945; the synonymy of *Xerula chrysopepla*, see Mycologia **35**: 158. 1943, the unending confusion between *Collybia* and *Marasmius*, *Tricholoma* and *Clitocybe* (see Pap. Mich. Acad. **28**: 85–86. 1943), *Naucoria* and "*Galera*"). Why, then, do some taxonomists so stubbornly adhere to the Friesian scheme? If it is because we cannot offer anything perfect or foolproof in exchange, this reason may just as well be given forever. Determining agarics in the field with a handlens, and writing keys for this purpose, is definitely impossible. He who recognizes an agaric in a familiar fungus flora does so thanks to experience and the intuition that comes with it. The best way to gain this experience, is to study carefully both the external and anatomical characters of the agarics.

brownish-hyaline; *basidia* 19–33×4.5–7.5μ, 4-spored; *cystidia* of the *Melanoleuca*-type; *trama* of the gills regular, consisting of subinterwoven, hyaline, long-cylindric hyphae with small diameter and thin, non-amyloid walls; *hyphae of scales* filamentous to short-cylindric (to as broad as 12×11μ), in subparallel chains forming strands; *hyphae of cuticle* repent, somewhat radially arranged, hyaline; all hyphae with clamp connections.

On trunks, logs, roots, detritus, also on buried wood, mostly on *Nyssa*, *Persea*, *Quercus*, and other frondose trees in low hammocks as well as in flatwoods, cespitose to gregarious, fruiting mostly from August till November. Thus far observed in Florida, in the extratropical zone rather frequent (Highlands Hammock State Park, and in Alachua Co.), and Brazil.

NAUCORIA ALACHUANA Murr., Lloydia **5**: 149. 1942. (Type and co-type.)
PSILOCYBE ALACHUANA Murr., Lloydia **5**: 155. 1942. (Type.)
GALERULA SEMIGLOBATA Murr., Mycologia **35**: 531. 1943. (Type.)

Spores 6.7–9×3.5–5.3μ, smooth, with moderately thick wall, brownish-melleous (not rusty), reniform- to subglobose-reniform; *basidia* 13.5–26×6.7–7.2μ, 4-spored; cystidia cheilocystidioid, near the edge, rare; the *cheilocystidia* 32–65×6.8–16μ, mostly around 49×7.5–11.5μ, exceptionally as small as 28×5μ, hyaline, often slightly brownish at the base, smooth, numerous, making the gill edge heteromorphous, clavate or with vesiculose apex and thin base, more rarely versiform, subcyclindric with ventricose portions etc., apex always broadly rounded; gill trama regular, consisting of elongated, in accumulations brownish-hyaline hyphae; *cuticle* a thick layer of erect dermatocystidia forming a palisade; *dermatocystidia* most frequently subulate, also ventricose near the middle, more rarely vesiculose or broader above, with broadly rounded apex, brownish below, hyaline above, 22–87×8–20μ, mostly 46–70×9–10μ; with no or little pigment incrustation; all hyphae with clamp connections.

The above data prove that all the characters, color, shape and size of the spores, absence of a germ pore, size of the basidia, shape and character of the cystidia, the palisade of dermatocystidia on the surface of the pileus, the presence of clamp connections, and also the macroscopical characters are those of *Naucoria* (Fr.) Quél. em. Singer (1936), including such species as *N. centunculus*. This means that the name *Naucoria alachuana* Murr. should be accepted, and the two other names should be rejected as being later synonyms.

Fam. STROPHARIACEAE

AGARICUS HAEMATITES Berk. & Curt., (Proc.) Am. Acad. **4**: 117. 1860. (Type.)
AGARICUS FLAVOLIVENS Berk. & Curt., Proc. Am. Acad. **4**: 117. 1860. (Type.)

AGARICUS MUSAECOLA Berk. & Curt. Journ.) Linn. Soc. **10**: 291. 1868. (Type.)
AGARICUS PROTEUS Kalchbr. *apud* Thümen, Flora *59*: 424. 1876. (Type.)
CREPIDOTUS PSYCHOTRIAE Pat., Bull. Soc. Myc. Fr. **18**: 173. 1902. (Type.)
CREPIDOTUS BAMBUSINUS Pat., Journ. de Bot. **5**: 309. 1891. (Type.)

All these species were described as belonging to *Crepidotus*, but are different. They have the following characters in common: pleurotoid habit; whitish to purplish—fuscescent color of the pileus; purplish brown to sepia colored spore print; small size; spores with distinct germ pore, lentiform (compressed frontally), with double wall which is smooth, their length around 6.5μ; cheilocystidia distinct but rather small, ventricose below, ampullaceous or with a slightly capitulate apex, hyaline numerous; cystidia none; dermatocystidia none; epicutis of repent, thin, filamentous, hyaline hyphae; clamp connections present.

These characters would indicate a pleurotoid parallel, in the subtropics and tropics, of the more generally distributed genus *Deconica*, and this is exactly how Kühner has understood Patouillard's genus *Melanotus*. *Melanotus* Pat. has the same kind of relationship to *Deconica* as *Pyrrhoglossum* to *Gymnopilus*. On this basis, I think that *Melanotus* is a small, natural, autonomous genus, closely related to *Deconica*, and belonging to the family Strophariaceae Sing. & Smith. Consequently, the following new combinations are proposed.

Melanotus haematites (B. & C.) Sing. comb, nov.; **Melanotus flavolivens** (B. & C.) Sing. comb. nov.; **Melanotus musaecola** (B. & C.) Sing. comb.nov.; **Melanotus proteus** (Kalchbr. *apud* Thümen) Sing. comb. nov.; **Melanotus Psychotriae** (Pat.) Sing. comb. nov.; besides, there are two forms, well preserved and provided with ample notes, both of which belong to this genus, one from Tennessee, U.S.A., collected by D. H. Linder on corn (*Zea*); another one from Florida and Brazil, collected by R. Singer and J. Rick, on palms. I hesitate to describe these forms in spite of the fact that the substrata are new for this genus, considering the present uncertainty concerning the delimitation of the existing species and the value of the habitat in a group that has never been monographed. It is possible that the nature of the substratum, or at least its taxonomic position does not play a major role in the systematics of *Melanotus*.

AGARICUS CACAOPHYLLUS Berk. & Curt., Journ. Linn. Soc. **10**: 291. 1868. (Type).

This peculiar species has also been described as belonging in *Crepidotus*. It does however not belong in that genus, as the following notes will show.

Spores 6.8–7.2–(8)×4.8–5.2–(5.5)μ, warty-rough, melleous, without plage (i.e. a smooth disc in the inner suprahilar zone, such as observed in

Galerina); basidia 21–24×5.3–7μ, 4-spored, entirely imbedded in a chestnut brown to melleous-fulvous, thick, tough, insoluble, resinaceous incrustation; cystidia (or perhaps merely basidioles, sterile because of the incrustation?), fusoid, the same size as the basidia, and likewise incrusted; cheilocystidia filamentous, very thin, often thicker beneath and ampullaceous above, 18–19×2–5.5μ (neck, if present, 2.2–2.5 μ in diameter), yellow in KOH; surfaces with KOH unchanging macroscopically; their anatomical structure impossible to determine with the material at hand; hyphae with clamp connections.

This is not a truly pleurotoid agaric, rather it exhibits a *Naucoria*-habit. The incrustation of the hymenial elements is unique, but it also makes observation of anatomical details rather difficult. Since only the type is known (its Curtis Herbarium part consisting of but one specimen and this is pressed flat and perhaps atypical). It does not seem advisable to erect a genus for this plant unless new collections in the West Indies add more data to the above description. The latter does not suggest any of the known genera in the brown spored agarics (Cortinariaceae, Strophariaceae).

The Genus Phellorina

W. H. Long

(*Albuquerque, N. M.*)

This genus is closely related to *Dictyocephalos* Underwood and *Chlamydopus* Spegazzini, having numerous characters in common. It is widely but sparingly distributed over the world, varying in size of individual specimens and in size and characters of the experidia, but apparently all one polymorphic species. Usually only a few plants are found in widely scattered localities in any given area.

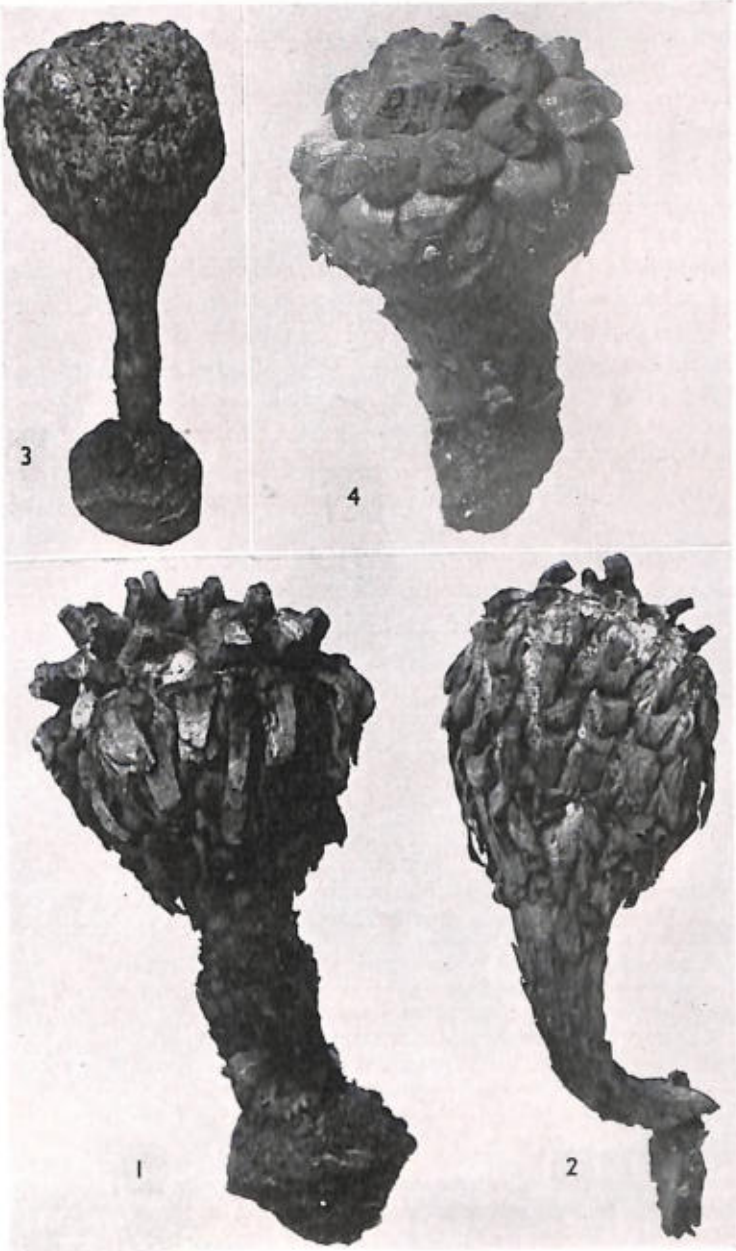
PHELLORINA Berkeley, London Jour. Bot., **2**: 521. 1843.

1845 *Xylopodium* Montagne, Ann. Sci. Nat. (3rd. ser.) **4**: 364.
1883 *Areolaria* Kalchbrenner, Ertek. Term. 11 no. **8**: 8.
1906 *Cypellomyces* Spegazzini, An. Mus. Nac. Buenos Aires **16** (ser. 3, 9): 25.

Sporophore epigeous, *Peridium* of 2 layers- an exoperidium and an endoperidium. *Exoperidium* verrucose, continuous with the stem cortex. *Endoperidium* coriaceous, continuous with the stem apex, becoming urceolate on maturity. *Stipe* dilated at apex into the endoperidium, long, stout, becoming woody. *Gleba* powdery, having capillitium, spores and persistent, fasciculate basidia. *Columella* none. *Spores* colored, globose, verrucose. *Basidia* bearing apically 1–4 spores on short sterigmata.
Type locality: South Africa.
Distribution: North America; South America; Africa; Asia; Europe; Australia.

PHELLORINA INQUINANS Berk. London Journal Bot. **2**: 521, 1843.

1845 *Xylopodium delestrei* Dur. & Mont. Ann. Sci. Nat. (3rd. ser.) **4**: 364.
1872 *Xylopodium australe* Berk. Jour. Linn. Soc. **13**: 171.
1875 *Scleroderma strobilina* Kalch. Grev. **4**: 74.
1880 *Phellorina strobilina* Kalch. Grev. **9**: 4.
1881 *Phellorina erythospora* Kalch. Bull. de l'Acad. Imper. des Sciences de St. Petersbourg **27**: 141–142.
1882 *Phellorina squamosa* Kalch. & MacOwan, Grev. **10**: 109.
1886 *Areolaria strobilina* Kalch. Ertek. Term. 11 no. **8**: 8.
1887 *Xylopodium ochroleucum* Cke & Mass. Grev. **15**: 95.
1890 *Phellorina californica* Peck, 43. Rept. New York State Mus.: 35–36.
1891 *Phellorina squamosa* Kalch. & MacOwan var. *mongolica* P. Henn. Engler Bot. Jahrbüch. **14**: 362.
1896 *Phellorina saharae* Pat. & Trab. Bull. Soc. Myc. de France **12**: 151.
1899 *Xylopodium bonacinai* Speg. An. Soc. Cient. Argent. **47**: 268–269.
1900 *Phellorina delestrei* (Dur. & Mont.) Ed. Fischer, E. & P. Nat. Pfl. **1**: 1xx, 334.
1902 *Lycoperdon erinaceum* Speg. An. Mus. Nac. Buenos Aires **8**: 56–57.
1903 *Phellorina leptoderma* Pat., Bull. Soc. Myc. de France **19**: 250.
1905 *Phellorina australis* (Berk.) Lloyd Myc. Writ. **1**: Lyc. Aust.: 11.
1906 *Cypellomyces argentinensis* Speg. An. Mus. Nac. Buenos Aires **16**: 25.
1909 *Phellorina argentinensis* (Speg.) R. E. Fries, Arkiv. för Bot. **8**: 25.
1912 *Phellorina erinacea* (Speg.) Speg. An. Mus. Nac. Buenos Aires **23**: 19.



FIGS. 1–4. *Phellorina inquinans*, ×1.

Type species: *Phellorina inquinans* Berkeley

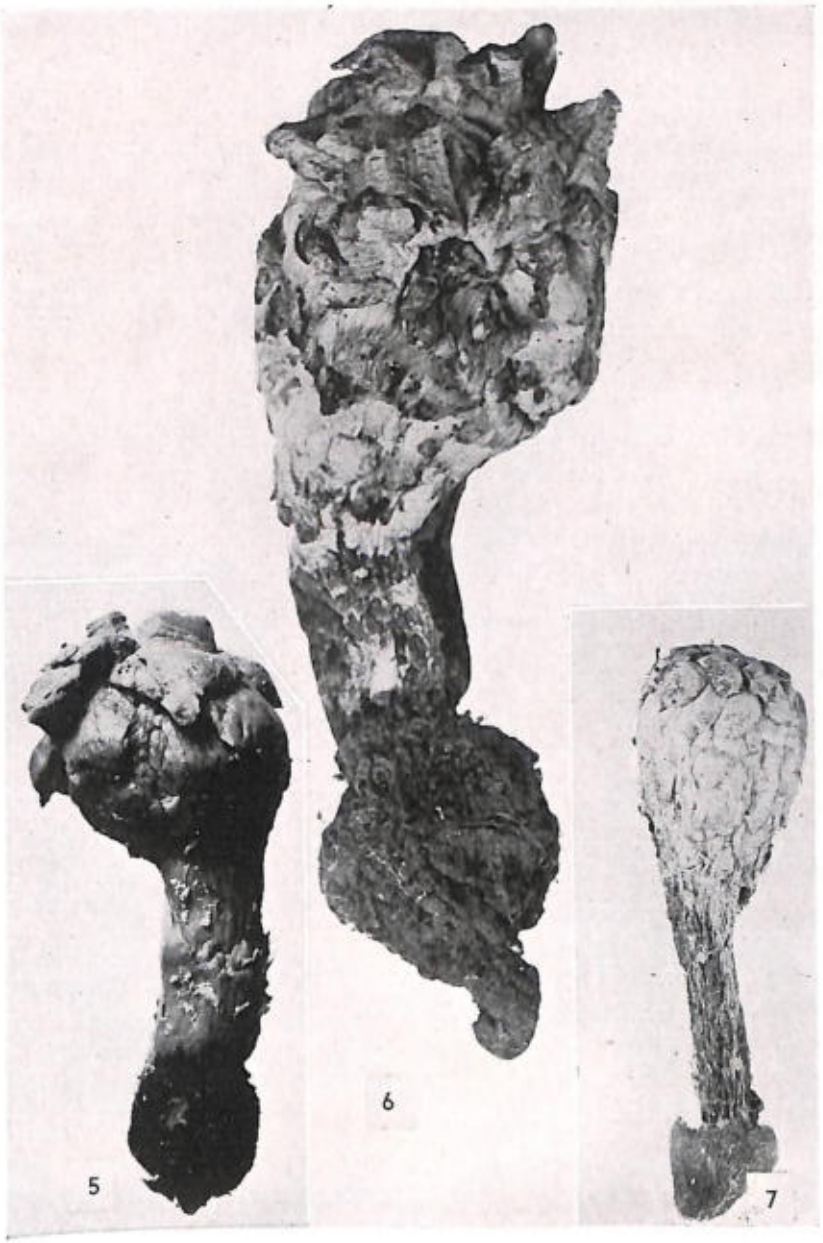
Sporophore consisting of sporocarp, stipe and bulbous base. *Sporocarp* globose to pyriform, 1½–5 cm. tall by 2–5 cm. wide at top. *Exoperidium* white when fresh becoming cinnamon in age, scaly, scales imbricated or erect, top scales or warts often large, quadrangular to pyramidal, usually flat on tops, 5–12 mm. across by 4–12 mm. tall, scales smaller and more or less imbricated on lower half of sporocarp, dehiscing in irregular pieces. *Endoperidium* a cupulate or urceolate expansion of stem apex, coriaceous and permanent for ½ to ⅚ of length, remainder a thin fragile membrane which disappears on dehiscence of the exoperidium, shining, pinkish buff to light pinkish cinnamon to usually cinnamon. *Mouth* an indefinite, irregular apical opening 2–5 cm. wide, formed when the exoperidium dehisces. *Stipe* consisting of a definite 2-layered cortex, outer layer of flattened imbricated scales which are usually deciduous, inner layer of cortex not scaly, usually darker in color than the outer layer, pecan brown to walnut brown, deciduous; stem firm, woody solid, cinnamon after the shedding of cortex, terete or usually flattened, tapering to base, 2–5 cm. tall by 8–20 mm. thick at apex, by 1–4 mm. thick at base, often with fragments of cortex still persisting (fig. 9). *Bulb* firm, a hard mass of hyphae and sand, rarely with a volvoid top (figs. 7 & 9), 10–20 mm. tall by 15–20 mm. wide. *Volva* none. *Radicating base* often present, roots stout, 10–18 mm. long. *Gleba* cinnamon when mature. *Capillitium* scanty, flattened, sparsely septate, subhyaline. *Spores* globose, 5–7μ in diameter, average 6μ. *Epispore* tinted yellow, echinulate.

Habitat; solitary or in small groups, rarely twins from common base, in sand or clay soil, in open or in partial shade of desert vegetation.

Distribution: AFRICA: North Africa, in Lloyd Myc. Collections as *Phellorina inquinans:* Algeria, Moghar Fockhani Sud Oranais, ex Herb. Patouillard, *30998;* Tunisia, Bis-M'Cherga, *X. Gillot*, 1903, *30999*, March 1904, *31000*, 1906, *31001*. Tunis, region de Zaghouan, April 1903, *31002;* Ex Herb. Paris, scrap of gleba *58492;* Ex Herb. Patouillard in N. Y. Bot. Garden, slide and scrap, *58848 Union of South Africa* in Lloyd Myc. Collections; Stellenbosch, *A. Duthie, 30997;* Cape Prov. Malcomess, Knapdaar District, comm. *A. M. Bottomley*, April 13, 1924, *27629* as *Ph. inquinans, 27632* as *Ph. strobilina:* Cape Good Hope, ex type at Kew, slide *58553* as *Ph. inquinans;* Branfort, *Dr. Schankan* comm. *A. V. Duthie* (*300*), April 1921, *30313* as *Ph. strobilina;* Grahamstown, *H. Becker, 30702* as *Ph. strobilina. North Africa* in Lloyd Myc. Collections: Ex herb. Patouillard, slide *58473* as *Ph. leptoderma;* ex Herb Paris, scrap and slide, *58472* as *Ph. saharae;* Slides ex Berlin & Kew, *58554* as *Ph. squamosa*. Abyssinia, *P. Schweinfurth*. 1891, slides *58555* as *Ph. squamosa*.

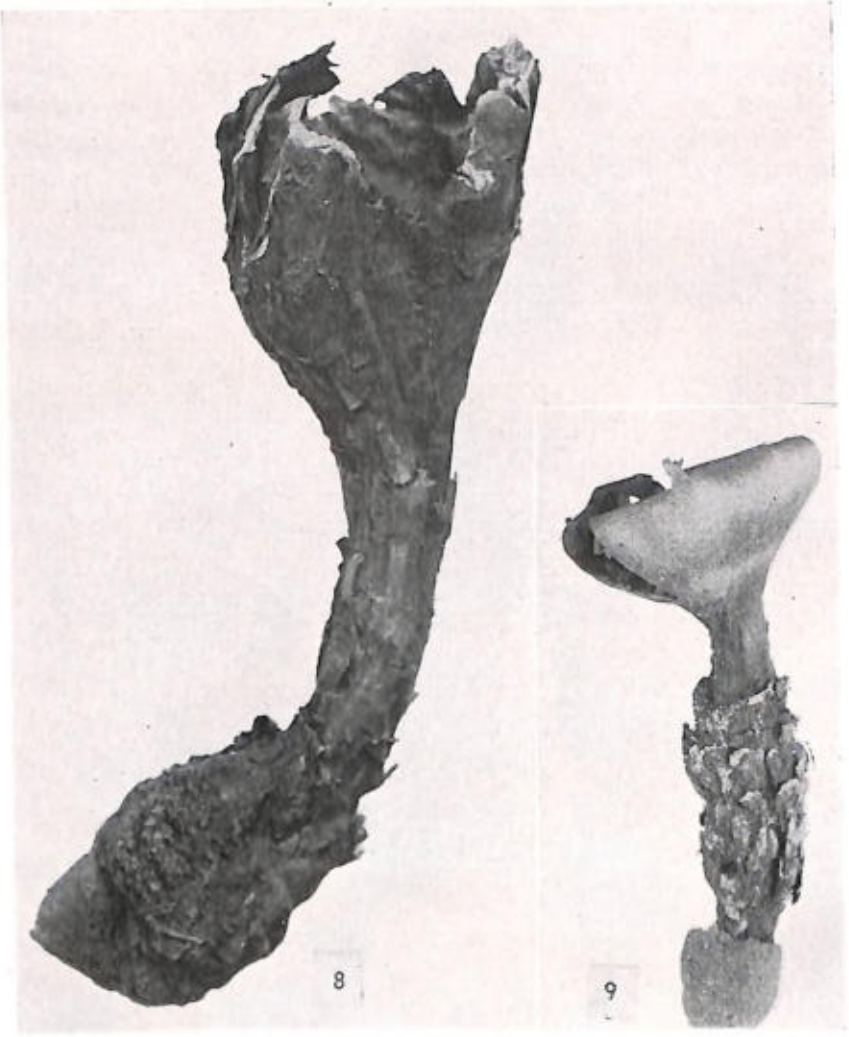
ASIA: India, Said Circle, Hyderabad Forest Division, *S. N. Ratnagar*, Lloyd Myc. Col. *31007* as *Ph. inquinans:* Rohtak District, Rohtak, *S. Ahmad*, December 28, 1942, no *681* (Ahmad), no. 11176 Herb. Long, (1 plant) as *Phellorina* sp.; July 10, 1945, no. *1297* (Ahmad), *11094* Herb. Long (2 plants) as *Ph. strobilina*.

NORTH AMERICA: *Arizona*, Peach Springs, *N. C. Wilson*, in N. Y. Bot. Garden 1 plant as *Tylostoma* sp. *California*, Crutts, 22 miles north of Barstow, May 13, 1922, *I. M. Johnston, 30314*, Lloyd Myc. Coll. as *Ph. inquinans. Nevada*, Reno, *P. B. Kennedy*, Lloyd Myc. Coll. *5632* as *Ph. inquinans. New Mexico*, Dona Ana County, Jornado Experimental Range about 28 miles east of Las Cruces on Highway 70, elevation 4150, *R. S. Campbell & L. Ellison*, no. *694*, August 27, 1829 1 plant as *Ph. strobilina; K. A. Valentine*, summer 1941, *10109* (2 plants); June-July, 1942, *10264*



FIGS. 5–7. *Phellorina inquinans*, ×1.

(4 plants); *W. H. Long*, November 12, 1938, *8348* (10 plants), October 2, 1939, *8404* (1 plant), October 3, 1939, *8421* (2 plants); *W. H. Long & David J. Stouffer*, September 7, 1941, *9586* (1 plant). Mesilla Park, in Herb. A&M College, comm. *H. L. Barnett*, May 16, 1939, *7765* (1 plant).



FIGS. 8–9. *Phellorina inquinans*, ×1.

Albuquerque, 5½ miles north on Old Town Boulevard, elevation, 4950 feet, *W. H. Long*, June 18, 1941, *9359* (1 plant) in shade of *Populus wislizeni*. *Texas*. Travis County, Austin, on Colorado River near old dam site, elevation 650 feet, *T. Moberg*, May 15, 1935, *7698* (2 plants), *7701* (10 plant); near Austin in mesquite flats, *W. H. Long*, November, 1911, *4539* (8 plants). Burleson County, on Porter farm in Brazos River bottom, elevation 367 feet, *G. E. Altstatt* (no. *93*), May 29, 1935, comm. *Dr. Walter Ezekiel*, *4539* (8 plants), *8446* (2 plants). *Utah*. Grantsville, near Salt Lake City, *Dr. H. L. Shantz*, August, 1912, *11075* (2 plants).

MEXICO: Culiacan, *T. S. Brandegee*, 1904, Lloyd Myc. Coll. *31003* as *Phellorina* sp.

AUSTRALIA: Warrecknabel, *F. M. Reader*, December 1903, Lloyd Myc. Coll. *31004* and *31005* as *Xylopodium australe;* Murray Desert, New South Wales, slide ex type at Kew, Lloyd Myc. Coll. *58686* as *Xylopodium* australe; Sydney, New South Wales, *J. B. Cleland* (*25a*), Lloyd Myc. Coll. *30996* as *Xylopodium delestrei;* East Canfield, *J. T. Paul* (*203*), Lloyd Myc. Coll. *50104* as *Ph. inquinans*, scrap and slide ex type at Kew, Lloyd Myc. Coll. *58684* as *Xylopodium ochroleucum. South Australia, J. B. Cleland* (*787*), Lloyd Myc. Coll. *30316* as *Ph. strobilina*.

Figures 1–4 show plants with 4 different types of warts on the exoperidium, large type in figure 1, medium size in figure 2 and practically no warts in figure 3, all from the same collection, same date and same locality; while figure 4 shows a plant with large pyramidal warts. Figures 5–7 again show 3 types of warts, figure 6 has large pyramidal warts similar to figure 4 while figure 5 has smaller flattened warts, both 4 and 6 came from the same area as figures 1–4, figure 7 shows the flattened, small type of warts usually attributed to *Ph. inquinans*. These 7 figures show all stages of warts from the large pyramidal ones to very small ones yet all are undoubtedly the same species; plants with the large pyramidal warts have been called *Ph. strobilina* while those with the smaller less conspicuous warts are known as *Ph. inquinans*. Figures 7 and 9 show plants with the so-called volva, which is only a mass of sand and hyphae left in volvoid shape when the exoperidium separated from the basal bulb; such plants represent a condition on which Spegazzini (1906) based his genus *Cypellomyces*.

The various so-called species of *Phellorina* are based on the size of plants, size and characters of the warts on the exoperidium, but such criteria are worthless for differentiating species in this genus since such variations may be found in the same collection as is shown in figures 1–6; the glebal characters in all the proposed species are practically the same, there may be a few minor variations in size and color of the spore.

Many desert genera, such as *Dictyocephalos*, *Podaxon* and others have marked variations in size and shape of the plants and in the character and size of the warts, still but one and only one real species is found under each genus. *Dictyocephalos attenuatus* especially is a very variable species as to size, shape and markings of the exoperidium as is shown by Long & Plunkett (1940).

A careful study of the descriptions and figures of the species listed here as synonyms does not show any characters on which a valid species could be based, all are therefore reduced to synonymy.

Phellorina macrospora Lloyd (1913) does not belong to this genus, according to Long (1942) but is an immature, depauperate specimen of *Podaxon pistillaris*, while the plant figured by Lloyd (1917) in his Myc. Writings as *Phellorina strobilina* has been shown by Long & Plunkett (1940) to be a specimen of *Dictyocephalos attenuatus*.

ACKNOWLEDGMENTS

I am under many obligations to Mr. John A. Stevenson for loan of material and for very valuable aid on the bibliography and to Dr. Fred J. Seaver for loan of material.

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The Genus Poronia in India

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The genus *Poronia* belongs to the family Xylariaceae of the Sphaeriales. It is distinguished from other members of the family by the black carbonous perithecia embedded in a white fleshy hemi-spherical or discoid stroma borne on a long or short stipe. It is closely allied to the genus *Carnostroma* which, however, differs from it in having a club shaped form like *Xylaria*.

Of the fifteen definitely known species of the genus only five have so far been reported from India. Another species, *Poronia punctata* noted by Lloyd (1920) as reported from India has not been included by Butler and Bisby, probably through oversight. In addition to the already known species the writer has recently collected one new species and another (*Poronia leporina*) of rare occurrence from the Punjab which brings the total number of species in this country to eight.

In the following key two of the species, viz. *P. punctata* and *P. gigantea*, are omitted as the record of the occurrence of the former requires verification, while the latter is imperfectly known.

KEY TO THE SPECIES

Group 1. *Growing on dung*

Plants small, growing on rabbit dung ..... 1. *P. leporina*
Plants large, growing on horse dung ..... 2. *P. oedipus*

Group 2. *Growing in sand*

Single species ..... 3. *P. arenaria*

Group 3. *Growing on dead or burnt stems*

Plants small, hemispherical, of bright yellow colour ..... 5. *P. kurziana*
Plants large, discoid.
Whitish in colour ..... 6. *P. polyporoides*
"Ageratum violet" in colour ..... 7. *P. indica*

1. PORONIA LEPORINA Ellis & Everhart, Proc. Phill., p. 229, 1890.

Stipitate, avellaneous to wood brown in colour; stipe up to 3 mm long, 0.5 mm thick, concolourous or olive brown, expanding above into a discoid stroma up to 2.8 mm in diameter and mamillose from the very prominent perithecia with black projecting ostioles; context light brown; perithecia ovate-globose, 315×385μ, 3–30 in a head; asci cylindrical, 8-spored, 10.5×100μ, with paraphyses; spores black, uniseriate, elliptical, 7.5–9 ×8.5–16.6μ, with a hyaline coat.

Jaggatpur, Gurdaspur Distt., August 12, 1938 (no. 335); Rohtak, Dec. 25, 1942 (no. 664), Jan. 14, 1944 (no. 846), Sep. 26, 1945 (no. 1476). On rabbit dung.

Distribution.—Europe; N. America; Ceylon; India.

This is a unique little species growing on rabbit dung. It is stated to be very rare. It is, however, very common in the Punjab plains but due to its very small size it easily escapes notice. *P. minuta* Petch is exactly the same plant and does not differ from the present species in any essential respect.

2. PORONIA OEDIPUS Montagne, Syll. Plant Crypt. p. 209.

Stipitate, large, stroma light brown but the stipe almost black; stipe simple or branched up to 4.5 cm. high and 0.5 cm. thick at the clavate swollen base, tapering upwards and expanding into a discoid stroma up to 0.5 cm. in diameter, at first concave and then plane or slightly convex, pierced by the black prominent ostioles, context white; perithecia ovate, sunk in the stroma; asci cylindrical, 8-spored, with paraphyses; spores uniseriate, elliptical, 26.5–29.5×15.5μ, almost black.

Jaggatpur, Gurdaspur Distt., Sept. 15, 1941 (no. 464). On horse dung. Pusa (E. J. Butler); Botanic Garden, Saharanpur (W. Gollan). On horse dung.

Distribution.—Cosmopolitan.

This species is easily distinguished from the closely allied species *Poronia punctata* in having a long clavate swollen stipe.

3. PORONIA PUNCTATA (L.) Fries.

As already pointed out Lloyd notes that this species has been reported from India. It is a fairly common species in Europe and America but its occurrence in India needs verification.

4. PORONIA ARENARIA Syd. et Butler, Ann. Myc. Berl. 9: 420, 1911.

Stipitate, stipe up to 6 cm. long, 2–7 mm. in diameter, clothed with "mars brown" mycelium enclosing large particles of sand, tapering downwards, enlarged above into a discoid stroma which is elliptic to spherical and 0.5–1.5 cm. in diameter, "mouse gray" in colour, context white; perithecia globose; asci cylindrical, 8-spored, 112×12μ with numerous paraphyses; spores uniseriate, elliptical, 7–8×14–16μ, black.

Chatrapur, Madras Presidency; August 29, 1904. On sandy dunes near *Casuarina equisetifolia*, leg. E. J. Butler, co-types in Herb. Crypt. Ind. Orientalis, New Delhi, 3 specimens in Herb. Ahmad (no. 503).

Distribution.—India. Known only from the type collection.

According to Sydow and Butler (loc. cit.) this species is closely related to *Poronia Doumetii* Pat. from Tunis, but differs in form, colour and spores. The writer has examined the co-types of *Poronia arenaria* and finds that they closely agree in form with *P. Doumetii* as shown in the photograph of the type made by C. G. Lloyd. The spores measuring 7–8 ×14–16μ also perfectly agree with those of the latter which measure

9×15μ. Although the close resemblance in the habitat, form and spores strongly suggests that the two plants are one and the same species yet it has been thought advisable to keep them separate until some authentic material of *P. Doumetii* is available for comparison.

5. PORONIA KURZIANA (Curr.) Lloyd, Myc. Writ. **6**: 939, 1920.

Xylaria Kurziana Curr. Trans. Linn. Soc. II. **1**: 129, 1876.
Kretschmaria Kurziana (Curr.) Sacc. Syll. Fung. **2** (Addenda ad vol. 1): 26, 1883.
Kretschmaria truncata Pat. Bull. Soc. Myc. Fr. p. 109, 1888.
Poronia fornicata A. Moeller.

Sessile or sub-sessile, of bright yellow colour when fresh but turning to "light ochraceous buff" in drying, solitary or caespitose, sometimes contiguous, 3.2–7.4 mm. in diameter, forming a convex hemispherical stroma which appears mamillose under a hand lens from the slightly prominent perithecia; context white; perithecia globose, 400–450μ; asci cylindric 8.5–10×110–120.5μ with numerous filiform paraphyses; spores uniseriate, elliptical 6–7.5×12.5–16.5μ, black.

Jaggatpur, Gurdaspur, August 15, 1941 (no. 415); and September 20, 1941 (no. 441); Ladhar, Sheikhupura, August 25, 1942 (no. 679); Sargodha, September 12, 1943 (no. 842). On dead and burnt culms of *Saccharum munja* Roxb. Leg. S. Ahmad.

Botanic Garden, Calcutta; on brick laid paths where fire had been burnt. Rainy season. Leg. S. Kurz.

Distribution.—Brazil; Venezuela; Uganda; India.

The original description of the fungus suggests that it was probably found growing on the ground, but in view of the literature on the point it does not seem to be correct. It appears that the brick laid paths were covered with some grass which was burnt by fire and that the plants were actually growing from the burnt roots and rhizomes of grass, the usual habitat. It is a very common species frequenting the same habitat as the next, but easily distinguished from all the other species of the genus in having a golden yellow hemispherical head. The plants which are generally caespitose are sometimes actually contiguous in the manner of a *Kretschmaria*. It is cited as *Kretschmaria Kurziana* (Curr.) Sacc. by Butler and Bisby (1931).

6. PORONIA POLYPOROIDES P. Henn., Hedwigia **40**: 340, 1901.

Stipitate, white when fresh, "tilleul buff" on drying; stipe 1–1.25 cm. long, 1.5 mm. thick, expanding above into a flat or convex disc, 3.19–9.2 mm. in diameter with an irregular margin, pierced by numerous prominent black shining ostioles; context white; perithecia globose or subglobose, 340μ in diameter; asci cylindrical, 8-spored, 6.6×92.5μ, with numerous paraphyses; spores uniseriate, elliptical, 4–5×8.5–10.5μ, black.

Jaggatpur, Gurdaspur, August 15, 1939 (no. 371); September 20, 1941 (no. 420). On burnt culms of *Saccharum munja* Roxb. Leg. S. Ahmad.

Botanic Garden Saharanpur, August 25, and September 20, 1901. On dead stem and on the ground. Leg. W. Gollan.

Distribution.—India.

This is the first time this fungus has been found since the type was found in India. It is a beautiful plant with white discoid, punctate stroma borne on a short or long stalk. This species I think is very close to, if not the same as, *Poronia ustorum* described by Patouillard from New Caledonia.

7. **Poronia indica**, sp. nov.

Stromatibus stipitatis; stipite ad 1 cm. longo, apice 2 mm. diam., basi attenuato, purpurascenti-caeruleo("purplish blue"), superne stroma violaceum ("ageratum violet") ellipticum vel sphaericum incrassato, 4 mm. diam., hyphis zona 60–80μ lata externa unicoloribus; disco ostiolis nigris dense papillato; contextu albo; peritheciis ovalibus vel globosis, 300–350μ diam., immaturis.

Stroma stipitate, stipe up to 1 cm. long, 2 mm. in diameter at the top, attenuated below, "purplish blue" in colour, enlarged above into an elliptical or spherical stroma, 4 mm. in diameter, "ageratum violet" in colour, the colouring matter uniformly distributed in the hyphae forming a distinct zone 60–80μ thick on the exterior; the disc bears on the surface numerous black papillate ostioles; context white; perithecia oval or globose, 300–350μ in diameter, immature.

Ladhar, Sheikhupura, August 6, 1944 (no. 1477); on a fallen piece of dead wood buried in sand; September 20, 1945 (no. 1490), on dead roots of grass (*Eleusine flagellifera* Nees); Gakkhar, Gujranwala, July 20, 1945 (no. 1480), on dead roots of grass (*Cenchrus biflorus* Roxb.).

This species is very close to *Poronia arenaria* Syd. et Butl. but differs in its smaller size, distinctive colour, and the papillate ostioles from this and all other known species. The habitat of this plant as growing on dead pieces of wood buried in sand and the dead roots of grasses suggests that probably *Poronia arenaria* and *Poronia Doumetii* grow in a similar way but with age the substratum gradually decays and is ultimately lost.

IMPERFECTLY KNOWN SPECIES

The following species of Poronia described from India is based on immature material which is not available for study anywhere in this country. In the Herb. Crypt. Ind. Orientalis, New Delhi, there is a note in the box containing the specimens of this species "sent to Sydow for determination but never returned."

It has been thought best to include the original description of this

species in order that our present knowledge of the species of this genus in India may be readily accessible in a single paper.

8. PORONIA GIGANTEA Sacc., Ann. Mycol. Berl. **12:** 302, 1914.

"Stromatibus longissime stipitatis; stipite 18–20 cm. long. (cum sclerotio), 2.5–3 mm. diam., cylindrico leviter flexuoso. sursum sensim tenuato, glabro, sicco crebro longit. sulcato, nigricante, basi sclerotiacea nigricante nunc tuberiformi, 12–15 mm. diam. nunc elongata inaequali 4 cm. longa, 7–8 mm. cr. intus aeque ac stipite alba, coriacea; cupula discoideo-convexa circa 1 cm. lata alba, ostiolis papillatis, crebris nigris punctato-asperula infra concaviuscula, nigra, rugulosa; peritheciis ovoideis, 300–400μ altis; omnino immaturis, parietibus prima aetate fulvescentibus, matero coriaceo-molli immersis."

"Hab. in fimo putrescente Elephantis in silvis pr. Mundomuzhi in India merid. Augusto 1913 (M. S. Ramaswami no. 331). Quamquam exemplaria sint adhuc immatura. Species eximia videtur et tam a multo minori *Poronia oedipode*, quam ab aeque procera sed tomentosa, arenicola et sclerotio destituta *Poronia Ehrenbergii* P. Henn. distincta."

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New Peronosporaceae from China*

LEE LING AND M.C. TAI

During the period from 1942 to 1944, downy mildews occurred abundantly in the vicinity of Chengtu, West China, and aroused the interest of the writers in this group of fungi. Altogether 36 species belonging to the Peronosporaceae have been collected during that period. Of these, four proved to be unknown and are here described as new.

Plasmopara Plectranthi sp. nov.

Maculis brunneo-flavis, angularibus, ad 5 mm. diam.; caespitulis niveo-floccosis, hypophyllis; conidiophoris 160–325μ altis, 5.7–9.9μ crassis, ramis 1–4-furcatis, rectangulis, furcis terminalibus 5.7–11.4μ longis, rectis, apice acutiusculis; conidiis ovatis vel oblongatis, rare late ellipsoideis, hyalinis, (17)–24.55–(33)μ longis, (14)–18.80–(24)μ latis.

Spots brownish yellow, angular, up to 5 mm. diam., bounded by the leaf veins; sporangiophores hypophyllous, forming a layer of white growth on the infected area, 160–325×5.7–9.9μ, 1–4 times monopodially branched at right angles, ultimate branchlets straight, 5.7–11.4μ long, slightly acute at the tips; sporangia ovate to oblong, rarely broadly elliptical, hyaline, 17–33×14–24μ, averages 24.55×18.80μ.

On *Plectranthus amethystoides* Bentham, Chengtu, Nov. 9, 1943.

Peronospora Thyrocarpii sp. nov.

Maculis pallide viridi-flavis, irregularibus; caespitulis hypophyllis, griseo-brunneis, inconspicuis; conidiophoris 370–840μ altis, 5.7–7.6μ crassis, hyalinis vel fuscatis, 5–7-ies dichotome ramosis; conidiis subglobosis vel late ellipsoideis, fuscatis (11)–16.03–(21)μ longis, (10)–13.30–(17)μ latis.

Spots light greenish yellow, irregular, mostly on the lower leaves of the host; sporangiophores hypophyllous, forming a grayish brown growth, inconspicuous due to the heavy growth of hairs on the host leaves, 370–840×5.7–7.6μ, 5–7 times dichotomously branched, hyaline to light brown, ultimate branchlets straight or slightly curved; sporangia broadly elliptical to subglobose, light brown, 11–21×10–17μ, averages 16.03×13.30μ.

On *Thyrocarpus Sampsonii* Hance, Chengtu, March 15, 1943.

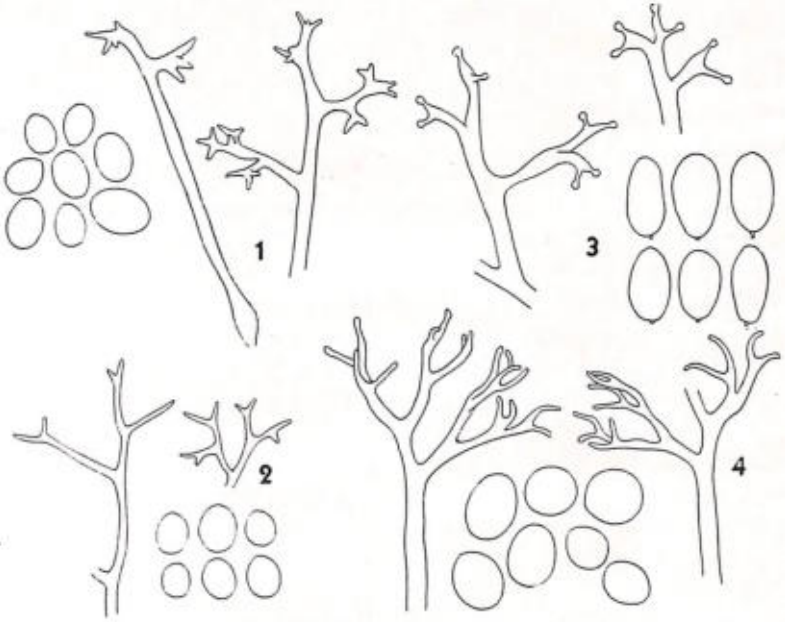
Peronospora Artemisiae-annuae sp. nov.

Maculis viridi-flavis, irregularibus, plerumque in foliorum marginibus dispositis; caespitulis sparsis, hypophyllis, griseolis; conidiophoris 345–880μ altis, 10–14μ crassis, 4–7-ies dichotome ramosis; ramulis ultimis rectis, rectangulis, terminalibus inflatis; conidiis ovoideis vel ellipsoideis, griseo-brunneis, (24)–37.03–(46)μ longis, (14)–20.19–(24)μ latis.

Spots yellowish green, irregular, mostly on the leaf margin; sporangio-

* Received for publication from the Division of Cultural Cooperation, Department of State.

phores hypophyllous, forming a thin sparse grayish growth, 345–880×10–14μ, 4–7 times dichotomously branched; ultimate branchlets straight, arising at right angles, terminating with a swollen tip; sporangia nar-



FIGS. 1–4. Conidiophores and conidia. 1. *Plasmopara Plectranthi*. 2. *Peronospora Thyrocarpii*. 3. *Peronospora Artemisiae-annuae*. 4. *Peronospora Lycii*.

rowly ovate to ellipsoidal, usually with a short pedicel, grayish brown, 24–46×14–24μ, averages 37.03×20.19μ.

On *Artemisia annua* L., Chengtu, April 21, 1943.

Peronospora Lycii sp. nov.

Maculis pallide viridi-flavis, immarginatis, plerumque in foliorum marginibus dispositis; caespitulis hypophyllis, niveis, inconspicuis; conidiophoris 240–400μ altis, 12.9–17.2μ crassis, 4–7-ies dichotome ramosis, furcis terminalibus 11.5–20μ longis, 2–2.8μ crassis, curvatis, rare rectis, divaricatis; conidiis subglobosis vel late ellipsoideis, rare globosis, fuscatis, (19)–25.6–(33)μ longis, (16)–22.34–(25.6)μ latis.

Spots light yellowish green, margin indistinct, usually along the leaf margin; sporangiophores hypophyllous, forming an inconspicuous loose white growth, 4–7 (mostly 4) times dichotomously branched, 240–400×12.9–17.2μ, ultimate branchlets curved, rarely straight, arising at acute angles, 11.5–20×2–2.8μ; sporangia light brown, subglobose to broadly elliptical, rarely globose, 19–33×16–27μ, averages 25.6×22.34μ.

On *Lycium chinense* Mill., Chengtu, Jan. 10, 1944.

Effects of Selected Properties of Soils on Growth of Sudan Grass[1]

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INTRODUCTION

A description of the chemical characteristics of a group of soils near Midland, Douglas County, Kansas, has been published by Wynd and Romig (1), and by Wynd and Noggle (2). Wynd and Noggle (3, 4, 5) have reported the effects of these characteristics on the growth of oats and rye harvested at the jointing stage. These earlier papers were detailed studies of the effects of the base exchange capacity, degree of base saturation, total replaceable bases, exchangeable calcium, magnesium, and potassium, organic matter, nitrogen, pH, calcium carbonate, and various fractions of phosphorus. The oats for these studies were grown on a group of fields during the winter and spring of 1940 and 1941. The rye was grown on a different group of soils in the same vicinity during the spring of 1941.

Comparisons of the effects of each of the several soil characteristics on the responses of both oats and rye suggested that growth was limited by the amount of total replaceable bases, while the content of nitrogen and carotene in the crop was governed by the amount of nitrogen in the soil.

The most satisfactory soils in this area for the production of oats and rye harvested at the jointing stage were characterized by relatively large amounts of replaceable bases, chemosorbed phosphorus, and nitrogen. The results of these earlier studies suggested that it might be possible to rate comparatively the values of the soils in this area for the production of immature grasses by the determination of a few major characteristics of the soil.

The purpose of the present paper is to report the relationships between a selected group of soil characteristics and the growth of Sudan grass.

MATERIALS AND METHODS

Sudan was grown on a group of 10 soils in the vicinity of Midland, Douglas County, Kansas, during the summer of 1943. None of these soils was included in any of the previous studies. The crops were harvested at, or just before, the jointing stage. The determinations of the base exchange capacity, total replaceable bases, percentage base saturation, and nitrogen were accomplished by the methods described in the previous papers (1, 2, 3).

[1] The expenses incurred by the present study were borne in part by a grant from the Cerophyll Laboratories, Inc., Kansas City, Missouri.

TABLE 1. *Field data for Sudan grass and "first bottom" soils.*

Field no.	Soil type	Previous crop	Date planted	Date harvested	Age in Days	Growth stage	Color and condition
305	Medium sandy loam, First bottom.	Alfalfa, winter killed.	Aug. 7	Aug. 26	19	Unjointed. 10–12″ height.	Dark green. Excellent condition.
306	Heavy black loam. First bottom.	Corn, winter killed.	July 21	Aug. 9	19	Unjointed. 12″ height.	Dark green. A little leaf spot.
309	Heavy clay loam, slightly sandy. ½–3″ sandy river fill. First bottom.	Rye, flooded.	July 30	Aug. 16	17	Unjointed. 12″ height.	Medium green.
311	½ black loam, second bottom. ½ medium sandy loam, second bottom.	Oats, corn. Flooded.	Aug. 18	Sept. 11	24	5–10% jointed. 14″ height.	Light green. Spotty in sandy areas.

TABLE 2. *Field data for Sudan grass and "upland" soils.*

Field no.	Soil type	Previous crop	Date planted	Date harvested	Age in Days	Growth stage	Color and condition
300	Medium loam. Second bottom. Not subject to flood.	Peas	June 24	July 23	29	20% jointed. 12″ ave. height.	Light to medium green.
301	Sandy loam. Upland soil.	Brome, winter killed.	June 3	June 27	24	Unjointed. 12″ ave. height.	Dark green, perfect condition.
302	Heavy black loam. Second bottom.	Peas	June 29	July 21	22	22% jointed. 14″ ave. height.	Dark green, perfect condition.
303	Heavy black loam. Second bottom.	Peas	June 21	July 21	30	41% jointed. 20″ ave. height.	Medium green. Small amt. of leaf spot.
304	Sandy loam. Upland, with clay sections.	Oats	July 2	July 24	22	1% jointed. 10″ ave. height.	Yellowish green. Spotty in color and rank.
307	Gumbo. Second bottom.	Soybeans. Winter killed.	July 8	Aug. 4	27	Unjointed. 14″ height.	Dark-medium green. A little leaf spot.
308	Fine sandy loam, with river silt.	Corn and melons. Winter killed.	Aug. 5	Aug. 25	20	Unjointed. 10″ height.	Very light green.

The field data are presented in tables 1 and 2, and the chemical data in tables 3 and 4. The number of each point in the figures is the last digit of the corresponding field number presented in the tables.

If for the data for both the "first bottom" and "upland" soils are pooled, very irregular distributions of points are obtained. The data for these

TABLE 3. *Growth of Sudan grass, and properties of "first bottom" soils.*

Field no.	Nitrogen %	Base exchange capacity m.e. per 100 grams	Replaceable bases m.e. per 100 grams	Base saturation %	Yield lbs. per acre
305	0.131	25.0	29.3	117	623
306	0.142	25.8	31.9	124	714
309	0.126	23.0	28.3	123	537
311	0.122	22.8	20.1	8	377

TABLE 4. *Growth of Sudan grass, and properties of "upland" soils.*

Field no.	Nitrogen %	Base Exchange capacity m.e. per 100 grams	Replaceable bases m.e. per 100 grams	Base saturation %	Yield lbs. per acre
300	0.127	18.4	14.4	78	680
301	0.228	22.6	19.0	84	737
302	0.140	18.3	12.5	68	838
303	0.141	18.8	13.6	72	1009
304	0.127	14.4	10.5	73	493
307	0.165	22.9	17.9	78	958
308	0.083	13.2	13.8	105	466

groups of soils are, therefore, presented separately in the graphs. The soils of this area have not yet been classified into definite series, and the types included in the present study are grouped together loosely as "first bottom" and "upland" soils. First bottom soils are subject to periodic flooding by overflow from the Kansas River and Mud Creek, while the upland soils rarely, if ever, are inundated by river overflow. Topographically, field number 311 is an upland soil, yet its chemical characteristics relate it to the first bottom group. The data obtained from this field are very irregular, and their erratic locations in the figures should not prejudice the reader.

EXPERIMENTAL RESULTS

Replaceable bases: The data in table 1 and figure 1 show that a close relationship exists between the growth of Sudan grass and the amount of replaceable bases in the first bottom soils.

The data for the relationship between the amounts of replaceable bases in the upland soils and the growth of Sudan grass are not as consistent as those obtained from the first bottom soils. However, figure 2 shows that a recognizable positive relationship does exist. An inspection of the data in

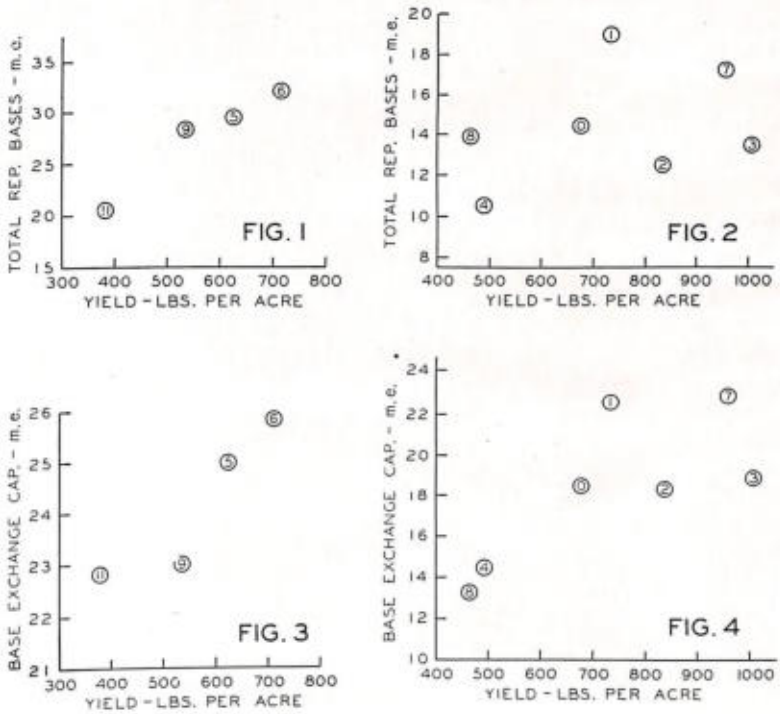


FIG. 1. Relationship between the growth of Sudan grass and the amount of replaceable bases in the first bottom soils.

FIG. 2. Relationship between the growth of Sudan grass and the amount of replaceable bases in the upland soils.

FIG. 3. Relationship between the growth of Sudan grass and the base exchange capacity of first bottom soils.

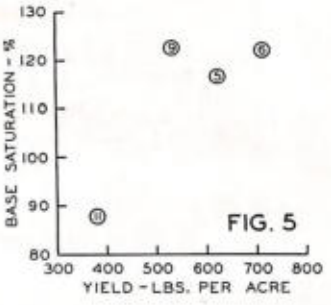
FIG. 4. Relationship between the growth of Sudan grass and the base exchange capacity of the upland soils.

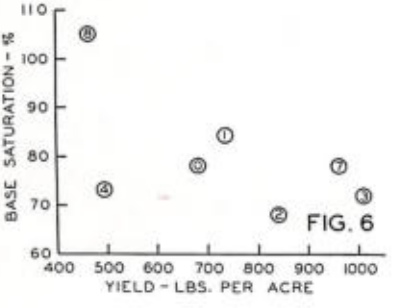
table 2 shows that the grass from fields 302 and 303 was well past the jointing stage at the time of harvest. The yields for these fields are, therefore, too large in comparison to other yields from this group of fields. These erroneous data are largely responsible for the irregular distribution of the points in figure 2.

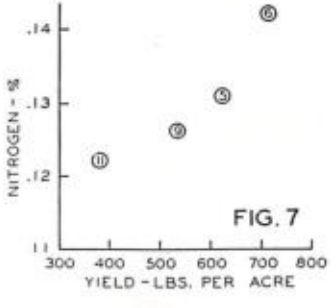
Base exchange capacity: Data in table 3 and figure 3 show a rather marked relationship between the base exchange capacity of the first bottom soils and the growth of Sudan grass. However, it should be noted that the

yield for field 309 falls in a somewhat erratic position with respect to the remaining points in the figure. Figure 1 showed that this yield fell regularly into line with the other yields when they are graphed with respect to the amounts of replaceable bases.

Data in table 4 and figure 4 show that the base exchange capacities of







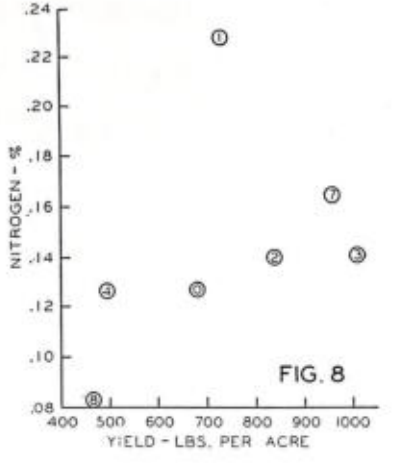


FIG. 5. Relationship between the growth of Sudan grass and the degree of base saturation of first bottom soils.

FIG. 6. Relationship between the growth of Sudan grass and the degree of base saturation of upland soils.

FIG. 7. Relationship between the growth of Sudan grass and the amount of nitrogen in first bottom soils.

FIG. 8. Relationship between the growth of Sudan grass and the amount of nitrogen in upland soils.

the upland soils are also positively related to the growth of Sudan grass. It should be recalled that the crops from fields 302 and 303 were harvested well after jointing was in progress, and therefore, the yields for these fields were too large in comparison with those from the remaining fields in this group.

Degree of base saturation: The data in tables 3 and 4 and figures 5 and 6 show that the degree of base saturation exerts no discernible effect on the growth of Sudan grass.

Nitrogen: The data in table 3 and figure 7 show a very definite correlation between the growth of Sudan grass on first bottom soils and the amount of nitrogen in the soil. The discussion below will show that this situation does not necessarily indicate an intrinsic relationship between growth and nitrogen.

The data in table 4 and figure 8 are particularly instructive. In general, there is a positive correlation between the growth of Sudan grass on the upland soils and the amount of nitrogen in the soil. Again, it should be recalled that the yields from fields 302 and 303 are too large. The yield from field 301, however, is very erratic with respect to the yields from the remaining fields of this group. Yet, figure 2 shows that yield is not erratic when the yields are plotted with respect to the amounts of replaceable bases. This fact suggests that the effect of the amount of replaceable bases is dominant over the effect of nitrogen in determining the growth of Sudan grass in the area studied. This statement is in agreement with the conclusions of Wynd and Noggle concerning the relative importance of replaceable bases and nitrogen on the growth of oats (3) and of rye (4). It is important to note that an entirely different group of soils was used for the study of each of these species.

SUMMARY

1. A group of 10 soils in the vicinity of Midland, Douglas County, Kansas, was studied in respect to the association which existed between the total replaceable bases, base exchange capacity, degree of base saturation, and nitrogen and the growth of Sudan grass. These soils were loosely grouped as "first bottom" and "upland" soils.

2. A very positive correlation existed between the amount of replaceable bases and growth.

3. A positive correlation also existed between the amount of nitrogen present in the soil and growth, but this was true *only* if the amounts of nitrogen paralleled the amounts of replaceable bases.

4. The amount of replaceable bases is dominant over nitrogen in its effect on the growth of Sudan grass.

5. The degree of base saturation exerts no discernible influence on the growth of Sudan grass.

6. These results are in complete agreement with the authors' previous findings based on the study of oats and rye.

7. Different groups of soils in this area (i.e., "first bottom" and "upland") affect the growth of Sudan grass differently and the data may not be pooled, therefore, in the determination of correlations between soil characteristics and the growth of this species.

8. Although the results described are true for oats, rye, and Sudan grass grown in the vicinity of Midland, it is not known how generally applicable they would be for soils in other areas.

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Vol. 9 SEPTEMBER · 1946 No. 3

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

The Physiology of Polyploidy in Plants
I. Review of the Literature

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Our increasing knowledge of the food values of crops requires an examination of the factors influencing those biochemical activities of plants which are related to the composition of the plant tissues. The effect of increasing the normal number of chromosomes on plant size and on yields of agricultural crops is well known, but the published data have been primarily morphological in nature. It is a matter of considerable interest, therefore, to know how an increase of the number of chromosomes affects the mineral composition, vitamin content, and other nutritive components of plants. With the advent of the colchicine technique and other techniques of increasing the chromosome number, material for biochemical study has become readily accessible.

Various aspects of the physiology of polyploid plants have been reviewed elsewhere. Thus Müntzing (1936) reviewed much of the early work on physiological aspects of polyploidy and discussed the data in relation to evolutionary trends. He distinguished between autopolyploidy, the reduplication of the same genome, and allopolyploidy, the summation of different genomes, and concluded that allopolyploidy had played an important part in the evolution of plant species, especially among Angiosperms. In discussing the physiological consequences of autopolyploidy he emphasized the retarding effect which this condition exerted on the growth of the plant.

While reviewing the literature pertaining to the colchicine technique Dermen (1940) mentioned a number of papers dealing with the physiological differences induced by polyploidy. Pirschle (1941) discussed many earlier contributions in relation to his own studies on polyploidy in *Petunia*, and concluded that most of the observed differences between diploids and polyploids could be ascribed to the difference in the rate of growth of the polyploids.

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Finally Randolph (1941), in a paper describing the value of induced polyploidy as a method of breeding crop plants, reviewed a number of papers describing the physiological differences caused by polyploidy. After discussing the differences which were known to exist, such as a decreased rate of growth, increased water content, and a larger cell size, he emphasized the lack of agreement among authors concerning the nature of the physiological differences due to polyploidy and stated the need for further studies along this line.

A. GROWTH

1. SIZE OF THE PLANT

One of the common effects of polyploidy is usually an increase in size of the plant parts. Many of the morphological studies on polyploidy have shown a slower rate of growth and development of the polyploid individuals. Pirschle (1941), Schlösser (1940), Shao-Lin Chen and P. S. Tang (1945), and others showed that polyploids grew more slowly than diploids and therefore were about two days to a week behind the diploids in physiological development.

The slower rate of development of the polyploid plants has been thought to depend on a decreased rate of cell division. Wettstein (1924) noted that an altered rate of cell division in the mosses was characteristic of the *gigas* type and Dorries-Rüger (1929) reported similar observations.

The work of several investigators suggests that the slower rate of growth may be caused by the smaller amount of growth hormone present in the tissues. Gustafson (1944) studied two varieties of Marigold (*Tagetes*), Guinea Gold and Golden West, and the cherry tomato (*Lycopersicon pimpinellifolium*). The diploid and the related tetraploids were analyzed at the same stage of development which happened to occur on the same day in his experiment. The autotetraploid marigold, variety Guinea Gold, had only 58.1 per cent as much growth hormone (*Avena* test) as did the diploid; the autotetraploid marigold, variety Golden West, had only 76.3 per cent as much, and the autotetraploid of *L. pimpinellifolium* had only 56.8 per cent as much growth hormone as did the corresponding diploid plants.

Shao-Lin Chen and Tang (1945) investigated the metabolism of colchicine-induced tetraploid barley. The oxygen consumption and carbon dioxide production of germinating seeds of diploid and tetraploid barley were measured by means of Warburg microrespirometers. The tetraploid seeds of barley had a lower rate of respiration than the diploid seeds. These authors thought that the lowered rate of metabolism in the tetraploid seeds may bear a relationship to their slower rate of growth and development.

2. SIZE OF THE CELLS

A number of workers have studied the size of the individual cells of polyploid plants. The Marchals (1909), Winkler (1916), Wettstein (1924),

Sinnott, Houghlating and Blakeslee (1934), and others agree that the volume of the cell is approximately proportional to the chromosome number. However, Kostoff and Axamitnaja (1935a) made a cytogenetical analysis of diploid and autotetraploid tomatoes and of *Petunia* and concluded that the volume of the tetraploid cells usually was not exactly doubled as was the chromatin material; in other words, the chromatin/cytoplasm ratio, and consequently the genes/cell volume ratio, were not alike in the diploid and tetraploid cells. The increase in the cell size of the tetraploids did not lead to an increase of size of the tomato plants but an increase was observed in the size of the plants of tetraploid *Petunia*.

The size of the endosperm cells of tetraploid and diploid corn was studied by Randolph and Hand (1940). They found that the cell volume of the tetraploid cells was about 3.6 times as great as that of the diploid endosperm tissue. Sinnott and Franklin (1943) described a developmental analysis of tetraploid and diploid races of cucurbit fruits and found that the size of both cells and of organ primordia were about twice as great in the tetraploids at the beginning of development. This larger size was maintained until about the time of flowering. However, the diploid plants developed to such an extent between flowering and maturity that at maturity the volume of mature fruit and its constituent cells was alike in both tetraploids and diploids. Randolph, Abbe and Einset (1944), working with diploid and tetraploid maize, compared the tissue of the shoot apex at the time of the initiation of the tenth leaf. They noted no change in the number of cells nor in the cell pattern although the tetraploid cells were larger. The data of these authors may be summarized as follows:

Shoot apex of maize

	Diploid	Tetraploid	Times larger
Average cell volume $(\mu)^3$	1,342	2,636	1.96
Nuclear volume $(\mu)^3$	212	421	1.99

3. DISCUSSION

There is general agreement among botanists that polyploidy brings about a slower rate of growth. An increase in size of the plants, or of the cells, may or may not be brought about by chromosome doubling. Dermen (1940) considered that the duplication of chromosomes may result in at least three types of tetraploids: "(1) There may occur an appreciable increase in size of each vegetative cell in the tetraploid individual while the total number of cells making up the plant remains relatively the same as in the diploid form; consequently the tetraploid plant appears larger than the diploid individual. Most of the changes following polyploidy appear to fall into this category. (2) An increase in cell volume may follow a doubling of chromosomes but there may be a decrease in the total number of cells making up the tetraploid plant; therefore the tetraploid individual

will not appear different from the diploid. (3) The doubling of chromosomes may not have any effect on the size of the cells. The polyploid individual remains indistinguishable, except probably in sexual and in some obscure physiological behavior." It is apparent that any observable increase in the size of the plant results from an increase in the size of the individual cells which comprise the tissues.

Some of the physiological effects attributed to polyploidy may be related to the changes in the ratio of cell volume to cell surface. Dermen (1940) stated: "It is probable that changes of relationship would occur between total chromosome volume and total chromosome surface, nuclear volume and nuclear surface, and between these and cytoplasmic volume and cell surface. It may therefore be assumed that measurable differences between a diploid and, especially, an autoploid vegetative sib are expressions of a physiological nature resulting from physical changes of relationship referred to above, rather than of a genetic nature resulting from numerical duplication of genetic factors, e.g., genes." Regarding genetic factors, Dermen wrote, "However, a change in the balance of genes—their activity and genetic expressions—would perhaps result from some physiological consequences of polyploidy which may be in the nature of changes in oxidation and respiration rate, viscosity movement of protoplasm, including cytoplasm and nucleus; in the rate of intake of various substances and output of various metabolic by-products; in enzymatic activities; and a number of other physiological phenomena."

B. Water Relationships

1. water content

A number of investigators have reported data concerning the moisture content of diploid and polyploid plants. It may be assumed that if there is an increase in the moisture content, the osmotic concentration will decrease. Kostoff and Axamitnaja (1935a) calculated that the moisture content of diploid tomatoes was 90.37 per cent while that of tetraploid tomatoes was 91.26 per cent. Fabergé (1936) noticed a higher moisture content in the tetraploid, as compared with diploid, tomatoes. Noguti, Oka and Ôtuka (1940) investigated diploid and tetraploid *Nicotiana rustica* and *N. Tabacum*. The tetraploids had a slightly lower moisture content than the diploids. Pirschle (1941) grew different strains (DD, dd, Dd and DDDD) of *Petunia* in gravel culture and made five cuttings at weekly intervals for chemical analysis. The plant material was separated into leaves and stems. During the early growth, the moisture contents of the diploid and tetraploid leaves and stems were about equal, but as the plants matured, the tetraploid tissue showed the greater percentage of moisture. Schlösser (1937), working with the polyploid tomatoes, *Lycopersicon cerasiforme* and *L. racemigerum*, found a higher moisture content in the

tetraploid forms. Shao-Lin Chen and Tang (1945) found that tetraploid barley seeds contained 5.3 per cent moisture while the diploid seeds contained 5.7 per cent moisture.

2. OSMOTIC CONCENTRATION

It was stated above that one of the consequences of polyploidy frequently is an increase in cell size and an increase in the moisture content, with a consequent decrease in the osmotic pressure. Becker (1931) reported that his studies of the relationship between the chromosome number and osmotic pressure in moss species showed that the osmotic pressure was inversely proportional to the chromosome number. With *Physcomitrium piriforme*, he found that the osmotic pressure decreased from 12.15 ± 0.158 atmospheres for the univalent series to 9.759 ± 0.116 atmospheres for the tetravalent series. Schlösser (1936), in a study on the relation between frost hardiness and polyploidy, determined the osmotic value of the expressed juice of winter rape. The osmotic concentration was equivalent to 0.71 mol. of sugar in the 2N plants, and only 0.48 in the 4N plants. Schlösser (1937) later reported that the osmotic concentration of 2N wild tomatoes was equivalent to 0.63—0.60 mol. but only 0.46—0.47 mol. for 4N plants.

Hesse (1938), in an investigation with *Petunia*, noted that the water content of tetraploids was somewhat higher, and that the osmotic concentration was a little lower in the tetraploids. Gries (1940) measured the osmotic concentrations of diploid and tetraploid barley and found that the leaf cells of the 2N plants showed an osmotic concentration equivalent to 0.516 ± 0.006 mol. of sugar, while the concentration in 4N plants was 0.346 ± 0.01. A barley chimera with diploid and tetraploid stalks was also investigated, the 2N tissue exhibited an osmotic concentration of 0.517 ± 0.01 mol., while that of 4N tissue was 0.344 ± 0.004 mol. Pirschle (1941) mentions some unpublished work by Györffy, who investigated the osmotic concentration of *Petunia*, *Solanum*, *Capsicum*, and other polyploid plants. Györffy found only small differences, and in some cases even higher osmotic concentrations in the polyploid tissue at various stages of development. Taylor (1942) found the osmotic concentration to be considerably reduced in tetraploid *Vinca*, but found small differences between diploid and tetraploid *Petunia*. Freisleben (1942) produced tetraploid barley by heat shock at the time of the first division of the zygote, and studied the water relationships of the plants. He found the osmotic concentration of the cell sap of the tetraploid plants to be lower than that of the diploids. Oka (1942) induced tetraploidy in five varieties of tomatoes by the decapitation-callus method. The cell sap concentration decreased 0.06—0.14 mol. in the root hairs and 0.2 mol. in the leaves of the tetraploids. Shao-Lin Chen and Tang (1945) found that the osmotic value of the cell

sap of diploid barley was equivalent to 0.9 M of sucrose solution while the cell sap of tetraploid barley was equivalent to 1.1 M of sucrose solution. They also investigated the suction pressure of the leaves of diploid and tetraploid barley. The diploid leaves had a suction pressure equivalent to 0.75 M of sucrose solution while the tetraploid leaves had a suction pressure equivalent to 0.875 M of sucrose solution.

3. TRANSPIRATION, IMBIBITION

Shao-Lin Chen and Tang (1945) measured the rates of transpiration of 55-day old diploid and tetraploid barley by means of potometers. The diploid seedlings transpired 78.3 ml. of water per gram of dry weight while the tetraploid seedlings transpired 38.8 ml. of water per gram of dry weight. The same workers studied the imbibition of water by seeds of diploid and tetraploid barley and noted that the tetraploid seeds had a higher imbibition capacity.

4. DISCUSSION

The majority of the experimental evidence indicates that polyploid plants have a higher water content than diploids. Most of the samples have been obtained at only one stage in the development of the plant, but it is well known that the moisture content of tissue changes with the age of the plant. Before any general statement could be made regarding the moisture content, studies should be made on plants at various stages of growth.

The question of cell size is intimately related to the problem of osmotic pressure, moisture content, and the chemical composition of polyploid plants. With an increase in cell size, there is an increase in the amount of cell sap, and there may or may not be a decrease in the concentration of its soluble constituents. Also, a decrease may occur in the percentage of structural constituents such as cellulose and crude fiber.

Most investigators are in agreement that the osmotic concentration of polyploid forms is lower than in diploids. This condition probably is due to the fact that the polyploid forms have the higher moisture content, and the osmotic concentration is consequently reduced.

The published data on water content and the osmotic concentration are summarized in the following table (Table 1).

C. COMPOSITION

1. ORGANIC COMPONENTS

a. Nitrogen fractions

1. Total nitrogen.—Heilbronn (1933) found that the diploid fronds of *Polypodium aureum* contained 0.578 per cent nitrogen and the tetraploid fronds 0.568 per cent, calculated on the fresh weight basis. Kostoff and

Axamitnaja (1935) in a study of F_1 hybrids of *Nicotiana* and their amphidiploids, found that the F_1 hybrid of *N. rustica* × *N. paniculata* contained 6.01 per cent total nitrogen while the amphidiploid contained only 2.74 per cent. The F_1 hybrid *N. glauca* × *N. Langsdorffii* contained 5.16 per cent total nitrogen, while the amphidiploid contained 5.31 per cent. Kostoff and Axamitnaja (1935a) determined that *S. Lycopersicum* tetraploids contained a higher percentage of total nitrogen than the diploids, while the

TABLE 1. *Summary of the data concerning the water content and the osmotic concentration of diploid and tetraploid plants.*

	Osmotic concentration		*Water content*	
	Diploid	Tetraploid	Diploid	Tetraploid
Physcomitrium piriforme	higher	—	—	—
Winter rape	higher	—	—	—
Wild tomato	higher	—	—	—
Petunia	higher	—	—	higher
Barley	higher	—	—	—
Petunia	little difference	—	—	—
Solanum	little difference	—	—	—
Capsicum	little difference	—	—	—
Vinca	higher	—	—	—
Petunia	no difference	—	—	—
Barley	higher	—	—	—
Tomato	higher	—	—	—
Tomato	—	—	—	higher
Tomato	—	—	—	higher
Nicotiana	—	—	higher	—
Petunia	—	—	—	higher
Tomato	—	—	—	higher
Barley seeds	—	—	higher	—
Barley	—	higher	—	—

Petunia diploids and tetraploids contained about the same percentage of nitrogen.

Sullivan and Myers (1939), by an experimental treatment of the seeds of *Lolium perenne* L., obtained plants which were chimeras of diploid and tetraploid tissue. These were vegetatively propagated and a number of diploid and tetraploid clones were established. The arithmetical mean of the percentage of total nitrogen in ten such diploid and tetraploid clones was 4.762 for the diploids and 4.647 for the tetraploids, calculated on the dry weight basis. Noguti, Oka and Ôtuka (1940) found a higher percentage of total nitrogen in all tetraploid samples of *Nicotiana Tabacum* var. Yellow Orinoco. In his study of polyploid barley, Gries (1940) noted that the

diploid plants contained 2.10 per cent nitrogen and the tetraploid 1.12 per cent, calculated on a dry weight basis. Schlösser (1940) found the nitrogen content of diploid and tetraploid tomato shoots to be approximately identical, while in the roots of the tetraploids, the nitrogen content was smaller. In a series of analyses on the leaves of polyploid sugar beets, the diploid forms were found to contain 2.24 per cent, the triploid 1.76 per cent, and the tetraploid 1.56 per cent. Pirschle (1941) did not find much difference in the percentage of nitrogen in diploid and tetraploid *Petunia;* although in most cases, the tetraploid values were slightly higher, he believed the differences to fall within the range of his experimental error.

Sullivan (1944) grew diploid and tetraploid rye grass under field conditions and analyzed the tops for the percentage of total nitrogen. He reported no difference between the diploids and the tetraploids. Sullivan also grew rye grass in gravel culture in low-nitrate and high-nitrate nutrient solutions. Different frequencies of clipping were made and the tops analyzed. There was little difference in the total nitrogen. The same investigator grew tetraploid and octoploid *Trifolium repens* under field conditions and again the percentage of total nitrogen did not differ significantly in the two strains. Shao-Lin Chen and Tang (1945) analyzed the seeds of diploid and tetraploid barley and found that the diploid seeds contained 12.7 per cent protein while the tetraploid seeds contained 14.7 per cent protein.

2. Protein and colloidal nitrogen.—Kostoff and Axamitnaja (1935), in a study of F_1 hybrids of *Nicotiana* and their amphidiploids, determined protein nitrogen. The F_1 hybrid of *N. rustica*×*N. paniculata* contained 5.61 per cent protein nitrogen and 35.00 per cent protein (protein N×6.25), while the amphidiploid contained 2.48 per cent protein nitrogen and 15.90 per cent protein. The F_1 hybrid *N. glauca*×*N. Langsdorffii* contained 5.09 per cent protein nitrogen and 31.81 per cent protein with the amphidiploid containing 4.50 per cent protein nitrogen and 28.12 per cent protein.

Protein nitrogen and protein were determined in diploid and tetraploid tomatoes and *Petunia* by Kostoff and Axamitnaja (1935a). *S. Lycopersicum* tetraploids were found to contain more protein nitrogen and protein than the diploids. The *Petunia* diploids contained more protein nitrogen and protein than the tetraploids. Sullivan and Myers (1939), by treatment of seeds of *Lolium perenne* L., obtained plants which were chimeras of diploid and tetraploid tissue. Following vegetative propagation, a number of diploid and tetraploid clones were established. The arithmetical mean of ten such diploid and tetraploid clones gave the following data: alcohol insoluble nitrogen (colloidal nitrogen) $2N = 3.516$ per cent, $4N = 3.466$ per cent. Barr and Newcomer (1943) studied colloidal nitrogen in diploid and tetraploid cabbage and found that the diploid plants contained less colloidal nitrogen than the tetraploids. Sullivan (1944) grew diploid and tetraploid rye grass under field conditions and analyzed the tops for insoluble

or colloidal nitrogen. He reported no differences between the amount of protein nitrogen in the diploid and tetraploid plants. Rye grass grown in gravel culture in a low-nitrate and a high-nitrate nutrient solution and clipped with different frequencies, were analyzed, but there was little difference in the insoluble nitrogen produced by these treatments.

3. Soluble nitrogen.—Sullivan and Myers (1939) established clones of diploid and tetraploid *Lolium perenne* L., and studied the amounts of soluble nitrogen in the two types. The arithmetical means of ten such diploid and tetraploid clones showed that the diploids contained 1.241 per cent of alcohol-soluble nitrogen and the tetraploids 1.174 per cent. Barr and Newcomer (1943) studied soluble nitrogen in diploid and tetraploid cabbage and discovered that the diploid plants contained more soluble nitrogen than the tetraploids. Sullivan, in a study of field grown rye grass, analyzed the tops and reported no difference in soluble nitrogen between the diploids and tetraploids. He also grew rye grass in gravel culture in low-nitrate and high-nitrate nutrient solutions. Different frequencies of clipping were made and the tops analyzed. There was little difference in the percentage of soluble nitrogen produced by the various treatments.

4. Discussion.—Most of the published data indicate that the diploid plants contain a higher percentage of nitrogen. None of the investigators suggested any particular reason why the tetraploid plants should contain less nitrogen. The experimental work also shows that the diploid plants contain more protein nitrogen than the polyploids. Barr and Newcomer (1943) found that diploid plants contained less protein nitrogen and more soluble nitrogen. The authors suggested that the higher soluble nitrogen content of the diploid plants might be explained by assuming that soluble nitrogen was utilized in synthesizing the 4N protoplast, thereby causing a higher colloidal or protein nitrogen percentage in the tetraploid tissue.

The data regarding the nitrogen content of diploid and polyploid plants are summarized in Table 2.

b. Carbohydrate components

1. Starch.—Heilbronn (1928) noted that the production of starch was much greater in the fronds of tetraploid *Polypodium aureum* than in the diploid fronds. Kostoff and Axamitnaja (1935a) could find little difference in the starch content of diploid and tetraploid *Petunia*. Diploid tomatoes contained more starch than tetraploid plants. Kostoff and Axamitnaja (1935) reported that the amphidiploids of F_1 hybrids of *Nicotiana* had a higher starch content. According to Barr and Newcomer (1943) tetraploid cabbage contained more starch than did the diploid plants.

2. Cellulose.—Kostoff and Axamitnaja (1935) found that F_1 hybrids of *Nicotiana* contained slightly higher amounts of cellulose than did their amphidiploids. The same authors (1935a) could find little difference in the

cellulose content of diploid and tetraploid *Petunia*. There was little difference in the cellulose content of diploid and tetraploid tomatoes.

3. *Hemicellulose.*—Similarly Kostoff and Axamitnaja (1935) found that the F_1 hybrids of *Nicotiana* contained slightly higher percentages of hemicellulose than their corresponding amphidiploids. According to these authors (1935a) there is little difference in the hemicellulose content of

TABLE 2. *Summary of the published data concerning the percentage of nitrogen in diploid and tetraploid plants; x signifies an increase; — signifies no difference.*

Species	Total Nitrogen		Protein and Colloidal Nitrogen		Soluble Nitrogen	
	Diploid	Polyploid	Diploid	Polyploid	Diploid	Polyploid
Polyplodium aureum	x					
Nicotiana	x		x			
Nicotiana		x	x			
Nicotiana		x				
Petunia			x			
Petunia	—	—				
Tomato		x	x	x		
Tomato roots	x					
Lolium perenne	x		x		x	
Lolium perenne (field)	—	—	—	—	—	
Barley	x					
Sugar Beets	x					
Cabbage				x	x	
Barley		x				

diploid and tetraploid *Petunia*, although tetraploid tomatoes contained more hemicellulose than the diploid plants.

4. *Total sugars.*—Oka (1940) noted an increase in the percentage of total sugar in tetraploid tomatoes. Noguti, Oka and Ôtuka (1940) in a study of diploid and tetraploid *Nicotiana* showed that tetraploids contained smaller percentages of total sugar. Peto and Boyes (1940) claimed that triploid sugar beets contained 14.9 per cent more sugar than did diploid beets. Armstrong (1942) found no increase in percentage of sugar in triploid and tetraploid sugar beets when compared with diploids. The results of Sullivan (1944) indicated that tetraploid clones of rye grass grown in field rows contained more total sugar than the diploid clones. A comparison of tetraploid and octoploid *Trifolium repens*, grown in the field, showed no difference in nitrogen-free extract (total carbohydrate). The seeds of diploid and tetraploid barley were analyzed by Shao-Lin Chen and Tang (1945)

for nitrogen-free compounds. The diploid seeds contained 83.5 per cent nitrogen-free compounds while the tetraploids contained 80.2 per cent nitrogen-free compounds.

5. Non-reducing sugars.—Sullivan and Myers (1939) reported that the tetraploid plants of *Lolium perenne* L. contained a higher concentration of sucrose than the diploids. The results of Sullivan (1944) indicated that tetraploid clones of rye grass grown in field rows contained more sucrose than the diploid clones.

6. Reducing sugars.—Kostoff and Axamitnaja (1935) found that the amphidiploids of F_1 hybrids of *Nicotiana* had a higher content of reducing sugar. But according to these authors (1935a) there is little difference in the reducing sugar content of diploid and tetraploid *Petunia*. With diploid and tetraploid tomatoes, on the other hand, reducing sugars were higher in the tetraploids. Sullivan and Myers (1939) found more reducing sugar in tetraploid plants of *Lolium perenne* L. than in diploids. Noguti, Oka and Ôtuka (1940) showed that the tetraploid plants of *Nicotiana* contained less reducing sugar than the diploid plants. Barr and Newcomer (1943) reported that tetraploid cabbage contained a higher concentration of reducing sugar than did the diploid plants.

7. Resin.—Noguti, Oka and Ôtuka (1940) found a higher resin content in tetraploid *Nicotiana* plants.

8. Fructosan.—Sullivan (1940) could find no significant difference in the fructosan content of field grown diploid and tetraploid clones of rye grass.

9. Lignin.—Sullivan (1940) found no significant difference in the lignin content of field grown clones of diploid and tetraploid rye grass.

10. Fiber.—Sullivan and Myers (1939) could find no difference in crude fiber between clones of diploid and tetraploid rye grass. Sullivan (1940) reported that octoploid plants of field grown *Trifolium repens* had a lower fiber content than tetraploid plants.

11. Discussion.—Most investigators found that polyploid plants contain a greater percentage of total sugar, non-reducing sugar, reducing sugar and starch than do diploid plants. Diploid plants contain greater percentages of the structural constituents, cellulose, hemicellulose and crude fiber. The lessened amount of structural constituents in the tetraploids may be related to the decreased number of cells per plant in the tetraploid tissue. The increase in the percentage of soluble carbohydrates in polyploid tissue may be related to their higher water content.

A summary of the published data concerning the carbohydrate components in diploid and tetraploid plants is presented in Table 3.

c. Other components

1. Polyphenols.—Kostoff and Axamitnaja (1935) were unable to find any difference between the polyphenol content of *Nicotiana* F_1 hybrids and their amphidiploids.

TABLE 3. *Summary of the published data concerning the percentages of carbohydrate components in diploid and tetraploid plants. x signifies an increase; — signifies no difference.*

	Starch		Cellulose		Hemicellulose		Total sugars		Non-reducing sugars		Reducing sugars		Resin		Fructosan		Lignin		Crude fiber	
	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.
Fern		x																		
Nicotiana		x	x		x						x									
Nicotiana							x				x		x							
Petunia	—		—		—						—									
Tomato	x		—		x						x									
Tomato							x													
Rye grass							x		x		x				—		—		—	
Rye grass							x		x											
Sugar beet							x													
Cabbage		x					x				x									
Clover							—												x	
Barley							x													

2. *Nicotine.*—Kostoff and Axamitnaja (1935) found that the amphidiploids of F_1 *Nicotiana* hybrids contained a higher percentage of nicotine. The nicotine content of a tetraploid *Nicotiana* was found to be higher than that of a diploid strain by Noguti, Okuma, and Oka (1940). Noguti, Oka, and Ôtuka (1940) confirmed the higher nicotine content of the tetraploid *Nicotiana*.

3. *Organic acids.*—Kostoff and Axamitnaja (1935) found no consistent difference in the percentage of citric acid in *Nicotiana* F_1 hybrids and their amphidiploids. Kostoff (1938) investigated the citric acid content in allopolyploid hybrids of *Nicotiana*. He found no consistent difference between the hybrids and their 5th generation of amphidiploids. The amphidiploids gave both higher and lower results than either of the parents. Noguti, Oka, and Ôtuka (1940) found a greater percentage of organic acid in the tetraploids of *N. rustica* and *N. Tabacum* var. Yellow Orinoco.

4. *Crude fat or other extract.*—Noguti, Oka and Ôtuka (1940) found that the tetraploid of *N. Tabacum* var. Yellow Orinoco had a higher ether extract than the diploid. The results of Shao-Lin Chen and Tang (1945) showed the seeds of tetraploid barley to contain 2.6 per cent ether extract while the diploid seeds contained 2.2 per cent ether extract.

5. *Discussion.*—It is evident from the published data that the amount of many constituents of the plant body may be altered by an increase in the number of chromosomes.

d. Vitamins

1. *Vitamin C.*—The early development of convenient methods of assaying ascorbic acid in plant tissue has resulted in a mass of experimental work. The relative ease with which vitamin C can be determined by the guinea pig biological assay, or by the colorimetric indophenol titration method has stimulated many workers to study the effect of various factors on the vitamin C content of plant tissues.

In 1931, Crane and Zilva suggested that there might be a connection between vitamin C content and the number of chromosomes in apples. In 1932, these authors reported a higher vitamin C potency in triploid as compared to diploid apples. Sansome and Zilva (1933) produced tetraploid tomatoes by the decapitation-callus method and investigated the indophenol-(dimethylamino-phenylindophenol) reducing capacity of the tetraploid and diploid tomato fruits. The tetraploid material had an indophenol-reducing capacity about twice that of the diploids. This result was verified by a biological assay with the guinea pig. The authors used tomatoes of different genetic constitutions and concluded that the vitamin C activity was independent of the genetic character of varieties tested. Key (1933) could find no difference in the vitamin C content of diploid and tetraploid tomatoes of the same genetic constitution. McHenry and Graham (1935) found a higher vitamin C content in tetraploid tomatoes

than in diploids. Göthlin (1935), using the guinea pig method of assay, reported that eight diploid apple varieties averaged 5.35 mgm. of ascorbic acid per gram, while 4 tetraploid varieties averaged 12.00 mgm. Sansome and Zilva (1936) confirmed their earlier data which indicated that tetraploid tomatoes contained a higher vitamin C content. Oka (1942) induced polyploidy in several varieties of tomato (Burbank, Ponderosa, Acte, Cooper's Globe, and Red Cherry) and concluded that the tetraploids contained more vitamin C than did the diploids. Darlington (1942) listed the vitamin C content of a number of rose fruits, and showed that the ascorbic acid content became higher as the chromosome number was increased; 2N plants contained 0.08 per cent while 8N contained 1.20 per cent. Barr and Newcomer (1941, 1942) determined vitamin C photometrically in diploid and tetraploid cabbage and discovered that the tetraploid plants contained more ascorbic acid than did the diploid—2N contained 48.40 and the 4N contained 59.95 mgm. per 100 gm. fresh tissue. Their later data showed that the 2N plants contained 53.51 mgm. and the 4N contained 63.46 mgm.

2. *Riboflavin.*—Smith and Olmo (1944) analyzed the fresh juice of diploid and tetraploid grapes for riboflavin using the microbiological assay method (*Lactobacillus casei e*). They could find no significant difference in vitamin content between the diploids and tetraploids.

3. *Pantothenic acid.*—The concentrations of pantothenic acid in the fresh juice of diploid and tetraploid grapes was shown by Smith and Olmo (1944) to be about the same.

4. *Carotenoids.*—Randolph and Hand (1940) carried out a rather extensive survey of the carotenoid pigments, beta-carotene and cryptoxanthin, precursors of vitamin A, and of zeaxanthin which has no relationship to vitamin activity, in commercial samples of hybrid corn and in some other diploid and tetraploid strains. A comparison was made of cell-volume relationships and of the carotenoid content of pure yellow diploid corn carrying the three dominant genes, YYY, for yellow and a derived tetraploid carrying the doubled number of genes. Analyses were made of the mature endosperm cells. There was a 40 per cent increase in the total carotenoids in the tetraploid material. A microscopic examination of the endosperm cells showed that the tetraploid cells were much larger than the diploid cells, the ratio of their volumes being 3.6:1. The data of these authors may be summarized as follows:

Proportional differences between the endosperm of diploid and tetraploid strains of yellow corn

Item	Diploid	Tetraploid
Cell volume	1	3.6
Carotenoid per unit volume	1	1.4
Genes per cell	1	2
Genes per unit volume	1	0.55
Carotenoid per cell	1	5
Carotenoid per gene	1	2.5

Straub (1940) investigated the carotenoid content of the "yellow spot" on the lower lip of *Torenia Fournieri*. The relative carotenoid content per cell of the polyploid series ran as follows: 2N—1, 3N—1.8, 4N—3.5, 6N—5.3, and 8N—6.1. Freisleben (1942) in a study of tetraploid barley could find no difference in carotene content of diploids and tetraploids. Sullivan (1944) found the carotene content of octoploid white clover to be lower than that of tetraploid plants.

5. *Discussion.*—Most of the published data indicate that polyploidy is associated with an increased ascorbic acid content of plants. How much of this increase might be due to differences in rates of growth, or in the moisture content, can not be determined since many of the investigators do not report the necessary data. Randolph and Hand (1940) discussed their findings in relation to the increase of the carotenoids of tetraploid corn and suggested "that there are two categories of gene action in the autotetraploids: (1) cumulative gene action, which yields percentage increases and accounts for the distinctive traits of autotetraploids other than those that may be attributed directly to the presence of an increased number of chromosome sets, and (2) non-cumulative gene action, which yields percentage decreases when the percentages of other constituents are increased." Smith and Olmo (1940) suggested several possibilities as to why chromosome doubling did not increase the riboflavin and pantothenic acid content of grapes. In the first case, if it is assumed that vitamin production is controlled by gene action, then the fact that doubling the number of genes did not increase vitamin production might indicate that a certain maximum threshold of production had already been reached in the diploid. The second explanation might be based on the supposition that a certain balance exists in vitamin production; the doubling of the genes which control synthesis is counterbalanced by the doubling of other genes utilizing or destroying the vitamins at equal rates.

e. Pigments

1. *Anthocyanin.*—Straub (1940) determined the red anthocyanin pigment from the petals of diploid and tetraploid *Impatiens Sultani*. The tetraploid flowers contained more pigment than the diploids.

2. *Chlorophyll.*—Pirschle (1941a) investigated the chlorophyll content of autopolyploid plants. On the fresh weight basis, the leaves of all tetraploids contained less chlorophyll than those of the diploids. However, per unit of area, the tetraploids were richer in chlorophyll: 110–120 per cent for *Antirrhinum* and *Epilobium* and 150 per cent for *Torenia*, while there was no change for *Impatiens*. The reason for these observed differences was the greater thickness of the tetraploid leaves. Freisleben (1942) found no differences in chlorophyll and xanthophyll in diploid and tetraploid barley. Györffy (1941) investigated the pigment content of different autotetraploid plants, *Antirrhinum majus*, *Epilobium*, *Lycopersicum*, etc., and found

that the pigment content of most of the tetraploids of the different species was higher than that of the diploids.

f. Enzymes

In connection with their physiological studies on the seeds and plants of diploid and tetraploid barley, Shao-Lin Chen and Tang (1945) investigated the enzyme activities. They studied catalase activity by measuring the O_2 evolution from finely ground powder of barley seeds in a Warburg microrespirometer. The tetraploid barley yielded 58 cmm. of oxygen while the diploid barley evolved 23 cmm. of oxygen. They found that the relative diastatic activity of tetraploid malt extract was 20, and that of the diploid malt extract was 11. They also studied the dehydrogenase activity of leaf extracts of diploid and tetraploid barley. Their work indicated that the diploid and tetraploid plants had similar dehydrogenase systems. The leaf extracts of both diploid and tetraploid plants were without effect in reducing methylene blue in the presence of succinic acid, e-malic acid, lactic acid, citric acid, and Ca-glycerophosphate. Both diploid and tetraploid leaf extracts effected a reduction of methylene blue in the presence of ethyl alcohol, glycine, dl-alanine, glutamic acid, cystene, and l-cystine. The rate of reduction was faster in the presence of the leaf extract from diploid barley.

g. Discussion

The organic components in polyploid plants have been more extensively studied than the other components. This is probably the result of their greater economic importance for human and animal nutrition. Randolph (1941) points out, "If such important constituents such as the protein content of cereals, the vitamin content of fruits and leafy vegetables and the sugar content of sugar-producing plants are increased significantly by chromosome doubling without attendant deleterious effects, induced polyploidy will most certainly become an increasingly important method of plant breeding."

When percentage increases of certain constituents are found, there must be a corresponding decrease in other constituents. It is impossible to determine such relative changes from published data because many workers have studied only single constituents. A number of investigations show a decrease in total nitrogen in the tetraploids accompanied by an increase in carbohydrate fractions such as total sugars.

The enzyme studies associated with polyploidy are of considerable interest because they indicate inherent differences in diploid and tetraploid cells. Additional studies in known plant enzyme systems might give further insight into fundamental physiological differences between diploid and polyploid cells. The enzyme studies are also of interest because of the role

that certain vitamins play in making up enzymes. Differences in the vitamin content of diploid and polyploid plants might be correlated with different enzyme activities.

2. INORGANIC COMPONENTS

a. Total ash

The published data concerning the total ash or the mineral components of diploid and related polyploid plants are scarce. Kostoff and Axamitnaja (1935) determined the total ash of F_1 hybrids and their amphidiploids of *Nicotiana*. In the F_1 hybrid (*N. rustica*×*N. paniculata*), the ash content was 12.61 per cent; the amphidiploid has an ash content of 23.20 per cent. The F_1 hybrid (*N. glauca*×*N. Langsdorffii*) had an ash content of 16.97 per cent while the amphidiploid contained 17.72 per cent. Kostoff and Axamitnaja (1935a) investigated the chemical differences between diploid and tetraploid tomatoes (var. Micado) and *Petunia*. The diploid tomatoes contained 24.80 per cent ash, the tetraploids 21.10 per cent, while the *Petunia* diploids contained 20.60 per cent ash and the tetraploids 22.50 per cent. Schlösser (1937) determined the ash in several diploid and polyploid forms of tomato. Diploid *Lycopersicon cerasiforme* plants contained 684 mgm. of ash per plant, while tetraploid plants contained 797 mgm. per plant. *L. racemigerum* diploids had 519 mgm. per plant and tetraploids had 577 mgm. of ash per plant.

These data recalculated as ash per gram of dry matter showed that *L. cerasiforme* diploids contained 179 mgm. of ash and tetraploids 166 mgm., and *L. racemigerum* diploids contained 137 mgm. and the tetraploids 139 mgm. of ash. Gries (1940) found the ash of diploid barley to be 11.3 per cent of the dry weight and the tetraploid barley to contain 16.4 per cent ash. Noguti, Oka, and Ôtuka (1940) analyzed *Nicotiana* diploids and polyploids for soluble ash. They divided their leaf material into upper and lower, depending on position occupied on the stem, and into medium and good quality. The soluble ash content of the tetraploids was in all cases higher than that of the diploid material. Pirschle (1941) found the ash content of tetraploid *Petunia* to be slightly higher than that of diploids during the early stages of growth, but as the plants approached maturity, the ash content of the tetraploids became considerably greater. Barr and Newcomer (1943) reported that the ash content of normal diploid cabbage was 4.94 per cent of the dry weight, while the tetraploid cabbage contained 3.99 per cent. Sullivan (1944) found the ash content of field grown tetraploid *Trifolium repens* to be 13.85 per cent of the dry weight, while the octoploid form contained 14.07 per cent ash. Shao-Lin Chen and Tang (1945) showed that the tetraploid seeds of barley contained 2.5 per cent ash while the diploid seeds contained 1.6 per cent ash.

b. Metallic elements

Noguti, Oka and Ôtuka (1940) analyzed the mineral constituents of field grown, flue-cured tobacco (*N. Tabacum* var. Yellow Orinoco). The tetraploids were found to contain more CaO, K_2O, and MgO. Pirschle (1941) determined K, Ca, Mg, P, Fe, and Mn in diploid and tetraploid *Petunia*. The tetraploids contained slightly more K and Mg than the diploids. Rohweder (1937) studied the chromosome number of *Dianthus* plants found in a region with highly calcareous soils. Diploids did not grow well on the calcareous soil, but if the chromosome set was doubled the plants thrived. There were many other tetraploid plants growing in this calcareous region.

c. Acidic elements

Noguti, Oka, and Ôtuka (1940) found that tetraploid tobacco (*N. Tabacum* var. Yellow Orinoco) had less SO_3 and P_2O_5 than the diploid plants.

d. Discussion

There have been no extensive studies on the mineral composition of diploid and polyploid plants. The one paper by Noguti, Oka, and Ôtuka

TABLE 4. *Summary of the published data concerning the inorganic components in diploid and polyploid plants.*

	Total ash		Soluble ash	
	Diploid	Polyploid	Diploid	Polyploid
Nicotiana		x		
Nicotiana				x
Tomato	x			
Tomato	x			
Tomato	----------			
Barley		x		
Petunia, early growth	x			
Petunia, maturity		x		
Cabbage	x			
Clover		x		
Barley		x		

	Individual ash constituents									
	SO_3		P_2O_5		CaO		K_2O		MgO	
	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.	Dip.	Poly.
Nicotiana	x		x		x		x		x	
Petunia							x		x	

showed that the tetraploid plants contained greater percentages of the metallic elements and decreased percentages of the acid elements. Rohweder suggests the interesting possibility that chromosome doubling may increase the ability of a plant to utilize certain soil constituents. This particular problem may be of economic interest where soils are deficient or contain relatively unavailable forms of mineral nutrients.

The published data concerning the inorganic components of diploid and tetraploid plants are summarized in Table 4.

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A Revision of Dyera (Apocynaceae)[1]

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Conspectus.—In this paper a detailed bibliographical revision of Dyera is presented. All data available to the author which might bear taxonomic significance for the genus or its species are elaborated, and all the important non-taxonomic references are at least cited in the bibliography. This treatise is chiefly a compilation and lacks taxonomic finality. It does not even represent an outstanding advance in our taxonomic understanding of Dyera, though particular attention has been paid to any information which may serve for this purpose.

The major portion of the present study was conducted at a time when the herbarium specimens of the genus available in the United States were woefully inadequate. Recently, however, with the termination of the War, the material from Kew has been received for examination, thereby enabling me to formulate an opinion regarding the taxonomy of the group. Unfortunately I have been unable definitely to resolve one of the gravest problems concerning the genus, the true position of *Dyera Lowii* and *Alstonia polyphylla* in respect to each other and their specific separation from *D. costulata*. I have not seen the types of *Alstonia polyphylla*, *A. eximia*, and *A. grandifolia*, species which probably belong to Dyera.

By way of introduction, the following topics pertaining to Dyera are discussed: literature, uses, cultivation, produce, local names, abbreviation of herbaria and acknowledgments. In the taxonomic portion of the paper, the following order is adopted: generic description, citation of type species, references to illustrations, field observations, distribution. After a discussion, in which Dyera is accepted as being morphologically closest related to Alstonia and consisting of merely two not clearly defined species, follows a systematic treatment of all the names involved. A bibliography of 133 entries is appended.

Literature.—The Botanical Identity of Jelutong[2] by C. F. Symington, Botanist of the Forest Research Institute, Kepong, is an excellent taxonomic account of *Dyera costulata*, although not monographic in character. I do not find it possible at the present time to supplement or qualify his botanical treatment of *D. costulata*, for Mr. Symington had not only the opportunity to study the herbarium material at Kew, Singapore and Kepong, but also the benefit of considerable field observation in the Malay Peninsula, where Jelutong is well known both in the forest and in commerce.

[1] This contribution is made possible by the financial support of the Chicle Development Company.

[2] Jelutong has gained sufficient importance to be mentioned in Webster's New International Dictionary of the English Language. 2nd Ed. Vol. 2. 1942.

In this article, Symington reviews the history of Dyera with particular attention to the proposed differences between *D. costulata* and *D. laxiflora*. He concludes that the two are synonymous. As additional synonymy of *D. costulata* he lists questionably Miquel's *Alstonia eximia* and *A. grandifolia*, species which, however, were known to him only from description. *A. polyphylla*, it is suggested with reference to the authority of Heyne, may be *Dyera Lowii*. The ample description and detailed plate of *D. costulata* which follow are among the best available.

Citations of the specimens examined are omitted in Symington's treatment; no detailed distribution of Dyera is presented; and, although the author apparently accepts *D. Lowii* as distinct from *D. costulata*, he does not indicate the differences between these two species.

Similarly, references to the botanical distinction between *D. Lowii* and *D. costulata* by other authors are practically missing. M. E. G. Brown (in manuscript) presents several field differences in habitat, average dimensions, and presence of pneumatophores, characters which are useless in herbarium studies. E. M. Drees refers merely to the different altitudes above sea level in which the two species are found. H. N. Ridley (98, p. 95) notes minor dissimilarities in leaf-shapes, which he himself doubts (99) as being of specific value.

Good descriptions of Dyera and valuable distribution data are presented by King & Gamble, Burkill (16) and Ridley (97, 98). The field description and general information in Foxworthy's Commercial Timber Trees of the Malay Peninsula are particularly noteworthy. Judging by the frequency with which it is cited in the literature concerning Dyera, Burn-Murdoch's Trees and Timbers of the Malay Peninsula (not seen by me) probably deserves mention here.

Among the less important taxonomic contributions to the genus the following should be mentioned: Corson, Watson (127), Heyne, and Smith. Van Romburgh's notes on his various encounters with *D. Lowii* in Borneo, and particularly his field observations on the pneumatophores of this species are of interest. The original diagnoses presented by Miquel, Hooker (67, 68), and Baillon (4) are historically important.

Detailed reports of the occurrences of *D. Lowii* and *D. costulata* in Palembang and Lampoeng, Sumatra, appear in M. E. G. Brown's manuscript on the forest survey of these regions. This author's Forest Survey for Jelutong in Lingga and Singkep should also be included here.

Edwards & Mead's growth records of Dyera in sample plots, and Holttum's notes on the leaf-change periodicity and formation of fruits in *D. costulata*, are valuable original observations. Raciborski treats the vegetative morphology of the species.

Besides casual remarks on the timber of Dyera in various publications and a figure of the wood anatomy of *D. Lowii* in Foxworthy (45), the only signifi-

cant contributions to the study of the wood structure of this genus are those of Cockrell and Bargagli-Petrucci.

The literature on the silviculture, tapping, coagulation of the latex, and the commercial aspects of Dyera is extensive. The numerous contributions of Georgi in the Malayan Forester and the Malayan Agricultural Journal, extending from the year 1927 to 1935, and those of Eaton, Georgi & Teik in 1926 & 1927, and Watson & Georgi (Mss.) in 1945 are the most important ones. Greenstreet (1925), Corson (1927), Watson (127) (1935), Brown (1939 & 1940), and Smith (1940) are equally important. The following references are also significant: Burkill (16), Drees, Eaton & Dennett, Foxworthy (47), Heyne, Laan & Meurs, Ridley (98), Schidrowitz, Walton. Statistics on the exports and imports of Jelutong, and other data mostly borrowed from Heyne, appear in Vander Laan's Production of Gutta-Percha, Balata, Chicle and Allied Gums.

Numerous references to chemical studies in Dyera are found in Wehmer's Pflanzenstoffe. The outstanding ones cited in the Bibliography at the end of the present paper are those of Ellis & Wells, and Hillen on the resin extracted from Jelutong. Chute and Dubosc also experimented with this product. Pearson (89) quotes Ellis' essay on the use of Pontianak resin in the waterproofing of concrete. Cohen and Nöjd treat the Lupeol derived from Dyera, while Sack & Tollens and Alexander write about other compounds. Hinrichsen & Marcusson and Tilden are minor contributors.

The list of references presented in the Bibliography at the end of this paper does not include all those published on Dyera. However, it is hoped that the important contributions have been recorded and that the catalogue might eventually serve as a basis for a complete revision both bibliographically and taxonomically.

Uses.—The principal use of Dyera is found in its latex which has been used extensively as a basic material in the manufacture of chewing gum. It is estimated (unpublished survey, May 31, 1944) that the yearly average amount of Jelutong from 1912 to 1922 produced for this purpose was 30,500,000 lbs.[3] According to Vander Laan (122, p. 65; source: Commerce and Navigation of the United States) the total imports in pounds of Jelutong into the United States for the years 1901 to 1925 have been as follows: 1901—9,371,087; 1902—16,850,821; 1903—13,984,817; 1904—14,887,416; 1905—19,104,911; 1906—21,390,116; 1907—28,437,660; 1908—22,803,303; 1909—24,826,296; 1910—52,392,444; 1911—51,420,872; 1912—48,795,268; 1913—45,345,338; 1914—24,926,571; 1915—14,851,264; 1916—27,858,335; 1917—23,376,389; 1918—21,399,377; 1919—18,662,702; 1920—12,705,923; 1921—3,908,401; 1922—5,229,505; 1923—10,226,281; 1924—13,809,583; 1925—15,118,547. Thus, the yearly amount for the period has always exceeded 3

[3] J. G. Watson in Burkill (16, p. 877) writes: "Between 1913 and 1922 its [Jelutong's] exploitation would have ceased everywhere, except that it was used on a small scale."

million pounds and in 1910 exceeded 52 million. Howes estimated in 1930 that the American markets were capable of absorbing about 5000 tons of Jelutong annually. The United States is the largest consumer of Jelutong. See Vander Laan (122, pp. 63, 64, 65) for further statistics.

With the intensive exploitation of Jelutong which will now probably be resumed as a peacetime activity, what is the outlook for the future supply of the gum? While the habit of chewing gum is apparently steadily increasing, it was reported in the 1944 survey that the Jelutong area about Pontianak in Dutch Borneo was exhausted. The suggestion is made that this lack might be replaced by a possible substantial production in East Borneo. The blame for exhaustion of Dyera in some areas is attributed to the method of working the trees. Watson (127, p. 59) writes: "Where such operations [silvicultural treatment applied under scheme felling] have been carried out in areas containing *Jelutong* the percentage of this species has increased to an extent that justifies the assumption that there need be no fear of a shortage in the future, and that this tree will not only continue to yield an abundance of latex but will, in due course, provide a surplus of timber suitable for export." He continues (p. 60): "Experience in areas treated under scheme felling has shown that *Jelutong* recovers very rapidly from felling damage and that it coppices readily. Examination of natural regeneration invariably discloses a high percentage of saplings that have originated as stool shoots."

The market demands for Jelutong are now controlled almost exclusively by the chewing gum industry. Watson does not believe that the uses of Jelutong can be widely extended. To a very limited extent, principally in the earlier period, other uses for the latex of Dyera have been reported. Pontianak found some employment in the manufacture of inferior or secondary rubber goods for which elasticity was not a prime consideration; in the adulteration of the better rubbers or gutta percha for production of the cheaper qualities of rubber articles, or in compounds and fillings or as a binding ingredient in mixings. Dyera product is reported to have been utilized in making architectural work water-tight, as in waterproofing mixtures applied to the walls, floors and roofs of houses; to make mouldings of picture-frames; in various assorted articles or goods, as rubber shoes, asbestos, celluloid and linoleum.

Clercq notes doubtfully that the latex of *D. costulata* is drinkable when hot and states that it tastes somewhat like milk. Corson remarks that the congealed rubber is pleasant to the taste. Hasselt & Boerlage (57, p. B15) refer to the latex as tasting like milk, and add that it is a good means against blisters on the tongue.

The caoutchouc from Dyera comprises only about 20 per cent of the total dry weight of the coagulum, the remainder being chiefly resin. Chute (20, p. 351) reports: "Pontianak resin has been used with some success, as one producer claims to have sold 400 tons to a single varnish company, and car-

loads to several others, and the companies who have used it assert that after a year's test they find the varnishes with the resin in them in better condition than those without."

The resistance of Pontianak resin to the action of aqueous alkali solutions has led to its application as a coating material for cement and concrete, or for waterproofing concrete (Ellis' patent No. 999,493). The resin has also been used in paints or as priming for concrete (Ellis' patent No. 999,708) and for sizing paper (Ellis' patent No. 1,007,681). The volatile oils resulting from the destructive distillation of the rubber resins have been suggested as a raw material for preparing isoprene.

The wood of Dyera is very soft, light, even-grained and very easily worked. It is not durable, for when in contact with the ground it is usually destroyed by termites in less than six months, and it is subject to the attacks of boring beetles. The timber of Dyera is not suitable for structural purposes because of this weakness and lack of durability. However, Ridley (94, p. 250) suggests that it might be employed for walls and partitions of houses. The wood was formerly used locally for manufacturing Chinese clogs (the Malay "trompah" or wooden sandals in Singapore), and is said to be excellent for making patterns. It has also been reported serviceable for furniture, chests, match sticks, match boxes, packing cases, and drawing boards. Low reports that Jelutong wood was used by undertakers ("cheaper grade of Chinese coffins," Foxworthy, Indo-Malayan Woods). Hasselt & Boerlage (57, p. B20) record that a gambier is baked from the wood.

Amongst the aborigines of the Malay Peninsula, the Mintira and Berembun (Skeat & Blagden) and the Benua (Burkill, 16, p. 876) have been reported to contrive caps for their quivers from small blocks of Jelutong wood. The Benua have been observed to also use the wood to make mouthpieces for their blowpipes.

Winkler states that the roots of Dyera served as substitutes for cork and for making ax handles. Corson (26, p. 48) reports how the follicles, which burn with a steady bright flame, are sometimes used by the natives of Sarawak as torches, or are kept merely glowing to keep mosquitoes at bay by the pungent smoke they emit. Hasselt & Boerlage (57, p. B15) also had referred to their use as torches (in remarks under *Alstonia grandifolia*), and added that the fruits of *D. costulata* are burnt as a resin and used as ointment against sores.

Cultivation.—Dyera is widely distributed in the Malay Peninsula, Sumatra and Borneo. It is classed by Foxworthy (47, p. 109) as nineteenth in order of abundance of the commercial trees of the Malay Peninsula. This author, however, doubts whether there is in the Peninsula as a whole an average of more than one matured tree to nine acres. The difficulty always attending the exploitation of a product in the wild, coupled with Dyera's encouraging habit of fast growth after an initial establishment period, its

adaptability and great recuperative power, have suggested the cultivation of this valuable giant tree, but without conclusive results. Brown (12, p. 14) reported in 1939 that the British and Dutch Department had endeavoured to form artificial plantations with *D. costulata* without very great success. On the other hand, Smith (114, p. 317) announced in 1940 that a seven year old plantation in Sarawak was reported to be making good progress. Watson (127, p. 58) wrote in 1934: "Sporadic attempts have been made from time to time to start plantations on lines similar to those adopted for the cultivation of Para rubber. Most of these schemes failed to materialize owing to the difficulty of obtaining supplies of seed. Collection of seeds is extremely difficult. Gathering the fruits is, more often than not, a practical impossibility owing to their distance from the main branches and the difficulty of climbing the long clear bole that is so characteristic of the tree. And even if the fruits are secured they are useless unless they are just ready to open, a condition that is by no means obvious at close quarters, much less from the ground level. Attempts to encourage collections by the offer of substantial rewards have been singularly unsuccessful." In the following year, in Burkill's Dictionary (16, pp. 881–882), Watson wrote: "From the behaviour of the tree in open places in the forest, from such meager growth statistics as are available, and from our limited nursery experience, the indications are that the tree could be grown under plantation conditions and might be expected to reach tappable size (as judged by Para rubber standards) in about 15 years." The difficulty, he insists, is in obtaining ripe seeds: "The fall of these featherweight seeds is so gradual that they are scattered over a very extensive area. That few of them reach the seedling stage is evident from the sporadic occurrence of the tree and the difficulty that has been experienced in obtaining, even at exorbitant prices, sufficiently naturally sown transplants to stock a 10-acre experimental plot." To facilitate the collection of the seeds, Corson (26, p. 51) suggests gathering the fruits before they are fully ripe, to slit and suspend them in sheds to ripen and dispel their seeds artificially.

The seeds of Dyera are said to be difficult to handle in artificial planting but to germinate readily, requiring 11–15 days (35–50 days, according to Derry) or as little as 10 and as long as 90 days. Watson (127, p. 58) writes that the growth is not very rapid in the early stages, six month old seedlings being only about 3 inches high, and that it is of very uneven rate in spite of identical treatment. Individual heights of as much as 12 feet have been recorded at 3 years of age (19 feet at 4 years), but the average of a batch of transplants set out under favourable conditions was little more than 3 feet. "It seems, therefore, that like many other of our indigenous trees, Jelutong requires a protracted establishment period, and that it does not embark on rapid growth until its root system is well developed."

Young saplings of Jelutong are very susceptible to injury but have great

powers of recuperation, and once established Dyera is said to be one of the most rapidly growing trees in the Malay Peninsula. Specimens under observation have attained a girth of 18 inches at the end of 5 years. "The highest recorded girth increment for a single tree is 4.2 inches over a period of 4 years (maximum 5.0 inches in 1927), which is a record for measured trees of any local species," Watson (127, p. 59) states. "On the basis of a considerable number of annual measurements of dominant trees in sample plots it has been estimated by Edwards in Malayan Forest Record No. 9 that Jelutong takes about 46 years to reach a girth of 5 feet and 70 years to reach 7 feet, exclusive of the time required for establishment, which, according to plantation experience, should be about 4 years."

Produce.—According to Watson, high-yielding trees 7 ft. or more in girth will give about 20 oz. of latex a day, or about 400 oz. a month coagulating to 8 lbs. of commercial Jelutong. One tree might yield 67 lbs. per year. Pearson (88) calculates it is capable of yielding 100 lbs. of gum when cut down. Corson estimates a single laborer can tap between 25 and 30 trees a day and collect from 3 to 4 or more gallons of latex. A tree tapped once in 3 days, he states (26, p. 52), has been found satisfactory.

Local names.—The best known of the popular names of Dyera is *Jelutong*. Easily recognizable variant spellings of Jelutong are found in literature: *Dgiuluton*, *Dgiulutong*, *Djelutang*, *Djeloetoeng*, *Djelutung*, *Edjelotong*, *Gelutong*, *Jeluntong*, *Telutong*. The name is applied interchangeably to the tree or its gum. The rubber is usually called *Gutta Jelutong* (*Ghettà Dgiulutong*, or with the components of the name appearing as linguistic or orthographic variants, e.g. *Gĕtah*). Sometimes reference is made to the timber of Jelutong, the habitat or some particular descriptive feature: *Kayù* (wood) *Jelutong*, *Hill Jelutong* (*Dyera costulata*, the swamp Jelutong being *D. Lowii*), *Jelutong Daun Lebar* (broad-leaved), *Jelutong Daun Merah* (red-leaved), *Jelutong Pipit* (Sparrow's Jelutong).

Jelutong is a characteristic tree rarely mistaken for any other. When this name designates the gum rather than the tree, however, it frequently stands for a mixture derived from Dyera and other genera. Ridley (100, p. 50) writes in reference to Getah Jelutong or Pontianac: "it is probable that the material as met with in commerce is a mixture of guttas derived from different sources. It has been stated, in fact, that it is the custom of the natives to mix the latex of the Jelutong tree with that derived from different species of *Willoughbeia*, which yield an inferior rubber." Vander Laan (122, p. 61) quotes a translation from Heyne's Wild Rubber: "*Dyera Lowii* Hook. f. yields Jelutong, as does *Dyera costulata* Hook. f. Other species which probably yield Jelutong are *Alstonia Scholaris* R. Br., *Alstonia grandiflora* Miq., *Alstonia eximia* Miq., and *Rauwolfia spectabilis* Boerl." Karling (72, pp. 77, 81) remarks that, according to Heyne and Corson, the names Dead Borneo, Pontianak, and Gutta Jelutong are applied to the above species of

Alstonia and Rauwolfia as well as to Dyera. It should be noted, however, that *Alstonia grandifolia* Miq. ("*A. grandiflora*" is an error for this) and *A. eximia* are probably merely synonyms for *Dyera costulata*. King & Gamble (p. 439) state that a *Wray* collection of *Alstonia angustiloba* Miq. from Perak was given the vernacular name Jelutong.

Ridley (94, p. 249) received a plant named Getah Jelutong from British North Borneo which obviously is neither Dyera nor Alstonia or Rauwolfia: "I have received another plant from British North Borneo at Labuk Bay under the name of Getah Jelutong from Mr. Wade. This, a branch with leaves only, has the leaves scattered, not in whorls; they are rather thin textured, very long and narrow lanceolate acuminate, 8 inches long, 2" wide, with a slender petiole an inch long. It is probably not a *Dyera* at all, but further material is required."

In Malay Plant Names, Ridley (93, p. 260) attributes the local name Jelutong Badak to *Tabernaemontana corymbosa* Roxb. and Jelutong Laut (Singapore) to *Euphorbia atoto* Forst. The identification by Murton (84) of Alxyia sp. for Gutta Jelutong was through error.

The following additional local names for Dyera or its gum appear in literature (the diphthong *æ* is equivalent to *u;* when names are identical except for this variant spelling only those with *æ* will be listed): *Badang, Badong & Bedok* (in Sakai), *Besk* or *Bresk, Bulantan* (south Borneo), *Dead Borneo, Fluvia & Gambria* (the gum; Pearson), *Gapoek* (west Sumatra; Cockrell), *Handjalotong* (south-east Borneo; under *Dyera Maingayi;* Clercq), *Laboeai* or *Laboei* or *Laboewai* or *Laboeweh* (Sumatra), *Lu Tong* (Siamese, Setul), *Malaboeai, Melaboewai* (Sumatra), *Medang Palai* or *Medang Pelai* (Malaya; under *Dyera Maingayi;* Clercq), *Mesenteh* (under *Alstonia polyphylla;* Heyne, 60, p. 64), *Njahtoeng, Palai* (Malaya; under *Dyera Maingayi;* Clercq), *Paloja* (a base produced by Jelutong mixed with other substances; Smith, p. 306), *Pantoeng*[4] or *Pantoeng Kapoer* or *Pantoeng Senaman* (Borneo), *Pelai* (south east Borneo under *Dyera Maingayi;* Clercq), *Plaai* (under *Alstonia eximia;* Kurz), *Poelai* (under *Alstonia polyphylla;* Heyne, 60, p. 64), *Pontianak, Pulih,*[5] *Susu.*[6]

[4] Boerlage (10, pp. 15 & 12), deriving his data from Van Romburgh, ascribes the name Pantoeng to *Alstonia scholaris* from Boentok and *Rauwolfia spectabilis* from Moeara Teweh, as well as to *Dyera Lowii* from Medara and Pangenang, Borneo.

[5] The name Gutta Pulih appears on the label for a *Dyera costulata* collected in the Garden Jungle, Singapore. The vernacular Pulai, however, is more commonly applied to Alstonia spp. There is available a collection distributed as *Rauwolfia samarensis* Merr. from British North Borneo, which is noted as having the local name Pulai. This plant is very closely related to, if not identical with, *Rauwolfia spectabilis* (Miq.) Boerl.

[6] A gum named Gutta Susu received from the Langkawi Islands was identified as from Dyera in the Bulletin of the Imperial Institute (2, p. 15). Watson (16, p. 876) and Ridley (93, p. 96) affirm that one of the alternative names for Dyera rubber is Getah Susu. However, this vernacular epithet is applied by Vander Laan (122, p. 68) to *Willughbeia firma*, a vine found commonly in the Netherlands East India islands. Heyne (59, p. 52. 60, p. 1272) notes Getah Soesoe (*æ* is pro-

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DYERA Hook. f., Jour Lin. Soc. Bot. **19**: 293. Aug., 1882.

Distinctive giant trees of rapid growth, copiously laticiferous, usually more or less conic in shape, commonly 50 m. in height and 65 cm. diam., occasionally reaching over 66 m. in height, 3 m. diam., and 36 m. to first branch, the trunk rounded, columnar, without buttresses (often with slight swelling at base), with or without pneumatophores, the crown with 33–50 m. spread; BARK 0.5–2.6 cm. thick, corky, smooth or warty or rough, often cracking into small irregularly shaped pieces, without longitudinal furrows, grey or greyish red to brown or almost black, with reddish color when cut, the inner bark thick, brittle, pale brownish or dull whitish, with abundant latex which also flows in small amounts from outer part of wood; BRANCHLETS verticillate, stout, rigid, sometimes swollen at termination of last season's growth, 5–8-angled with strong ridges in line below petioles, deeply channelled, often minutely rugulose, glabrous, brownish or reddish brown when young, dark or light grey when old; leaf-scars shield-shaped towards termination of branchlets, becoming crescent-shaped lower down, sometimes with orbicular gland-scar above, almost touching around branchlets, separated by ridges; gland at axil of petiole, prominent, rigid, deltoid-lanceolate, up to 4 (–7) mm. long and 3 (–4) mm. broad, sometimes deciduous together with petiole, as numerous as number of leaves in whorl and together forming an ungulate connivent (glands sometimes rather spreading) ring to protect terminal bud; LEAVES verticillate towards ends of branchlets, usually about

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7 (6–8) in a whorl (opposite in seedlings), deciduous with new leaves appearing shortly, glabrous; petioles 2–6 (–7) cm. long, drying blackish or brown; blades very variable in shape and size, elliptic, oblong to obovate or oblanceolate, up to 23 cm. long (–43 cm. in shoots) and 12 cm. broad, rounded or slightly subcordate to obtuse, or cuneate-attenuate at base, frequently asymmetrical, the apex short-acuminate to rounded or slightly retuse, the margins often faintly undulate, incurved, coriaceous to chartaceous, the midrib keeled on upperside, prominent on underside, the principal lateral or secondary nerves 13–30 pairs, with a distance of 4–18 mm. apart near middle of blade, minor intermediaries sometimes present, diverging mostly upwards from midrib, arcuate, joined by a marginal nerve, the reticulation prominent in matured leaves, the upper surface typically bright green, glossy, drying a reddish or yellowish brown, the lower surface pale bluish green, glaucous; INFLORESCENCES axillary at base of season's new growth (axil of penultimate whorl of leaves or their scars), rarely appearing terminal by suppression of new growth, in ample paniculate many-flowered cymes, up to about 18 cm. long, bracteolate, glabrous, the primary peduncle (2.5–) 6–9 (–12) cm. long, strongly angled, the infl. branches usually in 4–6-verticils along infl. rachis, the pedicels up to 10 mm. long, the bracteoles minutely triangular or linear, occasionally foliaceous at base of primary verticil, deciduous; CALYX-LOBES 5, quincuncial, ovate to ovate-orbicular, 0.6–1.3 mm. long and 1.2–1.5 mm. broad, rounded to subacute at apex, glabrous, not ciliate, flattened or faintly keeled, sometimes minutely jagged at edges, the glands at base within short, in one series, close together, about 4; COROLLA developing with new leaves, hypocrateriform, white, slightly fragrant; corolla-tube short, cylindric-urceolate, slightly widened upwards, hardly dilated at region of anthers, 1.2–3 mm. long, faintly angled in line with sinuses outside, glabrous except for a line of minute hairs within at level with or a little below insertion of filaments, this pubescence developing into denser tufts alternate with stamens; corolla-lobes oblongish to linear-oblong, much longer than corolla-tube, mostly 3–9 mm. long and 2–3.8 mm. broad, auriculate and asymmetric at base, obtuse at apex, glabrous, veiny, sinistrorsely contorted in bud (viewed externally), not twisted, spreading at maturity; STAMENS inserted a little below middle of corolla-tube, the anthers on very short but distinct filaments, oblongish to lanceolate, shallow-cordate at base, 0.9–1.6 mm. long, their polleniferous cells below, the upper half of anther consisting merely of sterile connective produced into a thickened fleshy appendage, terminated by a short point which is sometimes inflexed, reaching up to throat of corolla-tube or a little exserted; OVARY apocarpous but appearing as single with two cells, semi-orbicular, about half or more inferior, densely pubescent on upper part, rounded at apex, without glands or apparent disk, the ovules numerous, pluriseriate; STYLE very short, up to 0.16 mm. long, the thickened clavuncle annular-cylindric, 0.15–0.25 mm. long, glabrous, without membranous

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fringe, the stigmatic-apiculi two, about 0.31–0.32 mm. long, blunt at apex, microscopically papillose: MERICARPS two large cylindric woody follicles, up to 40 cm. long and 4 cm. broad, connate at base on a thickened peduncle, dehiscing along a dorsal suture, diverging at maturity and finally curved backwards so as nearly to touch at apices; SEEDS numerous, 12–24 in each follicle, crowded in two rows, very thin and light, peltate, elliptic to oblong, markedly papillose on their surfaces, surrounded by an elliptic to oblong membranous wing which is strongly radiately striate and lightly reticulate, much broader at ends where rounded, their edges sometimes minutely jagged, the seed part up to 3.5 cm. long and 2.5 cm. broad, the wing up to 2.2 cm. long and 2.5 cm. broad at both ends, with margins near middle up to about 0.5 cm. broad, the albumen very thin, the cotyledons ovate, very thin and difficult to separate, up to 2 cm. long and 1.2 cm. broad, the radicle short; germination epigeal.

Type species.—*Dyera costulata* (Miquel) Hook. f.

Illustrations.—*Dyera costulata* (115): flowering branchlets; fallen leaf with gland adhering to petiole; mature flower-bud; corolla from expanded flower, and flower analyses; dehiscing follicle; seeds; stages in germination of seed. Four photos between pp. 110 and 111 (47): habit of a large tree; branch with inflorescences, fruit, and leaves; trunk of a large tree; close-up of bark. Getah Jelutong (98, pl. 3): habit photo of tree in Botanic Gardens, Singapore. (98, pl. 4): branch with leaves and flowers; flower analysis; fruit. *Dyera costulata* & *D. laxiflora* (17, pls. 19 & 20): habit, bole, leaves, and fruits (fide Symington). *Dyera laxiflora*, the big Jelutong Tree (15, p. 33): Habit photo of a large tree in the Singapore Bot. Gd. Fig. 4 (91): branches with leaves. "*Dyera costulata* Hoch." (22, pl. 74): transverse & tangential sections (100×) and transverse section (10×). *Dyera Lowii* Hook. f. (6): tangential wood-section. *Dyera Lowii* (45): wood anatomy. Map 2 (72, p. 80): areas in the East Indies and Malaya in which Jelutong is extracted.

In addition to the published illustrations cited above, there are available in the Conservatoire et Jardin Botanique, Geneva, unpublished excellent line sketches showing detailed floral analyses, inflorescences, fruits, and leaves of *Dyera costulata* (under *D. costulata*, *Maingay 1097* from Malacca, and *Griffith* from Malacca; Comm. Van Romburgh 1882 cult. in hort. bot. Bogar., Sumatra; also under *D. laxiflora*, coll. not cited). Del. Nov. 1902, E. Delpy; these drawings were from the herbarium of Charles-Joseph Pitard-Briau.

Field observations (see Cultivation and Distribution for further information).—Dyera in the forest has a predominance in the topmost story. The mature trees are usually so distinctive in appearance that they are rarely confused with other genera. The young plants, however, are sometimes mistaken for the closely allied Pulai (Alstonia spp.). Foxworthy (47, p. 110), referring to his experience with *D. costulata* in the Malay Peninsula, writes:

"Bark of saplings smooth, with horizontal markings indicating where leaves have fallen. As the young tree grows the bark acquires a curious reticulate pattern and shows a good deal of chlorophyll. This curious marking is lost before the tree reaches commercial size and the bark becomes rather smooth again. Trees growing in the open usually have a much lighter-coloured bark than those growing in dense forest."

Jelutong is very resistant to injury, girdling, burning, is very tenacious of life, and can grow through Lalang. It has a fair amount of natural regeneration.

Dyera costulata was observed by Holttum at Singapore as a deciduous tree or as intermediate between the normal deciduous and evergreen types, with no strictly regular leaf periods. There were complete leaf-changes at intervals of from 3 to 11 months, sometimes with partial changes in between; usually all the old leaves were lost before the new buds opened, but new leaves sometimes appeared before the old leaves had fallen. The tendency of leaf-fall was to follow dry weather. "Dyera trees," Holttum writes, "are fairly frequent in the Garden Jungle, and they tend to change their leaves at the same time, though they do not always behave alike." There are known some irregularities of behaviour, and all the trees do not always change their leaves simultaneously. Derry (29, p. 245) writes from his experience at Singapore: "The leaf-fall is usually complete, the tree entirely defoliating itself in a remarkable short space of time and is immediately followed by young leaves and flowers (about the end of March). The fruits ripen during the following February." Foxworthy (47, p. 112) states concerning Dyera in the Malay Peninsula that individual trees have been known to shed their leaves twice within one year. The new leaves have a bronze colour for the first few days while they are unfolding.

Foxworthy (47, p. 112) offers his observations on the flowering and fruiting habit of Dyera in the Malay Peninsula: "Flowering takes place within a few weeks after the appearance of the new leaves. Jelutong has been collected in flower in all months except January and December, and in fruit in all months except August. The flowers open at night or in the early morning and the corollas are usually shed before 9 A.M. There is a succession of flushes of flowers for about ten days and the amount of flowers borne is so great that the ground under the trees is each morning carpeted with the white fallen corollas, which turn brown within a few hours. The fruit is usually ripe within two or three months of the first appearance of the flowers. The seeds are dropped in the morning and are dispersed by the wind."

Watson (127, p. 57) writes that Dyera has no definite fruiting season in the Malay Peninsula. The fruits are estimated by him to take about two months to ripen. But Holttum (63, p. 190) asserts that the fruits of Dyera take nine months to ripen, although grown approximately full size in less than half that time. It is recorded that in Singapore they began to dehisce

about December 20th in 1929. Watson (127, p. 58) states that the opening of the follicles usually occurs in the afternoon, and is inhibited by dull or wet weather. The fruits do not fall until all the seeds have been released.

Ridley (106, p. 129) has observed seeds of Dyera blown by a fairly strong wind a distance of 40 yards from a tree 80 feet tall in the Singapore Botanic Gardens. He notes: "The tree sometimes attains a height of 200 feet and I have little doubt that the seeds are often blown to a much greater distance."

In reference to the seedlings of Dyera, Foxworthy (47, p. 111) states: "The first leaves are opposite and the whorled arrangement does not appear until quite a number of months have elapsed. The first four or five pairs of leaves are narrow, acute, much smaller than those of the mature tree, and are not noticeably glaucous beneath. They somewhat resemble in appearance the leaves of Tembusu [Fagraea sp.]. Later leaves are longer than those of the mature trees, sharp-pointed and glaucous beneath. They are followed by whorled leaves."

Distribution.—Dyera is common on the whole Malay Peninsula up to Penang and lower Siam (Pūket).[7] Extending south to Malacca, it is known from the islands of Singapore, Riouw, Lingga, Singkep, Banka, and Billiton. Dyera occupies vast areas in Sumatra. It is very frequent in Sarawak and is widely distributed in Dutch and British Borneo and Brunei. Van Steenis lists the genus as questionably from Celebes.

Dyera grows in a variety of soils from low lying swamps with water one meter deep, or in flat or undulating lands, to dry hills up to 870 m. in altitude. It is not gregarious in primeval forests but is associated with various other genera. Principally a light demanding tree (Watson, 127, p. 59, states: "There is no doubt that Jelutong is a marked light demander"), it responds quickly to the opening of the forest canopy and it is believed that the silvicultural operations being undertaken chiefly in the interest of Dipterocarps will result in a very considerable increase in the proportion of Jelutong.

Foxworthy (47, p. 109) writes that Dyera in the Malay Peninsula "occurs

[7] Dyera is not reported from Siam in H. N. Ridley's Flora of Lower Siam and An Account of a Botanical Expedition to Lower Siam or in W. G. Craib's Contributions to the Flora of Siam (Year 1912). Ridley remarks (104, pp. 15, 55) on how the flora of lower Siam is "quite distinct from that of the Malay Peninsula," and notes (p. 59) Dyera as seeming to stop altogether south of Alor Star (Kedah). Kerr, in editing Craib's Florae Siamensis Enumeratio (27), cites two collections from Setul. These collections have been checked by me. It seems, then, that although Dyera is not altogether lacking from lower Siam, it is not widely distributed far north of the Federated States.

Dyera is known from the Ranau region in south Sumatra, but apparently fails to cross the Sunda Straits into Java. The genus is not found in Java, except in cultivation. Van Steenis (123, p. 37) notes Dyera not crossing the Sunda Straits and explains that: "the lowland forests of Sumatra, the Malay Peninsula, Borneo and the Philippines show a very close affinity, the typical representatives of which do not occur in Java and the Lesser Soluda Islands."

There is no record available of Dyera extending into the Andaman Islands or otherwise west of Malaya and Sumatra. East of Borneo there is only a dubious report of the genus from Celebes.

on flat land and low hills, from sea level up to about 1400 ft., on laterite or alluvial soil. Never the most abundant tree and, if the forests of the whole Peninsula are considered, it is doubtful if there is an average of more than one tree of commercial size to nine acres." It is listed as nineteenth in order of abundance amongst the more common commercial trees. Although distributed in every district, Dyera grows sporadically and is uncommon in the Malay Peninsula except on the lower lying hill forests.

Cantley in 1883 observed Dyera as on the road to extinction in Singapore Island. Brown (13) reports it is plentiful on the foot hills and low lying districts of the north, northeastern or eastern part of Singkep; that in the west of Lingga only a few trees are found on the foothills, but it is distributed on all low lying areas (4 or 5 trees per acre around Kotadaik and along the river Nereheh).

In Palembang, Sumatra, where areas have been cleared of other trees, Dyera is estimated (12) to be represented by about 8–10 large specimens per acre and as many young ones.

Jelutong is more densely distributed in certain areas in Sarawak and in the Netherland East Indies than in the Malay Peninsula. It is the most obvious tree in many swampy districts of the lower river basins, so characteristic that such areas are commonly referred to as "Jelutong Swamps." These swamps vary in width from 10 to 60 or more miles along the coast. They are not salty, brakish or stagnant. The soil is generally sandy; the forest, evergreen. The best areas are reported by Corson (26, p. 47) to have about 12 trees over 45 cm. diam. per acre. Dyera trees in the "Pantoengbosch," according to Heyne (59, pp. 42 & 51) generally stand at distances of 50 to 400 m. from each other. A survey for 1944 reports Dyera in the Pontianak region in Dutch Borneo is exhausted. Endert notes Dyera as one of the less common trees in the tuff plateau forests near Poehoes and L. Djenèau.

From a survey of literature and the collections examined, it seems that only *D. costulata* (including *D. laxiflora*) is known from the Malay Peninsula and Singapore. Both *D. costulata* and *D. Lowii* are found in all the other major regions. According to Brown (13), while *D. Lowii* is met in all the low lying swamps of Singkep and Lingga, *D. costulata* is restricted almost exclusively to the north and eastern districts of Singkep, although a few specimens of this species were seen in the foothills north of Lingga. Of these two islands, as far as *D. costulata* is concerned, Singkep is the only one worth exploitation. Smith (114, p. 307), on the authority of Drees, states that the habitat of *D. costulata* is dry lands at altitudes up to about 2600 feet, while that of *D. Lowii* is marshlands below an altitude of some 170 feet. *D. costulata*, Brown (12) claims, is exclusively a dry land species in Palembang. Specimens of *D. Lowii* grow much closer together in the jungle than those

of *D. costulata*, it is reported, but in the swamp habitat of the former species the undergrowth is thicker and travel from tree to tree is more difficult.

Taxonomic relationship.—In reference to the relationship of Dyera[8] to other genera, Hooker (67, p. 292) writes: "Its nearest affinity is no doubt with *Alstonia*, from which it differs conspicuously in the sessile stigma, a character rare in the Order, and in the singular fruit. It further differs from that genus in the extraordinary minuteness of the flowers, which are scarcely 1/18 of an inch in length, whilst the ovules have a diameter (as taken from dried specimens after saturation with warm water) of only 1/200 to 1/300 of an inch. These latter minute organs are succeeded by fruits of unusually large dimensions for the Order."

The close tie between Alstonia and Dyera is universally accepted. Schumann places Dyera in "Plumieroideae-Plumiereae-Alstoniinae." The floral and fruit or seed characters of Dyera easily distinguish it from all the other genera in this subsection. It should be noted that there are other members in this group with winged seeds, but the precise morphology of their seeds is obviously different. Considering the gross features of Jelutong, its tree habit removes it from the genera numbered 36–44 in Schumann's treatment, which are either vines or subshrubs (the West Indian Strempeliopsis, sometimes arborescent, seeds winged, has its leaves minutely finely lineate and an entirely different appearance from Dyera). The fruit bears no resemblance to those in the genera numbered 32–35. The leaves of Plumeria (fruit large follicles, seeds winged) and Stephanostegia are spirally arranged. In Skytanthus and Holarrhena the leaves are opposite; the former genus has its anthers with characteristic long tail-like appendages at their apices, the latter has its linear-fusiform seeds comose at one end. Gonioma, from the Cape, has whorled leaves, but is a shrub with an entirely different aspect from Dyera, in addition to having various technical differences (e.g., ovules in 2 ranks, style long).

The resemblance between Dyera and the remaining two genera, which immediately precede it in Schumann's treatment, is highly significant. Paralstonia has its seeds somewhat winged but the thickened follicles are short, little surpassing the length of the seeds; the ovules are in two series; the anthers are without the fleshy appendage so characteristic in Dyera; the flowers are arranged in fascicles in the inflorescence-branches.

In view of the obvious similarity both technical and habital between Dyera and Alstonia, the great amplitude of sectional heterogeneity within the latter genus and the wide diversification of its forty or more species, compared with the almost monotypic character of Dyera, it might be argued that Dyera is merely a limital representative of Alstonia, in which it might be best included. In my judgment, however, Dyera is sufficiently distinctive

[8] The genus was named in honor of W. T. Thiselton-Dyer.

to be maintained in its generic status. The two genera are compared[9] by the following key (italics) and descriptive characters:

Trees, glabrous, the branchlets stout; leaves whorled; gland at axil of petiole conspicuous large rigid; *inflorescences axillary* at base of season's new growth; flowers glabrous except for ring of hairs within corolla-tube below stamens; *calyx-lobes glandular* at base within; corolla-tube very short, naked at throat; corolla-lobes overlapping to right; stamens inserted a little below middle of corolla-tube; *anthers with connectives produced into a large thickened fleshy appendage;* ovary pubescent, half or more inferior; *style very short, indistinct;* gland surrounding ovary apparently none; *follicles very large and thick; seeds large, membranous-winged, glabrous*.....*Dyera.*

Trees to shrubs, glabrous to pubescent, the branchlets stout to slender; leaves whorled or opposite; gland at axil of petiole not as conspicuous as in Dyera; *inflorescences apparently terminal;* flowers glabrous to pubescent; *calyx usually eglandular;* corolla-tube very short to long, without or with a ring at throat; corolla-lobes overlapping to right or left; stamens inserted from near middle to almost throat of corolla-tube; *anthers without thickened appendage;* ovary pubescent to glabrous, half inferior to entirely superior; *style filiform, distinct;* disc apparently none, or annular, lobed or truncate; *follicles slender; seeds relatively small, comose or ciliate, not winged*.....*Alstonia.*

The species of Dyera are very closely interrelated, having overlapping vegetative characters and hardly any floral differences. "The species are so difficult to distinguish," wrote Burkill (16, p. 875), "that it is impossible to assign much of the available information to any one." This author, however, might have had in mind only the Malayan plants, *D. costulata* and *D. laxiflora*, which are here accepted as representing a single taxonomic unit. Ridley (99, p. 191) states: "I am rather doubtful as to whether there is really more than one variable species of the genus." Nevertheless, he (94, p. 249) found *Haviland 2170* (which is *D. Lowii*) a "very distinct plant." Romburgh (108, pp. 23 & 153) claims that various examples of Djeloetoeng he had observed in the jungles of Borneo resembled entirely or seemed identical in all parts, leaves, flowers and fruits, with *D. costulata* which he examined in the Botanical Gardens at Pontianak and Singapore. Howes remarks that there does not appear to be any intrinsic difference in the Jelutong of the three species, *D. Lowii*, *D. costulata* and *D. laxiflora*, though the Malayan product, owing to better methods of preparation, is generally preferred and commands an enhanced price. It is doubtful, Derry (28, p. 51) opined, whether the Jelutong produced by *D. Lowii* [spelled "*Dyera Lowiana*" through error] is distinct from that of *D. costulata*.

The taxonomic differences between the only two acceptable species of Dyera, *D. costulata* and *D. Lowii*, are extremely tenuous and difficult to express as key characters. I emphasize that it is highly dubious whether *D. Lowii* merits specific separation from *D. costulata*. Their practical differentiation, if any, must rely chiefly upon actual comparative experience. The most reliable judgment in specific identification here is that based on the agreement of several features, allowing any one of these features a wide

[9] The characters submitted for Alstonia are derived from literature and a very limited personal experience with the genus; consequently they are tentative. A taxonomic revision of Alstonia by the writer is proposed for the near future.

amplitude of individual variation. There is no clear delimitation for any single character and sometimes several or all the diagnostic features of the two species seem to intergrade. Obviously, the difficulty in naming incomplete or scanty herbarium material of non-typical specimens is sometimes insurmountable.

Leaf-blades (typical) rounded to subcordate, or narrowed but finally lightly rounded at base, short-acuminate to rounded at apex; anthers oblong-lanceolate, abruptly acute or obtuse at apex below the mucro, 0.99–1.26 mm. long.....*D. costulata.*
Leaf-blades (typical) cuneate-narrowed at base and decurrent on petiole, rounded at apex, the principal lateral nerves more numerous and closer together than in *D. costulata;* calyx-lobes tending to be more acute; anthers lanceolate, gradually acuminate at apex and merging into the mucro, 1.26–1.58 mm. long (only buds examined).....*D. Lowii.*

Seeds of only a single specimen of each species were examined; those (matured?) of *D. Lowii* were merely up to 3.5 cm. long and 1.3 cm. broad, whereas those of *D. costulata* were up to 7 cm. long and 3 cm. broad. *D. Lowii* is reported by Brown to have pneumatophores, whereas aerial roots are lacking in *D. costulata*. It is said not to grow as large as *D. costulata*, with bark not so thick, and the latex not so viscous or abundant. Brown adds, moreover, that *D. Lowii* is not so liable to disease as *D. costulata*. Several authorities agree that *D. Lowii* inhabits damp swampy lands below 50 m. alt., whereas *D. costulata* prefers dry hill forests up to 800 m. alt. In reference to altitudinal distribution, however, there are available typical specimens of *D. costulata* collected on terrain less than 20 m. high (as low as 5 m.).

In reference to the important feature of pneumatophores Romburgh (108, p. 153) states: "Dans les forêts humides où le sol est inondé de temps, on distingue déjà à une assez grande distance la présence de cét arbre grâce à certains renflements (souvent plus gros qu'une tête d'homme) que portent ses racines superficielles. L'écorce de ces renflements est d'un brun jaune, riche en latex, et couverte de lenticelles.—Dans les terrains plus élevés et plus secs, ces tubérosités sont complètement défaut."

1. DYERA COSTULATA (Miquel) Hook. f., Jour. Lin. Soc. Bot. **19**: 293. Aug., 1882.

Alstonia ? costulata Miquel, Fl. Ind. Bat. Suppl. 556. 1860.
?Alstonia eximia Miquel, loc. cit. 555.
?Alstonia grandifolia Miquel, loc. cit. 555.
Dyera laxiflora Hook. f., Fl. Brit. India **3**: 644. Dec., 1882.

Type of *Alstonia? costulata*.—"Sumatra occid. in prov. Priaman (*Diepenhorst*)." This collection consists of sterile material.

Hooker, under his original publication of *Dyera costulata*, cites: "Hab. Sumatra, *Teysmann;* Malacca, *Griffith, Maingay* (*Kew distrib. 2573*)." The *Teysmann* collection consisted of foliage only; the *Griffith* specimen was in flower, and the *Maingay* plant included flowers and fruits. As a

Malacca plant of *D. costulata*, Hooker also mentions a specimen collected by "Murton, late Superintendent of the Singapore Botanical Gardens, who has communicated to the museum at Kew leaves and old fruits, from which unfortunately the seeds have escaped." In this connection, it should be noted that a *Murton* specimen from Singapore was subsequently selected as a cotype of *D. laxiflora* Hook. f. King & Gamble cite for *D. costulata:* "Sumatra (*Teysmann, Diepenhorst 1114*)."

Distribution.—D. costulata is found generally in the entire range of the genus. It is the exclusive species in the Malay Peninsula.

Specimens examined.—Siam, Setul: *Kerr 13909* (Tung Wa; fl., Jan.; A, K, P); *Lakshnakava 353* (fl. & fr., Nov.; K, P). Federated Malay States: *For. Dept. F.M.S. 1772* (Kwala Lumpur; fl., Oct.; K), *2258* (Selangor; fr., Nov.; K), *3328* (Kwala Lumpur; immature fl., April; K), *3391* (Pulau Penang; immature fl., June; K), *3885* (Kwala Lumpur; fl. past anth., June; K), *4906* (Foxworthy; KwalaLumpur; fl. past anth., Sept.; K), *4917* (Kwala Lumpur; fl. past anth., Sept.; K); *Griffith s.n.* (1845; K); *King's Coll. 4689* (Larut, Perak[10]; fr., Aug.; K), *7852* (Perak; fl., July; K); *Maingay 1097* (=No. *2573;* Malacca; fr. & fl., Aug.; K); *Scortechini 1973* (Goping; K) *Wray 541* (fr., Jan.; Perak; K). Singapore: *Anderson 119* (K); *Burbidge s.n.* (Year 1878; K); *Cantley 226* (1882: cotype coll. *D. laxiflora;* fl., Aug.; G, K); *Clemens 22455* (fl., Oct.; N.Y); *Hullett 343* (K); *Nas s.n.* (fl., Oct.; A, NY); *Ridley* (1890; K); *undesig. coll.* (1882; K). Riouw; *Neth. Ind. For. Ser. 29993* (en Ond. Indragirische-bovenlanden, Moeara Serangge; M). Sumatra:: *Castillo & Valderrama 10* (Palembang; C, K); *Endert. 37 E. 1 P. 466 & 38 E. 1 P. 394* (Palembang; K, P); *Krukoff 237* (West Coast, Hoeta Padang Estate, near Kisarin; NY); *Neth. Ind. For. Serv. 16400 & 16407* (East Coast, below Langkat; A), *31601* (East Coast, Serdang Boschreserve Silinda; A); *Teysmann s.n.* (ex herb. Miquel; K). Sarawak, Borneo: *Clemens 21502* (Gat, upper Rejang Rv.; A); *Haviland 2049* (path to Teyora; fl., Dec.; K). British North Borneo: *Ramos 1912* (Sandakan or vicinity; fr., Sept.—Dec.; A, P, US); *D. D. Wood 2290* (C). Dutch Borneo: *Neth. Ind. For. Serv. 16255 & 16265 & 16280 & 16742 & 16962* (southeast division, West. Koetei; A), *17952 & 18246* (south-east division, Tidoengsche Landen; A), *21178* (south-east division, Poeroek Tjahoe Tahoedjan; A), *24663* (south-east division, West. Koetei; A); *Winkler 2435* (south-east division, Hayoep; K). Hort. Bot. Bog., Java: *Merrill sn.*. (fr., Nov.; cult; NY, US); *undesig. coll. 359* (cult; US). Hort. Bot. Reg. Kew, England: *Holland s.n.* (det. doubtful; cult., undesig. origin; K).[11]

The type of *Alstonia eximia* was from "Bangka, prope Djebus (*Teysmann*)" and that of *A. grandifolia*[12] was from "Sumatra orient. in prov. Palembang (*Teysmann*)." These two species were described from sterile material (*A. grandifolia* in fruit). The diagnoses are in harmony with *Dyera costulata*, although too incomplete for positive identification. The follicles of *A. grandifolia* are described as elongated and woody, which is the fruit character of Dyera rather than Alstonia. The apiculate leaf-apices in the two plants suggest *D. costulata* rather than *D. Lowii*. Miquel states

[10] *4689* is cited by Narayanaswami as collected by Kunstler in Gopeng.

[11] This specimen is sterile, consisting of a branch with terminal leaves. The leaf-blades have their lateral nerves more numerous (up to 25 principal pairs) and closer together (mostly 5–7 mm. apart near middle) than is usual in *D. costulata;* they are slightly retuse at the apex and acute-decurrent at the base. The only information appearing on the label is: "From Mr. Holland, 1916. Herb. Hort. Bot. Reg. Kew. Dyera laxiflora, H.K. f. det. J. Hutchinson. 23.6.1916." Its anomalous appearance may be accounted for by the growth of the plant under artificial conditions.

[12] *A. grandifolia* is cited in Catalogus Plantarum quae in Horto Botanico Bogoriensi Coluntur (1866).

that *A. grandifolia* approximates *A. eximia*, but is more robust and with larger leaves. In the absence of the actual specimens, I place these species questionably in synonymy of *D. costulata*, where they very probably belong.

The above disposition of *A. eximia* and *A. grandifolia* is in agreement with that of Heyne (60, p. 1276) and Symington. Heyne cited these species as belonging to Dyera: "*Alstonia* (*Dyera*) *Eximia* Miq." and "*Alstonia* (*Dyera*) *grandifolia* Miq." For the former he stated: "De onder dien naam beschreven boom behoort echter tot het geslacht Dyera"; and for the latter: "Ook deze boom is ongetwijfeld een Dyera soort en zeer waarschijnlijk identiek met *D. costulata* Hook. f." Hooker (68, p. 643) describes *A. grandifolia* under Species of Doubtful Position, and cites *T. Anderson* (Singapore). He notes: "Of this I have seen only two leaves, which precisely agree with Miquel's from Sumatra." Likewise, King & Gamble place *A. grandifolia* under Species Imperfectly Known and cite *Anderson 119*. Ridley (105, p. 348) states that the *Anderson* collection consists of leaves apparently of *Dyera costulata;* Symington also identifies them as of *D. costulata*, and there is no doubt that this determination is correct.

The cotypes of *Dyera laxiflora* Hook. f. are: "Singapore; *Murton, Cantley*." The following is the original description of this species by Hooker: "leaves narrowed to the rounded or subacute base, cymes long peduncled, corolla-lobes four times as long as the tube. Closely allied to *D. costulata*, but with much larger leaves, sometimes 8 in. long, petioles 1½–2 in. Peduncles of cymes very slender, 3–5 in., pedicels ¼–½ in. Corolla-lobes linear, ⅛ in. long." In comparison, Hooker notes in the same work the following characters for *D. costulata:* leaves rounded at the base, 2–4 in. long, petioles ½–1 in., cymes shortly peduncled, 2–3 in. long, pedicels short, corolla-lobes about twice as long as the tube.

King & Gamble, Ridley in the Flora of the Malay Peninsula (105, p. 345), and Foxworthy (47, p. 110) accept the validity[13] of *D. laxiflora* and compare it with *D. costulata* as follows (characters compiled from the three works conjointly):

Corolla-tube (0.075 in. long) much shorter than lobes (0.2 in. long); cymes with long peduncles; fruits rather larger than in *D. costulata*, seeds distinctly smaller (about 2 in. long and not more than ¾ in. wide including wing); leaves under 8 in. long, shorter acute at tip, the main lateral

[13] Mention has already been made of Ridley's expression of doubt in the Agricultural Bulletin (99, p. 191) concerning the validity of *D. laxiflora* & *D. Lowii* as distinct species from *D. costulata*. Previously in the same Bulletin (98, p. 95) Ridley had gone on record as regarding *D. costulata* and *D. laxiflora* synonymous. Several years earlier (Year 1900. 94, p. 249) he had written: "The leaves vary a good deal and are often smaller than described and in young shoots, stumps, etc., very much longer. This variation in specimens is perhaps the cause of two species of Dyera being described in the Flora of British Indies, viz. *D. costulata* and *D. laxiflora*. I have not recognized more than one species here, but the Malays do talk of two plants, Jelutong and Jelutong Pipit."

nerves (13–17 pairs) starting at about 60° with the midrib ..... *D. laxiflora.*
Corolla-tube (0.1 in. long) nearly as long as lobes (0.15 in. long); cymes with short peduncles; leaves usually under 6 in. long, the main lateral nerves (16–20 pairs) starting nearly at right angles to the midrib ..... *D. costulata.*

According to Foxworthy, *D. laxiflora* has a denser crown than *D. costulata;* bark thicker, with rougher surface, inner bark rather whitish (pale brownish in *D. costulata*); latex much less. According to Burn-Murdoch, *D. laxiflora* yields about $\frac{1}{5}$ as much latex as *D. costulata* (*D. laxiflora* yields practically no Djeloetoeng, according to Heyne, Recueil, p. 52); wood is lighter (19.5 lb. per cubic ft.); and the tree is more common than *D. costulata* in the Malay Peninsula.

Several other authorities apparently have accepted the validity of *D. laxiflora*, but the latest and most thorough student of the problem, Symington, finds this species identical with *D. costulata*. Watson (127, p. 57) writes concerning *D. laxiflora:* "As a result of careful examination by the Forest Botanist of the type material on which the descriptions were based, combined with field investigations, which have been greatly facilitated by the large number of trees now being tapped all over the country, there is hardly room for doubt that the second species can not stand." Burkill (16, pp. 875 & 876) makes a similar statement. And in his own words, Symington concludes: "After study of the herbarium material at Kew, Singapore, and Kepong, and after considerable field observation, I am forced to conclude that we have but one species [in the Malay Peninsula], namely *Dyera costulata* Hook. f."

I have examined a fair representation of the two species, including a cotype of *D. laxiflora*, and besides finding the flower-pedicels in the latter to average a trifle longer than in typical *D. costulata* I could not discover any difference between the two. This apparent difference in length of pedicels is hardly uniform even in equally matured flowers and is not without intergradation even in the very limited material examined by me; consequently it should not be regarded as of specific value.

Naturally, as it is true of most of the economically important plants which have been extensively exploited, there are recognized in *D. costulata* various minor field distinctions which are sometimes based on real individual or local (ecological) variations. Generally, however, the popular classifications fancied by the native collectors of latex are mere chimeras. Brown reports that some individual trees have a different type of bark from others—thin hard bark, and produce less latex than those whose bark is thick and quite soft. Foxworthy (47, p. 111) also notes that some individuals are very much better yielders than others. Burkill (16, p. 876) states: "Collectors of latex frequently distinguish between red-barked and black-barked kinds, but, so far, no one has succeeded in definitely rec-

onciling any particular forest characteristics with either of the two supposed forms. Their requirements in the way of soil appear to be identical."

2. DYERA LOWII Hook. f., Jour. Lin. Soc. Bot. **19**: 293. Aug., 1882.

?Alstonia polyphylla Miquel, Fl. Ind. Bat. Suppl. 556. 1860.
Dyera borneensis Baillon, Bull. Men. Soc. Linn. Paris 1(94): 751. 1888.

Cotypes of D. Lowii.—"Hab. Borneo, *Low*, *Beccari;* Sarawak, *Thos. Lobb.*" The *Beccari* specimen is numbered *3570*.[14]

Hooker notes that he also examined a flowering specimen collected by *Burbidge* from cultivation in the Singapore Botanical Gardens. The only *Burbidge* collection seen by me is of *D. costulata;* it is deposited at Kew and is probably the specimen Hooker had in mind.

Distribution.—*D. Lowii* is found generally in the entire range of the genus outside of the Malay Peninsula. It is reported from Borneo and Sumatra, and Billiton, Banka, Singkep, Lingga and Riouw.

Specimens examined.—Riouw: *Neth. Ind. For. Serv. 28564* (en Ond. Indragirische-bovenlanden, Belimbing; A), *29145* (en Ond. Indragirische-bovenlanden, P. Gelang; M). Billiton: *Heyne 765* (K). Dutch Borneo: *Low s.n.* (cotype; K); *Neth. Ind. For. Serv. 18112* (south-east division, Koeala Kapoeas; A), *19973* (south-east division, Bencde Dajak, Bawan; A). British North Borneo: *J. P. Edwards 3893 & 3894* (Mile 53: J'ton-B'fort; K). Sarawak: *Beccari 3570* (type of *D. borneenis*, cotype *D. Lowii;* K, P); *Haviland 2170* (Kuching; fl., Dec.; K); *Haviland & C. Hose 3495* (Niah; fl. & fr., May; K); *Thos. Lobb s.n.* (1857; cotype; K).

The type of *Alstonia polyphylla* is from "Bangka (*Teysmann*)." The species was described from sterile material. The diagnosis is in harmony with *Dyera Lowii,* although too incomplete for positive identification. The leaves cuneate obovate or obovate-oblong, broadly rounded or sometimes retuse at the apex, suggest *D. Lowii* rather than *D. costulata*. In the absence of the actual specimen, I place this species questionably in synonymy of *D. Lowii*. It should be noted that the publication of *A. polyphylla* antedates that of *D. Lowii*, and in the event the two are proven identical, which most probably will be the case if the type of Miquel's species becomes available, *D. Lowii* (unless conserved) will fall into synonymy under *Dyera polyphylla*.

Heyne (60, p. 1277) referred *A. polyphylla* to Dyera with certainty: "*Alstonia (Dyera) polyphylla* Miq. . . . De door Miquel beschreven plant is zeker een Dyerasoort een gelijkt zeer op *Dyera Lowii* Hook. f."

The type of *Dyera borneensis* is from Sarawak, Borneo, "le N° *3570* de la collection *Beccari*." It was extracted from the cotypes of *D. Lowii*, published earlier by Hooker. Baillon, in Bull. Soc. Lin. Paris, states that he believes *Beccari 3570* is a Dyera. In which case, he adds, some modifications are desirable in Hooker's generic diagnosis: the ovary is $\frac{1}{2}$–$\frac{2}{3}$ inferior, its two cells incompletely closed at the top, the thecae of its anthers very

[14] *Beccari 3570* was subsequently selected by Baillon as the type of *Dyera borneensis*.

unequal. These characters are repeated by Baillon in the generic description of Dyera in Histoire des Plantes. Baillon adduces hardly any specific features for distinguishing *D. borneensis*. The leaf-blades of *Beccari 3570* are noted as being attenuated at base, rounded at apex, and with at least 20 pairs of secondary nerves.

I find the ovary in Dyera to be partly inferior as noted by Baillon, but consisting of two very closely set carpels. There is thus no indication of a single cell. Schumann remarked that he doubted *D. borneensis* was a Dyera, judging by its supposed one celled ovary.

Burkill (16, p. 875) stated that *D. borneensis* and *D. Lowii* are probably identical and, moreover, perhaps identical with *Alstonia polyphylla*.

I have examined the type collection of *D. borneensis* and do not hesitate to place the species with the typical material of *D. Lowii*.

EXCLUDED NAMES

"*Dyera Maingayi* Hook. f."—nomen nudum. Ridley, in Malay Plant Names (Year 1897. 93, p. 110) lists *Dyera Maingayi* Hook. fil. and *D. costulata* Hook. fil. as corresponding to the native name Jelutong. He submits no description for either name, merely remarking: "A big tree which gives a very inferior India Rubber, and a timber used for clogs, boxes and such things." The name *Dyera Maingayi* has appeared without diagnosis in the works of various other authors: Morris (year 1898), Warburg (1902), Ridley & Curtis (1902, As *D. Maingayii*), Skeat & Blagen (1906. Said to abound in the Malay forests and noted to have a bark corresponding closely to the color of the Spectacled Monkey), Clercq (1909), Gerth van Wijk (1941. A Dictionary of Plant Names). The only original species of Apocynaceae described by Hooker fil. in The Flora of British India under the specific name *Maingayi* are in the genera Vallaris, Urceola, and Epigynum.

"*D. Plumosa*."—After referring to *Dyera costulata*, Derry (29, p. 51) adds in a footnote that another species, "*D. Plumosa*," grows in Fiji and is stated to produce rubber of some value. The name is probably an error for *Alstonia plumosa*. Jumelle (70, p. 168) records that, on the basis of a sample sent from Fiji and experimented upon at Kew, *Alstonia plumosa* produces a very useful caoutchouc.

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Studies on Some Fungi of Northwestern Wyoming
III. Pleospora and Leptosphaeria[1]

Lewis E. Wehmeyer

A previous paper (10) was devoted to a general list and account of the fungous flora of northwestern Wyoming, and data concerning elevation and other particulars of the chief localities in which collections were made can be found therein. The present paper is concerned with a more detailed consideration of the many collections of the genera Leptosphaeria and Pleospora made upon herbaceous stems in this region.

The taxonomic situation in the genera Leptosphaeria and Pleospora is one of great confusion. This confusion stems from two sources; first the actual situation as it exists in nature; and second, that created by systematic mycologists in the literature. Let us look more closely at these two sources of confusion.

It is necessary to realize at the outset that nature recognizes no such entity as a species. There exists in nature a vast assemblage of individual occurrences which present an overlapping series of variations for almost any character one wishes to mention. Such a series for any one character, furthermore, is not necessarily correlated with the series for any other character. Only where long periods of time, or other factors, have eliminated blocks of such series, do well defined groups of individuals stand out as isolated entities which we can recognize as natural species. In other complexes, particularly if variation is actually taking place at the present time, specific lines must be drawn in an entirely artificial manner and all sorts of intergrades, which must be arbitrarily placed, are to be expected.

For example, if one takes a large series of collections, or even such a moderate number as in the present study, of Pleospora, and arranges them according to several spore characters such as size and septation, it will be found that over a wide range there are no breaks in the overlapping variations of individual collections. Where there are such breaks, one suspects and often finds that further collections will fill these gaps. A certain correlation will be found between spore size and septation, i.e. the smaller spores, in general, have the fewer septa, but here too there is a great deal of overlap. The greater the number of characters considered, the greater this apparent confusion becomes. This leads one to the concept of large species complexes, within which specific or varietal boundaries are purely arbitrary.

In such a situation it is obligatory that any exposition of the natural relationships should be based upon the careful comparative study of a

[1] Papers of the Department of Botany, University of Michigan No. 766.

large series of collections covering the entire field of the category under consideration. This has never been done for either Pleospora or Leptosphaeria.

What then is the present situation in the taxonomic literature? If one plots, as mentioned above, the spore size and septations as recorded in Saccardo for the various described species, the same overlapping series presents itself, suggesting that individual variations are being described as species. This, however, is only a superficial manifestation of several sources of confusion. Most species have been erected upon one or a few collections without any regard to their relation to the already described species or the plan of evolution within the group. Each individual worker has used his own concept of what character or characters are of diagnostic value, so that important data are often lacking in a description and there is an insufficient common background upon which the supposed species can be compared. The concept of the host occurrence as a differential character, for instance, is used by some writers and not by others. The present study indicates that species of Pleospora are not limited as to the host genus upon which they occur. A glance at the tables presented will show this. Nevertheless, the difficulty of matching collections with published descriptions has led species describers to accept the occurrence of a Pleospora on a new host as the basis for the erection of a new species. This naturally leads to numerous synonyms, which are, however, almost impossible to place correctly until the true relationships of these fungi as they exist in nature are known.

If one looks farther in the literature, another consequence of this confusion appears. Each writer has made his own interpretation of described species so that spore measurements and other characters show a wide variation in the interpretation of one and the same binomial in different publications. Many determinations, likewise, are unreliable. Another source of confusion is the fact, already mentioned (10), that several species, particularly of Pleospora, often occur intermixed on one and the same stem. As a result, even much type material consists of such mixtures.

From what has just been said, it is obvious that the application of binomials to collections of Pleospora and Leptosphaeria is a somewhat hazardous undertaking. In the following pages an attempt has been made to arrange a series of western collections of Pleospora and Leptosphaeria in such a way as to indicate the general tendencies in the evolution of these groups so that natural species groups based largely upon spore characters, which seem to be the most dependable, could be detected. When collections having a similar spore form are arranged according to spore size and septation it is found that the different series of overlapping spore sizes do show slight breaks which are sometimes correlated with change in spore form and sometimes not. These groups, which are rather large, for the most part, are

considered here as species. Such a conservative separation is believed by the writer to be the preliminary step in any recognition of natural species. Further study of larger numbers of collections may show other characters which may be used to segregate smaller groups as species or varieties, or may advise the union of groups now supposed to be good species, but to make such separations without sufficient data to show real differences is what has caused a great deal of the confusion in the past. The naming of these groupings is another matter. Most of the groups present ranges of variation which extend over that of several already described species. Ultimately, a name is merely a handle to be used as a convenience. If misused, it may equally become an inconvenience. When type material has been found to fall in these groups, the name applied to this type is used, or if a group seems to coincide with a commonly used name, it is also adopted. The probable change of these names in the future does not seriously worry the writer, if such change is proper and helps simplify the nomenclature. The important thing is to recognize the group of collections, present and future, which may properly go together to form a natural species or other group.

PLEOSPORA

The spore forms in both Pleospora and Leptosphaeria appear to be derived from a common type which is the 3-septate, dark brown, ellipsoid or inaequilateral spore common to many species of Leptosphaeria. In Pleospora the spore forms can be roughly grouped into four series. In the first, the spore is derived from the Leptosphaeria type just mentioned by the insertion of vertical walls in only some of the transverse cells, or in an irregular fashion. In the second, the vertical walls are more constant, but often absent from the end cells, but the spore retains the inaequilateral fusoid-ellipsoid form. In the third series, there is a greater tendency for the formation of vertical walls. There are often two, three or more vertical walls here formed in each transverse section. The end cells are usually vertically septate and the spore becomes broader, oblong-ellipsoid, with rounded ends. There is also a tendency for the spores to be asymetrically divided, by a constriction, into two unequal portions. The fourth series, distinct from the first three in the flattened character of the spores, has been segregated into a separate and fairly distinct genus, Clathrospora, which is characteristic of high latitudes and altitudes. The perithecia in Pleospora are often thick walled or sclerotial and the development is probably of the pseudosphaeriaceous type throughout, but they may become thin-walled and in many species are pezizoidly collapsed. There is a definite tendency for the formation of a radiating brown tomentum from the base of the perithecium in many species, or of upright spine-like hyphae from the upper portion. This latter character has been used to segregate the

genus Pyrenophora. This character is sometimes quite pronounced, but there is so much variation with age and conditions of growth, that it is of doubtful value as a generic character. Other genera, such as Catharinia Comoclathris etc. have been segregated, but in this account all species are reported under Pleospora.

With the spore changes mentioned above, the asci in Pleospora tend to become broadly ellipsoid to saccate with thickened walls and a short claw-like base. There is, apparently, a thick gelatinous layer just inside an outer tough wall. At maturity, in water, this gelatinous layer absorbs water creating a pressure which ruptures the outer wall at some point (not necessarily the apex). When this occurs the protoplasmic content of the ascus elongates to twice or more the length of the ascus wall, carrying the spores within it in a single row, beyond the old and now discarded ascus wall. This emission of spores was seen in asci which had been dried in the herbarium for four years.

Only one species belonging to the first spore type was found in the Wyoming collections, and it appears to be new.

Pleospora Amelanchieris sp. nov.

Pl. 1, Figs. 1–2

Perithecia large, 400–800μ in diameter, subglobose or slightly flattened, carbonaceous, black, rimosely cracked, ostiole not apparent or present as a mere perforation from which radiate deep cracks in the wall. Perithecia formed beneath the periderm, which tissue is, however, soon exfoliated, leaving the perithecia superficial and appearing as a Teichospora, thickly scattered or clustered, walls thick (50–100μ), of coarse black parenchyma.

Asci clavate at first, becoming long cylindric, with a claw-like base, 140–195 × 14–16μ.

Spores biseriate at first, becoming uniseriate, oblong- to fusoid-ellipsoid, 22–26 × 9–10.5μ. These spores are primarily 3-septate, but secondary transverse or vertical septa can be laid down in any or all of the central cells, giving rise to a 3–5 septate spore. The septa in the end cells are often oblique, forming a "Y"-shaped septum.

Hoback Canyon July 16, on *Amelanchier elliptica* A. Nels. legit L. E. Wehmeyer (1141) (Type).

Perithecia 400–800μ diametro, subglobosa vel paululum depressa, atra, dense dispersa vel aggregata, carbonacea, rimosa, sub peridermate mox exfolianti formata, delapsu peridermatis superficialia ut in Teichospora, parietibus 50–100μ crassis, atris, parenchymatosis; ascis clavatis, 140–195μ longis, 14–16μ crassis, ultimo longe cylindricis, basi unguiformibus; sporis biseriatis, demum uniseriatis, oblongis vel fusiformiter ellipsoideis, 22–26μ longis, 9–10.5μ crassis, primum triseptatis sed saepe septis secondariis transversis vel verticalibus in cellulis singulis vel in omnibus centralibus, ad ultimum 4- vel 5-septatis, septis in cellulis terminalibus obliquis Y-formibus.

Specimen typicum in ramis *Amelanchieris ellipticae A.* Nels., in Hoback Canyon, Jackson, Wyoming, 16 Jul., 1940, legit L. E. Wehmeyer, sub numero 1141.

This species is characterized by the large, black, rimose perithecia which

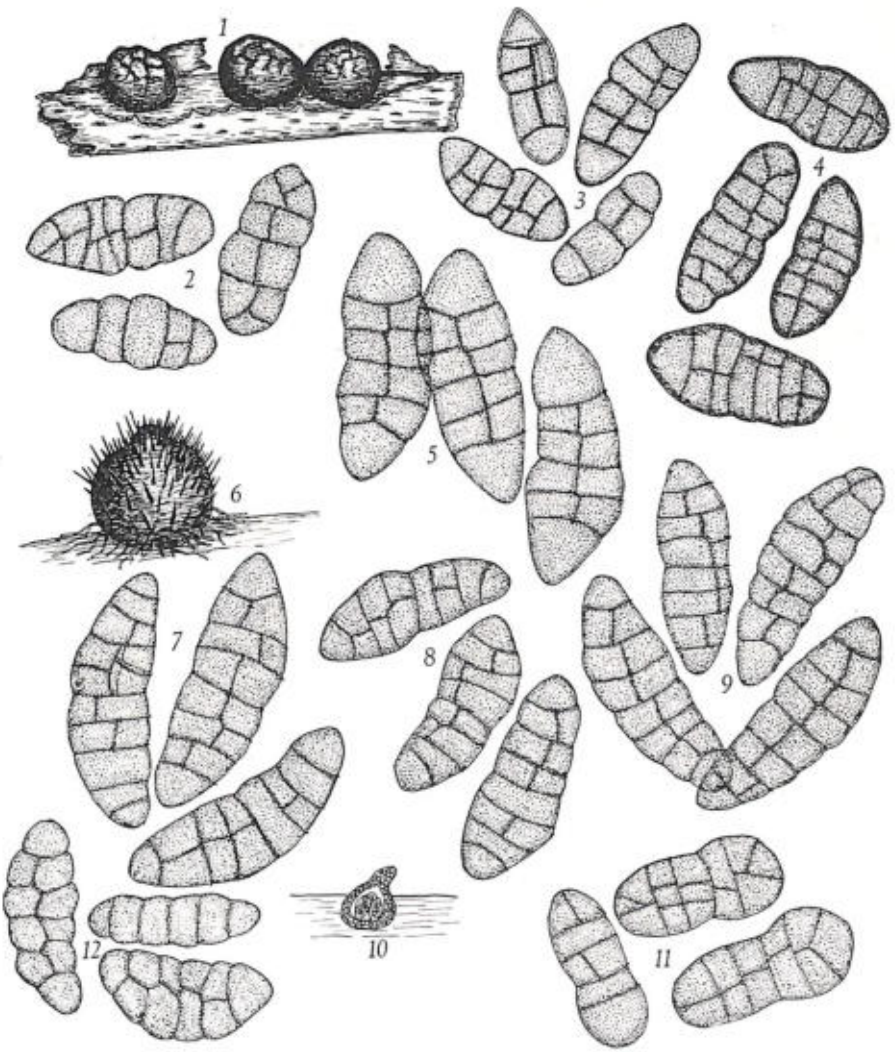


PLATE 1. 1. Habit of "rimose" perithecia of *Pleospora Amelanchieris* sp. nov. 2. *Pleospora Amelanchieris* sp. nov. 3. *Pleospora vulgaris* Niessl. 4. *Pleospora Compositarum* Earle. 5. *Pleospora richtophensis* E. & E. 6. Setose perithecia of *Pleospora* (*Pyrenophora*) *pleosphaerioides* sp. nov. 7. *Pleospora* (*Pyrenophora*) *pleosphaerioides* sp. nov. 8. *Pleospora punctata* sp. nov. 9. *Pleospora* (*Pyrenophora*) *tomentosa* sp. nov. 10. Vertical section of perithecium of *Pleospora oligasca* Bub. 11. *Pleospora oligasca* Bub. 12. *Pleospora* (*Clathrospora*) *togwotiensis* sp. nov. Scale, 1 mm. = 1μ. Figs. 1, 6, 10. Perithecia. Figs. 2–5, 7–9, 11–12. Ascospores.

soon become superficial by the exfoliation of the periderm, and by the variable septation of the spores. It has been issued by Clements (Crypt. Form. Colo. No. 456) as a new species, *Teichospora praestipa*, but, apparently, a description was never published. It might easily be mistaken for a Teichospora. It is near *P. Shepherdiae* Pk., but that species differs in the more deeply seated, not widely erumpent perithecia, whose surface is granular rather than rimose; in the narrower (110–160×7–9μ) more cylindric asci; and in the spores which are constantly 3-septate, measure 17.5–21×7.5–9μ and are very tardy in the formation of their vertical septa.

THE VULGARIS SERIES

The name "vulgaris" series is used here merely for convenience for several species which seem to be derived from what is interpreted as *P. vulgaris*.

Table 1 represents, entirely aside from the application of any binomials, a series of collections from Wyoming in which there is a common basic spore form. This table (and those following) gives the characters of each collection by host and number. The figures for spore and ascus size and for spore septation are taken from one or more mounts, including anywhere from several to a dozen or more perithecia. They do not show any distribution curve, but are fairly accurate as to the range in size for each collection. Under perithecia, the figures represent the diameter, "D" stands for depressed-globose, "C" for collapsing-pezizoid, "T" for basal tomentum, "S" for apical setae, and "G" for globose perithecia. Small letters indicate a lesser degree of the same condition.

The basic spore type in this series is fusoid-ellipsoid in form, slightly curved or inaequilateral and more acute than in the following "herbarum" series. This spore is at first 1- then 3-septate. A vertical wall is then laid down in the two central cells of this 4-celled spore. Following this, cross-walls are independently formed on the two sides of the vertical septum, so that they may occur on only one side of the vertical wall, or at different levels on the opposite sides. The end cells remain without a vertical septum.

If one glances at Table 1, it will be seen that the spore ranges of individual collections present an almost continuous overlapping series with gradually increasing size. The collections in section "A" have spores (fig. 3) of this basic type with 3–5 cross walls and measuring 17–26×7–10μ, and are considered under the name of *P. vulgaris*. Section C of the table is a continuation of this same series, in which the spores (fig. 5) run larger, 26–40×9–15μ, and are more constantly 5-septate. These appear to fit *P. richtophensis*. This increase in the number of cross septa is carried still further in the 7-septate species, *P. tomentosa*, *P. pleosphaerioides* and *P. punctata*.

In section B, of Table 1, we have a series of collections with spore sizes more or less parallel to those in section A, but which show the transition in spore form (fig. 4) from that of the vulgaris to that of the herbarum series. In these collections the spores are more constantly 5-septate and there is a tendency for a "Y"-shaped septum, or a transverse and vertical wall, to form in each end cell. This results in a 7-septate spore with vertically sep-

TABLE 1

No.	Host	Spore Range	Septation	Asci	Perithecia
		A			
1016a	Penstemon	17.5–21.5×7–9.5	3–5	75–120×14–18	3–350, D
1220	Bupleurum	18–23×7–8.5	3–5	70–88×14–18	250–350, d
1015	Castilleja	19.5–24×7.5–9	3–5	78–85×14–18	2–350, D, c, T
1056c	Aquilegia	19.5–26×7–9	3–7	70–80×16–18	250–300, D, C, t
1067a	Pedicularis	19.5–25×8.5–10.5	5	75–90×16–17	250–350, d, t
1185a	Draba	20–25×8.5–9.5	3–5	60–65×16–19	150–200, D, c, t
		B			
1108a	Rudbeckia	19.5–26×9–10.5	5–7	78–100×19.5–23	2–300, t
1201	Penstemon	20–26×8–10.5	5–7	78–90×14–18	250–350, D, T
1159	Castilleja	21.5–24.5×8.5–9	5–7	78–88×17–19	2–300, D, C, t
1089	Penstemon	21.5–26×10–11	5–7	65–70×17–21	1–200, d, t
1086	Penstemon	21.5–28.5×9–12.5	5–7	85–96×21–22	2–250, t
1121a	Agastache	22–28×9–12	5–7	85–110×17–20	2–250, t
1078	Castilleja	22–27×9.5–11.5	3–7	70–78×16–18	150–200, d
1022	Umbellifer	23–28×9–12.5	7	110–135×18–22	2–400, d, t
1085	Solidago	23–28×10–12	5–7	75–88×19–21	2–250, d, t
		C			
1168a	Senecio	26–32×9–11	5	78–90×20–22	250–450, C, T
1100b	Helianthella?	28–35×11–13	5	120–130×24–26	3–450, D, C, T
1127a	Achillaea	28.5–32×10–11	5	88–100×21–24	3–400, D, T
1113b	Erigeron	30–34×11–13.5	5	85–95×21–23	3–400, d, t
1121	Agastache	30–35×12.5–15	5	120–140×26–31	350, D, C, T
1119a	Osmorrhiza	30–35 (37)×11–14	5	78–110×20–22	350–400, D, C, T
1084	Umbellifer	30–39×12–13	5	100–120×23–27	2–350, D, C, T
1127	Achillaea	35–38×12.5–15	5	85–120×21–26	250–500, DT,
1280a	Senecio	35–40×12.5–14	5	134–175×27–32	3–400, d

tate end cells. Spores of these collections also tend to be broader and more rounded at the ends, although an inaequilateral form can be distinguished in many spores. These collections correspond to *P. Compositarum* and the continuation of these tendencies to form broader, larger, more oblong, more definitely 7-septate spores results in a complete intergrading series into forms like *P. herbarum*.

These collections are easily confused with *P. vulgaris*, and certain ones, such as Nos. 1159 & 1078 on *Castilleja* and 1056c on *Aquilegia*, show spores

of both types, and are difficult to place. The size of the perithecia and the amount of basal tomentum in both *P. vulgaris* and *P. Compositarum* is variable but shows no correlation with spore characters or host, as can be seen from Table 1. In the upper range of the *P. Compositarum* series, as in the series of *P. herbarum*, there is a tendency for some collections to form apical setae, which will be mentioned later.

In this situation, specific lines must be drawn in an entirely arbitrary fashion, for there will always be collections which will overlap such arbitrary limits.

PLEOSPORA VULGARIS Niessl

Pl. 1, Fig. 3

Perithecia causing scattered, black, conic, papillate pustules on the stem, globose or usually depressed-globose, becoming somewhat pezizoid collapsed with age, with more or less brown creeping tomentum at the base, but this usually beneath the epidermis and not visible superficially, 100–350×100–250μ.

Asci stout clavate with a thickened wall and a stout, short, claw-like base, 70–120×14–19μ.

Spores biseriate, oblong- to fusoid-ellipsoid, ends usually acute but sometimes obtuse, often inaequilateral or slightly curved, 3-septate at first, then 5-septate, 2nd and 4th septa commonly incomplete, lacking or irregular, constricted at the central septum, with a vertical septum in each of the central cells but not in the end cells, rather dark brown, 17.5–26×7–10μ.

Camp Davis: on *Penstemon glaber* Pursh, June 18 (1016a); *Bupleurum americanum* Coult. & Rose, July 4 (1220); *Castilleja flava* S. Wats., June 18 (1015); *Pedicularis groenlandica* Retz. (Willow Creek), June 28 (1067a), and *Senecio Rydbergii* A. Nels., June 19 (1033b).

Hoback Canyon: on *Aquilegia coerulea* James (Forest Camp), June 25 (1056c); *Draba luteola* Greene (Red Creek), June 29 (1185a).

Niessl (8, p. 187) says that *P. vulgaris* differs from *P. herbarum* only in the 5-septate, smaller spores and in the smaller asci and perithecia. These American collections show spores which are more fusoid-ellipsoid and inaequilateral, but there is an intergrading series into *P. herbarum* as has been mentioned. Berlese (2, 2; 11) places *P. vulgaris*, *P. socialis* etc. as synonyms of *P. infectoria* Fck., and gives an excellent figure of the type of spore here discussed (Pl. 13, fig. 2), for this latter species. The spores of *P. infectoria* have been variously given as 18–26×9–12 (Fuckel & Saccardo) 17–26×7–9 (Winter), 18–22×8–10 (Berlese) and 15–21×8–10 (Ellis). An examination of a Fuckel collection (No. 463) in the Farlow Herbarium, which is apparently a syntype with Fung. Rhen. 2246, shows small spores 15–18 (20)×6–7μ in perithecia which are crowded in linear blackened spots on grasses, in which respects it differs from these western

collections, which are, therefore, kept separate under the binomial *P. vulgaris*. Only comparison with Niessel's type can determine whether it is identical with these western collections.

Pleospora Compositarum Earle

Pl. 1, Fig. 4

Perithecia scattered, appearing as blackened conic pustules, often with an abundant surface growth of brown torulose hyphae, globose to depressed-globose, ostiole minute papillate, becoming collapsed in age, with more or less radiating tomentum at the base beneath the epidermis and sometimes with a few apical spines, when young, 100–350×100–250μ.

Asci stout clavate, thick-walled, with a claw-like base, 65–135×14–23μ.

Spores biseriate, oblong-ellipsoid, ends rounded, obtuse or with the lower half inaequilateral and more acutely tapered, 5- to 7-septate, with usually one vertical septum in each cell, including the end cells, in most cases, 19.5–28×8–12.5μ, dark in color.

Camp Davis: on *Castilleja linariaefolia* Benth., July 3 (1078); *Penstemon glaber* Pursh., Aug. 3 (1201).

Junction of Hoback & Snake Rivers: on *Castilleja linariaefolia*, Benth., July 15 (1159).

Cream Puff Mt.: July 5, on *Penstemon Rydbergii* A. Nels. (1089); *P. stenosepalus* (Gray) Howell (1086) and *Solidago sp.* (1085).

Teton Pass Road: on Umbellifer, June 2 (1022); and South of Teton Pass: July 11, on *Rudbeckia occidentalis* Nutt. (1108a) and *Agastache urticifolia* (Benth.) Rydb. (1121a).

The species complex represented by the group of collections in section B of Table 1 is no doubt represented by a number of described species. *P. lepidiicola* Earle, *P. Senecionis* Earle, and *P. Compositarum* Earle are all of this series (with spores 18–26×7–10μ). Inasmuch as *P. Compositarum* is the first name (in page position) to be definitely fixed with this series, it is used here. This series probably also corresponds to the *P. media* of Niessl (8, p. 188), who says that that species differs from *P. vulgaris* chiefly in the darker spores and the vertical septum which extends through the end cells. He gives the spores as 5-septate, however, and 18–23×10–11μ, which would correspond only to the smaller spored representatives of this series. Berlese (2, 2; 12) gives the spores of Niessl's material as 22–24×9–12μ, and those of his var. *Limonum* as 25–38×10–12μ.

The perithecia of this group often form a crown of setae on their upper surface. When the epidermis is persistent, these setae may have difficulty in penetrating it, or they may be deciduous in age, so that there is a great deal of variation in this character. In collections in the higher spore range and more constantly seven-septate, these setae are often persistent and have been described in Pyrenophora. *Pyrenophora Castillejae* Earle, and

P. Clematidis Earle are of this type. This type of spore, again, grades off gradually into that characteristic of *P. herbarum*. The spores of No. 1098, on Solidago, are definitely larger than those of No. 1108a, on Rudbeckia, but all intermediate variations are encountered. Host distribution again is not correlated with spore size.

PLEOSPORA RICHTOPHENSIS E. & E.

Pl. 1, Fig. 5

Perithecia widely or thickly scattered, at first immersed, appearing under the epidermis as hemispheric black pustules, later free, superficial, depressed spheric, with a minute papillate ostiole, finally somewhat collapsed and with a more or less well developed radiate basal tomentum beneath the epidermis, but not visible superficially, 250–500μ in diameter.

Asci stout clavate with thickened walls and a claw-like base, 80–108×19–23μ.

Spores biseriate in the ascus, fusoid-ellipsoid, inaequilateral or slightly curved, 5-septate, constricted at the central septum, with one vertical septum in the four central cells, end cells elongate and without a vertical septum, (26) 28–35 (40)×(9) 11–14μ.

Cream Puff Mt.: on umbellifer, July 5 (1084).

South of Teton Pass: July 11, on *Achillea Millefolium* L. (1127, 1127a); *Agastache urticifolia* (Benth.) Rydb. (1121); *Erigeron salsuginosus* Gray (1113b); *Glycosma* (Osmorrhiza) *occidentalis* Nutt. (1119a).

Togwotee Pass: July 8, on Composite (Helianthella?) (1100b)

Skyline Trail: on *Senecio crassulus* Gray, July 24 (1168a); and *Senecio* sp. (Overlook), Aug. 5 (1208a).

This species seems to be more alpine in its distribution than the two preceding. All of the collections were made above 9000 ft. elevation.

Ellis' N.A.F. 3523, of *P. richtophensis*, collected by Baker in Colorado, is identical with this group of collections, the spores (26–32×10.5–12.5μ) being in the lower portion of their range. This species has the spore form of *P. vulgaris*, but the spores are larger and more constantly 5-septate. The perithecia run somewhat larger and the asci somewhat broader than in that species.

The collection on Achillea of this species shows a mixture of perithecia of two types (1127 & 1127a), one containing spores 28.5–32×10–11μ and the other, spores 35–38×12.5–16μ. The spores were all 5-septate, but the two types were distinct enough to be easily picked out by the eye. Of some twelve perithecia examined, all but one contained only spores of one type or the other. The one exception had spores of the smaller type, with some spores running to 35×12.5μ. Similar situations have been noted in other species and they are of special interest, for they suggest that there may be strains within these larger complexes, as to spore size, which may be more

constant within themselves, but that there may be some mechanism of hybridization which results in the overlapping variations usually found.

The following three species are all similar in having a 7-septate type of spore which could easily be derived from that of *P. richtophensis* by the insertion of an extra septum in each end cell.

Pleospora (Pyrenophora) tomentosa sp. nov.

Pl. 1, Fig. 9

Perithecia scattered, 300–400×150–200μ, depressed spheric, with a minute papillate ostiole, collapsing with age, remaining long immersed beneath the epidermis, with an abundant radiate growth of basal brown hyphae and some stiff setose hairs on the upper surface of the wall, which may project beyond the epidermis as brown setae.

Asci clavate, thick-walled, with a claw-like base, 85–108×19–23μ.

Spores biseriate, fusoid-ellipsoid, slightly curved, muriform, 7-septate, constricted at the central septum, end cells without any vertical septum, yellow-brown, 26–35×10.5–13μ.

Hoback-Snake River Junction, on *Castilleja linariaefolia* Benth., July 15 (1159a); and Teton Pass Rd., on *Rudbeckia occidentalis* Nutt., July 11, legit L. E. Wehmeyer (1108) (Type).

Perithecia dispersa, depresse globosa, 300–400μ diametro, 150–200μ alta, sub epidermate immersa, basi tomento brunneo, copioso, radiato, et in superiore parte paucis setis interdum supra epidermatem prolongatis praedita. Asci clavati, crasse membranosi, 85–108μ longi, 19–23μ lati, basi unguiculiformes. Sporae biseriatae, fusiformiter ellipsoidales, paululo curvatae, muriformes, 7-septatae, ad septum medium constrictae, lutei-brunneae, 26–35μ longae, 10.5–13μ crassae, cellulis terminalibus non verticaliter septatis.

Specimen typicum in caulibus vetustis *Rudbeckiae occidentalis* Nutt., prope Teton Pass, Jackson, Wyoming, 11 Jul., 1940, legit L. E. Wehmeyer, sub numero 1108.

It is quite possible that this and the following species are growth forms or varieties of the same species. If so, it illustrates the difficulty of separating Pleospora and Pyrenophora. On Castilleja, the overlying stem tissues are quite adherent and only a very few of the setose hairs, which are borne in addition to the basal tomentum, penetrate these tissues. On Rudbeckia, these overlying tissues are more easily ruptured, the setiform hyphae are more abundant, and the Pyrenophora character is quite evident.

In the following species, the epidermis is thin and very soon ruptured. As a result, the perithecia are very soon erumpent-superficial, become globose, instead of flattened globose, and are densely covered over the entire wall by setiform hyphae, giving them the appearance of a Pleosphaeria. The large globose perithecia may also be responsible for the more elongate cylindric asci and uniseriate spores, characteristic of this species, for the asci are obviously crowded in the flattened perithecia of *P. tomentosa*.

The spores of *P. tomentosa* and *P. Compositarum* are easily confused.

The figs. 4 & 9 of Plate 1 show that on Castilleja they are somewhat intermediate. The material seen of this species was sparse and was mixed with *P. Compositarum* on Rudbeckia. Further collections are needed for confirmation.

Pleospora (Pyrenophora) pleosphaerioides sp. nov.

Pl. 1, Figs. 6–7

Perithecia thickly scattered or crowded, arising beneath the epidermis but soon erumpent and almost entirely superficial, large, globose, 400–600μ in diameter, tomentose at the base with creeping brown hyphae and covered over the entire wall surface, particularly about the ostiole, with dark brown, tapered, blunt, non-septate, upright setae, 50–150×4–5μ. Ostiole small and widely punctate.

Asci long cylindric, thick-walled, with a claw-like base, 160–200×17–19μ.

Spores overlapping uniseriate, fusoid-ellipsoid, somewhat curved, muriform, 7-septate, with the end cells, and often some central cells, lacking vertical septa, constricted at the central septum, yellow-brown, 32–39×9.5–12.5μ. These spores may become 9-septate by the insertion of faint or irregular secondary septa.

South of Teton Pass: on *Gillia Watsonii* Gray, July 11, legit L. E. Wehmeyer (1118a) (Type).

Perithecia dense dispersa, sub epidermate orientia, deinde superficialiter erumpentia, globosa, 400–600μ diametro, basi tomentosa, hyphis tomenti radiatis, procumbentibus, brunneis; pariete totaliter investo praecipue circum ostiolum cum setis atrobrunneis, sursum angustatis, obtusis, nonseptatis, erectis, 50–150μ longis, 4–5μ crassis. Ostiolum parvum late apertum. Asci longe cylindrici, crasse membranosi, basi unguiculiformes, 160–200μ longi, 17–19μ crassi. Sporae imbricatae, uniseriatae, fusiformiter ellipsoideae, paulum curvatae, muriformes, 7-septatae, luteibrunnae, 32–39μ longae, 9.5–12.5 crassae, cellulis terminalibus et saepe interioribus absque septis verticalibus.

Specimen typicum in caulibus vetustis *Gilliae Watsoni* Gray, prope Teton Pass, Jackson, Wyoming, 11 Jul., 1940, legit L. E. Wehmeyer, sub numero 1118a.

This species has spores similar to but larger than those of *P. tomentosa*, but the perithecia are large, globose, becoming superficial and densely covered with upright setae, so that they resemble a Pleosphaeria at maturity. The asci are long cylindric and the spores uniseriate also. These characters seem correlated with the free superficial growth of the perithecia (see last species).

Pleospora punctata sp. nov.

Pl. 1, Fig. 8

Perithecia thickly scattered as minute dots, the barely erumpent ostioles, forming rather sharply limited grayish colored areas on the stem, small, globose, thin-walled, 120–150μ in diameter.

Asci saccate, thick-walled, with a claw-like base, 75–85×21–25μ.

Spores biseriate, fusoid-ellipsoid, inaequilateral or slightly curved, 5- to 7-septate, constricted at the central septum, upper half commonly more broadly rounded, lower half more acutely tapered, with one vertical septum in each central cell, but not in the end cells, 26–30 (33)×9–11μ.

Elk Refuge, Jackson, Wyo.: on *Scirpus validus* Vahl, July 1, legit L. E. Wehmeyer (1071) (Type).

Perithecia dense dispersa (sicut macula minuta) areas griseas valde circumscriptas in caulibus *Scirpi validi* occupantia, globosa, 120–150μ diametro; pariete tenui; ostiolo perminuto vix erumpente; ascis sacciformibus, 75–85μ longis, 21–25μ latis, crasse membranosis, basi unguiformibus; sporis biseriatis, 26–30 (33)μ longis, 9–11μ crassis, fusiformiter ellipsoideis, paulum curvatis vel inaequilateralibus, 5–7-septatis, ad septum medium constrictis, plerumque in parte superiore latiuscule rontundatis, in parte inferiore acutiuscule angustatis; cellulis interioribus verticaliter uniseptatis, eis terminalibus nonseptatis.

Specimen typicum in caulibus vetustis *Scirpi validi* Vahl, prope Elk Refuge, Jackson, Wyoming, 1 Jul., 1940, legit L. E. Wehmeyer, sub numero 1071.

This species, again, has 7-septate fusoid spores similar to the last two species, but the perithecia are minute, smooth and entirely immersed in the stem. The spores are similar to those of *P. juncicola*, except that the latter are described as flattened, clathrate. *P. punctiformis* and *P. spinosella* are also similar species but they both have smaller spores (20–24μ long) and those of the former species are clathrate according to Berlese (2, 2; 32).

THE "HERBARUM" SERIES

The "herbarum" series consists of another large group of collections with a basic spore form, arising from the previous type and characteristic of the *Pleospora herbarum* complex. It has already been pointed out that there is a continuous series of intergrading forms from those typical of *P. vulgaris* through *P. Compositarum* to those typical of *P. herbarum*. The basic spore of this group has seven transverse septa, with the end cells vertically septate, and is oblong-ellipsoid with rounded ends rather than fusoid-ellipsoid with acute ends as in the preceding series. This spore type is also usually asymmetrical; the portion above the median constriction is usually broader, shorter and more rounded, whereas the portion below this constriction, is longer, narrower, and in some cases tapered or inaequilateral.

In Table 2, the western collections of this type with seven-septate (3–1–3) spores are arranged according to spore size. Here again the specific separation must be largely arbitrary, as represented by the solid lines. In the section A are the collections which fall in the spore range of *Pleospora herbarum* as interpreted by Rabenhorst. The tendency to form stiff hairs about the ostiole, which may penetrate through the epidermis, which was seen in the larger spored forms of the previous series, is continued into this group and the two collections in section B, placed under *Pleospora* (*Pyrenophora*) *Tetraneuridis*, are of this sort. Section C, includes a group of collections in which the spore size overlaps that of section A, but the

halves of the spore are more symmetrical, usually broader, and the spores reach a much greater size than in *P. herbarum*. This group has been described as *P. Balsamorrhizae*.

The group of collections presented in Table 3 is the most confusing of these western Pleosporas. They include all those collections of this spore type with more than seven septa and represent the tendency to lay down extra cross walls. These extra transverse septa first occur in the lower half of the spore giving 8-9- or 10-septate spores with a 3–1–4, 3–1–5 or 3–1–6 arrangement of the septa. In the large spored forms extra septa may also

TABLE 2

No.	Host	Spore Range	Septation	Asci	Perithecia
		A			
1201c	Penstemon	26–35×12.5–16	7	80–96×18–26	2–400
1055	Sphaeralcea	25–34×11–16	7	88–97×23–26	250–350, D, C
1110a	Lupinus	26–33×10.5–12.5	7	98–110×26–38	3–350, d, c
1121d	Agastache	27–35×12–14.5	7	110–145×24–36	3–400, T
1033a	Senecio	28–34×12.5–16	7	100–145×26–32	150–300, D, C
1170	Horkelia	32–35×14–16	7	105–125×33–35	200, D
		B			
1096a	Pedicularis	28–35×10.5–12.5	7	90–120×20–26	1–200, G, S
1176	Zygadenus	32–37×10.5–14.5	7	100–115×23	250–350, G, S
		C			
1221	Pseudocymopteris	33–42×14–18	7	105–160×35	1–200, D
1143	Polemonium	33–42.5×14–19.5	7	115–125×35	2–300, d, t
1063	Balsamorrhiza	42–63×19.5–25	7	133–175×53–65	150–250, t

occur in the upper portion of the spore, which is more persistently 3-septate than the lower half.

This increase in the number of septa is correlated somewhat, but not completely, with the increase in size of the spore. Ascus measurements are also correlated in a general way with the size of the spore. The perithecia are extremely variable as to size, amount of tomentum and the presence or absence of setae, which seem to be correlated in no way with spore form or host. A comparative study of these collections indicates that the septation of the spore, although variable, is much more dependable than any other character. Here again, therefore, the specific demarcation is made arbitrarily as indicated by the solid lines.

In section A, the spore size overlaps that of *P. herbarum*, but always runs higher. Likewise, the spores are fundamentally 7-septate, but there are always some spores showing an extra septum in the lower half. In section B, the spore sizes again overlap, somewhat, those of section A,

but the fundamental number of septa is 9, with a 3–1–5 arrangement, and commonly with an extra septum, in either half. In section C, the spore size is about the same as in section B, but the spores are fundamentally 11-septate, with a 3–1–6 or a 3–1–7 arrangement. The one collection in section D has larger spores with a still greater number of septa.

There is no doubt that a large number of species could, and have been erected upon minor characters within this "herbarum" group. As a matter of fact, thirty-nine varieties of *P. herbarum* alone have been erected, covering a range of variation wider than that covered by both Tables 2 and 3. It is the writer's belief, however, that such indiscriminate erection of species with no correlation with those already erected, is the direct cause of much confusion. What is needed is a preliminary conservative separation of species upon the basis of the natural variation. When the background of such a conservative natural arrangement is known, it will be much easier to recognize minor variations from this pattern, and segregate them accordingly.

Pleospora oligasca Bub.

Pl. 1, Figs. 10–11

Perithecia thickly scattered, minute, 70–150μ in diameter, conic-globose, with a comparatively large conic, often curved, beak-like ostiole, soon erumpent superficial.

Asci few (1–5), at first broad saccate, almost globose, with a thickened apical wall and a claw-like base, becoming broad clavate, 45–70×30–60μ.

Spores 2- to 3-seriate, oblong-ellipsoid, brown, 4- to 6-septate, constricted at the second or third septum, upper half short, stout, globose and 1- to 2-septate, lower half longer, narrower, oblong, and 2- to 3-septate, with one, or rarely two vertical septa in all cells except the end cells in some cases, extremely variable in size with age, 23–35μ long, 10.5–14μ in diameter in the upper and 8–11μ in the lower half.

Camp Davis: on *Sieversia ciliata* (Pursh) G. Don, June 17 (1017).

This is a very distinctive little species with minute sclerotial perithecia (fig. 10) of the Scleroplea type, large ostioles, few saccate asci and 4- to 6-septate spores (fig. 11) which do not fit directly into this herbarum series and may represent a separate series.

This collection (no. 1017) fits perfectly the description of *P. oligasca*, although the spore measurements given for that species are at the lower end of this spore range. The spores seem to increase in size after being formed in the ascus, which swells to a clavate form when released from the small perithecia. Clements Crypt. Form. Colo. No. 34, under the unpublished name of *Pleospora cybospora*, is also this species, on *Drymocallis fissa*, from Colorado. Bubak reports his collection from an elevation of 2000 meters.

Pleospora herbarum (Pers.) Rab. var. **occidentalis** var. nov.

Pl. 2, Fig. 13

Perithecia scattered, often mixed with other species of Pleospora or other fungi, depressed-spheric, with a minute central papillate ostiole, 250–400×150–300μ, collapsing somewhat with age, sometimes with a few basal hairs, but not obviously tomentose, immersed beneath the epidermis, which is eventually exfoliated.

Asci clavate, thick-walled, with a claw-like base, elongating at maturity, 80–145×20–28 (35)μ.

Spores biseriate to obliquely uniseriate upon ejection, oblong-ellipsoid, often inaequilateral, particularly in the lower half, which may be tapered, slightly bent, or curved, 7-septate, rather dark brown, with 1–2 vertical septa in each cell, 26–35×11–16μ.

Hoback Canyon: on *Spaeralcea rivularis* (Dougl.) Torr. (Forest Camp), June 25, legit L. E. Wehmeyer (1055) (Type).

Camp Davis: on *Senecio Rydbergii* A. Nels., June 9 (1033a); and *Penstemon glaber* Pursh, Aug. 3 (1201c).

South of Teton Pass: July 11, on *Agastache urticifolia* (Benth.) Rydb. (1121d); and *Lupinus parviflorus* Nutt. (1110a).

Skyline Trail: on *Horkelia* (*Ivesia*) *Gordonii* Hook., July 24 (1170).

Perithecia dispersa, depresse globosa, ostiolo minuto papilliforme praedita, 250–400μ lateraliter diametientia, altitudine 150–300μ, aetate collapsa, interdum basi pilis paucis investa, sub epidermate immersa. Asci clavati, maturitate 80–145μ longi, 20–28 (35)μ crassi; basi unguiculiformes; pariete crasso. Sporae biseriatae vel oblique uniseriatae, oblongi-ellipsoidales, media parte paulum constrictae, saepe inaequilaterales (praecipue in parte inferiore aut augustata aut curvata), 7-septatae, modice atribrunneae, 26–35μ longae, 11–16μ crassae; cellulis septis 1 vel 2 verticalibus praeditis.

Specimen typicum in caulibus vetustis *Sphaeralceae rivulari* (Dougl.) Torr. ad Forest Camp, Hoback Canyon, Jackson, Wyoming, 25 Jun., 1940, legit L. E. Wehmeyer, sub numero 1055.

A forma typica Europaea differt sporis atrioribus saepe deorsum asymetricis et aliquantum latioribus.

The binomial *Pleospora herbarum* is applied to a species complex (including some 39 varieties) into which all sorts of 7-septate entities have been dumped. The *Sphaeria herbarum*, of both Persoon and Fries, were probably mixed species, and without an examination of their original material, or microscopical data (lacking from their descriptions) it is impossible to place their interpretations of this name. It seems best to the writer to base *P. herbarum* on the excellent series of exsiccati (Rab. Herb. Myc. 547a–e) of this species on various hosts, and this has apparently been done by most authors.

The Wyoming collections differ in certain respects from these European exsiccati, and these differences are recognized by the erection of a new variety, *occidentalis*, which is distinguished by the somewhat darker colored, more inequilateral spores (fig. 13) which are more consistently

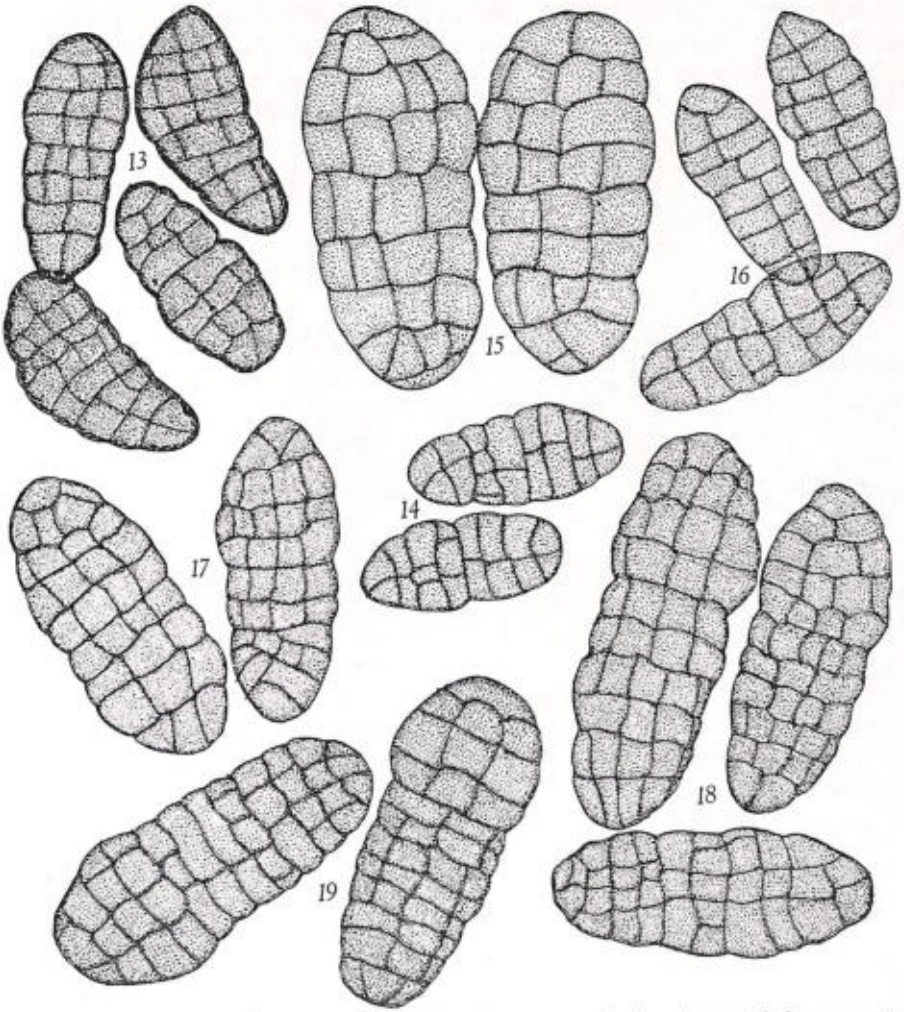


PLATE 2. 13. *Pleospora herbarum* var. *occidentalis* var. nov. showing characteristic asymmetry in two spores. 14. European *Pleospora herbarum* (Pers.) Rab., (from Rab., Herb. Myc. 547). 15. *Pleospora Balsamorrhizae* Tracy & Earle. 16. *Pleospora* (*Pyrenophora*) *Tetraneuridis* Earle. 17. *Pleospora stenospora* Schroet. 18. *Pleospora njegusensis* Bub. 19. *Pleospora montana* sp. nov. Scale, 1 mm. = 1 μ. Figs. 13–19. Ascospores.

biseriate in somewhat shorter broader asci. The spores of the European species (Pl. 2, fig. 14) are light yellow brown with the lower portion straight but somewhat narrower. In these western collections, the spores are a darker reddish-brown and the lower portion is often tapered, slightly curved or inaequilateral. In Rabenhorst's exsiccati the asci are 160–215×21–26μ, whereas in this variety they are 80–145×20–28 (35)μ. The separation of this species and variety from the large spored forms of *P. Compositarum* is purely arbitrary. On the other hand, it grades off into the next species which differs only in the more symmetrical spores, generally smaller perithecia, and greater range in spore size.

PLEOSPORA BALSAMORRHIZAE Tracy & Earle

Pl. 2, Fig. 15

Perithecia small, 100–250μ in diameter, thickly scattered beneath the epidermis, globose at first, finally somewhat flattened but not collapsing, with a minute papillate ostiole and a few coarse radiating basal hyphae, which are not apparent except under a microscope.

Asci saccate, then broad clavate, thick-walled, with a claw-like base, 115–175×35–65μ.

Spores 2- to 3-seriate, oblong-ellipsoid, straight, ends blunt, broad, constricted at the central septum, 7-septate (rarely 8-septate in large old spores), yellow brown at first becoming black brown to opaque, halves symetrical, variable in size, 33–63×14–25μ.

Hoback Canyon: June 16, on *Pseudocymopterus anisatus* (Gray) C. & R. (1221); and *Polemonium viscosum* Nutt. (1143).

Camp Davis: on *Balsamorrhiza sagittata* (Pursh) Nutt., June 16 (1063).

This species is characterised by the small perithecia and the large, broad, 7-septate spores (fig. 15). *P. Balsamorrhizae* is difficult to interpret because of its apparent extreme variation in spore characters. The type (Baker, Earle, and Tracy, Plants S. Colo. No. 1097) shows spores which are broad ellipsoid, pale yellow brown, 7-septate and 30–55×16–21μ. An unpublished variety, "*perseptis*," is distributed in Clements Crypt. Form. Colo. No. 439, which has spores which are darker brown, almost opaque, more elongate fusoid, often showing 4 or even 5 septa in the lower half, and 50–60×21–26μ. At first these appear to be quite distinct, but intermediate conditions occur on this last exsiccatus, and in No. 1063, on Balsamorrhiza, both types of spores are found intermingled on the same stem and in identical appearing perithecia. The typical, young, pale spores of the type differ from *P. herbarum* only in being larger, particularly broader, and with the lower half practically as broad as the upper. The larger, darker, 8- to 9-septate spores, on the contrary, are very much like those of *P. njegusensis*, but become even larger than in that species. In fact No. 1025a, of *P. njegusensis*, on Balsamorrhiza, may be this species. In this

last collection, however, the smaller spores, as well as the larger, have 4–5 septa in the lower half. The two collections on Pseudocymopteris and Polemonium do not show these larger, more septate spores, and appear more as examples of a large spored *P. herbarum*. This situation, again illustrates the difficulty of drawing sharp specific lines.

PLEOSPORA (PYRENOPHORA) TETRANEURIDIS Earle

Pl. 2, Fig. 16

Perithecia loosely scattered, 100–350μ in diameter, pyriform to globose at first, then depressed or even collapsing, formed beneath the epidermis

TABLE 3

No.	Host	Spore Range	Septation	Asci	Perithecia
			A		
1175	Rydbergia	35–41×14–17	(7)8	95–140×35–39	2–300, T
1117	Senecio	35–42×(13) 18–19	7(8)	115–170×32–38	250–350, D, C, T
1167	Linum	37–44 (48)×14–19	7(8–9)	110–140×38–42	2–250, d, t
1173a	Hedysarum	37–42×16–18	(7)8	90–133×30–35	3–400, T, S
			B		
1025a	Balsamorrhiza	33–44×(13) 16–19	8(9)	115–160×44–50	250–350, D, c
1176a	Zygadenus	34–44×(13) 14–17	9	105–125×32–35	2–300, d, t
1128	Valeriana	37–47×14–18	9(10)	115–150×39–42	
1063a	Balamorrhiza	39–50(60)×14–18	(8)9	175–210×30–40	250–300, S
1110	Lupinus	39–51×16–19.5	9(10–11)	135–145×40–45	150–250, d, T
1134c	Linum	41–46×16–20	9(10)		450, T
1211	Gillia	31–54×(17) 21–23	9(10–11)	150–180×40–55	250–400, D
1121e	Agastache	42–48×16–18	9(10)	125–150×40–45	3–400
1124a	Clematis	42–50×16–19	9(10)	105–135×43–47	250
1096	Pedicularis	43–50×18–25	9(10–11)	160–220×43–45	D, T, S
1118	Gillia	43–48×20–25	9(10–11)	160–175×50–53	
1126d	Hedysarum	44–53×15–19	9(10–11)	140–150×47–52	2–300, G, t
1173c	Hedysarum	46–53×17–18	9(10)	175–180×30–35	3–400, T, S
			C		
1101	Lupinus	41–51×16–21.5	11(10)	125–142×50–55	150–300, G, T
1103	Lupinus	41–53×17.5–21	11(12)	175–210×57–60	3–350, G, T
1107	Lupinus	43–57×17–21	11(10–12)	125–135×40–45	2–300, G, T
			D		
1134h	Linum	68–80×23–28	11(14)		

which falls off. Perithecia thin-walled, membranous, covered above with upright, stiff, setose, tapered, brown, hairs, up to 300μ in length and 4–6μ in diameter, which are sparingly septate.

Asci clavate, thick-walled, with a claw-like base, 90–115×23–26μ.

Spores biseriate, fusoid- to oblong-ellipsoid, with ends either rounded or

acute, mostly straight, 7-septate, constricted at the central septum, with 1 or 2 vertical septa in each cell, one end often narrower than the other, 28–37 × 10.5–14.5μ.

Togwotee Pass: on *Pedicularis Hallii* Rydb., July 8 (1096a).

Skyline Trail: on *Zygadenus alpina* Blank., June 24 (1176).

The spores of this species might be confused with either *P. tomentosa* or *P. herbarum*. They differ from the former in having septate end cells and usually more than one vertical septum. The latter species has perithecia which are not setose. *P. Tetraneuridis* represents the tendency of some members of this herbarum series to produce setose perithecia and is its Pyrenophora representative. This seems to be a characteristic of alpine forms, and suggests a close relationship to *Pyrenophora chrysospora* Niessl of Europe and to such similar species as *P. oligotricha* (Niessl)B. & V., *P. Tragacanthae* Berl. etc. *Pyrenophora Castillejae* and *P. Clematidis* of Earle have similar, but smaller spores of the *P. Compositarum* type and show very few setae, if any, in their type material. *P. Eriogoni* Earle has somewhat larger spores, but very few setae and his *P. Tetraneuridis*, which is on leaves, shows definitely spiny perithecia, particularly when young. The spores in the type of *P. Tetraneuridis* (N.Y.B.G., Earle Herb. No. 1068) are 30–37 × 12–18μ. Whether these all represent separate species, and where the specific lines can be drawn or whether they should all be placed in the same species complex, can only be decided by the study of a much larger series of collections than were available to the writer. Both of the Wyoming collections were obtained at about 10,000 ft. elevation.

PLEOSPORA STENOSPORA Schroet.

Pl. 2, Fig. 17

Perithecia rather widely scattered, immersed, or rarely erumpent-superficial, 250–450μ in diameter, globose or slightly depressed, only rarely collapsing, walls rather thick, of coarse black parenchyma, usually with more or less basal tomentum and occasionally with a few spine-like setae projecting through the epidermis.

Asci clavate, thick-walled, with a claw-like base, 90–170 × 30–42μ.

Spores biseriate, oblong-ellipsoid, 33–44 (48) × 17–19μ, with several vertical septa in each cell, constricted at the central septum, somewhat above the middle; upper half usually shorter and broader with blunt rounded apex and three septa; lower half longer, narrower, often with a tapered, more acute end and commonly with an irregular angular arrangement at the lower end of 3 or 4 transverse or oblique septa.

Skyline Trail: July 24, on *Hedysarum* sp. (1173a); *Linum Lewisii* Pursh (1167); *Senecio* sp. (1177); and *Rydbergia grandiflora* (Pursh) Greene (1175).

It is interesting to note that although these collections were segregated

entirely on morphological grounds, they all came from the same locality, but on different hosts, at an elevation of about 10,000 feet. This species is very similar to the European *P. herbarum* except that the spores are slightly larger and tend to be 8-septate, because of the irregular septation in the lower end of the spore. On Hedysarum and Senecio the perithecia may produce a few stiff hairs which may penetrate the epidermis. On Senecio the perithecia are pezizoid collapsed and on Hedysarum they are globose. The constancy of such minor variations cannot, however, be judged from so few collections.

There are a score or more species described with 7-septate spores within this size range, but only a few of these vary to the 8- or 9-septate condition. Of these, P. *Van Hoffenii* Henn. has somewhat smaller and *P. Ephedrae* Fabre somewhat larger perithecia (both have 7- to 9-septate spores, 35–45×11–14μ). *P. laxa* Ell. & Galw. is also similar but has smaller perithecia and somewhat different spores. *Pleospora* (*Pyrenophora*) *Robertiana* Boy. & Jacz., with spores 35×14μ might fit those collections with setose perithecia. *P. bobanensis* Bub. has somewhat larger spores (42-48×15–19μ). *P. stenospora* Schroet., on Anemone, from Labrador, with spores 33–38× 11–14μ and 8-septate, seems to fit this group best, and the name, therefore, is here used provisionally.

Pleospora njegusensis Bub. ?

Pl. 2, Fig. 18

Perithecia scattered to thickly scattered over wide areas, formed beneath the epidermis, but often erumpent-superficial, varying from globose to somewhat depressed, smooth, with slight basal tomentum, or with basal tomentum and a few upright setae, often pezizoid or irregularly collapsed, 200–400μ in diameter.

Asci clavate, thick-walled, with a claw-like base, 105–220×32–55μ.

Spores biseriate, oblong-ellipsoid, (33) 37–54×15–20 (23)μ, constricted at the fourth septum, unequally bipartite, upper half broader, shorter and 3-septate, lower half longer, narrower and somewhat tapered, mostly with 5 septa but sometimes with a 6th transverse septum inserted, and with several vertical septa. Rarely, there is a fourth septum in the upper half. This gives a 9- to 11-septate spore.

Camp Davis: on *Balsamorrhiza sagittata* (Pursh) Nutt. (1063a).

Glory Mt.: on *Balsamorrhiza sagittata* (Pursh) Nutt. (1025a).

South of Teton Pass: July 11, on *Gillia Watsonii* Gray (1118 & 1211); *Valeriana sp.* (1128); *Lupinus parviflorus* Nutt. (1110); *Linum Lewisii* Pursh (1134c); *Agastache urticifolia* (Benth.) Rydb. (1121e); *Clematis Douglasii* Hook. (1124a); *Hedysarum uintahense* A. Nels. (1126d).

Skyline Trail: July 24, on *Hedysarum sp.* (1173c); and *Zygadenus alpinus* Blank. (1176a).

Togwotee Pass: on *Pedicularis Hallii* Rydb., July 8 (1096).

This seems to be ubiquitous in the alpine area for all the collections, on many different hosts (except the one from Camp Davis), came from elevations of over 9000 ft. There is a good deal of variation in the spore size of these collections, but they all differ from the previous species in having at least five septa in the lower half of the spore. Occasionally there are 6 septa in the lower half, and rarely four septa in the upper half. Some collections such as 1063, on Balsamorrhiza, 1096, on Pedicularis, and 1110 on Lupinus, may show a few upright stiff hairs and approach the Pyrenophora type. Such minor differences, however, do not seem constant enough to justify specific separation.

Described species having this range of spore size and septation are *P. papillata* Karst., *P. Collaltina* Sacc. & Speg., *P. Prostii* Pass. & Roum., *P. Straminis* Sacc. & Speg., *P. ligni* Karschst. and *P. njegusensis* Bub. Berlese (2, 2; 26–27) disagrees with the original descriptions of all of the first four species, as to spore size and septation, on the basis of examination, apparently, of authentic material. *P. njegusensis*, with spores 38–48×15–19μ and 8–10 septate seems to fit this group fairly well although the spores of the Wyoming collections are seldom 8-septate. This binomial is used with reservations, until comparison with more authentic material can be made.

Pleospora montana sp. nov.

Pl. 2, Fig. 19

Perithecia rather small, 150–300μ, with a rather prominent conic ostiole, wall thick, composed of coarse, dark colored parenchyma, rather scattered at first, then erumpent-superficial, globose or only slightly depressed, smooth or with a basal tomentum or occasionally with a few upright, septate, brown setae, which are 4–5μ in diameter.

Asci comparatively few, saccate to broad clavate, thick-walled, with a claw-like base, 125–210×40–60μ.

Spores 2- to 3-seriate, oblong-ellipsoid, muriform, constricted at the fourth septum, dark brown, 10- 11- or rarely 12-septate; upper half shorter and broader, rounded and 3-septate; lower half longer and narrower, rounded, 6- or usually 7-septate; 41–57×16–21μ. There is rarely a fourth septum inserted in the upper half. There are several vertical septa in each cell.

Togwotee Pass: July 8, on *Lupinus candicans* Rydb. (1101) (Type) & (1107); and *L.* (*parviflorus* Nutt. ?) (1103).

Perithecia plus minusve dispersa, immersa, deinde superficialiter erumpentia, globosa vel paulum depressa, 150–300μ diametro, glabra vel basi tomentosa, vel interdum setis paucis, rectis, 4–5μ crassis praedita; ostiolo prominenti conico; pariete crasso ex parenchymate crasso fusco; ascis paucis, 125–210μ longis, 40–60μ latis, sacculiformibus vel late clavatis, crasse membranosis, basi unguiformibus; sporis 41–57 longis, 16–21μ crassis, 2- vel 3-seriatis, oblonge ellipsoideis, muriformibus, ad septum quartum constrictis, atribrunneis, 10- vel 11- (vel 12-) septatis, dimidio

superiore brevi latoque, rotundato et 3-septato, interdum 4-septato, dimidio inferiore longiore et angustiore etiamque rotundato, 6- vel plerumque 7-septato; cellulis omnibus verticaliter multiseptatis.

Specimen typicum in caulibus vetustis *Lupini candicantis* Rydb., ad montem dictum Breccia Peak, prope Togwotee Pass, Teton Co., Wyoming, 8 Jul., 1940, legit L. E. Wehmeyer, sub numero 1101.

Another alpine species, with all collections found at the same locality and on the same host genus. It is characterised by rather dark brown spores with the septum arrangement of 3–1–6 or 3–1–7. The perithecia are more stoutly subglobose than in many other species. The only described species which approaches this is *P. megalotheca* Tracy & Earle with spores 40–45 × 16–20 and 11- to 13-septate. Type material (Pl. South Colo. No. 172) of this species yielded several species of Pleospora but none that would fit the original description.

Pleospora amplispora E. & E.

Perithecia and asci not seen. Spores oblong-ellipsoid, constricted above the middle, upper half shorter and broader, 4- to 5-septate, lower half longer and narrower, 7- to 8-septate, with 2 to 4 vertical septa in each cell, entire spore 12- to 14-septate, 68–80 × 23μ.

South of Teton Pass: on *Linum Lewisii* Pursh, July 11 (1134h).

Only one crushed perithecium was seen of this species, but the spores are very large and characteristic, and show the extreme septation of the upper half of the spore. The two species, *P. gigantasca* Karst. and *P. amplispora* E. & E., which fit this collection are considered to be synonyms by Berlese (2, 2; 28) and were described in the same year (1884). Inasmuch as *P. amplispora* was described from the western United States, on Lupinus, that name is used here.

The "clathrate" series

The species of Pleospora with a clathrate or flattened spore were placed in a separate genus Clathrospora, by Rabenhorst, which is a much more distinct separation than the one based on setose ostioles, in the genus Pyrenophora. These clathrate species seem to be a common and characteristic component of the arctic-alpine fungous flora of many regions. All but one of the Wyoming collections with clathrate spores are similar in spore form with many intergrading variations. This common spore form is broadly rhomboid-ellipsoid to clavate-ellipsoid (see figs. 31-34) without sharp constrictions at the 3 to 5 septa and, in face view, showing a single central vertical septum in the central cells but not in the end cells. The number of septa seems to be quite constant (in any one collection), but the variations in spore size, again, gives an overlapping series.

In Table 4, the collections with 3-septate spores are arranged according to spore size. Ascus size is fairly constant and the perithecia are charac-

teristically flattened spheric, soon collapsing in a pezizoid manner and with a dense basal radiating tomentum (Pl. 3, fig. 30). The last two collections (section B) show spores and asci with rather definitely larger measurements and are placed in a separate species *P. diplospora*. The collections in

TABLE 4. *Spores clathrate, 3-septate*

No.	Host	Spore Range	Asci	Perithecia
		A		
1032	Syntheris	21–31×10–12.5×7–9	75–95×21–24	2–300, D, C, T
1110c	Lupinus	23–26×10.5–11.5×8.5–10	88–98×19–21	2–250, D, t
1129a	Delphinium	23–28×12.5×8–9	85–90×21–25	3–500, D, C, T
1133b	Sambucus	23–30×12.5–13×9–10.5	85–95×21–22	2–400, D, C, T
1158	Stephanomeria	24.5–26×12.5×9–10	85–95×25–26	2–300, D, C
1134f	Linum	24–26.5×10.5–12.5×8–9		
1209	Brickellia	24–27×10.5×8–9	70×26	250–300, D, C, t
1124b	Clematis	24–28×10–12.5×7.5–9	78–95×19–23	350–400, D, C, T
1086a	Penstemon	24–27×11–12.5×9–10.5	88–96×20	D, C, T
1166a	Carum	25–26×10–12.5×8–9	88–100×20–21	300–350, D. C, T
1023b	Linaria	25–27×10.5–12.5×9–10	70×23	D, C, T
1128a	Valeriana	25–28.5×11–12.5×9–11	85–96×20–22	3–400, D, C, T
1025	Basamorrhiza	25–28.5×12.5×8.5–9.5	85–105×20–22	300, D, C, T
1208b	Senecio	25–29×11–12.5×8–9.5	78–97×23–26	
1126b	Hedysarum	26–28×12.5×9		
1130b	Lupinus	26–28×10–11×9		
1100a	Helianthella	26–29×12.5×7.5–9	75–90×25–25	2–300, D, C, T
1024	Penstemon	26–30×12.5–13×9.5–10.5	95–120×21–25	350–400, D, C, T
1104	Artemisia	26.5–28×11–12.5×9–10.5	90–106×23–25	250–350, D, C, T
1132a	Carum	26.5–30×12–14×9–10.5	88–115×23–25	300, D, C, T
1028	Cynamorathrum	26.5–32×9–12.5×9	88–106×26.5–30	150–300, D, C, T
		B		
1026a	Umbellifer	30–40×16–21×11–14	125–160×26–30	250–350, D, C
1134a	Linum	38–43×19–24×12.5–15	160–175×35–40	350–550, d, T

section A, although showing quite a bit of difference in spore size, are all very similar and are placed in *P. permunda*.

In Table 5 are listed the collections with 4- or 5-septate spores. Section A includes the 4-septate collections which show a continuous series and are placed under *P. aurea*. The single collection in Section B has a spore form different from all the other clathrate spores seen and seems to be a new species. The collection in Section C has the same spore form as those previously mentioned but the spores are 5-septate. It is the same as *P. planispora* Ellis.

PLEOSPORA (CLATHROSPORA) PERMUNDA (Cke.) Sacc.

Pl. 3, Figs. 30–31

Perithecia thickly and widely scattered beneath the epidermis, tardily superficial by the exfoliation of this tissue, flattened-spheric, disc-like with

a minute central ostiole, 200–400μ in diameter, soon collapsing pezizoid, saucer shaped with age and surrounded by a more or less dense halo of dark brown septate radiating hyphae which is commonly visible through the epidermis and quite characteristic.

Asci broadly clavate, with a thickened wall and a claw-like base, 75–115×19–30μ.

Spores biseriate, broadly rhomboid-fusoid to clavate-ellipsoid in face view, 3-septate, end cross walls often at an oblique "Y" angle to the single central septum which is found in two central cells but not in the end cells;

TABLE 5. *Spores clathrate, 4- to 5-septate*

No.	Host	Spore Range	Septation	Asci	Perithecia
		A			
1129b	Delphinium	23–28×11–11.5×8–10	4	85–90×21–25	2–250, D, c, T
1110d	Lupinus	26–30×12–13×8–9	4	88–97×23–26	250–350, D
1130a	Lupinus	26–32×11–13×8–10	4	85–90×18–21	250–350, D, C, T
1131b	Clematis	26.5–30×11–12×7.5–8	4	95–115×21–23	250–350, D, C, T
		B			
1101d	Lupinus	23.5–28.5×9–11×7–8.5	5	100–125×12–16	3–400, D, C
		C			
1201d	Penstemon	28–35×13–16×9–11	5	78–100×23–26	300, d, t

cylindric to fusoid or inaequilateral in edge view, with no vertical walls visible, 21–32×10–12.5 (14)×7–10μ.

Camp Davis: on *Penstemon glaber* Pursh, June 18 (1016b); and *P. stenosepalus* (A. Gray) Howell, July 5 (1086a).

Cream Puff Mt: on *Penstemon stenosepalus* (A. Gray) Howell, July 5 (1086a).

Gros Ventre River: on *Stephanomeria tenuifolia* (Torr.) Hall, July 19 (1158).

Glory Mt.: June 20, on *Syntheris dissecta* Rydb. (1032); *Penstemon* sp. (1024); *Linaria vulgaris* Mill. (1023b); *Balsamorrhiza sagittata* (1025); and *Cynomarathrum Parryi* (S. Wats.) Coult. & Rose (1028).

South of Teton Pass: July 11, on *Lupinus parviflorus* Nutt. (1110c); *Sambucus microbotrys* Rydb. (1133b); *Delphinium Brownii* Rydb. (1129a); *Clematis Douglasii* Hook. (1124b); *Hedysarum uintahensis* A. Nels. (1126b); *Lupinus parviflorus* Nutt. (1110c & 1130b); *Carum Carui* L. (1132a); *Valeriana* sp. (1128a); and *Linum Lewisii* Pursh (1134f).

Togwotee Pass: July 8, on *Helianthella* (?) (1100a); and *Artemisia pedatifida* Nutt. (1104).

Skyline Trail: Death Canyon, on *Brickellia grandiflora* Nutt., Aug. 4,

(1209); Overlook, on *Senecio sp.*, Aug. 4 (1208b) and on *Carum Carui* L., July 24 (1166a).

This is the most common of all the species of Pleospora in this region of Wyoming. It was found on a wide range of hosts, often mixed in with other fungi and probably could be isolated from other collections if looked for intensively. It is quite distinct, when plentiful, having small collapsing cup-shaped perithecia with a halo of tomentum easily distinguishable under a lens.

As seen in Table 4, section A, these collections show a continuous overlapping series of spore lengths from 21 to 31μ. Cooke's description of *Sphaeria permunda* in Vize (9, p. 111) is an incomplete one and gives the spores as 30×15μ. Ellis (4, p. 341) gives the spores as 20–24×10–11μ, whereas Berlese (2, 2; 29) says that spores from an Ellis specimen measure 23–26×12–15×8μ. Berlese's figures (2, 2, Pl. 45, fig. 1) are typical of these western species. There is evidence that certain extremes of this series, as well as certain other variations might be separated as varieties, but further data in support of this evidence is needed before one can be confident that these do reoccur as good varieties.

On Cynomarathrum, the spores are mostly immature, are more tapered toward one end and are commonly without vertical septa in some of the central cells. Decision as to whether this is a good variety or merely a young condition depends upon comparison with further collections.

PLEOSPORA (CLATHROSPORA) DIPLOSPORA E. & E.

Pl. 3, Fig. 32

Perithecia scattered, somewhat depressed-spheric, 250–600μ in diameter, not collapsing but with a radiating basal tomentum of rather stiff, unbranched, brown hairs.

Asci clavate, thick-walled, with a claw-like base, 125–175×26–40μ.

Spores biseriate, ovoid, rhomboid-ellipsoid, clathrate-flattened, 3-septate, central cells with a vertical septum, end cells without vertical walls, cylindric to fusoid in edge view, without any vertical walls, 30–43×16–24×12.5–15μ.

Glory Mt. on umbellifer, June 20 (1026a).

South of Teton Pass: on *Linum Lewisii* Pursh, July 11 (1134a).

The two collections in section B of Table 4 have spores identical with those in section A but show an extension in the size range. Ellis (5, p. 20) described *Pleospora diplospora*, on Asclepias, as having clathrate spores, 24–30×10–15×7–8μ, which were at first 3- then 5- to 7-septate. Berlese (2, 2; 30) states that material sent him by Ellis is a mixture of *Pleospora herbarum* (with 5- to 7-septate spores) and a clathrate species with 3-septate spores, which he renames *Clathrospora Ellisiana* Berl. He gives the spores as 32–35×16–18×12μ. The type of *P. diplospora* (N. Y. B. Gard.,

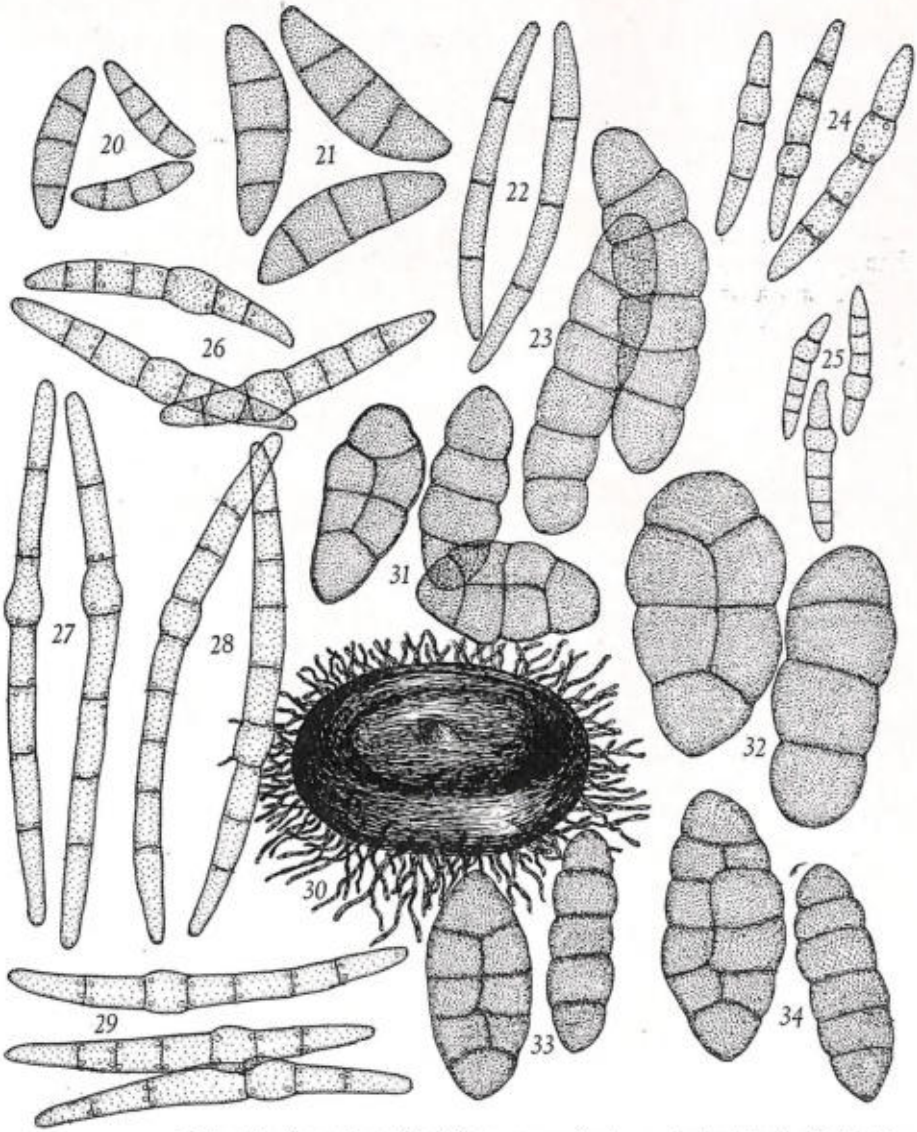


PLATE 3. 20. *Leptosphaeria eustoma* (Fr.) Sacc. sensu Berl. 21. *Leptosphaeria Euphorbiae* Niessl. 22. *Leptosphaeria tetonensis* sp. nov. 23. *Leptosphaeria sp.*, from Agastache. 24. *Leptosphaeria oreophila* Sacc. 25. *Leptosphaeria tenera* Ellis. 26. *Leptosphaeria agnita* (Desm.) Ces. & de Not. 27. *Leptosphaeria olivacea* Ellis. 28. *Leptosphaeria octoseptata* sp. nov. 29. *Leptosphaeria Erigerontis* Berl. 30. Perithecium of *Pleospora* (*Clathrospora*) *permunda*, of the tomentose collapsed type, common to many species of the clathrate Pleosporae. 31. *Pleospora* (*Clathrospora*) *permunda* (Cke.) Sacc. 32. *Pleospora* (*Clathrospora*) *diplospora* E. & E. 33. *Pleospora* (*Clathrospora*) *aurea* Ellis. 34. *Pleospora* (*Clathrospora*) *planispora* Ellis. Scale, 1 mm. = 1μ. Figs. 20–29, 31–34. Ascospores.

Ell. coll. No. 894) includes drawings of these 5- to 7-septate spores and states that they come from the same perithecia as the 3-septate ones. Examination of the material shows that the many septate spores are only on the surface. They are abnormal and seem to be germination stages of the 3-septate spores, having a variable number of transverse, but always one central vertical septum. They do not belong to *P. herbarum*, and there is no reason for changing Ellis' name, inasmuch as it is quite obvious that he is describing the 3-septate clathrate species which is present and which has spores 30–35×14–19×8.5–10.5μ in the type material. Several species of Pleospora are commonly found mixed on type material, and this is no reason for a name change. The species must be interpreted through the original description, where possible.

PLEOSPORA (CLATHROSPORA) AUREA Ellis

Pl. 3, Fig. 33

Perithecia widely or thickly scattered, 200–350μ in diameter, depressed-spheric, collapsing pezizoid with age, with a basal halo of radiating, dark brown, hyphal tomentum, usually visible through the epidermis, beneath which the perithecia are imbedded.

Asci clavate, thick-walled, with a claw-like base, 85–115×18–26μ.

Spores biseriate, rhomboid to ovoid in face view, flattened, 4-septate, with vertical septa in the central but not in the end cells, end cross-walls often bent at an angle where they meet the vertical septum, oblong to fusoid-ellipsoid in edge view, without any vertical septum visible, 26–32×11–14×7.5–10μ.

South of Teton Pass: July 11, on *Delphinium Brounii* Rydb. (1129b); *Lupinus parviflorus* Nutt. (1110d & 1130a); and *Clematis Douglassi* Hook. (1131b).

Section A, in Table 5, represents the 4-septate spore group of the clathrate series. Here, again, there are overlapping spore sizes running from 23 to 32μ in length, giving a series parallel to that of *P. permunda* but differing in the extra septum. All of the Wyoming collections were taken in one locality, but on different hosts.

There are six species, *P. platyspora* Sacc., *P. quadriseptata* Cke. & Harkn. *P. pentamera* Karst., *P. aurea* Ell., *P. Passeriniana* Berl., and *P. Pteridis* Lind, described with 4-septate spores of this type. It is possible that some of these species represent varietal sections of the rather wide spore range shown here, but an examination of the literature shows that each species has been interpreted differently and given different spore ranges by different authors. Finally, Lind (7, p. 165) has placed all but *P. quadriseptata* in synonymy under *P. pentamera*. His figures of this species, from Nova Zembla (6, Pl. 2, fig. 2) shows spores which are more ellipsoid, or clavate than the rhomboid spores of the Wyoming collections. Inasmuch as there

may be variations in this series which should later be segregated, the binomial *P. aurea* is used here instead.

The type of *P. aurea* Ellis (N. Y. B. Gard., Ellis coll., 1881) has spores which are typical of the Wyoming collections, and 23–26.5×10.5–12.5×7–9μ., which is in the lower range of this series. Furthermore, a second packet (collected in 1882), with the type, shows spores 27–32×12–12.5×7–9μ, which lie in the upper range as represented in section A.

Pleospora (Clathrospora) planispora Ellis

Pl. 3, Fig. 34

Perithecia scattered, somewhat depressed-globose, slightly tomentose at the base, about 300μ in diameter.

Asci clavate, thick-walled, with a claw-like base, 78–100μ×23–26μ.

Spores biseriate, broadly rhomboid- to fusoid-ellipsoid in face view, flattened, 5-septate, not constricted at the septa, with a single vertical septum passing through the central cells, commonly with a characteristic "jog" where it crosses the 2nd and 4th septum, without vertical walls in the end cells, cylindric to fusoid-ellipsoid in edge view with no vertical septa visible, 28–35×13–16×9–11μ.

Camp Davis: on *Penstemon glaber* Pursh, Aug. 3 (1201d).

The single collection of this species represents the continuation of the tendency towards an increase in the number of septa formed in this clathrate series. The type of *P. planispora* (N. Y. B. Gard., Ellis coll., Harkness No. 94), which is distributed in N. A. F. No. 1584, is a mixture of a 4-septate and a 5-septate, clathrate Pleospora. In Ellis' manuscript description he gives the spores as 4- to 5-septate, but in the published description they are given only as 5-septate. The two species seem to be distinct. The 5-septate spores (fig. 34) are 28–41×13–17×8–10μ and differ from the 4-septate ones in the fainter septa and the characteristic "jog" where the 2nd and 4th septa cross the vertical wall.

Pleospora (Clathrospora) togwotiensis sp. nov.

Pl. 1, Fig. 12

Scattered as black circular spots which are the depressed-spheric perithecia, 300–400μ in diameter, immersed beneath the epidermis. Perithecia collapsing pezizoid, with a minute central papillate ostiole but no basal tomentum. Walls of coarse dark parenchyma.

Asci long cylindric, with a thickened wall and a claw-like base, 100–125×12–16μ.

Spores overlapping, uniseriate, flattened, muriform, narrowly fusoid-ellipsoid, inaequilateral or slightly curved in face view, 5-septate, with one vertical septum in each cell except the end cells, constricted at the septa,

cylindric to fusoid-cylindric in edge view, with no visible vertical walls, 23.5–28.5×9–11×7–8.5μ.

Togwotee Pass: on *Lupinus candicans* Rydb., July 8 (1101d) (Type).

Perithecia nigra maculiformia, depresse spherica, sub epidermate in caulibus *Lupini candicantis* Rydb. dispersa, 300–400μ diametro, demum delapsu cupuliformia; ostiolo centrali, minuto, papilliforme praedita, absque tomento basali; pariete fusco ex parenchymate crasso constante. Asci longe cylindrici, basi unguiculiformes, 100–125μ longi, 12–16μ crassi, membrana crassa. Sporae uniseriatae, imbricatae, applanate muriformes, 5-septatae, ad septa constrictae, 23.5–28.5μ longae, 9–11μ latae, 7–8.5μ crassae, in aspectu frontali anguste fusoideo-ellipsoidales, inaequilaterales vel paulum curvatae, cum cellulis centralibus verticaliter uniseptatae (omnibus, apicalibus exceptis), in aspectu laterali cylindricae vel fusoideo-cylindricae, absque septis visibilibus.

Sepcimen typicum in caulibus vetustis *Lupini candicantis* Rydb., ad locum dictum Breccia Peak, prope Togwotee Pass, Teton Co., Wyoming, 8 Jul., 1940, legit L. E. Wehmeyer, sub numero 1101d.

This single collection differs from all of the other collections with clathrate spores in the narrowly ellipsoid spore form and the definite constrictions at the septa. The asci are also longer and narrower.

It resembles *Clathrospora Donacis* Berl. somewhat, in these characters, but that species is figured by Berlese (2, p. 48, fig. 2) as having two vertical septa, whereas this collection has only one.

LEPTOSPHAERIA

The taxonomic situation in Leptosphaeria is much the same as it is in Pleospora. The spore forms can also be derived from the same type of 3-septate dark brown spore, but in this genus a different course in the evolution of the spore and ascus has occurred. The spores tend to become lighter in color, more elongate, narrower, and more septate. This tendency leads directly, without a break, into the genus Ophiobolus. In one series, there is a definite tendency for one of the cells of the spore to become somewhat enlarged or swollen. The number of septa and the position of this swollen cell seem to be quite constant.

The asci in Leptosphaeria tend to become narrowly clavate with only a slight thickening in the apical wall. The more elongated spores tend to become arranged in a parallel fascicle, and at maturity the base of the ascus becomes elongate attenuate. A pressure is generated in the upper portion of the ascus, which apparently ruptures the weakened basal portion of the ascus, and squeezes the spores out through the lower end.

The perithecia in Leptosphaeria tend to be more permanently immersed and occur in more "pure stands," and not mixed with other fungi as those of Pleospora often are. They are rarely of the collapsed, pezizoid type so commonly found in Pleospora, but may be tomentose.

There are some 382 species of Leptosphaeria described with the simple 3-septate type of ascospore. Many of these must obviously be synonyms, but the great number of names indicates the plentifulness of this type.

Comparatively, only a few of this type were found among the Wyoming collections.

LEPTOSPHAERIA EUSTOMA (Fr.) Sacc. Sensu Berl.

Pl. 3, Fig. 20

Perithecia scattered or clustered, small, 90–150 (200)μ in diameter, formed beneath the epidermis which is ruptured and thrown off, globose at first becoming depressed and pezizoid collapsed, sometimes with a sparse radiating tomentum at the base.

Asci broad- to narrow-clavate, wall somewhat thickened, with a claw-like base, not tapered below, 45–70×8–12μ.

Spores biseriate, fusoid-ellipsoid, inaequilateral to curved, deep yellow-brown, 3-septate, not much constricted at the septum, 16–20 (23)×3.5–5.3μ.

Hoback Canyon: on *Draba luteola* Greene (Red Creek), July 29 (1185). South of Teton Pass: July 11, on *Thalictrum occidentale* Gray (1115a); and *Aquilegia coerulea* James (1114a).

The collections on Thalictrum and Aquilegia are very similar; the one on Draba differs somewhat in the broader asci (45–70×9–12) and larger spores (16–23×4.3–5.3μ) which are somewhat more constricted, and the small perithecia (90–140μ) which are not collapsed, but these differences do not seem sufficient for a separate species, at least until more material so indicates.

There are a score of more species of Leptosphaeria described with small perithecia and 3-septate spores within this size range. Only a comparative study of a large number of collections of these species can determine what if any are good lines of specific demarcation. Berlese (2, 1; 55) has placed a large number of these as forms of *L. eustoma* (Fr.) Sacc., the spores of which he gives as 17–20×4–5μ. Consequently, these collections are referred to *L. eustoma*, in the sense of Berlese, as a collective species, until such time as differential characters can be established.

LEPTOSPHAERIA EUPHORBIAE Niessl (?)

Pl. 3, Fig. 21

Perithecia scattered or clustered, small, 150–200μ in diameter, sphaeric or slightly flattened, with a slight growth of tomentum at the base.

Asci stout clavate, rather thick-walled, with a claw-like base, 70–78×17–18μ.

Spores overlapping biseriate, fusoid-ellipsoid, inaequilateral to slightly curved, 3-septate, dark yellow-brown, not constricted at the septa, 25–30×7–8μ.

Skyline Trail: on *Carum Carui* L., July 24, (1166c).

This species differs from the last chiefly in the larger, broader spores.

As in the case of the previous species, there are a large number of species described in this general spore range. This collection differs from *L. Doliolum* in the larger, biseriate spores and broader asci. It comes closer to *L. vagabunda* in its ascus characters, but the spores in that species are smaller, again. *L. Steironematis* Ell. is also similar but has shorter and broader spores and the type shows much larger perithecia, 300–600μ in diameter. The description of *L. Euphorbiae* Niessl seems to fit better than any other.

Leptosphaeria tetonensis sp. nov.

Pl. 3, Fig. 22

Perithecia globose to somewhat depressed, 200–300μ in diameter, thickly scattered and formed beneath the epidermis, but superficial and shiny black on old stems, ostiole fairly prominent, papillate to short cylindric, walls about 30μ thick, of dark walled parenchyma.

Asci clavate, with a thickened apical wall and a claw-like base, becoming attenuate below, 78–90×12–13μ. Paraphysis-like strips of interthecial tissue present between the asci.

Spores overlapping 3-seriate, elongately fusoid-cylindric, straight or curved, 3-septate, pale yellow-brown, not constricted at the septa, 44–48×3.5–4μ.

South of Teton Pass: on *Pedicularis bracteosa* Benth., July 11 (1117) (Type).

Perithecia globosa vel paulum depressa, 200–300μ diametro, dense dispersa, primum sub epidermate sed ultimo in caulibus vetustis superficialia, atra, nitida; ostiolo modice prominenti, papilliformi vel breviter cylindrico; pariete ca 30μ crasso, atro, parenchymatoso; ascis clavatis, 78–90μ longis, 12–13μ crassis, ad apicem pariete incrassatis, basi unguiformibus demum attenuatis, separatis a pseudoparaphysibus; sporis 44–48μ longis, 3.5–4μ crassis, triseriatis, imbricatis longe fusiformiter cylindricis, rectis vel curvatis, 3-septatis, pallide lutei-brunneis, ad septa non constrictis.

Specimen typicum in caulibus vetustis *Pedicularis bracteosae* Benth., prope "Teton Pass," Jackson, Wyoming, 11 Jul., 1940, legit L. E. Wehmeyer, sub numero 1117.

This species is distinctive among those with 3-septate spores in the long narrow, non constricted spores. It is very similar to *L. petkovicensis*, but that species has smaller perithecia (100–200μ) and occurs on Juncus, which indicates it is probably distinct.

A Septoria with long needle-like spores 40–45×1–1.5μ occurs abundantly on these same stems.

LEPTOSPHAERIA sp.

Pl. 3, Fig. 23

Perithecia scattered. Asci broad-clavate, thick-walled, base claw-like, 85–106×28–31μ.

Spores biseriate, fusoid to cylindric, straight to somewhat curved, dark brown, 5- or rarely 6-septate, constricted at first at the central septum, later at all the septa, 31–44×10.5–12.5μ.

TABLE 6

No.	Host	Spore Range	Septation	Asci	Perithecia
		A			
1035	Pedicularis	(23) 26–34×3·5–4	4	70–80×8.5–10.5	2–250, d
1126c	Hedysarum	25–28.5×3·5–4	4		250–300, d
1022a	Umbellifer	26–32×3·5	4	78–90×9–11	2–300, G, d
1197	Boykinia	26.5–31×3·5	4		150–200
1045	Delphinium	27–30×3·5–4	4	60–70×8.5–10.5	250–300, D
1159b	Castilleja	28.5–31×3·5–4	4	60–70×8.5–10	180–250, t
1056a	Aquilegia	32×3·5–4	4	45–70×8–9	200
		B			
1131d	Clematis	18–23×2.5–3·5	5	75–95×6–7	2–350, G
		C			
1065	Lupinus	35–39×3·5–4·5	6	70–90×9–12	2–300, d
1043a	Castilleja	35–40×3·5–4	6	78–90×9–12	2–250, d
1110e	Lupinus	39–42×4–4·5	6	88–97×12.5	2–350, g
1130	Lupinus	39–45 (47)×4–5·5	6	115–150×12.5	250–350, d
		D			
1166b	Carum	(46) 53–60×5–5·5	6	70–80×10–11	300, g, T
1112e	Carum	(48) 53–60×5–5·5	6	88–97×14–15	250–350, d
1111	Heracleum	(49) 53–59×3·5–5	6	85–115×12.4–14	250–300, d, T
1169	Aconitum	53–57×4·3–5	6	85–90×12.5	2–300, d, T
1114c	Aquilegia	53–60×4·3–5·3	6	100–110×14–16	250, d
1113a	Erigeron	53–60×5	6	97–106×12.5–16	350–400, t
1129c	Delphinium	58.5×3·5	6	100–110×12.5–14	250–350, d, T
		E			
1084a	Umbellifer	(60) 67–73×3·5–4	6	90–110×13–14	2–275, d
1112	Carum	67–74×4·5–5	6	90–150×14	2–300, d
1109b	Agastache	67.5–74×4·5–5	6	90–105×14	2–250, d
1026b	Umbellifer	(56) 69–75×4–4·5	6	85–95×12–16	2–250, d
1132	Carum	70–74×5	6	96×105×15	3–350, g
		F			
1168	Senecio	66–78×3·5–5	8	85–90 (140)×14–16	3–400, g, T

South of Teton Pass: on *Agastache urticifolia* (Benth.) Rydb., July 11 (1121b).

Only a single perithecium of this species was found, mixed in with many other fungi, and it needs confirmation. There seems to be no other species with these large cylindric dark-brown, 5-septate spores, but inasmuch as insufficient type material is available, no species name is applied at this time.

THE "AGNITA" SERIES

Table 6 deals with a series of collections, all of which have spores containing a swollen cell near one end. Most of these collections form an almost

continuous series, but with more definite breaks than in some of the series of Pleospora. Section A includes all of the 4-septate spores with a second cell swollen, which appear to be a single species, *L. oreophila* Sacc. The single collection in section B has 5-septate spores which are distinctly smaller, and is *L. tenera* Ell.

Sections C, D, & E, all have 6-septate spores with the third cell somewhat enlarged. There are certain minor differences of form correlated with the increase in spore size here, however, and three species can be distinguished which are placed under *L. agnita* (Desm.) Ces & deNot., *L. Erigerontis* Berl. & *L. olivacea* Ell. The spores of these three species are easily confused, however, when only single collections are considered. The collection on Senecio, in Section F, is a continuation of this same series with an additional septum inserted on each side of the swollen cell.

LEPTOSPHAERIA OREOPHILA Sacc.

Pl. 3, Fig. 24

Perithecia 150–300μ in diameter, globose to somewhat depressed-spheric, thickly scattered beneath the epidermis, with a papillate or slightly elongate ostiole erumpent through this tissue, wall parenchymatic, variable in thickness (10–50μ) and often with a slight basal radiating tomentum.

Asci clavate, with a tapering lower portion, and a claw-like basal attachment, wall thickened, particularly above, 60–90×8–11μ.

Spores 2- to 3-seriate, fusoid-cylindric, straight or slightly curved, pale yellow-brown, 4-septate, with 2–several small droplets on either side of each septum, second cell somewhat enlarged, 26–34×3.5–4μ.

Camp Davis: on *Delphinium Brownii* Rydb., June 24 (1045).

Hoback-Snake River Junction: on *Castilleja linariaefolia* Benth., July 15 (1159b).

Hoback Forest Camp: on *Aquilegia coerulea* James, June 25 (1056a)

Granite Creek Canyon: *Boykinia Jamesii* (Torr.) Engler, Aug. 1 (1197).

South of Teton Pass: June 20, on *Pedicularis bracteosa* Benth. (1035); *Hedysarum uintahense* A. Nels., (1126c) and an umbellifer (1022a).

The small droplets lying on each side of the septa, even before these septa themselves are apparent, are typical of the spores of this series.

These collections belong to a group of species including *L. oreophila* Sacc. *L. Niessleana* Rab., *L. quadriseptata* Trail, *L. Lonchampsii* (West.) Sacc., *L. primulana* All., *L. montana* Trav. and *L. spectabilis* Niessl (sensu Berl.). The spore range in one mount will cover that given for all these species. *L. oreophila* is merely chosen as the earliest binomial with the most suitable description.

LEPTOSPHAERIA TENERA Ellis

Pl. 3, Fig. 25

Perithecia somewhat depressed-globose, 200–350μ in diameter, formed beneath the epidermis, but this tissue later exfoliated, erumpent at first as a minute papillate ostiole, usually thickly scattered, wall membranous, 20μ thick.

Asci clavate, wall somewhat thickened, base claw-like, becoming long tapered below and breaking away allowing the spores to escape from the lower end, 75–95×6–7μ.

Spores 2- to 3-seriate, fusoid-cylindric, straight or slightly curved, pale yellow, 5-septate, second cell somewhat enlarged, 18–23×2.5–3.5μ.

South of Teton Pass: on *Clematis Douglasii* Hook., July 11 (1131d).

The type (N. Y. B. Gard., Ellis coll., Harkness No. 3) of *L. tenera* is identical with this collection, although the spores are slightly paler, probably because they are not so mature. Although having an additional septum, these spores are smaller than those of *L. oreophila*.

LEPTOSPHAERIA AGNITA (Desm.) Ces. & deNot.

Pl. 3, Fig. 26

Perithecia scattered over wide areas of the stems, which are not much discolored, causing papillate pustules and erumpent as minute papillate ostioles, 200–300μ in diameter, globose or slightly depressed, walls 20–30μ thick, composed of dark colored parenchyma.

Asci short clavate at first, with a thickened apical wall and a claw-like base, basal portion becoming elongate and tapered, 70–115 (150)×9–12.5μ.

Spores fasciculate, parallel at first, slipping over one another as the ascus elongates, fusoid-cylindric, pale yellow-brown, 6-septate, constricted at first at the 3rd septum, which is practically in the middle of the spore, third cell becoming enlarged. Spores tapered equally toward both ends, with droplets on each side of each septum, somewhat curved, 35–45 (47)× 3.5–5.5μ.

Camp Davis: on *Castilleja miniata* Dougl., June 24 (1043a); and *Lupinus parviflorus* Nutt., June 26 (1065).

South of Teton Pass: on *Lupinus parviflorus* Nutt., July 11 (1110e & 1130).

Berlese's figures (2, 1; 81, Pl. 71, fig. 1) and spore measurements (34–38×4–5) for *L. agnita* fit this collection very well. *L. acuta* (Moug. & Nestl.) is also very similar. This species differs from the following two in the shorter spores and in the position of the constriction at the third septum which is practically in the center of the spore in this species. It seems to favor stems of Lupinus as three of the four collections were on that host.

LEPTOSPHAERIA ERIGERONTIS Berl.

Pl. 3, Fig. 29

Perithecia 250–350μ in diameter, somewhat depressed-globose, thickly scattered in localized, slightly blackened or discolored areas, beneath the epidermis, causing conic pustules with only the papillate ostiole erumpent, often with brown, radiating hyphae about the base beneath the periderm.

Asci short clavate at first, with a thickened apical wall, into which a cylindric extension of the protoplasm extends, base claw-like, becoming attenuated and dissolving to allow the escape of the spores, 70–115× 12.5–15μ.

Spores parallel in the ascus at first, then 4-seriate, elongately cylindric-fusoid, 6-septate, somewhat curved, evenly tapered toward the ends, with the third cell somewhat enlarged, pale yellow-brown, with small globules on each side of the septa (46) 53–60×3.5–5.5μ.

South of Teton Pass: July 11, on *Carum Carui L.* (1112e); *Heracleum sp.* (1111); *Delphinium Brownii* Rydb., (1129c); *Erigeron salsuginosus* (Rich.) A. Gray (1113a); and *Aquilegia coerulea* James (1114c).

Skyline Trail: on *Carum Carui* L., July 24 (1166b).

There is doubt as to just what *L. Erigerontis* is. It was first described by Berlese (1) as a variety of *L. agnita* from material sent by Ellis on *Erigeron canadensis*. He gave the spores as 48–50×4–5μ and his figure (2, 1, Pl. 71, fig. 3) shows a spore similar to that described for *L. agnita*, with the constriction practically in the middle, but the spore measurements agree better with this group of collections. Collections of this species in the N. Y. Bot. Garden show a variety of four or five different Leptosphaerias. An Ellis collection, on Lactuca, labelled L. *agnita* var. *Erigerontis*, has spores 34–37×3–3.5μ which are of the *L. ogilviensis* type with a different shape. The binomial *L. Erigerontis* is used here provisionally.

This species seems to favor the Umbelliferae, since three of the six collections are on umbelliferous hosts. It is easily confused with the following species, *L. olivacea*, particularly, because the two may occur mixed on the same stems (i.e., 1112 & 1112x). *L. Erigerontis* differs in the shorter spores which taper toward the two ends, whereas in *L. olivacea* the spores are more evenly cylindric and the swollen cell is more prominent. *L. Erigerontis* differs from *L. agnita* in the position of the constriction, at the third septum, which in the former is above the middle of the spore.

LEPTOSPHAERIA OLIVACEA Ellis

Pl. 3, Fig. 27

Perithecia globose to slightly depressed, 200–400μ in diameter, thickly scattered beneath the epidermis in locally blackened or somewhat discolored areas, forming small conic pustules, and erumpent as small papillate ostioles, walls 20–40μ thick, of rather small, dark-walled parenchyma.

Asci clavate, soon with an elongate tapered base, apical wall thickened and often with a cylindric extension of protoplasm projecting into it, 70–110×13–16μ, or up to 160μ, as the base elongates at spore ejection.

Spores 4-seriate to overlapping fasciculate, elongately cylindric-fusoid, pale yellow-brown, somewhat curved, 6-septate, at first constricted at the third septum and then with the third cell somewhat enlarged, ends of spores rounded, not much tapered, with small globules on each side of the septa (60) 67–75×3.5–5μ.

Cream Puff Mt.: On Umbellifer stems, July 5 (1084a).

Glory Mt.: on Umbellifer stems, June 20 (1026b).

South of Teton Pass: July 11, on *Carum Carui* L. (1112 & 1132); and *Agastache urticifolia* (Benth.) Rydb. (1109b).

Ellis (3, p. 53) described *L. olivacea*, from herbaceous stems, from Utah. He gave the spores as 75×3.5μ, 6- to 7-septate, and with the third cell swollen. His figure (4, Pl. 28, fig. 13) shows its spore as of the same type as in these collections, but 7-septate. Berlese and Voglino (in Saccardo, Add. Fung. Syll. 186) placed this species in Ophiobolus. Whatever the line of demarcation is to be between Leptosphaeria and Ophiobolus, it will have to be purely arbitrary. Inasmuch as this species is obviously closely related to the two preceding, it is retained in Leptosphaeria.

This species differs from *L. Erigerontis*, as here interpreted, in the longer spores and the sudden narrowing of the swollen cell, with the remainder of the spore length being cylindric with very little taper, rather than gradually tapering toward the end, as in that species. It, again, seems to favor the stems of umbellifers.

Leptosphaeria octoseptata sp. nov.

Pl. 3, Fig. 28

Perithecia thickly scattered over wide areas of the stem, slightly depressed globose, 300–400μ in diameter, formed beneath the epidermis, at first erumpent only as the small papillate ostiole, later erumpent-superficial by exfoliation of the epidermis, with a basal radiating tomentum beneath the epidermis and often a tomentum of short hairs over the entire surface.

Asci clavate at first, 85–90μ long, then with a long tapering base, 140×14–16μ, apical wall somewhat thickened.

Spores overlapping fasciculate in the ascus, elongately fusoid-cylindric, slightly curved, ends acute, pale yellow, typically 8-septate, fourth cell slightly swollen, small guttulae on each side of the septa, 66–78×3.5–5μ.

Skyline Trail: on *Senecio crassulus* Gray, July 24, legit L. E. Wehmeyer (No. 1168), (Type).

Perithecia dense dispersa in areis caulis latis, depressiuscule globosa, diametro 300–400μ, sub epidermate formantia, primum solum erumpentia ut ostiola papilliformia, demum super-

ficialiter erumpentia a epidermatis exfoliatione, tomento basali radiato subepidermali praedita, omnino breviter tomentosa. Asci juvenales clavati, vetustiores basi angustati, 140μ longi, 14–16μ crassi, membrana apicali crassiuscula. Sporae irregulariter fasciculatae, longe fusiformi-cylindricae, paulum curvatae, apicibus acutae, pallide luteae, typice, 8-septatae, guttulis typice utrinque ad latera ambo septorum omnium, 66–78μ longae, 3.5–5μ crassae; cellula quarta modice dilatata.

Specimen typicum in caulibus vetustis *Senecionis crassuli*, secus viam "Skyline Trail," Teton National Park, Wyoming, 24 Jul., 1940, legit L. E. Wehmeyer, sub numero 1168.

This species is the culmination of the agnita series, having the spore form of *L. olivacea* but with more acute ends, and showing the insertion of an additional cross wall on each side of the swollen cell, as a result of the elongation of the spore.

A second collection (1065a) on *Lupinus parviflorus*, from Camp Davis, with similar spores 50–60×2–3μ and showing 7 to 9 faint septa, but no swollen cell, may well be an immature specimen of this species and is referred here for the present. *L. Drabae* (Nyl.) Karst. is the only described species of Leptosphaeria which at all resembles this collection, and its description is insufficient to fix it as the same.

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Vol. 9 DECEMBER · 1946 No. 4

LLOYDIA

A Quarterly Journal of Biological Science

Published by the Lloyd Library and Museum, Cincinnati, Ohio

Studies in the Sapotaceae—II

Survey of the North American Genera

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The *Sapotaceae*, a well-marked natural family of the order *Ebenales*, may be briefly characterized as follows: Woody plants, with milky juice; leaves simple, entire, alternate or rarely opposite; flowers in axillary clusters, these sometimes branched; sympetalous; stamens epipetalous, in 1–3 whorls, often some reduced to staminodes (these commonly alternate with the corolla-lobes, often petaloid), at least one antheriferous whorl opposite the corolla-lobes, or rarely all suppressed and the flowers thus polygamous; pistil 1, the style sometimes obscurely lobed at the summit; locules about 1–14, 1-ovulate, the placenta essentially axial; fruit indehiscent, usually fleshy, with large seeds.

The family has acquired a reputation as a highly confused and difficult group. The many evident morphological differences within it have led splitters to propose almost innumerable genera, while the widespread intergradation of these characters has led lumpers to equally extreme reduction. Furthermore, the large and often fleshy fruits are seldom preserved, so that floristic and casual workers may be unaware of the great importance of the seeds, while monographers do not find adequate material for study.

In spite of these difficulties, I believe that reasonable genera can be recognized and defined. Granted that occasional intermediates or exceptions occur, I believe that the presence or absence of staminodes, the presence and position of appendages on the corolla-lobes, the general type of seed-scar and ovular attachment, and the presence or absence of endosperm are of generic importance in the family. Number and arrangement of parts, while sometimes attaining considerable significance, frequently fail as generic characters, as witnessed by the occurrence in the same species or even on the same branch of 4-merous flowers with biseriate calyx and 5-merous flowers with imbricate calyx. The number of carpels seems to be scarcely more reliable than the numbers of other floral parts,

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being helpful chiefly as a specific criterion, and then only to be used cautiously. The importance of leaf-venation, while very considerable, has sometimes been over-emphasized. It cannot be doubted that characters of venation frequently mark natural groups, but these characters scarcely seem as reliable, in our area, as those of the staminodes, appendages, and seeds.

All of the genera treated in this paper are fairly well defined, at least as they occur in North America. While some failure of the distinctions may be expected among the more numerous South American species, it is not to be expected that any of the generic alignments will be seriously disturbed. The characters used to separate genera in this work have been recognized as important by most serious students of the group since the turn of the century. The outstanding exception is Baehni, who, unjustly, I believe, denies the importance of endosperm, and has very little faith in leaf-venation.

Since most of the species treated in detail in this paper are also treated in Baehni's monograph of *Pouteria*, a brief appraisal of that work may be appropriate. His treatment has been a ready and valuable source of bibliographical references and synonymy, and in most cases we are in agreement as to specific limits, but as an authoritative work to use in identifying specimens and determining the correct names for them, it is hopeless. *Pouteria campechiana*, for example, appears no less than 14 times in the key to the species, this counting as one appearance each of the several cases in which all four varieties that he recognizes are separately but adjacently keyed. Similarly, *P. dominigensis* appears 8 times in the key, and the average number of appearances for all the species is more than $2\frac{1}{2}$. Nor is this multiplicity of appearance due to an attempt to establish a natural key, for the characters used are frequently most inconsequential, and the whole key is set up entirely independently of and at cross-purposes with the key to the sections. Furthermore, although Baehni correctly reduces a number of familiar but poorly defined "genera" to *Pouteria*, he seems unlikely to have many followers in reducing such groups as *Micropholis*, *Achrouteria*, and *Planchonella*. The criticisms made by Lam of Baehni's earlier survey of the family (Candollea **7**: 394–508. 1938.) apply with undiminished force to his monograph of *Pouteria*.

A revolutionary interpretation of the floral morphology of the *Manilkara* group has recently been made by Gilly (Trop. Woods **73**: 1–22. 1943). According to his view, the inner calyx-whorl of other authors constitutes the true corolla, while the corolla of other authors constitutes an outer whorl of partly fused staminodes. The evidence for this view is presumably to be published in a later paper. If this new interpretation of the floral morphology is not carried over into other genera, a division of the family is in order, since the one group would be polypetalous, with a highly de-

veloped staminodial tube, while the other group would be constantly sympetalous, with free staminodes or none at all. Previous authors, however, have considered the family to be natural, a view with which I agree.

On the other hand, an attempt to carry Gilly's interpretation into other genera leads into considerable difficulties. Some species of *Pouteria* bear on the same branch flowers with 4-biseriate sepals, the inner somewhat petaloid in texture, and flowers with 5 imbricate sepals all about alike. Other genera, such as *Chrysophyllum*, which commonly has 5 sepals, 5 corolla-lobes, and no staminodes, according to the usual interpretation, and whose flowers look much like the flowers to be found in many other sympetalous families, would presumably be regarded as apetalous. Under these circumstances, I think it best to follow the customary interpretation of the floral morphology, at least until strong anatomical and ontogenetic evidence for Gilly's interpretation, with due consideration for the relationship of the *Sapotaceae* to other families, is presented.

This study was made under the auspices of the Chicle Development Co., and at the suggestion of Mr. B. A. Krukoff, to both of whom I acknowledge my thanks. The curators of several herbaria have provided essential assistance by kindly loaning specimens for study. The abbreviations used in the text to indicate these herbaria are as follows:

A—Arnold Arboretum, Harvard University, Jamaica Plain, Mass.,
CR—Museo Nacional de Costa Rica, San Jose,
CU—Estacion Experimental Agronomica, Habana, Cuba,
F—Field Museum (Chicago Natural History Museum),
G—Gray Herbarium, Harvard University, Cambridge, Mass.,
Mich—University of Michigan, Ann Arbor,
MO—Missouri Botanical Garden, St. Louis,
NY—New York Botanical Garden,
PR—Tropical Forest Herbarium, U. S. Forest Service, Rio Piedras, Puerto Rico,
US—United States National Herbarium, Washington, D. C.,
Y—Yale University School of Forestry, New Haven, Conn.

Since many of the older types are at present unavailable for study, the prevailing interpretations as to their identity have been accepted. No attempt is made to give complete synonymy, especially of the older names. This can generally be found elsewhere, as for example in Baehni's monograph of *Pouteria* and in Pierre and Urban's treatment of the *Sapotaceae* of the West Indies. The genera *Bumelia*, *Dipholis*, and *Manilkara* are here merely defined; it is intended to treat these in detail later.

In using the following treatment, it should be borne constantly in mind that, as in most tropical groups, the material available for study is frequently inadequate. One species may be known only in flower, another only in fruit, so that the key distinction must be made on the leaves. Differ-

ences which loom large when only a few specimens are available may appear insignificant when more material is accumulated. Contrariwise, small differences now disregarded may later prove to be constant. The problem frequently is not, to determine from a large series of specimens which differences are constant, but rather, to make the best possible guess as to which characters will prove to be constant when more material is available. Doubtless it will sometimes be found that the species here recognized are valid but some of the characters used to separate them are not. I hope and believe that nearly all of the entities I have recognized will prove tenable; only time and more material will tell.

KEY TO THE NORTH AMERICAN GENERA

1. Sepals imbricate or spiraled, not distinctly biseriate except sometimes in *Pouteria*, and then 2 plus 2; appendages of the corolla-lobes lateral or absent.
   2. Staminodia present (rarely suppressed in *Pouteria*, which has no endosperm).
      3. Seed-scar basal or basilateral, not extending to the middle of the seed; ovules basilaterally attached; ovary glabrous or hairy.
         4. Corolla-lobes without lateral lobes; endosperm present; ovary glabrous; leaves mostly well over 6 cm. long; unarmed ..... 1. *Mastichodendron*.
         4. Corolla-lobes bearing lateral lobes (absent in a few species of *Bumelia*); leaves often but not always less than 6 cm. long; frequently spiny or thorny.
            5. Endosperm present; ovary nearly always glabrous; young fruit commonly abruptly tapering to the style; unarmed ..... 2. *Dipholis*.
            5. Endosperm absent; ovary usually hairy; young fruit commonly not at all tapering to the style, being rounded or truncate at the apex instead; usually spiny or thorny ..... 3. *Bumelia*.
      3. Seed-scar lateral, generally extending nearly or quite the whole length of the seed, or sometimes nearly the whole seed-coat more or less grown to the pericarp; ovules attached laterally, though sometimes near the base; ovary hairy.
         4. Endosperm present; primary lateral veins of the leaves relatively numerous, crowded, and straight or nearly so, the leaf more or less striate ..... 5. *Micropholis*.
         4. Endosperm absent; primary lateral veins fewer, more widely spaced, evidently curved at least near the margins, the leaf not striate ..... 6. *Pouteria*.
   2. Staminodia absent; endosperm present ..... 4. *Chrysophyllum*.
1. Sepals biseriate, commonly 3 plus 3 (rarely 2 plus 2, occasionally 4 plus 4); corolla-lobes often but not always with paired dorsal appendages which resemble supernumerary lobes; endosperm present; seed-scar lateral ..... 7. *Manilkara*.

1. MASTICHODENDRON

The genus *Sideroxylon* was founded on *S. inerme* L., an African species. As pointed out by Dubard in 1912, *S. inerme* and a number of other African species differ from the American species which have been referred to *Sideroxylon*, in the horizontal rather than vertical embryo, and in the closely areolate venation of the leaf. Generic segregation of the two groups seems warranted by the technical characters, general appearance, and geographic distribution. Unfortunately, Dubard maintained the name *Sideroxylon* for the American species, taking up the name *Calvaria* for the African group which contains the type of *Sideroxylon* L.

In 1939 Lam, in his critique of Baehni's survey of the *Sapotaceae*, attempted to rectify the situation, and took up the name *Mastichodendron*

Jacq. for the American species. Unfortunately, *Mastichodendron* seems never to have been validly published, so that Lam's new combinations were made under a generic name which, according to the Rules, does not exist.

The name Auzuba Plum. ex Juss., listed in the synonymy of *Sideroxylon* by Pierre & Urban, and by Baehni, was published merely as a common name, rather than as a new genus. There seems to be no validly published generic name for the American species related to *Sideroxylon*, and I therefore take up *Mastichodendron* as a new genus.

Mastichodendron Cronquist, gen. nov.

Sideroxylon sensu Dubard, Ann. Mus. Col. Marseille, ser. 2. 10: 81. 1912.
Not *Sideroxylon* L. Sp. Pl. 192. 1753.

Arbores; folia exstipulata, solute reticulata, non dense areolata; sepala petala stamina et staminodia 5; ovarium glabrum; area derasa seminis basilateralis; albumen copiosum; embryon erectum.

Type species: *Sideroxylon foetidissimum* Jacq. Enum. Pl. Carib. 15. 1760.

Whether the two or three Chinese species included in *Mastichodendron* and *Sideroxylon* by Lam and Dubard, respectively, properly belong to *Mastichodendron* is open to question. They have a relatively longer corolla-tube, and "*S. wightianum* H. & A.," the only one available to me, has a very thin corolla with large petaloid staminodes, as contrasted to the firm corolla and non-petaloid staminodes of *Mastichodendron*. The seed-scar of the Chinese plant also looks different from that of the American species, being almost exactly basal and evidently impressed. When coupled with geographic distribution, these differences, if they hold up in the other species, might warrant generic segregation.

MASTICHODENDRON Cronquist

Leaves alternate or subopposite, exstipulate, the midrib more or less canaliculate, the channel often terminating in a pouch at the base of the blade; primary lateral veins not very numerous, curved; secondary lateral veins forming an evident fairly open reticulum, the surface not closely areolate; flowers, 5-merous as to sepals, petals, stamens, staminodes, and usually locules of the young ovary; corolla subrotate, the tube short; stamens attached at or a little above the level of the sinuses; staminodes present, not petaloid; ovary essentially glabrous; ovules attached basilaterally, usually only 1 maturing in each fruit; seed about 1–2.5 cm. long, with basilateral lanceolate to circular scar up to as much as 9 mm. long but not extending to the middle of the seed; endosperm copious; mature fruit more or less fleshy, mostly 1.5–4.5 cm. long.

Mastichodendron is the least specialized American genus of the family, although some old-world genera are almost certainly more primitive.

KEY

1. Seed-coat fragile, only about 0.1–0.2 mm. thick; Jamaica ..... 2. *M. floribundum.*
1. Seed-coat firm, 0.5 mm. thick or more; general distribution, including Jamaica.
   2. Corolla 3.5–5.0 mm. long; anthers about 1.3–2.0 mm. long; leaves glabrous from the first; Florida, West Indies, and the Yucatan peninsula of Mexico and British Honduras ..... 1. *M. foetidissimum*
   2. Corolla 5.0–8.5 mm. long; anthers about 2.0–3.8 mm. long; leaves often hairy, sometimes glabrous; Mexico and Central America, but not, except for *M. belizense*, on the Yucatan peninsula.
      3. Petioles relatively long, rarely less than ½ as long as the blades, and then at least 4 cm. long; fruit reputedly yellow ..... 3. *M. capiri*
      3. Petioles short, about ⅛–½ as long as the blades, up to 3 cm. or rarely 3.5 cm. long; fruit various.
         4. Sepals hairy; leaves more or less hairy, or in age subglabrate; fruit blue-black, with a light blue bloom; Sonora, Mexico, to Huehuetenango, Guatemala. 4. *M. angustifolium*
         4. Sepals glabrous; leaves glabrous; fruit reputedly yellow; British Honduras, and Izabal, Guatemala ..... 5. *M. belizense*

1. **Mastichodendron foetidissimum** (Jacq.) Cronquist, comb. nov.

Sideroxylon foetidissimum Jacq. Enum. Pl. Carib. 15. 1760.

Tree sometimes reaching 25 m. in height; leaves glabrous, of variable size and shape, the blade most commonly broadly elliptic, rounded to acutish at both ends, about 10 cm. long or less, and up to half as wide, sometimes becoming very broadly elliptic, or narrower and elliptic-lanceolate, and then frequently up to 15 cm. long and more or less acuminate; marginal veins becoming more or less raised and wing-edged at the base of the blade, sometimes joined to form a small pocket or pouch, sometimes gradually sinking into the petiole; petioles mostly ¼–½ as long as the blades, sometimes much shorter; flowers numerous in clusters axillary to leaves or leaf-scars; calyx about 1.3–2.1 mm. long; the sepals broad, rounded, glabrous or nearly so, occasionally finely ciliolate; corolla yellow or yellowish, about 3.5–5.0 mm. long, nearly rotate, the lobes commonly elliptic-ovate, with thin and scarious margins, often slightly auriculate at the base; filaments commonly a little shorter than the corolla-lobes, the anthers about 1.3–2.0 mm. long, included or the tips a little exserted; staminodes commonly ovate to deltoid or lanceolate, attenuate, and not much shorter than the filaments, but variable, sometimes shorter, broader, and somewhat toothed at the summit; fruit yellow or reputedly sometimes black, often turning dark in herbarium specimens, about 1.5–3 cm. long, more than half as thick, commonly a little compressed, becoming irregularly wrinkled and sometimes somewhat longitudinally ridged in drying; seed not much shorter than the fruit, about 12–23 mm. long and 9–16 mm. wide, broadly elliptic-oblong to somewhat ovate or obovate, generally a little compressed, commonly slightly oblique at the base because of the scar, which varies from circular to lanceolate, and from about 2 to 8 mm. long; a slightly thickened longitudinally bipartite plate often present on the ventral side of the seed, variable in shape and size, but most commonly

obovate and about twice as long as the scar; seed-coat firm, about 0.5–1.0 mm. thick.

Type: None given.

Local names: Mastic, acomat, caya, caya blanca, tortugo amarillo, tortugo prieto, jocuma amarillo, tabloncillo, jocuma, jocuma lechero.

Distribution: Florida, Bahama Islands, Greater Antilles, Lesser Antilles, and the Yucatan peninsula of Mexico and British Honduras.

KEY TO THE SUBSPECIES

1. Seed-scar mostly less than 4 mm. long (rarely to 5 mm.), commonly broadly elliptic to suborbicular; Florida and the West Indies.....subsp. *typicum*
1. Seed-scar about 4–8 mm. long, tending to be lanceolate or narrowly elliptic, sometimes broader; Mexico and British Honduras.....subsp. *gaumeri*

1A. **Mastichodendron foetidissimum** (Jacq.) Cron. subsp. **typicum** Cronquist, nom. nov.

Sideroxylon foetidissimum Jacq. Enum. Pl. Carib. 15. 1760.
S. jamaicense Urb. Symb. Ant. 5: 134. 1904.
S. portoricense Urb. loc. cit.
S. domingense Urb. loc. cit. p. 135.
Mastichodendron foetidissimum Cronquist, above.

Characters as in the key; fruit 1.5–2.5 cm. long; seed commonly but not always with a thickened longitudinally bipartite plate on the ventral side near the scar.

Distribution: Florida and the West Indies.

U. S. A.: Florida: *Bessey 63* (A); *Blodgett s.n.* (G, NY); *Chapman 9* (US); *Chapman 11* (MO, US); *Cooper s.n.* (G); *Cowles 910* (US); *Curtiss 1759* (A, G, Mich, MO, NY, US); *Garber s.n.* (July 1877) (G, US); *J. A. Harris C21355* (US); *Hitchcock 200* (G, MO, NY, US); *Howell 878* (US); *Macdonald 22* (Y); *McFarlin 6611* (Mich); *Mell s.n.* (February 15, 1911) (US); *Miller 1697* (US); *Mosier 339* (US); *Mosier 5584* (NY); *O'Neill s.n.* (September 12, 1939) (US); *Orrok s.n.* (March, 1915) (NY); *Rehder 717* (A); *Rehder 745* (A); *Rhoads 8313* (A); *Rugel 173* (NY); *Rugel 247* (NY, MO, US); *Safford & Mosier 110* (US); *Sargent s.n.* (April 6, 1886) (A); *Sargent s.n.* (April 9, 1886) (A); *Sargent s.n.* (April 16, 1886) (A); *Simpson 218* (A, Mich); *Simpson s.n.* (November, 1912) (A); *Small 7648* (Mich, MO); *Small 7662* (NY); *Small 7789* (NY); *Small & Carter 800* (NY); *Small & Carter 3034* (NY); *Small & Mosier 5747* (G, NY); *Small & Nash 125* (NY); *Small & Small 4216* (NY); *Small & Small 4649* (NY, US); *Spalding s.n.* (March 11, 1902) (Mich). BERMUDA: *Wortley 1867* (NY). BAHAMAS: *Ames s.n.* (14. Febr.–4. Mar., 1926) (A); *Brace 4544* (NY); *Brace 6780* (NY); *Britton 6468* (NY); *Britton & Millspaugh 2292* (NY); *Britton & Millspaugh 5564* (NY); *Coker 325* (NY); *Eggers 4313* (NY); *Millspaugh 2432* (M); *Northrop & Northrop 450* (NY, F); *Small & Carter 8883* (NY); *Wilson 8200* (NY); *Wilson 8365* (NY, MO). CUBA: *Gill & Whitford 9* (Y); *Hioram 1784* (NY); *Leon 7687* (NY); *Linden 1982* (G); *Roig & Cremata 2264* (NY); *Wright 1324* (G, MO, NY, US); *Wright, s.n.* (1860–1864) (G); *Wright s.n.* (1865) (US). Pinar del Rio: *Britton & Earle 7579* (G, NY, US); *Shafer 11129* (NY, MO, US). Isla de Pinos: *Britton & Wilson 14886* (NY, US). Habana: *Leon 6259* (NY); *Leon 7672* (NY); *Leon 7681* (NY). Santa Clara: *Britton, Cowell & Earle 10302* (NY); *Howard 4793* (G); *Howard 5445* (G); *Howard 6599* (G); *Jack 5061* (A); *Jack 5221* (A); *Jack 5257* (A); *Jack 5530* (A, US); *Jack 5584* (A); *Jack 5712* (Mich); *Rehder 1106* (A); *White 671* (A). Camguey: *Shafer 555* (NY, US). Oriente: *Britton, Britton & Cowell 12832* (NY, US); *Crosby & Matthews 17* (Y); *Ekman 4145* (US); *Ekman 4342* (F, G, US); *Ekman 4447* (A, G, MO); *Ekman 6120* (US); *Ekman 6246* (F, G, Mich, NY, US); *Ekman 6386* (A, F, Mich, MO, NY, US); *Ekman 7374* (US); *Ekman 19081* (G, NY, US); *Hamilton 88* (NY); JAMAICA: *Harris 7030* (NY); *Harris 10805* (NY, F, US); *Harris 10808* (NY, US); *Harris & Britton 10715* (NY, US); *Wright s.n.* (NY). NAVASSA: *Rehder 10* (A, NY, US); *Rehder 14* (A,

NY, US). HAITI: *Cook, Scofield & Doyle 263* (US); *Ekman H 5122* (US); *Ekman H 8081* (US); *Ekman H 8737* (US); *Ekman H 9790* (US); *Leonard 3023* (NY, US); *Leonard 5225* (G, NY, US); *Leonard & Leonard 11443* (A, NY, US); *Leonard & Leonard 13248* (G, MO, US); *Leonard & Leonard 15809* (NY, US); *Miller 291* (US); *Nash & Taylor 1532* (NY); *Sweet 10* (US). DOMINICAN REPUBLIC: *Abbott 919a* (US); *Eggers 1985* (A, NY, US); *Fuertes 243* (A, F, G, MO, NY, US); *Fuertes 986* (A); *Holdridge 495* (NY, PR); *Rose, Fitch & Russell 4231* (NY, US); *Scarff 5* (F, Y); *Schiffino 32* (Y); *Schiffino 113* (Y); *Taylor 270* (NY, US); *Taylor 448* (NY); *Valeur 942* (NY, MO, US). PUERTO RICO: *Britton, Britton & Brown 6233* (NY, US); *Britton & Marble 2280* (NY, MO, US); *Gregory 20* (NY, PR); *Heller & Heller 507* (NY, F, US); *Holdridge 320* (PR); *Miller 1629* (US); *Sintenis 3950* (F, G, MO, NY, US); *Sintenis 5001* (F, G, MO, NY, US); *Sintenis 6365* (F, G, MO, NY, US); *Velez 587* (NY); *Velez 1063* (NY); ST. THOMAS: *Eggers s.n.* (March 24, 1876) (MO). TORTOLA: *Beard 338* (A). SABA: *Boldingh 2049 B*. ANTIGUA: *Box 1035* (A, US); *Box 1475* (US). GUADELOUPE: *Bertero s.n.* (MO); *Duss 2915* (F, G, MO, NY, US); *Stehle 1264* (A, US). MARTINIQUE: *Duss 1910* (NY, F, US).

1B. **Mastichodendron foetidissimum** (Jacq.) Cron. subsp. **gaumeri** (Pittier) Cronquist, comb. nov.

Sideroxylon gaumeri Pittier, Contr. U. S. Nat. Herb. **13**: 460. 1912.

Characters as in the key; fruit mostly 2–3 cm. long, the seed correspondingly larger than in subsp. *typicum*, and without any thickened ventral plate.

Type: *Gaumer 763*, Isamal, Yucatan, 1895 (A, F, G, MO, NY, US).

Distribution: Yucatan peninsula, in Mexico and British Honduras.

MEXICO: Campeche: *Lundell 1241* (F, G, Mich, MO, NY, US); Yucatan: *Gaumer 763* (A, F, G, MO, NY); *Gaumer 23228* (F, G, MO, NY, US). BRITISH HONDURAS: *Gentle 28* (F); *Gentle 403* (F, Mich, MO); *Gentle 2609* (A, Mich); *Gentle 4753* (NY); *Lundell LP17* (NY, F, US); *Lundell 639* (F, G, MO, NY, US); *Lundell 4753* (A, F, G, MO, Mich, US); *Lundell 7495* (A); *Meyer 65* (F); *Meyer 152* (F); *Meyer 171* (F); *Smart & Stevenson 150.* (F, Y)

The Mexican and West Indian plants seem to differ only in the characters just given, the leaves and flowers being very similar. In the absence of any constant technical character, plants which look so much alike can scarcely be considered distinct species. Following the concept of intraspecific units given in a previous publication (Bull. Torrey Club **70**:265. 1943.), I am treating the Mexican plants as a sub-species.

Several collections from Guatemala, Honduras, and Nicaragua seem to represent a distinct species related to *M. foetidissimum*. They are essentially glabrous, and have short petioles. The leaves, however, are longer and relatively narrower than in *M. foetidissimum*, tend to be broadest above the middle, and have a somewhat different aspect. In the absence of flowers or mature fruit, I refrain from proposing a name.

GUATEMALA: Peten: *Egler 42–222* (F); *Egler 42–232* (F); Retalhuleu: *Standley 87220* (F); *Standley 87603* (F); Escuintla: *Aguilar 1589* (F); Santa Rosa: *Kellerman 7075* (F); *Standley 79526* (F); *Standley 79665* (F). HONDURAS: Comayagua: *Edwards 402* (A F, US). NICARAGUA: Chinandega: *Maxon, Harvey & Valentine 7148* (F, US).

2. **Mastichodendron floribundum** (Griseb.) Cronquist, comb. nov.

Sideroxylon floribundum Griseb. Fl. Br. W. Ind. 399. 1861.

Tree reaching 25 m. high; leaves glabrous, similar to those of *M. foetidissimum*, but somewhat acuminate, and not developing a pocket at the base

of the blade; flowers numerous in clusters axillary to leaf-scars; calyx about 1.8 mm. long; corolla about 5.5 mm. long, the suborbicular or orbicular-elliptic lobes conspicuously auriculate at the base; filaments equaling or surpassing the corolla, the anthers conspicuously exserted and about 2.2–2.5 mm. long; staminodes short and relatively broad, several times shorter than the filaments, commonly somewhat 2–3-lobed at the summit; fruit evidently yellowish, ellipsoid, about 26 mm. long and 12–14 mm. thick, becoming strongly ridged longitudinally in drying; seed relatively small, only about 12–14 mm. long and 9–10 mm. thick, slightly compressed, the seed-coat fragile, only about 0.1–0.2 mm. thick, the seed-scar a little more nearly basal than in *M. foetidissimum*.

Type: *March 1562* (or *1502*), Jamaica (G, NY-drawing).

Distribution: Jamaica.

JAMAICA: *Harris 11217* (G, MO, NY, US); *Perkins 1424* (G).

Since the Harris collection has leaves similar to those of the type of *M. floribundum*, and fruits which show several significant differences from those of *M. foetidissimum*, it seems reasonable to associate the specimens with *M. floribundum*, and the description of the fruit for that species is drawn from them.

3. **Mastichodendron capiri** (A. DC.) Cronquist, comb. nov.

Lucuma ? capiri A. DC. Prodr. 8: 173. 1844.

Tree up to about 25 m. high; leaves elliptic to ovate, rounded to acute or acuminate at the apex, up to about 20 cm. long and 11 cm. wide, with or without a well marked pouch at the base, glabrous to densely and loosely villous, the hairs sometimes a little reddish; petioles about 3–10 cm. long, mostly $\frac{1}{3}$ as long to fully as long as the blades, occasionally a little less than $\frac{1}{3}$ as long as the blade, but then at least 4 cm. long; flowers numerous in clusters on defoliated nodes; calyx about 2.2–2.8 mm. long, the sepals broad, rounded, finely hairy; corolla yellow or yellowish, about 5.0–8.5 mm. long; anthers about 2.4–3.8 mm. long; staminodes commonly lanceolate, acuminate or attenuate, and 1–2.5 mm. long, sometimes shorter, broader, and erose; fruit about 2.5–4 cm. long, generally ellipsoid, sometimes subglobose, reputedly yellow and edible; seed ellipsoid to sometimes nearly subglobose, a little compressed, about 2.0–2.5 cm. long and 1.5–1.8 cm. thick, with lanceolate to subglobose scar mostly 6–9 mm. long and 4–6 mm. wide; seed-coat firm, nearly 1 mm. thick.

Type: *Sesse* and *Mocino s.n.*, Mexico (NY-drawing; F-photo of drawing).

Local names: Tempisque, tempixtle, capiré.

Distribution: Nayarit, Mexico, to Cocle, Panama, chiefly on the Pacific slope, but sometimes crossing over, especially in Guatemala.

KEY TO THE VARIETIES

1. Leaves densely and finely villosulous with loose or spreading hairs when young, later becoming more sparsely so, or in age more or less glabrate.....var. *typicum*
1. Leaves either essentially glabrous from the first, or soon glabrate, occasionally more persistently hairy along the midrib beneath.....var. *tempisque*

3A. **Mastichodendron capiri** (A. DC.) Cron. var. **typicum** Cronquist, nom. nov.

Lucuma ? capiri A. DC. Prodr. **8**: 173. 1844.
Sideroxylon petiolare A Gray, Proc. Am. Acad. **22**: 434. 1887.
Sideroxylon capiri Pittier, Contr. U. S. Nat. Herb. **13**: 462. 1912.

Characters as given in the key.

Distribution: Nayarit, Mexico, to Oaxaca, and perhaps occasionally southeastward.

MEXICO: *Haenke 965* (F); *Sesse, Mocino & Maldonado 5152* (F). Nayarit: *Mexia 750*(A, F, G, Mich, MO, NY, US). Jalisco: *Palmer 131* (G, NY, US); *Palmer 135* (NY, G, US); *Palmer 136* (NY, G, MO, US); *Pringle 5298* (G). Michoacan: *Hinton 5974* (A, MO); *Hinton 13911* (G); *Langlasse 225* (G, US); *Leavenworth & Hoogstraal 1382* (G, MO, NY); *Leavenworth & Hoogstraal 1432* (G, MO); *Leavenworth & Hoogstraal 1454* (G, Mich, MO, NY); *Leon 6* (US); *Nelson 6955* (US). Mexico: *Hinton 746* (G); *Hinton 3833* (A, F,). Morelos: *Pringle 7820* (G, MO). Guerrero: *Gamon 39* (F, US, Y); *Hinton 5879* (F); *Hinton 5882* (F); *Nelson 7066* (G, US). Oaxaca: *Conzatti 2456* (F); *Conzatti 4133* (US); *L. C. Smith 38* (G).

3B. **Mastichodendron capiri** (A. DC.) Cron. var. **tempisque** (Pittier) Cronquist, comb. nov.

Sideroxylon tempisque Pittier, Contrib. U. S. Nat. Herb. **13**: 461. 1912.

Characters as given in the key.

Type: *Pittier 1917*, La Laguna de Santa Tecla, Salvador, 800 m., February 6, 1907 (US).

Distribution: Cocle, Panama, to Oaxaca, Mexico, and perhaps occasionally northwestward.

MEXICO: *Haenke 1599* (NY). Oaxaca: *Reko 4261* (US). Chiapas: *del Pino s.n.* (December 1, 1933) (US); *Goldman 873* (US); *Purpus 375* (US); *Purpus 10375* (NY). GUATEMALA: *Aguilar 1186* (F). Santa Rosa: *Standley 79149* (F). Huehuetenango: *Cook 62* (US); *Steyermark 50911* (F). Izabal: *Whitford & Stadtmiller 71* (G, US, Y). Zacapa: *Kellerman 5023* (US); *Steyermark 42108* (F). Guatemala: *Standley 59307* (F). Escuintla: *Standley 63418* (F). Amatitlan: *Kellerman 6721* (F); *Donnell-Smith 2508* (F, G, MO, NY, US). HONDURAS: Comayagua: *Edwards P-97* (A, F); *Edwards P-371* (A, F, US). SALVADOR: *Calderon 31* (F); *Calderon 190* (G, NY, US). Ahuachapán: *Padilla 190* (US); *Padilla 447* (US). Sonsonate: *Standley 22017* (G, NY, US). San Salvador: *Calderon 256* (G, NY, US); *Standley 19493* (G, MO, NY, US). San Vicente: *Standley 21698* (F, G, MO, NY, US). NICARAGUA: Managua: *Garnier 839* (Mich, US); *Garnier 4325* (A); *Oersted 332A* (US). COSTA RICA: Guanacaste: *Brenes 12574* (F, CR); *Standley & Valerio 46677* (A, US). PANAMA: Cocle: *Williams 421* (NY, F, US).

The difference in known distribution of the two varieties of *M. capiri* might seem to call for subspecific treatment, but the occasional occurrence of intermediates almost throughout the range of the species suggests that one or both of the entities may later be found to occur sparingly in the range of the other. Until the apparent geographic segregation is fully sub-

stantiated by further collections, I prefer to treat the two pubescence-forms as varieties.

4. **Mastichodendron angustifolium** (Standl.) Cronquist, comb. nov.

Sideroxylon angustifolium Standl. Contr. U. S. Nat. Herb. **23**: 1124. 1924.
Chrysophyllum tepicense Standl. Contr. U. S. Nat. Herb. **23**: 1115. 1924.

Large tree reaching at least 20 m. in height; leaves elliptic to narrowly obovate, rounded to acute at both ends, mostly 7–17 cm. long and 3–6.5 cm. wide, loosely spreading-villous with curled slightly reddish hairs on both sides when young, becoming more sparsely so, especially above, at maturity, or in age subglabrate; petioles short, about 1–3 cm. or rarely 3.5 cm. long, about $\frac{1}{9}$–$\frac{1}{3}$ as long as the blades; flower clusters borne at defoliated nodes; sepals rounded, short-hairy, about 2.0–2.5 mm. long; corolla apparently greenish, about 5.0–7.0 mm. long, the lobes elliptic-oblong, narrower than in some other species; anthers about 2.0–2.5 mm. long; staminodes lance-attenuate, nearly 2 mm. long; fruit about 3–4.5 cm. long, ellipsoid, blue-black with a light bloom, edible; seed ellipsoid, or narrowly obovoid, about 2 cm. long and 10–12 mm. thick, with ellipsoid seed-scar about 3–4 mm. long; seed-coat firm, about 0.6–0.8 mm. thick.

Type: *Montes & Salazar 884*, La Peonia, Sinaloa, Mexico, 610 m. (US).

Local names: Tempisque, tempixtle.

Distribution: Sonora, Mexico, to Guatemala. All known stations, except that in Huehuetenango, Guatemala, are on the Pacific slope.

MEXICO: Sonora: *Gentry 2931* (A, F, MO); *Rose, Standley & Russell 12981* (US); *Rose, Standley & Russell 13002* (US); *Russell & Souviron 9* (US). Sinaloa: *Rose 3173* (NY, US); *Rose 3213* (US); *Ortega 884* (F); *Ortega 3033* (US); *Ortega 4616* (US); *Ortega 4719* (US, F). Tepic: *Rose 1456* (US). Michoacan: *Hinton 13911* (US); *Leavenworth & Hoogstraal 1474* (G, MO). Oaxaca: *Galeotti s.n.* (F); *Nelson 2345* (US, G). GUATEMALA: Huehuetenango: *Steyermark 50722* (F). Guatemala: *Standley 80495* (F).

5. **Mastichodendron belizense** (Lundell) Cronquist, comb. nov.

Sideroxylon belizense Lundell, Contr. U. Mich. Herb. **6**: 55. 1941. Not *Pouteria belizensis* (Standl.) Cronquist.

Tree up to at least 15 m. high; leaves glabrous, elliptic-ovate, about 5–9 cm. long and 2–3.5 cm. wide, obtuse or acutish at the base, mostly abruptly short-acuminate at the apex, without any pouch at the base, the petioles about 8–18 mm. long, up to $\frac{1}{4}$ as long as the blades; flowers in clusters at defoliated nodes, sweet-smelling; sepals firm, reniform, about 2.0–2.4 mm. long, glabrous except for some short deep red hairs at the base of the inner ones; corolla white, about 6.7 mm. long, very firm, strongly thickened at the throat, the outer lobes markedly cordate-auriculate; anthers about 2.3–2.8 mm. long; staminodes short, less than 1 mm. long, irregularly much-thickened, seemingly attached at the base of each side of the 3 inner corolla-lobes, rather than merely at the sinuses; fruit reputedly yellow.

Type: *Schipp 1269*, Camp 32, British Honduras-Guatemala Survey, British Honduras, 2100 feet, March 15, 1934 (A, F, G, MO).

Distribution: British Honduras, and Izabal, Guatemala.

BRITISH HONDURAS: *Schipp S-697* (F). GUATEMALA: *Johnson 1233*, Izabal. (F, US).

The flowers of this species, with their very thickened throat and with the thickened staminodes seemingly attached at the sides of the inner corolla-lobes rather than merely at the sinuses, are very distinctive in appearance and furnish in themselves sufficient grounds for taxonomic segregation. The short petioles, glabrous leaves, and geographic distribution of the species amply confirm its status. The floral measurements given in the description are taken from a single apparently representative flower.

2. DIPHOLIS A. DC. Prodr. **8**: 188. 1844.

Similar to and evidently derived from *Mastichodendron*, from which it differs primarily in the presence of lateral lobes on the corolla-lobes. The leaves are commonly but not always smaller than those of *Mastichondendron*. About 15 species, confined to the warmer regions of North America.

3. BUMELIA Sw. Prodr. 49. 1788.

Similar to and evidently derived from *Dipholis*, from which it differs primarily in the absence of endosperm. According to Record (Trop. Woods **59**: 33. 1939), there is some difference in the wood-anatomy. Two other differences are that the ovary of *Bumelia* is nearly always hairy, while that of *Dipholis* is nearly always glabrous, and that the young fruits of Bumelia are rounded or subtruncate at the apex, the style appearing as a mere filiform appendage, while in *Dipholis* the young fruits generally taper somewhat to the style. *Bumelia* commonly has small leaves, like *Dipholis*, and is often also spiny. Twenty-three species, chiefly of the warmer regions of North America, a few species occurring in South America.

4. CHRYSOPHYLLUM L. Sp. Pl. 192. 1753.

Differentiated from all other North American *Sapotaceae* by the absence of staminodes and presence of endosperm. The seed-scar is either lateral or basilateral, in either case very large. Eleven species in North America (treated in detail in Bull. Torrey Club **72**: 192–205. 1945), many more in South America, and several in the old world.

Chrysophyllum tepicense Standl., which I earlier allowed to stand on the basis of the original description, proves, on examination of the type (which has only recently become available), to be *Mastichodendron angustifolium*.

5. MICROPHOLIS

The genus *Micropholis* was founded in 1891 by Pierre, in his Not. Bot. Sapot. 37, based on *Sapota* sect. *Micropholis* Griseb., Fl. Brit. W. Ind. 399.

1861. The sole species in Grisebach's section *Micropholis* was *Sapota rugosa* (Sw.) Griseb., from Jamaica, which therefore becomes the type of the genus. Engler, in the Pflanzenfamilien, treated *Micropholis* as part of *Sideroxylon*, while Baehni subordinated it to *Pouteria*. It is distinguished from both of these genera by satisfactory technical characters, and so far as I am aware does not pass into either. It is related, I believe, to *Mastichodendron*, on the one hand, and *Chrysophyllum* on the other. It differs from *Mastichodendron* in its long and lateral seed-scar, from *Chrysophyllum* in the uniform presence of staminodes, and from both in the striate venation of the leaves. Technically, it is most nearly approached by the South American monotype *Achrouteria*, which differs primarily in the pouterioid leaf-venation and secondarily in the attachment of the stamens at the base of the corolla-tube. *Achrouteria* is probably related, however, to *Pouteria* and to the old-world genus *Planchonella*.

Micropholis seems to be confined strictly to the new world, reaching its greatest development in South America. Most of the South American plants described as species of *Sideroxylon* belong here.

MICROPHOLIS Pierre, Not. Bot. Sapot. 37. 1891

Leaves alternate, exstipulate, more or less striate, the lateral veins numerous, crowded (mostly less than 1 mm. apart, rarely a little over 2 mm.), nearly straight, not distinctly curved near the margins; flowers 5-merous throughout, in all our species; stamens attached about at the level of the sinuses, or reputedly sometimes at the middle of the tube, rarely with abortive anthers; staminodes present, often subpetaloid; ovary hairy; ovules laterally attached, becoming seeds with long linear scar; endosperm present but not very copious; fruit fleshy, with 1 or several seeds.

KEY

1. Leaves very finely sericeous-strigose beneath, the pubescence commonly obscuring the veins; fruit ellipsoid, oliviform, 1.5 cm. thick or usually less; Puerto Rico and the Lesser Antilles ..... 1. *M. chrysophylloides*
1. Leaves glabrous at maturity, or with some hairs on the midrib beneath, the veins more or less conspicuous beneath except sometimes in *M. polita;* fruit ovoid to subglobose or obovoid, about 1.5 cm. thick or generally more; Greater Antilles, Mexico, and British Honduras.
   2. Flowers relatively large, the corolla 5–6.5 mm. long, the anthers 0.8–0.9 mm. long, the style 5–6 mm. long; continental ..... 5. *M. mexicana*
   2. Flowers smaller, the corolla about 2.5–5 mm. long, the anthers mostly about 0.5 mm. long, the style about 3 mm. long or less; antillanean.
      3. Leaves appearing very finely striate, the lateral veins mostly about 0.3 mm. apart, or less; corolla with a sparsely hairy patch on the tube beneath each lobe; Jamaica ..... 4. *M. rugosa*
      3. Leaves appearing more coarsely striate, the lateral veins mostly about 0.5 mm. apart, or more; corolla glabrous.
         4. Leaves nearly always less than twice as long as wide, rounded or retuse to obtuse or rarely abruptly acute, strongly and conspicuously striate; Puerto Rico ..... 3. *M. garciniaefolia*
         4. Leaves more than twice as long as wide, distinctly acuminate, rather weakly and obscurely striate; Cuba ..... 2. *M. polita*

1. MICROPHOLIS CHRYSOPHYLLOIDES Pierre, Not. Bot. Sapot. 38. 1891.

M. cruegeriana Pierre, loc. cit.
M. portoricensis Pierre, loc. cit.
M. imrayana Pierre, loc. cit. p. 39.
M. achradoformis Pierre, Symb. Ant. **5**: 118. 1904.
M. eggersiana Pierre, Symb. Ant. **5**: 118. 1904.
M. truncata Pierre, Symb. Ant. **5**: 119. 1904.
M. balata Pierre, Symb. Ant. **5**: 120. 1904.
M. discolor Pierre, Symb. Ant. **5**: 121. 1904.
M. dominicensis Pierre, Symb. Ant. **5**: 122. 1904.
Pouteria cruegeriana Baehni, Candollea **8**: 206. 1942.
P. achradoformis Baehni, loc. cit. p. 207.
P. balata Baehni, Candollea **9**: 351. 1942.

Tree up to 30 m. high; leaves elliptic or sometimes obovate, obtuse to abruptly acuminate, mostly 3–15 cm. long and 1.5–5 cm. wide, glabrous above, very finely and closely sericeous-strigose beneath, sometimes partially glabrate in age, the pubescence generally reddish when young, later pale, commonly obscuring the lateral veins, which, as seen on the lower surface, are mostly 1–2 mm. apart; petioles short, about 1 cm. long or less, the margins raised and thin-edged; flowers few—several in axillary clusters, the pedicels commonly 3–8 mm. long; sepals 5, about 1.4–3.0 mm. long, loosely hirsutulous to finely and sparsely strigose outside, all evidently strigose-sericeous within; corolla about 2.0–4.0 mm. long, glabrous, the 5 lobes shorter than or sometimes nearly equaling the tube, truncate or nearly so; anthers about 0.5–0.9 mm. long; filaments short, attached about at the level of the sinuses; staminodes broadly linear to trapezoidal, truncate; ovary 5-loculate, the style about 1–3 mm. long; fruit ellipsoid, oliviform, 2–4.5 cm. long, about 1.5 cm. thick or usually less, tipped by the persistent style; seed solitary, ellipsoid, somewhat compressed, up to about 3 cm. long and 13 mm. wide, the seed-coat brown, lustrous, 0.4–0.5 mm. thick; seed-scar narrow, less than 4 mm. wide.

Type: *Sintenis 91*, Puerto Rico.

Local names: Balata, caimitillo, kaimitier-bois, leche prieto.

Distribution: Puerto Rico, Lesser Antilles, and Trinidad.

PUERTO RICO: *Britton, Britton & Brown 6540* (NY, F); *Britton, Cowell & Brown 5605* (NY, US); *Britton & Earle 6087* (NY, F); *Britton & Hess 2280* (NY, F, US); *Britton & Shafer 2101* (NY, US); *Britton, Stevens & Hess 2605* (F, MO, NY, US); *Cowles 232* (NY); *Gerhart s.n.* (NY); *Gerhart 607* (NY); *Gregory 347* (PR); *Otero 762* (A); *Sintenis 4022* (G, US); *Sintenis 4128* (F, G, MO, NY, US); *Sintenis 4341* (F, G, MO, NY, US); ANTIGUA: *Duss 46* (NY). GUADELOUPE: *Duss 3379* (F, G, MO, NY). DOMINICA: *Imray 181* (G); *Lloyd 759* (NY); *Lloyd 762* (NY); *Lloyd 912* (NY). MARTINIQUE: *Duss 268* (=*4436*) (F, G, MO, NY, US). ST. LUCIA: *Beard 171* (A). ST. VINCENTS: *H. H. & G. W. Smith 755* (NY). GRENADA: *Beard 161* (A); *Broadway s.n.* (NY).

The flowers of this species are more variable than those of some others, and there is also some variation in the leaves, but the variations seem not to be correlated, and there is a certain overall unity of appearance about the species that makes it readily recognizable. Pierre's segregates seem to

me to represent nothing more than individual variations, not worthy of taxonomic recognition.

Although clearly a member of *Micropholis*, this species approaches certain species of *Chrysophyllum*, such as *C. oliviforme*, in the venation of the leaves.

A sterile specimen from Haiti (*Ekman 5218*) apparently represents an undescribed species allied to *M. chrysophylloides*, from which it differs in its narrower leaves (four times as long as wide) with a denser, coarser, and redder pubescence beneath.

2. MICROPHOLIS POLITA (Griseb.) Pierre, Not. Bot. Sapot. 41. 1891.

Sapota polita Griseb. Pl. Wright. **2**: 517. 1862.
Pouteria polita Baehni, Candollea **9**: 206. 1942.

Tree up to 20 m. or more high; leaves firm, elliptic, about 5–13 cm. long, 2–5 cm. wide, more than twice as long as wide, commonly acute or acutish at the base, acuminate at the apex, the very tip blunt, glabrous at maturity, or with some appressed reddish hairs on the midrib beneath; lateral veins not so numerous nor prominent as in some species, averaging well over 0.5 mm. apart, sometimes some of them straighter and more raised than the intervening ones; petioles less than 1 cm. long, the margins raised and thin-edged; flowers (ex. descr.) solitary or paired in the axils, or pedicels 3–5 mm. long, the 5 sepals 3 mm. long, rufous-hairy on the back and near the margins within, rotund, the corolla somewhat thickened, 4–5 mm. long, the lobes equaling the tube, the filaments attached near the level of the sinuses or reputedly at the middle of the tube, the staminodes lanceolate, about 1 mm. long, the ovary 5-loculate, the style 1–3 mm. long; fruit red, broadly ovoid or subglobose, pointed at the tip, 3–5 cm. long, 2.5–4 cm. thick, 2–5-seeded; seeds about 2–3 cm. long, ellipsoid, somewhat compressed, the scar 3–5 mm. wide, or reputedly 1 cm. wide; seed-coat light brown, lustrous, 0.7 mm. thick.

Type: *Wright 1323*, forest near Monteverde, Oriente, Cuba (G, MO, NY-fragment).

Distribution: Oriente: Cuba.

CUBA: Oriente: *Shafer 4221* (NY, US); *Ekman 4201* (NY); *Acuña 12656* (CU).

3. MICROPHOLIS GARCINIAEFOLIA Pierre, Not. Bot. Sapot. 38. 1891.

M. urbanii Pierre, loc. cit.
Pouteria garciniaefolia Baehni, Candollea **9**: 202. 1942.

Large shrub, or tree up to 20 m. high, leaves firm, broadly elliptic, rounded or retuse to sometimes abruptly acute, about 3–12 cm. long and 1.8–8 cm. wide, less than twice as long as wide, rarely a very little more, strongly and coarsely striate, the veins averaging about 0.5 mm. or more

apart, glabrous at maturity, or with a few hairs along the midrib beneath; petioles short, about 1.5 cm. long or less, the margins raised and thin-edged; flowers few in axillary clusters, the pedicels about 1–8 mm. long, the 5 sepals about 2.3–4.5 mm. long, rufous-hairy outside, glabrous inside; corolla about 2.5–4 mm. long, glabrous, the lobes equaling or shorter than the tube; filaments about 0.5–0.6 mm. long, flattened, broadly triangular; anthers about 0.4–0.5 mm. long; staminodes lance-ovate to linear-oblong, about 0.9–1.3 mm. long, slightly thickened, subpetaloid in texture; ovary hairy, 5-loculate, the style thick, 1–2 mm. long; fruit ovoid, pointed at both ends, 2.5–4 cm. long, 1.5–2 cm. thick; seeds several, about 1.5–1.8 cm. long, 7–9 mm. wide, moderately compressed, with lustrous but roughened dark brown coat 0.5–0.6 mm. thick; seed-scar linear, less than 3 mm. wide.

Type: *Sintenis 1492*, Sierra de Luquillo in regione media montes Mimenes in sylvis, June 13, 1885 (F, G, Mo, US, NY).

Distribution: Puerto Rico.

PUERTO RICO: *Gregory 346* (PR); *Gerhart s.n.* (NY); *Kramer 36* (NY); *F. H. Sargent 547* (US); *Shafer 3593* (NY, US), *3637* (NY, US); *Sintenis s.n.* (G), *1367* (F), *5333* (G, MO, US, NY).

Although the revised spelling *garciniifolia* was proposed by Pierre and Urban in 1904 and subsequently widely adopted, the original spelling *garciniaefolia* must stand.

4. MICROPHOLIS RUGOSA (Sw.) Pierre, Not. Bot. Sapot. 37. 1891.

Chrysosphyllum rugosum Sw. Prod. Ind. Occ. 49. 1788.
Sapota rugosa Griseb. Fl. Brit. W. Ind. 399. 1891.
Pouteria rugosa Baehni, Candollea **9**: 201. 1942.

Tree up to 25 m. high; leaves firm, elliptic, rounded to shortly acuminate, mostly 7–22 cm. long and 3–8 cm. wide, glabrous at maturity, or sometimes with a few hairs on the midrib beneath, finely striate, the lateral veins averaging about 0.3 mm. apart, or less; petioles short, about 1.5 cm. long or mostly less, the margins raised and thin-edged; flowers few or several in axillary clusters, the pedicels up to about 7 mm. long; sepals 5, about 1.4–2.5 mm. long, sparsely strigose or subglabrate on both sides, ciliolate on the margins; corolla about 2.7–4.0 mm. long, the 5 lobes shorter than the tube, which has a sparsely hairy patch near the base beneath each lobe; filaments attached a little below the level of the sinuses, less than 0.5 mm. long, the anthers about 0.25 mm. long, or sometimes abortive; staminodes 0.25–0.7 mm. long, lanceolate to ovate or obovate, sometimes subpetaloid; ovary 5-loculate, hairy, the style stout, 1–3 mm. long; fruit broadly ovoid or subglobose, abruptly short-beaked, about 3–4 cm. long, orange-yellow, with 2–5 seeds; seeds elliptic, a little over 2 cm. long and 1 cm. wide, moderately compressed, with lustrous but roughened dark brown coat about 0.7–0.9 mm. thick; seed-scar linear, about 3 mm. wide or less.

Type: *Swartz s.n.*, Jamaica.

Distribution: Jamaica.

JAMAICA: *Bertero s.n.* (MO); *Britton 2272* (NY); *Harris 8559* (A, NY), *6334* (US), *8717* (NY), *10287* (NY, US), *11016* (NY, US), *11043* (F, NY, US).

Local names: Cow-apple, bull-apple, beef-apple.

5. **Micropholis mexicana** Gilly ex Cronquist, nom. nov.

Sideroxylon calophylloides Lundell, Contr. U. Mich. Herb. **6**: 56. 1941. Not *Micropholis calophylloides* Pierre, Not. Bot. Sapot. 40. 1891.

Tree 20 m. high; leaves mostly 10–15 cm. long, 3–5 cm. wide, narrowly elliptic, acute at the base, abruptly acuminate at the apex, essentially glabrous; lateral veins very numerous and fine, averaging about 0.3 mm. or less apart, the leaf appearing finely striate; petioles short, about 1 cm. long or less, the margins raised and thin-edged; flowers rather numerous in axillary clusters, sometimes at defoliated nodes, the pedicels finely hairy, mostly 4–8 mm. long; sepals 5 or sometimes 6, 2.7–3.5 mm. long, broadly ovate, finely hairy, the outer generally acute, the inner becoming obtuse or rounded and ciliolate; corolla white, glabrous, about 5–6.5 mm. long, the 5 lobes evidently exceeding the tube; filaments about 1.0–1.8 mm. long, attached at or a little above the level of the sinuses, the anthers 0.8–0.9 mm. long; staminodes lance-subulate, 1.7–2.8 mm. long, sometimes with a few hairs at the tip; ovary hairy, 5-loculate, the style 5–6 mm. long, glabrous; fruit broadly ellipsoid, 3 cm. long, a little over 2 cm. thick, coarsely wrinkled in herbarium specimens; seed solitary, ellipsoid, compressed, about 2.5 cm. long and 1.5 cm. wide, with a linear scar 5 mm. wide extending its whole length; seed-coat dark brown, firm, lustrous.

Type: *Matuda 4195*, Mt. Ovando, Escuintla, Chiapas, Mexico, July 1–16, 1940, 900 m. (F, NY).

Local name: Silion blanco.

Distribution: Chiapas, Mexico, and British Honduras. The only species of *Micropholis* known in continental North America.

Among the North American species, this most closely resembles *M. rugosa*, of Jamaica.

BRITISH HONDURAS: *Kinloch 216* (Y).

6. POUTERIA

The genus *Pouteria* was founded in 1775 by Aublet, in his Hist. Pl. Guian., p. 86, pl. 33, based on the single species *P. guianensis*. It is now generally agreed that the fruit described and pictured with the other parts of the plant is not sapotaceous (see Eyma, Rec. Trav. Bot. Néerlands. **33**: 159. 1936, and Baehni, Candollea **9**: 264. 1942). so that technically the name is a nomen confusum, to be rejected under article 64 of the rules. The only other name which has commonly been applied to the

group of species here considered is *Lucuma* Mol. Sagg. Chil. 161. 1782. Of the 5 species originally described by Molina, 3 are generally agreed not to be sapotaceous, while the identity of the other 2 is uncertain (see Eyma, ibid., p. 160). Furthermore, Molina wrote that his new genus had no corolla and about 20 stamens, characters which would surely remove it from the *Sapotaceae*.

The adoption of one of the various generic segregates for *Pouteria* sens. lat. would necessitate a great many new combinations, thus further confusing the nomenclature. In view of the fact that the name *Pouteria* Aublet has been adopted in recent years by Eyma, Lam, and Baehni, and that the application of Aublet's name is reasonably certain if the fruit be excluded, I propose to continue using the name, and suggest that it be conserved by the next botanical congress.

There has been no general agreement as to the limits of *Pouteria*. The broadest definition is that of Baehni, who includes such relatively well-characterized groups as *Micropholis*, in the new world, and *Planchonella* in the old. This great extension of the genus is due in part to Baehni's deprecation of the importance of the development of endosperm, a character which other students of the family have consistently used to distinguish genera. Although, like other characters in the family, this character sometimes fails, it seems in general to run parallel to natural groups. Dubard has pointed out, and Eyma has further emphasized, that in the occasional cases where a thin sheath of endosperm is developed, the shape of the embryo indicates the affinity of the plant with the endospermous or non-endospermous group. In the former the caudicle is well developed and slender; in the latter it is short, broad, and minute.

Eyma, while recognizing the importance of endosperm, minimized the significance of staminodes, therefore reducing *Oxythece* and *Pradosia*. It must be admitted that in the case of *Oxythece* he is right, for the development of staminodes is very irregular, and they may be present or absent in the same plant. The only other distinguishing feature of this small group of species, leaf-texture and venation, fades gradually into the usual *Pouteria*-type. I regard this failure of the staminode-character, however, as merely another of the exceptions to which all characters used in the family are occasionally subject.

Most authors prior to Eyma and Baehni further subdivide *Pouteria* sens. lat. into several genera, based on number and position of flower-parts, and degree of adherence of the seed to the pericarp. Any considerable study of an adequate series of specimens can leave no doubt that these characters are so untrustworthy as to furnish no reasonable ground for generic segregation. They frequently vary between closely related species or even within species.

We come now to the case of *Calocarpum*, which has been generally up-

held since its proposal 50 years ago, even by extreme conservatives such as Baehni. The only character on which this "genus" rests is the excessive number of sepals, arranged in an evident spiral. Only a few species have been recognized, and there are others which connect these to *Pouteria*.

P. fossicola, described herein, has about 8 sepals, spirally arranged, increasing in size centripetally, and having the general appearance of *Calocarpum*. The genus *Urbanella* Pierre, referred to *Calocarpum* by Baehni, was described as having 6–7 sepals. *P. sclerocarpa*, which was excluded from *Pouteria* and referred to *Calocarpum* by Baehni, has 6–7 sepals, the 2 outer of which are evidently shorter than the others. *P. izabalensis*, a small-flowered species apparently related to *P. amygdalina* rather than to the *Calocarpum* group, has 6–7 sepals spirally arranged and increasing in size centripetally. *P. glabrifolia*, also referred to *Calocarpum* by Baehni, has 6 essentially equal sepals, and is evidently related to *P. campechiana*, which has 4–6 (commonly 5) sepals that are about equal or sometimes increase slightly in size centripetally. It may also be noted that species of *Dipholis* may have as many as 8 or 9 sepals, although no segregation of the genus on that character has been proposed. There is, then, no significant discontinuity in the character on which the generic segregation is based, and, especially when so few species are involved, I see no point in maintaining the separation.

The genus *Pouteria* in our area, as I understand it, may be defined as follows:

POUTERIA Aubl. Hist. Pl. Guian. 86. pl. 33. 1775

Leaves alternate or occasionally subopposite, exstipulate, more or less veiny, the primary lateral veins strongly curved at least near the margins and scarcely crowded; flowers white to yellow or green; sepals distinct, about 4–12, paired when 4, otherwise imbricate or spiralled; corolla subrotate to cylindric, with 4–6 lobes, occasionally more; filaments attached to the corolla, from essentially at the base and almost free to more commonly near the level of the sinuses, or the stamens occasionally abortive; staminodes alternating with the corolla-lobes, and sometimes apparently in the same series, sometimes petaloid, sometimes not, or rarely absent; ovary more or less hairy, with about 1–10 locules; ovules laterally attached; fruit commonly fleshy, sometimes sclerotic or even gall-like, with one or several seeds; seeds with long and often broad lateral scar, or sometimes nearly the whole surface more or less grown to the pericarp; endosperm absent.

As so delimited, *Pouteria* is a chiefly American genus, though a number of African and possibly also Asiatic species should presumably be included in it. Many of the old-world species referred to *Pouteria* by Baehni have thin cotyledons and well developed endosperm, and are more properly referable to *Planchonella*.

KEY

1. Leaves permanently white-tomentose on both sides; Baja California.....29. *P. leucophylla*
1. Leaves glabrous at least above, when mature, sometimes sericeous or hirsute beneath, but not at all white-tomentose; not of Baja California.
   2. Flowers relatively small, the corolla 5.5 mm. long or usually less, the calyx about 4 mm. long or usually less.
      3. Flowers evidently pedicellate, at least some of the pedicels 3 mm. long or more. Secondary lateral veins of the leaves very obscure beneath; pedicels 8–15 mm. long; Lesser Antilles.....11. *P. pallida*
      4. Secondary lateral veins conspicuous beneath, or in *P. calistophylla*, of Panama, obscured by the pubescence; pedicels about 7 mm. long or less, or sometimes 9 mm. long in *P. dictyoneura;* Mexico, Central America, and the Greater Antilles.
         5. Leaves sericeous beneath; Panama.
            6. Filaments attached about at the middle of the tube; corolla-lobes fringed-ciliolate; pubescence pale.....1. *P. euryphylla*
            6. Filaments attached about at the level of the sinuses; corolla-lobes not ciliolate; pubescence rufous.....2. *P. calistophylla*
         5. Leaves glabrous or nearly so; general distribution.
            6. Ovary 4–5-loculate.
               7. Corolla lobes fringed-ciliolate; Guatemala.....3. *P. quicheana*
               7. Corolla-lobes smooth; Panama and Cuba.
                  8. Fruit about 4–5 cm. thick; seed-scar linear, 2 mm. wide or less; Panama .....4. *P. lucentifolia*
                  8. Fruit about 3 cm. thick or less; seed-scar broader (unknown in *P. cubensis*, but presumably so).
                     9. Fruit stipitate, yellow, less than 2 cm. thick; Panama..5. *P. stipitata*
                     9. Fruit not stipitate, brown, about "28 mm." thick; Cuba.6. *P. cubensis*
            6. Ovary 1–2-loculate.
               7. Locules 2; corolla-lobes smooth; leaves evidently reticulate above.
                  8. Leaves, or some of them, well over 5 cm. long, sometimes acuminate, but not at all aristate.
                     8. Corolla-lobes much exceeding the tube; Greater Antilles..... .....7. *P. dictyoneura*
                     8. Corolla-lobes equaling or a little shorter than the tube; Mexico and Guatemala.....9. *P. belizensis*
                  8. Leaves less than 5 cm. long, conspicuously aristate; Cuba..8. *P. aristata*
               7. Locule 1; corolla-lobes fringed-ciliolate; leaves generally obscurely reticulate above; Mexico to Costa Rica.....10. *P. unilocularis*
      3. Flowers subsessile, the pedicels, if any, not more than 2 mm. long.
         4. Filaments attached at or generally below the middle of the corolla-tube; seeds, where known, more or less grown to the pericarp nearly or quite throughout, the smooth free part of the seed-coat occupying $\frac{1}{4}$ or less of the surface; continental and antillanean.
            5. Fruit not more than 2 cm. long and thick; leaves sericeous beneath; Cuba and Haiti.
               6. Leaves evidently acuminate; fruit 2–4-loculate; Haiti and the Dominican Republic.....12. *P. sessiliflora*
               6. Leaves obtuse or acutish to abruptly short-acuminate; fruit 1-loculate; western Cuba.....13. *P. chrysophyllifolia*
            5. Fruit at least 3 cm. long and thick; leaves various.
               6. Leaves coarsely veiny, slightly hairy when young, but not at all sericeous; Greater Antilles.
                  7. Leaves broadly oblanceolate to narrowly cuneate-obovate, tapering gradually to the cuneate acute base, mostly 2–6 cm. wide; Cuba..14. *P. micrantha*
                  7. Leaves broadly elliptic-obovate, obtuse at the base, mostly 5–9 cm. wide; Haiti to Puerto Rico.....15. *P. hotteana*

6. Leaves more finely veiny, more or less sericeous beneath, but sometimes soon glabrate; Mexico to Panama.
7. Leaves rounded to acutish at the apex; fruit 5–10 cm. thick; flowers numerous in each cluster; Mexico to Guatemala and Salvador.....16. *P. hypoglauca*
7. Leaves distinctly acuminate; fruit about 3.5 cm. thick; flowers few in each cluster; Panama and perhaps also Costa Rica and Honduras..17. *P. stylosa*

4. Filaments attached at or near the level of the sinuses, well above the middle of the tube (unknown in *P. chiricana*); smooth free part of the seed-coat occupying about ½ of the surface, or more (unknown in *P. subrotata*); continental.
5. Ovary with 4 or 5 locules; fruit, where known, 1-seeded, the seed-coat about 0.4 0.8 mm. thick; leaves, except in *P. subrotata*, broadest about at the middle, or below; corolla 1.3–3.8 mm. long; anthers 0.5–1.0 mm. long.
6. Leaves mostly elliptic, conspicuously reticulate-veiny, the secondary veins irregularly anastomosing; corolla tubular or campanulate, 1.2–3.2 mm. long the lobes about 0.8–2.0 mm. long; filaments about 1 mm. long or less, or absent; fruit 1-seeded, the seed-coat 0.4–0.8 mm. thick.
7. Sepals 4–5; seed-scar covering less than half the seed.
8. Seed-coat very smooth and shining; leaves very closely reticulate, the veins much raised beneath; British Honduras and Guatemala.....18. *P. amygdalina*
8. Seed-coat dull, with raised honeycomb pattern visible at 10 diameters magnification, conspicuous at 25; leaves closely reticulate, the veins slightly or scarcely raised; Panama.....19. *P. chiricana*
7. Sepals 6–7; seed-scar covering half the seed; seed-coat lustrous but roughened; British Honduras to Nicaragua.....20. *P. izabelensis*
6. Leaves obovate, not conspicuously reticulate-veiny, the secondary lateral veins numerous, fine, sinuous but regularly disposed; corolla subrotate, 3.5–3.8 mm. long, the lobes about 2.5–3.0 mm. long; filaments about 1.7–1.9 mm. long; fruit unknown; Panama.....22. *P. subrotata*
5. Ovary with 2 (rarely 3) locules; fruit with 2 (rarely 1–3) seeds; seed-coat only 1.15–0.25 mm. thick; leaves commonly broadest distinctly above the middle; corolla 3.8–5.5 mm. long; anthers 1.2–1.5 mm. long.....21. *P. durlandii*

2. Flowers relatively large, the corolla about 6–16 mm. long (sometimes only 5 mm. in *P. caimito*, of southern Panama), the calyx 4.5 mm. long or usually more (sometimes only 4 mm. in *P. semecarpifolia*, of the Lesser Antilles, and in *P. caimito*).
3. Sepals 4–6 and generally about equal, or in *P. sclerocarpa* 6–7, the 2 outer evidently shorter than the others.
4. Flowers and fruit evidently pedicellate (fruit with a 5 mm. pedicel in *P. squamosa*, the flowers therefore assumed to be pedicellate).
5. Fruit gall-like, covered with flattened chaffy finely hairy divergent processes; Guatemala.....28. *P. squamosa*
5. Fruit fleshy (unknown and perhaps gall-like in *P. austin-smithii*).
6. Corolla glabrous on the outside; sepals commonly 4.
7. Corolla 4-lobed; filaments attached well below the middle of the corolla-tube; Costa Rica.....23. *P. austin-smithii*
7. Corolla generally 6-lobed; filaments attached at or a little below the level of the sinuses, well above the middle of the tube; antillanean.
8. Leaves appearing very veiny, the primary lateral veins closely set, generally well under 1 cm. apart, the secondary veins also raised and conspicuous beneath; fruit with a conspicuous light-colored areola surrounding the persistent style; ovary commonly 6 loculate; pedicels relatively short, less than 1 cm. long.....24. *P. dominigensis*
8. Leaves not appearing very veiny, the primary lateral veins relatively widely spaced, generally at least some of them 1 cm. or more apart, the secondary veins not much raised; fruit not areolate at the end; ovary commonly 4 loculate; pedicels relatively long, commonly but not always at least some of them 1 cm. long or more.....25. *P. multiflora*

6. Corolla more or less hairy on the outside, at least on the lobes; sepals commonly 5–6, sometimes 4.
7. Corolla merely strigose or strigose sericeous, often sparsely so; general distribution ..... 26. *P. campechiana*
7. Corolla loosely villous hirsute; Panama ..... 27. *P. glabrifolia*

4. Flowers and fruit sessile or subsessile.
5. Fruit fleshy.
6. Midrib of the leaves evidently hirsute beneath, at least toward the base; fruit about 2 cm. thick; Dominica and Martinique ..... 30. *P. semecarpifolia*
6. Midrib, as well as the surface of the leaves, glabrous; fruit about 4 cm. thick or more; Panama.
7. Fruit densely hairy; reticulation of the leaves not especially fine and close ..... 31. *P. sambuensis*
7. Fruit glabrous; reticulation of the leaves very fine and close .. 32. *P. caimito*
5. Fruit gall-like or sclerotic, not fleshy.
6. Sepals 4, all about the same length; fruit gall-like, covered with short cylindric densely hairy processes; British Honduras and Guatemala to Costa Rica.
7. Corolla evidently exceeding the calyx; anthers essentially cuspless; secondary lateral veins irregular and only slightly more conspicuous than the final reticulum ..... 33. *P. gallifructa*
7. Corolla shorter than the calyx; anthers with an evident cusp 0.3–0.4 mm. long at the tip; secondary lateral veins rather regularly disposed, nearly perpendicular to the costae, distinctly more raised and conspicuous than the final reticulum ..... 34. *P. neglecta*
6. Sepals 6–7, the 2 outer conspicuously shorter than the others; fruit sclerotic; Panama ..... 35. *P. sclerocarpa*

3. Sepals about 8–12, evidently spiralled, increasing in size centripetally.
4. Sepals conspicuously appressed-hairy on the back, not particularly thick and fleshy; fruit fleshy; secondary lateral veins rather regularly disposed, more or less perpendicular to the primary ones, more conspicuous than the fine reticulum; general distribution.
5. Fruit mealy-roughened and sometimes rugose; leaves essentially glabrous beneath, except usually for some chiefly appressed hairs along the midrib and main veins.
6. Fruit mealy-roughened, not rugose, brown, subglobose to ovoid or ellipsoid; sepals, or some of them, generally evidently lobed or emarginate at the summit; primary lateral veins mostly 20–50 pair; general distribution ... 36. *P. mammosa*
6. Fruit rugose (at least in herbarium specimens) and also somewhat mealy-roughened, yellow-green, obovoid; sepals scarcely emarginate; primary lateral veins mostly 15–20 pair; Panama ..... 37. *P. fossicola*
5. Fruit smooth; leaves more or less spreading-villous beneath, especially on the midrib and main veins, and the pubescence occasionally chiefly confined thereto; Mexico to Costa Rica ..... 38. *P. viridis*
4. Sepals very thick and fleshy, not hairy; fruit woody; secondary veins rather irregularly disposed, scarcely more prominent than the rather coarse reticulum; Panama ..... 39. *P. cooperi*

1. POUTERIA EURYPHYLLA (Standl.) Baehni, Candollea **9**: 249. 1942.

Lucuma euryphylla Standl. Field Mus. Pub. Bot. **4**: 252. 1929.
Labatia euryphylla Standl. Trop. Woods **31**: 43. 1942.

Tree about 15 m. high; leaves elliptic or elliptic-obovate, rather abruptly and narrowly acuminate, about 10–22 cm. long, 4–12 cm. wide, glabrous above, very closely and finely sericeous-strigose with pale hairs beneath; primary lateral veins about 9–13 pair, not becoming crowded and obscure near the base of the blade, as they do in many species; secondary lateral

veins, except those near the midrib, nearly perpendicular to the primary ones, but also somewhat sinuous and often branched; petioles about 1.5–6 cm. long; flowers few in the axils, the closely sericeous-strigose pedicels about 4–5 mm. long; sepals 4, about 3.5 mm. long, broadly elliptic-ovate, the outer closely hairy on the back, the inner glabrous except for a strip down the middle of the back; corolla about 3.7–4.5 mm. long, the lobes a little shorter than the tube, evidently fringed-ciliolate; filaments attached about at the middle of the corolla-tube, and trace raised and conspicuous to the base; anthers about 1 mm. long, short-cuspidate; staminodes about 1 mm. long, triangular-lanceolate, ciliolate like the corolla-lobes, and alternating with them, nearly or quite in the same series; ovary densely hairy 4-loculate, the style a little over 2 mm. long; fruit unknown.

Type: *G. Proctor Cooper 611*, Buena Vista Camp on Chiriqui Trail at 1250 feet, Almirante region, Bocas del Toro, Panama (F, NY).

Distribution: Known only from the type collection, Bocas del Toro, Panama.

2. POUTERIA CALISTOPHYLLA (Standl.) Baehni, Candollea **9**: 419. 1942.

Lucuma calistophylla Standl. Field Mus. Pub. Bot. **4**: 252. 1929.

Tree about 20 m. high; leaves firm, obovate or elliptic-obovate, acute at the base, abruptly short-acuminate at the apex, about 14–22 cm. long and 6–10 cm. wide, glabrous above, finely and densely rufous-sericeous beneath; primary lateral veins prominent, about 18–22 pair; secondary lateral veins obscured by the pubescence, those near the mid-rib curving and oblique to the costae, those near the margins about perpendicular to the costae; well-developed flowers unknown, but a very young flower has a stout pedicel 5 mm. long, with 5 sepals and a 5-lobed corolla, the filaments attached at the level of the sinuses, the staminodes narrow, approximately triangular-lanceolate; an overmature flower has 5 deltoid-ovate very firm sepals about 2 mm. long, the ovary parasitized, probably originally 2-loculate; fruit unknown.

Type: *G. P. Cooper 481*, Cricamola Valley, near Almirante, Bocas del Toro, Panama, February 10, 1928 (F, US, Y).

Distribution: Known only from the type collection, Bocas del Toro, Panama.

3. **Pouteria quicheana** Cronquist, sp. nov.

Woody, presumably a tree; leaves narrowly elliptic or elliptic-oblanceolate, about 8–17 cm. long and 2–4 cm. wide, merely acutish at the tip, glabrous at maturity; primary lateral veins about 15 pair; secondary veins fine and slightly raised beneath, those near the midrib curving and oblique, those nearer the margins becoming perpendicular to the costae; petioles about 1–1.5 cm. long; flowers clustered in the axils, the pedicels

about 3–4 mm. long, finely grayish-sericeous; mature flowers unknown, but a nearly mature bud shows the following characteristics: sepals 4, about 4.3 mm. long, the outer ones finely grayish-sericeous outside, the inner glabrous; corolla 3.5–3.9 mm. long, 4-lobed, the lobes fringed-ciliolate, about $\frac{2}{3}$ as long as the tube; filaments about 2 mm. long, attached about 0.5 mm. from the base of the tube; anthers plump, evidently short-cuspidate; 0.65–0.75 mm. long; staminodes oblong-spatulate, nearly as long as the corolla-lobes; ovary 4-loculate; fruit unknown.

Arbor?; folia glabra anguste elliptica vel elliptico-oblanceolata, 8–17 cm. longa, 2–4 cm. lata, costis ca. 15 jugis; flores pedicellati, sepalibus 4, ca. 4.3 mm. longis, corolla ca. 4 mm. longa vel longioribus lobis ciliatis 4, filamentis ad tubi basim versus affixis, ovario 4-loculare; fructus ignotus.

Type: *Aguilar 1331*, Quiche, Guatemala (F).

Distribution: Known only from the type collection, Quiche, Guatemala.

The flowers of this species are very similar to those of *P. euryphylla*, to which it is evidently related.

4. POUTERIA LUCENTIFOLIA (Standl.) Baehni, Candollea **9**: 424. 1942.

Lucuma lucentifolia Standl. Field Mus. Pub. Bot. **4**: 251. 1929.
Lucuma pentasperma Standl., loc. cit.
Pouteria pentasperma Baehni, Candollea **9**: 353. 1942.

Tree up to 11 m. or more high; leaves smooth and shining (the midrib sometimes loosely hirsutulous beneath), elliptic-obovate, about 7–25 cm. long, 3.5–10 cm. wide, generally abruptly acuminate at the apex, sometimes very shortly so; primary lateral veins about 8–14 pair; secondary veins curving and oblique, becoming perpendicular to the primary ones near the margins; flowers unknown, but a young developing fruit has a thick pedicel 5 mm. long and nearly glabrous ovate sepals 3 mm. long; pedicels evidently not elongating in fruit; fruit golden brown, globose, about 4–5 cm. thick, edible; seeds 5, strongly flattened, about 2.5–3.5 cm. long, 13–16 mm. wide, and 7–8 mm. thick; seed-coat smooth, shining, about 0.4–0.6 mm. thick; seed-scar linear, about 1.5–2 mm. wide, extending the length of the seed.

Type: *G. P. Cooper 13*, Talamanca Valley, Costa Rica, June, 1927 (F, G, US, Y).

Local Names: Wild sapote, matasano.

Distribution: Costa Rica and Panama.

COSTA RICA: *Oersted 12350* (F). PANAMA: Bocas del Toro: *Dunlap 591* (F, Y); *Cooper 369* (A, F, US, Y).

The leaves of this species look much like some forms of *P. campechiana*, and I do not feel sure that I can always distinguish them when in sterile condition.

5. **Pouteria stipitata** Cronquist, sp. nov.

Tree; leaves elliptic or narrowly elliptic-obovate, acuminate at the tip, acute or acuminate at the base, glabrous, or with some appressed hairs on the midrib beneath, mostly 6–12 cm. long and 2–4 cm. wide, evidently veiny, the primary lateral veins 10 or less on each side, the secondary ones irregularly anastomosing; petioles about 1 cm. long; flowers fasciculate at defoliated nodes, pedicellate; sepals 4 or 5, suborbicular, about 2.2–2.5 mm. long, appressed-hairy; corolla very thin, about 2.3 mm. long, the lobes only 0.6 mm. long; stamens abortive, consisting of mere filaments attached about the middle of the corolla-tube; staminodes oblong-spatulate, about 0.3 mm. long, conspicuously fringed-hairy especially near the tip; ovary 4-loculate; fruit yellow; finely warty-roughened, the body ellipsoid, apiculate, about 2–2.5 cm. long and a little over 1.5 cm. thick, constricted to a stipe about 7 mm. long and 3–4 mm. thick; seed 1, ellipsoid, 2.2 cm. long, 1.5 cm. thick, with oblanceolate scar about 8 mm. wide running its whole length; seed-coat about 0.5–0.7 mm. thick.

Arbor; folia elliptica vel anguste elliptico-obovata, acuminata, ca. 6–12 cm. longa, 2–4 cm. lata, glabra, costis 10-jugis vel pauciorbius, venulis secundariis irregulariter anastomosis, petiolis 1 cm. longis; flores fasciculati pedicellati, sepalibus 4–5 suborbiculatis ca. 2.2–2.5 mm. longis, corolla tenuissima ca. 2.3 mm. longa, lobis 0.6 mm. longis, antheris abortivis, staminodiis usitatis oblongo-spathulatis ad apicem perspicue fimbriato-hirsutis, ovario 4-loculare; fructus flavus ellipsoidalis ca. 2.5 cm. longus stipo 7 mm. longo; semen solitarium, cicatrice oblanceolata 8 mm. lata.

Type: *Zetek 4693*, Barro Colorado Island, Panama Canal Zone, October 30, 1940 (F).

Cotype: *Shattuck 1125*, Gigante Bay, Barro Colorado Island, Panama Canal Zone, August 2, 1934 (F).

Distribution: Known from Barro Colorado Island, and the Pearl Islands, Panama.

PANAMA: Pearl Islands: *Johnston 634*, San Jose Island (NY).

The leaves of this species are somewhat like those of *P. lucentifolia*, but less shining, and with the secondary lateral veins more irregular.

6. POUTERIA CUBENSIS Baehni, Candollea **9**: 237. 1942.

Labatia grandifolia Urb. Symb. Ant. **9**: 413. 1925. Not *Pouteria grandifolia* (Wall.) Baehni, 1942.

Small tree; leaves elliptic to elliptic-ovate, obtuse to acuminate at the tip, about 10–22 cm. long, 4–8 cm. wide, glabrous; primary lateral veins about 14–18 pair; secondary lateral veins somewhat sinuous but mostly about perpendicular to the primary ones; petioles about 1–4 cm. long; flowers 1–3 in the axils or at defoliated nodes; the pedicels about 3 mm. long; sepals 4, about 4 mm. long, the outer ovate and hairy, the inner obovate

and smooth; corolla about 4–5 mm. long, the 4 suborbicular lobes about half as long as the tube; staminodes nearly as long as the corolla-lobes, and apparently in the same series with them; ovary densely hairy, 4-loculate, the glabrous style 1–3 mm. long; fruit globose, brown, about 28 mm. thick. (Description largely compiled; no flowers or fruits seen.)

Type: *Ekman 7265*, Sierra Maestra, between Rio Oro and Rio Bayamo, 200–400 m., May, 1916, Oriente, Cuba (F-fragment).

Local name: Guyabilla de la maestra.

Distribution: Oriente, Cuba.

CUBA: Oriente: *Ekman 14797*, (F-fragment).

7. POUTERIA DICTYONEURA (Griseb.) Radlk. Sitzb. Akad. Wiss. München **14**: 464. 1884.

Small tree up to 8 m. high or perhaps more; leaves narrowly lanceolate to ovate, about 2–6 times as long as wide, up to about 25 cm. long and 6 cm. wide, acute to acuminate, glabrous, or loosely villous-hirsute beneath, very veiny, the primary lateral veins about 10–35 pair, the secondary veins rather irregularly anastomosing, some of them sometimes nearly as large as the primary ones; petioles about 0.5–2 cm. long; flowers several in the axils, the slender pedicels appressed-hairy, mostly 5–9 mm. long; sepals 4–5, ovate or elliptic, about 1.7–2.5 mm. long, short-hairy; corolla 2.5–3.5 mm. long, the 4–5 lobes suborbicular, auriculate, evidently longer than the tube, commonly nearly twice as long; filaments attached at or reputedly a little below the level of the sinuses; anthers about 1.0–1.2 mm. long; staminodes about 1 mm. long or a little less, lanceolate or narrower; ovary finely hairy, 2-loculate; fruit subglobose or broadly ellipsoid, 2.0–2.5 cm. long, 1.5–2.0 cm. thick, sparsely hairy; seed solitary, apparently all more or less grown to the pericarp, sometimes with a broad and irregular lateral scar discernible; seed-coat about 0.3 mm. thick.

Type: *Wright 1329*, near Monte Verde, Oriente, Cuba, 1860 (F-fragment, G, MO).

Distribution: Cuba to Puerto Rico.

7A. **Pouteria dictyoneura** subsp. **typica** Cronquist, stat. nov.

Sideroxylon dictyoneuron Griseb. Pl. Wright. 517. 1862.
Labatia dictyoneura Griseb. Cat. Pl. Cub. 166. 1866.
Paralabatia dictyoneura Pierre, Not. Bot. Sapot. 24. 1890.
Pouteria dictyoneura Radlk. Sitzb. Akad. Wiss. München **14**: 464. 1884.
Pouteria dictyoneura var. *typica* Baehni, Candollea **9**: 227. 1942.

Leaves mostly 2–3 times as long as wide, commonly glabrous beneath, or merely hairy along the midrib, not subtruncate at the base; petioles mostly 1–2 cm. long.

Local names: Mariquita, arcalita, vigueta peluda, caimito de pero.

Distribution: Cuba.

CUBA: *Wright 2923* (F, G, MO); *Leon 1519* (F), *12243* (F); *Leon & Fortin 8652* (F). Pinar del Rio: *Fors 4851* (Cu); *Roig 6324* (Cu). Santa Clara: *Jack 8526* (A, F, US). Oriente: *Ekman 4183* (G. MO), *4653* (F, G), *6278* (A, F, G), *6279* (F); *Wright 1330* (F, G, MO).

7B. **Pouteria dictyoneura** subsp. **fuertesii** (Urb.) Cronquist, stat. nov.

Paralabatia fuertesii Urb. Symb. Ant. **7**: 323. 1912.
Paralabatia portoricensis Britt. & Wilson, Bull. Torrey Club **53**: 471. 1926.
Pouteria dictyoneura var. *fuertesii* Baehni, Candollea **9**: 227. 1942.

Leaves mostly 3–6 times as long as wide, often subtruncate at the base, commonly somewhat hairy beneath, though not infrequently glabrous; petioles mostly 0.5–1.5 cm. long.

Type: *Fuertes 19*, Barahono, Dominican Republic, 350 m., May, 1918, (F, G, US).

Local names: Cuya, cuero de puerco, tabloncillo prieto.

Distribution: Haiti, Dominican Republic, and Puerto Rico.

HAITI: *Ekman 2421* (F), *6040* (F), *6909* (F); *Holdridge 1338* (US). DOMINICAN REPUBLIC: *Holdridge 493* (NY, PR); *Scarff 4* (Y), *12E* (F, Y), *s.n.*, (F). PUERTO RICO: *Britton 9317* (F); *Cowles 702* (F).

8. POUTERIA ARISTATA (Britton & Wilson) Baehni, Candollea **9**: 228. 1942.

Labatia aristata Britt. & Wilson, Bull. Torrey Club **43**: 460. 1916.

Much-branched shrub or small tree, up to about 8 m. high; leaves firm, elliptic-orbicular, up to about 4.5 cm. long and 4 cm. wide, sharply aristate at the otherwise rounded or obtuse apex, glabrous, very veiny, the primary lateral veins about 6–8 pair, the secondary ones somewhat irregularly anastomosing; petioles 1 cm. long or less; flowers few or solitary in the axils, pedicellate, the 4 or 5 sepals 2.5–3 mm. long, the corolla 2.5 mm. long, with 4–5 broad lobes; filaments attached at the level of the sinuses; staminodes ovate; ovary 2–loculate; fruit about 2.5 cm. long ovoid, 2-seeded.

Type: *Leon 6230*, between Cnorrera River and trolley track to Marianao, Habana, Cuba, May, 1916 (F-fragment).

Local names: Chicharrón, chicarrón de costa.

Distribution: Coastal thickets, Pinar del Rio to Oriente, Cuba.

CUBA: Pinar del Rio: *Ekman 13114* (F). Habana: *Britton, Earle & Gager 6305* (F); *Earle & Wilson 6245* (F); *Ekman 13397* (F); *Killip 13815* (US); *Leon 6230* (F); *Leon & Hioram 5610* (F); *Leon & Roig 13758* (Y). Oriente: *Ekman 8519* (F); *Cuebelo 182* (CU).

9. **Pouteria belizensis** (Standl.) Cronquist, comb. nov.

Lucuma belizensis Standl. Trop. Woods **4**: 6. 1925.
Sideroxylon lundellii Standl. Pub. Carnegie Inst. Wash. **461**: 79. 1935.

Tree about 10 m. high; leaves elliptic or elliptic-obovate, short-acuminate, generally abruptly so, about 5–11 cm. long, 1.5–4.5 cm. wide, evidently reticulate-veiny on both surfaces, the primary lateral veins about a dozen pair, not much raised, the secondary lateral veins irregularly

anastomosing and scarcely distinguishable from the tertiary ones; flowers numerous, clustered in the axils, evidently pedicellate, the pedicels, or some of them, about 3–5 mm. long; sepals 4, suborbicular, about 1.5–1.9 mm. long, short-hairy; corolla about 2.0–2.5 mm. long, the 4 lobes about 0.8–1.0 mm. long, nearly reniform-ovate, slightly auriculate; filaments about 0.3–0.4 mm. long, firm, nearly perpendicular to the corolla, attached at or a little below the level of the sinuses; anthers about 0.6 mm. long; staminodes narrowly triangular to ovate or oblong-trapezoidal, about 0.4–0.5 mm. long, fairly thick and firm; ovary densely hairy, 2-loculate, the ovules attached laterally near the base; fruit unknown.

Type: *Kluge 41*, British Honduras, December, 1924 (F-fragment, Y).

Distribution: Tabasco, Mexico, Petén, Guatemala, and British Honduras.

MEXICO: Tabasco: *Matuda 3073* (A, F, Mich). GUATEMALA: Petén: *Lundell 2767* (F, G, Mich, US).

The type is completely sterile, and there is some possibility that it is not the same species as the flowering material to which Standley gave the name *Sideroxylon lundellii*.

10. POUTERIA UNILOCULARIS (Donn.-Sm.) Baehni, Candollea **9**: 273. 1942.

Sideroxylon uniloculare Donn.-Sm. Bot. Gaz. **35**: 5. 1903.
Sideroxylon hondurense Pitt. Contr. U. S. Nat. Herb. **20**: 483. 1922.
Sideroxylon meyeri Standl. Trop. Woods **31**: 45. 1932.
Pouteria hondurensis Baehni, Candollea **9**: 228. 1942.
Pouteri meyeri Baehni, Candollea **9**: 272. 1942.

Tree up to 20 m. high; leaves elliptic, up to about 20 cm. long and 9 cm. wide, generally considerably smaller, acute or acutish at the base, acuminate at the apex, the slender tip commonly 1 cm. long or more; leaves closely and conspicuously reticulate beneath, generally very obscurely so above, the primary lateral veins less prominent than in related species; flowers fasciculate in the axils, evidently pedicellate, the pedicels mostly 3–7 mm. long, or rarely most of them a little shorter, commonly elongating in fruit; sepals 4–6, sparsely rufous-hairy, about 1.4–1.7 mm. long; corolla white, about 2.2–2.7 mm. long, the lobes about 1.4–1.8 mm., fringed-ciliolate; filaments attached about at the level of the sinuses, or sometimes merely at the middle of the tube, 0.25–0.5 mm. long; anthers 0.5–0.8 mm. long; staminodes lance-ovate or lance-triangular, thick or somewhat petaloid, about 0.7–0.9 mm. long; ovary 1-loculate, the style about 0.5 mm. long; fruit yellow, about 1.5–2 cm. long, obovoid or subglobose; seed about 14 mm. long, with lateral scar 3–5 mm. wide; seed-coat smooth, shining, about 0.15 mm. thick.

Type: *Tonduz 13358*, Tucurrique, Rio de las Vueltas, Costa Rica, 635 m., May, 1899 (G, US).

Local names: Sapotillo, sapotillo negro.

Distribution: Campeche, Yucatan peninsula, Mexico, to Costa Rica.

MEXICO: Campeche: *Lundell 1287* (F, Mich, MO); *Lundell 1345* (A, F, G, Mich, MO GUATEMALA: Petén: *Bartlett 12361* (A, F, Mich, NY); *Bartlett 12681* (A, F, Mich. NY, US); *Egler 42-220* (F); *Lundell 3947* (F, Mich. US); *Steyermark 46105* (F). Alta Verapaz: *Steyermark 45572* (F). Izabal: *Steyermark 39541* (F). BRITISH HONDURAS: *Gentle 1208* (A, F, G, Mich, MO, NY, US); *Lundell LP 5* (F); *Lundell 420* (F, G); *Lundell 6153* (F, G, Mich, NY); *Lundell 6184* (Mich, NY); *Lundell 6343* (F, G, Mich, NY); *Meyer 158* (F); *Schipp 1238* (A, F, G, Mich, MO, NY); *Schipp 1287* (A, F, G, Mich, MO, NY); *Stevenson 4* (F, Y). HONDURAS: Copán: *Pittier 8480* (F, G).

Although *Sideroxylon hondurense* Pitt. was described as having a 2-celled ovary, with the filaments attached at the base of the corolla-tube, two flowers from some fragments of the type preserved at the Field Museum each have one locule, with the filaments attached about at the middle of the tube.

This species looks very much like *P. amygdalina*, vegetatively, differing in the less prominent reticulation on the upper surface of the leaves, which have a generally longer and more slender acuminate tip than does *P. amygdalina*. Flowering or fruiting specimens need never be confused.

11. POUTERIA PALLIDA (Gaertn. f.) Baehni, Candollea **9**: 352. 1942.

Lucuma pallida Gaertn. f. Fruct. **3**: 130. t. 204. 1807.
Oxythece kahnianum Pierre ex Duss. Ann. Inst. Col. Mars. **3**: 387. 1897.
Oxythece fabrilis Pierre, Symb. Ant. **5**: 160. 1904.

Tree up to 30 m. high; wood reputedly pink; leaves elliptic to obovate, rounded to abruptly short-acuminate, mostly 7–18 cm. long and 2.5–10 cm. wide; veins generally slightly impressed above; primary lateral veins about 7–10 pair; secondary lateral veins obscure beneath, commonly forming a slightly impressed loose reticulum above; lower leaf-surface pale, appearing glaucous; petioles short, about 1 cm. long or less; flowers numerous in axillary clusters, the pedicles about 8–15 mm. long; sepals commonly 5, about 1.7–2.0 mm. long, rotund-ovate, sparsely strigillose; corolla about 2.7–3.5 mm. long, the lobes a little exceeding the tube, or, when the stamens and staminodes are suppressed, sometimes only 1.5 mm. long; anthers about 1.0–1.3 mm. long, sessile or borne on short filaments up to nearly 1 mm. long, attached about at the level of the sinuses, sometimes suppressed; staminodes variable, up to nearly 1 mm. long, often suppressed; ovary densely hairy, 2-loculate, with a short style; fruit ellipsoid, about 5 cm. long and 1.5–2 cm. thick, reputedly edible; seed solitary, ellipsoid, somewhat compressed, about 2.5–4 cm. long, 1.3–1.5 cm. wide, and 1 cm. thick, the seed-coat straw-colored or light tan, smooth and shining, about 0.5 mm. thick; seed-scar about 8–9 mm. broad, extending nearly the whole length of the seed; cotyledons free, longitudinally furrowed.

Type: *Delessert s.n.*

Local names: Balata rouge, balata blanc, merise.

Distribution: Guadeloupe to Santa Lucia, Lesser Antilles.

GUADELOUPE: *Duss 3493* (NY). MARTINIQUE: *Hahn 1365* (F). DOMINICA: *Fishlock 29* (F, MO, NY, US), *54* (NY); *Imray s.n.* (NY); *Lloyd 758* (NY), *760* (NY). ST. LUCIA: *Beard 170* (A).

12. POUTERIA SESSILIFLORA (Sw.) Poir. Encyc. Suppl. 4: 546. 1816.

Labatia sessiliflora Sw. Prodr. 32. 1788.

Similar to *P. chrysophyllifolia;* leaves narrower in shape and usually evidently acuminate, up to 12 cm. long and 4.5 cm. wide, the width equaling about 30–50 per cent of the length; sepals perhaps a little narrower; fruit 2–4-seeded; seed-coat only 0.25 mm. thick.

Type: *Swartz s.n.*, Island of Santo Domingo.

Distribution: Haiti & Dominican Republic.

HAITI: *Eyerdam 248* (A, F, G, MO); *Ekman 2563* (F); *Ekman 8763* (F). DOMINICAN REPUBLIC: *Ekman 15048* (US).

Were it not for the geographical separation (some 500 miles, on different islands) of *P. sessiliflora* and *P. chrysophyllifolia*, I would be inclined to combine them, and the accumulation of more material may yet necessitate their union. Both are very scantily represented in herbaria, and it is not at all certain that the differences that have been observed will prove to be constant or even significant. Certainly one can find individual leaves of *P. sessiliflora* that could readily pass for those of *P. chrysophyllifolia*.

13. POUTERIA CHRYSOPHYLLIFOLIA (Griseb.) Baehni, Candollea 9: 243. 1942.

Labatia chrysophyllifolia Griseb. Cat. Pl. Cub. 166. 1866.

Shrub or small tree about 1–5 m. high; leaves commonly elliptic-obovate, obtuse to acutish or abruptly short-acuminate, up to about 9 cm. long and 4 cm. wide, the width equalling about 40–65 percent of the length, glabrous above, except when young, closely sericeous beneath, the hairs at first golden or light brown, later becoming silvery white, and often eventually deciduous; petioles very short, less than 5 mm. long; flowers few in the axils, sessile or nearly so; sepals 4, about 2.2–2.8 mm. long, the outer elliptic and finely rufescent, the inner obovate or spatulate-obovate and glabrous; corolla about 2.1–2.6 mm. long, the 4 lobes a little shorter than the tube; filaments attached at the base of the corolla-tube, or about 0.5 mm. above, the trace raised and evident, or the stamens abortive; staminodes triangular-lanceolate, about 0.4–0.6 mm. long; ovary densely hairy, 4-ovulate, the style less than 1 mm. long; fruit broadly ellipsoid or subglobose, yellow or brown, densely puberulent, about 1.5–2 cm. long, with thin flesh; seed solitary, the scar covering all but an area on the back about 8–9 mm. wide; seed-coat about 0.3–0.5 mm. thick.

Type: *Wright 2929*, Cuba, near Toscano (MO, G, F-fragment).

Distribution: Habana, Pinar del Rio, and reputedly Isla de Pinos, Cuba.

CUBA: Habana: *Ekman 13445* (G), *14121* (F), *16921* (A, F, MO). Pinar del Rio: *Wilson 11502* (F, G); *Acuña 10943* (Cu); *Roig 8722* (Cu).

14. POUTERIA MICRANTHA (Urb.) Baehni, Candollea **9**: 256. 1942.

Labatia micrantha Urb. Ant. **9**: 414. 1925.

Tree; leaves veiny, broadly oblanceolate to narrowly cuneate-obovate, broadly rounded or subtruncate at the apex, tapering gradually to the cuneate acute base, commonly 5–14 cm. long, 2–6 cm. wide, glabrous or nearly so at maturity; primary lateral veins about 9–14 pair; secondary lateral veins tending to be nearly perpendicular to the costae; tertiary lateral veins more or less evident, tending to be perpendicular to the secondary ones; petioles short, about 1 cm. long or less; flowers reputedly 2–5 in the axils, sessile or short-pedicellate (pedicels 1–3 mm.), with 4 short-hairy sepals 2 mm. long, and a short glabrous 4-lobed corolla, the lobes ciliate, the filaments attached at the base of the tube, the style very short, the ovary 4-loculate; fruit unknown.

Type: *Ekman 6416*, Sierre de Nipe, Rio Piloto, Oriente, Cuba, 350 m., April, 1926 (F-fragment).

Local name: Sapotillo.

Distribution: Oriente, Cuba.

CUBA: Oriente: *Ekman 4993* (F, G).

15. POUTERIA HOTTEANA (Urb. & Ekm.) Baehni, Candollea **9**: 423. 1942.

Labatia ? hotteana Urb. & Ekm. Arkiv Bot. **22A** (17): 69. 1929.

Tree 15 m. high; leaves glabrous at maturity, broadly elliptic-obovate, obtuse at the base, broadly rounded at the summit, mostly 8–15 cm. long, 5–9 cm. wide; primary lateral veins about 8–14 pair, prominent; secondary veins, except for the curving ones near the midrib, tending to be nearly perpendicular to the costae; tertiary veins relatively obscure, tending to be perpendicular to the secondary ones; petioles short, about 1 cm. long; flowers unknown; fruit sessile, globose, glabrous, sometimes somewhat warty, about 3–6 cm. long and thick; seeds 2–4, 2.5–3.5 cm. long, rounded on the back, flattened on one or two ventral sides, according to the number in the fruit, light brown, somewhat grown to the seed-coat throughout, more markedly so on the flattened side or sides; in my specimens the seed-coat about 1.2 mm. thick dorsally, and 2 mm. thick ventrally, in the type reputedly 0.8 mm. dorsally and half as much ventrally.

Type: *Ekman H9534*, Morne de la Hotte near Grand Goave, Morne Descassiers, Haiti, 1200 m., Jan.

Distribution: Haiti to Puerto Rico.

HAITI: *Ekman H7338* (F). PUERTO RICO: *Gerhart 602* (NY), *s.n.*, (NY).

The characteristically veiny, broad, rounded leaves make this species readily identifiable. It is probably related to *P. micrantha* of Cuba, which

has much narrower leaves that taper more gradually to the base, with the tertiary veins more evident. Inasmuch as the flowers of one species and the fruit of the other are unknown, further differences can not yet be noted.

16. POUTERIA HYPOGLAUCA (Standl.) Baehni, Candollea **9**: 250. 1942.

Lucuma hypoglauca Standl. Trop. Woods **4**: 4. 1925.

Tree up to 20 m. high; leaves broadly oblanceolate to narrowly elliptic, up to about 25 cm. long and 8 cm. wide, glabrous above, very finely and closely white-sericeous-strigose beneath, later glabrate but often remaining light-colored; primary lateral veins about 8–15 pair, raised beneath; secondary lateral veins less prominent and more regular than in *P. amygdalina;* petioles short and stout, about 1 cm. long or less; flowers numerous and subsessile in axillary clusters, often at defoliated nodes; sepals 4 or sometimes 5, about 2.8–3.4 mm. long, the outer broadly ovate and closely hairy, the inner commonly oblong or oblong-spatulate, glabrous, and subpetaloid in texture; corolla about 2.0–2.8 mm. long, the 4 or sometimes 5 lobes about 0.5–0.6 mm., broader than long, truncate or nearly so, oblong; anthers about 0.7–1.0 mm. long; filaments about 1 mm. long, attached $\frac{1}{4}$–$\frac{1}{2}$ of the way up the tube; staminodes oblong or ovate, petaloid in texture, shorter than the corolla-lobes; ovary deeply 4-lobed, with 4 ovules; style about 1.2–1.5 mm. long, glabrous, cylindric or clavate; fruit with hard shell and edible pulp, subglobose, about 5–10 cm. thick; seeds commonly 4, about 4 cm. long, more or less grown to the pericarp nearly or quite throughout, but reputedly sometimes with an elliptic-linear scar 2.5 cm. long.

Type: *Calderon 1935*, Villa del Guyabal, El Salvador, January, 1924 (F-fragment).

Local names: Pan de la vida, palo de calentura, chicosapote, zapote blanco, choch, socovite.

Distribution: San Luis Potosi and Vera Cruz, Mexico; cultivated and perhaps native south to Yucatan, Guatemala, and Salvador.

MEXICO: *Galeottii 1662* (F); *Zetek s.n.* (F). San Luis Potosi: *Edwards 680* (F); *Lundell 7128* (A, F, Mich. NY). Vera Cruz: *Karwinsky 61* (F); *Palmer 451* (F); *Worownow 2144* (F). Yucatan: *Gaumer 23203* (F); *Gaumer 23299* (A, F, G, MO, NY); *Gaumer 23385* (F, G, MO). GUATEMALA: Petén: *Aguilar 81* (A, F, Mich); *Lundell 3265* (F, Mich). SALVADOR: *Calderon 1114* (F).

17. POUTERIA STYLOSA (Pierre) Dubard in Lecomte, Not. Syst. **1**: 381. 1911.

Guapeba stylosa Pierre, Not. Bot. Sapot. 42. 1891.
Lucuma standleyana Pitt. Contr. U. S. Nat. Herb. **18**: 166. 1916.
Labatia standleyana Pitt. loc. cit. **20**: 481. 1922.
Pouteria standleyana Baehni, Candollea **9**: 255. 1942.

Tree about 5 m. high; leaves elliptic-lanceolate to narrowly elliptic-obovate, acute at the base, conspicuously acuminate at the apex, about 7–20 cm. long, 2.5–7 cm. wide, glabrous above, finely and closely sericeous

beneath, the hairs pale or slightly brownish, sometimes deciduous in age; primary lateral veins about 10–20 pair, secondary lateral veins relatively fine and numerous, raised and curving, those near the midrib oblique, those near the margin commonly straighter and nearly perpendicular to the costae; petioles short, about 1 cm. long or less; flowers sessile or nearly so in small axillary clusters; sepals 4, about 2.7–3.6 mm. long, the outer broadly ovate and finely rufescent, the inner oblong-spatulate and glabrous; corolla about 2.6–3.0 mm. long, glabrous, the 4 broad subtruncate lobes half as long as the tube, or shorter; filaments attached at the base of the corolla-tube, or as much as 0.8 mm. above it, the traces raised and conspicuous; anthers nearly 1 mm. long; staminodes oblong-lanceolate, about 0.6–0.7 mm. long; ovary very densely hairy, with 4 or sometimes 6 lobes and sinuses, and as many ovules; style glabrous or somewhat hairy, up to 2 mm. long or perhaps more; fruit oblate-spheroidal, about 3 cm. long and 3.5 cm. thick, hard, glabrous or reputedly sometimes hairy; seeds 2, nearly 2 cm. long, about as broad, and a little over 1 cm. thick, firmly grown to the pericarp except for a narrowly elliptical area about 5 mm. wide on the back; seed-coat firm, about 1–2 mm. thick.

Type: *Sutton-Hayes 67*, Panama.

Distribution: Panama; perhaps also Costa Rica and Honduras.

PANAMA: Bocas del Toro: *Cooper 509* (F, NY, Y). CANAL ZONE: *Pittier 3807* (F, G, NY); *Allen 2572* (NY); *Zetek 4804* (F).

Several sterile specimens from Costa Rica and Honduras resemble this species, but have much larger and less markedly acuminate leaves (20–50 cm. long, 7–20 cm. wide, with 20–40 pairs of primary veins and petioles 2–7 cm. long), and some are reported to come from large trees. When better known, these plants may perhaps prove to represent a distinct species.

COSTA RICA: Alajuela: *Standley 40129* (F). HONDURAS: Atlantida: *Standley 54634* (A, F), *55606* (A, F), *55816* (A, F).

I have not seen the type of *P. stylosa*, and there might possibly be some question whether it is the same as *P. standleyana*, from which the foregoing description is largely drawn. Both Pierre and Dubard described the leaves as glabrous, but Baehni, who has seen the type, keys it under the heading "folia glabrescentia," and says in his description that the leaves are "adpresse indumento luteolo-viride sericeo vestita" beneath. The other differences between *P. stylosa*, as described, and *P. standleyana*, as represented in the herbarium, are entirely minor and not to be expected to be constant. Furthermore, although *P. standleyana* is common in Panama, *P. stylosa*, sens. strict. seems never to have been recollected, a suggestive circumstance, in view of the fact that Sutton-Hayes, an invalid physician who made only a relatively small collection in the three years he spent in Panama prior to his death in 1863 in Colon, could scarcely have gotten far from the beaten track.

18. POUTERIA AMYGDALINA (Standl.) Baehni, Candollea **9**: 360. 1942.

Lucuma amygdalina Standl. Trop. Woods **4**: 5. 1925.
Sideroxylon amygdalinum Standl. Trop. Woods **18**: 31. 1929.
Bumelia laurifolia Standl. Trop. Woods **31**: 45. 1932.
? *Pouteria psilocarpa* Baehni, Candollea **9**: 249. 1942.

Tree to 35 m. high; leaves glabrous, lanceolate to elliptic, about 5–15 cm. long and 2.6 cm. wide, acute to acuminate at the apex, the slender tip sometimes more than 1 cm. long, closely and conspicuously reticulate-veiny beneath with raised veins, less prominently so above; petioles short, about 1–2 cm. long; flowers borne in small axillary clusters, the short pedicels only 1–2 mm. long; sepals most commonly 4, the outer ovate, the inner oblong, about 1.7–2.5 mm. long, or sometimes 5 and imbricate, all more or less hairy, or the inner subglabrous; corolla small, firm, reputedly creamy, soon deciduous, shorter than or sometimes slightly exceeding the calyx, about 1.2–3.0 mm. long, the lobes about 0.8–1.2mm. long and subrotund; anthers about 0.5–0.7 mm. long, or perhaps sometimes abortive, a little shorter than the filaments, which are attached at or a little below the level of the sinuses; staminodes mostly trapezoidal, about 0.5–0.8 mm. long; style about 1.0–1.5 mm. long; ovules 4 or 5, attached at or a little above the middle; fruit green, obovoid or broadly ellipsoid, commonly contracted to a short and broad substipitate base, about 2–3 cm. long, one-seeded; seed about 1–2 cm. long, the seed-coat very smooth and shining, somewhat fragile, about 0.4 mm. thick, with a broad lateral scar extending its full length.

Type: *Durland s.n.*, El Paso, El Petén, Guatemala, 1925 (F-fragment).

Local Names: Zapote faisan, silly young, paacecan.

Distribution: British Honduras and Guatemala.

GAUTEMALA: Petén: *Bartlett 12438* (A, F, Mich, NY); *Bartlett 12748* (A, F, Mich, NY, US); *Bartlett 12817* (F, Mich); *Egler 42-213* (F); *Lundell 3935* (F). BRITISH HONDURAS: *Lundell LP 14* (F); *Lundell 419* (F); *Lundell 6246* (G, Mich, NY, US); *Lundell 6264* (F, G, Mich, MO, NY); *Lundell 6362* (F, G, Mich, NY); *Meyer 159* (F); *Meyer 186* (F); *Schipp 1289* (A, F, G, Mich, MO, NY); *Stevenson 2* (Y).

I have not seen the type of Baehni's *P. psilocarpa*, but the description sounds very much like *P. amygdalina*. The only differences that can be made out from his description are the abortive anthers, which mean little in a species with such reduced flowers, and the scarcely prominent veins of the leaves, which may well be significant.

19. POUTERIA CHIRICANA (Standl.) Baehni, Candollea **9**: 421. 1942.

Lucuma chiricana Standl. Field Mus. Pub. Bot. **4**: 251. 1929.

Tree to 30 m. high; leaves somewhat resembling those of *P. amygdalina*, glabrous, elliptic, about 8–15 cm. long, 2.5–6 cm. wide, acuminate at the apex, evidently reticulate-veiny, but the areolae larger than in P. *amygdalina*, the veins commonly only slightly or scarcely raised; petioles short,

about 1 cm. long; flowers subsessile in small axillary clusters; sepals 5, about 2.2–2.6 mm. long, closely hairy, the outer ovate, the inner oblong-spatulate; corolla 5-lobed, about 3.0–3.2 mm. long, the lobes about 2 mm. long, rounded; stamens absent; staminodia very small and inconspicuous; ovary 4-ovulate; fruit about 3.5 cm. long, broadly ellipsoid, smooth, reputedly edible, narrowed to a more or less definite short and broad stipitate base; seed solitary, ellipsoid, about 2.4 cm. long and 1.8 cm. broad, the seed-coat about 0.5–0.7 mm. thick, dull, with a fine raised honeycomb pattern, the scar oblanceolate, about 8 mm. wide, extending the length of the seed.

Type: *Cooper & Slater 254*, Progreso, Chiriqui, Panama, 1927 (F, Y).

Local Name: Nispero colorado.

Distribution: Panama.

PANAMA: Bocas del Toro: *Cooper 445* (F, Y); *Cooper 457* (F, Y). Chiriqui: *Cooper & Slater 230* (A, F, G, Y).

This species is evidently related to the more northern *P. amygdalina*, from which it differs in the less prominent venation of the leaves, slightly larger fruits and seeds, and especially in the dull seed-coat with pronounced honeycomb pattern.

20. POUTERIA IZABALENSIS (Standl.) Baehni, Candollea **9**: 346. 1942.

Lucuma izabalensis Standl. Trop. Woods **4**: 6. 1925.

Tree up to 20 m. or more high; leaves glabrous, firm, elliptic, acute or more commonly acuminate, about 10–22 cm. long and 3.5–7 cm. wide, evidently reticulate-veiny on both sides, more prominently so beneath, but the areolae larger and the veins less raised than in *P. amygdalina;* petioles about 1–2 cm. long; flowers subsessile, the pedicles 2 mm. long or less, borne few or singly in the axils, or sometimes on slender axillary twigs several cm. long with few or abortive leaves; sepals 6–7, spirally arranged, the outer about 1 mm. long or less, the inner about 2 mm. long or a little more, all glabrous or nearly so outside, appressed-hairy within; corolla about 1.3–3.0 mm. long, the 5 lobes about 0.9–1.1 mm.; filaments attached about at the level of the sinuses, less than 1 mm. long; anthers about 0.6 mm. long; staminodes linear or linear-oblong, about 0.5–1.0 mm. long; style short, often thickened at the middle; locules 4 or 5; fruit brown, broadly ellipsoid or subglobose, about 2.5–3 cm. long; seed solitary, 2–2.5 cm. long, the seed-coat rich dark brown, lustrous but somewhat roughened, 0.5–0.8 mm. thick; seed-scar covering half the seed.

Type: *Whitford & Stadtmiller 35*, Las Playitas, Izabal, Guatemala, May 13, 1919 (F-fragment, Y).

Local name: Silion.

Distribution: British Honduras and Guatemala to Nicaragua.

BRITISH HONDURAS: *Schipp S-396* (F, Mich, MO); *Schipp S-897* (A, F, G, Mich, MO, NY); *Schipp 1124* (A, F, G, Mich. MO). GUATEMALA: *Record G-10* (Y); *Whitford & Stadtmiller 65* (Y). Petén: *Bartlett 12219* (F, Mich). Izabal: *Steyermark 38047* (F); *Steyermark 42060* (F); *Whitford & Stadtmiller 35* (F-fragment, Y). HONDURAS: Atlántida: *Standley 54148* (F); *Standley 54679* (A, F, G). NICARAGUA: *Englesing 46* (F, Y).

This species might be confused with *P. amygdalina*, from which it differs in its usually larger leaves with coarser and less raised reticulation, more numerous sepals, and dark brown, roughened, slightly thicker-walled seeds, with broader scar.

21. POUTERIA DURLANDII (Standl.) Baehni, Candollea 422. **9**: 1942.

Lucuma durlandii Standl. Trop. Woods **4**: 5. 1925.

Tree up to 25 m. high; leaves broadly oblanceolate to narrowly obovate or narrowly elliptic, generally broadest above the middle, acuminate, often abruptly so, at the apex, generally gradually narrowed to the base, up to 30 cm. long and 10 cm. wide, glabrous or nearly so, prominently reticulate with raised veins beneath, less conspicuously so above, the primary lateral veins about 8–16 pair, the secondary ones irregularly anastomosing; flowers and fruits subsessile, clustered at the nodes, these sometimes defoliated; sepals 5, ovate, about 2.5–4 mm. long, sparsely or moderately rufous-hairy; corolla glabrous, about 3.8–5.5 mm. long, reputedly white or creamy, the tube from much shorter than to about equaling the 5 orbicular-ovate and prominently auriculate lobes; stamens attached at the level of the sinuses, the anthers about 1.2–1.5 mm. long, the filaments from a little shorter to a little longer than the anthers; staminodes varying from thickened and lance-subulate to petaloid in texture and orbicular-ovate, about 1–2 mm. long; ovary with 2 or occasionally 3 locules, the ovules attached laterally but sometimes near the base; fruit green, broadly ellipsoid to subglobose or oblate-spheroidal, about 15–20 mm. long, with very thin-pulp; seeds commonly 2, sometimes 1 or 3, nearly as long as the fruit, ellipsoid, with thin and fragile dull and minutely roughened seed-coat only about 0.15–0.25 mm. thick; seed-scar covering about half the seed.

Type: *Durland s.n.*, El Paso, El Petén, Guatemala, 1925 (F-fragment).

Local names: Zapotillo, sapote blanco, mammy cederia, wild mammee.

Distribution: Alajuela, Costa Rica, to San Luis Potosi, Mexico.

MEXICO: San Luis Potosi: *Lundell* (A, F, Mich, NY). Tabasco: *Matuda 3297* (A, F, Mich, NY). GUATEMALA: Petén: *Bartlett 12308* (F, Mich, NY), *Bartlett 12142* (A, F, Mich, NY), *Egler 42-226* (F), *Lundell 2154* (F, G, Mich), *Steyermark 45426* (F), *Steyermark 46192* (F). Alta Verapaz: *Steyermark 44514* (F). Izabal: *Steyermark 39228* (F). BRITISH HONDURAS: *Gentle 1809* (A, F, Mich, MO, NY), *Gentle 2597* (A, F, Mich, MO), *Gentle 3223* (NY, A, Mich), *Lundell 6327* (F, Mich, NY), *Lundell 6402* (G, Mich, NY), *Lundell 6442* (G, Mich, NY, US), *Schipp 1126* (A, F, G, Mich, MO. HONDURAS: Colon: *von Hagen & von Hagen 1333* (NY, G), *von Hagen & von Hagen 1371* (NY, F). COSTA RICA: Alajuela: *Austin Smith 1874* (NY, MO, F).

Pouteria durlandii, *P. amygdalina*, *P. chiricana*, and *P. izabalensis* are closely related and not always readily separable on vegetative characters.

P. durlandii differs from the other three in generally having the leaves broadest distinctly above the middle, with a tapering base, the others generally being broadest near or below the middle, and carrying their width well toward each end. When flowers or fruits are available, all are readily separated.

22. **Pouteria subrotata** Cronquist, sp. nov.

Tree 10–15 m. high, the limbs and branchlets erect; leaves firm, obovate, rounded or subtruncate and cuspidate at the apex to abruptly short acuminate, about 10–20 cm. long, 5–12 cm. wide, essentially glabrous above at maturity, sparsely and inconspicuously strigulose beneath; primary lateral veins prominent, about 9–11 pair; secondary lateral veins numerous, fine, sinuous but rather regularly disposed; petioles about 1.5–3 cm. long; flowers clustered in the axils or at defoliated nodes, subsessile, the pedicels less than 2 mm. long; sepals 5, ovate, about 1.7–2.0 mm. long, finely hairy inside and out; corolla white, about 3.5–3.8 mm. long, subrotate, the 5 lobes about 2.5–3.0 mm. long, finely strigose on the back; filaments about 1.7–1.9 mm. long, attached to the lower part of the corolla-lobes or at the level of the sinuses; anthers about 0.9–1.0 mm. long; staminodes linear-filiform, about 2.0 mm. long or a little more; ovary short-hairy, 5-loculate; style thick, 1.4–1.7 mm. long; fruit unknown.

Arbor 10–15 m. alta; folia dura, obovata, cuspidata vel breviter acuminata, 10–20 cm. longa, 5–12 cm. lata, supra glabra, infra sparse strigulosa, costis 9–11-jugis, venulis secondariis numerosis, tenuibus, sinuosis sed regulariter dispositis, petiolis 1.5–3 cm. longis; flores numerosi, subsessiles, sepalibus 5, ovatis, ca. 1.7–2.0 mm. longis, utrinque strigosis, corolla subrotata, 3.5–3.8 mm. longa, lobis 5 ca. 2.5–3.0 mm. longis, extra strigosis, filamentis fauce affixis, 1.7–1.9 mm. longis, antheris 0.9–1.0 mm. longis, staminodiis lineari-filiformibus, ca. 2.0 mm. longis, ovario 5-loculare; fructus ignotus.

Type: *Pittier 6548*, forests around Pinogana, southern Darien, Panama, April 16–20, 1914 (US).

This species does not seem to be closely related to any other of my acquaintance.

23. **Pouteria austin-smithii** (Standl.) Cronquist, comb. nov.

Lucuma austin-smithii Standl. Field Mus. Pub. Bot. **22**: 367. 1940.

Tree 12 m. high; leaves glabrous except when young, elliptic-obovate, rounded to abruptly acuminate, mostly 10–17 cm. long, 4–8 cm. wide; petioles short, about 1–2 cm. long; primary lateral veins about 15–20 pair, somewhat irregularly spaced; secondary lateral veins oblique and curving, except near the margins, where perpendicular to the costae; flowers few in the axils, the pedicels about 9–12 mm. long; sepals 4, about 7–8 mm. long,

the outer finely and closely rufous-hairy, the inner glabrous and subpetaloid in texture; mature corolla not known, but one from a maturing bud is glabrous, 6.5 mm. long, the 4 lobes a little longer than the tube, the staminodes spatulate, petaloid in texture, a little shorter than the corolla-lobes, the anthers 1.5 mm. long, the filaments attached only about 1 mm. from the base of the tube, and with conspicuous raised traces; ovary very densely long-hairy, 4-loculate, the glabrous style several mm. long; fruit unknown.

Type: *Austin Smith H. 1280*, La Piña de Farcero, Alfaro Ruiz, Alajuela, Costa Rica, cloud forest, Caribbean watershed, 1575 m., October 22, 1938 (F, US).

Distribution: Known only from the type collection, Alajuela, Costa Rica.

This species is probably related to *P. gallifructa*, and may be expected to have a similar fruit.

24. POUTERIA DOMINIGENSIS (Gaertn. f.) Baehni, Candollea **9**: 402. 1942.

Tree up to about 10 m. high; leaves glabrous, except when very young, or in var. *cuprea* more or less persistently rufous-strigose beneath, oblanceolate to obovate or sometimes elliptic, commonly rounded, sometimes acute, about 5–13 cm. long, 2.5–7 cm. wide, or in var. *cuprea* sometimes 20 cm. long and 10 cm.wide, evidently reticulate-veiny on both sides, the primary lateral veins generally well under 1 cm. apart and sometimes difficult to distinguish from the secondary ones, about 10–20 pair; secondary veins anastomosing, often more or less parallel to the primary ones, forming areolae with the long axis directed likewise, or somewhat irregular; petioles short, commonly 1–1.5 cm. long; flowers solitary or generally several in the axils, the closely rufous-hairy pedicels commonly 4–8 mm. long; sepals 4, broad, about 4–9 mm. long, the outer densely and finely rufous-hairy, the inner similarly hairy only down the middle, otherwise glabrous and yellow-green; corolla yellow or white, about 8–16 mm. long, the lobes generally 6, about $\frac{1}{3}$–$\frac{2}{3}$ as long as the tube, papillate but not hairy; anthers about 1.5 mm. long, the filaments likewise or a little longer, attached at or a little below the level of the sinuses; staminodes linear-subulate, about 2.5 mm. long or more; style glabrous, 5 mm. long or more; ovary with 5–8 (commonly 6) locules; fruit yellow, edible, subglobose, about 3–6 cm. thick, tipped by the persistent style, which is surrounded by a conspicuous light-colored areola commonly 1–2 cm. in diameter; seeds 1–several, about 1.5–3 cm. long, the smooth brown seed-coat about 0.25–0.35 mm. thick; seed-scar variable, sometimes as long as the seed, sometimes much shorter, about 3–10 mm. wide.

Type: *Poiteau s.n.*, Haiti.

Pouteria dominigensis var. **dominigensis** (Gaertn.) Cronquist, comb. nov.

Lucuma dominigensis Gaertn. f. Fruct. **3**: 131. 1807.
Lucuma serpentaria HBK. Nov. Gen. & Sp. **3**: 242. 1818.

Lucuma pauciflora A. DC. Prodr. **8**: 168. 1844.
Lucuma valenzuelana Rich. in Sagra, Hist. Pol. Nat. Cuba **11**: 83. 1850.
Lucuma serpentaria var. *dominigensis* Dubard, Ann. Mus. Col. Marseilles **20**: 13. 1912.
Pouteria dominigensis var. *typica* Baehni, Candollea **9**: 403. 1942.

Leaves essentially glabrous except when very young. Local names: Sapote de culebra; siguapa; jaune d'oeuf; egg fruit.

Distribution: Cuba, Haiti, Dominican Republic, Bahamas, and s. Florida; cultivated in Panama.

U.S.A.: Florida: *Peattie s.n.*, *Rugel 160* (MO). BAHAMAS: Andros: *Northrop 703* (A, F, G). New Providence: *Britton & Brace 834* (F, MO). CUBA: *Bucher 152* (Y), *Eggers 5156* (US), *Ekman 1152* (F), *Rehder 1200* (A) *Wright 2924* (G, MO), *Wright 2925* (G, MO), *Wright 2926* (G, MO). Pinar del Rio: *Britton, Britton & Cowell 10099* (G), *Roig 3167* (F). Isla de Pinos: *Britton & Wilson 14872* (F). Habana: *Baker 5123* (A, MO), *Ekman 13503* (F, G), *Leon 2929* (F). Matanzas: *Rugel 319* (G). Santa Clara: *Britton, Britton & Wilson 5552* (G), *Britton, Earle & Wilson 4601* (F) *Britton & Wilson 5629* (F), *Combs, 344* (F, G, MO), *Jack 4980* (A, F), *Jack 5016* (A, MO), *Jack 7312* (A, F, US), *L. B. Smith et al. 3077* (G, NY, US). Camaguey: *Shafer 155* (F). Oriente: *Ekman 6273* (F), *Ekman 7431* (A, G, F), *Howard 6210* (G), *Shafer 3657* (F), *Shafer 8518* (G), *Wright 346* (F, G, MO), *Wright 346a* (F, G, MO). HAITI: *Ekman 2043* (F), *Ekman 2641* (F), *Eyerdam 211* (G), *Leonard 14069* (A, F). DOMINICAN REPUBLIC: *Fuertes 1304* (A, G). CANAL ZONE: *Johansen 36* (F), *Standley 26894* (F), *Standley 30859* (F).

Pouteria dominigensis var. **cuprea** (Urb. & Ekm.) Cronquist, stat. nov.

Lucuma cuprea Urb. & Ekm. Ark. Bot. **21A** (5): 55. 1927.
Pouteria dominigensis f. *cuprea* Baehni, Candollea **9**: 404. 1942.

Leaves strongly rufous-strigose beneath, tardily glabrate.

Type: *Ekman 4695*, Massif du Nord, near St. Louis du Nord, Haiti, 950 m., August, 1925 (F-fragment).

Distribution: Haiti and the Dominican Republic.

HAITI: *Ekman 2814* (F). DOMINICAN REPUBLIC: *Ekman 12257* (US), *Ekman 15845* (F).

Although subsequent authors have consistently spelled the epithet *domingensis*, Gaertner's original spelling was *dominigensis*, both with the description and with the plate. I doubt that Gaertner's spelling can be considered an orthographic error, intentional or otherwise, and the repetition of the same spelling indicates that it was probably not a printer's error. The original spelling should therefore be retained, according to the rules, even though the altered spelling is more euphonious and more commonly used.

Although difficult to define adequately, the difference in leaf-venation between *P. dominigensis* and *P. multiflora* is sufficient to distinguish them at a glance.

25. POUTERIA MULTIFLORA (A. DC.)Baehni, Candollea **9**: 391. 1942.

Lucum multiflora A. DC. Prodr. **8**: 168. 1844.
L. urbanii Pierre, Symb. Ant. **5**: 103. 1904.
L. stahliana Pierre, loc. cit. p. 104.
L. martinicensis Pierre, loc. cit. p. 105.
L. quadrifida Pierre, loc. cit. p. 106.
L. dussiana Pierre in Duss. Fl. Ant. Fr. 388. 1897.
Pouteria multiflora var. *urbanii* Baehni, Candollea **9**: 392. 1942.
P. multiflora var. *quadrifida* Baehni, loc. cit. p. 393.

Tree up to 30 m. high; leaves glabrous, lanceolate to elliptic or obovate, tapering to the base, rounded to acuminate at the apex, up to 45 cm. long and 15 cm. wide, usually much smaller, not very veiny, the surface appearing smoother than in related species; primary lateral veins about 9–16 pair, well-spaced, at least some of them 1 cm. or more apart, except sometimes in very small leaves; secondary lateral veins not much raised, commonly more or less perpendicular to the primary ones, especially near the margins, or somewhat irregular; petioles short, about 1–3 cm. long; flowers clustered in the axils, the pedicels well developed, generally about 1 cm. long or more, sometimes a little less; sepals 4, rarely 5, the inner glabrous or nearly so, orbicular or reniform-orbicular, slightly auriculate, about 5–7 mm. long, the outer a little shorter, ovate, more or less acutish, without auricles, finely appressed-hairy; corolla about 6–9 mm. long, generally 6-lobed, the lobes spatulate or obovate, rounded, equaling or surpassing the tube; anthers about 2.0–2.5 mm. long, apiculate, the filaments about 1.0–2.5 mm. long, attached at or a little below the level of the sinuses; staminodes lance-subulate, about 2.5–3 mm. long, style about 4 mm. long or more, glabrous, persistent in fruit; ovary with 3–6 locules, commonly 4; fruit yellow, edible, globose or broadly ellipsoid, about 2–6 cm. long; seeds 1–3, about 1.5–4 cm. long, subglobose when solitary, otherwise with 1 or 2 flattened sides, the scar generally elliptic, often somewhat irregular, commonly 6–25 mm. wide, sometimes scarcely longer than wide; seed-coat smooth and shining, brown, about 0.2–0.7 mm. thick.

Type: *Bertero s.n.*, in sylvis Portorici, 1820 (F-photo).

Local names: Penny piece, jacana, bully tree, savannah bully tree.

Distribution: Jamaica, Dominican Republic, Puerto Rico, and through the Lesser Antilles to Trinidad; Bermuda.

Sesse, Mocino, et al. 1334 (F), *Sesse, Mocino, et al. 5110* (F). BERMUDA: *Brown, Britton & Whortley 1659* (F). JAMAICA: *Alexander s.n.* (F), *Crawford 780* (F), *Harris 5419* (A, F), *Harris 6089* (A), *Harris 6355* (NY), *Harris 9099* (F), *Harris 9101* (F), *Harris 9830* (F), *Harris 10327* (F), *Harris 11087* (F), *Harris 11221* (F), *Harris 12019* (F), *Perkins 1444* (G), *Purdie s.n.* (F, G). DOMINICIAN REPUBLIC: *Ekman H 11187* (US). PUERTO RICO: *Britton & Shafer 1717* (F), *Gregory 477* (PR) *Heller 1256* (F), *Otero & Alvarez 561* (A, F), *Sargent 367* (US), *Sintenis 3860* (G), *Sintenis 3878* (F, G, MO), *Sintenis 4340* (F, G, MO), *Sintenis 4548* (G), *Sintenis 6218* (F, G, MO), *Sintenis 6760* (A, F, G, MO), *Stevenson 1762* (A, F). GAUDELOUPE: *Duss 2916* (F), *Fairchild 3854* (A). MARTINIQUE: *Duss 257* (F), *Hahn 1359* (F, G). ST. VINCENTS: *H. H. & G. W. Smith 472* (F, G). GRENADA: *Beard 221* (A).

26. POUTERIA CAMPECHIANA (HBK.) Baehni, Candollea **9**: 398. 1942.

Lucuma campechiana HBK. Nov. Gen. et Sp. **3**: 240. 1818.
Lucuma salicifolia HBK. ibid. p. 241, not P. salicifolia (Spreng.) Radlk.
Lucuma nervosa A. DC. Prodr. **8**: 169. 1844.
L. sphaerocarpa A. DC. loc. cit.
L. palmeri Fern. Proc. Am. Acad. **33**: 87. 1897.
Sideroxylon campestre Brandegee, U. Calif. Pub. Bot. **7**: 329. 1920.
Lucuma laeteviridis Pitt. Contr. U. S. Nat. Herb. **20**: 482. 1922.
L. heyderi Standl. Trop. Woods **11**: 22. 1927.

Pouteria campechiana var. *palmeri* Baehni, Candollea 9: 400. 1942.
P. campechiana var. *salicifolia* Baehni, loc. cit.
P. campechiana var. *nervosa* Baehni, loc. cit. p. 401.

Tree sometimes as much as 25 m. high, commonly much smaller; leaves elliptic to narrowly obovate, rounded to acuminate at the apex, up to 35 cm. long and 10 cm. wide, glabrous, borne on petioles up to 4 cm. long; primary lateral veins about 12–20 pair; secondary lateral veins fairly regularly disposed, those near the midrib curving and oblique to the costae, those nearer the margins becoming nearly perpendicular to the costae; flowers clustered in the axils, the pedicels about 1 cm. long or more; sepals 4–6, commonly 5, the inner usually a little larger than the outer, the larger ones commonly 4.5–9 mm. long, all minutely pubescent outside, except near the margins, glabrous within; corolla 7–12 mm. long, the 4–7 (commonly 5) lobes shorter than the tube, finely and sometimes very sparsely sericeous outside; anthers 1.3–2.0 mm. long, the filaments about as long, attached near the level of the sinuses; staminodes linear or lanceolate, about 2.4–2.9 mm. long; locules commonly 5, sometimes as many as 10; style glabrous, about 5 mm. long or more; fruit sugblobose or pyriform, up to about 7 cm. long and thick, edible, green or brownish to sometimes yellow, the pulp yellow or orange; seeds about 1–4, 2–4 cm. long, with broad scar 1–2 cm. wide extending the whole length; seed coat shining, light brown, about 0.3–0.5 mm. thick.

Type: *Humboldt, Bonpland,* and *Kunth s.n.* near Campeche, Mexico (F-photo).

Local names: Mamey cerera, mamey ciruela, kaniste, canistel, kakixo, chunak, huicumo, zapotillo calenturiento, zapote, zapote de niño, caca de niño, caca de mico, ingerto de montaña.

Distribution: Southern Mexico to Panama; also in Cuba and on the Florida Keys, though perhaps only in cultivation or as a recent escape.

U.S.A.: Florida: *Curtiss s.n.* (G). CUBA: (cultivated) *Wright s.n.* (G, MO). Isla de Pinos: (cultivated) *Curtiss 491* (A, F, G, MO). Habana: *de la Sagra 511* (F-fragment). Habana: (cultivated) *Ekman 13593* (F). Santa Clara: (cultivated) *Jack 6312* (G), *Jack 6892* (A), *Jack 7362* (A, F), *Salvoza 576* (A). MEXICO: *Haenke 1595* (F), *Haenke 1597* (F), *Liebmann 319* (F), *Liebmann 320* (F), *Liebmann 331* (F), *Sesse, Mocino et al. s.n.* (F). Vera Cruz: *Bourgeau 1960* (F, G), *Purpus 8545* (G, US, MO), *Purpus 9048* (G), *Purpus 10898* (F-fragment). Mexico: *Hinton 3210* (US), *Hinton 4145* (MO, US), *Hinton 5391* (A). Morelos: *Zetek s.n.* (F-fragment). Pueblo: *Salazar s.n.* (F-fragment). Guerrero: *Barkley 1405* (F), *Haenke 1603* (F), *Haenke 1604* (F), *Hinton 5940* (A), *Hinton 6116* (G), *Hinton 9185* (F, MO), *Palmer 248* (F-fragment), *Palmer 386* (A, F, G, MO), *Reko 4926* (F-fragment). Oaxaca: *Conzatti 1916* (F, G), *Jurgensen 130* (F). Oaxaca: (cultivated) *Reko 4259* (F). Tabasco: *Lundell 3071* (A, F, Mich), *Matuda 3351* (A, F, Mich, MO, NY), *Steyermark 3071* (Mich). Campeche: *Lundell 983* (A, F, G, Mich, MO). Yucatan: *Gaumer 529* (A, F, G, Mich, MO), *Gaumer 23636* (A, F, G, MO), *Gaumer 23981* (F, G, MO), *Lundell 983* (A, G, Mich), *Palmer 1346* (A, F, G, MO). Chiapas: *Matuda 3713* (Mich). GUATEMALA: *Wilson 377* (F). Petén: *Bartlett 12798* (A, F, Mich), *Egler 42-246* (F), *Lundell 3192* (F, Mich, A), *Lundell 3618* (F, Mich, G), *Lundell 3948* (F, Mich), *Standley 69350* (F). Alta Verapaz: *Steyermark 46347* (F), *Standley 69486* (F). Izabal: *Pittier 8534* (G), *Steyermark 39537* (F), *Steyermark 39425* (F). San Marcos: *Steyermark 52139* (F). Quezaltenango: *Skutch 1308* (A, F), *Skutch 2019* (NY, US, F, A).

Retalhuleu: *Standley 88375* (F), *Standley 87419* (F), *Standley 87789* (F). Suchitepéquez: *Standley 66959* (F). Chimaltenango: *Standley 62129* (F), *Steyermark 52904* (F). Escuintla: *Standley 64560* (A, F). SALVADOR: *Calderon 218* (F, G), *Calderon 1474* (F, G), *Standley 19502* (F, G). BRITISH HONDURAS: *Bartlett 13071* (F, Mich), *Gentle 1072* (A, F, Mich, MO), *Heyder 25* (F-fragment, Y), *Lundell LP6* (F), *Lundell LP35* (F, G), *Lundell 495* (F), *Lundell 673* (A, F), *Lundell 4804* (F, Mich), *Meyer 153* (F), *Schipp S-659* (F), *Schipp 764* (A, F, G, Mich, MO). HONDURAS: *Bangham 307* (A, F). Yoro: *Standley 55026* (A, F). Atlantida: *Yuncker et al. 8778* (NY, F, G), *Yuncker et al. 8800* (NY, F, MO, US). COSTA RICA: *Jimenez 513* (F). PANAMA: Cocle: *Williams 56* (F). CANAL ZONE: *Piper 6027* (F). Pearl Islands: *Allen 2609* (NY).

This species is variable in size and shape of leaf, size and number of flower parts, and size and texture of the fruit. Numerous segregates have been proposed; it is possible that some of these, such as "*Lucuma laeteviridis* Pitt.," with larger leaves and flowers, and reputedly slightly different color and texture of fruit than usual forms, should be recognized as varieties, but any attempt at varietal segregation should be preceded by extensive field study.

Pouteria lucuma (R. & P.) Kuntze ex Baehni, a South American species known to be cultivated in San Jose, Costa Rica, resembles *P. campechiana* but has larger flowers (calyx 8–12 mm., corolla ca. 15 mm.) and a glabrous corolla, as well as a somewhat different leaf-venation.

27. **Pouteria glabrifolia** (Pitt.) Cronquist, comb. nov.

Lucuma glabrifolia Pitt. Contr. U. S. Nat. Herb. **20**: 481. 1922.

Small tree; leaves clustered at the ends of the twigs, narrowly obovate or elliptic, about 10–20 cm. long, 4–8 cm. wide, obtuse to abruptly acuminate at the apex, cuneate at the base, glabrous or nearly so, borne on petioles 2–3 cm. long; primary lateral veins about 10–16 pair; secondary lateral veins, except those nearest the midrib, more or less perpendicular to the costae; tertiary lateral veins mostly more or less perpendicular to the secondary ones; flowers few or solitary in the axils, the finely rufescent pedicels about 1 cm. long; sepals 6, broad, finely and closely hairy, about 10–12 mm. long; corolla yellowish, about 14 mm. long, the 6 or 7 lobes shorter than the tube and strongly hairy on the back, except near the margins, where granular papillate; anthers about 2 mm. long; staminodes linear-subulate, papillate; stigma finely 8-lobed; ovary about 8-loculate; fruit unknown.

Type: *Pittier 6542*, forests around Pinogana, southern Darien, Panama, April 16–21, 1914 (F, G).

Distribution: Known only from the type collection, Darien, Panama.

This species is obviously related to *P. campechiana*, from which it differs in its larger flowers, with the corolla rather loosely hairy on the back. In the absence of fruit, no more definite distinctions can be made, but I believe it represents a distinct entity. The hairiness inside the corolla, emphasized by Pittier, seems, to be due merely to a mold, in the corolla I examined.

28. **Pouteria squamosa** Cronquist, sp. nov.

Tree; leaves elliptic or narrowly elliptic-obovate, with an acuminate tip about 1–2 cm. long, acute at the base, 15–25 cm. long, 5.5–9 cm. wide, glabrous; primary lateral veins well-spaced, about 15–20; secondary lateral veins curved, oblique to the primary ones, those near the margins becoming straighter and perpendicular or nearly so; petioles about 2–3 cm. long; sepals persistent in fruit, firm, relatively narrow, about 5 mm. long; fruiting pedicel about 5 mm. long; fruit spherical or nearly so, about 3–4 cm. thick, gall-like in appearance, the pericarp thick and woody, covered with closely set divergent scales less than 1 cm. long, about 4-loculate.

Arbor; folia elliptica vel anguste elliptico-obovata, acuminata, 15–25 cm. longa, 5.5–9 cm. lata, glabra, costis ca. 15–20-jugis, venulis secondariis obliquis arcuatis, petiolis 2–3 cm. longis; flores fasciculati pedicellati, sepalibus persistentibus ca. 5 mm. longis; fructus ca. 4-locularis, dense squamosus, gallam simulans.

Type: *Steyermark 39557*, Rio Dulce, 2–4 miles west of Livingston, on south side, alt. 1–3 m., Izabal, Guatemala, April 16, 1940 (F).

The possibility exists that the fruits of the type are abnormal, or that the plant is not sapotaceous. The absence of seeds from the fruit is hardly significant, since they frequently fail to develop in other members of the family. The fact that the two fruits preserved with the specimen look just alike, and that other gall-like fruits are known in the genus, suggest that the appearance of the fruits is normal. Furthermore, the leaves do not match any other species from the region. As to the family referral, suffice it to say that all the observed features of the specimen, including the malpighian hairs on the terminal bud, are consonant with the *Sapotaceae*.

29. **Pouteria leucophylla** (Wats.) Cronquist, comb. nov.

Sideroxylon leucophyllum Wats. Proc. Am. Acad. **24**: 59. 1889.

Shrub or small tree 1.5–6 m. high, with a relatively heavy trunk; leaves elliptic to lanceolate or ovate, permanently tomentose on both sides, the tomentum white or somewhat dingy, those of the flowering branches densely tomentose, mostly 4–10 cm. long and 1.5–5 cm. wide, those on the lower branches thinly tomentose, only about 1.5–3 cm. long and 6–10 mm. wide; flowers numerous, clustered at the nodes, the pedicels 4 mm. long or less; sepals 4 or 5, reniform to suborbicular, about 3.5–5 mm. long, densely white-tomentose; corolla 4- or 5-lobed, about 6–8 mm. long, the tube firm, the lobes very thin, erose, equaling or generally exceeding the tube; filaments attached about at the level of the sinuses, about 3.5–4.5 mm. long, firm; anthers about 1.5 mm. long; staminodes resembling the corolla-lobes but a little smaller, 2.5–3.5 mm. long; style about 3.5–5 mm. long, glabrous; ovary densely woolly, 5-loculate; fruit densely short-woolly, subglobose, nearly 1.5 cm. long, 1-seeded, or perhaps sometimes 2 cm. long

and 2 seeded; seeds a little over 1 cm. long, broadly ellipsoid, slightly compressed, the scar ovate, truncate at the base, acuminate at the apex, about 1 cm. long and 6 mm. wide; seed-coat smooth, about 0.3–0.8 mm. thick.

Type: *Palmer 516*, deep canyons near Los Angeles Bay, Baja California, Mexico, 1887 (NY, G, US).

Distribution: Canyons and dry rocky mountainsides; Baja California.

MEXICO: Baja California: *Brandegee s.n.* (May 14, 1889) (A, F, G, US); *Johnston 3365* (A, G, NY, US), *3409* (A, F, G, MO, NY, US), *3438* (A, G, MO, NY, US), *3507* (G, US).

30. POUTERIA SEMECARPIFOLIA Pierre Symb. Ant. **5**: 108. 1904.

Gaupeba ? semecarpifolia Pierre, Not. Bot. Sapot. 43. 1891.

Large tree; leaves oblong-obovate to narrowly elliptic-obovate, about 12–24 cm. long and 5–8 cm. wide, commonly subtruncate and more than 1 cm. wide at the base, sometimes narrower and more acutish; midrib loosely hirsute beneath, at least toward the base, the 10–16 pairs of primary nerves sometimes also slightly hairy beneath, the surfaces otherwise glabrous; secondary lateral veins irregularly anastomosing; petioles short, 2 cm. long or less; flowers subsessile, about 7–8 in a cluster; sepals 4, about 4–5 mm. long and 3 mm. wide, hairy; corolla about 6–7 mm. long, the lobes shorter than the tube, ciliolate; filaments about 3.5 mm. long, attached below the middle of the tube or merely a little below the level of the sinuses; anthers about 1.4–1.8 mm. long exserted; staminodes linear-subulate or lanceolate; ovary 4-loculate, with a slender glabrous style 4–6 mm. long; fruit reputedly ovate, 3.8 cm. long, 2.4 cm. wide, densely short-hairy; seeds reputedly 1–2, about 2.4 cm. long, 2 cm. wide, the scar nearly as long as the seed, 11 mm. wide.

Type: *Duss 255*, Martinique.

Local names: Bois caraibe, bois contrevent.

Distribution: Dominica and Martinique.

MARTINIQUE: *Duss 4435* (F), *Hahn 1368* (F, US).

31. POUTERIA SAMBUENSIS (Pitt.) Baehni, Candollea **9**: 250. 1942.

Lucuma sambuensis Pitt. Contr. U. S. Nat. Herb. **18**: 167. 1916.
Labatia sambuensis Pitt. loc. cit. **20**: 481. 1922.

Tree 10 m. high; leaves glabrous, oblanceolate to obovate, acute at the base, acuminate at the tip, mostly 20–25 cm. long and 5–9 cm. wide; primary lateral veins about 13–15 pair; secondary lateral veins prominent, anastomosing, somewhat irregular; petioles short, about 1–1.5 cm. long; sepals 4, presumably large; other flower parts unknown; fruit sessile or subsessile, fleshy, densely hairy, ovoid, about 5.5 cm. long, 4 cm. thick, obscurely sulcate from base to top.

Type: *Pittier 5621*, foothills of the Garagará Mts., Sambú Valley, southern Darien, Panama, February 7, 1912 (F-fragment).

Distribution: Known only from the type collection, Darien, Panama.

32. POUTERIA CAIMITO (R. & P.) Radlk. Sitzb. Akad. Wiss. München **12**: 333. 1882.

Achras caimito R. & P. Fl. Peruv. **3**: 18. pl. 240. 1802.
Lucuma caimito Roem. & Schult. Syst. **4**: 701. 1819.

Large tree; leaves obovate to elliptic or lanceolate, gradually narrowed to the base, generally acuminate at the apex, glabrous or nearly so, mostly 5–20 cm. long and 2–6 cm. wide, very veiny, the final reticulum minute; petioles short, about 1 cm. long or less; flowers solitary or few in the axils, sessile or subsessile; sepals commonly 4, about 4 mm. long or a little more; corolla about 5–8 mm. long, glabrous, the lobes generally 4, less than half as long as the tube; staminodes lanceolate or subulate, shorter than the corolla-lobes; filaments attached about at the middle of the tube; ovary commonly 4-loculate, with a long glabrous style; fruit edible, globose or ellipsoid, yellow, 5–10 cm. long, 4–8 cm. thick; seeds 1–4, the scar extending the whole length.

Type: *Pavon*, Peru.

Local names: Cauje, abiu, caimo, caimento, temare, balata, madera verde.

Distribution: Brazil and Peru to southern Panama; sometimes cultivated.

PANAMA: Darien: *Pittier 5555* (F).

This species is easily recognized by the very close reticulation of the leaves.

33. **Pouteria gallifructa** Cronquist, sp. nov.

Tree up to nearly 30 m. high; leaves broadly obanceolate or narrowly obovate, obtuse or with a very short abrupt acumination, about 10–21 cm. long, 4–8 cm. wide, clustered at the ends of the twigs, glabrous or with some strigose hairs on the midrib and main veins beneath; primary lateral veins raised and conspicuous beneath, about 15–25 pair, more closely set near the base than above; secondary lateral veins irregular and only slightly more conspicuous than the final reticulum, which is evident and slightly raised on both surfaces; petioles about 1–3 cm. long; flowers abundant, fasciculate chiefly at defoliated nodes, subsessile, the densely strigose pedicels about 1–3 mm. long; sepals 4, about 4.5–6.5 mm. long, elliptic-orbicular, densely strigose; corolla about 8.5–9.0 mm. long, greenish-white, finely papillate, the 4 erose lobes not quite half as long as the tube; filaments about 2–2.5 mm. long, attached a little above the middle of the tube; anthers about 1.3–1.5 mm. long; staminodes subulate, about 1.2–1.4 mm. long; style slender, about 8–10 mm. long; ovary densely pilose, strongly flattened, about 4–6-loculate; fruit gall-like, covered with short densely hairy processes, probably reaching 3–4 cm. in diameter.

Arbor usque ad 30 m. alta; folia late oblanceolata vel anguste obovata, 10–21 cm. longa, 4–8 cm. lata, glabra vel costis strigulosa, costis 15–25-jugis, venulis secondariis irregulariter dispositis, quam venulis ultimis vix conspicuoribus, petiolis 1–3 cm. longis; flores numerosi fasciculati subsessiles calyce dense strigoso ca. 4.5–6.5 mm. longo, corolla glabra 8.5–9.0 mm. longa, lobis 4 dimidio tubi subaequalibus, filamentis supra medio tubi affixis, staminodiis subulatis ca. 1.2–1.4 mm. longis, stylo 8–10 mm. longo, ovario ca. 4–6-loculare; fructus dense brunneo-lanatus, gallam simulans.

Type: *Schipp 1323*, Temash River, British Honduras, in primary forest at 150 feet altitude, March 2, 1935 (NY); isotypes (A, F, G, Mcih., MO).

Cotype: *Schipp 1357*, Temash River, British Honduras, in primary forest at 200 feet altitude, May 22, 1935 (A, F, G, Mich., NY).

Distribution: Known only from the type and cotype collections, British Honduras.

This species is closely related to *P. jenmanii* (Pitt.) Sandw., of British Guiana, which has much larger flowers, and larger leaves with longer petioles.

34. **Pouteria neglecta** Cronquist, sp. nov.

Tree reaching 15 m. or more in height; leaves broadly oblanceolate to obovate, with an acuminate tip commonly 1–4 cm. long, about 10–50 cm. long, 4.5–16 cm. wide, glabrous above, rufous-hirsute with loosely spreading hairs especially along the midrib and main veins beneath, becoming subglabrous in age; primary lateral veins about 20–35 pair, raised and conspicuous beneath, more closely set toward the base than above; secondary lateral veins fairly regular and nearly perpendicular to the primary ones, distinctly more raised and conspicuous than the final reticulation; petioles about 1-4 cm. long; flowers few, fasciculate at defoliated nodes, subsessile; sepals 4, about 7.5–8.5 mm. long, loosely appressed-hirsute, the outer suborbicular and enclosing the broadly obovate inner; corolla greenish, glabrous, about 6.5 mm. long, the 4 lobes a little exceeding the tube; anthers conspicuously extrorse, about 1.4–1.5 mm. long, including the prominent 0.3–0.4 mm. cusp at the apex; staminodes linear-cylindric, about 1.5 mm. long; style short, about 2.5 mm. long; fruit gall-like, covered with short hairy processes, becoming 5 cm. long and 3.5 cm. thick; seeds subspherical, about 2–3 cm. long, the scar covering a little more than half the surface; seed coat about 0.7 mm. thick.

Arbor usque ad 15 m. vel altior; folia late oblanceolata vel obovata, acuminata, 10–50 cm. longa, 4.5–14 cm. lata, supra glabra, infra hirsuta pilis rufis patentibus deinde deciduis, costis 20–35-jugis, venulis secondariis regulariter dispositis prominentibus ad costam perpendicularibus, petiolis 1–4 cm. longis; flores pauci fasciculati subsessiles, calyce adpresso-hirsuto 7.5–8.5 mm. longo, corolla glabra ca. 6.5 mm. longa, lobis 4 tubum supe-

rantibus, filamentis supra medio tubi affixis, antheris perspicue cuspidatis, staminodiis linearibus 1.5 mm. longis, stylo ca. 2.5 mm. longo; fructus dense brunneo-lanatus, 5 cm. longus 3.5 cm. crassus, gallam simulans.

Type: *Schipp 1354*, primary forest, Temash River, British Honduras, 200 feet altitude, April 7, 1935 (Mich); isotypes (A, F, G, MO, NY).

Local names: Red manwood.

Distribution: Guatemala, British Honduras, Honduras and Costa Rica.

GUATEMALA: Izabal: *Steyermark 38768* (M), *Steyermark 39086* (F), *Steyermark 39134* (F), *Steyermark 41607* (F). BRITISH HONDURAS: *Lundell 688* (A, F, Mich), HONDURAS: Atlantida: *Bangham 226* (A, F, US), *Salvoza 813* (A), *Standley 52904* (A, F, US), *Standley 53319* (A, F, US), *Standley 55616* (A, F, US). COSTA RICA: Limon: *Cooper s.n.* (October 1926) (US, Y).

Sterile specimens of *P. neglecta* may be confused in the herbarium with *P. mammosa* or *P. viridis*. The pubescence is distinctly redder than in either of the latter, and is more spreading and commonly more copious than in *P. mammosa*, but much less copious than in ordinary specimens of *P. viridis*. In addition, the secondary lateral veins are more raised and conspicuous than is usual for *P. mammosa*.

35. **Pouteria sclerocarpa** (Pitt.) Cronquist, comb. nov.

Lucuma sclerocarpa Pitt. Contr. U. S. Nat. Herb. **18**: 166. 1916.

Tree 25 m. high; leaves glabrous, elliptic, acuminate, about 10–25 cm. long, 4–7.5 cm. wide, the petioles about 1–2 cm. long; primary lateral veins about 15–20 pair; secondary and tertiary veins forming a close slightly raised reticulum beneath; flowers clustered at defoliated nodes, subsessile; sepals 6 or 7, ovate, the two outer ones about 3.0–3.7 mm. long, the others 5–6.5 mm. long, all hairy within, the inner otherwise essentially glabrous and somewhat petaloid; corolla about 7.5–8 mm. long, the lobes a little over half as long as the tube; anthers about 1.0 mm. long, borne on short filaments attached about at the level of the sinuses; staminodia nearly 2 mm. long, narrowly ovate, subtruncate; style about 6.5 mm. long; ovary densely hairy, 5-loculate; fruit sclerous, pyriform to obovoid, somewhat narrowed toward the base, yellow, about 7 cm. long and 4.5 cm. thick; seed presumably solitary, 4 cm. long, 2.5 cm. wide, brown, shining, the scar large and extending its full length.

Type: *Pittier 4357*, plain of Sperdi, near Puerto Obaldiá, San Blas Coast, Panama, September 3, 1911 (F, G, MO).

Distribution: Known only from the type collection, San Blas, Panama; reported by the collector to be common along the San Blas coast.

36. **Pouteria mammosa** (L.) Cronquist, comb. nov.

Sideroxylon sapota Jacq. Enum. Pl. Carib. 15. 1760, as to description and reference, perhaps not as to type.

Achras mammosa L. Sp. Pl. ed. 2. 469. 1762.

Lucuma mammosa Gaertn. Fruct. **3**: 130. 1807.

Calocarpum mammosum Pierre, Symb. Ant. **5**: 98. 1904.
Achradelpha mammosa Cook, Journ. Wash. Acad. Sci. **3**: 160. 1913.

Tree up to 30 m. high; leaves broadly oblanceolate or narrowly obovate, mostly abruptly acuminate, about 10–60 cm. long, 4.5–15 cm. wide, essentially glabrous above, glabrous or more commonly with some appressed or somewhat loose hairs along the midrib and main veins beneath; primary lateral veins about 20–50 pair; secondary lateral veins rather regularly disposed, more or less perpendicular to the primary ones, distinctly more conspicuous than the fine and close reticulum; petioles subglabrous to densely spreading-hairy, 4 cm. long or less; flowers clustered at defoliated nodes, subsessile or on short pedicels as much as 4 mm. long; sepals about 8–12, spirally arranged, increasing in size centripetally, the inner commonly 5 mm. long, all closely sericeous on the back, except for the thin glabrous margins, very broad, commonly some or all of them distinctly bilobed or emarginate at the summit; corolla about 9–10 mm. long, white, the lobes about equaling or a little exceeding the tube; filaments attached at or a little below the level of the sinuses, about 3.5–5 mm. long; staminodes filiform or nearly so, about 2 mm. long; ovary 5-loculate; fruit brown, ellipsoid or ovoid to subglobose, about 8–20 cm. long, mealy-roughened, fleshy, edible; seed commonly solitary, large, with a broad obovate scar.

Type: *Sloane*, Jamaica.

Local names: Sapote, mamey sapote. For numerous others, see Contr. U. S. Nat. Herb. 18: 82. 1914, and 23: 1120. 1924.

Distribution: Widely cultivated in tropical America, from southern Mexico to northern South America, and in the West Indies; original natural range uncertain.

CUBA: Pinar del Rio: *Palmer & Riley 280* (US). Isla de Pinos: *Curtiss 224* (A, F, G, MO, NY, US). Habana: *Cook 85* (NY, US), *Ekman 13454* (NY), *van Hermann 150* (F, MO, NY, US), *Wilson 3637* (F, NY, US). Santa Clara: *Coombs 684* (F, G, MO, NY, US), *Jack 8662* (A, NY). JAMAICA: *Harris 7053* (F, NY). HAITI: *Ekman H 4796* (US). PUERTO RICO: *Sintenis 6391* (F, G, MO, US). GUADELOUPE: *Duss 3784* (NY, US). MARTINIQUE: *Duss 1901* (NY). MEXICO: Sinaloa: *Rose, Standley & Russell 14087* (US). Jalisco: *Safford 1462* (US). Vera Cruz: *Williams 8231* (F, Y). Michoacan: *Emrick 17* (F), *Leavenworth 1459* (G, MO). Oaxaca: *Williams 9272* (F). Yucatan: *Gaumer 23790* (F, US), *Steere 1620* (Mich). Chiapas: *Fisher 35428* (F, MO). GUATEMALA: Petén: *Lundell 2826* (F, Mich), *Steyermark 45356* (F), *Steyermark 46113* (F). Huehuetenango: *Steyermark 49680* (F). Alta Verapaz: *Steyermark 44524* (F), *Steyermark 44824* (F). Izabal: *Steyermark 38110* (F). *Steyermark 39290* (F). Zacapa: *Kellerman 5871* (US). Santa Rosa: *Donnell-Smith 4363* (G, NY, US). BRITISH HONDURAS: *Bartlett 12876* (A, F, Mich), *Gentle 212* (A, F, Mich, NY, US), *Heyder 26* (US, Y), *Lundell LP6* (F, G, NY, US), *Lundell 687* (F), *Meyer 160* (F), *Peck 229* (G), *Schipp 440* (A, F, G, MO, NY). HONDURAS: *Wilson 316* (NY). Comayagua: *Standley 56064* (A, F, US), *Yuncker et al. 5774* (F, G, MO, Mich). Copan: *Whitford & Stadtmiller 13* (US, Y). Tegucigalpa: *von Hagen 1167* (F, NY). Atlántida: *Standley 53110* (A, F, US), *Standley 53291* (A, F, US), *Yuncker et al. 8494* (F, G, Mich, MO, NY, US). Colon: *von Hagen 1408* (F, NY). SALVADOR: San Salvador: *Calderón 696* (NY), *Standley 20542* (G, NY, US), *Standley 23635* (G). NICARAGUA: *Englesung 85* (F, Y). COSTA RICA: *Cook & Doyle 382* (US), *Cook & Doyle 691* (US), *Jimenez 697* (US), *Leon 731* (F), *Tonduz 13105* (F, CR). Guanacaste: *Standley & Valerio 46557* (US). Alajuela: *Brenes 4342* (F, CR), *Orozco 115* (F). PANAMA: *Duchassaing* (F), *Standley*

27916 (US). Coclé: *Pittier 5089* (NY, US). CANAL ZONE: *Pittier 4628* (NY, US), *Standley 26080* (US).

It might be argued that Jacquin's name *Sideroxylon sapota* should be taken up, under *Pouteria*, for this species, but it is doubtful that Jacquin intended to do any more than transfer *Achras sapota* L. to *Sideroxylon*. The situation has been discussed at length by Cook (Contr. U. S. Nat. Herb. **16**: 277–285. 1913.)

37. **Pouteria fossicola** Cronquist, sp. nov.

Tree 10 m. high; leaves clustered near the ends of the twigs, obovate, obtuse to generally abruptly short-acuminate, mostly 8–30 cm. long and 4–13 cm. wide, glabrous above except when young, finely white-strigose on the midrib and main veins beneath, sometimes with a few similar hairs on the surface as well; primary lateral veins about 15–20 pair; secondary lateral veins slender and somewhat flexuous, more or less perpendicular to the primary ones, and much more conspicuous than the final reticulum; flowers clustered at defoliated nodes, the pedicel about 5 mm. long; sepals about 8, broad, spirally arranged, increasing in size centripetally, the larger about 6 mm. long, all densely grayish-strigose-sericeous on the back, except for the thin glabrous margins; other flower-parts unknown; fruit yellowish-green, obovoid, 8.5 cm. long, 4.5 cm. thick, the surface irregularly wrinkled and somewhat mealy-roughened; seed solitary, obovoid, 7 cm. long, 3.5 cm. thick, with obovate basally acuminate lateral scar about 3 cm. wide and extending its whole length; seed-coat firm, shining, yellowish-tan.

Arbor 10 m. alta; folia obovata, 8–30 cm. longa, 4–13 cm. lata, costis strigosis ca. 15–20-jugis, venulis secondariis regulariter dispositis ad costam perpendicularibus; flores 5 mm. pedicellatis sepalibus dense strigoso-sericeis marginibus glabris ca. 8; fructus luteo-viridis rugosus obovoideus ca. 8.5 cm. longus 4.5 cm. crassus; semen unicum obovoideum 7 cm. longum, area derasa obovata 3 cm. lata.

Type: *Salvoza 999*, north shore near Pearson terminal, Barro Colorado Island, Panama Canal Zone, September 7, 1929 (A).

Cotypes: *Zetek 3870*, Miller Trail, Barro Colorado Island, Panama Canal Zone, June 28, 1937 (F). *Bangham 583*, Island made by French Canal to end of Pearson trail, Barro Colorado Island, September 8, 1929 (A, F).

Distribution: Known only from the type and cotype collections, Barro Colorado Island, Panama Canal Zone.

A note with the *Zetek* specimen says "Fruit collected November 5, 1937 measures 9 inches long×4.5 inches diameter, green with brown raised transverse irregular interrupted flat bars which may be fungus."

This species is related to *P. mammosa*, but has more evidently pedicel-

late flowers, narrower scarcely emarginate sepals, wrinkled fruit of different color and shape, and smaller relatively broader leaves with fewer lateral veins.

38. **Pouteria viridis** (Pitt.) Cronquist, comb. nov.

Calocarpum viride Pitt. Contr. U. S. Nat. Herb. **18**: 84. 1914.
Calocarpum huastecanum Gilly, Bull. Torrey Club **71**: 659. 1944.

Tree; leaves narrowly obovate to elliptic, obtuse to abruptly short-acuminate, commonly 10–25 cm. long and 4–10 cm. wide, densely spreading-villosulous on the midrib and main veins beneath, usually also on the whole surface; primary lateral veins about 15–25 pair; secondary lateral veins, except those near the midrib, about perpendicular to the primary ones, commonly a little fewer and more raised than in *P. mammosa;* petioles about 1.5–3.5 cm. long, commonly densely spreading-hairy; flowers clustered at defoliated nodes, subsessile or borne on short pedicels sometimes nearly 5 mm. long; sepals about 10, spirally arranged, increasing in size centripetally, the inner about 4–6 mm. long, all finely and densely sericeous-strigose on the back except for the thin glabrous margins, broad and rounded, but generally scarcely or not at all emarginate at the summit; corolla about 7.5–10 mm. long, sericeous-strigose, except for the margins of the lobes, which equal or are surpassed by the tube; filaments about 2–4 mm. long, attached just below the level of the sinuses; anthers 1.7–2.4 mm. long; staminodes filiform to linear-subulate, about 2–2.5 mm. long; ovary 5-carpellate; fruit oblate-spheroidal to ellipsoid or ovoid, about 6–10 cm. long, green or brownish-green, fleshy, edible, smooth, 1–2-seeded; seeds light brown, ellipsoid, about 3–6 cm. long and 1.5–3.5 cm. thick, the scar obovate, about 11-23 mm. wide; seed-coat firm, about 0.6–1.2 mm. thick.

Type: *Cook 214*, Coban, Alta Verapaz, Guatemala, August 6, 1910 (F-fragment, US).

Local names: Ingerto, zapote ingerto, zapote blanco, zapote, zapotillo, satul, chulul.

Distribution: San Luis Potosi, Mexico, to San Jose, Costa Rica, often cultivated.

MEXICO: *Sessé, Mociño, et al. 5108* (F). Chiapas: *Martinez s.n.* (1943) (F). GUATEMALA: *Hatch & Wilson s.n.* (August 14, 1936) (F), *Popenoe 691* (US). Alta Verapaz: *Cook 214* (F, US), *Cook & Griggs 183* (US), *Cook & Griggs 647* (US), *Standley 70336* (F), *Standley 71523* (F), *Standley 71641* (F), *von Türckheim 1776* (G, NY, US). Sacatepéquez: *Standley 60282* (F), *Standley 64213* (A, F, NY). Santa Rosa: *Donnell-Smith 6183* (F, G, Mich, MO, NY, US). SALVADOR: *Calderón 2017* (G, US). Ahuachapán: *Standley 20089* (G, NY, US). San Salvador: *Calderón 696* (US). *Standley 23635* (MO, NY, US). COSTA RICA: ? *Tonduz 13105* (US). Guanacaste: *Standley & Valerio 45542* (F, US), *Standley & Valerio 46479* (US). San Jose: *Standley 49303* (US).

This species is closely related to *P. mammosa*, and there is some intergradation in the pubescence-character, so that sterile specimens cannot always be satisfactorily determined. The difference in the fruit appears to

be entirely constant, and that in the shape of the sepals reasonably so. The type of *Calocarpum huastecanum*, from San Luis Potosi, was stated to be at the New York Botanical Garden, but has not yet reached there. The description is wholly consonant with *P. viridis*, which is otherwise known to extend north to Chiapas.

39. **Pouteria cooperi** Cronquist, sp. nov.

Tree about 15 m. high; leaves clustered toward the ends of the twigs, elliptic or elliptic-obovate, about 8–17 cm. long, 3–7 cm. wide, mostly abruptly short-acuminate, loosely hirsutulous on the midrib and main veins beneath, sometimes with a few hairs on the surface as well; primary lateral veins about 10–13 pair; secondary veins not much more prominent than the rather coarse and conspicuous reticulum, mostly irregularly anastomosing, sometimes some of them more evidently perpendicular to the costae; petioles about 1–3 cm. long; flowers (separately preserved) apparently sessile or nearly so; calyx of about 12 or perhaps more thick and fleshy broad sepals, increasing in size centripetally, the inner about 4-5 mm. long when dry, all finely warty-wrinkled when dry, otherwise apparently glabrous, with narrow thin margins; other flower-parts unknown; fruit reputedly woody.

Arbor 15 m. alta; folia elliptica vel elliptico-obovata, 8–17 cm. longa, 3–7 cm. lata, costis hirsutulis ca. 10–13-jugis, venulis secondariis irregulariter dispositis; flores sessili sepalibus glabris crassissimis ca. 12; fructus lignosus.

Type *G. Proctor Cooper 499*, Holstein farm, Cricamola Valley, Almirante region, Bocas del Toro, Panama, February 13, 1928 (NY); isotypes (F, US, Y).

This species is distinguished from the others of the *Calocarpum* group by its relatively coarse and irregular venation, fleshy glabrous sepals, and woody fruit.

7. MANILKARA Adans. Fam. 2: 166. 1763

Sepals biseriate, 3 plus 3, rarely 2 plus 2 or 4 plus 4; corolla-lobes as many as the sepals, each with a pair of more or less petaloid dorsal appendages, or the appendages obsolete through fusion with the lobes; ovules laterally attached; seed-scar long and lateral; endosperm present; primary lateral veins of the leaves generally parallel, nearly straight, but not crowded. Thirty or more species, in both the old and the new worlds.

The old-world genus *Mimusops*, to which some have reduced *Manilkara*, is well separated by the relatively small and basilateral seed-scar, and by commonly having the sepals 4 plus 4 instead of 3 plus 3, with attendant differences in number of corolla-lobes, stamens, and staminodes. One species, *M. elengi* L., has been introduced into Puerto Rico and the Virgin Islands.

The *Manilkara* group has recently been studied by Gilly, who revived *Muriea*, reduced *Achras*, and segregated a new genus *Shaferodendron*, as well as introducing revolutionary changes in the concept of floral morphology, referred to earlier in this paper. *Muriea*, consisting of several widely separated species that have the staminodes replaced by functional stamens, has sometimes been regarded as merely an artificial group of several exceptional species of *Manilkara*. That view is here adopted. *Shaferodendron* differs from *Manilkara* only in having a relatively long corolla-tube and short lobes, with the stamens inserted at the middle of the tube instead of at the level of the sinuses. The difference, I think, is at best of no more than sectional importance. *Achras* differs from *Manilkara* only in the absence of the dorsal appendages on the corolla-lobes, apparently as a result of their fusion with the corolla-lobes. Although the genera have traditionally been put in different tribes or subfamilies, the transitional forms discovered by Gilly so completely bridge the gap that the union of the two groups seems inevitable. As pointed out by Gilly, the original *Achras* L. seems wholly unlike the plants to which the name is now commonly applied, so that it cannot properly be used for the plants here considered.

A Résumé of the American Carisseae (Apocynaceae)[1]

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INTRODUCTION

Conspectus.—In the following résumé of the American Carisseae are presented a key to the genera and supplementary remarks on several species. Certain genera excluded from the tribe are discussed. An errata, addenda, and index to the more important botanical and local names appearing in the author's serial revisions of the American genera of Carisseae are appended.

Literature.—The writer's serial publications, in which all the American genera of Carisseae are revised, comprise the only integral study on the taxonomy of this tribe as represented in the Western Hemisphere. The titles and places of publication of these revisions are as follows:

A Revision of Couma and Parahancornia. (Lloydia **6**: 229–247. 1943 [Published in 1944].
A Revision of Lacmellea, and the Transfer of Zschokkea. (Lloydia **7**: 275–302. 1944). [1945].
A Revision of Ambelania, Inclusive of Neocouma. (Lloydia **8**: 109–130. 1945).
A Revision of Hancornia. (Lilloa **11**: 19–48. 1945).
A Revision of Macoubea and the American Species of Landolphia. (Lloydia **8**: 291–317. 1945) [1946].

Of the earlier regional works, Mueller Argoviensis' treatment of Apocynaceae in Martius' Flora Brasiliensis is the most complete in number of species described. The genera Ambelania (under Tabernaemontana in part), Couma, Zschokkea (i.e. Lacmellea), Hancornia, and Macoubea (under Tabernaemontana) are here presented. Markgraf, in Pulle's Flora of Surinam, describes all the American genera of Carisseae except Hancornia, but treats only the species found in the Guianas.

The general treatment of the Carisseae presented by Schumann in Die Natürlichen Pflanzenfamilien and Bentham in Genera Plantarum are helpful for an over-all view of the entire tribe. In this respect, Hallier's Ueber Kautschuklianen und andere Apocyneen also deserves notice.

Uses.—The important economic uses of the American Carisseae are principally in the latices of several of its representatives. The latex of Couma, particularly of *C. macrocarpa* Barb. Rodr., and to a lesser extent that of Lacmellea, is used as a basic material in the manufacture of chewing gum; that of Hancornia, as a source of secondary rubber. The fruits of the majority of the Carisseae are edible, those of Couma and Hancornia being regarded as delicious. For a more detailed account and other uses of the Carisseae consult the individual generic revisions.

Abbreviations of Herbaria and Acknowledgments.—The abbreviations of herbaria adopted in this paper are the same as those employed previously

[1] This contribution is made possible by the financial support of the Chicle Development Company.

(no place of deposit is generally indicated when a particular collection is represented either in the Britton Herbarium or in the Krukoff Herbarium at the New York Botanical Garden, except when it is a type collection): B—Forest Department of British Guiana, Mazaruni, British Guiana; Brx—Jardin Botanique de l'Etat, Brussels; F—Field Museum of Natural History, Chicago; NY—New York Botanical Garden, New York; P—Muséum d'Histoire Naturelle, Paris; S—Naturhistoriska Riksmuseet, Stockholm, Sweden; US—United States National Herbarium, Washington. Acknowledgment is here made to the directors and curators of the institutions listed for their generous loans of herbarium material, and my particular gratitude is expressed for the aid rendered to me by Mr. B. A. Krukoff, Miss E. C. Hall, and Drs. H. A. Gleason and H. N. Moldenke.

SYSTEMATIC TREATMENT

Carisseae as here delimited comprises in general the tribe Carisseae in Bentham's treatment of Apocynaceae in Bentham & Hooker's Genera Plantarum (**2**: 683–684, 691–696. 1876), or the sections Arduineae, Melodininae and Landolphiinae under Plumieroideae in Schumann's Apocynaceae in Engler & Prantl's Pflanzenfamilien (**4** (2): 122–132. 1895), or Adruineae in Dalla Torre & Harm's Genera Siphonogamarum (**6**: 404–405. 1904). Allamanda is excluded. Thevetia is excluded from the tribe as delimited in the Carisseae of Mueller's Apocynaceae in Martius' Flora Brasiliensis (**6** (1): 6, 15–25. 1860).

Many early writers placed Strychnos in the Apocynaceae, in which family the character of its fruit would suggest the tribe Carisseae. Saint-Hilaire (Pl. Usuelles Bras. 1824. Pl. 1) notes the similarity in the seeds of *Strychnos pseudoquina* and *Hancornia speciosa*. Augier (Essai Nouv. Class. Végét. 1801. P. 145) classifies Pacouria (i.e. Landolphia) and Strychnos together in the family "Pacourides." Kurz (Jour. As. Soc. Bengal **46** (2): 245. 1877) treats Carisseae and Strychneae as separate tribes under "Ser. I. Gymnospermae" of the Apocynaceae. The stigmatic structure or lack of a clavuncle in Strychnos easily removes the genus from Apocynaceae.

The American Carisseae are tropical (Hancornia extending to warm-temperate) woody plants of diverse habits and floral structure; shrubs, small or large trees up to or over 45 m. high and 60 cm. diam., sometimes large lianas (Landolphia), unarmed or armed with deciduous conic spines (Lacmellea in part), the white latex abundant, sweet to bitter, mostly non-poisonous, the branchlets slender to thick and fistulose, terete to very sharply quadrate; LEAVES opposite or 3–4-whorled (Couma), glabrous to densely pubescent on under surface, the petioles 0.5–40 mm. long, with or without a thick saucer-like gland or minute processes in their axils, the blades variously shaped, 5–38 cm. long and 1–20 cm. broad, rounded or slightly retuse to short-acuminate at apex, sharply cuneate to subcordate

at base, dull to nitidous, the under surface sometimes dotted with minute points, the midrib slightly impressed to raised on upper surface, raised on under surface, the principal secondaries (secondary or lateral veins) pinnately arranged, 6–70 pairs with an average distance of 1–30 mm. apart near middle, well impressed to raised on upper surface, slightly impressed to raised on under surface, straight to strongly arcuate, simple or branched, connected by a marginal nerve, the minor secondaries in between principal ones evident or obscure, the tertiaries obscure to numerous and raised, the reticulation close to open, obscure to conspicuous; INFLORESCENCES axillary or terminal, densely crowded to lax, few or profusely flowered, sessile or pedunculate, sometimes tendraloid (Landolphia), the flowers sessile to pedicellate (pedicels up to 11 mm. long); CALYX 5- or 4-parted, 1–7 mm. diam., the calyx-tube very short, the calyx-lobes quincuncial, broadly oblong to lanceolate, 0.8–13 mm. long, obtuse to acute at apex, glabrous to densely pubescent, ciliate or eciliate, without or with glands (1–4 series) inside at base; COROLLA evolving before, with or after leaves, white to yellowish or orange, the corolla tube 3.5–40 mm. long, cylindric or gradually dilated towards apex, usually more or less swollen at region of anthers where sometimes are protruding pockets, glabrous to densely pubescent outside, glabrous to conspicuously pilose inside, the corolla-lobes 5, sinistrosely contorted (viewed externally), not twisted or twisted in either direction, ovate to linear-oblong, 1–45 mm. long and 1–15 mm. broad, glabrous or pubescent, eciliate or ciliate, erect or spreading at maturity; STAMENS inserted at various levels from near base to near throat of corolla-tube, the filaments reduced or evident (up to 1.6 mm. long), the anthers elliptic to lanceolate, 0.8–9 mm. long, the basal lobes close together to strongly spreading, blunt to sharply acute, the apex rounded or extending into a non-polleniferous acute appendage up to 1.2 mm. long, sometimes penicillate, the loculi polleniferous their entire lengths or the pollen lacking or undeveloped in basal lobes (Ambelania in part); OVARY syncarpous, superior to partly inferior, ovate to cylindric, conical to truncate or depressed at apex, sometimes capped with carnose tissue, glabrous to densely pubescent, sometimes grooved, without apparent disk or glands, unilocular or bilocular, ovulate to base or the base on a sterile podium up to 0.5 mm. high, the ovules numerous, in 2–10 series, seen in longitudinal view generally as irregular polygons arranged in honeycomb-like mosaics; STYLE at maturity 0.3–30 mm. long up to clavuncle, sometimes angled or fluted, sometimes bulbose-thickened at base, glabrous, the clavuncle 0.3–2.5 mm. long, with or without a ring at base, sometimes obscurely membranous-fringed at base, pyriform to cylindric or elliptic, glabrous to densely hirtellous-lanate, sometimes sharply crested (Ambelania), the stigma-apiculi 0.15–1.9 mm. long, two-cleft or apparently united, glabrous to hispidulous or hirtellous; FRUIT a berry (usually edible at maturity), spherical or ob-

long to elliptic and in cross section circular to elliptic or star-like pentagonal, 1–18 cm. long, rounded or slightly depressed to narrowed and pointed at apex, rounded to narrowed at base, sometimes short-stalked, one or two celled; SEEDS one to numerous, orbicular to elliptic, more or less flattened, 5–25 mm. long, variously marked, roughened with protuberances or smooth, the embryo about length of seed, the cotyledons from $\frac{1}{3}$ to over 5 times length of the cylindrical radicle.

Carisseae, both in number of genera and species represented, comprises but a small portion of the Apocynaceae as a whole, and the American members of the tribe are less than one third the species found in the Old World. Lacmellea, with 18 species, is the largest genus in America; Ambelania, next in size, has only 11 known species; Parahancornia and Couma, 6 and 5 respectively; Landolphia, 3; Hancornia, merely 1. The American genera of Carisseae are endemic to this continent, except Landolphia which is represented in both the New and the Old World (3 known South American species and over 50 African).

Carisseae, in its broader delimitations, is not always easily and clearly definable from the extra-Carisseae. In the American genera, Ambelania occupies the boundary line of the tribe and approaches closely or conjoins the tabernaemontanaceous genus Macoubea.

In respect to the generic affinities of the various members of the American Carisseae, Hancornia and Parahancornia are obviously closely related, and Couma belongs with the latter. Lacmellea stands further removed. Ambelania links with Parahancornia, but displays evident tendencies towards the extra-Carisseae. Landolphia, characteristic member of the Carisseae, is the only indigenous liana in our group. A strictly natural serial arrangement of these genera is not possible, but the following sequence is convenient: Landolphia, Lacmellea, Couma, Hancornia, Parahancornia, Ambelania.

The best single natural character for distinguishing the American genera of Carisseae is the construction of the clavuncle (sensu Miers, Apoc. S. Am., pp. 2 & 3), that is, the shape of the capitulum between the apex of the style and the base of the stigma-apiculi. The close examination of this minute organ alone is sufficient to identify the genera as defined in my treatment. After a little familiarity, sterile material can be generally placed in the proper genus, and often in the precise species, with little difficulty.

A great degree of morphological heterogeneity is evident in Ambelania and to a much less marked degree in Lacmellea. Extreme varietal differentiations are found only in Hancornia.

Members of the Carisseae in America are found in southern British Honduras and the Atlantic area of Guatemala, thence from Panama they are distributed throughout in scattered or gregarious stands in South

America down to the state of São Paulo or to about the middle of the state of Paraná, Brazil, and in Paraguay, and from the Atlantic coast to the Pacific coast of Colombia and the Andean frontiers of Ecuador, Peru and Bolivia. Numerically, the center of distribution is undoubtedly the Amazon Valley, where all the American genera and the great majority of the species are found. Hancornia extends to the warm-temperate regions, otherwise the tribe in America is exclusively tropical; moreover, with the exception of this genus which prefers arid regions, the New World Carisseae are most at home in humid habitats.

Key to the American Genera of Carisseae

(Characters in italics not found in genera other than where designated.)

1. *Vines;* leaves opposite, the secondaries (lateral veins) widely spaced; terminal inflorescences *with elongated tendriliform axis, the flowers in remote densely subcapitate clusters;* ovary pubescent; clavuncle (podium beneath stigma-apiculi) fusiform ..... *Landolphia* (American spp.)
1. Trees or shrubs; inflorescences not tendriliform 2
2. Leaves *3–4-whorled;* petioles with a thick broad saucer-like axillary gland; inflorescences axillary; ovary *more or less imbedded in receptacle (inferior) and capped with carnose tissue* at the depressed to slightly elevated apex, glabrous; clavuncle subcylindric, sometimes fringed at base with an obscure shallow membrane ..... *Couma*
2. Leaves opposite; ovary superior 3
3. Clavuncle not crested 4
4. Inflorescences terminal; clavuncle not densely hirsute 5
5. Principal secondaries widely spaced (over 5 mm. apart) and of varying prominence; corolla-tube less than 1.5 cm. long; corolla-lobes not ciliate; stamens inserted near middle of corolla-tube; ovary closely pubescent; style less than 0.5 cm. long; clavuncle pyriform, apparently glabrous ..... *Parahancornia*
5. Principal secondaries very close (averaging 1–2 mm. apart); corolla-tube more than 2 cm. long; corolla-lobes ciliate; stamens inserted near throat of corolla-tube; style more than 1 cm. long; clavuncle cylindric, *bearded with circle of hairs at base and summit* ..... *Hancornia*
4. Inflorescences axillary; clavuncle *densely lanate-hirsute;* secondaries on upper surface of leaves typically depressed, the tertiaries on under surface generally finely raised; calyx-lobes almost always minutely ciliate; fruits globose to spheroid, 1–4 cm. diam.; seeds one or two ..... *Lacmellea*
3. Clavuncle *flabellate-crested, with ring at base;* stamens inserted below middle of corolla-tube; seeds very numerous 5
5. Inflorescences terminal or axillary; calyx-lobes *not ciliate;* corolla glabrous outside, the lobes not ciliate; ovary glabrous ..... *Ambelania*
5. Inflorescences terminal; calyx-lobes ciliate; corolla more or less pubescent outside, the lobes ciliate; ovary *apocarpous* but appearing as one, quadrate, truncate-depressed at apex, densely pubescent; style 0.3–1 mm. long. (Properly *Tabernaemontanae*) ..... *Macoubea*

Supplementary Citations and Remarks on the American Members of Carisseae

Landolphia Pal. de Beauv. (Lloydia **8**: 300–312. 1945.)

Landolphia guianensis (Aubl.) Pulle. (L. c. 310.)

Specimen examined.—French Guiana: *F. Geay 1878* (P).

This specimen is sterile. The leaves bear a very close similarity to those of *L. boliviensis*. They are obtuse or acutish at base.

LANDOLPHIA PARAËNSIS Hub. (L. c. 311.)

Additional specimen examined.—Brazil, Pará: *Ducke 21595* (Rio Anauerapucu infer. prope Mazagão; May, fl.; S.)

LACMELLEA Karst. (Lloydia **7**: 275–302. 1944.)

LACMELLEA STANDLEYI (Woodson) Monachino. (L. c. 285.)

Additional illustrations.—Bull. Torr. Club **65**. 1938: fig. 66–70 (p. 157), vascular anatomy of the gynoecium; fig. 10 (p. 141), diagram of calyx anatomy.

Additional specimen examined.—British Honduras: *Gentle s.n.* (*Kr. Herb. 18419*).

LACMELLEA PANAMENSIS (Woodson) Monachino. (L. c. 286.)

Additional specimen examined.—Colombia, Choco: *Killip & Cuatrecasas 39155* (banks of Quebrada Togoroma; June, fr.).

This is the first record of the species from Colombia. It is reported to be a tree 10 m. high, growing in dense tidal forest. Flowers are necessary to distinguish it with certainty from *L. edulis* and *L. armata*.

LACMELLEA EDULIS Karst. (L. c. 287.)

Additional specimen examined.—Colombia, Bogotá: *Triana s.n.* (Villavicencio, 400 m.; P).

The specimen is sterile. It was collected probably in the general vicinity of the type locality of the species. Local name: Leche Miel.

LACMELLEA LACTESCENS (Kuhlm.) Monachino. (L. c. 288.)

Additional specimens examined.—Brazil, terr. Acre: *Kuhlmann 22408* (Rio Abunan; Oct., fl.; P, S). Peru, Loreto: *Bliss 12849/234* (Iquitos).

The local name noted for *Bliss 12849/234* is *Tananqueira Preta*.

LACMELLEA ACULEATA (Ducke) Monachino. (L. c. 292.)

Additional specimens examined.—French Guiana: *Benoist 1321* (P); *Leprieur s.n.* (year 1838; P); *Martin s.n.* (P); *Poiteau s.n.* (P); *Wachenheim 013* & *286* & *315* & *474* (P).

Mature flowers are present in *Wachenheim 315* & *474*. The corolla-tubes are about 3.7 cm. long; corolla-lobes 7 mm. long and 4 mm. broad; anthers 7.5 mm. long; style up to woolly part 9 mm. long, the woolly portion 1.3 mm. long, the apical branches 1.1 mm. long. The remaining specimens are either sterile, with young fruits, or with flower-buds only. *Wachenheim 223*, previously identified on basis of its vegetative characters as *L. guyanensis* (L. c. 295), apparently also belongs with this series. The examination of these specimens from French Guiana throws strong suspicion upon the specific distinction between *L. aculeata* and *L. guyanensis*. *L. guyanensis* was described as having a corolla 15 mm. long. It was noted as contrasting with *L. floribunda* in its much smaller flowers: "floribus plus quam duplo minoribus distincta." The stigmatic branches were described as being half

the length of the style: "cruribus stigmatis stylum dimidium aequantibus." These floral proportions are found in 15 mm. long buds of *L. aculeata*, for the style lengthens only with maturity. In very young flower-buds the styles are not developed, while the stigmatic parts are almost full length. The leaves in the series of French Guiana plants studied vary from typical *L. aculeata* to individual ones closely approaching the description of those of *L. guyanensis*. The leaf-blades of *Leprieur s.n.* cited above are much smaller than in usual *L. aculeata* but the secondaries are of about 12 pairs. (In *L. guyanensis:* "secundarii distantes, utroque latere circ. 6–8.") In *Poiteau s.n.* the flower-buds reach up to 15 mm. long but the leaves are typically like those of *L. aculeata*. It is not possible to define with assurance the specific distinctions between *L. guyanensis* and *L. aculeata*, or place the former in its precise taxonomic position, without study of the type specimen of *L. guyanensis* ("*Poiteau* in hb. Petropal.")

LACMELLEA MICROCARPA (Muell. Arg.) Monachino. (L. c. 295.)

Additional specimen examined.—Venezuela, Amazonas: *L. Williams 14937* (Caño Pimichín, Rio Guainia; US).

LACMELLEA DENSIFOLIATA (Ducke) Monachino. (L. c. 296.)

Specimen examined.—Brazil, Pará: *Ducke 17455* (type coll.; S).

The corolla-lobes are longer than in *L. arborescens* (up to 4 mm. long) and glabrous.

LACMELLEA ARBORESCENS (Muell. Arg.) Monachino. (L. c. 297.)

Additional specimens examined.—Brazil, Pará: *Kuhlmann 3652* (Bôa Vista; June, fl.; S); *Spruce 679* (cotype coll. *Zshokkea monosperma;* May, fl.; NY, P). Brazil, Amazonas: *Spruce 1001* (cotype coll.; Dec.-Mar., fl.; NY).

LACMELLEA GRACILIS (Muell. Arg.) Monachino. (L. c. 300).

Additional specimens examined.—Brazil, Amazonas: *Ducke 1423* (Manáos; Nov., fl.); *Spruce 1275* (Manáos; P), *3841* (Manáos; 1855–6; S), *1000* (cotype; NY).

There are two sheets of *Spruce 3841* at the Stockholm museum, one with flowers, the other with young fruits. The label on the flowering specimen reads: "prope Tarapoto Peruviae orientalis," that on the latter: "Barra." The Spruce cotype is from "in vicinia Barra do Rio Negro." Recent collections of the species by Ducke from Manáos suggest the correct locality for *Spruce 3841* is Barra (=Manáos).

COUMA Aubl. (Lloydia **6**: 231–240. 1943.)

COUMA MACROCARPA Barb. Rodr. (L. c. 234.)

Additional specimens examined.—Brazil, Amazonas: *Azevedo 2080/952; J. T. Baldwin Jr. 3655* (US); *Bliss s.n.* (Cult.); *Ducke 22405* (July, fls.; US); *Walter Lewin s.n.* (*Kr. Herb. 2023/49*), *s.n.* (*Kr. Herb. 2024/50*). Brazil, Pará: *Ducke 17463* (Bella Vista; Aug., fls.; S, US), *21695* (Juruty Velho; July, fls.; S, US); *Le Cointe 8682* & *16013* (Obidos; Jan., fls.; S & US). Venezuela: *L. Williams 14569* (San Carlos de Rio Negro). Colombia: *R. W. Crosse 12810* (Rio Quito, upper Atrato

Rv., Chocó); *Cuatrecasas 13975* (Puerto Merizalde, Rio Naya, dept. Calle); *De Freitas 12802/1–12805/4* (near Santa Margarita, Nechi Rv.); *J. C. Treadwell s.n.* (Quibdo; US); *Pedro Lopez 12813* (Rio Tamana, affluent of Rio San Juan, Chocó); *J. J. Triana s.n.* (US); *Wesselhoeft 12745* (Querari Rv. area). Peru, Loreto: *Bliss 12848/235* (Iquitos). Panama: Blair *2064* (Rio Indio, prov. Colon, Atlantic slope). Guatemala: *Jean Macho 12840/2* (Entre Rios, Izabal); *Morales R. 737* (Dept. Zacapa, San Agustin Acasaguastlán); *Standley 25100* (Dept. Izabal, vicinity of Puerto Barrios).

The *Bliss* collection is of seedling leaves infected with Pestalozzia. The plant had been grown indoors in Manáos.

Local names.—The following regional names for "Perillo" (i.e., *C. macrocarpa*) in Colombia are reported by R. W. Crosse: *Juansoco* (Vaupés, Caqueta, Putumayo), *Lirio* (Atrato basin), *Pera* (Bahia Solano area of the Pacific coast), *Perilla* (Nechi Rv. area), *Popa* (Rio San Juan and Pacific coast in general). A specimen of *C. macrocarpa* from Venezuela (Amazonas, San Carlos de Rio Negro) is given the local name *Pendare;* one from Panama (Rio Indio, prov. of Colon), *Chingongo.*

It is reported in a recent survey that *C. macrocarpa* is found in the mountains of the Atlantic coast of Panama starting from Largartos Rv. and extending through the provinces of Colón, Veraguas, the southern part of Bocas del Toro, and also a small portion of Cocle. The local name of the plant in this region is Perillo or Pera. According to information received, Perillo was exploited to an extent of about 6 million pounds in this area during a period of two years about 16 years ago

De Freitas reports that the Perilleros of Colombia, both on the Pacific coast and in the Nechi Rv. area, generally discriminate between two kinds of *C. macrocarpa*, "Black Perillo" and "Red Perillo," and that some maintain there is a "White Perillo." Vouchers representing these color forms of Perillo examined by me are not botanically distinguishable. However, it should be stressed that subspecific entities of taxonomic value are probably present in *C. macrocarpa*, and it is anticipated that this will eventually be demonstrable when long series of adequate collections from the vast area of distribution of the species is accumulated.

COUMA GUIANENSIS Aubl. (L. c. 235.)

Additional specimens examined.—Brazil, Pará: *Ducke 17327* (Belém; June, fls.; US); *P. Dusen s.n.* (Belém; Ap., fls.; US); *Huber 1280* (Belém; Aug., fls.; US), French Guiana: *Benoist 1543* (Gourdonville; P); *Melinon 526* (P), *s.n.* (year 1863; P), *s.n.* (year 1865; Maroni; P); *Perrottet s.n.* (year 1820; P); *Sagot 808* (Karouany; P, S); *Vaillant s.n.* (P). Dutch Guiana: *Forest Bureau 5382* (Sectie O; US); *Kappler 1985* (Marowyne Rv.; P).

See previous comments (L. c. 236) on the different appearances presented by the Pará and the Guianas plants.

James Collins (Report on the Caoutchouc of Commerce, p. 24. 1872) refers to a Couma as "C. *triphylla*, Aubl." The specific name was derived from *Cerbera triphylla* Rudge, which is a synonym of *Couma guianensis* Aubl.

COUMA CATINGAE Ducke. (L. c. 236.)

Additional specimen examined.—Brazil, Amazonas, upper Rio Negro, municip. Sta. Izabel: *Krukoff 12134* (Carueira on Rio Tea).

COUMA UTILIS (Mart.) Muell. Arg. (L. c. 237.)

Additional specimens examined.—Brazil, Amazonas: *Kuhlmann 2901* (Feb., fls.; US). Brazil, Pará: *Ducke 3687* (Obidos; July, fls.; US).

COUMA RIGIDA Muell. Arg. (L. c. 238.)

Additional specimens examined.—Brazil, Bahia: *Froes 2002* (Olivença), *2006* (Cumamú), *12736* (Bom Gosto; Mar., fls.); *Piraja da Silva 21696* (Nazareth; fls.; S, US). Venezuela, Bolivar: *Enrique Duarte 12798/3* (Gran Sabana, zona Kavanayen). British Guiana: *Maguire & Fanshawe 23232* (Kaieteur Plateau).

The specimens from British Guiana and Venezuela conform with *Tate 732* from Mt. Duida (see my discussion in Lloydia **6**: 239. 1943). With these interesting collections, a sizable distribution-range of the species in the savanna-plateau area of the two countries is established. Unfortunately both numbers, like *Tate 732*, are of sterile material and consequently their identity with the Bahia plants must still remain somewhat dubious. Vegetatively they display hardly any difference from the Macuge; leaves 10–27 cm. long and 5.5–13 cm. broad, rounded or sometimes short-acuminate at apex, the secondaries up to 20 pairs (usually 15); fruits up to 5.5 cm. diam.

HANCORNIA Gomes. (Lilloa **11**: 19–48. 1945.)

HANCORNIA SPECIOSA Gomes. (L. c. 31.)

Additional specimen examined.—Brazil, Minas Geraes: *Glaziou 12947* (Approaching var. *Lundii;* S. João d'El Rei; Mar., fls.; P).

PARAHANCORNIA Ducke. (Lloydia **6**: 240–247. 1943.)

PARAHANCORNIA AMAPA (Huber) Ducke. (L. c. 241.)

Additional specimens examined.—Brazil, Amazonas: *Ducke 22403* (Manáos, Igarape da Cachoeira Grande; US). Brazil, Pará: *Capucho 540* (Bóa Vista; Feb., fr.; F); *Ducke 1237* (Belém ex insulis Breves, Aramá, in hort. Mus. a J. Huber anno 1900 intro.; June, fls.; US), *11497* (Obidos; US), *17235* (Almeirim; Aug., fls.; US), *17460* (Bragança; July, fls.; P, US). French Guiana: *Benoist 1319* (P); *Wachenheim 116* & *224* & *375* (P). Dutch Guiana: *Forest Bureau 2592* (Sectie O; Jan., frs.; US). British Guiana: *For. Dept. Brit. Guiana 2306* (Mazaruni Station; Aug., fls.; B).

Local name.—Brazil, Pará: *Pau de Leite.*

PARAHANCORNIA AMARA (Mgf.) Monachino. (L. c. 243.)

Additional specimens examined.—Brazil, Amazonas: *Ducke 22424* (type coll.; June, fl.; P, S).

PARAHANCORNIA OBLONGA (Benth.) Monachino. (L. c. 243.)

Local name.—Brazil, Amazonas: *Tururirana* (São Gabriel).

PARAHANCORNIA NEGROENSIS Monachino. (L. c. 244.)

Additional specimens examined.—Brazil, Amazonas: *Ducke 30114* (Rio Negro, Santa Izabel, Quatia; Dec., fls.; S, US).

Corolla-tube about 13 mm. long; corolla-lobes about 13 mm. long and 2.5–3 mm. broad, twisted to the left in bud (viewed externally), spreading at maturity, sparsely ciliate; style up to clavuncle about 3 mm. long.

AMBELANIA Aubl. (Lloydia **8**: 109–130. 1945.)

AMBELANIA ACIDA Aubl. (L. c. 117.)

Additional specimens examined.—French Guiana: *Melinon 14* (Maroni; P), *s.n.* (Mana; P); *L. C. Richard s.n.* (P); *Sagot 393* (Cotype coll. A. *Sagoti;* Brx, P, S); *Wachenheim 403* (P).

AMBELANIA MARKGRAFIANA Monachino (L. c. 122.)

Additionl specimen examined.—Brazil, Amazonas: *Ducke 22418* (type coll.; S).

AMBELANIA QUADRANGULARIS Muell. Arg. (L. c. 124.)

Additional specimen examined.—Venezuela, Amazonas: *Spruce 3026* (type coll.; Brx, P).

AMBELANIA ZSCHOKKEIFORMIS Markgraf. (L.c. 125.)

Additional specimen examined.—Brazil, Amazonas: *Ducke 22421* (type coll.; S).

AMBELANIA LAXA (Benth.) Muell Arg. (L. c. 126.)

Additional illustration.—Webber, I. E. The wood of Ambelania laxa Muell. Arg. Lilloa. Vol. 11. 1945. Pp. 49–53. Pl. 1, cross section of wood; tangential & radial sections of xylem. Pl. 2, cross & radial sections through a leaf scar; tangential section of xylem; tracheids; parenchyma strand; vessel members.

AMBELANIA MACROPHYLLA Muell. Arg.

Specimen examined.—Brazil, Amazonas: *Spruce 2483* (type coll.; Brx, P.)

Leaves with numerous close lateral nerves, the principal secondaries about 60 pairs with an average distance of 2–3 mm. apart near middle; calyx (not mature) about 3 mm. diam. below lobes; anthers 5 mm. long.

MACOUBEA Aubl. (Lloydia **8**: 291–300, 315–316. 1945.)

See citation under Excluded Genera.

MACOUBEA GUIANENSIS Aubl. (L. c. 297.)

Additional specimens examined.Brazil, Bahia: *Blanchet 2336* (Cotype coll. *Tabernaemontana reticulata;* NY). French Guiana: *Wachenheim 195* & *238* (P). Venezuela, Delta Amacuro Ter.: *Enrique Duarte 12809* (opposite Curiapo, Rio Orinoco).

Local names.—Venezuela: *Amio* or *Amiobo* (Curiapo).

Species of Carisseae cultivated in America, other than in genera previously revised:

Acokanthera spectabilis (Sonder.) Hook. f. and *A. venenata* G. Don (cult. outdoors in Fla. & Calif.—Bailey's Cyclo.; the former, in St. Thomas in

the West Indies, and in the conservatories of the N. Y. Bot. Gd. and Nat. Bot. Gd.).

Carissa acuminata A. DC., *C. Arduina* Lam. (Royal Bot. Gd. in Trinidad.—H. Prestoe), *C. Carandas* L. (Jard. Bot. Saint-Pierre,—Duss; Royal Bot. Gd.,—Prestoe), *C. edulis* Vahl (Jard. Bot São Paulo,—Hoehne), *C. grandiflora* A. DC. (Florida,—Moldenke, Snyder), *C. ovata* R. Br., *C. spinarum* L. (Puerto Rico.—Cobin). (All these species of Carissa appear in Bailey's Cyclo.)

Clitandra Stapfiana A. Chev. (Trinidad,—see discussion under Excuded Genera).

Excluded Genera

Carissa L. *C. verticillata* Sessé & Moc. La Naturaleza, ser. 2, **1**: 29. 1888. (Plantae Novae Hispaniae). "Arbor quindecimpedalis inelegans. Folia terna lineari-lanceolata, transverse venosa glabra, breviter petiolata. Racemi terminales compositi. Flores decolores inodori. Habitat in Mazatlani montibus. Floret Julio." The description appears also in the second edition (1893) of Plantae Novae Hispaniae, but is missing from Sessé & Mociño's Flora Mexicana (1891–1897). The species was figured in Fl. Mex. Ic. 263, but no tracing of the original illustration is found in A. De Candolle's Dessins de la Flore du Mexique. It is very unlikely that the species represents a member of the Carisseae, or that the genus Carissa[2] is indigenous to the New World.

Clitandra Benth. *C. Stapfiana* A. Chev., Bull. Soc. Bot. Fr. **55** (Mém. 8b): 43. 1908. This species was described from a plant "cultivé au Jardin botanique de la Trinidad (Herb. Kew)." Chevalier remarked that it probably originated from tropical Africa. The single reference made to this plant in Thiselton-Dyer's Flora of Tropical Africa (**4**: 61. 1902) is a note under the description of Clitandra: "15 species, endemic, except 1 in Trinidad (indigenous?)." No name or description is given for it in the treatment. The questionable Trinidad distribution for the genus also appears in Dalla Torre & Harms' Genera Siphonogamarum (**6**: 405. 1904). The species is cited as "Clitandra, sp.?" on page 36 of J. H. Hart's Herbarium List of the Plants in the Botanical Department, Trinidad (1908). Hutchinson & Dalziel, Flora of West Tropical Africa (**2**: 34. 1931), state concerning *C. Stapfiana*: "Known only from a specimen cultivated in the Botanic Garden, Trinidad, supposed to be of West Tropical African origin." A specimen of this species labeled "Flora of Trinidad. Botanic Garden Herbarium. No. 3678" and deposited in the U. S. Nat. Herb. was examined by me. It is highly improbable that Clitandra is indigenous to America.

Coupoui Aubl., Pl. Guian. **2** (Suppl.): 16. Pl. 377. 1775. This genus was founded by Aublet on a flowerless specimen, and no botanical affinity was

[2] See remarks on *Carissa speciosa* (Gomes) St. Hil. in Monachino, A Revision of Hancornia.

suggested for it. Rafinesque (Princip. Fond. Somiologie 29. 1814) thought best to Latinize Aublet's name to Cupuia. A. De Candolle (Prod. **3**: 295. 1828) placed Coupoui in "Myrtaceae dubiae;" Endlicher (Gen. Pl. 1234. 1836–1840) and Lindley (Veg. King. 755. 1846) doubtfully in section Barringtoniae of the Myrtaceae. Listing the genus under this section. Schomburgk (Reisen 1023. 1848) reported it from British Guiana. Bentham (Gen. Pl. **1**: 696. 1865) noted that a flowering specimen collected by Martin, belonging to the Rubiaceae, matched in foliage that illustrated for Coupoui. Miers (Apocyn. S. Am. 15. 1878) stated: "Its true place, however, is unquestionably in *Apocynaceae*, as I have ascertained by flowering specimens of the same plant collected in Cayenne by Martin." He referred it to the tribe Carisseae (loc. cit. 6), and presented a detailed illustration of the Martin plant. Coupoui, Miers feared, might be confounded with Couepia, Goupia and Cupia, so he proceeded to create the name Cupirana for the genus. In this matter of nomenclature, Kuntze (Rev. Gen. Pl. **2**: 414. 1891) re-adopted Rafinesque's Cupuia, citing it under Apocynaceae. Baillon (Hist. Pl. **10**: 176. 1891) restored the original name Coupoui, including the genus with question among the "Arduineae," merely on the strength of Miers' treatment. Whereas Schumann (Engl. & Prantl Pflanzenf. **4**(2): 132–133. 1895), like Bentham, inclined to regard the genus as a member of the Rubiaceae, Stone (Ann. Mus. Col. Mars. 3e Sér. **6**: 50. 1918) placed it in the Apocynaceae tribe Carisseae. Hallier (Med. Rij. Herb. Leid. **35**: 22. 1918) remarked on how Coupoui, as figured, differs from Terminalia, and pointed out the justification of Schumann's view in regarding as a member of the Rubiaceae. Coupoui is obviously not a member of the Apocynaceae. For a detailed account of the genus see H. F. Wernham, Tropical American Rubiaceae.—XIII. (Journ. Bot. **58**: 105–108. 1920). James Ladbrook, in the July issue of the same Journal (pp. 176–177), supports Wernham's disposition of Coupoui in Rubiaceae.

MACOUBEA Aubl. (See Lloydia **8**: 291–296. 1945.)

MAYCOCKIA A. DC., Prod. **8**: 324. 1844. The genus was proposed in the subtribe Eucarisseae of the tribe Carisseae. The type species of Maycockia was examined by Mueller who placed the genus in synonymy of Condylocarpon (Mart. Fl. Bras. **6** (1): 63. 1860), a disposition which has been universally accepted.

POMPHIDEA Miers, Apocyn. S. Am. 18. Pl. 1 D. 1878. This genus was based on a plant collected by Swartz in Jamaica and deposited in the British Museum Herbarium. Miers proposed it in the apocynaceous tribe Carisseae; he remarked that "its floral structure, in many points, approaches that of *Ambellania*." Baillon, in Histoire de Plantes, also referred it to the Carisseae ("Arduineae"). Urban (Symb. Ant. **6**: 96. 1909) placed Pomphidea correctly in the Rutaceae, a disposition confirmed by Gilg in

his structural study of the leaf and branch fragments of the type. Fawcett and Rendle (Journ. Bot. **55**: 38. 1917) referred it to Ravenia, noting (Flora of Jamaica **4**: 170. 1920): "The examination of Swartz's specimen on which Miers founded the genus *Pomphidea*, of which it is the only representative, shows conclusively that it is a species of *Ravenia*."

ERRATA

(Code numbers to publications are as in Index below)

Publication	Page	Line	Error	Correction
1	234	9 from bottom	*oapida*	*sapida*
3	112	1 from bottom	Abelania	Ambelania
3	118	15 from top	type coll.	cotype coll of *A. Sagoti*
3	129	9 from top	distinction	distribution
3	130	1 from top	1838	1837
4	24	2 from bottom	in	is
4	25	4 from top	dischasial	dichasial
4	25	7 from top	*calix*	*calyx*
4	27	11 from top	"Mangaba"	"Mangabiba"
4	27	16 from bottom	*Hanconia*	*Hancornia*
4	27	12 from bottom	than	that
4	38	14 from bottom	variety	variety of
4	45	23 from top	Arvik	Arkiv
5	299	17 from top	but from	from
5	305	2 from top	Castelloa	Castilloa
5	316	19 from bottom	1838	1837

ADDENDA

Publication	Page	Following Line	Insert
4	41	17 from bottom	HANCORNIA LAXA A.DC., Prodr. **8**: 326. 1844. = *Ambelania laxa* (Benth.) Muell. Arg.
5	297	16 from top	*Macoubea reticulata* Mgf., Notiz. Bot. Gart. Mus. Ber.-Dah. **14** (122): 178. 1938.

INDEX

In the following index to the more important scientific and vernacular names appearing in the author's serial publications on the American genera of the Carisseae the journals in which the references appear are given these code numbers:

1.—Lloydia **6.** 1943. A Revision of Couma and Parahancornia.
2.—Lloydia **7.** 1944. A Revision of Lacmellea, and the Transfer of Zschokkea.
3.—Lloydia **8.** 1945. A Revision of Ambelania, Inclusive of Neocouma.
4.—Lilloa **11.** 1945. A Revision of Hancornia.
5.—Lloydia **8.** 1945. A Revision of Macoubea and the American Species of Landolphia.
6.—Lloydia [present paper]. A Résumé of the American Carrisseae.

The page number follows the colon; e.g. "*3:* 113" signifies page 113 in journal number *3* cited above. Pagination is omitted from references to the present paper (Code number *6*).

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The Australian Blue Gum (Eucalyptus globulus Labill.) in Ecuador

IRA L. WIGGINS
(Dudley Herbarium, Stanford University, Calif.)

Great areas of the inter-Andean valley in Ecuador are high, wind-swept páramo, where only grasses, various tundra plants, and scattered low shrubs cover the terrain. Protected hillsides below the normal limits of the páramo, and gulches and canyons where native trees once grew, have long since been denuded of their forest growth until almost no native trees remain. When the common blue gum (*Eucalyptus globulus* Labill.) was introduced from Australia it found quick favor with the Ecuadoreans because it would grow well and rapidly almost anywhere from the northern to the southern boundaries of the country between elevations of from about 6,000 to 10,000 feet above sea level. Groves of the rapidly growing tree soon supplied many of the people's needs for lumber and firewood, and was less extensively planted as an ornamental and as a windbreak. It is in evidence from Tulcán to Loja at favorable elevations, except in a few arid regions where the rainfall is too scanty to support even this hardy tree.

It is grown on a few of the infrequent flat stretches, along roadsides, on steep hillsides, in rich loam and on sandy or ash-covered slopes, and along stream banks. It is planted as isolated trees, in single rows, in small groups, and in huge groves. Nearer the larger towns and the cities it is particularly abundant for there it usually provides the chief supply of firewood. It seems to be able to survive wide ranges in the amount of rainfall, doing well where the precipitation is as low as 25 or 30 centimeters per year and in other localities where the annual rainfall runs well up toward 200 centimeters annually. In none of the areas where it came under my observation was it subject to frost, except, possibly, at the higher levels where infrequent and irregular light frosts occur. In most regions the trees withstand the lashing of frequent, and occasionally severe, winds. It seemed to me that fewer of them succumb to the strain than do representatives of the same species in California. Severe damage in the way of broken limbs is even less frequent, doubtless owing to the general practice of lateral pruning.

In the larger groves the trees are set out in rows six to ten meters apart with the trees in each row separated by spaces of from 3 to 6 meters. The denser planting is commoner than the more open type. In roadside files of one or two rows the individual trees within a row were often planted as closely as two meters from one another, but three meters being a commoner distance between trees. Very little if any cultivation is given the trees, even during the period immediately following planting in the field,

but the stands obtained are remarkably uniform with very few missing trees in uncut stands. Irrigation may be resorted to in young plantings, but if so, I didn't see it being practiced. In a few plots where individual trees had been crowded excessively and the hillside was situated where the water supply was irregular and approaching the sub-desert conditions, there were a few gaps where trees had been unable to survive.

By the time a tree attains a height of forty to fifty feet, or sometimes at an even earlier age, lateral pruning is begun. Even trees growing in roadside files are pruned, the natives climbing the trunks and snicking the laterals until only a small, rounded crown is left at the top of the tree. It is not uncommon to see an isolated tree or a small group or a roadside planting, towering well toward a hundred feet, possibly higher, with no branches below the terminal fifteen or twenty feet. The prunings, plus slabs of bark, and even the leaves are carefully picked up and carried away for fuel. The thorough removal of all inflammable material results in a remarkably clean floor in the groves, although this practice is dictated by the urgent need for fuel rather than by greatly advanced concepts in silviculture. Few weeds grow under the gum trees where the latter are planted in groves, and the few that do are just about as spindly as their close relatives struggling for existence in similar situations in California. Nor do other crops, such as the cereal grains, potatoes, "horse" beans, and garden peas, grow successfully under or immediately adjacent to plantings of the Blue Gum. Where cultivated fields abut upon rows or groves of *Eucalyptus* the field crops begin to show the effects of the competition some fifteen to thirty meters from the bases of the trees, and each successively closer plant appears a trifle more depauperate than the previous one, until they cease to live at all in the immediate vicinity of the trees.

Natural reproduction by seed appears to be commoner in Ecuador than in those regions where the Blue Gum is common along the North American Pacific coast. Numerous thrifty seedlings were spontaneous about the margins of groves near Quito, Cayambe, Ibarra, Caldarón, Otovalo, and Atuntaqui. The seedlings were observed only in those areas where the rainfall is above 60 or 70 centimeters per year, and where the ground water is reasonably abundant even during the "dry" season. This reseeding does not constitute a menace of any magnitude to cultivated fields, however, for nowhere did I see any encroachment of *Eucalyptus* seedlings into cultivated soil or into heavily grazed pasture land—and all pasture land is heavily grazed. Stumps send up second growth suckers readily and this characteristic enhances the value of the tree to the natives for it makes replanting following harvesting unnecessary. Some stands had been cut a second time and were already producing a third growth of timber in some areas. Such a situation was observed near Latacunga, at Alangasí, and near Pillaro.

In some isolated roadside plantings trees of the Blue Gum have attained diameters of well over a meter, for example, near Ibarra on the road to Olmedo, but most of the timber is harvested while the trees are from 20 to 60 centimeters in diameter. The explanation given in answer to my question as to why the trees were cut while still of such slender girth was that after a tree had reached a diameter of about 40 to 50 centimeters, it took longer for each additional centimeter of diameter to accumulate and the deferment of the harvest was unprofitable. And besides that, what difference did it make if the boards were narrow instead of broad? If they were narrow, one used two boards instead of only one! The trunks are tall, straight and relatively free from knots owing to the practice of close planting and lateral pruning. A trunk 60 centimeters in diameter at the base and 25 meters long is not uncommon.

Many of the slender, clear logs are used just as they are cut, with little hewing and no sawing, for bridge timbers and for scaffold poles. Supports for scaffolds are, of course, much less than 60 centimeters in diameter, usually not over 15 or 20 centimeters in diameter at the base and often not more than five or six at the top of a fifteen meter pole. The bridge timbers are frequently hewed flat along the upper side before the planking is spiked in place. When the ends of such timbers are set in masonry in such a way that they are not subjected to continuous moisture, they last reasonably well. Several logs are usually used, the smaller ends resting on alternate sides of the span if the latter is over six or eight meters long.

Many of the logs are sawed into boards and planks, almost all of the sawing being done by hand with whipsaws, one man perched on top of the log, the other in a pit or below a trestle supporting one end of the log. The planks average about three centimeters in thickness as they come from the pits and range in width from 12 to 60 centimeters. Few of them are over three or four meters in length. After being sawed, the planks are stacked in tepee-like piles, covered with a few branches, and allowed to dry slowly. It is the intention of the sawyers to thereby avoid checking and excessive warping of the lumber, but their efforts are crowned with indifferent success. Sometimes the planks are piled loosely in horizontal layers five or six deep, the layers separated by small branches from the felled trees, and turned periodically to reduce warping. This method is more satisfactory in producing straighter, unchecked boards, but it entails more labor so is less commonly practiced than the other method.

When ready for marketing the planks are hauled into town on trucks if the grove is situated on a good road, or, which is more often, when no road suitable for a wheeled vehicle is available, the planks are lashed to burros in such a manner that two or three planks brush the little beast's ears on either side, and the after ends of the boards drag on the ground. Thus, one sees numerous planks with one end worn off at an angle where

they were scraped along over volcanic ash, the cobble stones, and through the mud! In still other instances, neither truck nor burros are available and the planks are carried into town on the backs of Indians, from one to four constituting a load.

All the small branches, the more slender apical part of the trunk, and the twigs and leaves are utilized for firewood. In the immediate vicinity of Quito, a city of approximately 100,000, only the basal logs of a tree are sawed into lumber, the rest of the tree going into firewood to cook the meals of the Quiteñans. Wood is rarely used to warm the houses, for Quito is the "land of perpetual spring." Actually, Quito, situated at an elevation of 9,300 feet has a climate that is invigorating during the early morning and evening, comfortably warm during the middle of the day if the sun is shining, and outright chilly at night! But wood is too precious to waste in heating houses; one puts on heavier clothing or goes to bed if he is cold!

The planks and boards are put to almost every use for which sawed lumber is used in our own country. It is used extensively for flooring, as finish lumber around windows and doors, in the manufacture of furniture and cabinets, and the poorer grades go into boxes, pack saddles, crating, and other such uses. The wood takes a good polish and has a pleasing grain. It varies in color from a light straw to a pale brown, the darker hues being the commoner. It is rather difficult to work owing to the peculiar wavy structure of the wood, but the native carpenters use sand paper, or a flattened piece of pumice to work over the more refractory spots, and thereby obtain a passably smooth surface even on some of the poorer grades and a beautiful sheen on the finer panels. It is used to a limited extent in making carved panels and cornerposts for pieces of heavy furniture, but for this purpose the wood is inferior to some of the native woods brought from the jungles on the western and eastern slopes of the cordillera.

The chief shortcomings of the Eucalyptus lumber is its tendency to warp, shrink and crack. If the logs were allowed to season for some time before being sawed, it is probable that this difficulty would be overcome or reduced, but a well seasoned log of Eucalyptus is very difficult to saw, so all logs intended for planks are sawed immediately after felling. This practice of sawing "green" logs in a country where kiln drying is unknown results in the use of lumber that is not even completely air dried, so furniture and interior finish work in which the Blue Gum lumber has been used almost invariably shrinks badly. In a bedroom I occupied for some weeks in Ibarra a very attractive clothes locker made of lumber cut from *Eucalyptus globulus* had recently been installed when I moved in. The doors were well finished and fit perfectly. Within a week they had shrunk until the blade of a moderately thick hunting knife could be slipped between the door and the casing. At the end of a month the shrinkage had progressed to such an extent that a pencil could be used instead of a knife

blade, and the locks on the doors no longer worked because the latch wouldn't even touch the metal catch! Floors made of Blue Gum lumber fit tightly at first—although the boards were not tongued and grooved—but within a few weeks cracks three to six millimeters wide opened up between the boards.

But with all of their disadvantages, *Eucalyptus* wood and lumber have been a beneficial addition to the Ecuadorean economy. For although millions upon millions of board feet of excellent hard woods grow in the jungles both the western and eastern slopes of the Andes, these slopes are separated from the intermontane valley by a high mountain range running along the western edge of the trough and a similar one along the eastern edge. To reach the forests the highland people would have to struggle through passes that run up to twelve or fourteen thousand feet and over indifferent roads. In fact, most of the passes boast of nothing more than mere trails, over which it is practically impossible to transport timber. The transportation problems involved are stupendous and have not as yet been solved. So the majority of the people are content to use locally produced Eucalyptus lumber that shrinks, splits, and warps. They burn Eucalyptus twigs, leaves,—and if in the upper of stratum of society—wood, for this is much better than twisted hanks of Ichu grass, arduously collected on the páramos and dried during the sunny portions of the day. Probably *Eucalyptus globulus* has entered Ecuador to stay.

New and Interesting Florida Fungi

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All the specimens cited in this paper are permanently deposited in the herbarium of the Florida Agricultural Experiment Station at Gainesville. The scientific names here used correspond to those used by me in "North American Flora." For those more familiar with Saccardo's nomenclature a list of equivalents is appended.

Clitocybe cortinarioides sp. nov.

Pileo convexo-depresso, 5.5 cm. lato, glabro, pallido; lamellis adnatis, confertis, violaceis; sporis ovoideis, levibus, albis, 5×3μ; stipite bulboso, violaceo, 3×0.5–0.7 cm.

Pileus convex to depressed, solitary, 5.5 cm. broad; surface dry, smooth, glabrous, pallid, margin even, entire; context thin, white, unchanging, odorless; lamellae adnate or slightly decurrent, inserted, narrow, crowded, entire, violet, fulvous after drying for some time; spores ovoid, smooth, hyaline, about 5×3μ; cystidia none; stipe equal above the bulbous base, finely fibrillose, smooth, pale-violet, shining, 3×0.5–0.7 cm.

Type collected by W. A. Murrill in a live-oak hammock at Gainesville, Fla., Jan. 1, 1940 (*F 20040*). Suggesting *C. violaceifolia* Murr., described from Oregon. The violet gills and stem remind one of certain species of *Cortinarius*.

Gymnopus atrigilvus sp. nov.

Pileo convexo-subexpanso, gregario, 3–4 cm. lato, glabro, grato; lamellis adnexis, subconfertis, subgilvis; sporis subellipsoideis, levibus, 7×3–4μ; stipite glabro, atrogilvo, 2.5–4×0.5–0.7 cm.

Pileus convex to subexpanded, usually broadly umbonate, gregarious, 3–4 cm. broad; surface smooth, glabrous, dark-isabelline, fading to isabelline, margin even, entire, browning in drying; context thin, soon isabelline, mild, with slightly anise odor; lamellae sinuate or adnexed, inserted, plane, broadest behind, rather close, medium broad, fragile, entire, dull-isabelline; spores subellipsoid, smooth, not amyloid, about 7×3–4μ; cystidia long, hair-like, thin-walled, hyaline, abundant on gill-edge; stipe equal or tapering downward, compressed, smooth, glabrous, concolorous, 2.5–4×0.5–0.7 cm.

Type collected by W. A. Murrill at the base of a loblolly pine in mixed woods in Gainesville, Fla., Aug. 1, 1944 (*F 38937*). In dried specimens the caps are fulvous and shining, the gills slightly tinged with dull-violet.

Gymnopus subabundans sp. nov.

Pileo 2 cm. lato, subcremeo, centro roseo-isabellino; lamellis adnexis; sporis levibus, hyalinis, 5.8–7×2–2.7μ; stipite roseo-isabellino, 4×0.2 cm.

Pileus convex to plane, solitary, 2 cm. broad; surface smooth, dry, glabrous, pale-cremeous, rosy-isabelline at the center, margin even, entire; lamellae adnexed, rounded behind, several times inserted, crowded, entire, white; spores, according to Singer, smooth, hyaline, 5.8–7×2–2.7μ; stipe with bulbous base, smooth, glabrous, rosy-isabelline, 4 cm. long, 2 mm. thick, bulb 5 mm.

Type collected by Erdman West and W. A. Murrill on the ground in oak woods at Gainesville, Fla., Nov. 12, 1932 (*F 9842*).

Gymnopus subconiceps sp. nov.

Pileo convexo-subexpanso, umbonato, gregario, 1 cm. lato, glabro, roseo-isabellino, disco fulvo; lamellis adnexis, confertis, pallidis; sporis ellipsoideis, levibus, 5–6×3–4μ; stipite aequali, badio, 3×0.05–0.1 cm.

Pileus convex to subexpanded with mammillate umbo, gregarious, about 1 cm. broad; surface dry, smooth, glabrous, rosy-isabelline, umbo fulvous, margin even, entire; context thin, white, unchanging, odorless; lamellae adnexed, plane, close, medium broad, pallid, fimbriate; spores ellipsoid, smooth, hyaline, 1-guttulate, not amyloid, 5–6×3–4μ; cystidia none; stipe equal, bay with white pulverulence, about 3×0.05–0.1 cm.

Type collected by W. A. Murrill on an open grassy lawn in Gainesville, Fla., Sept. 20, 1944, (*F 17452*). Small, shapely and attractive.

Gymnopus subfunicularis sp. nov.

Pileo convexo-expanso, umbonato, caespitoso, 5–6 cm. lato, glabro, roseo-isabellino, grato; lamellis adnexis, confertis, albis; sporis obovoideis, levibus, 7×3–4μ; stipite pruinoso, 5×0.4–0.6 cm.

Pileus convex to expanded, umbonate, cespitose, about 5–6 cm. broad; surface dry, glabrous, rosy-isabelline, the center darker, margin even, entire to undulate, often upturned with age; context membranous, white, odorless, mild; lamellae adnexed, narrow, close, inserted, white, entire; spores obovoid, smooth, white, about 7×3–4μ; cystidia none; stipe enlarged below, often twisted, pruinose to subglabrous, subconcolorous, about 5×0.4–0.6 cm.

Type collected by W. A. Murrill in dry oak-pine woods at Gainesville, Fla., Aug. 14, 1944 (*F 38949*). Suggesting *G. subluxurians* Murr. Frequent on shaded lawns in the vicinity in July and August.

Gymnopus subtortipes sp. nov.

Pileo 2 cm. lato, fulvo, centro fuligineo; lamellis latis, albis; sporis levibus, hyalinis, 7×2.7μ; stipite roseo-avellaneo, pulverulento, 3–5×0.2–0.3 cm.

Pileus convex, gregarious, 2 cm. broad; surface smooth, glabrous, moist, opaque, dull-fulvous, fuliginous on the disk, paler near the entire, even margin; lamellae adnate or slightly sinuate, inserted, broad, not crowded, entire, white; spores, according to Singer, smooth, hyaline, 7×2.7μ; stipe slender, subequal, not twisted, dry, dull-rosy-avellaneous, grayish-pulverulent, whitish-mycelioid below, about 3–5×0.2–0.3 cm.

Type collected by Erdman West and W. A. Murrill on dead wood in woods at Gainesville, Fla., Nov. 7, 1932 (*F 9869*). Also picked up by the same collectors among humus and dead sticks in woods (*F 9845*). A small, trim species suggesting *Marasmius urens* (Bull.) Fr.

Lepiota anomala sp. nov.

Pileo conico-subexpanso, umbonato, gregario, 1 cm. lato, sicco, isabellino, subsquamuloso, striato, grato; lamellis latis, albis, integris; sporis subglobosis, levibus, 5×4μ; stipite aequali, pallido, fibrilloso, 2–3×0.1 cm.; velo evanido.

Pileus conic to subexpanded, umbonate, gregarious, about 1 cm. broad; surface dry, isabelline, darker isabelline on the umbo, minutely squamulose, margin subentire, becoming broadly striate; context thin, white, unchanging, odorless, mild; lamellae broad, ventricose, white, close, entire, unchanging; spores subglobose or broadly ellipsoid, smooth, 1-guttulate, hyaline, about 5×4μ; cystidia none; stipe equal, pallid, fibrillose, about 2–3×0.1 cm.; veil white, scant, evanescent, leaving no annulus.

Type collected by W. A. Murrill on an open grassy lawn in Gainesville, Fla., Sept. 23, 1944 (*F 20099*). Having the appearance of a Lepiota except for the ring, which is represented by fragments of the delicate veil spread along the stem.

Lepiota citriniceps sp. nov.

Pileo convexo-expanso, umbonato, 1.5 cm. lato, citrino, subsquamuloso; lamellis liberis, confertis, albis; sporis ovoideis, levibus, 6×3μ; stipite clavato, glabro, albo, 4×0.15–0.3 cm.; annulo amplo, citrino.

Pileus convex to expanded with a broad flat umbo, solitary, 1.5 cm. broad; surface dry, minutely scaly, uniformly lemon-yellow, slightly radiate-rimose, margin subentire; context thin, white, unchanging; lamellae free, inserted, narrow, crowded, entire, white; spores pip-shaped, smooth, hyaline, about 6×3μ; cystidia none; stipe equal above the clavate base, smooth, glabrous, white, 4×0.15–0.3 cm.; annulus 2 cm. from apex, ample, fixed, lemon-yellow, persistent.

Type collected by W. A. Murrill on the ground in a high hammock at Gainesville, Fla., Sep. 25, 1944 (*F 2509*). A rare and very attractive little species related to *L. flavescens* Morg. and *L. subflavescens* Murr. When dried the cap and ring remain bright-yellow but the stem becomes blackish.

Lepiota cristatiformis sp. nov.

Pileo convexo-expanso, umbonato, caespitoso, 2–3 cm. lato, squamuloso, grato, disco badio; lamellis liberis, confertis, albis; sporis ellipsoideis, levibus, albis, 10×6μ; stipite clavato, testaceo, 4×0.2–0.5 cm.; annulo amplo, albo, dein testaceo.

Pileus convex to expanded with broad umbo, usually cespitose, 2–3 cm. broad; surface dry, white with small testaceous scales, disk bay, cuticle cracked radially, margin subentire; context thin, white, unchanging, odorless, mild; lamellae free, inserted, rounded behind, crowded, 3 mm. broad, slightly ventricose, white, finely fimbriate; spores ellipsoid, smooth, hyaline, about 10×6μ; cystidia none; stipe enlarged downward, clavate, hollow, fibrillose, scaly at base, pale and glabrous at apex, testaceous below, about 4×0.2–0.5 cm.; annulus apical or median, white to testaceous, fixed, ample.

Type collected by W. A. Murrill in a high hammock at Gainesville, Fla., July 20, 1944 (*F 16049*). Also by the author under a tung-oil tree in the vicinity on Mar. 27, 1944 (*F 15507*).

Lepiota gilvidisca sp. nov.

Pileo convexo-expanso, umbonato, 2 cm. lato, albo, subsquamuloso, grato, disco isabellino; lamellis latis, confertis, albis; sporis ellipsoideis, levibus, albis, 5–6×4–4.5μ; stipite aequali, albo, 3×0.15 cm.; annulo parvo, albo.

Pileus convex to expanded, umbonate, gregarious, 2 cm. broad; surface dry, white, with minute scales, umbo isabelline, smooth, margin even, entire; context pallid, unchanging, odorless, mild; lamellae free, broad, crowded, white, entire, isabelline when dry; spores broadly ellipsoid, smooth, white, 1-guttulate, 5–6×4–4.5μ; cystidia none; stipe equal, smooth, white, about 3×0.15 cm.; annulus 1 cm. from apex, fixed, small, white, unchanging, semipersistent.

Type collected by W. A. Murrill on a lawn partly shaded by oaks in Gainesville, Fla., July 5, 1944 (*F 10056*).

Lepiota pinicola sp. nov.

Pileo conico-campanulato, 2.5 cm. lato, striato, fulvo-squamuloso, disco fulvo, margine subintegro; lamellis liberis, albis, angustatis; sporis ovoideis, levibus, albis, 10×6μ; stipite clavato, glabro, albo, 3×0.1–2.2 cm.; annulo medio, albo, parvo.

Pileus conic to campanulate, solitary, 2.5 cm. broad; surface dry, white with minute fulvous scales, disk small, smooth, fulvous, margin paler, subentire, broadly striate; context thin, white, unchanging, odorless; lamellae free, narrow, close, white, unchanging, entire; spores ovoid, smooth, hyaline, 1-guttulate, about 10×6μ; cystidia none; stipe tapering upward

from a clavate base, smooth, glabrous, white, unchanging, about 3×0.1–0.2 cm.; annulus scant, white, persistent, fixed near the middle of the stipe.

Type collected by W. A. Murrill on a rotten pine log in mixed woods at Gainesville, Fla., Aug. 1, 1945 (*F 38913*). Suggesting *L. cretacea*(Bull.) Morg. Very rare.

Lepiota roseifulva sp. nov.

Pileo convexo-expanso, umbonato, 1–2 cm. lato, roseo-fulvo, squamuloso, excoriato; lamellis latis, subdistantibus, roseis; sporis ellipsoideis, levibus, albis, 6–7×4–5μ; stipite clavato, glabro, albido, 1.5–2×0.1–0.15 cm.; annulo demum roseo.

Pileus convex to expanded, mammillate, gregarious, 1–2 cm. broad; surface dry, rosy-fulvous, with few scales, umbo small and darker, margin even, entire, excoriate; context thin, odorless; lamellae free, broad, ventricose, rather distant, few inserted, entire, pink; spores ellipsoid, smooth, hyaline, 6–7×4–5μ; cystidia none; stipe equal above the clavate base, smooth, glabrous, whitish, the base reddish, 1.5–2×0.1–0.15 cm.; annulus superior, 5 mm. from apex, soon pink, fixed, collapsing.

Type collected by W. A. Murrill in an open high hammock at Gainesville, Fla., July 17, 1945 (*F 38933*).

Lepiota subrosea sp. nov.

Pileo umbonato, dein subdepresso, gregario, 1.5 cm. lato, grato, subsquamuloso, subroseo, disco atro-roseo-isabellino; lamellis latis, confertis, albis, dein subroseis; sporis ellipsoideis, levibus, albis, 6–7×4–5μ; stipite aequali, glabro, rubro-brunneo, 3.5×0.15 cm.; velo evanido, annulo nullo.

Pileus broadly umbonate, at length slightly depressed, gregarious, about 1.5 cm. broad; surface dry, finely squamulose, pale-rosy over white, umbo dark-rosy-isabelline, margin even, entire; context very thin, white, unchanging, odorless, mild; lamellae free, broad, ventricose, close, entire, white to pinkish; spores broadly ellipsoid, smooth, hyaline, 6–7×4–5μ; cystidia none; stipe equal, smooth, glabrous, shining, pale-reddish-brown to darker, about 3.5×0.15 cm.; veil scant, evanescent, leaving no annulus.

Type collected by W. A. Murrill in grass under frondose trees at Gainesville, Fla., Aug. 12, 1944 (*F 38907*). Rare.

Lepiota subroseifolia sp. nov.

Pileo convexo-subdepresso, gregario vel caespitoso, 2–2.5 cm. lato, isabellino, grato, striato, disco castaneo; lamellis subroseis, latis, confertis; sporis subellipsoideis, albis, 5–7×4–5μ; stipite aequali, glabro, rubrobrunneo, 3×0.1–0.15 cm.; annulo pallido, dein evanido.

Pileus convex to slightly depressed, gregarious to cespitose, 2–2.5 cm. broad; surface dry, dull-isabelline, castaneous at the center, margin striate,

subentire; context very thin, pallid, unchanging, mild, with pleasant odor; lamellae free, inserted, broad, ventricose, close, entire, pink; spores broadly subellipsoid, smooth, white, 5–7×4–5μ; cystidia none; stipe equal, smooth, glabrous, shining, reddish-brown, unchanging, about 3×0.1–0.15 cm.; annulus 1 cm. from apex, fixed, pallid, usually disappearing with age.

Type collected by W. A. Murrill in soil under a palm at Gainesville, Fla., Aug. 12, 1944 (*F 39023*).

Marasmius hemisphaericus sp. nov.

Pileo hemisphaerico, gregario, 3–4 mm. lato, subpruinoso, striato, pallido-isabellino, amaro; lamellis adnatis, latis, distantibus, albis; sporis ovoideis, levibus, 5×3μ; stipite aequali, fistuloso, tomentoso, albo umbrinoque, 2×0.05 cm.

Pileus hemispheric, gregarious, 3–4 mm. broad; surface finely pruinose, striate, dull, pale-isabelline, margin entire, paler; context membranous, isabelline, odorless, bitter; lamellae adnate, few inserted, broad, distant, entire, white, unchanging; spores ovoid, smooth, hyaline, scant, about 5×3μ; stipe equal, fistulose, white and finely pubescent at the apex, umbrinous and finely tomentose below, about 2 cm. long and 0.5 mm. or less thick.

Type collected by W. A. Murrill on open bare ground near short grass in Gainesville, Fla., June 18, 1944 (*F 38942*).

Marasmius multivenosus sp. nov.

Pileo convexo-subdepresso, caespitoso, 3 cm. lato, glabro, pallido, striato, anisato; lamellis adnexis, albis, distantibus, venoso-conjunctis; sporis ovoideis, levibus, 5×3μ; stipite glabro, albo et rubro-brunneo, 4–6×0.2–0.3 cm.

Pileus convex to plane or slightly depressed, cespitose, about 3 cm. broad; surface, dry, glabrous, dull, pallid, striate, margin thin, entire; context thin, white, mild, with anise odor; lamellae adnexed, narrow, distant, conspicuously interveined, entire, white; spores ovoid, smooth, hyaline 1-guttulate, not amyloid, about 5×3μ; stipe equal, smooth, glabrous, often compressed, white above, reddish-brown below, 4–6×0.2–0.3 cm.

Type collected by W. A. Murrill in leaf-mold beside a road through a high hammock in Gainesville, Fla., Aug. 3, 1944 (*F 38930*).

Marasmius pseudimpudicus sp. nov.

Pileo convexo-plano, 2.5–3 cm. lato, glabro, isabellino, subgrato; lamellis adnexis, confertis, pallidis; sporis levibus, 5–6×2–4μ; stipite aequali, subcastaneo, albopruinoso, 3–4×0.2–0.3 cm.

Pileus convex to plane, gregarious to subcespitose, 2.5–3 cm. broad; surface smooth, glabrous, dull, isabelline or dark-isabelline with fulvous disk,

margin even, entire to undulate, upturned with age; context very thin, isabelline, odorless, taste pleasant to slightly bitter; lamellae adnexed, inserted, narrow, close, entire to undulate, fragile, pallid to pale-rosy; spores elongate pip-shaped, smooth, white, about 5–6×2μ; cystidia none; stipe equal, hollow, smooth, latericious or chestnut with white pruinosity, becoming glabrous in part, 3–4×0.2–0.3 cm.

Type collected by W. A. Murrill on an open lawn in Gainesville, Fla., Aug. 8, 1944 (*F 38951*). Rare in the vicinity. Some American mycologists might refer this plant to *M. impudicus* Fr., which is very distinct.

Marasmius quercuum sp. nov.

Pileo convexo-subdepresso, gregario, 2–3 cm. lato, glabro, substriato, roseo-isabellino, grato; lamellis adnatis, confertis, pallidis; sporis ovoideis, levibus, 4×2μ; stipite roseo-isabellino, albo-pruinoso, 5×0.1–0.2 cm.

Pileus convex to saucer-shaped, gregarious, 2–3 cm. broad; surface dry, glabrous, lightly radiate-striate, rosy-isabelline, disk darker, margin splitting with age; context membranous, pallid, odorless, mild; lamellae adnate, inserted, close, narrow, pallid, fimbriate; spores pip-shaped, smooth, hyaline, about 4×2μ; cystidia none; stipe tapering downward, smooth, rosy-isabelline with white pruinosity, about 5×0.1–0.2 cm.

Type collected by W. A. Murrill on trash under a laurel oak in Gainesville, Fla., July 23, 1944 (*F 38924*). Near *Mycena marasmius* Murr. but distinct.

Marasmius subalbiceps sp. nov.

Pileo convexo-expanso, gregario, 5–8 mm. lato, glabro, albo, disco roseo-isabellino, grato; lamellis adnexis, distantibus, latis, albis; sporis ovoideis, levibus, 5×3μ; stipite pruinoso, albo nigroque, 1 cm. longo.

Pileus convex to expanded, gregarious, 5–8 mm. broad; surface glabrous, white, sulcate, disk rosy-isabelline, slightly umbilicate, margin very thin, entire; context membranous, white, odorless, mild; lamellae adnexed, rounded behind, inserted, distant, broad, ventricose, entire, white; spores pip-shaped, smooth, about 5×3μ; stipe equal, capillary, pruinose, white above, fuliginous to blackish below, about 1 cm. long.

Type collected on dead leaves under a laurel oak at Gainesville, Fla., July 2, 1944 (*F 38916*). Suggesting *M. albiceps* Pk. Rare in the vicinity.

Marasmius testaceiceps sp. nov.

Pileo convexo-plano, 1 cm. lato, rugoso, testaceo, grato; lamellis emarginatis, confertis, albis; sporis subfusoideis, hyalinis, levibus, about 10–12×3μ; stipite pallido, basi subtestaceo, pubescenti, 3–4×0.1 cm.

Pileus convex to plane, gregarious to cespitose, about 1 cm. broad; surface dry, rugose, testaceous with a slight bloom, margin entire, incurved when young; context membranous, testaceous, unchanging, odorless, mild;

lamellae emarginate, inserted, narrow, close, white, entire; spores copious, white, smooth, subfusoid; about 10–12×3μ; stipe slightly enlarged at apex, pallid, concolorous near base, with short dense pubescence, 3–4 cm. long, 1 mm. or less thick.

Type collected by W. A. Murrill in grass under a red maple in Gainesville, Fla., Aug. 11, 1944 (*F 38912*). Suggesting *M. bahamensis* in size and shape but the cap is testaceous instead of isabelline.

Melanoleuca piperatiformis sp. nov.

Pileo convexo-subexpanso, umbonato, 5 cm. lato, glabro, griseo; lamellis sinuatis, albis; sporis subglobosis, 4–5×3–4μ; stipite albo, glabro, 4–5×1–1.5 cm.

Pileus convex to nearly plane, broadly umbonate, gregarious, about 5 cm. broad; surface slightly viscid, smooth, glabrous, shining, uniformly gray, margin deflexed, undulate, even, fertile, concolorous; context firm, about 5 mm. thick, white, unchanging, mild, with odor of anise; lamellae sinuate, inserted, medium distant, about 5 mm. broad, thin, entire, white, unchanging; spores subglobose or broadly ovoid, smooth, hyaline, 1-guttulate, 4–5×3–4μ; stipe equal, smooth, glabrous, white, unchanging, with streaks as in asbestos, solid, 4–5×1–1.5 cm.

Type collected by W. A. Murrill in red-oak woods at Planera Hammock, eleven miles northwest of Gainesville, Fla., Dec. 10, 1941 (*F 18330*). Also collected by the author in dry oak-pine woods at Bronson, Levy Co., Fla. (*F 19645*). Suggesting *M. piperata* but mild and fragrant. Not *Lyophyllum australe* Singer.

Omphalina praerimosa sp. nov.

Pileo umbilicato, gregario, 1 cm. lato, subavellaneo, praerimoso, grato; lamellis distantibus, angustatis, albis; sporis obovoideis, levibus, 5×4μ; stipite aequali, albo, glabro, 1.5–2×0.1 cm.

Pileus umbilicate, not expanding, gregarious, about 1 cm. broad; surface pale-avellaneous, the cuticle radially cracked, margin deflexed, entire; context membranous, white, odorless, mild; lamellae long-decurrent, arcuate, distant, narrow, entire, white; spores broadly obovoid, smooth, hyaline, about 5×4μ; cystidia none; stipe equal, smooth, white, glabrous, with pruinose apex, about 1.5–2×0.1 cm.

Type collected by W. A. Murrill on a lawn under a frondose tree in Gainesville, Fla., Aug. 8, 1944 (*F 38917*). Suggesting *O. alachuana* Murr. but pileus rimose.

Omphalopsis paucifolia sp. nov.

Pileo umbilicato, 7 mm. lato, glabro, subavellaneo; lamellis latis, distantibus, pallidis; sporis globosis, 2μ; stipite pruinoso, atro-avellaneo, 2×0.05–0.1 cm.

Pileus depressed, solitary, 7 mm. broad; surface dry, smooth, glabrous, pale-avellaneous, margin even, entire, straight, slightly upturned on drying; context membranous, white, odorless; lamellae long-decurrent, few, broad, distant, pallid; spores globose, smooth, hyaline, about 2μ; cystidia none; stipe tapering downward, pruinose, dark-avellaneous, 2×0.05–0.1 cm.

Type collected by W. A. Murrill on a lawn near frondose trees in Gainesville, Fla., July 5, 1944 (*F 32833*). Very rare.

Omphalopsis subreclinis sp. nov.

Pileo praedepresso, 1.3 cm. lato, glabro, avellaneo; lamellis confertis, subavellaneis; sporis ovoideis, levibus, 6×4μ; stipite glabro, subavellaneo, 1.5×0.1 cm.

Pileus deeply infundibuliform, solitary, 1.3 cm. broad; surface dry, glabrous, avellaneous, margin straight, even, entire, radiate-rugose when dry; context membranous, avellaneous, odorless; lamellae decurrent, narrow, close, inserted, entire, pale-avellaneous; spores ovoid, smooth, hyaline, not amyloid, about 6×4μ; cystidia none; stipe equal, smooth, glabrous, pale-avellaneous, whitish-tomentose at the enlarged base, 1.5×0.1 cm.

Type collected by W. A. Murrill in a path through flatwoods near Santa Fé, Alachua Co., Fla., Nov. 3, 1940 (*F 21479*). Very rare.

Prunulus subepipterygius sp. nov.

Pileo convexo-depresso, 1–2 cm. lato, viscido, sulcato; sporis ellipsoideis, 5–6×3–4μ; cystidiis subcylindricis, 15–30×15μ; stipite albo, glabro, 1–3×0.1–0.2 cm.

Pileus convex to plane, depressed at the center, gregarious to cespitose, 1–2 cm. broad; surface slimy-viscid, smooth, glabrous, sulcate, white, umbrinous on the disk; context membranous, white; lamellae adnexed, narrow, tapering behind, medium distant, inserted, entire, white, unchanging; spores ellipsoid, smooth, hyaline, 1-guttulate, 5–6×3–4μ; cystidia subcylindric, smooth, hyaline, projecting 15–30×15μ, occupying the entire edge of the gill; stipe smooth, white, glabrous, viscid, ridged at the apex, 1–3×0.1–0.2 cm.

Type collected by West and Murrill on a hardwood log in Planera Hammock, eleven miles northwest of Gainesville, Fla., July 20, 1938 (*F 18363*). Also collected at the same place by West, Arnold and Murrill on an oak log, July 21, 1938 (*F 17910*). Evidently near *P. epipterygius* (Scop.) Murr. but having a shorter stem and smaller spores.

Singer considers this identical with his *Mycena chlorinosma* but Smith says he is wrong. These species even differ in the size and amyloid character of the spores.

RUSSULA SUBCYANOXANTHA Murr. f. **olivacea** f. nov.

Pileo convexo-depresso, 5–8 cm. lato, olivaceo, sapore grato; sporis globosis, cremeis, 6–8μ; stipite albo, 3–5×1–1.5 cm.

Pileus convex to depressed, 5–8 cm. broad; surface olive-green, often slightly darker in the center, margin striate, peeling; spores 6–8μ; stipe white, slightly pinkish at times, 3–5×1–1.5 cm.

Type collected by West and Murrill on the ground under hardwood trees in Planera Hammock, eleven miles northwest of Gainesville, Fla., July 20, 1938 (*F 17258*). Also collected at other places in and near Gainesville (*F 17701, F 17263, F 17938*). Although resembling *R. variata* somewhat in color, it is smaller, with much rougher spores.

Venenarius roanokensis (Coker), f. **inodora** f. nov.

A typo inodoro recedit.

This form is common about Gainesville under evergreen oaks and seems to differ from the typical form only in the lack of odor. Type of form collected by W. A. Murrill under live-oak in Gainesville, Fla., Aug. 29, 1944 (*F 20091*). Spores of this type specimen measure 12–14×3–3.5μ.

Eccilia heterospora sp. nov.

Pileo convexo, umbilicato, 2–3 cm. lato, glabro, pallido; lamellis confertis, angustatis, subdecurrentibus; sporis globosis, levibus, 5μ; stipite pallido, 2–2.5×0.2–0.3 cm.

Pileus convex, umbilicate, gregarious, 2–3 cm. broad; surface dry, smooth, glabrous, pallid, margin even, scalloped; context thin, white, odorless; lamellae slightly decurrent, tapering behind, narrow, crowded, entire, pallid to discolored; spores globose, smooth, 1-guttulate, about 5μ; cystidia none; stipe subequal, tomentose below, pallid, about 2–2.5×0.2–0.3 cm.

Type collected by W. A. Murrill on an open grassy lawn in Gainesville, Fla., Aug. 8, 1944 (*F 38908*). Suggesting omphalia but having pink spores, not at all angular, each with a large gutta that looks like a pearl. In *E. mordax* Atk. the spores are not angular but ovoid, 6–7×4–5μ.

Entoloma sublucidum sp. nov.

Pileo convexo-plano, 4–5 cm. lato, glabro, avellaneo, farinaceo; lamellis praelatis, adnexis, integris; sporis angulatis, 10μ; stipite avellaneo, glabro, 2–7×0.5–1 cm.

Pileus convex to plane with conic umbo in younger stages, scattered, 4–5 cm. broad; surface smooth, glabrous, subshining, avellaneous with umbrinous tint, disk dark-avellaneous, margin even, entire; context membranous, dull-whitish, odorless, taste very farinaceous; lamellae adnexed, 1 cm. broad, rounded behind, medium distant, pallid, entire; spores globose in outline, very angular, 1-guttulate, about 10μ; cystidia none; stipe equal

above enlarged base, hollow, avellaneous, glabrous, grooved lengthwise, 5–7×0.5–1 cm.

Type collected by W. A. Murrill in leaf-mold in a high hammock 10 mi. northwest of Gainesville, Fla., Feb. 18, 1945 (*F 19396*). Related to *E. Grayanum* (Pk.) Sacc. and *E. subcostatum* Atk. A very strict species with remarkably thin context and broad gills. The dried specimens are even more shining than the fresh ones.

Leptoniella australis sp. nov.

Pileo convexo-subexpanso, umbilicato, 1–1.5 cm. lato, subhispido, livido, grato; lamellis adnatis, distantibus; sporis angulatis, 10×6μ; stipite glabro, lilacino, 3×0.15–0.2 cm.

Pileus convex to subexpanded, slightly umbilicate, gregarious to subexpanded, 1–1.5 cm. broad; surface dry, very slightly hispid and radiate-lineate, dark-livid, margin incurved, entire; context membranous, livid, odorless, mild; lamellae adnate, plane, 3 mm. broad, distant, lilac, uneven, inserted; spores ellipsoid in outline, very angular, 1-guttulate, rosy, about 10×6μ; cystidia none; stipe enlarged downward, smooth, glabrous, lilac, often compressed, hollow, about 3×0.15–0.2 cm.

Type collected by W. A. Murrill on an open grassy lawn in Gainesville, Fla., Aug. 11, 1944, (*F 21555*). A typical representative of the genus with attractive form and coloring.

Leptoniella melleipes sp. nov.

Pileo convexo-subexpanso, papillato, 1.5 cm. lato, striato, atroavellaneo, farinaceo; lamellis adnatis, distantibus, melleis; sporis angulatis, 10×7μ; stipite aequali, glabro, submelleo, 3×0.15 cm.

Pileus convex to subexpanded with minute umbo, 1.5 cm. broad; surface dry, dull-avellaneous, striate to the disk, fibrillose, margin subentire; context membranous, pale-melleous, odorless, taste farinaceous; lamellae emarginate-adnate, inserted, distant, 2 mm. broad, ventricose, pale-melleous, entire; spores broadly ellipsoid in outline, angular, 1-guttulate, rosy, about 10×7μ; cystidia none; stipe equal, smooth, glabrous, pale-melleous, apex scurfy, 3×0.15 cm.

Type collected by W. A. Murrill under a laurel oak in Gainesville, Fla., Sept. 22, 1944, (*F 31500*). A small, rare species with striate cap and honey-yellow gills and stipe.

Leptoniella subnigra sp. nov.

Pileo convexo, umbonato, gregario, 2–2.5 cm. lato, fuligineo vel nigro, grato; lamellis adnexis, latis, albis; sporis angulatis, 11×7μ; stipite aequali, glabro, subfuligineo, 3–5×0.2–0.3 cm.

Pileus convex, rarely fully expanding, umbonate to umbilicate, gregari-

ous, 2–2.5 cm. broad; surface dry, fuliginous or black, slightly scaly to glabrous, becoming radiate-rimose at times, margin incurved, entire to ragged, context membranous, pallid, odorless, mild; lamellae adnexed, plane, broad, white; spores distinctly angular, 1-guttulate, pink, about 11×7μ; cystidia none; stipe equal, flat, hollow, smooth, glabrous, subfuliginous, about 3–5×0.2–0.3 cm.

Type collected by W. A. Murrill on an open grassy lawn at Gainesville, Fla., July 24, 1944 (*F 18251*). Frequent on lawns in the vicinity after rains from July to October. Related to *L. nigra* Murr., described from Calif., and L. *Davisiana* (Pk.) Murr., described from Mass.

Nolanea murinipes sp. nov.

Pileo convexo, 3 cm. lato, glabro, striato, griseo, disco atro; lamellis adnexis, angustatis, pallidis; sporis angulatis, 8×5–6μ; stipite glabro, murino, 4×0.2–0.3 cm.

Pileus broadly convex, not fully expanding, about 3 cm. broad; surface striate, glabrous, griseous, the disk ater, margin straight, very thin, entire to ragged; context very thin, white, unchanging, odorless; lamellae adnexed, inserted, narrow, rather close, uneven, pallid to pink; spores very angular, 1-guttulate, about 8×5–6μ; cystidia none; stipe tapering downward, compressed, smooth, glabrous, murinous, about 4×0.2–0.3 cm.

Type collected by W.A. Murrill in leaf-mold in a high hammock near Gainesville, Fla., July 16, 1944 (*F 38950*). Somewhat suggestive of *N. staurospora* Bres. in form and color.

Nolanea myceniformis sp. nov.

Pileo campanulato, 1.3 cm. lato, glabro, subavellaneo, disco atro-avellaneo; lamellis sinuatis, latis, integris; sporis angulatis, 9–11×5–6μ; stipite glabro, submelleo, 4×0.1–0.2 cm.

Pileus conic to campanulate, 1.3 cm. broad; surface dry, pale-avellaneous, smooth, glabrous, shining, umbo darker, margin even, entire to splitting; context membranous, white, unchanging, odorless; lamellae sinuate, broad, medium close, entire, soon pink; spores angular, very irregular, narrow, 1-guttulate, about 9–11×5–6μ; cystidia none; stipe enlarged downward, smooth, glabrous, pale-melleous, 4×0.1–0.2 cm.

Type collected by W. A. Murrill in leaf-mold in a low hammock near Gainesville, Fla., Feb. 23, 1945 (*F 38953*). Suggesting a mycena in shape and color and having spores resembling those of *N. venosa* Bres.

Pluteus pumilus sp. nov.

Pileo convexo, umbonato, 1.2 cm. lato, subsquamuloso, radiato-rimoso, castaneo, margine pallidiore; lamellis latis, albis; sporis subglobosis, levibus, 5μ longis; stipite subglabro, albo, 1.5×0.1–0.15 cm.

Pileus convex, not fully expanding, with mammillate umbo, 1.2 cm. broad; surface dry, minutely squamulose, radiate-rimose, disk castaneous, paler toward the entire margin; context thin, white, odorless; lamellae free, inserted, broad, ventricose, rounded behind, rather close, white, slightly fimbriate; spores subglobose, smooth, 1-guttulate, about 5μ long; stipe slightly tapering upward, smooth, subglabrous, white, 1.5×0.1–0.15 cm.

Type collected by W. A. Murrill on a rotten magnolia log in a high hammock at Gainesville, Fla., Sept. 16, 1944 (*F 21843*). Small and dainty, and evidently rare.

VOLVARIOPSIS VILLOSOVOLVA (Lloyd) Murrill

This species was collected by West and Murrill on the ground in a hammock ten miles northwest of Gainesville, July 19, 1938 (*F 17912*). The stipe was twice as long as in typical specimens, the volva elongate instead of rounded, and the spores ellipsoid (not globose), uninucleate, about 5× 3–4μ. The cap was plane instead of convex, 3 cm. broad, avellaneous with darker umbo, hispid, and rimose-striate; while the volva was pale-umbrinous, 1 cm. long and 5 mm. thick. However, I still believe it is the same as Lloyd's plant, because I saw the long, white, mycelial hairs on the volva.

Galerula locellina sp. nov.

Pileo conico, 4 cm. lato, isabellino, disco subfulvo, margine striato; lamellis adnatis, angustatis, confertis, pallidis; sporis ellipsoideis, levibus, 12×6μ; stipite clavato, albo, 7–9×0.5–1 cm.; volva alba, parva, evanida.

Pileus conic, gregarious, about 4 cm. broad; surface dry, isabelline, disk darker, margin closely striate, upturned at times; context thin, dull-isabelline, mild, odor slightly unpleasant; lamellae adnate, close, narrow, pallid, entire; spores ellipsoid, deep-ferruginous, smooth, about 12×6μ; stipe tapering upward from a clavate base, hollow, white, atomate and pubescent to mostly glabrous, 7–9×0.5–1 cm.; volva limb entire, small, white, sometimes persisting.

Type collected by W. A. Murrill on exposed sawdust from a stable in Gainesville, Fla., Feb. 19, 1945 (*F 22477*). Previously found by the author on a nearby manure pile. Kept in *Galerula* because of its close affinities. In young stages the volva is very distinct but it usually becomes indistinct or disappears with age.

Hebeloma crustuliniforme brevipes var. nov.

Pileo convexo; stipite 2–5×1–1.5 cm.

Pileus without umbo, isabelline with fulvous blotches; taste nutty, becoming somewhat astringent; spores subellipsoid, gibbous, 8.5–11×5–6μ; stipe short and thick, pallid, 2–5×1–1.5 cm.

Type collected by W. A. Murrill on the ground under a live-oak at

Gainesville, Fla., Jan. 12, 1938 (*F 15937*). Forming a fairy ring. Like typical H. *crustuliniforme* (Bull.) Quél. and having a similar odor but stipe much too short and pileus not at all umbonate.

NAUCORIA CURCUMA (B. & C.) Sacc.

Described in 1853 from South Carolina, on an old stump, and not reported since. Collected by the author on dead wood in Kelley's Hammock, ten miles northwest of Gainesville, July 19, 1938, with notes on fresh specimens, as follows.

Pileus convex, about 1.5 cm. broad; surface umbrinous-fulvous, with sharp conic worts, margin even, entire; lamellae plane, adnate, broad, medium distant, inserted, pale-isabelline with white, eroded edges; spores ovoid, smooth, opaque, pale-isabelline, about 8×5μ; cystidia none; stipe equal above the enlarged base, whitish and pruinose at the apex, shaggy and concolorous below, about 2×0.2–0.25 cm.

Agaricus subhortensis sp. nov.

Pileo convexo-subexpanso, gibboso, 5 cm. lato, rubro-brunneo, grato, margine pallido, glabro; lamellis liberis, latis, confertis; sporis subellipsoideis, 7–8×4–5μ; stipite aequali, albo, 3–4×1 cm.; velo amplo; annulo parvo, albo.

Pileus convex to subexpanded, gibbous, solitary, 5 cm. broad; surface dry, central area reddish-brown with radiating edges, margin pallid, glabrous, even, entire; context white, odorless; lamellae free, broad, close, ventricose, entire; spores subellipsoid, smooth, 1-guttulate, dark-purplish-brown, 7–8×4–5μ; cystidia none; stipe equal, smooth, white, 3–4×1 cm.; annulus a median white trace, although the veil is ample.

Type collected by W. A. Murrill on an open dry lawn near longleaf pines in Gainesville, Fla., Jan. 9, 1945 (*F 17971*). Also collected by the author nearby under longleaf pines, Apr. 26, 1943 (*F 9668*), and sent to A. H. Smith, who could not place it. In *A. campester umbrinus* Fr. the entire cap is covered with large fragments of the ruptured cuticle; while in *A. campester hortensis* Cke. both the habit and the habitat are entirely distinct. My species is very rare and grows in sterile sandy soil without visible manure or leaf-mold.

Agaricus Wilmotii sp. nov.

Pileo convexo-plano, caespitoso, 7–15 cm. lato, squamuloso, umbrino-avellaneo, grato; lamellis confertis, albis, liberis; sporis ovoideis, 5×4μ; stipite subaequali, albo, glabro, 10–15×1.5–2 cm.; annulo amplo, albido, dein parvo.

Pileus hemispheric with broad umbo to plane or slightly depressed, caespitose, 7–15 cm. broad; surface dry, uniformly covered except on the

disk with close, appressed, fibrillose, umbrinous-avellaneous scales, white beneath the scales, margin entire, even, with smaller avellaneous scales less appressed; context 1 cm. or less thick, white, firm, sweet and nutty with anise odor, unchanging until old; lamellae free, curved, 5 mm. wide, tapering at both ends, inserted, close, white, late in coloring, entire; spores ovoid, smooth, purplish-brown, about $5\times4\mu$; cystidia none; stipe mostly equal, solid to stuffed, smooth, glabrous, white and unchanging without and within, 10–15×1.5–2 cm.; veil smooth and white above, cracked and spongy below with avellaneous tint, ring fixed 2.5 cm. from apex, ample to shriveled.

Type collected by R. J. Wilmot and W. A. Murrill on leaf-mold in a high hammock at Gainesville, Fla., July 20, 1945. Suggesting *A. placomyces* and *A. subrufescens*.

Boletinellus proximus (Singer) Murr. comb. nov.

Gyrodon proximus Singer, Farlowia **2**: 244. 1945.
Boletinellus merulioides regularis Murr. ined.

Dr. Singer says this species is easily distinguished from *B. merulioides* by not bluing on injury. For many years I have treated the Florida plant as a variety and my description was in course of publication when Dr. Singer's name appeared. My varietal name is given above because it was used on so many specimens distributed by me. According to Snell, *Boletinellus* is preferable to *Gyrodon* as a generic name.

Ceriomyces albellus reticulatus var. nov.

Pileo 5 cm. lato, pallido, reticulato.

Pileus broadly convex, solitary, 5 cm. broad; surface pallid with a rosy-isabelline tint, beautifully reticulate; context white, taste mild; tubes large, dirty-rosy-isabelline; stipe pale-gray, rough, 9×0.7–1 cm.

Type collected by W. A. Murrill on the ground in high-pine-oak woods at Gainesville, Fla., June 9, 1939 (*F 19737*). Larger than our common local form of *C. albellus* (Pk.) and coarsely reticulate over the entire surface of the cap.

Tylopilus isabellescens sp. nov.

Pileo gregario vel caespitoso, 5–10 cm. lato, glabro, isabellino vel umbrino, amaro; poris parvis, isabellescentibus; sporis cylindricis, roseis, 9.5–10.5×2.5μ; stipite concolore, isabellescenti, 4–6×1–2 cm.

Pileus convex, gregarious to closely cespitose, 5–10 cm. broad; surface dry, smooth, glabrous, isabelline or umbrinous; context firm, bitter, pallid, becoming slightly dirty or purplish when cut; tubes small, white with a faint pinkish tint, becoming isabelline when bruised or with age; spores pink, cylindric, smooth, 9.5–10.5×2.5μ; stipe subequal, rather short and

thick, 4–6×1–2 cm., concolorous except where shaded, isabelline when bruised, not reticulate, pallid within, as many as five sometimes united into a common enlarged base.

Type collected by W. A. Murrill under loblolly pines at Gainesville, Fla., Aug. 13, 1937 (*F 15871*). Also commonly collected by W. A. Murrill under oaks and pines in and about Gainesville, Fla., during the summer season; under live-oak in Marion Co. Distributed widely by the author as *Tylopilus peralbidus* (Snell & Beards.) Murr., which was described from Altamonte Springs, Fla. I have been unable so far to see the type specimens, but the name *peralbidus* would indicate something quite different from my plant.

NEW COMBINATIONS

For those using Saccardo's nomenclature the following new combinations are made.

Boletinellus proximus = **Boletinus proximus**
Ceriomyces albellus reticulatus = **Boletus albellus reticulatus**
Galerula locellina = **Galera locellina**
Gymnopus atrigilvus = **Collybia atrigilva**
Gymnopus subabundans = **Collybia subabundans**
Gymnopus subconicus = **Collybia subconica**
Gymnopus subfunicularis = **Collybia subfunicularis**
Gymnopus subtortipes = **Collybia subtortipes**
Leptoniella australis = **Leptonia australis**
Leptoniella melleipes = **Leptonia melleipes**
Leptoniella subnigra = **Leptonia subnigra**
Melanoleuca piperatiformis = **Tricholoma piperatiforme**
Omphalina praerimosa = **Omphalia praerimosa**
Omphalopsis paucifolia = **Omphalia paucifolia**
Omphalopsis subreclinis = **Omphalia subreclinis**
Prunulus subepipterygius = **Mycena subepipterygia**
Tylopilus isabellescens = **Boletus isabellescens**
Venenarius roanokensis inodora = **Amanita roanokensis inodora**

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LLOYDIA

A Quarterly Journal of Biological Science

THEODOR JUST, *Editor*
JOHN H. HOSKINS, *Associate Editor*

Vol. 9, Nos. 1-4, 1946

LLOYD LIBRARY AND MUSEUM
Lloydia—Publication Office, 450 Ahnaip St., Menasha, Wis.
Editorial Office—309 W. Court St., Cincinnati, Ohio

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Dates of Publication

Volume 9, 1946

Number 1, March ..... June 17, 1946
Number 2, June ..... September 16, 1946
Number 3, September ..... November 17, 1946
Number 4, December ..... December 20, 1946

